NUNAVUT WILDLIFE MANAGEMENT BOARD

Agenda: Regular Meeting 001-2021

March 10, 2021

Meeting Location: Zoom

	No:	Item:	Tab:	Presenter:	Maximum Time
9:00 AM – 9:02 AM	1	Open Meeting		Chairperson	2 minutes
9:02 AM - 9:03 AM	2	Declaration of Conflict of Interest		Chairperson	1 minute
9:03 AM - 9:05 AM	3	Agenda Review and Approval	1	Chairperson	2 minutes
		Government of Nunavut - Department of Environment			
9:05 AM - 10:00 AM	4	Total Allowable Harvest on McClintock Polar Bear (For Decision)	2	Government of Nunavut	55 minutes
10:00 AM - 10:15 AM		**BREAK**			15 minutes
10:15 AM - 11:15 AM	5	Total Allowable Harvest on Gulf of Boothia Polar Bear (For Decision)	3	Government of Nunavut	60 minutes
		Government of Nunavut - Department of Economic Development and Transportation			
11:15 AM - 11:45 AM	6	Fisheries and Sealing Update (For Information)	4	Government of Nunavut	30 minutes
11:45 PM - 1:00 PM		**LUNCH**			1 hr 15 minutes
		Fisheries and Oceans Canada (DFO)			

1:00 PM - 1:45 PM	7	Total Allowable Catch Levels for Northern Shrimp and Striped Shrimp for the 2021-2022 Season in the Western and Eastern Assessment Zones (For Decision and Recommendation)	5	Fisheries and Oceans	45 minutes
1:45 PM - 2:15 PM	8	Total Allowable Catch levels for Northern Shrimp for the 2021 Season in Shrimp Fishing Area 0 (For Recommendation)	6	Fisheries and Oceans	30 minutes
2:15 PM - 2:45 PM	9	Integrated Fisheries Management Plan for the Cambridge Bay Arctic Char Commercial Fishery (For Decision)	7	Fisheries and Oceans	30 minutes
2:45 PM - 3:00 PM		**BREAK**			15 minutes
3:00 PM - 3:30 PM	10	Information Regarding Plans for Consultation and Decision-making Regarding the Possible Addition of the Ringed Seal to the List of Wildlife Species at Risk on the *Species at Risk Act* (For Information)	8	Fisheries and Oceans	30 minutes
3:30 PM - 4:00 PM	11	Juvenile redfish (*Sebastes mentella* and *S. fasciatus*) bycatch in the Northern Shrimp Fishery in the Eastern Assessment Zone (For Information)	9	Fisheries and Oceans	30 minutes
4:00 PM - 4:30 PM	12	Department of Fisheries and Oceans Canada - Operational Updates (For Information)	10	Fisheries and Oceans	30 minutes
4:30 PM - 5:00 PM	13	Fisheries and Oceans Canada Update - Marine Conservation Initiatives (For Information)	11	Fisheries and Oceans	30 minutes
5:00 PM - 5:45 PM	14	Precautionary Approach Framework for Northern and Striped Shrimp in the Western and Eastern Assessment Zones (For Information)	12	Fisheries and Oceans	45 minutes
		Nunavut Fisheries Association			
5:45 PM - 6:15 PM	15	Access Fees Charged to the Nunavut Fishing Industry by the Department of Fisheries and Oceans for Shrimp in the Western and Eastern Assessment Zones (For Decision and Recommendation)	13	NFA	30 minutes

6:15 PM	16	Adjournment of RM001-2021 Meeting		Chairperson	

SUBMISSION TO THE

NUNAVUT WILDLIFE MANAGEMENT BOARD

FOR

Information: **Decision: X**

Issue: Total Allowable Harvest Recommendations for the M'Clintock Channel Polar Bear Subpopulation

Background:

- M'Clintock Channel (MC) is a relatively small polar bear subpopulation managed by Nunavut. The last inventory study to estimate abundance was conducted between 1998-2000, which resulted in an estimate of 284 bears.
- Past harvests of 34 bears/year between 1979-1999 were unsustainable because the harvest levels where higher than what the estimated population size of 700 bears could support.
- A moratorium from 2001/2002 – 2003/2004 was implemented, followed by a reduced Total Allowable Harvest (TAH) of 3 bears until 2015. The subpopulation was managed to achieve recovery, and local traditional knowledge confirmed that there were more bears being seen in MC in the 2010s. As a result of the assumed increase, and to meet local harvest needs, the TAH was increased to 12 bears in the 2015/16 harvest season. Those 12 bears were divided evenly between Gjoa Haven, Cambridge Bay, and Taloyoak.
- The population data were out-of-date, and a new study was needed to assess the status of this subpopulation. Following community consultations during 2012 and 2013, a new 3-year study began in 2014.
- The method used for this study was the less-invasive genetic mark-recapture through DNA-biopsy sampling. The new study was conducted between 2014 and 2016.
- The Government of Nunavut, Department of Environment (DOE) initially planned to have a community project to collect local traditional knowledge from MC community members and hunters. However, the COVID-19 pandemic prevented local in-person meetings for interviews during 2020. As a result, that study could only be conducted remotely and is still ongoing as of January 2021.

Current Status:

- The final report and results for the 2014-2016 study was completed and distributed to all relevant co-management partners in summer 2020.
- The new abundance estimate based on animals ≥ 2years old is 716 bears (95% Credible Interval = 545 – 955), which is considered a statistical increase from the previous estimate of 284 bears.
- The new results suggest that the subpopulation is productive with mean cub-of-the-year and yearling litter sizes for the period 2014-2016 of 1.70 (Standard Error = 0.09) and 1.61 (Standard Error = 0.11), respectively.
- The calculated mean number of yearlings per adult female declined from 0.39 (SE = 0.10) during 1998-2000 to 0.28 (SE = 0.06) between 2014-2016.
- When using available sampling data, the estimated apparent survival rate for bears aged 2 and older was 0.88 (SE = 0.02), which would mean the population is declining. However, calculating the survival rate necessary to achieve the observed increase in abundance was 0.93. The discrepancy between the two survival estimates is likely because of a lack of movement data. Movement data informs survival models about how many bears move in and out of the area versus how many die.
- Body condition of bears in spring increased between the periods 1998-2000 and 2014-2016, which is likely due to changing ice conditions (i.e., reduction in multi-year ice) in the study area. The changes from less multi-year ice to more annual ice may have provided bears with improved prey accessibility, but this is not currently scientifically testable.
- Due to the lack of movement data (e.g. telemetry/spatial) it is difficult to quantify the amount of immigration and emigration that occurs between GB and neighbouring subpopulations. Although there are subpopulation boundaries, bears in adjacent subpopulations likely move back and forth across boundaries at different times of year. The abundance estimate represents the “superpopulation” (e.g., it includes all bears that were using the GB management area).
- Small sample sizes, low probability of recapturing the same bear, and lack of movement information constrained the analyses in this study such that the estimates of abundance and survival are certainly biased high and low, respectively.

Consultations:

- In-person community consultations with relevant representatives from MC Hunters and Trappers Organizations (HTO) were held between October 19-21, 2020.
- During these consultations, the DOE representatives presented a harvest recommendation of increasing the TAH to 16 bears.

- There was general consensus among HTO members on the findings of the GN report.
- Some communities requested that any increase in the TAH should be an amount that could be divided equitably between the three communities.
- Some communities are more interested in harvesting from MC than others so they felt the allocation of tags should reflect that.
- Staff from Nunavut Tunngavik Inc. and Nunavut Wildlife Management Board were unavailable to attend these consultation meetings.
- A Kitikmeot Regional Wildlife Board (KRWB) representative attended the Cambridge Bay meeting (see details in Consultation Summary Report by DOE).

Recommendations:

1. DOE recommends an **increase in the MC TAH from 12 bears to 18 bears at a 1:1 male to female sex harvest ratio**.

   Rationale:

   a. The field data obtained from the 2014-2016 MC study came with many analytical limitations due to the nature of the data. Analytical procedures could be applied under specific sets of assumptions only, which led to an abundance estimate that is biased positively. The degree to which this estimate is biased positively cannot be determined at this time due to the lack of adequate data.

   b. The recommended TAH can be considered a conservative level in order to avoid a similar dilemma to what this subpopulation just recovered from, particularly in light of the uncertainties surrounding the abundance and survival estimates. Abundance estimates during the 1970s-1980s were imprecise yet formed the basis for harvest levels. These harvest levels turned out to be unsustainable in the long-term and abundance subsequently declined to levels where MC communities were negatively impacted by very limited harvest opportunities for over a decade. Setting MC harvest levels too high increases the risk for biological decline or depletion not only in MC, but also for neighboring subpopulations due to the unknown emigration/immigration rates.

   c. The recommended TAH keeps in mind that the goal is to maintain a viable polar bear subpopulation. With the slight increase over the scientific-based harvest recommendation, the potential impacts of the harvest should be closely monitored and assessed over time using all available information (science and Inuit Qaujimajatuqangit).

   d. The changes to the ecosystem (e.g. sea-ice conditions) should be monitored since there have been significant changes due to climatic changes. As multi-year ice conditions change to annual ice, the long-term impacts to the bears and their prey species is not yet known.

2. DOE recommends that the Kitikmeot Regional Wildlife Board discuss MC tag allocations with communities that harvest from both MC and the Gulf of Boothia polar bear subpopulations.

   Rationale:

   a. During consultation meetings (October 19-21, 2020) there were similar concerns expressed in each community that the current tag allocation for MC communities needed a revision and re-allocation.

Appendix 1

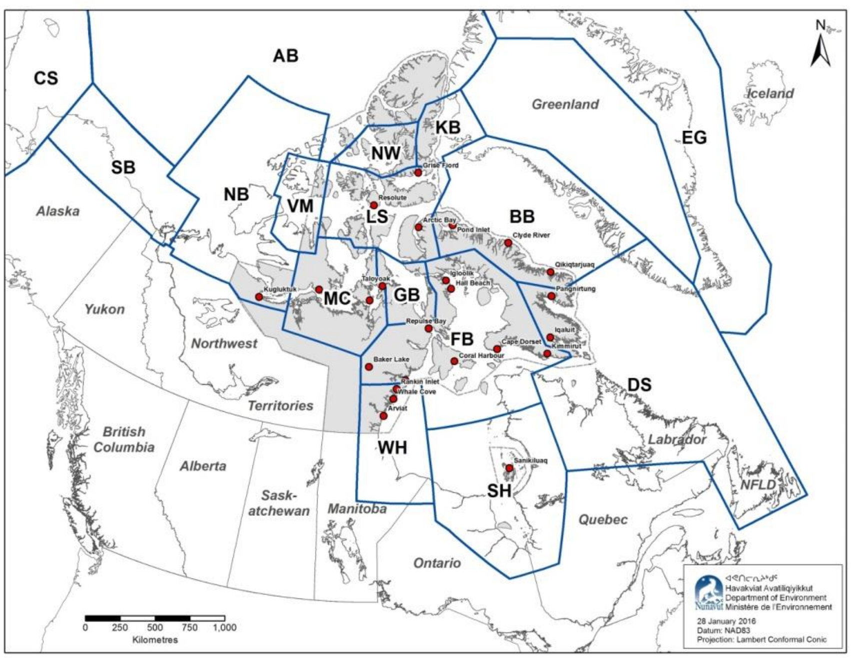

Figure 1. Overview of Nunavut polar bear subpopulations (GB = Gulf of Boothia, MC = M'Clintock Channel).

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Building Nunavut Together
Nunavuliuqatigiingniq
Bâtir le Nunavut ensemble

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Department of Environment
Avatiliqiyikkut
Ministère de l'Environnement

M'CLINTOCK CHANNEL POLAR BEAR SCIENTIFIC STUDY RESULTS

Consultations October 19-21, 2020

Consultation Summary Report

Polar Bear Research Group
Department of Environment
Government of Nunavut
Igloolik, NU

Executive Summary

Government of Nunavut, Department of Environment (DOE) representatives, together with representatives from the Kitikmeot Regional Wildlife Board (KRWB) conducted consultations with Hunters and Trappers Organizations (HTOs) from October 19-21, 2020. The purpose of the consultations was to provide co-management partners with an overview of the most recent scientific study results on the M'Clintock Channel (MC) polar bear subpopulations, as well as collect feedback on the results presented and collect additional traditional knowledge (TK). Only the HTOs in communities that hunt from the MC subpopulation were consulted. The feedback and TK collected during these consultations will be considered when forming Total Allowable Harvest (TAH) recommendations for the MC subpopulation to be submitted to the Nunavut Wildlife Management Board (NWMB) for decision. This report attempts to summarize the comments made by participants during the consultations.

Contents

Preface

This report represents the Department of Environment's best efforts to accurately capture the information that was shared during consultation meetings with the Hunters and Trappers Organizations of Cambridge Bay, Gjoa Haven and Taloyoak. The views expressed herein do not necessarily reflect those of the Department of Environment, or the Government of Nunavut.

1.0 Report Purpose and Structure

This report is intended to collate and summarize comments, questions, concerns and suggestions provided by the HTOs in response to the results from the 2014-2016 MC scientific study. Pre-study consultations with these communities were conducted in 2013.

The following communities were consulted from October 19-21, 2020:

- Cambridge Bay, October 19, 2020
- Gjoa Haven, October 20, 2020
- Taloyoak, October 21, 2020

During the meetings DOE provided input on what the GN's TAH recommendation would be for MC. Representatives from the NWMB, Nunavut Tunngavik Inc. (NTI) were invited to these meetings but unfortunately no representative was available to participate in person. A representative from the Kitikmeot Regional Wildlife Board (KRWB) was in attendance in Cambridge Bay and Kugaaruk (Note: The GN representatives presented the MC results to the KRWB representative in Kugaaruk after a presentation was given on Gulf of Boothia results in that community because the KRWB representative was unable to attend the Gjoa Haven and Taloyoak meetings).

2.0 Purpose of Consultations

The purpose of these consultations was to discuss the newest scientific information regarding the MC polar bear sub-population as reported in the GN scientific study report produced by the GN polar bear biologists. In addition, the GN also put forward a TAH recommendation during these consultations, but also discussed that management objectives can be formulated depending on the communities' needs and objectives for this subpopulation.

2.1 Format of Meetings

The meetings were held in the evening (e.g., beginning between 17:00 and 18:30) and ran between 3 to 4 hours depending on HTO engagement. Meetings were facilitated and led by GN Polar Bear Biologists M. Dyck and J. Ware, who also presented. The biologists presented the historic management background, and a detailed overview of the results from the 2014-2016 polar bear study conducted in MC (Appendix 1). The participants were invited to ask questions, raise concerns, or provide recommendations throughout the meetings. It was also pointed out that there is still the on-going MC TK study in which results are expected by the end of 2020, depending on how the COVID-19 pandemic evolves.

After the presentation, questions/discussion continued until no further questions were raised. At the end of the meeting, the GN position on the TAH for MC was presented. In addition, it was also mentioned that the GN position not necessarily reflects the Management Objective goal of the communities and communities were encouraged to work with the KRWB and/or the GN to work on the development of a Management Objective for the MC subpopulation. The biologists explained that consideration for a TAH that differs from the GN recommendation should include the uncertainty of the results, the changing environment, and the past where a moratorium was in place that was followed by a reduction in TAH. Discussions and questions were raised regarding the tag distribution in Gulf of Boothia (GB) and MC for communities that harvest from both subpopulations. The biologists advised the participants that this is a matter for the KRWB to consider as tag allocation within a subpopulation falls under their purview.

3.0 Summary by Community

The objectives of the consultation meeting were made clear to the HTO members prior to, and at the start of, each meeting. There were many similar questions, concerns and suggestions raised by HTO Board members in the communities consulted. A full, detailed report of the questions and comments from each community can be found in Appendix 2.

3.1 Cambridge Bay Consultation Summary

Date: October 19, 2020
Time: 18:15 – 22:20

Representatives:

- GN-DOE, Polar Bear Biologists M. Dyck, J. Ware
- GN-DOE, Conservation Officers M. Angohiatok, S. Angulauk
- GN-DOE, Regional Manager, K. Methuen
- KRWB, Chairperson: B. Klengenberg
- Cambridge Bay HTO Board Members

Comments and Questions:

The board members wanted to get more clarification on the new harvest system according to the Nunavut Polar Bear Co-Management Plan, and they needed additional information on the harvest table and credit use. Overall, the board members were in agreement that there are more bears now than 20 years ago, and that bears are healthy. Concerns were raised that the distribution of tags for GB and MC are not distributed fairly, especially now that MC shows an increase. It was suggested by the GN representatives to bring this up with the KRWB. The board was thankful and appreciative that the GN visited the community to present the results and to have a discussion.

3.2 Gjoa Haven Consultation Summary

Date: October 20, 2020
Time: 18:50 – 21:15

Representatives:

- GN-DOE, Polar Bear Biologists M. Dyck, J. Ware
- GN-DOE, Conservation Officer J. Skilling
- GN-DOE, Regional Manager, K. Methuen
- Gjoa Haven HTO Board Members

Comments and Questions:

After the presentation about MC, board members discussed their experiences from over the past years and how they lined up with the GN study results. Generally, the board members agreed with the GN findings. It also became clearer by comments from board members that Gjoa Haven hunters are not hunting much in GB. Some points were raised that the distribution of tags for GB and MC are not distributed fairly, especially now that MC shows an increase. It was suggested by the GN representatives to bring this up with the KRWB. There were also concerns from hunters that Taloyoak uses their MC tags to cover problem bears in the overlap area of the subpopulation boundaries. The board was thankful and appreciative that the GN visited the community to present the results and to have a discussion. Some clarity was provided on how the BEARWATCH project and, individuals associated with the project, relate to the GN.

3.3 Taloyoak Consultation Summary

Date: October 21, 2020
Time: 17:45 – 20:15

Representatives:

- GN-DOE, Polar Bear Biologists M. Dyck, J. Ware
- GN-DOE, Conservation Officer D. Anavilok
- GN-DOE, Regional Manager, K. Methuen
- Taloyoak Spence Bay HTO Board Members

Comments and Questions:

After the presentation about MC, board members discussed their experiences from over the past years and how they lined up with the GN study results. Generally, the board members agreed with the GN findings. It also became clearer by comments from board members that Taloyoak hunters are not hunting as much in MC, although some comments were in conflict with that sentiment, and perhaps some hunting in MC by Taloyoak is preferred. Some points were raised that the distribution of tags for GB and MC are not distributed fairly, especially now that MC shows an increase. It was suggested by the GN representatives to bring this up with the KRWB.

4.0 Overall Consultation Summary

The consultations for all communities harvesting from MC were conducted in a roundtable, open discussion format in which all participants were able to provide feedback, ask questions, and speak. Participants offered context and understanding to the scientific results. The major points raised by communities regarding MC were:

1) agreement with the scientific findings that the population appears to have increased since the last scientific study in 1998-2000, and

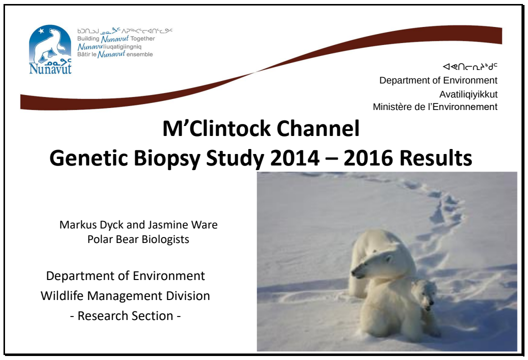
2) MC tag allocation is a major concern.

Minor points, which represent comments by some communities but not all, included wanting clarification on the new 1:1 harvest management system and credit usage and questions as to why DNA biopsy methodology takes longer than traditional mark-recapture to complete.

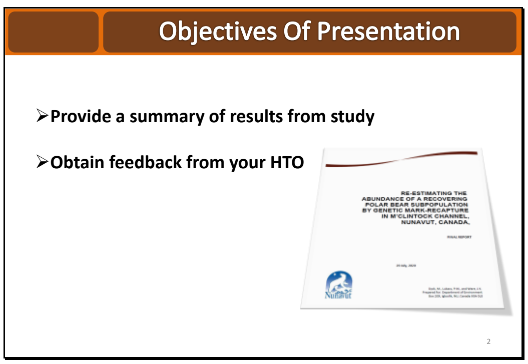
The GN proposed an increase in TAH for MC to 16 bears at a 1:1 male-female sex ratio based on the scientific findings of an increased population. The TAH was increased to 12 in 2014/2015 based on Inuit Qaujimajatuqangit (IQ) observations of an increased population and the scientific results align with these data. There is an ongoing IQ study for MC which may offer more comprehensive insight into hunters' and users' observations of bear distribution or abundance. Given the overall community consensus that they agreed with the findings, there were no major oppositions to this proposal. However, communities pointed out that 16 tags could not be divided evenly among the three communities currently harvesting from MC. One of the major points was that the tag allocation needed to be revisited to ensure fairness and equity among the communities that harvest from MC. This was raised most emphatically by communities that were harvesting from both MC and GB populations, with a range of attitudes towards harvesting from GB. Some communities indicated willingness to forgo GB harvest in order to harvest additional bears from MC, while other communities felt GB areas were more important. These concerns of fair and equitable tag distribution, which necessitate review and action by the RWOs, were a major topic of discussion for MC harvesting communities. The GN representatives discussed roles and responsibilities of the relevant bodies for tag allocation outlined the process via the RWOs. The GN offered to provide guidance or further information to any interested community.

Appendix 1: Complete Consultation Presentation of the M’Clintock Channel Polar Bear Study Results 2014-2016

Slide 1



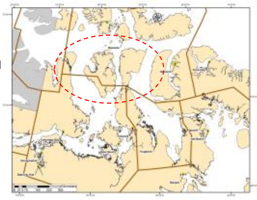
Slide 2



Slide 3

Background

- First mark-recapture study between 1973-78
  - MC and GB treated as one unit, estimate of 1,081
- GB estimate increased to 900 in mid-90s based on local knowledge and uneven and incomplete sampling
- MC estimate decreased from 900 to 700 based on local knowledge in mid-90s
- Population boundaries in 1995 and 2001



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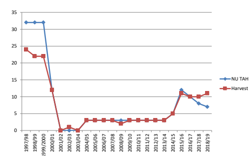
Slide 4

Background – Harvest

- Concerns over low bear densities in MC lead to new mark-recapture study 1998-2000; GB also included in the work.
- Estimate for MC was 284
- Average harvest of 34 bears/year from 1979-1999 for MC
- MC harvest unsustainable:
  a) hunting moratorium 2001-2003
  b) TAH of 3 until 2015/16
- MC population likely growing
- TAH of 12 since 2016



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Slide 5

Background – Where does that bring us?

- Population status unknown (stable? increasing?)
- Population boundaries of MC/GB/LS?
  Inuit Qaujimajatuqangit/genetics suggest movement between both units

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Slide 6

Goals of study

- Need for new information – current data was deficient
  - Re-assess population abundance
  - Evaluate population boundaries/movements of bears
  - Provide information for review of Total Allowable Harvest (TAH)
  - Observe effects of changing sea-ice conditions

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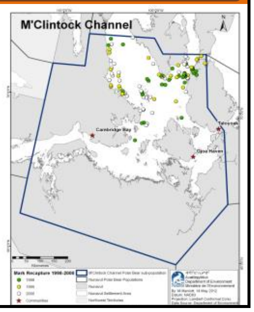
Slide 7

Study method choices

- Co-management partners indicated concern about drugging & handling bears
  - Explore alternative population assessment methods
  - Better reflect Inuit societal values
- Balance with analysis needs –to properly monitor population



Slide 8

Study method chosen

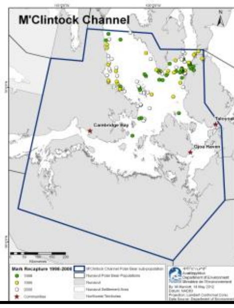
- Co-management partners and GN selected less invasive choice:

Genetic mark-recapture (biopsy sampling, no physical handling)

Slide 9

Genetic capture mark-recapture study goals

- Estimate polar bear abundance in MC
- Compare with 1998-2000 estimate
- Compare information on reproduction, survival
- Cannot estimate movement or boundaries with this method



Slide 10

Study funding and support

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Nunavut

Nunavut General Monitoring Plan

WWF

QIKIQTAALUK WILDLIFE BOARD

HTOs from Gjoa Haven, Cambridge Bay, Taloyoak

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Slide 11

Study Design

Community Participation

- Survey design and method choice - 2013
- Survey observers – participants from Ekaluktutiak HTO and Spence Bay HTO available in 2014 and in 2015; no participants available from Gjoa Haven
- Review & evaluation of results - 2020

Slide 12

Study Design – Data collection

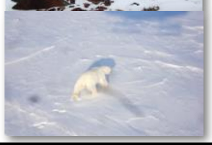
- Method choice: genetic capture mark recapture
- Timing of study: mid-April to early June
- HTO participation on searching and sampling flights
- Used helicopters to search

Willy Nakashook, from Cambridge Bay, searches for bears in MC 2015.

Slide 13

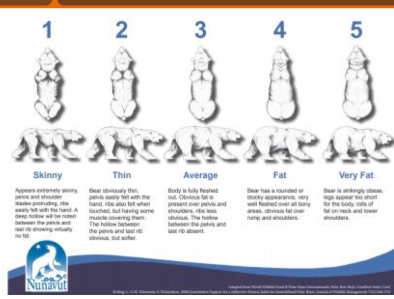
Study Design – Data collection

- Recording age class, sex, body condition, litter size, location of bears



Slide 14

Study Design – Data collection



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Slide 15

Study Design – Data collection

- Collected small tissue samples for genetic analysis (to genetically identify and "mark" an individual)
- No cubs-of-the-year sampled
- No drugging, no collaring
- No specific ages or samples for other studies (e.g., contaminants)

Slide 16

Study Design - Analysis

- Included all mark-recaptures and dead recoveries for analysis:
  - Genetic mark-recapture (biopsy) information 2014-2016
  - 1998-2000 capture mark-recapture information
  - Harvest recoveries (e.g., when an ear tag/lip tattoo is recovered by a hunter) 1998-2016

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Analysis Goals

- Use all information to determine:

1. Trends in abundance from 2000-2016
2. Survival rates of different age classes and sexes over time
3. Reproductive parameters such as size of litters, litter rate per adult female (how productive are the females/population)
4. Population growth rate – determined using survival rates and litter production rates
5. Evaluate body condition of bears across the searched MC area

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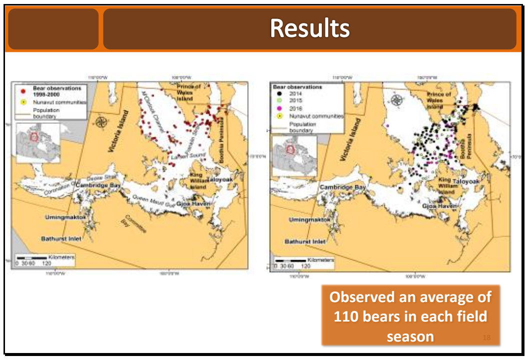
Slide 18



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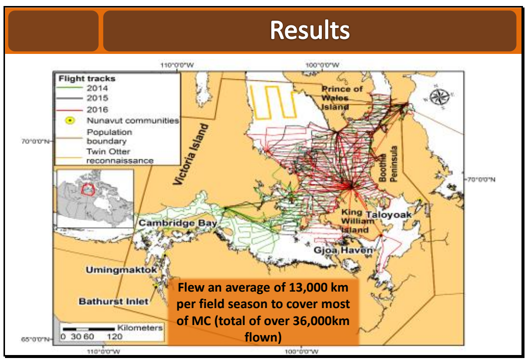

Slide 20

Results – mark-recapture samples

- 953 samples genetically analysed (319 biopsy, 532 harvest, 102 old capture)
- Live re-sampled 6 bears from old study, and 33 from new study
- Dead-recoveries through harvest:
  - 15 recovered inside MC
  - 7 recovered outside MC but not in GB
- 7 bears marked in M'Clintock study 2014-2016 sampled in GB 2015-2017

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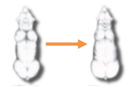
Slide 21

Results – body condition

- All bears except adult males were in better condition (fatter) in 2014-2016 compared to 1998-2000



- **No change** in condition for adult males

- Why? Your thoughts?

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Slide 22

Results – Reproduction

- What does "reproduction" mean? What do scientists look at?
- Litter size
  - data from: 1998-2000 and 2014-2016

	1998-2000	2014-2016
Cubs of the year:	12 family groups	27 family groups
COY litter size:	1.58 COYS in each litter	1.70 COYS in each litter
Yearlings:	11 family groups	18 family groups
Yearling litter size:	1.71	1.61

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Slide 23

Results – Reproduction cont.

- Number of offspring per adult female

1998-2000	2014-2016
COYs: 0.38 COYs/adult female	0.43 COYs/adult female
Yearlings: 0.39 yearlings/adult female	0.28 yearlings/adult female

  - Sample size very small to suggest changes over time – only for information
- Number of yearlings per adult female is important because it shows how many cubs-of-the-year survive to be yearlings
  - it is a good measure of reproduction
- Appears MC subpopulation has healthy reproduction

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Slide 24

Results – Survival

- We had limited samples – MC is a small population, few recoveries through harvest, big time gap with no data – and could not explore all possible survival models

- Independent bears > 2 years
- Apparent survival constant at 0.88
- It is a lower estimate, and does not reflect true survival
  (We do not know what happens to bears once they leave MC: they can be dead = are not re-sampled; they also can be alive and are not re-sampled)

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Slide 25

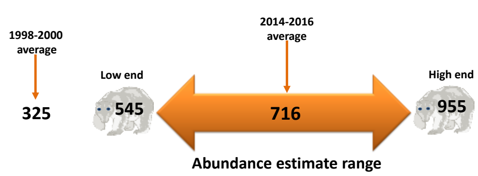
Results – Population growth rate

- Population growth rate indicates males and females increased in abundance since 2000 (recovered from low numbers)
  (growth rate is simply the difference between what is added through births minus the deaths and takes into account how animals survive)
- Male growth rate was stronger than female growth rate which allowed them to recover from overharvest

Slide 26

Results – Abundance

- Assessment of number of bears in MC



- Increased over time

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Slide 27

Results – Interpretation

- MC is doing well, healthy subpopulation for now
- Because we don't have a quantifiable idea about movement, we are likely counting bears from other subpopulations like LS and MC as GB bears → increases the abundance assessment.

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Slide 28

Further Questions

- Boundary between GB-MC-LS?
  - Genetic mark-recapture method does not provide data to answer these questions
  - Movement data are necessary
  - How important is the boundary issue to you and other users?
    - IQ says there is movement. How much? Where? When? Which animals?
    - Are bears changing where they choose to spend their time? Is this related to sea ice changes? Seals?

- Options:
- The Government of Nunavut is committed to surveying Lancaster Sound in the next few years
  - With your support, we could propose to put collars and satellite ear tags on a small number of bears in LS and MC/GB to gather info about bear movements between and among these areas.

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Slide 29

Further Questions

- Do you agree that the number of bears increased over time?
- What did you observe in the bears' body condition over time?
- Are there enough bears to harvest? Are there too few? Too many?
- Is there anything special that you observed and wanted to share with us?
- Where do you agree/disagree with our findings?

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Slide 30

Suggested Harvest Recommendation

- MC is doing well, healthy subpopulation for now
- Because we don't have a quantifiable idea about movement, we are likely counting bears from other subpopulations like LS and MC as GB bears → increases the abundance assessment, and uncertainty.
- Recommend increase in TAH from 12 to 16 bears/year (8 male bears and 8 female bears).

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Slide 31

Further Questions? - Thank you

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Appendix 2: Complete Consultation Summary of the M'Clintock Channel Community Consultations

Nunavut Community Consultations on the results from the 2014-2016 M'Clintock Channel Polar Bear Study

October 19-21, 2020

HTOs Consulted:
Cambridge Bay
Gjoa Haven
Taloyoak

Summary of Consultations:

A: Cambridge Bay

October 19, 2020

Start: 18:15 **End:** 22:20

Participants:

Beverly Magsagak - Manager
Bobby Greenley – Chairperson
George Angohiatok – Vice Chair
Peter Evalik – Secretary/Treasurer
Ipeelie Ootoova – Director
Clarence Kaiyogana – director
Mercy Panegyuk – director
Alice Maghagak – director
M. Dyck – GN-DOE
J. Ware – GN-DOE
K. Methuen – GN-DOE
M. Angohiatok – GN-DOE
S. Angulauk – GN DOE
Bobby Klengenberg – KRWB chair

Harvest table and credit discussion:

- The meeting began with introduction of participants.

- GN representatives then discussed harvest table and Up to 1:1 Harvest Management system handout. During meeting/consultation planning, HTO expressed interest to obtain more information on those topics. – Jasmine

- HTO board asked questions about credits and the table. Board was well informed about how the credit exchange worked within the subpopulation.

- Markus explained fractional credits are from 2:1 system

Main presentation:

Background on MC slides:

- GN representatives went over MC history and background to allow HTO representatives to become familiar about past research and management items

- GN representative passed around the biopsy dart to demonstrate how the biopsy method works, pros and cons and limitations of that method.

- **Question: Bobby G:** would you dart both mom and cub if you came across them?

- **Answer Markus** – we'll answer this in the methods very shortly (GN explained that depending on offspring age both mother and offspring would be sampled – no young small bears->COYs in spring, but older offspring-> yearlings).

Community participation slides:

- discussed study design during 2013 consultations, talk with hunters in town – where do bears go, when should we go search. Observers from Cambridge Bay participated in field work.

Study design: reviewed slides; no questions

- **Question Bobby G:** – were there any bears that were marked in 1998-2000 that were marked again in 2014-2016?

- **Answer Markus/Jasmine** – yes

- George: In the mid 1960's, was the first time I went in M'Clintock channel, there was no quota system and there were very, very few bears. No signs either. Took a lot to get bears. As the years went on, started noticing more and more bear-- Lots of bearded seals around. Big bears are around the bearded seals and feed on them. In the last few years, I've seen many healthy bears, sow and cubs. This year was the very first time in March I saw open water---never seen that in my whole life. Birds were there too. Lots and lots of sign of bear. Pre-2000 started seeing more bear sign. Ten to twenty bearded seals around a single hole, big male bear can get those pretty easy when the seals try to go into a seal hole.

- Bobby K: end of October, near Kent Peninsula, south of Cambridge Bay, polar bears were spotted, which is very rare.

- Beverly – there was one in gravel pit area in June and then another one just a week ago.

- Bobby K – using the multi year ice to come in and near, large floes

Flight path slide:

- Markus explained that weather prevented coverage of MC channel proper. Maybe local knowledge could fill this information in. Maybe with Pam (the contractor for the on-going IQ study on MC and Gulf of Boothia) the IQ study can help answer that question of whether there are a lot of bears in that area in the spring. The flight with Twin Otter was early April, but don't know what's going on in early June.

- Bobby G: they didn't want to have collars which I agree with and when I first got on, they didn't have an ear tag.

- **Question Bobby G**: - Is there anything long term, short term effects of immobilization on the bear?

- **Answer Markus** – There are advances in the drugs—there are reversals now. Immobilize the animal but you can introduce agents that reverse the effects and so the bears recover way faster – within minutes.

- Bobby – so there is nothing left long term effects?

- Markus – Health Canada has looked at how fast the drugs are metabolized and found it's completely safe after 45 days---even before, but they are being conservative. Other studies, by US Fish and Wildlife Service did studies examining movement rates, survival rates, reproduction – there were no negative impacts they could find on survival or reproduction. Movement rates were back to 95% of normal after 2 days and 100% after 5 days.

- Jasmine – reversals bind to the drugs and pull them off the receptors so the liver/kidney can process. Bear is awake very fast. Physically, no long-term effects, but we have heard concerns about psychological trauma and can't really say about that being a long-term effect? We can't really say. Drugging over and over and over would probably have long term effects---like us if we drank and drank and drank alcohol. Even for the 2-minute darting the bear is not enjoying that event, but the idea is that in order to collect the data, these are the trade offs and what we (as co-managers) are all willing to accept is a personal, ethical question. We find that bears return quickly to where they were sampled and take that to mean that the experience wasn't so bad psychologically that they stay away from where they want to be –their preferred habitat/hunting ground.

- Markus – there are also new release mechanisms for collars so that bears do not have to be handled so often, and release is pre-programmed.

- George – The collars likely don't really affect hunting as much for bigger bears as they do for smaller bears ---trouble to break the ice with their heads

- **Question Peter** – could we not use the Google Earth satellite images and count bears that way?

- **Answer Markus** – very good points and questions: GN has partnered with universities and people are trying to examine just that. Using summer and spring satellite images, there are at times difficulties when there are white rocks – can't tell the difference; a computer program, or algorithm has to be developed, that takes time and patience.

- Jasmine – and this is where big donors come in---that technology is a good potential, but need money to pay people to work on it and develop it. My understanding is that this is the current obstacle because it takes time and effort to work on developing it and program it properly.

Body condition slides – thoughts on why body condition improved?

- Bobby – did you guys look at weather and see if there were differences in warmth and seals—more seals out basking?

- Markus – We kind of did that with the model where we incorporated sea ice because there is a lot less multi-year ice in MC now….what I've seen was lots of rubble ice and the packed to old ice is gone. What we were thinking and what we proposed in the report, is that the changes in sea ice, not being packed, more leads, more open water was good for seals and therefore temporarily good for bears.

- George: another thing is that when the sea ice freezes and freezes flat, this is not good habitat for bearded seals ---go to rough ice to find the bears cause that's where seals make their lairs.

Reproduction --- explained the slides; no questions

Survival --- explained the slides; no questions

Population growth – explained slides; comment by George about the skinny bear picture from Baffin Bay by some people that made the rounds around the world.

- Markus – That brings up a good point and is maybe a good time to point out part of my job is to gather data and provide information that allows me, Nunavut, and Canada to stand up to those organizations to are showing misinformation about bears. We try to get the word out that bears in Nunavut generally are doing well, and that there are more bears now than there have been since the 1960s.

Abundance – explained slides; also the surrounding uncertainty of the estimate

- **Question Peter** – Where do we want this population to go? Do we let it keep increasing? How do we know? What does an ever-increasing population do to other parts of the ecosystem?

- **Answer Jasmine** – this is the real question and one that community and HTO have to decide.

- **Answer Markus** – had discussions with DFO to try and get some seal surveys so that some of those impacts on other parts of the ecosystem can be answered or at least some data provided. Want to see recent estimates of polar bear abundance coordinated with new seal studies.

- Peter – like ECCC saying polar bears are declining due to climate change ---but polar bears are increasing and increasing even though sea ice is declining—even what you show.

- Markus – These reports for MC and GB are used for SARA and new population assessments; and not all NU populations are doing poorly, but some are not doing well. I should point out that in the recent years ECCC has been supporting Nunavut with the new management plan, and the harvest system.

- **Question Bobby G** – after the tour, when does this end up at NWMB table?

- **Answer Markus** – we will probably put our recommendation to the NWMB for March because deadlines for December are likely already passed by the time we get through the consultations

- **Question Beverly** – have you looked at other species for the bear? Like the invasive species such as beaver, pelican, etc. and how they might be affecting bears?

- **Answer Markus** – There are some projects going on like poop and intestine collections and collaborations with other universities that are designed to see how diet is changing with bears. The NWMB has priority meetings every few years---should be coming up next year – HTO or RWO should bring up these questions as priorities because that is how funding might get allocated.

- George – you were saying how difficult it was to count the bears due to weather. When my daughter got at a John Hackett Island (correct location name?) on a pressure ridge –never seen so many bears in one spot. Counted 13 bears--May 2nd. A good percentage were sows with cubs. All moving east on the ridge.

- **Question Peter** – have you thought using a ground survey –in the area that was hard to survey?

- **Answer Markus** – We are starting Lancaster Sound next spring hopefully, what I'm going to do is fly into M'Clintock Channel during the same time for a reconn. I want to know what is going on in the area and if bears are moving, we are going to sample bears that are moving in and out. there is some uncertainty

- **Answer Jasmine** -- specifically to your point about ground surveys…the issue is that for the survey to work, every bear in the area has to have an equal chance (theoretically) of being sampled. This detection probability is different between an aircraft and ground based. Unfortunately, the math doesn't know how different those two types of methods are and so we can't combine them without introducing more bias into the model…which increases uncertainty about the estimates even further.

- Markus – a ground survey in some of these areas are also very difficult because you cannot travel easily by snow machine; get stuck, break equipment and that limits the usefulness of ground survey.

- Monica – the area you talk about there is open water now and maybe there are animals moving in like killer whales ---they chase the seals away. That will change things for the polar bears.

- Markus – Local knowledge like this should drive the IQ research questions. That's what we have to consider in the abundance estimate---think about that ecosystem might change for the bears and how that might affect them—what happens in 5 to 10 years?

- **Question Bobby G**:– these studies were done in 2014-2016; how come these are just now being presented?

- **Answer Markus** – Thanks for this question and it needs to be asked. These biopsy studies that rely on DNA take much longer because the DNA takes 9-10 months to get back and then, for MC, the computer models were difficult with such small samples. Followed by ransomware and COVID-19. It's been a long road and we appreciate your patience.

- **Question Clarence**– What's your plan if you get MC bears in LS?

- **Answer Markus**—depends on how many we get. If we get many samples, we're going to try to analyze the complex together MC/GB/LS ---this might give us more information about their movements and that might help improve survival estimate. We did leave it open for collars for the communities in Lancaster Sound. Whenever there is interest by communities if you want to investigate the LS/MC/GB, we can always investigate movement through collars.

- Bobby Klengenberg – thanks for HTOs work and biologists' work. Saw hundreds of polar bear tracks. Maybe HTO could use locals to get information of observations –feed to HTO and biologists. Signs of tracks and information to help feed the understanding of the whole picture; maybe take also photographs as record.

- **Question Ipeelie** – do you have any idea of what proportion of bears are in water versus land? Is there a way to compare the samples between ice and land bears? There are some bears that rarely leave the water, they are found all year in water.

- **Answer Markus** – We try to cover the entire study area, but when there is open water, there are safety concerns so we can't fly over tons of open water. We will dart in water, and can do it, but there is no way to know how long that bear has been in the water, and pilots do not want to fly lots over open water.

- Ipeelie – Reason I was asking is that bears that are in the water eat differently than bears that spend most of their time on land. Wondering if you ever thought of biopsy sampling those versus the land bears? Some bears might end bowhead whales.

- Markus – we use the fat from biopsy samples to see what they're eating but there isn't really a way to know which samples would be from bears that spend a lot of time in the water versus those that spend most time on land.

- **Question Peter** – going back to LS study, you said your biopsy might get MC bears --- if you find that there a lot of MC in LS…would that help increase the TAH?

- **Answer Markus** – I would not be comfortable saying that that would increase the TAH, but if there is more new information, then that could put more information to NWMB and let them decide. But, ultimately, we don't know and we don't know what we'll find.

- **Question Peter** – how do we know there are not lots of bears that were in LS that you missed?

- **Answer Markus/Jasmine** – Ultimately, we don't know that's the plus/minus we have on the abundance estimate here. It is unlikely that hundreds were missed because that is like an entire population. However, there is likely some movement between MC and LS, but we don't know how much.

- Jasmine --- we recommend to not get too hung up on the abundance number, but more focus on what the community is comfortable with ---you know what it's like on the land and what this amount feels like---this range that we've presented.

Does that feel like too many? Just right? Want more? This is big question --- we have an estimate that is useable, though it does have uncertainty.

- **Question Beverly** – we are seeing more grizzlies coming up to island. No idea what that is going to mean in the future. And there are hybrids -what do you even classify those animals as? Grizzly or polar bears?

- **Answer Markus** – we aren't sure because the hybrids are not in the Wildlife Act – they didn't think of these back then when it was written. Lol…what we see right now is evolution on how polar bears came about…but it all also depends on how we view the hybrids and their importance.

Discuss TAH – Markus – the reason we recommend an increase from 12-16 is we are cautious, and the recommendation is based on maintaining the population roughly on where it is right now, but also considering uncertainty. We saw what happened in the past, and we all do not want to go back where this population is overharvested, and a moratorium has to be put in place.

- **Question Clarence** – is it possible to have the IQ study included so that this TAH goes up? If Pam's data is super great, could this TAH come up then?

- **Answer Markus** – at this time, this recommendation is just based on the scientific survey and we can't speak to IQ study since Pam hasn't finished. All information, science and IQ, will go to the NWMB – they will consider all information for decision making.

- **Question Beverly** – have you talked to Wily Nakashook?

- **Answer Markus** – I wanted to but haven't been able to get him.

- **Question Beverly** --- are you coming back for consultations after you've finished this tour and heard from all the communities?

- **Answer Markus** – We were not planning on that, but we're willing to have video conference and answer questions

- Jasmine – we will circulate the notes to make sure that we captured the comments and concerns raised today. Will include all the communities' notes.

- Peter – I would really recommend if we accept this, then we should make it even for every community so each community has the same number of tags otherwise there will be conflict.

- Markus – there are options to work together through the KRWB with other communities that harvest from MC and see if the redistribution of tags can be changed. It is also worth thinking about what is the goal with a management objective – are there too many bears? What is tolerable as a number of bears around? There is uncertainty around the number of bears. If the TAH is increased by a few bears there is a risk we all must be willing to accept that the response of the population might be different from what we expect, and we want to avoid a potential reduction and depletion, like what happened in the 1990s.

- Jasmine – we can only base our recommendation on the survey. That doesn't mean that there can't be a joint submission among HTOS and the GN, but for this meeting right now, the recommendation is based on the science. There are a lot of good points relative to the fairness to communities regarding allocation, what the community wants to do relative to the management of this unit. It is ultimately what the community wants.

- Kevin – Grizzly bear TAH submission to KRWB could be done similarly for polar bears.

- Monica – they want the tags too – the other communities so it will be a hard fight. They want them as much as we do.

- Beverly -- Send the link for the harvest tables (*email link sent 10/30/2020*)

Meeting ended with parties being appreciative of the visit and the opportunity to discuss these topics and interesting questions.

B: Gjoa Haven

October 20, 2020

Time Start: 18:50

Time End: 21:15

Participants:

Enuk Pauloosie
William Aglukkaq
James Qitsualik via cell phone video chat
Simon Komangat
Jimmy Qirqqut
Roger Ekilik
Ben Putuguq
Jimmy Pauloosie
Ralph Porter Sr.

J. Skillings – GN-DOE
K. Metheun – GN-DOE
M. Dyck – GN-DOE
J. Ware – GN-DOE
Jacob Keanik - translator

- Markus introduced option to go over background of MC/GB or skip it? Question to the board---what would you prefer?

- Ralph: we don't need super detailed on the background so you can go through it quickly.

Background slides: review – our objective to provide new data for the co-management partners and the NWMB to make decisions on setting harvest levels. We are here to hear feedback.

Study methodology: review, no questions

Community participation: review; no questions

Study design: review; no questions

Study design analysis: explained why the amounts of data matter for getting the results; no questions

- Ben: Years ago, when the moratorium came, I was one of the Board members back then and remember it. We used to go all the way to Prince of Wales Island before the quota system was put in place to harvest as much as we could.

- Markus: thank you, I'd like to hear about the ice back then.

- Ben: it's totally different. There isn't any ice really.

MC Study Results: Body condition

- Willy: From experience, males during the spring mating season, the males have empty bellies, just snow in there. They are so focused on females.

- Males are also mating that is likely why male body condition did not improve between studies

MC Study Results: Reproduction, Survival, Abundance; no questions

MC Harvest Recommendation: the increase is our GN recommendation from the scientific study. It doesn't mean that it has to be the TAH. It depends on what the goal for this population is—what do the communities want? Raising harvest higher carries more risk. This level represents what we think from a scientific study what would maintain this population.

GB Results:

- Willy—the board isn't that interested in Gulf of Boothia because it is very rare that we go there to hunt. The ice conditions are too dangerous. Young hunters do not have any knowledge about that area. We are not that interested in this population.

- Ralph said if a bear doesn't want to show up, you can't see it. It is the knowledge of our ancestors.

- Ben: when our young hunters go to Gulf of Boothia, they don't have a clue about the ice conditions and it's very dangerous…the ice can just take them.

- Willy: that actually happened with a sport hunting group—the ice split and took the hunters out to sea.

- Ben: the hunters that were taken the sport hunters, I was there, and I managed to get home before the ice split. The younger generation doesn't have a clue how the ice conditions.

- Markus: I can go over GB very quickly. It is my job; I have to tell you about it.

GB Results/TAH recommendation: Because it's stable and there are no changes that we can detect, we are recommending that there is no change to the TAH. If the communities feel differently—want more meat or public safety is an issue, then that is an opportunity to discuss how the TAH could change.

- Willy: It doesn't affect us.

- Markus: That's pretty much it for the presentation for the MC/GB. Are there any questions that the community here has with regards to GB/MC/LS boundaries and movements? We can hear these comments and try to see if they can be incorporated into our future work. We are doing LS and are going to be analyzing those samples in the next 4-6 years and we will let you know what we find—were there MC bears up there that we marked in 2014-2016.

- I know there is no desire from this community for collaring, but there are some communities that are interested in movements because they are wondering about climate change, increased development, increased shipping. For example, NTI approached me once about impact on bears from a development project, but I couldn't answer those questions because we don't have movement data. For now, maybe this is okay, but this may be important in the future.

- If there are specific questions from the communities or specific areas of interest, bring those forth to the regional wildlife board/NWMB priority—those priorities help the GN determine how they focus their resources and money along with our mandate to get updated information for the polar bear subpopulations.

- **Question Simon**: Peter DeGroot seems to be doing a lot of research in the last 20 years. What does he do with you guys?

- **Answer Markus**: He works for a university, not affiliated with GN. He is part of a big project, multiple universities, maybe 25 organizations supporting BearWatch – Peter is involved, but he is not the lead. It is looking at genetics, bacteria, developing a kit for fecal sampling. A lot of different projects but Peter is a tiny part of the bigger project. The GN supported Bearwatch because there are bits and pieces of this project that could help for management that we could not collect alone.

- **Question Willy:** Is this work they are doing helping us? It is helping the government…but what is it doing for us?

- **Answer Markus**: the samples are still being analyzed…from the many samples they are trying to determine if it's possible to see contaminants and genetics. As the GN, we could not do it. The idea was to be able to harness the resources of universities and their labs to gather information and develop potential new methods for non-invasive health monitoring of the bears.

- **Answer Jasmine:** also, we don't know if what BearWatch has proposed will work –it was an idea that had to be tested. The idea was to develop less invasive technologies and methods, but will it actually work? Don't know.

- **Question Ralph**: so whatever Peter does it is not affiliated with the NWMB?

- **Answer Markus**: that is correct. Whatever Peter does is not counting bears and they are not primarily responsible to providing info to NWMB for management decisions.

- Willy: they are mostly doing contaminants, health, same as they are doing with the fish.

- Roger: Hunting bears in GB is too far—takes a lot of gas and people don't go there. Mostly MC.

- Markus: the GN is not responsible for allocation—the KRWB does that. For GB, all 3 regional wildlife boards are involved for GB—they all have to talk to each other. That requires a lot of discussion, I think. I think it requires involvement of all the RWOs.

- Ben: Bears in MC once it starts to freeze up, they start to come to town…that's because they are not being harvested due to the moratorium. Even during the summer, there are bear sightings now.

- Markus: Also, probably not that much noise and traffic going out so they aren't afraid.

- Ben: it's because they aren't being harvested or disturbed by machines. They are even sighted far inland on King William Island. The population is healthy.

- Willy: Another thing is that between here and Taloyoak, there used to be a lot of traffic between the two communities even in the spring. Lately they have been seeing bears between here and Taloyoak. Seeing a lot of bears tracks, even wolf and wolverine around Clarence islands. Packs of wolves on the sea ice – Markus you've seen the wolves come into camp, two of them. Even going up to Boothia. But there are packs of wolves and they can also kill polar bears, from experience.

- Markus: the wolves could have an impact on the offspring of polar bears

- Willy: bottom line is that we saw a lot of bear sign and the 3 bears we got were very healthy and over 10 ft.

- Markus: that lines up with what we are seeing –that is really nice to hear.

- **Question Simon**: you were going to talk about sea ice Markus?

- **Answer Markus**: I think the way we looked at sea ice was that we included it our body condition analysis and how that might affect the body condition. We know from satellite imagery from last 30 years that ice has changed. We didn't do full analysis from satellite imagery or ice analysis on ice specifically. I don't' know if that's answering your question.

- Simon/Willy nod it was sufficient answer

- Ben: Used to have icebergs that even have cracks and there used to be abundance of seals and there were ice packs and they were easy to spot. Nowadays the bears are moving more because there are less icebergs –we don't see the icebergs anymore.

- Willy: we don't see much ice anymore.

- Markus: agree with the satellite imagery—barely any ice in MC channel in fall

- Willy: people that used to go harvest belugas to Prince of Wales, but as soon as they get westerly winds the ice would get pushed in and they'd be stuck for weeks---they have a hard time getting through because of ice, but now no problem…20 years a big difference in sea ice.

- **Question Markus**: that's the other question I have---if this northern area is free of ice, what's going on with bears? Do they stay on the little ice? Do they go on land? What do you guys see when you travel int eh summer?

- Ben: northwest king William island, bears would be swimming miles away from sea ice and can catch seal in open water. They're still hunting even if it's free of ice. They're always traveling even when it's full of ice.

- Willy: During the summer months, July/Aug prince of Wales, I stood and counted 33 bears in Cunningham bay—this happens when the beluga whales are coming in with their calves.

- Markus: to Willy---we tried to figure something out with you and watch bears there - remember?

- Willy: polar bears going after belugas staying in the mouth of the bay to catch them.

- **Question James** (via video on smartphone): Going to that old MOU, remember we had that issue with Taloyoak with them "stealing" our tags when the TAH went to 12. But maybe this is a RWO issue.

- **Answer Markus**: You are correct, this is definitely a point to bring up with the RWO.

- James: I'm trying to make the numbers more equal. I'm just trying to make the communities have a fair trade. If we want a higher TAH is that NTI?

- Jasmine: that would be the NWMB to raise the TAH. The RWO decides how to allocate the TAH.

- **Question Willy**: Why is Taloyoak involved in the TAH for MC when they were not involved when we signed the MOU. Taloyoak can harvest from MC but Gjoa can't get to GB. What are bears considered when they are harvested—MC/GB

- **Answer Markus**: The boundary goes right through Taloyoak

- Willy: so if Taloyoak has a defense kill is that considered MC

- Ben: there was a big male harvested as defense and counted as GB -- happened last year

- Markus: that is something that Kevin/Jack look into

- Kevin: okay

- **Question Jack**: isn't within 30km of the management unit a buffer zone?

- **Answer Markus**: yes, there is a 30 km zone that they can go on both sides.

- Willy: to board---do you have any concerns on bears?—time to ask

- **Question**:---is there going to be another polar bear survey again some time seen?

- **Answer Markus**: that is a very good question---we have seen with our experience that having these long empty data periods of many, many years, it makes analysis very, very challenging. Not just in MC, all the populations this is a struggle having these long gaps. That was the old system because it worked for money resources, bears are long-lived, and it was the management and monitoring plan initially but now we have realized that 15-20-year gaps are not good for analysis. Ideally, we'd like to be back in a few years for a one-year effort to sample bears in MC. That would help us get better data and get better estimates for survival. That is where the HTO comes in—if you make it a priority and identify it to the RWO and NWMB---say it's not okay to have long huge gaps for population assessments---that helps then us and the GN to make our case to allocate time/funding.

- **Question Kevin**: question regarding the 30 km buffer zone – where did that come from?

- **Answer Markus**: that was originally from the MOU—because bears don't respect boundary and hunters may not have always a precise location.

- Willy: like the Hadley Bay population and with NWT

- **Question Jack**: does that get carried forwarded from the MOU into the new polar bear management plan?

- **Answer Markus**: not sure, probably, don't have it memorized, can check. Just want to thank you for allowing us to come in person and giving us your time. Just because we're talking here, doesn't mean that we have to end the conversation…we are open for contact and can help any way we can.

- **Question Simon**: how often could you come to Gjoa Haven?

- **Answer Markus**: 2013 and now 2020 – so maybe twice in 7 years? We rotate through the 12 subpopulations – we have a better chance to make it to the regional AGM and we are certainly open to joining via video conference on an HTO meeting if you have interest or questions for us.

- Jasmine: Unfortunately, you are looking at all the biologists for Nunavut. What we'd like to do personally isn't always what we can do realistically. We would ideally be able to make regular visits and updates for all communities.

- Simon: reason I'm asking is because we've been waiting to hear since 2017

- Markus: I'll tell you the same thing I told Cambridge Bay—it was a long time to wait for these results I admit, it is not ideal --- MC was challenging because the data was so sparse, analysts really struggled to analyze the little bit of data, ransomware, and COVID. I wanted to be able to stand behind these numbers and support them and so it took longer than we predicted. We apologize for that.

- **Question Willy**: another comment/concern I'd like to mention is did you do MC then to GB? --

- **Answer Markus**: we did them at the same time

- **Question Willy**: could you do a survey in the summer?

- **Answer Markus**: No---because there is still ice enough for bears, but not enough for pilots. The pilots don't want to fly over open water and bears would still be in the water and on ice pans during that time—we would not be able to do proper coverage of the area. You'd have to have really low ice and bears would have to be on shore.

- Willy: it is good to hear that we are having a recommended increase and the population is healthy. Of course, we'd like a bit more. A lot of activity and population is increasing.

- End of meeting

C: Taloyoak

October 21, 2020

Start: 17:45

End: 20:15

<u>Participants:</u>

Joe Ashevak, Chairperson HTO
Tommy Aiyout
Bruce Takolik
Jayko Neeveacheak
Kovalak Kootook
J. Ware – GN-DOE
M. Dyck – GN-DOE
K. Methuen – GN-DOE
D. Anavilok – GN-DOE

- Joe: Board wanted to know whether there was going to be a public meeting and were under the impression that there was going to be a public meeting. It appears that Jimmy the manager forgot to bring this up to the GN (Joe asked Jimmy if he let the GN know that the HTO wanted a public meeting and Jimmy indicated that he forgot). *Note, the GN did not receive any notification or request for a public meeting prior to this meeting.*

- This is very important to us and we can wait—sometime this winter would be good. We really want this and have been waiting a long time. M'Clintock is very important. Is this a possibility to do?

- Markus/Jasmine – This is possible to do, but we don't know if it is likely and we cannot commit at this moment because we need to discuss with our supervisors and figure out a schedule.

Background slides: review; no questions

Study design/methods slides: passed around biopsy dart; answered a few questions regarding how the dart sampled the bear. No other questions.

Community participation slides: review; no questions

MC study results:

Body condition results: question to board – do you see the improvements in body condition between now and 20 years ago?

- Joe: well, we don't go to MC too much, but what we see are good. Up in Cunningham Bay, we see lots of bear there and they all seem to be in good shape. Did see a subadult that was frozen, dead, and had no fat on it. During darting, do you take a picture of every bear you see/dart? If not, you should. Take a picture of every bear you see and dart – from the top and side. That way you can easily see what kind of shape they're in.

- David A: two years ago, from Gjoa Haven, there were about 5 or 6 males around one female

- Joe: Cape Sydney---where they congregate when they are mating

- Markus: I found most of the breeding pairs in Larsen Sound and tip of King William Island—hanging out in the rough ice around the islands.

TAH recommendation/discussion:

- the GN recommendation is based on how certain we are with the estimate, it takes into account the uncertainty with the survival and abundance and it takes into account to maintain the population at our current estimate of ~700. This doesn't mean that the community has to decide to maintain the population at 700—there may be different management objectives. We've shared the same information with the other communities. The communities have to decide what the management objective will be for the population.

- One thing to keep in mind, every time that the harvest TAH gets higher, there is increased risk for population to down. Depending on what the management objective is, this may be a good thing or not. The objectives must be discussed among the communities. Also have to consider what effects the sea ice changes and environmental changes might have on the bears and their abundance. Any bear that the TAH is being increased is also increasing the risk for the population to decline in numbers. The communities should discuss really how they want to manage this population for the future for Nunavummiut thinking about harvest, and all the other factors such as ecosystem, sea ice, seals, contamination.

- You can bring your requests to the RWOs or you can contact us to help with these requests/questions. We are here to provide information and even after we are gone from here in person, we are still available to chat/help how we can.

- Joe/others: noted that there have been some observations of mothers with 3 cubs, even during the moratorium

- Markus: we didn't see any in MC or GB with 3 cubs

- **Question David**: did you see other animals during your survey –wolf and wolverine?

- **Answer Markus**: we saw 2 grizzly bears, but no wolves or wolverines during that time we were flying.

- Peter Aqqaq: regarding the lower yearling litter size---maybe you see less yearlings because there is a greater chance of running into an adult male now that there are more males in the population.

- Markus: good point. I've found 1 male coy over the years killed over the years. I thought if I saw more then it would be a big impact.

- **Question Joe**: So with MC, are we increasing the TAH?

- **Answer Markus**: the government is recommending an increase from 12 to 16

- **Question Joe**: we have 12 right now?—between Taloyoak, Gjoa Haven, Cambridge Bay? So only an increase of 4 –that's not very much.

- **Answer Markus**: yes, that is what the government is recommending.

- Kevin: to be consistent with other communities, you can make a submission at any time to the KRWB about allocation. That is the responsible body for allocating tags and the NWMB makes decisions on setting the TAHs.

- **Question Joe**: and if we get 16, how long would that be for—like how many years?

- **Answer Markus**: Speaking as a biologist, not only as the GN, you guys should chat with the other communities and decide on the management objective for the population. Decide what you want to do with this population. Is 700 just right? Want more? Fewer? These questions help decide what kind of harvest level you would want. So, I can't say for how long the TAH would be set.

- **Question Joe**: what was the TAH before the moratorium?

- **Answer Markus**: it was 32 and it was too high---led to the situation where the population went down to 284-300 bears.

- Jasmine: we provide the scientific estimate based on the survey data, but the hunters and communities know what that means practically on the land—what does this ‘number’ we provide mean to hunters using the land? That is the question – do hunters/communities feel comfortable at this level of bears, is that something you would like to maintain.

- Markus: the GN will only have real issues if it conflicts with The Agreement in which it is the government’s mandate to ensure sustainable harvests into the future.

- David: about the distribution of locations of sampling –found that during hunting there are differences in where seals are---seal distribution changing.

- Joe: global warming may be causing more open water and seals in the newer times—why the distribution of bears is changing. Shipping traffic increased.

- **Question Peter Aqqaq**: the GN has a fisheries and sealings department -- Do you compile the seal data with your polar bear data? Would that be a great idea to compile?

- **Answer Markus**: I’ve been wondering about that the last 10 years or so to see what they have. I do not know what they have --- they count the hides they buy and sell, but not sure if that would be able to tell how many seals there are just by counting the pelts that are sold.

- Joe: there was a cruise ship that ran aground a few years ago that could have an effect on the seal population. We didn’t get a report about that---whether there was fuel or other things that leaked.

- **Question Jayko** : Do you do studies in the summer time?

- **Answer Markus**: It depends on the population….when there are areas with both ice and water it is hard to know if bears on land or on the ice and pilots don’t like to fly over open water so those aren’t good study designs…for example MC or GB. In other areas, where it goes completely ice free and almost all the bears are on the shore, we can do the summertime.

GB results:

- **Question Joe**: what is the TAH for GB?

- **Answer Markus:** 74

- **Question Jayko:** are you guys getting new equipment –like cameras and stuff to take pictures that have the built-in ability to see how big the bears are?

- **Answer Markus:** I think I know what you're saying, and it might be a bit more complicated to determine actual size from a picture -- we would need to know altitude, distance, focal length. It might be possible to calculate size and do that. We could look into that.

- **Question Tommy**: talking about quota –all those communities Gjoa, Igloolik, Sanirajak, What the quota like before MC was shut down?

- **Answer Markus:** it was 42 until 2003/2004. It was increased to 74 in 2004/2005 because the study in 1998-2000 showed ~1600 bears instead of 900. I was around at that time of the moratorium in MC that communities were given a few tags for GB to preserve traditions during that moratorium and low harvest in MC.

- Joe: that was a big jump from 42 to 74.

- Markus: yes, I don't know how the recommendation went, but it seems that the 74 has been okay because the population has remained stable, though there may be some environmental changes that have helped the population---like the sea ice thinning/reduction in multi-annual ice and becoming better habitat for fish/seals/algae/etc.

- **Question Jimmy**: no colons being collected anymore?

- **Answer Jasmine:** correct, that was a collaborator project and they had funding for only a set number of years. That funding has run out and now they are working on analyzing the data. I am not sure when reports/information will be ready, but reports will be sent to communities with what they find.

- **Question Jimmy:** about credits? If we want to have a sport hunt, can we use our credits for sport hunts?

- **Answer Kevin:** Yes, that is not a problem. However, keep in mind that we haven't approved any outfitter licenses due to COVID. But, we can help support you for that if you have questions. Not much going on with sport licensing this year still with COVID.

- **Question David A.:** with the feces and Peter DeGroot study ---maybe ask the HTO to make sure there was approval – we're not sure there was approval.

- **Answer Markus:** I'm pretty sure that all Bearwatch research had permits—they would have gone through our department.

- **Question Kevin:** do you know when that permit expires?

- **Answer Markus**: I'm not sure—probably multi-year

- Kevin: during the research permit review period that is a good time to bring up any concerns or comments---that is the time to bring that forward and decide if you support. If you don't say anything, it is assumed to be approval from the HTO.

- **Question Bruce**: Is it mostly the GN that counts bears or do other people do it?

- **Answer Markus**: mostly it is GN, but sometimes we have to have help because it is only me and Jasmine. There are a few people that have lots of experience that we bring on to help out on big projects. I'm in charge of the program and I only get people with experience to do the work. And there are locals involved—it's not just the biologists.

- Following the meeting after Jasmine/Markus left, Kevin remained for other agenda items and it was mentioned again that there was a lot of disappointment that the public would not be hearing these results. Kevin reiterated that it appears this was not communicated to the GN and the biologists were not able to plan for this. Tonight was the first it was brought up about the desire for a public meeting.

- End of meeting

RE-ESTIMATING THE ABUNDANCE OF A RECOVERING POLAR BEAR SUBPOPULATION BY GENETIC MARK-RECAPTURE IN M'CLINTOCK CHANNEL, NUNAVUT, CANADA,

FINAL REPORT

29 July, 2020

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1. A) EXECUTIVE SUMMARY – ENGLISH

Polar bears (*Ursus maritimus*) are managed across Nunavut, Canada, under a harvest and monitoring system that seeks to ensure harvest is sustainable and identified management objectives are achieved. In recent decades, climatic changes across the Arctic have altered polar bear habitat at unprecedented rates. To retain viable polar bear subpopulations as part of the ecosystem and provide a subsistence resource for Inuit, scientific research and monitoring studies are conducted to evaluate subpopulation status and whether management objectives are being met. Here we report the results of a population study for polar bears inhabiting the M'Clintock Channel (MC) conducted 2014 – 2016. Current samples were collected using less-invasive genetic biopsy darting without immobilizing or physically handling bears. Our analyses included data from the 2014 – 2016 biopsy mark-recapture study, live-capture data collected under a mark-recapture study 1998 – 2000, and limited harvest recovery data over the entire period 1998 – 2016.

Results of a closed capture-recapture model, implemented in a Bayesian framework and fitted to data for independent animals (i.e., >2 years), suggest a mean abundance estimate of 716 (95% Credible Interval [CRI] = 545 – 955) for the period 2014 – 2016, indicating that the MC polar bear subpopulation increased from the mean abundance in 1998 – 2000 (325 [95% CRI = 220 – 484] in this study; 284 [SE: ± 59.3] in Taylor et al. [2006]). Both the male and female segment of the subpopulation increased between study periods (1998 – 2000 and 2014 – 2016), likely because of a combination of reduced harvest pressure and improved habitat quality. We used a closed population model because data were too sparse for models with more parameters. Estimates of abundance should be interpreted with caution because they reflect the "superpopulation" (e.g., it includes all bears that use the MC management area, some of which spend time in other subpopulations as well) and likely include positive bias due to violation of model assumptions in addition to the negative bias caused by variation in the capture probability. The overall mean litter sizes for the period 2014 – 2016 were 1.70 (SE = 0.09) and 1.61 (SE = 0.11) for cubs-of-the-year and yearlings, respectively. The calculated mean number of yearlings per adult female declined from 0.39 (SE =

0.10) to 0.28 (SE = 0.06) between both study periods, but MC remains a productive polar bear subpopulation despite that decline and observed sea-ice changes. However, given the sparse reproductive data, we are not able to make any substantive inferences. Polar bear body condition (i.e., relative fatness), assessed in the spring, generally increased between the periods 1998 – 2000 and 2014 – 2016. Estimated apparent survival for bears aged 2 and older was 0.88 (SE = 0.02), although this is likely biased downward due to temporary or permanent movement of individual bears with respect to the study area and limited data availability concerning immigration and emigration. This is corroborated by the increase in abundance estimates across periods indicating the survival rate had to be greater than 0.88 to achieve such substantial growth. When we calculated adult survival using the change in abundance estimates between 1998 – 2000 and 2014 – 2016, our estimated rate of 0.93 suggests that the population growth is positive, with a growth rate of 2%. Overall, our findings align with local knowledge that the MC subpopulation recovered from over-harvest that occurred 1979 – 1999 (average harvest 34 bears/yr). Ecologically, we hypothesize that the observed improvements in body condition and strong population growth over time may be related to spatial and temporal reductions in sea-ice type and quantity providing transient benefits to the MC subpopulation due to lighter ice conditions (i.e., a reduction in thick, multiyear ice) and increased biological productivity. However, climate change is the primary long-term threat to polar bears and the threshold beyond which the MC subpopulation could be negatively affected by continued ice loss, like some other polar bear subpopulations, is currently unknown.

Estimating demographic parameters for the MC subpopulation proved to be challenging because small sample sizes, low probability of recapturing the same bear, and lack of movement information constrained analyses in this study such that the estimates of abundance and survival are almost certainly biased. Our estimates represent only the second time the MC subpopulation has been inventoried under a replicable, structured study design and thus offer many opportunities to learn from these experiences in analysis and data collection methodology. For other wildlife populations or ecosystems that share similarities with MC, we recommend collecting additional reproductive data and genetic samples at approximately the midpoint between the current study and the next comprehensive subpopulation assessment (in Nunavut's case, that would be 5 – 7 years post-field work completion) or increasing study length (e.g. 4 – 5 years), to increase confidence in the survival rates, possible emigration, and reproduction. Further, movement data (satellite telemetry) are recommended. In the absence of satellite telemetry data on polar bear movements, we recommend conducting a meta-analysis to investigate exchange between MC and nearby subpopulations (i.e., Lancaster Sound, and Gulf of Boothia).

1. **B)** ᐊᐅᓚᙱᓂᕐᒧᑦ ᓇᐃᓈᕝᓯᒪᔪᑦ –

ᓇᓄᐃᑦ (*Ursus maritimus*) ᐊᐅᓚᑕᐅᒪᑕ ᓄᓇᕗᓕᒫᒥ, ᑲᓇᑕᒥ, ᐊᖑᓇᓱᐊᖅᑕᐅᓂᖏᓐᓂ ᐊᒻᒪᓗ ᖃᐅᔨᒪᓇᓱᐊᖅᑕᐅᓂᖏᓐᓂ ᐱᓕᕆᔾᔪᑎᒃᑯᑦ ᐋᖅᑭᒃᓯᓯᒪᓇᓱᐊᕈᑎᒋᔭᐅᓪᓗᓂ ᐊᖑᓇᓱᐊᖅᑕᐅᔪᑦ ᐋᖅᑭᒃᓯᒪᑎᑕᐅᕙᑎᐊᕈᓐᓇᕐᑯᓗᒋᑦ ᐊᒻᒪᓗ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᓗᑎᒃ ᐊᐅᓚᑕᐅᓂᖏᓐᓄᑦ ᐱᓕᕆᐊᖑᔪᒪᔪᑦ ᐊᑐᖅᑕᐅᔪᓇᕐᑯᓗᒋᑦ. ᐊᓂᒍᓚᐅᖅᑐᓂ ᕐᑯᓕᐅᕙᓚᐅᖅᑐᓂ ᐊᕐᕿᒍᓂ, ᓯᓚᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖓ ᐅᑭᐅᖅᑕᖅᑐᓕᒫᕐᒥ ᐊᓯᕈᒃᑎᙱᑎᓯᒪᖕᒪᑦ ᓇᓄᐃᑦ ᓇᔪᖅᐸᒃᑕᖏᓐᓂᑦ ᐊᔾᔨᐅᖏᑦᑐᒥᒃ ᐊᒃᓱᐋᓗᕐᓂᕋᕐᓗᑎᒃ. ᐱᓯᒪᔭᐅᖏᓐᓇᕐᑯᓪᓗᒍ ᐊᑐᖅᑕᐅᙱᑎᐊᕈᓐᓇᕐᓂᖏᑦ ᓇᓄᐃᑦ ᐊᒥᓲᓂᕐᑲᕐᕷᕆᔭᖏᑦ ᐃᓚᒋᔭᐅᓗᑎᒃ ᐅᒪᔫᕐᑲᑎᕆᒡᕕᐅᔪᓄᑦ ᐊᒻᒪᓗ ᓄᖑᑉᐸᓪᓕᐊᓗᐊᕐᑯᓇᒋᑦ ᐱᔭᐅᕐᑲᙱᑕᕈᓐᓇᕐᓂᖏᑦ ᐃᓄᖕᓄᑦ, ᖃᐅᔨᓇᓱᐊᕐᓂᕐᒧᑦ ᖃᐅᔨᓇᓱᐊᕐᓂᑦ ᐊᒻᒪᓗ ᖃᐅᔨᒪᒋᐊᖅᓯᓂᒧᑦ ᖃᐅᔨᓇᓱᐊᕈᑕᐅᔪᑦ ᐱᓕᕆᐊᖑᓯᖑᒪᑕ ᖃᐅᔨᓴᖅᓯᔾᔪᑕᐅᓗᑎᒃ ᐊᒥᓲᓂᒃᑲᓂᖏᑕ ᖃᓄᐃᓕᖓᓕᕐᓂᖏᓐᓂᑦ ᐊᒻᒪᓗ ᐊᑐᖅᑕᐅᙱᑎᐊᓕᕋᓗᐊᕐᒪᖕᒋᑕᓗ ᐊᐅᓚᙱᓂᕐᒧᑦ ᐱᓕᕿᐊᖑᔪᒪᔪᑦ ᓇᒪᓈᖅᑕᐅᓗᑎᒃ. ᑕᕝᕙᐅᑯᐊ ᐅᓂᒃᑳᓕᐊᕗᑦ ᓴᕿᓯᒪᔪᑦ ᐊᒥᓲᓂᖏᑕ ᖃᐅᔨᓇᓱᐊᖅᑕᐅᓂᖏᑦ ᓇᓄᐃᑦ ᓇᔪᖅᓯᔪᑦ ᐃᑦᑐᐊᖅᑑᑦ (MC) ᐱᓕᕆᐊᖑᓚᐅᖅᑐᑦ 2014-2016–ᒥ. ᒫᓐᓇᓕᕆᐃᑦ ᖃᐅᔨᓴᖅᓯᔾᔪᑎᒃᓴᑦ ᐱᔭᐅᕐᑲᑦᑕᓚᐅᖅᐳᑦ ᐊᑐᕐᓗᑎᒃ ᕿᒫᑎᙱᑎᓗᐊᕞᓗᖏᓐᓂᖅᓴᐅᓪᓗᑎᒃ ᐆᒪᔫᓂᖏᑕ ᖃᓄᐃᑑᓂᖏᓐᓂᑦ ᑲᐱᓯᔾᔪᑎᕐᑲᕐᓗᑎᒃ ᐊᐅᓚᔪᓐᓇᐃᓕᑎᑕᐅᖏᓪᓗᑎᒃ ᐊᕙᓗᓂᑦ ᐊᒃᑐᐊᔭᐅᓗᑎᒃ ᐱᓕᕆᐊᖑᖏᓪᓗᑎᒃ ᓇᓄᐃᑦ. ᖃᐅᔨᓴᖅᓯᓂᕗᑦ ᐃᓚᕐᑲᒃᐳᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᓂᒃ ᑕᐅᕙᖓᑦ 2014 – 2016–ᒥᑦ ᖃᓄᐃᑑᓂᖏᓐᓂᑦ ᓇᓗᓇᐃᖅᓯᖕᒪᑕ–ᐱᔭᐅᒃᑲᓐᓂᕐᓂᖏᓐᓂᑦ ᖃᐅᔨᓇᓱᐊᕈᑎᑦ, ᐆᒪᑎᓪᓗᒋᑦ–ᐱᔭᐅᔪᑦ ᖃᐅᔨᒪᔪᑎᒃᓴᑦ ᓄᐊᑕᐅᔪᑦ ᐅᑯᓇᓃᓪᓗᑎᒃ ᓇᓗᓇᐃᖅᓯᖕᒪᑕ–ᐱᔭᐅᒃᑲᓐᓂᕐᓂᖏᓐᓂᑦ ᖃᐅᔨᓇᓱᐊᕈᑎᑦ 1998-2000, ᐊᒻᒪᓗ ᑭᒡᓕᓕᓯᒪᔪᑦ ᓇᓐᓄᒃᑕᐅᓯᒪᔪᓂ ᑕᓱᖅᓯᔾᔪᑎ ᖃᐅᔨᒪᔪᑎᒃᓴᓂᒃ ᐊᑐᕐᓂᓕᒫᖓᓂ 1998-2016.

ᓴᖅᑭᓐᓂᖏᑦ ᒪᑐᔭᐅᓯᒪᓕᖅᑐᑦ ᐱᔭᐅᓚᐅᖅᑐ–ᐱᔭᐅᒃᑲᓐᓂᖅᑐᓄᓪᓗ ᐱᓕᕆᔾᔪᑕᐅᔪᖅ, ᐊᑐᓕᖅᑎᑕᐅᓚᐅᖅᓯᒪᖕᒪᑕ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᓕᐅᑎᐊᕈᑎᑦ ᓴᓇᓯᒪᔾᔪᑎᖏᓐᓂ ᐊᒻᒪᓗ ᓈᒻᒪᒃᑎᖅᑕᐅᓪᓗᑎᒃ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᓄ ᐃᒻᒥᑯᖅᑐᓄᑦ ᐆᒪᔪᓄᑦ (ᑐᑭᓕᐅᑎᓗᒍ, >2 ᐊᕐᕌᒍᑦ), ᐃᒫᖑᑐᐃᓐᓇᕆᐊᕐᑲᓂᕋᐃᓪᓗᓂ ᐊᒥᒐᖏᓐᓂᕆᓚᐅᖅᑕᖏᓐᓂᑦ ᒥᒃᓵᓴᒃᑕᐅᓂᕐᑲᕐᓗᑎᒃ 716–ᖑᓂᖏᓐᓂᑦ (95% ᐳᓴᓐᑎᑦ ᓱᓕᑐᐃᓐᓇᕆᐊᕐᑲᕐᓗᓂ ᓇᓪᓕᐊᖑᓕᖕᒋᕋᓱᐊᕐᓂᖓᓂ [CRI] = 545 – 955) ᐊᑐᕐᓂᖓᓂ 2014-2016, ᐅᖃᐅᓯᕐᑲᕐᓗᓂ ᑕᐃᒃᑯᐊ ᐃᑦᑐᐊᖅᑑᑦ (MC) ᓇᓄᖏᑕ ᐊᒥᓲᓂᒃᑲᓐᓂᖏᑦ ᐊᒥᓱᕈᓐᓇᐊᒃᑲᓐᓂᓚᐅᕐᒪᑕ ᑕᒫᙵᑦ ᐊᒥᒐᖏᓐᓂᕆᓚᐅᖅᑕᖏᓐᓂᑦ

ᑕᐅᕙᓂ 1998-2000–ᒥ (325 [95% ᐳᓴᓐᑎᑦ ᓱᓕᑐᐃᓐᓇᖏᖃᕐᓗᓂ ᓇᓪᓕᐊᖑᓕᖕᒫᕋᓱᐊᕐᓂᖔᓂ [CRI] = 220-484] ᑖᒃᑯᓇᓂ ᖃᐅᔨᓇᓱᐊᕈᑎᓂ; 284 [SE: ± 59.3] ᑕᐃᓗᕐ ᐃᑦ ᐊᐅᓪ [2006]). ᑕᒪᒃᑭᒃ ᐊᖑᑎᑦ ᐊᕐᓇᓪᓗᐃᓪᓗ ᖃᐅᔨᓴᖅᑕᐅᔪᑦ ᐊᒥᓲᓂᒃᑲᓐᓂᖏᓐᓂᑦ ᐊᒥᓱᕈᒃᑲᓐᓂᓚᐅᕐᒪᑕ ᐊᑯᓐᓂᖏᓐᓂ ᖃᐅᔨᓴᖅᑕᐅᑎᓪᓗᒋᑦ (1998-2000 ᐊᒻᒪᓗ 2014-2016), ᑕᐃᒪᐃᓕᔾᔪᑎᖃᒃᑐᒃᓴᐅᔪᖅ ᐊᑕᐅᑦᑎᒃᑰᕐᓗᒋᒃ ᖃᑦᓲᓐᓇᕈᓇᐊᖅᑕᐅᓚᐅᕐᓂᖏᓐᓂᑦ ᓇᓐᓄᒃᑕᐅᕙᒃᑐᑦ ᒪᓕᒃᑕᐅᕐᑯᔭᐅᓪᓗᓂ ᐊᒻᒪᓗ ᐱᐅᓂᖅᓴᐅᓕᕐᓂᖔᓄᑦ ᓇᔪᖅᑕᐅᕙᒃᑐᑦ ᐱᐅᓂᖓ. ᐊᑐᓚᐅᕋᑦᑕ ᒪᑐᓯᒪᓪᓗᒋᑦ ᐊᒥᓲᓂᖏᓐᓄᑦ ᐱᓕᓇᒧᑎ ᐱᔾᔪᑎᒋᓪᓗᒍ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᑦ ᓇᓗᓈᕿᓗᐊᓚᐅᕐᒪᑕ ᐱᓕᓇᔾᔪᑎᒃᓴᑦ ᖃᓄᐃᓕᒃᑲᓐᓂᖃᑦᑕᕐᓂᖏᓄᑦ. ᒥᒃᓴᐅᓴᒃᓯᔾᔪᑎᑦ ᐊᒥᖓᒋᓐᓂᖏᓄᑦ ᑐᑭᓕᐅᖅᑕᐅᔭᓇᖏᖃᕐᒪᑕ ᐅᔾᔨᖅᑐᖅᑕᐅᑦᑎᐊᕐᓗᑎᒃ ᐱᔾᔪᒋᓪᓗᒍ ᓴᕿᔾᔮᖅᑎᑦᑎᒻᒪᑕ “ᐊᒥᓱᕐᔪᐊᕌᓗᓂᖏᓐᓂᑦ” (ᑐᑭᓕᐅᑎᓗᒍ, ᐱᖃᓱᐅᔾᔨᖕᒪᑕ ᐃᓘᓐᓇᖏᓐᓂᑦ ᓇᓄᓕᒦᓂᑦ ᐊᑐᖅᑐᓂᒃ ᐃᑦᑐᐊᖅᑑᑦ (MC) ᐊᐅᓚᑕᐅᔪᒥ ᓇᔪᖅᑕᐅᕙᒃᑐᒥ, ᐃᓚᖏᓪᓗ ᑕᐃᒃᑯᐊ ᐃᓚᒋᔭᐅᑲᐃᓐᓇᓱᖑᓪᓗᑎᒃ ᐊᓱᖏᓐᓄᑦ ᐊᒥᓲᓂᒃᑲᓐᓂᐅᔪᓄᑦ) ᐊᒻᒪᓗ ᐱᖃᓱᐅᔾᔨᑐᐃᓐᓇᖏᖃᕐᒪᑕ ᓇᓚᐅᑦᑎᓗᑎᒃ ᐃᓚᐃᓐᓈᕐᓂᕐᒥᑦ ᑕᐃᒪᐃᔾᔪᑎᖃᕐᓗᓂ ᒪᓕᒃᑕᐅᑦᑎᐊᖏᓐᓂᖔᓂᑦ ᐱᓕᓇᔾᔪᑎ ᒥᒃᓴᐅᓴᒃᓯᔾᔪᑎ ᐃᓚᒃᑲᓐᓂᖏᓐᓂᑦ ᐱᐅᓈᖏᓪᓗᓂ ᐃᓚᐃᓐᓈᕐᓂᖅ ᑕᐃᒪᐃᑎᑕᐅᓗᓂ ᐊᔾᔨᒌᖏᓐᓂᖏᓐᓄᑦ ᐱᔭᐅᓂᖏᑕ ᑕᐃᓖᖑᑐᐃᓐᓇᖏᑲᕈᑎᖏᑕ. ᐃᓘᓐᓇᖏᓐᓄᑦ ᐃᕐᓂᐊᖑᔪᑦ ᐊᑎᖅᑕᐃᑦ ᐊᒥᓲᓂᖏᑦ ᐊᑐᖅᑎᓪᓗᒍ 2014-2016 ᐃᒫᑎᒋᐅᓚᐅᖅᐳᑦ 1.70 (SE = 0.09) ᐊᒻᒪᓗ 1.61 (SE = 0.11) ᐊᑎᖅᑕᕐᓄᑦ–ᐊᕐᕿᒍᒥ ᐊᒻᒪᓗ ᐊᕐᕿᒍᔾᔭᐅᔪᓄᑦ, ᐃᒃᐱᒋᑦᑎᐊᕋᓱᐊᕐᓗᒋᑦ. ᓈᓴᐅᓯᓇᐊᖑᔪᑦ ᐊᒥᓲᓂᖏᑕ ᖃᑦᓯᐅᓂᖏᓄᑦ ᐊᕐᕿᒍᔾᔭᐃᑦ ᐊᑐᓂ ᐃᓐᓇᕐᓄᑦ ᐊᕐᓇᓪᓗᓐᓄᑦ ᐅᓄᕈᓐᓃᓇᐊᓚᐅᕐᒪᑕ ᐃᒪᓐᓇᓂᑦ 0.39 (SE = 0.10) ᑎᑭᓪᓗᒋᑦ 0.28 (SE = 0.06) ᑕᒪᒃᑭᖏᓐᓂ ᖃᐅᔨᓇᓱᐊᖅᑕᐅᔪᓂ ᐱᓕᓇᐊᖑᓂᖏᓐᓂ, ᑭᓱᐊᓂ ᐃᑦᑐᐊᖅᑑᑦ (MC) ᐊᓱᕈᒃᑎᑦᑎᖏᒻᒪᑦ ᕿᑐᙱᐅᕈᓐᓇᕐᓂᖏᓂᑦ ᐊᒥᓲᓂᒃᑲᓐᓂᖏᑕ ᑕᒪᓐᓇᐅᓚᓗᐊᖅᑎᓪᓗᒍ ᖃᑦᓲᓐᓇᕈᒃᑲᓐᓂᕐᓂᖏᑦ ᐊᒻᒪᓗ ᖃᐅᔨᒪᒋᐊᖅᑕᐅᓂᖓ ᐃᒪᕼᐅᑉ–ᓯᑯᖓᑕ ᐊᓱᕈᕐᓂᖓ. ᑕᐃᒪᐃᒃᑲᓗᐊᖅᑎᓪᓗᒍ, ᑕᒪᓐᓇᐅᑎᓪᓗᒍ ᓇᓗᓈᕿᓗᐊᕐᓂᖓ ᕿᑐᙱᐅᕐᓂᖏᓐᓄᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᖅ, ᐊᔪᕋᑦᑕ ᑐᑭᖃᑦᑎᐊᖅᑐᓂᒃ ᖃᐅᔨᒪᔾᔪᑎᓕᐅᖅᑎᐊᒃᓴᖅ. ᓇᓄᐃᑦ ᑎᒥᖏᑕ ᖃᓄᐃᓐᓂᖏᑦ (ᑐᑭᓕᐅᑎᓗᒍ, ᑯᓂᓂᓪᓗᐊᑕᖓ), ᖃᐅᔨᓴᖅᑕᐅᔪᑦ ᐅᐱᕝᓛᒃᑯᑦ, ᐊᒃᓲᓂᖅᓴᐅᕙᓚᐅᖅᑐᑦ ᐊᑯᓐᓂᖏᓐᓂ ᐊᑐᖅᑎᓪᓗᒍ 1998-2000 ᐊᒻᒪᓗ 2014–2016. ᒥᒃᓴᐅᓴᒃᓯᔾᔪᑎᑦ ᐆᒪᓂᓇᓱᖏᓐᓂ ᓇᓄᐃᑦ ᐅᑭᐅᖃᓕᕐᓗᑎᒃ 2–ᓂᒃ ᐊᒻᒪᓗ ᐃᓐᓇᐅᓂᖅᓴᐅᓕᕐᓗᑎᒃ ᐃᒫᖑᓚᐅᖅᐳᖅ 0.88 (SE = 0.02), ᑕᐃᒃᑲᓗᐊᖅᑎᓪᓗᒍ ᑕᐃᓐᓇᐃᑦᑐᒃᓴᐅᔪᖅ ᐃᓚᐃᓐᓈᖅᑐᖅ ᐊᒃᐸᓇᐊᓂᖏᓄᑦ ᑕᐃᒪᐃᑲᐃᓐᓇᑐᐃᓐᓇᕋᓗᐊᖅᑎᓪᓗᒋᑦ ᐅᕝᕙᓗᓂᑦ ᐅᑎᔾᔩᔪᓐᓃᖅᑎᓪᓗᒋᑦ ᐃᕆᒃᑯᖓᔪᑦ ᓇᓄᐃᑦ ᖃᐅᔨᓇᓱᐊᖅᑕᐅᑯᒋᔭᖏᓐᓂ ᐊᒻᒪᓗ ᑭᒡᓕᓕᓯᒪᓂᖏᓄᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᑦ

ᐊᑐᓐᓇᐅᔪᑦ ᓇᓕᐊᖓᓄᐊᕐᑲᑦᑕᕐᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᓇᔪᒐᒡᓗᐊᑕᕆᓲᖏᓐᓂ. ᓇᓚᐅᑦᑎᓂᕋᐃᔾᔪᑕᐅᖓᑦ ᐊᒥᓲᓂᖅᓴᐅᓕᕐᓂᖏᓄᑦ ᐊᒥᒐᖏᓐᓂᖏᑕ ᒥᒃᓴᐅᓴᒃᑕᐅᓂᖏᓐᓄᑦ ᐊᑐᕐᓂᓕᒫᖓᓂ ᐅᕐᑲᐅᑕᐅᔪᖅ ᐆᒪᑯᑖᕐᑲᑦᑕᕐᓂᖏᑕ ᕐᑲᓄᑎᒋᐅᓂᖏᑦ ᐊᒃᓲᓂᖅᓴᐅᔭᕆᐊᕐᑲᕐᒪᑦ 0.88–ᒥᑦ ᑎᑭᐅᑎᔪᓐᓇᕋᔭᖅᐸᑦ ᑕᐃᒫᑎᒋᐊᓘᒃ ᐊᒥᓱᕈᓂᖏᓄᑦ. ᓈᓴᐅᓯᕆᔾᔪᑎᕐᑲᓕᕗᖓᑦᑕ ᐃᓐᓇᐃᑦ ᐆᒪᑯᑖᕐᑲᑦᑕᕐᓂᖏᓐᓂ ᐊᑐᕐᓗᑕ ᐊᓯᕈᕐᓂᖏᓐᓂᑦ ᐊᒥᒐᖏᓐᓂᖏᑕ ᒥᒃᓴᐅᓴᒃᑕᐅᔪᑎᖏᓐᓂᑦ ᐊᑯᓐᓂᖏᓐᓂ 1998-2000 ᐊᒻᒪᓗ 2014-2016, ᒥᒃᓴᐅᓴᒃᓯᔾᔪᑎᑦᑕ ᐊᒥᓲᓂᕋᐃᔾᔪᑎᕐᑲᕐᒪᑕ 0.93 ᐃᒫᖑᓂᕋᐃᖓᒪᑕ ᐊᒥᓲᓂᖏᑕ ᐊᒥᓱᕈᕐᓂᖏᑦ ᐱᐅᓈᕐᓂᕋᒃᑕᐅᓪᓗᑎᒃ, ᐊᒥᓱᕈᕐᓂᕐᑲᕐᓗᑎᒃ ᐱᕙᓪᓕᐊᓂᓕᖏᑦ 2% ᐳᓴᓐᑎᓂᒃ. ᐃᓅᓐᓇᓕᒫᖏᑦ, ᕐᑲᐅᔨᔭᑦᑕ ᐊᔾᔨᕐᑲᓪᓗᐊᓕᖅᓯᒪᖓᒪᑕ ᓄᓇᓕᖕᓂ ᕐᑲᐅᔨᒪᓂᕆᔭᐅᔪᓄᑦ ᑕᒪᒃᑯᐊ ᐃᑦᑐᐊᖅᑰᑦ (MC) ᐊᒥᓲᓂᒃᑲᓐᓂᖏᑦ ᕐᑲᓄᐃᑦᑐᓐᓃᓚᐅᕐᒪᑕ ᓇᓐᓄᒃᑕᐅᓗᐊᕐᑲᑦᑕᓚᐅᖅᑎᓪᓗᒋᑦ ᐊᑐᓚᐅᖅᑐᓂ 1979-1999-ᒥ (ᐃᒪᓐᓇᑎᒋᐅᑲᔪᙵᓗᑎᒃ ᓇᓐᓄᒃᑕᐅᕗᒃᑐᑦ 34 ᓇᓄᐃᑦ/ᐊᕐᕌᒍᒥ). ᓄᓇᒥᐅᑕᓕᕆᓗᓂ, ᑲᖏᓱᒃᑲᑦᑕ ᕐᑲᐅᔨᔭᐅᓯᒪᔪᑦ ᐱᐅᓯᒃᑲᓐᓂᕈᑎᑦ ᑎᒥᖏᑕ ᕐᑲᓄᐃᓐᓂᖏᓐᓂ ᐊᒻᒪᓗ ᐊᒃᓯᐊᓗᒃ ᐊᒥᓱᕈᕐᓂᖏᑕ ᐱᕈᑦᑎᐊᕐᓂᖏᑦ ᐊᑐᖅᑎᓪᓗᒋᑦ ᐱᕙᒃᓴᕐᑲᕐᓂᑦ ᑐᕙᖓᑐᐃᓐᓇᕆᐊᕐᑲᕐᒪᑕ ᐃᓂᕐᑲᕐᓂᖏᓄᑦ ᐊᒻᒪᓗ ᐱᕕᕐᑲᓗᐊᕈᓐᓃᕐᓂᖏᓄᑦ ᐃᒪᕕᐅᑉ–ᓯᑯᖓᓂ ᑕᐃᒫᖑᒃᐸᑦ ᐊᒻᒪᓗ ᐊᒥᓲᓂᖏᑦ ᕿᓚᒥᐋᓗᕐᓗᑎᒃ ᐱᕚᓪᓕᕈᑎᒃᓴᐅᓂᖏᑦ ᐃᑦᑐᐊᖅᑰᑦ (MC) ᐊᒥᓲᓂᒃᑲᓐᓂᖏᓄᑦ ᑕᐃᒪᐃᑎᑕᐅᓗᓂ ᓵᓐᓂᖅᓴᐅᓕᕐᓂᖓᓄᑦ ᓯᑰᑉ ᕐᑲᓄᐃᓕᖓᓂᖓᑕ (ᑐᑭᓕᐅᑎᓗᒍ, ᓵᒡᓕᒃᑲᓐᓂᕐᓂᖓᓄᑦ ᐃᔾᔪᓂᖓᑕ, ᓯᑯᑐᕐᑲᓗᒃ) ᐊᒻᒪᓗ ᐊᒃᓲᓂᖅᓵᓕᕐᓂᖓ ᐅᒪᔪᑦ ᕿᑐᙵᐅᕈᓐᓇᕐᓂᖏᑦ. ᑕᐃᒪᐃᒃᑲᓗᐊᖅᑎᓪᓗᒍ, ᓯᓚᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖓ ᐱᓪᓗᐊᑕᐅᖓᑦ ᐊᑯᓂ–ᑕᐅᕙᖓᑐᕐᒃᑲᒃ ᓯᕗᕋᓇᖅᑎᑦᑎᔪᖅ ᓇᓄᕐᓄᑦ ᐊᒻᒪᓗ ᐱᒋᐊᕐᕕᒋᑐᐃᓐᓇᕆᐊᕐᑲᓕᕐᓗᓂᐅᒃ ᐅᖓᑕᓄᑦ ᐃᑦᑐᐊᖅᑰᑦ (MC) ᐊᒥᓲᓂᒃᑲᓐᓂᖏᑦ ᐱᐅᓈᖏᑐᒃᑯᑦ ᐊᒃᑐᖅᑕᐅᓂᕐᑲᑐᐃᓐᓇᕆᐊᕐᑲᓕᕐᒪᑕ ᓯᑯᕐᑲᕈᓐᓃᖅᐸᓪᓕᐊᑐᐃᓐᓇᖅᐸᑦ, ᑕᐃᒪᓐᓇᑦᑕᐅᖅ ᐊᓯᖏᑎᑐᑦ ᓇᓄᐃᑦ ᐊᒥᓲᓂᒃᑲᓐᓂᖏᑕ, ᒫᓐᓇ ᕐᑲᐅᔨᒪᔭᐅᖏᒪᑕ. ᒥᒃᓴᐅᓴᒃᓯᓂᖅ ᐅᓄᖅᓯᕙᓪᓕᐊᓂᓕᕆᓂᖅ ᕐᑲᓄᐃᓕᕙᓪᓕᐊᕐᑲᑦᑕᕐᓂᖏᓐᓄᑦ ᐃᑦᑐᐊᖅᑰᒥ ᐊᒥᓲᓂᒃᑲᓐᓂᖏᑕ ᓇᓗᓇᐃᖅᓯᓚᐅᕐᒪᑕ ᐱᓕᕆᐊᕆᓇᓯᐊ]ᒡᒐᕆᐊᕐᑲᕐᓂᖏᓐᓂᑦ ᐱᔾᔪᑎᒋᓪᓗᒍ ᒥᑭᔪᐋᓗᓂᖏᓄᑦ ᕐᑲᐅᔨᓴᒐᒃᓴᐃᑦ ᐊᖏᓂᖏᑦ, ᐱᔭᐅᒃᑲᓐᓂᖏᑐᐃᓐᓇᕆᐊᕐᑲᕐᓂᖏᓄᑦ ᐱᒃᑲᓐᓂᖅᑕᐅᒐᔭᕐᓂᖏᑦ ᑖᓐᓇᑦᑕᐃᓐᓇᐅᑉ ᓇᓄᑉ, ᐊᒻᒪᓗ ᐱᑕᕐᑲᖏᓐᓂᖓᓄᑦ ᓇᓕᐊᖓᓄᐊᕐᓂᖏᑕ ᑐᓴᐅᒪᔾᔪᑎᒃᓴᐃᑦ ᓄᕐᑲᒃᑎᑦᑎᓱᒍᒪᑕ ᕐᑲᐅᔨᓇᓯᐊᕐᓂᕐᒥᑦ ᑕᑦᓱᒪᓂ ᕐᑲᐅᔨᓇᓯᐊᕐᓂᕐᒥ ᓲᕐᓗ ᑕᒪᒃᑯᐊ ᒥᒃᓴᐅᓴᒃᓯᔾᔪᑎᑦ ᐊᒥᒐᖏᓐᓂᖏᓐᓂᑦ ᐊᒻᒪᓗ ᐆᒪᑯᑖᕐᑲᑦᑕᕐᓂᖏᓐᓂᑦ ᐃᒫᐸᓗᓪᓚᕆᐅᖓᑕ ᓇᓗᓇᖏᑦᑎᐊᕐᓗᑎᒃ ᐃᓚᐃᓐᓈᕐᓂᖏᑦ. ᒥᒃᓴᐅᓴᒃᓯᓂᕆᔭᕗᑦ ᑭᒡᒐᖅᑐᐃᖓᑕ ᐊᐃᑉᐹᓂᑐᐊᖅ ᐱᕕᕐᑲᕐᓂᕐᒥ ᐃᑦᑐᐊᖅᑰᒥ ᐊᒥᓲᓂᒃᑲᓐᓂᕆᔭᐅᔪᑦ ᓈᓴᖅᑕᐅᓚᐅᕐᒪᑕ ᐊᑐᖅᑕᐅᓕᖅᑭᒍᓐᓇᕐᑯᓪᓗᒋᑦ,

ᐋᖅᑭᒃᓱᖅᑕᐅᓯᒪᓗᑎᒃ ᖃᐅᔨᓇᓱᐊᕐᓂᐅᑉ ᓴᓇᓯᒪᓂᖓ ᐊᒻᒪᓗ ᑕᐃᒪᐃᓂᖓᓄᑦ ᐊᒥᓱᓂᒃ ᐱᓕᕆᕕᒃᓴᐅᓕᖅᑎᑦᑎᓪᓗᓂ ᐃᓕᓐᕕᒃᓴᐅᓂᖓᓂᑦ ᑕᒪᒃᑯᓂᖓ ᐱᓕᕆᐊᖑᓯᒪᔪᓂᑦ ᖃᐅᔨᓇᓱᐊᖅᑕᐅᓯᒪᔪᓂᑦ ᐊᒻᒪᓗ ᖃᐅᔨᒪᔪᑎᒃᓴᐃᑦ ᓄᐊᑕᓯᒪᓂᖏᓄᑦ ᐱᓕᕆᔾᔪᓯᐅᓲᓂᑦ. ᐊᓯᖏᓐᓄᑦ ᐆᒪᔪᑦ ᐊᒥᓲᓂᖏᓄᑦ ᐅᓐᓄᓗᓂᑦ ᐆᒪᔫᖃᑎᒋᕝᕕᐅᔪᓂ ᐱᖃᖃᑎᖃᒃᑐᓂᒃ ᐊᔾᔨᓗᐊᐸᓗᖏᓐᓂᑦ ᐃᑦᑐᐊᖅᑑᑦ (MC), ᐊᑐᖅᑕᐅᖁᔨᕗᒍᑦ ᓄᐊᑦᑎᖁᔨᓪᓗᑕ ᐃᓚᒃᑲᓐᓂᖏᓐᓂᑦ ᕿᑐᙱᐅᕈᓐᓇᕐᓂᖏᓐᓄᑦ ᖃᐅᔨᒫᔪᑎᒃᓴᓂᒃ ᐊᒻᒪᓗ ᐆᒪᔫᓂᖏᑕ ᖃᐅᔨᓴᖅᑕᐅᔾᔪᑎᒃᓴᖏᓐᓂᑦ ᑎᑭᐅᒪᐸᓗᒡᓗᑎᒃ ᕿᑎᓪᓗᐊᐸᓗᐊᓄᑦ ᐊᑯᓐᓂᖏᓐᓂ ᒫᓐᓇᕋᑕᖅ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᓂ ᐊᒻᒪᓗ ᑭᖑᓪᓕᕐᒥ ᑕᒪᐃᓐᓂᑦ ᐊᒥᓲᓂᒃᑲᓐᓂᕆᔭᐅᔪᓂᑦ ᖃᐅᔨᓴᖅᓯᔪᖃᓕᕐᓂᖅᐸᑦ (ᓄᓇᕗᒻᒥ ᐱᓕᕆᐊᖑᔪᓂ, ᐃᒑᖑᒐᔭᖅᐳᑦ 5-7 ᐊᕐᕌᒍᓂ ᓯᕗᓂᖓᒍ–ᑕᖅᑮᓂ ᐃᖃᓇᐃᔭᖑᒐᔭᑐᓂ ᐱᔭᕇᒃᓯᔪᖃᕋᓱᐊᕐᓂᖓᓂ) ᐅᕝᕙᓗᓂᑦ ᐊᑯᓂᐅᓂᖅᓴᐅᓕᖅᑎᑕᐅᒋᐊᕐᓗᓂ ᖃᐅᔨᓇᓱᐊᕐᕕᐅᓲᑦ ᐊᑯᓂᐅᓂᕆᓲᖓ (ᑐᑭᓕᐅᑎᓗᒍ 4-5 ᐊᕐᕋᒍᓄᑦ), ᐊᒃᓲᓂᖅᓴᐅᓕᖅᑎᒋᐊᕐᓗᒋᑦ ᖁᓚᕐᓇᕐᒋᑦᑎᐊᕐᓂᕐᒋᑦ ᐆᒪᑯᑖᖅᑲᑦᑕᕐᓂᕐᒋᑕ ᖃᓄᑎᒋᐅᓂᕐᒋᑦ, ᐊᓯᐊᓄᐊᑐᐃᓇᓕᐊᖃᕐᓂᕐᒋᑕ, ᐊᒻᒪᓗ ᕿᑐᕐᐅᖃᑦᑕᕐᓂᕐᒋᑕ. ᓱᓕᒃᑲᓐᓂᖅ, ᓇᓕᐊᕐᓄᐊᕐᓂᕐᒋᑕ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᕐᒋᑦ (ᖃᕐᓚᑦᑕᖅᑎᑕᐅᓯᒪᔫᒃᑯᑦ ᑎᑎᖅᓯᕙᓪᓕᐊᔪᑎᑦ) ᐊᑐᖅᑕᐅᖁᔭᐅᕗᑦ. ᐱᑕᖃᒃᑎᓐᓇᒍ ᖃᕐᓚᑦᑕᖅᑎᑕᐅᓯᒪᔫᒃᑯᑦ ᑎᑎᖅᓯᕙᓪᓕᐊᔪᑎᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᓂᒃ ᓇᓄᐃᑦ ᓇᓕᐊᕐᓄᐊᕐᓂᕐᒋᓐᓂᑦ, ᐊᑐᖅᑕᐅᖁᔨᕗᒍᑦ ᐱᓕᕆᐊᕐᖁᖁᓪᓗᒋᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᓕᐅᕐᓂᖅ ᖃᐅᔨᓇᓱᐊᖅᑕᐅᖁᓗᒍ ᑕᐅᖅᓯᕐᓃᑦ ᐅᑯᓇᓂ ᐃᑦᑐᐊᖅᑑᑦ (MC) ᐊᒻᒪᓗ ᖃᓂᒋᔾᔭᓂᑦᑐᑦ ᐊᒥᓲᓂᒃᑲᓐᓂᕐᒋᑦ (ᑐᑭᓕᐅᑎᓗᒍ, ᐸᓐᓂᖅᑐᑉ ᑲᕐᒋᖅᓘᐊᓂ, ᐊᒻᒪᓗ ᐃᑭᕋᓴᐅᑉ ᐃᒪᖓᓂ).

1. C) KAVAMALIQINIRNUT NAINAAQHIMAJUQ –

Nanuit (*Ursus maritimus*) munariyauyut tamainni Nunavunmi, Kaanatami, angunahuarniqmut munariniqmulu qiniqtut naunairiami angunahuarniq munariyauyuq ilitariyauyuqlu munariniqmut piyangit. Taimaa 10nik ukiunik, hilaup aadlangurninnga tamainni Ukiuqtaqtumi aadlanguqtitait nanuit nayugangit aadlatqiiktumik nampanik. Pihimagiami nakuuyumik nanuit amihunik ilagiyanganik avatinganik tuniyuqlu inuujjutikhangit Inungnut, nalunaqtunik naunaiyainiq munarininnganiklu piyait naunaiyariami amihunik qanurittaakhaanik taimaalu munarininngit piliqtait. Hamani uqaqtavut qanurittaakhaanik amihuuninnginnik naunaiyainiq nanuqnut nayugangit Ittuaqtuuq (MC) havaktait 2014-2016. Nutaat uuktuutingit katitiqtauyut aturhutik mikitqiamik-pittailiniq ihariagiyainnik niqinginnik piiyaqtauniq kapuqtauyut nutqaqtihimaittumik akhuraalukluuniit pilugit nanuit. Ihivriurutivut ilaliutihimayuq nampangit uumannga 2014-2016 niqinginnik piiqtauniq naunaiqtait piffaarhugit nanuit naunaiyainiq, tuqutihimaittumik piplugit nampangit katitiqtait uumani naunaiyainiq piffaarhugit naunaiyainiq 1998-2000, kikliqaqtumiklu angunahuarniq piffaarninnga nampangit tamainni uumani 1998-2016.

Qanurittaakhaanik umikhimayumik piyait piffaaqtait uuktuutigiplugu, iliuraqtuq uuminnga Nampanik ihivriuqniq tunngavinga ihuarhaqtauyuqlu nampangit inmikkuuqtunut huradjat (ukunatitut, >2 ukiunik), piyuq piqarninnganik itqurnarutauyuq uuminnga 716 (95pusantmik Itquumayuq Nutqarninnga [CRI] = 545 – 955) uumunnga 2014-2016, naunaiqtait tamna MC nanuit amihuuninngit angikliyuumiqtuq uumannga amihuuninnganik uumani 1998-2000 (325 [95pusantmik CRI = 220 – 484] uumani naunaiyaininngani; 284 [SE: ± 59.3] uumani Taylor aadlallu. [2006]). Tamarmik anguhalluk arnallatlu ilagiyanga uuminnga amihuuninngit angikliyuumiqtuq naunaiyaqtillugit (1998-2000 uumanilu 2014-2016), aadlatqiiktumik ikikliyuumiqtuq angunahuarniqmut akhuurniq ihuaqhaqhimayuqlu nayugangit qanurittaakhaanik. Atuqtugut qaffit inuuyut angikliyuumiqtut tuqutut uuktuutigiplugu taimaa nampangit piqalluanginmat uuktuutikhamut amihunik kikliqarninnga. Itqurnarninnga amihuuninnganik pipkaijjutauyukhaq qayagilugit taimaa naunaiqmata “amigaininnga” (ukunatitut, ilaliutikmata tamaita nanuit atuqtait MC munarininnga, ilangit nayuqpaktut aadlani amihuuninngit ukuatlu) ilaliutiniaruknaqhiuq nakuuyumik ihuittumik piyuq ulapiqutiyuq uuktuutimut maliktakhangit unalu nakuungittumik ihuittumik pipkaijjutauyuq aadlatqiininnganik pigaangamitkik. Tamainnit nanunnuangit aktikkulaangit uumunnga 2014-2016 ittuq 1.70 (SE = 0.09) unalu 1.61 (SE = 0.11) nanunnuangit-ukiungani unalu atauhiqmik ukiulik, inmikkut. Naunaiyarhimayuq qaffiuyut atauhiqmik ukiulik atauhiqmut arnallakmut mikhiyuq uumannga 0.39 (SE = 0.10) uumunnga 0.28 (SE = 0.06) tamarmiknit naunaiyaininnganik, kihimi MC nakuuyumik piyuq nanuit amihuuninngit humaangittuq mikhiyuq qun’ngiaqtauyuqlu tariup hikunga aadlangurniq. Kihimi, tuttumik nanunnuaqarninnganik nampangit, piliulimaittugut ihariagiyauyumik ihumagininngit. Nanuit timingit qanurittaakhaanik (ukunatitut, puvalaniq), naunaiyarhimayuq upin’ngakhami, angikliyuumiqtuq uumani 1998-2000 uumanilu 2014-2016. Itqurnarutauyut naunaittuq inuujjutingit nanuqnut ukiulgit 2mik avatqumayuqluunit 0.88 (SE = 0.02), taimaa pilimaittuq ihuittuq mikhiyuq tadjakaffukmut ingilrainnaqtullu nanuit naunaiyaininnganut kikliqaqtumiklu nampangit piqarninnga piyuq tikittunik nuutiqtirninngalu. Una naunaiqtauyuq angikliyuumiutinganik amihuuninnganit itqurnarninnga tamainni naunaiyaiyuq inuujjutingit nampangit angitqiyauyukhaq uumannga 0.88 pigiami angiyumik angikliyuumirniq. Taimaa naunaiyarmatku angayukhiuyut inuujjutingit aturhugu aadlangurninnga amihuuninnganik itqurnarninnga uumani 1998-2000 uumanilu 2014-2016, itqurnarutauyut nampavut uuminnga 0.93 pitquyait amihuuninnga angikliyuumiutinga nakuuyuq, piqarhuni angikliyuuminnga nampanga 2pusantmik. Tamainnit, naunaiqtavut aadjikutariyaa nunallaani ilihimaniq tamna MC amihuuninngit piffaaqtait amihumik angunahuarniq piyuq uumani 1979-1999 (angunahuarninnga 34 nanuqnik/atauhiqmi ukiumik). Avatininnganut, ihumagiyaqqut qun’ngiaqtauniq ihuarhiyut timinginnik akhuraaluklu amihuuninnga angikliyumiqtuq taimaa piyuq inikhanganik qangarnitamik ikikliyuumiqtuq tariup hikunga qanurittaakhaanik qanuraaluklu tuniyuq tadjakaffuk ikayuutauyuq uumunnga MC amihuuninngit pikmat uumannga tualihimayuq hikunga (ukunatitut, ikikliyuumiqtuq hilikninnga, amihunik ukiut hikunga) unalu angikliyuumiqtuq inuujjutinganik qanurittaakhaanik. Kihimi, hilaup aadlangurninnga hivulliutinga akuniraalukmik qayangnarutauyuq nanuqnut aullaqtirininnga uumannga MC amihuuninngit nakuungittumik ayurhautipkaiyuq hikuirninnganit, taimaatut ilangit aadlat nanuit amihuuninngit, tadja naluyait.

