NUNAVUT WILDLIFE MANAGEMENT BOARD
Agenda: Regular Meeting 003-2023
August 30, 2023
Baker Lake

	No:	Item:	Tab:	Presenter:	Maximum Time
9:00 - 9:02 AM	1	Open Meeting		Chairperson	2 Minutes
9:02 - 9:04 AM	2	Declaration of Conflict of Interest		Chairperson	2 Minutes
9:04 - 9:05 AM	3	Agenda: Review and Approval of RM003-2023	1	Chairperson	1 Minute
9:05 - 10:00 AM	4	Total Allowable Harvest Recommendation for the Davis Strait Polar Bear Subpopulation (Decision)	2	Government of Nunavut	55 Minutes
10:00 - 10:15 AM		**BREAK**			15 Minutes
10:15 - 11:00 AM	4	Total Allowable Harvest Recommendation for the Davis Strait Polar Bear Subpopulation (Decision)	2	Government of Nunavut	45 Minutes
11:00 - 12:00 PM	5	Total Allowable Catch Levels and 100 Tonne Inshore Quota for Greenland Halibut in Subarea 0 for the 2024 Fishing Season (Advice)	3	Fisheries and Oceans	1 hour
		LUNCH			1 Hr & 30 Min
1:30 - 2:00 PM	6	Development of Harvest Decision Rules as part of the Precautionary Approach Frameworks for Northern (*Pandalus borealis*) and Striped (*Pandalus montagui*) Shrimp in the Western and Eastern Assessment Zones (Information)	4	Fisheries and Oceans	30 Minutes

2:00 - 2:30 PM	7	Information Regarding Plans for Consultation and Decision-Making Regarding the Possible Addition of the Harbour Porpoise (Northwest Atlantic Population) to the List of Wildlife Species at Risk on the *Species at Risk Act* (Information)	5	Fisheries and Oceans	30 Minutes
2:30 - 3:00 PM	8	Update on the New Walrus Sport Hunt Licensing Process (Information)	6	Fisheries and Oceans	30 Minutes
		BREAK			
3:15 - 3:45 PM	9	Proposed Multi-species Marine Mammal Fall Survey in Ungava Bay and Hudson Strait (Information)	7	Fisheries and Oceans	30 Minutes
3:45 - 4:15 PM	10	Fisheries and Oceans Canada Update – Southampton Island Area of Interest (Information)	8	Fisheries and Oceans	30 Minutes
4:15 - 4:20 PM	11	Adjournment of RM003-2023 Meeting		Chairperson	5 Minutes

<u>SUBMISSION TO THE</u>

<u>NUNAVUT WILDLIFE MANAGEMENT BOARD</u>

<u>FOR</u>

Information: **Decision: X**

Issue: Total Allowable Harvest (TAH) Recommendations for the Davis Strait (DS) Polar Bear Subpopulation

Background:

- The Davis Strait (DS) polar bear subpopulation is shared between Greenland, Nunavut, Nunatsiavut (Newfoundland and Labrador) and Nunavik (Québec) (Figure 1). The last inventory study to estimate abundance was conducted between 2005-2007, which resulted in an estimate of 2,158 ± 360 bears (Peacock et al. 2013). The DS polar bear subpopulation was considered stable at that time, but was displaying lowered reproductive rates.

- The Nunavut communities of Iqaluit, Kimmirut, and Pangnirtung harvest from DS. The current TAH for DS is 61 bears per year. This TAH was set under the Flexible Quota System (FQS) at a 2:1 harvest sex ratio. The average harvest between 2012/2013 and 2021/2022 was 42 bears per year (Figure 2). The lower actual harvest relative to the TAH is likely a result of reduced market value of polar bear hides. The harvest limit in Labrador is 12 bears per year, with no mandated harvest sex ratio. There is no mandatory harvest reporting in Quebec; harvest numbers are approximated based on tags issued for hides that are sold.

- The population data were out-of-date, and a new study was needed to assess the status of this subpopulation. Following community consultations during 2016, a new 2-year study began in 2017. The method used for this study was the less-invasive genetic mark-recapture DNA-biopsy sampling. The new study was conducted between 2017 and 2018 (Dyck et al. 2021).

- Alongside scientific monitoring, an IQ study on the health, abundance, and distribution of polar bears in DS was conducted with Hunter and Trapper Associations (HTAs) from Pangnirtung, and Kimmirut, and Government of Nunavut, Department of Environment (GN ENV) collaborators at Environment and Climate Change Canada (ECCC) and the University of Calgary (Tomaselli et al. 2022). Initially, it was planned to have both individual and group interviews in person, however, the COVID-19 pandemic prevented local in-person meetings for group interviews in Pangnirtung only. As a result, there were 14 participants individually interviewed in Pangnirtung, 21 participants individually in Kimmirut, and 4 group interviews in Kimmirut.

Current Status:

- The final report and results for the 2017-2018 study are available and were distributed to all relevant co-management partners in May 2022. The new abundance estimate of 2,015 bears is slightly less than the estimate from the last study in 2005-2007 in which abundance was estimated at 2,158 (Dyck et al. 2021).
- This corresponds with the Nunavut management objective to slightly reduce the Davis Strait subpopulation which was part of the rationale to increase the total allowable harvest from 46 to 61 bears in 2013.
- Population growth between 2006 and 2018 was 0.989 which corresponds to a 90% probability that population growth was <1 and thus the population did not increase over this period.
- Body condition of bears was better in 2017-2018 compared to 2005-2007; in both study periods bears, on average, were not in poor condition.
- Reproduction was similar in 2017-2018 compared to 2005-2007, although reproduction remains lower than neighbouring subpopulations, such as Baffin Bay.

Consultations:

In-person community consultations with relevant representatives from DS Hunters and Trappers Associations (HTA) were held between May 8-11, 2023. Consultations included discussions around the results of the scientific study and the IQ study and how both contributed to knowledge on DS polar bears. HTA members agreed generally with the findings of the reports, although the scientific polar bear abundance showed a decline, whereas, IQ showed an increase. It was noted that these differences are likely due to differences in spatial coverage, perspective (i.e., snowmobile vs. helicopter), and timeframe (1970s-2019 vs. 2005-2018). GN ENV staff sent discussion questions regarding TAH recommendations to HTAs after the consultations. To date, no HTAs have sent feedback. Staff from Nunavut Tunngavik Inc., Nunavut Wildlife Management Board, and Qikiqtaaluk Wildlife Board (QWB) also attended several meetings (see details in DS Consultation Summary Report by GN ENV).

Recommendations:

1. ENV recommends **no change to the current TAH of 61**.

These recommendations were derived by taking all available information into consideration. Particular comments are as follows:

a) Although a TAH of 61 was put into place at a sex selective ratio of 2:1, our recommendation of a TAH of 61 would be at a ratio of 1:1 under the Harvest Administration and Credit Calculation System (HACCs). Since HACCs began, the average female proportion of harvest in 2019/2020 until 2021/2022 was 30.1%. Females have been underharvested relative to the annual recommended quota by approximately 38.2% on average during 2017/2018 – 2021/2022 time-period. This is similar to the 2:1 ratio, but allows Inuit to harvest up to 1:1 if needed.

b) The recommended TAH keeps in mind that the previous management objective was to slightly reduce the DS subpopulation, while maintaining a viable polar bear subpopulation, and that the ecosystem of which DS bears are an integral part of continues to undergo change due to climatic changes. Setting DS harvest levels too high increases the risk for biological decline or depletion in DS.

References:

Dyck, M., K. D. Dunham, J. V. Ware, D. N. Koons, E. V. Regehr, D. W. Hosmer, A. E. Derocher, A. Dale, J. Pisapio, and G. Szor. 2021. Re-estimating the abundance of the Davis Strait subpopulation by genetic mark-recapture. Prepared for Department of Environment, Government of Nunavut, Igloolik, Nunavut, 108 pp.

Government of Nunavut, Department of Environment. 2023. Consultation with Pangnirtung, Amaruq, and Mayukalik Hunters and Trappers Association on the Re-estimating the Abundance of the Davis Strait Polar Bear Subpopulation by Genetic Mark-Recapture 2022 Report and the Nunavut Inuit Qaujimajatuqangit on the Health of the Davis Strait Polar Bear Population 2022 Report, May 8-11, 2023. Iqaluit, NU. 24 pages.

Peacock, E., Taylor, M.K., Laake, J., and Stirling, I. 2013. Population ecology of polar bears in Davis Strait, Canada and Greenland. Journal of Wildlife Management 77: 463-476.

Tomaselli, M., Henri, D., Pangnirtung Hunters and Trappers Organization, Mayukalik Hunters and Trappers Organization, Akavak, N., Kanayuk, D., Kanayuk, R., Pitsiulak, P., Wong, P., Richardson, E., and Dyck, M. 2022. Nunavut Inuit Qaujimajatuqangit on the Health of the Davis Strait Polar Bear Population. Final Project Report.

Appendix 1

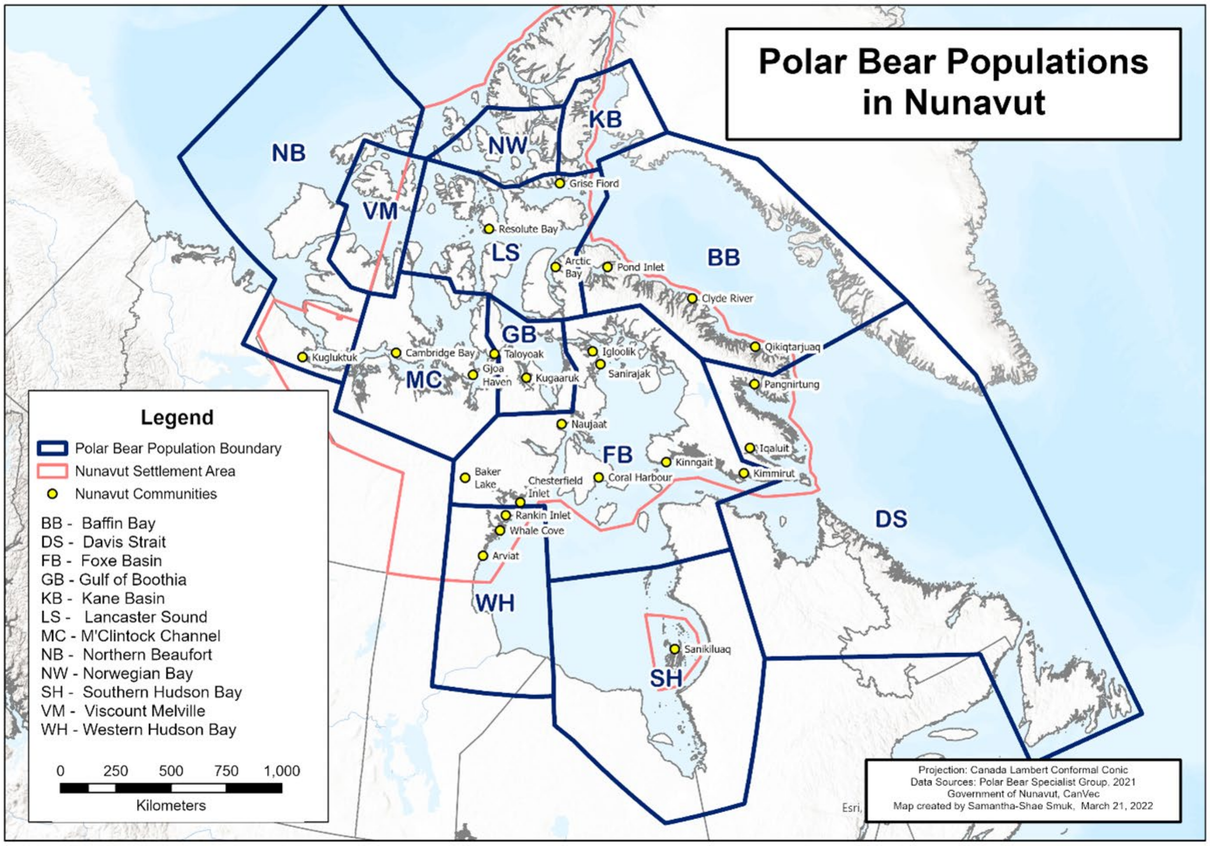

Figure 1. Overview of Nunavut polar bear subpopulations (DS = Davis Strait, BB = Baffin Bay).

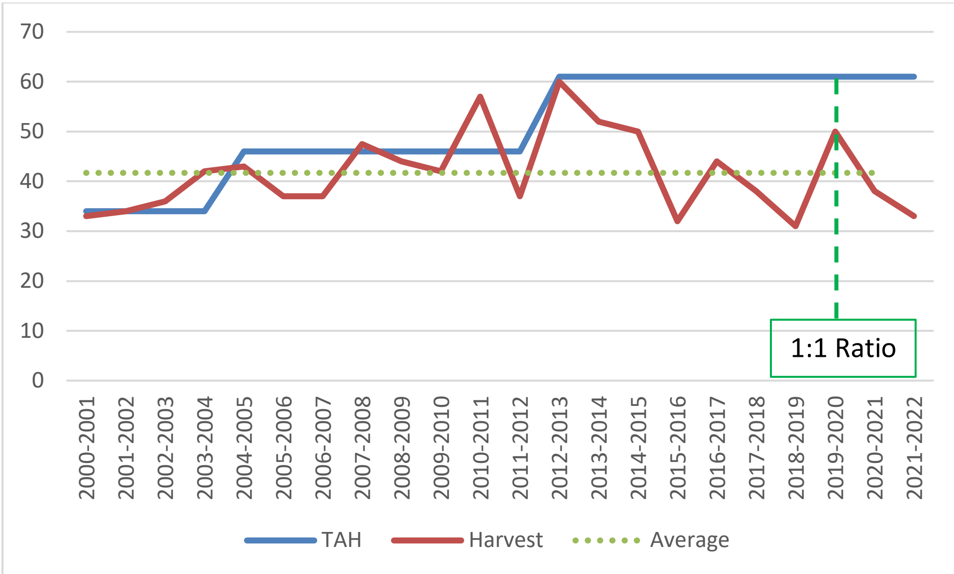

Figure 2. Overview of the Davis Strait polar bear Total Allowable Harvest (TAH), actual and average harvest since 2000. The harvest sex ratio was changed to 1:1 in the 2019-2020 harvest season.

RE-ESTIMATING THE ABUNDANCE OF THE DAVIS STRAIT POLAR BEAR SUBPOPULATION BY GENETIC MARK-RECAPTURE

FINAL REPORT-amended

May 18, 2022

Dyck, M., Dunham, K.D., Ware, J.V., Koons, D.N., Regehr, E.V., Hosmer, D.W.,
Derocher, A.E., Dale, A., Pisapio, J., and Szor, G.
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Citation:

Dyck, M., Dunham, K.D., Ware, J.V., Koons, D.N., Regehr, E.V., Hosmer, D.W., Derocher, A.E., Dale, A., Pisapio, J., and Szor, G. 2021. Re-estimating the abundance of the Davis Strait polar bear subpopulation by genetic mark-recapture. Final Report, Government of Nunavut, Department of Environment, Iglulik.

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EXECUTIVE SUMMARY (ALL LANGUAGES)

ᐊᐅᓚᑦᑎᔨᓂᙳᖅᑐᑦ ᓇᐃᓅᖅᓯᒪᔪᑦ

ᐊᓂᒍᓚᐅᖅᑐᓂ ᖁᓕᐅᕙᓚᐅᖅᑐᓂ ᐊᕐᕌᒍᓂ, ᓯᓚᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖓ ᐅᑭᐅᖅᑕᖅᑐᓕᒫᕐᒥ ᐊᓯᕈᒃᑎᑦᑎᓯᒪᙱᑦ ᓇᓄᐃᑦ ᓇᔪᖅᐸᒃᑕᙱᓐᓂᑦ ᐊᔾᔨᐅᙱᑦᑐᒥᒃ ᐊᒃᓱᐋᓗᕐᓂᖅᑳᕐᓗᑎᒃ ᐊᓯᔾᔨᒃᑲᓐᓂᕈᑎᓪᓗ ᓂᕆᐅᒋᔭᐅᔪᑦ.. ᐱᓯᒪᔪᒪᓗᓂ ᑲᔪᓯᓐᓇᑦᑎᐊᖅᑐᒥᒃ ᓇᓄᕐᓄᑦ ᓇᓄᖃᑎᒌᒃᑲᓐᓂᖅᑐᓄᑦ ᐃᓚᒋᔭᐅᓪᓗᑎᒃ ᓄᓇᒧᑦ ᓇᓗᙱᑦᑎᐊᕈᒪᓂᐅᕝᕕᖅ ᑲᔪᓲᓐᓇᖅᑐᒥᒃ ᒪᓂᒪᕙᙱᓂᙱᓐᓂᒃ ᐊᑐᖅᑕᐅᔪᓐᓇᖅᐳᓂ ᐃᓄᙱᓄᑦ, ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᓇᐅᑦᑎᖅᓱᖅᓯᓂᕐᒧᓪᓗ ᐱᓕᕆᐊᖑᕙᒃᐳᑦ ᖃᐅᔨᓴᖅᓯᔪᒪᓂᕐᒧᑦ ᓇᓅᖃᑎᒌᒃᑲᓐᓂᖅᑐᑦ ᖃᓄᐃᓕᖓᓂᙱᓐᓂᒃ ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᑐᕌᓇᔭᐅᔪᑦ ᐋᕗᑎᓯᒪᔭᐅᕙᓗᐊᕐᒪᙱᑕ. ᐅᕙᓂ, ᑎᑎᕋᖅᑲᑦᑕᖅᑕᕗᑦ ᖃᓄᐃᑦᔪᑎᙱᑦ ᐱᓕᕆᐊᖑᔮᖅᑐᓂ ᐅᓄᕐᓂᙱᓐᓄᑦ ᖃᐅᔨᓴᕐᓂᕐᓂ ᓇᓄᕐᓄᑦ ᕿᑭᖅᑖᓗᑉ ᐃᑭᙵᓂ ᐃᓚᒃᑲᓂᙱᑦ ᐅᓄᕐᓂᙱᓐᓂ. ᖃᐅᔨᓇᓲᑎᕗᑦ ᐃᓚᐅᑎᑦᑎᓪᓗᑎᒃ ᓇᑮᑳᕐᓂᙱᑦ ᑎᒥᙱᓐᓂ ᖃᐅᔨᓴᕈᑎᒃᓴᑦ ᐊᕙᖅᑕᐅᓪᓗᑎᒃ 2017 ᐊᒻᒪ 2018-ᒥ, ᐆᒪᔪᓂᒃ ᑎᒍᓯᓂᖅ ᑲᑎᖅᓱᖅᓯᒪᔪᓂ ᐊᕙᖅᑰᑕ 2005 - 2007, ᐊᒻᒪ ᐊᖑᓇᓱᙱᓂᕐᒧᑦ ᐅᑎᖅᑎᑦᑎᓂᖅ ᑲᑎᖅᓱᖅᓯᒪᔪᓂᒃ ᐊᕙᕐᓂᖅ ᐊᕐᕌᒍᑕᒫᑦ 2005 - 2018. ᓇᓚᐅᑦᑖᖅᑕᖅ ᐱᖃᕐᓂᖓ 2017 - 2018 ᐃᒪᓐᓇᐅᓚᐅᖅᑐᑦ 2,015 ᓇᓄᐃᑦ (ᒪᓕᒋᐊᓕᙱᓄᑦ ᒪᓕᒃᐸᙱᕐᓗᑎᒃ [SD] = 251; 95% ᖃᐅᔨᒪᔾᔭᑎᒃᓴᑦ ᓱᓕᔪᓂᒃ ᐊᑯᓐᓂᓕᕇᑦ [CRI] 1,603 - 2,588). ᓇᓚᐅᑦᑖᖅᑕᖅ ᐱᖃᕐᓂᖓ 2006 - 2007 ᐃᒪᓐᓇᐅᓚᐅᖅᑐᑦ 2,250 [SD = 133; ᖃᐅᔨᒪᔾᔭᑎᒃᓴᑦ ᓱᓕᔪᓂᒃ ᐊᑯᓐᓂᓕᕇᑦ 1,989 - 2,512]. ᐊᔾᔨᒌᙱᒪᙱᑕ, ᐹᑳᒃ ᐊᓯᙱᑦᑐ. 2013 ᓇᓚᐅᑦᑖᖅᑕᖅ ᐱᖃᕐᓂᖓ ᐃᒪᓐᓇᐅᓚᐅᖅᑐᑦ 2005 - 2007 ᐅᕙᙳᑦ 2,158 [95% ᓱᓕᔪᓂᒃ ᐊᑯᓐᓂᓕᕇᑦ (CI) = 1,833 – 2,542]. ᐱᖕᔪᐊᙳᔪᕐᓕ, ᓇᓚᐅᑦᑖᖅᑕᕗᑦ 2006 - 2007 ᐊᑐᖅᑎᓪᓗᒍ ᐊᑦᑎᒃᓯᒋᐊᕐᓗᑎᒃ ᐃᓗᐊᓂ ᓱᓕᔪᓂᒃ ᐊᑯᓐᓂᓕᕇᑦ ᑖᒃᑯᑎᒎᓇᖅ ᐹᑳᒃ ᐊᓯᙱᑦᑐ. 2013 ᐅᑯᓄᙵ 2005 - 2007 ᐊᑐᖅᑎᓪᓗᒍ. ᑐᑭᓕᐅᖅᓯᒪᔪᑦ ᑐᑭᖃᖅᑐᖅ ᐊᒥᓱᕈᓇᐊᕐᓂᙱᓐᓂ ᐊᑯᓐᓂᙱᓐᓂ 2006 ᐊᒻᒪ 2018 ᐃᒪᓐᓇᐅᓚᐅᖅᑐᖅ 0.989 (95% ᖃᐅᔨᒪᔾᔭᑎᒃᓴᑦ ᓱᓕᔪᓂᒃ ᐊᑯᓐᓂᓕᕇᑦ 0.974 – 1.010) ᑭᐅᔾᔭᑎᖃᕐᓂ 0.896 ᐊᔾᔪᙱᓐᓂᖓᓂᒃ ᐊᒥᓱᕈᓇᐊᖅᑐᓂ ᐃᒪᓐᓇᐅᓚᐅᖅᑐᖅ <1 ᐊᒻᒪᑦᑕᐅᖅ ᐊᒥᓲᔪᓐᓃᓇᐊᖅᑐᒃᓴᐅᓚᐅᖅᑐᑦ ᑕᒪᓐᓇ ᐊᕐᕌᒍᑦ ᐊᑐᖅᑎᓪᓗᒍ. ᑖᒃᑯᑎᒎᓇᖅ 2006-2018, ᓄᓇᕗᒻᒥ ᒐᕙᒪᙳᑦ ᐋᖅᑭᒋᐊᕐᓂᔾᔪᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᑐᕌᓂᔾᔭᖓ ᐱᖃᓗᐊᕈᓐᓃᖁᓪᓗᒍ ᐊᒥᓱᓂᙱᓐᓂ ᑐᑭᖃᕐᓂᓗ ᐊᕐᕌᒍᑕᒫᑦ ᐅᖃᐅᓯᐅᔪᑦ ᐊᙳᑕᐅᔪᓂ ᓄᓇᓕᓖᒫᓂ ᑲᑎᓪᓗᒋᑦ ᐊᒥᓱᕈᓇᐊᕐᓂᒃ 64.1 ± 10.1 (ᒪᓕᒋᐊᓕᙱᓄᑦ ᒪᓕᒃᐸᙱᕐᓗᑎᒃ) ᓇᓄᐃᑦ/ᐊᕐᕌᒍᖕᒋᓐᓂ ᐊᑯᓐᓂᖕᒋᓐᓂ 1999 – 2008 ᐅᕗᖓ 86.8 ± 23.6 ᐊᑯᓐᓂᖕᒋᓐᓂ 2009 – 2019. ᖃᐅᔨᒪᖁᔨᙱᔪᒍᑦ ᓂᕐᔪᑎᑦ ᐱᔭᐅᔪᓐᓇᕐᓂᖕᒋᑦ ᓄᖅᑲᑦᕿᙱᑦ ᐊᒥᓱᕈᓇᐊᖅᑎᑕᐅᓪᓗᑎᒃ ᓂᐅᕙᓐᓃᓐ ᐊᒻᒪᓗ ᓈᐸᑐᐊᒥ ᐊᕿᓂᓕᙱᓂ ᓇᓄᕐᓂ 12-ᓄᑦ

