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Arctic Region and Ontario and Prairie Region

Canadian Science Advisory Secretariat
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2020 HARVEST ADVICE FOR NORTHERN HUDSON BAY NARWHAL

*Narwhal (*Monodon monoceros*)*

Figure 1. Map indicating the three regions in Nunavut, and the summering area for the Northern Hudson Bay narwhal population (dark blue).

Context:

*Inuit subsistence harvests of the Northern Hudson Bay (NHB) narwhal (*Monodon monoceros*) population occur mainly in the Kivalliq Region of Nunavut, with smaller subsistence harvests in four Qikiqtaaluk Region communities (Sanirajak, Igloolik, Kinngait and Kimmirut), and in Inuit communities (primarily Salluit) along Hudson Strait within the Nunavik Marine Region (Nunavik, Northern Quebec) (Figure 1). The Nunavut Agreement (NA) and the Nunavik Inuit Land Claims Agreement (NILCA) may limit Inuit harvesting to effect a valid conservation purpose. In their respective jurisdictions, a decision from the Nunavut Wildlife Management Board (NWMB) and the Nunavut Marine Region Wildlife Board (NMRWB) is required to modify the currently established levels of landed catch (i.e., Total Allowable Harvest (TAH) or Total Allowable Take (TAT)) from the NHB narwhal population. Narwhal are listed on Appendix II of the Convention on International Trade in Endangered Species (CITES). To export narwhal products internationally, CITES requires updated science and a documented management approach that ensures sustainable narwhal management; a non-detriment finding (NDF) from a DFO Scientific Authority is also required.*

DFO aerial surveys conducted in 2011 (DFO 2012) produced an overall harvest recommendation of 157 narwhal from the NHB population. In 2013 the NWMB established a Total Allowable Harvest (TAH) of 147 NHB narwhal in the Nunavut Settlement Area (NSA), and the NMRWB established a Total Allowable Take (TAT) of 10 NHB narwhal in the Nunavik Marine Region (NMR). Community harvests of NHB narwhal are allocated in the NSA by the Regional Wildlife Organizations (RWO), and in the NMR by the Regional Nunavimmi Umajulivijiit Katujiqatigininga (RNUK).

With the addition of a new abundance estimate in 2018, Fisheries Management requested DFO Science to 1) determine whether a model-based approach is suitable for providing sustainable harvest advice for the NHB narwhal population, and if so, should the model-based approach take priority over a Potential Biological Removal (PBR) threshold determined from the 2018 aerial survey estimate for NHB narwhal, and 2) provide information on the probability that the stock will decline in 10 years under a range of harvest scenarios (from 0–100% probability of decline).

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SUMMARY

- To estimate current abundance and determine trends in population dynamics of Northern Hudson Bay (NHB) narwhal, a population model was fit to four survey estimates from 1982–2018 and a series of reported annual harvests from 1951–2018.
- Earlier surveys in the series (1982 and 2000) were conducted and analysed using different protocols than the more recent surveys in 2011 and 2018. The estimates from these earlier surveys were adjusted to account for different analyses and survey methods to make them comparable.
- The model was robust to input parameters, and estimated a 2019 abundance of 14,400 (95% CI 10,300–20,400 [rounded to the nearest hundred]) narwhal.
- Based on the model trajectories, a total landed catch of 0, 63, 83, 93, 108, 173, and 450 narwhal per year would result in a 0%, 20%, 40%, 50%, 60%, 80%, and 100% probability of decline, respectively, in this NHB narwhal population in ten years.
- Potential Biological Removal (PBR) from the modelled 2019 abundance estimate was calculated to be 188, resulting in a landed catch of 151 to account for whales killed but not landed.