Itqurnarutiyuq piyuq amihuuninnganik kiklikhangit uumunnga MC amihuuninngit naunaiqtuq akhuurutauyuq taimaa mikkait uuktuutingit aktikkulaangit, piqalluanginmat piniaruknaqhiyuq piffaarumitkut tamna piyaraluangit nanuq, piqalluanginmallu ingilrarninnga naunaitkutingit pitquyauyuq naunaiyainiq uumani naunaiyaqtamiknik taimaa itqurnarninnga amihuuninnganik inuujjutingalu taimaa ihuittuq. Itqurnarutikput piyaa tuglianganik MC amihuuninngit naunaiqtauyuq uumani aadjikutaliurhimayuq, ihuarhaqhimayuq naunaiyaininnga piliurninnga talvuuna tuniyuq amihunik pivikhaqautikhaq ayuiriami tahapkunanit atuqtamiknik naunaiyaininngani nampanganiklu katitiqtut piplugu. Aadlanut huradjat amihuuninngit avatingaluuniit atuqtait aadjikutariikninnga uumunnga MC, katitiquyavut aadlanik nanuliurniqmut nampangit unalu auminganik uuktuqtut qitqani uumannga nutaamit naunaiyainiq aippaangalu iluittuq amihuuninngit naunaiyainiq (Nunavutimi, inniaqtuq 5-7 ukiunik maniqqamungaqtinnagu havaanga iniqtaukpat) angikliyuumirluguluuniit naunaiyaininnga qanuraaluktut piyakhaq (ukunatitut 4-5 ukiunik), angikliyuumiriami ilihimaninnga inuuyunik nampanginnik, unaluuniit ahinunngauyut, nanuliurniqlu. Unalu, ingilraninnga nampangit (saatalaitkut nipiliurniq tunigiamilu taiguqtanginnik) pitquyauyuq. Piqangitkumi saatalaitkut nipiliurniq tunigiamilu taiguqtanginnik nampangit nanuit ingilraninnginnik, pitquyavut pigumik ihivriurninnga nampanganik ihivriuriami himmautingit uumannga MC qanittullu amihuuninngit (ukunatitut, Aqqusiriaq, uumanilu Kangirłurulukmilu).

2. INTRODUCTION

Wildlife managers face complex decisions when seeking to balance conservation and human priorities. Decisions and outcomes must be evaluated periodically so that new information can be fed back into an adaptive management framework (Holling 1978, Lancia et al. 1996, Johnson 1999). Accurate and up-to-date estimates of population abundance are often a key component of informed management decisions (Nichols and Williams 2006). Typically, new estimates of abundance are acquired periodically according to a monitoring interval that is determined by management objectives, species' biology (Gibbs 2008), and available resources. As climatic changes affect many areas around the globe, shortened monitoring intervals may be required to understand the concurrent effects of management interventions and environmental change. Broadly, more frequent monitoring increases the probability of meeting management objectives and reduces the severity of potential negative outcomes (Taylor et al. 2007, Regehr et al. 2017).

One species that has received significant monitoring attention is the polar bear (*Ursus maritimus* Phipps 1774). Polar bears are characterized by having delayed maturation, small litter sizes, and high adult survival rates (Bunnell and Tait 1981). They are at the top of the Arctic food chain and depend on the sea ice for hunting, travel, mating, and in some instances denning (Amstrup 2003). Sea-ice loss resulting from climate change is predicted to impact polar bear subpopulations severely in the future (Derocher et al. 2004, Stirling and Parkinson 2006, Amstrup et al. 2008, Durner et al. 2009, Stirling and Derocher 2012, Atwood et al. 2016, Regehr et al. 2016). The global polar bear population, consisting of 19 subpopulation units, is estimated to be approximately 26,000 polar bears (Obbard et al. 2010, Wiig et al. 2015). There is not currently empirical evidence for declines in global abundance due to sea-ice loss (Regehr et al. 2016). However, accurate assessment of such changes is complicated by poor data for many polar bear subpopulations (Durner et al. 2018, Hamilton and Derocher 2018), spatial and temporal variation in the effects of sea-ice loss, and the fact that some subpopulations have likely recovered in recent decades from overexploitation prior to the 1973 Agreement on the Conservation of Polar Bears (Honderich 1991, Larsen and Stirling 2009).

Despite on-going research and monitoring efforts on polar bears to date, reliable and updated abundance and demographic information about all subpopulations is still lacking (Obbard et al. 2010, Vongraven et al. 2012, Durner et al. 2018). Polar bear research is expensive and logistically challenging, especially for management jurisdictions that oversee more than one subpopulation. Nunavut, Canada, is home to 12 subpopulations (8 shared with other jurisdictions, 4 entirely within Nunavut; Obbard et al. 2010) and as such, carries the major responsibility of polar bear research and management in Canada. In order to maintain healthy and viable polar bear subpopulations, population studies in Nunavut are carried out on average within a 10 – 15-year rotational cycle, which can vary depending on research needs and priorities (Hamilton and Derocher 2018) along with available resources. Here we present findings from a 2014 – 2016 monitoring study to re-estimate abundance of the M'Clintock Channel (MC) polar bear subpopulation.

M'Clintock Channel is entirely managed by Nunavut, Canada (Figure 1) and an initial physical mark-recapture study was carried out from 1973 – 1978 (Furnell and Schweinsburg 1984) for both MC and the adjacent Gulf of Boothia (GB) subpopulation together as a single demographic unit. The total abundance estimate for both areas was 1081 bears. The estimate was known to be biased by non-representative sampling and was subsequently increased to 900 for GB and 900 for MC based on back-calculations to determine abundance levels that would be necessary to sustain the existing subsistence harvest levels (Aars et al. 2006, Taylor et al. 2006) along with local indigenous knowledge.

In the mid-1990s, the MC estimate was revised downwards to 700 based on hunter reports of reduced densities of polar bears (Aars et al. 2006, Taylor et al. 2006). M'Clintock Channel and GB were later delineated based on movements of satellite radio-collared adult female bears, recoveries of research tags in the harvest (Taylor and

Lee 1995, Taylor et al. 2001), and Inuit knowledge about how local conditions may influence the movements of polar bears (Keith et al. 2005). Genetic analyses based on microsatellite data also suggested some level of differentiation between the MC and GB subpopulations, although the magnitude of population structuring was higher among females than males (Campagna et al. 2013). Past harvests in MC of 34 bears/year from 1979 – 1999 were considered unsustainable (Taylor et al. 2006), resulting in a harvest moratorium from 2001/2002 – 2003/2004 and a reduced harvest of 3 bears annually until 2015. Prior to the current study, the most recent estimate of abundance for the MC subpopulation was 284 bears (SE: ± 59.3) from a physical mark-recapture study conducted 1998 – 2000 (Taylor et al. 2006). In recent decades the subpopulation has been managed to achieve recovery, and local knowledge indicates that more bears have been seen in the 2000s by Gjoa Haven and Taloyoak hunters during their travels across the sea ice (Dyck personal communications with hunters during consultation meetings 2013). This perceived increase in abundance resulted in an increase in the annual harvest from 3 to 12 bears at a 2:1 male to female harvest sex ratio, beginning with the 2015/2016 harvest season.

Nunavut's polar bear co-management system is based on memoranda of understanding (MOU)[1] developed between each community's Hunters and Trappers Association and the government. These MOUs lay out harvest, management and research aspects for each polar bear subpopulation. Under the existing MOU that was co-signed by all parties in 2005, the Government of Nunavut (GN) committed to a new population study for MC. The new study had the objective to estimate the current subpopulation size and composition, and to compare those results to the former study so that this information would be available to responsible management authorities for decision-making. In addition, we sought to obtain data that would provide estimates on survival and reproductive parameters in order to allow population viability analyses. Lastly, by implementing a research method that was minimally invasive but supported by local communities and stakeholders, we sought to evaluate whether genetic mark-recapture can be a useful alternative in population monitoring (Vongraven and Peacock

[1] The MOUs were replaced by the Nunavut Polar Bear Co-Management Plan in September 2019

2011, Vongraven et al. 2012). To address these objectives, we conducted a genetic mark-recapture study from 2014 – 2016.

3. STUDY AREA

The current management boundary for the MC subpopulation (Figure 1) is mainly based on telemetry data for adult female bears that were fitted with radio-collars in adjacent subpopulations, and tag returns from harvested bears (Schweinsburg et al. 1982, Bethke et al. 1996, Taylor et al. 2001). This boundary has also been supported by recent genetic analyses (Campagna et al. 2013, Malenfant et al. 2016) although its validity has been questioned by Inuit (Keith et al. 2005). The MC study area (about 495 000 km^2 including land mass, or 140 000 km^2 of sea-ice; Barber and Iacozza 2004, Hamilton and Derocher 2018) is bound by Victoria Island to the west, Prince of Wales Island to the north, Boothia Peninsula to the east, and the Nunavut mainland to the south (Figure 1). These land barriers are believed to restrict bear movement in and out of the study area. A detailed description of the physiography, currents, and sea ice of the region can be found in Schweinsburg et al. (1981).

Over the past 20 – 30 years, there has been a change in sea-ice quantity and composition. Multi-year sea ice has declined and been replaced by annual ice (Schweinsburg et al. 1981, Rothrock et al. 1999, Comiso 2002, Barber and Iacozza 2004, Keith et al. 2005, Howell et al. 2008, 2009, Sou and Flato 2009, Perovich et al. 2018, Richter-Menge et al. 2018, Environment and Climate Change Canada 2019). This has resulted in a smoother sea-ice platform interspersed with long pressure ridges, with rougher multi-year ice generally limited to localized areas (i.e., M'Clintock Channel proper; Dyck pers. observations). For most of the year, the sea is completely ice covered except for a few small polynyas that attract seals, polar bears, and other species (Hannah et al. 2009, Stirling 1997). From approximately mid-June to July, wide cracks form and extend for miles, providing haul-out habitat for ringed (*Pusa hispida*) and bearded seals (*Erignathus barbatus*) and thus, good foraging habitat for polar bears. From August to early October, much of the sea ice disappears in the southern and eastern portion of the study area, allowing shipping traffic along the Northwest Passage route (Stewart et al. 2007, Howell et al. 2008, 2009, 2013a, Analyse and Strategi 2011). Currently, some multi-year ice remains in M'Clintock Channel proper year-round – ice that originates and is pushed south from the Queen Elizabeth Islands and M'Clure Strait (Howell et al. 2008, 2013b). How important the contemporary remaining summer multi-year ice in M'Clintock Channel proper is to MC polar bears is currently unknown.

4. METHODS

Sampling – field collections

Our study design followed that of the previous physical mark-recapture study conducted in MC between 1998 – 2000 (Taylor et al. 2006; Figure 2); however, it did not involve the immobilization and physical handling of bears. Inuit co-management partners in Nunavut expressed their concern over wildlife capture and handling during a wildlife symposium in 2009 (Lunn et al. 2010, Department of Environment 2013). As a result, the responsible government management agency explored alternative research methods. Given the presumed low densities of bears (Hamilton and Derocher 2018) and the vast study area, genetic mark-recapture was chosen as the method since it is minimally invasive (Garshelis 2006) and has been successfully applied on various species, including bears (Brown et al. 1991 (right whales (*Eubalaena glacialis*)), Palsbøll et al. 1997 (humpback whales (*Megaptera novaeangliae*)), Boulanger et al. 2004, Olson 2009 (brown bear (*U. arctos*)), Pagano et al. 2014, SWG 2016 (polar bear)). We obtained genetic material for individual bears from a small sample of skin and hair collected via a remote biopsy dart (Pneudart Type C - Polar Bear) fired from a dart gun (Capchur Model 196) from inside a Bell 206 Long Ranger helicopter (Pagano et al. 2014). The extracted DNA was used to identify individual animals without the need for ear-tagging or lip-tattooing (see section "Genetic analysis"). Recaptures occurred when a previously sampled bear was biopsy-darted on a later occasion or when a genetic sample was recovered through the Nunavut polar bear harvest monitoring program. Every hunter in Nunavut is required to submit samples to the polar bear harvest lab so that age, gender and various other variables can be used in any ecological or demographic assessment (Nunavut Wildlife Act, SNu 2003).

We initially intended to begin field work in early April, but poor spring weather forced us to wait until late April to early May each year between 2014 and 2016. Field work usually was completed by mid-June. Approximately 80% of the entire MC study area was searched every year though poor weather and unsafe flying conditions prevented us from searching the entire study area during each field season, and we were not able to sample M'Clintock Channel proper in any year. In mid-April 2016, we used a Twin Otter for a reconnaissance flight over M'Clintock Channel proper to assess bear presence and sign. This allowed us to infer whether this portion of the study area potentially contained animals that were unlikely to be exposed to sampling effort unless they moved into areas that were searched by field crews.

Searches for bears were conducted at approximately 100 – 120 m above sea level, and at average speeds between 120 – 150 km per hour. Search areas were initially discussed with hunters and local Hunters' and Trappers' Associations during pre-study consultation meetings to gain insight about sea-ice conditions and bear distribution. Also taking past capture locations (Taylor et al. 2006) into account, we searched the sea ice, adjacent coastal areas, and small islands of Coronation Gulf, Dease Strait, Victoria Strait, Franklin Strait, James Ross Strait, Larsen Sound, Rae Strait, and Queen Maud Gulf during 2014 and 2015 (Figure 1). We decided to forego the Coronation Gulf and Queen Maud Gulf areas in 2016 because we observed very low bear activity and presence during our survey flights, and local knowledgeable hunters also indicated and confirmed that bears are rarely seen in those areas.

In order to minimize potential sampling bias, and to allow replication of this study, we used a "semi-structured" sampling approach. Generally, we flew transect lines across the sea ice and small islands with search intensity proportional to apparent bear activity (or bear presence). When signs of bears (e.g., tracks, bears, seal kills) were rare or plentiful, search transect lines were spaced further apart (i.e., 11 – 16 km), or closer to each other (i.e., 7 – 10 km), respectively. In that fashion, we were able to cover large sections of the study area efficiently (Figure 3). We decided to fly our survey transects from east to west and vice versa whenever possible (e.g., perpendicular to suspected density gradients based on past capture and harvest locations).

Once we located a bear, a small sample of tissue (<5 mm diameter), mostly skin with some adipose tissue attached to it (Pagano et al. 2014), was taken from the rump area at an approximate distance (or altitude) of 3 – 7 m using a biopsy dart (5CC Polar Bear Biopsy DNA Dart, Pneu-Dart Inc., Williamsport, PA). All bears except cubs-of-the-year (C0) were sampled. Cubs-of-the-year in early spring are still small and easily confused (Atkinson and Ramsay 1995, Robbins et al. 2012), so we decided not to dart C0s to avoid possible injury and the splitting-up of family groups. Every bear that was biopsied received a unique field identification number so that the genetic results and our field data could be cross-referenced and linked.

The biopsy darts are designed to fall to the ground after impact and are retrieved without physically handling a bear (see Appendix A for images). The effectiveness of these darts for sampling polar bears has been previously demonstrated (Pagano et al. 2014, SWG 2016, Dyck et al. 2020). The darts are quick and easy to use and require less pursuit time of bears than during capture operations. On average, it took less than 4 minutes from when a bear was initially spotted to the time when the dart was picked up after sampling a bear (GN, unpublished data). The design and relatively low velocity of the dart means that risk of injury to a bear is minimal. Typically, bears show no or very little response to the impact of the dart and are left with no obvious visible mark. In order to facilitate easy spotting of darts on the ice or in deeper snow, a 10 – 15 cm long and ~2 cm wide strip of brightly colored flagging tape (C.H. Hanson, Naperville, IL; or Johnson, Montreal, PQ) was tied and wrapped around the distal end of the dart.

We recorded the date, time, location of each observed bear (or group of bears), body condition based on aerial inspection using a subjective standard fat index (Stirling et al. 2008; a scale from 1 – 5 with 1 being skinny, 3 average and 5 obese), specific markings or characteristics, group size or litter size, the estimated field age class (C0, yearling (C1), 2-year old, subadult, adult) and field sex both with a confidence qualifier (a = high confidence; b = low confidence). Field age class and sex where assessed remotely from the helicopter at altitudes between 3 – 7 m by the same observer. When we encountered mothers and their dependent offspring we distinguished C0s, C1s, and 2-year old bears based on their size and physical features (e.g., blood or fecal/urine stains, scars) or their behavior to a) assign them to a field age class, and b) avoid sampling the same individual more than once. Additional cues such as body size of the individual bear in relation to its surrounding or group members, body shape and proportions, presence of scars, secondary sexual characteristics, observation of urination, and gait were all used to determine sex and age class (SWG 2016, Laidre et al. 2020).

When field age class and sex of a bear were initially assessed with low confidence, additional field notes were taken. For example, young subadult male bears and younger adult females are at times difficult to discern from the air when they are solitary. If we thought that the encountered bear was a young adult female, but were uncertain (confidence classifier “b”) then we also noted what this bear could be as alternative – in this case “maybe a young subadult male”. We used genetic results to confirm the field-recorded sex and age classes. Lastly, we recorded factors that may have influenced detection probability during sightings, including weather conditions (e.g., cloudy, clear, sun glare), bear activity when first observed, and sea-ice characteristics in general and within the immediate vicinity (~ 30 m) of an individual bear that may impede detection (e.g., sea-ice type: flat, intermediate, rough multi-year ice).

Our work combined data collected during the genetic biopsy sampling sessions from 2014 – 2016, considered the *late period,* and data from the previous capture-mark-recapture study conducted 1998 – 2000, or the *early period*.

Sampling – recovering previously marked bears through harvest

To detect the recovery of previously 'marked' bears (e.g., when bears were marked either during the initial mark-recapture study from 1998 – 2000, or from a previous biopsy-darting field season), we asked hunters to return any ear tags or lip tattoos from their harvested bears. To detect recoveries for bears in which a tattoo may be too faded to see or bears that had been marked through biopsy sampling (which leaves no physical marking), small muscle tissue samples were collected from all bears harvested in MC and surrounding subpopulations such as GB, Lancaster Sound (LS) and Viscount Melville Sound (VM) throughout the duration of the study (May 2014 – June 2016). These samples were stored in 2 ml cryovials (ThermoScientific, Nalgene long-term storage cryogenic tubes) at - 20˚C until sample preparation and analyses.

Sampling - recaptured bears from past population study

Because the initial subpopulation inventory for MC (1998-2000) was conducted using physical capture-mark-recapture methods in which a physical tag or tattoo was used for identification, we had no genetic database for these bears. In order to identify recaptures of bears during our 2014-2016 study that were originally marked during the 1998-2000 study, we examined captures and recaptures from the 1998 – 2000 population inventory, removed bears that we knew were dead (e.g., through a recovered ear tag or tattoo by harvest) and selected the remaining individuals that could be still alive (≤ 34 years of age) in 2014 for genetic analyses. Samples (ear plugs from punching a hole through the pinna so that unique identification ear tags can be applied) of captured and re-captured bears from the initial study had been stored in cryovials at - 20˚C until preparation for genetic analyses.

Sample preparations

We used the same method to prepare all field and laboratory tissues or biopsy samples. A lentil-size piece of skin (~1 – 1.5 mm thick) or tissue was cut from either the biopsy sample, the ear plug, or the muscle tissue with a new scalpel blade (# 20) and transferred onto a shipping card (Avery, 70 x 35 mm) and attached with scotch tape. Each sample card was labelled with the unique bear identification number and placed into a coin envelope (57 x 89 mm) and left to dry at room temperature for up to 3 days. The dried specimens where then sent to Wildlife Genetics International Inc. (Nelson, British Columbia) for individual genotyping and sex determination.

Genetic analysis

DNA was extracted from tissue with QIAGEN DNeasy Blood and Tissue Kits (Qiagen, Inc.). The tissue samples were genotyped at eight previously published dinucleotide microsatellite loci (REN145P07, CXX20, MU50, G10B, G10P, G10X, MU59, G10H; Paetkau and Strobeck 1994, Paetkau et al. 1995, 1998; Taberlet et al. 1997, Breen et al., 2001, Ostrander et al. 1993). Analysis of individual identity followed a 3-phase protocol previously validated for bears and described elsewhere (Paetkau 2003; Kendall et al. 2009).

First, to select markers for the analysis of individual identity, we used allele frequency data from approximately 1700 polar bears for which complete 20-locus genotypes existed before the genetic mark-recapture study began (GN, unpublished data). We ranked the 20 microsatellite markers in the dataset by expected heterozygosity. The eight most variable markers that could be analyzed together in a single sequencer lane were selected for use. These surpassed the required standard for marker variability (Paetkau 2003). In addition to the eight microsatellite markers, we analyzed sex on every sample, using a *ZFX*/*ZFY* marker. We searched the dataset for genotype matches that seemed unlikely based on our field data. In each case, three extra markers were added to the genotypes to lower the probability of chance matches between individuals. The extra loci confirmed all of these matches. Once the genotyping and error-checking was complete, we defined an individual for each unique eight-locus genotype.

Abundance

We estimated abundance using a closed-population mark-recapture model (Otis et al. 1978) in a Bayesian framework (Kéry and Schaub 2011) for independent animals (>2 years old) encountered during 2 primary sampling periods which occurred during the spring field seasons for the years 1998 – 2000 (early sampling period) and 2014 – 2016 (late sampling period). We used annual time-steps referenced to the springtime field seasons, resulting in three capture occasions within the early and late period (1998, 1999, 2000 and 2014, 2015, 2016, respectively). The model allowed for capture probability to vary by sex but was held constant across capture occasions within each primary sampling period. We fit separate models for the early and late periods. Abundance estimates for the two sampling periods were derived separately without any shared parameters. Furthermore, we split each abundance estimate by sex to obtain separate estimates of detection and abundance by sex. We make no assumptions about the change in population between the periods, nor do we assume equal capture probability. We fit a total of four separate closed-population models, one for each sex and time period.

The model assumed that the MC subpopulation was a geographically and demographically closed population within each three-year period of data collection. Therefore, the model assumes there is no movement in or out of the study area and no birth or death. Polar bear survival is generally higher for adults (Amstrup and Durner 1995), which should reduce bias associated with violation of the demographic closure assumption. However, lower survival rates for younger polar bears (Regehr et al. 2010) and recruitment of juvenile animals into the study population could be expected to cause positive bias in estimates of abundance (Pollock et al. 1990). Furthermore, potential violations of the geographic closure assumption due movement of animals in and out of the study area mean that the estimate of abundance does not represent the number of animals within the study area at any given time, but rather represent the total number of bears available for capture across the three-year period (i.e., the "superpopulation"; Kendall et al. 1997). We estimated abundance using closed models, despite potential biases, because the data were sparse and insufficient to parameterize an open population model. Moreover, because the survey area changed annually with changing weather and effort, common estimators such as the Horvitz-Thompson for *N* from each year's sampling were not appropriate because the estimator's results would conflate changing survey area with population size in unknown ways. We chose to estimate abundance using data from the 2 primary sampling periods rather than from all data from 1998 – 2016 because the 13-year gap between the 1998 – 2000 and the 2014 – 2016 surveys will overstate permanent emigration causing survival (φ) to go down and capture probability (*p)* to go up. Therefore, the estimate of *p* will be too high underestimating population size. While not ideal, using the closed models provides the best estimate with the available data.

To fit the closed-population capture-recapture models, we performed Markov chain Monte Carlo (MCMC) analysis using JAGS (Plummer 2003) through the R package *R2jags*. Each model was run for 20,000 iterations with the initial 2,000 discarded for burn-in. We used diffuse normal prior distributions on a logit link for all parameters. We checked for model convergence using $\hat{R}$ statistics and by examining MCMC chain plots (Gelman et al. 2013).

Survival

We estimated annual, apparent survival for independent bears >2 years old using all encounters from 1998 – 2016 by grouping our data into the 2 capture-mark-recapture sampling periods (1998 – 2000 and 2014 – 2016) and using available dead-recoveries from 1998 – 2016. Data were sparse with respect to live-recaptures and dead-recoveries and there was a 13-year gap (i.e., 2001 – 2013) in sampling between the capture-mark recapture studies. The gap period was characterized by a very low harvest rate resulting in minimal dead-recovery opportunities (e.g., 3 bears per year as harvest). Additionally, *p* is essentially equal to zero because the closed population model does not allow any recaptures during the gap period between sampling efforts. Because we did not have radiotelemetry data, and very few or no data on recoveries of previously marked animals, we could not estimate fidelity (*F;* the probability that an animal does not permanently emigrate from the sampling area and remains available for live observation in the future*)* to our study area. Therefore, estimates are not true survival but rather apparent survival, which is the probability of a bear remaining alive and available for capture, given it was alive at the previous sampling time. Bears that permanently leave the study area and remain alive, but are unavailable for recapture cannot be separated from mortality when estimating apparent survival. Therefore, apparent survival will likely be lower than true survival due to emigration.

We used a Cormack-Jolly-Seber (CJS) model (Cormack 1964, Jolly 1965, Seber 1965) and considered apparent survival (ϕ) varying by sex (i.e., male or female) or remaining constant, and capture probability (*p*) varying by sex, study period (i.e., early versus late period), or remaining constant. The commonly used Burnham model was not applicable for estimating MC survival rates because the harvest rate changed, yet there are insufficient data to estimate multiple recovery probabilities. Therefore, the survival from the Burnham model would be unreliable and would reduce to a CJS model in the absence of additional data. We fit six models representing all combinations of ϕ and *p* in Program Mark (White and Burnham 1999) through the *Rmark* (Laake 2013) package in R. We used AIC to rank models with the lowest AIC value suggesting the strongest support (Burnham and Anderson 2002). All models differed by a single, nested parameter, therefore we evaluated whether that parameter resulted in a model improvement based on ΔAIC and parameter estimates.

Reproduction

We calculated reproductive indices for MC polar bears using data for the early and late study periods by using reproductive metrics that have been identified as important for monitoring (Vongraven et al. 2012). The annual observations of dependent young during the sampling periods were few and variable which limited our ability to estimate many reproductive indices. We calculated the mean number of C0 and C1 per adult female (AF) by year and study period (± SE) using the observed sampling data. Adult females were a) bears identified genetically as females, and b) bears classified in the field with the age class “adult” with high confidence. We also calculated mean C0 and C1 litter size by study period, although the data were too sparse to evaluate patterns in litter size as function of biological, environmental and temporal factors.

Population growth

We estimated population growth rate in two ways to understand differences between observed changes in abundance and demographic rates. First, we estimated the empirical growth rate as the ratio of the late period abundance over the early period abundance for males and females. We then computed an average annual growth rate (λ) by taking the 17^{th} root of the growth rate to account for the length of time between the two study periods. We estimated separate growth rates for males and females because the abundance estimates differed by sex. Second, we computed an asymptotic growth rate from a 4-stage matrix model based on the demographic rates estimated in this study (Mills 2012). For rates that were not available from our study, we used values from Taylor et al. (2006). The population matrix was defined as:

$$L = \begin{bmatrix} 0.00 & 0.00 & 0.00 & 0.17 \\ 0.62 & 0.00 & 0.00 & 0.00 \\ 0.00 & 0.88 & 0.00 & 0.00 \\ 0.00 & 0.00 & 0.88 & 0.88 \end{bmatrix},$$

where C0 survival probability = 0.62 (Taylor et al. 2006), 2+ year old survival probability = 0.88 (present study), and recruitment = 0.39 C0 per AF (present study). The value of 0.17 in the upper right of the matrix is the product of AF survival (0.88), recruitment (0.39), and sex ratio at birth (0.5). We solved for asymptotic growth rate by calculating the dominant eigenvalue of the matrix (*L*) assuming a stable stage distribution.

Body condition

We compiled body condition score (BCS) data for the early and late study periods. Bears were assigned a BCS on a scale of 1 – 5 with 1 being skinny and 5 being obese

(Stirling et al. 2008) through physical handling and capture (early period; 1998 – 2000) or aerial observation during biopsy sampling (late period; 2014 – 2016) from April to June. Sex, age, and reproductive classes were assigned during physical handing during the early period and ages were determined based on previous capture history, known birth year, or from tooth analysis (Calvert and Ramsay 1998). During the late sampling period, classification was done during biopsy sampling while flying approximately 3 – 7 m above the ground with sex verified by subsequent genetic analysis (SWG 2016, Laidre et al. 2020). Observers who participated in classifying age class and sex during biopsy sampling had either participated in both study periods, or were experienced in physical capture-mark-recapture studies.

The BCS raw scores were binned into 3 classes: 'poor' (1 – 2), 'average' (3), and 'good' (4 – 5) in order to follow recommended monitoring schemes (Stirling et al. 2008, Vongraven et al. 2012) and facilitate comparison between previous studies (SWG 2016, Laidre et al. 2020). Like previous studies, we did not include dependent offspring in the BCS analyses because their body condition is dependent on maternal condition (SWG 2016) and we excluded within-year observations of the same individual.

We modeled BCS using ordinal logistic regression and included *period* as an indicator of sampling period (early = 1998 – 2000 or late = 2014 – 2016). Reproductive status, age, and sex were combined into one 4-level categorical variable, *reproclass* (ADM = adult male, ADFI = independent adult female, ADFWO = adult female with offspring, and SUB = subadults of both genders) and Julian date of sampling (*jul_cap_day)* was included as a continuous covariate to reflect the amount of time a bear had on their preferred sea-ice hunting platform before being sampled in year *t*. The sampling seasons (April-June) in this study also coincided with the annual seal pupping period, which is known to be prime feeding period for bears (Pilfold et al. 2012, Reimer et al. 2019). Thus, we predicted that increased time on the ice prior to sampling would be associated with higher BCS. The number of days between sea-ice retreat and advance ($icetm1_{t-1}$) was included to evaluate the hypothesis that interannual variation in BCS was related to sea-ice availability in the previous year. We selected a global model that reflected biological and environmental variables we hypothesized, or that have been shown in other studies, to have effects on BCS (Rode et al. 2012, SWG 2016, Laidre et al. 2020). Finally, given our interest in evaluating whether different reproductive classes and age classes had varying BCS based on the amount of time they spent on the sea ice during the months immediately prior to observation (*jul_cap_day)* and whether this relationship was different between our two sampling periods (*period)*, we included a 3-way interaction for *reproclass, jul_cap_day,* and *period.* Once the global model was selected, we performed a backwards and forwards model comparison (stepAIC; Package *MASS* with AICc criteria functionality added) to obtain the most supported model which included main effects for *epoch*, *reproclass, jul_cap_day, icetm*, and interactions for *epoch* and *icetm* and *epoch* and *reproclass* (Table 1). On the final model, we performed ordinal regression-specific goodness of fit test (Pulkstenis-Robinson test; $p > 0.1$; Fagerland and Hosmer 2017). Covariates were considered significant at $p < 0.05$ and predicted probabilities were calculated for significant covariates.

We hypothesized that BCS would be correlated with ice conditions based on previous studies suggesting decreased body condition with increased ice-free days and lower sea-ice concentrations (Rode et al. 2012, Laidre et al. 2020). Thus, we calculated the number of days between the summer sea-ice retreat and fall sea-ice advance in *sampling year t - 1* (Environment and Climate Change Canada 2018). Sea-ice retreat and advance in MC were defined as the point in which the sea-ice concentration for a given year fell below, or exceeded, respectively, the halfway point between the averaged 1979 – 2016 March sea-ice concentration (representative of annual sea-ice maximum) and the average September sea-ice concentration (annual minimum). For MC, that transition threshold sea-ice concentration was 59%.

Seal observations

There is little recent information about seal abundance across the Canadian Arctic. We therefore recorded all seal locations encountered along our flight paths while searching for polar bears. These data were collected only during the 2014 field operations due to logistical challenges and can potentially provide baseline information on relative abundance for help in assessing ecosystem productivity.

5. RESULTS

General overview

During research operations 2014 – 2016, we spent between 72.5 and 97.5 hours flying each season in search of polar bears across the sea ice, with an average distance flown per year of 12,300 km (Table 2, Figure 3). The highest bear encounter rate occurred during 2014. Each field season was conducted generally between May and early to mid-June. Due to poor weather conditions a large portion of M'Clintock Channel proper could not be surveyed (Figure 3) and a reconnaissance flight via plane into the Channel in 2016 found few signs of bears (e.g., only one bear was observed).

The MC study area is vast and bears occur at low densities (Hamilton and Derocher 2018). In addition, polar bears were not distributed evenly across the study area (Figure 4). Most bears across all study periods were encountered from Franklin Strait southward to Victoria Strait and Jenny Lind Island. The sea ice in Queen Maud Gulf, Dease Strait and Coronation Gulf did not exhibit many signs of polar bears, at least not during the time of the survey (i.e., April to early June). The low coverage of M'Clintock Channel proper by Twin Otter did not suggest high bear density, however, it remains uncertain if sea ice is used by bears with higher intensity north of Gateshead Island during early spring at times when we were not present.

Due to logistical constraints we were only able to record seal observations during 2014. During that field season, work continued into June when ambient temperatures were sufficiently high for seals to haul out on the sea ice and bask in the sun. On our search flights we observed 2,236 seals distributed across the area where most bears were encountered (Figure 5).

Samples examined

For the entire study period 1998 – 2016 we analyzed a total of 953 (319 biopsy, 102 physical capture, and 532 harvest) tissue samples for genetic identification. We identified 244 individual bears through the biopsy sampling activities 2014 – 2016. All 102 tissue samples from physical captures during the early study period (1998 – 2000) were successfully analyzed and of the 532 harvest samples, 99% produced reliable genetic results. Overall, the success rate of extracting DNA material from all study samples (research and harvest) was 97.8%.

Dead recoveries of marked bears through the harvest resulted in 22 bears being identified, 7 of these were recovered in subpopulations outside MC (4 in LS, 1 in Northern Beaufort Sea, 1 in Foxe Basin, and 1 in Viscount Melville Sound). Sixty-eight percent of all recoveries occurred in MC, and no recoveries were made in GB. We live-recaptured 6 bears marked in 1998 – 2000 and 33 bears 2015-2016. As a note of interest, 7 bears that were originally marked via biopsy in MC 2014 – 2016 were live re-captured in Gulf of Boothia during the GB population study conducted 2015 – 2017 (Dyck et al. 2020).

Population demographic information

Abundance – Estimated total (males and females combined) abundance was 325 (95% Credible Interval (CRI) = 220 – 484) for the period 1998 – 2000, and 716 (95% CRI = 545 – 955) for the period 2014 – 2016 (Figure 6). The CRIs around the total abundance do not overlap across the two study periods providing substantial evidence for an increase. Estimated recapture probability was 0.13 in both periods with higher precision in the later period (95% CRI = 0.03 – 0.19 (early), 95% CRI = 0.10 – 0.18 (late)).

We estimated sex-specific abundance to obtain additional insight into population dynamics. Between the two study periods, the female segment of the MC subpopulation increased from 219 (95% CRI = 124 – 405) to 327 bears (95% CRI = 230 – 487, Figure

7). The males showed a larger increase from 134 (95% CRI = 74 – 256) to 360 bears (95% CRI = 244 – 550, Figure 6).

Survival – We estimated apparent survival for independent bears aged 2 and older from 1998-2016. The best-supported model included constant survival and detection probabilities across time and sex (Table 3). All other models showed no support given that the AIC values increased when a single parameter was added. Apparent survival from the top model was 0.88 (SE = 0.02) and detection probability was 0.17 (SE = 0.02). Cub-of-the-year survival was not possible to estimate because they were not sampled due to their small physical size (see Methods above).

Reproduction and Recruitment – During the 1998 – 2000 mark-recapture sampling efforts, 23 family groups (5 with single C0, 7 with 2 C0, 3 with single C1, 8 with 2 C1) were sampled, representing a total of 38 (19 C0 and 19 C1) dependent offspring. Through the genetic biopsy sampling study 2014 – 2016, we sampled 27 family groups with 46 C0 (8 with single C0, 19 with 2 C0), and 18 family groups with 29 C1 (7 with single C1, and 11 with twins; Table 4). For the 1998 – 2000 period, C0 and C1 mean litter sizes were 1.58 (SE = 0.14) and 1.71 (SE = 0.14), respectively. Calculated mean C0 and C1 litter sizes for 2014 – 2016 were 1.70 (SE = 0.09) and 1.61 (SE = 0.11), respectively. We calculated the number of C0 and C1 per AF across the two study periods (Table 4). The mean C0 and C1 per AF from 1998 – 2000 was 0.38 (SE = 0.02) and 0.39 (SE = 0.10), respectively. The mean C0 and C1 per AF for 2014 – 2016 was 0.43 (SE = 0.10) and 0.28 (SE = 0.06), respectively. The overall mean C0 recruitment was 0.39 (SE = 0.11).

Population Growth – Based on the estimated increases for the female and male proportions of the subpopulation between the two time periods, the average annual growth rate (λ) was 1.02 for females and 1.05 for males. We built a 4-stage matrix population model to describe the polar bear subpopulation with C0, C1, subadult, and adult as life stages. We included vital rates estimated above. For parameters not included in this analysis, we used estimates from Taylor et al. (2006). Specifically, adult survival and C0 per AF were estimated in this analysis and therefore those estimates were used. Cub-of-the-year survival was taken from Taylor et al. (2006) because we were not able to estimate this value reliably using this study's methodology. Using our calculated recruitment value of 0.39 for C0 per AF, a survival rate of bears older than 2 of 0.88, and C0 survival of 0.62 the matrix model results suggest a declining subpopulation ($\lambda = 0.97$). This represents a discrepancy between observed demographic rates and calculated abundance. Our estimate of apparent survival is biased low compared to true survival due to unknown emigration. Furthermore, unmodeled heterogeneity in recapture probability is a well-known source of bias in estimates of survival from CJS-type models (Devineau et al. 2006). To explore this, we calculated what level of adult survival would be needed to achieve the estimate of female $\lambda = 1.02$ based on changes in abundance across study periods. The new adult survival probability of 0.93 provides a population growth of $\lambda = 1.02$ (Figure 8). That survival value is consistent with survival in the absence of harvest from Taylor et al. (2006). Flat population growth ($\lambda = 1.0$) occurs when survival is 0.91.

Body condition

We analyzed a total of 380 BCSs from the two study periods (Table 5). The most supported model included *period*, *reproclass*, *jul_cap_day*, and $icetm_{t-1}$ and interactions *period:reproclass* and *period:*$icetm_{t-1}$ (Table 1). Body condition of bears improved for all reproductive classes from the early period to the late ($P_{Poor\ early\ adult\ females\ and\ subadults}$ = 0.50 vs $P_{Poor\ late\ adult\ females\ and\ subadults}$ = 0.14), except for adult males (X^2 = 10.81, P = 0.01; $P_{Poor\ \mathrm{early\ ADM}}$ = 0.15 vs $P_{\mathrm{Poor\ late\ ADM}}$ = 0.17; Figure 9). Later sampling in the year was associated with better body condition (X^2 = 9.38, P < 0.01; Figure 10). As the number of days between sea-ice retreat and advance increased (*icetm)*, the predicted probability of a bear being in poorer condition increased but this was more pronounced in the early period (X^2 = 3.86, P < 0.05; $P_{\mathrm{Poor\ early\ icetm136}}$ = 0.58 vs $P_{\mathrm{Poor\ late\ icetm136}}$ = 0.19).

6. DISCUSSION

General

This study reports population abundance, survival, population growth, reproductive indices and body condition using the data from surveys conducted in the MC polar bear subpopulation between 2014 – 2016 and 1998 – 2000 along with dead-recoveries of harvested bears from 1998 – 2016. After more than 15 years of a reduced harvest and a moratorium that were implemented because of overharvest (Taylor et al. 2006), the subpopulation has recovered to the determined mid-1990s level (Aars et al. 2006; Taylor et al. 2006). Without the support and participation of community co-management partners from Taloyoak, Cambridge Bay and Gjoa Haven, this subpopulation would not have recovered over the past 15 years, hence this report and results should be welcomed as good news.

The recovery of this subpopulation may have been aided not only by concerted conservation actions by communities and management authorities, but also, counterintuitively, by climate-induced sea ice changes occurring in this region. While some polar bear subpopulations are showing negative impacts from climate change, (Regehr et al. 2007, Regehr et al. 2010, Lunn et al. 2016, Obbard et al. 2016, 2018), the short-term narrative may be different in terms of MC. Historically, the study area, and in particular M'Clintock Channel proper, had an abundance of multi-year sea-ice that remained mostly throughout the year (Schweinsburg et al. 1981, Barber and Iacozza 2004; Howell et al. 2008, 2009; Environment and Climate Change Canada 2018, 2019; Sou and Flato 2009). However, recent evidence suggests that the open-water extent in the western Arctic (including the study area) has been increasing between 1968 and 2005 (Stewart et al. 2007) and sea-ice cover during the summer has declined (Stern and Laidre 2016, Rothrock et al. 1999, Comiso 2002). In addition, some heavy multi-year sea-ice has been already replaced by annual ice (Barber and Iacozza 2004, Environment and Climate Change Canada 2018, 2019, Marz 2010, Perovich et al. 2018, Richter-Menge et al. 2018) and an even greater shift is expected (Sou and Flato

2009; Hamilton et al. 2014). The observed changes from multi-year to annual sea ice result in declining sea-ice thickness. Younger and thinner sea ice is more mobile and susceptible to mechanical wind forcing and is also more vulnerable to complete melting in the summer which contributes to the observed decrease in summer sea-ice extent. (Richter-Menge 2018, Perovich et al. 2018). This reduction in sea ice results in the absorption of more heat by the upper ocean (Richter-Menge 2018). While sea-ice loss overall is considered very detrimental to the persistence of polar bears, in the short term, it may have beneficial effects since many of the observed sea-ice changes have been associated with greater Arctic marine productivity (Derocher et al. 2004, Häder et al. 2014, Frey et al. 2018). This increased productivity and dynamic ice may have played a role in the observed improvement in body condition of bears in MC between the late 90s and the recent study period (Derocher et al. 2004).

Currently, it is uncertain when continued reductions in sea-ice availability may cross a threshold such that limited time to hunt seals on the ice begins to have a negative effect on the MC subpopulation which have been documented for more southerly polar bear subpopulations (Bromaghin et al. 2015, Lunn et al. 2016). Over the long term, progressive loss of Arctic sea ice is a primary threat to the species (Atwood et al. 2016, Regehr et al. 2016).

Abundance

Polar bear abundance has increased across the two study periods with the male segment of the subpopulation increasing more rapidly than females. This may reflect recovery of the male segment after depletion due to general harvest overexploitation, which, when coupled with a sex-selective harvest (2 males for each female in Nunavut) could have been further exacerbated (Taylor et al. 2005, McLoughlin et al. 2005, Taylor et al. 2008a). Male abundance was almost half of female abundance in the early period but grew to be equal to or slightly larger than female abundance during the late time period. Increases in male abundance over females reflect a higher growth rate for males during the study period, potentially from reductions in harvest pressure and/or immigration of males into MC from other subpopulation units.

We estimated abundance of MC polar bears using closed-population mark-recapture models. Yet, our sampling occurred across 3-year periods suggesting that the assumptions of demographic and geographic closure are almost certainly violated. The limited numbers of bears detected and the sparse recaptures within a year precluded fitting models that can potentially reduce bias in parameter estimates, such as the 'robust design' or 'spatially-explicit' capture-recapture models. Moreover, 'open' population models that include an abundance estimate (e.g. forms of the Jolly-Seber model) require more years of data with more recaptures than our data allowed. Thus, despite evidence from the few harvest-recovered marked bears that the subpopulation is not, in fact, 'closed' to emigration, our limitations with available data prevented these more highly-parameterized models from being fitted. These more complex models better reflect biological and ecological systems. However, they are 'data-hungry' (Bromaghin et al. 2015, Lunn et al. 2016, Regehr et al. 2018) meaning if less data are available due to low densities or other constraints, then these approaches, such as multistate capture-recapture models and integrated population models, are generally not options to estimate abundance, despite the potential advantages of these models in estimating demographic parameters of interest and reducing bias.

The basis for capture-mark-recapture studies rely on the marks that are initially put out into the population during the study's first field season and the subsequent recovery of those marks (recaptures) through harvest recovery or re-sampling (Caughley et al. 1977, Amstrup et al. 2010). This approach has worked relatively well for larger, denser subpopulations that allow for relatively large sample sizes (Regehr et al. 2007, Peacock et al. 2013). However, when populations are small, occur at low densities, have low harvest levels, and/or are located in remote regions that are difficult to access, recapturing or recovering marked individuals from the population is difficult (e.g. M'Clintock Channel). This process is made more complicated when it is unknown if the subpopulation is open or closed (Kendall 1999), which can only be determined through radiotelemetry to examine long-term movement patterns of individual bears.

The consequences of assumptions violations in closed-population models are well known (Otis et al. 1978) and affect both the actual abundance and what that abundance geographically represents. A lack of demographic closure results in underestimated detection probability (for example, bears that die are no longer available for detection). The underestimated detection probability leads to an overestimated abundance for any given year. Despite these caveats, for this study, the total number of bears in the study area available for detection across the three years appeared to have been unbiased (i.e., a similar number of bears frequented the study area while the study was conducted) and our estimated abundance for MC using a closed population model for the early period with 325 bears was similar to Taylor et al. (2006; 284 bears). A lack of geographic closure blurs the boundaries of the study area. If bears move in and out of the sampled area, then the estimated abundance refers to an area larger than the area sampled (e.g., estimating the "superpopulation"). A superpopulation is defined as all the animals with a chance (non-negligible probability) of occurring within the MC management boundary, regardless of where the animals were located at any given sampling occasion (Schwarz and Arnason 1996). Thus, estimates of superpopulation size in year *t* likely reflect some animals that were temporary emigrants in year *t*. We were not able to estimate temporary emigration directly from the sampling area (Cooch and White 2019) because our sample sizes were not sufficiently large to do so, and there are no recent radiotelemetry data to provide location and movement data. However, recoveries of previously marked bears in other subpopulations through the harvest sampling program indicate that movement into and out of MC is occurring.

Lastly, the fact that we were not able to survey the entire study area – namely the portions of M'Clintock Channel proper – contributes to the uncertainty surrounding our abundance estimate. Although we did not detect many signs of bear activity while conducting our reconnaissance flight, it is unknown how many bears (e.g., bears that may temporarily move into this area from the neighboring LS subpopulation, or resident

MC bears) may utilize this section of the study area throughout the timing of our surveys since we were able to conduct only one limited survey flight due to poor weather conditions. Because we have no information on how many bears could have been in this area, we are unable to determine whether or not our abundance estimate would be affected negatively or positively.

Taken together with the effects of demographic and geographic closure violation, the estimate of abundance is almost certainly larger than the actual number of animals within the MC subpopulation boundary at any given time. This should be taken into consideration when using these findings to inform management decisions. For example, if capture-recapture analyses are performed independently for multiple adjacent subpopulations that experience exchange of animals, the sum of the estimates of superpopulation size will be larger than the actual total number of bears in the subpopulations (i.e., there will be "double counting" of some bears). This could lead to cumulative TAH levels that result in removal of a larger proportion of polar bears each year than was intended based on the TAH levels for the individual subpopulations.

Survival

We estimated apparent survival of polar bears from 1998 – 2016. The resulting survival probability (0.88) is lower than biological survival estimated from other studies (Taylor et al. 2006). This is likely due to a combination of factors such as emigration away from the study area, which will cause apparent survival to be lower than biological survival (Lebreton et al. 1992). Further, capture-recapture data were collected intensively for 3 years in 2 distinct study periods separated by 13 years. Therefore, few observations of bears exist between 2001 and 2013. The missing sampling years greatly reduce the power to estimate survival or estimate variation in survival across time, sex, or age classes.

Survival is known to differ among sex and age classes; however, none of the models including differences in survival by sex were supported by the data (Table 3). In addition we were not able to test for differences in survival by age class. It is very likely that by pooling age classes and sexes the overall mean natural survival rate was also biased low (SWG 2016). Furthermore, unmodeled heterogeneity in recapture probabilities can introduce substantial negative bias into estimates of survival (Regehr et al. 2009). Unfortunately, with live capture-recapture data, limited harvest data, and no contemporary information on animal movements (e.g., from satellite radiocollars), there are few options to estimate biological survival. Our data were too sparse for joint live/dead models and capture probability was too low for known fate models. These challenges were also recognized by Taylor et al. (2006).

Reproduction

Our field observations of C0 and C1 litter sizes revealed inter-annual variation with mean values similar to other subpopulations within the Canadian Arctic Archipelago (Table 4; Durner et al. 2009; dated estimates – Lancaster Sound and Norwegian Bay: Taylor et al. (2008b); Gulf of Boothia: Dyck et al. (2020); Kane Basin: SWG (2016)), although our sample sizes were small. We estimated reproduction based on counts of C0 and C1 observed with adult females. Reproduction rates were very similar across our study periods and were within the ranges estimated by Taylor et al. (2006).

It is difficult to draw definite conclusions about whether all reproductive parameters differ between the two studied periods because of limited data. Estimating the number of C1 per AF is considered a key reproductive parameter (Vongraven et al. 2012, Regehr et al. 2015) because it integrates cub production and cub survival.
The C1 per AF of the recent period of 0.28 was lower than during the earlier period (0.39 in this study). Whether this decline is real or represents an artifact of sample size is unknown. Nevertheless, our observed number of C1 per AF appears to be sufficient to maintain a viable subpopulation, provided that survival is within the normal range for healthy subpopulations (Regehr et al. 2015). Continued monitoring of MC to obtain

improved estimates of survival and reproductive rates is prudent to determine whether this subpopulation remains healthy.

Population Growth

We estimated population growth rate both empirically based on changes in abundance and using a matrix population model to compare observed changes in abundance to theoretical population growth rates arising from the vital rates. For the purpose of estimating an asymptotic population growth rate based on the vital rates, we used a simplified matrix projection model that does not accurately represent the multiyear reproductive cycle of polar bears (Regehr et al. 2017). Although such a simplified model would not be suitable for stochastic projections (Taylor et al. 1987), we believe it was sufficient for a general assessment of consistency between empirical and matrix-based estimates of population growth rate. The changes in abundance suggest that growth was approximately 2% per year for females and 5% per year for males for the period 1998 – 2016. Conversely, the estimated vital rates suggested a population growth rate of -3% per year (i.e., that a subpopulation with these vital rates would decline by 3% per year). Therefore, the demographic rates and abundance estimates are not internally consistent. The most likely explanation is negative bias in estimates of true survival for adult females. We estimated apparent survival rather than biological survival. In addition, we pooled independent bears (subadults and adults) in order to obtain survival rates during this study. Adult polar bear survival rates are higher than subadults (Regehr et al. 2007, 2010), and pooling them would bias the result negatively. Finally, there was likely unmodeled heterogeneity in recapture probabilities that introduced additional negative bias into survival estimates (Regehr et al. 2009). If we replace estimated survival from Taylor et al. (2006), the model shows growth similar to our observed female population growth.

The discrepancies in abundance and survival provide insight into the utility of each data type. Abundance data appear to be providing stronger inference into population dynamics of this polar bear population. The survival information contains too much bias relative to biological survival to be meaningful for polar bear management. If capture-recapture data were collected over a longer time period, then survival may become a more useful parameter. Other data-based and simulation studies for polar bears have documented that, although mean percent relative bias can be higher for estimates of abundance than survival, the resulting challenges to demographic inference are actually larger for bias in adult female survival because it is a primary driver of population growth for long-lived species like polar bears (Eberhardt 1990).

One question that remains is the amount of potential bias in estimates of abundance and survival for the two study periods. The abundance estimates use data across 3-year periods, therefore some bears included in the estimate died before the end of the period. Our estimated apparent survival rate (0.88) would suggest a declining subpopulation, however, to achieve abundance estimates derived for this study, survival rates would need to be 0.92, which is reasonable for polar bears. Therefore, the total mortality during a 3-year abundance estimate is expected to be about $0.15 = (1 – 0.92^2)$. An increase in abundance is also supported by other lines of evidence. First, the MC subpopulation was managed for recovery and had a restricted harvest for 15 years that was designed to nurture population increase (Taylor et al. 2006) and likely led to a recovery of the depleted male proportion. Second, body condition of bears improved between the two studies, which could be an indication that the habitat improved as multi-year ice decreased over the past 15 years resulting in increased productivity, enhancing seal habitat which may be reflected in a larger carrying capacity.

Similar to estimates of abundance and survival, potentially high and variable levels of immigration and emigration across subpopulation boundaries can directly affect estimation and interpretation of population growth rate (Peňaloza et al. 2014). In some other subpopulation studies, radiotelemetry data have been critical to resolving these issues (Regehr et al. 2018). For regions where radiotelemetry is not available, we recommend that the best way to reconcile these interpretation challenges and provide accurate information to inform management is to perform a meta-analysis of the capture-recapture and harvest recovery data for all subpopulations within the region that are known to exhibit substantial levels of exchange (e.g., GB, MC, and LS).

Body condition

Polar bears observed during the recent study period were in better body condition compared to the late 1990s with the exception of adult males, which is not unexpected given that during April – June, males are often intent on searching for mates and breeding rather than only feeding (Stirling et al. 2016). Further, rapid changes in sea-ice characteristics in the last 15 years from multi-year to more annual ice, which is less thick and prone to experiencing leads and cracks, may facilitate increased opportunities for hunting during the annual seal pupping period that occurs in mid-April. These conditions potentially account for our finding that body condition improves later in the year (Stirling and Archibald 1977, Pilfold et al. 2014, Reimer et al. 2019).

It is less likely that sampling method is responsible for changes in the observed BCS between time periods. Raw BCS scores were binned into 3 general categories to account for any potential small biases in observer classifications (Laidre et al. 2020). Furthermore, there have been varied results in other studies in which earlier time period BCS classification was done by physical handling and compared to later time period BCS classifications based on aerial observations, suggesting that there is not an inherent bias in aerial observation versus physical handling body condition classification (Kane Basin: no change in BCS, Baffin Bay: decrease in BCS, Gulf of Boothia: increase in BCS; SWG 2016, Dyck et al. 2020, Laidre et al. 2020). Many of the same observers and biologists that participated in the early physical capture and handling studies also participated in the aerial observation studies which supports reliability and consistency between study methods for BCS. The general application of our index during physical handling has been shown to be a reliable indicator in the assessment of body condition (Stirling et al. 2008). Moreover, there is the potential to assess the lipid content of the extracted adipose tissue from the biopsy darts (Pagano et al. 2014, McKinney et al. 2014) which could be used to verify the aerial condition assessments.

The replacement of multi-year with annual ice in our study area may have also provided improved seal habitat and contributed to an increase in the polar bear prey base. To our knowledge, there are no quantitative data about seal abundance from our study area available; however, during our investigations and observations, it became apparent that ringed and bearded seals appear relatively abundant and demonstrated a preference for annual sea ice (GN, unpublished data reports). These longer-term changes in habitat may be in part responsible for the fact that we found BCS of bears sampled in the late period to be relatively unaffected by the number of days between sea-ice retreat and advance, which wasn't the case in the early period, suggesting that over time, the ecosystem has become more productive. It is important to note that our study periods encompass a relatively short period of time, with 3 years in the early period and 3 years for the late period. Inter-annual variation could significantly affect BCS for such a limited temporal window. Thus, we caution over-interpretation beyond general trends for BCS. It is likely that the potential enhanced productivity brought on by changes in sea-ice dynamics may be a short-lived advantage to polar bears if access to their prey is reduced by a declining sea-ice hunting platform, though the time scale of these events remains unknown.

7. MANAGEMENT IMPLICATIONS

The need for continued monitoring

In the past 20 years, polar bear population studies in Nunavut were generally conducted over a 3-year period, which is a relatively short time considering polar bear life spans. In many studies, survival rates tend to be biased low because of limited study length, low recapture probabilities, unmodeled heterogeneity in recapture probability due in part by prohibitive weather to cover the entire study area, and movements of animals with respect to the sampling area (Taylor et al. 2008b, Regehr et al. 2009, SWG 2016, Dyck et al. 2020). In the case of MC, several of these factors are true, including unknown emigration rates, low density of bears (fewer bears receive marks), and potential heterogeneity in recapture probability resulting in a likely low-biased survival rate.

What we have learned from this process of studying and analyzing MC data is that continued monitoring, in the form of increasing study length or adding an intermittent marking session, would reduce the type of bias we encountered in estimating population parameters like survival and abundance (Peacock et al. 2012).

Further, the MC subpopulation area has experienced drastic sea-ice changes since the 1990s with multi-year sea-ice diminishing and being replaced by annual ice (Stern and Laidre 2016, Environment Canada 2018, 2019). It is currently unknown what importance the little remaining multi-year ice plays for MC polar bears, especially during the summer months (e.g., as feeding platform or summer retreat areas).

The need for improved data

Concomitant to adding intermittent marks or increasing study length, is the need to obtain an understanding of the movement into, and out of, the MC subpopulation boundaries, especially in light of continuing sea-ice changes. The results of this study were affected by the lack of available data to inform even the simplest population models, leading to abundance, survival, and population growth estimates that are known to be biased. Emigration rates are vital to accurately estimating survival.

The delineation of this subpopulation is inferred based on movement of collared bears in adjacent subpopulations from the 1990s, prior to the large-scale ice changes in the region (Taylor et al. 2001). Tag recoveries of captured and harvested bears, and some genetic analyses, indicate that MC likely is a distinct unit, but that has been disputed by local hunters and community members (Taylor et al., 2001; Bethke et al. 1996; Schweinsburg et al. 1982; Campagna et al. 2013; Malenfant et al. 2016; Keith et al. 2005, Dyck and Bohling, in prep.) and the current study provided evidence that bears tagged in the MC region were harvested in adjacent subpopulations (see Results Section – samples examined). With continued reduction in multi-year sea-ice, and sea-ice in general predicted to decline, (Sou and Flato 2009; Hamilton et al. 2014), understanding the behavior of bears and their ecology in MC is critical to maintaining a healthy population (Vongraven et al. 2012). Very little about the movement patterns and habitat use of MC polar bears is known under the current environmental conditions since there has not been a satellite telemetry study to monitor movements and habitat use. At the direction of community co-partners representing Inuit societal values and concerns over physically handling wildlife, the GN Department of Environment, did not carry out any collaring for telemetry data in MC, despite efforts to garner support. In the future, the GN will have to make decisions on how to continue monitoring polar bears in this subpopulation in order to provide adequate information to decision makers.

Harvest management and considerations

The MC subpopulation represents a unique polar bear management unit in that bears are sparsely distributed (low density) over a large geographic area. This requires adaptive harvest management and considerations. The MC polar bear subpopulation saw a harvest of approximately 32 ± 10 bears (range: 12 – 55) between 1970 and 2001 (roughly 19.5 males and 12.0 females; GN, unpublished data) which was not sustainable over the long-term (Taylor et al. 2006) and led to a moratorium and harvest reduction. Harvest levels in the past were based on vague abundance data with high uncertainty and expert opinion (Aars et al. 2006, Taylor et al. 2006). Our study suggests that MC abundance increased since 2000, although with significant caveats and high uncertainty (e.g., biased survival rates and biased abundance; unknown emigration). Future research and monitoring should seek to understand the role emigration plays in this subpopulation so that estimates of survival can be re-assessed.

Here we provide several considerations to aid in harvest management decisions:

- The mean abundance estimate of 716 bears (95% CRI = 545 – 955) for the period 2014 – 2016 is for independent bears 2 years and older and includes substantial caveats and uncertainty, including the knowledge that this estimate is positively biased. Furthermore, this estimate applies to a group of bears that use the MC region but may also use other management units (e.g., superpopulation; see Discussion Section).

- Data for this subpopulation are sparse and a quantitative harvest risk assessment using subpopulation-specific estimates of vital rates (Regehr et al. 2018) is not possible with the available data.

- A conservative approach to harvest will reduce the probability of subpopulation declines, especially in light of uncertainty in the available information and the documented changes in the sea ice regime.
    - Attempts to reduce subpopulation abundance without effective monitoring and a coupled research-management system increase the probability of negative biological effects on the subpopulation (e.g., reduction to a small size).

- Although recovery of this subpopulation from previous overexploitation appears successful, it came at a high cost to communities during the recovery period from reduced hunting opportunities and knowledge transfer to new hunters of polar bear hunting practices. To prevent this from recurring, we recommend focusing on the considerations above and additional recommendations below to achieve long-term sustainability and subsistence use of this subpopulation.

Additional specific recommendations for MC

1. Seek support from co-management partners to implement a radiotelemetry study to collect movement data in MC to obtain emigration estimates, resolve boundary issues, collect missing demographic data, and evaluate changes in habitat use and denning in light of the ongoing sea ice changes. Before starting such a study, it would be possible to identify the sample size and

duration required to address information needs so that no more bears are physically captured than necessary;

2. a) Increase monitoring activities by sampling bears (i.e., introduce more marks into the MC subpopulation) 5 – 7 years post-completion of the field portion of the last study (e.g., in 2023 or 2024) for a 1 year injection of marks until the next comprehensive population study will be conducted (~10 – 15 post-completion of last inventory; 2027 – 2032) to increase the number of marked individuals, recaptures and recapture probability of marked individuals. These factors will assist in determining more realistic survival rates when the next comprehensive study is undertaken (note that a power analysis will likely aid in determining whether additional marks really provide more data, and if this endeavor is cost-effective);

   b) Monitor reproductive metrics at the time of mark introduction to assess reproductive performance of MC, and if there are significant changes in reproduction consider whether the timing of the next comprehensive subpopulation assessment should be changed;

3. Increase population study length to 4 – 5 years to ensure that it covers a full reproductive cycle and reduces potential biases and assumptions that are required during the modeling process;

4. Consider any TAH recommendation above the current TAH allocation with caution and as an interim harvest level until a) the meta-analysis is performed and/or b) the boundary issue has been resolved which can assist in resolving the caveats of whether MC is a closed or open subpopulation, and to what degree emigration (either temporary or permanent) is affecting vital rates.

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10. FIGURES AND TABLES

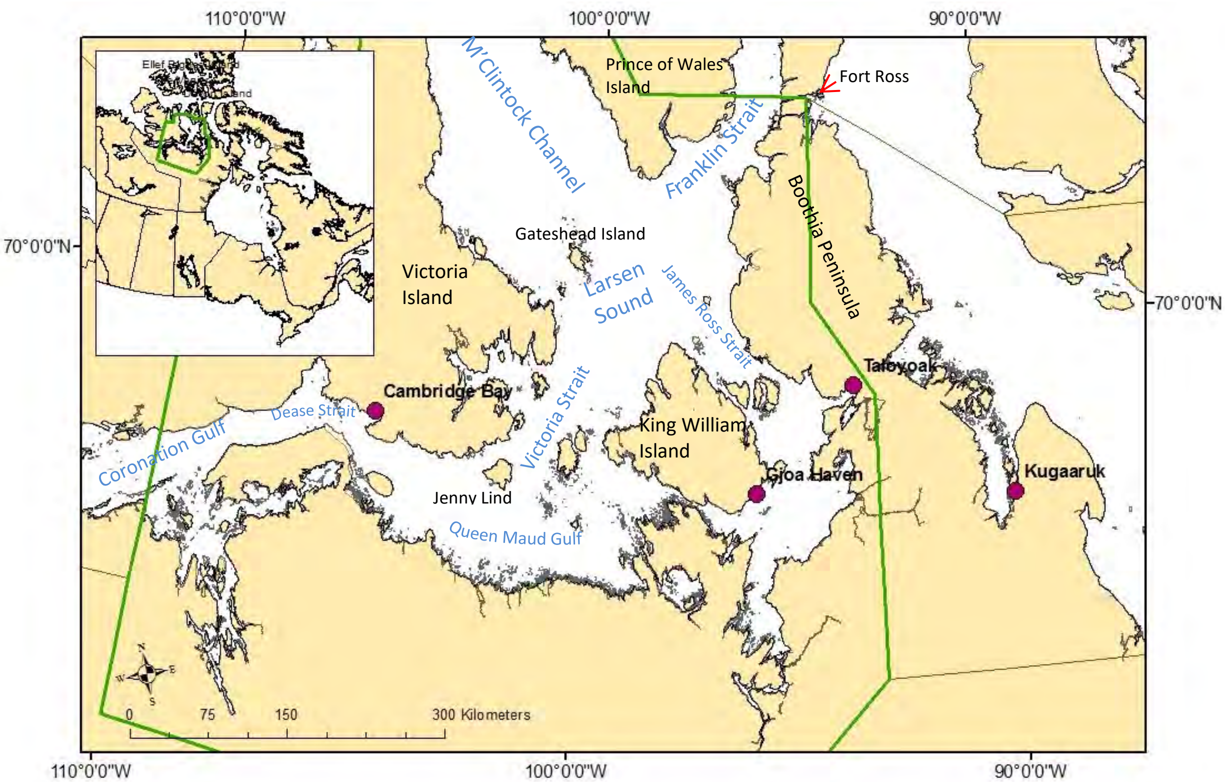

Figure 1. *Overview and location of the M'Clintock Channel polar bear subpopulation with major geographical features and water bodies.*

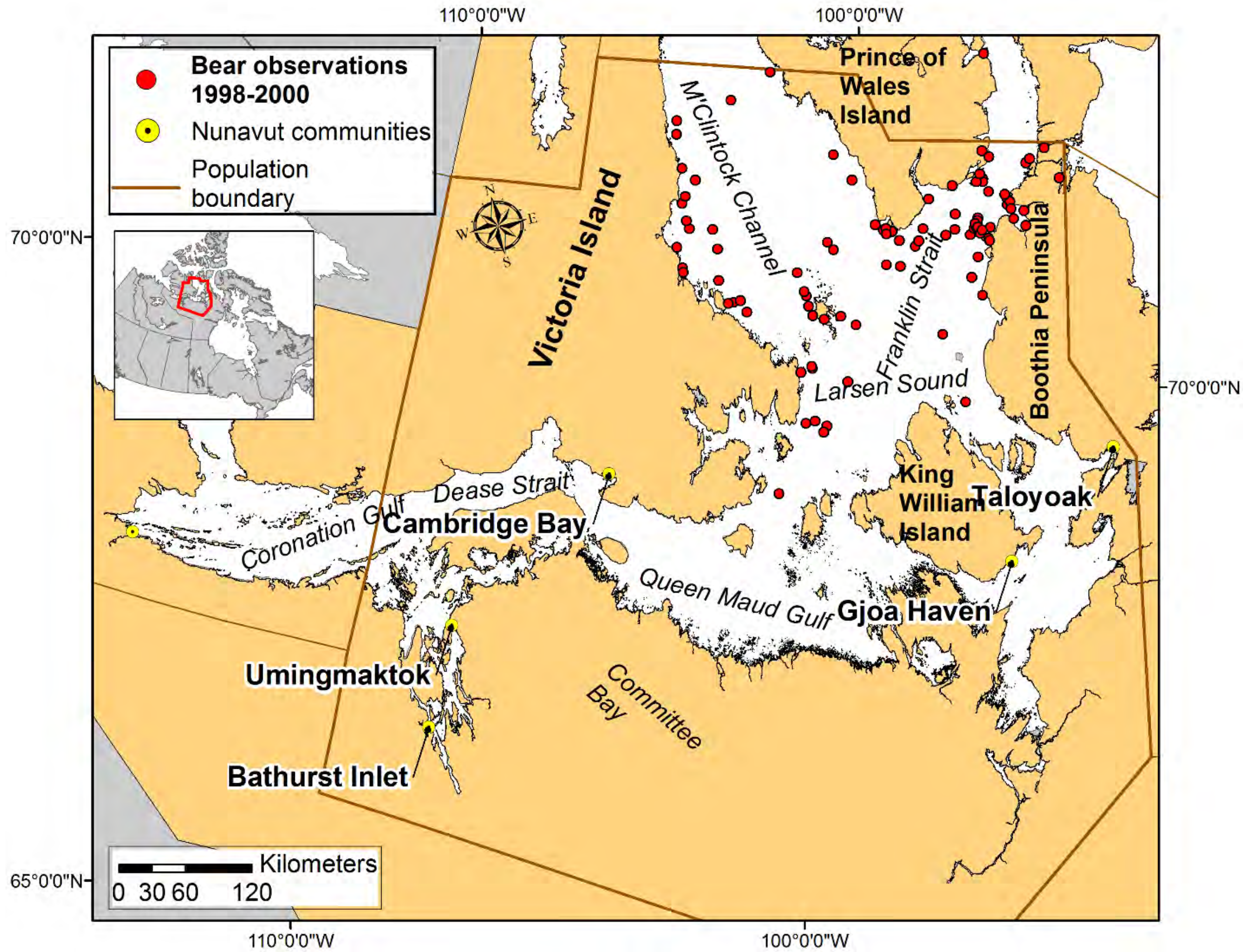

Figure 2. Capture and re-capture locations for the 1998 – 2000 M'Clintock Channel polar bear study.

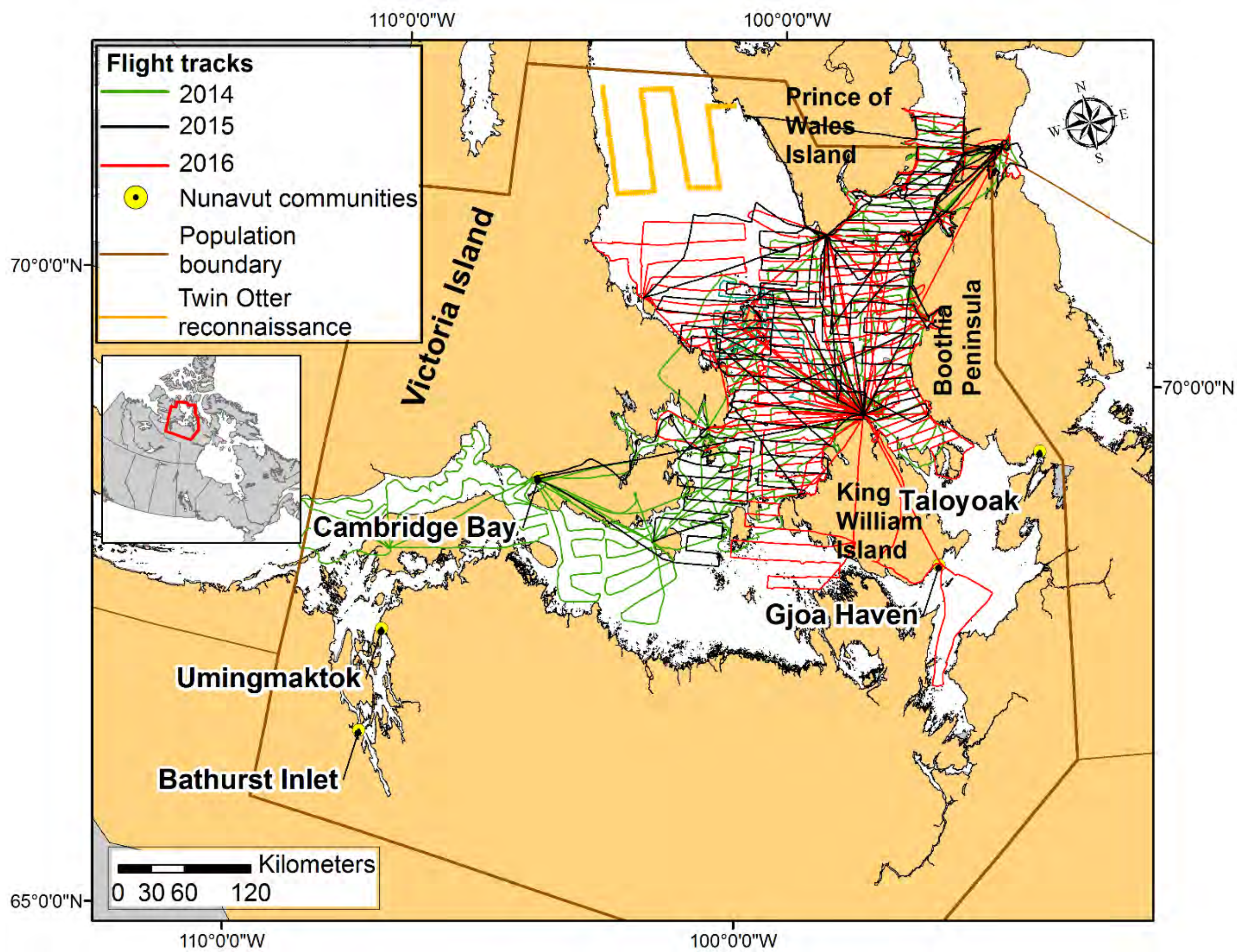

Figure 3. Helicopter paths flown in search for polar bears in M'Clintock Channel, Nunavut, Canada, during April/May-June 2014 – 2016. The golden path represents the Twin Otter reconnaissance flight during April 2016.

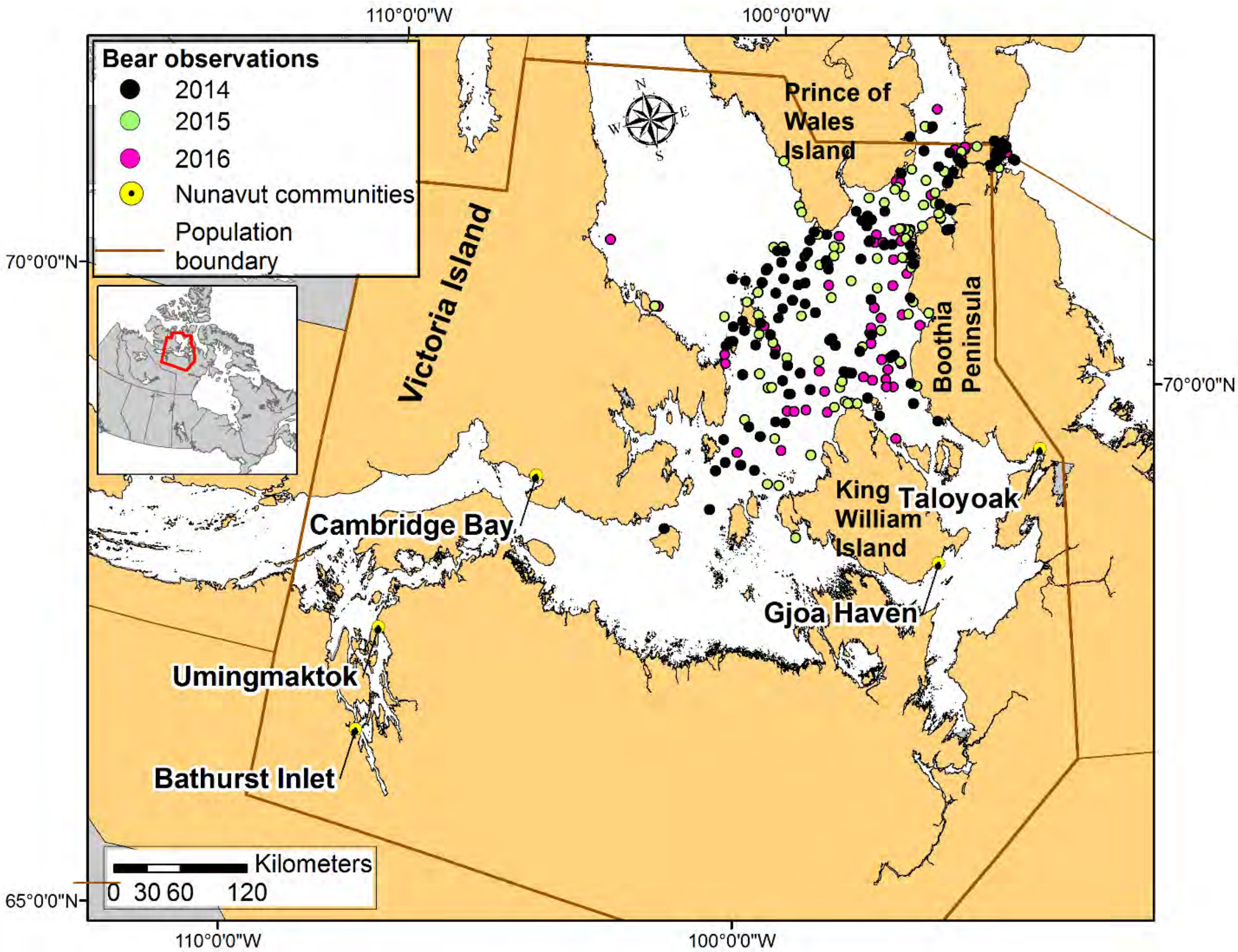

Figure 4. *Locations of polar bear encounters in the M'Clintock Channel polar bear subpopulation during April – June of 2014 – 2016.*

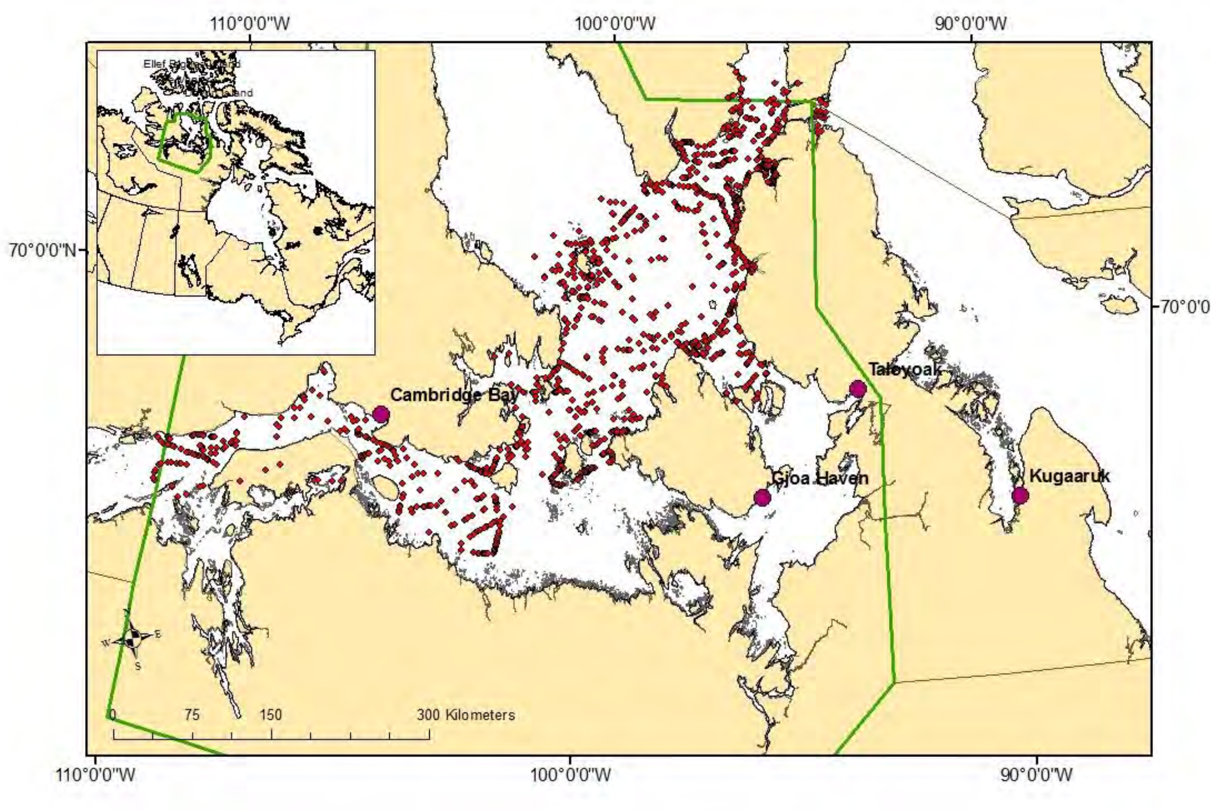

Figure 5. *Seal observations for May – June 2014 in M'Clintock Channel (n = 2,236) recorded during search for polar bears.*

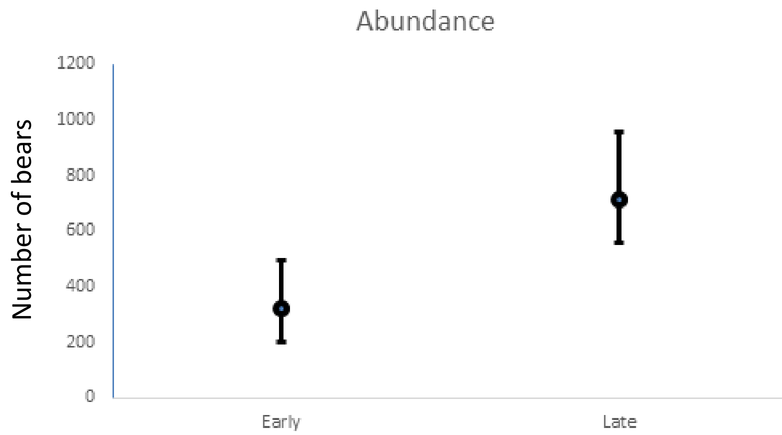

Figure 6. Estimated polar bear abundance in M'Clintock Channel during the early (1998 – 2000) and late (2014 – 2016) study periods.

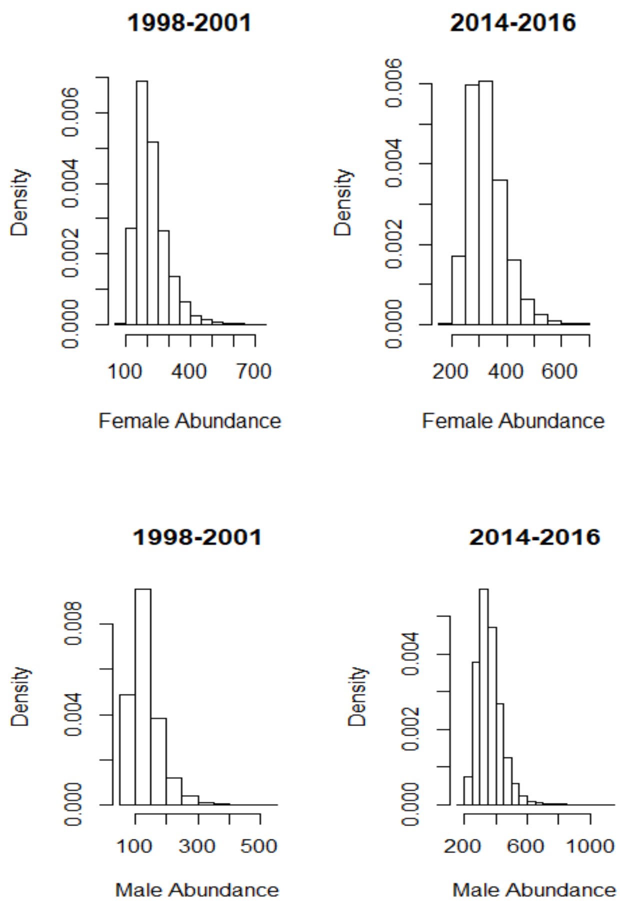

Figure 7. Posterior distributions for abundance estimates of female (top) and male (bottom) M'Clintock Channel polar bears.

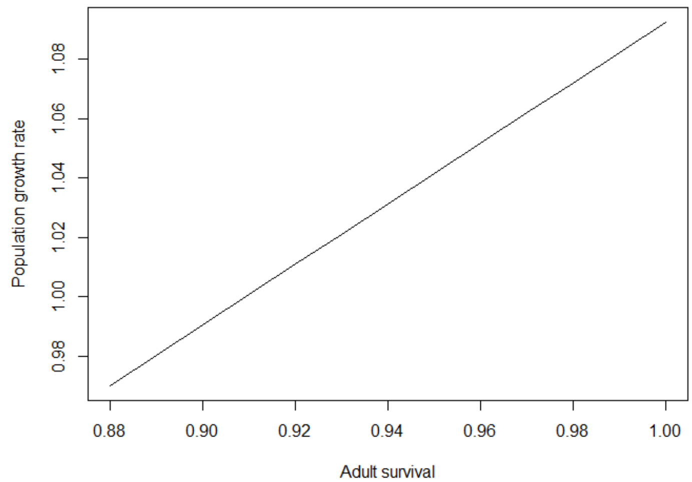

Figure 8. Population growth rate (λ) as a function of adult female survival. The observed growth rate is achieved when survival is approximately 0.92.

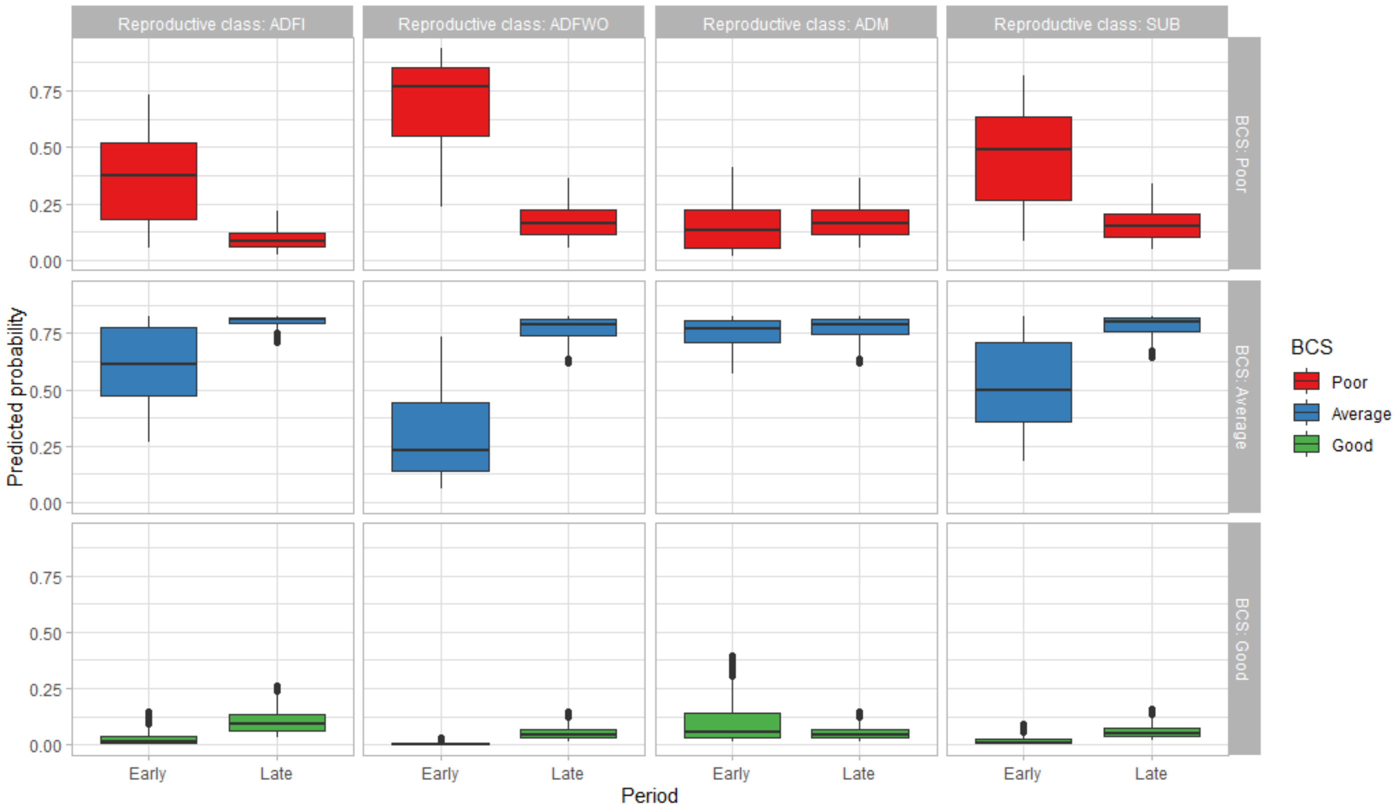

Figure 9. Predicted probabilities of bears being classified in Poor, Average, or Good condition in the early (1998 – 2000) and late (2014 – 2016) sampling periods. ADFI = adult, independent female, ADFWO = adult female with offspring, ADM= adult male, SUB = subadults of both sexes

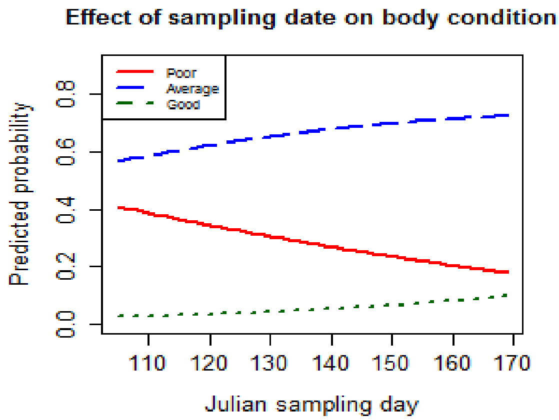

Figure 10. *Predicted probabilities of a bear being in Poor, Average, or Good body condition when sampled at different dates.*

Table 1. Parameter estimates for best fit ordinal logistic regression model for body condition analysis of the M'Clintock Channel polar bear subpopulation

Parameter	Estimate	SE	*p*
periodEarly	1.27	1.54	0.41
reproclassADFWO	-0.74	0.47	0.12
reproclassADM	-0.73	0.40	0.07
reproclassSUB	-0.62	0.50	0.21
jul_cap_day	0.02	0.01	<0.01
$icetm_{t-1}$	-0.01	0.01	0.11
periodearly: $icetm_{t-1}$	-0.03	0.01	0.05
periodearly:reproclassADFWO	-0.97	0.82	0.24
periodearly:reproclassADM	2.07	0.96	0.03
periodearly:reproclassSUB	0.14	0.77	0.86

Table 2. Overview of field statistics of the M'Clintock Channel polar bear study 2014 – 2016.

Field Year	Search time (hrs)	Number of bears/hr	Bears encountered[a]	Flown distance (km)	Duration
2014	97.5	1.90	155	12,600	4 May – 18 June
2015	72.5	1.68	122	10,100	5 May – 8 June
2016	94.0	1.00	95	14,200	19 April – 7 June

[a] The number of bears encountered does not represent the number of unique individuals (e.g., some bears have been resampled within same sampling period)

Table 3. Model selection results for Cormack-Jolly-Seber models of polar bear capture-recapture data from 1998 – 2016 used to estimate apparent survival of independent bears > 2 years. K is the number of parameters in the model.

Model	*K*	AICc	∆AICc	Weight	Deviance
Phi(constant) p(constant)	2	425.53	0.00	0.28	26.46
Phi(sex)p(constant)	3	426.22	0.69	0.19	420.15
Phi(constant)p(period)	3	426.40	0.87	0.18	25.30
Phi(sex)p(period)	4	427.02	1.49	0.13	418.90
Phi(sex)p(sex)	4	427.25	1.72	0.12	419.13
Phi(constant)p(sex)	3	427.46	1.94	0.10	421.39

Table 4. Mean numbers for cubs-of-the-year (C0) and yearlings (C1) per adult female and litter size for the M'Clintock Channel polar bear subpopulation, 1998 – 2000 and 2014 – 2016.

	Offspring per adult female		Litter size*			
Year	C0	C1	C0	n	C1	n
1998	0.40	0.25	2.00	4	1.67	3
1999	0.40	0.33	1.20	5	1.67	3
2000	0.33	0.60	1.67	3	1.80	5
2014	0.41	0.15	2.00	8	1.50	4
2015	0.61	0.35	1.50	14	1.71	7
2016	0.26	0.32	1.80	5	1.57	7

*Litter sizes of zero (whole litter loss) are not listed; all litters depend on at least one offspring being present.

Table 5. Body condition scores (BCS) for polar bears (n = 380) in the M'Clintock Channel subpopulation 1998 – 2000 and 2014 – 2016. Poor BCS corresponds to a thin bear and Good BCS corresponds to a fat/obese bear. Age classes are adult (≥ 5 years) and subadult (2 – 4 years).

	Body condition scores					
	1998 – 2000			2014 – 2016		
	Poor	Average	Good	Poor	Average	Good
Adult female without offspring	6	12	1	4	52	8
Adult female with offspring	22	8	1	4	44	1
Adult male	2	9	1	18	78	11
Subadult	24	31	2	2	38	1

Appendix A Study activities

Ice habitat images from the field work, in addition to some images of the genetic biopsy darting activities are presented in this appendix to demonstrate the harsh environment, field activities and the non-invasiveness of the technique.

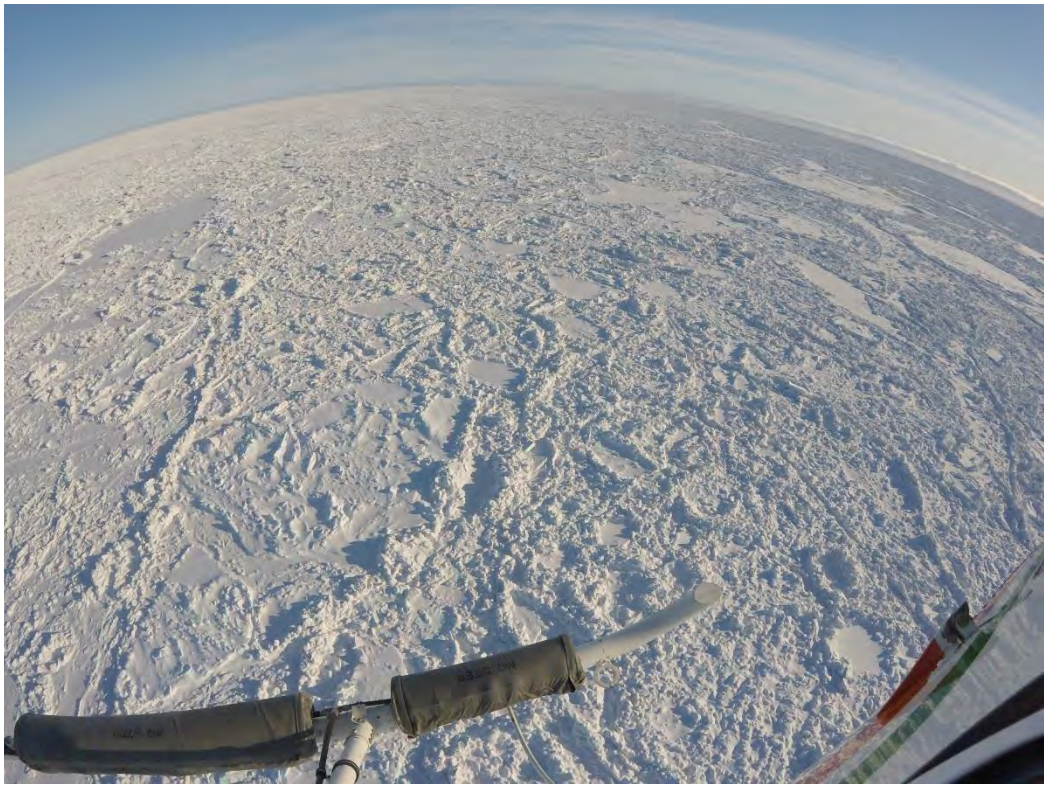

Plate A1. Image from the helicopter directly facing the sea ice. Rough ice, pressure ridges, and ice pans are visible (M. Dyck, Government of Nunavut).

Plate A2. A polar bear being genetically sampled from the air. The **orange color at the left rump area is the flagging tape from** the mid-air dart as it hits the bear and falls to the ground (M. Dyck, Government of Nunavut).

Plate A3. View of the sea ice with pressure ridges and a wind-blown and snow-encrusted surface. A polar bear is visible in the red circle (M. Dyck, Government of Nunavut).

Plate A4. Discoloured multi-year ice pushed together to form high pressure ridges and rubble ice fields (M. Dyck, Government of Nunavut).

Plate A5. Five adult male polar bears along a crack in the sea-ice. These bears were observed feeding together on a bearded seal carcass in May 2014. The sixth bear is not pictured (M. Dyck, Government of Nunavut).

Plate A6. Genetic biopsy sampling is very minimally invasive. A male polar bear is pictured lying down after being darted, with the dart in the background (M. Dyck, Government of Nunavut).

Plate A7. View of flatter sea-ice areas with a polar bear circled on the flat portion of the sea ice (M. Dyck, Government of Nunavut).

SUBMISSION TO THE

NUNAVUT WILDLIFE MANAGEMENT BOARD

FOR

Information: **Decision: X**

Issue: Total Allowable Harvest Recommendations for the Gulf of Boothia Polar Bear Subpopulation

Background:

- The Gulf of Boothia (GB) polar bear subpopulation is entirely managed by Nunavut (Figure 1). The last inventory study to estimate abundance was conducted between 1998-2000, which resulted in an estimate of 1592 bears. The GB polar bear subpopulation was considered stable in 2000, or slightly increasing.
- Communities from Igloolik, Sanirajak, Naujaat, Taloyoak, Gjoa Haven, and Kugaaruk harvest from GB. The current Total Allowable Harvest (TAH) for GB is 74 bears per year. The average harvest between 2004/2005 and 2018/2019 was 63 bears per year (Figure 2). The lower actual harvest relative to the TAH is likely a result of proactive management by communities, whereby they stopped the harvest when the female allocation in the 2:1 male to female quota was reached to avoid female overharvest and subsequent quota reductions, and poor ice conditions that prevented travel to preferred GB hunting locations.
- The population data were out-of-date, and a new study was needed to assess the status of this subpopulation. Following community consultations during 2012 and 2013, a new 3-year study began in 2015. The method used for this study was the less-invasive genetic mark-recapture DNA-biopsy sampling. The new study was conducted between 2015 and 2017.
- The Government of Nunavut, Department of Environment (DOE) initially planned to have a community project to collect local traditional knowledge from GB community members and hunters. However, the COVID-19 pandemic prevented local in-person meetings for interviews during 2020. As a result, that study could only be conducted remotely and is ongoing as of January 2021.

Current Status:

- The final report and results for the 2015-2017 study was completed and distributed to all relevant co-management partners in Summer 2020. The new abundance estimate of 1525 bears is not scientifically different from the previous estimate of 1592 (1998-2000).
- The new results suggest that the subpopulation is stable and has good reproductive performance. Mean cub-of-the-year and yearling litter sizes for the period 2015-2017 were 1.61 (95% confidence interval [CI] = 1.51 – 1.70) and 1.53 (95% CI = 1.41 – 1.64), respectively, with no apparent trend compared to 1998-2000.
- Body condition of bears in spring increased between the periods 1998-2000 and 2015-2017, which is likely due to changing sea ice conditions (i.e., reduction in multi-year ice) in the study area. The changes from less multi-year ice to more annual ice may have provided bears with improved prey accessibility.
- Due to the lack of movement data (e.g., telemetry/spatial) it is difficult to quantify the amount of immigration and emigration that occurs between GB and neighbouring subpopulations. Although there are subpopulation boundaries, bears in adjacent subpopulations likely move back and forth across boundaries at different times of year. The abundance estimate represents the “superpopulation” (e.g., it includes all bears that were using the GB management area).
- The TAH of 74 has not been filled for this subpopulation over the past ten harvest seasons. The average harvest over the last five years has been 64 bears (Figure 2).

Consultations:

- In-person community consultations with relevant representatives from GB Hunters and Trappers Organizations (HTO) were held between 20-28 October 2020.
- There was consensus among HTO members regarding the findings of the GN report, although some HTO members inquired about how they could get more tags.
- There was a consistent concern among HTOs that tag allocation needed to be revisited to ensure fairness and equity among the communities that harvest from the GB subpopulation
- Staff from Nunavut Tunngavik Inc., Nunavut Wildlife Management Board, Kitikmeot Regional Wildlife Board (KRWB), and Qikiqtaaluk Wildlife Board (QWB) were also available to attend several meetings (see details in GB Consultation Summary Report by GN DOE).
- Representatives from the Kivalliq Wildlife Board (KWB) were unable to attend.

Recommendations:

1. DOE recommends **no change to the current TAH of 74 bears at a 1:1 male to female sex harvest ratio.**

   Rationale:

   a. The recommended TAH considers the management objective to maintain a viable polar bear subpopulation. The results of the survey show that the population has remained stable with a TAH of 74 bears.
   b. The recommendation also factors in the changes to the ecosystem, of which GB bears are an integral part. The ecosystem has undergone a drastic change due to climatic changes and the long-term effects, as conditions continue to change, are unknown.
   c. Setting GB harvest levels too high increases the risk for biological decline or depletion, not only in GB but also for neighboring subpopulations due to the unknown emigration/immigration rates.
   d. The TAH of 74 has not been filled for this subpopulation over the past ten harvest seasons. The average harvest over the last five years has been 64 bears.

2. DOE recommends that all involved Regional Wildlife Organizations discuss the GB tag allocations with the affected communities, including the ones harvesting from the M'Clintock Channel (MC) polar bear subpopulation.

   Rationale:

   a. During consultation meetings (October 20-28, 2020) there were similar concerns expressed in each community that the current tag allocation for GB communities needed a revision and re-allocation.
   b. The TAH of 74 has not been filled for this subpopulation over the past ten harvest seasons. The average harvest over the last five years has been 64 bears.

Appendix 1

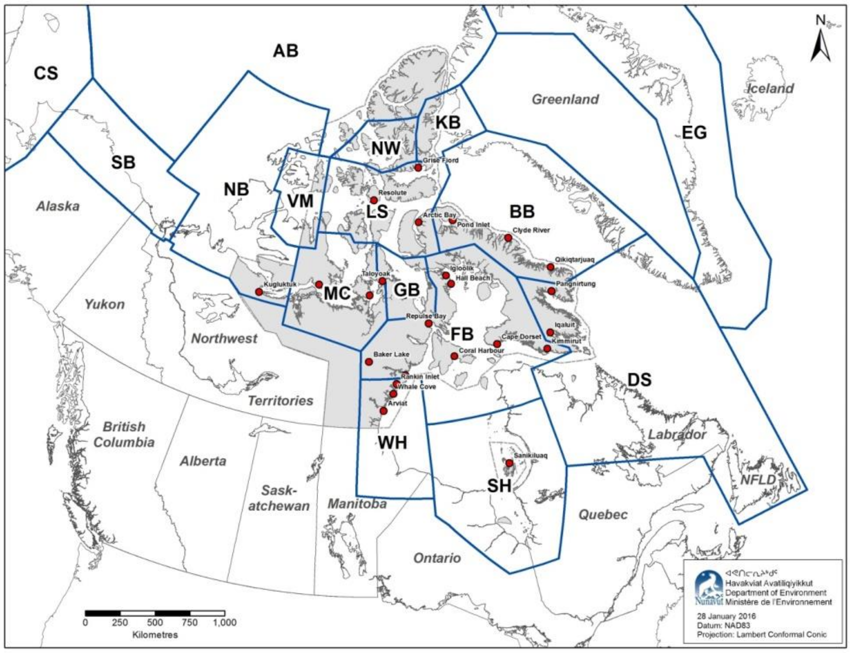

Figure 1. Overview of Nunavut polar bear subpopulations (GB = Gulf of Boothia, MC = M'Clintock Channel).

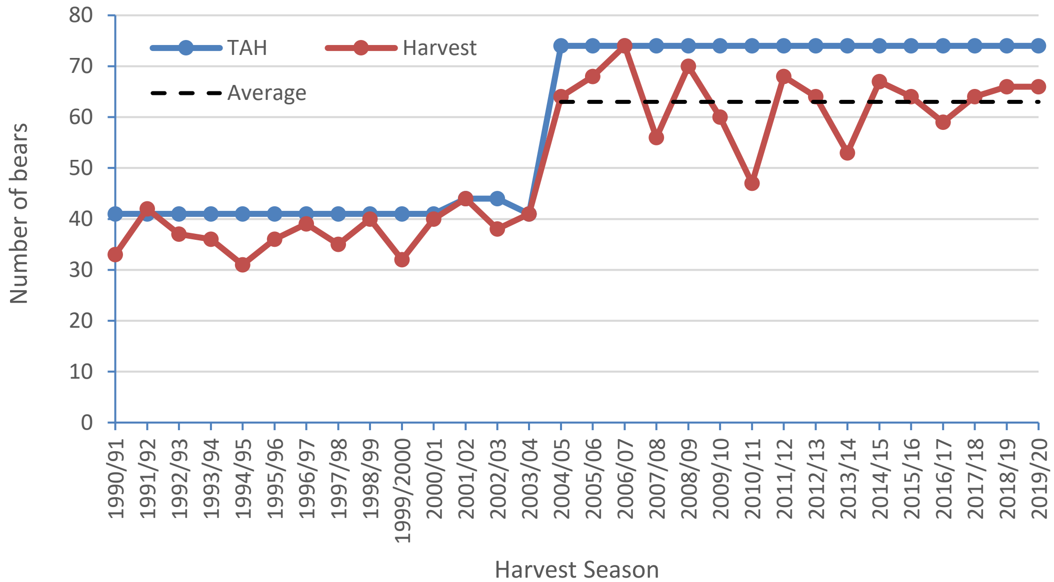

Figure 2. Overview of the Gulf of Boothia polar bear Total Allowable Harvest (TAH), actual and average harvest since 1990.

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Building Nunavut Together
Nunavuliuqatigiingniq
Bâtir le Nunavut ensemble

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Department of Environment
Avatiliqiyikkut
Ministère de l'Environnement

GULF OF BOOTHIA POLAR BEAR SCIENTIFIC STUDY RESULTS

Consultations October 20-28, 2020

Consultation Summary Report

Polar Bear Research Group
Department of Environment
Government of Nunavut
Igloolik, NU

Executive Summary

Government of Nunavut, Department of Environment (DOE) representatives, together with representatives from the Kitikmeot Regional Wildlife Board (KRWB), Nunavut Tunngavik Inc (NTI), Nunavut Wildlife Management Board (NWMB), where available, conducted consultations with Hunters and Trappers Organizations (HTOs) from October 20-28, 2020. The purpose of the consultations was to provide co-management partners with an overview of the most recent scientific study results on the Gulf of Boothia (GB) polar bear subpopulation, as well as collect feedback on the results presented and collect additional traditional knowledge (TK). Only the HTOs in communities that hunt from the GB subpopulation were consulted. The feedback and TK collected during these consultations will be considered when forming Total Allowable Harvest (TAH) recommendations for the GB subpopulation to be submitted to the NWMB for decision. This report attempts to summarize the comments made by participants during the consultations.

Preface

This report represents the Department of Environment's best efforts to accurately capture all information that was shared during consultation meetings with the Hunters and Trappers Organizations of Gjoa Haven, Igloolik, Kugaaruk, Naujaat, Sanirajak, and Taloyoak. The views expressed herein do not necessarily reflect those of the Department of Environment, or the Government of Nunavut.

Contents

1.0 Report Purpose and Structure

This report is intended to collate and summarize comments, questions, concerns and suggestions provided by the HTOs in response to the results from the 2015-2017 GB scientific study. Pre-study consultations with these communities were conducted in 2013.

The following communities were consulted from October 20-28, 2020:

- Gjoa Haven, October 20, 2020
- Taloyoak, October 21, 2020
- Kugaaruk, October 22, 2020
- Naujaat, October 26, 2020
- Sanirajak, October 27, 2020
- Igloolik, October 28, 2020

During the meetings DOE provided input on what the GN's TAH recommendation would be for GB. Representatives from the NWMB, NTI, KRWB, Kivalliq Wildlife Board (KWB), and the Qikiqtaaluk Wildlife Board (QWB) were invited to these meetings and they participated whenever representatives were available to attend in person.

2.0 Purpose of Consultations

The purpose of these consultations was to discuss the newest scientific information regarding the GB polar bear subpopulation as reported in the GN scientific study report produced by the GN polar bear biologists. In addition, the GN also put forward a TAH recommendation during these consultations, but also discussed that management objectives can be formulated depending on the communities' needs and objectives for co-managing this subpopulation.

2.1 Format of Meetings

The meetings were held in the evening (e.g., beginning between 17:00 and 18:30) and ran between 2.5 to 4 hours depending on HTO. Meetings were facilitated and led by GN Polar Bear Biologists M. Dyck and J. Ware. The biologists presented the historic management background, and a detailed overview of the results from the 2015-2017 polar bear study conducted in GB (Appendix 1). The participants were invited to ask questions, raise concerns, or provide recommendations throughout the meetings. It was also pointed out that there is still the on-going GB TK study in which results are expected by the end of 2020, depending on how the COVID-19 pandemic evolves.

After the presentation, questions/discussion continued until no further questions were raised. At the end of the meeting, the GN position on the TAH for GB was presented. In addition, it was also mentioned that the GN position may not reflect the Management Objective goal of the communities and communities were encouraged to work with the Regional Wildlife Organizations (RWOs) and/or the GN to develop a Management Objective for the GB subpopulation. The biologists explained that consideration for a TAH that differs from the GN recommendation should include the uncertainty of the results, the changing environment, and the needs of communities. Discussions and questions were raised regarding the tag distribution in GB and M'Clintock Channel (MC) for communities that harvest from both subpopulations. The biologists advised the participants that this is a matter for relevant RWOs to consider as tag allocation within a subpopulation falls under their purview.

3.0 Summary by Community

The objectives of the consultation meeting were made clear to the HTO members prior to and at the start of each meeting. There were many similar questions, concerns and suggestions raised by HTO Board members in the communities consulted. A full, detailed report of the questions and comments from each community can be found in Appendix 2.

3.1 Gjoa Haven Consultation Summary

Date: October 20, 2020
Time: 18:50 – 21:15

Representatives:

- GN-DOE, Polar Bear Biologists M. Dyck, J. Ware
- GN-DOE, Conservation Officer J. Skilling
- GN-DOE, Regional Manager, K. Methuen
- Gjoa Haven HTO Board Members

Comments and Questions:

After the presentation about GB, board members discussed their experiences from over the past years and they lined up with the GN study results. Generally, the board members agreed with the GN findings. It also became clearer by comments from board members that currently, not much hunting in GB is done by Gjoa Haven hunters due to unpredictable ice conditions. Some points were raised that the distribution of tags for

GB and MC are not distributed fairly, especially now that MC shows an increase in bear abundance. The GN representatives suggested this subject be raised by the HTO with the KRWB. The board was thankful and appreciative that the GN visited the community to present the results and to have a discussion. Some clarity was provided on how BEARWATCH and individuals associated with the project are related to GN projects.

3.2 Taloyoak Consultation Summary

Date: October 21, 2020
Time: 17:45 – 20:15

Representatives:

- GN-DOE, Polar Bear Biologists M. Dyck, J. Ware
- GN-DOE, Conservation Officer D. Anavilok
- GN-DOE, Regional Manager, K. Methuen
- Taloyoak HTO Board Members

Comments and Questions:

After the presentation about GB, board members discussed their experiences from over the past years and how they lined up with the GN study results. Generally, the board members agreed with the GN findings. Some points were raised that the distribution of tags for GB and MC are not distributed fairly, especially now that MC shows an increase in bear abundance. The GN representatives suggested this subject be raised by the HTO with the KRWB.

3.3 Kugaaruk Consultation Summary

Date: October 22, 2020
Time: 18:50 – 21:20

Representatives:

- GN-DOE, Polar Bear Biologists M. Dyck, J. Ware
- Kugaaruk/ Kurtairojuark HTO Board Members
- KRWB representative Ema Qaqqutaq.

Comments and Questions:

After the presentation about GB, board members discussed their experiences from over the past years and how they lined up with the GN study results. Generally, the board members agreed with the GN findings. A longer discussion ensued about handling and collaring bears, and whether this could be applied in the future to answer questions from the HTO especially as it relates to shipping and industrial activities.

