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National Capital Region

Canadian Science Advisory Secretariat
Science Advisory Report 2025/005

REVISED ATLANTIC SEAL MANAGEMENT STRATEGY

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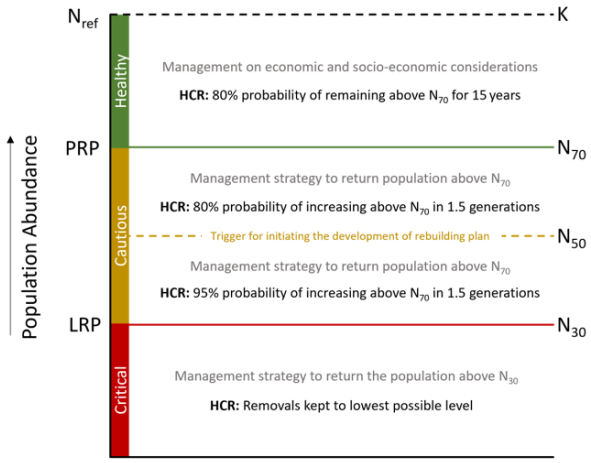

Figure 1. Revised Atlantic Seal Management Strategy (ASMS) for Data Rich populations. K, environmental carrying capacity (100% of the reference abundance level, N_{ref}). LRP, Limit Reference Point (30% of N_{ref}, N_{30}). PRP, Precautionary Reference Point (70% of N_{ref}, N_{70}). N_{50}, 50% of N_{ref}. HCR, Harvest Control Rule.

CONTEXT

The Atlantic Seal Management Strategy (ASMS) was the first Precautionary Approach (PA) developed for a fishery in Canada and was adopted prior to the implementation of the DFO PA Policy (DFO 2009). In light of the time since the initial development of the ASMS, Resource Management requested that Science review the existing ASMS framework to ensure consistency with DFO's PA Policy. Science was also asked to provide clarification on the recovery factor to be used when calculating the Potential Biological Removal (PBR).

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

- Since its adoption in 2003, the Atlantic Seal Management Strategy (ASMS) Precautionary Approach (PA) framework has been used to provide advice on sustainable harvest levels for Atlantic seals and other marine mammal stocks in Canada.

- To account for differences in the current state of knowledge and the level of uncertainty associated with estimates of stock status, two categories are distinguished within the ASMS, 'Data Rich' and 'Data Poor'.
- For a stock considered Data Rich, harvest advice is made using a population model that describes the dynamics of the stock.
- Under the ASMS Data Rich PA framework, five recommendations were made, including to use estimated environmental carrying capacity (K) instead of maximum population size observed or estimated (N_{max}) for the reference abundance level (N_{ref}) where K can be reliably estimated.
- Changes were also made to the timeframes used for the Harvest Control Rules (HCRs) in the Healthy (15 years) and Cautious Zones (1.5 generations) in keeping with the PA. Simulations will be required to evaluate whether or not these timeframes are appropriate for Atlantic seals under the established risk tolerance levels for preventable decline under the PA Policy.
- For a stock considered Data Poor, total removals are estimated using the Potential Biological Removal (PBR) approach which is a product of three parameters: a minimum estimate of abundance (N_{min}), one-half of the maximum intrinsic rate of population growth (R_{max}), and a recovery factor (F_R).
- Under the ASMS Data Poor PA framework, five recommendations were made for refining PBR calculation, including guidelines on estimating N_{min}, the value to be used for R_{max}, and the criteria for the selection of the F_R.
- Both the Data Rich and Data Poor PA frameworks described in the ASMS are consistent with the intent of the DFO PA Policy. The ASMS was revised to fill gaps and clarify details from the previous approach.
- The revised ASMS PA framework can be generalized to extend to other marine mammal stocks in Canada. Variations in the timeframes for the HCRs could be evaluated using simulations for marine mammals with different life histories.