INTRODUCTION

Narwhal (*Monodon monoceros*) from Northern Hudson Bay (NHB) form a genetically and geographically distinct narwhal population. Visual systematic aerial surveys of NHB narwhal have been conducted in 1982, 2000, and 2011. In 2018, a visual aerial survey produced a population estimate of 19,200 (95% Confidence Interval [CI] 11,300–32,900) (rounded to the nearest hundred) narwhal. With the addition of the 2018 abundance estimate (DFO 2020) and updated harvest statistics, a population model with aerial survey (1982–2018) and reported harvest data (1951–2018) was assessed. Here we present the results from this population model.

ASSESSMENT

Surveys in 1982 and 2000 were conducted and analysed using different methods than in 2011 and 2018 and resulted in abundance estimates that were negatively biased. Neither of the surveys in 1982 or 2000 incorporated perception bias, which occurs when observers may miss whales close to the track line even if they are available. The 1982 survey was analysed assuming all narwhal within a set strip width were observed and counted, despite the fact that narwhal detectability declines with distance, and the 2000 survey assumed animals could be seen directly under the plane, which later surveys showed not to be the case for the type of

aircraft used during these surveys. To make them comparable with the surveys from 2011 and 2018, which did account for these factors, the estimates from the 1982 and 2000 surveys were multiplied by factors of 2.56 and 2.29, respectively. These factors were estimated from a previous analysis that compared the early surveys to the 2011 survey. A correction for availability bias (when whales are missed because they are too deep below the surface of the water), was also applied to all four surveys.

The population model fit to the aerial surveys and reported annual harvests estimated a current (2019) population of 14,400 (95% CI 10,300–20,400 [rounded to the nearest hundred]) (Figure 2). This estimate of abundance was consistent among a range of alternative model runs using different input parameters. Under recent landed catches, the accepted model estimated the population has been stable or increasing slowly.