3.4 Naujaat Consultation Summary

Date: October 26, 2020
Time: 18:10 – 21:50

Representatives:

- GN-DOE, Polar Bear Biologists M. Dyck, J. Ware
- GN-DOE, Conservation Officer P. Papatsie
- GN-DOE, Acting Regional Manager J. Neely
- Naujaat HTO Board Members
- QWB Chairperson J. Qillaq
- NTI Director of Wildlife P. Irngaut
- NWMB D. Ndeloh, S. Mapsalak, KJ England

Comments and Questions:

After the presentation about GB, board members discussed their experiences from over the past years and how they lined up with the GN study results. Generally, the board members agreed with the GN findings. A longer discussion ensued about how current allocations are distributed among communities and that some communities would like to see this reviewed. It was also discussed what steps are involved to see allocation changed via relevant RWOs.

3.5 Sanirajak Consultation Summary

Date: October 27, 2020
Time: 19:15 – 21:15

Representatives:

- GN-DOE, Polar Bear Biologists M. Dyck, J. Ware
- GN-DOE, Conservation Officer B. Grosset
- GN-DOE, Acting Regional Manager J. Neely
- Sanirajak HTO Board Members
- QWB, Chairperson J. Qillaq
- NTI, Director of Wildlife P. Irngaut
- NWMB, Director of Wildlife D. Ndeloh, NWMB Biologist KJ England

Comments and Questions:

After the presentation about GB, board members discussed a little of their GB experiences and few observations from past years and they somewhat lined up with the GN study results. Some comments were made that just few bears are harvested in GB by Sanirajak.

3.6 Igloolik Consultation Summary

Date: October 28, 2020
Time: 18:40 – 21:42

Representatives:

- GN-DOE, Polar Bear Biologists M. Dyck, J. Ware
- GN-DOE, Acting Regional Manager J. Neely
- Igloolik HTO Board Members
- QWB, Chairperson J. Qillaq
- NTI, Director of Wildlife P. Irngaut
- NWMB, Director of Wildlife D. Ndeloh, Biologist KJ England

Comments and Questions:

After the presentation about GB, board members discussed sea ice changes, shipping, and that more bears are seen – though much of the observations were related to Foxe Basin. There was discussion about harvesting cubs and the permit for that, and how to get a TAH increase in Foxe Basin. Overall, the members agreed with the findings of the study.

4.0 Overall Consultation Summary

The consultations for all communities harvesting from GB were conducted in a roundtable, open discussion format in which all participants were able to provide feedback, ask questions, and speak. Participants offered context and understanding to the scientific results. The major points raised by communities regarding GB were:

1) agreement with the scientific findings that the population appears stable—no major changes based on land observations—since the last scientific study in 1998-2000, and

2) GB tag allocation is a major concern.

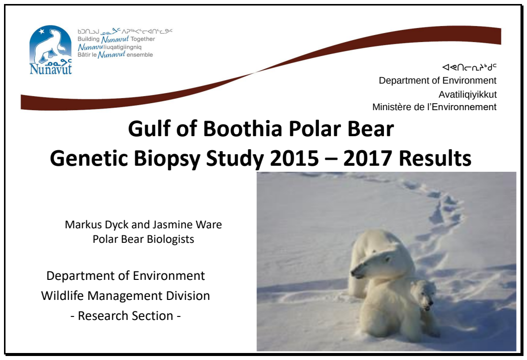
Minor points, which represent comments by some communities but not all, included an interest in gathering movement data to determine potential effects of increased industrial development and shipping and an interest in harvesting cubs.

The GN proposed no change in TAH for GB based on the scientific findings of a stable population. Given the overall community agreement with the findings, there were no major oppositions to this proposal. There is an ongoing Inuit Qaujimajatuqangit study for GB which may offer more comprehensive insight into hunters' and users' observations of bear distribution or abundance.

One of the major points brought up during consultation was that the tag allocation needed to be revisited to ensure fairness and equity among the communities that harvest from GB. This was raised most emphatically by communities that were harvesting from both MC and GB populations. The GN representatives discussed roles and responsibilities of the relevant bodies for creating the tag allocation among communities. The GN outlined the process via the RWOs and offered to provide guidance or further information to any interested community.

Appendix 1: Complete Consultation Presentation of the Gulf of Boothia Polar Bear Study Results 2015-2017

Slide 1



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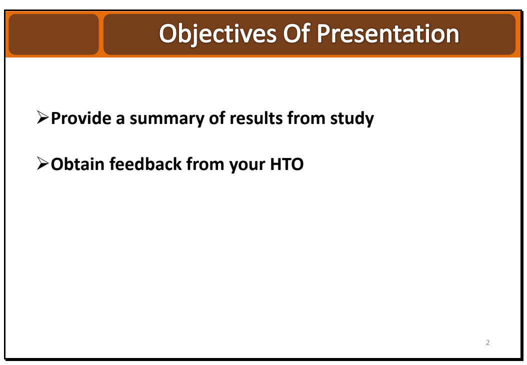

Slide 3

Background

- First mark-recapture study between 1973-78
  - MC and GB treated as one unit, estimate of 1,081
- GB estimate increased to 900 in mid-90s based on local knowledge and biased sampling
- MC estimate decreased from 900 to 700 based on local knowledge in mid-90s
- Population boundaries in 1995 and 2001

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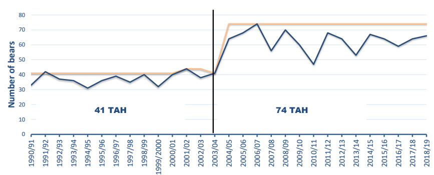
Background

- 1998-2000--Mark-recapture estimate for GB was 1592 bears
- TAH of 41 for GB until 2003/2004
- Increased TAH to 74 bears in 2004/2005
- Average harvest per year: **63 bears since 2005**



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Background

- Population status unknown (stable? increasing?)
- Population boundaries of MC/GB/LS?
  Inuit Qaujimajatuqangit/genetics suggest movement between both units

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Goals of study

- Need for new information – current data was deficient
  - Re-assess population abundance
  - Evaluate population boundaries/movements of bears
  - Provide information for review of Total Allowable Harvest (TAH)
  - Observe effects of changing sea-ice conditions
  - Assess potential impacts of industrial activity

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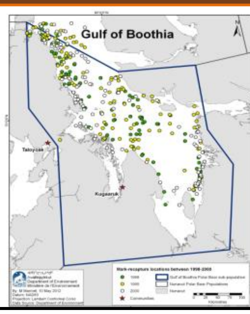
Study method choices

- Co-management partners indicated concern about drugging & handling bears
  - Explore alternative population assessment methods
  - Better reflect Inuit societal values
- Balance with analysis needs –to properly monitor population



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Study method chosen

- Co-management partners chose, and GN supported, less invasive choice:

Genetic mark-recapture (biopsy sampling, no physical handling)

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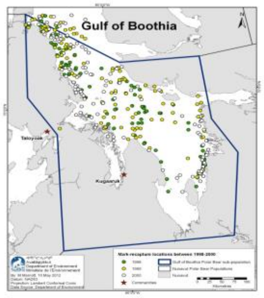
Genetic capture mark-recapture study goals

- Estimate polar bear abundance in GB
- Compare with 1998-2000 estimate
- Compare information on reproduction, survival
- Cannot estimate movement or boundaries with this method



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Study funding and support

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Nunavut

Nunavut General Monitoring Plan

WWF

QIKIQTAALUK WILDLIFE BOARD

HTOs from Gjoa Haven, Igloolik, Kugaaruk, Naujaat, Taloyoak, Sanirajak

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Study Design

Community Participation

- Survey design and method choice - 2013
- Survey observers – 2015 through 2017
- Review & evaluation of results - 2020

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Study Design

- Method choice: genetic capture mark recapture
- Timing of study: mid-April to early June
- HTO participation on searching and sampling flights where available

- Used helicopters to search

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Study Design

- Recording age class, sex, body condition, litter size, location of bears

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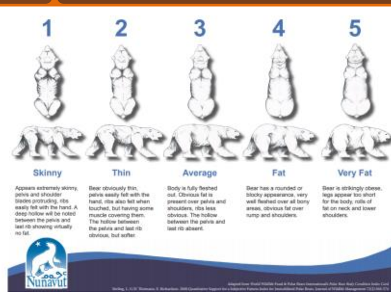
Study Design



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Study Design

- Collected small tissue samples for genetic analysis (to genetically identify and "mark" an individual)
- No cubs-of-the-year sampled
- No drugging, no collaring
- No specific ages or samples for other studies (e.g., contaminants)

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Study Design - Analysis

- Included all available information for analysis:
  - Genetic mark-recapture (biopsy) information 2015-2017
  - 1998-2000 capture mark-recapture information
  - Harvest recoveries (e.g., when an ear tag/lip tattoo is recovered by a hunter) 1976-2017
  - 1976-1997 capture mark-recapture information

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Analysis Goals

- Use all information to determine:

1. Trends in abundance from 2000-2017
2. Survival rates of different age classes and sexes over time
3. Reproductive parameters such as size of litters, litter rate per adult female (how productive are the females/population)
4. Population growth rate – determined using survival rates and litter production rates
5. Evaluate body condition of bears across the entire GB area

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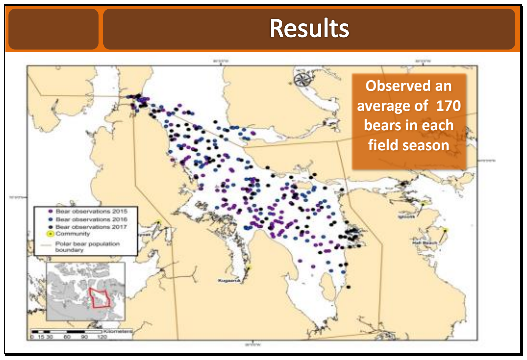

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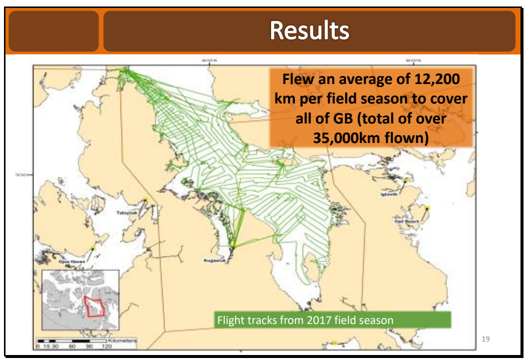

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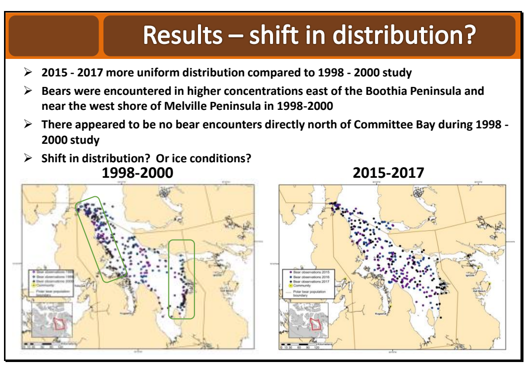
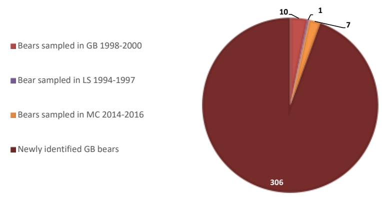


Slide 21

Results – mark-recapture samples

- 324 individual bears identified through genetic biopsy sampling using DNA
- 10 bears were previously marked in 1998-2000 study
- 1 bear previously marked in Lancaster Sound study in 1994-1997 study
- 7 bears marked in M'Clintock study 2014-2016



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Results – body condition

- Bears were in better condition (fatter) in 2015-2017 compared to 1998-2000
  - 30% chance of poor Body condition (1 or a 2 score) in 1998-2000
  - 7% chance of poor Body condition in 2015-2017
- Why? Your thoughts?

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Results – Reproduction

- What does "reproduction" mean? What do scientists look at?
- Litter size
  - data from 1998-2000 and 2015-2017
    - 99 females observed with COY litters
      - COY litter size: 1.61
    - 80 females observed with Yearling litters
      - Yearling litter size: 1.53

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Results – Reproduction cont.

- Number of offspring per adult female

1998-2000	2015-2017
0.51 COYs/adult female	0.43 COYs/adult female
0.37 yearlings/adult female	0.36 yearlings/adult female

  - 85% chance that COYs per adult female was less in 2015-2017 compared to 1998-2000

- Number of yearlings per adult female is important because it shows how many cubs-of-the-year survive to be yearlings
  - good measure of reproduction

- The GB subpopulation has healthy reproduction

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Results – Survival

- Females and males separated
- Adults and subadults separated

- Data support similar survival across time

- Unsurprisingly, subadults have the lowest survival of these groups with subadult males lower than subadult females.

- There were fewer adult males than expected, but that is likely due to the past harvest with a 2 males for 1 female harvest system

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Results – Population growth rate

- Population growth rate similar to assessments from the last study
(growth rate is simply the difference between what is added through births minus the deaths and takes into account how animals survive)

- Growth rate indicates strong potential for growth

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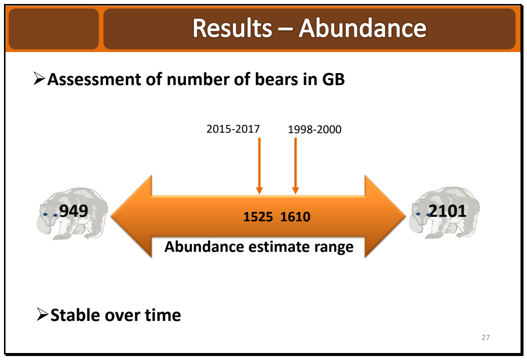

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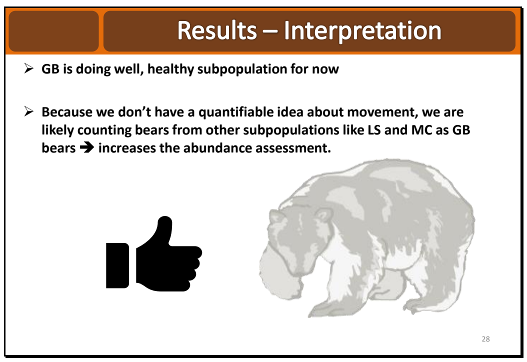

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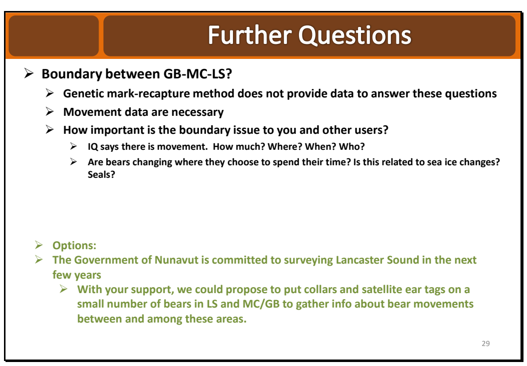

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Further Questions

- Do you agree that the number of bears stayed relatively the same over time?
- What did you observe in the bears' body condition over time?
- Are there enough bears to harvest? Are there too few? Too many?
- Is there anything special that you observed and wanted to share with us?
- Where do you agree/disagree with our findings?

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GN Recommendation

- The GB subpopulation has remained stable – we recommend no change in TAH
- What are your thoughts about the recommendation?

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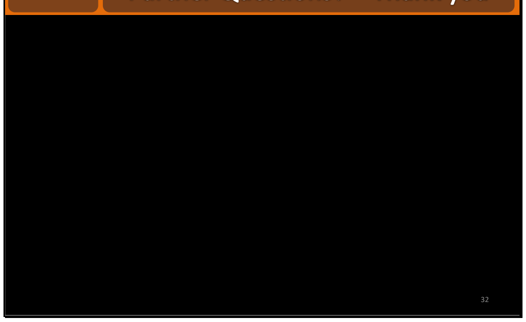
Further Questions? - Thank you



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Appendix 2: Complete Consultation Summary of the Gulf of Boothia Community Consultations

Nunavut Community Consultations on the results from the 2015-2017 Gulf of Boothia Polar Bear Study

October 20-28, 2020

HTOs Consulted:
Gjoa Haven
Taloyoak
Naujaat
Kugaaruk
Igloolik
Sanirajak

Summary of Consultations:

A: Gjoa Haven

October 20, 2020

Time Start: 18:50

Time End: 21:15

Participants:

Enuk Pauloosie
William Aglukkaq
James Qitsualik via cell phone video chat
Simon Komangat
Jimmy Qirqqut
Roger Ekilik
Ben Putuguq
Jimmy Pauloosie
Ralph Porter Sr.
J. Skillings – GN-DOE
K. Metheun – GN-DOE
M. Dyck – GN-DOE
J. Ware – GN-DOE
Jacob Keanik - translator

- Markus introduced option to go over background of MC/GB or skip it? Question to the board---what would you prefer?

- Ralph: we don't need super detailed on the background so you can go through it quickly.

Background slides: review – our objective to provide new data for the co-management partners and the NWMB to make decisions on setting harvest levels. We are here to hear feedback.

Study methodology: review, no questions

Community participation: review; no questions

Study design: review; no questions

Study design analysis: explained why the amounts of data matter for getting the results; no questions

- Ben: Years ago, when the moratorium came, I was one of the Board members back then and remember it. We used to go all the way to Prince of Wales Island before the quota system was put in place to harvest as much as we could.

- Markus: thank you, I'd like to hear about the ice back then.

- Ben: it's totally different. There isn't any ice really.

GB Results:

- Willy—the board isn't that interested in Gulf of Boothia because it is very rare that we go there to hunt. The ice conditions are too dangerous. Young hunters do not have any knowledge about that area. We are not that interested in this population.

- Ralph said if a bear doesn't want to show up, you can't see it. It is the knowledge of our ancestors.

- Ben: when our young hunters go to Gulf of Boothia, they don't have a clue about the ice conditions and it's very dangerous…the ice can just take them.

- Willy: that actually happened with a sport hunting group—the ice split and took the hunters out to sea.

- Ben: the hunters that were taken the sport hunters, I was there, and I managed to get home before the ice split. The younger generation doesn't have a clue how the ice conditions.

- Markus: I can go over GB very quickly. It is my job; I have to tell you about it.

GB Results/TAH recommendation: Because its stable and there are no changes that we can detect, we are recommending that there is no change to the TAH. If the communities feel differently—want more meat or public safety is an issue, then that is an opportunity to discuss how the TAH could change.

- Willy: It doesn't affect us.

- Markus: That's pretty much it for the presentation for the MC/GB. Are there any questions that the community here has with regards to GB/MC/LS boundaries and movements? We can hear these comments and try to see if they can be incorporated into our future work. We are doing LS and are going to be analyzing those samples in the next 4-6 years and we will let you know what we find—were there MC bears up there that we marked in 2014-2016.

- I know there is no desire from this community for collaring, but there are some communities that are interested in movements because they are wondering about climate change, increased development, increased shipping. For example, NTI approached me once about impact on bears from a development project, but

I couldn't answer those questions because we don't have movement data. For now, maybe this is okay, but this may be important in the future.

- If there are specific questions from the communities or specific areas of interest, bring those forth to the regional wildlife board/NWMB priority—those priorities help the GN determine how they focus their resources and money along with our mandate to get updated information for the polar bear subpopulations.

- **Question Simon**: Peter DeGroot seems to be doing a lot of research in the last 20 years. What does he do with you guys?

- **Answer Markus**: He works for a university, not affiliated with GN. He is part of a big project, multiple universities, maybe 25 organizations supporting BearWatch – Peter is involved, but he is not the lead. It is looking at genetics, bacteria, developing a kit for fecal sampling. A lot of different projects but Peter is a tiny part of the bigger project. The GN supported Bearwatch because there are bits and pieces of this project that could help for management that we could not collect alone.

- **Question Willy:** Is this work they are doing helping us? It is helping the government…but what is it doing for us?

- **Answer Markus**: the samples are still being analyzed…from the many samples they are trying to determine if it's possible to see contaminants and genetics. As the GN, we could not do it. The idea was to be able to harness the resources of universities and their labs to gather information and develop potential new methods for non-invasive health monitoring of the bears.

- **Answer Jasmine:** also, we don't know if what BearWatch has proposed will work –it was an idea that had to be tested. The idea was to develop less invasive technologies and methods, but will it actually work? Don't know.

- **Question Ralph**: so whatever Peter does it is not affiliated with the NWMB?

- **Answer Markus**: that is correct. Whatever Peter does is not counting bears and they are not primarily responsible to providing info to NWMB for management decisions.

- Willy: they are mostly doing contaminants, health, same as they are doing with the fish.

- Roger: Hunting bears in GB is too far—takes a lot of gas and people don't go there. Mostly MC.

- Markus: the GN is not responsible for allocation—the KRWB does that. For GB, all 3 regional wildlife boards are involved for GB—they all have to talk to each other. That requires a lot of discussion, I think. I think it requires involvement of all the RWOs.

- Ben: Bears in MC once it starts to freeze up, they start to come to town…that's because they are not being harvested due to the moratorium. Even during the summer, there are bear sightings now.

- Markus: Also, probably not that much noise and traffic going out, so they aren't afraid.

- Ben: it's because they aren't being harvested or disturbed by machines. They are even sighted far inland on King William Island. The population is healthy.

- Willy: Another thing is that between here and Taloyoak, there used to be a lot of traffic between the two communities even in the spring. Lately they have been seeing bears between here and Taloyoak. Seeing a lot of bears tracks, even wolf and wolverine around Clarence islands. Packs of wolves on the sea ice – Markus you've seen the wolves come into camp, two of them. Even going up to Boothia. But there are packs of wolves and they can also kill polar bears, from experience.

- Markus: the wolves could have an impact on the offspring of polar bears

- Willy: bottom line is that we saw a lot of bear sign and the 3 bears we got were very healthy and over 10 ft.

- Markus: that lines up with what we are seeing –that is really nice to hear.

- **Question Simon**: you were going to talk about sea ice Markus?

- **Answer Markus**: I think the way we looked at sea ice was that we included it our body condition analysis and how that might affect the body condition. We know from satellite imagery from last 30 years that ice has changed. We didn't do full analysis from satellite imagery or ice analysis on ice specifically. I don't' know if that's answering your question.

- Simon/Willy nod it was sufficient answer

- Ben: Used to have icebergs that even have cracks and there used to be abundance of seals and there were ice packs and they were easy to spot. Nowadays the bears are moving more because there are less icebergs –we don't see the icebergs anymore.

- Willy: we don't see much ice anymore.

- Markus: agree with the satellite imagery—barely any ice in MC channel in fall

- Willy: people that used to go harvest belugas to Prince of Wales, but as soon as they get westerly winds the ice would get pushed in and they'd be stuck for weeks---they have a hard time getting through because of ice, but now no problem…20 years a big difference in sea ice.

- **Question Markus**: that's the other question I have---if this northern area is free of ice, what's going on with bears? Do they stay on the little ice? Do they go on land? What do you guys see when you travel int eh summer?

- **Answer Ben**: northwest king William island, bears would be swimming miles away from sea ice and can catch seal in open water. They're still hunting even if it's free of ice. They're always traveling even when it's full of ice.

- Willy: During the summer months, July/Aug prince of Wales, I stood and counted 33 bears in Cunningham bay—this happens when the beluga whales are coming in with their calves.

- Markus: to Willy---we tried to figure something out with you remember?

- Willy: polar bears going after belugas staying in the mouth of the bay to catch them.

- **Question James** (via video on smartphone): Going to that old MOU, remember we had that issue with Taloyoak with them "stealing" our tags when the TAH went to 12. But maybe this is a RWO issue.

- **Answer Markus**: You are correct, this is definitely a point to bring up with the RWO.

- **Question James**: I'm trying to make the numbers more equal. I'm just trying to make the communities have a fair trade. If we want a higher TAH is that NTI?

- **Answer Jasmine**: that would be the NWMB to raise the TAH. The RWO decides how to allocate the TAH.

- **Question Willy**: Why is Taloyoak involved in the TAH for MC when they were not involved when we signed the MOU. Taloyoak can harvest from MC but Gjoa can't get to GB. What are bears considered when they are harvested—MC/GB

- **Answer Markus**: The boundary goes right through Taloyoak

- Willy: so, if Taloyoak has a defense kill is that considered MC

- Ben: there was a big male harvested as defense and counted as GB -- happened last year

- Markus: that is something that Kevin/Jack look into

- Kevin: okay

- **Question Jack**: isn't within 30km of the management unit a buffer zone?

- **Answer Markus**: yes, there is a 30 km zone that they can go on both sides.

- Willy: to board---do you have any concerns on bears?—time to ask

- **Question**: ---is there going to be another polar bear survey again some time soon?

- **Answer Markus**: that is a very good question---we have seen with our experience that having these long empty data periods of many, many years, it makes analysis very, very challenging. Not just in MC, all the populations this is a struggle having these long gaps. That was the old system because it worked for money resources, bears are long-lived, and it was the management and monitoring plan initially, but now we have realized that 15–20-year gaps are not good for analysis. Ideally, we'd like to be back in a few years for a one-year effort to sample bears in MC. That would help us get better data and get better estimates for survival. That is where the HTO comes in—if you make it a priority and identify it to the RWO and NWMB---say it's not okay to have long huge gaps for population assessments---that helps then us and the GN to make our case to allocate time/funding.

- **Question Kevin**: question regarding the 30 km buffer zone – where did that come from?

- **Answer Markus**: that was originally from the MOU—because bears don't respect boundary and hunters may not have always a precise location.

- Willy: like the Hadley Bay population and with NWT

- **Question Jack**: does that get carried forwarded from the MOU into the new polar bear management plan?

- **Answer Markus**: not sure, probably, don't have it memorized, can check. Just want to thank you for allowing us to come in person and giving us your time. Just because we are talking here, doesn't mean that we have to end the conversation…we are open for contact and can help any way we can.

- **Question Simon**: how often could you come to Gjoa Haven?

- **Answer Markus**: 2013 and now 2020 – so maybe twice in 7 years? We rotate through the 12 subpopulations – we have a better chance to make it to the regional AGM and we are certainly open to joining via video conference on an HTO meeting if you have interest or questions for us.

- Jasmine: Unfortunately, you are looking at all the biologists for Nunavut. What we'd like to do personally isn't always what we can do realistically. We would ideally be able to make regular visits and updates for all communities.

- Simon: reason I'm asking is because we've been waiting to hear since 2017

- Markus: I'll tell you the same thing I told Cambridge Bay—it was a long time to wait for these results I admit, it is not ideal --- MC was challenging because the data was so sparse, analysts really struggled to analyze the little bit of data, ransomware, and COVID. I wanted to be able to stand behind these numbers and support them and so it took longer than we predicted. We apologize for that.

- **Question Wally**: another comment/concern I'd like to mention is did you do MC then to GB? --

- **Answer Markus**: we did them at the same time

- **Question Wally**: could you do a survey in the summer?

- **Answer Markus**: No---because there is still ice enough for bears, but not enough for pilots. The pilots don't want to fly over open water and bears would still be in the water and on ice pans during that time—we would not be able to do proper coverage of the area. You'd have to have really low ice and bears would have to be on shore.

- Wally: it is good to hear that we are having a recommended increase and the population is healthy. Of course, we'd like a bit more. A lot of activity and population is increasing.

- End of meeting

B: Taloyoak

October 21, 2020

Start: 17:45

End: 20:15

Participants:

Joe Ashevak, Chairperson HTO
Tommy Aiyout
Bruce Takolik
Jayko Neeveacheak
Kovalak Kootook
J. Ware – GN-DOE
M. Dyck – GN-DOE
K. Methuen – GN-DOE
D. Anavilok – GN-DOE

- Joe: Board wanted to know whether there was going to be a public meeting and were under the impression that there was going to be a public meeting. It appears that Jimmy the manager forgot to bring this up to the GN (Joe asked Jimmy if he let the GN know that the HTO wanted a public meeting and Jimmy indicated that he forgot). *Note, the GN did not receive any notification or request for a public meeting prior to this meeting.

- This is very important to us and we can wait—sometime this winter would be good. We really want this and have been waiting a long time. M'Clintock is very important. Is this a possibility to do?

- Markus/Jasmine – This is possible to do, but we don't know if it is likely and we cannot commit at this moment because we need to discuss with our supervisors and figure out a schedule.

Background slides: review; no questions

Study design/methods slides: passed around biopsy dart; answered a few questions regarding how the dart sampled the bear. No other questions.

Community participation slides: review; no questions

GB results:

- **Question Joe**: what is the TAH for GB?

- **Answer Markus:** 74

- **Question Jayko:** are you guys getting new equipment –like cameras and stuff to take pictures that have the built-in ability to see how big the bears are?

- **Answer Markus:** I think I know what you're saying, and it might be a bit more complicated to determine actual size from a picture -- we would need to know altitude, distance, focal length. It might be possible to calculate size and do that. We could look into that.

- **Question Tommy**: talking about quota –all those communities Gjoa, Igloolik, Sanirajak, What the quota like before MC was shut down?

- **Answer Markus:** it was 42 until 2003/2004. It was increased to 74 in 2004/2005 because the study in 1998-2000 showed ~1600 bears instead of 900. I was around at that time of the moratorium in MC that communities were given a few tags for GB to preserve traditions during that moratorium and low harvest in MC.

- Joe: that was a big jump from 42 to 74.

- Markus: yes, I don't know how the recommendation went, but it seems that the 74 has been okay because the population has remained stable, though there may be some environmental changes that have helped the population---like the sea ice thinning/reduction in multi-annual ice and becoming better habitat for fish/seals/algae/etc.

- **Question Jimmy**: no colons being collected anymore?

- **Answer Jasmine:** correct, that was a collaborator project and they had funding for only a set number of years. That funding has run out and now they are working on analyzing the data. I am not sure when reports/information will be ready, but reports will be sent to communities with what they find.

- **Question Jimmy:** about credits? If we want to have a sport hunt, can we use our credits for sport hunts?

- **Answer Kevin:** Yes, that is not a problem. However, keep in mind that we haven't approved any outfitter licenses due to COVID. But we can help support you for that if you have questions. Not much going on with sport licensing this year still with COVID.

- **Question David A.:** with the feces and Peter DeGroot study ---maybe ask the HTO to make sure there was approval – we're not sure there was approval.

- **Answer Markus:** I'm pretty sure that all Bearwatch research had permits—they would have gone through our department.

- **Question Kevin:** do you know when that permit expires?

- **Answer Markus**: I'm not sure—probably multi-year

- Kevin: during the research permit review period that is a good time to bring up any concerns or comments---that is the time to bring that forward and decide if you support. If you don't say anything, it is assumed to be approval from the HTO.

- **Question Bruce**: Is it mostly the GN that counts bears or do other people do it?

- **Answer Markus**: mostly it is GN, but sometimes we have to have help because it is only me and Jasmine. There are a few people that have lots of experience that we bring on to help out on big projects. I'm in charge of the program and I only get people with experience to do the work. And there are locals involved—it's not just the biologists.

- Following the meeting after Jasmine/Markus left, Kevin remained for other agenda items and it was mentioned again that there was **a lot of disappointment that the public would not be hearing these results**. Kevin reiterated that it appears this was not communicated to the GN and the biologists were not able to plan for this. Tonight, was the first it was brought up about the desire for a public meeting.

- End of meeting

C: Kugaaruk

October 22, 2020

Start: 18:50

End: 21:20

<u>Participants:</u>

Athol Ihakkaq
Jesse Apsaktaun
Mariano Uqqaraluk
Columban Pujuarajok
Mark Kutsiutikku
James Nasalik
Ema Qaqqutaq from KRWB
J. Ware – GN-DOE
M. Dyck – GN-DOE

Introduction and Objectives:

- mandate is to provide this information to co-management partners. Ideally, I would have liked to have both the science and IQ studies come out at the same time---unfortunately COVID impacted the IQ study researcher's ability to finalize the study at the same time.

Background:

- background of studies from 1970s to 2000. Heard from communities from last 3-4 days is that there have been a lot of changes in the environment and sea ice. Our obligation is to get new information to not just the GN, but also hunters, HTOs, RWOs, and to NWMB because they need the information to set the TAH; no questions

- The question that was important at the time—number of bears can be answered by the biopsy darting. However, with this method, we cannot answer questions about movement or industrial activity.

Community participation:

- incorporate the input from HTO/hunters to help us know where to look for bears---where were good places to search; no questions

Study Design/Methods: review; no questions

Study Design/Analysis: review; no questions

Results: shift in distribution? Why are there changes in the bear observations?

- Ema: that area in committee Bay was usually open water in 1998-2000

- Athol: Yeah, that is often open water near the floe edge

Results: body condition? Any thoughts or similar observations of you guys as to bear fatness? Are you seeing any skinny bears? No real comments---board seemed to agree

Results: reproduction – key measures we look at to help compare from old study to new study or to other populations

- **Question Jesse**: have the number of Coys per adult female gone down because there are more females in the population now than 1998-2000?

- **Answer Markus**: can't remember off the top of my head---will have to consult the report, but my memory is that the number of males has gone down slightly---likely because of the 2:1 harvest ratio. Females may have increased slightly.

- **Answer Jasmine** – cited report for female proportion – 57% in 98-00 and 61% in 15-17. That is in line with the 2:1 male to female sex ratio—that's why it's not 50:50.

Results: survival; no questions

Results: growth rate; no questions

Results: abundance; population is stable, even with changes in environmental changes. This is good news. This is a collective accomplishment among the hunters and government in managing this population.

GN Recommendation: we are not recommended a change in TAH.

- **Question Ema**: would you recommend to SARA to down list?

- **Answer Markus**: there isn't anything to down list because they look at polar bears as a whole. SARA and COSWIC looks at these data for the next assessment. The next assessment will be likely in 2025—I provide this information to them. Plus, this information not only goes into Canadian assessment, but also internationally. I am defending the Nunavut polar bear numbers internationally. This is good information for the outside world. However, it is important to remember to that we, me and you, we cannot know for certain what the future holds---what do the environmental changes impact for bears do in 5, 10, 20 years. What do the communities want and feel? There are different communities in Nunavut that note public safety, levels of social tolerance, I hear the communities say those things. It is important for the community to come up with what you want to do with this population---having a management objective. The decision you make now, always keep in mind to keep the future in mind.

Shows video of biopsy darting

- One more thing to mention to be fair since I've mentioned to the other communities. This is about movement….I respect that communities and HTOs do not want collaring or handling. I have had, in the past, organizations have asked about impacts of development on polar bears, but I could not provide that information because we do not have it. There is no pressure from me or the GN for collaring, but it's important to think about what questions you have and the information you need---describes benefits of collaring.

- I know that we have not been able to visit communities and I regret that. You are looking at the 2 people, sometimes 1 person, and we can't be there or everywhere.

- Jasmine: also, as the future unfolds, if there are priorities from the communities, bring those forth to the RWO and NWMB priority meetings because the GN uses those to help determine how they allocate funding. We have a mandate for abundance, but for other priorities, knowing what communities wants is very helpful.

- Markus: addresses why it has taken so long for us to get here with results. DNA analysis, finding old samples, ransomware, COVID

- Another thing we learned is that having long gaps of 15 years makes it very difficult to get survival. Doing one more year of marks/biopsy sampling would be helpful, maybe 5 years.

Questions:

- **Question Mariano**: did you see any bears that were wounded or sick?

- **Answer Markus**: in 3 years, I haven't seen any sick bears and no dead bears. I didn't see any dead cubs.

- Mariano: We had 4 bowhead whales die and was wondering if the bears were sick from that---not sure why the whales died.

- Jesse: going back to the topic of collars, I like the ideas of perhaps of collaring some bears because I do like seeing scientific data because it can tell a story. I'm not pushing back against IQ. But I like to see the procedure – what are the pros and cons --- how many bears would you collar. I would want to see the positive and negative impact. Because it would be good to see where the bears are traveling. In the past 3 years, we are having bowhead whale issues since the cruise ships. Is the Northwest Passage going to affect the bears?

- Jasmine: I feel like the IQ tells a story and the collars tell a story too –they together, tell a bigger story.

- Jesse: We need to get our residents to understand the positive and negative of bears. For example, if we have 10,000 bears and we collar 10 bears, what are the negative effects on those? I would recommend you providing a pros and cons. pamphlet

- Markus: Would it be helpful just to have a document, but that probably leads to more questions….it might be helpful to have a chat after you

- Athol: the Baffin area with the mine---they're going to put a shipping route in---that is going to affect the bears–we know that.

- Jesse: It's like we need the scientific data because we don't live out on the land like our grandparents did…I live in settlements 99% of the time. We have to educate ourselves and the future---like the shipping lanes.

- Markus: what you're exactly saying is similar to Baffin Bay and Kane Basin---communities saw climate change and wanted to know where the bears were going and what denning was doing. We worked with them and put out about 10 collars every year, a total of 30-35. And the data are huge

- Athol: the IQ and putting the collars together. I agree with the collars for the future.

- Markus: we are doing the LS starting next spring. We can maybe have communications to see what could work with the HTO. We have 3 years – maybe we could put a few collars out depending on your questions.

- Jasmine: to Jesse – maybe you could write your specific questions/concerns and that would help us design a study and collars.

- Mariano: I don't see any huge bears anymore 14-15ft bear.

- Markus: These are good observations to provide to Pam---that's the type of IQ that we need. When another study done in a few years, maybe there are different sizes and you document them.

- After board members left, GN representatives gave KRWB representative the MC presentation so that he also was informed about the study results.

D: Naujaat

October 26, 2020

Start: 18:10

End: 21:50

Participants:

NTI: Paul Irngaut
QWB Chairperson: James Qillaq
NWMB: Denis Ndeloh, KJ England, Steve Mapsalak
GN: Markus Dyck, Jasmine Ware, Jon Neely, Peterloosie Papatsie
HTO: Hugh Haqpi – acting manager
Paul Angotituar
David Ammaaq
John Ell Tinashlu
Peter Manniq
Dino Mablik
Mark Tigumiar – vice chairman

- Meeting started with introductions around the room

- Presentation
- GN representatives stressed that the IQ study is ongoing and has been delayed due to COVID because its results depend on ability of researcher, Pam Wong, being able to verify interviews and speak with interviewees. Ultimately, together the science and IQ will all go together to the NWMB for decisions for a bigger picture. Looking for a good discussion among everyone – we want to get feedback on what we present this evening.

- Paul Irngaut: Informing the group that NTI wasn't on the first leg of the consultations and explaining that he and James (QWB) are here as observers.

- Markus: asks board if they want to do background on GB and they agreed.
- **Background slide review:** no questions
- **Goals of Study/need for new info:** no questions

- **Question Hugh:** the boundary that you first showed is the boundary? What are the new boundaries that you show?

- **Answer Markus:** *reversed to previous slide showing 1970s boundary* Biologists back in the 1970s/Govt of NWT/local communities outlined as where there are a lot of bears and because they didn't know much about numbers of bears for any areas, they decided to survey this area. So, this circle (*shows red circle) was in a way arbitrary.

- Paul I.: can I explain a little bit? Explains the role of the Range States, Polar Bear committees like the PBAC/PBTC.

- Markus: Further explains the management unit boundaries---The brown lines show boundaries based on movements of female bears with collars that were put on bears in the 1980s-1990s.

- **Question David**: Question about the boundaries -- that NWT boundary (*red circle) that is pretty big --- do the tags depend on the boundaries?

- **Answer Markus:** For each of the areas, we know how many bears there are in each of these areas and the NWMB has set a TAH based on that. Based on how many bears there are in total and based on what the management objective is --- some communities want a population to stay stable, so you can't harvest as many if you want to keep population stable. From the total # that is determined the TAH. For Gulf of Boothia, NWMB decided 74 total allowable harvest and then the RWO decides how the tags get distributed.

- Denis: I think what he was asking: Is there a relationship to the size of the management unit to the number of tags?

- **Answer Jasmine:** No, the size doesn't tell you how many bears there are. Some areas are quite big but don't have many bears. MC/GB for example. Tags are based only on how many bears there are in an area.

- **Study method choices slides:** Discusses how alternative options to traditional capture mark recapture were presented during initial consultations in 2013 (aerial survey, DNA biopsy). Reviews biopsy darting and how it works. Shows biopsy dart, passes it around. Explains how the method differs from traditional mark recapture and why we don't get as much data.

- **Question Hugh:** does the genetic DNA biopsy indicate age and health of the bear? Has there been any disease since the start of the mine?

- **Answer Markus:** Lots of good questions in there. We cannot get the exact age because we do not have a tooth. We cannot see anything for contaminants–our sample is too small. And no disease can be seen other than a big injury on the bear because we are not handling or touching the bear. The hunters can report back if they notice something weird or sick with the bears, disease – fills in gaps that we have with the science study.

- **Community participation slides:** no questions

- **Study design slides:** no question

- **Question:** From the 70s study to now --- how do you see the health from then to now?

- **Answer Markus:** good question---we are going to get to that in a minute---not really from the 70s cause we don't have tissue and samples from back then, but we were able to compare to the 1998-2000 study and we will get to that shortly.

- **Results:**
- **Question Hugh:** was there any changes in the biopsy based on climate change? Were bears getting fat, getting skinny, any disease

- **Answer Markus** – We can't see disease from this type of study. We rely on hunters to bring in anything that looks diseased. Body condition we do know, and we will talk about that in a couple of slides.

- **Review of shifts in distribution slide:** Based on where we observed and sampled bears in 2015-17 compared to 1998/2000, appears to be a distributional change---maybe because of sea ice and seals? Bears have likely adjusted to these changes

- **Comment:** maybe more narwhal carcasses?

- **Peterloosie:** Those 2 high concentration areas in 2015-2017 – are two polynyas. Usually a polynya with open water around these areas that were empty of bear observations in 1998-2000.

- **Question Markus:** Do hunters notice changes in ice? How does ice look when compared to 20 years ago?
- David: The ice is very thin and more drifting snow---it's not compacting and not making ice. Not forming properly.

- Markus: how is that for seals?

- John: When it is very thick, it is good for the seals. When it is very thin, it is not good for seals.

- **Results: Body condition**

- Comment: Bears back then were skinnier so this fits with what you're showing us.

- **Question Hugh:** Have you noticed difference in temperature and its effects on body condition? As in warmer temperatures make bears skinnier and the cooler temps get them fatter and ready for hibernation?

- **Answer Jasmine:** we haven't looked at that, but we could easily see what the average temps were during the field work for each of the study years and compare.

- Peterloosie: I think that the seal pups are getting bigger – saw one that was 3 ft long –huge. Maybe they are bigger and feeding bears.

- Jasmine: Describes thinning ice and changing productivity of ecosystems with decreasing ice thickness and more dynamic ice being potentially helpful for bears because the ecosystem is boosted in productivity (algae, fish, seals, bears). Theory because we do not have data on seals or fish for these areas. Markus is working with DFO to try and get information for seals.

- Markus: describes efforts to get seal info with DFO. The Lancaster Sound is where we are going to try to get seal info as a start.

- Hugh: I'm from Baker Lake where there are no polar bears. Back in the 60s and 70s, there were 4 or 5 bears caught super inland --- the bears were migrating to the west. Cause looking at LS and GB and comparing the distance from Gjoa Haven and Hudson Bay is about the same distance.

- Markus: There are some bears that move a long distance. Gives a couple of examples.

- **Question John:** I have a question about scientists---do you keep in contact with other provinces, territories? Or do you not talk to the other scientists?
- **Answer Markus:** There are 8 populations in Nunavut that are shared between jurisdictions/provinces/territories that I work with when there are studies – mentioned Baffin Bay and James Qillaq working with Greenland. Also, Western

Hudson with Manitoba. All the jurisdictions meet once per year, more frequently on the phone, so definitely in contact with other scientists and jurisdictions.

- I also present information gathered in Nunavut to international community and defend the Nunavut harvesters and Nunavummiut. We exchange this information with different countries.

- Paul I.: talked in Inuktitut for a while and explained he reviewed the PBTC and polar bear advisory committee and status table. That you guys meet once per year and review the polar bear populations.

- John: conversation in Inuktitut with Paul I.

- Paul I: John was asking about the ECCC ongoing mark-recapture study in Western Hudson and the effects of being handled/lack of hearing. At the Advisory Meeting where ECCC is a member, we voiced our concerns with handling bears, but also mentioned that that handling occurs in Manitoba which Nunavut has no control or jurisdiction over.

- Inuit have been opposed to handling of wildlife of any kind, especially polar bears. We have pushed for biopsy darting. We have made this known to our counterparts in Manitoba and ECCC. They know our concerns and to date we haven't seen any changes on their part.

- Peterloosie: I think John that was saying is that the bears are going partly deaf after so many helicopters getting close and then landing next to them. Then the partially deaf bears are moving north into Nunavut and causing issues.

- Steven: you came here to do a presentation to do Gulf of Boothia; I think that maybe we stick on topic.

- Markus: We are happy to answer to any questions and it's not like we are here that often so we are more than happy to entertain any questions on any topics for as long as you all want.

- Break --- 10 minutes ---
- **Reproduction slides:** coys/yrlgs – offspring per ad. Female

- **Question Hugh** - Are there more cubs with females in old study?
- **Answer Jasmine** – there are a few that have 2 cubs more than just 1; some hunters see 3 coys, none were seen during the study period, but maybe recently this is happening more?

- **Question Peterloosie** – reproduction is low with 1.6?

- **Answer Markus:** I know it looks low, but in context, it is not a low number. That is actually very good reproduction numbers in Gulf of Boothia *explains values that would be concerning. The observation you see represent localized observations; our number is averaged across the entire study area at the same time so *all the moms with single cubs and twins get counted and averaged.

- **Question Hugh** – pb numbers are low with low seal numbers?

- **Answer Jasmine –** we do not have seal numbers in Nunavut, likely it is the case when seals are poor, bears likely do not reproduce.
- **Survival slides:** -- no questions
- **Pop growth slide** – no questions
- **Abundance slide** – no questions; describe the range of the number and why there is a range – uncertainty in science because no one thing can know all. It reflects that there are likely biases and errors in places, that is why the result produces a range of numbers rather than an exact number.

- **Further questions slide:** other questions that the hunters/communities have regarding boundaries, denning, development (mines, shipping) --- if these become concerns, methods such as collaring would likely have to employed. IQ and DNA biopsy can inform parts of the puzzle, but each method provides its own information.

- Markus: further questions – do you see bears staying the same?

- Comment: feels like they are increasing around.

- Markus: That's definitely true – between 1850-1935 that's when a lot of whalers came to Canada/Nunavut and bears were shot. Not many bears in the 1950s and 1960s –but definitely more bears now.

- John: even berry picking, we have to bring our gun and be a safety guide

- Paul: Can't even go camping anymore.

- Markus: that's good information – need to talk to Pam and see if that's helpful to include and help us to understand the bigger picture – have bear distribution changed? ---could ask that for Pam to include

- Hugh: population going up, bears come more to community. IQ says there is bear movement and that is true – larger bears move farther out. Now and then, there is sometimes a 12-footer, but average is 8 ft.

- Markus: do you see you big bears?

- Peterloosie: They are talking more Foxe Basin, not so much Gulf of Boothia for those big bears

- **GN Recommendation TAH slide**: with the info the government collected, and with the objective to maintain the subpopulation, we are not recommending a change in TAH.

- **Discussion with group about TAH Increase and Tag Allocations – originated organically from group and created lots of discussion with NTI, NWMB, QWB, and GN offering information on processes, options, and clarifications for how TAH increases or reallocation among communities may occur.**

- **Question:** about harvesting, can we have more than 5 tags?

- **Answer Markus:** There are a few options. The government is not recommending a change. However, depending what is presented to the NWMB, there are options for the Regional Wildlife Organizations and communities to talk ---have to be on the same page – the communities have to have the same objective –keep pop same, higher, lower. Then, the RWO, supported by HTO's needs, makes their submission to NWMB – may or may not be the same as the Governments.

- We have to understand that this is not black and white, we know that the population has stayed the same, but I don't have a crystal ball to know what the future holds. When the decision makers (RWO, NWMB, etc) increase the TAH, there is a risk that the system that you could screw up the system --- it is a question of how much risk are you willing to take. Are you willing to take a risk that is very high --- say TAH of 90-100? – but that is very very risky. We want to make sure we provide for future generations – that is our mandate in the Government. But it is not for us to say what the management objective for a population should be. This is a decision for the communities to think about. It is not an easy decision.

- Another option is to bring forth a request for reallocation to the Regional Wildlife Organizations– based on concern or need. The RWOs can redistribute the tags at any time—does not need to be a new study or anything like that.

- Anything that is not clear, contact us, we give you information. Our door is open.
- Hugh: Looking at TAH by Minister, maybe redistribute the tags ---like Coral Harbour. Difficult to talk to Arviat, Coral Harbour
- Markus: You can only discuss reallocation of tags with the communities that harvest from the same subpopulation. So, Gulf of Boothia communities. And Foxe Basin communities (Coral, Cape, etc)
- Comments: Naujaat suffering defense kills and impacts on their quota from hunters coming from Rankin and Arviat.
- Markus: we have to take a look at that and see. But harvests come off the hunter's home community – part of the Polar Bear Management Plan. MOUs are no longer in force
- *surprise comments from group indicating they are not aware of the Polar Bear Management Plan and have not seen it.
- Markus: *Explains the process the Polar Bear Management Plan went through before being ratified by the NWMB and Minister* --- The Polar Bear Management Plan was accepted after going through a multi-year process in which all HTOs across the territory were consulted. *NTI nods agreement* RWOs were consulted and part of it too. All partners were involved and – drafts sent back and forth and back and forth. Public hearing in fall 2018 and all HTOs invited.
- Denis: wanted to provide clarification for what Markus is talking about for the Polar Bear Management Plan – the wording about hunter's home community is part of an appendix that is approved on an interim basis right now.
- KJ: it is on the NWMB website.
- **Video of darting:** clapping from John – *not sure if sarcasm or true support of method/video*
- **Question Peterloosie:** what do you think of the 1:1 harvest ratio? I think that it will increase polar bear populations in the future.
- **Answer Markus:** This is something the communities wanted, maybe not every community, but the majority. Also, in the Polar Bear Management Plan hearings. There is a concern because the TAH was not adjusted when Nunavut went to 1:1. The TAHs were set to protect females and maximize sustainable harvest. But, when 1:1 went into effect, there is a chance that more females would be

harvested and could be riskier. If there is a concern, the GN will bring those concerns to the NWMB. Just because it's 1:1 doesn't mean it has to stay that way if there is a conservation concern with consultation with community.

- Hugh: there was a concern we would like to know the male/female ratio, we want to have balance and not drive the population down and what happens with climate change in the future is not really known.

- Markus: When there are concerns, hunters raise the flag – like MC not being able to find males – that was a trigger to lower harvest in MC and to do study. We rely on hunters to provide information because it's not possible to do studies/surveys frequently – costly.

- **Question Paul I.:** Asking how much harvesting done from here.

- John: Yes 5

- **Question:** That's why I ask if we can get more than 5. More people are hunting up there. Would like more tags. And more people go camping to hunt in March. – mostly people go to the island in Committee Bay (Peterloosie – about half the hunters go to the big island in Committee Bay).
- Markus: You don't have to wait for a new study, you can raise this with the NWMB with information or bring up with RWO to reallocate.

- John/Paul: conversation in Inuktitut -- summarizes that HTOs can allocate half a tag for a cub – request has to come from HTO, then approved by someone, Superintendent maybe. Also, they have made requests to increase TAH to the KWB but haven't heard anything. We have a committee, under NTI, Nunavut Inuit Wildlife Secretariat, the chairs sit on the committee and we can bring it up at the next meeting.

- James Qillaq – adds comments in Inuktitut

- Comments – Rob Harmer explained procedure in spring, and we are just starting to put it on paper and we can't just have ask – we have to go through process.

- Paul I.: Six communities harvest from GB so it seems that the allocation isn't exactly fair. But if want an increase in TAH, will have to bring to RWO which brings it to NWMB. If you want a re-distribution, then RWO has to do that – KWB, QWB, KRWB – they all are responsible for allocating GB.

- Steve M.: I used to be the Chair for the HTO when the MOU, there was a decrease in the TAH, Mitch Taylor was the pb biologist. There was a quota of 3 for GB for Naujaat. When the quota went to 74, Naujaat went to 5. The way the tags are allocated is done by the Regional Wildlife Organizations – it's up to them. But they have to follow the TAH. *note – not clear what this reduction is referring to. MD is not aware that there was TAH reduction for GB while Mitch Taylor was working.

- **Question:** Do you know when this will be going to the NWMB?

- **Answer Markus:** We have to finish consultations first and we maybe are done by Wednesday, and we could get back to the office and be told to get something ready for the NWMB. I don't know though.

- Jasmine: And just to reiterate, even if nothing ever goes to the NWMB and this study never happened, the concerns and requests for redistribution of tags can go to the Regional Wildlife Organizations at any time. Technically, they can reallocate each year the tags. They usually don't but it is within their rights/responsibilities.

- Steve/John Ell/James: conversation in Inuktitut

- Denis: assuming the request comes from the GN to the NWMB at some point, what is going to happen very likely, because it is 3 regions and NWMB cannot set a TAH Nunavut-wide --- the Board will determine what the TAH is for Gulf of Boothia. The NWMB will then send a letter to the 3 RWOs and ask to know how the RWOs are going to share it. The RWOs will meet and decide and then provide that info to the NWMB and this will be sent to the Minister. This is also when the communities can have their voice heard.

- Paul I.: that is why I mentioned the committee at NTI that we will bring forth this issue. If communities want to increase the TAH within the already set TAH, then that is the RWO jurisdiction.

- John Ell: conversation in Inuktitut – about Foxe Basin – *not sure what was said. Left abruptly*

- Paul I.: I was explaining that communities get together to discuss and agree on what they want—if they bring that forth, it is much more powerful than a single request.

- KJ: because there are so many communities and regions are covered, the easiest option would be to request for a transfer of credits for a short-term increase in quota. Another option would be going to the RWO, to advocate with the other RWOs, for a change in allocation. Thirdly, work with all the RWOs and advocate for a change in TAH.

- **Question:** when do you plan to study Gulf of Boothia again?

- **Answer Markus:** With the previous study plans, studies were done every 10-15 years. With this analysis, we realized that this long timeframe is too long. Makes the analysis really difficult to have that long period with nothing. We ideally would like to come back in 4 or 5 years after study completion to sample bears in the entire area, but only for a single year. This would put more 'marks' as we call them into the population and give us better understanding of survival, reproduction. Four to five years after the single year sampling effort, we'd do another full study—where we survey the entire area 3-4 years in a row.   But that depends on what information is coming in --- from communities, or the environment. NWMB sets regional priority and makes list --- get what you think is important on the priority list. Helps the GN allocate funding and know what is pressing priorities.

- **Question Hugh:** would 4 or 5 years be enough for you?

- **Answer Markus:** we would do a single year, cover the whole area between April/June. We'd do this in 4-5 years. In 5 years, we need to put more marks out because the bears marked in 2015-2017 are dying.

- We cannot get a full population abundance by putting 1 year of marks out. There is maybe a chance if we do genetic samples in 1 year, there is maybe a way to update the abundance – but there is no guarantee because it will be the first time. We are learning as we go.

- Jasmine: noted the increase in time for DNA biopsy analysis. DNA analysis takes significantly longer than traditional mark-recapture – by at least 9-10 months.

- Markus: we are open to communication and work for you.

- Jon Neely: I didn't realize that defense kills from residents from other communities might be counted on your quota so we can look at that. We also have money in the deterrence budget – HTOs can apply for up to 10k for bear deterrence equipment – bear bins, fence. If a bear does damage your cabin, we have another program that can pay up to a few k for repairs and such. Talk to Peterloosie a bit tomorrow.

- Peterlooise: We applied for scare cartridges in early June – but we haven't heard.

- Jon: We can look into that – I wasn't aware of this application. I do apologize – I did not see that program application this year. That is something we will fix on our side. We will make sure that program works better for you.

- KJ: thanked the biologists and their work, difficult to get around – only 2 of them. Thanks to the HTO for community sampling program.

End of meeting

E: Sanirajak

October 27, 2020

Start: 19:15

End: 21:15

Participants:

NTI: Paul Irngaut
QWB Chairperson: James Qillaq
NWMB: Denis Ndeloh, KJ England
GN: Markus Dyck, Jasmine Ware, Jon Neely, B. Grosset
HTO: Lizzie Phillip-Qanatsiaq – secretary manager
Jopie Kaernerk – Chairperson
Danny Arvaluk
Jaypeetee Audlakiak
Sam Arnardjuak
Zillah Piallaq
Cain Pikuyak
George Innuksuk

Introductions around the room

Question to the Board re: background – Markus asks Board how much detail on background

Question: how much time with all the background?

Markus—material about 2-2.5 hrs but depends on interaction and how many questions the members have. I think it's beneficial to have the background so we can go over it.

Objectives of Presentation: reminds Members that the IQ study is ongoing for Gulf of Boothia. We are hoping that the information you have is provided to Pamela. Ideally, the science and IQ would be together, but COVID has prevented the IQ and the fact that Sanirajak has not had a Manager for quite some time.

Background review slides: no questions

Goals of study slides: Refreshed commitment of MOUs that new research had to be conducted for GB in 2015. Review goals including how sea ice changes incorporated – see how bears are doing as sea ice changes. No questions.

Study method choices slides: Refresh that DNA biopsy method was supported by communities back in 2013. The DNA biopsy method gives us information about the abundance. Reminded about drawbacks of biopsy darting. No questions.

Community participation slides: review, no questions

Study design/analysis slides: review, remind that hunters bring muscle and fat that can be used to address contaminants questions; no questions

Results slides…map with dots, flight lines….map comparison old vs new distribution – no questions

Question Jasmine – are you seeing bears evenly distributed like in the 2015-17 study? Didn't catch answer…something with Naujaat

Who was sampled slide – tells us some bears are moving between areas – no questions

Jasmine question -- Body condition slides – have you noticed fewer skinny bears than 20 years ago?

Comment: Maybe more carcasses on shore than other areas?

Hunters are only over in GB in spring only – bears are skinnier due to mating, Sanirajak only goes there in spring

Some people do not hunt bears anymore because the hides are not worth a lot of money

Reproduction slides – review; no questions

Survival slides, review;– no questions

Growth rates slides – no question

Abundance slide – interpretation slide – no questions

Questions slide – questions: walrus on top of ice in September – did bears get counted in spring down there?

Answer Jasmine – we sample them when there is ice in spring, when there is open water we can't sample really – too dangerous for flying

Question was more about FB – when we do FB we actually do it in fall, Aug and Sep.

Review of slides and questions…are there too many bears in GB, too few?

Comment: not too many bears hunted in GB, not too many sport hunts; COVID-19 likely not much sport hunts

Question – seal populations is having an impact on pb population? Under water sonar…might have an impact on bear populations

Answer Markus – explained NWMB priority list, work with RWO to have seal abundance and impacts on priority list; I can also ask DFO biologists to see if there is a desire for research

TAH slide – question-in the winter when the quota is not completed; traditional hunting and bears taste better in summer – can we hunt in summer.

Jasmine Answer – when you hunt is an HTO decision; The GN does not care when hunts occur; season is July 1 – June 30…all year.

Question: when there are more bears in summer, and there are sport hunters, how can we harvest more?

Answer JNeely – we normally distribute tags in fall, but tags can be sent sooner in the season to assist with sport hunts if you want to have summer hunts

Movie – darting…..

Question: When you are doing your research – have you seen the bigger bears? 12-14 feet or more?

Question Markus - In FB? Or GB?

Question: they move in March, Sanirajak hunts in spring in GB…where are they moving to?

We asked hunters to show but they could not tell because of the ice conditions, changing too much

Question: is that the same in Hudson Bay bears from Churchill?…assumed the question relates to abundance(?).

Markus Answer – there are different numbers of bears in the populations, and not every area that is large does not necessarily have a large number of bears.

No more questions - End of meeting

E: Igloolik

October 28, 2020

Start: 18:40

End: 21:42

Participants:

NTI: Paul Irngaut
QWB Chairperson: James Qillaq
NWMB: Denis Ndeloh, KJ England
GN: Markus Dyck, Jasmine Ware, Jon Neely
HTO: Jacob Malliki
David Irngaut – Chairperson
Gideon Taqaugak
Daniel Akittirq
Michelline Ammaaq
Joannie Alaralak
Salomon Mikki
Natalino Piugattuk
Loyd Idlout
Janet Airut - translator

Introductions around the room

Background slides: review; no questions

Goals of Study: review and reasoning for new research study – MOUs obligations for updated information and Total Allowable Harvest information to decision-makers – RWO/NWMB; no questions

Study method choices: review when initial consultations occurred in 2013. Balance between methods and the trade-offs between different method choices. Review that all HTOs supported the less invasive method. Describe DNA biopsy and passed around dart. Explained how skin sample and genetics works to 'mark' or identify a bear so that we can track it through time. No questions.

Community participation slides: Review; no questions

Study design/goals slides: review; no questions

Results: maps – questions – shift in distribution?

Salomon: answer – count up to 47 family groups in summer – count bears in summer would be better.

Jasmine – is it new to see more than 2 cubs; usually 2 offspring, but recently seen 3 cubs, a bit rare but seen

Question Salomon – Could you monitor in summertime? Is that possible?

Answer Markus: The area you pointed on the map is Foxe Basin and we do our monitoring in the summer there. But for GB the ice doesn't go away completely so we do it in the spring when most bears will be on the ice hunting and breeding.

Natalino – ice comes from aqqu, ice transports animals, no more ice up there and around Moag Bay there are polar bear tracks, some come up to community (this past summer); not so much ice through Hecla and Fury strait

Salomon – are bears afraid of ships? Is it because there was a ship? Ship in Hecla Strait, ice breaker…..this summer there were lots of bears near the cabins

Comment: this summer saw lots of bears in that area, more than usual…during September

Question Jasmine – do hunters go in springtime to GB or mostly summer? Do hunters see GB much in the spring?…..

Michelline – recently less ice in that area, lots of tracks.

Paul I….shifting ice is likely;

Jasmine…if more ice is shifting, ice breakers are coming through, maybe this is a time to find out how bears are moving, maybe if it's important to the community?

Gideon – if there is less ice, less polar bears, but we do not see a negative effect yet

Salomon – bears are usually where there is food; ships were dumping in that area and the seal moved; the seals went further up, maybe bears are moving up there; same in Lancaster sound across Arctic Bay

Natalino – if area is researched the funding is always a problem; excuse is always there is no funding available……

Markus/Jasmine – nod in agreement that funding is always a challenge for big projects

Question Salomon – why are you not searching up there – points to BB and KB…bears are likely moving up there and are coming down into our areas?

Answer Markus – we did sampling and research in Baffin and KB, and we had collars, but we are doing LS in 2021 for several years; maybe some bears move between MC/GB and we pick them up –

Jasmine – we are doing LS work in spring—same as MC and GB so that also might help to find out how/where they move/are at that time of year. Sampling at the same time of year gives us information that is more comparable compared to spring vs. fall sampling.

Question: why does our quota never get an increase when we feel bears are increasing? *Interpreter struggling to translate conversation – following meeting, Inuktitut-fluent GN staff member indicated that the conversation also included that Igloolik area igunaq caches were being raided by bears in FB and that's one of the reasons the HTO wants to harvest more bears in the FB area.

Answer Jasmine: gave Baffin Bay example and how process went for increase there.

Answer Markus: Describes RWO allocation responsibility and NWMB responsibility of increasing TAH. The reason there has not been an increase for GB is that there has not been new scientific information since 1998-2000.

Paul – you can approach NWMB with requests, this information goes to the govt, you have to clarify why you want quota increased; because of the studies and the results they give to NWMB; there are 3 RWOs for GB; the quota is 74 for all the communities; for FB you would need to talk to that RWO and communities.

Gideon – there are NWMB reps here; concerned about seals, there are no caribou, they would deny us quota increase for bears because they've done it before.

Natalino – took sport hunter to hunt bear, caught collared when I was 7 years old; collar came off and they lost it; head was "separated from neck"??....*maybe no fur on neck?*...a bear was caught and hide was no good and he is asking for replacement of hide from GN

Question Daniel – in FB they wanted a cub, or a family group?

Answer Paul I…it comes out of the quota,

Requested a mother and a cub last year but we did not hear about it…anyone catches a cub it counts 0.5 of a tag;   *HTO comments and discussion about what 'half a tag' means. In order to stay on topic of presentation, GN indicated that these questions they could answer at an HTO meeting since they live in Igloolik and would be happy to answer harvest-related questions during a regular meeting*

James…to NWMB send your request about cubs….to them;

Results slide – describe how many individual bears and recaptures there were for GB

Question Jacob - Where is MC?

Answer Markus – explained where it is on a map

Results body condition –

Question Jasmine: Why are bears in better condition?

David: When Paul was kid almost no bears around; whenever a bear came near community, it made the news; because if there are more bears, they get skinnier – not enough food and they fight; haven't seen skinnier ones; I think and what I see is we used to wait until quota is increased, there are less bears and they are not attacking each other; the numbers will decline; not so much on the ice, more time on land; they tend to be fatter now; when people went caribou hunting hunters saw no caribou but polar bear tracks; they sometimes tend to stay in one place-someone cried about what is going to happen about to polar bears, it was a biologist, GB area always had polar bears – there are hardly any bears because they are on the land – we think if funding is available they should research sooner to get increase in quota; when they do research bears are not scared of machinery and people; the bears are not scared of people anymore; some hunters are aware of changes on bears; I would like to see more IQ being used;

Salomon – GB is being researched, I have been to Churchill and saw somebody attacked from bear; bears come into the community, up to 200 bears *unclear the time frame that the 200 observations came from*,

Natalino – went over quota, we were not penalized, we are grateful and there are lots of bears around

Paul I….talked about that the MOU is replaced by new plan; quotas were increased in BB; when a female is caught the quota is decreased, now it is 1 male or 1 female for any overharvest; the federal govt is not always in agreement with increase in quota but we have the reports from the government.

Reproduction slides – no questions

Survival slides – no questions

Growth – no slides

Abundance slides – no comments

Did not go over slides with boundary issues

Recommendations – slides

Denis – explains the process of how it works with TAH decisions and the role of NWMB; different ways of decisions and what info is used for decision making; says the GN position is to keep TAH same; Denis also explain or asks what is the risk the GN is willing to take with a new TAH decision

Paul I: the last TAH was changed in 2003 – no change in TAH since then, what is it what the communities want, The GN position is only a recommendation; send a request to NWMB, no problem if you do not agree with the recommendation right now

Natalino: chose a little increase in TAH because we have to kill bears or family group for different reasons; or the yearling is left behind when she is having another cub

Daniel-the other communities have not been communicating of what they want, and we can negotiate about the 74 bears; meet with other communities to increase quota, or talk to them

Jasmine – we are taking notes, we send them around to the communities so you can see what was discussed among the communities

Paul – we visited different communities, in Naujaat they hunt in GB, but Hall Beach does not really harvest there; have not heard from other communities

Salomon-if we make a request about GB, we need to ask QWB for support, and what government are they talking about? The Federal government, American government…?; would they say no about request immediately?

Paul explains process about how the RWOs need to discuss and decide how to split up the TAH and allocate among the communities. With NTI there is the NIWS that can assist; with NWMB you go take the request and then to RWO.

Film sampling

End of meeting

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Building Nunavut Together
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Bâtir le Nunavut ensemble

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Department of Environment
Avatiliqiyikkut
Ministère de l'Environnement

ASSESSMENT OF ABUNDANCE FOR THE GULF OF BOOTHIA POLAR BEAR SUBPOPULATION USING GENETIC MARK-RECAPTURE

Final Report

12 June 2020

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1.A) EXECUTIVE SUMMARY – ENGLISH -

Polar bears (*Ursus maritimus*) are managed across Nunavut, Canada, under a quota system that seeks to ensure harvest is sustainable. In recent decades, climatic changes across the Arctic have altered polar bear habitat at unprecedented rates. To retain viable polar bear subpopulations as part of the ecosystem ensure continued availability of a subsistence resource for Inuit, scientific research and monitoring studies are conducted to evaluate subpopulation status and whether management objectives are being met. Here we report the results of a population study for polar bears inhabiting the Gulf of Boothia (GB) conducted 2015 – 2017. Current samples were collected using less-invasive genetic biopsy darting without immobilizing or physically handling bears. Our analyses included 2015 – 2017 biopsy sampling data, live-capture data collected under a designed study 1998 – 2000, live-capture data collected opportunistically 1976 – 1997, and harvest recovery data over the entire period 1976 – 2017. Results of live-capture dead-recovery models fitted in Program MARK suggest that a mean abundance estimate of 1525 (standard error [SE] = 294) for the period 2015 – 2017 was similar to mean abundance in 1998 – 2000 (1610 [SE = 266] in this study; 1592 [SE = 361] in Taylor et al. [2009]). Mean cub-of-the-year and yearling litter sizes for the period 2015 – 2017 were 1.61 (95% confidence interval [CI] = 1.51 – 1.70) and 1.53 (95% CI = 1.41 – 1.64), respectively, with no apparent trend compared to 1998 – 2000. The mean number of yearlings per adult female for the period 2015 – 2017 was 0.36 (95% CI = 0.26 – 0.47) which suggests that GB is currently a productive polar bear subpopulation, despite sea ice change. This is consistent with our finding that polar bear body condition (i.e., fatness) in the spring increased between the periods 1998 – 2000 and 2015 – 2017. We detected sex- and age-specific variation in total survival rate (i.e., including harvest mortality) with higher estimates for adult females (0.95; 95% CI = 0.81 – 0.99) than adult males (0.85; 95% CI = 0.74 – 0.92) for the period 2005 – 2017. A potentially related effect was detected as an increase in the proportional abundance of females from 0.57 in 1998 – 2000 to 0.61 in 2015 – 2017. The asymptotic, intrinsic population growth rate calculated using a matrix projection model with estimates of total survival was 0.06 (95% CI = -0.06 – 0.12) for the period 2005 – 2017, suggesting strong

potential for growth. However, our results for subpopulation size and trend should be interpreted with caution because our estimate of abundance reflects the "superpopulation" (e.g., it includes all bears that use the GB management area, some of which spend time in other subpopulations as well) and our estimate of population growth rate does not account for permanent emigration from the GB management area. Overall, our findings suggest that the demographic status of the GB subpopulation is currently healthy, although we recommend that lower estimates of total and un-harvested survival for male bears warrant further investigation. We hypothesize that spatial and temporal reductions in sea ice may have provided transient benefits to the GB subpopulation due to increased biological productivity. Climate change is the primary long-term threat to polar bears and the threshold beyond which the GB subpopulation could be negatively affected by continued ice loss, like some other polar bear subpopulations, is currently unknown. This study represents the second structured population assessment in 22 years for the GB subpopulation. Based on experience garnered through this study and analysis, we submit several recommendations for consideration when planning future polar bear population studies. We suggest collecting additional data at approximately the midpoint between planned subpopulation assessments. In this case, that equals approximately 5 – 7 years from the 2017 completion of field work. Additionally, while the recommendation for movement data is not new, it continues to be highly recommended for subpopulations with known exchanges of bears between areas. In the absence of satellite telemetry data on polar bear movements, conducting a meta-analysis to investigate exchange between GB and nearby subpopulations (i.e., Lancaster Sound, GB, and M'Clintock Channel) may help alleviate some of the uncertainty around individual subpopulation estimates for these areas. Finally, when time, resources, and management objectives warrant it, we recommend conducting a quantitative harvest risk assessment to inform sustainable harvest levels.

1.B) EXECUTIVE SUMMARY INUKTITUT

ᖃᐅᔨᓴᖅᓯᓂᖅ ᐅᓄᕐᓂᖏᓐᓄᑦ Gulf of Boothia−ᒥ ᓇᓄᕆᔭᐅᒃᑲᓐᓂᖅᑐᓄᑦ ᐊᑐᖅᑐᖃᕐᓗᓂ ᑎᒥᖏᑎᒍᑦ ᓇᓗᓇᐃᒃᑯᑎᖅᓯᓂᕐᒥᒃ−ᐱᒃᑲᓐᓂᖅᓯᓂᕐᒥᒃ

ᐊᐅᓚᑦᑎᕈᓂᙱᖅᑐᑦ ᓇᐃᓈᖅᓯᒪᔪᖅ

ᓇᓄᐃᑦ (*Ursus maritimus*) ᐊᐅᓚᑦᑎᕙᐅᓂᒃᐳᑦ ᓄᓇᕗᓕᒫᒥ, ᑲᓇᑕᒥ, ᖃᔅᓯᕌᕈᓐᓇᕐᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᓂᒃᑐᑎᒍᑦ ᕿᓂᖅᑐᒃᑯᑦ ᓇᓗᙱᑦᑎᐊᕈᒪᓂᕐᒧᑦ ᑕᒪᓐᓇ ᐊᖑᓂᕆᔭᐅᓂᒃᑐᖅ ᑲᔪᓰᓐᓇᕈᓐᓇᕐᒪᖔᑦ. ᐊᕐᕞᒨᔭᖅᑐᓂ ᖁᓕᓂ, ᓯᓚᐅᑉ ᐊᓯᔾᔨᕐᓂᕆᔭᖏᑦ ᐅᑭᐅᖅᑕᖅᑐᓕᕐᒪᒥ ᐊᓯᔾᔨᖅᑎᑎᑦᑎᓯᒪᕗᖅ ᓇᓄᐃᑦ ᐃᓂᑭᓂᒃᑕᖏᓐᓂᒃ, ᑕᒪᓐᓇᓗ ᓱᒃᑲᓕᕚᒻᒪᕆᐅᓪᓗᓂ. ᐱᓯᒪᕙᒪᓗᓂ ᑲᔪᓯᕙᓐᓇᑦᑎᐊᖅᑐᒥᒃ ᓇᓄᕐᓄᑦ ᓇᓄᖃᑎᒌᒃᑲᓐᓂᖅᑐᓄᑦ ᐃᓚᒋᔭᐅᓪᓗᑎᒃ ᓄᓇᒧᑦ ᓇᓗᙱᑦᑎᐊᕈᒪᓂᐅᕗᖅ ᑲᔪᓰᓐᓇᖅᑐᒥᒃ ᒪᓂᒪᕙᖕᓂᖏᓐᓂᒃ ᐊᑐᖅᑕᐅᕙᓐᓇᖅᓱᓂ ᐃᓄᖕᓄᑦ, ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᓇᐅᑦᑎᖅᓱᖅᓯᓂᕐᒧᓪᓗ ᐱᓕᕆᐊᖑᕙᒃᐳᑦ ᖃᐅᔨᓴᖅᓯᕙᒪᓂᕐᒧᑦ ᓇᓅᖃᑎᒌᒃᑲᓐᓂᖅᑐᑦ ᖃᓄᐃᓕᖓᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᑐᕌᕆᔭᐅᕙᑦ ᐊᐴᑎᓯᒪᔭᐅᓚᐅᕐᒪᖔᑕ. ᐅᕙᓂ ᐅᓂᒃᑲᐅᓯᖃᖅᐳᒍᑦ ᖃᓄᐃᓕᖓᓂᖏᓐᓂᒃ ᖃᔅᓯᐅᓂᖏᓐᓄᑦ ᖃᐅᔨᓴᖅᓯᓂᕐᒥᒃ ᓇᓄᕐᓄᑦ ᓄᓇᓕᖕᓄᑦ Gulf of Boothia−ᒥ ᑲᔪᓯᓚᐅᖅᐳᖅ 2015-2017-ᒥ. ᒫᓐᓇ ᖃᓴᐅᒃᓴᐃᑦ ᑲᑎᑕᐅᓚᐅᖅᐳᑦ ᐊᑐᖅᑐᖃᖅᓗᓂ ᐸᕝᕙᓯᙱᓐᓂᖅᓴᒥᒃ ᑎᒥᖓᓂᑦ ᐹᖅᓯᐊᕐᕙᒃᓗᓂ ᓇᐅᒃᑲᖅᑕᐅᒪᒧᑦ ᐊᐅᓚᕙᓇᐃᓕᑎᑦᑎᙱᕐᓗᑎᒃ ᑎᒥᖏᑎᒍᓪᓘᓐᓂᑦ ᑲᓴᓗᒃᑕᐅᙱᓪᓗᑎᒃ. ᖃᐅᔨᓴᕐᓂᕆᔭᕗᑦ ᐃᓚᖃᓚᐅᖅᐳᖅ 2015-2017-ᒥ ᑎᒥᖓᓂᑦ ᖃᐅᔨᓴᐅᒃᓴᒥᒃ ᑎᑎᕋᖅᓯᒪᔪᓂᒃ, ᐆᒪᔪᒥᑦ−ᐹᖅᓯᓂᒥᒃ ᑎᑎᕋᖅᓯᒪᔪᓂᒃ ᑲᑎᑕᐅᔪᓂᒃ ᐋᖅᑭᒃᓱᖅᑕᐅᓯᒪᔪᒥ ᖃᐅᔨᓴᕐᓂᕐᒥ 1998-2000-ᒥ, ᐆᒪᔪᒥᒃ−ᐹᖅᓯᓂᕐᒥᒃ ᑎᑎᕋᖅᓯᒪᔪᓂᒃ ᑲᑎᑕᐅᓚᐅᖅᑐᓂᑦ ᐱᕕᒃᓴᖃᕐᓂᕐᒧᑦ 1976−1997−ᒥ, ᐊᖑᔭᖃᖅᐸᖕᓂᖓᓄᓪᓗ ᐅᑎᖅᑎᑦᑎᓂᕐᒧᑦ ᑎᑎᕋᖅᓯᒪᔪᓂᒃ ᐅᕗᖓᓕᒫᖅ 1976-2017-ᒧᑦ. ᖃᐅᔨᔭᐅᔪᑦ ᐆᒪᔪᒥᒃ−ᐱᓯᓂᕐᒧᑦ, ᑐᕐᑯᔪᓂᑦ−ᐱᖁᕕᖃᕐᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᓇᔭᖅᑐᓂᒃ ᐋᖅᑭᒃᓱᖅᑕᐅᓯᒪᔪᓂ MARK-ᒥ ᐃᒪᐃᑎᑦᑎᖅᑰᔨᕗᑦ, ᖃᔅᓯᐅᓂᖏᓐᓄᑦ ᖃᔅᓯᐅᓇᓱᒋᔭᐅᔪᒥ 1525−ᓂᒃ (ᑕᒻᒪᖅᑕᐅᓴᒃᐸᒃᑐᖅ [SE] = 294) 2015 – 2017−ᒧᑦ ᐊᔾᔨᖃᑲᓴᓚᐅᖅᐳᖅ ᐅᓄᕐᓂᕆᔭᖏᓐᓄᑦ 1998 – 2000−ᒥ (1610 [SE = 266] ᑖᕝᕙᓂ ᖃᐅᔨᓴᕐᓂᕆᔭᐅᔪᒥ; 1592 [SE = 361]ᐅᕙᓂ, Taylor et al. [2009−ᒥ]).

ᓇᓄᕋᓛᖅᑖᕆᔭᐅᔪᑦ ᐊᕐᕌᒍᒧᑦ ᐊᕐᕌᓂᓕᓴᐃᓪᓗ ᐊᖏᑎᒋᓂᖏᑦ 2015 – 2017–ᒧᑦ 1.61–ᖑᓚᐅᖅᐳᑦ (95%–ᒥᒃ ᑕᕝᕙᒻᒪᕆᐅᓂᖏᓐᓂᒃ [CI] = 1.51 – 1.70) ᐊᒻᒪᓗ 1.53 (95% CI 1.41– 1.64), ᑭᖑᓕᕇᒃᑐᑎᒃ, ᐅᔾᔨᕆᓇᖅᑐᒥᒃ ᖃᓄᐃᓕᕙᓪᓕᐊᓂᑲᕋᓂ ᑕᑯᓪᓗᒍ 1998 – 2000. ᖃᔅᓯᐅᓂᕆᔭᖏᑦ ᐊᕐᕌᓂᓕᓴᐃᑦ ᐃᓅᕐᒧᑦ ᐊᕐᓇᒧᑦ 2015 – 2017–ᒧᑦ 0.36–ᖑᓚᐅᖅᐳᖅ (95% CI = 0.26 – 0.47) ᑕᒪᓐᓇᓗ ᐃᒪᐃᑎᑦᑎᖅᑰᔨᓪᓗᓂ, ᑖᓐᓇ GB ᒫᓐᓇ ᕿᑐᙵᕆᐅᕝᕕᐅᓪᓗᓂ ᓇᓄᕐᓂᑦ, ᓱᑯᖓ ᐊᓱᔨᖅᓯᒪᓕᕋᓗᐊᖅᑎᓪᓗᒍ. ᑕᒪᓐᓇ ᐊᔨᖃᖅᐳᖅ ᖃᐅᔨᔭᑦᑎᓐᓂᑦ ᓇᓄᐃᑦ ᑎᒥᖏᑕ ᖃᓄᐃᓕᖓᓂᖏᑦ (ᓱᕈᓗ, ᖁᐃᓂᓂᖏᑦ) ᐅᐱᙳᒃᑯᑦ ᐊᖏᒃᓕᒋᐊᓚᐅᖅᓯᒪᕗᖅ ᐅᑯᓇᓂ, 1998-2000–ᒥ ᐊᒻᒪᓗ 2015-2017-ᒥ. ᖃᐅᔨᓚᐅᖅᐳᒍᑦ ᑭᓱᓂᖏᓐᓂᒃ ᖃᔅᓯᓂᒃᑯ ᐊᕐᕌᒍᖃᕐᓂᖏᓐᓂᒃ–ᐱᕝᕙᑎᖃᓪᓗᐊᑕᖅᑐᒥᒃ ᐊᔾᔨᙱᓐᓂᕐᒥᒃ ᑲᑎᕝᕓᑦ ᐆᒪᕙᓇᕐᓂᕆᔭᖏᓐᓂ (ᓲᕐᓗ ᐃᒪᓐᓇ, ᐃᓕᒋᔭᐅᓗᓂ ᐊᖑᔭᐅᓯᒪᕙᑦ ᑐᖁᑕᐅᕙᑦ) ᖁᑎᖕᓂᖅᓴᒥᒃ ᖃᔅᓯᐅᓇᓯᒋᓈᕙᖅᑲᓗᓂ ᐃᓅᕐᓄᑦ ᐊᕐᓇᓄᑦ (0.95;95% CI=0.81-0.99) ᐃᓅᕐᓂᑦ ᐊᖑᑎᓂᑦ (0.85;95% CI=0.74-0.92 ᐊᕐᕋᒍᓄᑦ 2005-2017. ᐊᒃᑐᐊᓂᖃᑐᐃᓐᓇᓇᐊᓕᖕᒥᒃ ᖃᓄᐃᓕᖓᓕᕐᓂᕐᒥᒃ ᖃᐅᔨᔭᐅᕙᖃᓚᐅᖅᐳᖅ ᐅᓄᖅᓯᒋᐊᕐᓂᐅᓪᓗᓂ ᖃᔅᓯᐅᓂᕆᔭᖏᓐᓄᑦ ᐊᕐᓇᐃᑦ 0.57–ᒥᑦ 1998–2000-ᒥ 0.61–ᒧᑦ 2015–2017–ᒥ. ᖃᔅᓯᐅᓂᖏᓐᓄᑦ ᐅᓄᖅᓯᕙᓪᓕᐊᓂᖏᑦ ᖃᔅᓯᐅᓇᓯᒋᔭᐅᓂᖏᑦ ᐊᑐᖅᑐᖃᖅᑰᓂ matrix ᖃᓅᓂᐊᕋᓯᒋᓈᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᓇᔭᖅᑐᒥᒃ ᖃᔅᓯᐅᓇᓯᒋᓈᕙᖃᑰᓂ ᑲᑎᕝᕓᑦ ᐆᒪᓂᓇᔭᖏᑦ 0.06-ᖑᓚᐅᖅᐳᖅ (95% CI = 0.06 - 0.12) 2005-2007–ᒧᑦ, ᐃᒪᐃᑎᑦᑎᖅᒃᑰᔨᓪᓗᑎᒃ ᓴᙱᕙᒥᒃ ᐊᕙᙱᓐᓂᖃᑐᐃᓐᓇᓇᐊᖃᑰᑎᒃ ᐱᕈᖅᐊᓪᓕᐊᓂᕐᒥᒃ. ᑭᓱᐊᓂᓗᑦᑕᐅᖅ, ᖃᔮᔭᕗᑦ ᖃᔅᓯᐅᓂᖓᑕ ᐅᓄᖅᑎᒋᓂᖏᑦ ᖃᓄᐃᓕᕙᓪᓕᐊᓂᖏᓪᓗ ᑐᑭᖃᖅᑎᑕᐅᓕᓪᓗᐊᖅᐳᑦ ᐅᔾᔨᖅᓱᑦᑎᐊᖅᑐᖃᕐᓗᓂ ᐃᒪᐃᓐᓂᖓᓄᑦ, ᖃᔅᓯᐅᓇᓯᒋᓈᓂᕗᑦ ᐅᓄᕐᓂᖏᑕ ᐊᒃᑐᐊᓂᖃᒪᑦ "ᐅᓄᕝᕙᕐᓂᖏᓐᓄᑦ" (ᓲᕐᓗ ᐃᒪᓐᓇ, ᑕᒪᓐᓇ ᐃᓚᖃᖅᐳᖅ ᓇᓄᓕᒫᓂᒃ ᐊᑐᖅᐸᒃᑐᓂᒃ GB-ᒥᒃ ᐃᓂᒥᒃ ᐊᐅᓚᑦᑎᕕᐅᕙᒥᒃ, ᐃᓚᖏᓪᓗ ᐊᓯᒥᓂᑦᑕᐅᖅ ᓇᓅᖃᑎᒋᔭᓃᑉᐸᒃᑯᑎᒃᑕᐅᖅ) ᖃᔅᓯᐅᓇᒋᓈᓂᖅᐳᓪᓗ ᖃᔅᓯᐅᓂᖏᑕ ᐅᓄᖅᓯᕙᓪᓕᐊᓂᕆᔭᖏᓐᓄᑦ ᐃᓚᕋᙱᓚᖅ ᐊᓯᐊᓄᐊᕋᔭᕐᓂᕐᒥᒃ ᑕᐃᑲᓃᖏᓐᓇᓂᕐᒧᓂᓗ GB–ᒥᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐃᓂᒥᑦ. ᐊᑕᖏᑉᓗᓂ, ᖃᐅᔮᔭᕗᑦ ᑕᑯᑎᑦᑎᖅᑰᔮᕗᑦ ᓇᓂᐅᓂᖏᓐᓄᑦ ᖃᓄᐃᓕᖓᓂᖏᑦ GB–ᒥ ᓇᓄᕆᔭᐅᒃᑲᓐᓂᖅᑐᑦ ᒫᓐᓇ ᖃᓄᐃᙱᑉᐳᑦ, ᐃᒪᐃᒃᑲᓗᐊᖅᑎᓪᓗᒍ, ᐃᒪᐃᓕᐅᕐᑯᔭᓇᔭᖅᑎᓪᓗᑕ ᐊᑦᑎᖕᓂᖅᓴᓂᒃ ᖃᔅᓯᐅᓇᓯᒋᓈᓗᑎᒃ ᑲᑎᕝᕓᑦ ᐊᖑᔭᐅᓯᒪᙱᑦᑐᓄᓪᓗ ᐆᒪᕙᓇᕐᓂᕆᔭᖏᓐᓄᑦ ᐊᖑᑎᖏᑕ ᓇᓄᐃᑦ ᓱᓕ

ᖃᐅᔾᔭᖅᑕᐅᒃᑲᓐᓂᕆᐊᖃᖅᑎᑦᑎᓗᑦ. ᐃᒪᓇᐅᓇᓱᒋᓐᓈᒍᒎᑦ, ᐃᓂᒥᓂ ᓇᓃᓐᓂᖕᒋᓐᓄᑦᑐ ᒥᑭᒡᓕᒋᐊᖅᑐᖅ ᑐᕝᕙ ᐱᑎᑦᑎᑐᐃᓐᓇᓇᐊᖃᖅᓯᒪᒍᖅ ᓅᓐᓂᕐᒧᑦ ᐱᕚᓪᓕᕈᑕᐅᓯᒪᔪᓂᒃ GB–ᒥ ᓇᓄᓇᔭᐅᒃᑲᓐᓂᖅᑐᓄᑦ ᑕᐃᒪᐃᔾᔪᑎᖃᖅᑰᑎᒃ ᓄᓇᒥᐅᑕᐅᓂᕐᒧᑦ ᐅᓄᖅᓯᕙᓪᓕᐊᕙᖕᓂᓇᔭᖕᒋᓐᓄᑦ. ᓯᓚᐅᑉ ᐊᓱᔮᖅᐸᓪᓕᐊᓂᖓ ᐱᓪᓗᐊᑕᒍᖅ ᐊᒍᖓᑲᓪᓚᒃ ᖁᐊᖅᕹᕐᓇᖅᑎᑦᑎᓪᓗᓂ ᓇᓄᕐᓄᑦ ᐊᑐᖅᑕᐅᓕᕋᔭᖅᑐᒧᓪᓗ ᑕᒪᒃᑯᐊ GB–ᒥ ᓇᓄᓇᔭᐅᒃᑲᓐᓂᖅᑐᑦ ᐱᐅᙱᑦᑐᒃᑯᑦ ᐊᒃᑐᖅᑕᐅᓇᔭᕐᓂᖕᒋᓐᓂᒃ ᑲᔪᒍᓐᓇᖅᑐᒃᑯᑦ ᑐᕙᖅ ᓄᖑᑉᐸᓪᓕᐊᓂᕿᔭᖕᖓᓄᑦ, ᓱᒑᕐᓗ ᐊᓱᖕᒋᓐᓄᑦ ᓇᓅᖃᑎᒌᓄᑦ, ᒫᓇᒧᑦ ᑎᑭᕐᓱᒍ ᖃᐅᔨᒪᔭᐅᙱᓕᖅ. ᑕᒪᓐᓇ ᖃᐅᔾᔭᐃᓄᒋᐊᓐᓂᖕᒋᑦᓂᓇᔭᐅᔪᖅ ᑭᒡᒐᖅᑐᐃᒍᖅ ᐊᐃᑉᐸᖓᓂᒃ ᐋᖅᑭᒃᓱᖅᑕᐅᓯᒪᔪᓂ ᖃᓯᐅᓂᖕᒋᓐᓄᑦ ᖃᐅᔾᔭᖅᓯᓂᖅ 22–ᓂ ᐊᕐᕌᒍᓂ GB-ᒥ ᓇᓄᓇᔭᐅᒃᑲᓐᓂᖅᑐᓄᑦ. ᑐᙵᕕᒋᓪᓗᒍ ᐱᓕᕆᖃᑦᑕᖅᓯᒪᓂᖅ ᐱᔭᐅᔪᖅ ᑕᕝᕗᓇ ᖃᐅᔼᓇᓱᙱᒃᑯᑦ ᖃᐅᔾᔭᕐᓂᒃᑯᓪᓗ, ᑐᓂᓯᒍᒧᑦ ᖃᓯᑲᓪᓚᙱᒃ ᖃᓄᐃᓕᐅᖁᔨᓂᕐᓂᒃ ᐃᓱᒪᒃᓴᖅᓯᐅᕆᑕᐅᓂᐊᖅᑐᓂᒃ ᐱᕙᓖᔭᖅᑐᖃᓕᖅᐸᑦ ᓯᒍᓂᒃᓴᒥ ᓇᓄᕐᓂᒃ ᖃᓯᐅᓂᖕᒋᓐᓄᑦ ᖃᐅᔾᔭᕐᓂᓇᔭᐅᔪᓂ. ᐃᒪᓇᐃᓕᐅᖁᔨᓇᔭᖅᐳᒍᑦ, ᑲᑎᖅᓱᐃᔪᖃᕐᓗᓂ ᑎᑎᕋᖅᓯᒪᒃᑲᓐᓂᖅᑐᓂᒃ ᕿᑎᐸᓗᐊᓂ ᐱᕙᓖᔭᖅᑕᐅᓯᒪᔪᑦ ᖃᓯᐅᒃᑲᓐᓂᕐᓂᖕᒋᓐᓄᑦ ᖃᐅᔾᔭᕐᓂᕐᓂ. ᑕᐃᒪᐃᓐᓂᖓᓄᓪᓗ, ᑕᒪᓐᓇ ᓇᓕᒧᕆᔭᕐᑲᖅᐳᖅ 5–7–ᐸᓗᖕᓂᒃ ᐊᕐᕌᒍᓂᒃ 2017–ᒥ ᐱᔭᕇᖅᑕᐅᓚᐅᖅᑐᒥ ᓯᓚᒥ ᐱᓕᕆᓂᓇᔭᐅᔪᒥ. ᐊᒻᒪᓗᒃᑲᓐᓂᖅᑕᐅᖅ, ᑕᒪᓐᓇ ᖃᓄᐃᓕᐅᓕᕐᑯᔨᓂᖅ ᓄᑦᑕᖅᐸᕐᓂᖕᒋᓐᓄᑦ ᑎᑎᕋᖅᓯᒪᔪᑦ ᓄᑖᕐᑐᙵᒋᑎᓪᓗᒍ, ᐊᑐᕐᑯᔭᐅᓯᒪᑦᑎᐊᖅᓯᒪᒍᖅ ᓇᓅᕐᑲᑎᒌᒃᑲᓐᓂᖅᑐᓄᑦ ᖃᐅᔨᒪᔭᐅᔪᑎᒍᑦ ᐃᓂᒥ ᐊᒥᖅᑲᑲᑎᕐᑲᖅᐸᕐᓂᖕᒋᓐᓂᒃ ᓇᓄᐃᑦ ᑕᒃᑯᓇᓂ ᐃᓂᓂ. ᐱᑕᕐᑲᙵᒋᓐᓂᖓᓄᑦ ᖃᖓᑦᑕᖅᑎᑕᐅᓯᒪᔪᑎᒍᑦ ᑎᑎᕋᖅᑕᐅᓯᒪᔪᓂᒃ ᓇᓄᐃᑦ ᓄᒃᑕᕐᓂᓇᕝᑲᖕᒋᓐᓄᑦ, ᑲᔪᓯᑎᑦᑎᓂᖅ ᖃᐅᔾᔭᖅᓯᓂᕐᒥᒃ ᖃᐅᔾᔭᕈᒪᓂᕐᒧᑦ ᐊᒥᖅᑳᕐᑲᑎᒌᒃᐸᖕᓂᓇᔭᖕᒋᓐᓄᑦ GB–ᒥ ᖃᓂᒋᔭᖓᓂᓗ ᓇᓄᓇᔭᐅᒃᑲᓐᓂᖅᑐᓄᑦ (ᓱᕐᓗ ᑕᓪᓗᕈᑎᐅᑉ ᐃᒪᖓ, GB, ᐊᒻᒪᓗ M'Clintock Channel) ᐃᑲᔪᑐᐃᓐᓇᓇᐊᖃᖅᐳᑦ ᒥᑭᒡᓕᒋᐊᖅᑎᑦᑎᓗᓂ ᐃᓚᖓᓂᒃ ᓇᓗᓇᕈᔪᒃᐸᒃᑐᒥᒃ ᐃᓖᒃᑰᖅᑐᓄᑦ ᓇᓄᓇᔭᐅᒃᑲᓐᓂᖅᑐᓄᑦ ᖃᓯᐅᓇᓱᒋᓐᓈᓂᕐᓂᒃ ᑕᒪᒃᑯᓄᖓ ᐃᓂᓄᑦ. ᑭᖑᓪᓕᖅᐹᒥᒃ, ᐱᕕᒃᓴᖅ, ᐊᑐᖅᑕᐅᔪᓐᓇᖅᑐᑦ, ᐊᐅᓚᑦᓂᕐᒧᓪᓗ ᑐᕌᓇᔭᐅᔪᑦ ᑕᐃᒪᐃᑦᑐᓐᓇᖅᑎᑦᑎᒃᐸᑕ, ᐃᒪᓇᐅᕐᑯᔨᓇᔭᖅᐳᒍᑦ, ᑲᔪᓯᑎᑦᑎᔪᕐᕿᓗᓂ ᖃᓯᐅᓂᖕᒋᓐᓄᑦ ᐊᖑᓗᓂ ᖁᐊᖅᕹᕐᓇᑐᐃᓐᓇᓇᐊᓕᖕᒧᑦ ᖃᐅᔾᔭᖅᓯᓂᕐᒥᒃ ᑐᓴᐅᒪᑎᑦᑎᔪᒪᓂᕐᒧᑦ ᑲᔪᓰᓐᓇᕈᓐᓇᖅᑐᓄᑦ ᐊᖑᓂᕐᒧᑦ ᖃᓯᕌᕈᓐᓇᕐᓂᓇᔭᐅᔪᓄᑦ.

1.C) EXECUTIVE SUMMARY INNUINAQTUN

Naunaiyaqni Amigaitpiaqni tapkuat Tariunga Boothia Nannut amigaitni Ilangi Atuqtauyut Aqnallut Anguhallut Titiqni-Angutqiktauyut

Aulapkaiyini Naittuq

Nannut (*Ursus maritimus*) aulatauyut humiliqak Nunavut, Kanata, atuqhugit haviktakhat havagutai pinahuat atuqpiaqni angutauyut ihuaqhihimanit. Taimaa 10nik ukiunik, hilaup aadlangurninnga tamainni Ukiuqtaqtumi aadlanguqtitait nanuit nayugangit aadlatqiiktumik nampanik. Pitariangi naamaktumik nannut amigaitni ilangi ilaunit tapkununga uumatyutit atuqpiaqni piyaunginnalaqnit niqikhanut piqaqnit tahapkununga Inuit, naunaiyainiq naunaiyaut munarinilu naunaiyautit havariyauyut naunairiangi amigaitni ilangi qanuritni aulatauninutlu ihumagini piyakhai. Hamani tuhaqhitautivut tapkuat qanuritni amigaitni naunaiyaut tapkununga nannut nayuqpaktat Tariunga Boothia (GB) havariyauyuq 2015-2017. Nutaat uuktuutingit katitiqtauyut aturhutik mikitqiamik-pittailiniq ihariagiyainnik niqinginnik piiyaqtauniq kapuqtauyut nutqaqtihimaittumik akhuraalukluuniit pilugit nanuit. Qauyihainivut ilalik 2015-2017 uumatyutit naunaiyautit tuhagakhat, uumatitlugit-tiguyauni tuhagakhat katitiqni atuqhugit hanatyuhikhat naunaiyaqni 1998-2000, uumatitlugit-tiguyauni tuhagakhat katitauni pilalirangata 1976-1997, angutauyutlu utiqtitni tuhagakhat tamaitnut pivigiyaini 1976-2017. Qanuritni uumatitlugit-tiguyaunituqungayut-utiqtitni pityuhit ihuaqhihimayut tapkunani Havagut MARK piniraqtai anginiqhamik amigaitni mikhautni tapkuat 1525 (atuqpakni ulamniqni [SE] = 294) pivigiyanut 2015-2017 ayyikkutapyagiya anginiqpaq amigaitni talvani 1998-2000 (1610 [SE = 266] uumani naunaiyaut; 1592 [SE = 361] talvani Taylor et al. [2009]). Anginiqpaq piarait-ukiumun tapkuatlu ukiulgit piarait aktilangi pivigiyanut 2015-2017 tapkuanguyut 1.61 (95% nalungitninut akunit [CI] = 1.51-1.70) tamnalu1.53 (95% CI = 1.41-1.64), tuklirinut, pitquhiqaqungitnit hutqikni tapkuat 1998-2000. Tamna anginiqpaq qaphiuni ukiulgit atuni iniqnit aqnallut pivigiyanut 2015-2017 tamnauyuq 0.36 (95% CI = 0.26-0.47) tapkuat piniraqtai tamna Tariunga

Boothia tatya piruttiaqtut nannut amigaitni ilangi, pigaluaqtitlugu tariup hikua allanguqnia. Una malikhaqmiya naunaiqtavut tapkuat nannut timingi qanuritni (naunaipkutariplugu, uqhuqaqnit) upingami ilagiaqtut akungani pivigiyai 1998-2000 tamnalu 2015-2017. Naunaiqtavut aqnallut anguhallut- ukiungilu-tainit allatqit katitlugit annaumani aktilat (naunaipkutariplugu, ilautitlugit angutat tuqutaunit) puqtutqiyautitlugit mikhautni iniqnit aqnallut (0.95; 95% CI = 0.81-0.99) tapkunangaunganit iniqnit anguhallut (0.85; 95% CI = 0.74-0.92) pivigiyanut 2005-2017. Atulaq turangayuq aktuania naunaiqtauyuq ilagiaqni avikhimaninut amigaitni qnallut talvanga 0.57 talvani 1998-2000 tikitlugu 0.61 talvani 2015-2017. Tamna ayyikkiquqni, taittiaqni amigaitni aglivaliani aktilat kititni atuqhugit kitityutit pinahuginit uuktut mikhauttaqnigut katitlugit annaktut tamnauyuq 0.06 (95% CI = -0.06-0.12) pivigiyanut 2005-2017, piniraqhugit akhut aglivalialaqni. Kihimik, qanuritnivut amigaitni ilangi aktilat pitquhitlu tukiliuqtakhat munarilugit piplugu mikhautnivut amigaitninut pihimani tapkuat “amigaitniqpanguni” (naunaipkutariplugu, ilalgit tamaita nannut atuqtat Tariunga Boothia aulatauvia inaa, ilangi nayuqtat ahii amigaitni ilangiluttauq) mikhautavutlu amigaitni aglivaliani aktilat piyaungittut ahiningartaqnit taphumanga Tariunga Boothia aulatauvia inaa. Tamaitnut, nalvaqtavut piniraiyut tapkuat amigaitni qanuritnit taphuma Tariunga Boothia amigaitni ilangi tatya nakuuyut, pinahuaquigaluaqhuta pukkitqiyat mikhautnit katitninut angutaungittutlu annaumani anguhalluit nannut naunaiyatqikharialgit. Pinahugiyavut tapkuat akuttuni mikhivallilaknilu tariup hikua piqarutaulat nuktiraqninut ikayuqtat tamna Tariunga Boothia amihuni ilangi piplugu ilagiaqni uumatyutit piaraniktaqni. Hilap allanguqnia tamna pityutauniqhaq hivituyumun hivuranauta nannut nayuqpaknitlu avataanut Tariunga Boothia amigaitni ilangi ihuittumik aktualaqni hikuiqpalianginnaqat, taimattauq ilai nannut amigaitni ilangi, tatya naunaqmata. Una naunaiyaut kivgaqtuta aipanik hanatyuhit amigaitni naunaiyaqni tapkunani 22 ukiut tahamunga Tariunga Boothia amigaiti ilangi. Piplugit atuqhimani piyauyut atuqhugu una naunaiyaut qauyihaqnitlu, tuniyavut qaphit aturahuaquni ihumagiyauyukhat parnaiyaititlugit hivunikhami nannut amigaitni naunaiyautit. Aturahuaquyavut katitiqni ilagiarutit tuhagakhat mikhaani qitqani akungani parnakhimayat amigaitni ilangi naunaiyaqni. Uumani piplugu, tamna piya mikhaani 5-7 ukiut talvanga 2017 iniqtauni maniqami havat. Ilagiaqhugu, pigaluaqtitlugit aturahuaquni nuktiraqnit tuhagakhat nutaungittut, huli pinahuaquyauqpiaqtuq tapkununga amigaitni ilangi ilihimayqnut himmiqtautai nannut akungani inait. Piqangititlugu qangattaqhimayunik takukhautitni tuhagakhat nannut nuktiraqnit, havarinia angiyumik-qauyihaqni naunaiyautit himmiqtautai akungani Tariunga Boothia hanianilu amigaitni ilangi (naunaipkutariplugu, Lancaster Hanikgakhik, Tariunga Boothia, tamnalu M’Clintock Kangikhuakyuk) ikayulat naunairutai ilai naunaqtut piplugu ilikkut amigaitni ilangi tahapkuat inait. Kingulliqpamik, pikpat pivikhait, piqaqni, aulataunilu ihumagiyauyut piyaqaliqturini, aturahuaquyavut havarini amigaitninut angutat hivuranaqni naunaiyaqni tuhaqhittangi ihuaqhihimani angutat puqtunit.

2. INTRODUCTION

Wildlife managers face complex decisions when seeking to balance conservation and human priorities. Decisions and outcomes must be evaluated periodically so that new information can be fed back into an adaptive management framework (Holling 1978, Lancia et al. 1996, Johnson 1999). Accurate and up-to-date estimates of population abundance are often a key component of informed management decisions (Nichols and Williams 2006). Typically, new estimates of abundance are acquired periodically according to a monitoring interval that is determined by management objectives, resource availability, and species' biology (Gibbs 2008). As climatic changes affect many areas around the globe, shortened monitoring intervals may be required to understand the concurrent effects of management interventions and environmental change. Broadly, more frequent monitoring can increase the probability of meeting management objectives and reduce the severity of potential negative outcomes resulting from mis-specified management interventions (Taylor et al. 2007, Regehr et al. 2017).

One species that has received significant monitoring attention is the polar bear (*Ursus maritimus* Phipps 1774). Polar bears are characterized by having delayed maturation, small litter sizes, and high adult survival rates (Bunnell and Tait 1981). They are apex predators and as such bioaccumulate environmental contaminants (e.g., Derocher et al. 2003, Fisk et al. 2009, McKinney et al. 2009, 2011, Letcher et al. 2010, Routti et al. 2019). As a circumpolar species that depends on the sea ice for hunting, travel, mating, and in some instances denning (Amstrup 2003), sea ice loss resulting from climate change is predicted to impact polar bear subpopulations severely (Derocher et al. 2004, Stirling and Parkinson 2006, Amstrup et al. 2008, Durner et al. 2009, Stirling and Derocher 2012, Atwood et al. 2016, Regehr et al. 2016). The global polar bear population, consisting of 19 subpopulation units, is estimated to be approximately 26,000 polar bears (Obbard et al. 2010, Wiig et al. 2015). Currently there is no empirical evidence for declines in global abundance due to sea-ice loss (Regehr et al. 2016). However, some subpopulations have exhibited negative effects resulting from climate change (e.g., Bromaghin et al. 2015, Lunn et al. 2016) and accurate assessment of global changes is complicated by poor data for many polar bear subpopulations (Durner et al. 2018, Hamilton and Derocher 2018), spatial and temporal variation in the effects of sea-ice loss (Rode et al. 2014), and the fact that some subpopulations have likely recovered in recent decades from overexploitation prior to the 1973 Agreement on the Conservation of Polar Bears (Honderich 1991, Larsen and Stirling 2009).

Despite the on-going research and monitoring efforts, reliable and updated abundance and demographic information about all subpopulations is still lacking (Obbard et al. 2010, Vongraven et al. 2012). Polar bear research is expensive and logistically challenging, especially for management jurisdictions that oversee multiple subpopulations. Nunavut, Canada, is home to 12 subpopulations (8 shared with other jurisdictions, 4 entirely within Nunavut; Obbard et al. 2010) and as such carries the major responsibility of polar bear research in Canada. In order to maintain healthy and viable polar bear subpopulations, population studies in Nunavut are carried out on average within a 10 - 15-year rotational cycle, which can vary depending on research needs, priorities, and available resource (Hamilton and Derocher 2018). Here we present findings from a 2015 - 2017 study to estimate abundance and evaluate the demographic status of the Gulf of Boothia (GB) polar bear subpopulation.

Gulf of Boothia (GB) is a relatively small polar bear subpopulation area that is entirely managed by Nunavut (Fig. 1). An initial physical mark-recapture study was carried out from 1973 - 78 for the M'Clintock Channel (MC) and the adjacent GB subpopulations, although at the time it did not identify these as separate management units. The total abundance estimate for both areas was 1081 bears (Furnell and Schweinsburg 1984, Urquhart and Schweinsburg 1984). The estimate was known to be biased by non-representative sampling and was subsequently increased to 900 for GB and 900 for MC (Furnell and Schweinsburg 1984, Aars et al. 2006) based on the fact that the entire area was sampled, and the knowledge of Inuit local hunters about polar bear abundance in the broader study area (Derocher et al. 1998, Aars et al. 2006).

The GB and MC subpopulations were later delineated based on movements of satellite radio-collared adult female bears, recoveries of research tags in the harvest (Taylor and Lee 1995, Taylor et al. 2001), Inuit knowledge about how local conditions may influence the movements of polar bears (Keith et al. 2005), and genetic analyses (Paetkau et al. 1999, Campagna et al. 2013, Malenfant et al. 2016).

Prior to this study, the most recent population inventory work for GB was completed in 2000, where abundance (mean ± SE) was estimated to be 1592 ± 361 polar bears (Taylor et al., 2009). Based on those results, the population was considered stable or very likely increasing during the early 2000s due to a high intrinsic growth rate and relative low harvest levels (Taylor et al. 1987, 2009, Durner et al. 2018). However, harvest rates for GB increased from an average of 40 bears per year (with a Total Allowable Harvest [TAH] of 41) as reported by Taylor et al. (2009), to 62 bears per year (22 females and 40 males on average annually with a TAH of 74 starting in 2004/2005; Government of Nunavut (GN), unpublished data), between 2005 and 2017 (GN, unpublished data). How this change in harvest may have affected the GB subpopulation abundance and status is unclear.

Polar bears in Nunavut are managed through a co-management system and memoranda of understanding (MOU) between each community's Hunters and Trappers Association and the territorial government[1]. These MOUs lay out harvest, management and research aspects for each polar bear subpopulation. Under the existing 2005 MOU, the GN committed to begin a new population study for GB in 2015. The new study had the objective to estimate the current subpopulation size and composition, and to compare these results to the former study. In addition, we sought to obtain data that would provide estimates on survival and reproductive parameters that can be used in population viability analyses and a quantitative harvest risk assessment. Lastly, by implementing a research method that was minimally-invasive and supported by local communities and stakeholders, we sought to evaluate whether genetic mark-recapture

[1] As of September 2019 the Nunavut Polar Bear Co-Management Plan is replacing the Memoranda of Understanding.

can be compared with traditional capture mark recapture studies previously done in GB in order to establish longer term trends for population monitoring (Vongraven and Peacock 2011, Vongraven et al. 2012).

3. STUDY AREA

The GB polar bear subpopulation lies entirely within Nunavut and encompasses an area of approximately 67 000 km^2 (excluding land; Taylor et al. 2001, 2009, Barber and Iacozza 2004, Hamilton and Derocher 2018; Fig. 1). The management unit is bound by the Boothia Peninsula to the west, and Brodeur Peninsula to the east. The geography of the study area is described in Schweinsburg et al. (1981). The current management boundary is mainly based on telemetry data for adult female bears that were fitted with radio-collars, tag returns from harvested bears (Schweinsburg et al. 1982, Bethke et al. 1996, Taylor et al. 2001), and genetic analyses (Campagna et al. 2013, Malenfant et al. 2016). Validity of the current boundary has been questioned by Inuit local knowledge (Keith et al. 2005).

Sea ice generally begins to form in early October and persists until July or August in most areas of GB (Schweinsburg et al. 1981). The most southerly area of GB, namely Committee Bay, remains mostly ice-covered throughout the year (Barber and Iacozza 2004). The presence of various ice types such as mobile, multi-year rubble, and first-year ice creates diverse seal habitat across GB (Barber and Iacozza 2004). Recent sea ice and climate data analyses indicate that the Arctic sea ice quality and abundance has changed during the past 30 years and that in most polar bear subpopulations, the sea ice melts sooner and forms later than in the 1980s (Stroeve et al. 2012, Stern and Laidre 2016, Regehr et al. 2016, Environment and Climate Change Canada 2019). Currently, sea ice persists across GB to various degrees throughout the year, but it is predicted that GB may be ice-free for 5 months each year by the late 21st century (Hamilton et al. 2014).

