Southern Hudson Bay Polar Baer Harvest Risk Analysis

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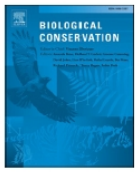

Incorporating climate change in a harvest risk assessment for polar bears *Ursus maritimus* in Southern Hudson Bay

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Overview

- This analysis provides decision-makers with scientific information on how different levels of human-caused removals can affect SH polar bears
- Recognizes that there is uncertainty in scientific information and our ability to know what will happen in the future
- Not prescriptive—does not try to say what managers "should" do
- A tool to inform decision-makers, along with other tools and types of knowledge

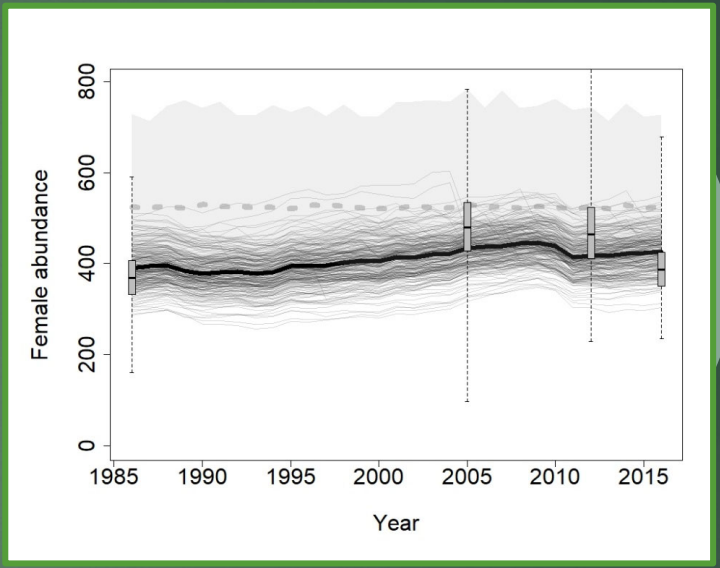

Figure 1. Population reconstruction (for female polar bears in Southern Hudson Bay based on modelling).

Modelling Approach

- Based specifically on the biology of Southern Hudson Bay Polar Bears
- Considered all existing population data – abundance, survival and reproductive rates, harvest data*
  - Hunter-provided harvest data are critical to this work and to all population studies of polar bears
- Population processes modelled for females only
- Evaluated the population-level effects of multiple potential harvest strategies
  - For example, the analysis can tell us if—based on the available scientific information—a harvest level of 50 bears/year would likely cause the population to increase, remain stable, or decrease

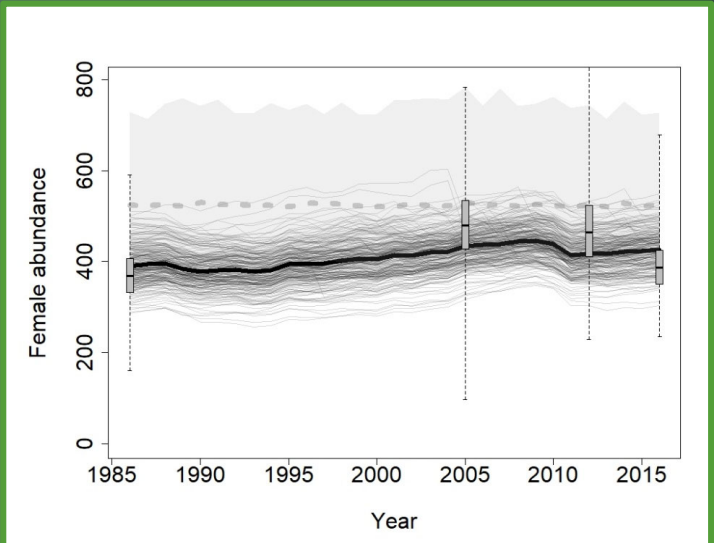

Figure 1. Population reconstruction (for female polar bears in Southern Hudson Bay based on modelling).