ᓇᓄᕐᓄᑦ ᖃᐅᔨᓴᕐᓂᑦᑕ ᐊᑯᓂᐅᑎᒋᔭᖓᒍᑦ. ᐱᓗᓇᐊᕐᑲᒪᓇᒃᑐᖅ ᐊᖑᓇᓱᙵᖅ ᐅᖃᐅᓯᖃᕐᓂᖅ ᐱᕐᑯᑎᖓ ᑯᐸᒃ ᐃᓕᖓᓄᑦ ᕿᑭᖅᑖᓘᑉ ᐃᑭᖓᓄᑦ, ᐋᖅᑭᒃᓯᓪᓗᓂ ᖃᐅᔨᒪᓈᓂᙱᔾᔪᑎᒥᒃ ᐊᒃᑐᐊᓂᓪᖓᓄᑦ ᑲᑎᕝᔪᕆᑦ ᐊᖑᑕᑦ ᓇᓃᓐᓂᖏᓐᓂ ᕿᑭᖅᑖᓘᑉ ᐃᑭᖓᑕ ᐅᓄᕐᓂᖏᓐᓂ ᑕᒪᒃᑭᕝᕙᒍ. ᑐᑭᖓ ᐊᑎᖅᑕᑦ ᐊᕐᕌᒍᒧᑦ ᐃᓂᑖᖅᑎᑦᑎᓂᖅ (ᖃᔅᓯᐅᓂᖏᑦ ᐊᑎᖅᑕᑦ ᐊᕐᕌᒍᒧᑦ ᐊᑕᐅᓯᕐᒧᑦ ᐃᓐᓇᕐᓄᑦ ᐊᕐᓇᕐᓗᖕᓄᑦ) ᐃᒪᓐᓇᑎᒋᒥᑦ 0.23 ᐅᕝᕙᓘ 0.45 ᑐᑭᖃᕝᕙᓂᓗ ᐊᑎᖅᑕᕕᓂᖅ ᐃᓂᑖᖅᑎᑕᖅ (ᖃᔅᓯᐅᓂᖏᑦ ᐊᑎᖅᑕᕕᓃᑦ ᐊᑕᐅᓯᕐᒧᑦ ᐃᓐᓇᕐᒧᑦ ᐊᕐᓇᕐᓗᖕᒧᑦ) ᐃᒪᓐᓇᑎᒋᒥᑦ 0.23 ᐅᕝᕙᓘ 0.41, ᐊᒥᒐᙱᕝᕙᓂ ᐋᖅᑭᒃᓯᒪᑎᓪᓗᒍ ᐃᓚᒃᑲᓂᖏᑦ–ᐅᓄᕐᓂᖏᑦ. ᓇᓂᓯᓚᐅᙱᑦᑐᒍᑦ ᐃᑲᔪᖅᓱᑎᒥᒃ ᐊᔾᔨᒌᖏᓐᓂᖏᓐᓄᑦ ᐊᓇᒍᓇᕐᓂᖅ ᑖᒃᑯᓇᙵᑦ ᐊᑎᖅᑕᑦ ᐊᕐᕌᒍᒧᑦ ᐊᑎᖅᑕᕕᓃᓪᓗ ᐅᕙᓗᓐᓃᑦ ᑭᓲᓂᖏᑎᒍᓪᓚᑦᑖᖅ ᐊᓇᒍᓇᕐᓂᕐᒧᑦ ᓈᓴᐅᑎᖏᑦ ᖃᓄᑐᐃᓇᖅ ᐅᑭᐅᓕᕐᓄᑦ. ᑐᑭᖃᖅᑎᑕᕗᑦ ᐊᓇᒍᓇᕐᓂᕐᒧᑦ ᓈᓴᐅᑎᖏᑦ ᐃᒪᓐᓇᐅᓚᐅᖅᑐᑦ 0.794 (95% ᖃᐅᔨᒪᔾᔪᑎᒃᓴᑦ ᓱᓕᔪᓂᒃ ᐊᑯᓐᓂᓕᓅᕐ; 0.723, 0.861) ᐊᑎᖅᑕᓄᑦ, 0.873 (95% ᖃᐅᔨᒪᔾᔪᑎᒃᓴᑦ ᓱᓕᔪᓂᒃ ᐊᑯᓐᓂᓕᓅᕐ; 0.826, 0.914) ᐃᓄᑑᔪᓄᑦ ᐃᓐᓇᙳᓕᖅᑐᓄᑦ, ᐊᒻᒪ 0.871 (95% ᖃᐅᔨᒪᔾᔪᑎᒃᓴᑦ ᓱᓕᔪᓂᒃ ᐊᑯᓐᓂᓕᓅᕐ; 0.853, 0.892) ᐃᓐᓇᕐᓄᑦ, ᐊᑦᑎᖕᓂᖅᓴᐅᔪᑦ ᐅᖃᐅᓯᐅᔮᓚᐅᖅᑐᓄᑦ ᐲᑳᒃ ᐊᓯᖏᓪᓗ. (2013) ᑭᓯᐊᓂ ᑕᐃᑯᙳᕐᓗᑎᒃ ᓱᓕᔪᕐᑯᑎᖏᓐᓂ ᐊᑯᓐᓂᓕᓅᖏᑦ. ᖃᐅᔨᓚᐅᙱᑦᑐᒍ ᖃᓅᕙᖓᒫᖏᑦ ᐊᓐᓇᐅᒪᓇᓱᖕᓂᖕᓂᑦ ᐊᕙᑖᓂᑐᓄᓪᓘᓐᓃᑦ ᖃᓄᐃᑦᑐᓄᑦ (ᓲᕐᓗ ᓯᕐᑯ ᐊᖏᓂᖏᑦ, ᓯᓚᐅᑉ ᖃᓄᐃᓂᖓ, ᓇᑦᑎᕐᑲᐅᖕᓂᖏᑦ). ᑎᒥᖏᑕ ᖃᓄᐃᓕᖓᓂᖏᓐᓂ ᖃᐅᔨᓴᕈᑎᑦᑎᓐᓂ ᓇᓗᓇᐃᖅᓯᓪᓗᑎᒃ ᓇᓄᐃᑦ ᑎᒥᖏᑦ ᖃᓄᐃᙱᑦᑎᐊᕐᓂᖅᓴᐅᓚᐅᖅᑐᑦ 2017 – 2018 ᐊᔾᔨᒋᙱᕝᕙᓂᐅᒃ 2005 – 2007. 2017 ᐊᒻᒪ 2018-ᒥ, ᐃᓐᓇᐃᑦ ᐊᖑᓴᓪᓗᑦ ᐃᓄᑑᔪᓪᓗ ᐃᓐᓇᐃᑦ ᐊᕐᓇᕐᓗᑦ ᖃᓄᐃᙱᓐᓂᖅᓴᐅᓚᐅᖅᑐᑦ ᐃᓐᓇᕈᓕᕝᖅᑐᓄᑦ ᐊᕐᓇᕐᓗᖕᓄᓪᓗ ᐊᑎᖅᑕᕐᑲᙱᑦᑐᓄᑦ. ᓯᕗᓕᖅᓱᕈᑎᖏᓐᓄᑦ ᓇᓗᓇᐃᒃᑯᑎᖅᓯᒪᔪᓄᑦ ᐱᒃᑲᓐᓂᕐᓂᖅ ᐅᕙᙱᑦ ᐲᖅᓯᓂᖅ ᖃᐅᔨᓴᖅᑕᐅᔪᑦᓴᒥᒃ ᐱᓱᒃᓯᓂᒃᑯᑦ ᐊᑐᖅᑕᐅᓪᓗᐊᑕᓚᐅᖅᑐᖅ ᖃᐅᔨᓴᕈᑎᒃᓴᓄᑦ ᓲᕐᑲᐃᒪᓗ ᖃᖓᑦᑕᖅᑎᑕᐅᓯᒪᔫᒃᑯᑦ ᖃᐅᔨᒪᓇᕈᑎ ᐱᓕᓇᐊᖑᓚᐅᙱᒪᑦ, ᖃᐅᔨᐊᓂᒍᓐᓇᓚᐅᙱᑦᑐᒍᑦ ᓇᔪᖅᐸᒃᑕᖏᓐᓂ ᐊᑐᕐᓂᕐᒥ ᑐᓂᓯᓂᕐᖁᓐᓂᑦ ᐊᓯᔾᔨᖅᑐᕕᓂᐅᑲᓪᓚᒃᐸᑦ.

ᑕᒪᓐᓇ ᖃᐅᔨᓴᐃᓄᕆᐊᓐᓂᖏᑦᓂᓇᔭᐅᔪᖅ ᑭᒡᒐᖅᑐᐃᕗᖅ ᐊᐃᑉᐸᖓᓂᒃ ᐋᖅᑭᒃᓱᖅᑕᐅᓯᒪᔪᓂ ᖃᔅᓯᐅᓂᖏᓐᓄᑦ ᖃᐅᔨᓴᖅᓯᓂᖅ 2005–ᒥ 2018-ᒧᑦ ᐊᕐᕌᒍᓂ ᕿᑭᖅᑖᓘᑉ ᐃᑭᖓᓂ ᓇᓄᓇᔭᐅᒃᑲᓐᓂᖅᑐᓄᑦ. ᐊᐅᓚᑦᑎᔾᔨᑦ ᐊᓯᖏᓪᓗ ᐅᖃᓕᒫᖅᑐᑦ ᐅᔾᔨᕈᓱᕆᐊᖃᖅᑐᑦ ᐊᒥᓱᑦ ᑲᑎᖅᓱᖅᓯᒪᔪᑦ ᑐᓗᕈᑎᖏᑦ (ᓲᕐᓗ, ᖃᖓᐅᔾᔪᑎᒧᑦ ᐊᑯᓐᓂᖅᓱᖅᑐᖅ ᐊᑯᓐᓂᖏᓐᓂ ᑲᔪᓯᑦᑎᐊᖅᑐᑦ ᖃᐅᓕᓴᕈᑎᑦ) ᑐᓐᓂᖅᑯᑎᒋᓯᒪᔪᓐᓇᖅᑐᑦ ᓇᓚᐅᑦᑖᕈᑎᖃᙱᓗᐊᕐᓂᖅ ᐱᓗᓇᐊᖃᓪᓚᓇᒃᓂᑦ ᖃᔅᓯᐅᓂᖏᓐᓂ, ᓲᕐᓗ ᐊᓇᒍᓇᕐᓂᖅ, ᐃᓚᖏᓪᓗ ᑭᒃᓕᖃᖅᑎᑕᐅᔪᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᓇᙱᑦᑐᑦ ᐅᑭᐅᖏᑦ ᓇᓄᐃᑦ ᑎᑎᕋᖅᑕᐅᙱᑉᐸᑕ ᓄᓇᒥ ᖃᐅᔨᓴᕈᑎᓕᓇᑎᓪᓗᒋᑦ. ᑕᐃᒪᐃᒃᑲᓗᐊᖅᑎᓪᓗᒍ, ᐱᑕᖃᕐᓂᖓ ᐊᒥᓱᓂᒃ

ᑲᑎᖅᓱᖅᓯᒪᔪᓂᒃ ᖃᐅᔨᓴᕈᑎᐅᓚᐅᖅᑐᓂ, ᐃᓚᖃᕐᓗᑎᒃ ᓇᓗᓇᐃᔭᐅᑎᑦ ᐊᕝᕗᖅᑕᓂ ᐊᖑᑕᕐᓂ ᓇᕗᕐᓂ ᓱᕗᓕᖅᓱᕈᑎᖕᒋᓐᓂᒃᑯ ᐲᖅᓯᓂᖅ ᖃᐅᔨᓴᖅᑕᐅᔪᒃᓴᓂ ᑎᑎᖅᑲᓕᖅᑕᐅᔪᓂ ᐱᔪᓐᓇᖅᑎᕐᓗᓂᑎᒍᑦ ᓇᓚᐅᑦᑖᕐᓗᒋᑦ ᐅᓄᖅᓯᕙᓪᓕᐊᓂᐅᒐᔪᒃᑐᓄᑦ ᖃᔅᓯᐅᓂᖕᒋᓐᓂ. ᐊᖑᓇᓱᖕᓂᖕᒧᑦ ᐊᑦᑕᕐᓇᐅᑎᑦ ᖃᐅᔨᓴᕐᓂᑦ ᐃᓱᒪᒋᔭᖃᕐᑐᑦ ᐊᑐᐃᓐᓇᐅᓂᖕᒋᑦ ᐊᒥᓲᓂᖕᒋᓐᓄᑦ ᑎᑎᖅᑲᐃᑦ ᐊᒃᑐᐃᓂᐅᑐᐃᓐᓇᕆᐊᓕᓪᓗ ᐃᓂᒐᔭᑦ ᐊᓯᔾᔨᕐᓂᖕᒋᓐᓄᑦ ᒫᓐᓇᓵᕈᓗ ᕿᒥᕐᕈᔭᐅᑎᐅ ᑐᑭᓯᕖᓪᓕᕈᑕᐅᔪᓐᓇᕋᔭᕐᑐᖅ ᓇᒦᓐᓂᖕᒋᓐᓄᑦ ᐊᒃᑐᐃᓂᐅᔪᑦ ᐊᔾᔨᐅᙱᑦᑐᓂᑦ ᐊᖑᓇᓱᖕᓂᖕᒧᑦ ᐅᐸᓗᖕᒪᐃᔭᐅᑎᓂᑦ. ᓱᕗᒧᐊᕐᓗᑕ, ᐊᖑᓇᓱᖕᓂᕐᒧᑦ ᐊᑦᑕᕐᓇᕐᓂᖕᒪᓂ ᖃᐅᔨᓴᕐᕈᓐᓇᕐᑐᑦ ᕿᑭᖅᑖᓘᒃ ᐃᑭᖕᒪᓂ ᐊᒥᓲᓂᖕᒋᑦ ᐊᑐᕐᓗᑎᒃ ᓇᓚᐅᑦᑖᒪᕐᓂᖅ ᖃᓄᐃᓐᓂᖕᒋᓐᓂ ᐊᒥᓲᓂᖕᒋᓐᓂᓪᓗ ᒫᓐᓇᓵᖅ ᖃᐅᔨᓴᕈᑎᓂᑦ.

RÉSUMÉ

Au cours des dernières décennies, les changements climatiques dans l’ensemble de l’Arctique ont modifié l’habitat de l’ours blanc (*Ursus maritimus*) à un rythme sans précédent et d’autres changements sont attendus. Afin d’aider à conserver des sous-populations durables d’ours blancs en tant que partie intégrante de l’écosystème et pour assurer la disponibilité continue d’une ressource de subsistance pour les Inuits, des recherches scientifiques et des suivis des populations sont réalisés afin d’évaluer l’état des sous-populations et de déterminer si les objectifs de gestion sont atteints. Nous présentons ici les résultats de l’étude récemment menée sur les ours blancs de la sous-population du détroit de Davis (DD). Nos analyses ont porté sur des échantillons génétiques prélevés par biopsie en 2017 et 2018, les données de captures vivantes recueillies de 2005 à 2007 et les données de récolte obtenues chaque année de 2005 à 2018. L’abondance estimée pour la période 2017-2018 était de 2 015 ours (écart-type [ET] = 251; intervalle de crédibilité bayésien [ICR] de 95 % 1 603 - 2 588). L’abondance estimée pour la période 2006-2007 était de 2 250 ours [ET = 133 ; ICR 1 989 - 2 512]. À titre de comparaison, Peacock et coll. (2013) ont estimé l’abondance pour la période 2005-2007 à 2 158 ours [intervalle de confiance (IC) de 95 % = 1 833 – 2 542]. Il est important de noter que nos estimations pour la période 2006-2007 se situent dans les intervalles de confiance rapportés par Peacock et coll. (2013) pour la période de 2005 à 2007. La moyenne géométrique de la croissance démographique entre 2006 et 2018

était de 0,989 (ICR de 95 % : 0,974 - 1,010), ce qui correspond à une probabilité de 0,896 que la croissance démographique soit <1, signifiant que la population a donc très probablement diminué (par au moins un ours) au cours de cette période. Entre 2006 et 2018, le gouvernement du Nunavut a modifié l'objectif de gestion de cette population afin de réduire son abondance. Ainsi, la récolte annuelle moyenne déclarée par l'ensemble des juridictions combinées est passée de 64,1 ± 10,1 (ET) ours/année entre 1999 et 2008 à 86,8 ± 23,6 ours entre 2009 et 2019. Notons également que le quota a été augmenté à Terre-Neuve-et-Labrador, passant de 6 à 12 ours au cours de notre période d'étude. L'absence d'obligation de déclaration des récoltes pour la partie québécoise du DD crée toutefois une incertitude quant aux niveaux de récolte totaux pour l'ensemble de la sous-population du détroit de Davis. Le recrutement moyen d'oursons de l'année (nombre d'oursons de l'année par femelle adulte) a varié entre 0,23 et 0,45 et le recrutement moyen de jeunes d'un an (nombre de jeunes d'un an par femelle adulte) a varié entre 0,23 et 0,41, ce qui semble suffisant pour soutenir la sous-population. Nous n'avons pas trouvé de preuve indiquant une différence entre le taux de survie des oursons de l'année et celui des jeunes d'un an ou indiquant un taux de survie spécifique au sexe pour aucun groupe d'âge. Nos taux de survie moyens étaient de 0,794 (ICR à 95 %; 0,723, 0,861) pour les jeunes dépendants de leur mère, de 0,873 (ICR à 95 %; 0,826, 0,914) pour les subadultes indépendants et de 0,876 (ICR à 95 %; 0,853, 0,892) pour les adultes, ce qui est inférieur à ce qui avait été rapporté précédemment par Peacock et coll. (2013) mais se situe dans leurs intervalles de confiance. Nous n'avons pas trouvé de soutien pour une relation entre la survie et les différentes variables environnementales (par exemple, les paramètres de glace de mer, les indices climatiques, l'abondance des phoques). Notre analyse de l'état corporel a indiqué que les ours étaient moins susceptibles d'être en mauvaise condition physique pendant la période 2017-2018 par rapport à la période 2005-2007. En 2017 et 2018, les mâles adultes et les femelles adultes indépendantes étaient en meilleure condition que les subadultes et les femelles accompagnées de jeunes dépendants. Étant donné que le marquage-recapture génétique par fléchette à biopsie était la seule méthodologie utilisée au cours de cet inventaire et que la télémétrie satellitaire n'a pas été utilisée, nous n’avons pas été en mesure de déterminer s’il y a eu des changements au niveau de l’utilisation de l’habitat ou de la distribution spatiale au fil du temps.

Cette étude constitue la deuxième évaluation structurée de l’état de la sous-population du DD entre 2005 et 2018. De grands écarts entre les prises de données (c’est-à-dire l’intervalle de temps entre les études successives) peuvent contribuer à une plus grande incertitude et à un biais potentiel dans les estimations des taux vitaux, tel que la survie, et certains paramètres ne peuvent pas être estimés lorsque l'âge des ours n’est pas déterminé au moment de l’échantillonnage sur le terrain. Néanmoins, la disponibilité d’un vaste ensemble de données provenant d’une étude antérieure, combinée à l’information obtenue à partir des ours récoltés et des échantillons génétiques obtenus par biopsie, nous ont permis d’estimer des taux démographiques de base. Les analyses d’évaluation des risques liés à la récolte représentent un outil analytique relativement récent qui examine l’impact démographique de différentes stratégies de récolte tout en considérant la précision des données disponibles pour une sous-population et les effets potentiels des changements environnementaux. À l’avenir, une telle analyse des risques de différentes stratégies de récolte pourra être réalisée pour la sous-population d’ours blancs du DD à partir des estimés d’abondance et des taux démographiques évalués par la présente étude.

ᐳᕐᑐᓂᕐᓴᑦ ᑐᓴᕐᑕᐅᑎᑕᖏᑦ

ᐊᕐᕌᒍᓂ ᑕᕝᓯᒪᐅᔪᕐᑑᓈᕐᑎᑐᓂ ᐊᒥᓲᖕᖏᑐᓂ, ᓯᓚᐅᑉ ᐊᓯᑦᔨᐸᕝᓯᐊᓂᖓ ᐅᑭᐅᕐᑕᑐᓯᒦᒥ ᖃᓄᐃᓯᖕᖏᒪᓇᑦᓯᒪᔪᖅ ᓇᓄᐃᑦ (*Ursus maritimus*) ᓇᔪᖓᖏᓐᓂᒃ ᐱᒻᒪᕆᐊᓗᑎᒍᑦ ᓂᕆᐅᒋᔭᐅᓯᒪᖕᖏᑐᓂᒃ ᑌᒣᕝᓗᐊᖅ ᐊᒻᒪᓗ ᓯᕗᓂᕐᒥ ᐊᓯᑦᔨᑎᑦᓯᒋᐊᕝᓚᑦᓛᕐᓂᖓ ᓂᕆᐅᓐᓇᓯᕐᓱᓂ. ᐃᑲᔪᕐᓯᒍᒪᑦᓱᒋᑦ ᓄᓇᐅᑉ ᑲᑎᒪᓲᒍᓈᕐᑎᑐᑦ ᐃᓯᒣᓐᓇᕆᐊᖃᕐᓂᖏᑎᒍᑦ ᐃᓚᐅᖃᒥᒃ ᓂᕿᖃᖃᑎᒌᓄᑦ ᐆᒪᔪᐃᑦ ᐱᕈᕐᑐᓗ ᐊᒻᒪᓗ ᐃᓄᐃᑦ ᓂᕿᒋᓲᖏᑦ ᑖᒃᑯᐊ ᐱᔮᕐᖃᔮᖕᖏᓯᕿᑎᑌᓯᒍᒪᒎᑦ, ᓲᑯᐃᔅᓂᕐᓄᑦ ᐊᒻᒪᓗ ᐃᑉᐱᒍᓱᓐᓂᓄᑦ ᖃᐅᔨᓴᕐᓂᖃᓯᕐᑐᖅ ᖃᐅᔨᒋᐊᕐᓱᒋᑦ ᓇᓄᐃᑦ ᑲᑎᒪᔩᑦ ᖃᓄᐃᓯᖕᖓᓯᕐᓂᖏᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑦᓯᓂᕐᓄᑦ ᑐᕌᒋᑦ ᐱᔮᕙᒻᒪᖕᖔᑕ. ᑕᒫᓂ, ᑐᓴᕐᑎᓯᔪᒍᑦ ᖃᐅᔨᓴᕐᓂᓄᑦ ᑐᑭᓯᔮᐅᓯᒪᔪᓂᒃ ᖃᒻᒥᖅ ᑲᔪᓯᑎᑕᐅᓯᒪᔪᑦ ᓇᓄᐃᑦ ᑲᑎᒪᔩᑦ ᖃᐅᔨᓴᕐᑕᐅᓂᖏᑦ ᑕᕝᓗᕈᑎᒦᔩᑦ Davis Strait-ᒥ. ᕿᒥᕐᕈᓂᕗᑦ ᐃᓚᖃᓚᐅᔫᖅ ᓄᓇᕕᓃᑦ ᐃᓕᑕᕐᓇᐅᑎᖏᑎᒍᑦ ᐆᑦᑐᕋᕆᑦᓴᑕᕐᓱᑎᑦ ᑲᑎᕐᓱᑕᐅᓯᒪᔪᕕᓃᑦ 2017-ᒥ ᐊᒻᒪᓗ 2018-ᒥ, ᐆᒪᑎᓗᒋᑦ ᖃᐅᔨᓴᕋᑦᓴᑕᕐᑕᐅᖃᑦᑕᑐᕕᓃᑦ 2005-ᒥᑦ 2007-ᒧᑦ, ᐊᒻᒪᓗ ᐆᒪᔪᕐᑕᐅᔪᕕᓃᑦ ᐳᑯᑦᑕᐅᑎᓗᒋᑦ