INTRODUCTION

The Atlantic Seal Management Strategy (ASMS) was the first Precautionary Approach (PA) developed for a fishery in Canada and was adopted prior to the implementation of the DFO PA Policy (hereafter referred to as the PA Policy, DFO 2009). Since its adoption in 2003, the ASMS PA framework has been used to provide advice on sustainable harvest levels for harp seals (*Pagophilus groenlandicus*), grey seals (*Halichoerus grypus*), hooded seals (*Cystophora cristata*), and other marine mammal stocks in Canada. Components of the ASMS have been reviewed and refined since its initial implementation, however, these reviews were limited in scope. Here, we review the ASMS PA framework to ensure consistency with the PA Policy and make recommendations for adjustments to the current strategy and suggestions for future work.

ANALYSIS

Under the PA Policy the primary components of the generalized framework are:

1. reference points and stock status zones,
2. harvest strategy and harvest control rules (HCR) for each stock status zone, and

3. the need to take into account uncertainty and risk when developing reference points, and when developing and implementing decision rules.

Three stock status zones (Critical, Cautious, and Healthy) are defined by the Limit Reference Point (LRP) and Precautionary Reference Point (PRP; Figure 1) which is referred to as the Upper Stock Reference (USR) point in the PA policy. The LRP represents the stock status below which the stock is in the Critical Zone and there is a risk of serious harm to the stock. Below the PRP, removals must be progressively reduced to avoid reaching the LRP. At a minimum, the PRP must be set above the LRP at a level that provides sufficient opportunity for the management system to recognize a declining stock status, and sufficient time for management actions to have an effect to avoid serious harm to the stock.

The ASMS Framework

For marine mammals, an estimate of total abundance is the metric used to indicate stock status. The amount of available information on abundance, trends, removals, and vital rates can vary substantially between stocks. To account for differences in the state of knowledge, two categories are distinguished within the ASMS, 'Data Rich' and 'Data Poor', each with its own PA framework.

If there are enough data to understand the dynamics of a stock and how removals or changes in the ecosystem may impact it, a stock is considered Data Rich. For the Atlantic seal species, a stock is considered Data Rich if it has three or more abundance estimates within a 15 year period, with the last estimate being ≤ 5 years old, and sufficient information on age composition, fecundity, and/or mortality to be able to assess stock status. If information on the abundance or dynamics of the stock is limited, the stock is considered Data Poor.

ASMS – Data Rich

Reference Levels

Multiple definitions have been used to set reference points for PA frameworks in Canada and other jurisdictions. Under the PA Policy, the requirement is that the reference points be appropriate for the stock and consistent with the intent of the PA Policy.

In some PA frameworks, pristine (pre-exploitation) population biomass (B_0) or abundance (N_0) as an estimate of environmental carrying capacity (K) is the reference abundance level (N_{ref}) against which the other reference points (PRP, LRP) are established. An alternative approach is to use an estimate of K from the population model used to determine current abundance. When the ASMS was created, the largest population abundance observed or estimated (N_{max}) was used as a proxy for K as it was not possible to obtain model estimates of K with the assessment models in use at the time. However, with additional data and new modelling approaches it may be possible to obtain an estimate of K from the model used to assess stock status. Therefore, we recommend:

ASMS – Data Rich – Recommendation 1

- If a reliable model-based estimate of K is available, it should replace N_{max} as the reference abundance level in the ASMS.
- K should be estimated over the longest possible time period while accounting for variation in contemporary environmental conditions.

The ASMS LRP (N_{30}) and PRP (N_{70}) (Figure 1) have been reviewed several times since the adoption of the ASMS framework. They have been shown to be consistent with the PA Policy,

and sufficiently robust as to avoid a population decline below levels where serious harm may occur.

Harvest Strategies and Harvest Control Rules

The management objective for the ASMS is to maintain the stock above the PRP (N_{70}). If the stock is in the Healthy Zone (Figure 1), the harvest control rule (HCR) applied is to ensure an 80% probability that the stock remains above the PRP for at least 15 years (although longer time periods have been used in recent grey seal and harp seal assessments). Based on the current management plan timeframe for Atlantic seals (5 years), the timing of pup production surveys (5 years), and the timing of population assessments for both harp seals and grey seals, the impact of a 5 year management plan which focuses on the harvest of young of the year should be fully observed in 15 years. Therefore, we recommend that:

ASMS – Data Rich – Recommendation 2

- If the stock is in the Healthy Zone, the timeframe over which the results of proposed management actions are compared to the PRP be set at 15 years.