4. METHODS

Sampling – field collections

Our 2015 - 2017 study design was informed by the previous physical mark-recapture study conducted in GB 1998 - 2000 (Taylor et al. 2009; Fig. 2), although our study did not involve the immobilization and physical handling of bears. Inuit co-management partners in Nunavut expressed concern over wildlife capture and handling during a wildlife symposium in 2009 (Lunn et al. 2010, Department of Environment 2013). As a result, the responsible government management agency explored alternative research methods. Given the generally low densities of bears on the sea ice and the vast study area, genetic mark-recapture was selected since it is minimally invasive (Garshelis 2006) and has been successfully applied on various species, including bears (Brown et al. 1991 (right whales [*Eubalaena glacialis*]), Palsbøll et al. 1997 (humpback whales (*Megaptera novaeangliae*)), Boulanger et al. 2004, Olson 2009 (brown bear (*U. arctos*)), Pagano et al. 2014, SWG 2016 (polar bear)). From 2015 - 2017, our biopsy darting sampling sessions occurred between April to late-May each year where we searched the sea ice and near-shore areas for bears across the entire study area. We allocated approximately 100 hours of helicopter time for each field season to search for bears. We obtained genetic material for individual bears from a small sample of skin and hair collected via a remote biopsy dart (Pneudart Type C - Polar Bear) fired from a dart gun (Capchur Model 196) from inside a Bell 206 Long Ranger helicopter (Pagano et al. 2014). The extracted DNA was used to identify individual animals without the need for ear-tagging or lip-tattooing, which are typical methods for individual identification during live-capture studies (see section “Genetic analyses”). Recaptures occurred when a previously sampled bear was biopsy-darted on a later occasion or when a genetic sample was recovered through the Nunavut polar bear harvest-monitoring program. Every hunter in Nunavut is required to submit samples from each polar bear harvest so that age, gender and various other variables can be used in ecological and demographic assessments (Nunavut Wildlife Act, SNu 2003).

Search areas were initially discussed with hunters and local Hunters' and Trappers' Associations during pre-study consultations to gain insight about sea-ice conditions and bear distribution. We also took past capture locations (Taylor et al. 2009) into account when searching the sea ice, adjacent coastal areas, and small islands of our study area (Figs. 2b and 3).

Searches for bears were conducted at approximately 100 - 120 m above sea level, and at average speeds between 120 - 150 km per hour. To minimize potential sampling bias, and to allow replication of this study, we used a semi-structured sampling approach. Generally, we flew transect lines across the sea ice and small islands with search intensity proportional to apparent bear activity (or bear presence). When signs of bears (e.g., tracks, bears, seal kills) were rare or plentiful, search transect lines reflected that with further (i.e., 11 - 16 km) or nearer spacing (i.e., 7 - 10 km), respectively. In that fashion, we were able to cover large sections of the study area efficiently (Fig. 3). We decided to fly our survey transects from east to west and vice versa whenever possible, and to be perpendicular to suspected density gradients based on local knowledge, past capture and hunter-provided harvest locations.

Once we located a bear, a small sample of tissue (<5 mm diameter), mostly skin with some adipose tissue attached to it (Pagano et al. 2014), was taken using a biopsy dart. All bears except cubs-of-the-year (C0s) were darted in the rump area from an approximate distance (or altitude) of 3 - 7 m. C0s in early spring are still small and easily confused (Atkinson and Ramsay 1995, Robbins et al. 2012), and therefore were not darted to avoid possible injury and the splitting-up of family groups. Every bear that was biopsied received a unique field identification number so that the genetic results and our field data could be cross-referenced and linked.

The biopsy darts are designed to fall to the ground after impact and can be retrieved without handling a bear. The effectiveness of these darts for sampling polar bears has been previously demonstrated (Pagano et al. 2014, GN, unpublished data and reports, SWG 2016). The darts are quick and easy to use and require less pursuit of bears than live-capture operations. On average, it took less than 4 minutes from when a bear was initially spotted to the time when the dart was picked up after darting a bear (GN, unpublished data). The design and relatively low velocity of the dart means that risk of injury to a bear is minimal. Typically, bears show no or very little response to the impact of the dart and are left with no obvious visible mark. In order to facilitate easy spotting of darts on the ice or in deeper snow, a 10 - 15 cm long and ~2 cm wide strip of brightly colored flagging tape (C.H. Hanson, Naperville, IL; or Johnson, Montreal, PQ) was tied and wrapped around the distal end of the dart.

In addition to collecting the biopsy sample, we recorded the date, time and location of each observed bear (or group of bears), body condition based on visual assessment using a standardized fat index (e.g., Stirling et al. 2008; a scale from 1 - 5 with 1 being skinny, 3 average and 5 obese), specific markings or characteristics, group size or litter size, the estimated field age class (e.g., C0, yearling (C1), 2-year old, subadult [approx. 2 - 4 years], adult [approx. ≥ 5 years]) and estimated gender. Both field age-class and gender estimated included a confidence qualifier (i.e., a = high confidence; b = low confidence). Field age-class and gender throughout this project were assessed remotely from the helicopter at altitudes between 3 - 7 m by four experienced observers. When we encountered mothers and their dependent young, we distinguished C0s, C1s, and 2-year old offspring based on their size relative to their mother and physical features (e.g., blood or fecal/urine stains, scars) to a) assign them to a field age class, and b) avoid sampling the same individual more than once. Additional cues such as body size of the individual bear in relation to its surrounding or group members, body shape and proportions, presence of scars, secondary sexual characteristics, observation of urination, and gait were all used to estimate gender and age-class. Genetic microsatellite analysis was used later to confirm the gender of each sampled bear (see section Genetic analysis).

When field age class and gender of a bear were initially assessed with low confidence, additional field notes were taken. For example, young subadult male bears and younger adult females are at times difficult to discern from the air when they are solitary. If we thought that the encountered bear was a young adult female, but were uncertain (e.g., confidence classifier "b") then we also noted what this bear could be as alternative – in this case "maybe a young subadult male". When genetics confirmed the field estimate of sex, we assessed the identity of the bear as recorded initially. If the genetics returned a different sex, we reviewed our notes and concluded that the bear, in this example, must have been a young subadult male. Lastly, we recorded factors that may have influenced detection probability during sightings, including weather conditions (e.g., cloudy, clear, sun glare), bear activity when first observed, and sea-ice characteristics in general and within the immediate vicinity (~ 30 m) of an individual bear that may affect detection (e.g., sea ice type: flat, intermediate, rough multi-year ice).

Our work combined data collected during the genetic biopsy sampling sessions from 2015 - 2017, data from the previous capture-mark-recapture study conducted between 1998 - 2000, sporadic live-captures conducted from 1976 - 1997, and harvest recovery data for the entire period 1976 - 2017 (Peacock et al. 2012).

Sampling – recovering previously marked bears through harvest

To detect the recovery of previously individually identified bears (e.g., when bears were marked either during the initial mark-recapture study from 1998 - 2000, or from a previous biopsy-darting field season) by hunters, small muscle tissue samples were collected from all bears harvested in GB and surrounding subpopulations such as MC, Lancaster Sound (LS) and Foxe Basin (FB) throughout the duration of the current biopsy darting study (i.e., April 2015 - May 2017). Polar bear harvesting occurs throughout the year and these samples were stored in 2 ml cryovials (ThermoScientific, Nalgene long-term storage cryogenic tubes) at - 20˚C after submission to our laboratory until sample preparation and analyses.

Sampling - recovered bears from past population study

We examined captures and recaptures from the 1998 - 2000 population inventory, removed bears that we knew were dead (e.g., through a recovered ear tag or tattoo by harvest) and selected the remaining individuals that could be still alive (e.g., ≤ 34 years of age) in 2015 for genetic analyses. Samples (e.g., ear plugs from punching a hole through the pinna so that unique identification ear tags can be applied) of captured and re-captured bears from the initial study had been stored in cryovials at - 20˚C until preparation for genetic analyses.

Sample preparations

We used the same method to prepare all field and laboratory tissues or biopsy samples. Briefly, a lentil-size piece of skin (~ 1 - 1.5 mm thick) or tissue was obtained from either the biopsy sample, the ear plug, or the muscle tissue using a scalpel blade (# 20) then transferred onto a shipping card (Avery, 70 x 35 mm) and attached with scotch tape. Each sample card was labelled with the unique bear identification number, placed into a coin envelope (57 x 89 mm), and left to dry at room temperature for up to 3 days. The dried specimens where then sent to Wildlife Genetics International Inc. (Nelson, British Columbia) for individual genotyping and sex determination.

Genetic analysis

DNA was extracted from tissue with QIAGEN DNeasy Blood and Tissue Kits (Qiagen, Inc.). The tissue samples were genotyped at eight previously published dinucleotide microsatellite loci (REN145P07, CXX20, MU50, G10B, G10P, G10X, MU59, G10H; Paetkau and Strobeck 1994, Paetkau et al. 1995, 1998, Taberlet et al. 1997, Breen et al. 2001, Ostrander et al. 1993). Analysis of individual identity followed a 3-phase protocol previously validated for bears and described elsewhere (Paetkau 2003, Kendall et al. 2009).

To select markers for the analysis of individual identity, we used allele frequency data from approximately 1700 polar bears for which complete 20-locus genotypes existed before the genetic mark-recapture study began (GN, unpublished data). We ranked the 20 microsatellite markers in the dataset by expected heterozygosity. The eight most variable markers that could be analyzed together in a single sequencer lane were selected for use. These surpassed the required standard for marker variability (Paetkau 2003). In addition to the eight microsatellite markers, we analyzed sex, using a *ZFX*/*ZFY* marker. We searched the dataset for genotype matches that seemed unlikely based on our field data. In each case, three extra markers were added to the genotypes to lower the probability of chance matches between individuals. The extra loci confirmed these matches. Once the genotyping and error-checking was complete, we defined an individual for each unique eight locus genotype.

Sea-ice metrics

Other population studies have identified relationships between the spatial and temporal availability of sea ice and demographic parameters for polar bears (Regehr et al. 2007, Rode et al. 2012, Laidre et al. 2020). March and September mean ice concentrations were calculated for the entire GB area for each day sea-ice data were available and then averaged across 1979 - 2016 (Environment and Climate Change Canada 2018). We calculated the number of days between the sea ice retreat and sea ice advance in calendar year *t* using the transition dates when ice concentration dropped below, and exceeded, respectively, the midway point of sea ice concentration between the March and September mean (Environment and Climate Change Canada 2018). For the GB area, this transition sea-ice concentration was 63% (Environment and Climate Change Canada 2018). We describe the annual interval that sea-ice concentration was below the transition threshold as the “low-ice days” (Fig. 4). To evaluate the potential relationships between sea ice and the status of GB polar bears, we analyzed several metrics (e.g., body condition, recruitment, and survival) of bears in year *t* as a function of the duration of low-ice days in year *t*-1.

Body Condition Score

We compiled body condition score (BCS) data from two distinct time periods of mark-recapture population sampling in GB. Bears were assigned a BCS on a scale of 1 - 5 with 1 being skinny and 5 being obese (Stirling et al. 2008) through physical handling and capture (1998 - 2000) or aerial observation during biopsy sampling (2015 - 2017). All BCS observations occurred in April and May. Sex, age, and reproductive classes were assigned during physical handing during 1998 - 2000 and ages were determined based on previous capture history, known birth year, or from tooth analysis (Calvert and Ramsay 1998). During the biopsy sampling period, classification was done at approximately 3 - 7 m above the ground with sex verified by subsequent genetic analysis (SWG 2016). Observers who participated in classifying age class and sex during biopsy sampling had either participated in both sampling periods or were experienced in physical capture-mark-recapture studies.

The BCS raw scores were binned into 3 classes: ‘poor’ (1 - 2), ‘average’ (3), and ‘good’ (4 - 5) to follow recommended monitoring schemes (Stirling et al. 2008, Vongraven et al. 2012) and facilitate comparison with other studies (SWG 2016, Laidre et al. 2020). Like previous studies, we did not include dependent offspring in the BCS analyses because their body condition is dependent on maternal condition (SWG 2016). We excluded within-year observations of the same individual but retained observations of the same individual in different years.

We modeled BCS using ordinal logistic regression (Venables and Ripley 2002) and included *period* as an indicator of sampling period (early = 1998 - 2000 or late = 2015 - 2017). Reproductive status, age, and sex were combined into the four-level categorical variable *reproclass* (ADM = adult male, ADFI = independent adult female, ADFWO = adult female with offspring, and SUB = subadults of both sexes), and sampling day of year (*jul_cap_day)* were included as a continuous covariate to reflect the amount of time bears had on their preferred sea ice hunting platform before being sampled in year *t*. The sampling periods in this study also coincided with the annual seal pupping period, which is known to be prime feeding period for bears (Pilfold et al. 2012, Reimer et al. 2019). Thus, we predicted that increased time on the ice prior to sampling would be associated with higher BCS. The number of low-ice days (*icetm1*$_{t-1}$) was included to evaluate the hypothesis that interannual variation in BCS was related to sea-ice availability in the previous year. We selected a global model that reflected biological and environmental variables we hypothesized, or that have been shown in other studies, to be related to BCS (Rode et al. 2012, SWG 2016, Laidre et al. 2020). Finally, given our interest in evaluating whether different reproductive classes and genders had varying BCS based on the amount of time they spent on the sea-ice during the months immediately prior to observation (*jul_cap_day)*, and whether this relationship was different between our two sampling periods (*period)*, we included a three-way interaction between *reproclass, jul_cap_day,* and *period.* Once the global model was selected, we performed a backwards and forwards model comparison (stepAIC; Package MASS in the R programming language [R Core Team 2019]) to obtain the best-supported final model (ΔAIC < 2) (Table 1). We performed Lipsitz and Hosmer-Lemeshow tests to evaluate fit of the global ordinal regression model ($p > 0.1$; Fagerland and Hosmer 2017). Best-supported model covariates were considered significant at $p < 0.05$ (Wald X^2 tests) and predicted probabilities for each BCS class were calculated based on the suite of final-model covariates.

Reproduction

We evaluated reproductive indices for polar bears in GB using data from physical captures 1998 - 2000 and biopsy sampling 2015 - 2017. We used reproductive metrics that have been identified as important for monitoring polar bears (Vongraven et al. 2012). First, we C0 and C1 litter size as a function of biological, environmental, and temporal factors using logistic regression. We considered litter size (*ls*) for adult female *i* in year *t* to be a binary response variable (i.e., ls_{it} = 1 or 2). Analyses for C0 and C1 litters were performed separately using a three-step modeling approach, although we note that the C0 and C1 litter size data were not independent due to potential repeated measures and correlations (i.e., C1 litter size in year *t* is likely a function of C0 litter size in year t-1). We created a general model that included the main hypothesized sources of variation in the data. General models were simple due to small sample size. To ensure the general model was a suitable starting point for model selection, we evaluated goodness-of-fit (GOF) using Hosmer and Lemeshow tests (Hosmer et al. 2013). Second, we developed a candidate model set representing all combinations of main effects and interaction terms in the general model, with a marginality constraint to ensure that interactions were only included if the corresponding main effects were included. Third, we performed model selection using Akaike's Information Criterion adjusted for small sample size (AIC_c) and then estimated model-averaged parameters for all models with $\Delta AIC_c < 4$ (Burnham and Anderson 2002). Modeling was performed in the R programming language version 3.5.2 (R Development Core Team 2016) using package *MuMIn* (Bartón 2018) for multi-model inference.

The general model for C0 litter size was $ls_{it} = \beta_0 + \beta_1\, period_{it} + \beta_2\, icetm1_{it} + \beta_3\, BCS_{it} + \beta_4\, month_{it} + \beta_5\, period_{it} \times month_{it}$, where $period_{it}$ is a two-level factor indicating whether the observation of adult female i in year t was in the early or late period (1998 - 2000 and 2015 - 2017, respectively); $icetm1_{it}$ is the duration of the low-ice days in calendar year t-1 (see section Sea-ice Metric) for a polar bear observed in calendar year t; BCS_{it} is a three-level factor representing the body condition score of the adult female at the time of observation (see section Body Condition Score); $month_{it}$ is a two-level factor indicating whether a bear was observed in April or May; and $period_{it} \times month_{it}$ is an interaction term allowing the month effect to potentially differ between the early and late periods (e.g., because within-year temporal variation in litter size could change due to changes in sea-ice conditions, den emergence date, etc.). We hypothesized that litter size would be negatively correlated with *icetm1* (Laidre et al. 2020), positively correlated with *BCS* (Derocher and Stirling 1998), and negatively correlated with *month* because observations later in the spring reflected additional time in which cubs could die.

The general model for C1 litter size was $ls_{it} = \beta_0 + \beta_1\, period_{it} + \beta_2\, icetm1_{it} + \beta_3\, BCS_{it}$, where definitions of the predictor variables are the same as in the model for C0s.

We did not include the predictor $month_{it}$ because individual C1 survival is generally high (e.g., Regehr et al. 2017) and we did not expect litter size to change between April and May.

After evaluating patterns in litter size, we calculated the mean number of dependent young (C0 or C1) per adult female and evaluated differences between time periods. We also evaluated litter production rate, defined as the proportion of adult females that are available to breed in year *t* that produce a litter of C0 in year *t*+1 (Taylor et al. 1987). These metrics have been used as indices of productivity for other polar bear subpopulations (e.g., Peacock et al. 2013, Regehr et al. 2015). We quantified uncertainty using a nonparametric bootstrap procedure with 1,000 iterations during which observations of individual polar bears were resampled with replacement and the three reproductive metrics were calculated from the resampled data.

Survival

We used the Burnham capture-recapture model (Burnham 1993) in Program MARK (Cooch and White 2019) to analyze live-observation and dead-recovery data for the GB subpopulation. Live observations consisted of physical captures during which bears were assigned an individual identification number, or the identity of a previously captured bear was recorded; and biopsy sampling during which individual identification was determined from genetic analysis of a tissue sample (see sections above about recovering samples of bears through harvest and from the previous study). Live observations were conducted under random sampling protocols that attempted to search the entire area within the GB subpopulation boundary in 1998 - 2000 (physical captures) and 2015 - 2017 (biopsy sampling). Additionally, bears were physically captured and released each year 1976 - 1978, and sporadically during the period 1979 - 1997. Because research conducted from 1976 - 1997 did not follow a sampling protocol designed to evaluate demography, we included initial captures from this period but did not include recaptures of previously marked bears. This approach has been used in other analyses (e.g., Taylor et al. 2009) to increase the number of marked bears without introducing heterogeneity into recapture probabilities, which can result in biased parameter estimates (Peňaloza et al. 2014). Because recaptures were excluded or did not occur in some years, within the Burnham model we fixed recapture probability to 0 in 1976 - 1997 and 2001 - 2014. Throughout the entire study period 1976 - 2017, dead-recovery data were obtained from hunter reports of research-marked bears and genetic analysis of tissue samples from bears that were harvested.

The Burnham model is a common choice for estimating survival and abundance of polar bears (SWG 2016). Parameters in the model are survival (S; the probability of surviving interval *t* to *t*+1), recapture probability (p; the probability of re-observing a live marked animal), dead reporting probability (r; the probability that an animal which dies is killed by humans and reported to authorities), and fidelity (F; the probability that an animal does not permanently emigrate from the sampling area and remains available for live observation in future years). We limited our analyses to bears age ≥ 1 year (i.e., C1s and older) because in the 2010s most C0s were not biopsy darted or individually identified.

We developed a candidate model set based on combinations of parameter-specific submodels, with the structure of each submodel informed by hypotheses about polar bear biology and study design. We considered 16 submodels for *S* (Table 2). The temporal factor *year* allowed survival to differ between 1976 - 2004 and 2005 - 2017. We chose these year blocks to evaluate the potential influence of habitat changes in the past decade (Environment and Climate Change Canada 2018) and because total allowable harvest (TAH) for the GB subpopulation was increased in 2004 (see section Introduction). The two-level factors *sex* (female vs. male) and *sub* (C1s and subadults [2 - 4 year] vs. adults [age ≥ 5 year]) were included to allow sex- and age-specific variation in survival (e.g., Regehr et al. 2007). The covariate *icetm1*, calculated the same as for reproductive analyses, was included to evaluate the hypothesis that interannual variation in survival was related to sea-ice availability in the previous year. We considered five submodels for *r* that included *sex* and *year* to reflect sex-specific harvest and potential changes in harvest mortality associated with changes in harvest level. The four submodels for p included *sex* to allow potential variation in recapture probability resulting from sex-specific habitat selection or movement patterns (Laidre et al. 2013), and *year* to accommodate different levels of sampling effort in the 1990s and 2010s. We did not include a submodel with annual variation in p because sample sizes were similar within each three-year block of intensive capture-recapture research. The four submodels for F included *sex* and *year*. Unlike Taylor et al. (2009), we estimated F rather than fixing it to 1 because bears captured in the GB management unit have been harvested in adjacent subpopulations, suggesting some degree of permanent emigration (see section Discussion - Abundance). Each submodel was constructed as a linear function, on the logit scale, of the various factors, covariates, and interaction terms discussed above. We fitted all possible combinations of the parameter-specific submodels in Program MARK (Cooch and White 2019) accessed through the R programming environment (R Core Team 2019) using the package RMark (Laake 2013).

We performed model selection and multimodel inference using $QAIC_c$ (Burnham and Anderson 2002). We used the overdispersion factor $\hat{c}$ = 1.2, calculated as the ratio of live observations of dependent cubs (i.e., C1s and two-year-old cubs still accompanying their mothers) to total live observations (Taylor et al. 2009). For validation, we derived a separate estimate of $\hat{c}$ using the parametric bootstrap procedure in Program MARK (Cooch and White 2019) with the general model *S*(*year*+*sex*+*year*:*sex*)*r*(*year*+*sex*+*year*:*sex*)*p*(*year*+*sex*)*F*(*sex*), where "+" represents an additive effect and ":" represents an interaction. The bootstrap estimate of $\hat{c}$ was 1.2, suggesting that our empirical estimate adequately reflected extrabinomial variation in the data. Model-averaged parameter estimates were derived from all candidate models with $\Delta QAIC_c < 4$. Our estimates of S reflected harvest mortality, so we derived estimates of un-harvested survival as $S^* = S + r \times (1 - S)$ (Peacock et al. 2013) and estimated variance via the delta method (Taylor et al. 2008). This equation assumes that harvest of all marked bears is reported, and that harvest mortality is additive (i.e., that no harvested bears would otherwise have died during a given interval).

Abundance

We used Horvitz-Thompson type estimators (McDonald and Amstrup 2001) to derive abundances in year *t* as $\widehat{N}_t = n_t / \hat{p}_t$, where n_t is the number of individually identified animals observed alive in year *t*, and $\hat{p}_t$ is a model-averaged estimate of recapture probability in year *t*. To estimate abundance of bears age ≥ 1 year we stratified the subpopulation by sex and summed the female and male estimates, which was necessary to accommodate sex effects in recapture probability. Finally, we adjusted annual abundances to include approximate numbers of C0s by adding the product ($\widehat{N}_t^{AFC0} \times \overline{ls}^{C0}$), where $\widehat{N}_t^{AFC0}$ is the estimated number of adult females with C0 litters in year *t*, and $\overline{ls}^{C0}$ is overall mean C0 litter size. We used the delta method to construct variance estimates for annual estimates of total *N* and for average estimates of total *N* over several years. In doing so, we assumed that estimates of recapture probability and C0 litter size were independent. Note that abundance estimates from a capture-recapture framework that allows permanent emigration, but not temporary emigration, may not represent the number of animals within the sampling area at a given point in time. Specifically, abundance estimates from the current study represent the "superpopulation", defined as the group of animals that are alive and have a non-negligible probability of occurring within the sampling area, regardless of their actual location at a particular time. In other words, the superpopulation estimate in year *t* reflects temporary emigrants (i.e., animals that are outside of the GB management unit in year *t* but may return in future years).

Population growth

We used estimates of *S* and *S** from live-recapture dead-recovery modeling, together with estimates of litter production rate and C0 litter size, to estimate intrinsic population growth rate (*gr*) using a 10-stage matrix-projection model based on the life history of polar bears (Regehr et al. 2017). Because we did not estimate C0 survival in the current study, we used the mean estimate of 0.889 (SE = 0.179) for the period 1976 - 2000 from Taylor et al. (2009) for all matrix calculations. We estimated var(*gr*) by generating

10,000 correlated samples of the input vital rates using the model-averaged variance-covariance matrix for sex- and age-specific estimates of survival. We assumed that the correlation structure for C0 survival was the same as for subadults, that litter production rate and C0 litter size had a correlation coefficient of 1, and that there was no correlation between survival and reproductive parameters. Estimates of *gr* represent asymptotic intrinsic growth rate at a stable stage distribution.

5. RESULTS

General overview

During research operations in 2015 - 2017, we spent an average of 103 hours of flying in April and May each year in search of polar bears across the sea ice, with an average distance flown per year of about 12,200 km (Table 3, Figs. 2 and 3). The number of bears encountered during each survey season was similar, with a mean of 170 observed bears per field season.

The GB study area is vast and consists of differing ice types (Barber and Iacozza 2004). The distribution of bears during the 2015 - 2017 study appeared to be more uniform across the study area as compared to 1998 - 2000 when bears were encountered in higher concentrations east of the Boothia Peninsula and near the west shore of Melville Peninsula (Figs. 1 - 3). Moreover, there appeared to be no bear encounters directly north of Committee Bay during the 1998 - 2000 study, in contrast to our recent observations. During both studies no bears were encountered in the lower section of Committee Bay (Fig. 2).

Samples examined

We collected a total of 406 biopsy samples during research operations in 2015 - 2017. Of these, 397 (97.8%) contained sufficient material for genetic analysis. We identified 10 GB bears that were previously captured during the 1998 - 2000 study (Taylor et al. 2009), and 1 LS bear that was 22 years old in 2017 when it was sampled. We also identified 7 individuals that were previously sampled during the MC study between 2014 - 2016. Overall, 324 individual bears were identified from these field samples. Some bears were resampled within the same season: 18 bears were sampled twice, 2 bears were sampled three times, and 1 bear was sampled four times (representing 5% of all successful samples). Re-sampling of the same individual within the same field season was low and likely occurred because weather prevented coverage of a large area within a short time frame, allowing bears to move over longer distances. Biopsy sampling leaves no visible marks on the individual animal as is the case with traditional mark-recapture studies (e.g., Peacock et al. 2013) thus it is impossible to avoid some re-sampling.

Through the harvest sampling program, we submitted 1704 samples between 2005 - 2017 from GB and neighboring subpopulations (338 GB, 701 FB, 402 LS, 47 MC, and 216 with unknown subpopulation) for genetic analyses. Twenty-five bears from the biopsy sampling sessions were harvested and recovered, as well as 8 previously marked bears from the 1998 - 2000 study. Those 8 bears were recovered in GB (6), MC (1) and LS (1). The 6 recovered bears in GB were identified through genetic testing because no ear tags and tattoos were reported.

Field sampling activities

Biopsy sampling activities on the sea ice went very well. The darts do not leave a mark when bears are darted in the rump, and most bears do not react to the impact of the dart. Many of the adult males move very slowly away once darted, if at all. The colored flagging tape attached to the end of the dart makes dart retrieval easy and quick.

During our survey flights, additional observers besides the pilot and biologist were on board the helicopter. In order to safely maneuver during darting, some observers had to be safely dropped off once a bear was seen to reduce weight, but before the darting activities began. It took the crew, on average, 4.3 min (± SE; 0.19; range: 2 - 8 min; n = 62) from the time a bear was observed for the first time (e.g., at times > 1 km from the helicopter) and when the additional observer was picked up again. The direct darting activities involving the safe approach of the bear, darting the bear, and dart retrieval took an average of 2.0 min (± SE; 0.11; range: 1 - 5 min; n = 62; GN, unpublished data).

Body condition score

Body condition scores were higher between 2015 - 2017 compared to 1998 - 2000 (n = 626; $\chi^2 = 5.5$, $p = 0.02$; Fig. 5, Table 4). This was reflected in a decrease in the proportion of bears in poor condition (P_{poor}) and an increase in the proportions of bears in average and good condition (i.e., $P_{poor} = 0.31$ for early period vs $P_{poor} = 0.07$ for the late period; Fig. 5; Table 4). Adult females with offspring ($P_{poor} = 0.28$) and subadults ($P_{poor} = 0.26$) were more likely to be in poor body condition compared to other age and reproductive classes (mean P_{poor} for ADFI and ADM = 0.11; $\chi^2 = 11.4$, $p < 0.01$, Fig. 6). For females with dependent offspring, increasing amounts of time on the ice before being sampled (*jul_cap_day*) was associated with higher BCS ($\chi^2 = 9.0$, $p < 0.05$).

In the early period, bears were more likely to be in poor condition as $icetm_{t-1}$ increased (*icetm* = 70 d: $P_{poor\ early\ period} = 0.24$ and *icetm* = 104 d: $P_{poor\ early\ period} = 0.39$; $\chi^2 = 13.5$, $P < 0.001$). The opposite was true in the late period; the probability of being in poor condition decreased as $icetm_{t-1}$ increased (*icetm* = 70 d: $P_{poor\ late\ period} = 0.12$ and *icetm* = 104 d: $P_{poor\ late\ period} = 0.03$).

Reproduction

We observed 99 adult females with C0 litters during intensive capture-recapture studies conducted in 1998 - 2000 and 2015 - 2017 (Table 5). The general model for C0 litter size provided an adequate fit to the data (Hosmer and Lemeshow test: $X^2 = 6.91$, $df = 8$, $P = 0.55$). The candidate model set included eight models with $\Delta AIC_c < 4$, from which model-averaged parameter estimates were derived (Table 6). Low importance scores (i.e., sums of normalized AIC_c weights for models that included a variable) indicated a lack of support for variation in C0 litter size as a function of our proposed predictor variables (Table 6). The low-AIC_c model included one parameter (i.e., intercept only; β = 0.43, SE = 0.21, P = 0.04). Overall mean C0 litter size was 1.61 (95% CI = 1.51 - 1.70).

We observed 80 adult females with C1 litters during intensive capture-recapture studies conducted 1998 - 2000 and 2015 - 2017 (Table 5). The general model for C1 litter size provided an adequate fit to the data (Hosmer and Lemeshow test: X^2 = 5.96, df = 7, P = 0.54). The candidate model set included five models with $\Delta AIC_c < 4$, from which model-averaged parameter estimates were derived (Table 7). Low importance scores indicated a lack of support for variation in C1 litter size as a function of our proposed predictor variables (Table 7). The low-AIC_c model included one parameter (i.e., intercept only; β = 0.10, SE = 0.23, P = 0.65). Overall mean C1 litter size was 1.53 (95% CI = 1.41 - 1.64).

The other reproductive metrics for GB polar bears were similar, or slightly lower, in 2015 - 2017 compared to 1998 - 2000. Mean number of C0s per adult female was 0.51 (95% CI = 0.39 - 0.64) for the 1990s and 0.43 (95% CI = 0.32 - 0.44) for the 2010s, which corresponds to a probability of 0.85 that values were smaller in the 2010s. Mean number of C1s per adult female was 0.37 (95% CI = 0.27 - 0.48) for the 1990s and 0.36 (95% CI = 0.26 - 0.47) for the 2010s, which corresponds to a probability of 0.54 that values were smaller in the 2010s. Mean litter production rate was 0.76 (95% CI = 0.48 - 1.0) for the 1990s and 0.64 (95% CI = 0.41 - 0.98) for the 2010s, which corresponds to a probability of 0.71 that values were smaller in the 2010s. Note that the ratio estimator we used to calculate litter production rate was different from the estimator used by Taylor et al. (2009), which required assumptions about litter loss and population growth rate.

Demographic analyses

Survival - The capture-recapture data contained 987 live observations of individually identified polar bears and 139 dead recoveries of research-marked bears during the period 1976 - 2017 (Table 8). The candidate model set included 1280 live-recapture and dead-recovery models representing combinations of the parameter-specific submodels. Of these, 104 models had $\Delta QAIC_c < 4$, indicating relatively high model-selection uncertainty. To evaluate the explanatory power of the various factors, covariates, and interaction terms in each parameter-specific submodel, we calculated importance scores defined as the sum of $QAIC_c$ weights for all submodels containing a given term (Table 9). Importance scores for survival (*S*) suggested strong support for a sex effect and for a step change between the year blocks 1976 - 2004 and 2005 - 2017, relatively weak support for an age effect, and little or no support for interannual variation in survival in relation to our sea-ice metric. Importance scores for recovery probability (*r*) provided weak to moderate support for a sex effect and a step change between year blocks. Finally, importance scores for recapture probability (*p*) and site fidelity (*F*) provided little or no support for sex or temporal effects.

Our model-averaged parameter estimates were consistent with patterns that would be expected based on the importance scores for the various terms (Table 10). Point estimates of un-harvested survival (*S**) increased for females, and decreased for males, between the year blocks 1976 - 2004 and 2005 - 2017. Point estimates for *r* decreased slightly for females and increased slightly for males. Point estimates of *F* ranged between 0.93 - 0.99, suggesting relatively high fidelity to the GB management unit. Due to sampling uncertainty and potential process variation, no temporal changes in parameter estimates were statistically significant at an alpha level of 0.05.

Abundance - Mean model-averaged estimates of total subpopulation abundance, including numbers of C0s, were 1610 (SE = 266) for 1998 - 2000 and 1525 (SE = 294, 95% CI = 949 - 2101) for 2015 - 2017. Based on a randomization procedure, this corresponds to a probability of 0.57 that abundance of the GB subpopulation was approximately stable or increasing (subjectively defined as $N_{2015\text{-}2017} \geq 0.9\times N_{1998\text{-}2000}$), and a probability of 0.43 that abundance was declining (defined as $N_{2015\text{-}2017} < 0.9\times N_{1998\text{-}2000}$). Our estimate of mean abundance for 1998 - 2000 was very close to the estimate of 1592 (SE = 361) for the same period from Taylor et al. (2009).

Population Growth – The time-constant estimate of asymptotic intrinsic population growth rate (*gr*) for the period 2005 - 2017, calculated using estimates of total survival (*S*), was 0.06 (95% CI = -0.06 - 0.12). The estimate of un-harvested growth rate for the period 2005 - 2017 was *gr* = 0.07 (95% CI = -0.05 - 0.13). This suggests a strong potential for growth in the absence of harvest, although precision was low. For the period 1976 - 2004, estimates of harvested and un-harvested *gr* were 0.03 (95% CI = -0.07 - 0.09) and 0.05 (95% CI = -0.04 - 0.10), respectively. Although comparison is complicated by different model structures and datasets, these values are similar to the corresponding point estimates of *gr* = 0.02 and 0.06 for the period 1976 - 2000 reported in Taylor et al. (2009).

6. DISCUSSION

General

The GB study area experienced drastic sea ice changes over the past decades (Barber and Iacozza 2004, Stern and Laidre 2016, Environment and Climate Change Canada 2018). The quantity of multi-year sea ice has declined across the Canadian Archipelago (Mudryk et al. 2018, Perovich et al. 2018, Richter-Menge et al. 2018) and the fall freeze and spring thaw cycles in GB changed significantly, extending the period between sea-ice retreat and sea-ice advance by 16 days per decade (Stern and Laidre 2016). Moreover, the mean summer sea-ice concentration (June to October) has been decreasing by 9% per decade (Stern and Laidre 2016). As recently as the 1980’s, the GB region was characterized by 40 - 50% multi-year ice during the summer, but this amount has declined to less than 10% between 2011 and now (Environment and

Climate Change Canada 2018) and the shift is predicted to continue (Sou and Flato 2009, Hamilton et al. 2014). The observed changes from multi-year to annual sea ice result in declining sea ice thickness. Younger and thinner sea ice is more mobile and susceptible to mechanical wind forcing. Annual sea ice is also more vulnerable to complete melting in the summer which contributes to the observed decrease in summer sea ice extent. (Richter-Menge 2018, Perovich et al. 2018). This reduction in sea ice results in the absorption of more heat by the upper ocean (Richter-Menge 2018). While sea ice loss overall is considered detrimental to the persistence of polar bears, in the short term, it may have beneficial effects in some parts of the high Arctic since many of the observed sea ice changes have been associated with greater marine productivity (Derocher et al. 2004, Häder et al. 2014, Frey et al. 2018).

Abundance

Our estimate of mean abundance for the period 1998 - 2000 was 1610 (SE = 266), which is very similar to the estimate of 1592 (SE = 361) for the same period from Taylor et al. (2009). The new mean abundance estimate of 1525 (SE = 294) for the period 2015 - 2017 corresponds to a probability of approximately 0.57 that the GB subpopulation has remained approximately stable or increased despite observed sea-ice changes. We suggest that abundance estimates from 1998 - 2000 and 2015 - 2017 are likely an accurate portrayal of trends in abundance given the consistent methodology between the intensive capture-recapture efforts. Taylor et al. (2009) suggested that the subpopulation could sustain a quota increase from 40 to 74 bears per year which was instituted in 2004/2005. The 74-bear quota was rarely filled over the past 14 years with an average of 62 bears per year (22 females and 40 males) removed from the subpopulation. The sex ratio of removed bears was 64.3% male in keeping with the 2:1 sex selective harvest management system in place in Nunavut during that time (range: 56.7 - 72.1% male for the 2004/2005 – 2016/2017 harvest seasons; GN, unpublished data).

The mean point estimate of the proportion of females among independent polar bears (i.e., age ≥ 2 years) increased from 0.57 for the period 1998 - 2000 to 0.61 for the period 2015 - 2017. This appears consistent with the estimates of harvest recovery probability and the estimated differences in total, and un-harvested, survival between females and males. This finding may suggest that the selective harvest of polar bears at a 2:1 male-to-female ratio has resulted in a gradual depletion of adult males in the subpopulation, which is consistent with model-based predictions of declining male numbers under a sex-selective harvest (McLoughlin et al. 2005, Taylor et al. 2008, Regehr et al. 2015). We suggest that this effect could be mitigated by lowering the TAH while maintaining a sex-selective harvest. Alternatively, maintaining the current TAH, but switching to a 1:1 sex ratio for several years could also mitigate the gradual depletion of males but would increase the risks of overharvest given that adult female bears are the most important contributors to population growth (Eberhardt 2002, Hunter et al. 2010). We recommend that a more thorough harvest risk assessment be conducted to further investigate this and other issues related to the sustainability of current removal levels from the GB subpopulation (e.g., change in carrying capacity and environment over time; Regehr et al. 2017).

The GB study area has an estimated density of 8.9 bears per 1000 km^2 based on the current abundance estimate, which is the highest, currently known, density of polar bears within the subpopulation boundaries recognized by the IUCN Polar Bear Specialist Group (Durner et al. 2018). It is more than 5 times the median density of 14 subpopulations for which abundance estimates exist (Hamilton and Derocher 2018). It is also important to note that our estimates of abundance from the current study, as well as from the past study (Taylor et al. 2009), represent the “superpopulation”. A superpopulation is defined as all the animals with a chance (non-negligible probability) of occurring within the GB management boundary, regardless of where the animals were located at any given sampling occasion (e.g., Schwarz and Anarson 1996). Thus, estimates of superpopulation size in year *t* likely reflect some animals that were temporary emigrants in year *t*. We were not able to directly estimate temporary emigration from the sampling area (Cooch and White 2019) because our sample sizes were not sufficiently large to do so, and there are no recent radio-telemetry data to provide location and movement data. However, recoveries of previously marked bears in other subpopulations through the harvest sampling program indicate that movement into and out of GB is likely occurring (Fig. 7). Therefore, our estimates of abundance are likely larger than the actual number of animals within the GB subpopulation boundary at any given time. This should be taken into consideration when using these findings to inform management decisions. For example, if capture-recapture analyses are performed independently for multiple adjacent subpopulations that experience exchange of animals, the sum of the estimates of superpopulation size will be larger than the actual total number of bears in the subpopulations (i.e., there will be "double counting" of some bears). This could lead to cumulative TAH levels that result in removal of a larger proportion of polar bears each year than was intended based on the TAH levels for the individual subpopulations.

Population Growth

Our estimates of the population growth rate (*gr*) for the period 2005 - 2017 based on total survival (gr = 0.06) and un-harvested survival (gr = 0.07) for the 2010s are high for polar bears, suggesting strong capacity for growth. Our estimates of *gr* for the 1990s were similar to estimates from Taylor et al. (2009), although a direct comparison is complicated by statistical uncertainty and different modeling structures and datasets. Note that our estimates of *gr* for the 1990s had more statistical uncertainty than that of Taylor et al. (2009) because we accounted for covariance among demographic parameters, whereas it appears that Taylor et al. (2009) considered variation in the different demographic parameters to be independent.

The high estimates of *gr* from this study should be interpreted with caution because they are based on estimates of total survival. Therefore, they reflect the potential for biological population growth but not necessarily the trend in the numbers of polar bears that remain within the GB subpopulation boundary. Indeed, when the harvested population growth rate for the period 2005 - 2017 is recalculated using estimates of apparent survival (i.e., the probability of remaining alive and not permanently emigrating from the GB management unit) the point estimate is negative (*gr* = -0.024; i.e., suggesting that the number of bears within the GB subpopulation boundary may be decreasing). Direct interpretation is complicated by statistical uncertainty (e.g., the coefficient of variation for the estimate of *gr* based on total survival was 0.79). However, this may suggest that emigration from the GB region is one explanation for the apparently contradictory findings of (1) a lower point estimate of abundance for 2015 - 2017 compared to 1998 - 2000 and (2) high point estimates of *gr* for 2005 - 2017 that suggest the GB subpopulation was growing during this period. In other words, it is possible that high estimates of *gr* based on total survival do indeed reflect increasing numbers of bears (i.e., there are more births than deaths), but that a substantial proportion of these bears are permanently emigrating from the GB management area. As the ice becomes more dynamic in GB and the surrounding areas, bears may be more dynamic in their movements. Potentially high and variable levels of immigration and emigration across subpopulation boundaries can directly affect estimation and interpretation of population growth rate (Peňaloza et al. 2014). In some other subpopulation studies, radio-telemetry data have been critical to resolving these issues (e.g., Regehr et al. 2018). For regions where radio-telemetry is not available, we recommend that the best way to reconcile these interpretation challenges and provide accurate information to inform management is to perform a meta-analysis of the capture-recapture and harvest recovery data for all subpopulations within the region that are known to exhibit substantial levels of exchange (e.g., GB, MC, and LS).

Reproduction

Our estimates of reproductive indices (e.g., litter size, offspring per female) are on the higher end of the range of expected values for polar bears (Baffin Bay: SWG 2016, Foxe Basin: Stapleton et al. 2016, Western Hudson Bay: Dyck et al. 2017, Southern Hudson Bay: Obbard et al. 2018, Chukchi Sea: Regehr et al. 2018), suggesting that the GB subpopulation is currently capable of healthy reproduction. During our genetic biopsy sampling we were not able to collect data on the numeric age of most bears (i.e., through counting cementum annuli in teeth; Calvert and Ramsay 1998), hence we cannot comment on age of first litter for females or inter-birth intervals. However, our estimated number of C1 per adult female of 0.36 in 2015 - 2017 appears to be sufficient to maintain a viable subpopulation, provided that survival is within the normal range for healthy subpopulations (Regehr et al. 2015). The number of C1 per adult female (0.36 in this study) is considered a key reproductive parameter (Vongraven et al. 2012, Regehr et al. 2015) because it integrates cub production and cub survival. This is especially important when C0s cannot be sampled or handled, as in this study (see Method section above). Our estimates for 1998 - 2000 and 2015 - 2017 suggest that no significant change in recruitment occurred over time. Declines in reproductive performance in association with sea ice deterioration have been documented for some polar bear subpopulations (Derocher and Stirling 1995, Derocher 2005, Rode et al. 2010, Peacock et al. 2013, Rode et al. 2014). As spring sea ice break-up occurs earlier (which is also associated with later fall freeze-up; Stern and Laidre 2016, Regehr et al. 2016) feeding opportunities for polar bears presumably decrease, leading to poorer maternal body condition and reduced investment in reproduction. Despite changes in sea ice conditions over the past decades we did not detect any significant changes in reproductive output for GB polar bears, although if climate change continues as predicted (IPCC 2014) there will likely be a threshold beyond which reproduction declines (Laidre et al. 2020).

Survival

Opposite to what Taylor et al. (2009) found in their study, our estimated survival rates (total and un-harvested) demonstrated lower survival rates for males than females (Table 10). Estimates of total (i.e., including harvest mortality) survival for adult females of 0.95 for the period 2005 - 2017 were high relative to other subpopulations for which survival estimates are available (Regehr et al. 2018, their Table S3). However, direct comparison is complicated because most other estimates are of apparent survival which includes permanent emigration. Similar to our findings for the GB subpopulation, a recent study documented male survival rates to be reduced for the Baffin Bay subpopulation (SWG 2016). We are unaware of why un-harvested male survival may be declining for GB bears and we recommend this as an important area for research and monitoring. There also was moderate support for a time-period effect on survival, with total survival increasing for females and decreasing for males. This should be interpreted with caution because confidence intervals had substantial overlap. There was relatively low support for an age class effect in survival, with point estimates of survival lower for subadults than for adults, although again the CIs overlapped. No support for variation in survival as a function of the sea-ice covariates we explored was detected.

Estimates of un-harvested survival for adult females for the period 2005 - 2017 (0.97) were also high. When considered along with the reproductive indices, these findings suggest that the GB subpopulation remains capable of strong growth. As a note, estimates of total survival (*S*) reflect the probability of remaining alive. Estimates of *S* directly from the Burnham models are not estimates of apparent survival (i.e., the probability of remaining alive and not permanently emigrating) because the Burnham model directly estimates the fidelity parameter *F*. Unlike Taylor et al. (2009), we did not fix the fidelity parameter (*F*) to 1 (i.e., no assumed permanent emigration) based on the evidence of some movement from GB garnered from harvest recoveries. These factors suggest that there is some permanent emigration, which should be estimated to reduce potential bias in estimates of survival and abundance. Estimates of the parameter *F* ranged between 0.93 and 0.99 depending on sex and time period, with very large confidence intervals. Collecting movement data through radiotelemetry would provide better understanding of the movement into and out of the GB boundaries allowing more precise estimation of survival and abundance.

Body condition

Bears in GB were in better body condition in the most recent survey from 2015 - 2017 compared to the previous survey in 1998 - 2000. This is in direct contrast to some other subpopulation studies that have found decreasing body condition of bears in recent years (Rode et al. 2012, Stirling and Derocher 2012, SWG 2016, Laidre et al. 2020). However, polar bear subpopulation ecosystems vary widely. Within GB, multi-year sea ice predominated until recently (e.g., mid-1990s) when a shift to thinner, annual ice has occurred (Schweinsburg et al. 1981, Barber and Iacozza 2004, Howell et al. 2008, 2009, Sou and Flato 2009, Environment and Climate Change Canada 2018). This shift to annual ice may facilitate a short-term boost in hunting opportunities for bears as the ice is thinner and more prone to leads and cracks allowing access to bears' preferred prey, ringed seals (*Pusa hispida*). Indeed, we saw that in the recent time period, as the duration of low-ice days increased, bears were more likely to be in better condition. This is counterintuitive when thinking about polar bears' reliance on sea ice as a hunting platform. However, the GB ecosystem does not currently experience 100% ice-free periods and the low-ice days represented concentrations that were 63% or lower (see Methods: Sea-ice metrics) which are still within the range of preferred polar bear ice concentrations (Durner et al. 2009). It is worth noting that during the period 2009 - 2014 (Stern and Laidre 2016), the sea-ice area dipped to ~10%. Polar bears come onshore at concentrations of around 10-15% ice (Cherry et al. 2013) and thus, if sea ice coverage declines further, we may see a similar negative relationship of body condition and low sea ice concentration or extent as has been reported for other subpopulations (Regehr et al. 2007, Rode et al. 2012, SWG 2016, Laidre et al. 2020).

More favorable ice conditions relative to seal hunting, coupled with the seal pupping period that occurs roughly around mid-April, may account for our finding that body condition improved for bears sampled later in the field season (Stirling and Archibald 1977, Pilfold et al. 2014, Reimer et al. 2019). Females with offspring were much more likely to be in poor body condition compared to the other reproductive groups. When they were sampled earlier in the year, their probability of being in poor condition was highest which is unsurprising given the increased nutritional stress this reproductive class faces due to lactation and parturition. As time progressed, the likelihood of being in poor condition declined and they were more likely to be rated as ‘average’ suggesting that access to prey during the prime feeding period in the spring was beneficial for accumulating nutritional stores.

Similar to previous studies (SWG 2016, Laidre et al. 2020, GN unpublished data report MC 2020), the differences in body condition we observed are not likely related to the sampling method. Raw BCS scores were binned into 3 general categories to account for any potential small biases in observer classifications. Furthermore, in other similar studies in which comparisons in BCS were made for an earlier time period that used physical capture to determine BCS and a later time period in which aerial classifications were done, there were no trends of either method for BCS, suggesting that there is not an inherent bias in either method for BCS classification (e.g. Kane Basin: no change in BCS over time, Baffin Bay: decrease in BCS over time, M’Clintock: increase in BCS over time; SWG 2016, Laidre et al. 2020, GN unpublished data). In this study, the observer with the most sampling observations participated in both the early sampling period and recent one. The other observers were experienced and had participated both in physical capture studies and in aerial observation studies. The general application of our body condition index during physical handling has been shown to be a reliable indicator (Stirling et al. 2008). Moreover, there is the potential to assess the lipid content of the extracted adipose tissue from the biopsy darts (Pagano et al. 2014, McKinney et al. 2014) which could be used to verify the aerial condition assessments.

7. MANAGEMENT IMPLICATIONS

The need for continued monitoring

Climate change has affected the sea ice in every polar bear management unit (subpopulation) (Stern and Laidre 2016; Regehr et al. 2016), including GB. Over time, ice concentrations and thickness have declined, and the break-up and freeze-up dates have advanced and delayed, respectively (Stern and Laidre 2016). These changes in sea ice dynamics can elicit behavioural, nutritional, and demographic changes in bears. For example, studies in Baffin Bay documented that bears have reduced their home range size and are spending more time on shore during the ice-free period with reduced denning periods (SWG 2016). In other subpopulations, the effects of climate change on polar bears have been exhibited through reduced body condition, survival rates, and litter sizes (Regehr et al. 2007, Stapleton et al. 2014, Lunn et al. 2016, Dyck et al. 2017, Obbard et al. 2016, 2018). These sea ice changes and their impact on bears have only become apparent because of concerted monitoring efforts of both sea ice and bear movements over long periods of time.

Body condition, reproduction, and survival may reflect changes on a finer temporal scale than abundance and can help understand the mechanisms through which environmental change affects polar bears. The GB subpopulation currently has several knowledge gaps that present challenges for informed decision making. It is currently unknown how bears in GB spend their time during the sea-ice minimum (e.g., July to October) due to the lack of movement data. Also, the delineation of this subpopulation is inferred based on movement of collared female bears during the 1990s (Bethke et al. 1996, Taylor et al. 2001), prior to the large-scale changes in sea-ice habitat. Recoveries of previously captured, and subsequently harvested, bears indicate that there is emigration into LS, MC, and FB (Fig. 7), although whether this is permanent or temporary is difficult to determine without movement data. Note also that our abundance estimate is for the superpopulation (see Discussion section) which likely reflects more animals than occur within the GB management boundary.

In respecting Inuit societal values and concerns over physically handling wildlife, the GN, Department of Environment, did not carry out any collaring to collect radio-telemetry data in GB, despite efforts to garner support for a collaring program and the associated valuable data. The GN, together with other co-management partners, will have to decide on how monitoring polar bears in this subpopulation will continue in order to provide adequate information to decision-makers.

Harvest management and considerations

The GB polar bear subpopulation experienced a mean annual harvest of approximately 62 bears between the harvest years 2004/2005 and 2016/2017 (roughly 40 males and 22 females; GN, unpublished data) with a TAH of 74 bears per year. Our current abundance estimate for the superpopulation, together with other demographic data, suggest that the subpopulation has likely remained stable or only declined slightly given the removal rates and observed climatic sea ice changes. We suggest that taken together this study provides evidence that the GB subpopulation is currently healthy and productive. We documented a potential decline in the male proportion of the subpopulation, which may reflect the harvest system in place (i.e., 2 males for every female). However, similar to the Baffin Bay subpopulation (SWG 2016), we also found evidence for a decline in un-harvested survival for males, which we cannot currently explain. Future research and monitoring should seek to understand the causes and potential ramifications of male survival rates.

Here we provide several considerations to aid in harvest management decisions:

- Conduct a meta-population analysis that includes all possible subpopulations where some exchange of bears occurs (e.g., with LS and MC). This is important because the current abundance estimate for the GB subpopulation of 1525 bears (SE = 294) likely includes bears that also spend time in other management units. Assessing each subpopulation individually could lead to overestimating the total number of bears available and increases the risk of overharvest.

- Determine harvest management objectives (e.g., to maintain, reduce, or increase the subpopulation), taking into account possible changes in environmental carrying capacity in the future and the observed reduction in male proportion and survival rates. Perform a quantitative harvest risk assessment so that scientific information is available to help inform and justify management decisions.

Research recommendations for GB

These recommendations reflect both newly gained insight from the experience of conducting and analyzing the GB data as well as continued awareness of the importance of certain research methods.

1. Seek support from co-management partners to implement a radio-telemetry study to collect movement data in GB to obtain emigration estimates, resolve boundary issues, collect missing demographic data, improve precision and accuracy of demographic estimates, and evaluate changes in habitat use and denning in light of the sea ice changes. Before starting such a study, it would be possible to identify the sample size and duration required to address information needs so that no more bears are physically captured than necessary;

2. a) Sample bears (i.e., introduce more marks into the GB subpopulation) 5 - 7 years post-completion of field portion of last study (e.g., in 2023 or 2024) until the next comprehensive population study will be conducted (~10 – 15 yrs post-completion of last inventory; 2027 - 2032) to increase the number of marked individuals, recaptures and recapture probability of marked individuals. These factors will assist in determining more realistic survival rates when the next comprehensive study is undertaken (note that a power analysis will likely aid in determining whether additional marks really provide more data, and if this endeavor is cost-effective);

   b) Monitor reproductive metrics at the time of mark introduction to assess reproductive performance of GB, and if there are significant changes in reproduction consider whether the timing of the next comprehensive subpopulation assessment should be changed;

3. Or, increase population study length to 4 - 5 years to ensure that it covers a full reproductive cycle and reduces potential biases and assumptions that are required during the modeling process;

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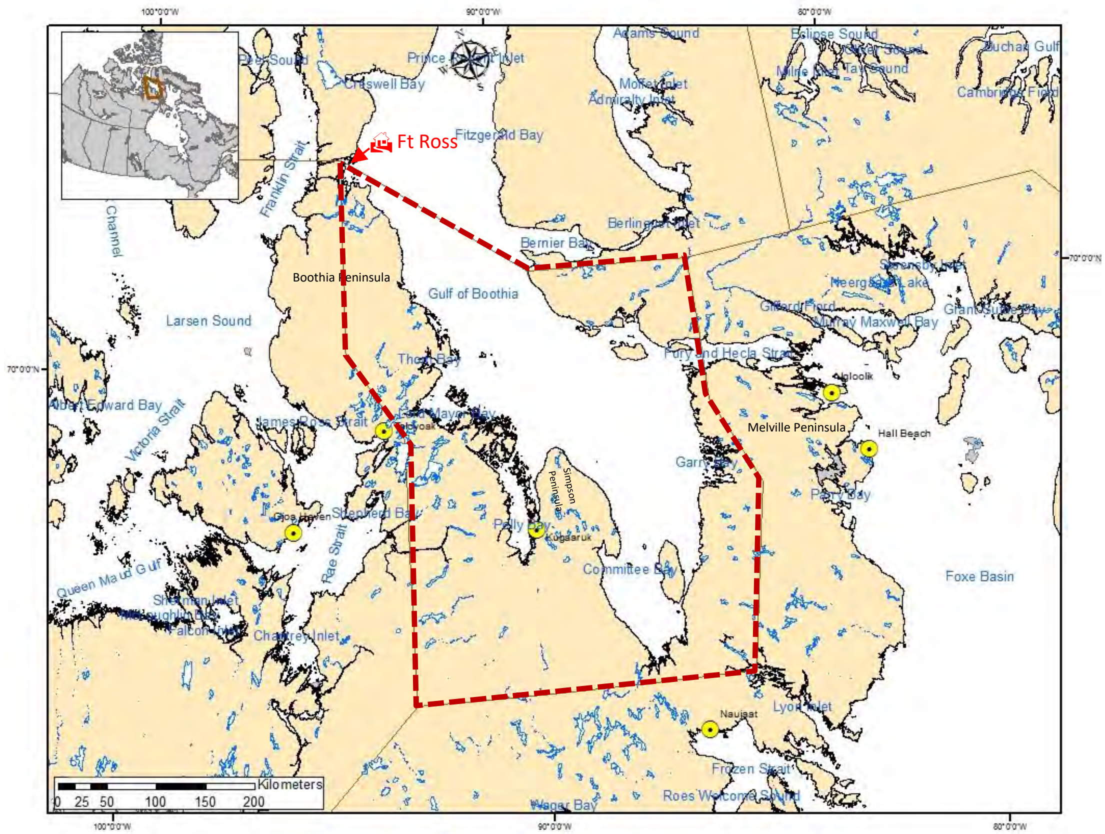
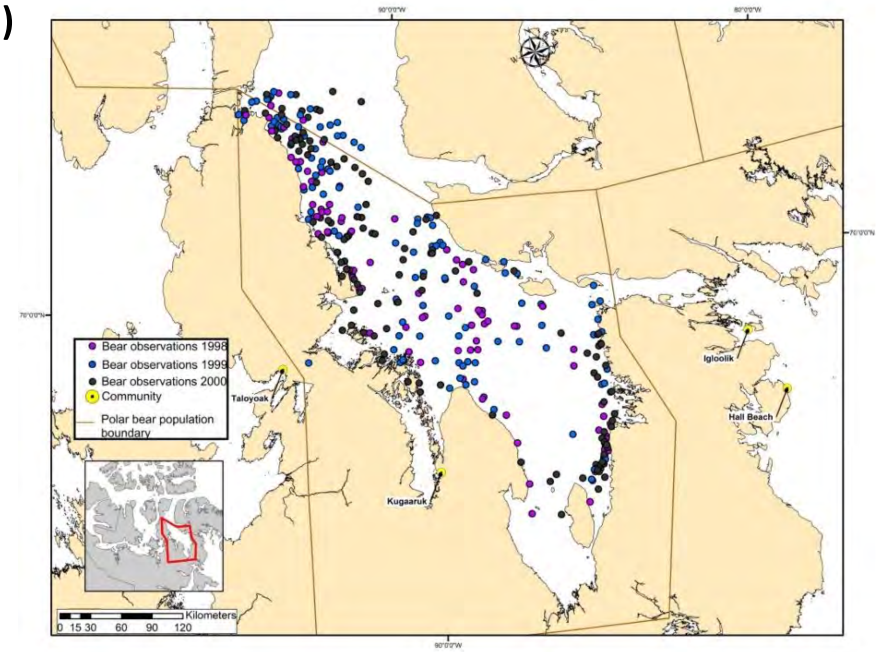


Figure 1. *Basic overview and location of the Gulf of Boothia polar bear subpopulation delineated by red dashed line.*

a)



b)

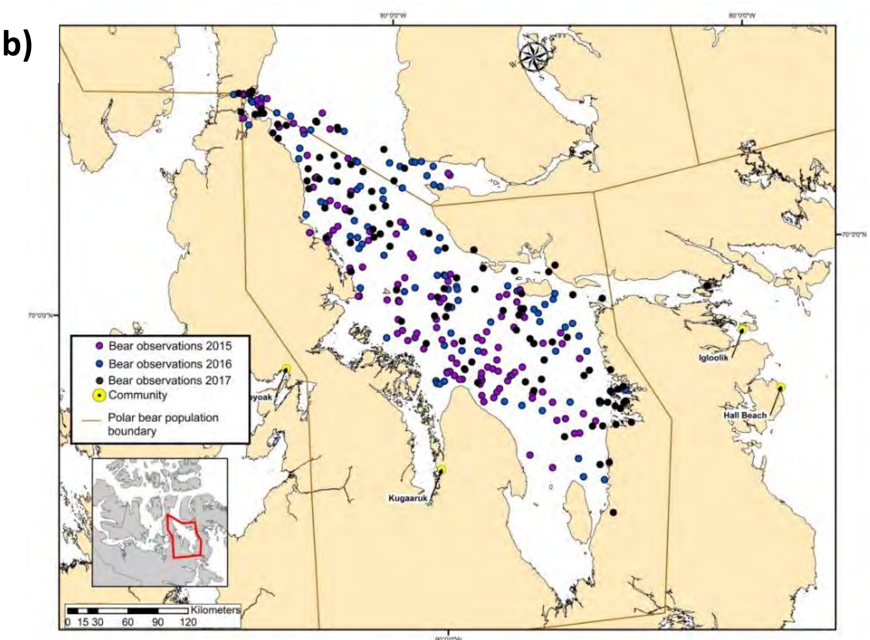


Figure 2. Locations of observed polar bears within the Gulf of Boothia study area during the 1998 - 2000 (a) and 2015 - 2017 (b) studies. Different colored dots indicate different years. Inset shows subpopulation boundary in red.

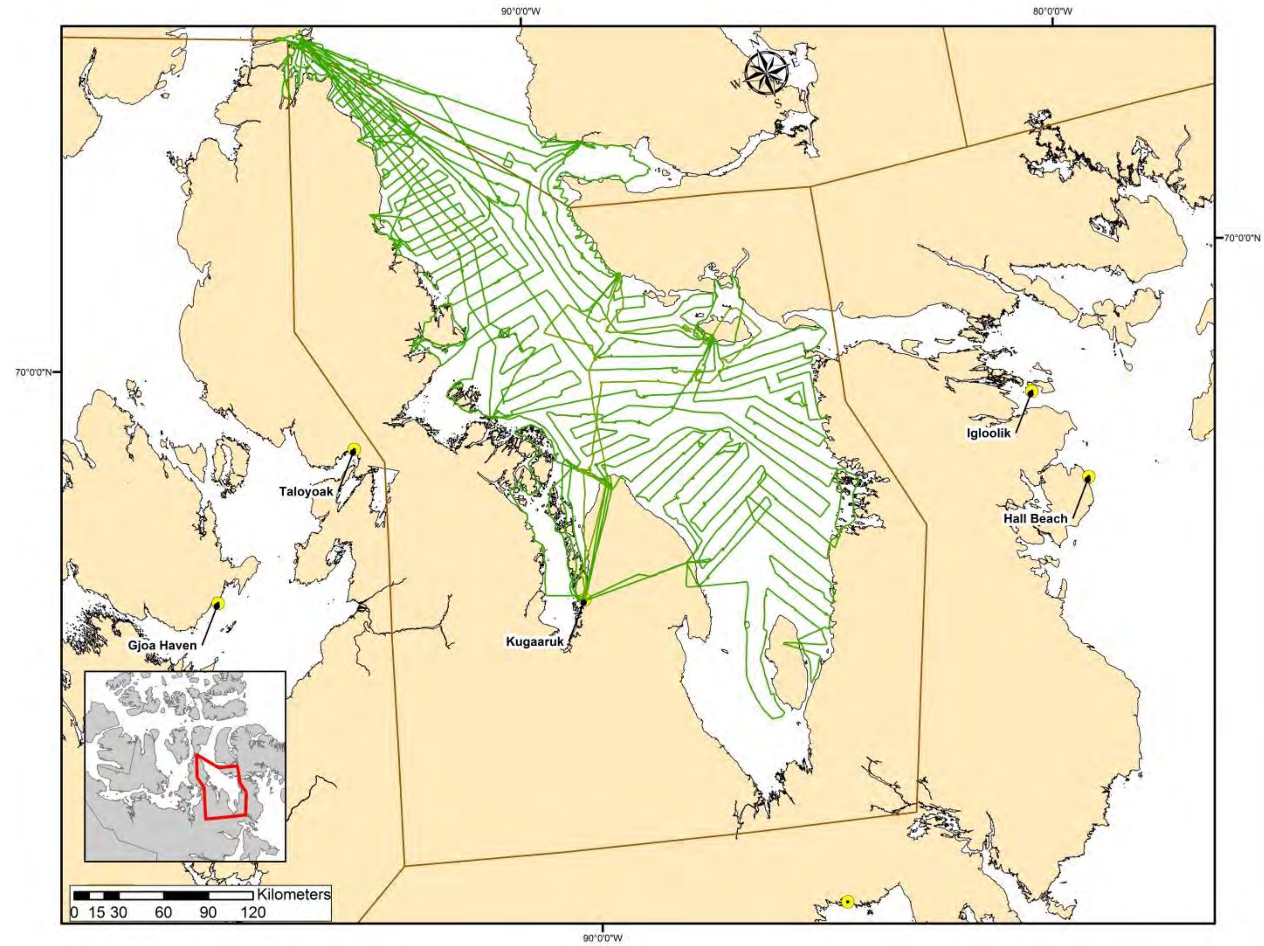


Figure 3. Flight tracks (green lines) of helicopter flown in search for polar bears in Gulf of Boothia, Nunavut, Canada, during April/May 2017. Inset shows subpopulation boundary in red.

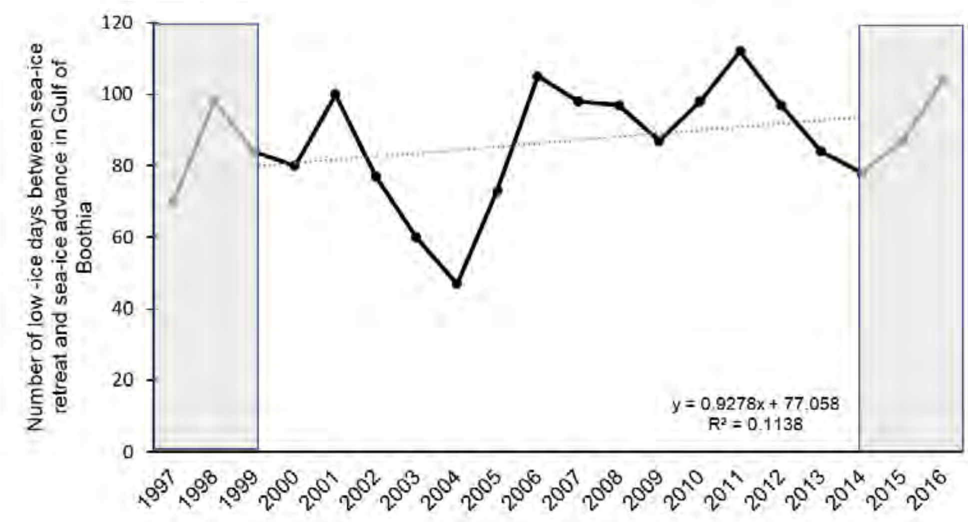


Figure 4. Sea-ice metric of 'low-ice days' calculated as the number of days between the sea ice retreat and sea ice advance in calendar year t *using the transition dates when ice concentration dropped below, and exceeded, respectively, the midway point of sea ice concentration between the March and September mean (Environment and Climate Change Canada 2018). Shaded boxes indicate sampling periods used in this study and intervening years are shown for context. Gray dotted line indicates the linear trend of low-ice days from 1997-2016.*

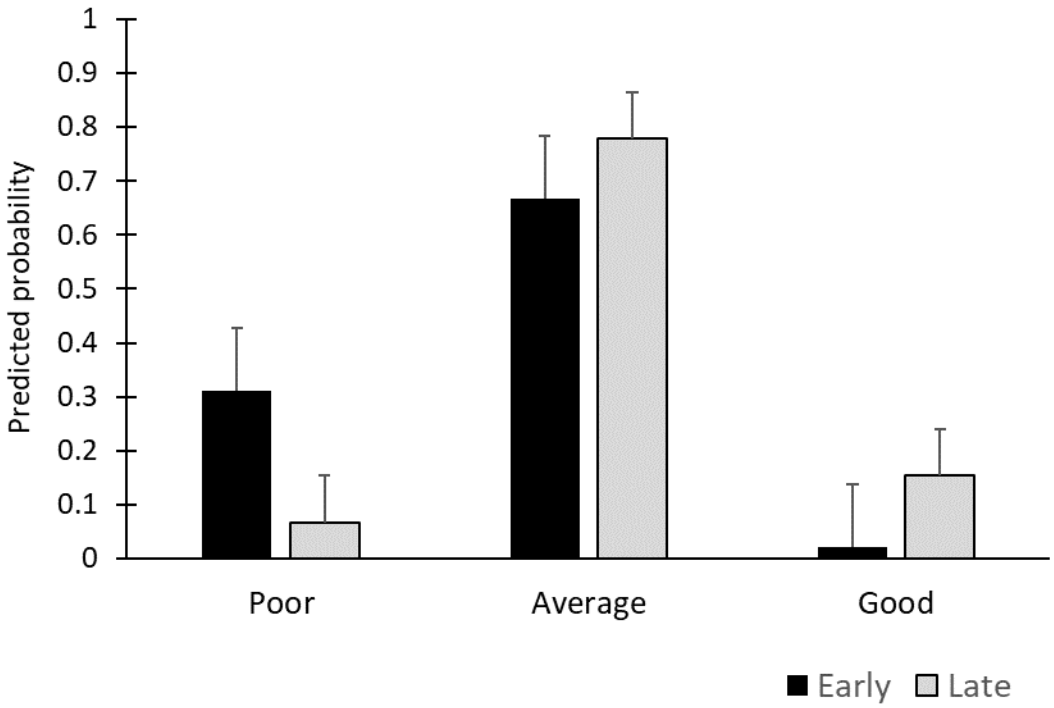


Figure 5. *Predicted probability based on best-fit model parameter estimates of a bear being classified as poor, average, or good body condition for each time period (Early = 1998 - 2000; Late = 2015 - 2017).*

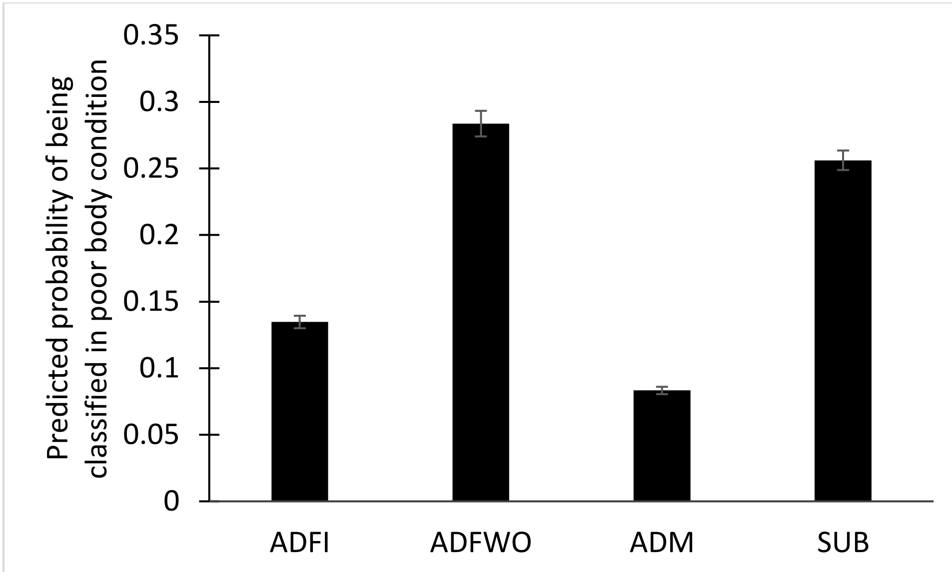


Figure 6. *Predicted probability based on best-fit model parameter estimates of a bear being classified in poor body condition for each reproductive age class across both time periods. Adult females with offspring and subadults were more likely than other reproductive age classes to be classified in poor body condition at the time of sampling (ADFI = independent adult female, ADFWO = adult female with offspring, ADM = adult male, SUB = subadults of both genders).*

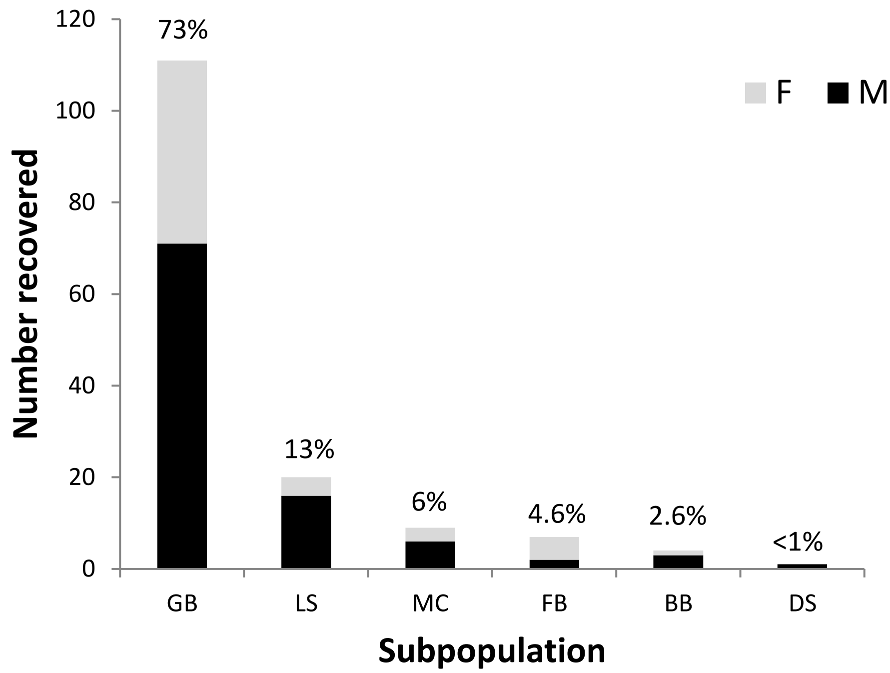


Figure 7. *Number of polar bear tags that were initially deployed within the Gulf of Boothia subpopulation boundary and subsequently recovered through the harvest between 1972 and 2017. Percentages indicate the proportion of total recoveries that occurred in a given subpopulation (GB=Gulf of Boothia; LS = Lancaster Sound; MC=M'Clintock Channel; FB=Foxe Basin; BB=Baffin Bay; DS=Davis Strait).*

Table 1. Parameter estimates for best-fit ordinal logistic regression model (reference level = “poor”/BCS = 1) for body condition score analysis of the Gulf of Boothia subpopulation.

Parameter	Estimate	SE	*p*
periodlate	3.77	1.61	0.02
reproclassADFWO	-5.70	3.12	0.07
reproclassADM	3.74	3.03	0.22
reproclassSUB	2.07	3.22	0.52
jul_cap_day	0.03	0.02	0.14
periodearly:icetm	0.04	0.01	0.001
periodlate:icetm	-0.02	0.01	0.08
reproclassADFWO:jul_cap_day	0.04	0.03	0.14
reproclassADM:jul_cap_day	-0.03	0.02	0.29
reproclassSUM:jul_cap_day	-0.02	0.03	0.35

Table 2. Parameter-specific submodels used to analyze live-recapture dead-recovery data for the Gulf of Boothia polar bear subpopulation.

Submodel name	Submodel structure
S1	.
S2	year
S3	icetm1
S4	sex
S5	sub
S6	year + sex
S7	year + sex + year:sex
S8	year + sub
S9	year + sub + year:sub
S10	icetm1 + sub
S11	icetm1 + sub + icetm1:sub
S12	sex + sub
S13	year + sex + sub
S14	year + sex + sub + year:sex + year:sub
S15	icetm1 + sex + sub
S16	icetm1 + sex + sub + icetm1:sex + icetm1:sub
r1	.
r2	year
r3	sex
r4	year + sex
r5	year + sex + year:sex
p1	.
p2	year
p3	sex
p4	year + sex
F1	.
F2	year
F3	sex
F4	year + sex

(*S* = survival; *r* = dead reporting probability; *p* = recapture probability; *F* = fidelity)

Table 3. Overview of descriptive field statistics of the Gulf of Boothia polar bear study 2015 - 2017.

Field Year	Search time (hr)	Number of bears/hr	Bears encountered[a]	Flown distance (km)	Duration
2015	96.0	1.90	185	11,737	29 April - 26 May
2016	99.3	1.62	161	12,867	20 April - 14 May
2017	115.0	1.40	162	12,200	26 April - 15 May

[a] The number of bears encountered does not represent the genetically corrected number of bears (e.g., some bears have been re-sampled within same sampling period)

Table 4. Body condition scores (BCS) for polar bears in the Gulf of Boothia subpopulation 1998 - 2000 and 2015 - 2017. Poor BCS corresponds to a thin bear and Good BCS corresponds to a fat/obese bear. Age classes are adult (≥ 5 years) and subadult (2 - 4 years).

	Body condition scores					
	1998 - 2000			2015 - 2017		
	Poor	Average	Good	Poor	Average	Good
Adult female without offspring	17	28	3	2	60	19
Adult female with offspring	30	40	2	5	86	4
Adult male	19	104	4	1	64	28
Subadult	25	34	2	4	43	2
Total	91	206	11	12	253	53

Table 5. Numbers and mean sizes of cub-of-the-year (C0) and yearling (C1) litters observed during capture-recapture studies on the Gulf of Boothia polar bear subpopulation.

	1998	1999	2000	2015	2016	2017
Number of C0 litters	20	13	20	12	22	12
Mean C0 litter size	1.60	1.54	1.70	1.75	1.50	1.58
Number of C1 litters	13	17	10	18	9	13
Mean C1 litter size	1.31	1.53	1.80	1.56	1.44	1.62

Table 6. Model-averaged parameter estimates for a binomial logistic regression on cub-of-the-year (C0) litter size for the Gulf of Boothia polar bear subpopulation.

Parameter	Estimate	SE	P	Importance
(Intercept)	0.78	1.12	0.49	NA
icefree.tm1	0.00	0.01	0.75	0.31
periodearly	0.02	0.19	0.90	0.18
month05	-0.01	0.18	0.98	0.17
BCS (level 1)	-0.07	0.27	0.79	0.15
BCS (level 3)	0.11	0.43	0.80	0.15

Table 7. Model-averaged parameter estimates for a binomial logistic regression on yearling (C1) litter size for the Gulf of Boothia polar bear subpopulation.

Parameter	Estimate	SE	P	Importance
(Intercept)	-0.74	1.53	0.63	NA
icefree.tm1	0.01	0.02	0.57	0.41
periodearly	-0.05	0.24	0.86	0.26
BCS (level 1)	0.02	0.13	0.91	0.06
BCS (level 3)	0.00	0.25	1.00	0.06

Table 8. Numbers of live-observations and dead-recoveries (in parentheses) of individually identified polar bears in the Gulf of Boothia subpopulation used in survival estimation.

Years	AFNC[a]	AFC0[b]	AFC1[c]	AM[d]	C1[e]	SF[f]	SM[g]
1976 - 1997	21 (18)	17 (0)	10 (0)	49 (23)	15 (0)	13 (4)	21 (0)
1998 - 2000	75 (3)	53 (0)	40 (0)	128 (6)	68 (0)	49 (3)	44 (5)
2001 - 2017	88 (5)	46 (0)	40 (0)	94 (19)	61 (0)	21 (1)	34 (5)

([a]AFNC = adult female no cubs; [b]AFC0 = adult females with cubs-of-the-year; [c]AFC1 = adult females with yearlings; [d]AM = adult male; [e]C1 = yearlings; [f]SF = subadult females; [g]SM = subadult males)

Table 9. Importance scores for the various factors and covariates within the parameter-specific survival submodels. Importance scores for interaction terms (e.g., year:sex) should be interpreted with caution because interactions can only appear in models with the corresponding main effects.

Factor or covariate	S	r	p	F
sex	0.82	0.33	0	0
year	0.71	0.35	0.06	0.16
year:sex	0.67	0.33	NA	NA
sub	0.23	NA	NA	NA
year:sub	0.23	NA	NA	NA
icetm1	0.05	NA	NA	NA
icetm1:sex	0	NA	NA	NA
icetm1:sub	0	NA	NA	NA

Table 10. Model-averaged parameter estimates for the Burnham model for survival and abundance.

Parameter	Class	Year block	Estimate	lci	uci
*S**	Adult female	1976-2004	0.94	0.90	0.98
*S**	Adult male	1976-2004	0.93	0.90	0.95
*S**	Subadult female	1976-2004	0.93	0.86	0.99
*S**	Subadult male	1976-2004	0.91	0.85	0.96
*S**	Adult female	2005-2017	0.97	0.91	1.00
*S**	Adult male	2005-2017	0.90	0.83	0.96
*S**	Subadult female	2005-2017	0.95	0.86	1.00
*S**	Subadult male	2005-2017	0.87	0.75	0.99
S	Adult female	1976-2004	0.92	0.86	0.96
S	Adult male	1976-2004	0.89	0.85	0.93
S	Subadult female	1976-2004	0.90	0.80	0.95
S	Subadult male	1976-2004	0.87	0.77	0.92
S	Adult female	2005-2017	0.95	0.81	0.99
S	Adult male	2005-2017	0.85	0.74	0.92
S	Subadult female	2005-2017	0.94	0.69	0.99
S	Subadult male	2005-2017	0.81	0.59	0.92
r	All female	1976-2004	0.26	0.17	0.38
r	All male	1976-2004	0.29	0.22	0.37
r	All female	2005-2017	0.22	0.08	0.46
r	All male	2005-2017	0.33	0.21	0.47
p	All female	1976-2004	0.11	0.08	0.15
p	All male	1976-2004	0.12	0.08	0.16
p	All female	2005-2017	0.10	0.07	0.14
p	All male	2005-2017	0.10	0.07	0.15
F	All female	1976-2004	0.95	0.71	0.99
F	All male	1976-2004	0.99	0.38	1.00
F	All female	2005-2017	0.93	0.79	0.98
F	All male	2005-2017	0.95	0.59	1.00

(S* = unharvested survival; S = total survival; r = dead reporting probability; p = recapture probability; F = fidelity)

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Ministère du Développement économique et des Transports

Information Item for the Nunavut Wildlife Management Board

Iqaluit, Nunavut

February 8, 2021

On April 1, 2021, the Fisheries and Sealing Division moved from the Department of Environment to the Department of Economic Development and Transportation by Cabinet decision. This transition started with the addition of Zoya Martin as the Director for Fisheries and Sealing for an interim period of 3 years on November 4, 2019. Following this the Division has moved over, hired new staff, reviewed its mandate and operations on how to best integrate with Economic Development and Transportation. We wish to provide the Nunavut Wildlife Management Board with an update on our Division's priorities and goals for the next few years as well as an introduction of our staff.

As Fisheries and Sealing is the Government of Nunavut's lead on fisheries and sealing files, we share many files with your organization. We look forward to working closely and collaborative with your staff to advance Nunavut's and Nunavummiut's interests in both fisheries and sealing.

We thank you for taking the time to listen and we look forward to our continued working together!

Kindly,

Zoya Martin

Fisheries and Sealing, Director
Economic Development and Transportation
Government of Nunavut

FISHERIES AND SEALING DIVISION,

ECONOMIC DEVELOPMENT AND TRANSPORTATION (EDT)

BY ZOYA MARTIN, DIRECTOR

FISHERIES AND SEALING FOCUS WITHIN ETD

- Fisheries and Sealing moved from Department of Environment (DOE) to EDT on April 1, 2020, by Cabinet decision.
- Mandate under EDT:

  "*supports subsistence and commercial fisheries and the sealing sector in Nunavut, ensuring sustainable harvests and maximum benefits to Nunavummiut in close collaboration with Inuit, co-management partners and other stakeholders.*"

- Departmental focus:

  1) sustainable economic development, 2) employment for Nunavummiut and 3) training for Nunavummiut

- Offices – Iqaluit (4 positions), Pangnirtung (3 positions), Rankin Inlet (1 position), and Kugluktuk (1 position).
  - Working to staff all positions with indeterminate employees who are invested in supporting and improving Nunavut's fisheries and sealing sectors.

FISHERIES AND SEALING FOCUS WITHIN ETD

Divisional Objectives:

- Encourage and support viable, sustainable fisheries, marine and sealing sectors in cooperation with stakeholders in all regions of Nunavut.
- Promote a clear understanding of all three sectors through education and awareness.
- Support inshore and offshore fishery development that is sustainable and ethical.
- Support research that contributes to sustainability and is done in a respectful and collaborative manner with Nunavut communities.
- Represent Nunavut's sealing and fishery interests locally, regionally, nationally and internationally.

DETAILING OF OBJECTIVES

Encourage and support viable, sustainable fisheries, marine and sealing sectors in cooperation with stakeholders in all regions of Nunavut.

- Provide internal funding for the diversification, development and marketing of Nunavut's sectors

  (Fisheries Development and Diversification Program (FDDP), Fish Freight Subsidy Program (FFS))

- Work at the community level to support local fisheries – making connections, education, training, advocacy
- Represent and advocate for Nunavut fisheries and sealing nationally and internationally – FTPs, EU, GoC
- Lead working groups that bring stakeholders togethers to make sure there is clear communication and opportunity for collaboration.

DETAILING OF OBJECTIVES

Promote a clear understanding of all three sectors through education and awareness

- Education and awareness to Nunavummiut on their resources, their reasonability and their sustainable economic potential.
- Education and awareness to national and international organization on Nunavut's resources and Nunavut's economic activities.
- Consulting and listening to Nunavummiut and other stakeholders to make sure we understand the issues, concerns and successes.

DETAILING OF OBJECTIVES

Support inshore and offshore fishery development that is sustainable and ethical.

- Funding to support the development through GN Grants and Contributions

  (Fisheries Development and Diversification Program (FDDP), Fish Freight Subsidy Program (FFS))

- Partner with stakeholders and apply for external funding where applicable
- Represent Nunavut on federal files where policy is being created/reviewed that may impact fisheries development
- Advocating for Nunavummiut's fair allocation of adjacent water quota
- Look for training opportunities for Nunavummiut and look at option to expand and grow training
- Work closely with industry and other stake holders to collaborate on sustainable development

DETAILING OF OBJECTIVES

Support research that contributes to sustainability and is done in a respectful and collaborative manner with Nunavut communities.

- Providing internal Grants and Contribution funding for research (FDDP, SFG, SG, FFS)
- Collaborate on funding applications with researchers and others
- Operate and offer space on the Nuliajuk (at cost) for research purposes
- Look for training opportunities for Nunavummiut with respect to research

DETAILING OF OBJECTIVES

Represent Nunavut's sealing and fishery interests locally, regionally, nationally and internationally.

- Nunavut's 'Recognized Body' for European Union Inuit/Indigenous exception
- Representative on Seals and Sealing Network
- Grants and Contributions for projects, Dressed Sealskins for Nunavummiut
  - (Seal and Fur Grant and Contribution (SFG), Seal Grant (SG))
- Collaborate with Inuit orgs, organizations and other groups to fill gaps for Nunavummiut with respect to sealing economy
  - Support skill redevelopment, cultural re-establishment
  - Consultation with Nunavummiut – what do people want to have for a sealing economy and where can GN support?

PRIORITIES FOR THE NEXT TWO YEARS

- Complete transition of Division to EDT
  - Finalize financial transition
  - Review policies and update to align with EDT
  - Staffing of vacant positions, training, networking and introduction of new staff
- Start consultations on Sealing Economy in Nunavut and Fisheries Strategy
- Advocate and work to increase Nunavut's adjacent water allocation
- Undertake economic analysis for Nunavut's fisheries and sealing economies
- Review of all training in Nunavut economies – look for gaps and potential improvements
- Contributed to Marine Protected Areas GN review

OVERVIEW

- Fisheries and Sealing has a vision within EDT and the Government of Nunavut to be an advocate and representative for Nunavummiut on all files related to fisheries and sealing industry (both subsistence and commercial), while fostering an open communication and collaboration within the Government of Nunavut, between Inuit organizations, other governments and other organizations for the benefit of Nunavut's fishing and sealing industries.

We feel our divisional mandate, vision and responsibilities link well to Economic Development and Transportation and we are encouraged to see where we can work together to strengthen and support the work done in EDT and the GN for Nunavummiut.

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QUJANNAMIIK

(ADDENDUM) SUBMISSION TO THE

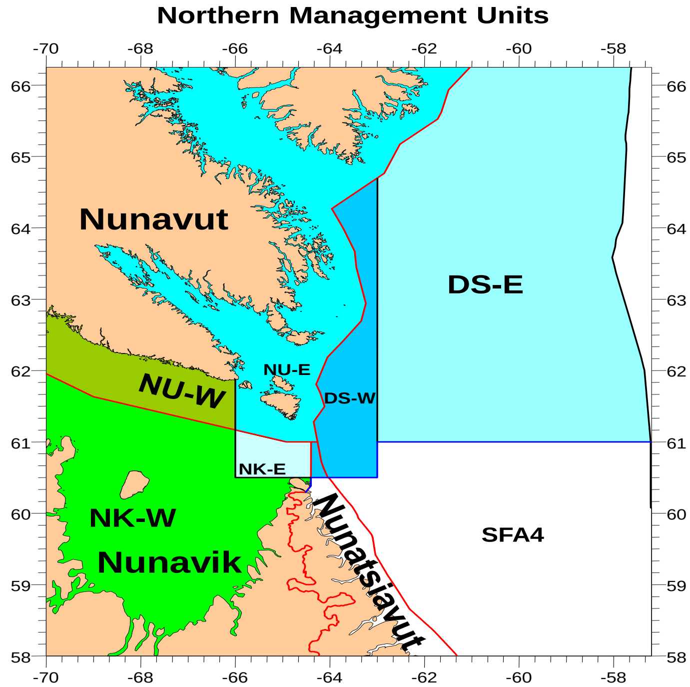
NUNAVUT WILDLIFE MANAGEMENT BOARD AND
NUNAVIK MARINE REGION WILDLIFE BOARD

FOR

Information: **Decision: X** **Recommendation: X**

Issue: Total Allowable Catch levels for Northern (*Pandalus borealis*) and Striped (*Pandalus montagui*) Shrimp for the 2021-22 season in the Western and Eastern Assessment Zones

Map:
Blue areas – Eastern Assessment Zone
Green areas – Western Assessment Zone



Northern shrimp (*Pandalus borealis*)

Striped shrimp (*Pandalus montagui*)

Background

Fisheries and Oceans Canada (DFO) submitted a briefing note to the Nunavut Wildlife Management Board (NWMB) and the Nunavik Marine Region Wildlife Board (NMRWB) (the Boards) in February 2021 as a placeholder for their joint decisions and recommendations on 2021-22 Total Allowable Catch (TAC) and harvest levels for two species of shrimp in the Western Assessment Zone (WAZ) and Eastern Assessment Zone (EAZ).

Science results from the 2020 DFO-Northern Shrimp Research Foundation multi species survey that would inform decision making were not available at the time of submission. Results of the Canadian Science Advisory Secretariat (CSAS) zonal peer review from the week of February 22, 2021, are now available and are being submitted through this addendum (Appendix 1; Appendix 2).

This addendum presents the Boards with the information needed to provide advice to the Minister of Fisheries and Oceans Canada for the 2021-22 fishery in the WAZ and EAZ. Recognizing that fishing may begin in these areas as early as May 2021, advice is requested as soon as possible.

A meeting of the Northern Shrimp Advisory Committee will occur on March 9, 2021. A summary of these consultations as they relate to the EAZ will be provided to the Boards by March 17, 2021.

WESTERN ASSESMENT ZONE (WAZ)

Fishery Profile

The fishery for *P. borealis* and *P. montagui* in the WAZ operates April 1 – March 31. Harvesting activity typically commences in May/June, subject to ice conditions.

The WAZ is divided into two management units, Nunavut West (NU-W) and Nunavik West (NK-W) (see map). These management units are located entirely within the Nunavut Settlement Area (NSA) and Nunavik Marine Region (NMR), respectively. The NWMB and NMRWB make decisions on management measures within their respective land claims areas and may make recommendations for adjacent management units. Notably, decisions have been given priority over recommendations in the event they are not aligned.

P. borealis and *P. montagui* allocations in the NU-W management unit have been allocated to Nunavut fishing interests. Similarly, allocations in the NK-W management unit have been allocated to Nunavik fishing interests. Although no formal sharing arrangement exists, harvest level decisions in NU-W and NK-W have historically resulted in equal distribution of the overall TAC for each species. In a practice initially recommended by the Boards and accepted by the Minister in 2013 (Appendix 3), these allocations have been permitted for harvest in either management unit regardless of land claim boundaries. DFO has requested that the Boards re-affirm this permission for reciprocal access between NU/NK-W.

A quota and catch history profile for the fishery in the WAZ is provided at Appendix 4.

Precautionary Approach Framework

Work is underway on the development of a draft Precautionary Approach (PA) framework for *P. borealis* and *P. montagui* in the WAZ. Status of this work has been outlined in greater detail to the Boards under separate cover.

Through a Canadian Science Advisory Secretariat (CSAS) peer-review process in May 2020, DFO Science established a Limit Reference Points (LRP) for each stock at 40% of the geometric mean of the Spawning Stock Biomass (SSB) index for the available time series, an increase from 30%. DFO Science also proposed an Upper Stock Reference (USR) point for each stock at 80% of the geometric mean of the SSB index. Through a series of working group sessions from November 2020 to February 2021, the Northern Precautionary Approach Working Group (NPAWG) has since considered a potential USR at 70% of the geometric mean of the SSB index for each stock[1].

[1] LRPs are considered established and are not subject to Board decisions or recommendations. USRs require Board decisions and recommendations (as appropriate) prior to being established. Use of the USR is for illustrative purposes for consideration in 2021-22 TAC decisions.

Relative to the established LRP and USR considered by the NPAWG, both *P. borealis* and *P. montagui* stocks would be situated in the Healthy Zone of a draft PA Framework.

Harvest Decision Rules (HDRs) that could prescribe harvest rates and other management procedures in each the Healthy, Cautious and Critical Zones are currently under development by the NPAWG. HDRs in the context of a PA Framework are not yet available.

Science Advice

Seven data points are now available in a new time series for the WAZ that began in 2014. *P. borealis* and *P. montagui* stocks have shown signs of high volatility, with no clear indication of mechanisms driving year-to-year fluctuations in biomass. Currently, DFO Science cannot detect trends for either stock at this time.

For ***P. borealis***, the 2020 survey indicates a Fishable Biomass (FB) increase of 61.1% from the 2019 survey, following a slight decline the year prior (-3.4%). The Spawning Stock Biomass (SSB) increased by 48.2% from the previous year's survey (Appendix 1; Appendix 2).

For ***P. montagui***, the 2020 survey indicates a FB decrease of 20.8% from the 2019 survey, following a decline the year prior (-19.5%). The SSB declined by 7.8% from the previous year's survey (Appendix 1; Appendix 2).

2021-22 Management Considerations

Although a PA Framework has not been fully established, both stocks would be situated in the Healthy Zone relative to the established LRPs and USRs considered by the NPAWG.

For ***P. borealis***, a rollover of the current TAC in 2021-22 would result in an ER of 9.6%. Maintaining the 15.5% ER in 2021-22 would result in a TAC of 5,089t (an increase of 1,926t or approximately 61%). Scenarios are illustrated below.

Scenario	TAC	ER	% change in TAC from previous year
Rollover TAC	3,163t	9.6%	0%
Maintain ER	5,089t	15.5%	61%
15% TAC increase	3,637t	11.1%	15%

For ***P. montagui***, a rollover the current TAC in 2021-22 would result in an ER of 23.5% (notably, outside the range of past ERs observed for this stock). Maintaining the 18.6% ER in 2021-22 would result in a TAC of 9,469t (a decrease of 2,506t or approximately 21%). Scenarios are illustrated below.

Scenario	TAC	ER	% change in TAC from previous year
Rollover TAC	11,975t	23.5%	0%
Maintain ER	9,469t	18.6%	-21%
15% TAC decrease	10,179t	20%	-15%

Recommendation: No HDRs currently exist for stocks in the WAZ. HDRs may be proposed in future, pending outcomes of NPAWG discussions.

The Department maintains its view from 2020-21 that the Boards could continue to establish an overall TAC (combined for NU-W and NK-W) with ER that falls within the range where the stock has shown an ability to recover; 7.3% - 19.8% for *P. borealis;* 8.0% - 19.3% for *P. montagui*.

<u>Summary of Request</u>

Western Assessment Zone:

1. Decisions on harvest levels for *P. borealis* and *P. montagui* in the NU-W (within the NSA) and NK-W (within the NMR) management units, respectively.

2. Recommendations on the overall TAC for *P. borealis* and *P. montagui* in the WAZ.

Management Measures:

1. Recommendation to continue the practice whereby *P. borealis* and *P. montagui* allocations in NU-W and NK-W may be harvested in either management unit, regardless of land claim boundaries.

Table 2. Summary of requested decisions and recommendations, WAZ.

Area (Management Unit)	***P. borealis***	***P. montagui***
NSA (NU W)	Harvest level decision NWMB *(Recommendation NMRWB)*	Harvest level decision NWMB *(Recommendation NMRWB)*
NMR (NK W)	Harvest level decision NMRWB *(Recommendation NWMB)*	Harvest level decision NMRWB *(Recommendation NWMB)*
TOTAL (WAZ)	*TAC recommendation (combined total of decisions) NWMB and NMRWB*	*TAC recommendation (combined total of decisions) NWMB and NMRWB*

EASTERN ASSESMENT ZONE (EAZ)

Fishery Profile

The fishery for *P. borealis* and *P. montagui* in the EAZ operates April 1 – March 31. Harvesting activity typically commences in May/June, subject to ice conditions.

The EAZ is divided into four management units, Nunavut East (NU-E), Nunavik East (NK-E), Davis Strait West (DSW) and Davis Strait East (DSE) (see map). These management units are located partially within and adjacent to the NSA and NMR, respectively. The NWMB and NMRWB make decisions on management measures within their respective land claims areas and may make recommendations for the adjacent Davis Strait management units. Notably, decisions have been given priority over recommendations in the event they are not aligned.

P. borealis and *P. montagui* allocations in the NU-E management unit have been allocated to Nunavut fishing interests. Similarly, allocations in the NK-E management unit have been allocated to Nunavik fishing interests. No formal sharing arrangement exists to prescribe distribution of allocations between NU-E and NK-E. In a practice initially recommended by the Boards and accepted by the Minister in 2013 (Appendix 3), these allocations have been permitted for harvest in either management unit regardless of land claim boundaries. DFO has requested that the Boards re-affirm this permission for reciprocal access between NU/NK-E.

Allocations in the Davis Strait management units have been allocated to Nunavut and Nunavik fishing interests, as well as to the offshore fleet. *P. montagui* is a bycatch species in Davis Strait. A quota and catch history profile for the fishery in the EAZ is provided at Appendix 4.

Precautionary Approach Framework

A PA Framework currently exists for *P. borealis* and *P. montagui* in the EAZ and work is underway to update this framework. In May 2020, DFO Science analysed the available longer data series and updated the LRP for each stock to 40% of the geometric mean of the SSB index for the available time series, an increase from 30%. DFO Science also proposed an updated USR for each stocks at 80% of the geometric mean of the SSB index. The NPAWG has since considered an updated USR at 70 of the geometric mean of the SSB index for each stock[2].

[2] LRPs are considered established and are not subject to Board decisions or recommendations. USRs require Board decisions and recommendations (as appropriate) prior to being established. Use of the USR is for illustrative purposes for consideration in 2021-22 TAC decisions.

Relative to the updated LRP and USR considered by the NPAWG, both *P. borealis* and *P. montagui* stocks would be situated in the Healthy Zone of an updated PA Framework.

HDRs are currently available to inform 2021-22 TAC decisions within the existing PA Framework for EAZ stocks. However, these HDRs are currently being reviewed and potential updates being developed by the NPAWG.

Science Advice

Twelve data points are now available in the time series for the EAZ. *P. borealis* and *P. montagui* stocks have shown signs of high volatility, with no clear indication of mechanisms driving year-to-year fluctuations in biomass. DFO Science cannot detect trends for either stock at this time.

For ***P. borealis***, the 2020 survey indicates a FB decrease of -9.4% from the 2019 survey, following a significant increase the year prior (102.9%). The SSB increased by 5.9% from the previous year's survey (Appendix 1; Appendix 2).

For ***P. montagui***, the 2020 survey indicates a significant FB increase of 121.1% from the 2019 survey, following a decline the year prior (-59.3%). The SSB increased by 227% from the previous year's survey (Appendix 1; Appendix 2). The FB of *P. montagui* has fluctuated precipitously every year since 2012, and the status of this resource is uncertain.

2021-22 Management Considerations

Both *P. borealis* and *P. montagui* stocks would be situated in the Healthy Zone relative to established LRPs and USRs considered by the NPAWG. Existing HDRs for stocks in the Healthy Zone prescribe ERs well above the base target ER of 15%, and changes in the TAC should generally not exceed 15% of the previous TAC.

For ***P. borealis***, it was observed that the 2020-21 TAC for *P. borealis* (10,653t) was the result of applying a 15% exploitation rate to a two-year average of the most recent fishable biomass indices. A rollover of the current TAC in 2021-22 would result in an ER of 12.4%. Maintaining the 11.2% ER in 2021-22 would result in a TAC of 9,656t (a decrease of 997t or approximately 9%). A 15% ER would result in a TAC of 12,932t (+21.4%). Scenarios are illustrated below.

Scenario	TAC	ER	% change in TAC from previous year
Rollover TAC	10,653t	12.4%	0%
Maintain ER	9,656t	11.2%	-9%
15% TAC increase	12,250t	14.2%	15%

The TAC for ***P. montagui*** has been 840t since 2014. A rollover the current TAC in 2021-22 would result in an ER of 4.5%. Maintaining the 9.9% ER in 2021-22 would result in a TAC of 1,861t (an increase of 1,021t or approximately 121%). Scenarios are illustrated below.

Scenario	TAC	ER	% change in TAC from previous year
Rollover TAC	840	4.5%	0%
Maintain ER	1,861t	9.9%	121%
15% TAC increase	966t	5.1%	15%

Recommendation:

For ***P. borealis***, an option could be to increase the TAC by 15% for 2021-22 (ER 14.2%). Where the stock remains in the Healthy Zone, the resulting exploitation rate is reasonable. This option considers that significant fluctuations in biomass indices have been observed for this stock. Significant changes in year-to-year TAC may require reductions in future.

For ***P. montagui***, an option could be to rollover the TAC at 840t for 2021-22. This option considers that significant fluctuations in biomass continue to be observed for this stock, and that the TAC has been maintained at 840t since 2014.

These recommendations do not take into account possible suggested revisions to EAZ HDRs, pending outcomes of NPAWG discussions.

<u>Summary of Request</u>

Eastern Assessment Zone:

1. Decisions on harvest levels for *P. borealis* and *P. montagui* in the NU E (within the NSA) and NK E (within the NMR) management units, respectively.

2. Recommendations on the distribution of the TAC for *P. borealis* between the Davis Strait management units (DS W and DS E). Recommendations on *P. borealis* allocations in Davis Strait management units.

3. Recommendations on the overall TAC for *P. borealis* and *P. montagui* in the EAZ, respectively.

Management Measures:

1. Recommendation to continue the practice whereby *P. borealis* and *P. montagui* allocations in NU E and NK E may be harvested in either management unit, regardless of land claim boundaries.

Table 3. Summary of requested decisions and recommendations, EAZ.

Area (Management Unit)	***P. borealis***	***P. montagui***
NSA (NU E)	Harvest level decision NWMB *(Recommendation NMRWB)*	Harvest level decision NWMB *(Recommendation NMRWB)*
NMR (NK E)	Harvest level decision NMRWB *(Recommendation NWMB)*	Harvest level decision NMRWB *(Recommendation NWMB)*
DS E	TAC distribution and allocation recommendation NWMB & NMRWB	TAC recommendation NWMB & NMRWB
DS W	TAC distribution and allocation recommendation NWMB & NMRWB	
TOTAL (EAZ)	*TAC Recommendation NWMB & NMRWB*	*TAC Recommendation NWMB & NMRWB*

Prepared by: Courtney D'Aoust, Fisheries Resource Management, Fisheries and Oceans Canada

Date: March 5, 2021

SUMMARY: Assessment of Northern Shrimp, *Pandalus borealis*, and Striped Shrimp, *Pandalus montagui*, in the Eastern and Western Assessment Zones, February 2021

SUMMARY

- The assessment includes the 2019 and 2020 survey and fishery data.
- It is recognized that the population of *Pandalus montagui* spans the area of EAZ, WAZ and SFA 4. Currently it is not known what the rates of exchange (export/import) are between these zones, therefore, understanding resource dynamics as a whole requires integrating information from all assessment areas.
- It is recognized that *P. borealis* are distributed broadly over the Northwest Atlantic Ocean, including the EAZ and WAZ, and that these areas are connected through larval dispersal, but rates of exchange of adults are less understood. These linkages need to be considered to interpret dynamics within and among assessment areas.
- In the EAZ the stocks are currently assessed with updated LRPs relevant to a PA Framework. Updated USRs are currently being considered.
- In the WAZ the stocks are currently assessed with the LRPs (established *de novo* in 2020). USRs are currently being considered.

Eastern Assessment Zone – *Pandalus borealis*

- Total catch varied without trend around 6,000 t from 1997 through 2020/21. Catch statistics in 2020/21 are preliminary.
- The fishable biomass index was above the long term mean (63,486 t) and was 86,211 t in 2020.
- The female spawning stock biomass (SSB) was above the long term mean (39,659 t) and was 60,531 t in 2020.
- The reported exploitation rate index for 2020/21 was 5.9% with 48% of the TAC taken. Based on the 2020/21 TAC of 10,653 t, the potential exploitation rate index was 12.5%.
- *Pandalus borealis* stock in the EAZ is currently well above the established LRP. Although there is currently no established USR, the stock is considered in a healthy state.

Eastern Assessment Zone – *Pandalus montagui*

- Total catch in 2020/21 was 267 t, 32% of the 840 t TAC. Catch statistics in 2020/21 are preliminary.
- The fishable biomass index is subject to considerable interannual variability potentially associated with resource distribution. Since 2017, it has generally been above the long term mean (14,076 t) and was 18,803 t in 2020. Fluctuations in fishable biomass may also differ across adjacent assessment areas within the same year for this stock.
- The female spawning stock biomass (SSB) index was above the long term mean (9,675 t) and was 14,437 t in 2020.
-

- The reported exploitation rate index for 2020/21 was 1.3% with 32% of the TAC taken. Based on the 2020/21 TAC of 840 t, the potential exploitation rate index was 4.5%.
- *Pandalus montagui* stock in the EAZ is currently well above the established LRP. Although there is currently no established USR and the stock biomass index is subject to considerable interannual variability, the stock is considered in a healthy state.

Western Assessment Zone – *Pandalus borealis*

- Total catch in 2020/21 was 625 t, which is 20% of the 3,163 t TAC. Catch statistics in 2020/21 are preliminary.
- The fishable biomass index in 2020 remained above the long term mean (19,219 t) and was 32,835 t.
- The female SSB index in 2020 remained above the long term mean (10,830 t) and was 17,555 t.
- The reported exploitation rate index for 2020/21 was 1.9% with 20% of the TAC taken. Based on the 2020/21 TAC of 3,163 t, the potential exploitation rate index was 9.6%.
- *Pandalus borealis* stock in the WAZ is currently well above the established LRP. Although there is currently no established USR, the stock is considered in a healthy state.

Western Assessment Zone – *Pandalus montagui*

- Total catch in 2020/21 was 3,917 t, which is 33% of the 11,975 t TAC. Catch statistics in 2020/21 are preliminary.
- Movement across management areas is suspected to contribute to inter-annual variability in the fishable biomass index. It was below the long term mean (56,609 t) and was 50,911 t in 2020.
- The SSB index was below the long term mean (31,640 t) and was 26,811 t in 2020.
- The reported exploitation rate index for 2020/21 was 7.7% with 33% of the TAC taken. Based on the 2020/21 TAC of 11,975 t, the potential exploitation rate index was 23.5%.
- Although there is currently no established USR for Pandalus montagui stock in the WAZ, the stock is above the established LRP relevant to a PA Framework.

APPENDIX 2

Table 1. Stock status indicators for *P. borealis* and *P. montagui* in the WAZ (2019-2021).

WAZ *P. borealis*			
	2021-22	**2020-21**	**2019-20**
Total Allowable Catch (TAC) (t)	*TBD*	3,163	3,163
% Change TAC	*TBD*	0.0%	52.1%
Fishable Biomass (FB)*	32,835	20,378	21,088
Spawning Stock Biomass (SSB)*	17,555	11,845	12,884
Potential Exploitation Rate	*TBD*	15.5%	15.0%
% Change FB	61.1%	-3.4%	101.1%
% Change SSB	48.2%	-8.1%	147.0%

WAZ *P. montagui*			
	2021-22	**2020-21**	**2019-20**
Total Allowable Catch (t)	*TBD*	11,975	11,975
% Change TAC	*TBD*	0.0%	95.1%
FB*	50,911	64,268	79,835
SSB*	26,811	29,079	47,834
Potential Exploitation Rate	*TBD*	18.6%	15.0%
% Change FB*	-20.8%	-19.5%	77.7%
% Change SSB*	-7.8%	-39.2%	57.8%

**Biomass indices reflect the prior year's survey (e.g. 2021-22 indices are reflective of the Fall 2020 survey).*

Table 2. Stock status indicators for *P. borealis* and *P. montagui* in the EAZ (2019-2021).

EAZ *P. borealis*			
	2021-22	**2020-21**	**2019-20**
Total Allowable Catch (TAC) (t)	*TBD*	10,653	8,610
% Change TAC	*TBD*	23.7%	9.8%
Fishable Biomass (FB)*	86,211	95,138	46,900
Spawning Stock Biomass (SSB)*	60,531	57,143	32,842
Potential Exploitation Rate	*TBD*	11.2%	18.4%
% Change FB	-9.4%	102.9%	19.6%
% Change SSB	5.9%	74.0%	32.4%

EAZ *P. montagui*			
	2021-22	**2020-21**	**2019-20**
Total Allowable Catch (t)	*TBD*	840	840
% Change TAC	*TBD*	0.0%	0.0%
FB*	18,803	8,503	20,895
SSB*	14,437	4,415	13,806
Potential Exploitation Rate	*TBD*	9.9%	4.0%
% Change FB*	121.1%	-59.3%	-16.3%
% Change SSB*	227.0%	-68.0%	-16.5%

**Biomass indices reflect the prior year's survey (e.g. 2021-22 indices are reflective of the Fall 2020 survey).*

Minister of
Fisheries and Oceans

Ministre des
Pêches et des Océans

Ottawa, Canada K1A 0E6

JUL 0 5 2013

Mr. Manasie Audlakiak
Acting Chairperson
Nunavut Wildlife Management Board
P.O. Box 1379
Iqaluit, Nunavut
X0A 0H0

Dear Mr. Audlakiak:

Thank you for your letters of May 9 and 14, 2013 regarding the Nunavut Wildlife Management Board's decisions and recommendations on shrimp management in the Nunavut Settlement Area for *Pandalus borealis* and *Pandalus montagui.*

First I would like to commend both the Nunavut Wildlife Management Board (NWMB) and the Nunavik Marine Region Wildlife Board (NMRWB) for the collaboration and cooperation in determining final harvest level decisions for the management units within the respective settlement areas and non –quota limitation decisions for the sustainable management of the shared shrimp resource. The efforts of the NWMB and NMRWB in working towards establishing a sound management structure for the sustainable management of the shared shrimp resource in the north has been appreciated.

I note that the joint decision letter of May 14, 2013 contains both final and initial Board decisions pursuant to the land claims agreements. I also note that the NWMB has provided separately on May 9, 2013 a related decision on the management regime in the Western Assessment Zone and on May 7, 2013 its recommendations on the sub-allocation of Nunavut's share of these shrimp resources. I have addressed each of the decisions and recommendations separately herein for simplicity.

Harvest levels

I accept the modified harvest levels in the Nunavut Settlement Area for *P. montagui* (2500t) and *P.borealis* (750t) shrimp for the Nunavut West management unit which represents a 50% share of the established Total Allowable Catch for each shrimp species in the Western Assessment Zone for a three year term (2013 to 2015 inclusive).

I also accept the modified harvest levels in the Nunavut Settlement Area for *P. montagui* (805t) and *P.borealis* (200t) shrimp for Nunavut East management unit which represents a 70% share of the established quota for *P. montagui* and 80% share of the established by-catch quota for *P.borealis* for the Nunavut /Nunavik East management units for a three year term (2013 to 2015 inclusive).

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Management Regime

I agree with the joint NWMB and NMRWB recommendation that, for the purpose of commercial shrimp fishing, respective shares in the Nunavut/Nunavik West and East management units are permitted to be fished in either land claims settlement area for a three year term (2013 to 2015 inclusive).

I accept the NWMB's non-quota limitation decision set out in its May 9, 2013 letter to have both P. *montagui* and *P. borealis* shrimp species managed as directed fisheries in the Western Assessment Zone for a three year term (2013 to 2015 inclusive).