ᑐᑭᓯᐅᑎᑦᓴᑖᕕᓂᕐᓂᑦ ᐳᑯᑦᑕᐅᓯᒪᑦᓯᑎᒃ ᐊᕐᕌᒍᑕᒫᑦ 2005-ᒥᑦ 2018-ᒧᑦ. ᒥᑦᓴᐅᓵᕐᓱᒋᑦ ᐅᓄᕐᓂᓕᕕᓃᑦ 2017-ᒥᑦ 2018-ᒧᑦ 2,015 ᓇᓄᐃᑦ (ᑭᑎᑦᓯᒍᑎᑐᐃᓐᓅᑦ ᐊᑐᕐᓱᒋᑦ Standard Deviation [SD] = 251; 95% Bayesian Credible Interval [CRI] 1,603-2,588). ᒥᑦᓴᐅᓵᕐᓱᒋᑦ ᐅᓄᕐᓂᖏᑦ 2006-2007-ᒥ 2,250 [SD = 133; CRI 1,989 - 2,512]. ᐆᑦᑐᕋᐅᑕᐅᑎᓗᒋᑦ, Peacock et al. 2013 ᒥᑦᓴᐅᓵᕐᓯᒪᔪᑦ ᐅᓄᕐᓂᖏᑦ 2005-2007-ᒥ 2,158-ᒍᑎᓗᒍ [95% Confidence Interval (CI) = 1,833-2,542]. ᐱᒻᒪᕆᐅᕗᖅ, ᒥᑦᓴᐅᓵᕈᑎᓕᐊᕆᓯᒪᔫᑦ 2006-ᒥᑦ 2007-ᒧᑦ ᓈᒻᒪᓯᒪᔪᑦ ᐃᓗᐊᓃᓐᓂᖏᑦ confidence intervals ᑐᓴᕐᑕᐅᑎᓯᒪᔭᖏᓐᓄᑦ Peacock et ak. 2013 2005-2007-ᒥ. ᓄᓇᓂ ᓇᔪᕐᑕᖏᑎᒍᑦ ᑲᑎᒪᔩᑦ ᐅᓄᕐᔾᓯᒪᔪᑦ 2006 ᐊᒻᒪᓗ 2018 ᐊᑯᓐᓂᖓᓂ 0.989-ᓄᑦ (95% CRI 0.974 – 1.010) ᑖᒃᑯᐊ ᐃᓕᖓᔪᑦ 0.896-ᒧᑦ ᐃᓚᓯᒪᑐᐃᓐᓇᕆᐊᖃᕐᑐᕕᓂᐅᓂᖏᓐᓄᑦ ᑲᑎᒪᔩᑦ ᐱᕈᕈᑎᒋᑦᓱᒍ <1 ᐊᒻᒪᓗ ᑲᑎᒪᔩᑦ ᐃᑭᓪᓕᐅᒥᔭᕕᓂᐅᔪᑦᓴᐅᓂᖏᓐᓄᑦ (ᐊᑕᐅᓯᕐᒨᓃᑦ ᓇᓄᕐᒧᑦ) ᑖᒃᑯᓇᓂ ᐊᕐᕌᒍᓂ. 2006-2018-ᒥ, ᓄᓇᕗᑦ ᑲᕙᒪᖓ ᐋᕐᕿᒋᐊᕐᓯᒪᔪᖅ ᐊᐅᓚᑦᓯᓂᕐᒧᑦ ᑐᕌᒐᕐᒥᒃ ᐃᑭᓪᓕᑎᕐᓱᒋᑦ ᐅᓄᕐᓂᖏᑦ ᑲᑎᒪᔩᑦ ᐊᒻᒪᓗ ᐊᕐᕌᒍᑕᒫᑦ ᓇᓗᓐᕐᑕᐅᓚᕆᓲᓂᒃ ᑐᓴᕐᑎᑕᐅᑦᓱᑎᒃ ᐱᔭᐅᓯᒪᔪᑦ ᐃᓘᓐᓄᑦ ᐊᐅᓚᑦᓯᖃᑕᐅᔪᓄᑦ ᑲᑎᓂᖏᑦ ᐅᓄᕐᓯᒋᐊᕐᑎᓗᒋᑦ ᐱᒋᐊᕐᕕᐅᑎᓗᒍ 64.1 ± 10.1 (SD) ᓇᓄᐃᑦ/ᐊᕐᕌᒍᒥ 1999 - 2008 ᐊᑯᓐᓂᖓᓂᑦ 86.8 ± 23.6 ᐊᑯᓐᓂᖓᓄᑦ 2009 – 2019. ᖃᐅᔨᓚᐅᔫᒥᓯᑕᓗ ᓇᓄᕐᑕᐅᒍᓐᓇᑐᑦ ᐅᓄᕐᓯᒋᐊᕐᑕᐅᑎᓗᒋᑦ ᓂᐅᕙᐅᓐᓛᒥ ᐊᒻᒪᓗ ᓛᐸᑐᐊᒥ 6-ᓂᒃ ᓇᓄᕈᓐᓇᓯᒪᑦᓱᑎᒃ 12-ᓂᒃ ᓇᓄᕈᓐᓇᓕᕐᑐᑦ ᑌᒣᓕᓚᐅᔫᖅ ᖃᐅᔨᓴᕐᓂᖅᕐᓂᑎᓂ. ᑕᓪᓗᕈᑎᒦᔩᑦ ᓅᑦᑕᕕᖏᓐᓂ ᓇᓐᓄᑕᐅᔪᓂᒃ ᑯᐯᒃ ᑐᓴᕐᑎᓯᕙᓪᓗᓂ ᑭᓯᐊᓂᐅᕕᖃᖕᖏᑐᖅ, ᑌᒣᖓᒻᒪᑕ ᖃᐅᔨᒪᓇᖕᖏᑐᖅ ᑲᑎᓂᕆᓪᓚᕆᓲᖏᓐᓂᒃ ᓇᓐᓄᑌᑦ ᑕᓪᓗᕈᑎᒦᔩᑦ ᓇᓄᐃᑦ ᖃᑦᓯᓗᑑᔩᒍᓂᖏᑦ. ᐅᓄᕐᓂᓚᕆᖏᑦ ᐱᐊᕐᕿᐅᑌᑦ ᐊᕐᕌᒍᒥ (COY) ᖃᐅᔨᒋᐊᕐᑕᐅᒍᑎᖏᑦ (ᐅᓄᕐᓂᖏᑦ COY ᐊᑐᓂᑦ ᐊᕐᓇᓄᑦ ᓇᓄᒻᒪᕆᓐᓄᑦ ᐱᐊᕋᕐᑖᕆᔦᑦ) ᐃᒡᓗᐊᑐᓃᓚᐅᔩᑦ 0.23-ᒥᑦ 0.45-ᒧᑦ ᐊᒻᒪᓗ ᐅᓄᕐᓂᓚᕆᖏᑦ ᐊᕐᕌᒍᑉᑦ (ᐅᓄᕐᓂᖏᑦ ᐊᕐᕌᒍᑉᑦ ᐊᑐᓂᑦ ᐊᕐᓅᑦ ᓇᓄᒻᒪᕇᑦ) ᐃᒡᓗᐊᑐᓃᓚᐅᔩᑦ 0.23-ᒥᑦ 0.41-ᒧᑦ, ᓈᒻᒫᔾᔭᕐᓱᑎᒃ ᓄᖑᖏᓐᓇᑎᑦᓯᒐᔭᕈᓐᓂᖏᑦ ᑲᑎᒪᔩᓂᒃ. ᓴᐳᑦᔭᐅᒍᑎᖃᓚᐅᔪᖕᖏᑐᒍᑦ ᐊᑦᔨᒌᖕᖏᓂᖏᓐᓂᒃ ᐆᒪᑯᑖᕈᓇᐅᓂᖏᑦᑕ COYs ᐊᒻᒪᓗ ᐊᕐᕌᒍᑉᑦ ᐅᑦᕙᓘᓐᓃᑦ ᐊᕐᓇᐅᓂᕐᒥᓄᑦ ᐊᖑᑕᐅᓂᕐᒥᓄᑦ ᐆᒪᑯᑖᕈᓐᓇᐅᑎᒋᒍᓇᖏᑦᑕ ᖃᑦᓯᐅᓂᖏᓐᓂᒃ ᖃᑦᓯᑐᐃᓐᓇᓂᒃ ᐅᑭᐅᑉᑦ. ᐆᒪᔪᓐᓇᕕᖃᕇᑦ ᐃᒡᓗᐊᑐᒨᓚᐅᔩᔭᕗᑦ 0.794 (95% CRI; 0.723, 0.861) ᐊᓈᓇᒥᓃᖏᓐᓈᑐᑦ ᓇᓄᐊᕈᐃᑦ, , 0.873 (95% CRI; 0.826, 0.914) ᐃᓕᒃᑰᓕᕐᑐᑦ ᓇᓄᒻᒪᕆᖕᖑᐸᓪᓕᐊᔪᑦ ᐊᒻᒪᓗ 0.871 (95% CRI; 0.853, 0.892) ᓇᓄᒻᒪᕇᑦ, ᐃᑭᓐᓂᓴᑦ ᑭᖑᓂᕐᒥ ᑐᓴᕐᑕᐅᑎᓯᒪᔭᖏᓐᓂᑦ Peacock et al. (2013) ᑭᓯᐊᓂ ᐃᓗᐊᓃᖏᓐᓈᓱᑎᒃ ᖃᓄᐃᓕᖕᖓᓂᐅᔭᖕᖏᕕᒻᒥᑕ. ᑕᑯᓚᐅᔫᖕᖏᑐᒍᑦ ᖃᐅᔨᒍᑎᓪᓚᕆᒻᒥᒃ ᐆᒪᒐᓱᐊᕐᓯᑎᐅᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐆᒪᕕᒋᔩᖏᑦᑕ ᖃᓄᐃᓕᖓᓕᕐᓂᖏᓐᓄᑦ ᑲᑕᑦᑕᐅᒥᓯᒪᐅᑎᖃᓕᕐᓂᖏᓐᓂᒃ (ᐆᑦᑑᑎᒃ ᑕᕆᐅᑉ ᓯᑯᖓᑕ ᓯᕕᑐᓂᖏᑦ, ᓯᓚᐅᑉ ᐱᐅᓯᖓ, ᓇᑦᓰᑦ ᐊᒥᒐᖕᖏᓂᖏᑦ). ᖃᓄᐃᓕᖓᓂᖏᓐᓂᒃ ᕿᒥᕐᕈᓂᑎᒍᑦ ᓇᓄᐃᑦ ᑎᒥᒥᒍᑦ ᓱᒃᑰᖏᓐᓂᓴᐅᓯᒪᓂᖏᓐᓂᒃ 2017 - 2018-ᒥ ᐆᑦᑑᑎᒋᑦᓱᒋᑦ 2005-2007-ᒥᓂᑌᑦ. 2017-ᒥ ᐊᒻᒪᓗ 2018-ᒥ, ᓇᓄᒻᒪᕇᑦ ᐊᖑᑏᑦ ᐊᒻᒪᓗ ᐃᒻᒥᓂᕐᓱᑐᑦ ᐊᕐᓅᑦ ᓇᓄᒻᒪᕇᑦ ᐱᐅᓂᖕᓴᐅᓯᒪᔪᑦ ᓇᓄᒻᒪᕆᖕᖑᐸᓪᓕᐊᔪᓂᒥᑦ ᐊᒻᒪᓗ ᐊᕐᓇᓂᑦ ᐱᐊᕐᕿᐅᑐᓂᑦ. ᐃᓚᑦᓴᔭᖃᕈᑎᓄᑦ

ᓇᓗᓃᕐᑐᐃᓂᖅ ᐃᓚᙱᕕᒋᖃᑦᑕᓱᒋᑦ ᖁᑭᖃᑦᑕᓱᒋᑦ ᖃᕐᕓᔭᕐᓄᑦ ᐱᓇᓱᐊᕈᑎᑑᓯᒪᔪᑦ ᐊᑐᕐᑕᐅᓱᓂ ᖃᐅᔨᓴᕐᓂᒥ ᐊᒻᒪᓗ ᖁᒻᒧᐊᑎᑕᐅᓯᒪᔪᒃᑯᑦ ᑕᑯᔅᓴᐅᑎᑦᓯᐅᑏᑦ ᑲᔪᓯᑎᑕᐅᓚᐅᔪᙱᒪᑕ, ᓲᖅᑯᐃᓱᒍᓇᓚᐅᔪᙱᑐᒍᑦ ᐊᓯᑦᔨᓯᕚᓪᓕᐊᓯᒪᓂᖏᓐᓂᒃ ᓇᔪᓲᖏᑦᑕ, ᐅᕝᕙᓘᓐᓃᑦ ᓇᓃᓐᓂᓇᓲᖏᑦᑕ.

ᑖᓐᓇ ᖃᐅᔨᓴᕐᓂᖅ ᐃᓕᖓᔪᖅ ᑐᖓᓕᖏᓐᓄᑦ ᑲᑎᒪᓪᓚᕆᓲᑦ ᓇᐅᑦᓯᑐᕐᑕᐅᓯᒪᓂᖏᓐᓄᑦ 2005 ᐊᒻᒪᓗ 2018 ᐊᑯᓐᓂᖓᓂ ᑕᓪᓗᕈᑎᒦᓲᑦᓱᑎᒃ ᐃᓚᖀᑦᓴᔭᓄᑦ. ᐊᖏᔪᕐᒧᑦ ᑐᑭᓯᐅᑎᑦᓴᓄᑦ ᐊᑯᓐᓂᖃᕈᑎᖏᑦ (ᐆᑦᑑᑎᒃ, ᐱᕕᑦᓴᑦ ᐊᑯᓐᓂᖏᑦ ᑭᖑᓕᓈᑦᓯᐊᓯᒪᒪᒐᑎᒃ) ᓈᒻᒪᓈᙱᐅᑕᐅᒍᓇᑐᑦ ᐊᒻᒪᓗ ᓈᒻᒪᓈᕐᓯᒪᒍᓐᓂᑎᑦᓯᓗᑎᒃ ᒥᑦᓴᐅᕌᕐᑕᐅᓯᒪᓂᖏᓐᓄᑦ ᐅᓄᕐᓂᓇᕆᐊᓕᖏᑦᑕ, ᐆᑦᑑᑎᒋᓗᒋᑦ ᐆᒪᒍᓇᓂᖏᑦ, ᐊᒻᒪᓗ ᐁᕕᕆᓲᖏᑦᑕ ᓯᕕᑐᓂᖏᑦ ᒥᑦᓴᐅᕌᕐᑕᐅᖃᔭᙱᕐᑐᑦ ᐅᑭᐅᖏᑦ ᓇᓄᐃᑦ ᓇᓗᓃᕐᑕᐅᖃᑦᑕᖏᑉᐸᑕ ᓄᓇᒦᑦᑐᑦ ᐆᑦᑐᕋᕋᑦᓴᑕᕐᑎᓗᒋᑦ. ᒐᓗᐊᕐᑎᓗᒍ, ᐊᑐᐃᓐᓇᐅᓂᖏᑦ ᐊᒥᓱᑦ ᑐᑭᓯᐅᑎᑦᓴᑕᕐᕕᑦᓴᑦ ᐱᓯᒪᔪᑦ ᑭᖑᓂᕐᒥ ᖃᐅᔨᓴᕐᓂᓂ, ᐃᓚᖃᕐᓱᑎᒃ ᑐᑭᓯᐅᑎᑦᓴᓂᒃ ᐳᑯᑦᑕᐅᓯᒪᔪᓂᒃ ᓇᓄᑐᕕᓂᕐᓂᑦ ᐊᒻᒪᓗ ᐃᑦᔭᓯᒍᑎᖏᑎᒍᑦ ᐃᓚᙱᐊᑎᓇᐅᑎᐅᓯᒪᔪᓂᒃ ᓇᓗᓃᕐᑐᐃᓯᒪᐅᑏᑦ ᐅᕙᑦᑎᓂᒃ ᒥᑦᓴᐅᕌᕈᑎᓂᒃ ᑐᙵᕕᖃᕐᑎᓯᓯᒪᔪᑦ ᓄᓇᒦᖃᑎᒌᑦ ᐅᓄᕐᓂᖏᓐᓂᒃ. ᓇᑭᓂᑕᐅᓂᖏᑎᒍᑦ ᓇᓐᓄᑕᐅᔪᓂᒃ ᑐᑭᓯᓴᕐᓃᑦ ᐃᓱᒪᒋᔭᐅᑎᓗᒋᑦ ᓈᒻᒪᓈᕐᓯᒪᒍᓇᐅᑎᖏᑦ ᐊᑐᐃᓐᓄᑦ ᑲᑎᒪᔩᓂᒃ ᑐᑭᓯᐅᑎᑦᓴᑦ ᐊᒻᒪᓗ ᖃᓄᐃᓕᙵᑕᐅᓯᒪᑐᐃᓐᓇᓇᐊᖃᕐᓂᖏᑦ ᓇᔪᓲᖏᑦᑕ ᐊᓯᑦᔨᓂᑯᖏᓐᓄᑦ ᖃᒻᒥᓂᑕᐅᓚᐃᑦᓯᑎᒃ ᕿᒥᕐᕈᕈᑎᐅᑦᓯᑎᒃ ᓴᓇᕐᕈᑎᐅᒻᒪᑕ ᒪᓂᔾᔪᑕᐅᒍᓇᓯᑎᒃ ᑐᑭᓯᐅᑎᑦᓴᓂᒃ ᓄᓇᐅᑉ ᖃᓄᐃᑦᑑᓂᖏᓐᓄᑦ ᖃᓄᐃᓕᙵᑕᐅᓯᒪᓂᖏᓐᓂᒃ ᓇᓄᕐᓯᐅᕕᐅᒍᓇᑐᑦ ᐋᕐᕿᓱᕐᑕᐅᓯᒪᒍᑎᖏᑦᑕ. ᓯᕗᒧᐊᒍᑎᕆᕆᐊᕐᓗᒋᑦ, ᓇᑭᓂᑕᐅᓂᖏᑎᒍᑦ ᑐᑭᓯᓴᕐᓂᖅ ᑲᔪᓯᑎᑕᐅᒍᓇᑐᖅ ᑕᓪᓗᕈᑎᒦᓲᓂᒃ ᐃᓚᖀᑦᓴᔭᓂᒃ ᐊᑐᕐᓗᒋᑦ ᒥᑦᓴᐅᕌᕈᑎᐅᓯᒪᔪᑦ ᑭᑎᑕᐅᓯᒪᐅᑎᒋᑦᓱᓂᖏᑦ ᐊᒻᒪᓗ ᐅᓄᕐᓂᖏᑎᒍᑦ ᒪᓂᔭᐅᓯᒪᓕᕐᑐᑎᒍᑦ ᐅᓪᓗᒥ ᖃᐅᔨᓴᕐᓂᐅᓕᕐᑑᑉ.

AULATSIJILLAGET NAILLITITAUSIMANNINGA

MânnaKammik jârini, silak asianguvallianinga nanituinnak Ukiuttattumi asiangutitsisimavuk nanunik (*Ursus maritimus*) inigiKattajanginnik nigiunangitunik sukkanigijanginnik ammalu suligok asianguvallialangajuk. Ikajugasuagiamut tigumiagiamullu nanunik ilangagijaulluni avatimmik ammalu atuinnaunginnaniammata niKitsagijaulluni piviannatolluni ilingajunut Inutuinnanut, Kaujisattilagijet Kaujisannik ammalu kamagigiangit Kaujisannink suliagijauKattavut Kimiggugiamut omajungita nanekkomangâmmik ammalu aulatsigunnagiamut tugâgutiliuttaujut kamagijaugaluammangâmmilonnet. Tapvani, Kaujititsivugut allaKutimmik Kaujijausimajunut mânnaKammik suliagijausimajunut omajunut Kaujisattausimajunut nanunik iniKajunut Davis Ikâgiapvingani (DI) nanuKutigijanginnik. Kaujisimajavut ilautitsivuk timinnint tigusisimavugut ottugattaugajattunut tigujaulauttunut jâringinni 2017 ammalu 2018, omatlutik-tigujausimajut Kaujigatsait katitsutausimavut 2005 - 2007, ammalu katitsutausimajut Kaujigatsait katitsutauKattasimavut jâri tamât 2005 - 2018. kititangit unuttotigijunut ilingajunut 2017 - 2018 imailingasimavut 2,015 nanuit (Ajunnangitumik Avittutausimajunut (AA) = 251; 95% Bayesian Credible Interval [CRI] 1,603 - 2,588). kititangit unuttoningit ilingajumut 2006 - 2007 imalingasimavut 2,250 [SD = 133; CRI 1,989 - 2,512]. Atjigengitonnik, Peacock et al. 2013 kititangit unuttoningit ilingajumut 2005 - 2007 omani 2,158 [95% Confidence Interval (CI) = 1,833 – 2,542]. IkKanaluattumut, uvagut kitisimajavut ilingajumut 2006 - 2007 jâringinni katasimavut iluani Kaujimajautsiatunut kitijausimajunut allaKutingatigut tâpsumunga Peacock et al. 2013 ilingajumut 2005 - 2007 jâringinni. Una taijaujuk Geometric tukiKajuk omajungita piguvallianingit akungani 2006 ammalu 2018 imailingasimajuk 0.989 (95% CRI 0.974 – 1.010) tamanna malitsiajuk ominga 0.896 piguvalliaKosimajunut ununningit imailingasimajumut <1 ammalu omajugijangit ikilliumisimakKotut Kângivalliasimanninganik. Jâringita 2006-2018, tainna kavamakkut Nunavummi asiangutitsilauttut aulatsijigijanginnik tugâgutinginnik ikilliumittisigiamut unuttoninginnik omajunik ammalu tukigijangita jâri tamât allaKutingit katitsutauKattajunik ilonnanginnik pitsatuniKajunut katiutigillugit puttusimavuk pisimajumit 64.1 ± 10.1 (AA) nanuit/jâringa akungani 1999 – 2008 tikijumut 86.8 ± 23.6 akungani 2009 – 2019. KaujimakKujigivugut taikkua tigujausot puttugiasimammijut Newfalâmi ammalu Labradorimi pisimajumit 6 nanunnik omunga12 nanunnut iluani Kaujisasimaniagatta. MaligatsaKalungilak katitsuigunnagiamut ilingajumut Quebec ininganik iniKajunut DI iningini, sakKititsijumik nalunattumik ilinganiKajumut ilonnanginnik kititanik pijausonik iniKajunut Davis Ikâgiapvingani nanugijanginnik iluingajunut. TukiKajuk piagait jârimi tigujausimajut (PT) (numarangit PT atunik anâlunnut pisimajumajunit 0.23 tikijumut 0.45 ammalu tukiKajuk piaganik tigujauKattajut (numarangit piagausimajut atunik annâlunnut) pisimajuk 0.23 tikijumut 0.41, sollu nâmmalungituk omajugijauKatigijaujunut. Kaujisimavugut ikajutsitaulungituk atjigengitojunut omajunut akungani PT ammalu piagausimajunut upvalu Kanuittoningit omaluasimajunut ammalu Katsinituinnak jâriKajunut. Tamanna tukiKattisijuk ununnigijangit omaKattajunut imalingasimavut 0.795 (95% CRI; 0.723, 0.861) piaganut, 0.873 (95% CRI; 0.826, 0.914) taikkununga immigolingajunut pigugesimajunut, ammalu piguKataugiallasimajunut, ammalu 0.871 (95% CRI; 0.853, 0.892) pigugesimajunut, taikkua ikinnisausimajut sivunganinit Kaujititauniammat allaKutimmi iluanit Peacock et al. (2013) tâvatuak iluanettitauvut Kaujimajautsiatunut kitijausimajunut. Ammalugiallak, sukkaninga sikuk nunguvallianinga piujogunnaininga malitsiatigivuk taikkununga pigugesimajunut omagunnagiamut () iluani omajunut ikilliumiliaKijunut jârini Kangatuinnak sikuk nunguvallialimmat (upvalu auvallialimmat) tapvainauluatlatumik., ilautillugit tamapsuminga kamagijausimajunut kititausimavut 50% taikkununga Kangaulimmat atjigengitoKattajunut (jârimit jârimut atjigengitonnningit) pigugesimajut omaKattaningit. Tamakkua kititangit attuininga sukkajonninganik sikumit nunguvallianinganik taikkununga pigugeKatausimajunullu piungitosimammijuk tâvatuak ikinnisamik malitsialugani (). Timigijavut piusinga Kimiggutausimajunut nalunaitsilaukKuk taikkua nanuit piungitualosimajut timingit jâringinni 2017 – 2018 atjigengitojunut taipsumaniusimajumut 2005 – 2007. Jâringani 2017 ammalu 2018, angutialuit ammalu immigolingajut pigugesimajut annâluit piunitsaulauttut timingit taikkunangat annanut piagaKajunut. Silak asianguvallianinga akunin ulugianattumettisivuk taikkununga nanunnut ammalu iluani DI omagiamut attutaulaukKut iinganiKajumut sukkajonninga sikuk auvalliajumut nalunaitsijumik nanuKutet piungitumik attutaulâttut kajusiutigijaumut sikumik asiujivalliagatta. Tigusitluta Kanuittoningit-tigusigiallagatta petsitluta timinginnit kapputinnik atutluta tainnatuak atulauttavut Kaujisagiamut ammalu sâtilaittikut Kaujisalaunginatta, Kaujigunnalaungilagut inigijauKattajut atuttauKattajut asianguvalliasimagalaummangâllonet Kângivalliatillugu.