If a stock is in the Cautious Zone (Figure 1) pre-agreed HCR are applied with the objective of returning the stock above the PRP within a specified time period. In the ASMS, there is an operational control point (N_{50}) within the Cautious Zone that triggers a change in the management strategy to increase the required probability for returning the stock above the PRP. Above the $N_{50,}$ the current HCR is to set the harvest to a level which results in an 80% probability of the stock increasing above the PRP in 10 years. Below $N_{50,}$ this probability increases to 95%, however, the time period for this HCR was never defined.

To date, simulation testing to evaluate the timeframes required for a stock in the Cautious Zone to increase above the PRP based on the stock status and trend, and the need to balance harvest rates against the risk of substantial depletion, have not been conducted. However, under the PA Policy a suggested reasonable timeframe for rebuilding is 1.5 to 2.0 generations, where generation length is based on the International Union for Conservation of Nature (IUCN) criteria for an exploited population. Using the suggested values under the PA Policy as a guideline we recommend:

ASMS – Data Rich – Recommendation 3

- The timeframe for each of the HCRs in the Cautious Zone be set at 1.5 generations until simulations can estimate timeframes for recovery above the PRP based on stock status and trend, and the established risk tolerance levels for preventable decline in the Cautious Zone under the PA Policy.
- Here generation length is defined based on the IUCN criteria for an exploited stock. In keeping with the PA Policy, the calculation used to estimate generation length must be clearly outlined.

Under the PA Policy, the obligation to implement a rebuilding plan is triggered when a stock declines to, or below, its LRP. For a stock which is decreasing and approaching the LRP, the requirement is to

1. implement management measures to encourage stock growth and arrest preventable declines and,
2. initiate the development of a rebuilding plan sufficiently in advance to ensure that the plan is ready to be implemented if the stock declines to its LRP.

Given the time required to develop a rebuilding plan, the length of time between abundance estimates (typically 5 years) and the life history of pinnipeds that limits their rate of growth, we recommend that:

ASMS – Data Rich – Recommendation 4

- A stock decline to or below N_{50} (with an 80% probability) be used as the trigger to initiate the development of a rebuilding plan.

Although simulations have been undertaken to evaluate components of the ASMS Data Rich framework since its development, these simulations were limited in scope and were conducted using the previous deterministic population model for harp seals. Given the recent development of integrated population models for both grey seals and harp seals, a closed-loop simulation approach that considers uncertainties in population dynamics, monitoring data, and environmental conditions could be to set up to evaluate reference points and the effectiveness of different HCRs for achieving management objectives under the PA framework. Therefore, we recommend that:

ASMS – Data Rich – Recommendation 5

- New simulations based on the current integrated population models for assessment of harp and grey seals be undertaken to evaluate strategies for achieving objectives under the PA framework.

Recommendations 1-4 for the Data Rich PA framework are illustrated in Figure 1.

ASMS – Data Poor

Under the ASMS, total allowable removals for stocks categorized as Data Poor are estimated using the Potential Biological Removal (PBR) approach. PBR is a precautionary approach which was developed by the United States (US) under the Marine Mammal Protection Act (MMPA). Under the MMPA, PBR represents the limit for human-caused mortality to a stock.

The PBR is a product of three parameters:

1. a minimum estimate of abundance (N_{min}) which provides reasonable assurance that the stock size is equal to or greater than the estimate, usually calculated as the 20th percentile of the lognormal distribution around the abundance estimate,
2. one-half of the maximum intrinsic rate of population growth (R_{max}) and,
3. a recovery factor (F_R) between 0.1 and 1.0.

$$PBR = N_{min} \cdot 0.5R_{max} \cdot F_R$$

PBR represents a removal control rule in that it accounts for total human removals from all sources, therefore, all known harvest, rates of struck and loss, and estimates of bycatch (if available) must be taken into consideration when applying PBR to determine sustainable harvest levels.

In 2016, the US implemented the MMPA Imports Provisions Rule. Under this legislation, a PBR value may be required for any marine mammal stock in Canada that is subject to incidental mortality or serious injury that is likely to result in death in a fishery which exports fish or fish product to the US. As such, the recommendations made below regarding R_{max} and the choice of the value for F_R are also applicable to the calculation of PBR for stocks categorized under the ASMS as Data Rich.