With respect to the joint non-quota limitation decision for the conservation of the *P. montagui* shrimp species in the Nunavut/Nunavik East management units, I note that the NWMB has indicated that it is prepared to rescind this decision if the Department advises that this additional conservation measure is unnecessary for the conservation of the shrimp resource in the Resolution Island area. You will recall that the conservation concerns for the *P. montagui* shrimp stock in the area resulted from the old management system which allowed quotas to be fished across management units all of which could be fished near Resolution Island. The new management measures put in place along with the reduction of the Total Allowable Catch for *P. montagui* to 2250t addressed the conservation concerns to my satisfaction. However I am prepared to accept this non-quota limitation decision for the three year term if the NWMB and NMRWB deemed it necessary.

I have asked my officials to provide the NWMB and NMRWB with background information to assist the Boards in evaluating the need for this non-quota limitation.

Sub-Allocation

I appreciate the detailed information on how the NWMB determined its sub-allocation recommendations of Nunavut's share of the shrimp resources in the Nunavut East and West management units. I have given considerable deliberation to the NWMB's recommendations, along with other relevant considerations, and have decided to allocate Nunavut's share of the shrimp resources to Baffin Fisheries Coalition for the 2013 season as recommended in your letter of May 7, 2013.

I look forward to continued collaboration with the Board in the management of this important resource.

Sincerely,

Keith Ashfield

Minister of
Fisheries and Oceans

Ministre des
Pêches et des Océans

Ottawa, Canada K1A 0E6

JUL 0 5 2013

Mr. Robbie Tookalak
Acting Chairperson
Nunavik Marine Region Wildlife Board
P.O. Box 433
Inukjuak, Quebec
J1O 1M0

Dear Mr. Tookalak:

Thank you for your letter of May 14, 2013 regarding the Nunavik Marine Region Wildlife Board's decisions and recommendations on shrimp management in the Nunavik Marine Region for *Pandalus borealis* and *Pandalus montagui* and the additional considerations provided in your letter of May 21, 2013.

First I would like to commend both the Nunavik Marine Region Wildlife Board (NMRWB) and the Nunavut Wildlife Management Board (NWMB) for the collaboration and cooperation in determining final harvest level decisions for the management units within the respective settlement areas and non-quota limitation decisions for the sustainable management of the shared shrimp resource. The efforts of the NMRWB and NWMB in working towards establishing a sound management structure for the sustainable management of the shared shrimp resource in the north has been appreciated.

I note that the joint decision letter of May 14, 2013 contains both final and initial Board decisions pursuant to the land claims agreements. I also note that the NMRWB's letter of May 21, 2013 identifies a Board decision on the management regime in the Western Assessment Zone. I have addressed each of the decisions and recommendations separately herein for simplicity.

Harvest levels

I understand from your letter of May 21, 2013, that the NMRWB will determine the basic needs level and allocation of the surplus at a later date. I look forward to hearing the Board's decisions on these items subsequently.

In the meantime, I accept the Total Allowable Take levels in the Nunavik Marine Region for *P. montagui* (2500t) and *P.borealis* (750t) shrimp for the Nunavik West management unit which represents a 50% share of the established Total Allowable Catch for each shrimp species in the Western Assessment Zone for a three year term (2013 to 2015 inclusive).

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I also accept the Total Allowable Take levels in the Nunavik Marine Region for *P. montagui* (345t) and *P.borealis* (50t) shrimp for Nunavik East management unit which represents a 30% share of the established quota for *P. montagui* and 20% share of the established by-catch quota for *P.borealis* for the Nunavik /Nunavut East management units for a three year term (2013 to 2015 inclusive).

<u>Management Regime</u>

I agree with the joint NMRWB and NWMB recommendation that, for the purpose of commercial shrimp fishing, respective shares in the Nunavut/Nunavik West and East management units are permitted to be fished in either land claims settlement area for a three year term (2013 to 2015 inclusive).

I accept the NMRWB's non-quota limitation decision set out in your May 21, 2013 letter to have both P. *montagui* and *P. borealis* shrimp species managed as directed fisheries in the Western Assessment Zone for a three year term (2013 to 2015 inclusive).

With respect to the joint non-quota limitation decision for the conservation of the *P. montagui* shrimp species in the Nunavik/Nunavut East management units, you will recall that the conservation concerns for the *P. montagui* shrimp stock in the area resulted from the old management system which allowed quotas to be fished across management units all of which could be fished near Resolution Island. The new management measures put in place along with the reduction of the Total Allowable Catch for *P. montagui* to 2250t addressed the conservation concerns to my satisfaction. However I am prepared to accept this non-quota limitation decision for the three year term if the NMRWB and NWMB deemed it necessary.

I have asked my officials to provide the NMRWB and NWMB with background information to assist the Boards in evaluating the need for this non-quota limitation.

I look forward to continued collaboration with the Board in the management of this important resource.

Sincerely,

Keith Ashfield

APPENDIX 4

		2016/17		2017/18		2018/19		2019/20		2020/21	
Species	**Management unit_Fleet/Interest**	**Quota**	**Catches**	**Quota**	**Catches**	**Quota**	**Catches**	**Quota**	**Catches**	**Quota**	**Catches *preliminary**
P. borealis	DSW_Offshore	4,813	4,852	4,813	5,009	4,013	4,576	4,737	4,511	5,250	4,917
	DSE_Offshore	1,604	848	1,604	530	802	352	802	4	1,000	0
	DSE_Nunavut	1,604	118	1,604	884	1,604	215	1,604	0	1,604	28
	DSW_Nunavut	1,084	722	1,084	928	1,084	1,055	1,084	976	1,778	1,147
	DSW_Nunavik	120	0	120	0	120	0	120	0	197	0
	NU-E_Nunavut	210	96.249	210	67	174	45	210	4	659	389
	NK- E_Nunavik	53	31.101	53	66	43	94	53	13	165	167
	TOTAL	***9,488***	***6,667***	***9,488***	***7,483***	***7,840***	***6,337***	***8,610***	***5,508***	***10,653***	***6,648***
P. montagui	NU-E_Nunavut	301	128.562	301	92	301	0	301	76	301	48
	NK-E_Nunavik	129	115.109	129	140	129	3	129	0	129	178
	DS E/W_Offshore (bycatch)	410	243	410	71	410	141	410	150	410	131
	TOTAL	***840***	***486***	***840***	***304***	***840***	***143***	***840***	***225***	***840***	***348***
P. borealis	NU-W_Nunavut	1,040	612	1,040	466	1,040	485	1,582	1,236	1,582	811
	NK-W_Nunavik	1,040	418	1,040	452	1,040	822	1,582	375	1,582	555
	TOTAL	***2,080***	***1,029***	***2,080***	***918***	***2,080***	***1,307***	***3,163***	***1,612***	***3,163***	***1,366***
P. montagui	NU-W_Nunavut	3,069	2,415	3,069	2,505	3,069	1,879	5,988	4,131	5,988	3,064
	NK-W_Nunavik	3,069	3,245	3,069	3,104	3,069	3,638	5,988	3,983	5,988	3,504
	TOTAL	***6,138***	***5,660***	***6,138***	***5,609***	***6,138***	***5,517***	***11,975***	***8,114***	***11,975***	***6,567***

<u>SUBMISSION TO THE</u>

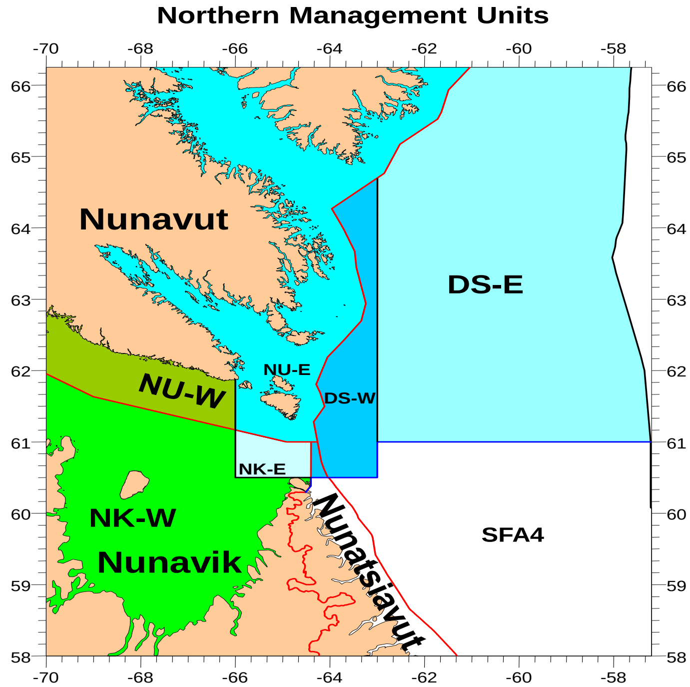
<u>NUNAVUT WILDLIFE MANAGEMENT BOARD AND</u>
<u>NUNAVIK MARINE REGION WILDLIFE BOARD</u>

<u>FOR</u>

Information: **Decision: X** **Recommendation: X**

Issue: Total Allowable Catch levels for Northern (*Pandalus borealis*) and Striped (*Pandalus montagui*) Shrimp for the 2021-22 season in the Western and Eastern Assessment Zones

<u>Map:</u>
Blue areas – Eastern Assessment Zone
Green areas – Western Assessment Zone



Northern shrimp (*Pandalus borealis*)

Striped shrimp (*Pandalus montagui*)

Background

Two shrimp species (*P. borealis* and *P. montagui*) occur in the Northern shrimp fishery that takes place in the Davis Strait and eastern Hudson Strait. The Total Allowable Catch (TAC) for each species is set for two distinct stock assessment zones, the Western Assessment Zone (WAZ) and the Eastern Assessment Zone (EAZ) (see Map). The TAC is further distributed into management units within these zones.

The fishery in these areas operates April 1 – March 31. Harvesting activity typically commences in May to June, subject to ice conditions.

Where this fishery occurs within and adjacent to the Nunavut Settlement Area (NSA) and Nunavik Marine Region (NMR), decisions and recommendations on TAC and harvest levels for each species are requested annually from the Nunavut Wildlife Management Board (NWMB) and the Nunavik Marine Region Wildlife Board (NMRWB) (the Boards).

This briefing note is intended as a placeholder to which an addendum will provide the necessary science information and advice to support Board decision making, as soon as it becomes available. A meeting of the Northern Shrimp Advisory Committee will occur on March 9, 2021 where stakeholders will discuss TAC options for both species in the EAZ (WAZ not discussed).

Science Advice

Fisheries and Oceans Canada's (DFO) Science sector conducts full stock assessments of *P. borealis* and *P. montagui* on a two-year cycle with updates in interim years. A full assessment using 2020 survey data is scheduled in late February, 2021. Due to this timing, peer-reviewed science advice was not available at the time of this submission and will be provided to the Boards for their March consultations once the assessment has concluded.

Summary of Request

An addendum to this briefing note will be submitted in the coming weeks to provide the necessary science information to support Board decision making. Recognizing that fishing may begin in the WAZ and EAZ as early as May, advice on the following matters is requested as soon as possible:

Western Assessment Zone:

1. Decisions on harvest levels for *P. borealis* and *P. montagui* in the NU W (within the NSA) and NK W (within the NMR) management units, respectively.

2. Recommendations on the overall TAC for *P. borealis* and *P. montagui* in the WAZ.

Table 1. Summary of requested decisions and recommendations, WAZ.

Area (Management Unit)	***P. borealis***	***P. montagui***
NSA (NU W)	Harvest level decision NWMB	Harvest level decision NWMB
NMR (NK W)	Harvest level decision NMRWB	Harvest level decision NMRWB
TOTAL (WAZ)	*TAC recommendation (combined total of decisions)* *NWMB and NMRWB*	*TAC recommendation (combined total of decisions)* *NWMB and NMRWB*

Eastern Assessment Zone:

1. Decisions on harvest levels for *P. borealis* and *P. montagui* in the NU E (within the NSA) and NK E (within the NMR) management units, respectively.

2. Recommendations on the distribution and allocation of the TAC for *P. borealis* within the Davis Strait management units (DS W, DS E).

3. Recommendations on the overall TAC for *P. borealis* and *P. montagui* in the EAZ, respectively.

Table 2. Summary of requested decisions and recommendations, EAZ.

Area (Management Unit)	***P. borealis***	***P. montagui***
NSA (NU E)	Harvest level decision NWMB	Harvest level decision NWMB
NMR (NK E)	Harvest level decision NMRWB	Harvest level decision NMRWB
DS E	TAC distribution and allocation recommendation NWMB	
DS W	TAC distribution and allocation recommendation NWMB & NMRWB	
TOTAL (EAZ)	*TAC Recommendation* *NWMB & NMRWB*	*TAC Recommendation* *NWMB & NMRWB*

Management Measures:

1. Recommendation to continue the practice whereby *P. borealis* and *P. montagui* allocations in NU W and NK W may be harvested in either management unit, regardless of land claim boundaries.

   Similarly, recommendation to continue the practice whereby *P. borealis* and *P. montagui* allocations in NU E and NK E may be harvested in either management unit, regardless of land claim boundaries.

Prepared by: Courtney D'Aoust, Fisheries Resource Management, Fisheries and Oceans Canada

Date: February 4, 2021

SUMMARY: Assessment of Northern Shrimp, *Pandalus borealis*, and Striped Shrimp, *Pandalus montagui*, in the Eastern and Western Assessment Zones and Western Assessment Zones, February 2021

SUMMARY

- The assessment includes the 2019 and 2020 survey and fishery data.
- It is recognized that the population of *Pandalus montagui* spans the area of EAZ, WAZ and SFA 4. Currently it is not known what the rates of exchange (export/import) are between these zones, therefore, understanding resource dynamics as a whole requires integrating information from all assessment areas.
- It is recognized that *P. borealis* are distributed broadly over the Northwest Atlantic Ocean, including the EAZ and WAZ, and that these areas are connected through larval dispersal, but rates of exchange of adults are less understood. These linkages need to be considered to interpret dynamics within and among assessment areas.
- In the EAZ the stocks are currently assessed with updated LRPs relevant to a PA Framework. Updated USRs are currently being considered.
- In the WAZ the stocks are currently assessed with the LRPs (established *de novo* in 2020). USRs are currently being considered.

Eastern Assessment Zone – *Pandalus borealis*

- Total catch varied without trend around 6,000 t from 1997 through 2020/21. Catch statistics in 2020/21 are preliminary.
- The fishable biomass index was above the long term mean (63,486 t) and was 86,211 t in 2020.
- The female spawning stock biomass (SSB) was above the long term mean (39,659 t) and was 60,531 t in 2020.
- The reported exploitation rate index for 2020/21 was 5.9% with 48% of the TAC taken. Based on the 2020/21 TAC of 10,653 t, the potential exploitation rate index was 12.5%.
- *Pandalus borealis* stock in the EAZ is currently well above the established LRP. Although there is currently no established USR, the stock is considered in a healthy state.

Eastern Assessment Zone – *Pandalus montagui*

- Total catch in 2020/21 was 267 t, 32% of the 840 t TAC. Catch statistics in 2020/21 are preliminary.
- The fishable biomass index is subject to considerable interannual variability potentially associated with resource distribution. Since 2017, it has generally been above the long term mean (14,076 t) and was 18,803 t in 2020. Fluctuations in fishable biomass may also differ across adjacent assessment areas within the same year for this stock.
- The female spawning stock biomass (SSB) index was above the long term mean (9,675 t) and was 14,437 t in 2020.
-
- The reported exploitation rate index for 2020/21 was 1.3% with 32% of the TAC taken. Based on the 2020/21 TAC of 840 t, the potential exploitation rate index was 4.5%.
- *Pandalus montagui* stock in the EAZ is currently well above the established LRP. Although there is currently no established USR and the stock biomass index is subject to considerable interannual variability, the stock is considered in a healthy state.

Western Assessment Zone – *Pandalus borealis*

- Total catch in 2020/21 was 625 t, which is 20% of the 3,163 t TAC. Catch statistics in 2020/21 are preliminary.
- The fishable biomass index in 2020 remained above the long term mean (19,219 t) and was 32,835 t.
- The female SSB index in 2020 remained above the long term mean (10,830 t) and was 17,555 t.
- The reported exploitation rate index for 2020/21 was 1.9% with 20% of the TAC taken. Based on the 2020/21 TAC of 3,163 t, the potential exploitation rate index was 9.6%.
- *Pandalus borealis* stock in the WAZ is currently well above the established LRP. Although there is currently no established USR, the stock is considered in a healthy state.

Western Assessment Zone – *Pandalus montagui*

- Total catch in 2020/21 was 3,917 t, which is 33% of the 11,975 t TAC. Catch statistics in 2020/21 are preliminary.
- Movement across management areas is suspected to contribute to inter-annual variability in the fishable biomass index. It was below the long term mean (56,609 t) and was 50,911 t in 2020.
- The SSB index was below the long term mean (31,640 t) and was 26,811 t in 2020.
- The reported exploitation rate index for 2020/21 was 7.7% with 33% of the TAC taken. Based on the 2020/21 TAC of 11,975 t, the potential exploitation rate index was 23.5%.
- Although there is currently no established USR for Pandalus montagui stock in the WAZ, the stock is above the established LRP relevant to a PA Framework.

RÉSUMÉ : Évaluation des stocks de crevette nordique, *Pandalus borealis*, et de crevette ésope, *Pandalus montagui*, dans les zones d'évaluation est et ouest et dans les zones d'évaluation ouest, février 2021.

RÉSUMÉ

- L'évaluation comprend les données des relevés et les données sur la pêche de 2019 et 2020.
- Il est reconnu que la population de *Pandalus montagui* s'étend sur les zones d'évaluation est (ZEE) et ouest (ZEO) ainsi que sur la ZPC 4. Actuellement, on ne sait pas quels sont les taux de change (exportations/importations) entre ces zones. Par conséquent, pour comprendre la dynamique des ressources dans son ensemble, il faut intégrer l'information provenant de tous les domaines d'évaluation.
- Il est reconnu que le *P. borealis* est largement réparti sur l'océan Atlantique Nord-Ouest, y compris la ZEE et la ZEO, et que ces zones sont reliées entre elles par la dispersion des larves, mais les taux d'échange des adultes sont moins bien compris. Il faut tenir compte de ces liens pour interpréter la dynamique au sein des zones d'évaluation et entre elles.
- Dans la ZEE, les stocks sont actuellement évalués à l'aide des points de référence limites (PRL) mis à jour en fonction d'un cadre d'AP. Des points de référence supérieurs (PRS) sont actuellement à l'étude.
- Dans la ZEO, les stocks sont actuellement évalués à l'aide des PRL (établis de novo en 2020). Les PRS sont actuellement à l'étude.

Zone d'évaluation est – *Pandalus borealis*

- Les prises totales ont varié sans tendance autour de 6 000 t de 1997 à 2020-2021. Les statistiques sur les prises en 2020-2021 sont préliminaires.
- L'indice de biomasse exploitable était supérieur à la moyenne à long terme (63 486 t) et était de 86 211 t en 2020.
- La biomasse du stock reproducteur (BSR) femelle était supérieure à la moyenne à long terme (39 659 t) et était de 60 531 t en 2020.
- L'indice du taux d'exploitation déclaré pour l'année 2020-2021 était de 5,9 %, 48 % du TAC étant pris. D'après le TAC de 10 653 t en 2020-2021, l'indice du taux d'exploitation potentiel était de 12,5 %.
- Le stock de *Pandalus borealis* dans la ZEE est actuellement bien supérieur au PRL établi. Bien qu'il n'existe actuellement aucun PRS établi, le stock est considéré dans un état sain.

Zone d'évaluation est – *Pandalus montagui*

- Le total de prise en 2020-2021 était de 267 t, soit 32 % du TAC de 840 t. Les statistiques sur les captures en 2020-2021 sont préliminaires.
- L'indice de biomasse exploitable est soumis à une variabilité interannuelle considérable potentiellement associée à la distribution des ressources. Depuis 2017, il est généralement supérieur à la moyenne à long terme (14 076 t) et était de 18 803 t en 2020. Les fluctuations de la biomasse exploitable peuvent également varier entre les zones d'évaluation adjacentes au cours de la même année pour ce stock.
- L'indice de la biomasse du stock reproducteur (BSR) femelle était supérieur à la moyenne à long terme (9 675 t) et était de 14 437 t en 2020.
- L'indice du taux d'exploitation déclaré pour l'année 2020-2021 était de 1,3 %, 32 % du TAC étant pris. D'après le TAC de 840 t en 2020-2021, l'indice du taux d'exploitation potentiel était de 4,5 %.
- Le stock de *Pandalus montagui* dans la ZEE est actuellement bien supérieur au PRL établi. Bien qu'il n'existe actuellement aucun PRS établi et que l'indice de biomasse des stocks soit soumis à une variabilité interannuelle considérable, le stock est considéré comme étant en bonne santé.

Zone d'évaluation ouest – *Pandalus borealis*

- Le total des captures en 2020-2021 était de 625 t, soit 20 % du TAC de 3 163 t. Les statistiques sur les captures en 2020-2021 sont préliminaires.
- L'indice de biomasse exploitable en 2020 est demeuré supérieur à la moyenne à long terme (19 219 t) et s'élevait à 32 835 t.
- L'indice BSR femelle en 2020 est demeuré supérieur à la moyenne à long terme (10 830 t) et s'est établir à 17 555 t.
- L'indice du taux d'exploitation déclaré pour l'année 2020-2021 était de 1,9 %, 20 % du TAC étant pris. D'après le TAC de 3 163 t en 2020-2021, l'indice du taux d'exploitation potentiel était de 9,6 %.
- Le stock de *Pandalus borealis* dans la ZEO est actuellement bien supérieur au PRL établi. Bien qu'il n'y ait pas de PRS établi actuellement, le stock est considéré comme étant en bonne santé.

Zone d'évaluation ouest – *Pandalus montagui*

- Le total des captures en 2020-2021 était de 3 917 t, soit 33 % du TAC de 11 975 t. Les statistiques sur les captures en 2020-2021 sont préliminaires.

- On soupçonne que les déplacements entre les zones de gestion contribuent à la variabilité interannuelle de l'indice de biomasse exploitable. Il était inférieur à la moyenne à long terme (56 609 t) et s'élevait à 50 911 t en 2020.
- L'indice du taux d'exploitation déclaré pour l'année 2020-2021 était de 7,7 %, 33 % du TAC étant pris. D'après le TAC de 11 975 t en 2020-2021, l'indice du taux d'exploitation potentiel était de 23,5 %.
  Bien qu'il n'y ait actuellement aucune PRS établie pour le stock de *Pandalus montagui* dans le ZEO, le stock est au-dessus du PRL établi pertinent pour un cadre d'AP.

SUMMARY: Assessment of Northern Shrimp, *Pandalus borealis*, in Shrimp Fishing Areas 4-6 and Striped Shrimp, *Pandalus montagui*, in Shrimp Fishing Area 4, February 2021

SUMMARY

- Resource status of Northern Shrimp in SFAs 5 and 6 was assessed based on Fisheries and Oceans Canada (DFO) fall multi-species trawl survey data (1996–2020). Resource status for Northern and Striped Shrimp in SFA 4 were assessed based on Northern Shrimp Research Foundation (NSRF)-DFO summer trawl survey data (2005–2020).
- Trawl survey data for SFAs 4–6 provided information on shrimp distribution, length frequencies and biomass. Trends in fisheries performance were inferred from total allowable catch (TAC), commercial catch to date, fisher catch per unit effort (CPUE) and fishing patterns.
- It is recognized that *Pandalus borealis* are distributed broadly over the Northwest Atlantic Ocean, including SFA 4-6, and that these areas are connected through larval dispersal, but rates of exchange of adults are less understood. These linkages need to be considered to interpret dynamics within and among assessment areas.
- It is recognized that the population of *Pandalus montagui* spans the area of EAZ, WAZ and SFA 4. Currently it is not known what the rates of exchange (export/import) are between these zones, therefore, understanding resource dynamics as a whole requires integrating information from all assessment areas.

Environment bullets

- Bottom and sea surface temperatures (SSTs) are important drivers for the development of shrimp eggs and larvae, respectively. In SFAs 4-6, these variables have shown similar trends over the last 40 years, with a cold phase in the mid-1980s and 1990s, and a warm period in the late 1990s and early-2010s, but their trends have diverged since 2015. While colder bottom waters prevailed between 2014 and 2017, warmer bottom temperatures led to above average extent of bottom thermal habitat (2–4°C) between 2018 and 2020. In 2020, SSTs were above normal for the first time since 2013.
- Chlorophyll concentrations and zooplankton biomass were below normal in the early and mid-2010s, increasing to values above the long term (1999-2020) average since 2016-2017. Additionally, there have been changes in zooplankton community structure over the past decade with fewer large and more smaller copepods although the abundance of large, energy-rich calanoid copepods has increased to above-normal levels in some areas since 2017. Additionally, changes in zooplankton seasonality (weaker spring and stronger summer and fall zooplankton signals) may change the quality and timing of food availability for upper trophic levels.

Ecosystem Bullets

- Ecosystem conditions in the Newfoundland Shelf and Northern Grand Bank (Northwest Atlantic Fisheries Organization [NAFO] Divs. 2J3KL; SFA 7, 6, and southern part of SFA 5) remain indicative of overall limited productivity of the fish community. While total biomass levels remain much lower than prior to the collapse in the early-1990s, it showed some recovery up to the early-mid 2010s, when some declines were observed. Current total biomass remains below the early-2010s level, but with some positive signals in 2020. Since the mid-2000s this fish community has shifted back to a finfish-dominated structure, but has shown small increases in shellfish dominance since 2018.

- The available information for the Labrador Shelf (NAFO Div. 2H, northern part of SFA 5) shows declines in total biomass of the fish community from the levels observed in the early-2010s, but the 2020 survey suggests a potential reversal of this trend. The structure of the fish community is also changing, showing reductions in the dominance of shellfish. This suggests that this ecosystem could be shifting to a finfish-dominated community, as observed in NAFO Divs. 2J3KL (SFA 7, 6, and southern part of SFA 5).
- Consumption analyses indicated that predation is a major driver of the stock. In 2020, the shrimp predation mortality rate in NAFO Divs. 2J3KL (SFA 7, 6, and southern part of SFA 5), which had reached its highest levels on record in 2018-2019, declined to levels comparable to the mid-2000s.
- The build-up of shrimp until the mid-2000s occurred during a period of favorable environmental conditions and reduced predation. Shrimp per-capita net production has declined since the mid-2000s, but the trend has shown some signals of reversal in 2019-2020. Shrimp per-capita net production is expected to remain around current values, or show modest improvement in the next 1-3 years.
- Predation, fishing pressure, and warm climate conditions remain negatively correlated with subsequent shrimp per-capita net production in NAFO Divs. 2J3KL (SFA 7, 6, and southern part of SFA 5). Fishing in NAFO Div. 2GH (SFA 4 and northern part of SFA 5) also shows a negative correlation with shrimp per-capita net production in NAFO Divs. 2J3KL, suggesting that shrimp productivity can be impacted by fishing in upstream areas.
- Under current ecosystem conditions (i.e. low shrimp biomass, but potentially declining predation pressure), fishing at the current exploitation rate is unlikely to be a dominant driver for shrimp in NAFO Divs. 2J3KL (SFA 7, 6, and southern part of SFA 5). Fishing pressure could now be more influential on stock trajectories than it may have been when the stock was large. Similar analyses on the relative impacts of predation and fishing for the Labrador Shelf (NAFO Div. 2H, northern part of SFA 5) suggest that fishing could be a more important driver than predation in this area.

SFA 6 *Pandalus borealis*

- TAC was increased from 8,730 t in 2018/19 to 8,960 t in 2019/20 and reduced, by 8%, to 8,290 t in 2020/21.
- The annual commercial CPUE declined considerably between 2015/16 and 2017/18 to the lowest levels in two decades and has remained low since.
- Over 1996 to 2020 the fishable biomass index averaged 370,000 t. It was 118,000 t in 2020, an increase from 2019, but still near the lowest levels in the survey time series.
- Over 1996 to 2020 the female spawning stock biomass (SSB) index averaged 232,000 t. It was 74,800 t in 2020, an increase from 2019, but still near the lowest levels in the survey time series.
- The exploitation rate index ranged between 5.5% and 21.5% from 1997 to 2020/21 and was 5.6% in 2020/21. If the TAC is fully taken in 2020/21 then the exploitation rate index will be 10%.
- The female SSB index is currently in the Critical Zone of the DFO Precautionary Approach (PA) Framework with a 35% probability of being in the cautious zone.

- The rebuilding plan states a maximum exploitation rate of 10% while the female SSB index is in the Critical Zone. If the 2020/21 TAC of 8,290 t is maintained and taken in 2021/22, the exploitation rate index would be 7%.

SFA 5 *Pandalus borealis*

- TAC was reduced from 25,630 t in 2018/19 to 22,100 t in 2019/20 and further reduced, by 35%, to 14,450 t in 2020/21.
- Standardized large-vessel CPUE had varied without trend at relatively high levels for more than a decade before falling below the long-term mean beginning in 2017/18. Commercial catch rates may have been partly influenced by ice coverage.
- The number of stations sampled by the DFO multi-species survey in 2020 was reduced due to several factors. Retrospective time-series simulations suggest that the biomass estimates may slightly underestimate the stock status in SFA 5 in 2020.
- Over 1996 to 2020 the fishable biomass index averaged 127,000 t. It was 80,400 t in 2020, an increase from 2019, but still near the lowest levels in the survey time series.
- Over 1996 to 2020 the female SSB index averaged 63,000 t. It was 51,300 t in 2020, an increase from 2019, but still near the lowest levels in the survey time series.
- The exploitation rate index varied without trend with a median value of 15% from 1997–2020/21 and was 16.4% in 2020/21. If the TAC is fully taken in 2020/21 then the exploitation rate index will be 22.4%.
- Female SSB index is in the Healthy Zone within the DFO PA Framework with 19% probability of being in the cautious zone. If the 14,500 t TAC is maintained and taken in 2021/22, then the exploitation rate index will be 18%.

SFA 4 *Pandalus borealis*

- TAC was reduced from 15,725 t in 2018/19 to 10,845 t in 2019/20 and further reduced by 20%, to 8,658 t, in 2020/21.
- Large-vessel standardized CPUE varied without trend near the long-term mean (1989–2019/20).
- Over 2005 to 2020 the fishable biomass index averaged 97,200 t. It was 58,900 t in 2020, a 9% increase from 2019 and the third lowest level in the time series.
- Over 2005 to 2020 the female SSB index averaged 60,900 t. It was 43,100 t in 2020, a 9% increase from 2019 and amongst the lowest levels in the time series.
- The exploitation rate index ranged between 7% and 37.3% from 2005/06 to 2019/20 and was 12.8% in 2020/21. If the TAC had been taken, the exploitation rate index would have been 14.7%.
- Female SSB index in 2020 was in the Cautious Zone within the DFO PA Framework, for the third consecutive year, with a 6% probability of having been in the Critical Zone and a 36% probability of having been in the Healthy Zone.

SFA 4 *Pandalus montagui*

- The by-catch limit of 4,033 t has not been taken in the past eight years, with the commercial catch ranging between 1,113 t and 3,035 t.

- Over 2005 to 2020 the fishable biomass index averaged 28,800 t. It was 25,500 t in 2020, a 25% decrease from 2019.
- Over 2005 to 2020 the female biomass index averaged 22,100 t. It was 18,700 t in 2020, a 43% decrease from 2019.
- The exploitation rate index was 9.7% in 2020/21. If the by-catch limit had been taken, the exploitation rate index would have been 15.8% in 2020/21.
- There was no limit reference point (LRP) established for this resource during this meeting. Subsequently, there is no DFO PA Framework for this resource.

RÉSUMÉ : Évaluation de la crevette nordique (*Pandalus borealis*) dans les zones de pêche à la crevette 4 à 6 et de la crevette ésope (*Pandalus montagui*) dans la zone de pêche à la crevette 4, février 2021

Résumé

- L'état des ressources de crevette nordique dans les ZPC 5 et 6 a été évalué à partir des données de relevés plurispécifiques au chalut de Pêches et Océans Canada (MPO) effectués l'automne (1996-2020). L'état des ressources de crevette nordique et de crevette ésope dans la ZPC 4 a été évalué à partir des données de relevés au chalut effectués l'été par la Northern Shrimp Research Foundation (NSRF) et le MPO (2005-2020).
- Les données des relevés au chalut des ZPC 4 à 6 ont fourni des renseignements sur la répartition des crevettes, les fréquences de longueur et la biomasse. Les tendances du rendement des pêches ont été déduites à partir des totaux autorisés des captures (TAC), du nombre de prises commerciales jusqu'à présent, des captures par unité d'effort (CPUE) et des habitudes de pêche.
- Il est reconnu que le *Pandalus borealis* est largement répandu dans l'océan Atlantique Nord-Ouest, y compris dans les ZPC 4 à 6, et que ces zones sont reliées par la dispersion des larves, mais les taux d'échange des adultes sont moins bien compris. Il faut tenir compte de ces liens pour interpréter la dynamique à l'intérieur des domaines d'évaluation et entre ceux-ci.
- Il est reconnu que la population de *Pandalus montagui* s'étend sur les zones d'évaluation est (ZEE) et ouest (ZEO) ainsi que sur la ZPC 4. Actuellement, on ne sait pas quels sont les taux de change (exportations/importations) entre ces zones. Par conséquent, pour comprendre la dynamique des ressources dans son ensemble, il faut intégrer l'information provenant de tous les domaines d'évaluation.

Puces sur l'environnement

- Les températures du fond et de la surface de la mer (SST) jouent un rôle important dans le développement des œufs et des larves de crevette, respectivement. Dans les ZPC 4 à 6, ces variables ont affiché des tendances similaires au cours des 40 dernières années, avec une période froide au milieu des années 1980 et 1990 et une période chaude à la fin des années 1990 et au début des années 2010, mais leurs tendances divergent depuis 2015. Alors que les eaux de fond plus froides ont prévalu entre 2014 et 2017, les températures de fond plus chaudes ont mené à une étendue supérieure à la moyenne de l'habitat thermique de fond (2 à 4 °C) entre 2018 et 2020. En 2020, les SST étaient supérieures à la normale pour la première fois depuis 2013.
- La concentration de chlorophylle et la biomasse de zooplancton étaient inférieures à la normale au milieu des années 2010, puis ont augmenté pour atteindre des valeurs supérieures à la moyenne à long terme (1999-2020) depuis 2016-2017. De plus, il y a eu des changements dans la structure des communautés de zooplancton au cours de la dernière décennie avec moins de copépodes de grande taille et plus de petits copépodes, bien que l'abondance de copépodes calanoïdes de grande taille et riches en énergie ait augmenté pour atteindre des niveaux supérieurs à la normale dans certaines régions depuis 2017. De plus, les changements de la saisonnalité du zooplancton (signaux du zooplancton

plus faibles au printemps et plus forts en été et à l'automne) peuvent modifier la qualité et le moment de la disponibilité des aliments pour les niveaux trophiques supérieurs.

Puces sur l'écosystème

- L'état de l'écosystème sur le plateau de Terre-Neuve et dans le secteur nord de Grand Banc (Division de l'Organisation des pêches de l'Atlantique nord-ouest [OPANO] 2J3KL; ZPC 6 et 7 et partie sud de la ZPC 5) reste révélateur de la productivité globale limitée de la communauté de poissons. Bien que les niveaux de biomasse totale demeurent bien inférieurs à ceux d'avant l'effondrement au début des années 1990, ils ont montré une certaine reprise jusqu'au début et au milieu des années 2010, où l'on a observé certains déclins. La biomasse totale actuelle demeure en deçà du niveau du début des années 2010, mais avec quelques signaux positifs en 2020. Depuis le milieu des années 2000, cette communauté de poissons est revenue à une structure dominée par les poissons, mais elle a connu de petites augmentations de la dominance des mollusques et crustacés depuis 2018.
- L'information disponible concernant le plateau du Labrador (division de l'OPANO 2H, partie nord de la ZPC 5) montre un déclin de la biomasse totale par rapport aux niveaux observés au début des années 2010, mais le relevé de 2020 suggère un renversement possible de cette tendance. La structure de la communauté piscicole est également en train de changer, ce qui indique une réduction de la prédominance des mollusques et des crustacés. Ces observations suggèrent que cet écosystème pourrait se transformer en une communauté dominée par les poissons à nageoires, comme cela s'est produit dans les divisions 2J3KL de l'OPANO (ZPC 6 et 7 et partie sud de la ZPC 5).
- Les analyses de la consommation ont indiqué que la prédation est un facteur important du stock. En 2020, le taux de mortalité par prédation de la crevette dans les divisions de 2J3KL de l'OPANO (ZPC 6 et 7 et partie sud de la ZPC 5), qui avait atteint ses niveaux les plus élevés jamais enregistrés en 2018-2019, est retombé à des niveaux comparables à ceux du milieu des années 2000.
- L'accumulation des crevettes jusqu'au milieu des années 2000 s'est produite pendant une période de conditions environnementales favorables et de prédation réduite. La production nette de crevettes par habitant a décliné depuis le milieu des années 2000, mais la tendance a montré certains signes de renversement en 2019-2020. La production nette de crevettes par habitant devrait se maintenir autour des valeurs actuelles ou s'améliorer légèrement au cours des trois prochaines années.
- La prédation, la pression de la pêche et les conditions climatiques chaudes demeurent négativement corrélées à la production nette de crevettes par habitant subséquente dans les divisions 2J3KL de l'OPANO (ZPC 6 et 7 et partie sud de la ZPC 5). La pêche dans les divisions 2GH de l'OPANO (ZPC 4 et partie nord de la ZPC 5) présente également une corrélation négative avec la production nette de crevettes par habitant dans les divisions 2J3KL de l'OPANO, ce qui laisse supposer que la productivité de la crevette peut être affectée par la pêche dans les zones en amont.
- Dans les conditions actuelles de l'écosystème (c.-à-d. une faible biomasse de crevettes, mais une pression de prédation potentiellement en baisse), il est peu probable que la pêche au taux d'exploitation actuel soit un facteur dominant pour la crevette dans les divisions 2J3KL de l'OPANO (ZPC 6 et 7 et partie sud de la ZPC 5). La pression exercée par la pêche pourrait maintenant avoir une influence plus grande sur la trajectoire des stocks qu'elle ne l'a été lorsque le stock était important. Des analyses semblables sur les répercussions relatives de la prédation et de la pêche sur le plateau du Labrador (division

2H de l’OPANO, partie nord de la ZPC 5) suggèrent que la pêche pourrait être un facteur plus important que la prédation dans cette zone.

Crevette nordique (Pandalus borealis) dans la ZPC 6

- De 2018-2019 à 2019-2020, le TAC a été augmenté, passant de 8 730 t à 8 960 t, mais a été diminué de 8 % pour s’établir à 8 290 t en 2020-2021.
- Les CPUE commerciales annuelles ont diminué de manière considérable de 2015-2016 à 2017-2018 pour atteindre leurs plus bas niveaux en deux décennies et sont demeurées faibles depuis.
- De 1996 à 2020, l’indice moyen de la biomasse exploitable se situait à 370 000 t. En 2020, il était de 118 000 t, ce qui représente une augmentation par rapport à 2019, mais tout de même près des niveaux les plus bas de la série chronologique des relevés.
- De 1996 à 2020, l’indice de la biomasse du stock reproducteur (BSR) femelle a atteint 232 000 t. Il était de 74 800 t en 2020, une augmentation par rapport à 2019, mais ce niveau reste toujours près des niveaux les plus bas de la série chronologique des relevés.
- De 1997 à 2020-2021, l’indice du taux d’exploitation a varié de 5,5 % à 21,5 %, et était de 5,6 % en 2020-2021. Si le TAC est atteint en 2020-2021, l’indice du taux d’exploitation sera de 10 %.
- L’indice de la BSR femelle se trouve actuellement dans la zone critique du cadre de l’approche de précaution (AP) du MPO avec 35 % de probabilité de se situer dans la zone de prudence.
- Le plan de reconstruction prévoit un taux d’exploitation maximal de 10 % lorsque l’indice de la BSR femelle se situe dans la zone critique. Si le TAC de 2020-2021 de 8 960 t est maintenu et pris en 2020-2021, l’indice du taux d’exploitation sera de 7 %.

Crevette nordique (Pandalus borealis) dans la ZPC 5

- Le TAC a été réduit en 2018-2019 pour passer de 25 630 t à 22 100 t en 2019-2020, et a encore été réduit de 35 % à 14 450 t en 2020-2021.
- Les CPUE normalisées des grands navires ont varié sans afficher de tendance à des niveaux relativement élevés pendant plus d’une dizaine d’années avant de tomber sous la moyenne à long terme à partir de 2017-2018. Les taux de prises commerciales peuvent avoir été influencés en partie par la couverture de glace.
- Le nombre de stations échantillonnées par les relevés plurispécifiques du MPO en 2020 a été réduit en raison de plusieurs facteurs. Des simulations rétrospectives des séries chronologiques donnent à penser que les estimations de la biomasse pourraient sous-estimer légèrement l’état des stocks dans la ZPC 5 en 2020.
- De 1996 à 2020, l’indice moyen de la biomasse exploitable se situait à 127 000 t. Il était de 80 400 t en 2020, une augmentation par rapport à 2019, mais toujours près des niveaux les plus bas de la série chronologique des relevés.
- De 1996 à 2020, l’indice de la biomasse du stock reproducteur femelle se situait à 63 000 t en moyenne. Il était de 51 300 t en 2020, une augmentation par rapport à 2019, mais toujours près des niveaux les plus bas de la série chronologique des relevés.

- De 1997 à 2020-2021, l’indice du taux d’exploitation a fluctué sans afficher de tendance, avec une valeur médiane de 15 %. Si le TAC est atteint en 2020-2021, l’indice du taux d’exploitation sera de 22,4 %.
- L’indice de la biomasse du stock reproducteur femelle se situe actuellement dans la zone saine dans le cadre de l’approche de précaution du Plan de gestion intégrée des pêches (PGIP) du MPO avec 19 % de probabilité de se situer dans la zone de prudence. Si le TAC de 14 500 t est maintenu et atteint en 2021-2022, l’indice du taux d’exploitation sera de 18 %.

Crevette nordique (Pandalus borealis) dans la ZPC 4

- Le TAC a été réduit de 15 725 t en 2018-2019 à 10 845 t en 2019-2020 et a encore été réduit de 20 %, à 8 658 t, en 2020-2021.
- Les CPUE normalisées des gros navires ont fluctué près de la moyenne à long terme sans afficher de tendance (1989 à 2019-2020).
- De 2005 à 2020, l’indice moyen de la biomasse exploitable se situait à 97 200. Il était de 58 900 t en 2020, en 2018, ce qui représente une augmentation de 9 % par rapport à 2019 et le situe au troisième niveau le plus bas de la série chronologique.
- De 2005 à 2020, l’indice de la BSR femelle se situait à 60 900 t en moyenne. Il était de 43 100 t en 2020, soit une augmentation de 9 % par rapport à 2019 et l’un des niveaux les plus bas de la série chronologique.
- L’indice du taux d’exploitation a varié de 7 % à 37,3 % de 2005-2006 à 2019-2020, et se situait à 12,8 % en 2020-2021. Si le TAC avait été atteint en 2018-2019, l’indice du taux d’exploitation aurait été de 14,7 %.
- En 2020, l’indice de la BSR femelle se situait dans la zone de prudence du cadre de l’AP du MPO avec une probabilité de 6 % d’avoir été dans la zone critique et une probabilité de 36 % d’avoir été dans la zone saine.

Crevette ésope (Pandalus montagui) dans la ZPC 4

- La limite des prises accessoires de 4 033 t n’a pas été atteinte au cours des huit dernières années, les prises commerciales se situant entre 1 113 t et 3 035 t.
- De 2005 à 2020, l’indice moyen de la biomasse exploitable se situait à 28 800 t. Il était de 25 500 t en 2020, soit une diminution de 25 % par rapport à 2019.
- De 2005 à 2020, l’indice de la biomasse du stock femelle se situait à 22 100 t. En 2020, il atteint 18 700 t, ce qui représente une diminution de 43 % par rapport à 2019.
- L’indice du taux d’exploitation était de 9,7 % en 2020-2021. Si la limite des prises accessoires avait été atteinte, l’indice du taux d’exploitation aurait été de 15,8 % en 2020-2021.
- Aucun point de référence limite (PRL) n’a été établi pour cette ressource au cours de cette réunion. Il n’existe pas de cadre d’AP du MPO pour cette ressource.

SUBMISSION TO THE

NUNAVUT WILDLIFE MANAGEMENT BOARD

FOR

Information: **Decision:** **Recommendation: X**

Issue: Total Allowable Catch levels for Northern Shrimp (*Pandalus borealis*) for the 2021 season in Shrimp Fishing Area 0

Northern shrimp (*Pandalus borealis*)

Background

A fishery for Northern shrimp (*Pandalus borealis*) exists in Shrimp Fishing Area (SFA) 0, located in Baffin Bay. SFA 0 is immediately adjacent to and partially within the Nunavut Settlement Area (NSA) (see Map).

Where this fishery occurs adjacent to the NSA, a recommendations on the Total Allowable Catch (TAC) for *P. borealis* in SFA 0 is requested from the Nunavut Wildlife Management Board (NWMB).

Fishery Profile

The fishery in SFA 0 operates according to a calendar year (January 1 – December 31). Harvesting activity, if any, would likely occur no earlier than June due to ice conditions.

The TAC in SFA 0 has been 500t since 1996 with the exception of 2020, where an interim TAC of 250t was set with no final TAC decision. No catches have been recorded since the onset of this fishery.

Historically, the TAC has been allocated on a competitive basis to the offshore fleet. Nunavut fishing interests have access to this competitive quota via the Qikiqtaaluk Corporation’s offshore licence, and through 50% ownership of the Unaaq offshore licence. Current Conditions of Licence do not permit offshore licence holders to prosecute this fishery within the boundaries of the NSA; all fishing occurs outside the NSA boundary.

Science Information

Regular stock assessment surveys for *P. borealis* are not conducted in SFA 0 as there has never been an active fishery in this management area. SFA 0 was last assessed in 2010 based on surveys conducted in 2006 and 2008 (Canadian Science Advisory Report 2010/024) (Summary in Appendix 2).

These surveys indicated that biomass indices were low. The fishable biomass index was 750 t (2006) and 1,100 t (2008) with female spawning stock biomass index of 580 t (2006) and 800 t (2008). A competitive TAC of 500 t, if fully taken, would result in an exploitation rate index of 40% (2008) to 70% (2006) based on the observed biomass at that time.

Given a historic data set derived from only two surveys, biomass trends cannot be determined and current biomass levels and recruitment status remain uncertain. Should industry express interest in fishing in this area in the future, requests for science advice can be considered at that time. There are no plans for future surveys at this time.

Consultation

On December 18, 2020, the NWMB recommended that all allocation holders identified under the NWMB's *Allocation Policy for Commercial Marine Fisheries* have access to the competitive fishery in SFA 0. Allocation holders under the NWMB's allocation policy have yet to be identified for the 2021 fishing season.

In December 2020, DFO sought the views of relevant stakeholders including Nunavut Tunngavik Incorporated, Nunavut fishing industry, the Government of Nunavut and the NWMB on TAC for SFA 0 for the 2021 fishery. The Canadian Association of Prawn Producers, representing 10 of the 17 offshore licence holders with historic access to this area, supported a rollover of the 500 t TAC.

Recommendation

It is recommended that the TAC for SFA 0 be set at 500 t for 2021.

Where no allocation holders have been identified under the NWMB's allocation policy for 2021, the Department is unable to consider the Board's December 18, 2020, recommendation. It is recommended that the 500 t quota be allocated on a competitive basis the offshore fleet.

Summary of Request

In order to ensure Board advice may be fully considered as part of 2021 management decisions for the SFA 0 fishery, Board recommendations on the following matters is requested no later than May 1, 2021:

1. Recommendation on the TAC for SFA 0.
2. Recommendation on allocation of the TAC on a competitive basis.

Prepared by: Courtney D'Aoust**,** Fisheries Resource Management, Fisheries and Oceans Canada

Date: February 4, 2021

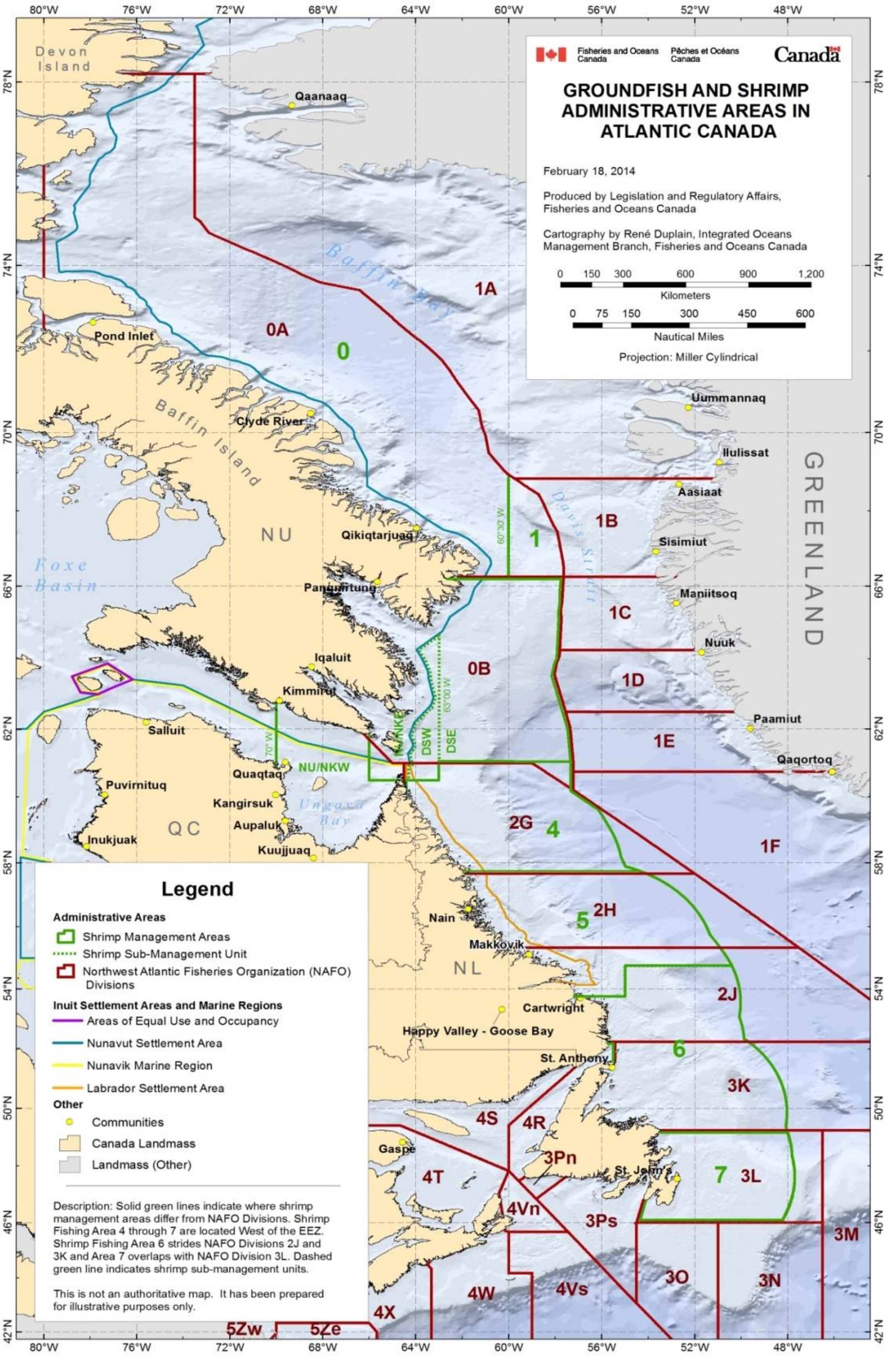
<u>Appendices</u>

Appendix 1 – Map of groundfish and shrimp administrative areas in Atlantic Canada (including Shrimp Fishing Area 0)

Appendix 2 – Summary: Assessment of Northern Shrimp (*Pandalus borealis*) in SFA 0, 2, 3 and Striped Shrimp (*Pandalus montagui*) in SFA 2, 3 and 4 west of 63°W (Science Advisory Report 2010/024)

Appendix 3 – Full publication: Assessment of Northern Shrimp (*Pandalus borealis*) in SFA 0, 2, 3 and Striped Shrimp (*Pandalus montagui*) in SFA 2, 3 and 4 west of 63°W (Science Advisory Report 2010/024)

APPENDIX 1



Fisheries and Oceans Canada
Pêches et Océans Canada
Canada
GROUNDFISH AND SHRIMP ADMINISTRATIVE AREAS IN ATLANTIC CANADA
February 18, 2014
Produced by Legislation and Regulatory Affairs, Fisheries and Oceans Canada
Cartography by René Duplain, Integrated Oceans Management Branch, Fisheries and Oceans Canada
0 150 300 600 900 1,200
Kilometers
0 75 150 300 450 600
Nautical Miles
Projection: Miller Cylindrical
Legend
Administrative Areas
Shrimp Management Areas
Shrimp Sub-Management Unit
Northwest Atlantic Fisheries Organization (NAFO) Divisions
Inuit Settlement Areas and Marine Regions
Areas of Equal Use and Occupancy
Nunavut Settlement Area
Nunavik Marine Region
Labrador Settlement Area
Other
Communities
Canada Landmass
Landmass (Other)
Description: Solid green lines indicate where shrimp management areas differ from NAFO Divisions. Shrimp Fishing Area 4 through 7 are located West of the EEZ. Shrimp Fishing Area 6 strides NAFO Divisions 2J and 3K and Area 7 overlaps with NAFO Division 3L. Dashed green line indicates shrimp sub-management units.
This is not an authoritative map. It has been prepared for illustrative purposes only.
80°W 76°W 72°W 68°W 64°W 60°W 56°W 52°W 48°W
78°N 74°N 70°N 66°N 62°N 58°N 54°N 50°N 46°N 42°N
Devon Island
Qaanaaq
Baffin Bay
1A
0A
0
Pond Inlet
Clyde River
Baffin Island
NU
Qikiqtarjuaq
Foxe Basin
Pangnirtung
Iqaluit
Kimmirut
Salluit
Quaqtaq
NU/NKW
NU/NKE
DSW
DSE
63°00'W
60°30'W
70°W
Puvirnituq
Kangirsuk
Ungava Bay
Aupaluk
Kuujjuaq
Inukjuak
QC
Uummannaq
Ilulissat
Aasiaat
GREENLAND
Davis Strait
1B
1
Sisimiut
Maniitsoq
1C
Nuuk
0B
1D
Paamiut
1E
Qaqortoq
2G
4
1F
Nain
5
2H
Makkovik
NL
2J
Cartwright
Happy Valley - Goose Bay
St. Anthony
6
3K
4S
4R
Gaspe
3Pn
4T
St. John's
7
3L
4Vn
3Ps
3M
3O
3N
4W
4Vs
4X
5Zw
5Ze

Science Advisory Report 2010/024

SUMMARY: Assessment of Northern Shrimp (*Pandalus borealis*) in SFA 0, 2, 3 and Striped Shrimp (*Pandalus montagui*) in SFA 2, 3 and 4 west of 63°W

SFA 0 – *Pandalus borealis*

Fishery

- No fishery in recent years.

Biomass

- Resource status is based on two surveys conducted in 2006 and 2008.
- Fishable biomass index was 750 t (2006) and 1,100 t (2008).
- Female spawning stock biomass index was 580 t (2006) and 800 t (2008).

Recruitment

- Recruitment is uncertain.

Mortality

- Competitive TAC of 500 t could result in a potential exploitation rate index of 40%-70% based on the observed biomass. A lower TAC is recommended.

Current Outlook and Future Prospects

- Future prospects for a fishery are limited.
- There are no plans for future surveys in this area.

Fisheries and Oceans Canada Pêches et Océans Canada
Science Sciences
Central and Arctic Region
Canadian Science Advisory Secretariat
Science Advisory Report 2010/024

ASSESSMENT OF NORTHERN SHRIMP (*Pandalus borealis*) IN SFA 0, 2, 3 AND STRIPED SHRIMP (*Pandalus montagui*) IN SFA 2, 3 AND 4 WEST OF 63°W

Top: Northern Shrimp (Pandalus borealis)
Bottom: Striped Shrimp (Pandalus montagui)

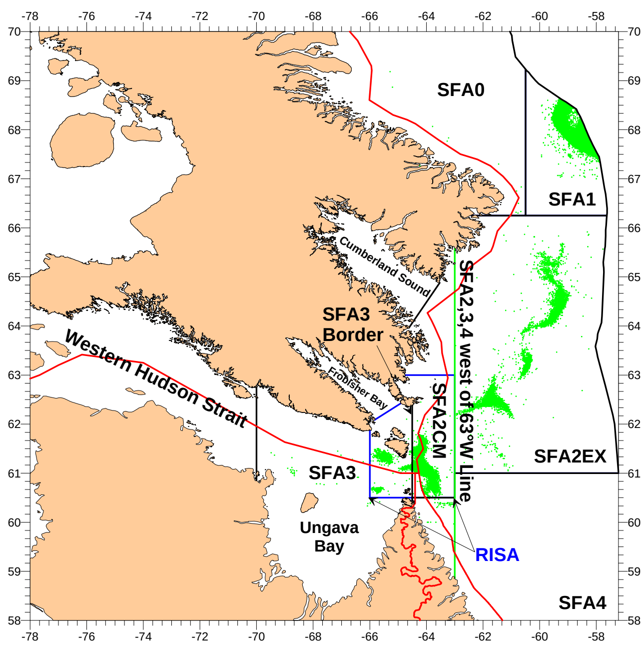


Figure 1. Map of Shrimp Fishing Areas and survey study areas in Hudson Strait and Ungava Bay, Davis Strait and Baffin Bay. Points are fishing locations from 1985-2009. Land claim boundaries are marked in red.

Context :

Fisheries and Oceans Canada (DFO) Fisheries and Aquaculture Management (FAM) has requested Science advice on the status of shrimp resources in the waters adjacent to Nunavut. The shrimp fishing areas (SFAs) being considered include SFAs 0, 2, 3 and 4 west of 63°W (Fig. 1). SFA 1 is assessed by the North Atlantic Fisheries Organization and will not be discussed here.

A series of fishery-independent surveys and fishery data formed the basis of the current assessment. Surveys were conducted in five study areas (Fig. 1); SFA 0, SFA 2EX (SFA 2 east of 63°W), the Resolution Island study area (RISA: 66°W-63°W and 60°30'N-63°N), SFA 3 (west of RISA) and western Hudson Strait (WHS: 70°W-78°W). Observer catch data corresponds to management areas SFA 0, SFA 2EX, SFA 2CM, SFA 3 and SFA 4 west of 63°W.

*Two species of shrimp, northern shrimp (*Pandalus borealis*) and striped shrimp (*P. montagui*), occur in these areas. Northern shrimp is the dominant species in SFAs 0 and 2EX. Striped shrimp is the dominant species in SFA 3. Both species are highly mixed and interspersed in RISA.*

Past management of the fishery has involved Total Allowable Catch (TAC) allocations for subareas of the SFAs under various exploratory and commercial licences. TACs were set without fishery-independent survey data from these areas.

This assessment follows the framework developed in 2007 for northern shrimp off Labrador and the northeastern coast of Newfoundland (DFO 2007). Both species were last assessed in 2008 (DFO 2008). Assessments are planned every two years.

SUMMARY

- *Pandalus borealis* was assessed in management areas SFA 0, SFA 2 (SFA 2EX and SFA 2CM), SFA 3 (SFA 3 and RISA west survey areas) and western Hudson Strait (WHS).
- *Pandalus montagui* was assessed in management area SFA 2, 3, 4 west of 63°W (SFA 2CM, SFA 3 and SFA 4 west of 63°W).
- Since the 2008 assessment, four research surveys: 2008 DFO survey of SFA 0, 2009 DFO survey of SFA 3 and western Hudson Strait, the 2008 and 2009 Northern Shrimp Research Foundation (NSRF)-DFO surveys of SFA 2EX and RISA provide the fishery-independent data for this assessment.
- Production (survey biomass and fishery data) and fishery exploitation rate indices are used to assess the resources.

SFA 0 – *P. borealis*

Fishery

- No fishery in recent years.

Biomass

- Resource status is based on two surveys conducted in 2006 and 2008.
- Fishable biomass index was 750 t (2006) and 1,100 t (2008).
- Female spawning stock biomass index was 580 t (2006) and 800 t (2008).

Recruitment

- Recruitment is uncertain.

Mortality

- Competitive TAC of 500 t could result in a potential exploitation rate index of 40%-70% based on the observed biomass. A lower TAC is recommended.

Current Outlook and Future Prospects

- Future prospects for a fishery are limited.
- There are no plans for future surveys in this area.

SFA 2 (SFA 2EX and SFA 2CM combined)– *P. borealis*

Fishery

- CPUE varied without trend at a high level from 2000 to 2008/09, increasing in 2009/10.

Biomass

- Resource status is based on fishery data and a four year survey series starting in 2006.
- Fishable biomass index increased from 33,000 t in 2006 to 78,000 t in 2009.
- Female spawning stock biomass index increased from 17,000 t in 2006 to 39,000 t in 2009.

Recruitment

- Recruitment is uncertain.

Mortality

- The observed exploitation rate index has declined from a 2006/07 high of 18% to 7% in 2009/10. The four-year mean was 13%.
- Potential exploitation rate index based on total TAC has declined from a high of 27% in 2006/07 to 11% in 2009/10 with a mean of 20%.
- SFA 2 comprises an exploratory area (SFA 2EX) with low exploitation rate index and a commercial area (SFA 2CM).

Current Outlook and Future Prospects

- Survey biomass indices have been increasing since 2006/07.
- Female spawning stock biomass is currently in the healthy zone, well above the provisional Upper Stock Reference.
- Transferring 1,200 t of *P. borealis* quota from SFA 2CM to SFA 2EX would reduce fishing pressure on SFA 2CM without exceeding an exploitation rate index of about 15% of the observed biomass.

SFA 3 (including RISA-W survey area) – *P. borealis*

Fishery

- There is no directed *P. borealis* fishery in this area.

Biomass

SFA3 west of RISA

- Resource status is based on two survey years, 2007 and 2009.
- Fishable biomass index for the two years was 14,600 t (2007) and 15,500 t (2009).
- Female spawning stock biomass index was 3,200 t (2007) and 3,800 t (2009).

RISA-W

- Resource status is based on two survey years, 2008 and 2009.
- Fishable biomass index for the two years was 3,700 t (2008) and 606 t (2009).
- Female spawning stock biomass index was 2,250 t (2008) and 200 t (2009).

Recruitment

- Recruitment is uncertain.

Current Outlook and Future Prospects

- Prospects are uncertain due to limited data.

SFA 2, 3, 4 west of 63° management area – *P. montagui*

Fishery

- CPUE has varied without trend since 2000 at a high level.

Biomass

- Resource status is based on fishery data and four years of survey data in SFA 2, SFA 4 using the Campelen trawl starting in 2006 and two surveys in SFA 3 east of 66°W using the Cosmos trawl in 2007 and 2009.
- Fishable biomass index for the area between 63°W to 66°W had an overall mean of 12,900 t.
- Fishable biomass index for the SFA 3 area was 48,400 t (2007) and 46,700 t (2009).

- Female spawning stock biomass index for area between 63°W to 66°W had an overall mean of 9,500 t.
- Female spawning stock biomass index for the SFA 3 area was 16,700 t (2007) and 18,000 t (2009).

Recruitment

- Recruitment is uncertain.

Mortality

- The observed exploitation rate index for 2008/09 and 2009/10 was low at 4%.
- The potential exploitation rate index varied between 28% and 47% based on the total TAC (6,300 t) for all *P. montagui* for 2008/09 and 2009/10.

Current Outlook and Future Prospects

- Female spawning stock biomass is currently in the healthy zone, well above the provisional Upper Stock Reference for the area between 63°W to 66°W.

Western Hudson Strait - *P. borealis* and *P. montagui*

Fishery

- There has never been a fishery in this area.

Biomass

- Resource status is based on one survey in 2009.
- Fishable biomass index was 175 t for *P. borealis*, 3,800 t *P. montagui*.
- Female spawning stock biomass 7 t for *P. borealis* and 1,200 t *P. montagui.*

Current Outlook and Future Prospects

- Outlook for a fishery in this area is poor.

BACKGROUND

Species Biology

Northern shrimp (*P. borealis)* are found in the Northwest Atlantic from Baffin Bay to the Gulf of Maine, and striped shrimp (*P. montagui)* are found from Davis Strait south to the Bay of Fundy. Both species have preferred depth and temperature distributions. In the north, *P. montagui* prefer cooler water (-1 to 2°C) which tend to occur in shallower depths than *P. borealis* (0 to 4°C). The main density for *P. borealis* tends to occur at 300-600 m while *P. montagui* occur mainly in 200-400 m. Northern shrimp have been found associated with sediment high in organic content. Striped shrimp adults prefer harder bottoms and are found on sand, mud, gravel and rocks.

Both species of shrimp are protandric hermaphrodites, functioning as males early in their lives then changing sex and reproducing as females for the remainder of their lives. Females usually produce eggs once a year in the late summer-fall and carry them, attached to their abdomen, through the winter until the spring, when they hatch. Newly hatched shrimp spend three to four months as pelagic larvae. At the end of this period they move to the bottom and take up the life style of the adults. Shrimp ageing in the north is uncertain but shrimp are thought to live five to eight years. Growth rates and maturation are likely slower in northern populations. Both species migrate into the water column during the night. The migration consists mainly of males and smaller females. Shrimp are opportunistic feeders on or near the sea floor and in the water column.

Pandalus shrimp are important forage species for fishes and marine mammals.

Fishery

The fishery is managed by Total Allowable Catch (TAC). Access to the fishery is limited to 17 offshore license holders and to special quota allocations to Nunavut managed by the Nunavut Wildlife Management Board (NWMB) to be fished within the Nunavut Settlement Area (NSA). The NWMB sub-allocates their quota to Hunters and Trappers Organizations (HTO) and other Nunavut organizations such as the Baffin Fisheries Coalition. New access to the fishery has been capped but Nunavut HTOs charter vessels on a royalty basis to fish their quota. All fishing to date has been conducted by large vessels (>500 t) with 100% observer coverage.

Fishing gear consists of single and more recently twin shrimp trawls requiring a minimum codend mesh size of 40 mm and Nordmøre separator grate (maximum 28 mm bar spacing). Since 2003, the management year has been April 1 to March 31. The fishing season is limited by the extent of sea ice, and is conducted between May and December in most years.

P. borealis has been the main commercial species throughout the history of the shrimp fishery in this area. Directed *P. montagui* fishing does occur but the majority of this species is taken as by-catch in the directed *P. borealis* fishery.

The fishery began in the late 1970s in SFA 1. Exploratory fishing expanded into northern SFA 2 and then to areas southeast of Resolution Island in Hudson Strait. In the mid-1990s, the fishery moved southeast of Resolution Island in SFA 2, where the main fishery remains to date. In recent years, no fishing has occurred in SFA 0, or the area of SFA 3 west of RISA. Over the last eight years the distribution of fishing effort has remained unchanged.

By-catch taken over the history of the fishery is summarized in Siferd (2010).

ASSESSMENT

This is an assessment of both *P. borealis* and *P. montagui*. These two species have overlapping distributions, especially in RISA, resulting in an overlap of their fisheries. The total removal, both directed catch and by-catch, of each species is considered in the assessment (Siferd in prep.).

Prior to the 2008 assessment, resource status could only be evaluated on the basis of trends in fishery CPUE and observer sampling. Fishery independent bottom trawl research surveys have been completed in SFA 0, SFA 2EX, RISA and SFA 3. In addition, for this assessment a survey of western Hudson Strait (west of SFA 3) was conducted to examine the western distribution of the population. These surveys allowed the estimation of abundance, biomass and recruitment indices for all SFAs in the assessment. Depending on the area, the number of surveys range from one to five years. Therefore for some areas, the time series is not long enough to draw definitive conclusions as yet. In SFAs 2 and 3, plans are in place to continue surveys. There are no further plans to survey SFA 0 and western Hudson Strait.

The assessment follows the framework established by DFO (2007) where possible. Fishery data and fishable and female spawning stock biomass (SSB) indices form the basis of the assessment. Fishable biomass refers to that portion of the survey catch with a carapace length greater than 17 mm and therefore includes both males and females. SSB refers to the female portion of the survey catch regardless of size. The recruitment index, which is the abundance of the population from 11.5 to 17 mm carapace length, was reviewed. An acceptable methodology to calculate total instantaneous mortality (Z) has not been found and therefore was not included as part of the assessment in these areas. Since surveys were conducted in the middle of the fishing season, exploitation rate indices were calculated based on catch divided by the fishable biomass index from the same year. TACs in these areas were not based on fishery independent biomass data when they were set so the assessment also considered the potential exploitation if the entire TAC was taken. Bootstrapped 95% confidence intervals have been included for each of the indices.

For this assessment, population status was evaluated within the Precautionary Approach (PA) framework (DFO 2006) against provisional limit reference points (LRP) developed for shrimp (DFO 2009a) for each management area. Proxies for the LRPs were based on geometric mean of available SSB. The provisional Lower Limit Reference (LRP) is 30% and Upper Stock Reference (USR) 80% of the mean.

SFA 0 and SFA 3 study areas were surveyed with a Cosmos trawl, whereas all other areas were surveyed with a Campelen trawl. Following the 2008 assessment, the mathematical model for determining swept area of the Cosmos trawl resulted in a smaller, more accurate swept area estimate than used previously. The new method was applied to all DFO surveys conducted with the Cosmos trawl including those assessed in 2008. This resulted in a higher biomass than was reported in the 2008 assessment.

Strong tidal currents up to five knots in Hudson Strait could result in quick shifts in shrimp biomass. This is an added complication when interpreting the data.

SFA 0 – *P. borealis*

Fishery

No commercial fishing has occurred in SFA 0 in recent years.

Biomass

The assessment of SFA 0 is based on two DFO surveys[1] conducted in late August-early September 2006 and October in 2008. *P. borealis* was the only commercial shrimp caught. Most *P. borealis* were found in the southern half of the study area with occasional *P. borealis* recorded north of 70°N. The fishable biomass index was 750 t (2006) and 1,100 t (2008). Most P*. borealis* were caught in the 400-600 m depth range in both years. The total area within this depth range combined with the species' preferred temperature (available habitat), limits the commercial potential in SFA 0. SSB index was 580 t (2006) and 800 t (2008). Individual size was larger than observed in other SFAs.

Recruitment

Very few individuals in either survey were found with carapace lengths less than 17 mm; therefore, the recruitment in this area is uncertain.

[1] All DFO surveys are funded in partnership with the Government of Nunavut, Nunavut Wildlife Management Board, Baffin Fisheries Coalition, Nunavut Tunngavik Inc., and Makivik Corp.

Mortality

Competitive TAC of 500 t, if fully taken, would result in an exploitation rate index of 40% (2008) to 70% (2006) based on the observed biomass.

Current Outlook and Future Prospects

With only two surveys, no biomass trends can be determined and current status remains uncertain. However, both surveys indicate very low total biomass of shrimp in this area. The area is not currently fished and based on the observed biomass, future prospects for a fishery are limited. As a result, no future surveys are planned at this time.

SFA 2 (SFA 2EX and SFA 2CM combined)– *P. borealis*

Fishery

SFA 2 is divided at 63°W forming two management areas, SFA 2EX (exploratory) to the east and SFA 2CM (commercial) to the west, each having an assigned TAC. Most fishing has occurred in SFA 2CM since 1994.

Some exploratory sets are taken in SFA 2EX annually, but from the low in 2003/04 catches have fluctuated around a mean of 350 t to 2008/09 with a sharp increase to 974 t in 2009/10 (Fig. 2a). CPUE in this area has varied without trend at a moderate level from 1999 to 2008/09 with a sharp increase in 2009/10 (Fig. 3a). Observer records for the 2009/10 management year are incomplete, only containing 2/3 of the catch reported in the Canadian Atlantic Quota Report (CAQR). CPUE may change once all observer data are included.

In SFA 2CM, total catches (directed and by-catch) of *P. borealis* were stable at about 5,500 t per year, slightly above the TAC (Fig. 2b) from 2001 to 2007/08, with a slight decrease over the last two years. CAQR is reporting 4,400 t as of March 2010 so it is unlikely that the entire TAC will be taken for 2009/10.

CPUE trends in SFA 2CM and SFA 2 combined varied without trend at a high level from 2000 to 2008/09, increasing in 2009/10 (Fig. 3b, c). Industry indicated that the reduction in catch (2008/09 and 2009/10) (Fig. 2b, c) was the result of commercial/operational factors rather than resource availability.

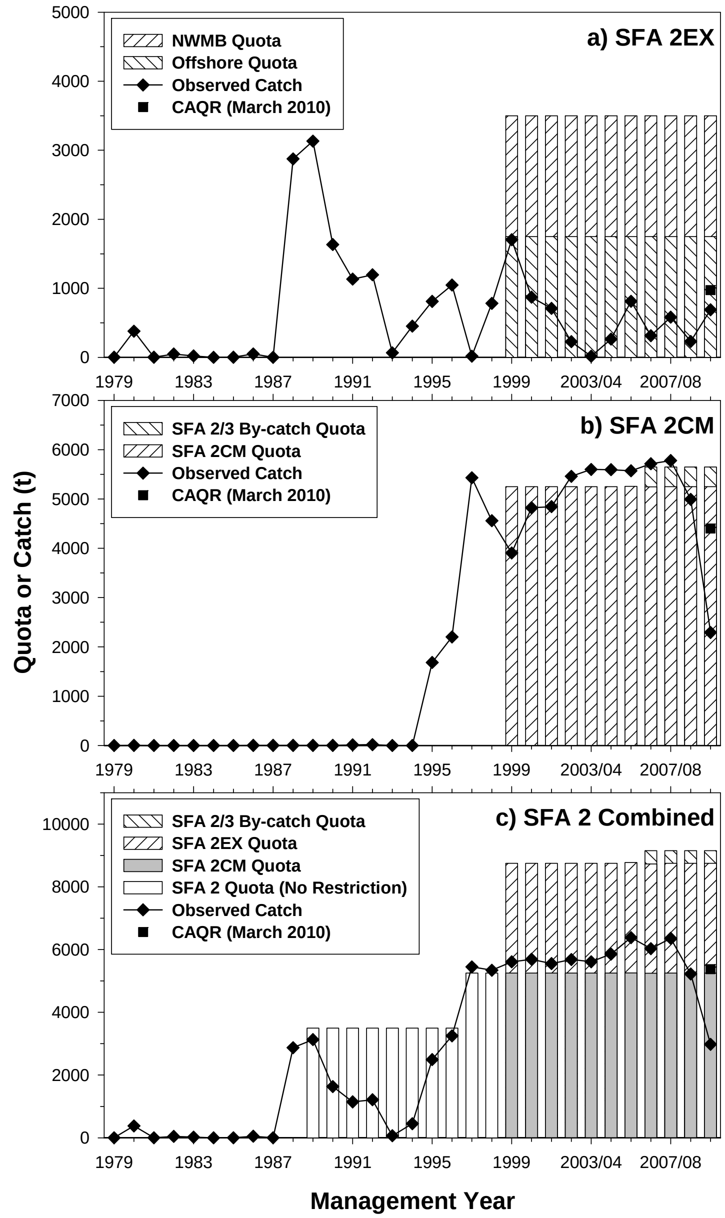


Figure 2. TAC, from the addition of assigned quotas, and historical catch as recorded by the observer program for a) SFA 2EX, b) SFA 2CM and c) SFA 2 combined. Observed catch records are incomplete for 2009/10 but CAQR (March 2010) reports 974 t. CAQR should be the total catch in 2009/10 as SFA 2 is generally not fished past December.

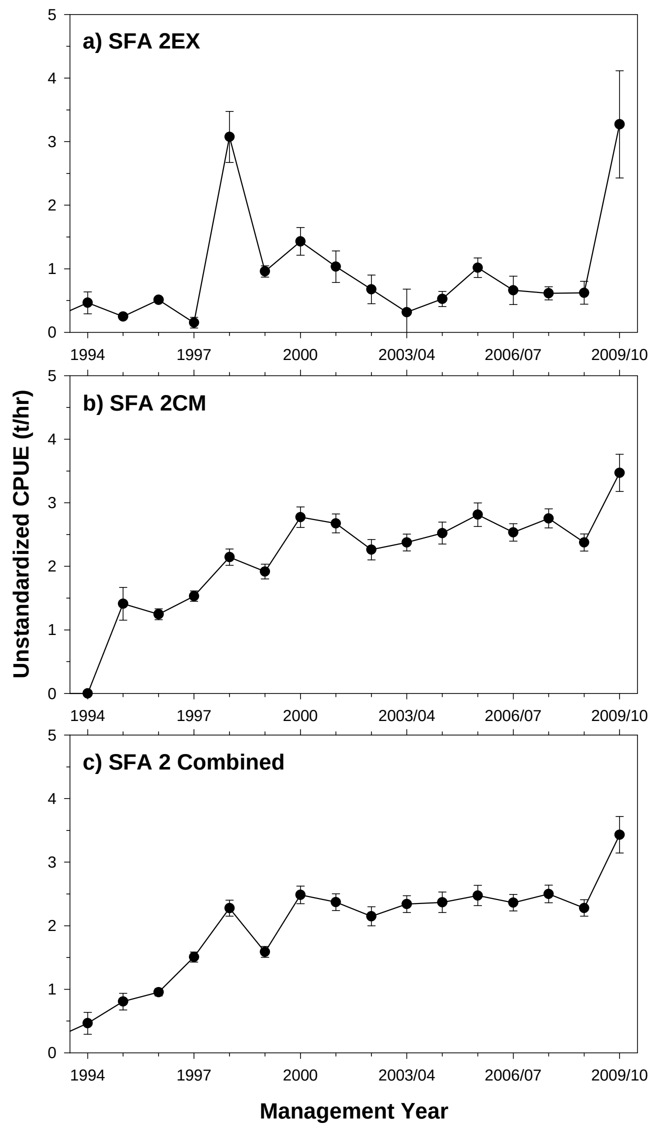


Figure 3. Unstandardized CPUE indices in a) SFA 2EX, b) SFA 2CM and c) SFA 2 combined. Observer records for 2009/10 season are incomplete.

Biomass

RISA was divided in half to allow biomass to be estimated for SFA 2CM (RISA-E) which could be added to SFA 2EX for an estimate of SFA 2 as a whole (DFO 2009b). SFA 2EX has five years of survey data, SFA 2CM has four years so there are four years of survey data for SFA 2 as a whole beginning in 2006.

In SFA 2EX, the fishable biomass index increased from 23,000 t in 2006 to 36,000 t in 2008 and 2009. The SSB index ranged from a low of 10,000 t in 2006 to 23,000 t in 2007.

In SFA 2CM, fishable biomass index increased from 11,000 t in 2008 to 42,000 t in 2009. The SSB index ranged from a low of 6,000 in 2008 to 22,000 in 2009.

In SFA 2, fishable biomass index increased from 33,000 t in 2006 to 78,000 t in 2009 (Fig. 4a). SSB index increased from 17,000 t in 2006 to 39,000 t in 2009 (Fig. 4b).

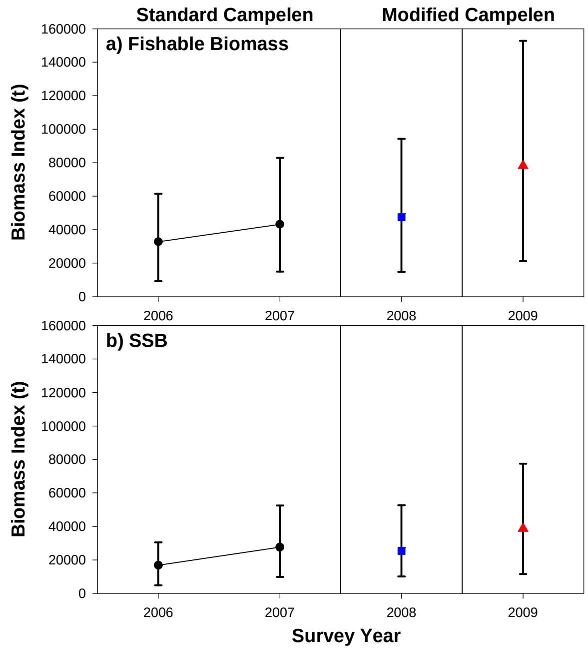


Figure 4. SFA 2 a) fishable biomass and b) SSB indices for the four common survey years 2006-2009. The modified Campelen was used in SFA 2CM (RISA-E), the standard in SFA 2EX in 2008. The modified was used in both areas in 2009.

Recruitment

Recruitment is uncertain. Currently, there is no recruitment index for this area but work continues to develop one.

Mortality

In SFA 2, the observed exploitation rate index has declined from a 2006/07 high of 18% to 7% in 2009/10 (Fig. 5a). The four-year mean was 13%. The potential exploitation rate index based on total TAC has declined from a high of 27% in 2006/07 to 11% in 2009/10 with a mean of 20% (Fig. 5b). The exploratory area (SFA 2EX) has a low exploitation rate index of 2% but a higher potential rate of 11% (i.e., if all TAC is taken). In comparison, the commercial area (SFA 2CM) has an exploitation rate index of 33% in 2008/09 and 10% in 2009/10 and potential exploitation rate indices of 37% in 2008/09 and 13% in 2009/10.

Current Outlook and Future Prospects

For SFA 2, survey biomass indices have been increasing since 2006/07. SSB is currently in the healthy zone, well above the provisional USR (Fig. 6). Trends in biomass are positive and CPUE appears stable in recent years. Future prospects appear positive for SFA 2.

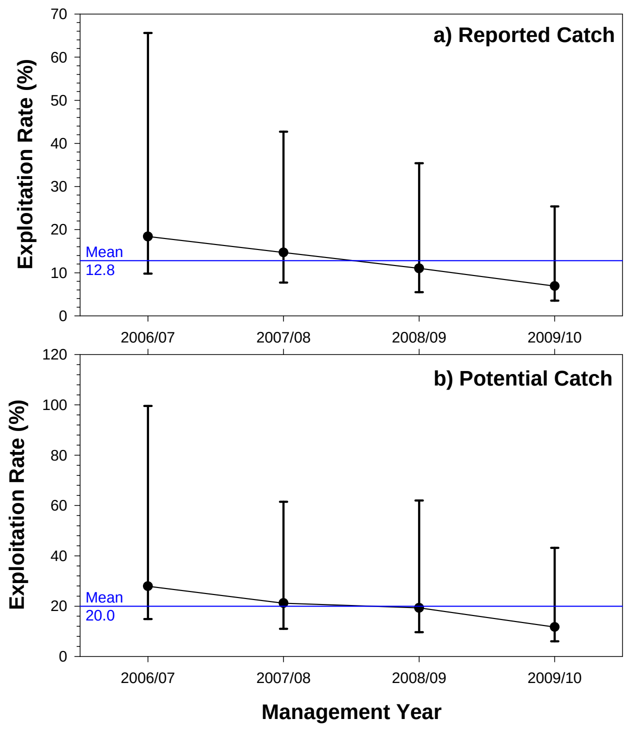


Figure 5. Exploitation rate index based on observed catch for 2006-2008 and CAQR reported catch in 2009/10 for the whole of SFA 2. Observer records are incomplete for the 2009/10 season.

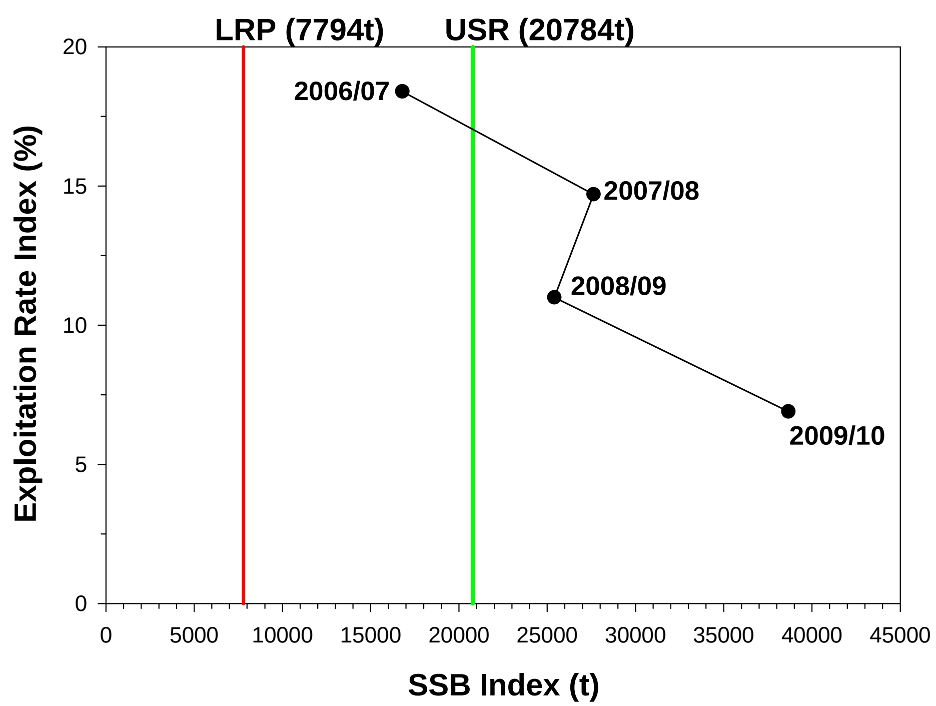


Figure 6. SFA 2 precautionary approach framework with provisional limit reference points and trajectory of exploitation rate index vs SSB.

In SFA 2EX, all indices indicate a stable population with low actual exploitation and a potential exploitation of less than 15%. The SFA 2CM sub-area has exhibited relatively high exploitation rates with a mean of 22% for 2008/09 and 2009/10. Transferring 1,200 t of *P. borealis* quota from SFA 2CM to SFA 2EX would reduce fishing pressure on SFA 2CM without exceeding an exploitation rate index of 15% of the observed biomass assuming that biomass levels remain the same as observed in 2009. Transferring quota from SFA 2EX to SFA 2CM would increase the already high exploitation rate indices in that area.

SFA 3 (including RISA-W survey area) – *P. borealis*

Fishery

There is no directed commercial fishery for *P. borealis* in the SFA 3 area.

Biomass

The assessment of SFA 3 is based on two DFO surveys conducted in October 2007 and 2009 in SFA 3 west of RISA-W using the Cosmos trawl and four NSRF-DFO surveys in August 2006-2009 using the Campelen trawl in RISA-W. Beginning in 2008, a modified Campelen trawl was used in RISA-W, resulting in better spatial coverage thereby increasing confidence in the 2008 and 2009 survey results.

The fishable biomass index in SFA 3 west of RISA-W was 14,600 t (2007) and 15,500 t (2009). In RISA-W, the fishable biomass index was 3700 t (2008) and 606 t (2009). The SSB index in SFA 3 west of RISA-W was 3200 t (2007) and 3800 t (2009). In RISA-W, the SSB index was 2250 t (2008) and 200 t (2009).

Recruitment

The recruitment index in the SFA 3 west of RISA-W increased from 700 to 900 million between 2007 and 2009 and increased from 2 to 12 million in RISA-W from 2008 to 2009. Recruitment is uncertain in these areas. However, the proportion of 11.5 mm to 17 mm shrimp in SFA3 is higher than seen in other northern SFAs.

Mortality

In recent years there has been no *P. borealis* exploitation in SFA 3 although there is a 400 t by-catch quota for *P. borealis* in the directed *P. montagui* fishery.

Current Outlook and Future Prospects

The majority of *P. borealis* was found in Hudson Strait north of Akpatok Island. This SFA is dominated by *P. montagui* with *P. borealis* comprising 25% of the total *Pandalus* biomass. With two surveys in each study area, no resource trends can be determined. The use of two different gears in surveying the SFA further limits our ability to provide advice. Solutions are being investigated. The fishable biomass index of at least 15,000 t would suggest there is potential for a *P. borealis* fishery in this area. However, there is a large proportion of smaller individuals and a mix of species in this area.

SFA 2, 3, 4 west of 63° management area – *P. montagui*

Resource status is based on fishery data and four years of survey data in SFA 2 and SFA 4 using the Campelen trawl starting in 2006 and two surveys in SFA 3 east of 66°W using the Cosmos trawl in 2007 and 2009.

Fishery

The majority of *P. montagui* catch is taken as by-catch in the directed fishery for *P. borealis*. The vast majority of *P. montagui* comes from SFA 2CM south of 63°N (i.e., RISA-E). There are quotas for directed *P. montagui* fisheries within the NSA in SFAs 2 and 3 but have generally not been taken. Catch is taken between 63°W and 64°30'W with small amounts just over the border in SFA 3 with none taken further west than 66°W in recent years. Catch has declined from a high of 4,200 t in 2000 to a low of 438 t in 2009/10 (Fig. 7). This decline is thought to be more a reflection of the industry's increased ability to find cleaner catches of *P. borealis* than of declining biomass of *P. montagui*. This is supported by the observation that CPUE has varied without trend at a high level during the same time period (Fig. 8).

Biomass

Biomass for common years can not be combined because of area specific differences in trawls, vessels used and survey timing. Since the NSRF-DFO survey covers the entire fishery area, it was used as the basis to assess this resource. SFA 3 biomass was not combined with that from the other area but is presented to represent biomass outside of the main fishing area. The fishable biomass index between 63°W and 66°W was 22,500 t (2008) and 13,500 t (2009) (Fig. 9). Confidence in the biomass estimates from the 2006 and 2007 NSRF-DFO surveys is low because of incomplete spatial coverage. The fishable biomass index for the SFA 3 survey area was 48,000 t (2007) and 47,000 t (2009). The SSB index between 63°W and 66°W was 19,000 t (2008) 11,000 t (2009). The SSB index for the SFA 3 survey area was 17,000 t (2007) and 18,000 t (2009).

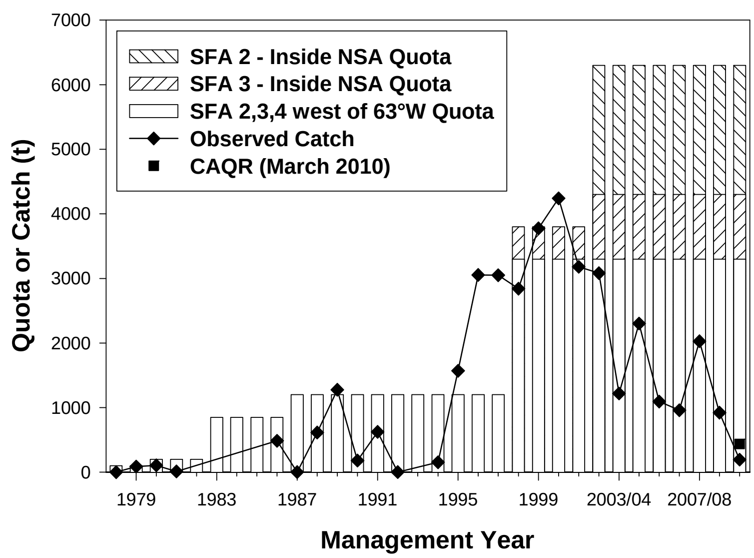


Figure 7. SFA 2, 3, 4 west of 63°W Quota Area cumulative quotas and historic catch. Observed catch records are incomplete for 2009/10 but CAQR (March 2010) reports 438 t. CAQR should be the total catch in 2009/10 as the area is generally not fished past December.

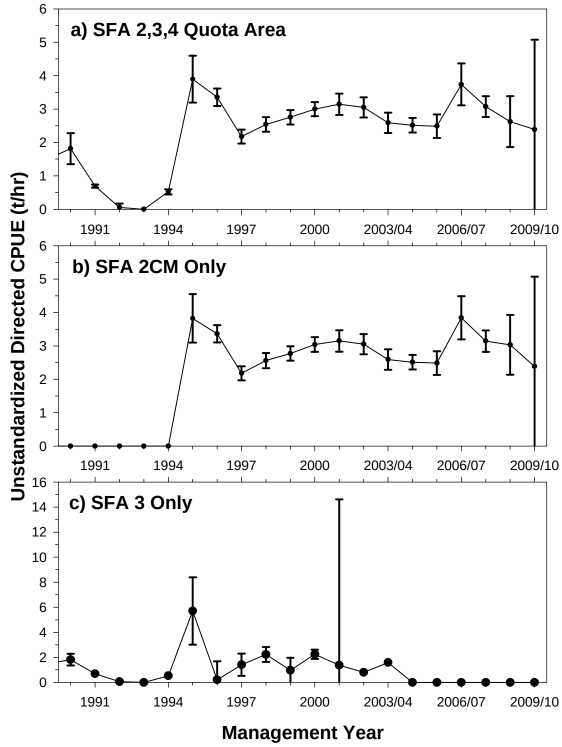


Figure 8: Unstandardized CPUE indices for directed P. montagui fishing in the a) SFA 2, 3, 4 Quota Area, b) SFA 2CM and c) SFA 3 with 95% confidence interval. Observer records for 2009/10 season are incomplete.

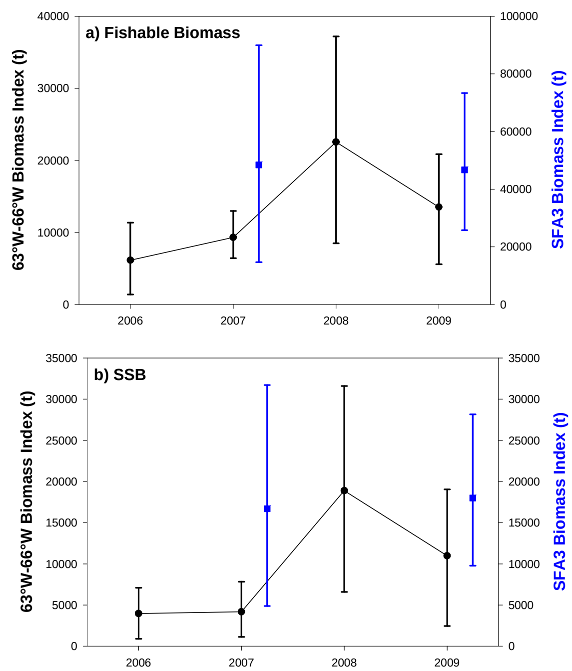


Figure 9: a) Fishable biomass and b) SSB indices for the 63°W-66°W area and the two years of DFO surveys in the SFA 3 survey area.

Recruitment

Recruitment is uncertain. Currently, there is no recruitment index for this area but work continues to develop one.

Mortality

Catch can only be related to biomass observed in the area of 63°W to 66°W as this is where the fishery occurs. The exploitation rate index for the last two years was low at about 4% (Fig. 10a). If the cumulative quotas were taken in the area of 63°W to 66°W this would result in a much higher exploitation rate index of 28% (2008/09) and 47% (2009/10) (Fig. 10b).

Current Outlook and Future Prospects

The SSB in the area between 63°W and 66°W is currently in the healthy zone, well above the provisional USR (Fig. 11). There is some concern that the potential exploitation rate index would be high if the entire TAC was taken from within the area between 63°W and 66°W. However, the additional biomass in SFA 3 west of this area somewhat lessens the concern. This highlights the need for rationalization of quotas and boundaries.

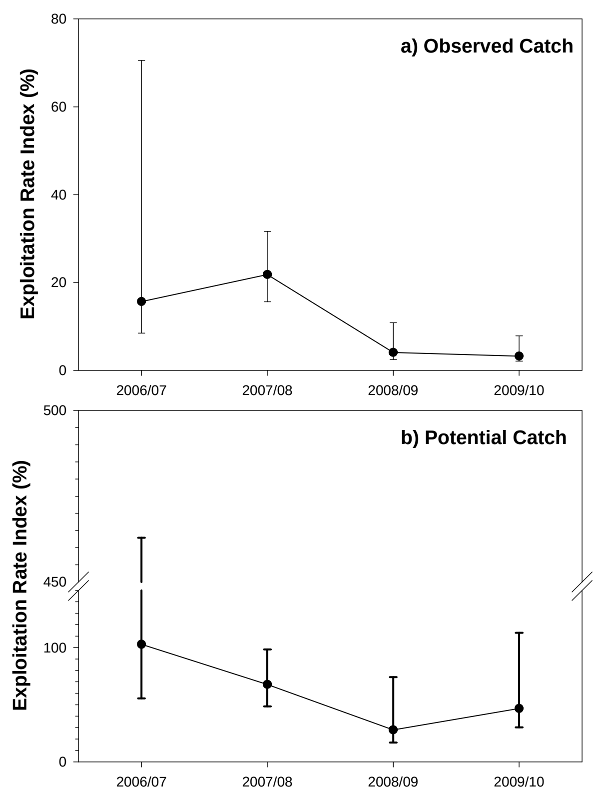


Figure 10. Exploitation rate index based on a) observed catch for 2006-2008 and b) potential catch should the entire TAC be taken in SFA 2, 3, 4 between 63°W and 66°W. Observer records are incomplete for the 2009/10 season.

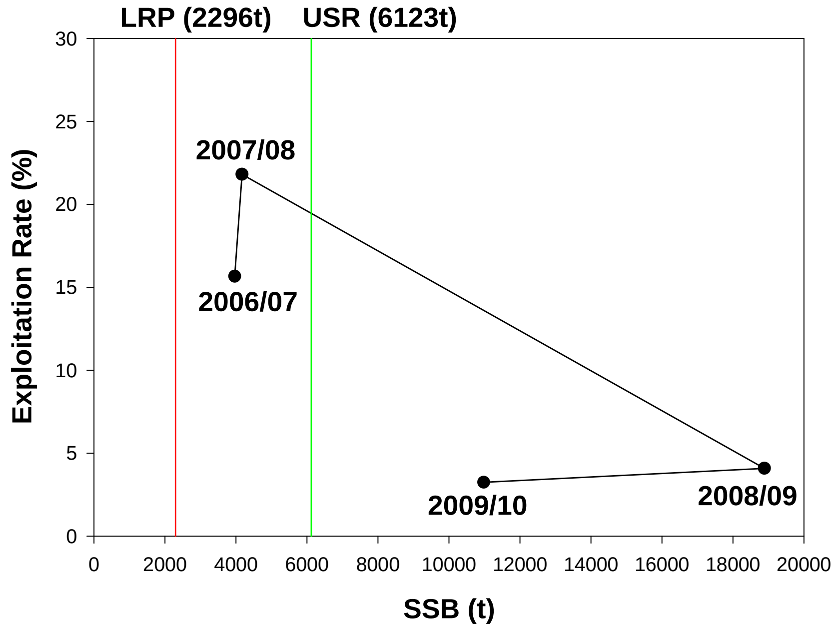


Figure 11. SFA 2, 3, 4, 63°-66°W precautionary approach framework with provisional limit reference points and trajectory of exploitation rate index vs SSB.

Western Hudson Strait - *P. borealis* and *P. montagui*

Fishery

This is not a commercial fishing area under the Atlantic Fisheries Regulations. The area has never been fished.

Biomass

The assessment of this area is based on a single DFO survey conducted in October 2009. *P. borealis* and *P. montagui* both occur in this area. The fishable biomass index for *P. borealis* was 175 t and for *P. montagui* was 3,800 t. The *P. borealis* biomass consisted mainly of males with an SSB of only 7 t. Approximately one third of the *P. montagui* biomass was females with an SSB of 1,230 t. The highest density of both species occurred in the far eastern portion of the survey area near SFA 3.

Recruitment

Recruitment is unknown.

Mortality

There is no fishing mortality.

Current Outlook and Future Prospects

The resource is currently unexploited. Based on the survey biomass estimates and limited suitable habitat, the prospect for a fishery in this area is very poor.

Sources of Uncertainty

Hudson Strait is a highly dynamic system with strong tidal currents and mixing. Shrimp could be transported great distances in a relatively short period of time. This could result in populations shifting rapidly among the small management areas.

Fisheries independent surveys are conducted annually or biennially depending on the survey area. If there is seasonality in the distribution of shrimp and/or the catchability of the shrimp in the trawl, this could affect the assessment.

Trawls used in the surveys have catchability less than one but the exact value is unknown. Therefore, estimates produced from the surveys are minimum observed rather than absolute levels. Catch is known; however, the total fishery induced mortality is unknown (landed catch plus incidental mortality from trawling). Exploitation rates are relative indices rather than absolute.

Modifications were made to the Campelen trawl which resulted in better spatial coverage in 2008 and 2009 within RISA. This provided increased confidence in the results from these two years. However, there are still only two years of complete surveys. Continued use of this modified trawl should allow better evaluation of future resource trends.

Surveys from 2006-2008 were all conducted at the height of the spring tide, while the 2009 survey was conducted at a neap tide. Experimental work done by DFO in 2007 in the Resolution Island area suggests that results may be affected by the tidal cycle. With the new standard gear for the northern study areas, this effect will be minimized by conducting the survey during neap tides as was done in 2009.

In RISA, fishery trends (CPUE) may not reflect resource abundance. The location of fishing sets is affected by the distribution of the two species and their different market values. Since 1999, the land claim borders changed the location of the fishery.

INDUSTRY PERSPECTIVES

Offshore Shrimp Sector

The offshore shrimp sector observes that resource conditions observed in SFA 2 continue to be positive.

CONCLUSIONS AND ADVICE

SFA 0 – *P. borealis*

While no commercial fishing occurs in SFA 0 it does have an assigned competitive 500 t TAC. This TAC was intended to provide fishers the opportunity to investigate the potential for shrimp fishing in the area. The current status is uncertain. The competitive TAC if taken would result in a very high exploitation rate index (40-70%). It is recommended that the TAC be lowered. This would still leave a small competitive TAC for exploration in the area but would reduce potential harm if fully taken.

SFA 2 (SFA 2EX and SFA 2CM combined)– *P. borealis*

The current status of this resource is considered healthy based on the provisional limit reference points. Fishing pressure in SFA 2CM is higher than in the SFA 2EX. Reducing the fishing effort in SFA 2CM by moving quota to SFA 2EX would be positive for the SFA 2 resource as a whole without increasing the overall TAC for SFA 2. Transferring up to 1,200 t should result in an exploitation rate index of less than 15% in SFA 2EX assuming that biomass levels remain the same as observed in 2009. Transferring quota from SFA 2EX to SFA 2CM would increase the already high exploitation rate index in that area.

SFA 3 (including RISA west survey area) – *P. borealis*

The current status of this resource is considered uncertain because the assessment is based on only two years of survey data in each of the sub-areas, complicated by use of different survey trawls. There is no TAC for directed *P. borealis* fishing. The fishable biomass index of at least 15,000 t would suggest there is potential for a *P. borealis* fishery in this area.

SFA 2, 3, 4 west of 63° management area – *P. montagui*

The current status of this resource is considered healthy based on the provisional limit reference points within the area 63°W-66°W. Although the actual exploitation rate index appears to be low due to limited directed fishing, the high potential exploitation rate index in the area is of some concern.

Western Hudson Strait - *P. borealis* and *P. montagui*

The objective of the 2009 survey in this area was to define the extent of the two *Pandalus* species to the west of SFA 3. Results suggest that the boundary at 70°W for SFA 3 adequately defines the western limit of the resource. Surveys west of the SFA 3 border would add little information to the assessment; therefore no future surveys are being considered.

MANAGEMENT CONSIDERATIONS

This is an extremely complex region with multiple management areas and overlapping quotas that can be fished across management units with the added complication of two highly intermixed species overlying three adjacent land claim areas (Nunavut Settlement Area, Nunavik Marine Region and Nunatsiavut Zone). This makes the assessment difficult.

The overlap of quotas in the northern SFAs result in TAC levels which would lead to very high exploitation rate indices if fished to their full extent. This continues to be a concern.

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DFO. 2010. Assessment of Northern Shrimp (*Pandalus borealis*) in SFA 0, 2, 3 and Striped Shrimp (*Pandalus montagui*) in SFA 2, 3 and 4 west of 63°W. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/024.

CO-SUBMISSION TO THE
NUNAVUT WILDLIFE MANAGEMENT BOARD March 10, 2021

FOR

Information:
Decision: X
Issue: Approval of the 2021 Integrated Fisheries Management Plan (IFMP) for Cambridge Bay Arctic Char (*Salvelinus aplinus*), Commercial Fishery, Nunavut.
Map: Commercial fishing locations for the Cambridge Bay Commercial fishery included in the IFMP.

Background:

The 2014 Integrated Fishery Management Plan (IFMP) for the Cambridge Bay Arctic Char Commercial Fishery has been updated and revised for 2021. The IFMP provides a clear and concise summary of the Arctic Char fishery characteristics, including the history, location, gear, participants, management issues, decision making processes and biology of Arctic Char (*Salvelinus aplinus*). The IFMP describes the existing previously approved management measures, current functioning, license conditions and regulations.

It is important to note that although the IFMP contains some new information, it does not include any proposed changes to the management regime that would affect any allocation holder, harvester or stakeholder in the fishery.

Of note, a new addition to the updated 2021 IFMP is a description of new initiatives and regulations including DFO's Ghost Gear Initiative and US-MMPA regulations, which have been consulted on with stakeholders. To adhere to the new initiatives and regulations, commercial license conditions and requirements for reporting have been updated in the IFMP and will be implemented in 2021. A summary of all changes to the 2021 IFMP is included in Tab 2.

Consultation:

DFO Arctic Region has consulted with stakeholders of the Cambridge Bay Commercial Arctic Char fishery to review and comment on the updated IFMP at previous pre and post season meetings and public engagements held in Cambridge Bay, Nunavut. The final draft was distributed to co-management partners and stakeholders for comments on January 14, 2021. A summary of consultations and stakeholders can be found in Tab 3.

The updated 2021 IFMP:

- summarizes the current management regime of this fishery, which has been used to sustainably manage the fishery for many years; ;
- updates the scientific and traditional knowledge of the stock that has been collected and shared since the 2014 IFMP was implemented;
- does not have any implications to any existing previously approved process / measure in the fishery;
- does not propose or imply any new management measures; and
- has undergone a full consultative process with all affected stakeholders and resource users.

It is recommended that the NWMB approve the updated 2021 IFMP to replace the 2014 IFMP previously approved by the Board.

Prepared by:

DFO Resource Management, Arctic Region.

Date:

February 4, 2021

Attachments: (4)

Tab 1: IFMP Summary (Translated/English)

Tab 2: Consultation Summary (Translated/English)

Tab 3: Summary of Changes (Translated/English)

Tab 4: Full 2021 Integrated Fisheries Management Plan (IFMP) (English/Inuinnaqtun)

Cambridge Bay IFMP Working Group Consultation on IFMP Update

Year	Stakeholder(s)	Mechanism
2017	Ekaluktutiak HTO, Elders, Kitikmeot Foods Ltd., Commercial Fishers, DFO	Post-season review and IFMP Working Group meeting - in-person meetings/persentation, notification of IMFP update forthcoming (5-year cycle)
2018	Ekaluktutiak HTO, Elders, Kitikmeot Foods Ltd., Commercial Fishers, DFO	Pre-season review and IFMP Working Group meeting - in-person meetings/persentation, discussion of aniticipated updates to IFMP
2018	Ekaluktutiak HTO, Elders, Kitikmeot Foods Ltd., Commercial Fishers, DFO	Post-season review and IFMP Working Group meeting - in-person meetings/persentation, review and discussion of curent IFMP and discussion of updates.
2018	Public engagements with community members	town hall public engagement to provide updates to the 2018 fishing season and discuss the need for updating of the IFMP.
2019	Ekaluktutiak HTO, Elders, Kitikmeot Foods Ltd., Commercial Fishers, DFO	Pre-season review and IFMP Working Group meeting - in-person meetings/persentation, discussion of aniticipated updates to IFMP - June 2019
2020	Ekaluktutiak HTO, Elders, Kitikmeot Foods Ltd., Commercial Fishers, DFO	Post fishing season - In-person meeting/presentation, . Presented proposed draft of updated IFMP January 2020
2020	Ekaluktutiak HTO, Elders, Kitikmeot Foods Ltd., Commercial Fishers, DFO	2019 post-season fishing meeting - dedicated overview, review and decisions on updates to current IFMP March 2020
2020	Ekaluktutiak HTO, Elders, Kitikmeot Foods Ltd., Commercial Fishers, DFO	June 2020 - Meeting to discuss final edits to IFMP update cancelled due to COVID travel restrictions - June 2020

2020	Ekaluktutiak HTO, Elders, Kitikmeot Foods Ltd., Commercial Fishers, DFO	Public engagement cancelled due to covid-19 - DFO was required to leave Cambridge Bay early - Dec 2020
2021	Ekaluktutiak HTO, Elders, Kitikmeot Foods Ltd.	Final review of IFMP update via email to IFMP Working Group - no face to face available due to COVID travel restrictions - December 2020

2020 Cambridge Bay Arctic Char IFMP Update Changes

All updates and changes are highlighed yellow in the full IFMP document

Section	Amended Text/Summary of Changes	Justification for Change
1 Overview	Section added to explain purpose of an Integrated Fisheries Management Plan (IFMP)	Information added to ensure completeness.
1.1 Cambridge Bay Arctic Char commercial fishery IFMP	Section added to explain the history and process of creating the IFMP in Cambridge Bay and the reason for updating it.	Information added to ensure completeness.
1.2 History	Addition of information about harvest at Paalik (Lauchlin River). River was not commercially harvested from 2010-2017 due to lack of economic viability. The EHTO and Kitikemot Foods Ltd. With support from DFO requested the targeted quota be increased. The NWMB determined the quota was legal and valid	Information added to ensure completeness.
1.3 Type of Fishery and Participants	Addition of information on Kitikmeot Food Ltd., local outfitters, and recreational fishing.	Information added to ensure completeness.
1.5 Fishery Characteristics	Additional information added on the use of weirs	Information was added to provide additional context for use of weir.
1.6.3 Policy on Managing Bycatch	Completion of logbooks is a licence condition to monitor bycatch. The usage of weirs eliminates almost all mortality of bycatch. Bycatch policies implemented for this fishery have ensured there is little concern to other animals other than the targeted Arctic Char.	Updated information to ensure completeness
1.6.4 Ghost Gear Initiative	Addition of information on DFO Ghost Gear Initiative and its implementation in the Cambridge Bay commercial fishery.	Section added to reflect current ghost gear management measures
2.2 Ecosystem Interactions	Addition of information on DFO's Sustainable Fisheries Framework (SFF) which aims to support stock conservation and sustainable use of aquatic resources in Canada. The SFF guides integrated fisheries management planning and also considers aquatic habitat and the species interactions within their ecosystem. Supporting the adoption of ecosystem-based approaches to management that aim to protect biodiversity and fisheries habitats	Information updated to highlight new SFF framework.
2.3 Traditional Knowledge and Inuit Qaujimajatuqangit (IQ)	Details of a collaboration between the Ekalultutiak Hunters and Trappers Organization (EHTO) to document the IQ of the Arctic in the Cambridge Bay region. It involved the training of local youth to conduct semi directed ethnocartographic interviews to document the IQ of nune individuals of the community. The IQ that was document was contributed to an IQ database managed by the EHTO and the project finished with a elder-youth knowledge exchange camp for a week in August 2016. There is a plan to organize and host similar events with the community.	Updated information to include new programs.
2.6 Research	There is a need to update stock assessment informatio and advice on sustainable harvest levels for each commercial waterbody and to improve the understanding of the Arctic char biology in the region. The continuation of annual fishery-dependent plant sampling of biological data facilitated through Kitikmeot Foods Ltd is very important, and has been ongoing since the 1970s. Fishery independent surveys are also completed annually to collect biological data to compliment the data collected throught he plant sampling program. DFO is collaborating with the Ocean Tracking Network (OTN), Universite Laval and the University of Windsor to use acoustic telemetry track the migrations of Arctic char in marine and fresh water habitats in the region. Additional research is being done has determined there is significant but weak genetic differentiation among char stock in the region and migratory harshness is an important friver of overwintering dispersal. Other work has focussed on assessing the effects of tempertature on aerobic metabolish and maximum heart rate of upriver migrating Arctic char in the Kitikmeot region. There are also unpublished ecosystem-based studies underway that are evaluating the marine food web in the region, including the trophic position of Arctic char in the marine environment, and assessing and quantifying bycatch the results from the commercial harvest of char in the region and resolving parasites that are common in commercially harvested char.	Updated to reflect current reasearch.
3.2 Economic Importance	Section updated to reflect current information on the economic value of the fishery over the past 5 years, fishery certifications, operation of Kitikmeot Foods Ltd. And market opportunities	Information added to ensure completeness.
4.2 Harvest Reporting	Addition of information on shared stewardship monitoring program involving the Ekaluktutiak HTO, Kitikmeot Foods Lts. And DFO that has been funded through the Nunavut General Monitoring Plan from 2011-2017. All current fisheries are monitored for total removals, including commercial landings, bycatch and discards and personal consumption as required by recently updated commercial licence conditions.	Information added to include addition of shared stewardship monitoring program
5. Objectives	Table 2 updated to reflect new objectives identified.	Ensure objectives are clear and up-to-date.
6. Access and Allocation	Information added about the addition of Paalik (Lauchlan River) fishing in 2018 and the use of a reduced, targeted quota at Paalik and other waterbodies in the fishery to ensure harvest rate is sustainable and does not exceed the processing capacity of the fish plant. Table 3 updated to reflect current quotas in use.	Section updated to clarify the sustainable management of quotas and harvest effort in the fishery. Some information removed since it is included in detail in Appendix 1. (below)
7.4 Supplemental Licence Conditions	Section added to have been incorporated into the commercial fishery to improve understanding for fishers, data collection efforts, and improved sustainable management of the fishery overalls.	To support improved monitoring and reporting of targeted catch, bycatch, bird and marine mammal interactions, and lost gear.
8.2 Best Management Practice - Precautionary Approach	Paalik (Lauchlan River) was not commercially harvested from 2010-2017 because of a lack of economic viablility. In 2018 Paalik was fished again with a reduced argeted quota to assist with improving stock assessment and economic viability.	Section added to add information on the current approach used to determine quotas for Paalik (Lauchlan) river using the precautionary approach.