Tamanna Kaujisannik kiggatuvuk aippanganik tungavigijausimajumut nunannik omajunginnik Kaujisannimik akunganit 2005 ammalu 2018 ilingajumut DI omajunginnik. Aulatsijet ammalu asigiallait sivukkatet Kaujimagialet angijualuk Kaujigatsait amigagijauvut (sollu., Kangaulimmat akungani kajusiutigijautsiaKattajunut Kaujisannet) tunitsigajattuk Kaujimajaugengitunik pimmagittunik sukkajoningit, sollu omaKattajunut, ammalu inigijangita Kaujijaugunnangitut taikkua nanuit jâringit Kaujijaungimata nunami Kaujisagasualimmata. Tamannaugaluatluni, atuinnauningit anginitsait Kaujigatsait pisimajumit sivunganit Kaujisattausimajunut, katiutigillugit taikkununga katitsutausimagettunut nanusimajunut ammalu timinginnit tigujausimajunut pivitsaKattisisimavuk uvattinik kititsigiamut ajunnangitunik inigijauKattajunut. Katitsuigiamut ulugianattuk Kimiggutaunninga (KUK) mânnaKammiuvuk Kaujijausimajut atuttausongutluni siumagijautitsijumik atjigengitunik katitsuigunnagiamut atâgut atjigengitojunik avatimit piusigijanginnik ammalu Katset katitsuiKattajut ulugianattojunut. Sivuppiagasualluta, taikkua Kaujisagiamut atuttausot atuinnauvut taikani DI omajugijanginnik aulataugiaKakKotunik pitsatunigijaulluni ippiniappata

EXECUTIVE SUMMARY

In recent decades, climatic changes across the Arctic have altered polar bear (*Ursus maritimus*) habitat at unprecedented rates and further changes are expected. To help retain viable polar bear subpopulations as part of the ecosystem and to 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 the recently conducted subpopulation study for polar bears of the Davis Strait (DS) subpopulation. Our analyses included genetic biopsy samples collected in 2017 and 2018, live-capture data collected 2005 - 2007, and harvest recovery data collected annually 2005 - 2018. Estimated abundance for the 2017 - 2018 period was 2,015 bears (Standard Deviation [SD] = 251; 95% Bayesian Credible Interval [CRI] 1,603 - 2,588). Estimated abundance for the 2006 - 2007 period was 2,250 [SD = 133; CRI 1,989 - 2,512]. For comparison, Peacock et al. 2013 estimated abundance for the period 2005 - 2007 at 2,158 [95% Confidence Interval (CI) = 1,833 – 2,542]. Importantly, our estimates for the 2006 - 2007 period fell within the confidence intervals reported by Peacock et al. 2013 for the 2005 - 2007 period. Geometric mean subpopulation growth between 2006 and 2018 was 0.989 (95% CRI 0.974 – 1.010) which corresponds to a 0.896 probability that subpopulation growth was <1 and thus the subpopulation most likely declined (by at least one bear) over this period. Through 2006-2018, the Government of Nunavut modified the management objective to reduce abundance of the subpopulation and mean annual reported harvest from all jurisdictions combined increased from 64.1 ± 10.1 (SD) bears/year between 1999 – 2008 to 86.8 ± 23.6 between 2009 – 2019. We also note

that the quota was increased in Newfoundland and Labrador from 6 bears to 12 bears within our study period. There is no mandatory harvest reporting requirement for the Québec portion of the DS range, creating uncertainty related to total harvest levels for the Davis Strait subpopulation. Mean cub-of-the-year (COY) recruitment (number of COYs per adult females) ranged from 0.23 to 0.45 and mean yearling recruitment (number of yearlings per adult female) ranged from 0.23 to 0.41, which appear to be sufficient to sustain the subpopulation. We found no support for differences in survival between COYs and yearlings or for sex-specific survival rates for any age class. Our mean survival rates were 0.794 (95% CRI; 0.723, 0.861) for dependent young, 0.873 (95% CRI; 0.826, 0.914) for independent subadults, and 0.871 (95% CRI; 0.853, 0.892) for adults, which are lower than previously reported in Peacock et al. (2013) but fall within their confidence intervals. We did not find evidence for a relationship between survival and any environmental variables (e.g. sea ice parameters, climate index, seal abundance). Our body condition analysis indicated that bears were less likely to be in poor body condition during 2017 – 2018 compared to 2005 – 2007. In 2017 and 2018, adult males and independent adult females were in better condition than subadults and females with dependent offspring. As genetic mark-recapture via biopsy darting was the sole methodology used for the survey and because satellite telemetry was not conducted, we were unable to determine whether habitat use, or distribution has changed over time.

This study represents the second structured subpopulation assessment between 2005 and 2018 for the DS subpopulation. Large data gaps (i.e., time intervals between successive studies) can contribute to higher uncertainty and potential bias in estimates of vital rates, such as survival, and some parameters cannot be estimated when ages of bears are not recorded during field sampling. Nevertheless, the availability of a large dataset from a previous study, combined with information collected from harvested bears and genetic biopsy markers allowed us to estimate basic demographic rates. Harvest risk assessments that consider the precision of available subpopulation data and the potential effects of habitat change are a relatively recent analytical tool that can provide information on the demographic effects of a range of potential harvest strategies. Moving forward, a harvest risk assessment could be performed for the DS subpopulation using estimates of vital rates and abundance provided by the current study.

INTRODUCTION

Wildlife managers face complex decisions when seeking to address conservation challenges against other societal priorities. Decisions and outcomes must be evaluated periodically so that new information can be fed back into an adaptive management framework (Holling 1978, Johnson 1999, Lancia et al. 1996). Accurate and up-to-date estimates of subpopulation 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 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 increases the probability of meeting management objectives and reduces the severity of potential negative outcomes (Taylor et al. 2007, Regehr et al. 2017a).

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 as such may bioaccumulate environmental contaminants (e.g., McKinney et al. 2009, 2011; Letcher et al. 2010, Fisk et al. 2009, Derocher et al. 2003). 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 in the future (Derocher et al. 2004, Amstrup et al. 2008, Stirling and Parkinson 2006, Stirling and Derocher 2012, Durner et al. 2009, 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 (Regehr et al. 2016, 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, accurate assessment of such changes is complicated by insufficient data for many polar bear subpopulations (Durner et al. 2018), spatial and temporal variation in the effects of 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 (Larsen and Stirling 2009).

Despite the various on-going research and monitoring efforts on polar bears, reliable and updated abundance and demographic information for some subpopulations are still lacking (Obbard et al. 2010, Vongraven et al. 2012). Polar bear research is expensive and logistically challenging, especially for management jurisdictions that oversee more than just 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 in Canada. To maintain healthy and viable polar bear populations, subpopulation studies in Nunavut are scheduled to follow a 10 to 15-year rotational cycle, which can vary depending on research needs and priorities. Here we present findings from a 2017 - 2018 monitoring study to develop an updated estimate of the abundance of the Davis Strait (DS) polar bear subpopulation, and to compare demographic data from this study to the results of the previously (2005 – 2007) conducted subpopulation study (Peacock et al. 2013).

Within Canada, the DS polar bear subpopulation is shared by Nunavut, Québec (Nunavik), and Newfoundland and Labrador (NL; Nunatsiavut) [Durner et al. 2018; Figure 1]. The subpopulation was first inventoried in the 1970s (Stirling and Kiliaan 1980; Stirling et al. 1980). Although that study did not cover the entire area, and likely underestimated the subpopulation size, it estimated the subpopulation to be around 900 bears. Subsequent work conducted on the Labrador coast in the early 1990s located approximately twice the numbers of bears per hour of search compared to observations during the 1970s (Stirling, unpubl.data *in Stirling and Parkinson, 2006*). During that same period (1970s to 1990s), abundance of harp seals (*Phagophilus groenlandicus*), the primary food source for DS polar bears (Iverson et al. 2006), as well as hooded seals increased significantly in the Northwest Atlantic (Bowen et al., 1987; Stenson et al.,1997; Healey and Stenson, 2000). This high abundance of food resources for DS polar bears during that period was suggested as a primary factor in the likely increase of their abundance during those two to three decades (Stirling and Parkinson, 2006). In early 2000, Nunavut Inuit inhabiting the Davis Strait region reported seeing more bears during all seasons (Kotierk 2009), also supporting the probable increasing abundance of DS polar bears. However, since the 1980s, a declining trend in sea-ice duration (forming later and breaking up earlier [Stirling and Parkinson 2006, Stern and Laidre 2016; Regehr et al. 2016]) has raised the question of how polar bears and seals are affected by climate warming, which has been identified as the primary threat to polar bears throughout their range (Polar Bear Range States 2015).

Because of the uncertainties surrounding the DS subpopulation status, the Government of Nunavut (GN) conducted another population survey from 2005 - 2007, with funding and logistic support from the governments of NL and Nunatsiavut, Makivik Corporation, Polar Continental Shelf Project, Parks Canada and the Nunavut Wildlife Management Board. That study resulted in an abundance estimate of 2,158 (95% CI: 1833 – 2542) bears (Peacock et al. 2013). The results suggested that the subpopulation had grown substantially between the 1970s and 2007 but was at that point experiencing a decline in both productivity and growth rate, possibly through density-dependent mechanisms. In addition, the observed declining trend in sea-ice duration might also have played a role in that productivity decline through reduced access to seals. If productivity remained low in subsequent years, bear abundance may have continued to decline in the region.

In recent years, Inuit have broadly expressed the view that increasing numbers of bears are causing increases in human-bear conflicts and generally creating elevated public safety concerns, especially for people going out on the land (Kotierk 2009; Henri 2012; NMRWB 2019). Inuit also report that the bears are increasingly impacting other wildlife by eating large numbers of young seals and eggs in bird colonies. (York et al. 2015; NMRWB 2019). Some corroborating science exists for these observations, particularly with respect to plasticity of bear foraging behaviour (Barnas et al. 2020, Rode et al. 2015). Although there is a logical relationship between increased abundance and increased human-bear conflicts, and such a relationship has been demonstrated for black bears (Garshelis et al. 2020), increases in the frequency of human-bear conflicts and any cause-and-effect relationships are not limited to considerations of bear abundance. There is also a substantial body of evidence that sea-ice declines have resulted in longer periods of bears being seasonally restricted to land (Bromaghin et al. 2015, Lunn et al. 2016, Obbard et al. 2016, Regehr et al. 2010, Stirling and Derocher 2012, among others). In some cases, this has resulted in further changes in seasonal distribution, migration, and concentration patterns of bears in relation to communities and other areas of high human use. These behavioural and movement pattern changes are also relevant to monitoring and assessing changes in frequency of human-bear conflicts and are not necessarily based on any change (increase or decrease) in abundance of bears.

Following the results from the 2005 – 2007 study, the co-management partners within Nunavut decided to increase the total allowable harvest (TAH) from 46 to 61 bears annually for the 2012/2013 harvest season in an effort to reach a managed decline of the DS subpopulation. Despite this change in TAH, Nunavut Inuit annual harvest only increased from an average of 39.4 bears during the 1999-2008 period to 44.2 bears during the 2009-2019 period. Inuit reported harvest in Nunavik (Québec) however increased significantly between those two same time periods from an average of 16.5 bears to 30.2 bears per year while Nunatsiavut (Newfoundland and Labrador) reported harvest increased from an average of 5.9 bears to 10.9 bears per year (Table 10). Given the increased harvest, Inuit observations, and continued sea-ice decline, there was uncertainty surrounding the current status of the DS subpopulation.

Polar bears in Nunavut have been managed through a complex co-management system that includes community-level (Hunters and Trappers Organizations, HTOs), regional-level (Regional Wildlife Organizations, RWOs), and territorial-level (Nunavut Wildlife Management Board, NWMB, and the GN) participants. Through consultation and discussion, memoranda of understanding (MOU)[1] between each community's HTO and the GN were developed. These MOUs lay out harvest, management, and research aspects for each polar bear subpopulation. Under the existing 2004 MOU, the GN committed to a new subpopulation study for DS. To address uncertainty in the DS

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

status and to fulfill its obligations under the 2004 MOU, the co-management partners, including jurisdictions that share this subpopulation, planned to conduct a new subpopulation study between 2017 and 2018. Consultations on the proposed study design and methodology were conducted with each Nunavut community that harvests from DS and all supported the less-invasive genetic mark-recapture methodology. Local HTO members participated in field research.

In Newfoundland and Labrador responsibilities for polar bear conservation and management are shared between the Government of Newfoundland and Labrador, the Nunatsiavut Government, and the Torngat Wildlife and Plants Co-Management Board, in accordance with the Labrador Inuit Land Claims Agreement (and its associated Act) and the Newfoundland and Labrador **Wild Life Act**. All three entities prioritized the 2017 - 2018 genetic mark-recapture methodology, led the field collection of data in the Labrador portion of the range and adjacent areas in Nunavut and Québec, and have engaged in the analysis. Co-management partners in Newfoundland and Labrador and Québec, as in Nunavut, have invested in this research to better understand various aspects of polar bear ecology and inform co-management decision-making.

Similarly, in Québec, the management of polar bears is complex and relies on a collaboration between the Québec government, wildlife management boards as well as local Inuit and Cree hunter organizations. Consultations were conducted in Québec with Local Nunavimmi Umajulivijiit Katujiqatigininga (LNUK) as well as with the Hunting, Fishing and Trapping Coordinating Committee who supported the 2017 - 2018 survey using the genetic mark-recapture approach. Representatives from the Québec government and from Nunavik communities participated in the collection of data in the Québec portion of the range and adjacent areas in Nunavut.

The new study had the objective to estimate the current subpopulation size and composition and compare those results to the 2005 – 2007 study to inform responsible management authorities for decision-making. In addition, we sought to obtain data that would provide estimates of survival and reproductive parameters for future subpopulation viability analyses and harvest risk assessments. Based on available methodologies and community-level feedback, the supported method was the less-invasive genetic mark-recapture method, which can be a useful alternative to physical mark-recapture in subpopulation monitoring (Vongraven et al. 2012; Vongraven and Peacock 2011). To address these objectives, we conducted a genetic mark-recapture study from 2017-2018.

Study Area

The Davis Strait demographic unit (Figure 1) has been previously delineated based on the movements of collared adult female bears (Taylor et al. 2001), the locations of bears marked and subsequently recaptured or harvested (Taylor and Lee 1995), and DNA analysis (Paetkau et al. 1999, Malenfant et al. 2016). The full range of polar bears in the DS subpopulation unit covers approximately 420,000 km^2 between Canada and Greenland, including the Davis Strait, Labrador Sea, Ungava Bay, Frobisher Bay and Cumberland Sound (Taylor et al. 2001, Taylor and Lee 1995). Davis Strait is generally ice free during summer and early fall (July – October; Stern and Laidre 2016) and polar bears are distributed and concentrated along the shoreline and on off-shore islands on the Canadian side of their distributional range, from Cape Dyer on eastern Baffin Island down to northern Labrador (Taylor et al. 2001, Peacock et al. 2013) during this time.

Using cluster analysis of polar bear movements from satellite telemetry, Taylor et al. (2001) identified a generally strong boundary between the DS and Baffin Bay (BB) subpopulations, and movements between DS and Foxe Basin (FB) were infrequent causing demographic discontinuity between the two subpopulations. Genetic clustering methods (Obbard et al. 2010) suggested that mating fidelity of polar bears to southern DS (i.e., south of Hudson Strait); central DS (i.e., south of Cumberland Sound on Baffin Island); and northern DS on Baffin Island (i.e., north of Cumberland Sound) exist. Peacock et al. (2013) suggested from their analysis that the sub-regions differed where a) harp seals constituted a significantly larger part of polar bear diet in southern DS compared to the more northerly sub-regions (Iverson et al. 2006); b) harvest levels in southern DS differed from those in central and northern DS; and c) exchange between polar bears in DS and BB was more likely to occur in northern DS than in other subregions (Figure 2; also see methods and results sections).

METHODS

Samples

Field collections

We conducted our survey across the entire DS subpopulation summer and fall range, including Nunavut, Québec and Labrador, during 2017 and 2018. Our study design followed that of the previous physical mark-recapture study conducted in DS between 2005 - 2007 (Peacock et al. 2013), however, it did not involve the immobilization and physical handling of bears (Figure 3 and 4). Inuit co-management partners in Nunavut and Nunavik frequently expressed their concern over wildlife capture and handling (Department of Environment 2013, Lunn et al. 2010) and as a result, the responsible government management agencies explored alternative research methods. After discussions with the affected communities and co-management partners in neighbouring jurisdictions, genetic mark-recapture was chosen as the method since it is less-invasive (Garshelis 2006) and has been successfully applied on various species, including bears (Brown et al. 1991, Palsbøll et al. 1997, Boulanger et al. 2004, Lukacs and Burnham 2005, Schwartz et al. 2006, Paetkau 2003). The survey team selected this methodology recognizing that certain aspects of habitat use, age structure and spatiotemporal comparisons with the previous study, Peacock et al. (2013), would not be available.

We constrained our study to August - October, like the 2005 – 2007 study, in order to search for bears along their summer and fall range, which consists of coastline and on near-shore islands. While on land, bears can be found further inland, and at higher elevations, which could make them undetectable if search effort is only concentrated along the coast (e.g., Ferguson et al. 1997, 2000; Taylor et al. 2001; Escajeda et al. 2018). In addition, bears frequently segregate by age class and reproductive status where adult females with cubs tend to select fjords, avoiding offshore islands and coastal regions where densities of adult males are usually greater. Pregnant bears select inland and upland denning habitats where they are less available for sampling (Ferguson et al. 1997, Escajeda et al. 2018). Therefore, we adopted a similar method as the 2011 - 2013 BB polar bear survey (SWG 2016). We applied the

BB study stratification to our study area with a high-density stratum, including the coastline and offshore islands, extending to 5 km inland; a moderate-density stratum including inland regions 5 – 10 km from the coastline; and a low-density stratum from 10 to 30 km inland (Figure 3). During the BB study, bears were reportedly found on glaciers, high-elevation snow patches, and plateaus along the coast and on islands (SWG 2016). For this study, we included all elevations within our strata to ensure the greatest opportunity for bears to be observed and sampled. Search efforts were allocated according to the anticipated bear densities with roughly 65%, 25%, and 10% of helicopter search effort spent in the high-, moderate-, and low- density strata, respectively. We set *a priori* guidelines to systematically distribute inland search effort along the entirety of the islands (SWG 2016). All offshore islands were surveyed as completely as possible, while accommodating weather and safety concerns. In both 2017 and 2018, portions of the Nunavut coastline as well as Resolution and Edgell Islands along with Loks Land could not be surveyed because of inclement weather, though this represented a small fraction of the overall study area (Figure 4).

This study combined genetic mark-recapture data collected during the 2017 and 2018 field seasons, data from earlier physical mark-recapture research conducted 2005 – 2007 in DS (Peacock et al. 2013), and information on harvest recoveries of marked bears. Genetic samples were collected from every bear that was encountered when operating and darting conditions were safe. The east coast of Baffin Island (including offshore islands), parts of the Ungava peninsula and Labrador, are very steep and sampling bears is challenging, especially when the field crews attempted to sample offspring of family groups. In such instances, attempts were made to collect a skin sample of the mother only, rather than all members of the family group, to minimize chase times and to avoid separation of family group members. Regardless of terrain or sampling, all offspring were recorded in the dataset to estimate reproductive parameters.

We obtained genetic material for individual bears from a small sample of skin and hair (< 5 mm diameter) collected via a remote biopsy dart (Pneudart Type C – Polar Bear, Williamsport, PA) fired from a dart gun (Capchur Model 196) from inside a helicopter[2] approximately 3 – 7 m above the ground and targeted at the rump (Pagano et al., 2014; SWG, 2016). Remote marking biopsy darts (Pneudart Type C – Polar Bear, Williamsport, PA) were also occasionally used when multiple bears were present at a given site (e.g., family group). Those darts were identical to the regular biopsy darts except they left a dye mark on the bear upon impact. The biopsy dart automatically falls off the bear after extracting the skin and hair sample via small barbs, thus eliminating the need to physically handle bears to obtain a DNA sample. The darts have relatively low velocity which means that risk of injury to a bear is minimal. Typically, bears show no or little response to the impact of the dart and are left with no obvious mark. In order to facilitate easy spotting of darts on the ground, 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. Alternatively, darts were spray painted bright orange to maximize detection and recovery. Every bear that was encountered and biopsied received a unique field identification number so that the genetic results and our field data could be cross-referenced and linked.

Additional field information included the date, time and location where each bear (or group of bears) was sampled, body condition based on visual assessment using a standardized subjective 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., cub-of-the-year [COY], yearling, 2-year-old, subadult, adult) and sex classification. Field age class and sex were both recorded with a confidence qualifier (e.g., high and low confidence). Dependent offspring were distinguished as COYs, yearlings, and 2-yr olds based on their size relative to their mother. Cues such as body size of the individual bear in relation to its surroundings or group members, body shape and proportions, presence of scars, secondary sexual characteristics, observation of urination, and gait were all used to determine field sex and age class (SWG, 2016; Laidre et al., 2020a, 2020b). When field age class and sex of a bear were initially assessed with low confidence, additional field notes were taken. For example, notes may suggest an alternative field age class and sex if observers were unsure, particularly for difficult-to-discern solitary young subadult male bears and

[2] (we used Bell 206 Long Ranger, Bell 407 or AS350 B2 AStar helicopters throughout this study)

younger adult females. These field observations, together with genetic microsatellite results, allowed us to confirm field-estimated sex and age class. 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 simple habitat characteristics in general, and within, the immediate vicinity (~ 30 m) of an individual bear that may make detection more difficult (e.g., boulders).

Recovering previously marked bears through harvest

Recoveries occurred when a previously sampled bear was recovered through the harvest monitoring program. Both Nunavut and Nunatsiavut polar bear harvest monitoring programs record detailed information about every human-caused bear-mortality and collect a variety of tissue samples (Lee and Taylor 1994, GNL tech reports) while Québec harvest reporting and sampling remains fragmentary. Polar bear harvest data from 2005 to 2018 were included in this study and compiled where possible from Nunavut, Greenland, Québec, and Newfoundland and Labrador. We assumed that the detection and reporting of previously marked bears would vary throughout this period. The detection rate of previously marked bears, through ear tag and tattoo recovery, drops to about 8 - 10% seven to eight years after a physical mark-recapture study has been concluded (Government of Nunavut, unpublished data). This is likely because ear tags are ripped out by conspecifics and tattoos fade, becoming harder to detect by hunters and officers. We assumed that returns of tag and tattoos for bears marked in DS was 100% between 2005 and 2011 and relied on hunter-reports to identify recoveries. After 2011, we used available harvest-collected tissue samples and genotyped those from DS, the neighbouring FB, and BB polar bear subpopulations. Logistical and financial constraints prevented us from using all available harvest samples from the neighbouring BB subpopulation to detect potential DS-marked bears that had been harvested there. Therefore, we restricted our BB harvest sample collection to bears that were harvested within 0 - 400 km north of the DS/BB subpopulation boundary. Sampling of harvested bears in Québec was low between 2005 and 2017 but a sampling program was implemented in in 2017 and 2018 to increase the detection of biopsied bears in the harvest. Sampling of harvested bears in

Newfoundland and Labrador began in 2011 and all samples were made available for this study. For the analyses in this report, we used all available harvest recoveries of bears marked in DS, including those that were recovered in neighbouring subpopulations (Burnham 1993).

Recaptured bears from past subpopulation study

Recaptures represent bears that were previously sampled and subsequently sampled in a later year. All available individuals of the 2005 - 2007 DS study were genotyped. These results (n = 1549) allowed us to determine, through DNA, whether a marked bear from the previous study was also encountered during the 2017 - 2018 genetic mark-recapture sessions.

Sample preparations

We used the same method to prepare all field and laboratory tissues. A small piece of skin (~ 1 - 1.5 mm thick) or tissue was cut from the biopsy sample, the ear plug (e.g., a small tissue core that was obtained when applying ear tags during the 2005 – 2007 study), or the muscle tissue with a new scalpel blade (# 20), transferred onto a shipping card (Avery, 70 x 35mm), and attached with scotch tape. Each sample card was labelled with the unique bear identification number, placed into a coin envelope (57 x 89mm), and left to dry at room temperature for up to three days. The dried specimens were then sent to Wildlife Genetics International Inc. (Nelson, British Columbia) for individual genotyping and sex determination.

Genetic analysis

The tissue samples had DNA extracted using QIAGEN DNeasy Blood and Tissue Kits (Qiagen Inc.) and 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 (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 (Government of Nunavut, 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 matches. Once the genotyping and error-checking was complete, we defined an individual for each unique eight-locus genotype.

Survival analysis

Data Collection

In the early study period (2005 - 2007), polar bears were physically captured following standard chemical immobilization techniques (Stirling et al. 1989). Bears captured during this period were given a unique identification number using an ear tag and upper lip tattoo. Information on the location of the capture along with sex and field age class were recorded. Additionally, genetic samples were collected, and most bears had a premolar tooth extracted for more accurate age determination (Calvert and Ramsay 1998). For the 2017 - 2018 study period, genetic capture-recapture techniques were employed, “marking” the bears using biopsy darts to collect small tissue samples which were later genetically analyzed to determine sex and to assign a genetic individual identification to each bear (Dyck 2017, Dyck and Ware 2018). For all captures in 2017 and 2018, exact age past the yearling classification could not be determined as bears were not physically handled. During surveys conducted in both study periods, bears were assigned a field age class (e.g., subadult, adult). We assigned a numeric age to the unknown-age bears in 2017 - 2018 based on the mean age of known-age bears within the same field age class from 2005 - 2007.