*The original analysis included data through 2016—will discuss how the 2021 aerial survey results affect conclusions of the risk assessment

Modelling Approach

- The model considered:
  - Density dependence – The fact that harvest can relieve crowding and competition, leading to increased reproduction and allowing for sustainable removals
  - Carrying Capacity (K) – Number of polar bears the environment can support, which can change in the future due to sea-ice loss
  - Population Growth Rate (r) – Rate at which population can increase, which can change in the future due to sea-ice loss

Future Biological Scenarios

- Uncertainty in the current and future status was accounted for by developing three biological scenarios representing a range of conditions, from optimistic to pessimistic, based on the available science and informed, to some extent, by documented Indigenous Knowledge
- From a scientific perspective, one of the scenarios is considered most plausible. However, other perspectives (e.g., IK) might support a different scenario, or something in-between

Future Biological Scenarios

SCENARIO	DESCRIPTION
Scenario 1	**Optimistic hypothesis** that the future will be similar to the past 30 years, with only gradual declines in *carrying capacity* (number of bears SH area can support) proportional to projected declines in the number of ice-covered days per year.
Scenario 2	**Middle-of-the-road hypothesis** that the future will be similar to the past decade, during which there is some evidence of changes in population characteristics (e.g. reproduction, survival, body condition, etc.), and that both *carrying capacity* and *population growth rate (how fast a population adds individuals)* will decline gradually in the future.
Scenario 3	**Pessimistic** hypothesis that the subpopulation experiences either:
Scenario 3a	A rapid decline in abundance (declining population growth rate) which is directly linked to the declining quality of sea ice (i.e. Polar bears will not be able to maintain growth rates in the current environment with poor ice quality).
Scenario 3b	*A rapid decline because the environment (sea ice) will not be able to support polar bears at the same level as in the past (carrying capacity will decline) even though the population maintains its growth rate.*