Estimated Abundance

The strength of the PBR approach is that it only requires a single abundance estimate to calculate an acceptable level of removals. However, under the ASMS Data Poor category there is a continuum from stocks with only a single recent abundance estimate, to those which have multiple abundance estimates but insufficient data to develop a population model, to those with multiple abundance estimates and sufficient information to provide a model estimate of current abundance.

When the ASMS was adopted, no standard was set for how abundance estimates should be used for calculating PBR in situations where multiple estimates may be available. Nor was a time limit placed on how long an abundance estimate would be considered valid for use in the calculation of PBR. We recommend:

ASMS – Data Poor – Recommendation 1

- Where a stock is categorised as Data Poor but it is possible to construct a population model that can provide a current estimate of abundance that is robust to differing model assumptions, the N_{min} for PBR should be calculated using the model estimate of current abundance. How N_{min} is calculated must be clearly described.

ASMS – Data Poor – Recommendation 2

- Where there are multiple estimates of abundance available for a Data Poor stock but insufficient information to construct a population model, N_{min} should be estimated using the most recent abundance estimate. Alternatively, weighted averages could be used to calculate N_{min} for PBR if the abundance estimates were obtained within the last 10 years and the population is considered to be increasing or stable. The rationale for including multiple estimates and the method used to calculate a weighted average must be clearly described.

ASMS – Data Poor – Recommendation 3

- If the most recent abundance estimate is greater than 10 years old, it should not be used to calculate N_{min} for PBR. In this situation PBR is considered to be unknown.

Maximum Rate of Population Growth (R_{max})

The actual value for R_{max} for a given stock is likely to differ from the default values suggested for PBR (0.04 for cetaceans and 0.12 for pinnipeds). Simulations indicate that PBR is very sensitive to the value of R_{max} and, thus, a bias in R_{max} can impact the probability of meeting management objectives. Replacing the default values for R_{max} with values specific to the stock under consideration can improve the probability of meeting management objectives, although additional adjustments may be needed to account for bias (see Recommendation 5 below). Given the potential impact on the PBR we recommend that:

ASMS – Data Poor – Recommendation 4

- Where it is possible to obtain a reliable estimate, the value of R_{max} for the stock being assessed should be used to calculate PBR. Alternatively, an estimate of R_{max} calculated for other stocks of the same species living in a similar environment could be used. The source and rationale for an R_{max} value which is different from the default values must be clearly documented.

Recovery Factor (F_R)

The F_R is used to account for uncertainties associated with our understanding of the stock. An F_R of less than 1.0 allocates a proportion of expected net production towards stock growth and compensates for potential biases which may impact the PBR estimate. The F_R can be selected on a case-by-case basis; however, having criteria for the selection of the F_R provides consistency and reduces the potential for arbitrary decisions.

When the ASMS was developed, no guidance was provided for the choice of F_R. However, in an effort to ensure consistency in the application of F_R to PBR estimates for marine mammals in Canada, criteria which could be used to set the F_R based on the general status of the stock and an understanding of the stock trend were developed in 2018. These criteria have been used to estimate the PBR for several stocks in Canada, although recent efforts to apply the criteria highlighted the need for further refinement.

Combining the assessment of current stock status with current stock trend and adjustments for bias in R_{max} we recommend that:

ASMS – Data Poor – Recommendation 5

- The F_R used in the calculation of PBR should be set based on the guidelines summarized in Table 1. In cases where the F_R is adjusted to account for a bias not addressed in in Table 1, the justification for the change must be provided.

In keeping with the continuum of information which may be available for stocks in the Data Poor category we have considered current status at one of two levels:

1. Stocks of unknown status, whereby there is insufficient information to make an assessment of the relative level of the current abundance.
2. Stocks with sufficient information to make an assessment of current status relative to a reliable estimate of contemporary K, or a proxy for K such as N_{max} or N_0. For stocks in this category, we have outlined four status levels, set as a proportion of K (or its proxy) which mimic the levels used in the Data Rich framework of the ASMS: >0.7, between 0.5 and 0.7, between 0.3 and 0.5, and <0.3.