Our analysis also included bears marked in DS that were subsequently shot and reported in DS or adjacent subpopulations, including BB, FB, and Lancaster Sound (LS; Figure 2). Unlike live captures which were constrained to the survey period (August – October), dead recoveries could occur year-round between the live-capture sampling study periods. For the DS data, there was minimal temporal overlap of live-recapture and dead-recovery periods. To ensure that there were no instances of bears being coded as harvested before being observed alive during the sampling period in year *t*, we set harvests recorded before August in year *t* as occurring after the live recapture sampling period in year *t-1*, whereas harvests after August 1 were assumed to have occurred after live-recapture sampling in year *t*.

Hierarchical model structure

We analyzed the capture-recapture-recovery data using a multistate survival model with a marginalized likelihood (Williams et al. 2002, Kéry and Schaub 2012, Yackulic et al. 2020). We developed different multistate model structures for females and males to accommodate the dynamic processes of aging and reaching sexual maturity in addition to transitions between live and dead states. For each sex, the multistate model structure included multiple live states determined by the aging process in addition to two dead states. For females, we considered eight possible states at time *t* that included cub-of-the-year (~ 9 months old and dependent on their mother; COY, state 1), yearlings (state 2), states 3-5 included independent subadults between ages 2 and 4, state 6 included adult females > 4 years old, state 7 included female bears shot and reported dead between time *t-1* and *t* (hereafter, "recently dead"), and state 8 was an absorbing dead state (e.g., "dead"). Because we had 9 years with dead recoveries only, we were unable to model survival of adult females with offspring as separate states because these states were unobservable and thus survival would be inestimable during this time (see Lunn et al. 2016). We set the adult female class to be > 4 years old as most females were first observed with COYs were ≥ 5 years old in the 2005-2007 data set. For males, we considered 11 possible states at time *t* that included COY (state 1), yearling (state 2), independent subadults between ages 2 and 7 (states 3-8), adults > 7 years old (state 9), bears shot and reported dead between time *t-1* and *t* ("recently dead", state 10), and an absorbing dead state (“dead”, state 11). For the males, we included an extended subadult stage because most males begin breeding at ca. 8 years old (Rosing-Asvid et al. 2002, Richardson et al. 2020), at which time they exhibit different behaviours than subadults that could affect survival.

Here, we include the female state transition matrix representing probabilities of transitioning from a true state at time *t* (rows) to a true state at time *t*+1 (columns).

$$
\begin{array}{c}
\\
\text{COY} \\ \text{YRL} \\ 2 \\ 3 \\ 4 \\ \text{AD} \\ \text{Recently dead} \\ \text{Dead}
\end{array}
\begin{array}{c}
\begin{array}{cccccccc}
\text{COY} & \text{YRL} & 2 & 3 & 4 & \text{AD} & \text{Recently Dead} & \text{Dead}
\end{array} \\
\begin{bmatrix}
0 & S_{COY} & 0 & 0 & 0 & 0 & 0 & 1 - S_{COY} \\
0 & 0 & S_{YRL} & 0 & 0 & 0 & (1 - S_{YRL}) * r_F & (1 - S_{YRL}) * (1 - r_F) \\
0 & 0 & 0 & S_{SA} & 0 & 0 & (1 - S_{SA}) * r_F & (1 - S_{SA}) * (1 - r_F) \\
0 & 0 & 0 & 0 & S_{SA} & 0 & (1 - S_{SA}) * r_F & (1 - S_{SA}) * (1 - r_F) \\
0 & 0 & 0 & 0 & 0 & S_{SA} & (1 - S_{SA}) * r_F & (1 - S_{SA}) * (1 - r_F) \\
0 & 0 & 0 & 0 & 0 & S_{AD} & (1 - S_{AD}) * r_F & (1 - S_{AD}) * (1 - r_F) \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
\end{array}
$$

Parameters in the state transition matrix included state-specific probabilities of survival (S) and recovery (r) (i.e., probability of reporting conditioned on mortality). This parameterization refers to the most general model (M1, see Table 2). Classes for survival included cubs-of-the-year (COY), yearlings (YRL), subadults (SA, ages 2-4), and adult females (AD, ages 5+). For recovery, class ‘F’ includes all females ≥ 2 years old. In our dataset, several yearlings (males and females) were recovered just before their second birthday and were also assigned the recovery probability for females. The state transition matrix for males is largely the same with an extended subadult stage (2-7 years old) and male-specific recovery probabilities. Transitions between live states were conditional on survival probability, $S_{x,t}$, defined as the probability that an individual in class *x* survives from year *t* to year *t+1*. Survival probabilities were affected by all sources of mortality, including harvest mortality and natural mortality, and are thus a measure of ‘total’ annual survival. In this framework, the first dead state (“recently dead”) was observable and could be entered at time *t* conditional on the probability of being shot (i.e., $1 - S_{x,t}) * r_{x,t}$) and being reported dead (i.e., recovery, $r_{x,t}$) since time *t-1*. Here, the recovery probability $r_{x,t}$ is equivalent to Seber’s conditional probability of detection for dead individuals (Otis and White 2004). This state could be entered from all but the COY live state because harvest of dependent young is prohibited and no marked COYs were reported as being harvested in our data set. The second dead state (“dead”) was an unobservable absorbing dead state that could be entered from the COY live state with probability $1 - S_{COY}$, entered from the remaining live states conditional on mortality ($1 - S_{x,t}$) and not being recovered and reported ($1 - r_{x,t}$), or entered from the recently dead state with probability of 1. Because we included dead recoveries of bears marked in DS and later shot and reported from anywhere in DS or the adjacent BB, FB, and LS subpopulations, we were able to estimate true probabilities of $S_{x,t}$ decoupled from permanent emigration outside of the capture-recapture survey area (Burnham 1993, Schaub and Pradel 2004).

Our observation model linked the true and observed states. Here, we include the female observation matrix representing the link between true (rows) and observed (columns) states at time *t* after release (COY are ‘recaptured’ for the first time as YRL). Parameters included class-specific recapture probability (p). Classes include adult females and offspring (FO) and subadults (SA) as denoted in the matrix below.

$$
\begin{array}{c|cccccccc|}
 & \text{Seen alive as COY} & \text{Seen alive as YRL} & \text{Seen alive as 2} & \text{Seen alive as 3} & \text{Seen alive as 4} & \text{Seen alive as AD} & \text{Recovered dead} & \text{Not seen o recovered} \\
\text{COY} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
\text{YRL} & 0 & p_{FO} & 0 & 0 & 0 & 0 & 0 & 1\text{-}\ p_{FO}
\end{array}
$$

$$
\begin{array}{r}
2 \\
3 \\
4 \\
\text{AD} \\
\text{Recently Dead} \\
\text{Dead}
\end{array}
\begin{bmatrix}
0 & 0 & p_{SA} & 0 & 0 & 0 & 0 & 1\text{-}\ p_{SA} \\
0 & 0 & 0 & p_{SA} & 0 & 0 & 0 & 1\text{-}\ p_{SA} \\
0 & 0 & 0 & 0 & p_{SA} & 0 & 0 & 1\text{-}\ p_{SA} \\
0 & 0 & 0 & 0 & 0 & p_{FO} & 0 & 1\text{-}\ p_{FO} \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
$$

Specifically, this matrix included the probability of being seen alive in class x (e.g., adult females and offspring (FO) or subadults (SA)) at time t, the probability of being recovered dead in class x at time t, and the probability of not being seen or recovered in class x at time t. The observation matrix for males was largely the same but again included the extended subadult stage (2 to 7 years old). We included r_x in the state transition matrix (Figure 2) instead of the observation matrix to overcome an update problem as described in Kéry and Schaub (2012).

Because the live capture-recapture surveys were conducted intermittently, several years of survival estimates for certain age classes were inestimable when there were no marked bears in the sample because they had aged out of the relevant states. For example, we could not estimate COY survival past 2008 because there were none in the sample (Table 1). In years when survival probabilities were inestimable due to the lack of data, we fixed the parameters to 1. Similarly, we fixed recapture probability (p), to 0 in years without live capture-recapture surveys. These parameter constraints had no bearing on the mean or on the estimates of recapture or survival probabilities in other years.

Parameterization

We constructed a series of candidate models for survival, recovery, and recapture probability with the initial state structure outlined above (see Hierarchical model structure). We conducted model selection for each parameter in a stepped fashion (Table 2). We used this approach to select the top-ranked model structure for each parameter (S, r, p) based on the selected structure for any previously evaluated parameters and a general structure for parameters not yet evaluated. When applicable, each parameter may include the subscript x to indicate the estimates are class specific (defined therein) and may include the subscript t to indicate year-specific estimates.

The parameterization of the most general model (M1) included 4 age classes for survival (COY, yearlings, subadults, adults). For offspring (COY and yearlings), survival was kept constant across time in all models because we lacked the data to model temporal variation. For the subadult and adult classes, we were specifically interested in evaluating temporal variation and modeled survival around a central mean (logit [$S_{x,t}$]) using independent Gaussian random effects for each class on the logit scale: $\varepsilon_{x,t} \sim Norm(0, \sigma_x^2)$. The general model included time-constant estimates of recovery, r_x, for 2 sex classes (females ≥ age 2, males ≥ age 2), and a separate mean recapture probability for 3 age-sex classes (adult females and offspring, subadults, and adult males) with an additive fixed effect β_{year} coefficients for each capture-recapture period to adjust the mean *p* up or down in a non-random fashion with the fixed effect of year to capture temporal variation, resulting in estimates $p_{x,t}$. The parameterization of the initial model (M1) was based on previous studies of polar bears (e.g., Regehr et al. 2010, Lunn et al. 2016), especially the previous DS study by Peacock et al. (2013).

Steps 1 – 3 in the model selection process were focused on identifying the best structure for survival probabilities. First, we compared models for age (Step 1, models M1 and M2) and sex (Step 2, models M3 and M4) structure, followed by alternative models for temporal variation (Step 3, models M5 – M6) while using the best age and sex structure from steps 1 and 2 (Table 2). Using the top model from steps 1 – 3, we then assessed alternative models for temporal variation in recovery probability (Step 4, models M7 and M8) and age-sex structure in recapture probability (Step 5, model M9). Finally, using the best model from steps 1 through 5, we tested alternative models for the effects of environmental covariates on annual survival rates (step 6, models M11 – M17). We describe these steps and models in detail below.

Our first step was aimed at identifying the best model for age structure in survival probabilities. Model M1 included 4 age classes (as described above). The second model (M2) included three age classes: a single class for dependent young (COY and yearlings), subadults, and adults. We note Peacock et al. (2013) found that point estimates of survival for old senescent bears (> age 20) were lower than those for prime-aged adults, however, bears marked or captured in 2017 - 2018 could not be assigned to an adult versus senescent age class and therefore we estimated a common $S_{x,t}$ for all adults (e.g., Regehr et al. 2010, Lunn et al. 2016). Following determination of the best age structure for survival probability, we assessed alternative models to identify the best model for sex-structured survival probabilities (Step 2). These models included either sex-specific survival for the adult and subadult age classes (e.g., 5 age-sex classes, M3) or sex-specific survival for the adult class only (e.g., 4 age-sex classes, M4).

Next, we assessed alternative models of temporal variation in survival using the best model for age and sex structure identified in steps 1 and 2. These models encompassed temporal variation parameterizations for the adult and subadult age classes ($S_{x,t}$) including a mixed effects model with linear time trends and year random effects (M5) and a year fixed effects model (M6). The year fixed effects model (M6) assumes survival is different at each occasion and estimates are independent of one another. We included the year fixed effects model given its common application in the literature and to compare the results to our year random effects general model structure. The use of random effects "shrinks" annual estimates towards the overall mean or trend for a given category of individuals, with greater shrinkage as parameter precision decreases (Royle and Link 2002). This property avoids the fitting of sampling noise as opposed to signal and analogously keeps probability estimates from converging on the boundaries of 0 or 1. Although correlated random effects would also allow for the sharing of information among age classes, we could not consider these because the intermittent capture-recapture sampling resulted in the absence of COY, yearling, and subadult individuals in the sample at different times. We considered the mixed-effects model with linear time trends in logit ($S_{x,t}$) for subadults and adults including stochastic departures ($\varepsilon_{x,t}$) around each trend (M5) according to the random-effects approach described above. The linear predictor for a given age class and the linear trend appeared as $\mathrm{logit}(S_{x,t}) = \beta_{0,x} + \beta_{1,x}Y_t + \varepsilon_{x,t}$, where each $\beta_{0,x}$ is equivalent to logit (S_x), Y_t denotes the year of study scaled to mean 0 and standard deviation of 1, and $\beta_{1,x}$ is the linear trend coefficient for each class, x.

Following steps 1 through 3 which focused on modeling survival, we assessed alternative models for temporal variation in recovery probability (Step 4) and age-sex structure in recapture probability (Step 5). Here, we compared the initial recovery model structure with time-constant, sex-specific recovery rates (r_x) to two alternative models. These models included class specific (M7) temporal random effects (e.g., $\varepsilon_{x,t} \sim Norm(0, \sigma_x^2)$) added to the mean of each r_x on the logit scale or (M8) temporal random effects shared between classes e.g., $\varepsilon_t \sim Norm(0, \sigma^2)$. Next, we compared the initial recapture parameterization with 3 age classes (subadults, adult females and offspring, adult males) and year fixed effects to a model with 4 age-sex classes (subadult males, subadult females, females with offspring, adult males) and year fixed effects (M9) to estimate $p_{x,t}$.

Using the best fit model from steps 1 through 5, we sought to identify the best fit model for explicit measurements of environmental effects on survival. We considered covariates describing sea-ice dynamics, climatic conditions, and prey abundance that could affect survival based on demographic analyses for other polar bear subpopulations (e.g., Lunn et al. 2016). These covariates included the ice-free period length, summer sea-ice concentration, the rate of within-year sea-ice decay, the North Atlantic Oscillation (NAO), the Arctic Oscillation (AO), and harp seal abundance (see below). We assessed models including only single covariates (M10 – M15) and tested two additional models that included multiple covariates (M16 and M17). Specifically, we modeled additive effects of the rate of sea-ice decay and harp seal abundance (M16) and additive effects of the rate of sea-ice decay, the NAO, and the ice-free period length (M17). We did not run additional models with other combinations of covariates primarily because most of the covariates were highly correlated and because the single covariate models had little support. All covariates were *Z*-scored.

Environmental conditions

We calculated sea-ice metrics within the DS subpopulation boundary following the methods employed by Stern and Laidre (2016) using daily sea-ice concentration data from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data available from the National Snow and Ice Data Center (NSIDC, Boulder, CO). These data include daily sea-ice concentrations, or the percentage of the ocean area covered by sea ice within the DS subpopulation boundary. We included two metrics common to polar bear studies: the length of the ice-free period and the mean summer sea-ice concentration. We define and calculate the length of the ice-free period as the number of days between the 50% threshold of sea-ice breakup and freeze-up over the continental shelf (water <300m deep). Mean sea-ice concentration represents the ice available during the summer period between June 1 and October 31. Because polar bears rely on sea ice to access their prey in addition to other critical life-history events, when sea-ice concentration is low and when the length of the ice-free period is extended, polar bears are subjected to dietary fasting with potential deleterious effects on body conditions and subsequently, survival. We also calculated the rate of sea-ice decay following Lunn et al. (2016), which describes how fast the ice disappears every spring and summer. In years when ice disappears rapidly, bears may become stranded and need to travel considerable distances to find suitable habitat. We used the absolute value of the slope of an ordinary least squares regression of sea-ice extent from May 1 until the date when ice concentration reached a threshold low of 16,000 km^2. We set the lower threshold to 16,000 km^2 to accommodate the noise associated with the sea ice data that may indicate sea ice is present when it is not. During the month of September, we expect there to be no sea ice in the DS region, yet, between 2005 and 2018 the sea ice concentration data indicated between 11,000 and 16,000 km^2 of sea ice in the area. The noise in the sea ice data is a product of the scale (satellite imagery grid size) and associated land contamination of ocean grid cells.

The North Atlantic Oscillation (NAO) and Arctic Oscillation (AO) influence regional climate variability and may impact sea-ice dynamics (Heide-Jorgensen et al. 2007) and abundance of prey species for polar bears (Stenson et al. 2016). We extracted the winter (December – March) indices for both the NAO and AO from the National Oceanographic and Atmospheric Administration (NOAA, College Park, Maryland, USA). Further, harp seals are an important prey species for DS polar bears (Iverson et al. 2006, Peacock et al. 2013). Thus, we also included annual estimates of the total population size of harp seals in the Northwest Atlantic as an index of prey availability (Hammill et al. 2021).

Model implementation, fit, and evaluation

We embraced the philosophy of Bayesian statistics and used informative priors where possible (Supplementary Table SM1). Specifically, we used informative Beta priors for subadult and adult survival based on point estimates of total survival probabilities (e.g., includes harvest and natural mortality) from 13 polar bear subpopulations, following the approach of Regehr et al. (2018) (Supplementary Table SM2). Because the prior distributions were based on survival estimates for subpopulations with differing demographic statuses and across the species' range, they corresponded to a range of biologically plausible survival probabilities for polar bear. When relevant for a given model, we included separate prior distributions by sex within the subadult and adult age classes. We used moment-matching to convert the informative means and standard deviations to shape and scale parameters for the respective *Beta* prior distributions (Hobbs and Hooten 2015). We used vague priors for all other parameters (Table SM1). Further details regarding the sensitivity of estimated parameters to the choice of priors are provided in the supplement.

To estimate all parameters in our multistate models, we multiplied the marginalized likelihood for the capture-recapture-recovery data ($\mathbf{m}$) and prior probability distributions using Bayes' theorem to attain the joint posterior distribution, for example:

$$\Pr(\mathbf{S}, \mathbf{p}, \mathbf{r}, \boldsymbol{\beta} | \mathbf{m})$$

where bold font denotes matrix notation that encapsulates age, sex, and time parameterizations. We sampled posterior distributions of the capture-recapture-recovery parameters using a Markov chain Monte Carlo algorithm (MCMC, Gelfand and Smith 1990) in JAGS 4.3.0 (Plummer 2017), run from the jagsUI package (Kellner 2015) in program R (R Core Team 2019). We ran three MCMC chains for 20,000 iterations in JAGS and discarded the first 16,000 as burn-in. We then thinned the samples to retain a total of 6,000 posterior samples for each parameter. The multiple MCMC chains allowed us to use the Gelman and Rubin (1992) $\hat{R}$ statistic (we sought $\hat{R}$ values < 1.10) along with trace plots to monitor chain convergence.

To score the relative within-sample predictive abilities of our multistate capture-recapture-recovery models with different parameterizations, we used the Watanabe-Akaike information criterion (WAIC; Watanabe 2010). In practice, we monitored the log-likelihood for each **m**, combined them into a joint likelihood, and then applied the *waic* function in the *loo* package for R (Vehtari et al. 2020).

Unlike other studies (see Lunn et al. 2016), we modeled the survival of adult females and offspring independently due to the extended period between capture-recapture surveys where the 'state' (with or without offspring) of adult females was unobservable and therefore unknown. Because the survival of offspring is dependent on the survival of their mothers, we calculated an overdispersion factor ($\hat{c}$) following methods employed by Taylor et al. (2009). We calculated $\hat{c}$ as the ratio of live observations of offspring (*nc*) to total live observations (n) where $\hat{c} = n/(n - nc)$ to serve as a rudimentary measure of goodness of fit due to a lack of independence.

Supplementary survival analyses

Finally, we wanted to assess the effects of prior choice and explore an additional model that is more commonly employed in the polar bear literature. Full methodological descriptions and results are included in the Supplementary Materials. The model included the same general structure as model M2 but did not include year random effects on subadult or adult survival (i.e., constant survival). We did not use this model for inference but report the results in the supplementary material and compare these results to those from model M2 in the discussion below. This model was fit using the same methods described above.

Reproduction

We calculated reproductive indices for polar bears in DS using data from physical and genetic mark-recapture surveys in 2005 - 2007 and 2017 - 2018, respectively. We summarized metrics identified as important for monitoring polar bear populations as outlined in Vongraven et al. (2012) and subsequently reported as indices of productivity in other studies (Peacock et al. 2015, Regehr et al. 2015). Specifically, we tallied the annual number of litters and mean litter sizes of COYs and yearlings, the ratio of the number of COYs and yearlings to adult females, the ratio of the number of females with COYs to the number of adult females in the subpopulation and summarized COY litter size by study period to compare to estimates from earlier analyses (Peacock et al. 2013). Because the data were collected intermittently, in our multistate model for survival we could not parse out the differences in recapture rates between females with and without offspring. Therefore, we calculate the reproductive metrics using the raw capture-recapture data and report only point estimates. Further, we did not consider the effects of environmental covariates on reproduction metrics because the final study period included only two years of data.

Abundance

As in other polar bear studies (McDonald and Amstrup 2001, Taylor et al. 2002, Peacock et al. 2013), we estimated annual abundance using the Horvitz-Thompson estimator: $\widehat{N}_t = c_{x,t}/\hat{p}_{x,t}$, where $c_{x,t}$ refers to the number of bears captured in class x (inclusive of recaptures) within a year t and $\hat{p}_{x,t}$ is the estimated probability of detection for class x in year t based on recapture probabilities according to age and sex class (Steinhorst and Samuel 1989, Williams et al. 2002). An advantage of the Bayesian analysis was our ability to use posterior distributions for the estimated $\hat{p}_{x,t}$ from our multistate capture-recapture-recovery model that best predicted the data (see Table 2) to ‘derive’ exact posterior distributions for $\widehat{N}_t$ with no need to approximate sampling variance with the delta method (e.g., Huggins 1989, Borchers et al. 1998). We define abundance here as the actual realized number of bears within this subpopulation (e.g., expected number of bears within the DS boundaries at these time periods).

Due to weather and logistical challenges during 2017 and 2018, sampling was not completed on Edgell or Resolution Islands. In 2018, a region around Loks Land in addition to Edgell and Resolution Islands could not be sampled due to inclement weather (Figure 4). During the 2005 - 2007 sampling period all these regions were comprehensively sampled with a considerable number of bear encounters. To determine the effects of differences in sampling on estimates of abundance, we subset the 2005 - 2007 live-capture data to remove captures that occurred within the areas that were not sampled in later years. We produced two geographic data subsets, one that removed just Edgell and Resolution Island samples, and another that also removed samples from the unsampled area around Loks Land to adjust for the year-specific unsampled areas. We fit our top model without covariates on survival (M8) to these two data sets. Following methods employed for similar issues with the Baffin Bay abundance estimate (SWG 2016), we compared estimates of abundance from using the full data set versus the geographic subset data to inform potential biases from incomplete sampling. Thus, we assumed that $\widehat{N}_{2006-2007}^{subset\ data}/\widehat{N}_{2006-2007}^{full\ data} \approx \widehat{N}_{2017-2018}^{subset\ data}/\widehat{N}_{2017-2018}^{full\ data}$, where the ratio of abundance estimates from the subset data in the early period $\widehat{N}_{2006-2007}^{subset\ data}$ to the full data in the early period $\widehat{N}_{2006-2007}^{full\ data}$ would provide an inflation factor that we could use to adjust the estimates of abundance for the later period $\widehat{N}_{2017-2018}^{subset\ data}$ for what we expect would have been obtained if the complete sampling area had been covered $\widehat{N}_{2017-2018}^{full\ data}$. We completed this using the two geographic subsets and adjusted the estimate in 2017 for missing Edgell and Resolution Islands and adjusted 2018 for missing Loksland in addition to Edgell and Resolution Islands. We calculated the geometric mean subpopulation growth rate (λ) between 2006 and 2018 as $\lambda = (N_{2018}/N_{2006})^{1/12}$ to generate the finite growth rate over this time period.

Body Condition

We compiled body condition index (BCI) data from the two distinct time periods of mark-recapture sampling in DS to allow inference on trends. Bears were assigned a BCI on a scale of 1 - 5 with 1 being skinny and 5 being obese (Stirling et al. 2008) through physical handling and capture (2005 - 2007) or aerial observation during biopsy sampling (2017 - 2018). All BCI observations occurred in fall (August through October) during the ice-free period in DS. Sex, age, and reproductive classes were assigned during physical handing during 2005 - 2007 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 (Atkinson et al. 2021, Dyck et al. 2020a, Dyck et al. 2021). 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 BCI data were summarized into 3 classes: 'poor' (1–2), 'average' (3), and 'good' (4–5) to facilitate comparison with other studies (Laidre et al. 2020a, b; Dyck et al. 2020a, Dyck et al. 2021). We did not include dependent offspring in the BCI 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. Observations collected during the 2005 – 2007 study and the 2017 – 2018 study were combined into their respective sampling periods ($period_{early}$ and $period_{later}$) to facilitate comparison over time. We combined reproductive status (i.e., with or without offspring), age, and sex into a four-level categorical variable *reproclass* (ADM = adult male, ADFI = independent adult female, ADFWO = adult female with offspring, and SUB = subadults of both sexes). Body condition varies among sex and age classes, most notably for females with dependent offspring generally being in poorer body condition that single bears of either sex (Rode et al., 2012; Laidre et al., 2020a, Dyck et al., 2021). To evaluate potential effects of ice availability on body condition, we included the covariate *ts.springtran,* which represented the length of time, in days, between sea-ice retreat and when we observed the animal, similar to previous studies (Laidre et al. 2020a, Obbard et al. 2016). Longer durations with reduced ice and open water were predicted to be negatively associated with body condition. Sea-ice retreat date was calculated as described above (See Data Analysis: Environmental conditions).