8.3 Best Management Practice - Weir Utilization	The weir is a traditional method of Inuit subsistence fishing at the mouths of rivers. The Cambridge Bay commercial fishery utilizes weirs at specific commercial waterbodies. The weir is the preferred method of fishing as it causes fish less stress, is more selective and allows quotas to be filled more quickly.	Section added to add information on the traditional usage of weird and using the weir as a preferred method of char harvest at certain locations
Appendix B Commercial quota and landing report	Tables updated with current data	Ensure analysis is up to date
Appendix D - Economic Analysis	Information added to reflect current fishery	Ensure analysis is up to date
Appendix E - Safety at Sea	Updated contact information for Transport Canada Office of Boarting Safety	Updated contact information.

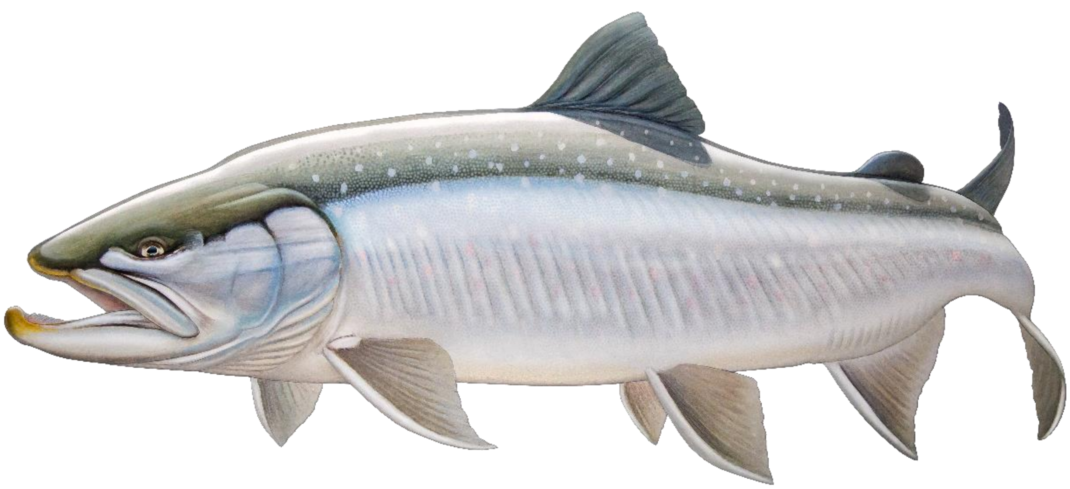
Fisheries and Oceans Canada | Pêches et Océans Canada
Fisheries Management | Gestion des pêches

Integrated Fisheries Management Plan
Arctic Region
Summary

Cambridge Bay Arctic Char, *Salvelinus alpinus*, Commercial Fishery, Nunavut

Effective 2021

Arctic Char
(*Salvelinus alpinus*)



Canada

Forward

The purpose of this updated Integrated Fisheries Management Plan (IFMP) summary is to provide a brief overview of the information found in the full IFMP for the Cambridge Bay Arctic Char (*Salvelinus alpinus)* commercial fishery. This document also serves to communicate basic information on the fishery and its management to Fisheries and Oceans Canada (DFO) staff, the Nunavut Wildlife Management Board (NWMB), Hunters and Trappers Organizations (HTOs), Regional Wildlife Organizations (RWOs), commercial fishers, communities and other stakeholders. The IFMP provides for more informed stakeholder input into management decisions, and promotes a common understanding of the "basic rules" for the sustainable management of the fisheries resource.

This IFMP is not a legally binding instrument which can form the basis of a legal challenge. The IFMP can be modified at any time and does not fetter the Minister's discretionary powers set out in the *Fisheries Act*. The Minister can, for reasons of conservation, or for any other valid reasons, modify any provision of the IFMP in accordance with the powers granted pursuant to the *Fisheries Act*.

Where DFO is responsible for implementing obligations under land claim agreements, the IFMP will be implemented in a manner consistent with these obligations. In the event that an IFMP is inconsistent with obligations under land claim agreements, the provisions of the land claim agreements will prevail to the extent of the inconsistency.

Gabriel Nirlungnayuq, Regional Director General, Arctic Region
Fisheries and Oceans Canada

IFMP SUMMARY

Figures, tables and appendices that are referenced below are included in the full IFMP.

1. OVERVIEW OF THE FISHERY

The Arctic Char commercial fishery addressed by this Integrated Fisheries Management Plan (IFMP) occurs on Victoria Island, near the Community of Ekaluktutiak, also known as Cambridge Bay. The Community of Cambridge Bay is located on the south shore of Victoria Island in the Canadian Arctic Archipelago. Cambridge Bay is the largest community in the Kitikmeot Region (Figure 1). Commercial fishing typically takes place at or near the mouth of the Ekalluktok (Ekalluk), Paliryuak (Surrey), Halokvik (Thirty-Mile), Paalik (Lauchlan) and Jayko (Jayco) rivers (**Error! Reference source not found.**) targeting either downstream (spring) or upstream (fall) migrants. Historical development of the Cambridge Bay Arctic Char commercial fishery is outlined in the full IFMP. Recent commercial landing are reported in Appendix B of the full IFMP.

The commercial fishery, which is the focus of this IFMP, is conducted by local Inuit fishers in conjunction with the operational support of Kitikmeot Foods Ltd., the commercial processing plant in Cambridge Bay. Kitikmeot Foods Ltd. currently employs approximately 28 local residents and beneficiaries, including management, seasonal processors and commercial fishers. Arctic Char are typically harvested by gillnet at or near the mouths of the rivers when fish are migrating downstream to marine waters in July, locally known as a spring fishery (Lauchlan and Surrey rivers), or via either gillnets or weir while returning to freshwater in mid-August through mid-September, locally known as the fall fishery (Halokvik, Ekalluk and Jayko rivers). Where conditions are favourable (there is a shallow narrowing in the river), a weir is the preferred method of harvesting. Arctic Char are dressed in the field (i.e., viscera and gills are removed) and washed before being packed on ice in tubs.
Float planes are contracted by Kitikmeot Foods Ltd. to transport fish from each location to Cambridge Bay, where they are offloaded at the dock and transported directly to the plant for immediate processing. As fish arrive at the plant, each tub is weighed separately and details related to fish quality and quantity are recorded.

Governance of the Fishery

The Cambridge Bay Arctic Char commercial fishery is co-managed by the Nunavut Wildlife Management Board (NWMB), Ekaluktutiak Hunters and Trappers Organization (EHTO), and Fisheries and Oceans Canada (DFO), in accordance with the Nunavut Agreement (NA), the *Fisheries Act* and its regulations. The Cambridge Bay Arctic Char commercial fishery is regulated by the *Fisheries Act* (R.S., 1985, c. F-14) and regulations made pursuant to it, including the *Fishery (General) Regulations* and the *Northwest Territories Fishery Regulations*. Where an inconsistency exists between these statutes and the Nunavut Land Claims Agreement, the Agreement shall prevail to the extent of the inconsistency.

DFO has adopted a Sustainable Fisheries Framework (SFF) for all Canadian fisheries to ensure that objectives for long-term sustainability, economic prosperity, and improved governance for Canadian fisheries are met. The Cambridge Bay commercial fishery has been added to the United States National Oceanic and Atmospheric Administration's **(**NOAA) List Of Foreign Fisheries (LOFF) to adhere to international regulations implementing the Marine Mammal Protection Act and import provisions.

This IFMP has been developed as an evergreen document, meaning that it is written in such a way as to be relevant over a long period of time, with no fixed end date. Through regular reviews (see Section 9 of IFMP) by the IFMP Working Group and stakeholders, updates and amendments will be provided to the NWMB and Minister of Fisheries and Oceans for approval, as required.

2. SCIENCE, TRADITIONAL ECOLOGICAL KNOWLEDGE AND STOCK ASSESSMENT

Stock Science

Arctic Char, *Salvelinus alpinus* (L.) are distributed throughout the Canadian Arctic including the islands of the Arctic Archipelago (McPhail & Lindsey, 1970; Scott & Crossman, 1973), and occur as both non-anadromous (lake-resident or land-locked) and anadromous (i.e., searun) forms (Johnson, 1980; Jonsson & Jonsson, 2001; Loewen et al., 2009). Feeding takes place in near-shore, shallow areas primarily in estuaries for around 30-45 days, although as little as six days has been documented (Dutil, 1986; Gyselman 1994; Moore, et al., 2016).). Feeding is primarily surface oriented although foraging dives of more than 30 m have been recorded (Harris, et al., 2020). Although estuaries are clearly important for summer foraging while at sea (Harris, et al., 2020), some long distance marine migrations have been recorded (e.g., ≥ 100-400 km, Gyselman 1994; Dempson & Kristofferson, 1987; Moore, et al., 2016). The Cambridge Bay commercial fishery targets downstream, or spring, migrations (July) associated with feeding and upstream, or fall, migrations (mid to late August and early September) associated with the return to spawning or over-wintering habitats.

Spawning takes place in fresh water in the fall, usually late-September or early-October, over gravel beds. In the Cambridge Bay area in particular, spawning takes place in lakes, because most rivers freeze completely in winter. The almost complete absence of spawners in the fall upstream migrations suggests that they do not, for the most part, go to sea the summer prior to spawning

Traditional Knowledge and Inuit Qaujimajatuqangit

The Cambridge Bay area has been a place of significant fishing activity for centuries. The Inuit of Cambridge Bay have accumulated a great deal of historical ecological and environmental expertise that provided a basis for their survival as it related to food sources and signs of decline in a given area. In particular, the Ekalluktok (Ekalluk River) has a well-documented history of the traditional ecological knowledge (TEK) of the Iqaluktuurmiut, the group of Inuit families who occupied the area for thousands of years.

Inuit knowledge and Inuit Qaujimajatuqangit (IQ) continues to be an important means of managing the fishery, and is used with scientific knowledge for effective fisheries decision-making and in the development of scientific research and fishery management plans. TEK has contributed to the information needed to support an updated stock status of the Cambridge Bay Arctic Char commercial fishery. This IFMP, including management measures and best practices related to the use of fishing gear and release of spawning Arctic Char, has been developed in consultation with the community by the Cambridge Bay Arctic Char Working Group.

Stock Assessment

A complete stock status assessment of Cambridge Bay Arctic Char was completed by Day & Harris (2013); This assessment concluded that all of the primary stock complexes, with the exception of the Ellice River, were considered to have a low level of risk of overexploitation given the harvest strategies at the time. Recently, an assessment of the Halokvik (Thirty-Mile River) and Jayko (Jayco River) concluded that both fisheries would be considered near the boundary of the healthy and cautious zone and that there is likely a moderate risk to these populations if harvest remains the same.

The Cambridge Bay commercial fishery for Arctic char is considered a data-poor fishery which presents a number of challenges and uncertainties for formal stock. A multi-year stock assessment plan has been developed by DFO, in consultation with resource users and co-management organizations, for the Cambridge Bay Arctic Char commercial fishery in order to address this data-poor concern.

3. SOCIAL, CULTURAL AND ECONOMIC IMPORTANCE OF THE FISHERY

Social and Cultural

Arctic Char is very important to the social connection, cultural definition and food requirements of Inuit across Canada. Cambridge Bay is also known as Ekaluktutuak , which in Inuinnaqtun translates to “Good Fishing Place” and reflects the strong historical and cultural connection the people share with Arctic Char. Arctic Char play an important role in the nutrition and social culture of the community – fostering the continuation of traditional culture and lifestyles, provision of traditional foods, and local self-sufficiency.

The commercial harvest of Arctic Char supports important social and cultural values of family, sharing and community that have been passed down through generations of fishers. Presently, Kitikmeot Foods Ltd. employs around 28 local residents and beneficiaries in support of the Arctic Char commercial fishery on an annual basis. The commercial fishery maximizes local employment opportunities, thus allowing fishers to live and work in Cambridge Bay and contribute to the local economy while continuing to carry forward skills from a more traditional way of life.

Economic Importance

The economic contribution of the Cambridge Bay Arctic Char commercial fishery is significant for both the local economy and the Territory. In 2015, the total Arctic Char commercial harvest in Nunavut was estimated at 72,574 kgs with an estimated landed value of $1,800,000 (2016 GN Fisheries Strategy). Cambridge Bay contributed 37,765 kgs (52%) of that total harvest, with an estimated market value contribution of $855,363. [1] More recently, in 2019 the Cambridge Bay commercial fishery harvested 99% of the targeted quotas (48,493 Kg), totalling 48,097 Kgs.

Ocean Wise seafood is a conservation program that makes it easy for consumers to choose sustainable seafood distributors and restaurants for the long term health and sustainability of Canada's fisheries. The four criteria to become Ocean Wise certified are: (1) Fisheries abundant and resilient to fishing pressures, (2) well managed with a comprehensive management plan based on current research, (3) harvested in a method that ensures limited bycatch on non-target and endangered species, and (4) harvested in ways that limit damage to marine or aquatic habitats and negative interactions with other species.

As Arctic Char total sales and market opportunities grow, operational costs too continue to increase. Kitikmeot Foods Ltd. has had to rely heavily on freight subsidies from the Nunavut Development Corporation on an on-going basis to offset high transportation costs incurred to bring Arctic Char from fishing sites to the plant and onto various domestic and international markets. Over the 5-year period of 2014-2018, Kitikmeot Foods Ltd. experienced an increase in transportation related costs annually, from 20% of overall operating expenditures in 2014 to 27% in 2018.

4. MANAGEMENT ISSUES

The priority management issues include the need for updated stock abundance estimates to support management decisions, timely harvest reporting and consistent reporting of bycatch and catch and effort information in support of sustainable harvest levels, and ensuring the long-term viability and prosperity of the commercial fishery.

Stock Abundance Estimates

Comprehensive up-to-date abundance (or biomass) estimates and stock assessments are still required for several of the stocks of commercially harvested Arctic Char. Traditional scientific approaches for stock assessments and abundance estimates for setting sustainable harvest levels may be impractical in terms of cost, feasibility and applicability at all river systems. Given this fishery is still considered data-poor, to support standard stock assessment, both fishery-dependent (those data collected directly from the commercial fishery) and fishery-independent data (those collected independent of the commercial fishery) are required. Long-term monitoring, designed to estimate annual CPUE of harvests and report bycatch and discards in the

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[1] See Appendix D: Economic Analysis for details.

fishery, will contribute to an improved understanding of abundance and species interactions, necessary for the sustainable and ecosystem-based management of Arctic Char in Cambridge Bay.

Harvest Reporting

Timely, accurate reporting of all catches and the effort exerted to harvest these catches from each of the commercial waterbodies is essential. Commercial harvesting needs to remain within regulated harvest levels, and the timeliness of reporting allows managers to assess the harvest as limits are approached. Recent initiatives have resulted in daily reporting of commercial landings through the processing plant. In addition, a shared stewardship monitoring program involving the EHTO, Kitikmeot Foods Ltd. and DFO has been funded through the Nunavut General Monitoring Plan ran from 2011-2017. All commercial fisheries are currently monitored for total removals, including commercial landings, bycatch and discards, and personal consumption as required by recently updated commercial license conditions.

Economic Viability of the Fishery

Rising transportation costs are impacting the economic feasibility of commercially fishing at some of the more distant river systems, and limit consideration of establishing new commercial fisheries at other distant fishery locations. Regional and territorial co-management organizations continue to promote economic viability while ensuring stocks remain healthy and abundant.

5. Objectives

Objectives for the Cambridge Bay Arctic Char commercial fishery are a key component of the IFMP. Long term objectives guide the management of the fishery and may be categorized as stock conservation, ecosystem, shared stewardship, and social, cultural and economic objectives. Each long term objective is supported by one or more short term objectives to address existing management issues in the fishery. The objectives listed in Table 1 were developed by the IFMP Working Group and other stakeholders.

Table 1. Long-term and short-term objectives for the Cambridge Bay Arctic Char commercial fishery.

Long-term Objectives	Short-term Objectives
Stock Conservation	
Conserve Arctic Char stocks through sustainable use and effective fishery management	• Update stock assessment information and advice on sustainable harvest levels for each commercial waterbody • Improve knowledge of Arctic Char biology, ecology and stock discrimination • Improve the timeliness and accuracy of harvest and CPUE reporting in commercial, recreational and food

Long-term Objectives	Short-term Objectives
	fisheries to monitor total removals of arctic Char and bycatch. • Encourage conservation and responsible fishing practices for Arctic Char. • Given uncertainties related to the abundance of Arctic Char stocks in the Cambridge Bay area, continue to harvest at conservative levels using PA framework.
Ecosystem	
Conserve bycatch species through effective fishery management.	• Improve the accuracy and completeness of reporting bycatch to improve understanding of species interactions and management.
Shared Stewardship	
Promote collaboration, participatory decision making, and shared responsibility with resource users, co-management organizations and other stakeholders.	• Conduct post-season fishery meetings and IFMP Working Group meetings on an annual basis. • Continue to engage local participation in co-management activities at every opportunity. • Promote the responsibility of commercial fishers to monitor and report, as per licence conditions. • Secure funding for monitoring programs for commercial, recreational and food fisheries.
Social, Cultural and Economic	
Promote an economically viable and self-sufficient fishery based on high quality that maximizes social and economic benefits, while ensuring stocks remain healthy and abundant for future generations.	• Support initiatives to optimize community-based processing and employment capacity. • Support strategies to increase feasibility of commercial operations at more distant river systems and other fishery locations. • Maintain and conserve local and traditional fishing activities and areas. • Promote collaboration among co-management organizations associated with economic development throughout Nunavut.

Long-term Objectives	Short-term Objectives
Compliance	
Promote compliance with legislation, regulations and management measures to achieve conservation and sustainable use.	• Ensure commercial licence conditions. are updated regularly, to reflect requirements related to the sustainable management of the fishery. Promote compliance through education and shared stewardship. Work collaboratively with local and territorial wildlife officers. • Promote compliance through regular monitoring and surveillance activities, and increased presence in the community.

6. Access and Allocation

Commercial quotas are established for each water body, as set out in Schedule V of the *NWT Fishery Regulations*. All waterbodies have a competitive quota; in other words, all fishers licensed to commercially fish a given waterbody collectively fish against the total quota for that waterbody. There are no individual quota allocations associated with the commercial fishery. The commercial fishery is opened annually through a Variation Order, and closed by a Notice of Closure when the quota is met. Commercial fishing licences are issued to fishers under Section 7 of the *Fisheries Act*.

After the addition of Lauchlan River (Byron Bay) in 2018, targeted reduced quotas were set for Ekalluk and Jayko Rivers to offset the increased landings expected from Lauchlan River. These targeted reduced quotas may vary each year depending on demand as the fish plant operates at full capacity with the current total quota and does not have the required storage space to accept more Arctic Char. The reduced targeted quotas are typically applied to the fall fisheries, improving the balance of the spring-fall harvest distribution, and additionally affords fishers and float planes to leave Jayko sooner, before ice and weather conditions become a safety concern later in September.

Table 1 displays current legal quotas for the commercial fishery in both round weight kilograms (the appropriate product form and unit of measure of quota allocation, as set out in Schedule V) and dressed weight pounds (form and unit of measure used to record landings)

Table 1. Legal quotas for the Cambridge Bay Arctic Char commercial fishery.

Location	Legal Quota *(Kg, Round Weight)*	Converted Legal Quota *(Lbs, Dressed Weight)*
Ekalluktok (Ekalluk) River	20,000	36,744

Halokvik (Thirty-Mile) River	5,000	9,186
Jayko (Jayco) River	17,000	31,232
Paliryuak (Surrey) River	9,100	16,718
Paalik (Lauchlan) River	9,100	16,718
Grand Total	**60,200 Kgs.**	**110,598 Lbs.**

7. Management Measures

Management measures outline the controls or rules adopted for the fishery, including stock conservation and sustainable management measures. Management measures for the Cambridge Bay Arctic Char commercial fishery include controls related to quota, openings and notices of closure for fisheries; licensing and conditions of licence, including reporting requirements of bycatch, discards, marine mammal interactions and found/lost gear through the use of commercial logbooks. These measures are based on the *Fisheries Act* and its regulations, the NA, DFO policies, and measures agreed upon by the IFMP Working Group, in support of sustainable fisheries management. In addition, these measures are aided by the shared stewardship arrangements and best practices in place for the Cambridge Bay Arctic Char commercial fishery (see Section 8). Appendix C provides an overview of the management measures currently in place.

Commercial fishing licenses are issued annually in accordance with Section 7 of the *Fisheries Act*. Commercial fishers are responsible for reporting landings, in accordance with the *Fishery (General) Regulations* and *NWT Fishery Regulations* and as outlined in the management measures of this plan. In support of this measure, commercial logbooks are available from the EHTO, GN Conservation Office, or Kitikmeot Foods Ltd. Supplemental License Conditions for Commercial fishers require the use logbooks to record all commercial landings, fishing effort, any Arctic Char discarded or kept for personal consumption, ghost gear reporting, seabird and marine mammal interactions, and all other fish bycatch encountered in the commercial fishery. Logbooks are submitted to the local wildlife office or fish plant and returned to DFO at the end of the season. To support real time harvest reporting and quota monitoring, daily records of landings for each commercial waterbody are kept by Kitikmeot Foods Ltd. and are reported daily to DFO.

8. Shared Stewardship

The IFMP for the Cambridge Bay Arctic Char commercial fishery was initiated and developed by the Cambridge Bay Arctic Char Working Group in 2010. Participation on the Working Group includes representatives from the EHTO (co-Chair), Kitikmeot Foods Ltd., commercial fishers, community elders, Department of Environment – Fisheries and Sealing Division, and DFO. Youth from the local high school are encouraged to actively participate as a sitting member of the Working Group. A letter of support from the NWMB was received by the Working Group in 2011 expressing support for the initiative of the Working Group and development of a management plan.

Best management practices, initiated by co-management organizations through the IFMP Working Group, are included in the IFMP. In support of the long-term health of Arctic Char stocks and sustainability of the fishery, it is important to reduce any potential impact to the spawning population. When spawners are captured in the gillnet fishery, and where they are alive, all spawning Arctic Char should be released where they were taken, in a manner that causes them the least harm. When encountered in a weir fishery, all spawning Arctic Char should be released unharmed. These best management practices are currently in place in the commercial fishery. The weir is the preferred method for the subsistence and commercial collection of Arctic Char at Jayko River. The usage of a weir causes fish less stress and allows for quotas to be filled more quickly, reduces bycatch, animal interactions and lost gear potential.

A five (5) year review of the IFMP was conducted in 2019/2020 and forms the basis of this updated version of the IFMP.

9. Compliance Plan

The DFO Conservation & Protection program promotes compliance with legislation, regulations and management measures implemented to achieve the conservation and sustainable use of Canada's aquatic resources. DFO Fishery Officers are responsible for compliance activities related to the Cambridge Bay Arctic Char commercial fishery. Fishery Officers conduct surveillance activities, and are supported by Regional DFO staff that provide assistance with monitoring, reporting, education and shared stewardship.

DFO Fishery Officers participate in fishery review meetings where compliance issues are presented and recommendations requested for resolution. As well, informal meetings continue on an ad hoc basis to resolve in-season matters. Fishery Officers discuss fisheries conservation and shared stewardship during visits to Cambridge Bay and interact with community resource users, fishers and processors.

10. IFMP Performance Review

This IFMP was developed through a consultative process including resource users, co-management organizations, and stakeholders.

Commercially fished Arctic Char stocks in the Cambridge Bay area will continue to be assessed through shared stewardship with resource users, and multi-year stock assessments that aim to provide scientific advice. Monitoring of the fishery will be accomplished using several tools including daily reporting of landings, quota monitoring, fishery-dependent (plant) sampling, logbooks, and surveillance.

Post season reviews will be conducted on a regular basis with stakeholders and the IFMP Working Group. Progress on achieving the short term objectives and effective implementation of management measures identified in this Management Plan will be reviewed.

Recommendations to improve management of the Cambridge Bay Arctic Char commercial fishery will be developed to meet the long term objectives of maintaining a sustainable fishery.

Figure 1. Map of the Nunavut Settlement Area with the Kitikmeot Region and the community of Cambridge Bay.

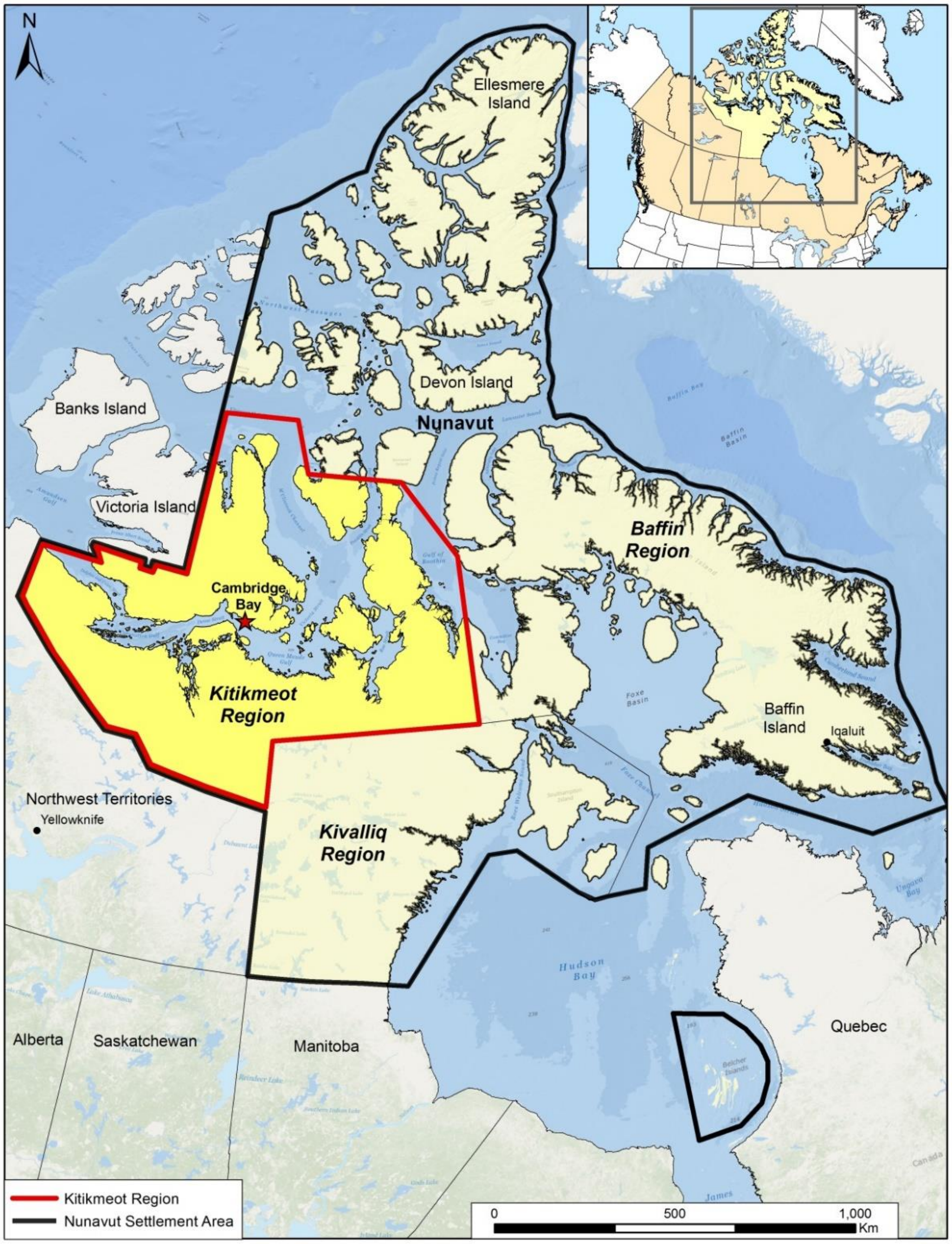


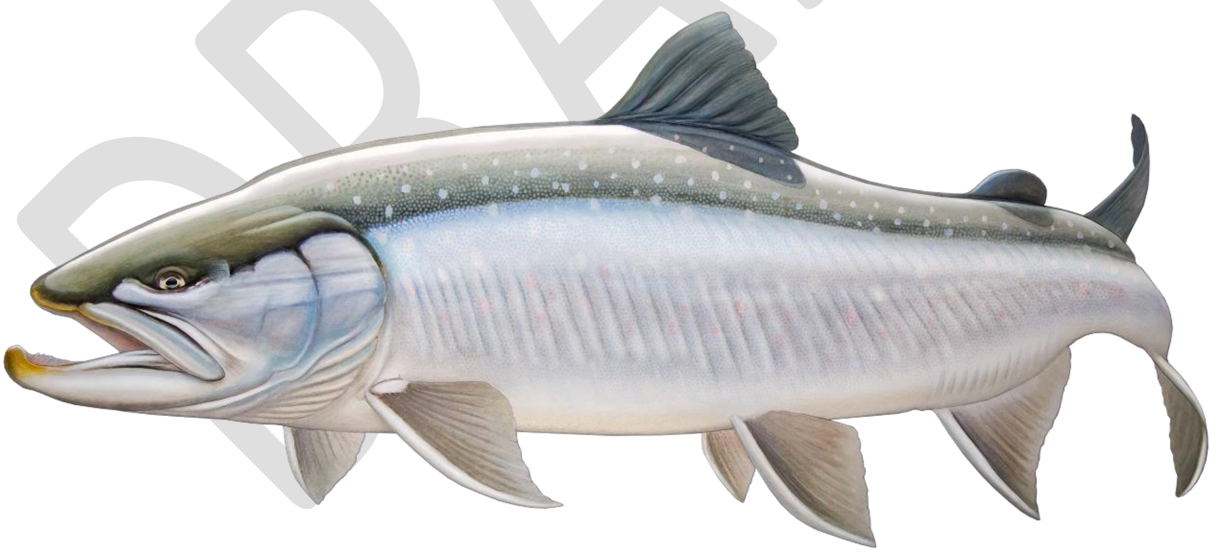
Figure 2: Map of Cambridge Bay area showing current commercial fishing locations.

Integrated Fisheries Management Plan
Arctic Region

Cambridge Bay Arctic Char, *Salvelinus alpinus*, Commercial Fishery, Nunavut

Effective 2021

Arctic Char
(*Salvelinus alpinus*)



Foreword

The purpose of this Integrated Fisheries Management Plan (IFMP) is to identify the main objectives and requirements for the Cambridge Bay Arctic Char (*Salvelinus alpinus)* commercial fishery, as well as the management measures that will be used to achieve these objectives. This document also serves to provide a common understanding of basic knowledge of the fishery, the biology of commercially harvested Arctic Char and outlines its sustainable management to Fisheries and Oceans Canada (DFO), legislated co-management organizations, including the Ekaluktutiak Hunters and Trappers Organization, as well as resource users and other stakeholders.

This IFMP is not a legally binding instrument which can form the basis of a legal challenge. The IFMP can be modified at any time and does not fetter the Minister's discretionary powers set out in the *Fisheries Act*. The Minister can, for reasons of conservation, or for any other valid reasons, modify any provision of the IFMP in accordance with the powers granted pursuant to the *Fisheries Act*.

Where DFO is responsible for implementing obligations under land claim agreements, the IFMP will be implemented in a manner consistent with these obligations. In the event that an IFMP is inconsistent with obligations under land claim agreements, the provisions of the land claim agreements will prevail to the extent of the inconsistency.

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Gabriel Nirlungnayuq, Regional Director General, Arctic Region
Fisheries and Oceans Canada

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Date

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Daniel Shewchuk, Chairperson, Nunavut Wildlife Management Board

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Date

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Acronym List

C&A	Central and Arctic Region, Fisheries and Oceans Canada
C&P	Conservation and Protection, Fisheries and Oceans Canada
CPUE	Catch-Per-Unit-Effort
DFO	Fisheries and Oceans Canada
EHTO	Ekaluktutiak Hunters and Trappers Organization
HTO	Hunters and Trappers Organization
IFMP	Integrated Fishery Management Plan
IQ	Inuit Qaujimajatuqangit
KRWB	Kitikmeot Regional Wildlife Board
NA	*Nunavut Agreement*
NSA	Nunavut Settlement Area
NWMB	Nunavut Wildlife Management Board
NWT	Northwest Territories
RWO	Regional Wildlife Organization
TC	Transport Canada
TEK	Traditional Ecological Knowledge
PA	Precautionary Approach

1 Overview

An Integrated Fisheries Management Plan (IFMP) is used to guide the conservation and sustainable use of marine resources, supports the management of sustainable fisheries, and combines available science and Indigenous traditional knowledge and shared Inuit Qaujimajatuqangit (IQ) on fish species with industry data to determine best practices for harvest and management. IFMPs are developed and finalized through an extensive and collaborative approach with co-management partners, local resource users and other stake-holders.

Fisheries and Oceans Canada (DFO) engages with fishery rights holders, Indigenous organizations, groups and communities, resource users and stakeholders to determine how to best manage fisheries and develop IFMPs in support of the fishery. The duty to consult on this IFMP has been recognized and incorporated into activities since the first stages of the planning and development process for this IFMP. A number of activities were used to involve fishery rights holders, Indigenous organizations, groups and communities, resource users and stakeholders, which have included: regular IFMP WG meetings; engagements and consultations; sharing information; opportunities to review and comment on the draft updated plan; annual fishery performance reviews.

All IFMPs require regular updating to address current objectives and issues, new information (biological and fishery-related), and varying pressures on the fishery resource.

1.1 Cambridge Bay Arctic Char commercial fishery IFMP

The IFMP for commercially harvested Arctic Char (*Salvelinus alpinus*) from the Cambridge Bay region of Nunavut was first implemented in 2014, making it the first IFMP for this species in Canada. The Cambridge Bay commercial Arctic Char IFMP is intended to be reviewed and updated every 5 years, or as required, by the Cambridge Bay IFMP Working Group (WG).

The IFMP WG meets annually to review the post-season performance of the fishery and the effectiveness of the management plan. The IFMP WG has met annually each year since the initial approval of the IFMP in 2014. Additionally, DFO has conducted annual pre-season and post-season engagements with commercial fishers and other stakeholders, as well coordinated public engagements to discuss and provide updates on the commercial fishery and related science research and activities, on an annual basis. DFO and the IFMP WG have used these conversations to identify the key challenges and priorities to be addressed in the fishery. All comments received were given careful consideration when finalizing this updated IFMP.

This IFMP was finalized on:

1.2 History

Arctic Char, Salvelinus alpinus, are distributed across the Canadian Arctic occurring as both non-anadromous (lake-resident or land-locked) and anadromous (searun) forms. The anadromous form is found in many of the rivers and lakes on Victoria Island, near the Community of Ekaluktutiak, also known as Cambridge Bay, where they are harvested in subsistence, recreational and commercial fisheries.

There are several key commercial waterbodies in the Cambridge Bay area. These waterbodies are known by several names, including local Inuinnaqtun and English names, as well as the legal name used in the Northwest Territories (NWT) Fishery Regulations (**Error! Reference source not found.**). Throughout this IFMP both the local Inuinnaqtun and English names are used concurrently given they are most commonly recognized by resource users.

Table 1. Commercial Waterbody Names in the Cambridge Bay Area.

Inuinnaqtun Local Name	English Local Name	English Legal Name
Ekalluktok	Ekalluk (Wellington) River	Ekalluk River
Halokvik	Thirty-Mile River	Halovik River
Paliryuak	Surrey River	Paliryuak River
Jayko	Jayco River	Jayco River, Albert Edward Bay
Paalik	Lauchlan River	Lauchlan River (Byron Bay)

Note: Legal Name refers to the commercial waterbody name used in Column I of Schedule V, *NWT Fishery Regulations*.

The early history of this fishery is described in Abrahamson (1964) and Barlishen & Webber (1973). Prior to the onset of the commercial fishery, it is likely that all river systems in the Cambridge Bay area were fished for food by Inuit (Friesen, 2002 and Appendix A has a map with historical fishing locations). Commercial fishing in the area first began in 1960, with a gillnet operation on nearby Freshwater Creek (Day & Harris, 2013). To avoid over-exploitation of this system from the competing pressure of the local food fishery, the commercial fishery was relocated in 1962 further from the community to the mouth of the Ekalluktok (Ekalluk) River, where the river empties into Wellington Bay (Day & Harris, 2013).

Initially, a river-specific quota was used at Ekalluktok (Ekalluk) River and remained in effect until 1967. Subsequently an “area” quota was established for Wellington Bay with the intent to distribute fishing pressure amongst additional rivers in the area (i.e. Paliryuak (Surrey), Halokvik (Thirty-Mile) and Paalik (Lauchlan) rivers). However, the decline in the fishery (as evidenced by a decrease in mean weight) at Ekalluktok (Ekalluk) River, where most of the fishing still took place given its proximity to Cambridge Bay, necessitated the establishment of “river-specific” quotas to distribute fishing effort amongst these systems. In the 1970s, commercial fishing was extended to Jayko (Jayco) River to the northeast of Cambridge Bay and the Ellice and Perry rivers, on the nearby mainland.

From 2010 to 2017 Paalik (Lauchlan River) was not commercially harvested due to a lack of economic viability related to the historically assigned commercial quota and significant transportation costs associated with the distance of this fishing location from

Cambridge Bay. With renewed interest in this fishery, the Ekaluktutiak Hunters and Trappers Organization (EHTO) and Kitikmeot Foods Ltd, supported by DFO, requested the targeted quota be increased to 5,000kgs (from the historically targeted 2,400kgs). The Nunavut Wildlife Management Board (NWMB) determined that the current commercial quota (in accordance with the *Northwest Territories Fishery Regulations*) of 9,100 kg was legal and valid. In its decision, the NWMB recognized and supported the continued conservation-based management approach of the fishery by the EHTO and DFO with the operational support of Kitikmeot Foods Ltd to maintain a sustainable commercial char fishery (Nunavut Wildlife Management Board, 2017). Beginning in 2018, Paalik (Lauchlan River) was harvested at a targeted quota of 5,000kgs, facilitated by fishery-dependent and –independent monitoring, and will continue to be harvested at this targeted quota until such time as a stock assessment can be completed and sustainable harvest levels can be established.

No fishing has occurred at the Ellice River since 1999 and the Perry River since 1991 for a variety of reasons, including transportation costs, noticeably whiter and less marketable flesh, and regularly inclement weather in the fall. Factors in considering commercial locations may include social and cultural practices (e.g., primary subsistence fisheries), availability of commercial quota, and geography in addition to economic viability (e.g., proximity to community, transportation costs), fish quality and marketability (e.g., flesh colouration) and weather conditions.

Current commercial fishing takes place at the Ekalluktok (Ekalluk), Paliryuak (Surrey), Halokvik (Thirty-Mile), Paalik (Lauchlan) and Jayko (Jayco) rivers (

Figure 2). Recent harvest and stock status of this fishery is provided by (Day & Harris, 2013) and is available on the internet at: http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2013/2013_068-eng.html.

For the purposes of this IFMP, all current Arctic Char commercial waterbodies (**Error! Reference source not found.**) in the Cambridge Bay area are collectively referred to as the "Cambridge Bay Arctic Char commercial fishery". For management purposes, each commercial waterbody is considered an individual management unit associated with a river-specific quota.

1.3 Type of Fishery and Participants

Arctic Char plays an important role in the social culture, nutritional and economic growth of the community – fostering the continuation of traditional culture and lifestyles, provision of irreplaceable traditional foods, and the economic benefits of successful commercial and recreational fisheries. Arctic Char are primarily harvested in subsistence and commercial fisheries with a few recreational (sport) fisheries in the Cambridge Bay area.

The commercial fishery, which is the focus of this IFMP, is conducted by local Inuit fishers in conjunction with the operational support of Kitikmeot Foods Ltd., the commercial processing plant in Cambridge Bay. Kitikmeot Foods Ltd. was established in 1990 as a subsidiary of the Nunavut Development Corporation, and serves a growing domestic and international fish market under the territorial brand *Truly Wild Arctic Char™*. This fishery has demonstrated sustainability in accordance with various independent measures, and is currently recognized by Ocean Wise as a sustainably managed fishery. Centrally located in Cambridge Bay, Kitikmeot Foods Ltd. currently employs as many as 28 local residents and beneficiaries, including management, seasonal processors and commercial fishers.

The Ekalluktok (Ekalluk River) and Paalik (Lauchlan River) locations have supported local outfitters that direct sport-fishing operations during upstream migrations. These outfitters, however, have not been in operation in recent years. The fishing pressure from these sport-fishing operations are considered low as they practiced catch and release; however, this is still taken into account for a small degree of fish mortality when conducting stock assessments on the rivers. The fishing pressure depends on catch rates and can continually fluctuate in any given year.

Several other locations nearer to and in the community are used for both recreational (sport) and subsistence fisheries (e.g. Starvation Cove, Long Point, Grenier Lake, Gravel Pit and Freshwater Creek) by local residents. Historically, each of the commercial locations has, at different times, been harvested for subsistence purposes. Currently most subsistence harvesting occurs at the local recreational fisheries locations close to the community of Cambridge Bay.

1.4 Location of the Fishery

The Community of Cambridge Bay is located on the south shore of Victoria Island in the Canadian Arctic Archipelago. Cambridge Bay is the largest community in the Kitikmeot Region (Figure 1). Fishing typically takes place at or near the mouth of the Ekalluktok (Ekalluk), Paliryuak (Surrey), Halokvik (Thirty-Mile), Paalik (Lauchlan) and Jayko (Jayco) rivers (

Figure 2) targeting either downstream (spring) or upstream (fall) migrants.

Figure 1. Map of the Nunavut Settlement Area with the Kitikmeot Region and the community of Cambridge Bay.

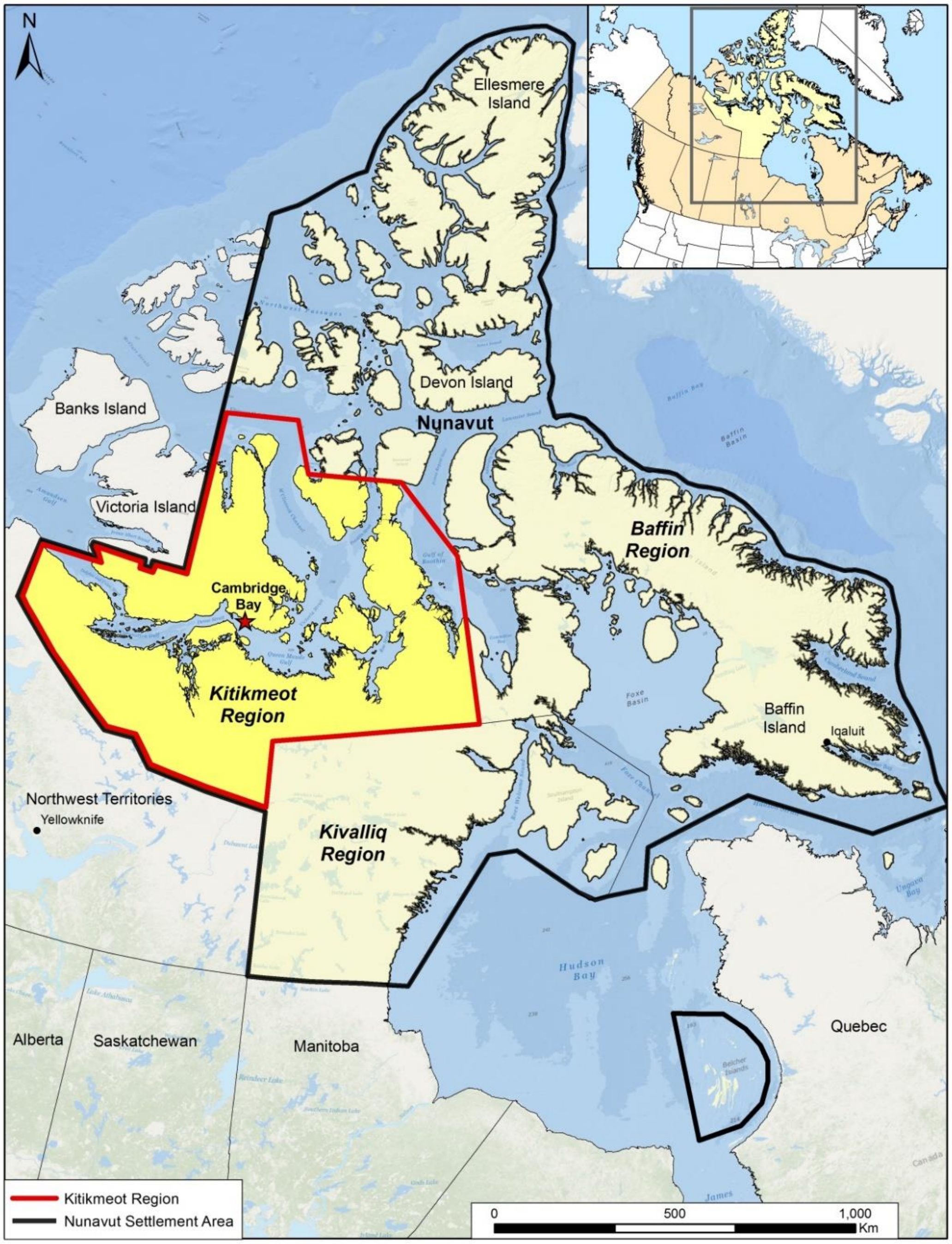

Figure 2. Map of Cambridge Bay area showing current commercial fishing locations.

1.5 Fishery Characteristics

Upon ratification of the NA in 1993, all existing restrictions or quotas on the amount of wildlife that could be harvested within the NSA were retained and deemed to have been established by the NWMB. These regulatory provisions continue to form the basis for the regulation and management of the Cambridge Bay Arctic Char commercial fishery, requiring among other things:

- A licence to commercially fish Arctic Char in water bodies identified in Schedule V of the *NWT Fishery Regulations* (https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._847/index.html)
- Management measures, including gear restrictions, to ensure sustainable harvests
- Requirements to keep records and to report harvest information

In accordance with Section 17(1) of the *NWT Fishery Regulations*, all waterbodies commercially fished in the Cambridge Bay area are listed in Schedule V under Region IV Central Arctic (see Table 3 (Section 6) in IFMP for current quotas).Variation Orders are issued annually by DFO to open each commercial waterbody specifying the fishing periods, quotas, and gear requirements. At the beginning of each year, DFO releases a summary of all issued Variation Orders (https://www.dfo-mpo.gc.ca/fisheries-peches/commercial-commerciale/atl-arc/variation-orders-ordonnances/nunavut-2018-19-v001-eng.html) to each community HTO office in Nunavut. Additionally, if there is community interest in opening a commercial waterbody that has not been harvested in recent years, an HTO can request the waterbody be opened for commercial fishing.

Fishers are responsible for obtaining a commercial fishing licence for each commercial waterbody. Licences specify the waterbody, quota and other conditions (including Supplemental License Conditions) and are currently issued by local Conservation Officers (Department of Environment - Government of Nunavut) on behalf of DFO. Each commercial waterbody is fished by a lead fisher with a crew of two to five other fishers. Due to the distance from Cambridge Bay, camps are established at each of the waterbodies, and fishers typically remain in camp for the duration of the harvest, which may last for 3 weeks or more.

Arctic Char are typically harvested by gillnet at or near the mouths of the rivers when fish are migrating downstream to marine waters in July, locally known as a spring fishery (Lauchlan and Surrey rivers), or via either gillnets or weir while returning to freshwater in mid-August through mid-September, locally known as the fall fishery (Halokvik, Ekalluktok and Jayko rivers). At Ekalluktok (Ekalluk) River fish are harvested at the outlet of this river system nearest to Ferguson Lake, to accommodate sport-fishing interests in the area.

Commercial harvests are conducted by either gillnet or weir, depending on the river characteristics. Where conditions are favourable (there is a shallow narrowing in the river), a weir is the preferred method of harvesting. Weirs more effectively allow smaller fish to avoid capture and spawning Char to be released unharmed, and those Arctic Char that are large enough to be retained are allowed to swim freely in the area, causing little stress and thus a better quality of fish. Whereas gillnets may leave markings on the flesh of the fish, weir harvests generate a greater market value for whole product form, and accordingly fishers are paid a premium. Weirs are also favourable as they essentially render by-catch negligible, significantly reduce the risk of lost gear, and eliminate any potential for marine mammal interactions.

Arctic Char are dressed in the field (i.e., viscera and gills are removed) and washed before being packed on ice in tubs. Each tub holds, on average, 45 kg (100 lbs.) of dressed fish and as many as 13 tubs can typically be loaded on a de Havilland Beaver float plane. Float planes are contracted by Kitikmeot Foods Ltd. to transport fish from each location to Cambridge Bay, where they are offloaded at the dock and transported directly to the plant for immediate processing. As fish arrive at the plant, each tub is weighed separately and details related to fish quality and quantity are recorded.

The plant reports harvest details related to each trip daily to DFO, allowing real time harvest reporting and quota monitoring during the commercial fishing season. Conversion factors are applied to the reported harvest to reconcile round weight (from dressed weight) in kilograms, as per the assigned commercial quota. When a quota is reached, a Notice of Closure is issued by DFO and posted in the community, formally closing the waterbody to further commercial fishing.

Throughout the year DFO works with commercial fishers, Kitikmeot Foods Ltd., and the EHTO to identify priority management issues, and during the fishing season DFO Fishery Officers monitor commercial harvesting activities for compliance with the *Fisheries Act* and applicable regulations. Management issues and compliance concerns are addressed during the fishing season and at pre- and post-fishing season meetings, or whenever possible. In addition, Kitikmeot Foods Ltd. holds a pre-season fishers' meeting in advance of each fishing season to discuss related issues and priorities.

1.6 Governance

The Cambridge Bay Arctic Char commercial fishery is co-managed by the Nunavut Wildlife Management Board (NWMB), Ekaluktutiak Hunters and Trappers Organization (EHTO), and Fisheries and Oceans Canada (DFO), in accordance with the Nunavut Agreement (NA), the *Fisheries Act* and its regulations. The NWMB is the main instrument of wildlife management in the Nunavut Settlement Area (NSA), although the Minister retains ultimate authority and responsibility for wildlife management and conservation of fish.

1.6.1 Fisheries Act, regulations and policies

The Cambridge Bay Arctic Char commercial fishery is regulated by the *Fisheries Act* (R.S., 1985, c. F-14) and regulations made pursuant to it, including the *Fishery (General) Regulations* and the *Northwest Territories Fishery Regulations*. Where an inconsistency exists between these statutes and the Nunavut Land Claims Agreement, the Agreement shall prevail to the extent of the inconsistency.

These documents are available on the Internet at: http://www.dfo-mpo.gc.ca/acts-lois/index-eng.htm

1.6.2 Sustainable Fisheries Framework

DFO has adopted a Sustainable Fisheries Framework (SFF) for all Canadian fisheries to ensure that objectives for long-term sustainability, economic prosperity, and improved governance for Canadian fisheries are met. The SFF contains policies for adopting an ecosystem based approach to fisheries management, including *A Fishery Decision-Making Framework Incorporating the Precautionary Approach*, *Managing Impacts of Fishing on Benthic Habitat, Communities and Species* and *Policy on Managing Bycatch*.

These documents are available on the Internet at: http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/overview-cadre-eng.htm

1.6.3 Policy on Managing Bycatch

Bycatch within the Cambridge Bay fishery is recorded via Logbooks as per commercial license conditions (see section 4.2 and 7.1). The fishery also utilizes weir harvesting techniques at two locations, which eliminates virtually all mortality of bycatch. After review of Logbook information, fisheries management data and communicating with resource users and co-management partners, it has been determined that this fishery little impact or concern to other fish, seabird or marine mammal populations. There has been no reported marine mammal Incidental Mortality and Serious Injury (IMSI) for the past 5 fishing seasons in the Cambridge Bay area. Commercial gillnets are checked 3-4 times daily, and if marine mammals are encountered and found alive are released, otherwise are opportunistically harvested for subsistence purposes in accordance with land claim rights.

The Cambridge Bay commercial fishery has been added to the United States National Oceanic and Atmospheric Administration's **(**NOAA) List Of Foreign Fisheries (LOFF) to adhere to international regulations implementing the Marine Mammal Protection Act and import provisions. The LOFF classifies each fishery as either an "exempt" or "export" fishery based on its risk of marine mammal bycatch. Prohibition of the intentional mortality or serious injury of marine mammals (including seals) during the course of commercial fishing operations is required for both exempt and export fisheries. The submission of the Cambridge Bay commercial fishery to the LOFF remains under review by NOAA, however it is expected to be exempt given the low impact and minimal interaction with marine mammals encountered in this fishery.

1.6.4 Ghost Gear Initiative

Beginning in 2019, DFO has started developing a Ghost Gear Initiative. The purpose of this Initiative is to reduce the impacts of plastic pollution and ghost fishing associated with lost fishing gear from Canadian fisheries, and promote the prosperity and sustainability of fisheries, marine species at risk, and the health of Canada's oceans and other aquatic ecosystems in support of DFO's core responsibilities. For the Cambridge Bay Arctic Char commercial fishery, license conditions have been implemented and management measures are being developed to better reflect current practices and further promote reporting of lost and/or found fishing gear. Presently, lost gear is not a concern for this fishery.

1.6.5 Nunavut Agreement

In 1993, Canada settled a comprehensive land claim agreement with the Inuit of the NSA. The Nunavut Agreement (NA) created priority access and wildlife harvesting rights for Inuit and other Aboriginal groups who traditionally harvested within the NSA.

The Agreement also created an Institution of Public Government, the NWMB, to share decision making authority with the Federal Government. The NWMB and DFO Minister consider matters relating to the proper management and control of fisheries and the conservation of fish within the NSA. Under this co-management regime, the NWMB is the main instrument of wildlife management, but the Minister retains ultimate responsibility for wildlife management and may accept, reject or vary decisions made by the NWMB with respect to harvesting and other decisions related to management and protection of wildlife and wildlife habitat.

The NA establishes wildlife management authority for Regional Wildlife Organizations (RWO) and Hunters and Trappers Organizations (HTO). The RWO in the Cambridge Bay area is the Kitikmeot Regional Wildlife Board (KRWB). The powers and functions of RWOs (NA 5.7.6) include:

- Regulation of harvesting practices and techniques among the members of HTOs in the region, including the use of non-quota limitations.
- Allocation and enforcement of regional basic needs levels and adjusted basic needs levels among HTOs in the region.
- Assignment to any person or body other than an HTO, with or without valuable consideration and conditions, of any portion of regional basic needs levels and adjusted basic needs levels.
- Generally, the management of harvesting among the members of HTOs in the region.

The HTO in the Cambridge Bay area is the Ekaluktutiak Hunters and Trappers Organization (EHTO). The powers and functions of HTOs (NA 5.7.3) include:

- Regulation of harvesting practices and techniques among the members, including the use of management measures.
- Allocation and enforcement of community basic needs levels and adjusted basic needs levels among members.
- Assignment to non-members, with or without valuable consideration and conditions, of any portion of community basic needs levels and adjusted basic needs levels.
- Generally, the management of harvesting among the members.

The Nunavut Agreement establishes authority to Nunavut Tunngavik Incorporated as the primary Designated Inuit Organization under the Agreement (Article 39). It is responsible for ensuring that Inuit rights and obligations under the land claim are implemented, including the wildlife management provisions (Article 5) of the Nunavut Agreement.

Under the Agreement, wildlife management and Inuit harvesting are guided by the principles of conservation (NA s.5.1.5).

The Nunavut Agreement is available on the internet at:
http://laws-lois.justice.gc.ca/eng/acts/N-28.7/

1.7 Approval Process

This IFMP will be provided to the Minister of DFO and the NWMB for approval. This IFMP has been developed as an evergreen document, meaning that it is written in such a way as to be relevant over a long period of time, with no fixed end date. Through regular reviews (see Section 9 of IFMP) by the IFMP Working Group and stakeholders, updates and amendments will be provided to the NWMB and Minister of Fisheries and Oceans for approval, as required.

The approved IFMP will be translated to Inuinnaqtun, hardcopies published and distributed to co-management partners, and made publically available on the internet by DFO.

2 Stock Assessment, Science and Traditional Knowledge (Science lead)

2.1 Biological Synopsis

Harris, et al., (2020a) provides a comprehensive summary of the biology of Cambridge Bay Arctic char, and some of their main points are touched upon below. Arctic Char, *Salvelinus alpinus* (L.) are distributed throughout the Canadian Arctic including the islands of the Arctic Archipelago (McPhail & Lindsey, 1970; Scott & Crossman, 1973), and occur as both non-anadromous (lake-resident or land-locked) and anadromous (i.e., searun) forms (Johnson, 1980; Jonsson & Jonsson, 2001; Loewen et al., 2009). Arctic Char can tolerate the salinity of the sea when they reach a length of 150 to 200 mm (Johnson, 1980; Gilbert et al., 2016), at which size they are able to descend rivers accessing marine habitats for feeding (Moore, 1975; Harris, et al., 2020). Feeding takes place in near-shore, shallow areas primarily in estuaries for around 30-45 days, although as little as six days has been documented (Dutil, 1986; Gyselman 1994; Moore, et al., 2016). Feeding is primarily surface oriented although foraging dives of more than 30 m have been recorded (Harris, et al., 2020). Although estuaries are clearly important for summer foraging while at sea (Harris, et al., 2020), some long distance marine migrations have been recorded (e.g., ≥ 100-400 km, Gyselman 1994; Dempson & Kristofferson, 1987; Moore, et al., 2016). The Cambridge Bay commercial fishery targets downstream, or spring, migrations (July) associated with feeding and upstream, or fall, migrations (mid to late August and early September) associated with the return to spawning or over-wintering habitats.

Spawning takes place in fresh water in the fall, usually late-September or early-October, over gravel beds in lacustrine habitats. In the Cambridge Bay area in particular, and the central Canadian Arctic in general, spawning takes place in lakes, because most rivers freeze completely in winter (Johnson, 1980). After hatching, the young Char spend their early years entirely in fresh water (Johnson, 1980). Young Arctic Char feed on freshwater shrimp (amphipods) and insect larvae, and the adults feed on small fish and benthic organisms including snails, clams and insect larvae. In most systems, the young Char reach a size of about 150-200 mm in four or five years, and they are ready to take their first migration to sea (Gilbert et al., 2016) so they can forage on lipid rich marine prey sources In the fall, all Char return to fresh water to overwinter and escape the lethal temperatures of winter marine waters (Johnson, 1980).

Non-anadromous Arctic Char are also found in systems inhabited by the anadromous form. Although these Char also have access to the sea, they do not migrate. The reasons for this have yet to be explored in the Cambridge Bay area, however, in other systems differential migratory strategies appear to be a life history tactic conditional on some threshold of size or growth (Hendry, et al., 2004; Moore et al., 2014).

Sexual maturity of anadromous Arctic Char is generally reached at a size of about 450 mm in length (Johnson, 1980; Harris et al. 2020a). Recently, Harris et al. (in press) estimated length (L_{50}) and age (A_{50}) at 50% maturity as an index for reproductive potential for two systems in the region. They estimated the overall L_{50} at the Jayko River to be 553.7 mm and at the Halokvik River to be 539.7 mm. Across all samples combined, Harris et al. (in press) found the overall A_{50} at Jayko was 12.5 years whereas the overall A_{50} at Halokvik was 10.4 years. These estimates of reproductive potential, however, were variable among years. Females generally carry 3000 to 5000 eggs (Scott & Crossman, 1973). Arctic Char are capable of spawning more than once in a lifetime. In the Cambridge Bay area, however, they do not appear to spawn in consecutive years, once sexual maturity is reached. The almost complete absence of spawners in the fall upstream migrations suggests that they do not, for the most part, go to sea the summer prior to spawning (Johnson, 1980, Moore et al., 2017). After spawning, the Char remain in fresh water for another winter before resuming their feeding migration to the sea the following spring. This behaviour results in a loss of 30-40% of their body weight, so they are often in very poor condition at this time (Dutil, 1986).

The life history and migratory patterns of Cambridge Bay Arctic Char and the subsequent implications for genetic stock structure are summarize succinctly by Harris et al. (2020a). Their main points are re-iterated below. Units of management composed of discrete stocks (i.e., “Wellington Bay”, “Albert Edward Bay” and mainland stock complexes) were initially proposed by Kristofferson et al. (1984, see also Dempson & Kristofferson, 1987) based on differences in biological characteristics between these stocks and evidence from a long-term tagging study. Assaying enzyme variation Kristofferson (2002) suggested spawning char in the region show high natal fidelity and that suggested that discrete stocks may exist between and within river systems. A more recent microsatellite DNA assessment (Harris et al. 2016) found that there was regional genetic structure across the entire study area similar to the proposed by Kristofferson et al. (1984), however, fishery sampling locations in the Cambridge Bay region were weakly differentiated. Harris et al. (2016) also suggested that discrete stocks are known to mix extensively while at sea which is consistent with emerging acoustic telemetry evidence (Moore, et al., 2016, 2017). This latter fact, severely complicates the management of this fishery. Most recently Moore et al. (2017) combined genomic and acoustic telemetry data to reveal weak, genetic population differentiation and asymmetric dispersal. Their combined data suggested that Arctic Char in the Cambridge Bay region return home to their natal river to spawn, but may overwinter in rivers with the shortest migratory route to minimize the costs of migration in nonbreeding years. This means that discrete stocks not only mix while at sea, they also mix extensively in freshwater overwintering habitats. Future mixed stock fishery analyses focusing on which stocks are being harvested and to what extent in both marine and freshwater locations should be a top priority.

As described by Harris et al. (2020a), the following are major points for understanding genetic stock structure as it relates the management of char stocks in the region:

1. discrete stocks are known to mix extensively while at sea,
2. the mixing of discrete stocks is likely also very prevalent in overwintering habitats,
3. individual Arctic char must return to fresh water annually to over winter regardless of reproductive status resulting in the potential for two types of dispersal (i.e., breeding and overwintering dispersal),
4. in the Cambridge Bay region virtually all upstream-migrating individuals are current-year non-spawners and have no potential for gene flow in the present year and,
5. the majority of dispersal events would therefore be overwintering dispersal and
6. overall fidelity appears to be quite low in this species.

For management purposes, all Arctic Char present within a given waterbody are treated as a single management unit, separate from Arctic Char stocks in the other waterbodies. This has been the historical management approach for the Cambridge Bay Arctic Char commercial fishery, and to date has proved to be sustainable. Updating information on the nature and prevalence of mixed-stock harvest may allow for modifications of the current river-specific management regime in the region.

2.2 Ecosystems Interactions

DFOs Sustainable Fisheries Framework (SFF) aims so support stock conservation and sustainable use of aquatic resources in Canada (DFO 2016). This framework guides integrated fisheries management planning but also considers aquatic habitat and how species interact within their ecosystem, supporting the adoption of ecosystem-based approaches to management that aim to protect biodiversity and fisheries habitats.

Habitat alteration and/or degradation of spawning and overwintering sites do not appear to be an issue. Kristofferson (2002), with the assistance of community elders and fishers, identified 12 spawning grounds in the Cambridge Bay area. Given the size and complexity of each commercial freshwater system, however, it is quite clear that there are other potential spawning areas within each watershed. Those that have been identified through traditional knowledge are not in the immediate vicinity of commercial fishing locations. Additional, spawning lakes have also been identified 2013 (L.N. Harris, unpublished data) as part of the long-term acoustic monitoring program that has been ongoing in the region since (see Moore et al. 2016, 2017, Harris et al. in press).

Anadromous Arctic Char feed on marine invertebrates (amphipods such as *Parathemisto libellula* and mysids (Mysidacea)) and marine fishes (mostly Arctic cod (*Boreogadus saida*), capelin (*Mallotus villosus*) and northern sand lance (*Ammodytes dubius*) while at sea in summer (Dempson & Kristofferson, 1987, Gyselman 1994, Dempson et al. 2002, Spares et al. 2012) . Young Char are preyed upon by Lake Trout (*Salvelinus namaycush*) in fresh water; and by gulls, other fish-eating birds and occasionally seals while in the sea. None of these impacts likely pose a serious threat to Arctic Char population health. Large Arctic Char appear to be virtually immune to predation and can be considered the terminal predator (Johnson, 1980), although seals have been observed actively chasing char in the area (L.N. Harris, personal observation).

There is minimal bycatch in the Cambridge Bay Arctic Char commercial fishery because of the targeted fishing period and gear selection. Recent commercial monitoring has identified that in the freshwater gillnet fishery (i.e., in Ferguson lake where the Ekalluktok stock is harvested) very little bycatch occurs, however when it does occur, Lake Whitefish (*Coregonus clupeaformis*) and Lake Trout are the most common bycatch species captured. In the marine environment, bycatch species include marine sculpins (*Myoxocephalus spp*.) and Arctic Cod. Some of the bycatch retained in the commercial fishery is used for personal consumption by fishers in the camps. In the weir fishery, all bycatch are released unharmed. Recently, with improved monitoring efforts, loons have been documented as bycatch. Overall, bycatch is considered to have a negligible impact to the ecosystem.

2.3 Traditional Knowledge and Inuit Qaujimajatuqangit

The Cambridge Bay area has been a place of significant fishing activity for centuries. The Inuit of Cambridge Bay have accumulated a great deal of historical ecological and environmental expertise that provided a basis for their survival as it related to food sources and signs of decline in a given area (Riedlinger & Berkes, 2001). In particular, the Ekalluktok (Ekalluk River) has a well-documented history of the traditional ecological knowledge (TEK) of the Iqaluktuurmiut, the group of Inuit families who occupied the area. As discussed in an exhibit booklet developed by the Kitikmeot Heritage Society (2007), because of the strong runs of Arctic Char that occur both in the spring and the fall the Ekalluktok (Ekalluk River) area has been an important settlement area with archaeological evidence of the area being continuously occupied for four thousand years (see also Friesen, 2002).

Since 2000, the Kitikmeot Heritage Society has collaborated with the University of Toronto on an oral history/archaeological research project documenting traditional life with specific attention given to fishing activities, including knowledge, practices and beliefs (Friesen, 2002, 2004). The exhibit booklet is available on the internet at: https://www.kitikmeotheritage.ca/.

Inuit knowledge and Inuit Qaujimajatuqangit (IQ) continues to be an important means of managing the fishery, and is used with scientific knowledge for effective fisheries decision- making and in the development of scientific research and fishery management plans (Thorpe and Moore 2019). Inuit knowledge and IQ associated with local Arctic Char spawning locations has been collected through the assistance of community elders and fishers (Kristofferson, 2002) and traditional knowledge has contributed to the information needed to support an updated stock status of commercially harvested Arctic Char in the Cambridge Bay area (Day & Harris, 2013, Harris et al. 2020a). Inuit knowledge, including TEK and IQ continue to be collected regularly through community consultations. DFO Science research plans are reviewed annually with resource users, and project designs are adjusted to incorporate local knowledge and advice. This IFMP, including management measures and best practices related to the use of fishing gear and the release of spawning char, has been developed by the Cambridge Bay Arctic Char Working Group in consultation with the community.Finally, in 2016 a collaboration was established with the Ekaluktutiak Hunters and Trappers Organization (EHTO) to document the IQ of Arctic in the Cambridge Bay region (Thorpe and Moore 2019). This work, funded by Polar Knowledge Canada, involved the training of local youth to conduct semi directed ethnocartographic interviews to document the IQ of nine individuals of the community (Thorpe and Moore 2019). Interview findings contributed to an IQ database managed by the EHTO and the initiative culminated in an elder-youth knowledge exchange camp for a week in August 2016. The plan is to organize and host similar events in the coming years where community members can come together to share knowledge on char research and management in the region.

2.4 Stock Assessment

A complete stock status assessment of Cambridge Bay Arctic Char was completed by Day & Harris (2013) and is available on the internet at: http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2013/2013_068-eng.html. The assessment analyzed fishery-dependent data focussed on trends in biological characteristics for all commercially harvested water bodies. This assessment concluded that all of the primary stock complexes, with the exception of the Ellice River, were considered to have a low level of risk of overexploitation given the harvest strategies at the time. Quantitative stock assessment modelling approaches have also been explored (Zhu et al. 2014 a,b) but the results of these analyses have not yet resulted in the modification of existing management strategies.

The Precautionary Approach (PA) to fisheries management within the sustainable fisheries framework involves applying a harvest strategy that (1) identifies three stock status zones (healthy, cautious, and critical) according to upper stock and limit reference points (2) set harvest rates for each zone and (3) adjusts the removal rate according to fish stock status (DFO 2006). Most recently, an assessment of the Halokvik (Thirty-Mile River) and Jayko (Jayco River) combined trend analyses (Harris et al. 2020a) with quantitative modelling (Zhu et al. in press) to assess stock and to biological reference points consistent with the PA to fisheries management. This assessment concluded that both fisheries would be considered near the boundary of the healthy and cautious zone and that there is likely a moderate risk to these populations if harvest remains the same.

In support of stock assessment, past attempts have also been made to determine the abundance of various systems (McGowan, 1990; McGowan and Low 1992, Harris et al. unpublished data), primarily through the use of weirs during upstream migrations. These counts were variable among river systems and, in some cases, among years within the same system. Accurate enumerations over multiple years would prove useful for understanding exploitation rates that are sustainable in this species. At this time, these data are not available.

The Cambridge Bay commercial fishery for Arctic char is considered a data-poor fishery which presents a number of challenges and uncertainties for formal stock assessments

(Tallman et al. 2013). A multi-year stock assessment plan has been developed by DFO, in consultation with resource users and co-management organizations, for the Cambridge Bay Arctic Char commercial fishery in order to address this data-poor concern. The objectives of the plan are to assess stock health and to establish sustainable harvest levels for all commercially harvested waterbodies. Both fishery dependent (those data collected directly from the commercial fishery) and independent data (those collected independent of the commercial fishery) are required as part of the plan and should be collected annually.

Fishery-dependent data continues to be collected through the DFO-funded plant sampling program, which has generated a long-term series of biological data (length, weight and age) and is a key assessment tool in Cambridge Bay. Samples are examined annually for changes in the average length, weight and age and their frequency distributions that may signal a response of the stock to the current level of harvest.

Starting in 2012, the EHTO, supported by Kitikmeot Foods Ltd and DFO, initiated a long-term, river-based monitoring program to collect catch per unit effort (CPUE) and harvest information. This program contributes to fishery dependent data collection for actively harvested commercial fisheries. The program was maintained for five consecutive years through a funding contribution from the Nunavut General Monitoring Plan before transitioning into a commercial fisher-led program. The monitoring program is designed to estimate annual CPUE of commercial harvest through the use of logbooks. Additionally, the reporting of bycatch and discards in the fishery will contribute to an improved understanding of species interactions. Filling out log books completely and accurately is now part of the license conditions for the Cambridge Bay Arctic Char commercial fishery.

Fishery-independent data was collected at Jayko (Jayco River) from 2010-2015, and at the Halokvik (Thirty-Mile River) from 2011-2015. These data formed the foundation of a 2017 assessment for each fishery (see Harris et al. in press, Zhu et al. in press).Fishery-independent sampling is now taking place at the Paalik (Lauchlan River) and is expect to continue until 2022, after which an assessment of this stock will take place. Additionally, a long-term acoustic tagging project (in collaboration with the University of Windsor and Universite Laval), which commenced in 2013, has been assessing straying and dispersal among systems, spatiotemporal ocean migration patterns and marine and fresh water habitat use (Harris et al. 2014, Moore et al. 2016, 2017, Harris et al. 2020). Finally, parasite assessments for Arctic Char from all river systems are currently being completed (in collaboration with Lakehead University), marine trophic structure is being assessed (in collaboration with McGill University), life history variation is being assessed through otolith microchemistry (in collaboration with the University of Waterloo), thermal limits and cardiac performance are being examined (in collaboration with the University of British Columbia) and the impacts of marine microplastics on Arctic char are being studied (in collaboration with the University of Toronto).

Current quotas are based on “Tallman’s rule” which is a conservative exploitation level of about 5% of the number of Char in the run vulnerable to the fishing (Tallman et al.

2015). As mentioned above, further research to update exploitation rates for commercially harvested Arctic Char in the Cambridge Bay area is needed. Improved understanding of abundance, biomass, and stock health are important for assessing these exploitation rates and for establishing sustainable harvest levels for each waterbody.

2.5 Precautionary Approach

As described above, the SFF also includes the adoption of the PA framework to fisheries management. This framework (1) identifies three stock status zones (healthy, cautious, and critical) according to upper stock and limit reference points (2) sets harvest rates for each zone and (3) adjusts the removal rate according to fish stock status. Only recently have reference points been identified for two of the river systems (Halokvik and Jayko Rivers) within the Cambridge Bay region (Zhu et al. in press). For this assessment a depletion-based stock reduction analysis (DB-SRA) and data-limited model (DLM) were employed to assess stock status and sustainable fisheries management of these fisheries. Under the precautionary approach in fisheries management, both fisheries would be considered near the boundary of the healthy and cautious zone with the most likely position being just below the Upper Stock Reference of 0.8 B_{MSY}. However, much uncertainty is present, and the lower bounds of the credible intervals also overlap the lower-limit reference points for these fisheries. Reference points have not been developed for any other fisheries in the Cambridge Bay region.

2.6 Research

Research is critical for informing the sustainable management of Arctic char in the Cambridge Bay region. As outlined in the short-term objectives of this document there is a need to update stock assessment information and advice on sustainable harvest levels for each commercial waterbody and to improve our understanding of the biology of Arctic Char in the region. Fishery-dependent data collection is an important part of char research in the region facilitating the collection of biological data (length, weight and age) from each harvested stock on an annual basis. This is done through an annual commercial plant sampling program (in collaboration with Kitikmeot Foods Ltd) that has been collecting biological data since the 1970s. Fishery independent surveys are also completed annually to collect biological data that compliments that collected through the plant sampling programs and to further our understanding of char biology. In 2013, a collaboration between DFO, the Ocean Tracking Network (OTN), Universite Laval and the University of Windsor was initiated to use acoustic telemetry to track the migrations of

Arctic char in both the marine and fresh waters of the region. The intent us that this research program will continue until 2022. The results form this work has provided novel insights into marine habitat use and the timing of migrations between freshwater and marine habitats for both Arctic char (Moore et al. 2016, 2017, Harris et al. 2020b) and Lake Trout (Harris et al. 2014, 2020c). The extent of freshwater migrations and freshwater habitat use (spawning and overwintering) are currently being studied for both Arctic char and Lake Trout as part of this program, the results of which have yet to be published. Additional research in recent year has focussed on stock discrimination and understanding straying and dispersal among stocks of char in the region (Harris et al.

2016, Moore et al. 2017). The results of these studies suggest that there is significant but weak genetic differentiation among char stocks in the region and that migratory harshness is an important driver of overwintering dispersal. Other recent work has focussed on assessing the effects of temperature on aerobic metabolism and maximum heart rate of upriver migrating Arctic char in the Kitikmeot region that ahs found char are already experiencing temperature above with performance would be limited (Gilbert et al. 2020). There are also several other unpublished ecosystem-based studies currently underway that are evaluating the marine food web in the region including the trophic position of Arctic char in the marine environment, assessing and quantifying bycatch that results from the commercial harvest of char in the region and resolving parasites that are common in commercially harvested char.

3 Social, Cultural and Economic Importance of the Fishery

3.1 Social and Cultural

Arctic Char is very important to the social connection, cultural definition and food requirements of Inuit across Canada (Myers et al 2005; Balikci 1980). Cambridge Bay is also known as Ekaluktutiak, which in Inuinnaqtun translates to “Good Fishing Place” and reflects the strong historical and cultural connection the people share with Arctic Char (Thorpe et al. 2019). Today the area remains a significant food fishery as well as a social and economic contributor through recreational and commercial fisheries.

Arctic Char play an important role in the nutrition (Evans et al. 2016) and social culture of the community – fostering the continuation of traditional culture and lifestyles, provision of traditional foods, and local self-sufficiency (Thorpe et al. 2019). The nutritional value of country foods like Arctic Char cannot be adequately replaced by southern foods, which are costly to transport and lack the same quality as a food source (Myers et al 2005). For example, the current Nunavut Fisheries Strategy, 2016-20 has estimated food replacement value of char is over $7 million (The Territory of Nunavut, Government of Nunavut, Department of Environment, 2016).Additionally, Arctic Char are considered a good food choice for those seeking to maintain a traditional diet while minimizing Hg (mercury) intake that can be associated with other traditional foods (e.g., Lake Trout and marine mammals, Evans et al. 2016). The commercial harvest of Arctic Char supports important social and cultural values of family, sharing and community that have been passed down through generations of fishers. Some of the fishers in the commercial fishery harvest at the same locations where they were born, and where their families spent their lives fishing and hunting. The skills and traditions they learned are passed down through their families and are shared with other fishers.

According to the Nunavut Wildlife Harvest Study (NWMB 2004), Arctic char is the most harvested resource in Nunavut. Between 1996 and 2001 the annual number of food harvesters in the Cambridge Bay area varied between 23 and 55, harvesting an average of 6,461 Arctic Char per year from the many nearby waterbodies. Fish sold to the fish plant were excluded from the study. Assuming that the average size of Arctic Char from the food harvest is similar to the average commercially harvested size, the Study suggests the food harvest may be as much as half of the average commercial harvest.

3.2 Economic Importance

The economic contribution of the Cambridge Bay Arctic Char commercial fishery is significant for both the local economy and the Territory. In 2015, the total Arctic Char commercial harvest in Nunavut was estimated at 72,574 kgs with an estimated landed value of $1,800,000 (2016 GN Fisheries Strategy). Cambridge Bay contributed 37,765 kgs (52%) of that total harvest, with an estimated market value contribution of $855,363.[1] More recently, in 2019 the Cambridge Bay commercial fishery harvested 99% of the targeted quotas (48,493 Kg), totalling 48,097 Kgs.

For the most recent 5-year period available for Cambridge Bay Arctic Char commercial harvests (2015-2019), the annual average landings as a percentage of targeted quota was found highest for Ekalluktok (Ekalluk River) (96%), followed byHalovik (Thirty-Mile River) (93%), Jayko (Jayco River) (89%), Paliryuak (Surrey River) (86%), and Paalik (Lauchlan River) (90% over 2 years). The landed value generated by the landings over this 5-year period were approximately $942,883, with an annual average of $188,577.

During the 2015-2019, period, the market value generated by the landings in Cambridge Bay were approximately $4,073,397, with an annual average of $814,679. The five-year average market value for all forms of Cambridge Bay Arctic Char produced by Kitikmeot Foods Ltd. was $22.65/kg[2].

Until recently, the economic contribution of Arctic Char could vary from one year to the next due to several factors. While the quotas continue to remain stable, annual operational costs, market demand and value, and opportunities to harvest as is not consistent and may vary annually. For example, rising transportation costs, productive food fisheries, and poor weather can negatively impact the market value, demand and supply of Arctic Char. A detailed analysis of landings, values, economic viability and potential economic influences is provided in Appendix D: Economic Analysis.

The Nunavut Development Corporation is a public agency of the Government of Nunavut, and is responsible for promoting economic opportunities, diversity, and long-term growth and stability in Nunavut. It is committed to maximizing opportunities across Nunavut, as well as expanding Arctic Char markets both domestically and internationally. Advancing collaboration with NDC, the Government of Nunavut, DFO, and community stakeholders to improve the understanding and potential for Arctic Char to contribute economic benefit locally and territorially is important to properly managing the fishery.

Ocean Wise seafood is an independent conservation program that makes it easy for consumers to choose sustainable seafood distributors and restaurants for the long term

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[1] See Appendix D: Economic Analysis for details.

health and sustainability of Canada's fisheries. The four criteria to become Ocean Wise certified are: (1) Fisheries abundant and resilient to fishing pressures, (2) well managed with a comprehensive management plan based on current research, (3) harvested in a method that ensures limited bycatch on non-target and endangered species, and (4) harvested in ways that limit damage to marine or aquatic habitats and negative interactions with other species.

Presently, Kitikmeot Foods Ltd. employs approximately 28 local residents and beneficiaries in support of the Arctic Char commercial fishery on an annual basis. The commercial fishery maximizes local employment opportunities, thus allowing fishers to live and work in Cambridge Bay and contribute to the local economy while continuing to carry forward skills from a more traditional way of life.

As Arctic Char total sales and market opportunities grow, operational costs too continue to increase. Kitikmeot Foods Ltd. has had to rely heavily on freight subsidies from the Nunavut Development Corporation on an on-going basis to offset high transportation costs incurred to bring Arctic Char from fishing sites to the plant and onto various domestic and international markets. Over the 5-year period of 2014-2018, Kitikmeot Foods Ltd. experienced an increase in transportation related costs annually, from 20% of overall operating expenditures in 2014 to 27% in 2018.

4 Management Issues

There are a number of issues that co-management organizations continue to address in the management of the Cambridge Bay Arctic Char commercial fishery. The priority management issues include the need for updated stock abundance estimates to support management decisions, timely harvest reporting and consistent reporting of bycatch and catch and effort information in support of sustainable harvest levels, and ensuring the long-term viability and prosperity of the commercial fishery.

4.1 Stock Abundance Estimates and Exploitation rates

Comprehensive up-to-date abundance (or biomass) estimates and stock assessments are still required for several of the stocks of commercially harvested Arctic Char (See Section 3.2.5). Traditional scientific approaches for stock assessments and abundance estimates for setting sustainable harvest levels may be impractical in terms of cost, feasibility and applicability at all river systems. To compliment these approaches, quantitative modelling methods with predictive strengths are now being recommended in many cases where the data are available. With updated abundance estimates and stock assessments, updated exploitation rates for commercially harvested Arctic Char in the Cambridge Bay area can be provided. It should be noted, however, that exploitation rates that are sustainable for Arctic Char are still not fully understood and research aimed at resolving levels acceptable in this species should be initiated. It has been suggested that in some regions of the Canadian Arctic, an exploitation rates of 11% is not sustainable

(Johnson 1980), while in the other areas they are removal rates of 15% - 41% have been noted (Dempson 1995).

Currently, the maximum exploitation rate that are still sustainable for Arctic Char in Nunavut is unknown and this makes it difficult for managers to optimally manage stocks. As mentioned above, where abundance (or biomass) is known a precautionary rate of 5% ("Tallman's Rule") has been proposed to ensure sustainability for data poor assessments. Thus, it is clear the work aimed at understanding the harvest pressure(s) this species can sustainable withstand paramount. All told, science research needs to continue to support management decisions and resource conservation.

Given this fishery is still considered data-poor, to support standard stock assessment, both fishery-dependent (those data collected directly from the commercial fishery) and fishery-independent data (those collected independent of the commercial fishery) are required. Long-term monitoring, designed to estimate annual CPUE of harvests and report bycatch and discards in the fishery, will contribute to an improved understanding of abundance and species interactions, necessary for the sustainable and ecosystem-based management of Arctic Char in Cambridge Bay.

4.2 Harvest Reporting

Timely, accurate reporting of all catches and the effort exerted to harvest these catches from each of the commercial waterbodies is essential. Without complete and accurate monitoring of all harvesting activities, total harvest removals from all fisheries remain unknown, and co-managers must exercise caution when establishing harvest limits so that healthy Arctic Char populations capable of sustaining commercial harvests and the subsistence needs of Inuit can be maintained.

Overharvests of commercial quotas have occurred on occasion. Commercial harvesting needs to remain within regulated harvest levels. The timeliness of the reporting allows managers to assess the harvest as limits are approached. Recent initiatives have resulted in daily reporting of commercial landings through the processing plant (see Management Measures, Section 7.4). In addition, a shared stewardship monitoring program involving the EHTO, Kitikmeot Foods Ltd. and DFO has been funded through the Nunavut General Monitoring Plan ran from 2011-2017. All commercial fisheries are currently monitored for total removals, including commercial landings, bycatch and discards, and personal consumption as required by recently updated commercial license conditions.

4.3 Economic Viability of the Fishery

Rising transportation costs are impacting the economic feasibility of commercially fishing at some of the more distant river systems, and limit consideration of establishing new commercial fisheries at other distant fishery locations. The purchase of Arctic Char from other nearby communities, the use of a collector vessel, and other strategies are being assessed by stakeholders to supplement commercial landings in Cambridge Bay, optimizing the full processing and employment capacity of Kitikmeot Foods Ltd.

Regional and territorial co-management organizations continue to promote economic viability while ensuring stocks remain healthy and abundant.

5 Objectives

Objectives for the Cambridge Bay Arctic Char commercial fishery are a key component of the IFMP. Long term objectives guide the management of the fishery and may be categorized as stock conservation, ecosystem, shared stewardship, and social, cultural and economic objectives. Each long term objective is supported by one or more short term objectives to address existing management issues in the fishery. The objectives listed in Table 2 were developed by the IFMP Working Group and other stakeholders.

Table 2. Long-term and short-term objectives for the Cambridge Bay Arctic Char commercial fishery.

Long-term Objectives	Short-term Objectives
Stock Conservation	
Conserve Arctic Char stocks through sustainable use and effective fishery management	• Update stock assessment information and advice on sustainable harvest levels for each commercial waterbody • Improve knowledge of Arctic Char biology, ecology and stock discrimination • Improve the timeliness and accuracy of harvest and CPUE reporting in commercial, recreational and food fisheries to monitor total removals of arctic Char and bycatch. • Encourage conservation and responsible fishing practices for Arctic Char. • Given uncertainties related to the abundance of Arctic Char stocks in the Cambridge Bay area, continue to harvest at conservative levels using PA framework.
Ecosystem	
Conserve bycatch species through effective fishery management.	• Improve the accuracy and completeness of reporting bycatch to improve understanding of species interactions and management.
Shared Stewardship	
Promote collaboration, participatory decision making, and shared responsibility	• Conduct post-season fishery meetings and IFMP Working Group meetings on an annual basis.

Long-term Objectives	Short-term Objectives
with resource users, co-management organizations and other stakeholders.	• Continue to engage local participation in co-management activities at every opportunity. • Promote the responsibility of commercial fishers to monitor and report, as per licence conditions. • Secure funding for monitoring programs for commercial, recreational and food fisheries.
Social, Cultural and Economic	
Promote an economically viable and self-sufficient fishery based on high quality that maximizes social and economic benefits, while ensuring stocks remain healthy and abundant for future generations.	• Support initiatives to optimize community-based processing and employment capacity. • Support strategies to increase feasibility of commercial operations at more distant river systems and other fishery locations. • Maintain and conserve local and traditional fishing activities and areas. • Promote collaboration among co-management organizations associated with economic development throughout Nunavut.
Compliance	
Promote compliance with legislation, regulations and management measures to achieve conservation and sustainable use.	• Ensure commercial licence conditions. are updated regularly, to reflect requirements related to the sustainable management of the fishery. Promote compliance through education and shared stewardship. Work collaboratively with local and territorial wildlife officers. • Promote compliance through regular monitoring and surveillance activities, and increased presence in the community.

6 Access and Allocation

Commercial quotas are established for each water body, as set out in Schedule V of the *NWT Fishery Regulations*. All waterbodies have a competitive quota; in other words, all fishers licensed to commercially fish a given waterbody collectively fish against the total quota for that waterbody. There are no individual quota allocations associated with the commercial fishery. The commercial fishery is opened annually through a Variation Order, and closed by a Notice of Closure when the quota is met. Commercial fishing licences are issued to fishers under Section 7 of the *Fisheries Act*.

After the addition of Paalik (Lauchlan River) in 2018, targeted reduced quotas were set for Ekalluktok and Jayko Rivers to offset the increased landings expected from Paalik (Lauchlan River). These targeted reduced quotas may vary each year depending on demand as the fish plant operates at full capacity with the current total quota and does not have the required storage space to accept more Arctic Char. The reduced targeted quotas are typically applied to the fall fisheries, improving the balance of the spring-fall harvest distribution, and additionally affords fishers and float planes to leave Jayko sooner, before ice and weather conditions become a safety concern later in September.

Table 3 displays current legal quotas for the commercial fishery in both round weight kilograms (the appropriate product form and unit of measure of quota allocation, as set out in Schedule V) and dressed weight pounds (form and unit of measure used to record landings). Conversion factor calculations are outlined in Section 7.3. Quotas and landings for the commercial fishery in recent years are presented in Appendix B. In recent years Kitikmeot Foods Ltd. has included target quotas to reflect the plant capacity.

Table 3. Legal quotas for the Cambridge Bay Arctic Char commercial fishery.

Location	**Legal Quota** *(Kg, Round Weight)*	**Converted Legal Quota** *(Lbs, Dressed Weight)*
Ekalluktok (Ekalluk) River	20,000	36,744
Halokvik (Thirty-Mile) River	5,000	9,186
Jayko (Jayco) River	17,000	31,232
Paliryuak (Surrey) River	9,100	16,718
Paalik (Lauchlan) River	9,100	16,718
Grand Total	**60,200 Kgs.**	**110,598 Lbs.**

7 Management Measures for the Duration of the Plan

Management measures outline the controls or rules adopted for the fishery, including stock conservation and sustainable management measures. Management measures for the Cambridge Bay Arctic Char commercial fishery include controls related to quota, openings and notices of closure for fisheries; licensing and conditions of licence, including reporting requirements of bycatch, discards, marine mammal interactions and found/lost gear through the use of commercial logbooks. These measures are based on the

Fisheries Act and its regulations, the NA, DFO policies, and measures agreed upon by the IFMP Working Group, in support of sustainable fisheries management. In addition, these measures are aided by the shared stewardship arrangements and best practices in place for the Cambridge Bay Arctic Char commercial fishery (see Section 8). Appendix C provides an overview of the management measures currently in place.

7.1 Licensing of Commercial Fishing Activities

Commercial fishing licenses are issued annually in accordance with Section 7 of the *Fisheries Act*. Section 5(1) of the *NWT Fishery Regulations* further specifies that all fishing activities must occur under the authority of a license. In addition to the provisions set out in the *Fishery (General) Regulations* and *NWT Fishery Regulations*, specific management measures may be outlined in commercial licenses.

7.2 Quota

All waterbodies have a competitive quota. Once the competitive quota is reached for a waterbody, no further harvesting of Arctic Char is allowed for commercial purposes for the remainder of the fishing period (March 31). The waterbody is closed to further commercial fishing through public issuance of a Notice of Closure by a Fishery Officer consistent with Section 19(2) of the *NWT Fishery Regulations*. This includes issuing the notice to both the EHTO and Kitikmeot Foods Ltd. for posting on their respective premises.

7.3 Monitoring and Reporting

Commercial fishers are responsible for reporting landings, in accordance with the *Fishery (General) Regulations* and *NWT Fishery Regulations* and as outlined in the management measures of this plan. In support of this measure, logbooks are available from the EHTO, GN Conservation Office, or Kitikmeot Foods Ltd. Completing logbooks is an updated condition of licence, and is the responsibility of commercial fishers. Commercial fishers are required to use logbooks to record all commercial landings, fishing effort, any Arctic Char discarded or kept for personal consumption, ghost gear reporting, seabird and marine mammal interactions, and all other fish bycatch encountered in the commercial fishery. Logbooks are submitted to the local wildlife office or fish plant and returned to DFO at the end of the season.

To support real time harvest reporting and quota monitoring, daily records of landings for each commercial waterbody are kept by Kitikmeot Foods Ltd. and are reported daily to DFO. Reports are verified regularly during the fishing season, and accumulated landings for each waterbody are tracked against the commercial quota. Plant reporting is validated using logbook information at the end of the season. Any discrepancies are addressed during the post-season review.

Effective quota monitoring requires the application of conversion factors. Landings are recorded in pounds (lbs.) dressed weight, whereas the quota is issued in kilograms (Kg) round weight. A conversion factor of 1.2 is used to convert product dressed weight to round weight. A standard conversion factor of 0.45359237 is applied to convert pounds to kilograms. Round weight kilogram estimation is therefore calculated using the following equation:

$$\text{Round Weight Kg} = (\text{Dressed Weight lbs.} \times 1.2) \times (0.45359237)$$

An example of the monitoring and reporting process is presented in Appendix B. A quota monitoring and conversion report (Figure 4) is maintained based on daily reporting summaries (Figure 5) and daily trip reports (Figure 6).

7.4 Supplemental License Conditions

In addition to current licence conditions, measures, and monitoring and reporting requirements, additional supplemental conditions have been incorporated into the fishery to improve understanding for fishers, data collection efforts, and improved sustainable management of the fishery overall.

7.4.1 The quota identified on a licence is a total allocation of the competitive commercial quota for the specified waterbody. Fishing activity must stop after the quota is reached. DFO will notify resource users of closure of the fishery by an official notice.

1.1 Fishing activity must cease immediately upon reaching the quota.

7.4.2. Commercial logbooks must be filled out accurately, completely, and legibly each time a gill-net is checked or a weir is emptied. All species caught, retained and discarded shall be recorded, including bycatch species, and any seabird and marine mammal interactions.

7.4.3. In support of the Ghost Gear Initiative (see section 1.6.4), license holders are required to report the loss or theft of any nets to DFO via the following email:

DFO.CALostandRetrievedGear-EnginsPerdusRecupCA.MPO@dfo-mpo.gc.ca.

Further to the Ghost Gear Initiative, gear tags are being implemented in the commercial fishery, supported by a pilot project led by DFO with the support of the HTO and local Conservation Officers. Valid gear tags are to be attached to commercial gill nets by a Fishery Officer or designated local Conservation Officer before fishing commences using a tamperproof fastener. Gear tags are to remain attached to gill nets at all times while the net is in use for commercial fishing purposes. Lost gear tags must be reported to Lostgear-enginsperdus@dfo-mpo.gc.ca or by calling toll-free 1-800-465-4336 and recorded (in the logbook).

8 Shared Stewardship Arrangements

The IFMP for the Cambridge Bay Arctic Char commercial fishery was initiated and developed by the Cambridge Bay Arctic Char Working Group in 2010. Participation on the Working Group includes representatives from the EHTO (co-Chair), Kitikmeot Foods Ltd., commercial fishers, community elders, Department of Environment – Fisheries and Sealing Division, and DFO. Youth from the local high school are encouraged to actively participate as a sitting member of the Working Group.

A letter of support from the NWMB was received by the Working Group in 2011 expressing support for the initiative of the Working Group and development of a management plan. Meetings have been held in Cambridge Bay at least once annually since 2010. Each meeting is accompanied by a community consultation to obtain community views regarding Arctic Char management issues, objectives, management measures and scientific research.
A five (5) year review of the IFMP was conducted in 2019/2020 and forms the basis of this updated version of the IFMP.

There are a number of different ways that the objectives for the fishery may be achieved. Current management measures are identified in Appendix C. Other measures may be initiated by co-management organizations, through the IFMP Working Group, and are included in this section of the IFMP.

8.1 Best Management Practice – Spawners

In support of the long-term health of Arctic Char stocks and sustainability of the fishery, it is important to reduce any potential impact to the spawning population. The almost complete absence of spawners in the fall upstream migrations suggests that the spawning component of the population is not adversely impacted by the commercial fishery. When spawners are captured in the gillnet fishery, and where they are alive, all spawning Arctic Char should be released where they were taken, in a manner that causes them the least harm. When encountered in a weir fishery, all spawning Arctic Char should be released unharmed. These best management practices are currently in place in the commercial fishery.

8.2 Best Management Practice – Precautionary Approach

Paalik (Lauchlan River) was not commercially harvested from 2010 through 2017 due to a lack of economic viability related to the available commercial quota and significant transportation costs. Starting in 2018, the targeted commercial quota for Paalik (Lauchlan River) was set at 5,000 kg, to assist with improving stock assessment and economic viability. The legal quota for this fishery is 9,100kg, but there is uncertainty in the stock biomass at this time.

8.3 Best Management Practice – Weir Utilization

The weir is a traditional method of the Inuit to subsistence fish at the mouths of rivers. Weirs traditionally span the entire width of a river allowing all migrating fish to be funnelled and sorted. The weir is the preferred method for the subsistence and commercial collection of Arctic Char at Jayko River. The usage of a weir causes fish less stress and allows for quotas to be filled more quickly, reduces bycatch, animal interactions and lost gear potential. Weirs also allow fishermen to be more selective with their collection of fish, and they can safely return spawning females to the river system unharmed; this would not be possible with the use of a gill net.

9 Compliance Plan

The DFO Conservation & Protection program promotes compliance with legislation, regulations and management measures implemented to achieve the conservation and sustainable use of Canada's aquatic resources.

The program is delivered by DFO Fishery Officers in the Central and Arctic Region through a balanced regulatory management and enforcement approach including the following:

- Promotion of compliance through education and shared stewardship;
- Monitoring, control and surveillance activities; and
- Management of investigations in relation to complex compliance issues.

9.1 Compliance Program Delivery

DFO Fishery Officers are responsible for compliance activities related to the Cambridge Bay Arctic Char commercial fishery. Fishery Officers conduct surveillance activities, and are supported by Regional DFO staff that provide assistance with monitoring, reporting, education and shared stewardship.

Fishery Officers are designated under Section 5 of the *Fisheries Act* with enforcement powers and responsibilities consistent with the *Fisheries Act* and any other Act of Parliament, including the Criminal Code and the *Constitution Act*. Fishery Officers can inspect and investigate processing operations, fishing locations and vessels for compliance with the *Fisheries Act* and related regulations, including Variation Orders and conditions of licences.

9.2 Consultation

DFO Fishery Officers participate in fishery review meetings where compliance issues are presented and recommendations requested for resolution. As well, informal meetings continue on an ad hoc basis to resolve in-season matters. Fishery Officers discuss fisheries conservation and shared stewardship during visits to Cambridge Bay and interact with community resource users, fishers and processors.

9.3 Compliance Performance

Post season analysis sessions are conducted to review issues encountered during the previous season and make recommendations on improving management measures.

10 IFMP Performance Review

This IFMP was developed through a consultative process including resource users, co-management organizations, and stakeholders.
Commercially fished Arctic Char stocks in the Cambridge Bay area will continue to be assessed through shared stewardship with resource users, and multi-year stock assessments that aim to provide scientific advice. Monitoring of the fishery will be accomplished using several tools including daily reporting of landings, quota monitoring, fishery-dependent (plant) sampling, logbooks, and surveillance.

Post season reviews will be conducted on a regular basis with stakeholders and the IFMP Working Group. Progress on achieving the short term objectives and effective implementation of management measures identified in this Management Plan will be reviewed. Recommendations to improve management of the Cambridge Bay Arctic Char commercial fishery will be developed to meet the long term objectives of maintaining a sustainable fishery.

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Glossary

Abundance: Number of individuals in a stock or a population.

Age Composition: Proportion of individuals of different ages in a stock or in the catches.

Anadromous: An anadromous species, such as salmon, spends most of its life at sea but returns to fresh water grounds to spawn in the river it comes from.

Bycatch: The unintentional catch of non-targeted species while directing fishing for another species. For example, in this IFMP the directed fishing is Arctic Char, bycatch is all other species.

Biomass: total weight of all individuals in a stock or a population.

Fishery: As defined by the *Fisheries Act*, a fishery includes the area, locality, place or station in or on which a pound, seine, net, weir, or other fishing appliance is used, set, placed, or located, and the area, tract or stretch of water in or from which fish may be taken. For the purposes of this IFMP, all current Arctic Char commercial waterbodies in the Cambridge Bay area are collectively referred to as the "Cambridge Bay Arctic Char commercial fishery".

Gillnet: Fishing gear: netting with weights on the bottom and floats at the top used to catch fish. Gillnets can be set at different depths and are anchored to the seabed. For the purposes of this IFMP, all commercially used gillnets must have a minimum mesh size is 139mm (5-½ inch), in accordance with the *NWT Fishery Regulations*.

Harvesting: Catching or attempting to catch fish by any method.

Landings: Quantity of a species caught and kept. For the purposes of this document, landings refer to the quantity of Arctic Char kept for commercial sale.

Notice of Closure: As defined in Section 19 of the *NWT Fishery Regulations*, a notice issued by a Fishery Officer or Regional Director-General stating that the quota set out in a Variation Order has been, or is about to be, reached. Notice must be brought to the attention of persons affected by (e.g. notice provided to Ekaluktutiak HTO and Kitikmeot Foods Ltd. for public posting).

Nunavut Agreement (NA): The 1993 agreement between the Inuit of the Nunavut Settlement Area, as represented by the Tunngavik Federation of Nunavut and Her Majesty the Queen in Right of Canada.

Nunavut Wildlife Management Board (NWMB): Established by the NA, an institution of public government that shares decision-making authority with the Federal Government.

Population: Group of individuals of the same species, forming a breeding unit, and sharing a habitat.

Quota: For the purposes of this IFMP, the total amount (in Kilograms Round Weight) of Arctic Char that can be commercially harvested, as set out in Column V, Schedule V of the *NWT Fishery Regulations* or in accordance with a Variation Order.

Spawner: Sexually mature individual.

Stock: Describes a population of individuals of one species found in a particular area. Ex: a group of Arctic Char that share a common gene pool. Waterbody specific stock is used as a unit for fisheries management purposes in the Cambridge Bay commercial fishery. For management purposes, each commercial waterbody is considered an individual management unit.

Traditional Ecological Knowledge (TEK): A cumulative body of knowledge handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.

Variation Order: As defined in Section 6(1) of the *Fishery (General) Regulations*, where a close time, fishing quota or limit on the size or weight of fish is fixed in respect of an area (such as a waterbody) under any Regulations, the Regional Director-General may, by order, vary such restrictions.

Weir: Fishing gear: an underwater fence that is set up in a V-shape, which is designed to hinder the passage of fish. It comes in from two sides in a channel, directing the fish into a catch basin. In the Cambridge Bay area fish weirs were traditionally built from stones. Current weirs are constructed of conduit pipe.

Appendix A Historical Commercial Fishing Locations

Figure 3. Map of Cambridge Bay area showing historical commercial fishing locations.

Appendix B Commercial quota and landing reporting

Table 4. Commercial Arctic Char quota and landings in the Cambridge Bay area, 2009-2019

Year	Ekalluktok/ Ekalluk River		Paliryuak/ Surrey River		Halokvik/ Thirty-Mile River		Paalik/ Lauchlan River		Jayko/ Jayco River		Total Quota	Total Landing
	Quota	Landing	Quota	Landing	Quota	Landing	Quota	Landing	Quota	Landing		
2009	20,000	12,666	9,100	8,657	5,000	5,219	2,400	NF	17,000	6,514	53,500	33,056
2010	20,000	20,434	9,100	9,074	5,000	3,317	2,400	2,534	17,000	NF	53,500	35,359
2011	20,000	13,636	9,100	11,475	5,000	1,124	2,400	NF	17,000	NF	53,500	26,235
2012	20,000	19,038	9,100	8,945	5,000	4,920	2,400	NF	17,000	15,231	53,500	48,134
2013	20,000	18,548.48	9,100	9,078.01	5,000	4,768.16	2,400	NF	17,000	15,195.25	53,500	47,589.9
2014	20,000	18,279.37	9,100	9,082.10	5,000	5,010.08	2,400	NF	17,000	14,892.62	53,500	47,264.17
2015	20,000	16,929.78	9,100	6,823.75	5,000	4,159.62	2,400	NF	17,000	9,851.21	53,500	37,764.37
2016	20,000	20,011.32	9,100	5,739.49	5,000	4,212.42	2,400	NF	17,000	17,010.8	53,500	46,974.03
2017	20,000	20,000.97	9,100	8,990.11	5,000	4,888.46	2,400	NF	17,000	16,199.51	53,500	50,079.05
2018	20,000	16,569.64	9,100	8,791.71	5,000	4,997.05	9,100	3,917.13	17,000	11,573.14	60,200	45,848.66
2019	20,000	16,698.91	9,100	8,883.97	5,000	4,971.74	9,100	5,061.27	17,000	12,481.32	60,200	48,097.21

Quota and landing values reported in Kilograms, Round Weight.
NF = Not Fished.

A complete history (1960 – 2009) of quota and harvest of the Cambridge Bay Arctic Char commercial fishery is provided by Day and Harris (2013).

Figure 4. Example of the quota monitoring and conversion report (2019)

Site	2019 Commercial Quota - Round Weight		2019 Targeted Harvest		2019 Commercial Quota - Dressed Weight (conversion =1.2)		2019 Targeted Harvest - Dressed Weight		Kitikmeot Foods Reported Harvest (original reporting in Dressed Weight)		Kitikmeot Foods Harvest (converted to Round Weight)		Quota (Round Weight) Remaining		Percentage Harvested
	KG	LB	KG	LB	KG	LB	KG	LB	KG	LB	KG	LB	KG	LB	
Lauchlan (Byron Bay)	9,100	20,062	5,000	11,023	7,583	16,718	4,167	9,186	4,217.73	9,298.50	5,061.27	11,158.20	-61.27	8,903.84	101.2%
Ekalluk	20,000	44,092	16,874	37,200	16,667	36,744	14,061	31,000	13,915.76	30,679.00	16,698.91	36,814.80	174.59	7,277.60	99.0%
Halovik (30 Mile)	5,000	11,023	5,000	11,023	4,167	9,186	4,167	9,186	4,143.11	9,134.00	4,971.74	10,960.80	28.26	62.30	99.4%
Jayco	17,000	37,479	12,519	27,600	14,167	31,232	10,433	23,000	10,401.10	22,930.50	12,481.32	27,516.60	37.68	9,961.94	99.7%
Paliryuak (Surrey)	9,100	20,062	9,100	20,062	7,583	16,718	7,583	16,718	7,403.31	16,321.50	8,883.97	19,585.80	216.03	476.24	97.6%
TOTAL	**60,200**	**132,718**	**48,493**	**106,908**	**50,167**	**110,598**	**40,410**	**89,090**	**40,081.01**	**88,363.50**	**48,097.21**	**94,878.00**	**456.56**	**17,778.08**	99.2%
					Reflects a round weight to dressed weight (gutted, head on) conversion in kilograms - Standard conversion for Cambridge Bay	Reflects a round weight to dressed weight (gutted, head on) conversion in pounds - Standard conversion for Cambridge Bay			Harvest converted to kilograms, Dressed Weight (gutted, head on) - this column can be compared to Column D	Original harvests from Kitikmeot Foods are reported in Lbs, Dressed Weight (gutted, head on) - this column can be compared to Column E (quota) THIS IS THE ONLY COLUMN YOU NEED TO ENTER DATA IN - all other data is automatically	Harvest converted to kilograms, Round Weight (gutted, head on) - this column is compared to Column B to determine over/under	Original harvests from Kitikmeot Foods in Lbs, converted to Round Weight - this column is compared to Column C to determine	A negative (-) value (displayed in red) indicates an over-harvest of the quota	A negative (-) value (displayed in red) indicates an over-harvest of the quota	
	This column reflects what is actually issued on a Variation Order		Kitikmeot Foods has advised that Ekalluk and Jayko targeted harvest is reduced by 5000 and 8000 lbs respectively to offset the increased landings expected from harvesting at Lauchlan. The fish plant operates at full capacity with the current total quota.			This column can be used by Kitikmeot Foods for tracking of the annual quota (since it reports harvests in dressed weight)				This column reflects what is actually reported by Kitikmeot Foods		This column reflects the dressed to round weight conversion of what is actually reported by Kitikmeot Foods (Column H)			

Original form is maintained in an Excel spreadsheet, and is updated regularly based on Daily Reporting Summary Sheet (see Figure 5 below)

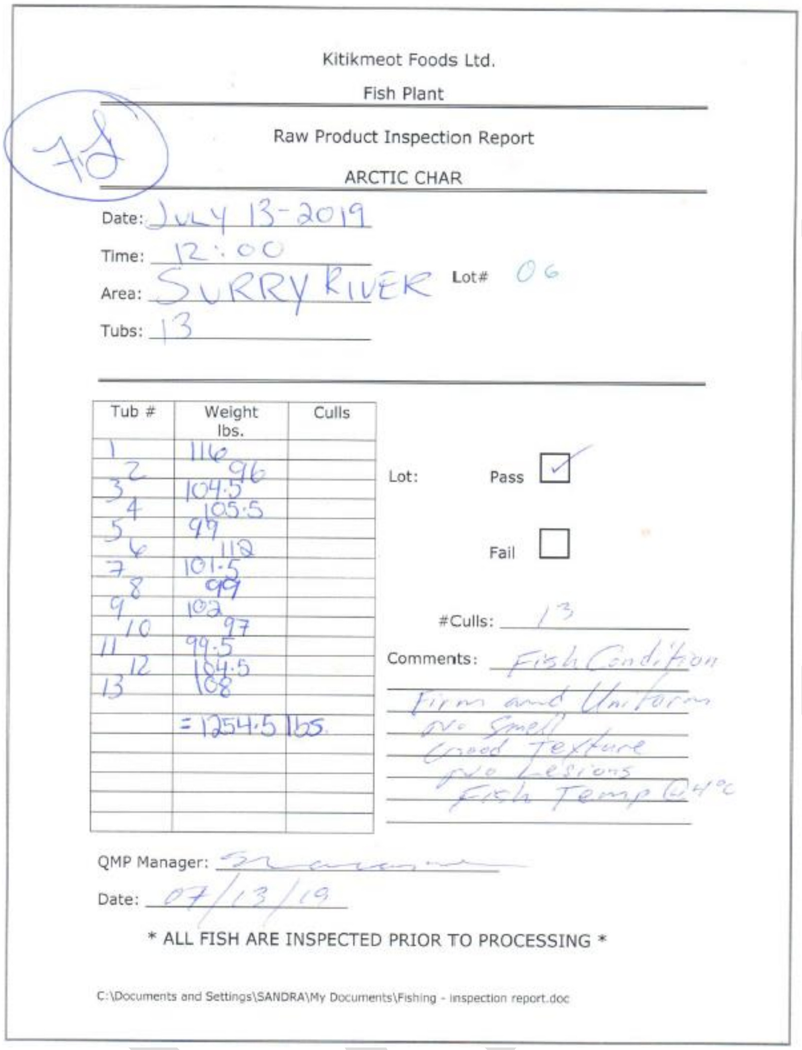
Figure 5. Example of the daily recording worksheet 2019

Date	Time	Lot#	Tub#	Dressed Weight (lbs)	Round Weight (Kg)	Trip Total	per Tub per Trip (Lbs)	Culls (#)	Comments
10-Jul-19	18:35	1	1	102.5	55.79				
10-Jul-19	18:35	1	2	110.5	60.15				
10-Jul-19	18:35	1	3	99.0	53.89				
10-Jul-19	18:35	1	4	102.0	55.52				
10-Jul-19	18:35	1	5	97.5	53.07				
10-Jul-19	18:35	1	6	98.5	53.61				
10-Jul-19	18:35	1	7	97.0	52.80				
10-Jul-19	18:35	1	8	81.0	44.09				
10-Jul-19	18:35	1	9	98.5	53.61				
10-Jul-19	18:35	1	10	96	52.25	982.50	98.25	10	Fish Condition: firm and uniform, no smell, good texture, no lesions, fish temp @ 3C.
11-Jul-19	10:15	2	1	100.0	54.43				
11-Jul-19	10:15	2	2	95.5	51.98				
11-Jul-19	10:15	2	3	89.0	48.44				
11-Jul-19	10:15	2	4	120.0	65.32				
11-Jul-19	10:15	2	5	107.0	58.24				
11-Jul-19	10:15	2	6	120.0	65.32				
11-Jul-19	10:15	2	7	96.5	52.53				
11-Jul-19	10:15	2	8	106.5	57.97	834.50	104.31	8	Fish Condition: firm and uniform, no smell, good texture, no lesions, fish temp @ 3C.
12-Jul-19	13:45	5	1	108.5	59.06				
12-Jul-19	13:45	5	2	103.5	56.34				
12-Jul-19	13:45	5	3	100	54.43				
12-Jul-19	13:45	5	4	100.5	54.70				
12-Jul-19	13:45	5	5	98.5	53.61				
12-Jul-19	13:45	5	6	94.5	51.44				
12-Jul-19	13:45	5	7	98.5	53.61				
12-Jul-19	13:45	5	8	102.0	55.52				
12-Jul-19	13:45	5	9	110.5	60.15				

Site:	Surrey River
Fishing Period:	7/10/2019 - 7/21/2019
Average Weight per Tub:	102.60
Average Weight per Trip:	1,088.10
Total Trips:	15
Total Culls:	159
Quota (Dressed Wt LB):	16,718
Targeted Quota (Dressed Wt LB):	16,718
Total Harvest (Dr Wt LB):	16,321.50
Remaining Quota (Dr Wt LB):	396.89
Remaining Trips (estimate):	0.364753438
Quota (Rd Wt KG):	9,100
Targeted Harvest (Rd Wt KG)	9,100
Harvest to date (Rd Wt KG):	8,883.97
Remaining Quota (Rd Wt KG)	216.03
Percent Landed to date:	97.6%

Original form is maintained in an Excel spreadsheet, and is updated daily based on Daily Trip Reports (see Figure 6 below)

Figure 6. Example of a daily trip report completed by Kitikmeot Foods Ltd (2019).