TWG recommendation

Future Biological Scenarios

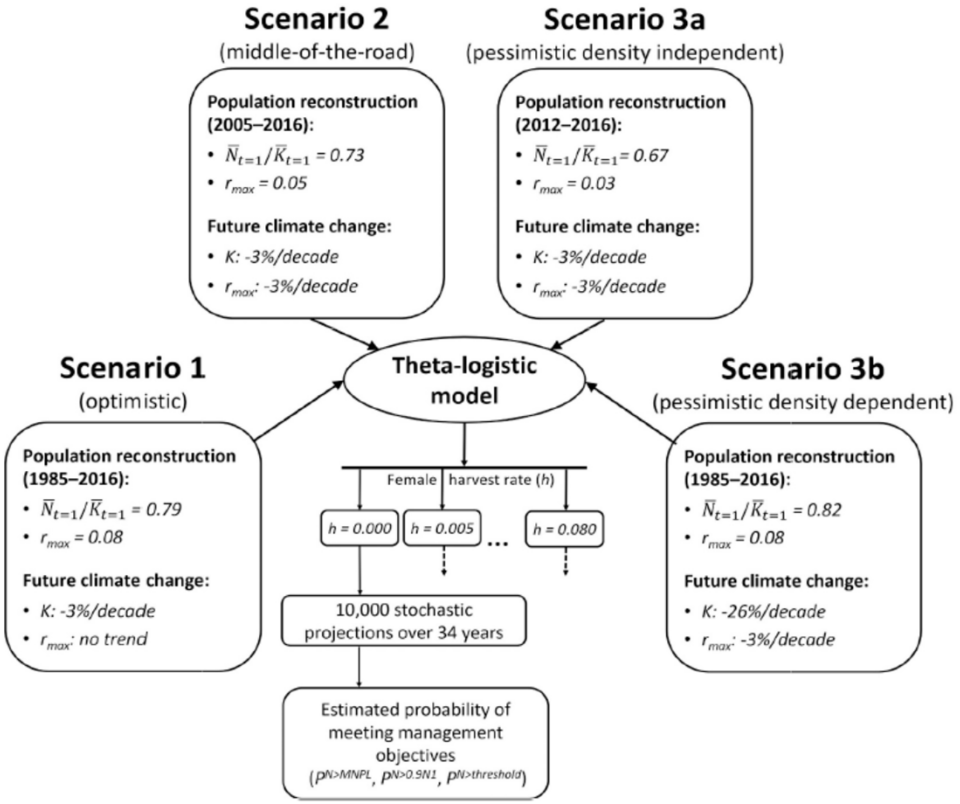

Fig. 2. Structure of the harvest risk assessment for the Southern Hudson Bay (SH) polar bear subpopulation. Scenarios represented different assumptions, from optimistic to pessimistic, about subpopulation status and the effects of climate change. Population reconstruction with demographic and harvest data for the specified period (e.g., 1985–2016) provided estimates of maximum intrinsic growth rate (r_{max}) and mean relative density at the start of forward projections ($\overline{N}_{t=1}/\overline{K}_{t=1}$, where N is abundance and K is carrying capacity). Using these estimates, subpopulations were projected forward 34 years subject to changing K and r_{max}, and female harvest at rate h. Stochastic results are presented as demographic outcomes (e.g., mean N at the end of projections; Table 1) and probabilities of meeting the three management objectives defined in the main text ($P^{N>MNPL}$, $P^{N>0.9N1}$, $P^{N>thresh}$).

Management Objectives

- The harvest risk model evaluates the probability of achieving three potential management objectives under different harvest strategies. Decision-makers in previous case studies have focused on Management Objective 1, because it recognizes that habitat is changing and seeks to balance opportunities for use with population protection
  - **Management Objective 1**: maintain a subpopulation size that achieves maximum sustainable yield—this is the most practical and useful objective
  - **Management Objective 2:** maintain current abundance
  - **Management Objective 3:** maintain a subpopulation size above a minimum threshold, below which there is a high risk of depletion

Risk Tolerance

- The harvest risk model also considered different levels of risk tolerance, recognizing that decision-makers have multiple considerations and may want to maximize harvest (which can be risky to the population), maximize protection (which can unnecessarily limit subsistence use), or something in the middle
  - "**Low**" risk = 90% chance of success (10% failure)
  - "**Medium**" = 70% chance of success (30% failure)
- The same levels of risk tolerance should not be applied to all three alternative management objectives because the consequence of failing to meet each objective is different
  - Failing to meet Management Objective 3 would mean that the population is greatly reduced in size and cannot support much harvest going forward

State-Dependent Harvest Management

- The harvest strategies in the report assume that harvest levels do not remain constant into the future but rather will be updated periodically using new data from scientific studies or other sources on the current status of the subpopulation
- The analysis assumes that new aerial surveys will be completed every 5 years, and that the updated abundance estimate will be used to calculate a new sustainable harvest level
- If we are not able to carry out this level of monitoring, a more conservative approach to harvest (i.e., a lower allowable harvest) will be necessary to avoid increased harvest risk

Original Results – Scenario 2 (Middle)

Harvest level (female bears/year)	Female Harvest rate	Total Harvest rate (2:1 males to females)	Mean Female abundance after 3 generations	Mean Carrying Capacity	Mean female harvest level	Percent chance of local extinction (%)	*Percent chance of meeting Obj. 1 (%)*	*Percent chance Of meeting Obj. 2 (%)*	*Percent chance Of Meeting Obj. 3 (%)*
0	0.000	0.000	466	474	0	0	100	100	100
2	0.005	0.008	456	474	2	0	99	99	100
4	0.010	0.015	443	474	4	0	99	98	100
6	0.015	0.023	429	474	7	0	97	96	100
8	0.020	0.030	412	474	8	0	92	89	100
10	**0.025**	**0.038**	**392**	**474**	**10**	**0**	**84**	**81**	**99**
12	0.030	0.045	369	474	11	0	75	70	98
14	0.035	0.053	344	474	12	0	63	57	96
16	0.040	0.060	316	474	13	0	51	43	90
18	0.045	0.068	286	474	13	0	38	29	83
20	0.050	0.075	255	474	13	0	26	19	74
21	0.055	0.083	222	474	13	2	17	11	64
23	0.060	0.090	190	474	12	6	10	06	52

Original Results – Scenario 2 (Middle)

Scenario 2 assumes that the population today is similar to the early-to-mid 2000s, and can support a standard (for polar bears) amount of harvest with some declines in abundance due to habitat loss in recent years

Harvest strategies with an 80% probability of meeting **Management Objective 1** (maintaining a subpopulation size that achieves maximum sustainable yield)

- **10 female bears/year***
  - 2.5% female harvest rate
  - The subpopulation would have a low probability of crossing below the minimum abundance threshold and a negligible probability of going extinct
  - Under **2:1 male to female** harvesting: **30 bears/year initially** (20 male and 10 females), which equates to a 3.8% harvest rate for all bears