The first decision that had to be made before statistical analysis could begin was how to model the three-category ordinal scaled outcome variable, BCI. The primary criteria were that any resulting analysis be not only statistically correct in the sense of adhering to statistical model assumptions, not be overly simplistic at the expense of foregoing useful descriptions of the results and would yield interpretable results for managers. We identified three possible approaches. The first was to fit an ordinal logistic regression as described in detail in Section 8.2 Hosmer, D.W., Lemeshow, S. and Sturdivant, R.X. (2013). The second approach used a binary classification that recoded BCI into two categories: Y = 1 if BCI was good or average and Y = 0 if BCI was poor. The third approach was to use the multinomial logistic regression model.

We rejected the ordinal logistic regression model as the data did not satisfy a key assumption, the parallel regression assumption, which states that the coefficients are the same for relationships between categories of the response variable. In this case, that would mean the relationship between being average to good body condition would be equal to comparing good to poor body condition. We rejected the binary logistic regression model, as it would not allow separate results for the good versus poor and average versus poor, which may be of interest to managers. Thus, the model we used was a full 3 category multinomial logistic regression model which yielded probabilities of inclusion in the poor, average, and good classes.

Multinomial logistic model development followed the methods described in Chapter 4 of Hosmer et al. (2013). Key steps in this process addressed the need for interactions between model covariates that made sense biologically. A second modeling issue addressed was to check the linearity on the logit assumption for continuous covariates in the model (*ts.springtran);* no fractional polynomial transformation was significantly better than linear, indicating that a linear term was the best fit (Hosmer et al. 2013). The final model: $BCI_{it} = \beta_0 + \beta_1\ period_t + \beta_2\ ts.springtran_{it} + \beta_3\ ADFW0_{it} + \beta_5\ ADM_{it} + \beta_6\ SAF_{it} + \beta_7\ SAM_{it} + \beta 8\ period_t{:}ADFWO_{it} + \beta_9\ period_t{:}ADM_{it} + \beta 10\ period_t{:}SAF_{it} + \beta 11\ period_t{:}SAM_{it}$, was evaluated for its goodness of fit using the multinomial model extension of the Hosmer-Lemeshow test (Fagerland and Hosmer, 2012). Results are presented by inverting the logit model, using *predict* function within package nnet in R, to calculate predicted probabilities (package nnet; Venables and Ripley, 2002).

RESULTS

General overview

We spent an average of 350 hours flying within the study area in search of bears during each of the 2017 and 2018 field seasons. Search operations were conducted between August and early October each year (i.e., when the sea ice is at its minimum in DS and most bears are onshore) along coastlines, inside fiords, over land and across near-shore islands, with an average distance flown of about 35,300 km per field season. The number of bears encountered during each survey season was similar, with a mean of 670 observed bears per field season.

Samples examined

During the 2017 - 2018 study periods, we encountered 1,343 polar bears, of which 1,139 were biopsied. The overall genotyping success rate from these samples was ~ 98% (n = 1,116). Field crews identified 493 male and 442 female solitary polar bears. The sex was correctly determined for 407 males and 368 females (or roughly between 82-84%) by aerial inspection based on verification via genetics. Subadult males were commonly misidentified as adult females (e.g., up to 70%; Government of Nunavut, unpublished data), and young adult females were often mis-classified in the field as subadult males (M. Dyck, personal obs). Field notes and sex identification through genetics aided in assigning age classes with high confidence.

From our field biopsy samples, we identified 34 individuals that were previously sampled in BB between 2011 - 2013, 177 individuals that were handled during the 2005 - 2007 DS study, and 669 new individuals that we sampled during 2017 and 2018. Of all biopsied bears in 2017, 110 were re-sampled during the 2018 field season. Re-sampling of bears within the same field season was relatively low with approximately 29 bears and 50 bears in 2017 and 2018, respectively, sampled more than once. Biopsy sampling leaves no visible marks on the individual animal unlike traditional mark-recapture studies (e.g., Peacock et al. 2013); thus, it is impossible to avoid some re-sampling, unless every sampled bear receives a dye mark.

Through the harvest sampling program, we submitted 1,623 tissue samples for genetic analysis, representing kills between 2006 - 2018 from DS and neighboring subpopulations (n = 445 BB, n = 460 DS, n = 718 FB). Sixty-four of these samples were unfit for genetic testing. The genotyping success rate of harvest samples was approximately 96.0%.

Survival

Our live-capture dataset consisted of 2,513 individuals (1,201 females, 1,312 males) collected in 2005 - 2007 and 2017 - 2018. We included 233 harvested bears (42 females, 191 males) as dead recoveries reported between 2005 and 2018 (Table 1). Of these dead recoveries, 22 bears were harvested in BB, 11 in FB, 1 in Lancaster Sound, and 199 in DS (Figure 2). A total of 681 individuals in our data set were of unknown age and were assigned the mean numeric age of known age bears within a field age class. The post-hoc test for overdispersion related to the lack of independence between females and offspring resulted in a $\hat{c} = 1.30$. Convergence was attained for all estimated parameters in all models ($\hat{R} < 1.02$) and trace plots indicated mixing among stationary chains.

We report results from the best fit model, M2, which we used for inference (Table 2). The best fit model included 3 age-sex classes and year fixed effects for recapture probability. Further, accounting for differences in recovery by sex (independent males, independent females) and constraining the estimates to remain time constant provided the best fit of the models we tested. The best model for survival included a time-constant estimate for offspring (COY and Yearlings), and separate means for subadults and adults with separate year random effects. No environmental covariates investigated for their effects on variation in survival were included in the top model, suggesting that interannual variation in survival was not related to the environmental covariates consider in our analyses.

Using combined capture-recapture-recovery data, we were able to estimate survival in all years (2005 - 2017) for adult bears (Figure 5). Estimates of survival for younger age classes were limited to years following releases based on the number of years individuals could remain within that age/sex class and be recaptured or recovered through harvest (Table 1, Figure 5). Mean survival rates were 0.794 (95% Credible interval (CRI); 0.723, 0.861) for offspring, 0.873 (95% CRI; 0.826, 0.914) for independent subadults, and 0.871 (95% CRI; 0.853, 0.892) for adults (Table 3). Mean estimates of survival for adults and subadults represent the long-term average or "global" mean survival for individuals in these age classes for this subpopulation. Annual departures are modeled as temporal random effects around this mean thereby producing annual estimates of survival for adults and subadults.

Mean recapture rates in the first year (e.g., 2006) were 0.383 (95% CRI; 0.327, 0.443) for subadults, 0.489 (95% CRI; 0.434, 0.544) for adult males, and 0.338 (95% CRI; 0.291, 0.390) for adult females and offspring (Table 4). The fixed effects of year indicated a negligible difference between recapture rates in 2006 and 2007 ($\beta_{2007} =$ -0.026; 95% CRI -0.248, 0.19) (Figure 6). However, the fixed effects of year indicated recapture rates were lower in 2017 ($\beta_{2017} =$ -0.456; 95% CRI -0.810, -0.108) and 2018 ($\beta_{2018} =$ -0.189; 95% CRI -0.469, 0.089) than in 2006 (Figure 6). Annual estimates of recapture probability are available in Table 4. Mean recovery rates (i.e., probability of reporting conditioned on mortality) were 0.072 (95% CRI; 0.053, 0.093) for females and 0.248 (95% CRI; 0.215, 0.282) for males (Table 3).

Abundance

The comprehensive data set used to estimate abundance in 2006, 2007, 2017, and 2018 included 2,226 individuals. The geographic subset data used to adjust abundance in 2017 included 2,163 individuals. The geographic subset of data used to adjust abundance for 2018 included 1,995 individuals. Parameter estimates (survival, recovery, and recapture) from the models fit with the geographic subsets of data were consistent with the comprehensive data set.

Annual estimates of abundance for the DS subpopulation were 2,190 (95% CRI 1,954 – 2,454) in 2006, and 2,311 (95% CRI 2,111 – 2,536) in 2007. After accounting for the incomplete sampling adjustment, estimates were 2,085 (95% CRI 1,613 – 2,699) in 2017 and 1,944 (95% CRI 1,593 – 2,366) in 2018 (Figure 7, Table 5). Geometric mean subpopulation growth between 2006 and 2018 was 0.989 (95% CRI 0.974 – 1.010) and the probability that subpopulation growth was <1 (e.g., declining) was 0.896 indicating the subpopulation likely declined by at least one bear over this period but stability could not be ruled out. The mean estimate for the first sampling period (2006 – 2007) was 2,250 (SD = standard deviation = 133; 95% CRI 1,989 - 2,512). The mean estimate for the second period (2017 and 2018) was 2,015 bears (SD =251; 95% CRI 1,603 - 2,588). Our estimate of abundance for the first study period (2006 – 2007) fell within the estimated confidence intervals of abundance between 2005 and 2007 reported by Peacock et al. (2013) (Table 5, Figure 7).

Reproduction

We observed a total of 231 adult females with COYs and 215 adult females with yearlings across all sampling years (2005 - 2007 and 2017 - 2018) (Table 6). Here, we report the overall and sampling period means and standard errors as the mean of the annual estimates and the standard error of the mean annual estimates. The overall mean COY litter size across all years was 1.43 (standard error of the mean [SE] = 0.039) and varied between 1.44 (SE 0.05) in the first study period (2005 - 2007) to 1.42 (SE 0.03) in the second study period (2017 - 2018) (Table 6). The overall mean yearling litter size was 1.53 (SE 0.088) and varied between 1.52 (SE 0.037) in the first study period and 1.54 (SE 0.17). Mean COY recruitment (e.g., number of COYs per adult females) ranged from 0.23 to 0.45 and mean yearling recruitment (e.g., number of yearlings per adult female) ranged from 0.23 to 0.41 (Table 7). The ratio of the number of females with COY litters to the number of total adult females varied annually and ranged from 0.16 in 2007 to 0.32 in 2017 (Table 7).

Body condition

Observations of BCI were taken on 1911 bears from 2005 - 2007 and 895 bears from 2017 - 2018 from early August to early October (Table 8). Bears were less likely (Wald z test $P < 0.001$) to be in poor body condition in the 2015 – 2017 sampling period. On average, bears observed in 2005 – 2007 had a 25% chance of being in poor body condition and 8% chance during 2017 -2018. (Figure 8, Table 9). Adult males and adult independent females were more likely to be in better body condition than subadults or females with offspring. On average, adult males and independent adult females had a 40% probability of being in good condition while subadults had 12% probability and females with offspring had a 5% chance of being scored as good condition, regardless of when they were observed (Figure 9). Overall, bears sampled later in the season were less likely to be in good body condition for a given year (Wald z test $P < 0.05$; Figure 9).

DISCUSSION

General

This study reports subpopulation abundance, survival, subpopulation growth, reproductive indices and body condition using the data from surveys conducted in the DS polar bear subpopulation between 2005 - 2007 and 2017 - 2018 along with dead recoveries of harvested bears from 2005 - 2018. Moreover, we evaluate the effects of environmental covariates on DS polar bear survival and body condition. We provide updated estimates of abundance, survival, reproduction, and body condition that can be used to inform harvest management.

Abundance

We estimated abundance in 2006, 2007, 2017, and 2018 to compare to estimates from previous analyses (Peacock et al. 2013) and provide updated estimates for use in harvest management. Again, we define abundance here as the actual realized number of bears within this subpopulation (e.g., expected number of bears within the DS boundaries at these time periods). Peacock et al. (2013) estimated abundance for the combined period of 2005 – 2007 at 2,158 (95% CI 1,833 – 2,542). Our annual estimates and early study period estimate fell within the confidence limits of these estimates even with major differences between our datasets (more years of data) and minor differences in analytical methods (Table 3, Figure 7). We estimated abundance in the most recent sampling period (2017 - 2018) by adjusting for incomplete sampling following an approach used to adjust for sampling differences in Baffin Bay (SWG 2016, Atkinson et al. 2021). Fortunately, the unsampled area included a relatively small portion of the total bears encountered in the DS and represented, at maximum, a difference of 7% between the adjusted and unadjusted estimates. The geometric mean growth rate between 2006 and 2018 indicates the subpopulation has most likely declined (mean = 0.989; 95% CRI 0.974 – 1.010), which suggests that the Nunavut management objective to decrease the subpopulation over this period was met to some degree. Harvest management varies across jurisdictions. The total allowable harvest in Nunavut was increased in 2013 from 46 to 61 bears per year based on traditional knowledge of increased abundance. However, the reported removal only increased by 13%, to 44.2 bears per year. Newfoundland and Labrador also increased the total allowable harvest from 6 to 12 bears annually over a similar period. While there are no quotas or mandatory reporting in Québec, of the bears reported removed, there was an increase over this time. The DS harvest quota was 73 (NL, NU) + 3 (Greenland) + QC with a reported annual mean removal of 86.8 bears in 2009 - 2019 compared to 64.1 during 1998 - 2008 (Table 10). Thus, it is possible that harvesting impacted abundance between our two study periods (2005 - 2007 and 2017 - 2018). However, the upper 95% credible interval of geometric mean growth rate overlaps 1, indicating there is a 0.104 probability that the subpopulation remained stable or increased over this period and a 0.896 probability that the subpopulation declined. These estimates currently represent the best-available science and are suitable for informing management.

Survival

Capture-recapture data were collected intermittently, and recapture probabilities were estimable for a total of 4 years across two sampling periods. In our top model (M11), recapture probability varied annually and across three age-sex classes which was consistent with the age-sex class structure used in previous analyses (Peacock et al. 2013). However, we note that Peacock et al. (2013) included a geographic component to model variation in survival (*S*), recovery (*r*), and recapture (*p*) probability as a function of a bear's initial capture location (e.g., North, Central, and South Davis Strait). We did not incorporate a geographic component in our models because we did not believe there was sufficient evidence to support 3 distinct subpopulations within the DS region, and furthermore, did not want to reduce sample sizes which would limit the scope of inference. Recapture rates of adult males were, on average, higher than those estimated for subadults or females and offspring, a finding consistent with previous analyses (Peacock et al. 2013). Recapture rates may vary by sex due to sex-based habitat segregation. Overall, recapture rates were higher in the first sampling period (2006 and 2007) than in the most recent sampling period (2017 and 2018). These results may reflect the change in capture methods (e.g., physical versus genetic) and/or a decline in survey effort. Estimates of recapture probabilities in the 2017/2018 period were less precise than those in the 2006/2007 period which is consistent with the extended interval between capture-recapture surveys. Recapture rates for Davis Strait polar bears are high compared to other subpopulation surveys (e.g., Lunn et al 2016). We suspect this is related to the particularly large number of individuals marked over a relatively short period of time (n = 2,513) and known late summer / fall concentration of bears on the northernmost portion of the Labrador Peninsula and Button Islands (Government of NL, unpublished data).

Our top model for recovery probability included 2 sex classes and was time constant. In contrast, Peacock et al. (2013) included a time period effect and an additional class to account for females harvested along with their offspring. Here, we did not consider an additional class for females with offspring because management systems preclude harvesting of family groups and during this period no marked females with COY were harvested. Several yearlings were harvested; however, they were likely independent at the time of harvest because they would have been > 1.5 years old and exhibited behaviours more like subadults than offspring. Furthermore, recovery rates were considerably higher for independent males than for independent females, consistent with male-biased harvest and estimates from earlier analyses (Peacock et al. 2013).

Our top model for survival and estimates therein differed from those in the previous analysis. In contrast to previous work, we found no support for differences in survival between COY and yearling or for sex-specific survival rates for any age class. Further, we did not explore geographic variation in survival rates. However, the point estimates of survival by geographic region were similar (Table SM2 and see Peacock et al. 2013) and we do not expect this to be a significant source of variation in survival. Though our point estimates of survival fall within the 95% confidence levels reported in Peacock et al. (2013), they are generally lower than those estimated for the overlapping period between these two studies (2005 - 2008) and we expect there are two possible explanations. The use of fixed effects to model full temporal variation in survival can bias estimates towards the boundaries (e.g., 0 or 1) when data are sparse (Kéry and Schaub 2012). The use of "time-binning", or averaging, estimates over a subjective time length is commonly implemented to overcome this issue while still accounting for some temporal variation (e.g., Peacock et al. 2013). However, because years with more data can have a strong influence on the mean estimate over the defined period, relative to true temporal variation, this approach can induce further bias (Koons et al. 2019). Considering Peacock et al. (2013) had separated the data into geographic regions, thus limiting sample size, and then used a time-binning approach, it is possible that the resulting point estimates of survival were biased high. Second, Peacock et al. (2013) included only known-age bears, and thus they were able to model adults (<20 years old) separately from senescent bears (≥20 years old). Survival estimates of senescent bears (≥20 years old) from DS and other subpopulations (e.g., Lunn et al. 2016, Peacock et al. 2013) are generally lower than those of prime-age adult bears (5-20 years old). Because the final two years of this data set are from non-invasive genetic captures only, we no longer have the information necessary to age-classify bears with that resolution. Thus, including the senescent bears with prime age adults likely reduced the overall estimate of adult survival. Finally, negative bias in survival estimates may occur at the end of a time series due to temporary emigration from the study area. Though we expect high site fidelity to the management region during the ice-free period, it is certainly possible that individuals had moved temporarily outside of the study area inducing negative bias on survival estimates. However, if this were the case, we would expect to see a decline in the annual estimates for adult bears in the final years of the study which did not occur.

Posterior estimates of survival for subadults were less precise and more variable than those for adults. While we expect subadult survival to be more variable than that of adults, the sample sizes of subadult bears were generally lower than adults, and without physical recapture to age the bears misclassification could have further contributed to the level of uncertainty in our estimates (e.g., some adult bears classified as subadults) (Figure 8, Table 4). The effects of sample size and the time between study periods were reflected by the imprecision or lack of subadult survival estimates in the years right before the second study period (Figure 5). Our survival estimates of offspring (COY and yearlings) were lower than estimates from the neighboring BB subpopulation (Atkinson et al. 2021) and those produced in the previous DS analysis (Peacock et al. 2013). Due to the intermittent surveys, we were unable to estimate annual survival rates for offspring and subsequently could not explore the effects of environmental factors on this sensitive life stage.

We tested a series of survival models including environmental covariates that have been evaluated across other polar bear studies. Previous research identified harp seal abundance and mean summer sea-ice concentration to be important predictors of DS polar bear survival (Peacock et al. 2013). In contrast to findings from Peacock et al. (2013), we were unable to detect a relationship between harp seal abundance or summer sea-ice concentration and survival. We should note that Peacock et al. (2013) analyzed data between 1974 and 2008, over which time harp seal abundance increased considerably (Hammill et al. 2021). While harp seal abundance increased between 2005 and 2018, numbers remained consistently high (> 5 million seals) (Hammill et al., 2021). Thus, we expect that when harp seal abundance was increasing over time this may have contributed to an increase in DS polar bear survival; however, now that harp seal abundance has stabilized, it likely has a less detectable influence on changes in polar bear survival. Peacock et al. (2013) identified support for a positive effect of mean summer sea-ice concentration on survival when the concentration was between 17% and 29%, however, mean summer sea-ice concentration did not exceed 8% within our study period. We investigated the relationship between sea-ice decay rate and survival following Lunn et al. (2016). Similarly, we found no relationship between DS polar bear survival and rate of sea-ice decay. Furthermore, we found no effect of the number of ice-free days on survival. The NAO and AO winter indices are strong indicators of sea-ice extent during the spring to summer period (Stern and Heide-Jorgensen 2003, Heide-

Jorgensen et al. 2007) though neither index had any detectable effect on polar bear survival in our independent or additive models.

For polar bears, modeling patterns of temporal variation in survival is a key step towards understanding how harvest and environmental change can affect subpopulation dynamics. For the DS subpopulation, we used sparse data to make inferences about temporal variation in survival and investigate relationships between survival and environmental conditions. Large sample sizes of marked and recovered bears allowed us to explore temporal variation in a more explicit manner than previous analyses (e.g., Baffin Bay [SWG 2016]). Specifically, within our modeling framework we were able to incorporate year-specific random effects on survival and were not limited to time constant or time binned estimates. Treating year effects as random variables generates estimates influenced primarily by the long-term mean and annual variance. Estimates deviate only when data support it, which is particularly advantageous in sparse data situations (Royle and Link 2002, Koons et al. 2019). The main benefit of using a random effects approach for modeling survival was the opportunity to estimate the percent of temporal variation explained by the addition of covariates (Kery and Schaub 2012). However, our analysis did not find a significant relationship between survival and any of the environmental covariates we tested. To contrast with our random effects approach, we ran an additional model (supplementary material, Table SR2) similar to model M2, but without year random effects for survival. The model was more parsimonious in that the WAIC values was substantially lower than those reported for our top model likely due to the reduction in the number of parameters (i.e., no year random effects). Despite the structural differences, the results from the time-constant model were consistent with its counterpart (M2). Specifically, there was considerable overlap between the posteriors for comparable parameters (Table SR2). There are several advantages to using random effects and mixed effects models; however, we note that the time-constant and fixed effects covariate models delivered comparable results and were more parsimonious.

Here, we present an improved analytical approach assessing a series of models that built upon previous analyses. The duration of the surveys and time between surveys ultimately limited our ability to make complete inference about temporal patterns in survival of all age-sex classes. Specifically, we were unable to model temporal variation in offspring survival and could not estimate survival for subadult polar bears in 2015 and 2016. We had a large sample of known-age bears from the initial capture period which was conducted with physical capture techniques and included marking COY. However, we could no longer estimate survival separately for adults and senescent bears. Moving forward with genetic mark-recapture only, we will lose more critical age-specific information and will not be able to estimate age-specific survival rates with the same degree of resolution that is possible during physical capture-recapture studies that provided numeric ages based on counts of cementum annuli. Future analyses may need to rely on field classifications, which are prone to error (Nunavut unpublished data) and may require more complex models to accommodate such uncertainty (e.g., multievent models [Pradel 2005]). Alternatively, we will need to further reduce model complexity and limit the age/sex classes to dependent and independent (e.g., <2 and >2 years old) which has been required for other polar bear subpopulations). While genetic mark-recapture has significant benefits, most notably lower intrusiveness and less stress on the bears, the implications of forgoing age-specific survival estimations needs to be acknowledged and carefully considered as part of study design and methodological processes. Integrating auxiliary data sets (e.g., sex-specific age-at-harvest data, harvest counts, satellite telemetry) may offer a considerable opportunity to estimate demographic rates more precisely when other data are sparse or intermittently collected.

Reproduction

We calculated reproductive metrics annually and by study period where possible. Drawing conclusions about how reproductive metrics differ between the two study periods is challenging because of the change in survey methods and sample sizes. Here, capture-recapture surveys were conducted during autumn and thus reproductive metrics cannot be compared to those estimated for populations surveyed in the spring because we do not have information on COY mortality between 0 and 9 months. Though it is difficult to compare reproductive metrics across subpopulations due to differences in sampling and analytical methods, estimates of COY litter size in DS in the previous study were the lowest of any other subpopulation studied during the autumn (Peacock et al. 2013). We calculated COY litter size to compare to previous estimates as the number of COYS divided by the number of adult females with COYS where our sample size reflects the number of adult females with COYS in our sample. Peacock et al. (2013) estimated COY litter size for the period between 2005 - 2007 as 1.49 (SE 0.14, n = 116). Over the same study period, we estimated COY litter size to be 1.43 (SE 0.05, n = 130) (Table 6). Our estimate of COY litter size for the 2017 - 2018 period was 1.42 (SE 0.03, n = 102), which is very similar to our estimate in the previous period. Overall COY litter sizes for the DS subpopulation remained lower than estimates for other subpopulations including Baffin Bay and Western Hudson Bay, both seasonal ice populations (Laidre et al. 2020a, Lunn et al. 2016). Peacock et al. (2013) did not report yearling litter size; thus, we cannot compare our estimates to previous estimates for the DS subpopulation. However, our estimates of yearling litter size (Table 6) are generally consistent with those estimated for Baffin Bay between 1993 and 2013 (Laidre et al. 2020a).