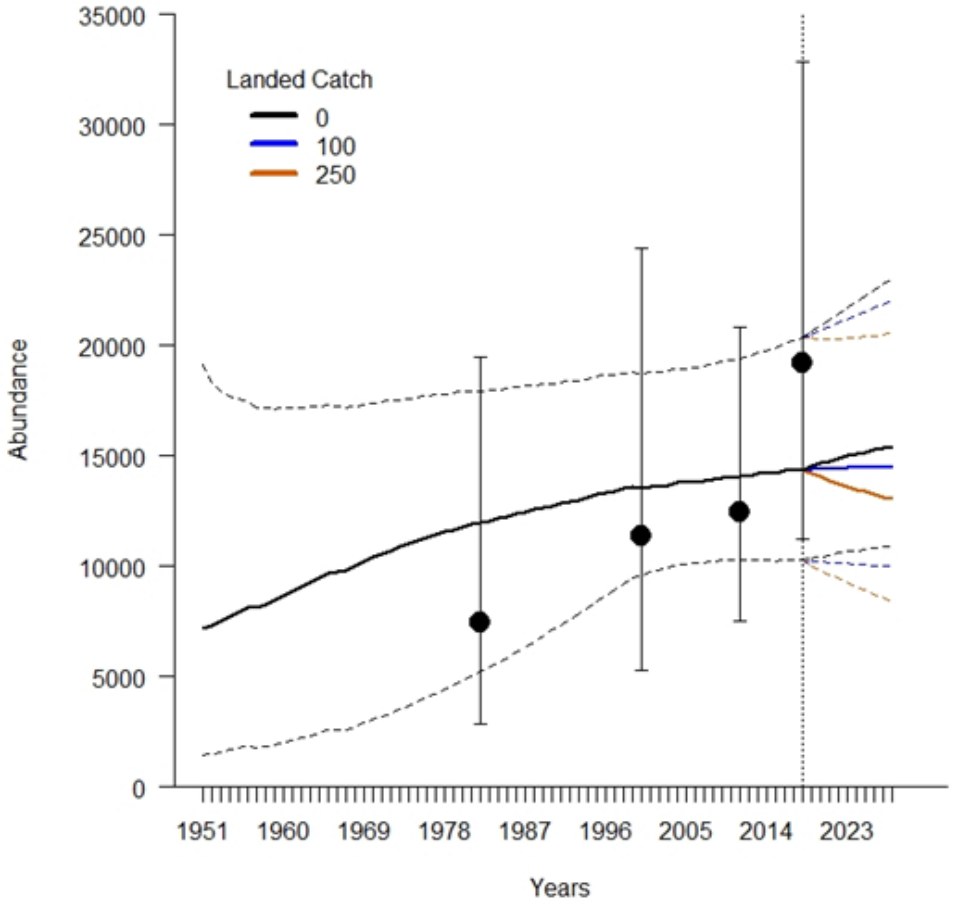

Figure 2. Estimated NHB narwhal population trajectory after fitting the population model to abundance estimates from aerial surveys flown between 1982–2018. The solid line indicates the median estimate and dotted lines represent the 95% Credibility Intervals. Coloured lines beyond 2019 are projected trajectories at annual landed catches of 0, 100, and 250.

The model predicted probabilities of decline associated with a given annual landed catch for the NHB narwhal population in ten years (Figure 3, Table 1), assuming animals are taken in proportion to the population sex and age structure. The average annual reported catch over the past ten years was 84 and was estimated to result in a 41% probability of decline in the NHB narwhal population in ten years.

Table 1. Percent probability (P) of population decline in 10 yrs under different annual landed catches.

P (%)	Landed Catch
0	0
10	54
20	63
30	73
40	83
50	93
60	108
70	135
80	173
90	243
100	450

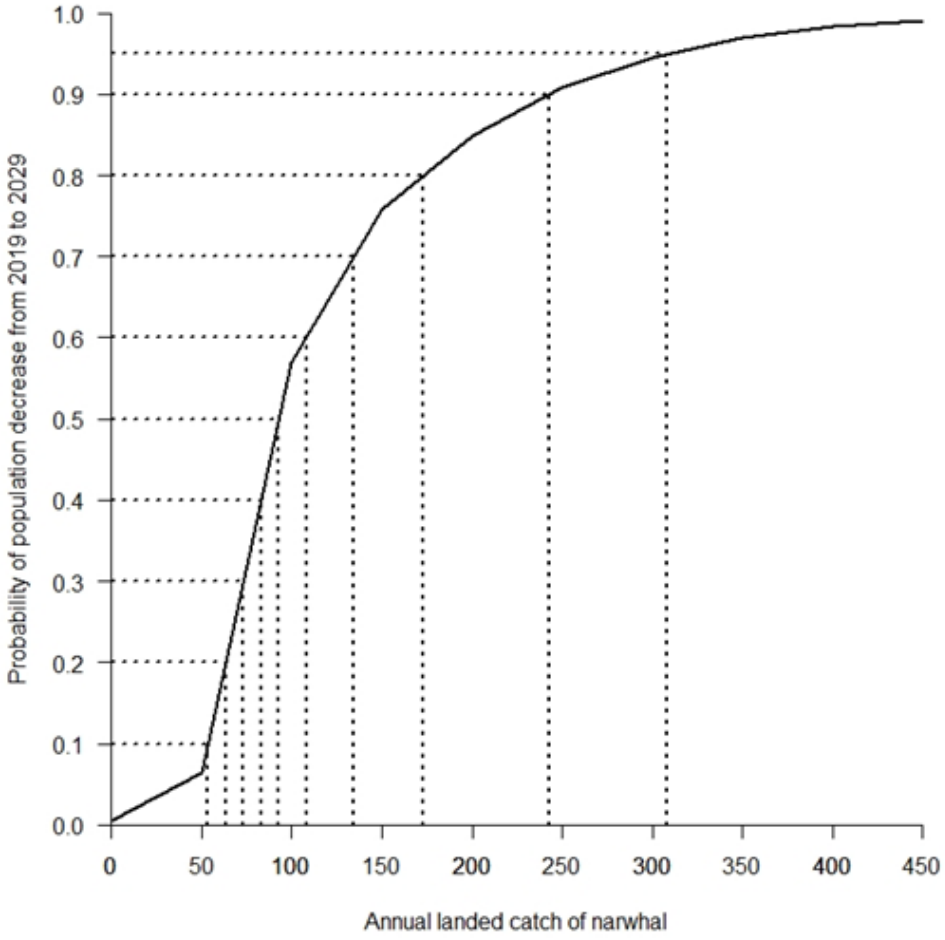

Figure 3. Probability of a NHB narwhal population decline over the next ten years as a function of annual landed catch. Dotted lines indicate landed catch (x-axis) and their corresponding probability of decline (y-axis).