*This harvest level is based on the 2016 abundance estimate of 780 bears, which may not be accurate considering the most recent information

- **This is the option supported as most scientifically plausible by members of the SH Technical Working Group**

Results – Updated

- The 2021 SH polar bear aerial survey provided an updated abundance estimate of 1,119 polar bears, representing an increase from the 2016 estimate of 780 bears
- The estimate of 1,119 likely represents a combination of SH population growth and movements of bears from the adjacent WH subpopulation—the available scientific data cannot resolve what specific value of abundance is most appropriate for evaluating harvest risk
- In August 2023, the TWG created an options document that considers how the results of Regehr et al. (2021) can be modified to reflect the updated scientific information
- The TWG recommended that Scenario 2 remains the most appropriate representation of the demographic status of the SH subpopulation, and that the harvest rate (i.e., percentage of abundance removed annually) from Scenario 2 can be applied to an updated estimate of abundance

Results – Updated

- This table presents a range of possible harvest strategies corresponding to several plausible values for population abundance
- The TWG suggests orienting around Option 3

Table 1: Recommended harvest rate under Scenario 2 of Regehr et al. 2021, considering a female harvest rate of 0.02 to 0.03, according to the three different abundance estimates options, and a 0.50 proportion of females in the SH subpopulation as per Regehr et al. 2021.

Total abundance estimate	Female abundance	Total female harvest	Overall population harvest level at 2:1 male-to-female ratio (harvest rate of population)	Overall population harvest level at 1:1 male-to-female ratio (harvest rate of population)
Option 1: 895	448	9-14	27-42 (3.0-4.7%)	18-28 (2.0—3.1%)
Option 2: 1119	560	12-17	36-51 (3.2 – 4.6%)	24-34 (2.1 – 3.0%)
Option 3: 1000	500	10-15	30-45 (3.0 - 4.5%)	20-30 (2.0 – 3.0%)

Conclusions

- The SH Technical Working Group originally, and currently, suggests that **Scenario 2** at a moderate degree of risk tolerance with respect to Management Objective 1 is biologically realistic and suitable for informing harvest:
  - This suggests female harvest levels of **10-15 female bears/year** (h = 0.02-0.03), if using a current abundance of 1,000 total bears.
  - This is equivalent to a total (i.e., female and male) harvest rate of approximately **20-30 bears** (2.0-3.0%) assuming a **1:1 male-to-female ratio** in the harvest; or approximately **30-45 bears** (3.0-4.5%) assuming a **2:1 male-to-female ratio**. Harvesting females and males has different effects on population status.
  - Per the previous slide, the range of harvest levels could be higher or lower if other types of evidence support use of a different abundance estimate (e.g., 780, 895, or 1119)
  - These findings require that abundance estimates are updated every 5 years, which limits the negative demographic consequences of getting things wrong at present

Conclusions

- Decision-makers can use this tool to investigate how different harvest strategies (i.e., harvest levels and sex ratios) will likely impact SH polar bears
- We evaluated sustainable harvest under different biological scenarios, assumptions and levels of risk tolerance. The TWG has made suggestions about which of these are most scientifically defensible but recognizes that decision-makers also have other sources of information and practical considerations.
- **The mid-range harvest strategies suggested by the TWG (i.e., Scenario 2, abundance of 1,000) likely have the benefit of limiting lost opportunities for subsistence use if conditions are more like Scenario 1, while reducing the chances of severe overexploitation if conditions are more like Scenario 3.**

Caveats and Future Needs

- Because there is movement between WH and SH, decisions on harvest levels in one subpopulation will affect the other subpopulation—the best way to avoid either overharvested or being overly conservative, is to consider the two subpopulations together
- Findings should be interpreted with caution due to an incomplete understanding of how sea-ice loss affects polar bear population dynamics and the use of a relatively simple model that did not include male bears or a detailed mechanism of reproduction
- Some biological questions cannot be answered with available data because current research on the SH subpopulation is focused on the use of aerial surveys, which do not provide information on animal movements or health
- State-dependent (i.e., adaptive) management, including continued monitoring, is necessary given that warming and sea-ice loss will continue
- Harvest data provided by hunters is critical to all scientific assessments of population status and sustainable harvest. This information makes it possible to maximize sustainable harvest opportunities.

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