Recruitment of COY (e.g., ratio of COY to adult females) is considered an important reproductive metric to monitor for polar bear populations (Vongraven et al. 2012). Our estimates of COY recruitment ranged between 0.23 and 0.45 and are substantially lower than those estimated for Baffin Bay across the time period 1993 - 2013 where values ranged between 0.55 and 0.83 (Laidre et al. 2020a). However, low rates of COY recruitment are consistent with low COY litter size in DS. Yearling recruitment (e.g., the ratio of yearlings to adult females) can be used as an indicator of population persistence (Regehr et al. 2017a). Studies indicate that yearling recruitment rates between 0.1 and 0.3 are sufficient for subpopulation persistence provided sufficiently high survival probability (Regehr et al. 2017a). Our estimates of yearling recruitment varied between 0.23 and 0.41 across our study period (2005 – 2018). These values are less variable but generally consistent with estimates from BB for the period between 1993 and 2013 (Laidre et al. 2020a). Despite low COY litter size, the recruitment of yearlings is seemingly adequate to sustain a viable DS subpopulation, although further demographic analyses are necessary to assess the subpopulation growth rates that would follow from the estimates of reproduction and survival in this study (Regehr et al. 2017a, Laidre et al. 2020a). Insight into reproductive dynamics for the DS are limited due to intermittent capture-recapture surveys. Increasing the duration of the survey periods may help provide further insight into annual variation in productivity, effects of environmental conditions on productivity, and how reproduction affects overall subpopulation dynamics.

Body condition

Observations collected during 2017 – 2018 reveal bears in DS were in better body condition than during surveys in 2005 - 2007. Similar improvements in body condition for polar bear subpopulations have been noted during studies in the last 10 years (e.g., 2011 - 2018), including Kane Basin (Laidre et al. 2020b), Gulf of Boothia (Dyck et al. 2020a), and M'Clintock Channel (Dyck et al. 2021). These subpopulations represent a range of ecosystems, though all have some amount of ice that persists through the summer and fall, whereas DS experiences a mostly ice-free summer (Stern and Laidre 2016).

Like other subpopulations, females with offspring were most likely to be in poorer body condition while adult males and independent females had the highest probabilities of being in good body condition (Laidre et al. 2020b, Rode et al. 2014, Dyck et al. 2020a, Dyck et al. 2021), though this relationship may vary seasonally or by ecosystem (Laidre et al. 2020a). Over the past 10-15 years, harp seal numbers in Davis Strait remained abundant (Hammill et al. 2021) and their availability likely contributed to improved polar bear body condition. Moreover, the annual DS harvest rate after 2008 increased from 64 to 86.8 bears and may have indirectly affected body condition of bears by reducing subpopulation density.

MANAGEMENT IMPLICATIONS

Through this study we demonstrated that sample sizes were sufficiently large for estimating annual survival rates for adult polar bears given the number of dead recoveries between the two capture-recapture periods. However, the duration of time between capture-recapture surveys (10 years for this subpopulation) ultimately limited our ability to make complete inference about annual changes in survival (e.g., inestimable for offspring and subadults in certain years) and resulted in less precise, estimates of recapture probability in the later survey period following an extended interval without capture surveys and therefore a diminished sample size of marked bears available for recapture. Subsequently, estimates of abundance in the later survey period, particularly in the first sampling year, are imprecise, limiting our ability to estimate trends in abundance over the time series. The negative effect of long periods between sampling efforts on obtaining more precise parameters and subpopulation demographics to inform management has also been noted recently for other subpopulations (Dyck et al. 2020a, Dyck et al. 2021). Sampling efforts, either capture-mark-recapture surveys or intermittent sampling to increase the number of marked individuals in the subpopulation, could be conducted with fewer years between them to provide a more detailed and accurate picture of how the subpopulation is changing over time. Analyses to determine the optimal survey frequency and sample size for DS are forthcoming in separate independent analyses.

Ideal wildlife management includes not only obtaining census data but also information about wildlife distributions and habitat use. This is particularly important in the Arctic where reports of human-bear interactions are increasing, and habitat is rapidly changing. Recent studies of long-term movement data for polar bear studies in the BB and Kane Basin subpopulations documented changes in denning habitat, habitat use and distribution (Escajeda et al. 2018, Laidre et al. 2018a, b) in response to long-term changes in sea-ice patterns and environmental changes. In addition, movement data can assist in determining the degree of temporal emigration, improve survival estimates, and can be used to determine whether an abundance estimate relates to a superpopulation (see Dyck et al. 2020a, b for details). Like recent studies in the Gulf of Boothia and M'Clintock Channel polar bear subpopulations (Dyck et al. 2020a, Dyck et al. 2021), use of satellite telemetry in DS was not supported by Inuit co-management partners given the option of utilizing less-intrusive biopsy darting and this was accepted by the study team. This decision limited our ability to make inferences about distribution and habitat use. From dead recovery data, however, it appears that the boundary for the DS subpopulation is still valid since over 85% of harvested bears were recovered within the DS management unit. Additionally, satellite telemetry from the northern neighboring subpopulation BB, supports the delineation between the two subpopulations (Laidre et al., 2018a).

Davis Strait is a subpopulation that is shared between Greenland and Canada (Nunavut, Newfoundland and Labrador, Québec), and is harvested by hunters in portions of their range in each of these jurisdictions (Peacock et al. 2013, Rode et al. 2012). This survey, inclusive to 2018, provides managers and responsible jurisdictions with an updated subpopulation estimate to inform respective jurisdictional harvest management objectives. Objectives among jurisdictions may not always be aligned and to ensure the sustainability and health of this subpopulation, communication on management objectives are required. Any such efforts are now informed by the updated survey findings presented in this report. Harvest risk assessment (HRA) is a relatively recent analytical tool that considers various harvest options under varying environmental conditions and levels of harvest risks (Regehr et al. 2017a, b; 2019). Moving forward, such analytical tools may be an appropriate for the multi-jurisdictional DS subpopulation should management authorities feel it warranted to pursue.

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FIGURES AND TABLES

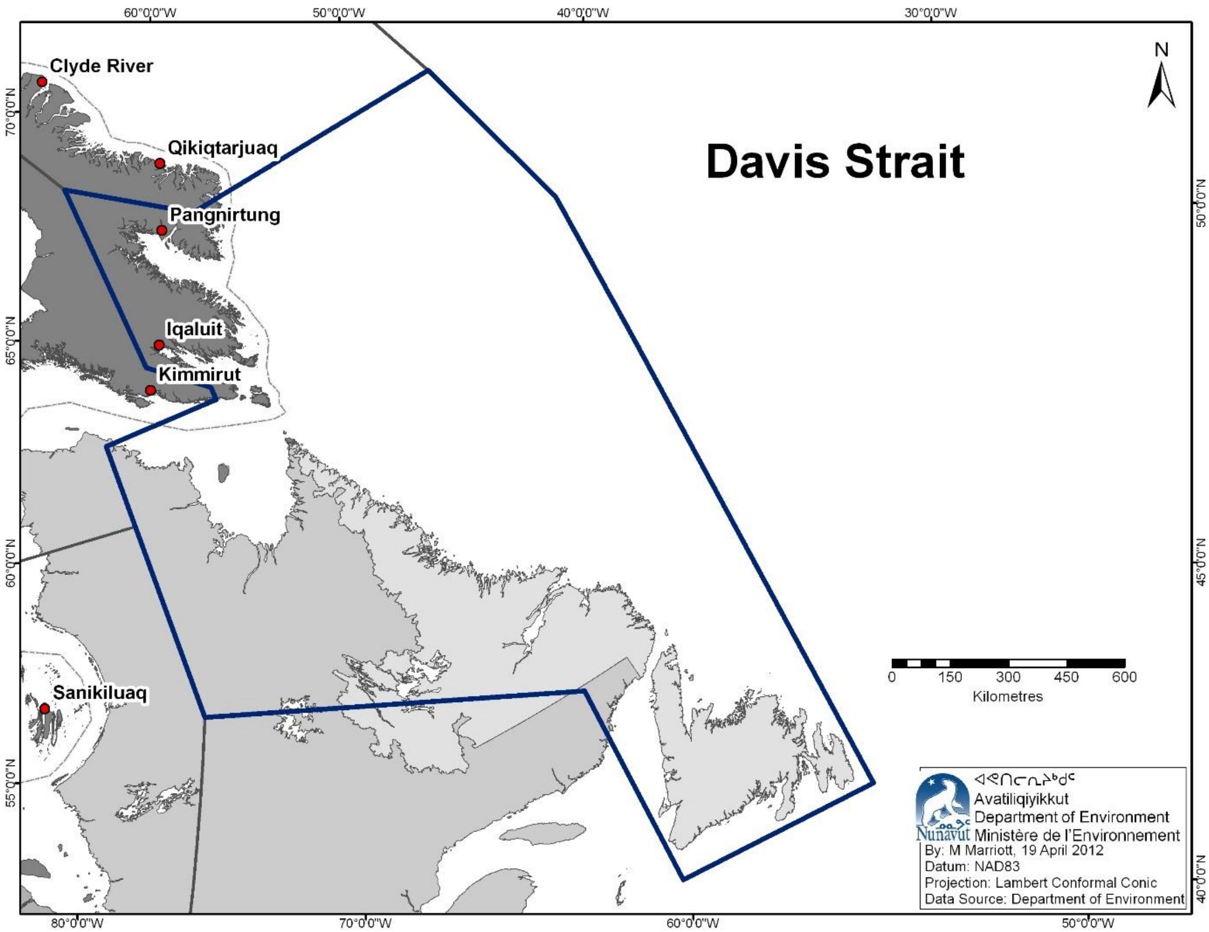

Figure 1. The Davis Strait polar bear subpopulation (blue outline) with different jurisdictions in shades of gray (Newfoundland and Labrador [Nunatsiavut], light gray; Nunavut, dark gray; Québec [Nunavik], medium gray).

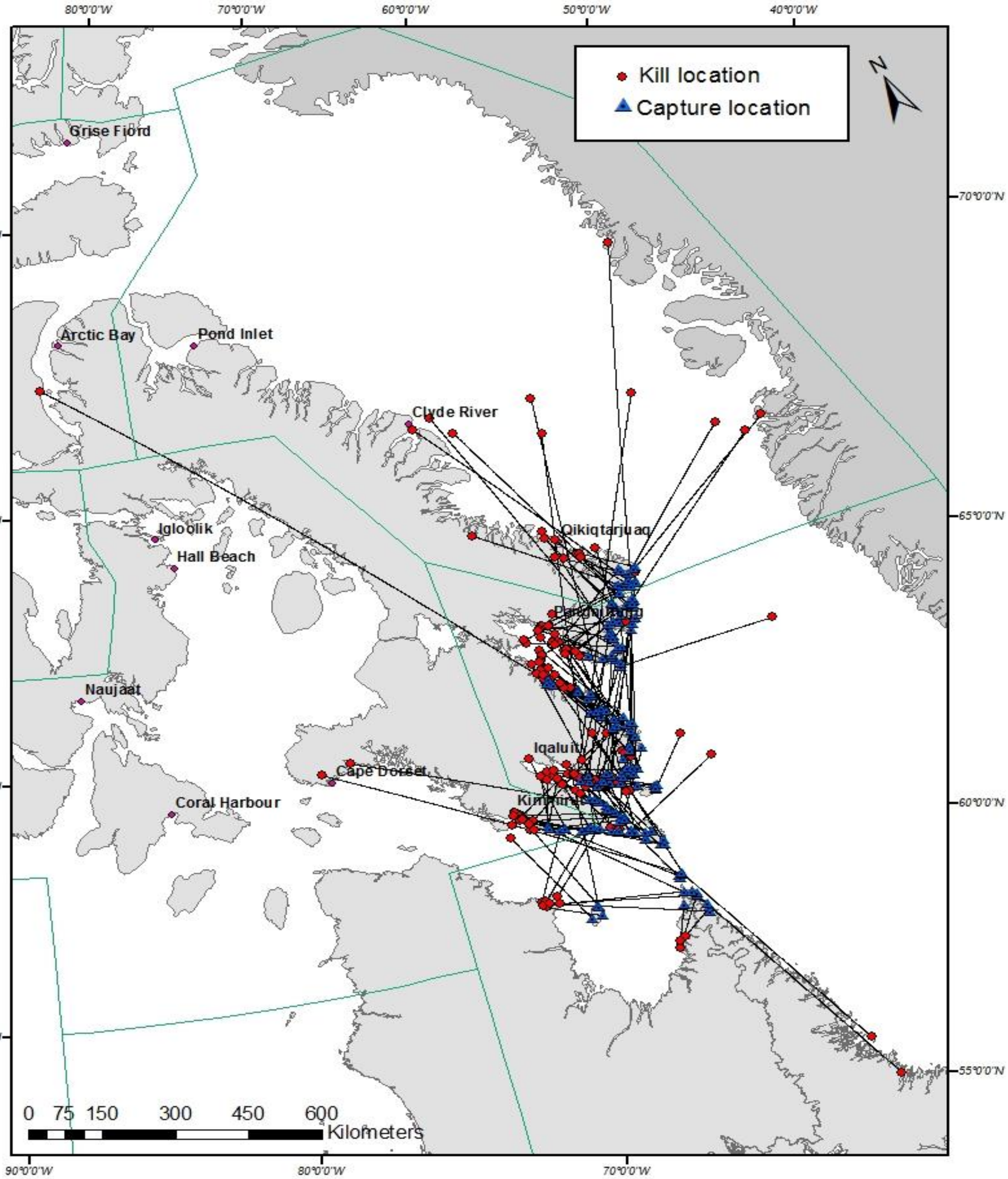

Figure 2. Sampling (blue triangles) and harvest (red circles) locations for Davis Strait polar bears where coordinates for both events for the same individual bear were available (n = 163). Green lines indicate subpopulation boundaries.

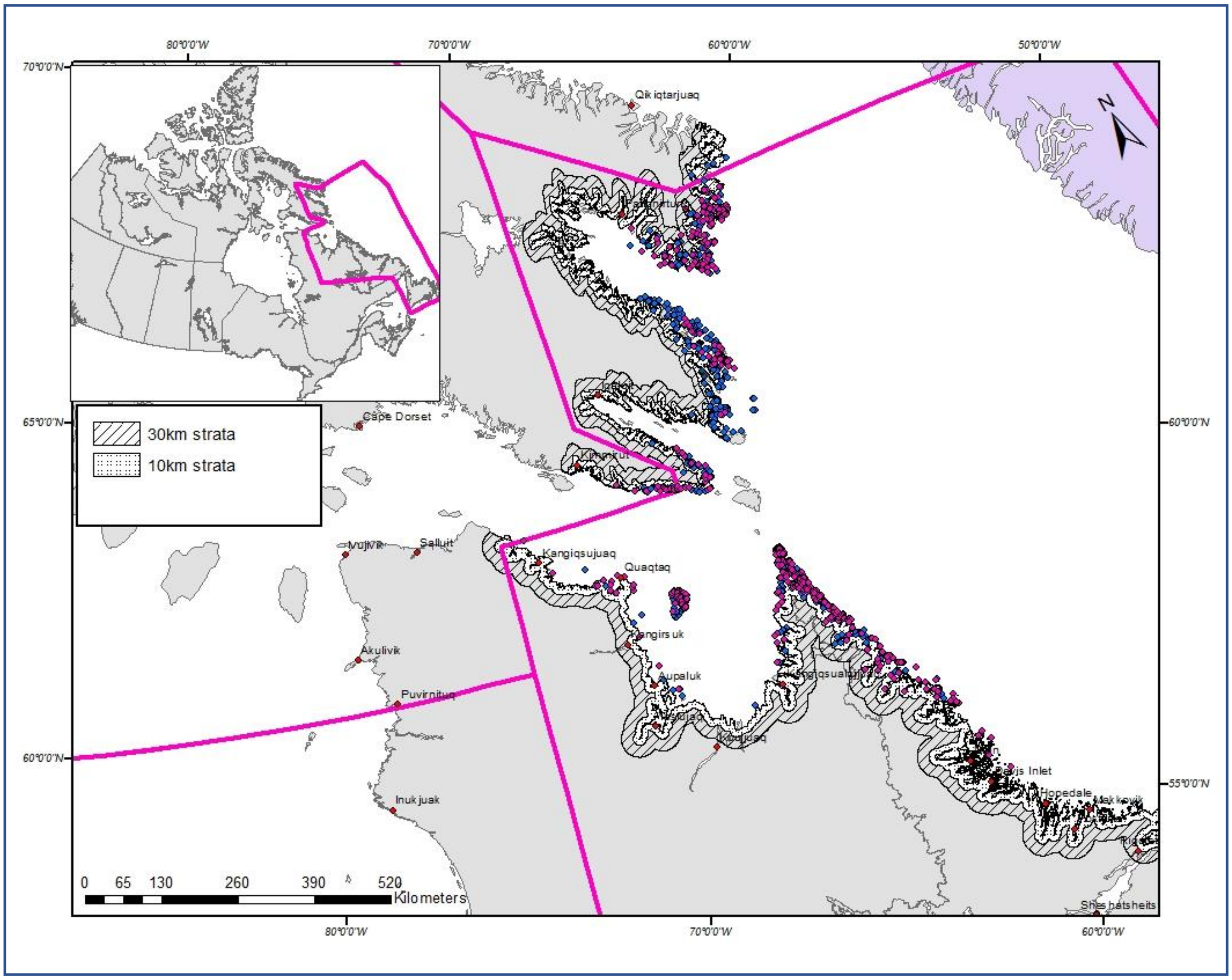

Figure 3. Sampling locations by field season (blue = 2017; purple = 2018) within the Davis Strait polar bear study area (Note: the sampling stratification for the coastline shown by black lines, the 10km and 30km strata are also indicated). Inset: Davis Strait subpopulation area in context of Canada.

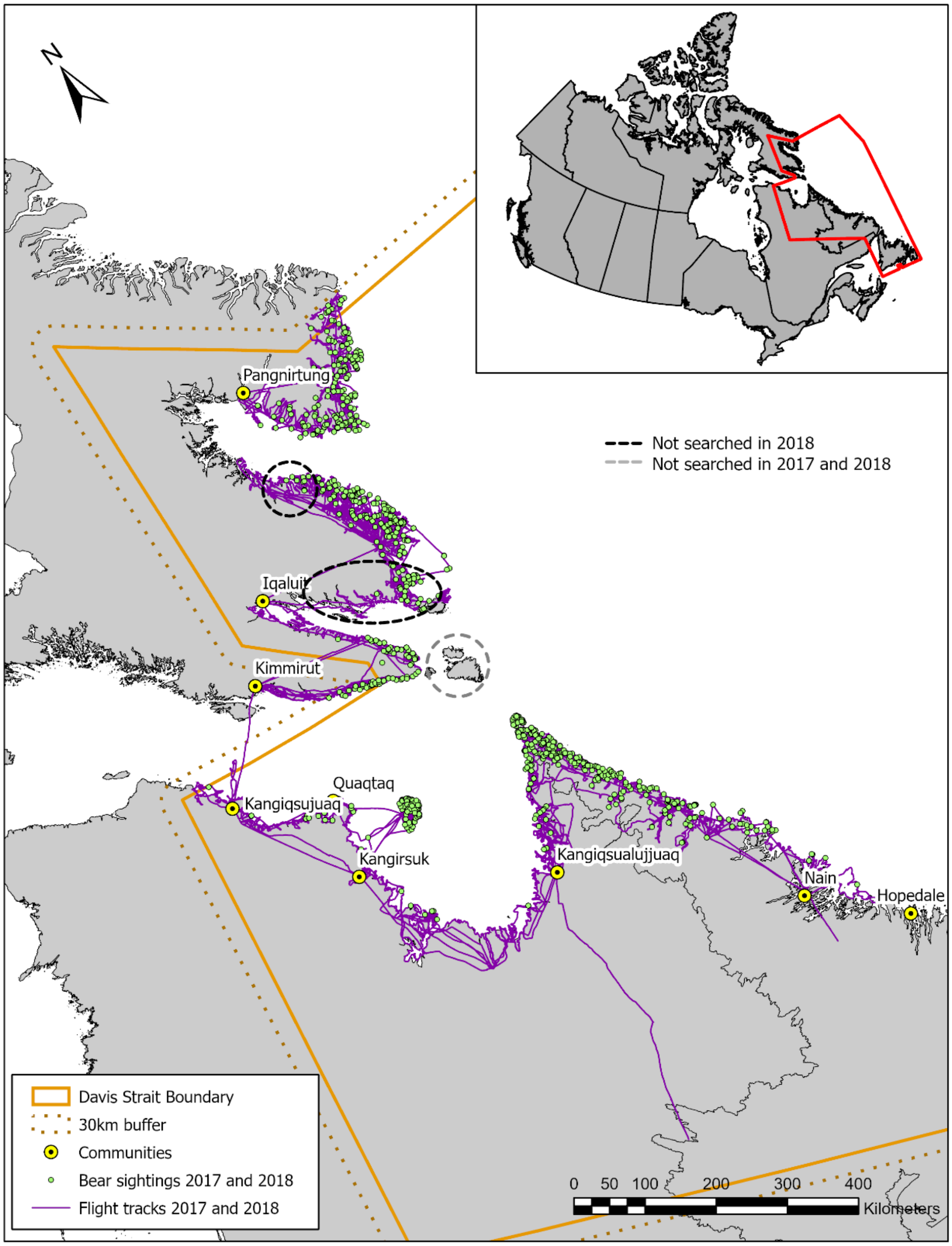

Figure 4. Overview of bear observations and helicopter paths flown in search for polar bears in Davis Strait during August - October 2017 and 2018. Inset: Davis Strait subpopulation area (red) in context of Canada.

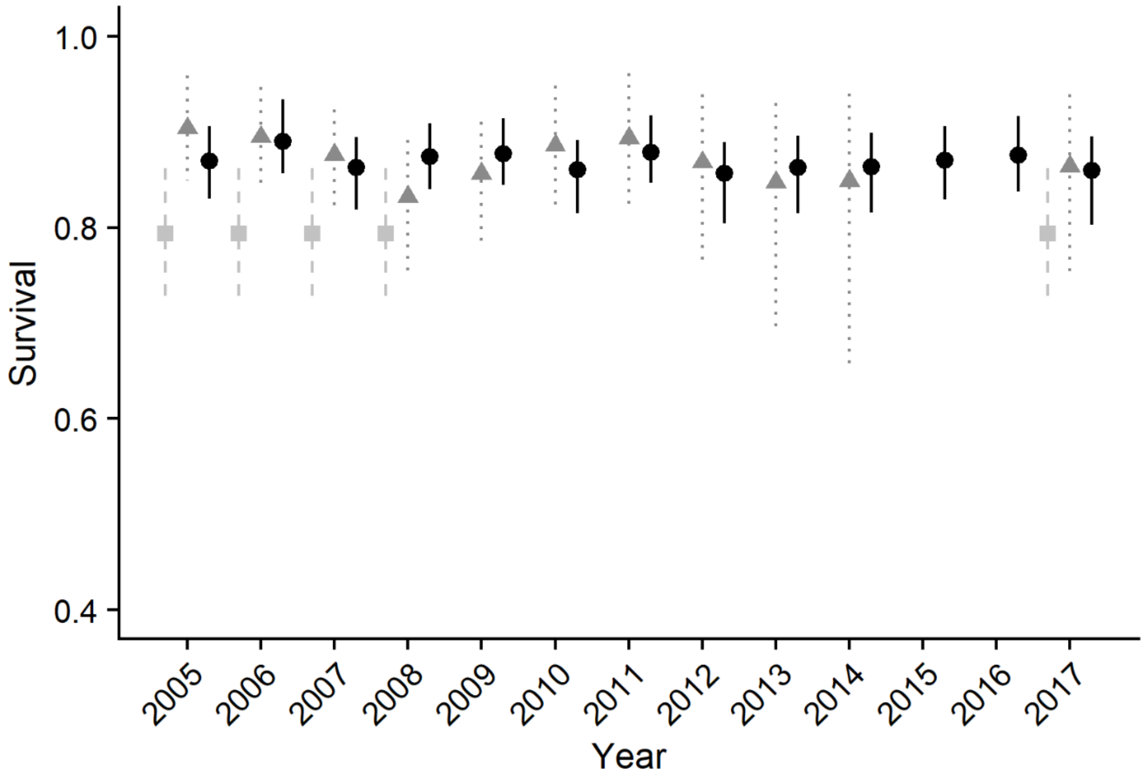

Figure 5. Estimates of annual survival rates for Davis Strait polar bears by age class. Light gray squares and dashed lines are the annual means and 95% Bayesian credible intervals for offspring (cubs-of-the-year and yearlings). Dark gray triangles and dotted lines are the annual means and 95% credible intervals for subadult polar bears (males: 2-7 years, females: 2-4 years). Black circles and solid black lines are the annual means and 95% Bayesian credible intervals for adult polar bears (males: 8+ years, females: 5+ years). Using combined capture-recapture-recovery data, we estimated survival in all years for adult polar bears; however, estimates of survival for younger age classes were limited to years following releases.