Kitikmeot Foods Ltd.

Fish Plant

Raw Product Inspection Report

ARCTIC CHAR

Date: July 13-2019

Time: 12:00

Area: Surry River Lot# 06

Tubs: 13

Tub #	Weight lbs.	Culls
1	116	
2	96	
3	104.5	
4	105.5	
5	97	
6	112	
7	101.5	
8	99	
9	102	
10	97	
11	99.5	
12	104.5	
13	108	
	=1254.5 lbs.	

Lot: Pass ☑ Fail ☐

#Culls: 13

Comments: Fish Condition Firm and Uniform No Smell Good Texture No Lesions Fish Temp @4°C

QMP Manager: [signature]

Date: 07/13/19

* ALL FISH ARE INSPECTED PRIOR TO PROCESSING *

C:\Documents and Settings\SANDRA\My Documents\Fishing - inspection report.doc

Note: landings are reported in Pounds, Dressed Weight. Weight conversions are applied as illustrated in Figures 4 and 5.

Appendix C Current management measures

Management Measure	Description
Locations	• Commercial waterbodies are set out in NWT Regulations. • Waterbodies opened annually by Variation Order
Quota	• Set out in NWT Regulations for each commercial waterbody. • All waterbodies have a competitive quota. There are no individual allocations associated with the commercial fishery.
Licences	• Required when commercially fishing.

Management Measure	**Description**
Species, area and catch limitations	• Species and waterbody permitted to fish are specified. • Quota is specified in Kilograms, Round Weight. • Conversion factors are specified, where applicable. • Quantity specified is the total competitive commercial quota available.
Fishing Season	• April 1 – March 31, annually.
Notification of closure	• Once the competitive quota is reached, the waterbody is closed to commercial fishing. • Via public notice, issued by Fishery Officer.
Fishing gear	• Minimum gillnet mesh size is 139mm (5-½ inch). • When using a weir, 1/3 of the width of any river or stream shall always remain open.
Ghost Gear	• The licensee must report the loss or theft of nets and any found fishing gear, within 24 hours to a specified DFO email listed on the Supplemental License Conditions of the commercial fishing license.
Disposal	• Fish are to be disposed in gurry grounds. These sites are designated by DFO Fisheries Officers under section 56 of the Fisheries Act.
Discards and Bycatch	• All discards of Arctic Char, including those for personal consumption, are to be reported in logbooks. • Any bycatch is to be reported in logbooks, identifying those kept for personal consumption and those that are not retained.
Reporting requirements	• Reporting of landings is required by commercial fishers. • Reporting of all bycatch and discards in logbook. • Reporting of all marine mammal interactions and result of interaction e.g. subsistence harvest or released alive; reporting is recorded in the logbook. • Commercial fishers to accurately and completely record fishing activities, including catch and effort of each gillnet set or weir landing, as per directions in logbooks. Logbook is to be provided to DFO immediately at the end of each fishery. Logbooks are available from the EHTO or Kitikmeot Foods Ltd. • Kitikmeot Foods Ltd. to provide report from each trip, which includes date, time, location, lot and tub numbers, and landing amounts. Raw Product Inspection Report is an acceptable format. Each trip report is faxed or emailed to DFO on the day of trip receipt.

Appendix D Economic analysis of Cambridge Bay Arctic Char for the Cambridge Bay Commercial Arctic Char Integrated Fisheries Management Plan

Fishers from Cambridge Bay have long recognized the importance of the Arctic char resource for their community. The commercial fishery is conducted by local Inuit fishers in conjunction with the operational support of Kitikmeot Foods Ltd. (KFL), the commercial processing plant for both Arctic Char and muskox. Kitikmeot Foods Ltd., the only processing plant in Cambridge Bay, was established in 1990 as a subsidiary of the Nunavut Development Corporation. KFL serves a growing domestic and international fish market under the territorial brand *Truly Wild Arctic Char*™.

The major commercial fishing sites in the Cambridge Bay area currently include Ekalluktok (Ekalluk), Paliryuak (Surrey), Halovik (Thirty-Mile), Paalik (Lauchlan) and Jayko rivers.

Landings and Landed Values

During 2014/15-2018/19, a combined total of 227,915 kg of Arctic Char was landed in the Cambridge Bay commercial fishery (Table 5 and Table 7).[2] To avoid calculation bias, annual average numbers used in this economic analysis exclude Paalik (Lauchlan River) as there was no commercial fishing activity between 2010 and 2018. Beginning in 2018, Paalik (Lauchlan River) was harvested using a targeted reduced quota, given the lack of recent scientific information, determined by the IFMP working group in support of a conservative approach to the sustainable management of the fishery. The landed value generated by the fishery was approximately $1.2 million during the same time period, with an annual average of $298,000.[3]

Table 5. Total landings over 5 year 2014/15-2018/19

	Landed catch (kg)[1] over 5 year period	Annual average landings (%)[2]
Ekalluktok (Ekalluk River)	91,791	95
Jayko (Jayco River)	69,528	86
Paliryuak (Surrey River)	39,427	87
Halovik (Thirty-Mile River)	23,268	93
Paalik (Lauchlan River)	3,902	7890 (over 2 years fished)
Total	**227,915**	**90**

[2] For details on landings and values, see Table 7.
[3] To avoid calculation bias, the annual average numbers exclude Paalik River, as it fished only in 2018/19.

Industry Viability

During 2014/15 - 2018/19, the 5-year combined market value generated by the landings were approximately $5.9 million, with an annual average of $1.5 million. The average market price of Cambridge Bay Arctic Char was $25.9/kg (see Table 7 details)[4] which reflected a market value increase of 22% during the 5 year period.[5]-The highest increase was recorded in head/tail off product form (35%) followed by whole dressed (28%), fillets (19%) smoked sides (10%) and jerky (4%). The increase in market value may be in part explained by increase consumer demand; the increase in estimated market price is likely due to the increase in cost of operation (particularly freight related expenses) of the fishery.

Table 6. KFL Operational Cost 2014/15 – 2017/18

Costs Items	2014/15	2015/16	2016/17	2017/18	Average
Freight Related Expenses	20%	21%	22%	27%	22%
Utilities	25%	25%	25%	24%	25%
Office Administration	38%	40%	36%	33%	37%
Fish Purchase and Processing	17%	15%	17%	16%	16%
Total	**100%**	**100%**	**100%**	**100%**	**100%**
Costs per Kg Processed	$16.6	$22.4	$18.3	$16.1	**$18.3**

Source: Policy and Economics, DFO Arctic Region calculations based on data provided by Kitikmeot Foods Ltd.

Note: KFL operational costs data for 2018/19 was not available at time of calculation.

During the 4 year period of 2014/15 – 2017/18 period, the average annual operational expenses incurred by KFL was approximately $800,000. Of that, office administration accounted for most expenses (37%) followed by, utilities (25%), freight (20%) and payment to fishers and processors (16%).

The analysis found that the cost of harvesting Arctic Char ranges from $2.9 - $3.6 per lb. for the commercial sites during the 2014/15 – 2017/18 period. It was evident that for some rivers, though the total cost of harvesting was high, the unit cost was low due to a greater amount of harvesting due to higher quotas (e.g. Ekalluktok river). In other words, the higher the level of harvest is at a given site, the lower the unit costs since the transportation costs and KFL Plant costs per unit are reduced. The analysis showed that after harvesting Arctic Char from the commercial sites and subsequently processing at the plant in order to distribute to primary markets, the annual average operational cost amounts to $18.0 per kg of Arctic Char processed.

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[4]The weighted market prices were calculated based on the percentages of sales volume as follows: (i) Whole dressed: 55% of production; (ii) Head, tail off: 23%; (iii) Fillets: 10%; (iv) Smoked sides: 8%; and (v) Jerky: 4%. For details about the percentages of sales volume, see RT & Associates (2001).

[5]Due to unavailability, market prices for 2016/17 and 2018/19 were estimated based on market prices for other years.

Employment

The commercial fishery and the processing plant are economically important for the community of Cambridge Bay. The Arctic Char fishery stimulates local job creation and business growth, provides long-term employment and training opportunities for local residents, and promotes economic diversification.

Kitikmeot Foods processes year-round and employs local fishers to harvest during the spring and fall fishing season. The fish plant employs 6 permanent staff, 14 seasonal staff, and up to 20 seasonal fishers.

In the Cambridge Bay Arctic Char fishery, each commercial fishing site is coordinated by a lead fisher, who manages a crew of other skilled fishers. The size of the crew may vary depending on different factors, including site location and gear used, expectations of the run (e.g. quota, climate, timing), and the availability and experience of fishers. Some fishers are employed at multiple sites. For the period 2014-18, the average annual number of harvesters was 10.[6] Most of the fish harvesters were active at Ekalluktok (Ekalluk) River, Paliryuak (Surrey) and Jayko (Jayco) Rivers, reflecting the larger quotas and landings and the required scale of operations at these sites.[7]

Distribution and Value

KFL promotes sustainable harvest of Arctic Char products from the Kitikmeot region of Nunavut. KFL has also developed important client partnerships with commercial customers throughout Nunavut and the Northwest Territories, southern Canada and into the United States. Recent recognition by Ocean Wise™, which has independently assessed this fishery has further promoted the sustainability of the Cambridge Bay Arctic Char fishery.

The primary markets for Cambridge Bay commercial Arctic Char includes Nunavut and the NWT, and select markets throughout Canada and the US. During the summer and fall harvesting seasons, fresh Arctic Char is shipped through Edmonton to be exported to other cities across Canada, and to San Francisco, where it gets distributed to high-end restaurants across the US (e.g. San Francisco, Boston). Toronto, Ottawa, and Montreal are currently the primary Canadian destinations for Cambridge Bay Arctic Char outside the territories.

Due to the remote nature of the fishery, fishers spend upward of a month at a given site catching fish, which are then shipped by float plane to KFL for processing. KFL staff process Arctic Char in various forms depending on demand throughout the year. Product forms include whole dressed (fresh/frozen), head/tail off, fillet (premium/regular), smoked fillet/sliced, candied char, and jerky (KFL Price List, 2017/18), and are marketed to hotels, discerning restaurants, institutional markets, grocery market, gift markets, and

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[6] The number is adjusted to avoid accounting for multiple employment of same fisher at different sites.
[7] The employment scenario discussed in this section focused on direct employment generated by fishing activities. It should, however, be noted that commercial fishing activities also generate some indirect and induced employment in other Indigenous businesses and investments.

local sales for consumption (Consilium Nunavut Inc., 2002). According to the 2011/12 comparative income statement of KFL, the total revenue generated from Arctic Char products was $466,916, of which whole dressed (fresh and frozen) accounted for 31%; premium and regular fillet (30%), jerky (12%), head/tail off (11%), smoked (7%), and other products (10%).

Arctic Char are considered a high-quality, but expensive, alternative to farm-raised Salmon (FishChoice, 2018). Iceland is the main supplier of farmed Arctic Char to the U.S., producing 3,260t in 2012, whereas Canada and the US combined producing around 500t. Production also occurs in Norway and Sweden, however, exports to the US are minimal (Eithier, 2014). This shows that demand for Arctic Char in the US far exceeds the current production of Arctic Char. Therefore, being able to realize this potential depends on KFL Arctic Char marketing and distinguishing itself within these markets so as to be able to compete with farmed Arctic Char and Salmon being supplied to these areas. There is demand for Arctic Char in Europe, but there is also local production, mostly farmed, that is likely meeting this demand.

It has been suggested that in addition to focusing on the US and Canadian markets, a stronger market may be developed for Char in Nunavut and the Northwest Territories (Consilium Nunavut Inc., 2002). Increasing costs related to operations, transportation, and alternate foods throughout Nunavut communities may limit the economic viability of expanding markets, and as a result may make local and traditional food sources a stronger market within Nunavut.

Conclusions

There are some issues that may impact the economic operation and viability of the fishery. Firstly, fluctuation of the Canadian dollar against the US dollar. In the last five years, the average value of the Canadian dollar depreciated by over 33% against the US dollar. Such an unprecedented level of depreciation of the Canadian dollar against the US dollar has substantial implications on revenues from Arctic Char fishing activities for the portion of the fishes exported and prices received in the US dollars. Secondly, increasing costs of production (e.g. freight and product distribution costs); and thirdly, interest in adjusting quotas and opportunities to fish alternate sites may increase the scale and viability of the fishery. Commercial harvesting at Paalik (Lauchlan River) is a case in point. Commercial harvesting at Paalik (Lauchlan River) was recorded in 2010 which was then discontinued due to a lack of economic viability related to the available commercial quota and significant transportation costs. In 2018, commercial harvesting at Paalik (Lauchlan River) has resumed with an adjusted quota of 5,000 kg (round weight) which is in compliance to the sustainable management of this fishery.

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Table 7. Landings, landed and market values and prices by waterbody, 2015 - 2019

Waterbody Name	2015	2016	2017	2018	2019	5-Year Total	5-Year Average
Ekalluktuk River (Ekalluk)							
Landings (kg)	16,930	20,011	20,001	16,570	16,699	**90,211**	**15,344**
Landed Value[8]	$88,712	$104,859	$104,805	$86,825	$87,502	**$282,684**	**$56,537**
Market Value[9]	$383,460	$453,256	$453,022	$375,302	$379,230	**$1,774,002**	**$354,800**
Jayko River (Jayco)							
Landings (kg)	9,851	17,011	16,200	11,573	12,481	**36,072**	**7,214**
Landed Value[10]	$51,620	$89,137	$84,885	$60,643	$65,402	**$161,292**	**$32,258**
Market Value[211]	$223,130	$385,295	$366,919	$262,132	$282,702	**$771,068**	**$154,214**
Halokvik River (Thirty-Mile)							
Landings (kg)	4,160	4,212	4,888	4,997	4,972	**19,135**	**3,827**
Landed Value[10]	$21,796	$22,073	$25,616	$26,185	$26,052	**$89,700**	**$17,940**
Market Value[11]	$94,215	$95,411	$110,724	$113,183	$112,610	**$419,245**	**$83,849**
Paliryuak River (Surrey)							
Landings (kg)	6,824	5,739	8,990	8,792	8,884	**43,007**	**8,601**
Landed Value[10]	$35,756	$30,075	$47,108	$46,069	$46,552	**$185,057**	**$37,011**

[8] Landed value for individual waterbodies excludes the freight guarantee. Data is not available by waterbody.

[9] Market price based on Kitikmeot Foods Ltd. Price List (various years) and were calculated based on the percentages of sales volume as follows: (i) Whole dressed: 55% of production; (ii) Head, tail off: 23%; (iii) Fillets: 10%; (iv) Smoked sides: 8%; and (v) Jerky: 4%.

Market Value[11]	$154,558	$129,999	$203,626	$199,132	$201,222	**$1,002,092**	**$200,418**
Paalik River (Lauchlan)							
Landings (kg)	NF	NF	NF	3,902	5,061	**8,963**	**1,792**
Landed Value[10]	-	-	-	$20,449	$26,521	**$46,970**	**$9,394**
Market Value[11]	-	-	-	$88,390	$114,638	**$203,028**	**$40,605**
Total[10]							
Landings (kg)	37,765	46,973	50,079	45,834	48,097	**228,748**	**345,749.6**
Landed Value[11]	$197,885	$246,144	$262,414	$240,170	$252,029	**$942,883**	**$188,577**
Landed Price/kg	$4.57	$4.29	$5.85	$7.04	$5.00		**$5.24**
Market Value[11]	$855,363	$1,063,962	$1,134,290	$1,031,139	$1,089,402	**$4,073,397**	**$814,679**
Market Price/kg	$19.23	$19.75	$24.26	$26.33	$24.09		**$22.65**

Market Prices/Lb. of Arctic Char by Product Form							
Whole Dressed	$6.02	$6.27	$7.67	$9.17	$8.15	NA	$7.45
Head, tail off	$7.04	$7.29	$10.21	$10.84	$9.05	NA	$8.89
Fillets	$10.22	$10.47	$11.87	$12.59	$12.61	NA	$11.55
Smoked sides	$15.39	$15.64	$17.04	$18.08	$18.15	NA	$16.86
Jerky	$39.02	$38.89	$47.85	$43.13	$41.84	NA	$42.14
Weighted Ave. Price	**$8.74**	**$8.98**	**$11.03**	**$11.97**	**$10.95**	**NA**	**$10.33**

Source: KFL Plant; Policy and Economics, C&A, DFO, staff calculations
Note: - Not Fished; NA – Not applicable.

Table 8. Operational costs incurred by by Kitikmeot Foods Ltd., 2008-2012

Cost Items	2008	2009	2010*	2011*	2012*	Total	Average
Ekalluktok River (Ekalluk)							
Operational Cost[12]	$34,136	$44,145	$74,441	$64,617	$63,347	$461,053	$56,537
Weight (lb.)	24,078	27,865	44,956	29,999	41,883	168,781	33,756
Costs per lb.[13]	$1.50	$1.58	$1.66	$2.15	$1.51		$1.67
Jayko River (Jayco)							
Operational Cost[12]	$65,912	$37,696	-	-	$57,684	$161,292	$53,764
Weight (lb.)	31,519	14,330	NF	NF	33,509	79,359	26,453
Costs per lb. [13]	$2.09	$2.63	-	-	$1.72		$2.07
Halokvik River							

[10] Slight discrepancies in total values due to rounding up of values/prices.
[11] Total landed value is the summation of payment to fishers and transportation costs. Does not include other operational costs. Total landed values for period 2010-12 include transportation cost guarantee. A freight subsidy of $32,555 given in 2012 is excluded.
[12] Operational costs include payment to fishers and transportation costs. Does not include KFL plant costs. Total operational cost values for period 2010-12 include transportation cost guarantee. A freight subsidy of $32,555 given in 2012 is excluded.
[13] Excludes KFL plant costs.

(Thirty-Mile)							
Operational Cost[12]	$21,533	$23,044	$15,253	$13,099	$16,770	$89,700	$17,940
Weight (lb.)	10,021	11,481	7,297	2,473	10,824	42,097	8,419
Costs per lb. [13]	$2.15	$2.01	$2.09	$5.30	$1.55		$2.27
Paliryuak River (Surrey)							
Operational Cost[12]	$25,533	$36,847	$38,451	$44,451	$39,804	$185,057	$37,011
Weight (lb.)	10,681	19,046	19,963	25,247	19,678	94,615	18,923
Costs per lb. [13]	$2.42	$1.93	$1.93	$1.75	$2.02		$1.89
Paalik River (Lauchlan)							
Operational Cost[12]	$19,795	-	$15,646	-	-	$35,441	$17,720
Weight (lb.)	5,208	NF	5,574	NF	NF	10,782	5,391
Costs per lb. [13]	$3.80	-	$2.81	-	-		$3.29
Total							
Operational Cost[12]	**$169,235**	**$141,732**	**$206,693**	**$184,715**	**$240,508**	**$942,883**	**$188,577**
Weight (lb.)	**81,507**	**72,722**	**77,791**	**57,719**	**105,895**	**395,634**	**79,127**
Costs per lb. [13]	**$2.08**	**$1.95**	**$2.66**	**$3.20**	**$2.27**		**$2.38**
KFL Plant Costs							
Wage	$40,228	$101,236	$38,491	$50,248	46,148	$276,350	$55,270
Electricity	$30,071	$58,109	$26,979	$40,330	36,892	$192,381	$38,476
Fuel	$3,933	$7,087	$7,065	$3,460	9,183	$30,728	$6,146
Water	$2,115	$2,067	$2,982	$1,744	3,028	$11,936	$2,387
Total	**$76,347**	**$168,499**	**$75,517**	**$95,781**	**$95,251**	**$511,395**	**$102,279**
Distribution of KFL Costs							
Operational Costs	32.0%	21.7%	25.8%	26.0%	32.4%		27.6%
KFL Plant Costs	31.1%	54.3%	26.8%	34.1%	28.4%		35.2%
Weight	81,507	72,722	77,791	57,719	105,895		79,127
Average Total Costs per lb.	**$3.01**	**$4.27**	**$3.63**	**$4.86**	**$3.17**		**$3.68**

Source: Kitikmeot Foods Limited (KFL).
Note: NF – Not Fished

Appendix E Safety at sea

Vessel owners and masters have a duty to ensure the safety of their crew and vessel. Adherence to safety regulations and good practices by owners, masters and crew of fishing vessels will help save lives, protect the vessel from damage and protect the environment. All fishing vessels must be in a seaworthy condition and maintained as required by Transport Canada (TC), and other applicable agencies. Vessels subject to inspection should ensure that the certificate of inspection is valid for the area of intended operation.

In the federal government, responsibility for shipping, navigation, and vessel safety regulations and inspections lies with TC; emergency response with the Canadian Coast Guard and DFO has responsibility for management of the fisheries resources. In Nunavut, the Workers Safety and Compensation Commission has jurisdiction over health and safety issues in the workplace. DFO and TC have a Memorandum of Understanding to formalize cooperation and to establish, maintain and promote a safety culture within the fishing industry.

For information on boating safety, please call the TC Office of Boating Safety toll-free at 1-800-267-6687 or visit the website at https://tc.canada.ca/en/marine-transportation/marine-safety/office-boating-safety.

SUBMISSION TO THE
NUNAVUT WILDLIFE MANAGEMENT BOARD

FOR

Information: X **Decision:**

Issue: Information regarding plans for consultation and decision-making regarding the possible addition of the Ringed Seal to the List of Wildlife Species at Risk on the *Species at Risk Act* (SARA).
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Background:

As per 3.5 of the Harmonized Listing Process, the Department of Fisheries & Oceans (DFO) is informing the Nunavut Wildlife Management Board (NWMB) of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessment results and a DFO intent to consult on the Ringed Seal (*Pusa hispida*) (Figure 1).

Ringed Seal

This small seal is broadly distributed throughout the Arctic and needs sea ice to thrive. It is the most abundant marine mammal in the Canadian Arctic. It is an important species for Inuit and is the primary prey of Polar Bear (*Ursus maritimus*). Its population levels and trends are uncertain, although the total population is about 2 million individuals. Aboriginal Traditional Knowledge from local communities across the species' range suggests that its population status varies regionally, but is generally considered stable. Reductions in the area and duration of sea ice due to climate warming in the Canadian Arctic, with consequent reductions in suitable pupping habitat due to loss of stable ice and a lower spring snow depth, are the primary threats to this species. The Canadian population is predicted to decline over the next three generations, and may become Threatened due to extensive and ongoing changes in sea ice and snow cover in a rapidly-warming Arctic.

The Ringed Seal was considered by COSEWIC in November 2019 and designated as Special Concern.

Significance

Ringed Seal are one of the smallest pinnipeds, with average adults being 1.5 m long and weighing 70 kg—males being slightly larger than females. Ringed Seal is important both economically and culturally to northern peoples. Ringed Seal is the primary prey for the Polar Bear, but is also preyed upon by Killer Whales (*Orcinus orca*), Walruses (*Odobenus rosmarus*), and Greenland Sharks (*Somniosus microcephalus*). The Arctic Fox (*Vulpes lagopus*) can also be important predators on pups, particularly when snow cover is very low.

Figure 1: Photo of the Ringed Seal (*Pusa hispida*) (from COSEWIC 2019).

Distribution

Ringed Seal has a circumpolar distribution over Arctic and subarctic waters, relying on sea ice as habitat. Their Canadian distribution ranges from Yukon in the west to southern Labrador in the east, with occasional sightings of vagrants south of the seasonal ice zone in both Pacific and Atlantic Oceans.

Requirements for Consultation and Approval

Article 5.2.34 (f) of the Nunavut Land Claims Agreement states that the NWMB shall, at its discretion, approve the designation of rare, threatened or endangered species. As well, Section 27 (2) (c) of the SARA requires that before making a recommendation as to whether or not to add a species at risk to Schedule 1, the Minister must consult the Board for species found in an area in respect of which the Board is authorized by a land claims agreement to perform its functions.

Due to their importance in Nunavut and the western Arctic as well as people in other areas of Canada, DFO anticipates that this will be a prolonged consultation process.

Consultation and Approval:

DFO is planning to consult with all Hunters and Trappers Organizations in Nunavut on Ringed Seal, probably commencing this fall, to ensure that any listing decision is made in full consideration of the views of Inuit. Comments received will be used by the Minister to decide whether to recommend legal listing of the Ringed Seal. A consultation summary will be provided to the NWMB, probably in the fall of 2022.

Approval

After public consultations have been completed, DFO will provide the Board with a summary of the community consultations for the Ringed Seal. At a later date we will inform the Board what the Minister plans to recommend to the Governor-in-Council with regards to listing. At that time DFO will ask the Board whether or not it wishes to express an opinion on listing.

Prepared by:

Sam Stephenson, Species at Risk Biologist, DFO, Ontario & Prairie Region, Winnipeg

Date:

January 12, 2021

Appendices

Appendix 1 - COSEWIC Executive Summary for Ringed Seal

Appendix 1:

COSEWIC Executive Summary
Ringed Seal
Pusa hispida

Wildlife Species Description and Significance
Ringed Seal is a phocid seal with five subspecies, one of which occurs in Canada: Arctic Ringed Seal (*Pusa hispida hispida*). They are one of the smallest pinnipeds, with average adults being 1.5 m long and weighing 70 kg—males being slightly larger than females. Ringed Seal is important both economically and culturally to northern peoples and are important prey for the Polar Bear (*Ursus maritimus*).

Distribution
Ringed Seal has a circumpolar distribution over Arctic and subarctic waters, relying on sea ice as habitat. Their Canadian distribution ranges from Yukon in the west to southern Labrador in the east, with occasional sightings of vagrants south of the seasonal ice zone in both Pacific and Atlantic Oceans.

Habitat
Ringed Seal is strongly ice-adapted. Their habitat requirements follow the annual cryogenic cycle, with adults establishing territories during fall freeze-up. Prime breeding habitats occur on stable ice, which tends to be landfast ice occurring over relatively shallow waters (< 150 m). Breeding also occurs on mobile pack ice. Ringed Seal moults on sea ice in late spring and is widely distributed over waters of varying depths during the open-water season, presumably in response to prey distribution. Ringed Seal can be negatively affected by both extreme heavy-ice years (longer ice seasons) and extreme low-ice years (short spring ice seasons).

Biology
The Ringed Seal mating system is thought to be one of weak polygyny, but observations suggest that alternative strategies exist depending on region. Gestation (10–11 months) is divided into ~2–3 months of embryonic diapause and ~8 months of fetal growth. Pups are born in spring, in subnivean birth lairs, and are nursed for 5–8 weeks. Females mate near the end of lactation or directly after. Age at maturity is variable, but is 6 years on average, with males entering the breeding population later than females. Maximum life span has been recorded at 45 years, but average adult life span is likely about 20 years.

During the open-water season, they feed on a wide variety of pelagic and benthic prey to build up blubber reserves. The most common prey across their range are pelagic schooling fish such as Arctic Cod (*Boreogadus saida*), Sand Lance (*Ammodytes* spp.) and Capelin (*Mallotus villosus*), as well as amphipods, euphausiids, shrimp and other crustaceans.

Individual movements are variable across the range and are dictated by prey distribution. Movements can be extensive during the open-water season, and likely consist of both seasonal migrations and dispersal events for subadults. At freeze-up, when adults move into breeding areas and establish territories, subadults are either driven out or choose areas of mobile ice and polynyas where the costs of maintaining breathing holes are lower. Adults have been shown to exhibit breeding site fidelity.

Ringed Seal is the primary prey for the Polar Bear but is also preyed upon by Killer Whales (*Orcinus orca*), Walruses (*Odobenus rosmarus*), Greenland Sharks (*Somniosus microcephalus*), and humans. The Arctic Fox (*Vulpes lagopus*) can also be important predators on pups, particularly when snow cover is very low.

Population Sizes and Trends

Most information on Ringed Seal population size comes from aerial surveys, which are conducted when seals are hauled out on ice to moult. Because these surveys are sporadic and localized, estimates are uncertain and dated. However, species abundance is thought to be high, with an estimated 2.3 million seals (1.15 million mature individuals) in Canada and adjacent waters (West Greenland, Alaska, Russian Federation).

Threats and Limiting Factors

The Arctic has undergone substantial climatic change since the late 1970s: annual, perennial, and multi-year Arctic sea ice extent, as well as Arctic sea ice thickness and volume, have decreased while the Arctic ice-free season has lengthened. Over the 1967-2012 period, Northern Hemisphere snow cover extent also decreased in all months and especially during spring. For ice-dependent Arctic marine mammals such as Ringed Seal, these extensive unidirectional changes in sea ice and snow cover can equate to habitat loss and cascading ecological impacts. For example, a very warm year in 2010 resulted in poor Ringed Seal body condition in Hudson Bay. Seals experienced increased stress, giving birth to fewer pups in the following years. In the long term, the loss of habitat due to climate change poses the most significant threat. Decreases in sea ice extent also increase opportunities for commercial shipping, tourism and industrial development, which could increase disturbance, habitat modification and pollutants. Predation by the Polar Bear is the most significant mortality source. Hunting by humans may also be a limiting factor, but removal rates are likely an order of magnitude lower than those for Polar Bear. Pollutant levels are variable amongst regions, with some levels of increase having known effects on Polar Bear but unknown effects on seals.

Protection, Status and Ranks

There are no international agreements or conventions specifically intended to protect Ringed Seal, but the International Agreement on the Conservation of Polar Bears and their Habitat provides some measure of protection. Ringed Seal is not listed on any appendices of the Convention on International Trade in Endangered Species, and they are “Least Concern” on the International Union for the Conservation of Nature (IUCN) Red List (as both species and Arctic subspecies). They are ranked “N5B, N5N, N5M” in the latest Wild Species (General Status) Report (CESCC 2016). COSEWIC assessed the species as Special Concern in November 2019; it was previously assessed as “Not at Risk” in 1989, and they are currently not listed under the *Species at Risk Act*. The Arctic subspecies is listed as threatened under the United States *Endangered Species Act.* Ringed Seal is ranked as Least Concern in Greenland, Vulnerable in Norway (Svalbard), and is not listed in Russia.

In Canada, Ringed Seal is managed under the authority of the Marine Mammal Regulations (SOR/93-56) of the *Fisheries Act*. Seal hunting in marine waters of the Northwest

Territories, Nunavut, Nunavik and Labrador are co-managed by various wildlife management boards, with scientific advice from the Department of Fisheries and Oceans. Existing national parks, national wildlife areas and other lands owned and managed by the Government of Canada afford little habitat protection. Existing and proposed marine protected areas and national marine conservation areas potentially afford some protection.

SUBMISSION TO THE

NUNAVUT WILDLIFE MANAGEMENT BOARD AND NUNAVIK MARINE REGION WILDLIFE BOARD

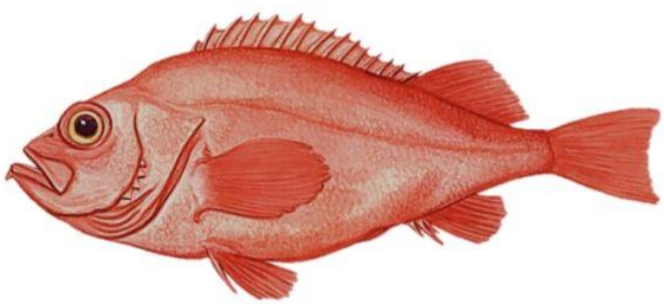
FOR

Information: X **Decision:** **Recommendation:**

Issue: Juvenile redfish (*Sebastes mentella* and *Sebastes fasciatus*) bycatch in the Northern Shrimp Fishery in the Eastern Assessment Zone

Northern shrimp (*Pandalus borealis*)

Striped shrimp (*Pandalus montagui*)



Redfish (*Sebastes mentella and S. fasciatus*)

Background

Two shrimp species (*P. borealis* and *P. montagui*) occur in the Northern shrimp fishery that takes place in the Davis Strait and eastern Hudson Strait. This fishery is managed according to two distinct stock assessment zones, the Western Assessment Zone (WAZ) and the Eastern Assessment Zone (EAZ) (Appendix 1).

In October 2020, representatives of the offshore Northern shrimp sector reported high juvenile redfish bycatches in portions of the EAZ (Davis Strait West) and Shrimp Fishing Area (SFA) 4 to the extent that it triggered move-away provisions within Conditions of Licence (COL).

These provisions require vessels to change fishing locations by a minimum of 10 nautical miles in the event that groundfish bycatch (including redfish) in any tow exceeds a pre-defined threshold (the greater of 2.5% by weight of the catch of shrimp, or 100kg) (Appendix 2).

In fall 2020, these move-away provisions were repeatedly triggered in the EAZ and SFA 4 to the extent that they inhibited successful prosecution of the shrimp fishery, posing a serious economic viability concern for the offshore shrimp sector. The occurrence of high juvenile redfish bycatch was considered an urgent and unusual circumstance. The need for a management response to address the interruption of shrimp fishing was especially urgent since fishing opportunity remaining was limited and subject to ice conditions.

There is currently no open directed redfish fishery in this area. The redfish fishery in Northwest Atlantic Fisheries Organization (NAFO) Subarea 2 + Division 3K has been under moratorium since 1997.

Science Advice

Redfish stocks exhibit periodic pulse recruitment, exhibited by very small year classes in most years and occasionally extremely large year classes that can be a decade apart. These periodic large pulses of population recruitment are important to sustain the population over time.

Where redfish and Northern shrimp are found in similar environments, the first sign of a strong cohort is typically evidenced via increased bycatch rates in other fisheries with non-selective gear types like Northern shrimp. Redfish bycatch may consist of two or three species (depending on the area) that are not separated in fishery reporting or for stock assessment purposes. The relative abundance of each redfish species in bycatches changes with latitude.

The last assessment of the redfish stock in NAFO Subarea 2 + Division 3K occurred in 2016. Survey results showed that redfish biomass increased considerably from 2003 to 2010 and that biomass during 2010-2015 was approximately half of the pre-collapse (1978-1990) levels. The 2016 survey showed that redfish recruitment since 2000 was above the long term average, with a time-series high in 2014 (Appendix 3).

More recent preliminary results from the multi-species survey (not dedicated to surveying redfish) in NAFO Subarea 2 + Division 3K show an increase in juvenile redfish recruitment in 2019 (likely 2018 year-class), as well as variability in the indices since the 2016 assessment.

Given there are no recent biomass estimates for redfish populations in SFA 4 or the EAZ, it is not possible to estimate the impact of juvenile redfish bycatches in these areas on population recovery. Further, it is not yet known if these recent large recruitments will persist over time in the population.

Fisheries and Oceans Canada (DFO) Resource Management has submitted requests for peer-reviewed stock assessments for redfish in NAFO Subarea 2 + Division 3K and Subarea 0 (overlapping with the EAZ), with results anticipated in April-May 2021.

Management Response

In November 2020, the Department sought views from industry and Board staff on an interim management response to high redfish bycatch that may allow harvesters to successfully prosecute the remainder of the 2020-21 shrimp fishery, while taking into consideration the potential impact on redfish stocks. The use of an interim measure was intended to facilitate innovative fishing techniques by harvesters in the affected areas to reduce future redfish bycatch.

The Department carefully considered industry-proposed measures in consultation with Board staff and DFO Science. In late November, offshore shrimp COLs were amended to require vessels to move 5 nautical miles if the total bycatches of redfish over the previous six tows exceeded 10% by weight of the total catch of shrimp (Appendix 2). This measure would allow for increased redfish bycatches and reduce the frequency of move-aways. This interim measure was approved for a period of 8 weeks (November 26, 2020, to January 21, 2020).

This targeted, responsive approach was limited to SFA 4 and Davis Strait West management units. Where Nunavut and Nunavik allocation holders may cross the between Davis Strait West and Nunavut / Nunavik East management units in the same tow, extension of this interim measure to Nunavut / Nunavik East was required from an operational standpoint.

Next Steps

To follow the availability of an updated stock assessment for redfish anticipated for April-May 2021, Resource Management has requested peer-reviewed science advice on management measures to address the issue of redfish bycatch in the Northern shrimp fisheries that occur in SFAs 4- 6, EAZ and WAZ. Science advice is requested in order to understand the potential impact of redfish removals on the health of the population in these areas. This work is anticipated to begin no earlier than Winter 2021.

DFO Resource Management will continue to monitor bycatch in the Northern shrimp fishery in the EAZ and neighboring shrimp management units to better understand the potential impact to harvesters and to the conservation of redfish stocks. In addition, DFO will consider support for industry initiatives to test innovative fishing techniques that may reduce future redfish bycatches, where appropriate.

It is not yet clear whether future circumstances may suggest a need for further interim response. At the time of this submission, no further flexibilities beyond the 8 week pilot have been proposed or approved.

Prepared by: Courtney D'Aoust, Fisheries Resource Management, Fisheries and Oceans Canada

Date: February 4, 2021

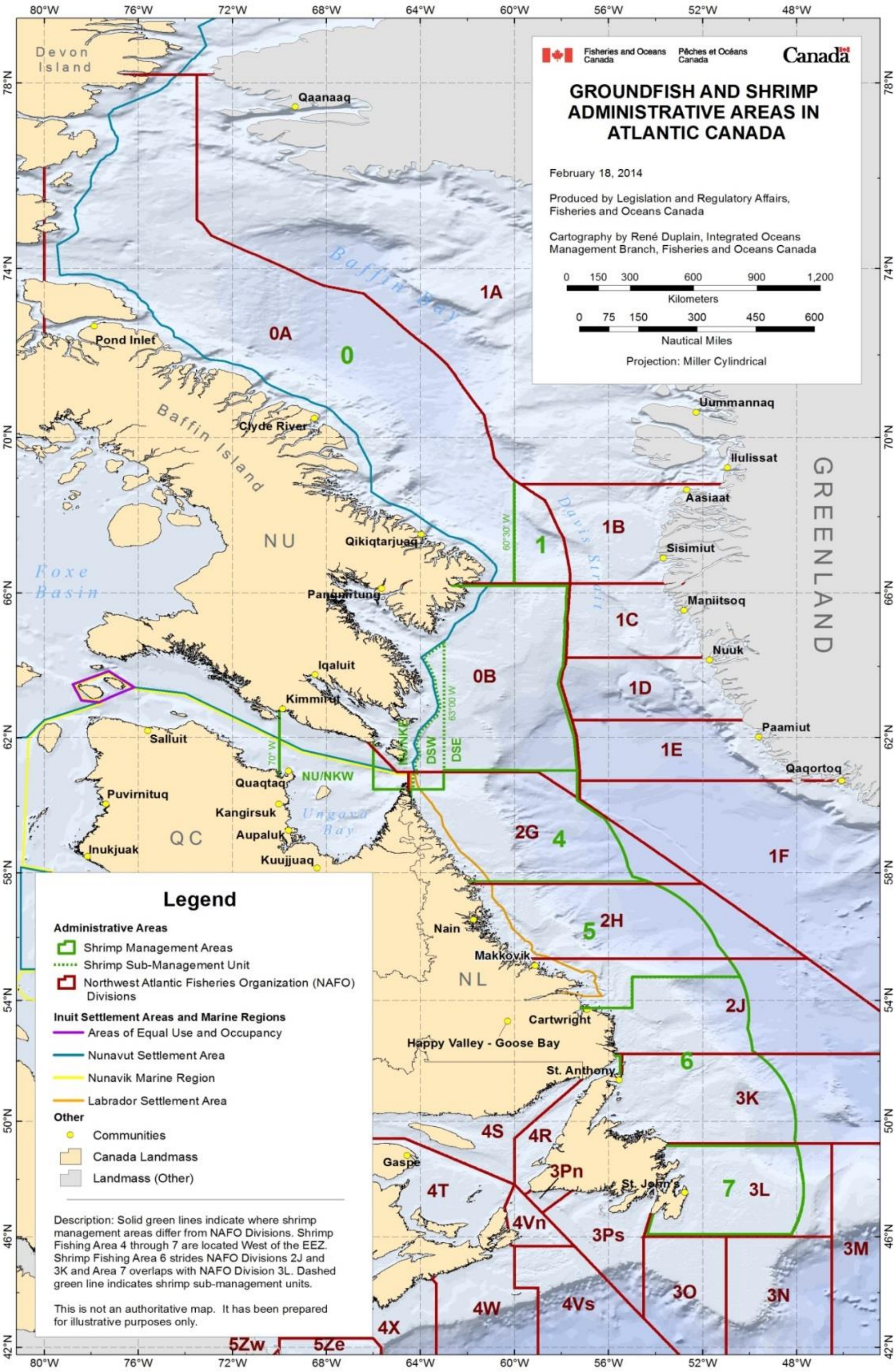
Appendices

Appendix 1 – Map of groundfish and shrimp administrative areas in Atlantic Canada

Appendix 2 – Condition of Licence amendment November 2020

Appendix 3 – Summary: Stock status of redfish in NAFO SA 2 + Divs. 3K (Science Advisory Report 2020/021)

Appendix 4 – Full publication: Stock status of redfish in NAFO SA 2 + Divs. 3K (Science Advisory Report 2020/021)


Fisheries and Oceans Canada
Pêches et Océans Canada
Canada
GROUNDFISH AND SHRIMP ADMINISTRATIVE AREAS IN ATLANTIC CANADA
February 18, 2014
Produced by Legislation and Regulatory Affairs, Fisheries and Oceans Canada
Cartography by René Duplain, Integrated Oceans Management Branch, Fisheries and Oceans Canada
Kilometers
Nautical Miles
Projection: Miller Cylindrical
Legend
Administrative Areas
Shrimp Management Areas
Shrimp Sub-Management Unit
Northwest Atlantic Fisheries Organization (NAFO) Divisions
Inuit Settlement Areas and Marine Regions
Areas of Equal Use and Occupancy
Nunavut Settlement Area
Nunavik Marine Region
Labrador Settlement Area
Other
Communities
Canada Landmass
Landmass (Other)
Description: Solid green lines indicate where shrimp management areas differ from NAFO Divisions. Shrimp Fishing Area 4 through 7 are located West of the EEZ. Shrimp Fishing Area 6 strides NAFO Divisions 2J and 3K and Area 7 overlaps with NAFO Division 3L. Dashed green line indicates shrimp sub-management units.
This is not an authoritative map. It has been prepared for illustrative purposes only.
Devon Island
Qaanaaq
Baffin Bay
Baffin Island
Pond Inlet
Clyde River
Qikiqtarjuaq
Pangnirtung
Iqaluit
Kimmirut
Foxe Basin
NU
QC
NL
GREENLAND
Salluit
Puvirnituq
Inukjuak
Quaqtaq
Kangirsuk
Aupaluk
Kuujjuaq
Ungava Bay
NU/NKW
NU/NKE
DSW
DSE
Nain
Makkovik
Cartwright
Happy Valley - Goose Bay
St. Anthony
Gaspe
St. John's
Uummannaq
Ilulissat
Aasiaat
Sisimiut
Maniitsoq
Nuuk
Paamiut
Qaqortoq
Davis Strait
0A
0B
0
1
1A
1B
1C
1D
1E
1F
2G
2H
2J
3K
3L
3M
3N
3O
3Ps
3Pn
4
5
6
7
4R
4S
4T
4Vn
4Vs
4W
4X
5Zw
5Ze
60°30' W
63°00' W
70° W

Offshore Shrimp Condition of Licence

5.2. If total by-catches of all groundfish species in any haul exceed the greater of 2.5% by weight of the catch of shrimp or 100 kg, the licence holder or vessel operator must immediately change fishing area by a minimum of ten (10) nautical miles from any position of the previous tow in an effort to avoid further by-catches of all groundfish. If after moving and for all subsequent moves, the next haul exceeds the greater of 2.5% by weight of the catch of shrimp or 100kg, the vessel must continue to move 10 nautical miles from any position of the previous tow to avoid by-catch. The licence holder or vessel operator must record in the logbook (in the Remarks field)the active avoidance measures taken in response to any tows that contained excessive groundfish by-catch, the position (latitude and longitude) at the time of groundfish by-catch, as well as the quantity caught by weight in kilogram.

Condition of Licence amendment effective November 26, 2020, to January 21, 2021:

5.2.3 Notwithstanding section 5.2 above, while fishing within and/or across the waters of the following Management Units on a single fishing trip: Nunavut East, Nunavik East, Davis Strait West, and/or Shrimp Management Unit 4, if total by-catches of Redfish exceed 10% by weight of the total catch of shrimp over the previous six tows, the licence holder or vessel operator must immediately change fishing area by a minimum of five (5) nautical miles from any position of the previous tow. Whenever the vessel moves five (5) nautical miles or more from any position of the previous tow, the following tow is to be considered to be the first of the next six tows to be considered. The licence holder or vessel operator must record in the logbook (in the Remarks field) the active avoidance measures taken in response to any tows that contained excessive Redfish by-catch, the position (latitude and longitude) at the time of Redfish by-catch, as well as the quantity caught by weight in kilogram. The above provisions of 5.2.3 are effective between 0001 UTC on November 26, 2020, to 2400 UTC on January 21, 2021.

APPENDIX 3

SUMMARY: Stock status of redfish in NAFO SA 2 + Divs. 3K (Science Advisory Report 2020/02)

- Biomass increased considerably from 2003 to 2010. Biomass during 2010-2015 was approximately half of the pre-collapse (1978-1990) levels.
- Recruitment (abundance of Redfish <15 cm) since 2000 was above the long term average with a time-series high in 2014.
- A fishing mortality proxy has been very low (<1%) since 2006. The fishery remains under moratorium, and average bycatch (including discards) since 2006 has been approximately 500 t.
- The meeting was neither able to validate nor invalidate existing reference points (DFO 2012) derived from production models due to substantive concerns about input data and an incomplete documentation of the rationale for model formulation.
- Other options for Limit Reference Points (LRPs) were considered. However, considering difficulties with respect to application of the LRP concepts for Redfish including its episodic recruitment, species separation, and other data limitations, these other LRP options were not accepted.
- No LRP examined (including DFO 2012) was considered applicable at this time.
- In the absence of a LRP, it is not possible to identify what zone of the Precautionary Approach (PA) framework this stock is currently within. It is recommended that adaptive and cautious management be applied to any reopened fishery.

STOCK STATUS OF REDFISH IN NAFO SA 2 + DIVS. 3K

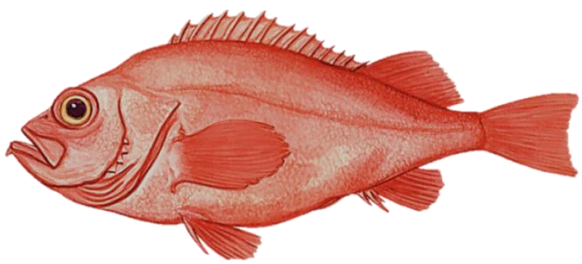


Image: Redfish

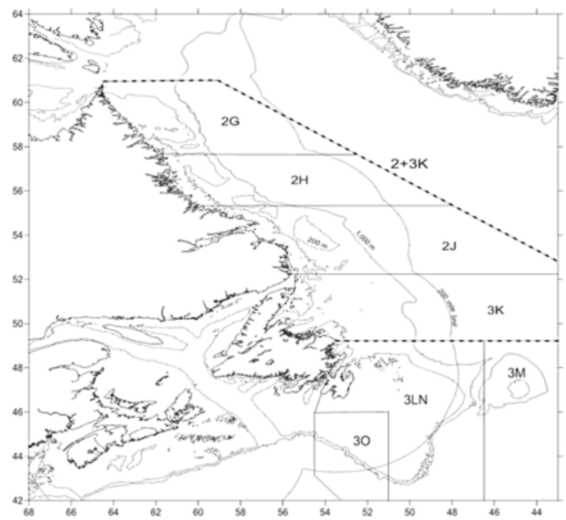


Figure 1. Map of the Northwest Atlantic indicating the SA 2 + Divs. 3K management area for Redfish.

Context:

In the Northwest Atlantic, Redfish range from Baffin Island in the north, to waters off New Jersey in the south and are managed in several discrete units. Redfish in Northwest Atlantic Fisheries Organization (NAFO) Subarea 2 (2G, 2H, and 2J) + Division 3K comprise stock complexes of two species (Sebastes mentella and S. fasciatus) recorded together in the landings because they cannot easily be distinguished visually, plus an additional less dominant species S. marinus that is visually distinct from the other species. The fishery on this stock was under Total Allowable Catch (TAC) regulation from 1974 (30,000 t) to 1996 (200 t). From 1997 to the present, the stock has been under moratorium to directed fishing. A previous assessment in 2001, of Redfish in stock status in Subarea (SA) 2 + Divs. 3K concluded that the population declined rapidly over a 10 year period from 1980-1990 and that surveys up to 2000 continue to indicate that the resource was at a low level reflecting over 25 years of recruitment failure. A Recovery Potential Assessment was conducted in a 2011 Zonal Advisory Process in which limit reference points (LRPs) were determined. During this process, stock status was updated and it was concluded that the biomass had remained stable at a low level from the mid-1990s until the mid-2000s when a period of marginal increase was evident.

This Science Advisory Report is from the October 19-21, 2016 Assessments of Redfish in Northwest Atlantic Fisheries Organization (NAFO) Subarea 0, and Subarea 2 and Division 3K. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- Biomass increased considerably from 2003 to 2010. Biomass during 2010-2015 was approximately half of the pre-collapse (1978-1990) levels.
- Recruitment (abundance of Redfish <15 cm) since 2000 was above the long term average with a time-series high in 2014.
- A fishing mortality proxy has been very low (<1%) since 2006. The fishery remains under moratorium, and average bycatch (including discards) since 2006 has been approximately 500 t.
- The meeting was neither able to validate nor invalidate existing reference points (DFO 2012) derived from production models due to substantive concerns about input data and an incomplete documentation of the rationale for model formulation.
- Other options for LRPs were considered. However, considering difficulties with respect to application of the LRP concepts for Redfish including its episodic recruitment, species separation, and other data limitations, these other LRP options were not accepted.
- No LRP examined (including DFO 2012) was considered applicable at this time.
- In the absence of a LRP, it is not possible to identify what zone of the Precautionary Approach (PA) framework this stock is currently within. It is recommended that adaptive and cautious management be applied to any reopened fishery.

INTRODUCTION

Redfish have been fished commercially in both the Atlantic and Pacific Oceans. They occur on both sides of the north Atlantic Ocean in cool waters (3 to 8°C) along the slopes of banks and deep channels generally in depths of 100-1,000 m. In the Northwest Atlantic, Redfish range from Baffin Island in the north, to waters off New Jersey in the south (Gascon 2003, Fig. 1).

Redfish found on the Northeast Newfoundland and Labrador Shelves (NAFO SA 2 + Divs. 3K) comprise a stock complex formed by three distinct species, *Sebastes mentella* (Deepwater Redfish) and *Sebastes fasciatus* (Acadian Redfish), which dominate commercial fisheries, and *Sebastes marinus* (Golden Redfish) which is much less abundant. Currently, *S. marinus* is recognized as being synonymous with *S. norvegicus* with most authorities reverting to *S. norvegicus* as the accepted binomial name. However, for consistency with previous Canadian Science Advisory Secretariat (CSAS) and Department of Fisheries and Oceans (DFO) publications, and this stock assessment, we will refer to this species as *S. marinus*. *S. mentella* and *S. fasciatus* are visually and anatomically very similar, and historically they have not been separated in commercial catches or in research vessel (RV) surveys. *S. marinus* can be distinguished by colour, eye size and the relative size of a bony protrusion on its lower jaw. These species are not separated in the fishery and are managed together. The current assessment is based upon *S. fasciatus, S. mentella,* and *S. marinus* combined.

Along the continental shelves and slopes *S. mentella* range predominantly from the Gulf of St. Lawrence northward whereas *S. fasciatus* range predominantly from the southern Grand Banks to the Gulf of Maine. Generally, *S. mentella* is distributed deeper than *S. fasciatus* (Gascon 2003).

Redfish are longlived (up to 75 years) with a slow growth rate (Campana et. al. 1990). Estimates of size at maturity vary between and within populations with lower estimates in the range of 22-24 cm (Sévigny et al. 2007) and upper estimates of 38-39 cm for deep-sea *S. mentella* (Magnússon and Magnússon 1995). Redfish produce live young that can disperse over large distances (Valentin et. al. 2015). Recruitment is episodic and there may be decades between strong cohorts. They form aggregations throughout life and survey results for Redfish are typically dominated by one or two very large samples which has an unknown influence on survey results.

Fishery Removals

A Canadian and non-Canadian Redfish fishery has been prosecuted in SA 2 + Divs. 3K since the late 1940s. Total Allowable Catch (TAC) was established in 1974 when a 30,000 t quota was implemented (Fig. 2). The TAC was increased to 35,000 t in 1980 and remained at that amount until it was lowered to 20,000 t in 1991 (Fig. 2). The TAC decreased to 1,000 t in 1994 and was reduced to 200 t in 1995. The stock has been under moratorium since 1997 (Fig. 2).

The highest recorded removal of SA2 + 3K Redfish was 187,000 t in 1959 (Fig. 2). Removals from 1980 onwards also include discard estimates from Canadian shrimp (1980-2015) and Canadian Greenland Halibut fisheries (1995-2015) derived from fishery observer data scaled to total shrimp and Greenland Halibut landings. Reported removals fell to 56,000 t in 1961 and varied between 14,500 t and 56,000 t during the period 1962 to 1987 (Fig. 2). Removals declined after 1987 ranging from 30 t to 7,500 t up to the declaration of the moratorium in 1997 (Figs. 2 and 3). Removals from bycatch and discards have ranged between 50 t and 1,500 t since the 1997 moratorium (average of 500 t annually). From 1980 to 1996, discards ranged between 15 t to 700 t annually, averaging 200 t per year. Since the moratorium in 1997, estimates of discards ranged between 50 t and 600 t annually, averaging <300 t per year (Fig. 3). Note that Russian (2001-2008) and Lithuanian (2001-2011) catches are considered to be from the Irminger Sea and are not included in SA2 + 3K removal totals for those years.

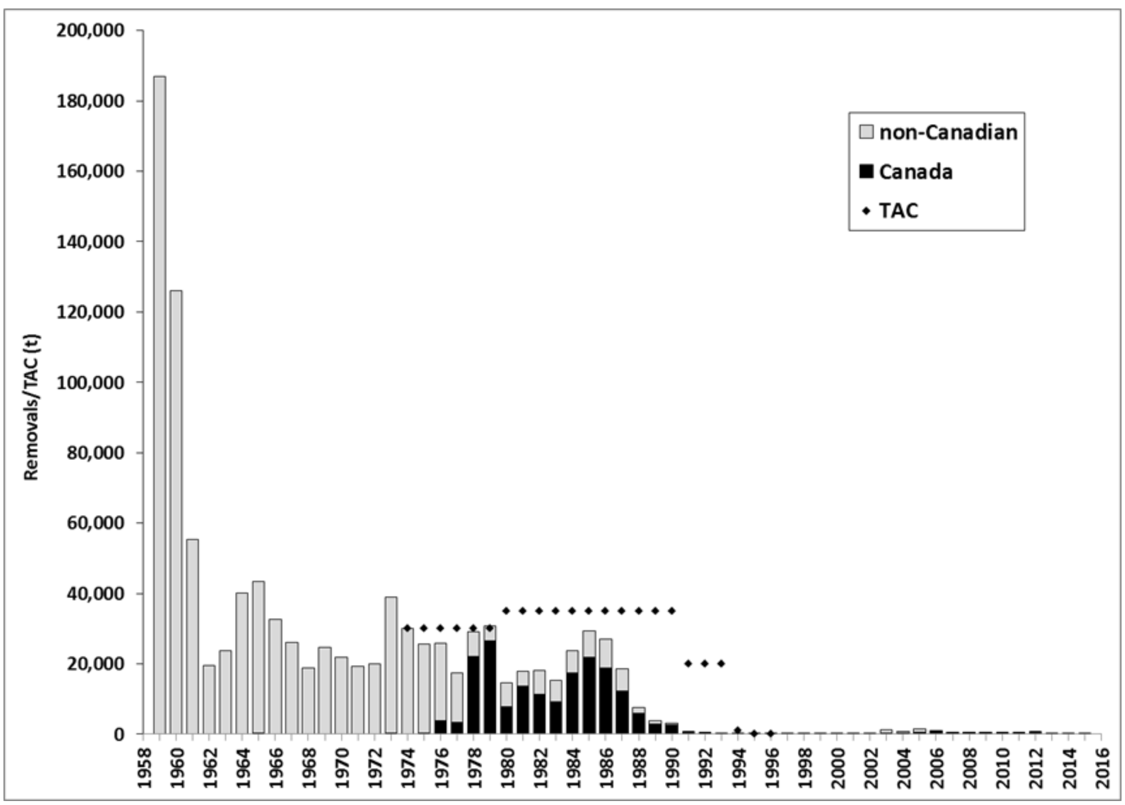


Figure 2. Redfish reported removals (t) by Canadian and non-Canadian fleets (including Canadian discard estimates from 1980-2015) and TAC in SA 2 + Divs. 3K from 1959 to 2015.

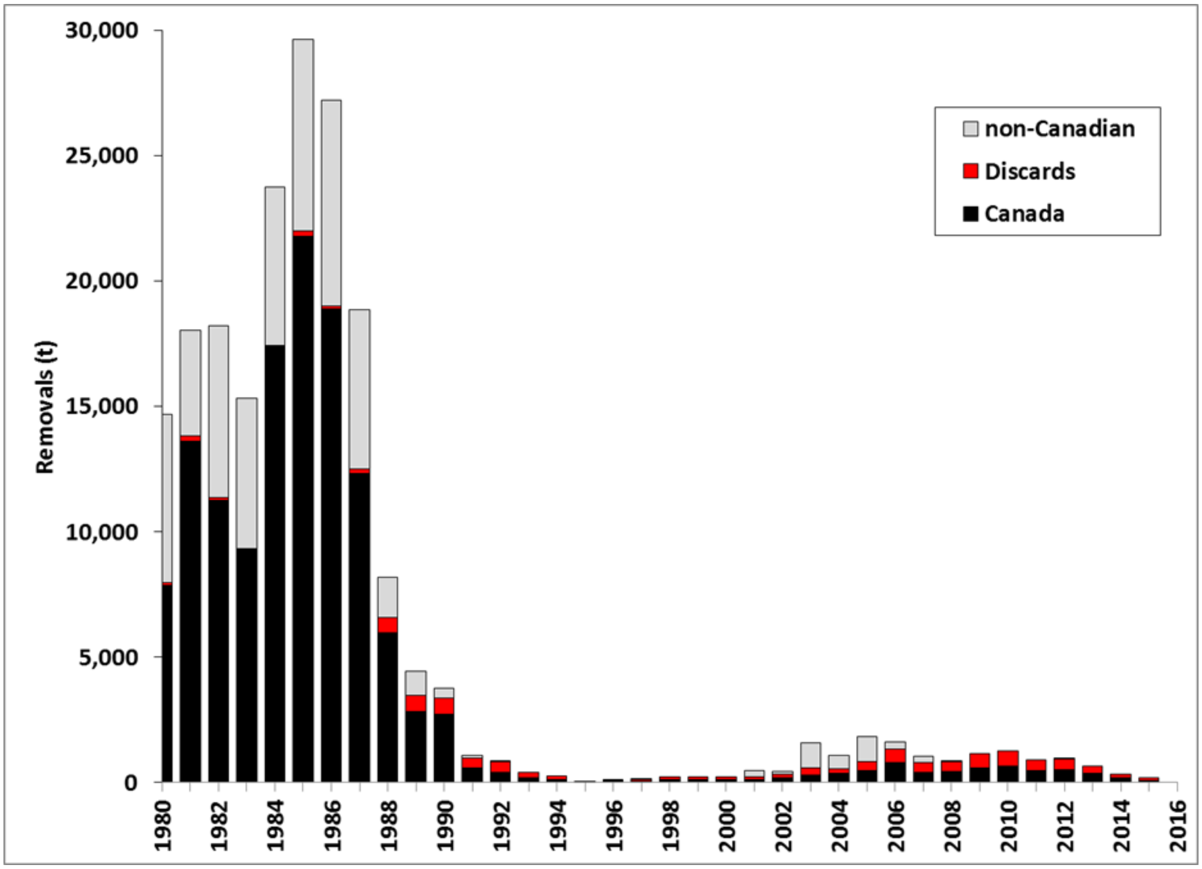


Figure 3. Redfish reported removals (t) by Canadian and non-Canadian fleets in SA 2 + Divs. 3K from 1980-2015 with Canadian discard estimates shown in red.

ASSESSMENT

This assessment considered information from landings from all countries (1959-2015) in conjunction with analyses of data from research vessel (RV) surveys conducted during autumn from 1978 to 2015.

Survey Methodology

Stratified random bottom trawl surveys were conducted in the autumn in Divs. 2J and 3K from 1977 to 1995 covering depths from 100 to 1,000 m and from 1996 to 2015 covering depths from 100 to 1,500 m. Surveys in Divs. 2G were conducted sporadically with varying spatial coverage and timing between 1978 and 1999 (the last year this Division was surveyed). Surveys were conducted sporadically in Divs. 2H between 1978 and 2010. Between 1978 and 1995 Divs. 2H surveys sampled depths from 100 to 1,000 m; in 1996 the depth range was extended to 1,500 m. Surveys have been conducted annually in Divs. 2H since 2010, although deep strata (>700 m) were not sampled in 2014 and 2015. Due to the inconsistent coverage of Divs. 2G and 2H, the primary indices for this stock are from Divs. 2J and 3K combined.

Survey Indices

Abundance and Biomass

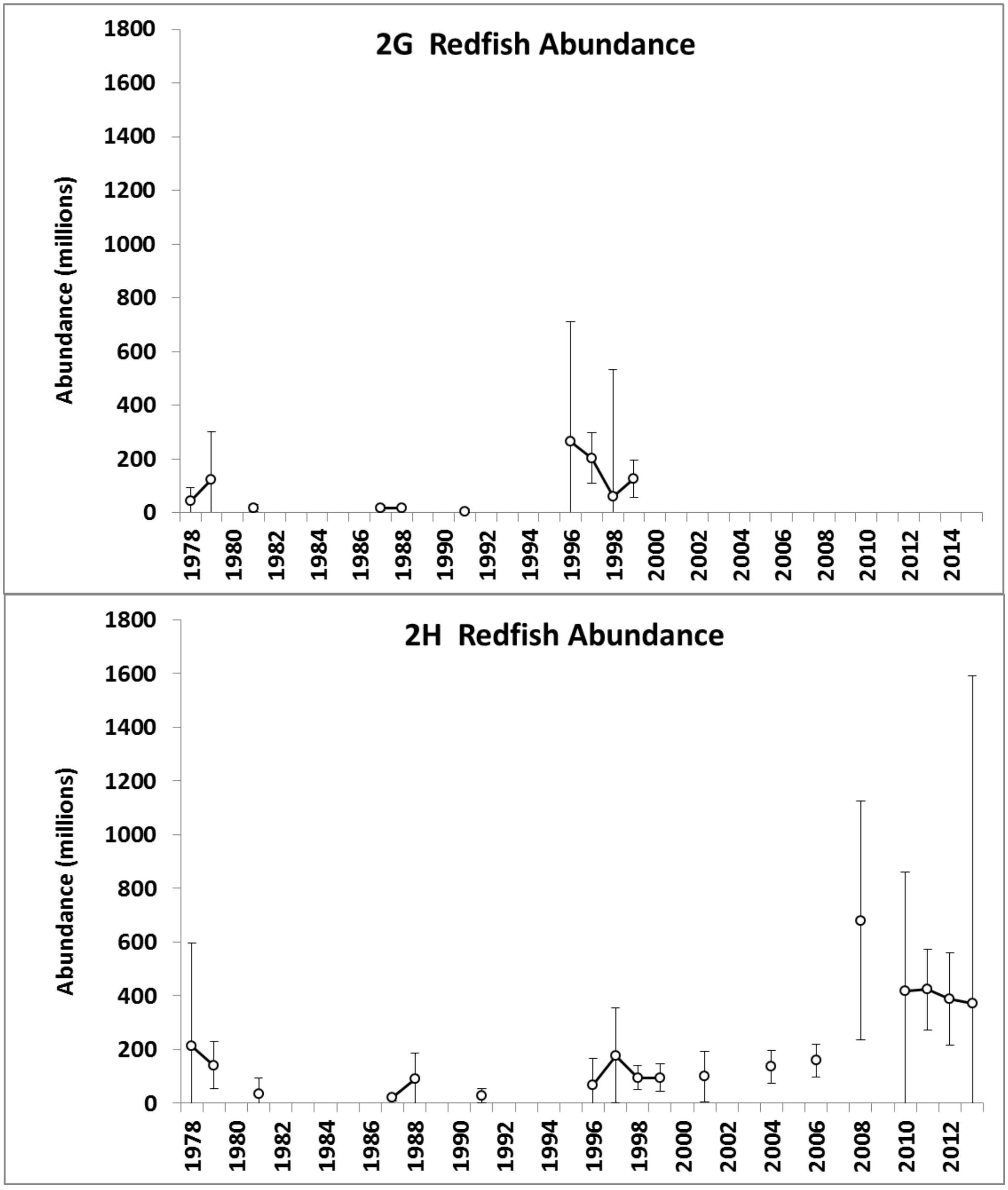


Figure 4. Abundance indices (millions) for Redfish in NAFO Divisions 2G and 2H from 1978 to 2013 (vertical lines represent 95% confidence intervals). Note that deep strata (>700 m) were not sampled in 2H in 2014 and 2015 (gaps represent years when the Division was not sampled).

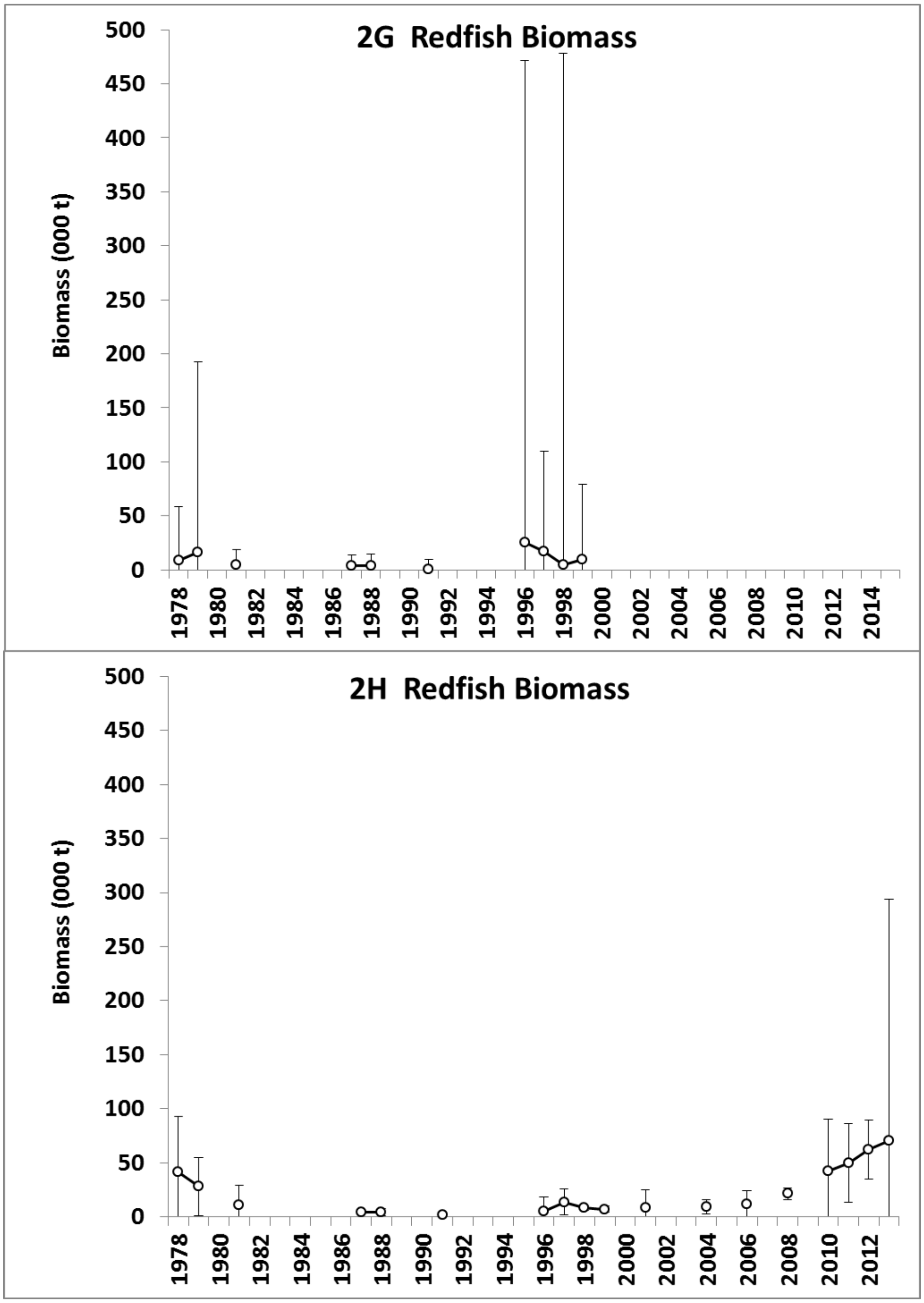


Figure 5. Biomass indices (000 t) for Redfish in NAFO Divisions 2G and 2H from 1978 to 2013 (vertical lines represent 95% confidence intervals). Note that deep strata (>700 m) were not sampled in 2H in 2014 and 2015 (gaps represent years when the Division was not sampled).

Abundance indices were relatively stable in Divs. 2H from 2010 to 2013 (Fig. 4). During this period, biomass values increased (Fig. 5) due to fish growth. In 2014 and 2015 the survey was incomplete as important areas for Redfish (depths >700 m) were not covered. Overall, both 2G and 2H represent a relatively small portion of the Redfish abundance and biomass within Divs. SA 2 + Divs. 3K.

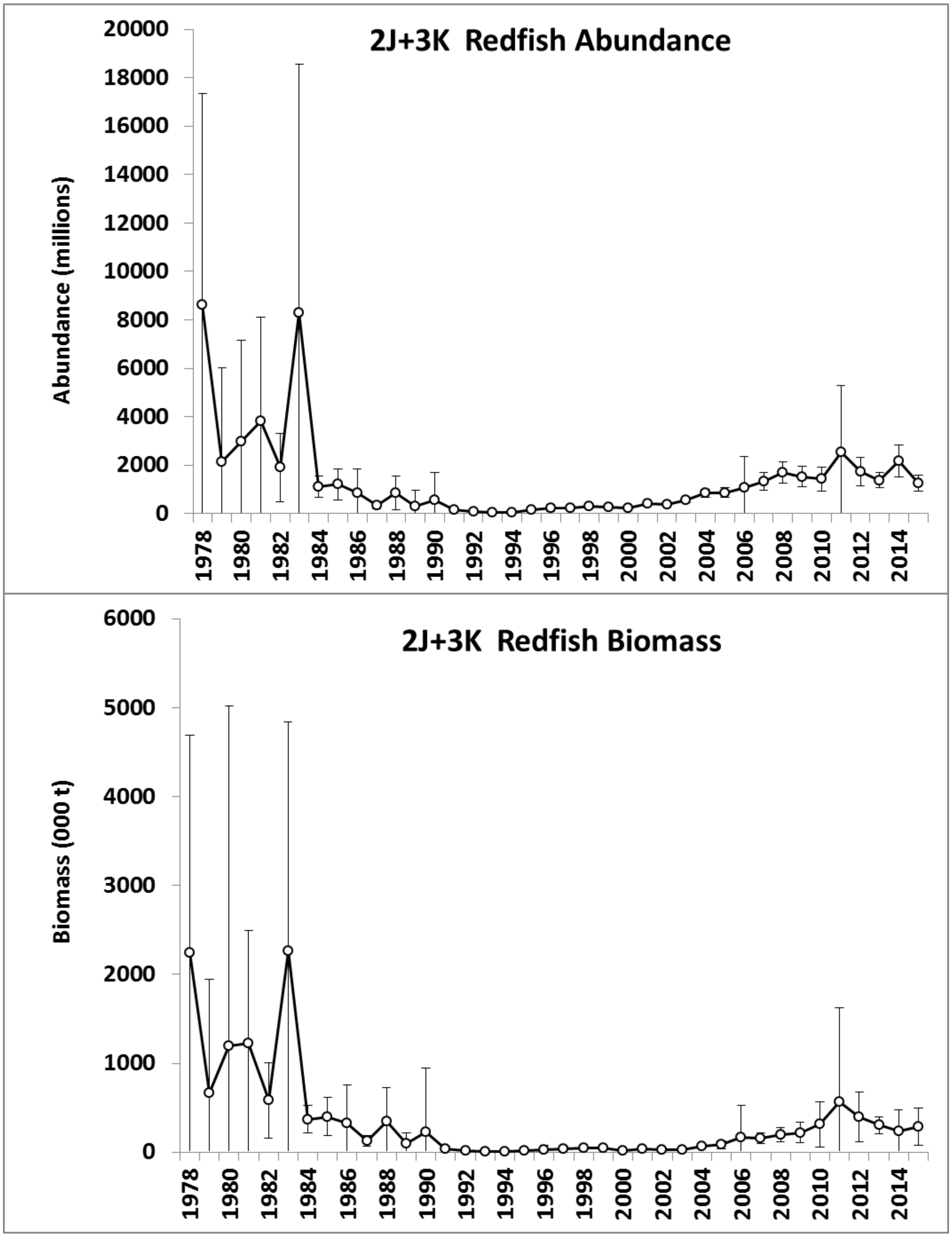


Figure 6. Abundance (millions) and biomass (000 t) indices for Divs2J3K Redfish from 1978 to 2015 (vertical lines represent 95% confidence intervals).

Abundance and biomass (Fig. 6) indices for Divs. 2J3K) were relatively high from 1978 to 1983, compared to the 1991 to 2003 collapse period. The biomass index increased by approximately a factor of 10 from 2003 to 2011. Biomass from 2011 to 2015 declined marginally but was relatively stable at approximately half of the pre-collapse (1978-1990) levels. Abundance values from 2011 to 2015 were also relatively stable at approximately 70% of pre-collapse levels. Generally, patterns were consistent between the abundance and biomass indices.

Mortality

A proxy for fishing mortality was calculated as the ratio of total landings (including discard estimates) in a given year to the RV survey biomass index from the previous year. This proxy was variable from the 1980s to the mid-2000s but since 2006, has been low (<1%) (Fig. 7).

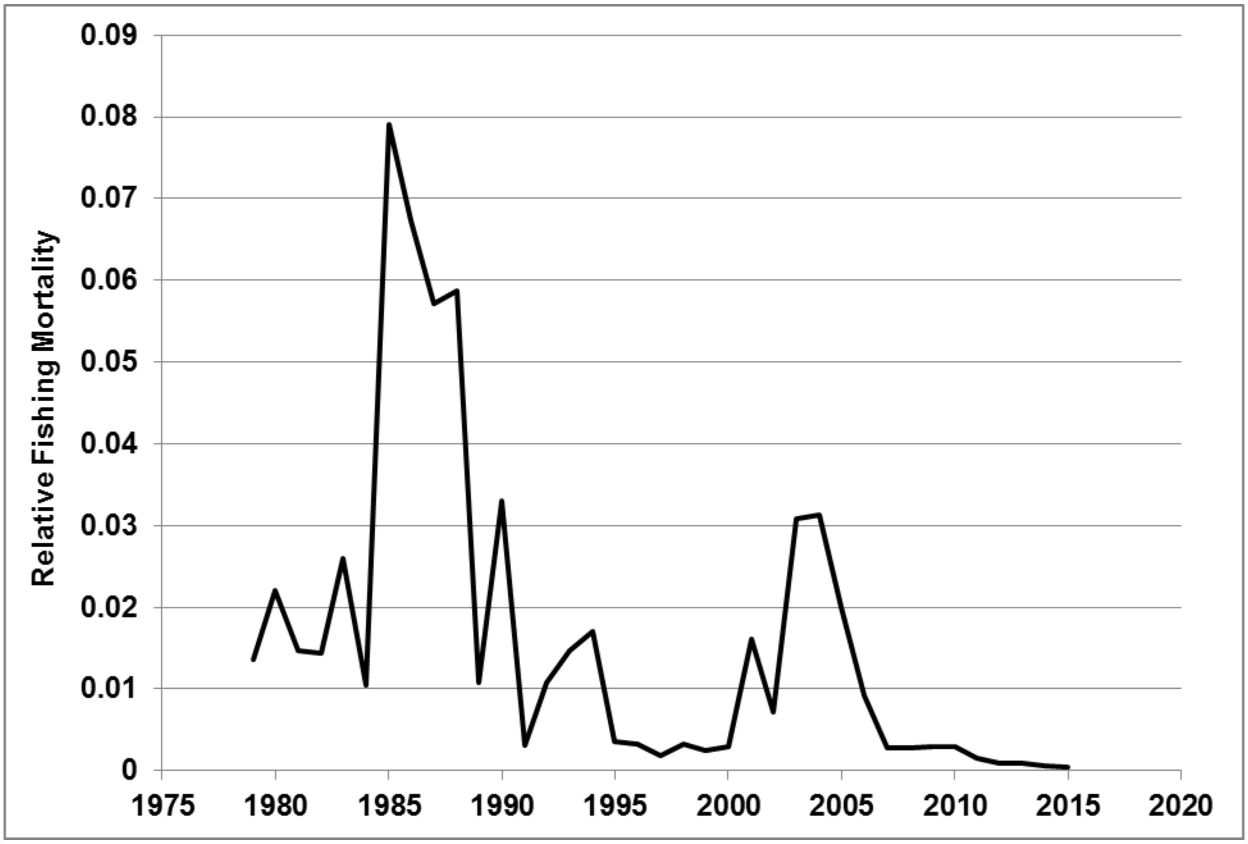


Figure 7. Proxy for Redfish fishing mortality from 1978 to 2015 in SA 2 + Divs. 3K calculated as the ratio of total landings in a given year to the survey biomass index in the previous year.

Recruitment

Length Composition

Although the Campelen trawl (1995 onward) samples small (<20 cm) Redfish more effectively than the Engel trawl, relatively few small Redfish were collected in annual sampling before 2001. From 2002 onward, one or multiple length modes were apparent in the length frequency distributions within Divs. 2H, 2J, and 3K. These modes persisted over time and some can be tracked over several years. However, few fish larger than 30 cm were sampled recently relative to the 1978 to 1983 period.

A strong length mode that first appeared in Divs. 3K during 2014 at 6 cm was apparent in both Divs. 2J and 3K at approximately 10 cm during 2015. Presently, it is unclear how these young fish will contribute to future fisheries. Previously, similar events have been observed in survey results, but modes were not tracked consistently over time.

Recruitment Index

A recruitment index, calculated as the abundance of Redfish less than 15 cm, was relatively low from 1979 to 2000 (Fig. 8). Since then, the recruitment index has generally been near or above the long term average with a time series high in 2014 (Fig. 8). As Redfish grow quite slowly, sequential index values are not independent and annual index values are comprised of multiple cohorts.

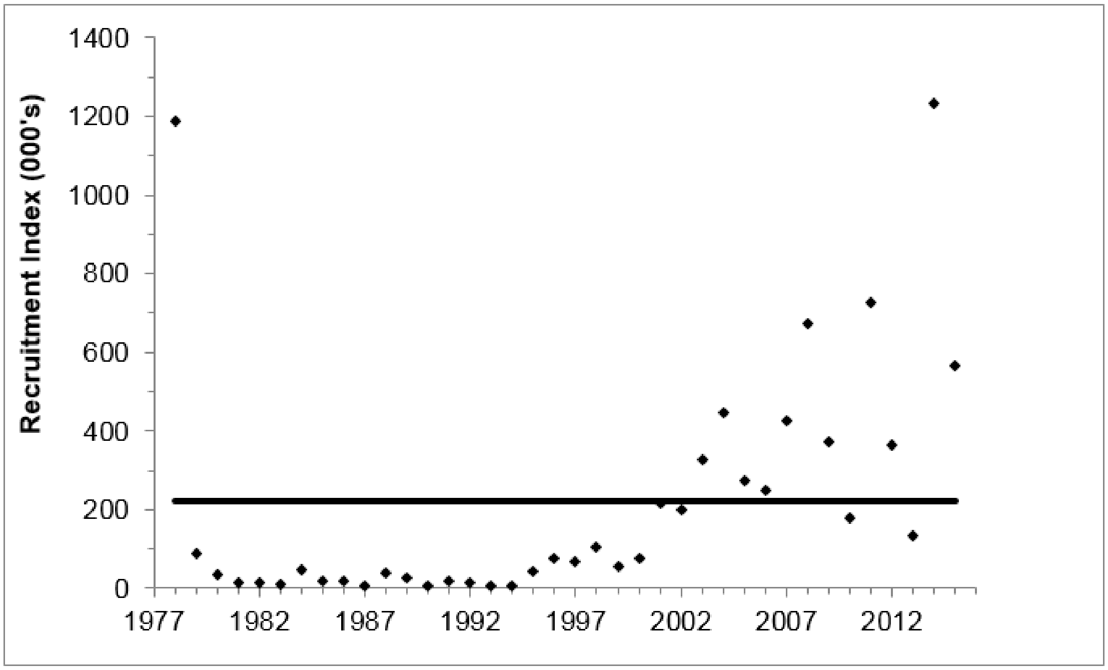


Figure 8. Recruitment index for Redfish in SA 2 + Divs. 3K based on total abundance estimates of Redfish less than 15 cm. The solid line indicates the time series average.

Reference Points

Models were developed through an external contract to explore LRPs for Redfish based on survey mature biomass (MacAllister and Duplisea 2011). Reference points for several Redfish stocks in the Northwest Atlantic were adopted by DFO based upon Bayesian production model results and various empirical methodologies (DFO 2012). This model was designed to investigate reference points but has not been applied directly to SA 2 + Divs. 3K stock assessments, nor has it been formally accepted for this purpose. Participants noted that assessments for Unit 1 and Unit 2 Redfish have discarded the production model. Prior to the current assessment of SA 2 + Divs. 3K Redfish, DFO received a critique of the existing production model and limit reference points for the stock from a former DFO Redfish biologist (GEAC [Atkinson, D.B. 2016] in Lee et al. in prep, Appendix 1[1]).

During the assessment plenary session it was agreed that there were substantive concerns about the input data and incomplete documentation of the rationale for model formulation.

[1] Lee, E., Ings, D. Mello, L., and R. Rideout. In prep. Stock status of Redfish (*Sebastes sp.*) in NAFO SA 2 + Div. 3K. Appendix 1 – GEAC (Atkinson D. B. 2016) An investigation of inputs to the analytical model used to determine stock status and limit reference points (LRP's) for Redfish (*Sebastes sp.*) in NAFO Subarea 2 + Division 3K. CSAS Res. Doc.

Specifically, the meeting recognized issues with separating the species in the survey and commercial catch data based on preliminary results from studies in the 1980s.

The assessment model for *S. mentella* was developed for the designatable unit spanning SA 2 + Divs. 3KLNO rather than just the SA 2 + Divs. 3K stock complex. This required apportioning biomass between Divs. 2J3K and Divs. 3LNO based on area of occupancy for the determination of LRPs. The meeting identified concerns with the validity of using this approach to delineate the critical/cautious and healthy zones for the SA 2 + Divs. 3K Redfish complex. The model built for *S. fasciatus* was specific to 2J3K. In both models, survey Q was allowed to vary across time blocks informed by Bayesian posteriors. Q shifts were incorporated to improve model fit, and were not based on gear changes. The need to sub-divide the survey series into multiple time periods to produce acceptable model fit caused concern as there is no *a priori* justification to support these groupings.

Length at maturity was based on empirical results from Unit 2 (Gulf of St. Lawrence/Southeastern NL). However, it is known that L_{max} increases in more northern populations; this may lead to overestimation of the spawning stock biomass if the L_{50} applied is less than the real L_{50}. Further, index-based LRPs using both $B_{Recovery}$ and B_{MSY} concepts were also presented to the meeting but were not accepted due to difficulties with respect to applying LRP concepts to Redfish, including its episodic recruitment, species separation and other data limitations.

Due to the incomplete documentation of model formulations, resource and data limitations, the existing model was not updated during the meeting nor were the previously calculated reference points accepted. Therefore, no LRP, including the previously established values (DFO 2012), was considered applicable at this time. In the absence of a LRP, it was not possible to identify which zone of the Precautionary Approach framework the stock is currently within.

Ecosystem

Physical Oceanographic Environment

The SA 2 + Divs. 3K region extends off northern Labrador to the eastern Newfoundland Shelf with bottom topography consisting of relatively shallow banks, deep cross-shelf channels and steep continental slopes. The ocean circulation is dominated by the southward-flowing Labrador Current which transports colder relatively fresh water from the north, as well as warmer saltier Labrador Sea water along the continental slope regions. Hydrographic conditions are determined in part by these and other factors, such as local winds and air temperatures. The main features of an analysis of historical climate data show mostly above average temperature conditions during the 1960s, a brief cold period during the early 1970s and again in the mid-1980s. Temperature conditions then declined to the coldest on record in the early 1990s and remained below normal until the mid-1990s. Since then there has been a significant warming trend with temperature values reaching record highs in the late 2000s. The most recent years, notably 2014 and 2015, experienced a short term decline but data available to date in 2016 indicates a return to a warming trend.

Invertebrate and fish community

The structure of the ecosystem within NAFO Divs. 2J and 3K has undergone significant changes since the mid-1990s. The entire fish community collapsed in the late 1980s and early 1990s, with average fish size also declining during this period. After the collapse, the system became highly dominated by shellfish, with peak dominance in 2003 when more than 60% of the estimated Fall RV biomass was shellfish. Consistent signals of rebuilding of the fish community appeared in the mid-to-late 2000s; this signal was also associated with an increase in average fish size. In the 2010s the overall biomass has remained relatively stable, but the dominance of groundfish has increased, while shellfish has decreased. Redfish is the dominant fish among plank-piscivores, having a three-fold increase in biomass between the mid-1990s and the 2010s.

Studies of diet composition of key groundfish species in Divs. 2J and 3K since 2008 indicate that Redfish is a frequent food item for Atlantic Cod and Greenland Halibut, and an occasional one for American Plaice. Despite its regular occurrence, Redfish does not appear as a dominant prey for these predators. However, long term diet data for Greenland Halibut indicate that Redfish represented up to 20% of its diet in the late 1980s, while available data from Divs. 2H shows up to a maximum of 30% of Redfish in the Greenland Halibut diet in 2010. Major diet changes in recent years involve the shift from shrimp to capelin as key prey item among fish top predators. As a predator, Redfish shows a variable diet composition between years, but amphipods, shrimp, myctophids, and euphausiids appear as consistently important prey items.

Sources of Uncertainty

Russian (2001-2015) and Lithuanian (2001-2015) catches assigned to Divs. 2J in the NAFO Statlant 21 database are fished outside the 200 mile limit and likely originate from the Irminger Sea pelagic stock (Power 2001). Subsequently, these values are omitted from the catch totals for SA 2 + Divs. 3K (2J + 3K) for the years 2001 to 2015. Prior to 2001, Russian and Lithuanian (and non-Canadian) catch are assumed to be primarily within the 200 mile limit and are included in the catch total. It is possible that a larger portion of non-Canadian catch currently assigned to SA 2 + Divs. 3K also originates within the Irminger Sea.

Redfish in SA 2 + Divs. 3K are composed of a mixture consisting primarily of *S. mentella*, lesser amounts of *S. fasciatus*, and sporadic occurrences of *S. marinus. S. mentella* and *S. fasciatus* are similar in appearance and are not separated in either the commercial or research survey catch. Despite their physical similarities the species have different depth and temperature preferences; changes in environmental conditions will not affect the three species equally, increasing the difficulty in interpreting survey indices changes in the stock complex.

Atlantic *Sebastes spp.* are known as episodically recruiting species where large year-classes may occur only once a decade or less frequently even in healthy populations.

Redfish survey catchability can vary significantly due to biological (formation of dense aggregations) or environmental (water temperature effects or depth range) reasons. This can result in inconsistent catch results within surveys, leading to high inter-annual variation at times. This is exacerbated by the combination of three species into a stock complex since the catchability of individual species can change independently in response to environmental changes.

Incomplete observer coverage of certain gear types, such as <50% coverage of trawl effort or <10% of gillnet effort, can introduce bias and/or uncertainty into analyses to determine Redfish bycatch and/or discards within commercial fisheries.

Lack of age information precludes certain types of analyses such as weight at age and cohort-based population modelling.

CONCLUSIONS AND ADVICE

Redfish biomass increased considerably from 2003-2010 with biomass during 2010-2015 reaching approximately half of the pre-collapse (1978-1990) levels. Recruitment (abundance of Redfish <15 cm) since 2000 was above the long term average with a time-series high in 2014. The fishery remains under moratorium, and average bycatch (including discards) since 2006 has been approximately 500 t. The meeting was neither able to validate nor invalidate existing reference points (DFO 2012) derived from production models due to substantive concerns about input data and an incomplete documentation of the rationale for model formulation.

In the absence of a LRP, it is not possible to identify what zone of the PA framework this stock is currently within. It is recommended that adaptive and cautious management be applied to any reopened fishery.

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SOURCES OF INFORMATION

This Science Advisory Report is from the October 19-21, 2016 Assessments of Redfish in Northwest Atlantic Fisheries Organization (NAFO) Subarea 0, Subarea 2 and Division 3K. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

DFO 2011. Recovery potential assessment of Redfish (*Sebastes fasciatus* and *S. mentella*) in the Northwest Atlantic. DFO Can Sci. Advis. Sec. Advis. Rep. 2011/044.

DFO 2012. Reference points for Redfish (*Sebastes fasciatus*, *S. mentella*) in the Northwest Atlantic. DFO Can Sci. Advis. Sec. Advis. Rep. 2012/004.

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MPO. 2020. État des stocks de sébaste dans la sous-division 2 et la division 3K de l'OPANO. Secr. can. de consult. sci. du MPO, Avis sci. Rép. 2020/021.

SUBMISSION TO THE
NUNAVUT WILDLIFE MANAGEMENT BOARD
March 2021

FOR

Information: X **Decision:**

Issue: Department of Fisheries and Oceans Canada – Operational Updates

Updates:

Marine Mammals:

1) Narwhal:

- In October 2020, the Department of Fisheries and Oceans Canada (DFO) published a Science Advisory Report (SAR) on the delineation of the Eclipse Sound and Admiralty Inlet narwhal stocks, which can be found at the following link: https://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2020/2020_048-eng.html.
- DFO is proposing a virtual meeting for the Nunavut Narwhal Working Group in late February 2021 to: 1) Provide an update on recently published Science advice and discuss and develop a community consultation plan, and 2) Initiate the development of a plan for the review of the Integrated Fisheries Management Plan for Narwhal in the Nunavut Settlement Area.
- Narwhal harvest tag returns and harvest numbers must be submitted to DFO by Hunters and Trappers Organizations/Associations (HTOs/HTAs) by the end of the harvest season, March 31, 2021. Prior to distributing the 2021 harvest tags, 2020 harvest data will be reconciled, carry-over allocations will be calculated, and community allocations will be sought from Regional Wildlife Organizations (RWOs).

2) Walrus:

- A Ministerial decision is expected by February 7, 2021 on the NWMB's approval of 21 walrus sport hunts for 2021.
- In partnership with the Sanirajak and Aiviit HTOs, the community-based catch monitoring programs for walrus in Sanirajak and Coral Harbour are expected to continue in 2021.

3) Beluga:

- The Cumberland Sound Beluga Working Group continues to meet virtually while COVID-19 restrictions limit in-person meetings. In 2020, teleconferences were held in September, October, and December to share updates from co-management partners and continue discussions on sustainable co-management of this fishery. The next Working Group meeting is currently scheduled for January 25, 2021.
- The Sanikiluaq HTO contacted DFO Science on January 20, 2021 to share a local hunter's observation that several belugas appear to have been killed by polar bears in the Belcher Islands. DFO and the Sanikiluaq HTO are working together

to document this event, and collect biological samples if possible.

4) Bowhead:

- DFO has been advised of the host communities for the 2021 bowhead harvest in the Kivalliq Region and is awaiting formal advisory letters for the Qikiqtaaluk and Kitikmeot Regions (the Department received informal update by email that Igloolik will host a bowhead hunt in 2021).
- In collaboration with the HTOs in Taloyoak and Kugaaruk, documentation and samples are now available from all of the nine bowhead carcasses discovered by local hunters this winter. These include one bowhead reported by Taloyoak hunters at Gulf of Boothia, and two separate groups of four bowheads reported by Kugaaruk hunters (Gulf of Boothia, Committee Bay). DFO Science has received the sample shipments and will begin to process them as soon as possible.

5) Harvest Reporting:

- DFO will soon be requesting harvest updates from HTOs/HTAs for beluga, walrus, bowhead, and narwhal for the 2020/21 harvest season. Information provided by the HTOs will be used to finalize harvest data by the end of this season. Reports of total marine mammal hunting mortality (landed and lost) are essential to develop reliable advice on sustainable harvests.
- DFO urges continued reporting of unusual marine mammal occurrences and events e.g. beached carcass, ice entrapments, etc.
- Timely and accurate reporting is required under the Fisheries Act, Marine Mammal Regulations, and the Nunavut Agreement. It is strongly recommended that co-management organizations emphasize the importance of harvest reporting and monitoring.

***Arctic Char*:**

1) Pangnirtung:

- DFO is working with the Pangnirtung HTA on plans to begin issuing licences for the 2020-21 winter Arctic char fishery.

Greenland Halibut (Turbot):

1) Cumberland Sound Greenland halibut Fishery:

- The on-ice Greenland Halibut fishery in the Cumberland Sound Turbot Management Area is expected to start in January 2021. DFO is working with the Pangnirtung HTA, Pangnirtung Fisheries Ltd., and Cumberland Sound Fisheries Ltd. on plans to officially open the fishery. Due to COVID-19 restricting the ability to hold an in-person pre-season meeting in Pangnirtung, the fishery will instead be opened via radio announcements.

2) 2021 Offshore Greenland halibut Fishery

- The 2021 Greenland halibut fishery in 0A and 0B started on January 01, 2021 and opened to fishing in 0B on January 01. 0A will open to fishing on June 01.
- The 2021 Greenland halibut Subarea 0 Total Allowable Catch (TAC) has been set. Allocations to Nunavut Enterprises are currently pending.

Northern and Striped Shrimp:

- The 2021 Northern shrimp fisheries in Shrimp Fishing Area (SFA) 0 and SFA 1 started January 01, 2021 and opened to fishing on January 01.
- The 2021/22 Northern and Striped shrimp fisheries in the Eastern Assessment Zone (EAZ) and Western Assessment Zone (WAZ) start April 01 2021 and open to fishing on April 01.
- The 2021 and 2021/22 Northern and Striped Shrimp TACs for SFA 0, 1, EAZ and WAZ are pending. Allocations to Nunavut Enterprises are currently pending.

Prepared by: Fisheries Management, Arctic Region – Fisheries and Oceans Canada

Date: January 20, 2021

SUBMISSION TO THE NUNAVUT WILDLIFE MANAGEMENT BOARD March 2021

FOR

Information: X **Decision:**

Issue: Fisheries and Oceans Canada (DFO) Update – Marine conservation initiatives

Background

DFO Marine Planning and Conservation Program (formerly the Oceans Program) focuses on implementation of responsibilities within the *Oceans Act*, using integrated oceans management and marine conservation tools. DFO - Arctic Region, is working with Inuit partners on a number of marine conservation initiatives within and adjacent to Nunavut. These activities include advancement of marine protection measures in Tuvaijuittuq and around Southampton Island and management of existing marine refuges. At the request of the Qikiqtani Inuit Association (QIA) and the community of Sanikiluaq, DFO has also become involved in multi-party discussions on advancing consideration of protection measures in Qikiqtait.

DFO is also advancing marine environmental quality guidelines in support of sustainable development and integrated management, and supporting implementation of recommendations from the Pikialasorsuaq Commission within Sarvariuaq in partnership with the QIA.

Current Status

Southampton Island Area of Interest

- DFO and Kivalliq Inuit Association (KIA) have partnered to advance the Southampton Island Area of Interest for potential designation as a new Marine Protected Area. The Southampton Island Area of Interest encompasses the nearshore waters around Southampton Island and Chesterfield Inlet in the Kivalliq Region of Nunavut. The final boundary of a potential future Marine Protected Area will be based on assessments.
- The Southampton Island Area of Interest Co-Development Committee met most recently in September 2020, to provide input on the Marine Protected Area process. The Co-Development Committee has representation from Aiviit and Aqigiq Hunters and Trappers Organizations, Irniurviit Co-Management Committee, Government of Nunavut, KIA, and DFO.
- An Inuit Qaujimajatuqangit workshop was held in February 2020 in Rankin Inlet, with five participants from Chesterfield Inlet, eight from Coral Harbour, and one each from

KIA and Government of Nunavut. An Inuit Qaujimajatuqangit Workshop Report was produced.

- DFO Canadian Science Advisory Secretariat (CSAS) meetings were held in December 2018 in Winnipeg and virtually in August 2020. Meeting documents are publically available on the CSAS website.

- We are currently conducting assessments of the area: ecological, Inuit Qaujimajatuqangit, socio-economic, petroleum potential. DFO is consulting with partners and stakeholders on the various assessment reports, with the aim of finalizing the reports by winter/spring 2021. The next step, expected to begin in spring of 2021, is to determine conservation objectives and conduct a risk assessment of current and potential future activities, which will inform the regulatory intent (i.e., proposed measures).

- DFO will continue engaging with partners and stakeholders throughout the Marine Protected Area establishment process.

Tuvaijuittuq Marine Protected Area

- Since the establishment of Tuvaijuittuq Marine Protected Area by Ministerial Order in August 2019, an assessment to determine the feasibility and desirability of long-term protection in the area has been underway in partnership with Parks Canada, Qikiqtani Inuit Association and Government of Nunavut. In February 2020, a working group was established with members from all parties to implement an agreed-upon work plan. Tuvaijuittuq Working Group advancement of this work is ongoing, with some delays due to COVID 19.

- Face-to-face community consultations in Arctic Bay, Clyde River, Grise Fiord, Pond Inlet and Resolute Bay were planned for fall 2020 but have been postponed. The Working Group is currently developing ideas for an alternative consultation process and materials for circulation in the new fiscal year. Additional consultations are expected later in the feasibility assessment process to provide communities and stakeholders with opportunities to comment on preliminary results.

- Upon completion of the feasibility assessment and associated consultation processes, a report with recommendations will be submitted the Minister of Fisheries and Oceans Canada and the Canadian Coast Guard, the Minister of Environment and Climate Change Canada, the Minister of Environment and the Minister of Economic Development and Transportation for the GN, and the President of QIA.

Eastern Arctic Marine Refuges

- With the support of co-management partners, fishing industry, and environmental organizations, three eastern Arctic Marine Refuges, fisheries closures under the *Fisheries Act* were implemented in 2017 also contributing 1.17% to marine conservation.

- DFO monitors compliance with these fishery closures by conducting at-sea patrols and aerial surveillance as well as using vessel monitoring systems. Since the Marine

Refuges were established in C&A Region, DFO has investigated one violation and detected several potential violations.

- Research projects such as electronic tagging and monitoring of Greenland Halibut, Greenland Shark and skates as well as fisheries surveys continue in and around these Marine Refuges.

- DFO was thrilled to be a partner in the public outreach project 'Guardians of Tariuq' which highlights the eastern Arctic Marine Refuges.

Pikialasorsuaq

- The Pikialasorsuaq Commission (PC) was established by the Inuit Circumpolar Council (ICC) to explore management options for a large, international Northwater Polynya marine area. The PC report contains three recommendations, two of which related to DFO mandate: The establishment of a management regime, including an Inuit-led management authority; and The identification of a protected area comprised of the polynya and including a larger management zone.

- The Inuit-Crown Partnership Committee released a joint statement in March 2019 that committed the Leaders to working together, and with the governments of Greenland and Denmark, on implementing an approach to address the concerns expressed by the Pikialasorsuaq Commission.

- Discussions with Inuit partners are ongoing to identify opportunities to provide support and build capacity within Inuit organizations to promote leadership on this initiative. The Qikiqtani Inuit Association has taken a leadership role in advancing discussions around Sarvarjuaq (the Canadian portion of the Pikialasorsuaq) and articulating their shared vision for the Qikiqtani region.

- Initial discussions have occurred with Greenland and the Kingdom of Denmark on development of a framework for implementing ocean management across the Pikialasorsuaq. DFO will also work with Canadian Inuit organizations and other key partners to inform international discussions.

- A DFO Canadian Science Advisory Secretariat (CSAS) meeting was held in January 2020 in Winnipeg with international experts and scientists to review the existing body of information relevant to the Northwater Polynya. Publication of meeting reports and documents are anticipated shortly and can be shared by request and are publicly available on the CSAS website

Marine Environmental Quality

- Recent Oceans Protection Plan (OPP) investments are supporting Marine Environmental Quality (MEQ) programs under the *Oceans Act*. A commitment under OPP is to focus on mitigating the risk of human caused stressors on the marine environment, including impacts of underwater noise from ships.

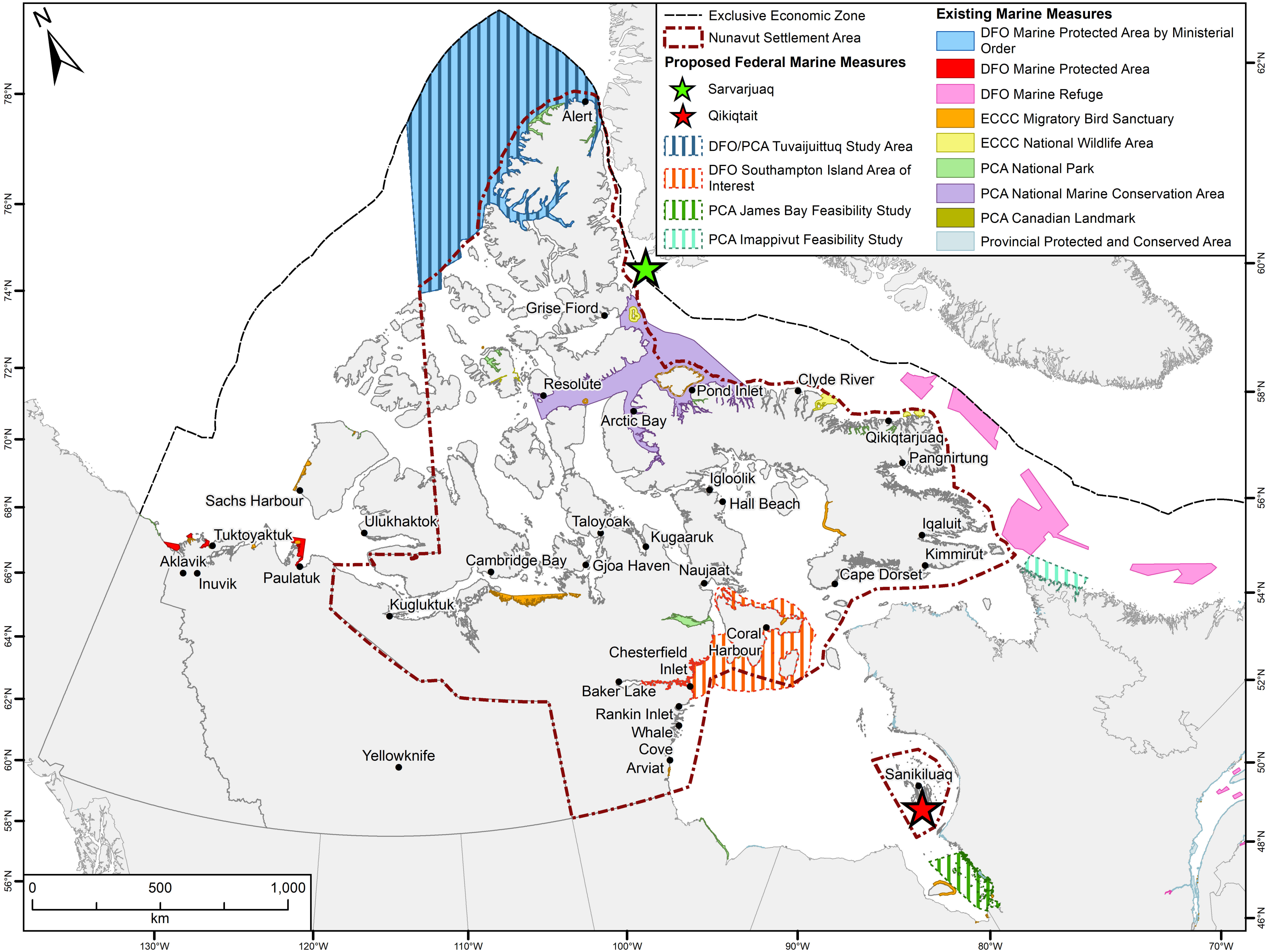
- In collaboration with partners, the national MEQ program is working towards developing integrated and evidenced-based tools and strategies to better manage and maintain healthy and sustainable marine, coastal and estuarine ecosystems.

- Nationally, working on development of an Ocean Noise Strategy to coordinate federal efforts in understanding and managing human-induced underwater noise. A discussion document was developed in collaboration with other federal departments and agencies to outline a framework for the strategy and act as the primary mechanism to receive initial feedback from partners, stakeholders, and the Canadian public. A presentation was delivered to the Nunavut Marine Conservation Targets Steering Committee on December 2, 2020.

- Within Nunavut, DFO is working with partners to establish underwater noise baseline data within Frobisher Bay and the Southampton Island Area of Interest.

- Developing an Arctic Pile Driving Protocol for Reducing Risks Caused by Underwater Noise. The draft is complete, it has been filed tested at the Iqaluit Deep Sea Port development site and has been submitted to DFO Science for review.

Prepared by: Arctic Region – Fisheries and Oceans Canada, Marine Planning and Conservation Program
Date: January 28, 2021



Existing and potential future Arctic protected and conserved areas. DFO = Fisheries and Oceans Canada; PCA = Parks Canada Agency; ECCC = Environment and Climate Change Canada

<u>**(ADDENUDM) SUBMISSION TO THE**</u>

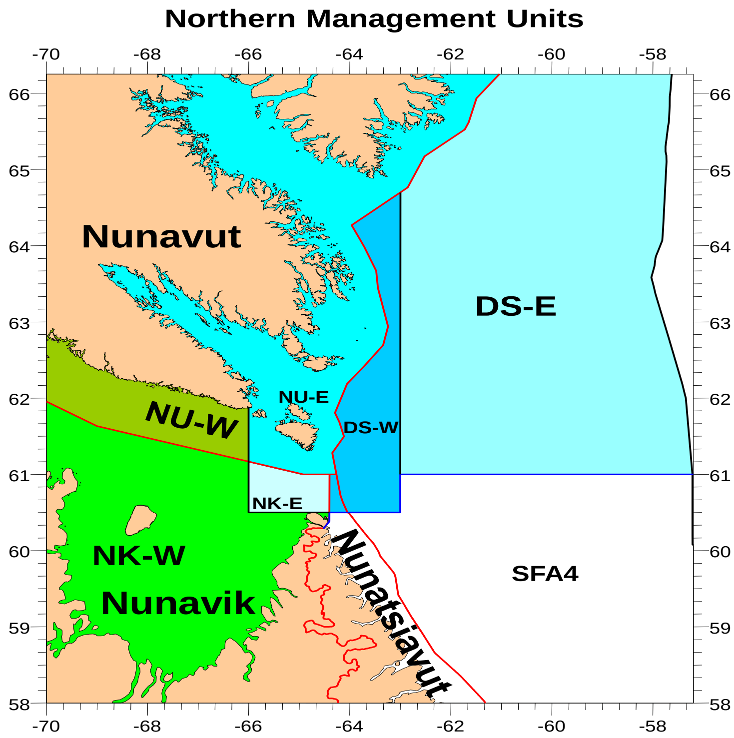
<u>**NUNAVUT WILDLIFE MANAGEMENT BOARD AND NUNAVIK MARINE REGION WILDLIFE BOARD**</u>

<u>**FOR**</u>

Information: X **Decision:** **Recommendation:**

Issue: Precautionary Approach Framework for Northern (*Pandalus borealis*) and Striped (*P. montagui*) Shrimp in the Western and Eastern Assessment Zones

<u>**Map:**</u>
Blue areas – Eastern Assessment Zone
Green areas – Western Assessment Zone



Northern shrimp (*Pandalus borealis*)

Striped shrimp (*Pandalus montagui*)

Background

Fisheries and Oceans Canada (DFO) submitted a briefing note to the Nunavut Wildlife Management Board (NWMB) and the Nunavik Marine Region Wildlife Board (NMRWB) (the Boards) in February 2021 as a placeholder for their joint decisions and recommendations on a Precautionary Approach (PA) Framework for two species of shrimp in the Western Assessment Zone (WAZ) and Eastern Assessment Zone (EAZ).

A report from the Northern Precautionary Approach Working Group (NPAWG) was not available at the time of submission. The NWMB requested this item be submitted as an information item for their March 10, 2021 meeting.

The Northern Precautionary Approach Working Group: Status Report (February 2021) is submitted for information through this addendum (Appendix 1). This report is intended to be a status report only, and is not intended for use in decision making. A final report of NPAWG will be prepared and submitted to the Boards upon conclusion of working group sessions.

Prepared by: Courtney D'Aoust, Fisheries Resource Management, Fisheries and Oceans Canada

Date: March 5, 2021

Appendices

APPENDIX 1 – Northern Precautionary Approach Working Group: Status Report (February 2021)

Northern Precautionary Approach Working Group: Status Report
February 2021

> ***Disclaimer:*** This report is intended to be a status report only and is not intended for use in decision making. A final NPAWG report will be prepared upon conclusion of working group sessions.

Composition & Structure

The Northern Precautionary Approach Working Group (NPAWG) was established in November 2020. The working group is composed of co-management partners, relevant industry stakeholders, provincial governments and officials from Fisheries and Oceans Canada (DFO). A complete list of NPAWG members is at Appendix 1.