Potential Biological Removal (PBR)

We are confident that the model provides a more robust estimate of the current population size than a point estimate from a single survey; therefore, we calculated PBR based on the modelled 2019 estimate of abundance rather than using the 2018 aerial survey estimate.

Based on the 2019 model estimate of N_{Min} (12,505), using a recovery factor of 0.75 following guidelines for an abundant population with uncertainty in the population trajectory, and the default maximum growth rate (4% per year), PBR was estimated to be 188 narwhal. The corresponding landed catch was 151 narwhal, using the model estimate for struck and lost, and non-reporting rate of 24.5%.

PBR and the model-based probabilities of decline represent two different approaches. PBR has the implicit aim to keep the population at or above its net maximum productivity level, which can result in declines if populations are already above that level, whereas the model estimates the probability of population decline from current abundance.

Sources of Uncertainty

The factors used to adjust the 1982 and 2000 surveys are estimates that may under- or over-estimate actual abundance, and therefore impart uncertainty in modelled population trajectories.

Surveys in 2011 and 2018 covered a larger area than those in 1982 and 2000. The presence of narwhals in the additional areas in 2011 and 2018 suggests there may be an unaccounted-for negative bias in the earlier surveys, although this is unknown due to possible changes in NHB narwhal distribution and/or range expansion over the 40 year time span.

Maximum growth rate, initial population size, and carrying capacity of the NHB narwhal population are unknown and we allowed the model to estimate these parameters. Additional vital rate information, independent from the surveys and models, would result in greater accuracy in the model output.

The model assumes animals are taken in proportion to the population's sex and age structure, but more information on the harvested animals is needed to test this assertion. For example, the demographic impacts of a male-biased hunt are unknown.

Detailed information on hunt struck and loss rates and therefore more precise levels of catch mortality, and information on killer whale predation rates are also needed to improve estimates of sustainable catch for this population.

This narwhal population has one of the most southern distributions for this species and there have been significant changes in environmental conditions in this area. The impacts of these changes on the future abundance of the NHB narwhal population are unknown.

CONCLUSIONS AND ADVICE

The addition of the 2018 abundance and long-term harvest information makes it possible to provide advice on landed catch using a population model. The population model estimated a stock abundance of 14,400 (95% CI 10,300–20,400) narwhal in 2019. The model predicted that a landed catch of 0, 63, 83, 93, 108, 173, and 450 narwhal per year would result in a 0%, 20%, 40%, 50%, 60%, 80%, and 100% probability of decline, respectively, in the NHB narwhal population in ten years. As a result of variable survey coverage among surveys, and uncertainty in the factors used to adjust the 1982 and 2000 surveys, confidence in the modelled population trajectory is reduced. A PBR of 188, corresponding landed catch of 151, was estimated from the modelled abundance for 2019. PBR may result in a population decline for a population at or

above its net maximum productivity level. A longer time series of survey estimates and independent estimation of demographic parameters would help to reduce uncertainty associated with the estimated population abundance and trend.

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SOURCES OF INFORMATION

This Science Advisory Report is from the November 16–20, 2020 National Peer Review on Northern Hudson Bay Narwhal - Sustainable Harvest Advice. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

DFO. 2012. Abundance and total allowable landed catch for the Northern Hudson Bay narwhal populations. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/028.

DFO. 2020. Abundance Estimate of the Northern Hudson Bay Narwhal Population from the 2018 Aerial Survey. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/055.

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