For stocks with unknown status or a stock status between 0.3 and 0.7 of K (or its proxy), we consider stock trends of either “increasing or stable” or “declining or unknown”, with increasing or stable assigned the highest (less precautionary) F_R value within each status level range. We consider stocks estimated to be greater than 0.7 of K in a healthy zone and adjustments to F_R based on population trend or values of R_{max} are not required. Populations with a stock status below 0.3 of K are considered to be in a critical zone and are assigned an F_R of 0.1 regardless of trend or values of R_{max}.

For populations assessed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or which meet the criteria for endangered under the COSEWIC guidelines, we have assigned an F_R of 0.1 regardless of trend or values of R_{max}. For populations which meet the criteria for critically endangered under the IUCN guidelines and are, therefore, considered to be facing a very high risk of extinction in the wild, we have assigned an F_R of 0. For stocks which are not currently assessed as endangered under COSEWIC or critically endangered under IUCN, the criteria used to classify a population into either of these two categories must be clearly outlined.

Sources of Uncertainty

The revised ASMS Data Rich PA framework does not address how to deal with long term changes in the state of the ecosystem. Additional evaluation is needed to determine the most appropriate timeframe to use when calculating reference levels in a changing environment, and how to establish HCRs that are robust to ecosystem change.

The default recovery target for PBR (0.5 of K) differs from the recovery target considered here (0.7 of K or a proxy). In addition, PBR's 100 year default recovery objective is longer than the 1.5 to 2.0 generations recommended for a harvested species under the PA Policy. Although we considered the impact of shorter recovery timelines and a higher target level when establishing our guidelines for the PBR recovery factor, further evaluation of the impacts of different recovery targets and timeframes could help refine our approach to the selection of recovery factors in Canada.

CONCLUSIONS AND ADVICE

The ASMS PA framework was reviewed and revised to address gaps and clarify approaches. Both the Data Rich and Data Poor PA frameworks used in the ASMS are consistent with the intent of the DFO PA Policy.

For the ASMS Data Rich PA framework there is a need to undertake simulations with recently developed integrated population models for grey and harp seals to further evaluate the recommended HCRs for the Cautious Zone based on stock status and trend and the established risk tolerance levels for preventable decline under the PA Policy.

The revised ASMS framework can be generalized to extend to other marine mammal stocks in Canada. Variations in the timeframes for the HCRs could be evaluated using simulations for marine mammals which have different life histories and harvest compositions.

Table 1. Guidelines for the selection of the Potential Biological Removal (PBR) recovery factor (F_R) in Canada. K, environmental carrying capacity. Proxies for K may include estimates of N_{max} (largest stock abundance observed or estimated) or N_0 (pristine abundance or unharvested abundance). R_{max}, maximum rate of population increase. The value used for K (or its proxy) should be a reliable estimate under contemporary ecosystem conditions.

Status (proportion of K or proxy)	Stock Trend	R_{max}[a]	F_R
>0.7	-	-	1
≥0.5, <0.7	increasing or stable	-	0.75
	declining or unknown	> default	0.75
	declining or unknown	< default or unknown[b]	0.50
≥0.3, <0.5	increasing or stable	-	0.50
	declining or unknown	> default	0.50
	declining or unknown	< default or unknown[b]	0.25
<0.3 Or Meets COSEWIC criteria for Endangered	-	-	0.10
Meets IUCN criteria for Critically Endangered[c]	-	-	0
Unknown	increasing or stable	-	0.50
	declining or unknown	> default	0.50
	declining or unknown	< default or unknown[b]	0.25

[a] default values: cetaceans 0.04, pinnipeds 0.12
[b] default value used
[c] the value for N_{min} and R_{max} must be provided when calculating PBR

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ISSN 1919-5087
ISBN 978-0-660-75764-3 Cat. No. Fs70-6/2025-005E-PDF

Correct Citation for this Publication:

DFO. 2025. Revised Atlantic Seal Management Strategy. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2025/005.

Aussi disponible en français :

MPO. 2025. Stratégie révisée de gestion des phoques de l'Atlantique. Secr. can. des avis sci. du MPO. Avis sci. 2025/005.