Discussions of NPAWG have proceeded through a series of virtual meeting from November 2020 to February 2021. A consultation schedule is at Appendix 2.

Purpose & Objectives

The purpose of NPAWG is to provide advice on the primary components of a Precautionary Approach (PA) Framework for Northern shrimp *(Pandalus borealis)* and Striped shrimp *(P. montagui)* stocks in the Western Assessment Zone (WAZ), and an updated PA Framework for these stocks in the Eastern Assessment Zone (EAZ).

Consistent with the *Fishery Decision-Making Framework Incorporating the Precautionary Approach* (DFO, 2009) (referred to herein as DFO's PA Policy), the primary components of the PA Framework will include reference points to define three stock status zones (Healthy, Cautious and Critical Zones (Figure 1)) as well as a harvest strategy that may include Harvest Decision Rules (HDRs).

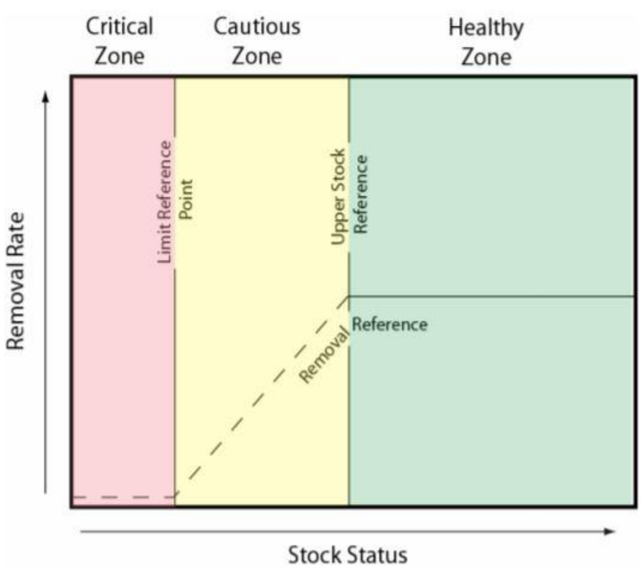


Figure 1. *Fisheries management framework consistent with a precautionary approach.*

A PA Framework for these stocks will serve to guide fisheries management decisions and contribute to sustainable management of the resource in these areas. In addition, efforts to develop a PA Framework for *P. montagui* in the WAZ, specifically developing a Limit Reference Point (LRP) and a Target Reference Point (TRP)), are directly related to conditions for Marine Stewardship Council (MSC) certification of this fishery.

Limit Reference Points (LRP)

Consistent with DFO's PA Policy, LRPs are established by DFO Science as the point below which serious harm is occurring to the stock. In May 2020, a Canadian Science Advisory Secretariat (CSAS) peer review process was convened to establish LRPs for *P. borealis* and *P. montagui* stocks in the WAZ, and update existing LRPs for these stocks in the EAZ. Publications from this peer-review process were released in November 2020 and distributed to NPAWG members. A copy of the Science Advisory Report (2020/053) was provided to the NWMB and NMRWB for December 2020 and March 2021 Board meetings.

- Terms of Reference
- Science Advisory Report 2020/053
- Research Document 2020/072
- Proceedings 2020/024

LRPs developed through the May 2020 peer review process were established at 40% of the geometric mean of the Spawning Stock Biomass (SSB) index for the available time series (Table 1).

Table 1. *Limit Reference Points and proposed Upper Stock Reference points[1] for P. borealis and P. montagui in the Western and Eastern Assessment Zones.*

Species	**Western Assessment Zone (WAZ)**		**Eastern Assessment Zone (EAZ)**	
	LRP (40%)	**USR[1] (80%)**	**LRP (40%)**	**USR[1] (80%)**
Northern Shrimp *(Pandalus borealis)*	4,100t **New*	8,200t	15,800t **Updated* *(increase from 6,800t implemented in 2009)*	31,600 **Updated* *(increase from 18,200 implemented in 2009)*
Striped Shrimp (*Pandalus montagui*)	12,300t **New*	24,600t	3,100t **Updated* *(increase from 2,300t implemented in 2009)*	6,100t **Updated* *(no change from 6,100t implemented in 2009)*

[1] USRs indicated in Table 1 were proposed by DFO Science. USRs require Board decisions and recommendations (as appropriate) prior to being established.

NPAWG Discussion

Although the development of LRPs for shrimp stocks in the WAZ and EAZ does not fall within the scope of NPAWG purpose and objectives, the working group did discuss general concerns toward the established reference points. In a submission from the Canadian Association of Prawn Producers (CAPP) and a joint submission from the Nunavut Fisheries Association (NFA) and Northern Coalition (NC), industry maintained that environmental and population dynamics of Northern shrimp stocks had not been adequately examined in setting the LRPs. Further, members expressed concern for the level of precaution taken in setting LRPs and that these reference points should be implemented on a temporary basis only.

Officials from DFO discussed the level of available information (limited data time series) and degree of uncertainty as to the point below which serious harm may be occurring to these stocks, noting the consensus of the May 2020 CSAS participants to exercise greater precaution in setting the LRPs. Representatives from the Government of Quebec and Government of Nunavut expressed concern for lack of an established plan or committed funds that could provide additional data (specifically, environmental and ecosystem data) for the WAZ and EAZ that could mitigate uncertainty and potentially lead to revised reference points in the near term.

Outcome

LRPs are considered implemented and remain in effect until such a time as they are revised by DFO Science. Accordingly, no decisions or recommendations are to be sought from the NWMB or NMRWB, nor the Northern Shrimp Advisory Committee (NSAC) on these biological points.

Upper Stock Reference Points (USR)

Consistent with DFO’s PA Policy, the USR is the stock level threshold below which removals must be progressively reduced in order to avoid reaching the LRP. The establishment of the USR is a management decision, driven by productivity objectives for the stock, broader biological considerations and social and economic objectives for the fishery. This decision is, therefore, informed by consultations with fishery and other interests, with advice and input from Science. NPAWG served as the body for this consultative process. USRs require Board decisions and recommendations (as appropriate) prior to being established by the Minister of Fisheries and Oceans Canada.

As part of the May 2020 CSAS peer review process, DFO Science also proposed USRs for stocks in the WAZ and proposed updated USRs for stocks in the EAZ. USRs were proposed at 80% of the geometric mean of the SSB index for the available time series (Table 1).

NPAWG Discussion

To a great extent, the working group discussed year-to-year variability in stock status indicators (fishable and SSB) for *P. borealis* and *P. montagui* in the WAZ and EAZ, recalling that no discernable trend has been observed for either species. Given influences beyond fishing mortality and the lack of trends that can be derived from a relatively limited time series, some NPAWG members felt that measures should be taken to mitigate the effects of this variability.

Measures discussed by the working group included the suggestion of a USR established at 70% of the geometric mean of the SSB index for the available time series. Some members proposed that averaging of multiple (2 or 3) SSB indices would be used to determine stock status relative to PA reference points. DFO Science maintained that the clearest and most recent expression of stock status is represented as a single data point, rather than an average. In reaction to this position, some working group members then proposed that a USR not be developed and instead NPAWG focus on a Target Reference Point (TRP) to satisfy MSC conditions. These measures would effectively reduce, or eliminate, the potential for stocks to enter a defined Cautious Zone. Industry members pointed to significant prospective harm to product marketability where stocks enter a Cautious Zone.

From DFO’s perspective, stock status is exclusively within the Science sector’s area of responsibility and a single-year value is the clearest expression of that status for a given point in time. Additionally, it was noted that USRs are an integral part of DFO’s PA policy, primarily serving as a point sufficiently above the LRP “to provide an opportunity for the management system to recognize a declining stock status and sufficient time for management actions to have effect”. In keeping with DFO’s PA policy, the USR is critical in defining the boundary between the Healthy and Cautious Zones and DFO continues to report in this context through the annual Sustainability Survey for Fisheries.

It remains a policy priority for the Department to establish complete PA Frameworks for Canada’s fisheries that include a USR. The establishment of a TRP without an accompanying (or dual purpose) USR would represent a departure from this priority. This would be particularly pertinent in the EAZ where a USR has been in place for a number of years.

Outcome

NPAWG members have shown significant support for a USR established at 70% of the geometric mean of the SSB index for the available time series, for stocks in the WAZ and EAZ. Ongoing work to develop HDRs has considered the USR at this prospective level. Members continue to see the establishment of a USR as coupled with the development of HDRs given their combined effect on potential fishing opportunities and stock conservation.

Harvest Decision Rules (HDRs)

Consistent with DFO's PA Policy, pre-agreed Harvest Decision Rules (HDRs) and management actions for each zone within the PA Framework are essential components of a harvest strategy. HDRs prescribe harvest rates and possibly other management procedures for each zone or steps within a zone. HDRs have not been established for stocks in the WAZ. HDRs are established within the Integrated Fisheries Management Plan (Annex I) for stocks in the EAZ and remain in effect until these have been revised.

NPAWG Discussion

Through initial discussions had to date, NPAWG has explored ways in which HDRs could accommodate significant variability in biomass indices for *P. borealis* and *P. montagui* stocks in the WAZ and EAZ. Industry noted the objective to promote catch stability in the short term ahead of a desired review of PA reference points, and the general need for predictability in annual Total Allowable Catch (TAC) levels. A number of proposals were prepared by industry representatives and presented to the working group for consideration.

One proposed HDR approach looked to establish a baseline TAC that could remain constant, with a trigger to respond to an unusual change in biomass patterns observed over the time series. The proposed trigger would consider the three-year average of the SSB index relative to the half-way point of Cautious Zone, and if below, would result in significant reduction in the TAC.

A second proposal presented the option to consider biomass indices for each species as a combined total for the WAZ and EAZ as a means to reduce year-to-year reduce variability. Exploitation rates (e.g. 20% exploitation rate in the Healthy Zone) could be applied to a three-year average of combined fishable biomass estimates to generate TAC levels for each species across a combined area. It was proposed that these TAC levels then be proportionally divided between the WAZ and EAZ.

The working group continues to consider industry proposed measures with possibility to suggest modifications or new approaches for consideration in future discussions.

Outcome

The development of HDRs for WAZ stocks and any possible revisions to existing HDRs for EAZ stocks is ongoing. Where a number of industry proposals have been brought forward to date, DFO is expected to present its response and/or additional option(s) for consideration by the working group in future sessions.

Other Areas of Discussion: Review Provision

Given the limited time series and uncertainty surrounding the stocks in the EAZ and WAZ, many group members stated a strong preference for a PA to be reviewed in the near-term (i.e., 2-5 years). Members suggested the benefit of doing so with the aid of additional survey results and, preferably, incremental science work that could provide some information related to environmental and ecological influences on these stocks.

NPAWG Discussion

DFO raised concern that a defined expiry date on a PA Framework is unlikely to be supported by DFO decision-makers and acknowledged that there could be implications for MSC certification for these fisheries in the event a PA Framework (including reference points) is not in place. The notion of a review after a certain time period was discussed.

DFO Science noted that the knowledge of these stocks is not likely to increase to an extent that could result in a different outcome in the development of a PA Framework to that being undertaken now. DFO proposed that the working group recommend a review of reference points (and any additional components of a PA Framework) in 4 or 5 years (i.e., 2025 or 2026), principally through the establishment of a committee to commence an initial review and to ultimately consider the merit of modifying the PA Framework at that time. Associated with the notion of available data for the WAZ and EAZ, NPAWG has noted the need for additional science to improve environmental knowledge.

Next Steps

NPAWG should reconvene to discuss on HDRs in mid-to-late March. Pending the outcomes of these sessions, DFO will seek decisions and recommendations from the NWMB and NMRWB on USRs and HDRs at the next opportunity.

APPENDIX 1

Fisheries and Oceans Canada (DFO) Members
Derek Mahoney (Resource Management Operations (RMO), Ottawa) *(Chair)*
Courtney D'Aoust (RMO, Ottawa)
Leigh Edgar (RMO, Ottawa)
Christi Friesen (RM, Arctic)
Jeff Adam (RM, Arctic)
Sheri Friesen (RM, Arctic)
Felix Dionne (RM, Quebec)
Jérôme Beaulieu (RM, Quebec)
Martin Henri (RM, Newfoundland and Labrador)
Wojciech Walkusz (Science, Ontario & Prairie)
Krista Baker (Science, Newfoundland and Labrador)
Katherine Skanes (Science, Newfoundland and Labrador)
Brittany Beauchamp (Science, Ottawa)

Non-DFO Members
Frankie Jean-Gagnon (Nunavik Marine Region Wildlife Board)
Amber Giles (Nunavut Wildlife Management Board)
Aaron Dale (Torngat Joint Fisheries Board)
Zoya Martin (Government of Nunavut)
Omar Sarr (Government of Quebec)
Todd Broomfield (Nunatsiavut Government)
Alastair O'Reilly (Northern Coalition)
Bruce Chapman (Canadian Association of Prawn Producers)
Tony Wright (Makivik Corporation)
Brian Burke (Nunavut Fisheries Association)

APPENDIX 2

Session Title	Objectives	Sub-group(s) to attend	Date & Time
USR 4: EAZ & WAZ stocks	Discuss reference points and harvest decision rules (Borealis + Montagui)	WAZ & EAZ	Thursday February 18 1 PM – 3 PM EST (2 hours)
USR 3: EAZ & WAZ stocks	Discuss reference points (Borealis + Montagui)	WAZ & EAZ	Friday February 5 9 AM – 11 AM EST (2 hours)
USR 2: EAZ & WAZ stocks	Discuss options for USRs (Borealis + Montagui)	WAZ & EAZ	Friday January 15 10 AM – 12PM EST (2 hours)
USR 1: EAZ stocks	Discuss options for USRs (Borealis + Montagui)	EAZ	Monday January 11 10 AM – 12PM EST (2 hours)
USR General	Discussion: Outcomes of CSAS peer-review Discuss key considerations for USRs	WAZ & EAZ	Thursday December 17 10 AM – 12PM EST (2 hours)
NPAWG Introductory Session	Welcome to NPAWG: Terms of Reference Introduction to the Precautionary Approach Framework Overview: CSAS peer-review outcomes (LRPs and USRs)	WAZ & EAZ	Monday November 30 10 AM – 12PM EST (2 hours)

SUBMISSION TO THE

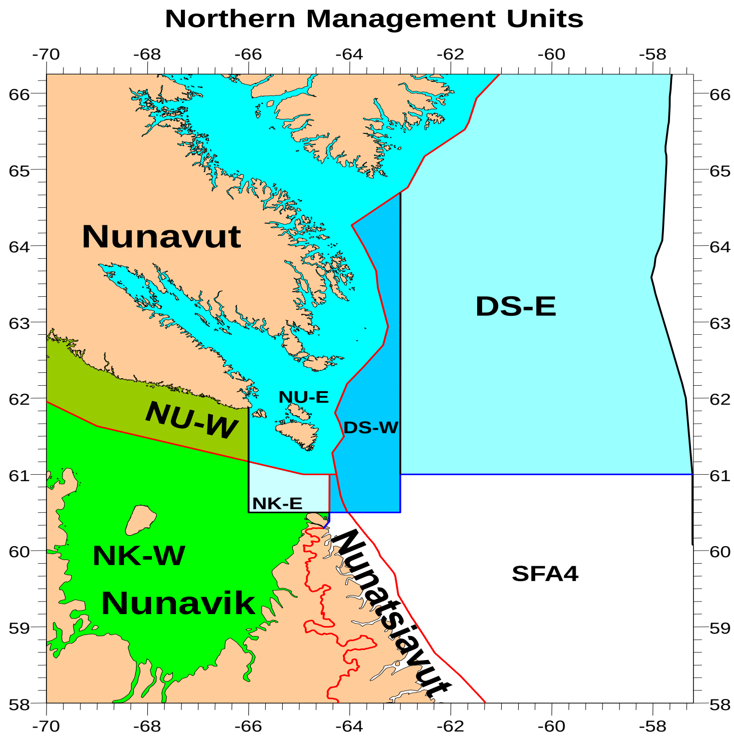
NUNAVUT WILDLIFE MANAGEMENT BOARD AND NUNAVIK MARINE REGION WILDLIFE BOARD

FOR

Information: **Decision: X** **Recommendation: X**

Issue: Precautionary Approach Framework for Northern (*Pandalus borealis*) and Striped (*P. montagui*) Shrimp in the Western and Eastern Assessment Zones

Map:
Blue areas – Eastern Assessment Zone
Green areas – Western Assessment Zone



Northern shrimp (*Pandalus borealis*)

Striped shrimp (*Pandalus montagui*)

Background

Two shrimp species (*P. borealis* and *P. montagui*) occur in the Northern shrimp fishery that takes place in the Davis Strait and eastern Hudson Strait. This fishery is managed according to two distinct stock assessment zones, the Western Assessment Zone (WAZ) and Eastern Assessment Zone (EAZ). These zones extend partly into the Nunavut Settlement Area (NSA) and partly into the Nunavik Marine Region (NMR) (see Map).

Further to the briefing note provided for information to the Nunavut Wildlife Management Board (NWMB) and the Nunavik Marine Region Wildlife Board (NMRWB) (the Boards) in December 2020, the Northern Precautionary Approach Working Group (NPAWG) continues its work to develop recommendations on a Precautionary Approach (PA) Framework for *P. montagui* and *P. borealis* stocks in the WAZ and EAZ, respectively (Appendix 1). A complete PA framework would include reference points and harvest decision rules (HDRs).

Development of a PA Framework for these stocks will serve to guide fisheries management decisions and contribute to sustainable management of the resource in these areas. In addition, efforts to develop a PA Framework for *P. montagui* in the WAZ, specifically developing a Limit Reference Point (LRP) and a Target Reference Point (TRP)), are directly related to conditions for Marine Stewardship Council (MSC) certification of this fishery.

Implementation of reference points for *P. borealis* and *P. montagui* in the WAZ and EAZ, respectively, is targeted for the 2021-22 fishery.

Progress to Date

Consistent with the *Fishery Decision-Making Framework Incorporating the Precautionary Approach* (DFO, 2006), DFO Science conducted a peer review process to establish LRP for shrimp stocks in the WAZ and update pre-existing LRPs for stocks in the EAZ. Results of the 2020 Canadian Science Advisory Secretariat (CSAS) process are at Appendix 2. LRPs are considered implemented and are not subject to Board decision.

Through a series of working group sessions held from November 2020 to February 2021, the NPAWG has made progress towards development of additional reference points for these stocks. Work will continue in February 2021 on this component of the PA Framework with the intent to finalize a report of NPAWG outcomes and recommendations in early March.

NPAWG outcomes and recommendations will be presented at the Northern Shrimp Advisory Committee meeting on March 9, 2021 (limited to EAZ stocks, WAZ stocks not discussed). At the time of this submission, a report from the NPAWG was not yet available. An addendum to this briefing note will present information to support Board decision making as it relates to a PA Framework for stocks in the WAZ and EAZ.

Next Steps

Work to develop HDRs, is intended to follow the development of recommendations on reference points. HDRs will provide details on harvest rates and other management procedures prescribed relative to stock status. Development of HDRs will include discussion of season-bridging protocols for allocations to Nunavut and Nunavik fishing interests in these zones.

Notably, development of HDRs are not a requirement for MSC certification of this shrimp fishery.

Summary of the Request

To support Board decision making as it relates to a PA Framework for stocks in the WAZ and EAZ, an addendum to this briefing note will be submitted in the coming weeks that will include a report of NPAWG outcomes and recommendations.

In order to fully or partially implement a PA Framework (including but not limited to reference points) for the 2021-22 fishery, advice on the following matters is requested as soon as possible:

Western Assessment Zone:

1. Decisions on reference points for *P. borealis* and *P. montagui* in the WAZ, respectively.*

Eastern Assessment Zone:

1. Decisions on reference points for *P. borealis* and *P. montagui* in the NU/NK E management units.*

2. Recommendations on reference points for *P. borealis* and *P. montagui* within the offshore Davis Strait management units.*

**Decisions and recommendations on reference points from NWMB and NMRWB must be compatible such that a common reference point is established the stock for the entire assessment zone.*

Prepared by: Courtney D'Aoust, Fisheries Resource Management, Fisheries and Oceans Canada

Appendices

APPENDIX 1 – [SUMMARY] DFO. 2020. Science Advice on Limit Reference Points for Northern Shrimp (*Pandalus Borealis*) and Striped Shrimp (*Pandalus Montagui*) in the Eastern and Western Assessment Zones. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/053.

APPENDIX 2 – FULL PUBLICATION: DFO. 2020. Science Advice on Limit Reference Points for Northern Shrimp (*Pandalus Borealis*) and Striped Shrimp (*Pandalus Montagui*) in the Eastern and Western Assessment Zones. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/053.

Appendix 1

SCIENCE ADVICE ON LIMIT REFERENCE POINTS FOR NORTHERN SHRIMP (*PANDALUS BOREALIS*) AND STRIPED SHRIMP (*PANDALUS MONTAGUI*) IN THE EASTERN AND WESTERN ASSESSMENT ZONES

Canadian Science Advisory (Science Advisory Report 2020/053)

SUMMARY

- The Precautionary Approach (PA) Framework for the Eastern Assessment Zone (EAZ) was established in 2009 on the basis of 3 years of survey data and the results of the *Precautionary Approach Workshop on Canadian Shrimp and Prawn Stocks and Fisheries* (DFO 2009b). The Western Assessment Zone (WAZ) PA Framework was deferred because of changes to the survey design in 2014 that reset the survey time series. The goals of this meeting were to establish the Limit Reference Point (LRP) and propose Upper Stock Reference Points (USR) for the WAZ and update the existing reference points for the EAZ.
- LRPs for Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*) in both the WAZ and EAZ are newly established as 40%, and the proposed USRs as 80%, of the geometric mean of the spawning stock biomass (SSB) index. These calculations are consistent with guidance in the DFO PA Policy.
- In the WAZ, the newly established LRPs for Northern Shrimp (4,100 t) and Striped Shrimp (12,300 t) are based on a 6-year time series (2014–2019). Similarly, a newly proposed upper stock reference (USR) is provided for each species (8,200 and 24,600 t, respectively).
- In the EAZ, the updated LRP for Northern Shrimp (increase to 15,800 from 6,800 t) and the proposed USR (increase to 31,600 from 18,200 t) are based on an 11-year time series (2009–2019). Re-calculation of the LRP and proposed USR for Striped Shrimp in the EAZ resulted in 3,100 t (increase from 2,300 t) and 6,100 t (no change), respectively.
- The LRPs and proposed USRs are based on the best available scientific information, but do not incorporate environmental or ecosystem factors into their calculations. Information pertaining to these metrics are lacking.
- The PA reference points for the WAZ and EAZ should be re-examined when a population model is developed or relationships between stock productivity and environmental or ecosystem factors are sufficiently developed to inform stock assessments.

Date: February 4, 2021

Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Central and Arctic Region

Canadian Science Advisory Secretariat
Science Advisory Report 2020/053

SCIENCE ADVICE ON LIMIT REFERENCE POINTS FOR NORTHERN SHRIMP (*PANDALUS BOREALIS*) AND STRIPED SHRIMP (*PANDALUS MONTAGUI*) IN THE EASTERN AND WESTERN ASSESSMENT ZONES

*Top: Northern Shrimp (*Pandalus borealis*)*
*Bottom: Striped Shrimp (*Pandalus montagui*)*
Photo: Fisheries Oceans Canada, Newfoundland and Labrador Region.

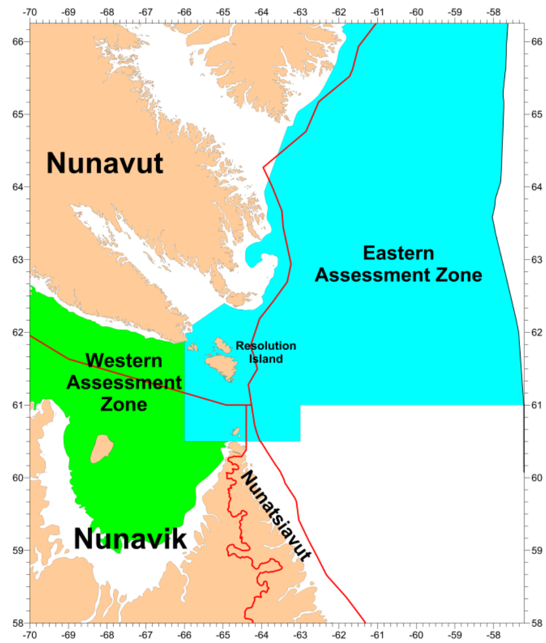


Figure 1. Eastern and Western Assessment Zones for shrimp fisheries in Arctic Region. Boundaries of the Nunavut, Nunavik and Nunatsiavut land claim areas are shown in red.

Context:

Fisheries and Oceans Canada's Fishery Decision-Making Framework Incorporating the Precautionary Approach describes a framework where reference points and harvest decision rules are used to make fisheries management decisions. The limit reference point (LRP) represents the stock status below which serious harm is likely occurring to the stock. The LRP is established based on biological criteria by Fisheries and Oceans Canada (DFO) Science. The Upper Stock Reference (USR) divides the Healthy Zone from the Cautious Zone and is established by DFO Resource Management in consultation with co-management partners, provincial and territorial governments, industry, and DFO Science, to enact harvest decision rules.

*Since the reorganization of the Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*) surveys conducted in the Arctic Region in 2014, the joint DFO-Northern Shrimp Research Foundation survey has covered the Western Assessment Zone (WAZ) and Eastern Assessment Zone (EAZ) survey areas annually with the same ship and gear (DFO 2020a). LRPs for the WAZ were developed in 2013, however, the restart of the time series in 2014 means they are no longer valid (DFO 2018a). Data points acquired since the new survey began will therefore be used to establish new reference points for* *the WAZ. Reference points will also be updated for the EAZ since the original points were calculated from only three surveys (Siferd 2015), which no longer correspond to the assessment area boundaries (DFO 2019a).*

DFO Resource Management has requested that Science establish LRPs consistent with the Precautionary Approach (PA) framework for Northern Shrimp and Striped Shrimp in order to determine the point below which serious harm may be occurring to the stock (i.e., the Critical Zone), and propose an USR. This Science Advisory Report is from the May 12–13, 2020 Meeting on Science Advice on Limit Reference Points for Northern Shrimp, Pandalus borealis, *and Striped Shrimp,* Pandalus montagui*, in the Eastern and Western Assessment Zones. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.*

SUMMARY

- The Precautionary Approach (PA) Framework for the Eastern Assessment Zone (EAZ) was established in 2009 on the basis of 3 years of survey data and the results of the *Precautionary Approach Workshop on Canadian Shrimp and Prawn Stocks and Fisheries* (DFO 2009b). The Western Assessment Zone (WAZ) PA Framework was deferred because of changes to the survey design in 2014 that reset the survey time series. The goals of this meeting were to establish the Limit Reference Point (LRP) and propose an Upper Stock Reference point (USR) for the WAZ and update the existing reference points for the EAZ.
- LRPs for Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*) in both the WAZ and EAZ are newly established as 40%, and the proposed USRs as 80%, of the geometric mean of the spawning stock biomass (SSB) index. These calculations are consistent with guidance in the DFO PA Policy.
- In the WAZ, the newly established LRPs for Northern Shrimp (4,100 t) and Striped Shrimp (12,300 t) are based on a 6-year time series (2014–2019). Similarly, a newly proposed USR is provided for each species (8,200 and 24,600 t, respectively).
- In the EAZ, the updated LRP for Northern Shrimp (increase to 15,800 from 6,800 t) and the proposed USR (increase to 31,600 from 18,200 t) are based on an 11-year time series (2009–2019). Re-calculation of the LRP and proposed USR for Striped Shrimp in the EAZ resulted in 3,100 t (increase from 2,300 t) and 6,100 t (no change), respectively.
- The LRPs and proposed USRs are based on the best available scientific information, but do not incorporate environmental or ecosystem factors into their calculations. Information pertaining to these metrics are lacking.
- The PA reference points for the WAZ and EAZ should be re-examined when a population model is developed or relationships between stock productivity and environmental or ecosystem factors are sufficiently developed to inform stock assessments.

BACKGROUND

Canadian Precautionary Approach Framework and Limit Reference Points

In 2009, Fisheries and Oceans Canada (DFO) published the Sustainable Fisheries Framework that provides the basis for ensuring Canadian fisheries are conducted in a manner which supports conservation and sustainability. The framework is comprised of a number of policies for the conservation and sustainable use of fisheries resources including "A Fishery Decision-Making Framework Incorporating the Precautionary Approach" (DFO 2009a). The Precautionary

Approach (PA) Policy applies where decisions on harvest strategies or harvest rates for a stock are taken to determine Total Allowable Catch (TAC) or other measures to control harvests. This is the case for Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*) stocks.

There are three components to the general decision framework for the PA:

1. Reference points and stock status zones;
2. Harvest strategy and harvest decision rules; and,
3. The need to take into account uncertainty and risk when developing reference points and developing and implementing decision rules.

The first component of the PA framework, reference points and status zones, is the subject of this advisory report. The PA is divided into three stock status zones: the Healthy, Cautious and Critical Zones (Figure 2). The Upper Stock Reference (USR) divides the Healthy Zone from the Cautious Zone and the Limit Reference Point (LRP) divides the Cautious Zone from the Critical Zone.

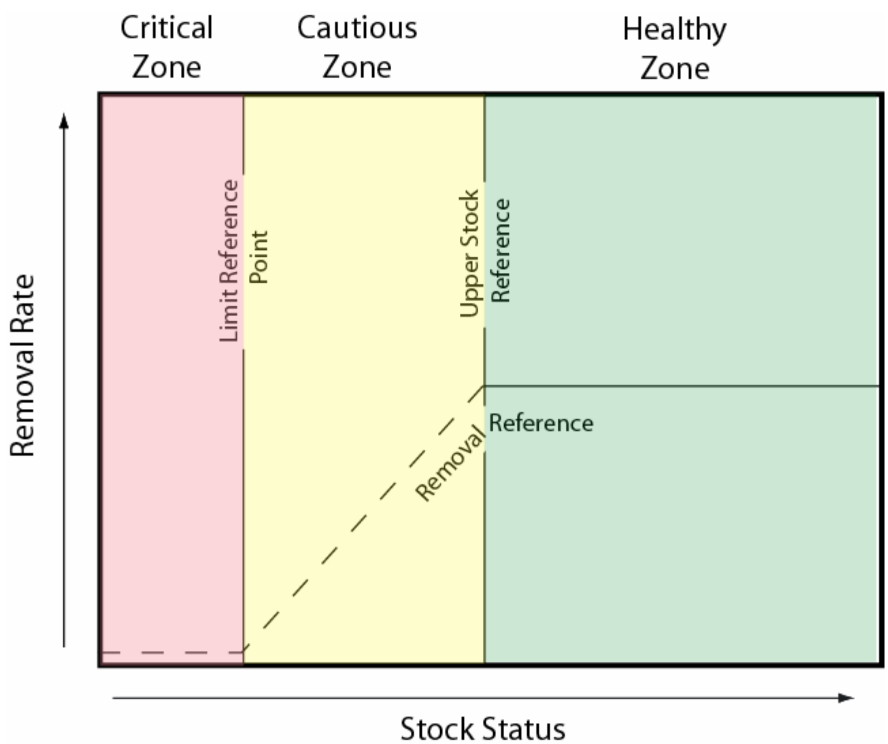


Figure 2. Elements of DFO's PA framework (from DFO 2009a).

The LRP is defined as the stock status *below which serious harm is being done to the stock*. However, a challenge in setting an LRP is identifying the threshold of where and when '*serious harm*' occurs to the stock. This threshold is approximated based on the best available information, below which validation is exactly the situation to be avoided. LRPs are based on biological criteria and are established by DFO Science. In the Critical Zone, conservation/biological considerations are meant to be the primary drivers for management decision-making (as opposed to socio-economic factors) and there is to be no tolerance for preventable declines as the primary goal is to rebuild the stock out of the critical zone. Management actions pertaining to this zone are to promote stock growth and removals are to be kept to the lowest possible level regardless of the stock trajectory.

When establishing an LRP, the guidelines advise choosing a stock metric that can account for changing productivity, generally the spawning stock biomass. An LRP should be determined by accounting for periods of high and low productivity over as long a time-series as possible, and based on the best information available on stock biology and fishery characteristics while acknowledging limitations of the data. However, in some cases there may be insufficient information on which to base choices of stock-specific precautionary reference points and harvest rules. In these instances, DFO has a guideline of 40% LRP and 80% USR. The PA Policy states:

> "In cases where insufficient stock-specific information is available, these reference points may be considered as the best available guidance for management and for assessing the stock in relation to sustainability. Actual reference points for a stock may use other metrics and be set lower or higher than these references but should be demonstrably appropriate for the stock and be consistent with the intent of the PA."

Furthermore, while reference points should be reviewed periodically, neither the timeframe nor the triggers for review are specified in the PA Policy. Given that reference points have not been previously proposed for Northern Shrimp and Striped Shrimp in the Western Assessment Zone (WAZ; Figure 1) and that the current reference points in the Eastern Assessment Zone (EAZ) have been in place since 2009 (DFO 2009b), Resource Management has requested a review of the LRPs, and their rationales, to be carried out for these stocks.

Species Biology

Northern Shrimp is found in the Northwest Atlantic from Baffin Bay to the Gulf of Maine, while Striped Shrimp is found from Davis Strait south to the Bay of Fundy.

Both species of shrimp are protandric hermaphrodites. They function as males early in their lives then change sex and reproduce as females for the remainder of their lives. Females usually produce eggs once a year in the late summer-fall and carry them, attached to their abdomen, through the winter until the spring, when they hatch. Newly hatched shrimp spend three to four months as pelagic larvae. At the end of this period they settle at the bottom and take up the life style of the adults.

Recent research by Le Corre (2019, 2020) on the connectivity of management units via shrimp larval drift found that virtually the entire population of Northern Shrimp along the Canadian Atlantic coast (from Baffin Bay to the Scotian Shelf) is connected through larval drift processes with variable retention success in a given management zone. Also, larval drift was found to promote genetic homogeneity in areas with strong currents (Jorde et al. 2015). These findings improved our understanding of recruitment mechanisms and may in the future help to inform management of Canadian shrimp stocks.

Shrimp lifespan is uncertain but shrimp in the north are thought to live five to eight years. Growth rates and maturation are likely slower in the northern populations.

Fishery

The fishery began in the late 1970s in what is known as shrimp fishing area (SFA) 1. Exploratory fishing expanded into what is now the Davis Strait-East management unit (previously known as SFA 2) and then to areas southeast of Resolution Island in Hudson Strait. Quotas in these areas were based on fishery performance and not scientific survey data. In the mid-1990s, the fishery moved southeast of Resolution Island in SFA 2, where the main fishery remains to date. Implementation of the Nunavut Agreement in 1999 shifted the main fishery east of the Nunavut Settlement Area.

Currently, the fishery in the EAZ and WAZ is managed by a TAC which is divided into individual quotas for 17 offshore licence holders and special allocations for Nunavut and Nunavik fishing interests. Changes to the management of the fishery in what were SFAs 2 and 3 created new SFAs and Management Units beginning with the 2013/14 fishing season (Figure 2). Nunavut Wildlife Management Board (NWMB) and Nunavik Marine Region Wildlife Board (NMRWB) advise on the allocation of quotas to Nunavut and Nunavik fishing interests, respectively. All fishing to date has been conducted by large vessels (> 100' overall length) with 100% At-Sea-Observer coverage.

Fishing gear in the EAZ and WAZ consists of single and, more recently, twin shrimp trawls requiring a minimum codend mesh size of 40 mm and separator grate (maximum 28 mm bar spacing). Since 2003, the management year has been April 1 to March 31. The fishing season is limited by the extent of sea ice, and is conducted between May and December in most years.

Northern Shrimp has been the main commercial species throughout the history of the shrimp fishery in this area. Historically, most of the harvest of Striped Shrimp occurred as by-catch in the directed Northern Shrimp fishery. Directed fishing for Striped Shrimp has become more important especially with quotas available in the Nunavut-West and Nunavik-West management units beginning with the 2013/14 fishing season.

Fishery catch per unit effort (CPUE) data are not considered to reflect stock status. Commercial fishing locations are not broadly distributed; fishing vessels target areas of high density. A mix of two shrimp species are disproportionally caught in the fishery and the composition of the two species in the catch determines which species is designated as directed, which biases CPUE calculations. Throughout the history of the fishery, economic factors (e.g., fuel prices, market price of shrimp) have influenced when and where the species are caught. In the EAZ, commercial vessel performance has changed over the years to target each species to achieve cleaner catches of just one species. Renewed effort in the WAZ is relatively recent. In some years, cleaner catches can be similarly achieved in the WAZ, however that varies in relation to the distribution of the two species.

ASSESSMENT

This is an assessment of LRPs for both Northern Shrimp and Striped Shrimp in the EAZ and WAZ (Figure 1). These two species have overlapping distributions, particularly in the Resolution Island area, resulting in an overlap of their fisheries. The total removal, both directed catch and by-catch, of each species is considered in the assessment.

DFO plans and the Northern Shrimp Research Foundation (NSRF) conducts annual surveys of the EAZ (Resolution Island Study Area; RISA-W, RISA-E and SFA 2EX) and WAZ (SFA 3) survey areas (Figure 3). Both species in the EAZ and WAZ were last assessed in 2019 (DFO 2019a) and updated in 2020 (DFO 2020a). Survey data in the EAZ are available for the period of 2006–2019, however, the first three years are not considered comparable with the rest of the series because of poor trawl performance, incomplete sampling coverage, and inconsistent timing, vessels, and gear (DFO 2018a). Therefore the first three years of data are excluded, and only 2009–2019 data are evaluated for the EAZ.

The WAZ (Figure 1) was surveyed biennially by DFO from 2007–2013. However, results could not be combined with the EAZ survey results because the surveys used different gear and occurred at different times of year. This prevented a comprehensive evaluation of the distributions of shrimp and a more practical look at broader stock assessment over a larger spatial scale. In 2014, the NSRF was commissioned to take over the survey of the WAZ so that it is sampled in conjunction with the EAZ as a means to maintain consistent methods among management units. This action started a new time series for the WAZ. In 2019, the WAZ was surveyed for the sixth year in the new time series. The advice contained herein marks the first occasion that LRPs have been developed in the WAZ.

Fishable and female spawning stock biomass (SSB) indices from scientific surveys form the basis of this assessment. Fishable biomass is based on male and female shrimp from the surveys with a carapace length greater than 17 mm; this represents shrimp that are large enough to be retained in commercial trawls. SSB is based on all female shrimp from the surveys regardless of size. Fishery data are used to determine the observed exploitation rate index, calculated as catch from the reporting records (Canadian Atlantic Quota Report; CAQR) divided by the fishable biomass index from the same year. The potential exploitation rate index is calculated to represent the exploitation rate if the entire TAC is taken. Bootstrapped 95% confidence intervals are included for each of the indices.

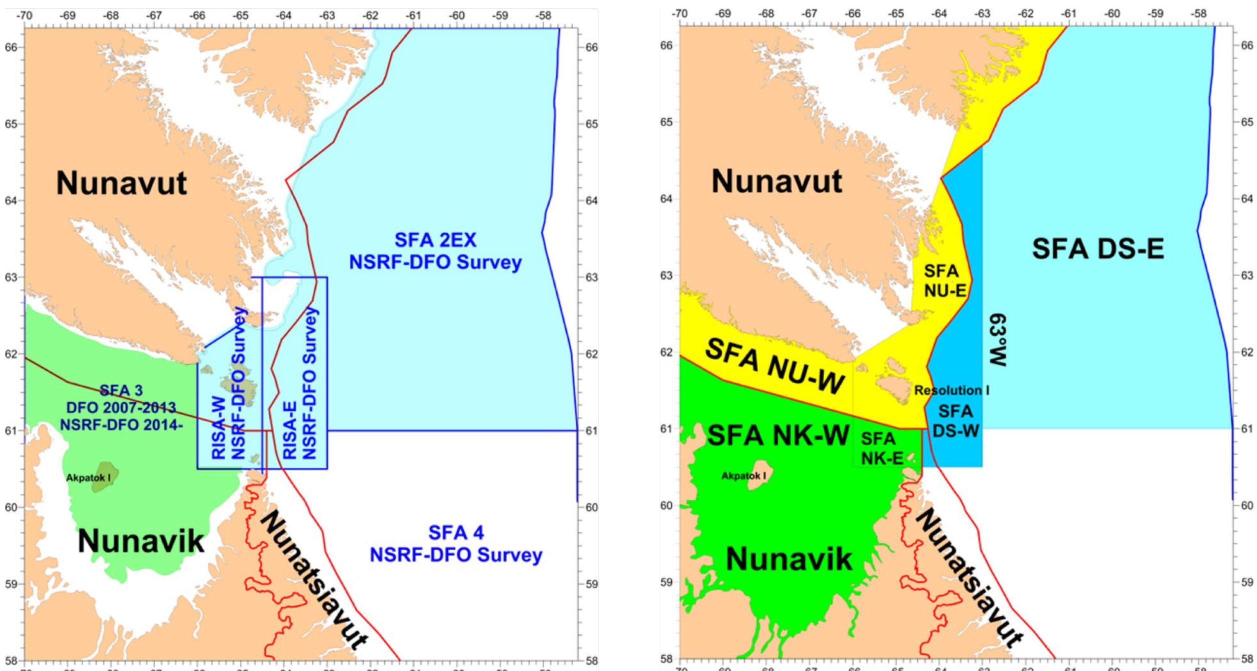


Figure 3. Locations of NSRF survey areas (left panel) within the Eastern (blue) and Western (green) Assessment Zones and the management units (right panel) referred to in this report. Shrimp Fishing Area (SFA), Exploratory (EX), Resolution Island Study Area (RISA), East (E), West (W), Nunavut (NU), Nunavik (NK) and Davis Strait (DS). Red lines show the borders of the Nunavut, Nunatsiavut and Nunavik Land Claims Areas.

For each assessment zone and shrimp fishery an LRP based on 30% and 40% of the SSB index was explored (Walkusz and Atchison 2020). Currently, a 30% LRP is being applied as a reference point by the Northwest Atlantic Fisheries Organization (NAFO) for the Northern Shrimp stock in SFA 1, which is adjacent to the EAZ. This was noted but not considered in-depth during a two-day workshop in 2008 among DFO-Science, DFO-Resource Management, co-management partners and stakeholders in an attempt to establish LRPs in these shrimp fisheries (2009b). Additionally, LRPs and the USRs were adopted at 30% and 80%, respectively, of the geometric mean of female SSB for both Northern and Striped Shrimp in other southern SFAs. The SSB was deemed to be a suitable proxy for B_{MSY}. The contributing factors leading to the use of 30 and 80% were three years of survey data (2006–2008) in Shrimp Fishing Area 2, and that it was consistent with the approach taken by NAFO. LRPs have since gone unchanged in the EAZ (Siferd 2015).

Adopting a 30% LRP as part of the 2020 process would be consistent with NAFO approach and how shrimp fisheries are managed in the Newfoundland and Labrador Region. However, the use of a 30% LRP is unsubstantiated for the WAZ and EAZ based on the best available scientific information for these particular fisheries (Walkusz and Atchison 2020). Furthermore, an LRP of 40% is suggested in the DFO PA Policy (DFO 2009a) for instances of data deficiency and uncertainty. Establishing LRPs based on 40% average SSB for the WAZ and the EAZ was determined to be the best way forward based on the information available and recent decreases in stock productivity in southern SFAs (e.g., SFAs 4–6, DFO 2019b; SFAs 13–15, DFO 2019c). Uncertainty remains with respect to biomass variability as it relates to environmental conditions (e.g., temperature). Patchy shrimp population distributions have led to occasional large catches and fluctuations and increased variance in biomass estimates for each of the assessment zones in different years. Other SFAs have longer data sets and can justify using 30% LRPs, while the WAZ and EAZ have shorter data sets, large fluctuations in biomass indices and a lack of stock trends. Furthermore, Striped Shrimp in the EAZ appear to have recovered from biomass levels equivalent to an SSB level near the 40% LRP; below this point the ability of the stocks to recover is unknown (DFO 2020b). Similarly, it is not known to what extent Northern Shrimp can recover from below their lowest recorded biomass levels (comparatively higher than Striped Shrimp in the EAZ). When the PA framework for the EAZ was initially established using 30% LRPs, the reference points were based on three years of data, the geographic area of SFA 2 and a different survey range. It was recommended that the initial EAZ PA framework be revised as soon as possible (DFO 2020b). One of the potential options would be to move to a dynamic LRP, which follows the pattern of the stock. Since information on shrimp stocks is limited in the WAZ and EAZ, a fixed LRP is recommended. The PA framework may be revised in the future when more data on variables affecting shrimp stocks in the WAZ and EAZ become available.

The recommended reference points follow DFO's PA Policy (2009a) and include new data to update existing LRPs in the EAZ and establish new LRPs in the WAZ. The geometric mean of SSB was used as a proxy for B_{MSY}. Furthermore, this framework suggests a starting point for calculating USRs. Accordingly, the LRPs and proposed USRs were calculated at 40% and 80%, respectively, of the geometric mean of SSB for both Northern and Striped Shrimp (Figures 4 and 5).

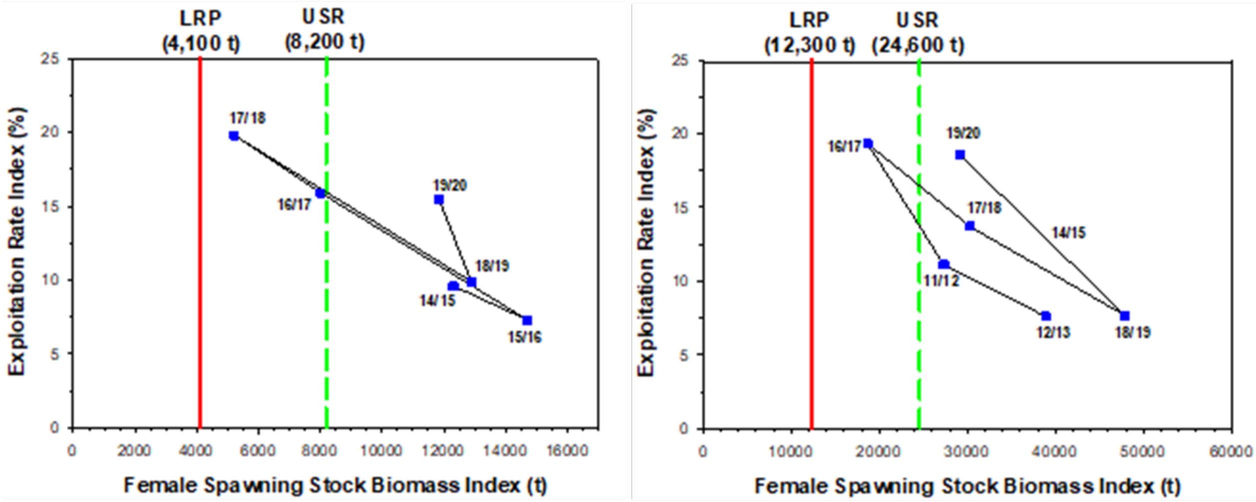


Figure 4. Newly established LRPs for Northern Shrimp (left) and Striped Shrimp (right) in the WAZ. The LRP (red line) is calculated as 40% of the geometric mean of the SSB index and the proposed USR (dashed green line) calculated as 80% of the geometric mean of the SSB index. Blue symbols are annual stock status values, numbers indicate the fishing season.

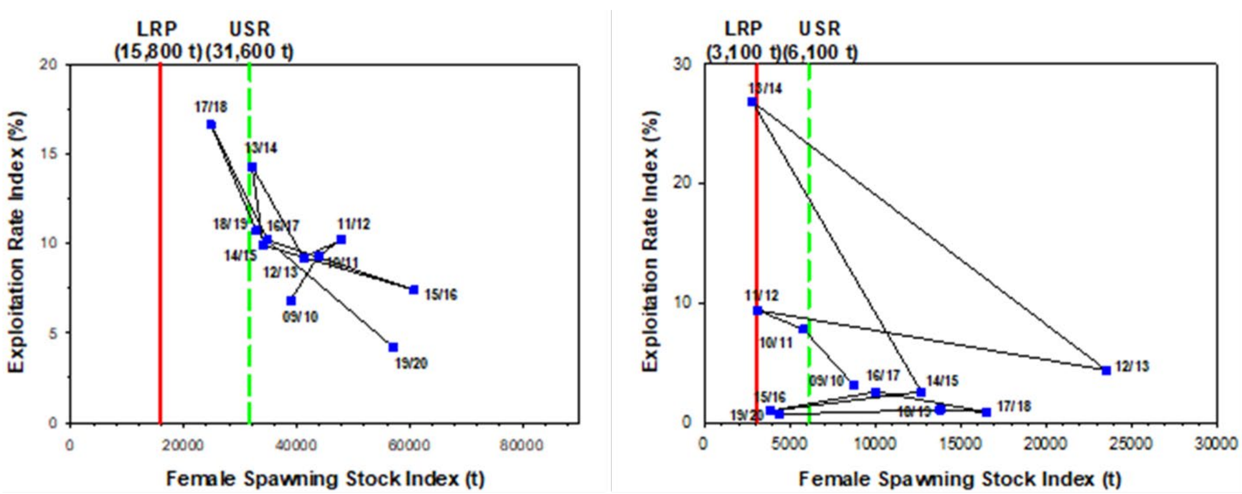


Figure 5. Updated LRPs for Northern Shrimp (left) and Striped Shrimp (right) in the EAZ. The LRP (red line) is calculated as 40% of the geometric mean of the SSB index and the proposed USR (dashed green line) calculated as 80% of the geometric mean of the SSB index. Blue symbols are annual stock status values, numbers indicate the fishing season.

Sources of Uncertainty

The sources of uncertainty that were not quantitatively incorporated into the establishment of LRPs for Northern and Striped Shrimp stocks in the WAZ and EAZ, include:

- Despite having data on temperature preferences of the two shrimp species, the distribution, availability and dynamics of preferred habitats is lacking. Future efforts should focus on moving towards an Ecosystem Approach to Fisheries Management to address knowledge gaps and drivers of stock variability, such as: larval drift related to the connectivity between management zones (stocks), habitat spatiotemporal variability, and ecosystem linkages (e.g., predator-prey interactions, oceanographic drivers). The lack of environmental information contributes to uncertainty.

- Given the short time series and the lack of observed trends, it is not feasible to identify periods of high productivity upon which to base reference points (as suggested in the DFO PA Policy).
- Trawls used in the survey are known to have a catchability less than one but the exact value is unknown. Therefore, the survey is an index of biomass and not an absolute estimate of the total biomass.
- Catch data are known; however, the total fishery-induced mortality is unknown (landed catch plus incidental mortality from trawling). Exploitation rates are a relative index rather than absolute.
- Survey of all stocks is completed in the middle of the fishing season. It is uncertain how much of the TAC has already been taken while the survey is ongoing. Results may be confounded by the timing of the survey and the concurrent level of harvest.
- It is uncertain to what extent these stocks have the capacity to recover from low levels of biomass. High biomass variability exhibited in these stocks can lead to their positioning within the proposed Cautious Zone of this PA framework. A longer time series and a better understanding of the drivers of stock variability may inform recovery potential.
- The stocks' natural mortality, including multi-species linkages, is currently unknown.
- Factors that may cause shrimp productivity to change are poorly understood within the WAZ and EAZ. For example, it is uncertain to what extent larval drift exists between these assessment zones, and to what extent shrimp productivity is impacted by their movements.
- Stocks of both species in both assessment zones exhibit relatively large inter-annual variability in biomass and no trends have been observed. The drivers leading to this variability are poorly understood.
- Northern and Striped Shrimp have populations spanning both assessment zones and their relative distributions are likely to change inter-annually. The stock structure of each species within and between assessment zones is unresolved. For example, it is possible there are multiple populations of the same species within a single assessment zone.
- DFO has recently discovered that a portion of what was previously identified as *P. montagui* from the Gulf and Scotian Shelf (Division 3PS) are in fact *Dichelopandalus leptocerus*. There remains uncertainty about whether this species has recently migrated to this area or may have been misidentified for several years. The same may be true in more northern areas including the WAZ and EAZ.

CONCLUSIONS AND ADVICE

The work described here represents new and updated science advice on reference points for the Northern and Striped Shrimp fisheries in the WAZ and EAZ. The advice is based on a traditional approach of calculating SSB from shrimp trawl surveys, and explores a time series of fishery-independent data. Data used to assess these fisheries are limited and highly variable, and currently no trends in stock status have been observed. Striped Shrimp in the EAZ have demonstrated an ability to recover from 40% of the SSB, the LRP, below which the ability of these stocks to recover is uncertain. Therefore, we recommend a PA consistent with DFO (2009a) that reflects insufficient stock-specific information: 40% LRP and 80% USR, with respect to the geometric mean SSB index. These reference points represent the best available scientific information and constitute advice to management for assessing the stock in relation to sustainability.

In the WAZ, the newly established LRP and the proposed USR for Northern Shrimp and Striped Shrimp are based on a 6-year time series (2014–2019; Table 1). In the EAZ, the updated LRP and the proposed USR for Northern Shrimp and Striped Shrimp are based on an 11-year time series (2009–2019; Table 1).

Table 1. Established Limit Reference Points (LRPs) and proposed Upper Stock Reference points (USRs) for Northern Shrimp and Striped Shrimp in the Western Assessment Zone and Eastern Assessment Zone. Spawning stock biomass is reported in tonnes. Previous reference points are provided in parentheses.

Species	Western Assessment Zone		Eastern Assessment Zone	
	LRP	USR	LRP	USR
Northern Shrimp (*Pandalus borealis*)	4,100	8,200	15,800 (from 6,800)	31,600 (from 18,200)
Striped Shrimp (*Pandalus montagui*)	12,300	24,600	3,100 (from 2,300)	6,100 (no change)

The PA reference points for the WAZ and EAZ should be re-examined when a population model is developed or relationships between stock productivity and environmental or ecosystem factors are sufficiently developed to inform stock assessments.

OTHER CONSIDERATIONS

In general, management of key forage species, such as shrimp, under an ecosystem approach, requires the adoption of a conservative approach with lower fishing mortality reference points and higher biomass reference points than would be considered under a single species management approach.

In cases where insufficient stock-specific information is available, DFO’s PA Policy (2009a) suggests reference points that may be considered as the best available guidance for management and for assessing the stock in relation to sustainability. The 40% LRP and 80% USR provided as guidance are the results of reviews and meta-analyses across a wide variety of fish stocks. However, it is uncertain to what extent this standard can be applied to shrimp fisheries. Here, 40% LRP and 80% USR of the geometric mean SSB index have been used to inform reference points for shrimp fisheries in the WAZ and EAZ without demonstrable validation of stock productivity. Indeed, most larvae released in any management area end up as functioning adults in another management area (in other words, most adults in any management area originated elsewhere; Le Corre et al. 2020). This in and of itself is evidence that the SSB index within an individual management area does not provide a defensible measure of the future health within any individual management area.

The PA reference points in both the WAZ and EAZ are based on the best available scientific information and need to be re-evaluated with new and/or alternative methodologies when data are available to corroborate the advice contained herein. Actual reference points for a stock may use other metrics and be set lower or higher than these references but should be justified for the stock and consistent with the intent of the PA. Ideally, more robust LRPs and associated PA frameworks should be considered by Science and Resource Management when additional data are available.

LIST OF MEETING PARTICIPANTS

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Amber Giles	Nunavut Wildlife Management Board

SOURCES OF INFORMATION

This Science Advisory Report is from the May 12–13, 2020 Meeting on Science Advice on Limit Reference Points for Northern Shrimp, *Pandalus borealis*, and Striped Shrimp, *Pandalus montagui*, in the Western and Eastern Assessment Zones. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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Aussi disponible en français :

*MPO. 2020. Avis scientifique sur les points de référence limites pour la crevette nordique (*Pandalus borealis*) et la crevette ésope (*Pandalus montagui*) dans les zones d'évaluation est et ouest. Secr. can. de consult. sci. du MPO, Avis sci. 2020/053.*

December 3, 2020

To: Derek Mahoney, Chair - Northern Precautionary Approach Working Group (NPAWG)
From: Alastair O'Rielly, Northern Coalition
Brian Burke, Nunavut Fisheries Association
RE: Northern Precautionary Approach Working Group (NPAWG)

Good day Derek,

The Northern Coalition (NC) and Nunavut Fisheries Association (NFA) are writing this letter in response to the November 30th meeting of the Northern Precautionary Approach Working Group (NPAWG) and specifically the CSAS document and advice discussed at this meeting. Combined the NC and NFA represent all commercial fishing interests in Canada's Eastern Arctic, a group of Indigenous-owned companies that hold seven of the 17 offshore shrimp licenses, 100% of the shrimp allocations in the Western Assessment Zone (WAZ) and 65.9% of the shrimp allocations in the Eastern Assessment Zone (EAZ). From an economic perspective, these EAZ and WAZ allocations are extremely important to the viability of our members, especially given the recent reductions in allocations in Shrimp Fishing Areas (SFAs) 4 and 5.

From our joint perspective, any discussion and recommendations of the NPAWG must be cognisant of the respective Land Claims Agreements and the critical role of the Wildlife Management Boards.

The CSAS advice seeks to move the Limit Reference Points (LRP) for all shrimp stocks in the Eastern and Western Assessment Zones from 30% of the mean spawning stock biomass (SSB) to 40% of the SSB, a 1/3 increase in the LRP, predicated on inadequate science information and a presumption that this increase could provide for earlier and more effective response measures to reductions in the SSB.

The correspondence to you from Mr. Bruce Chapman of the Canadian Association of Prawn Producers (CAPP) provides a thoughtful and well articulated critique of the proposed shift in the LRP for stocks in the EAZ and WAZ shrimp areas. We generally concur with the perspective contained in this letter and look forward to receiving further information from the Department on use of 40% LRPs in other relevant shrimp stocks throughout the North Atlantic. From our perspective, the most relevant stocks would be those in the SFA 1 to 7 complex, all of which we understand utilize LRPs set at 30% of the SSB.

The assertion that the risks of stock decline in the North are greater than in southern stocks is implausible. SFA 4, 5 and 6 have all experienced precipitous declines in biomass in recent years. SFA 5 has seen a 43.6% decline over the past two years. We do not understand that there is evidence to suggest that a 40% LRP for these stocks would have produced a more expeditious management response that could have arrested these reductions. It is generally recognized that neither the unprecedented growth in shrimp biomass levels during the 1990s, nor the dramatic declines of recent years are correlated with fishery removal levels.

Survey variability for *Pandalus borealis* and *montagui* in the EAZ and WAZ areas are extreme and may not necessarily reflect interannual biomass variability. Application of a 40% LRP for these stocks, particularly given extreme shifts in biomass indices, holds the potential risk of inducing a series of dramatic oscillations in management responses which are unlikely to mitigate stock declines, would prove very disruptive to fishing operations and potentially undermine the credibility of Canada's resource management regime. Based on the information and materials provided thus far, we see no benefits to an arbitrary shift in the LRP for these stocks.

This approach by the Arctic region to implement restrictions on fishing activity which are inconsistent with DFO's decisions in other regions is reflective of recent decisions and recommendations made on several other issues, most recently the Arctic region's opposition to a 5% increase in the 0A/0B turbot quotas and revisions to the turbot conversion factor to be consistent with changes in the south. Both NC and NFA strongly oppose this inequity in approach for different regions, particularly when dealing with the same stock complexes, which is also contrary to DFO's stated goal of regional consistency.

The CSAS document also recommends a very significant increase in the LRP and USR for the EAZ based on additional years of data. For both the EAZ and WAZ we have some concerns regarding the potential setting of LRPs and USRs at periods of high stock levels, which may not be sustainable in the long-term, thus impacting negatively on future allocation levels, as witnessed in SFA 6.

We also note concern with the composition of the meeting attendees at the May 12-13, 2020 meeting on Science Advice on Limit Reference Points for Northern Shrimp and Striped Shrimp in the Western and Eastern Assessment Zones. Other than the respective Nunavut and Nunavik Management Board representatives, the meeting was dominated by representation from the Arctic region and the only non-DFO attendee was a recent DFO Science employee. Having other academic and industry science and technical participation would be appropriate.

Moving the LRP to 40% was presented as a 'fait accompli' further to the outcome of the May 2020 Canadian Science Advisory Secretariat meeting. We note that the Research Document 2020/072 dated November 2020 states on page iv that "The intent of this document is to serve as a source of supporting information to provide advice to DFO Resource Management, consistent with the Department's PA Framework in support of the sustainable management of these fisheries." Your presentation at the Working Group meeting indicated that the CSAS process is not an advisory function with respect to the setting of Limit Reference Points but has de facto decision-making authority within DFO's PA Framework.

Finally, we are very appreciative of the work of DFO Science and the challenges in monitoring and analyzing an extremely dynamic marine environment with a dearth of critical biological and environmental data. However, the recommended move to increase the LRP for EAZ and WAZ Shrimp does not appear to be based "on biological criteria', nor can it be demonstrably linked to "stock status below which serious harm is likely occurring to the stock."

As discussed, we request that the next meeting of the NPAWG include the full group and a fulsome discussion on these issues.

Sincerely,

Alastair O'Rielly
Executive Director, Northern Coalition

Brian Burke
Executive Director, Nunavut Fisheries Association

cc: Arran McPherson – Assistant Deputy Minister, Ecosystems and Oceans Science
Sylvie Lapointe – Assistant Deputy Minister, Fisheries and Harbour Management
David Whorley – Chair, Northern Shrimp Advisory Committee (NSAC)
Adam Burns – Director General, Fisheries Management
Courtney D'Aoust – Fisheries and Aquaculture Management Officer, DFO
Daniel Shewchuk, Chair – Nunavut Wildlife Management Board (NWMB)
Robert Moshenko, A/Chair - Nunavik Marine Region Wildlife Board (NMRWB)
Jason Akearok, Executive Director, NWMB
Janelle Kennedy, Executive Director, NMRWB
Bruce Chapman – Canadian Association of Prawn Producers (CAPP)

Good afternoon:

Before our NPAWG session tomorrow, I thought that it would be useful to recap our discussions and to provide an assessment of where we are in our work with respect to key elements in development of a Precautionary Approach (PA) Framework. In addition, I can report on discussions I have had internally with my DFO colleagues and management. My hope is that this update will help to focus our discussions tomorrow and give indication of what we might be able to accomplish in our remaining time before reporting to NSAC, and providing information to the Nunavut Wildlife Management Board and the Nunavik Marine Region Wildlife Board (the Boards).

As chair of this working group, I would first thank each of you for your participation in the group and for your flexibility in making yourself available, particularly as times have shifted for a number of our meetings. I have tried to guide discussions in a way that promoted open dialogue, with my ultimate goal being a consensus recommendation to NSAC. I believe that would be the best outcome for all involved. However, while consensus is a worthwhile goal, working groups like NPAWG are not a decision-making bodies. At the conclusion of our work, the Minister, in keeping with co-management processes with the Boards, will take decisions on the PA Framework for shrimp fisheries in the Eastern Assessment Zone (EAZ) and the Western Assessment Zone(WAZ). These decisions will, therefore, be informed by either consensus recommendations or the various views of our group.

Limit Reference Points (LRP)
As discussed in detail in our early sessions, the LRP for shrimp stocks in the EAZ and WAZ are established by DFO Science through peer-review, in accordance with DFO's PA policy. While our work as NPAWG is limited to non-LRP elements of the PA, I took from our discussions and from written submissions from working groups members that there are general concerns related to the uncertainties associated with EAZ and WAZ shrimp stocks. These concerns were partly reflected in members' calls for a review, in the near term, of these LRPs. I will address the idea of such a review later in this note.

Upper Stock Reference (USR)
The bulk of our discussions to this point have centered around USRs and the variability of stock status for shrimp in these areas. The data points that collectively produce this variability represent our best available science and, therefore, our clearest expression of stock status. However, given influences beyond fishing mortality and the lack of trends that can be derived from relatively limited time series, some NPAWG members felt that measures should be taken to mitigate the effects of this variability. These measures included the suggestion of a USR established at 70% of the geometric mean of SSB, where averaging of multiple (2 or 3 year) stock status data points would be used to determine stock status relative to established

reference points. DFO Science has been clear that stock status needs to be represented as a single data point rather than an average. In reaction to this position, some working group members then proposed that a USR not be developed and instead the NPAWG focus on a target reference point (TRP) to satisfy Marine Stewardship Council (MSC) certification conditions. These measures would effectively reduce, or eliminate, the potential for stocks to enter a defined cautious zone, which industry members have stated is significantly harmful to product marketability.

From DFO's perspective, stock status is exclusively within our Science sector's area of responsibility and a single-year value is the clearest expression of that status for a given point in time. Additionally, USRs are an integral part of DFO's PA policy, primarily serving as a point sufficiently above the LRP "to provide an opportunity for the management system to recognize a declining stock status and sufficient time for management actions to have effect". In keeping with DFO's PA policy, the USR is critical is defining the boundary between the Healthy and Cautious zones and DFO continues to report in this context through the annual Sustainability Survey for Fisheries.

It is true that DFO does manage some fisheries for which USRs are not in place, including in the WAZ. However, it is a policy priority for the Department to establish complete PA Frameworks for Canada's fisheries that include a USR. The establishment of a TRP without an accompanying (or dual purpose) USR would represent a departure from this priority. This would be particularly pertinent in the EAZ where a USR has been in place for a number of years.

For these reasons, I believe a recommendation from NPAWG to move forward without USRs is unlikely to be accepted by the Minister. The development, however, of a distinct TRP in addition to a USR could be a productive effort for this group in my view.

Harvest Control Rules (HCRs)

Secondary to reference points has been NPAWG's consideration of HCRs for shrimp fisheries in the EAZ and WAZ. I note that HCRs are not an outstanding MSC condition for these fisheries. In my experience, the development of HCRs is best to follow the establishment of reference points, so that the potential impacts of their application can be assessed relative to defined biomass values. It is my feeling that we are unlikely to revisit the HCRs for EAZ and/or contemplate the development of HCRs for the WAZ in our time remaining before the March 9, 2021, meeting of NSAC.

Review Provision

Given the limited time series and uncertainty surrounding the stocks in the EAZ and WAZ, many group members stated a strong preference for the PA to be reviewed in the near-term (i.e., 2-5 years). Members suggested the benefit of doing so with the aid of additional survey and, preferably, incremental science work that could provide some information related to environmental and ecological influences on these stocks.

From discussions I have had and from my own perspective, an expiry date on a PA Framework is unlikely to be supported by DFO decision-makers. Further, there could be implications for MSC certification in the event a PA Framework (including reference points) is not in place. A review after a certain time period may be a better way to proceed rather than a predefined expiry. In the very short-term, I do not believe the knowledge of these stocks is likely to sufficiently increase to the extent that we could expect any difference in the outcome of a similar process to what we are now undertaking. For this reason, I would suggest that NPAWG recommend a review of reference points (and any additional components of a PA Framework) in 4 or 5 years (i.e., in 2025 or 2026).

NPAWG may wish to consider the usefulness of establishing a committee to undertake this review and ultimately consider the merit of modifying the PA framework. Such a group would likely best be composed of DFO and non-DFO members. Associated with the notion of available data, NPAWG may also wish to emphasize the need for additional science to improve environmental knowledge as part of its report to NSAC and the Boards.

Path Forward

As I see it, tomorrow's (February 5) meeting will be important in determining if there is basis to continue the NPAWG process of developing elements of a PA framework for these stocks. If that proves the case, I believe we could plan 1-2 additional sessions before turning our focus to the development of a report.

Once again, thanks for your participation in NPAWG sessions. I look forward to our coming discussions.

Regards,

Derek Mahoney

From:	Brian Burke
To:	Jason Akearok
Cc:	Amber Giles; Denis Ndeloh
Subject:	FW: NPAWG update Feb 4 / GTAPN mise a jour 4 fév
Date:	Friday, February 5, 2021 10:43:31 AM
Attachments:	DMahoney_Letter_to_NPAWG_Feb_4_2021_English.DOCX

Good morning,

Due to the late sending of this note and its content, which dismisses any suggestions made by stakeholders in favour of a dictated DFO approach to PA in the WAZ and EAZ, NFA has boycotted today's NPAWG meeting.

It is my understanding that DFO intends to make a submission on the NPAWG to the NWMB for its March meeting. From a NFA perspective, this late date does not provide adequate time for us to prepare and submit a detailed paper on our views regarding the PA approach in the WAZ and EAZ. However, if DFO does make a submission for decision at the upcoming meeting which is based on the approach outlined in this note from the NPAWG Chair, this is an approach which does not have the support of NFA or any other industry participants in the WAZ and EAZ shrimp fisheries. As such, we would ask for the opportunity to provide input at the March meeting and request a call for written submissions take place for the following meeting.

As per our prior NFA and industry correspondence on this critical issue, we entered into the "working group" process in good faith with the belief that, as a working group, reasonable approaches that do not impact on the stock status but do take into account the potential socio-economic impacts on industry would be fully considered, leading to a negotiated consensus agreement on the way forward. Unfortunately, this does not appear to be the case and rather than being coopted by our participation in the "working group" being seen as acceptance, we have taken the decision to, for the present time at least, remove ourselves from this flawed process.

As with other issues impacting the Nunavut fishery, it is our view that the NWMB has a very strong decision and recommendation making role and mandate, and we look forward to the NWMB exercising this authority for the benefit of Nunavut and Nunavummiut.

Regards,

Brian Burke
Executive Director
Nunavut Fisheries Association (NFA)
Tel: (709) 351-7263

From: D'Aoust, Courtney <Courtney.D'aoust@dfo-mpo.gc.ca>
Sent: February 4, 2021 5:17 PM
To: D'Aoust, Courtney <Courtney.D'aoust@dfo-mpo.gc.ca>

Subject: NPAWG update Feb 4 / GTAPN mise a jour 4 fév

Sent on behalf of Derek Mahoney, Chair, Northern Precautionary Approach Working Group (NPAWG)

Good afternoon, please find attached a **note from the Chair** in regards to tomorrow's discussion. A copy is also available in the NPAWG Dropbox.

Session Title	Objectives	Sub-group(s) to attend	Date & Time
USR 3: EAZ & WAZ stocks	Discuss reference points (Borealis + Montagui)	WAZ & EAZ	**Friday February 5** 9 AM – 11 AM EST (2 hours) Join Zoom Meeting https://zoom.us/j/93998895525?pwd=clpnYWVRQkZkUzdvYTVrTFFMTDcvZz09 Meeting ID: 939 9889 5525 Passcode: 761300 1-855-703-8985 Canada Toll-free **interpretation not available*

Thank you.

****

Envoyé de la part de Derek Mahoney, Président, Groupe de travail sur l'approche de précaution du Nord (GTAPN)

Bonjour, veuillez trouver ci-joint une **note du président** concernant la discussion de demain. Une copie est également disponible au Dropbox GTAPN.

Titre de la session	Objectifs	Sous-groupe(s) à assister	Date et heure
PRS 3: stocks ZEE & ZEO	Discuter les points de références (Borealis + Montagui)	ZEO & ZEE	**Vendredi le 5 février** 09h00 – 11h00 heure de l'est (2 heures) Rejoindre la réunion Zoom https://zoom.us/j/93998895525?pwd=clpnYWVRQkZkUzdvYTVrTFFMTDcvZz09 ID de la réunion: 939 9889 5525 Passcode: 761300 1-855-703-8985 Canada gratuit **interprétation non disponible*

Merci.

Courtney D’Aoust
Fisheries and Aquaculture Management Officer |
Agent, Gestion des pêches et de l’aquaculture
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SUBMISSION TO THE

NUNAVUT WILDLIFE MANAGEMENT BOARD

FOR DECISION AND RECOMMENDATION

Issue: Access Fees Charged to the Nunavut Fishing Industry by DFO for Shrimp in the WAZ and EAZ

Authority

Given that access fees are a key component of commercial fisheries management, the NFA believes the NWMB is the appropriate governing body to address this issue. Under Section 5.2.34 (d) of the Nunavut Land Claims Agreement, the NWMB has the authority to approve plans for *"(i) management, classification, protection, restocking or propagation, cultivation or husbandry of particular wildlife…"* Under Section 5.3.8, which governs section 5.2.34, "*when the NWMB makes a decision, it shall forward that decision to the Minister."*

Background

Access fees are standard practice in most non-Indigenous fisheries where fishing areas are not governed by Indigenous Land Claims Acts, Agreements, or Treaties. When fees are properly implemented and evenly applied, NFA members have no problem paying these fees on their allocations. However, in the WAZ and EAZ shrimp fisheries there are two distinct issues on access fees which our members are facing which need to be addressed in terms of equity and fairness. At present, the access fees unilaterally charged to industry by DFO on shrimp (both P. borealis and P. montagui) are $67.96/tonne. For montagui access fees in the WAZ Land Claims area, DFO simply applied the borealis fees that were being used in non-Land Claims areas. This appears to have been done without proper process, in both Nunavut and Nunavik.

WAZ Access Fees

- The Western Assessment Zone (WAZ) is situated fully within the Settlement Areas of Nunavut and Nunavik, where the Wildlife Management Boards have jurisdiction. Since the montagui and borealis fishery was established in this area, based on survey research which has been fully funded by industry and other stakeholders in Nunavut and Nunavik, DFO has been invoicing NFA members for access fees on both species at an equivalent rate. In total, the current access fees charged to the Nunavut industry for borealis and montagui in the WAZ are $514,389 per annum.

- NFA has been made aware that the Nunavik industry has not paid access fees in the WAZ since the start of this fishery. It is understood that the Nunavik industry takes the view that this region is under Nunavik Marine Region Wildlife Board (NMRWB) management and therefore they should not have to pay access fees.

- In contrast, NFA members have paid the majority of their access fees in the WAZ, with one member interrupting payment after learning of the situation in Nunavik. Millions in access fees have been paid by Nunavut industry

- NFA also understands that for First Nations in southern jurisdictions no access fees are paid on their communal fishery allocations.

- The annual stock survey in the WAZ is completed by the Northern Shrimp Research Foundation (NSRF), an industry organization, and fully paid for by stakeholders in Nunavut and Nunavik, consisting of industry and the Government of Nunavut (GN). As summarized in Appendix 1, since the initiation of this survey in 2014, NFA has paid almost $1.3 Million towards the survey costs, for 55.1% of the total costs. In total, Nunavut stakeholders have covered 76.3% of the $2.35 Million in contributions made to NSRF since 2014 to cover the survey costs. DFO has not provided any financial contribution towards the costs of undertaking this critical annual survey.

- NFA is seeking a decision from the Board on whether DFO has the right to charge access fees in an area which is subject to decision making by the NWMB without the Board's prior consent and approval.

- In addition, although montagui has been obtaining a much lower price than borealis in the market on a consistent basis, as detailed in Appendix 2, DFO has been charging the same access fees per tonne for both species. This is especially significant this year as the montagui prices have dropped significantly, such that these access fees now account for a significant portion of returns, making the fishery break-even at best. With one member in this fishery not paying any fees they have a competitive advantage in the market for montagui as compared to the Nunavut industry.

- Members of the NFA are asking NWMB make a decision to implement a moratorium on access fees within the Nunavut Land Claims Area, for equity and consistency with Nunavik. .

- In particular, NFA is requesting the NWMB consider, as part of its decision-making review: the overpriced fee structure for montagui as compared to much higher-valued borealis; the competitive disadvantage faced by Nunavut Inuit Companies compared to Nunavik Companies, and the significant contribution made by Nunavut fishing companies towards research costs, in the context of fee revenue being intended for research.

<u>EAZ Access Fees</u>

- The Eastern Assessment Zone (EAZ) is located primarily outside of the NSA (other than NU/NK E). In this area the Wildlife Boards do have a role to play in making recommendations to the Minister

- This Shrimp Fishing Area (SFA) is comprised of three sub-areas (the only SFA like this), i.e. Davis Strait West (DSW), Nunavut/Nunavik East (NU/NK E), and Davis Strait East (DSE). Both DSW and NU/NK E are

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considered commercial fishing areas while DSE is considered exploratory. DSE is very much a hit or miss fishery with limited harvests on an annual basis, somewhat similar to SFA 1.

- DFO is requiring NFA members to pay 50% of their access fees for DSE up front, regardless of whether they plan to fish in this area. With NFA members holding substantial allocations in DSE, this is a significant financial burden for access to an area that in most cases will not be fished. The total up front payment required for Nunavut's share of the DSE quota would be close to $55,000.

- For the offshore commercial shrimp sector, the longstanding practice has been for areas that are considered exploratory or questionable in terms of fishing success that participants could pay access fees in 50 tonne increments, as required, if they desired to try fishing in these areas. This has worked well and minimized the burden on industry.

- DFO has indicated that the 50% up front is written policy and that it is now being implemented for Nunavut industry, even though it was not in the past.

- NFA is requesting that the NWMB make a recommendation to the Minister on access fees in DSE (or any other exploratory area) where payment can be made in 50 t increments, as per past practice and to recognize the exploratory nature of these areas.

<u>Stakeholder Consultation</u>

NFA has reached out to its primary stakeholders to obtain their views and input on these issues. As outlined in Appendix 3, this has included several email exchanges with representatives of stakeholders in Nunavut, including the Government of Nunavut (GN), Nunavut Tunngavik Inc. (NTI), and the Qikiqtani Inuit Association (QIA). A conference call for these stakeholders was held on January 26th and attended by representatives from the GN, QIA and the NWMB.

DFO has also been contacted to provide their input and to provide notice of NFA's plans to make a submission to the NWMB on the access fees issues. Note that NFA was directed by DFO to approach the NWMB on these issues, given the Board's decision and recommendation making roles in the WAZ and EAZ respectively.

<u>Summary of Request</u>

NFA is requesting from the Board the following decisions/recommendations:

1) For the WAZ:
    a. A decision by the NWMB to place a moratorium on access fees within the Nunavut Land Claims Area;
    b. In its review and decision-making process, consideration of equity of the Nunavut industry: overpriced fees based on the market price differential between borealis and montagui shrimp; competitive disadvantage faced by Nunavut as compared to the Nunavik industry, and; research

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survey costs for the WAZ are primarily paid directly by Nunavut fishing enterprises and stakeholders, with no financial support from DFO.

2) For the EAZ, a recommendation on the following:
   a. That access fees in DSE, as an exploratory area, be payable up front in 50 tonne increments as utilized by allocation holders.

Prepared by: Brian Burke, Executive Director, Nunavut Fisheries Association

Date: February 5, 2021

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Appendix 1: Table of Contributions Toward Annual WAZ Shrimp Survey – 2014-2020

WAZ Survey Contributions		
2020		
NFA	$163,500	50.0%
Makivik	$163,500	50.0%
Total	$327,000	100.0%
2019		
NFA	$179,944	56.9%
Makivik	$136,247	43.1%
Total	$316,190	100.0%
2018		
NFA	$217,994	68.9%
GN	$43,579	13.8%
Makivik	$54,599	17.3%
Total	$316,172	100.0%
2017		
NFA	$207,587	69.0%
GN	$41,516	13.8%
Makivik	$51,897	17.2%
Total	$301,000	100.0%
2016		
NFA	$175,000	60.3%
GN	$40,000	13.8%
BF	$25,000	8.6%
Makivik	$50,000	17.2%
Total	$290,000	100.0%
2015		
NFA	$175,000	42.7%
GN	$160,000	39.0%
BF	$25,000	6.1%
Makivik	$50,000	12.2%
Total	$410,000	100.0%
2014		
NFA	$175,000	45.1%
GN	$138,000	35.6%
BF	$25,000	6.4%
Makivik	$50,000	12.9%
Total	$388,000	100.0%
2014 to 2020		
NFA	$1,294,025	55.1%
GN	$423,095	18.0%
BF	$75,000	3.2%
Makivik	$556,243	23.7%
Total	$2,348,362	100.0%

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Appendix 2: Market Price Differentials – P. borealis vs P. montagui

Price Differentials Between *P. borealis* and *P. montagui* Shrimp

The following paragraphs outline details on actual market price differentials between *P. borealis* and *P. montagui* shrimp obtained by Nunavut companies. For confidentiality purposes, the data has been summarized.

P. montagui as a targeted fishery is a relatively new species and when the volumes of the species were low the price differentials were minimal. However, with the rapid expansion in volumes in recent years, largely from the WAZ fishery, this situation has changed and price differentials with borealis have expanded and overall market prices have declined. In the early years, as industry was learning how to handle and process this species, there were quality issues (black spot) which impacted on prices and demand. Although these issues have been largely addressed, as demonstrated below the price differentials continue to expand. As such, the Nunavut industry is seeking to undertake a targeted marketing and branding program for montagui to address this situation in the coming years, with support from external sources.

Excerpt from Marketing Proposal Submitted by NFA to CanNor:

<u>Background</u>
The Canadian shrimp industry harvests two commercial species, *P. borealis* and *P. montagui*. The *P. borealis* is considered the main commercial species, with the largest quotas and is also considered by industry to be preferable in terms of quality and value. *P. montagui*, in contrast, is located in northern Shrimp Fishing Areas (SFAs) and until recently has not been a focus for industry. As such, minimum effort has been expended in general to evaluate and develop market opportunities for this species and industry has been accepting prices which are significantly discounted from their *P. borealis* sale values. Allocations of *P. montagui* shrimp are primarily held by northern indigenous businesses in Nunavut and Nunavik. These northern interests hold 100% of directed *P. montagui* allocations and 79% of total allocations (the remaining as bycatch allocations in the *P. borealis* fishery). In 2019, the quotas for *P. montagui* increased significantly in the Western Assessment Zone (WAZ), with a 95% increase almost doubling the allocations available to Nunavut and Nunavik industry players for directed fishing. The current breakdown of *P. montagui* shrimp allocations by quota holder is outlined in the following table.

2019 P. montagui Allocations					
	WAZ	EAZ	SFA 4	Total	%
Nunavut	5,987.5	337.2	355.9	6,680.6	40%
Nunavik	5,987.5	165.2	355.9	6,508.6	39%
Remaining Offshore (bycatch)	0.0	337.6	3,321.2	3,658.8	22%
Totals	11,975.0	840.0	4,033.0	16,848.0	100%
Note: NU and NK allocations for EAZ and SFA 4 include their respective shares of offshore bycatch in these areas. NU and NK hold 100% of directed P. montagui allocations.					

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Tel: (867) 979-7862 | Fax: (867) 979-7852

Price Differentials

The price differentials between borealis and montagui shrimp sales can be quite significant and can be even higher when coldwater shrimp is under negative pressure in terms of demand and overall price levels. Coldwater shrimp prices were under downward pressure in 2019 for all players in the sector, placing further pressure on *P. montagui* demand and pricing. At present, given the overall downward price pressure on coldwater shrimp, which is being further exacerbated by the COVID-19 crisis, and the significant discounts on *P. montagui*, the viability of harvesting this species by the Nunavut industry is questionable.

A review of pricing data provided confidentially by Nunavut industry participants for the past three years illustrates the significant price differentials and how the relative differentials have increased, especially for smaller industrial shrimp. For cooked borealis and montagui the price differentials ((borealis-montagui)/montagui) have ranged for similar pack sizes from 7-24% in 2017, to 20-50% in 2018, and 26-50% in 2019. For industrial shrimp the differentials have varied from 63-73% in 2018 to 112-125% in 2019. Although some of the price differentials may be attributable to some intrinsic differences in the species, any such differences do not account for the wide disparity experienced by industry.

Update to Include 2020 Prices:

For 2020 harvested shrimp, the price differential between borealis and montagui on cooked shrimp has ranged from 23% early in the season to 76% later in the season as markets tightened, while for industrial the price differential has been around 128%.

In addition to the differential in prices between the species which has expanded in recent years, the overall market prices for both species have been declining in recent years. For montagui, prices have declined by over 185% over three years and around 75% since last year.

(Detailed price sheets can be provided to NWMB on a confidential basis)

Nunavut Fisheries Association
Box 1349, Iqaluit, NU X0A 0H0
Tel: (867) 979-7862 | Fax: (867) 979-7852

Appendix 3: Correspondence with Stakeholders on Access Fees Issues

Correspondence with Nunavut stakeholders (GN, NTI, QIA), initiated on October 19, 2020 (5 emails)

Correspondence with DFO (2 emails)

From:	Brian Burke
To:	"Martin, Zoya"; Andrew Bresnahan; Andrew Randall; Jeffrey Maurice
Subject:	EAZ/WAZ Shrimp Access Fees Submission for the Next NWMB Board Meeting
Date:	October 19, 2020 3:33:00 PM

Good afternoon,

NFA's members who are participating in the EAZ and WAZ shrimp fisheries have been experiencing issues with DFO access fees in these fisheries which, once again, demonstrate the inequitable and less than fair treatment we are experiencing from DFO Arctic. As a result, as outlined below, NFA is planning to bring forward a submission to the NWMB Board for consideration at their upcoming December Board meeting. NFA is requesting support from our stakeholders on this issue, either through participating in a joint submission with NFA or through making individual representation to the NWMB in support of our submission. The final date for submission to the NWMB in advance of the next Board meeting is November 6th, as such time is of the essence.

DFO access fees are a normal cost of business for the Canadian commercial fishing industry and, where warranted and evenly applied, NFA members have no problem paying these fees on their allocations. However, in the WAZ and EAZ shrimp fisheries there are two distinct issues on access fees which our members are facing which need to be addressed in the spirit of equity and fairness. Each of these are outlined below:

- WAZ Access Fees:
    - As you are all aware the Western Assessment Zone (WAZ) is situated fully within the Settlement Areas of Nunavut and Nunavik. Since the montagui and borealis fishery was established in this area, based on survey research which has been fully funded by industry and other stakeholders in Nunavut and Nunavik, DFO has been invoicing NFA members for access fees on both species at an equivalent rate.
    - NFA has found out that Makivik has not paid access fees since the start of this fishery, refusing to do so based on decisions in this area being up to the Wildlife Boards and not DFO and we have heard that they also have a legal opinion in support of their position. In contrast, one of the NFA members has paid their access fees every year and another stopped paying for a couple of years after learning of the Makivik situation but had to pay again this year or DFO would refuse to transfer their license to another vessel for fishing in this area. Upwards of $1M has been paid in access fees by Nunavut industry while Nunavik industry has paid none.
    - NFA also understands that in the south First Nations pay no access fees on their communal fishery allocations.
    - NFA now questions whether DFO has the right to charge access fees in an area which is subject to decision making by the Boards without their prior consent and approval. Are land claims rights being ignored by DFO?
    - In addition, although montagui has been obtaining a much lower price than borealis in the market, DFO has been charging the same access fees per tonne for both species. This is especially significant this year as the montagui prices have dropped significantly, such that these access fees now account for a significant portion of returns, making the fishery break-even at best. With Makivik not paying any fees they have a competitive advantage in the market for montagui.

  - NFA members have discussed this with DFO management and have been told that this should be brought to the Wildlife Boards.
  - NFA is proposing to make a submission to the NWMB requesting a decision of the Board on whether Nunavut industry members should be paying access fees, to whom, and at what level.
- EAZ Access Fees:
  - Although the Eastern Assessment Zone (EAZ) is outside of the NSA (other than NU/NK E), the Wildlife Boards do have a role to play in making recommendations to the Minister in this area.
  - This Shrimp Fishing Area (SFA) is comprised of three sub-areas (the only SFA like this), i.e. Davis Strait West (DSW), Nunavut/Nunavik East (NU/NK E), and Davis Strait East (DSE). Both DSW and NU/NK E are considered commercial fishing areas while DSE is considered exploratory. DSE is very much a hit or miss fishery with limited harvests on an annual basis, somewhat similar to SFA 1.
  - For the first time, DFO Arctic is now requiring NFA members to pay 50% of their access fees for DSE up front, regardless of whether they plan to fish in this area. In addition, one member has asked if these fees for the DSE subarea can be transferred to one of the other subareas in the EAZ if not used and has been told no. With NFA members holding substantial allocations in DSE this is a significant financial burden for access to an area that in most cases will not be fished.
  - For the offshore commercial shrimp sector, the practice has been for areas that are considered exploratory or questionable in terms of fishing success that participants could pay access fees in 50 tonne increments as required if they desired to try fishing in these areas. This has worked well and minimized the burden on industry.
  - DFO Arctic has indicated that the 50% up front is written policy and that it is now being implemented for Nunavut industry, even though it was not in the past.
  - NFA is proposing to also request that the NWMB make a recommendation to the Minister on access fees in DSE (or any other exploratory area) where payment can be made in 50 t increments, as per past practice and to recognize the hit and miss nature of these areas.

As mentioned above, NFA would appreciate your support on these access fees issues (recommended by NWMB that we reach out to stakeholders to get their input/support). If you wish we can hold a call to discuss further. Please let me know if you are willing/able to participate in a joint submission or to write the NWMB outlining your support in advance of the deadline for their next meeting.

Regards,

Brian Burke
Executive Director
Nunavut Fisheries Association (NFA)
Tel: (709) 351-7263

From:	Brian Burke
To:	"Martin, Zoya"; "Andrew Bresnahan"; "Andrew Randall"; "Jeffrey Maurice"
Subject:	RE: EAZ/WAZ Shrimp Access Fees Submission for the Next NWMB Board Meeting
Date:	November 3, 2020 8:54:00 AM
Attachments:	NFA Submission to NWMB on Shrimp Access Fees - NFA Nov 6 2020 Final.docx

Good morning,

Attached is the submission NFA has prepared for the NWMB on the access fees issue. Please review and provide any comments and suggestions today if at all possible, as I have to get the document translated and submitted by this Friday. As per the prior emails, NFA would appreciate your support on this important issue. NFA members have paid DFO millions of dollars for access fees since the WAZ fishery started while Makivik has paid none, hardly a fair situation, especially when the margins on montagui are so tight (or possibly non-existent this year).

Regards,

Brian

From: Brian Burke
Sent: October 27, 2020 2:14 PM
To: 'Martin, Zoya' <Zoya.Martin@dfo-mpo.gc.ca>; Andrew Bresnahan <ABresnahan@QIA.ca>; Andrew Randall <ARandall@QIA.ca>; Jeffrey Maurice <JMaurice@tunngavik.com>
Subject: RE: EAZ/WAZ Shrimp Access Fees Submission for the Next NWMB Board Meeting

Good afternoon,

Following up on my prior email below. Any comments/suggestions for moving forward. I have to prepare our NWMB submission over the next few days.

Regards,

Brian

From: Brian Burke
Sent: October 19, 2020 3:33 PM
To: 'Martin, Zoya' <Zoya.Martin@dfo-mpo.gc.ca>; Andrew Bresnahan <ABresnahan@QIA.ca>; Andrew Randall <ARandall@QIA.ca>; Jeffrey Maurice <JMaurice@tunngavik.com>
Subject: EAZ/WAZ Shrimp Access Fees Submission for the Next NWMB Board Meeting

Good afternoon,

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December Board meeting. NFA is requesting support from our stakeholders on this issue, either through participating in a joint submission with NFA or through making individual representation to the NWMB in support of our submission. The final date for submission to the NWMB in advance of the next Board meeting is November 6th, as such time is of the essence.

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  - In addition, although montagui has been obtaining a much lower price than borealis in the market, DFO has been charging the same access fees per tonne for both species. This is especially significant this year as the montagui prices have dropped significantly, such that these access fees now account for a significant portion of returns, making the fishery break-even at best. With Makivik not paying any fees they have a competitive advantage in the market for montagui.
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As mentioned above, NFA would appreciate your support on these access fees issues (recommended by NWMB that we reach out to stakeholders to get their input/support). If you wish we can hold a call to discuss further. Please let me know if you are willing/able to participate in a joint submission or to write the NWMB outlining your support in advance of the deadline for their next meeting.

Regards,

Brian Burke
Executive Director
Nunavut Fisheries Association (NFA)
Tel: (709) 351-7263

From:	Brian Burke
To:	Martin, Zoya; Onalik, Jimi; Andrew Bresnahan; Andrew Randall; Jeffrey Maurice
Cc:	sakiasie sowdlooapik; Jerry Ward; Jaypetee Akeeagok; David Alexander; Harry Earle; Dave Bollivar (TFC; Peter Keenainak; Jesslene Jawanda
Subject:	FW: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry
Date:	November 18, 2020 6:12:00 PM
Attachments:	NFA Submission to NWMB on Shrimp Access Fees - NFA Nov 6 2020 Final.pdf NWMB ltr to NU Fisheries Association_RE_Access Fees_ENG.pdf
Importance:	High

See attached from the NWMB denying our request for a chance to present this issue at their upcoming December meeting. As you recall I did reach out to each of you on this issue and requested your input and support. With respect to DFO, it was actually David Whorley who had indicated to one of my members that this needed to go to the NWMB for review. I would greatly appreciate if you could each inform the NWMB of this prior contact and request and, if possible, indicate your support for our position. I have sent an immediate request for the NWMB to reconsider their position and this would greatly help. Otherwise our industry will continue to be treated unfairly on this issue into another fishing year.

Stakeholder support would be greatly appreciated. If you are unable or unwilling to provide this support please let me know as soon as possible.

Regards,

Brian Burke
Executive Director
Nunavut Fisheries Association (NFA)
Tel: (709) 351-7263

From: Taqialuq Sataa <tsataa@nwmb.com>
Sent: November 18, 2020 5:41 PM
To: Brian Burke <executivedirector@noaha.ca>
Cc: Gabriel Nirlungyuk <gabriel.nirlungayuk@dfo-mpo.gc.ca>; david.whorley@dfo-mpo.gc.ca
Subject: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry
Importance: High

Good afternoon,

Attached is titled "**NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry**", please confirm receipt, thanks.

PS the Inuktitut translation will be sent when we get it back from our translator, please let us know if you have any questions/comments, thanks again.

From: Brian Burke
To: "Martin, Zoya"; "Onalik, Jimi"; "Andrew Bresnahan"; "Andrew Randall"; "Jeffrey Maurice"
Cc: "sakiasie sowdlooapik"; "Jerry Ward"; "Jaypetee Akeeagok"; "David Alexander"; "Harry Earle"; "Dave Bollivar (TFC"; "Peter Keenainak"; "Jesslene Jawanda"
Subject: RE: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry
Date: January 18, 2021 6:19:00 PM

Good afternoon,

Following up on our access fees issue and obtaining input from the GN, NTI and QIA. We need to bring this back to the NWMB for their next Board meeting and need your input/response on the issues and/or a note indicating that your organization has been consulted. We can organize a call to discuss collectively or individually if you prefer.

Regards,

Brian

From: Brian Burke
Sent: November 18, 2020 6:12 PM
To: Martin, Zoya <ZMartin@gov.nu.ca>; Onalik, Jimi <JOnalik@GOV.NU.CA>; Andrew Bresnahan <ABresnahan@QIA.ca>; Andrew Randall <ARandall@QIA.ca>; Jeffrey Maurice <JMaurice@tunngavik.com>
Cc: sakiasie sowdlooapik <sowdlooapik@hotmail.com>; Jerry Ward <JWard@Qcorp.ca>; Jaypetee Akeeagok <Jaypetee@arcticfisheryalliance.com>; David Alexander <dalexander@baffinfisheries.ca>; Harry Earle <harry@arcticfisheryalliance.com>; Dave Bollivar (TFC <dbollivar@trinavfisheries.com>; Peter Keenainak <PKeenainak@Qcorp.ca>; Jesslene Jawanda <JJawanda@Qcorp.ca>
Subject: FW: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry
Importance: High

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Stakeholder support would be greatly appreciated. If you are unable or unwilling to provide this support please let me know as soon as possible.

Regards,

Brian Burke

Executive Director
Nunavut Fisheries Association (NFA)
Tel: (709) 351-7263

From: Taqialuq Sataa <tsataa@nwmb.com>
Sent: November 18, 2020 5:41 PM
To: Brian Burke <executivedirector@noaha.ca>
Cc: Gabriel Nirlungyuk <gabriel.nirlungayuk@dfo-mpo.gc.ca>; david.whorley@dfo-mpo.gc.ca
Subject: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry
Importance: High

Good afternoon,

Attached is titled "**NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry**", please confirm receipt, thanks.

PS the Inuktitut translation will be sent when we get it back from our translator, please let us know if you have any questions/comments, thanks again.

Brian Burke

Subject:	NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry
Location:	Call #: 866 969-8429 ID: 5111556#
Start:	Tue 2021-01-26 3:00 PM
End:	Tue 2021-01-26 4:00 PM
Recurrence:	(none)
Meeting Status:	Accepted
Organizer:	Andrew Bresnahan

For ease, this scheduler may appear in our calendars. Feel free to edit as needed.
AB

____
From: Brian Burke <executivedirector@noaha.ca>
Sent: January 25, 2021 10:29 AM
To: Martin, Zoya <ZMartin@gov.nu.ca>; Andrew Bresnahan <ABresnahan@QIA.ca>; Andrew Randall <ARandall@QIA.ca>; Onalik, Jimi <JOnalik@GOV.NU.CA>; Jeff Maurice <jmaurice@tunngavik.com>
Cc: sakiasie sowdlooapik <sowdlooapik@hotmail.com>; Jerry Ward <JWard@Qcorp.ca>; Jaypetee Akeeagok <Jaypetee@arcticfisheryalliance.com>; David Alexander <dalexander@baffinfisheries.ca>; Harry Earle <harry@arcticfisheryalliance.com>; Dave Bollivar (TFC <dbollivar@trinavfisheries.com>; Peter Keenainak <PKeenainak@Qcorp.ca>; Jesslene Jawanda <JJawanda@Qcorp.ca>
Subject: RE: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry

Fantastic. Let's go ahead with the call for 1:30 pm Eastern, using the following contact details:

Meeting Date: January 26, 2021
Meeting time: 1:30 pm Eastern
Call #: 866 969-8429
ID: 5111556#

Looking forward to the discussion and getting our partners' input on this important issue.

Regards,

Brian

From: Martin, Zoya <ZMartin@gov.nu.ca>
Sent: January 25, 2021 11:51 AM
To: Andrew Bresnahan <ABresnahan@QIA.ca>; Andrew Randall <ARandall@QIA.ca>; Brian Burke <executivedirector@noaha.ca>; Onalik, Jimi <JOnalik@GOV.NU.CA>; Jeff Maurice <jmaurice@tunngavik.com>
Cc: sakiasie sowdlooapik <sowdlooapik@hotmail.com>; Jerry Ward <JWard@Qcorp.ca>; Jaypetee Akeeagok <Jaypetee@arcticfisheryalliance.com>; David Alexander <dalexander@baffinfisheries.ca>; Harry Earle

<harry@arcticfisheryalliance.com>; Dave Bollivar (TFC <dbollivar@trinavfisheries.com>; Peter Keenainak <PKeenainak@Qcorp.ca>; Jesslene Jawanda <JJawanda@Qcorp.ca>
Subject: RE: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry

Tomorrow works for us! I will be in Pang supporting Delia and the team.

Z

From: Andrew Bresnahan <ABresnahan@QIA.ca>
Sent: January 25, 2021 10:20 AM
To: Andrew Randall <ARandall@QIA.ca>; Brian Burke <executivedirector@noaha.ca>; Martin, Zoya <ZMartin@gov.nu.ca>; Onalik, Jimi <JOnalik@GOV.NU.CA>; Jeff Maurice <jmaurice@tunngavik.com>
Cc: sakiasie sowdlooapik <sowdlooapik@hotmail.com>; Jerry Ward <JWard@Qcorp.ca>; Jaypetee Akeeagok <Jaypetee@arcticfisheryalliance.com>; David Alexander <dalexander@baffinfisheries.ca>; Harry Earle <harry@arcticfisheryalliance.com>; Dave Bollivar (TFC <dbollivar@trinavfisheries.com>; Peter Keenainak <PKeenainak@Qcorp.ca>; Jesslene Jawanda <JJawanda@Qcorp.ca>
Subject: RE: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Excellent – tomorrow works for the QIA team.
AB

Inuktitut ilinniatuinnaqtunga, tammaruma ajurirsiutinnga.

ᐋᓐᓄᓘ ᐳᕆᔅᓇᕼᐋᓐ / ᐅᖃᐅᔾᔨᕆᐊᖅᑎᓪᓗᐊᑕᖅ
Andrew Bresnahan, MD, MSc, MPH, FRCGS / Special Advisor
abresnahan@qia.ca / 867.975.8432

ᕿᑭᖅᑕᓂ ᐃᓄᐃᑦ ᑲᑐᔾᔨᖃᑎᒌᖕᒋᑦ
Qikiqtani Inuit Association
1.800.667.2742
ᓱᑲᑦᑐᒃᑯᑦ / Fax : 867.979.3238
www.qia.ca

From: Andrew Randall <ARandall@QIA.ca>
Sent: January 25, 2021 10:19 AM
To: Brian Burke <executivedirector@noaha.ca>; Martin, Zoya <ZMartin@gov.nu.ca>; Onalik, Jimi <JOnalik@GOV.NU.CA>; Andrew Bresnahan <ABresnahan@QIA.ca>; Jeff Maurice <jmaurice@tunngavik.com>
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Subject: Re: NWMB Review of Nunavut Fisheries Association’s Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry

Hi Brian,

Tomorrow works for me as well.

Thanks
Andrew

Get Outlook for Android

From: Brian Burke <executivedirector@noaha.ca>
Sent: Monday, January 25, 2021 8:12:58 AM
To: Martin, Zoya <ZMartin@gov.nu.ca>; Onalik, Jimi <JOnalik@GOV.NU.CA>; Andrew Bresnahan <ABresnahan@QIA.ca>; Andrew Randall <ARandall@QIA.ca>; Jeffrey Maurice <JMaurice@tunngavik.com>
Cc: sakiasie sowdlooapik <sowdlooapik@hotmail.com>; Jerry Ward <JWard@Qcorp.ca>; Jaypetee Akeeagok <Jaypetee@arcticfisheryalliance.com>; David Alexander <dalexander@baffinfisheries.ca>; Harry Earle <harry@arcticfisheryalliance.com>; Dave Bollivar (TFC <dbollivar@trinavfisheries.com>; Peter Keenainak <PKeenainak@Qcorp.ca>; Jesslene Jawanda <JJawanda@Qcorp.ca>
Subject: RE: NWMB Review of Nunavut Fisheries Association’s Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry

Good morning,

Looking to set a meeting time to discuss the access fees issues with the GN, QIA and NTI. Would 1 pm or later EST tomorrow (Tuesday) work for each of you? Let me know what time would be best and I will send around an invite.

Attached again is the NFA submission to the NWMB.

Regards,

Brian

From: Brian Burke
Sent: January 18, 2021 6:19 PM
To: 'Martin, Zoya' <ZMartin@gov.nu.ca>; 'Onalik, Jimi' <JOnalik@GOV.NU.CA>; 'Andrew Bresnahan' <ABresnahan@QIA.ca>; 'Andrew Randall' <ARandall@QIA.ca>; 'Jeffrey Maurice' <JMaurice@tunngavik.com>
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Sent: November 18, 2020 6:12 PM
To: Martin, Zoya <ZMartin@gov.nu.ca>; Onalik, Jimi <JOnalik@GOV.NU.CA>; Andrew Bresnahan <ABresnahan@QIA.ca>; Andrew Randall <ARandall@QIA.ca>; Jeffrey Maurice <JMaurice@tunngavik.com>
Cc: sakiasie sowdlooapik <sowdlooapik@hotmail.com>; Jerry Ward <JWard@Qcorp.ca>; Jaypetee Akeeagok <Jaypetee@arcticfisheryalliance.com>; David Alexander <dalexander@baffinfisheries.ca>; Harry Earle <harry@arcticfisheryalliance.com>; Dave Bollivar (TFC <dbollivar@trinavfisheries.com>; Peter Keenainak <PKeenainak@Qcorp.ca>; Jesslene Jawanda <JJawanda@Qcorp.ca>
Subject: FW: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry
Importance: High

See attached from the NWMB denying our request for a chance to present this issue at their upcoming December meeting. As you recall I did reach out to each of you on this issue and requested your input and support. With respect to DFO, it was actually David Whorley who had indicated to one of my members that this needed to go to the NWMB for review. I would greatly appreciate if you could each inform the NWMB of this prior contact and request and, if possible, indicate your support for our position. I have sent an immediate request for the NWMB to reconsider their position and this would greatly help. Otherwise our industry will continue to be treated unfairly on this issue into another fishing year.

Stakeholder support would be greatly appreciated. If you are unable or unwilling to provide this support please let me know as soon as possible.

Regards,

Brian Burke
Executive Director
Nunavut Fisheries Association (NFA)
Tel: (709) 351-7263

From: Taqialuq Sataa <tsataa@nwmb.com>
Sent: November 18, 2020 5:41 PM
To: Brian Burke <executivedirector@noaha.ca>
Cc: Gabriel Nirlungyuk <gabriel.nirlungayuk@dfo-mpo.gc.ca>; david.whorley@dfo-mpo.gc.ca
Subject: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry
Importance: High

Good afternoon,

Attached is titled "**NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry**", please confirm receipt, thanks.

PS the Inuktitut translation will be sent when we get it back from our translator, please let us know if you have any questions/comments, thanks again.

From:	Brian Burke
To:	Whorley, David
Subject:	Access Fee Issues
Date:	January 18, 2021 6:32:00 PM
Attachments:	NWMB ltr to NU Fisheries Association RE Access Fees ENG.pdf NFA Submission to NWMB on Shrimp Access Fees - NFA Nov 6 2020 Final.pdf

David,

Good evening, hope you had a good holiday season and that 2021 is an improvement on 2020.

Attached is a letter from the NMWB which denied NFA's request to bring issues related to access fees to their last Board meeting. One of the reasons identified for the denial was the need for more information from and consultation with DFO. This was a bit surprising in that my understanding is that it was actually DFO who indicated to one of my members that this needed to go the NWMB for their review and recommendations.

I am hoping to resubmit for consideration at the next NWMB Board meeting in March and request DFO's input so that the issues can be placed on the agenda. Available to chat if that would be helpful.

Regards,

Brian Burke
Executive Director
Nunavut Fisheries Association (NFA)
Tel: (709) 351-7263

From:	Brian Burke
To:	Whorley, David
Subject:	RE: Access Fee Issues
Date:	January 31, 2021 3:40:00 PM

David,

Good afternoon. Following up on my prior email, NFA held a meeting with its Nunavut stakeholders on these issues last Tuesday, which was attended by representatives from the GN, QIA and the NWMB. We are planning to resubmit our request to the NWMB this coming week, in time for their March Board meeting. Please let me know if you wish to discuss in advance of our submission, I will forward the final copy to you in advance.

Regards,

Brian Burke
Executive Director
Nunavut Fisheries Association (NFA)
Tel: (709) 351-7263

From: Brian Burke
Sent: January 18, 2021 6:33 PM
To: Whorley, David <David.Whorley@dfo-mpo.gc.ca>
Subject: Access Fee Issues

David,

Good evening, hope you had a good holiday season and that 2021 is an improvement on 2020.

Attached is a letter from the NMWB which denied NFA's request to bring issues related to access fees to their last Board meeting. One of the reasons identified for the denial was the need for more information from and consultation with DFO. This was a bit surprising in that my understanding is that it was actually DFO who indicated to one of my members that this needed to go the NWMB for their review and recommendations.

I am hoping to resubmit for consideration at the next NWMB Board meeting in March and request DFO's input so that the issues can be placed on the agenda. Available to chat if that would be helpful.

Regards,

Brian Burke
Executive Director
Nunavut Fisheries Association (NFA)

From:	Brian Burke
To:	Martin, Zoya; Onalik, Jimi; Andrew Bresnahan; Andrew Randall; Jeffrey Maurice
Cc:	CSFL - Sowdlooapik; QC - Jerry Ward; Jaypetee Akeeagok; David Alexander; AFA - Harry; Dave Bollivar (TFC; Peter Keenainak; Jesslene Jawanda; Jason Akearok; Denis Ndeloh; Amber Giles
Subject:	RE: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry
Date:	Tuesday, January 26, 2021 7:09:32 PM

Good evening,

Thank you to everyone who participated in this afternoon's call. As per the direction provided by the NWMB, it would be greatly appreciated if our stakeholders could provide the Board with their position on these issues and support for the NFA request in advance of the Board's upcoming deadline for their March 2021 meeting. Our submission will largely remain the same, I will be appending additional details on the market prices of borealis vs montagui shrimp, the costs that have been covered by industry to cover the annual WAZ survey, the 50 t increment access fee payment process used in other exploratory areas, and the reachout NFA has made to stakeholders on these issues. The revised document will also be shared in advance of the Board's deadline.

As indicated by the NWMB, consensus amongst our stakeholders would be very helpful in terms of the Board's decision making. Please let me know of any additional questions you may have and we would greatly appreciate your support on these issues, which are unfairly burdening our industry members.

Regards,

Brian

From: Brian Burke
Sent: January 25, 2021 9:43 AM
To: Martin, Zoya <ZMartin@gov.nu.ca>; Onalik, Jimi <JOnalik@GOV.NU.CA>; Andrew Bresnahan <ABresnahan@QIA.ca>; Andrew Randall <ARandall@QIA.ca>; Jeffrey Maurice <JMaurice@tunngavik.com>
Cc: sakiasie sowdlooapik <sowdlooapik@hotmail.com>; Jerry Ward <JWard@Qcorp.ca>; Jaypetee Akeeagok <Jaypetee@arcticfisheryalliance.com>; David Alexander <dalexander@baffinfisheries.ca>; Harry Earle <harry@arcticfisheryalliance.com>; Dave Bollivar (TFC <dbollivar@trinavfisheries.com>; Peter Keenainak <PKeenainak@Qcorp.ca>; Jesslene Jawanda <JJawanda@Qcorp.ca>
Subject: RE: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry

Good morning,

Looking to set a meeting time to discuss the access fees issues with the GN, QIA and NTI. Would 1 pm or later EST tomorrow (Tuesday) work for each of you? Let me know what time would be best and I will send around an invite.

Attached again is the NFA submission to the NWMB.

Regards,

Brian

From: Brian Burke
Sent: January 18, 2021 6:19 PM
To: 'Martin, Zoya' <ZMartin@gov.nu.ca>; 'Onalik, Jimi' <JOnalik@GOV.NU.CA>; 'Andrew Bresnahan' <ABresnahan@QIA.ca>; 'Andrew Randall' <ARandall@QIA.ca>; 'Jeffrey Maurice' <JMaurice@tunngavik.com>
Cc: 'sakiasie sowdlooapik' <sowdlooapik@hotmail.com>; 'Jerry Ward' <JWard@Qcorp.ca>; 'Jaypetee Akeeagok' <Jaypetee@arcticfisheryalliance.com>; 'David Alexander' <dalexander@baffinfisheries.ca>; 'Harry Earle' <harry@arcticfisheryalliance.com>; 'Dave Bollivar (TFC' <dbollivar@trinavfisheries.com>; 'Peter Keenainak' <PKeenainak@Qcorp.ca>; 'Jesslene Jawanda' <JJawanda@Qcorp.ca>
Subject: RE: NWMB Review of Nunavut Fisheries Association's Request for NWMB Decision and Recommendations Concerning Access Fees Charged to the Nunavut Fishing Industry

Good afternoon,

Following up on our access fees issue and obtaining input from the GN, NTI and QIA. We need to bring this back to the NWMB for their next Board meeting and need your input/response on the issues and/or a note indicating that your organization has been consulted. We can organize a call to discuss collectively or individually if you prefer.

Regards,

Brian

From: Brian Burke
Sent: November 18, 2020 6:12 PM
To: Martin, Zoya <ZMartin@gov.nu.ca>; Onalik, Jimi <JOnalik@GOV.NU.CA>; Andrew Bresnahan <ABresnahan@QIA.ca>; Andrew Randall <ARandall@QIA.ca>; Jeffrey Maurice <JMaurice@tunngavik.com>
Cc: sakiasie sowdlooapik <sowdlooapik@hotmail.com>; Jerry Ward <JWard@Qcorp.ca>; Jaypetee Akeeagok <Jaypetee@arcticfisheryalliance.com>; David Alexander <dalexander@baffinfisheries.ca>; Harry Earle <harry@arcticfisheryalliance.com>; Dave Bollivar (TFC <dbollivar@trinavfisheries.com>; Peter Keenainak <PKeenainak@Qcorp.ca>; Jesslene Jawanda <JJawanda@Qcorp.ca>
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