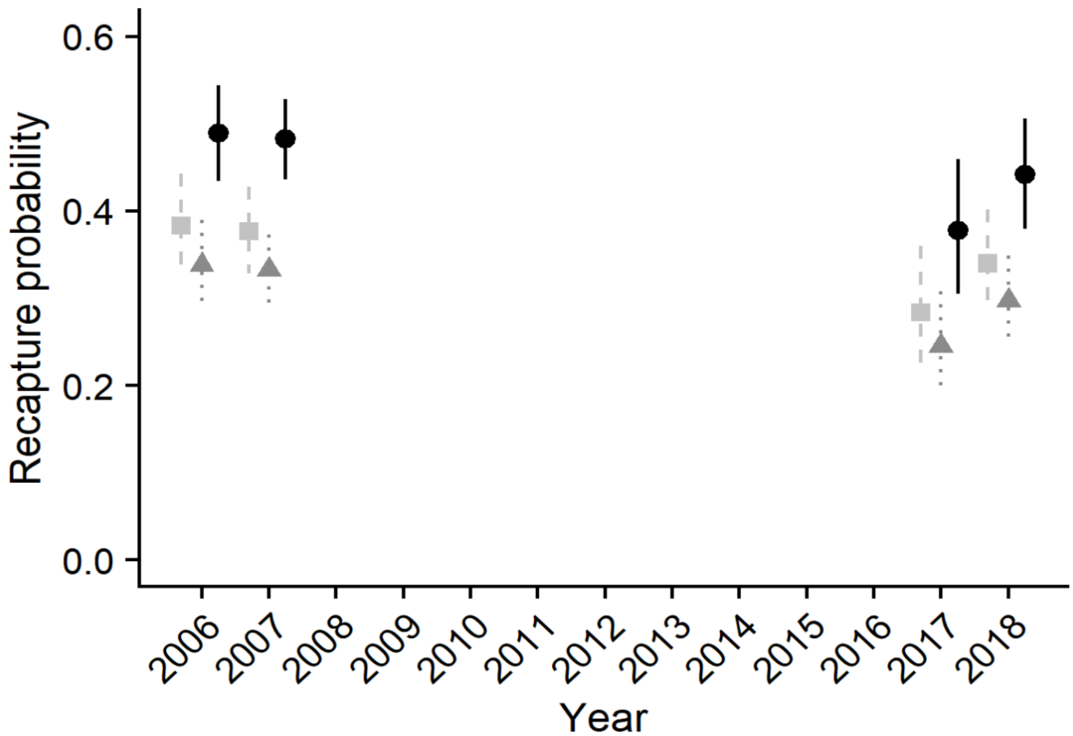

Figure 6. Estimates of annual recapture probability of Davis Strait polar bears by age and sex class. Capture-mark-recapture data were collected intermittently, and recapture probabilities were estimable for only four years across two sampling periods. Light gray squares and dashed lines are the annual means and 95% Bayesian credible intervals for subadult polar bears (males: 2-7 years old, females 2-4 years old). Dark gray triangles and dotted lines are the annual means and 95% Bayesian credible intervals for adult females (5+ years old) and offspring (cubs-of-the-year and yearlings). Black circles and solid lines are the annual means and 95% Bayesian credible intervals for adult male polar bears.

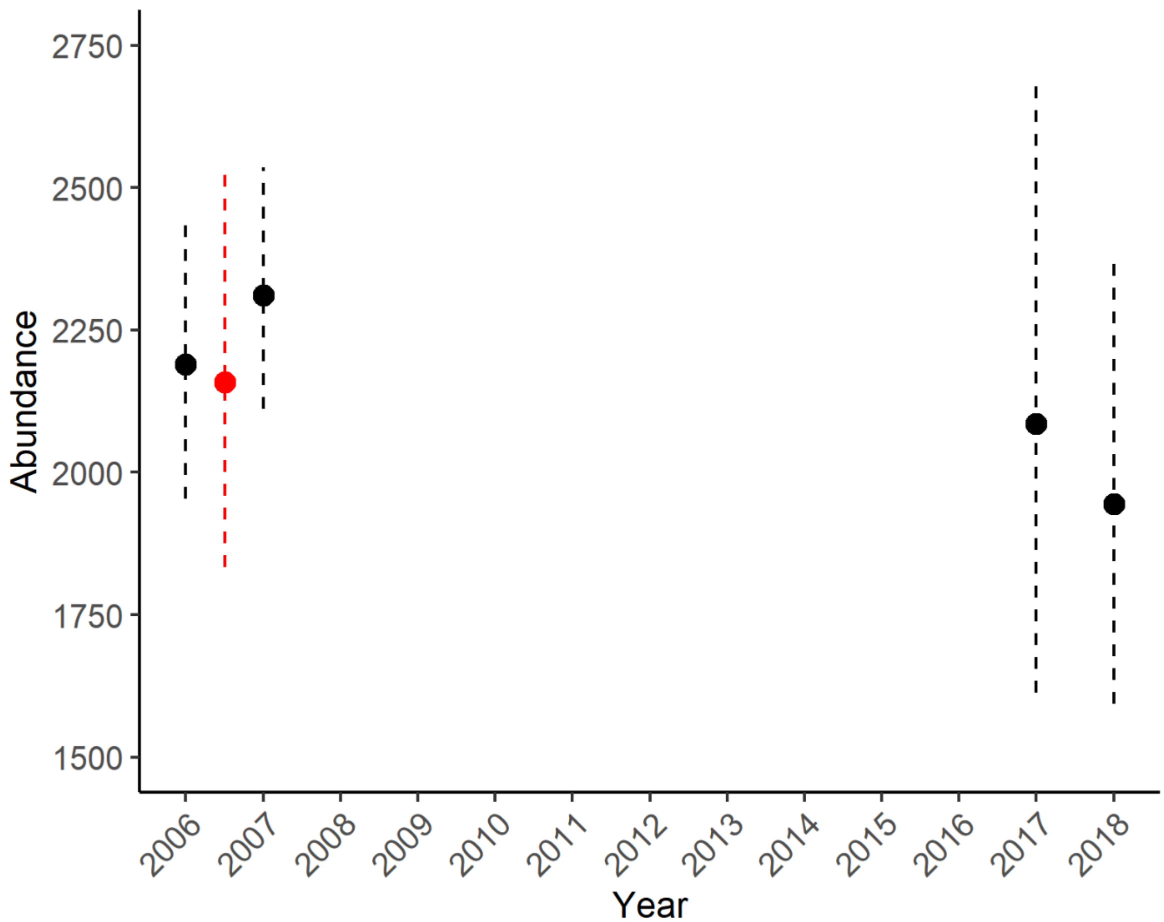

Figure 7. Estimates of abundance for the Davis Strait subpopulation of polar bears. Black circles and dashed lines represent the mean and 95% CRI derived from recapture probabilities using multistate live-capture dead-recovery models. Point estimates and credible intervals are shown for 2006, 2007, 2017, and 2018 only because those were the only years in which recapture probability were estimable due to intermittent sampling. The red circle and dashed lines represent the mean and 95% confidence interval of abundance estimated for the period of 2005 - 2007 and reported by Peacock et al. (2013) for comparison.

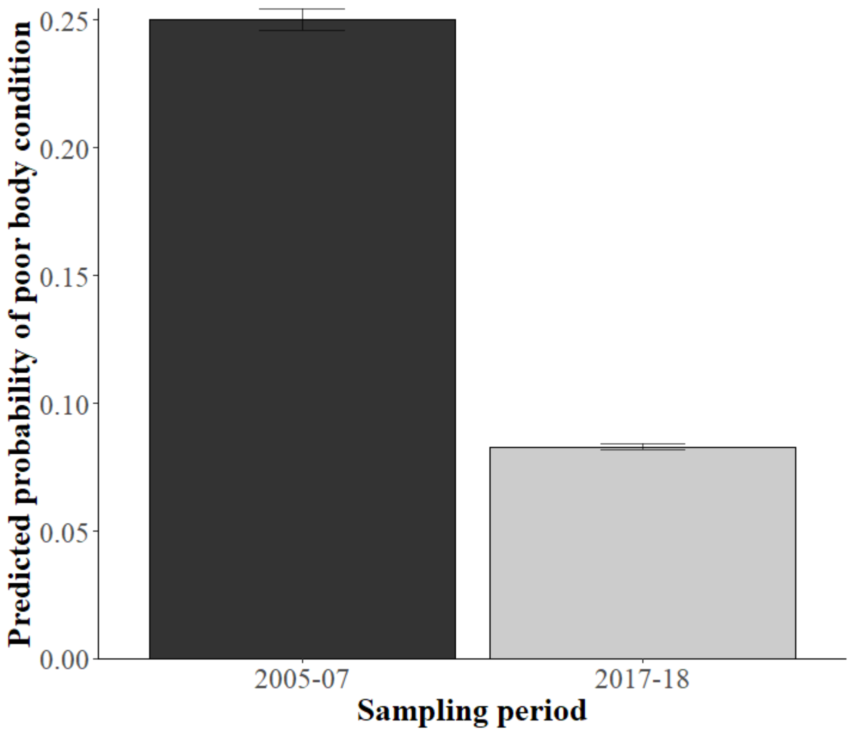

Figure 8. Predicted probability ± SD of bears being classified in poor body condition in the early sampling period (2005 - 2007) or the later sampling period (2017 - 2018).

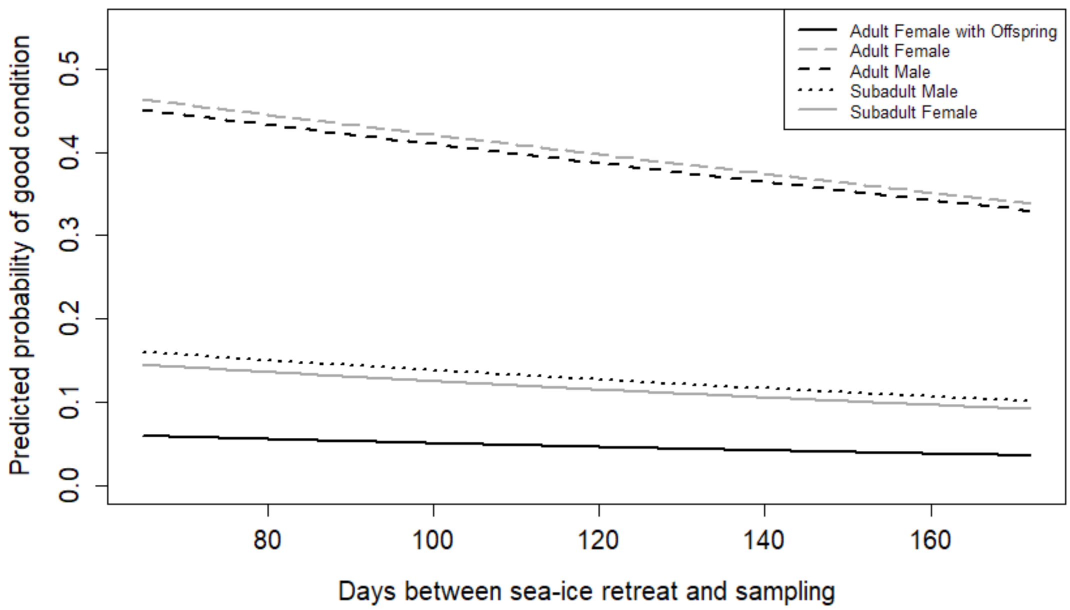

Figure 9. Predicted probability ± SEM of bears being classified in good body condition for each reproductive age class as a function of the number of days between sea-ice retreat and when the bear was sampled.

Table 1. Number of live observations (black, captures & recaptures) and dead recoveries (gray, in parentheses) of individually identified polar bears in the Davis Strait subpopulation used in survival estimation. No marked cubs of the year (COY) were harvested in our data set. However, there were a total of 9 marked bears harvested as yearlings (1.5 years old) prior to becoming subadults (at 2.5 years old).

Year	Adult Males	Adult Females	Subadult Males	Subadult Females	Yearlings	COY
2005	207	175	115	32	40	51
2006	263 (3)	206 (3)	160 (3)	64 (0)	70 (1)	76
2007	269 (4)	251 (2)	152 (5)	54 (0)	102 (1)	57
2008	(17)	(4)	(9)	(2)	(2)	
2009	(12)	(3)	(12)	(4)	(2)	
2010	(12)	(1)	(8)	(1)		
2011	(17)	(3)	(3)			
2012	(9)	(2)	(1)			
2013	(16)	(3)	(2)			
2014	(11)	(4)	(2)			
2015	(10)	(3)	(1)			
2016	(9)	(0)				
2017	156 (6)	172 (0)	48 (0)	40 (0)	46 (0)	76
2018	153 (13)	191 (2)	93 (1)	51 (1)	54 (3)	66

Table 2. Sequential model selection for Davis Strait polar bear survival and encounter probabilities based on information criterion (WAIC) to address our primary objective of identifying temporal patterns in survival.

Model	Parameterization	WAIC	ΔWAIC
Step 1. *Best model for age structure in survival; includes random effects*			
M2	3 age classes; Dependent young, Subadults, Adults	6883.6	
M1	4 age classes; COYS, Yearlings, Subadults, Adults	6891.6	8.0
Step 2. *Best model for sex structure in survival using the best model for age structure in survival (Model M2); includes random effects*			
M2	3 age classes; Dependent young, Subadults, Adults	6883.6	
M4	4 age-sex classes; Dependent young, subadults, adult males, adult females	6899.4	15.8
M3	5 age-sex classes; Dependent young, subadult males, subadult females, adult males, adult females	6910.3	26.7
Step 3. *Best model for temporal variation in survival using the best model for age/sex structure in survival (Model M2)*			
M2	Subadult and Adult class year random effects	6883.6	
M5	Subadult and Adult class linear trend with year random effects	6888.0	4.4
M6	Subadult and Adult class year fixed effects	6903.8	20.2
Step 4*. Best model for temporal variation in recovery using the best age/sex structure for survival (Model M2)*			
M2	2 sex classes; constant	6883.6	

M8	2 sex classes; shared year random effects	6890.1	6.5
M7	2 sex classes; year random effects	6894.2	10.6
Step 5. *Best model for age/sex structure in recapture probability using the best structure for survival and recovery (Model M2)*			
M2	3 age-sex classes and year fixed effects; Subadults, Females and Dependent young, Adult males	6883.6	
M9	4 age-sex classes and year fixed effects; Subadult Male, Subadult Female, Females and Dependent Young, Adult males	6886.6	3.0
Step 6. *Quantify effects of environmental covariates on adult and subadult survival*			
M2	Year random effect	6883.6	
M10	Ice decay + year random effect	6884.2	0.6
M11	Ice-free days + year random effect	6884.8	1.2
M14	NAOw + year random effect	6885.1	1.5
M13	Mean summer ice concentration + year random effect	6885.9	2.3
M12	Harp seals + year random effect	6893.3	9.7
M15	AOw + year random effect	6893.7	10.1
M16	Ice decay + harp seals + year random effect	6893.9	10.3
M17	Ice decay + NAOw + ice-free days + year random effect	6894.5	10.9

Table 3. Parameter estimates from the top model for Davis Strait polar bears with data from 2005 - 2018 (model M2; Table 2). Demographic parameters are reported as the mean, standard deviation, and 95% Bayesian credible intervals (CRI) on the probability scale. Temporal variance is reported on the logit scale.

Parameter	Mean	SD	95% CRI
Offspring survival	0.794	0.0353	(0.723, 0.861)
Subadult survival	0.873	0.0230	(0.826, 0.914)
Adult survival	0.871	0.009	(0.853, 0.892)
Male recovery	0.248	0.017	(0.215, 0.282)
Female recovery	0.072	0.010	(0.053, 0.093)
Temporal variance: subadult survival	0.236	0.336	(0.0019, 1.093)
Temporal variance: adult survival	0.048	0.059	(0.000007, 0.215)

Table 4. Recapture probability metrics for each year and each recapture age-sex class. (LCRI = lower Bayesian credible interval, UCRI = upper Bayesian credible interval)

Recapture Class	Year	Mean	SD	95% LCRI	95% UCRI
Females & Offspring					
	2006	0.338	0.025	0.291	0.390
	2007	0.332	0.020	0.294	0.373
	2017	0.246	0.030	0.191	0.308
	2018	0.298	0.025	0.252	0.349
Subadults					
	2006	0.383	0.029	0.327	0.443
	2007	0.377	0.025	0.329	0.427
	2017	0.284	0.037	0.218	0.360
	2018	0.340	0.031	0.284	0.402
Adult Males					
	2006	0.489	0.028	0.434	0.508
	2007	0.482	0.024	0.437	0.528
	2017	0.378	0.039	0.305	0.459
	2018	0.442	0.032	0.380	0.506

Table 5. Abundance estimates from our model (2006-2018) and average estimate over 2005-2007 from Peacock et al. (2013). In 2017, surveys were not conducted on Edgell and Resolution Islands. In 2018, surveys were not conducted on Edgell and Resolution islands or in an area around Loksland. Abundance estimates were subsequently adjusted for these incomplete surveys (see Methods for details; CRI = Bayesian credible interval).

Year	**Annual estimate (95% CRI)**	**Study period estimate (95% CRI)**	**Peacock et al. estimate *Average over 2005-2007* (95% Confidence Interval)**
2006	2,190 (1,954 – 2,454)	2,250 (1,989 – 2,512)	2,158 (1,833 – 2,542)
2007	2,311 (2,111 – 2,536)		
2017	2,085 (1,613 – 2,699)	2,015 (1,603 – 2,588)	NA
2018	1,944 (1,593 – 2,366)		

Table 6. Annual numbers of litters and mean litter sizes (LS) of cub-of-the year (COY) and yearling (YRL) litters encountered during the capture-recapture studies in Davis Strait.

	2005	**2006**	**2007**	**2017**	**2018**
No. COY litters	38	51	41	55	47
Mean COY LS	1.39	1.49	1.41	1.40	1.45
No. YRL litters	27	45	67	38	38
Mean YRL LS	1.48	1.56	1.52	1.66	1.42

Table 7. Ratio of the number of cubs-of-the-year (COY) to adult females (ADF), the number of yearlings (YRL) to adult females, and the number of adult females with cubs-of-the-year (ADF_COY) to adult females in the subpopulation.

	2005	2006	2007	2017	2018
COY: ADF	0.30	0.37	0.23	0.45	0.36
YRL: ADF	0.23	0.34	0.41	0.37	0.28
ADF_COY: ADF	0.21	0.25	0.16	0.32	0.25

Table 8. Number of polar bears classified in each category of body condition index (BCI) in the Davis Strait subpopulation 2005 - 2007 and 2017 - 2018. Poor BCI corresponds to a thin bear (BCI of 1 or 2) and Good BCI corresponds to a fat/obese bear (BCI of 4 or 5). Age classes are adult (≥ 5 years) and subadult (2 - 4 years).

	2005 - 2007			**2017 - 2018**		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**
Adult female without offspring	66	157	135	5	87	74
Adult female with offspring	113	146	13	17	176	10
Adult male	97	292	343	31	180	101
Subadult male	102	240	67	15	99	13
Subadult female	38	90	12	6	67	14
Total	**416**	**925**	**570**	**74**	**609**	**212**

Table 9. Fitted multinomial regression model parameter estimates (reference level = “poor”/BCI = 1 or 2, intercept represents adult independent females in 2005 - 2007 sampling period) for body condition index analysis of the Davis Strait subpopulation. See Methods for variable definitions.

	Parameter estimate ± SE										
BCI	Intercept	Time since spring transition	Period	Adult female with offpsring	Adult male	Sub-adult female	Sub-adult male	Period x adult female with offspring	Period x Adult male	Period x Sub-adult female	Period x Sub-adult male
Average	0.98 ± 0.307	-0.001 ± 0.002	1.97 ± 0.486	-0.61 ± 0.193	0.24 ± 0.188	-0.009 ± 0.243	-0.013 ± 0.188	0.09 ± 0.560	-1.33 ± 0.533	-0.44 ± 0.672	-0.96 ± 0.569
Good	1.40 ± 0.343	-0.006 ± 0.003	1.85 ± 0.490	-2.89 ± 0.329	0.56 ± 0.190	-1.90 ± 0.364	-1.15 ± 0.218	-0.33 ± 0.694	-2.06 ± 0.540	0.04 ± 0.764	-1.69 ± 0.636

Table 10. Reported mean harvest for the Davis Strait (DS) polar bear subpopulation by jurisdiction between 1999-2008 and 2009-2019 [Numbers represent mean ± standard deviation (range); NU = Nunavut, NL = Newfoundland and Labrador, GL = Greenland].

Harvest Years	**Jurisdiction**				**DS Mean**	**Proportion Female**
	NU	Quebec	NL	GL		
1999-2008	39.4 ± 4.6 (34 – 48)	16.5 ± 8.4 (7 – 31)	5.9 ± 1.4 (4 – 8)	2.3 ± 2.0 (0 – 7)	64.1 ± 10.1 (53 – 81)	0.345
2009-2019	44.2 ± 10.1 (31 – 60)	30.2 ± 5.9 (12 – 59)	10.9 ± 3.5 (2 – 14)	1.5 ± 1.5 (0 – 4)	86.8 ± 23.6 (62 – 126)	0.350

SUPPLEMENTARY MATERIALS

Supplementary Methods

Table SM1. Parameters, their definitions, and prior distributions used in a multistate model for Davis Strait polar bears.

Parameter	Definition	Prior Distribution
S_{coy}	Survival probability of cubs-of-the-year	Uniform (0, 1)
S_{yrl}	Survival probability of yearlings	Uniform (0, 1)
S_{sa}	Survival probability of subadults	Beta (14.07, 2.68) *mu = 0.84, sd = 0.09*
S_{saf}	Survival probability of subadult females	Beta (29.24, 4.04) *mu = 0.88, sd = 0.06*
S_{sam}	Survival probability of subadult males	Beta (12.23, 2.90) *mu = 0.81, sd = 0.10*
S_{ad}	Survival probability of adults	Beta (46.49, 4.70) *mu = 0.91, sd = 0.04*
S_{adf}	Survival probability of adult females	Beta (36.45, 2.70) *mu = 0.93, sd = 0.02*
S_{adm}	Survival probability of adult males	Beta (47.20, 6.01) *mu = 0.89, sd = 0.04*
σ_{sa}	Standard deviation for temporal variance of subadult survival	Uniform (0, 4)
σ_{ad}	Standard deviation for temporal variance of adult survival	Uniform (0, 4)
β	Regression coefficient	Normal (0, 10)
r_f	Recovery probability for females	Uniform (0, 1)
r_m	Recovery probability for males	Uniform (0, 1)
p_{fd}	Recapture probability for females and offspring	Uniform (0, 1)
p_{sa}	Recapture probability for subadults	Uniform (0, 1)
p_{am}	Recapture probability for adult males	Uniform (0, 1)
β_{year}	Year fixed effect term for recapture probability	Normal (0, 10)

Table SM2. Point estimates of total survival (includes natural and harvest mortality) from capture-recapture studies for polar bears. These values were used to generate informative priors for survival in a multi-state capture-recapture-recovery model for polar bears in Davis Strait. Further details on their use in the main text (Methods – Model implementation, fit, selection). Table adapted from supplementary table S3 in Regehr et al. (2018).

Subpopulation	**Subadult Females**	**Adult Females**	**Subadult Males**	**Adult Males**
Baffin Bay[1]	NA	0.95	NA	0.87
Davis Strait – Central[2]	0.92	0.95	0.89	0.94
Davis Strait – North[2]	0.9	0.94	0.87	0.92
Davis Strait – South[2]	0.92	0.95	0.89	0.94
Gulf of Boothia[3]	0.9	0.92	0.88	0.92
Kane Basin[1]	0.73	0.95	0.52	0.87
Lancaster Sound[4]	0.88	0.94	0.79	0.89
McClintock Channel[5]	0.90	0.90	0.90	0.88
Northern Beaufort Sea[6]	0.91	0.91	0.83	0.83
Norwegian Bay[4]	0.88	0.94	0.79	0.89
Southern Beaufort Sea[7]	0.92	0.95	0.87	0.93
Southern Hudson Bay[8]	0.92	0.91	0.86	0.86
Viscount Melville[9]	0.91	0.91	0.77	0.77
Western Hudson Bay[10]	0.82	0.94	0.75	0.90
Chukchi Sea[11]	0.79	0.90	0.71	0.89

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Supplementary Results

Prior sensitivity analysis

To evaluate the sensitivity of our parameter estimates to the choice of priors, we fit the "top" model (M2) using informative (Beta distributions; Table SM1) and uninformative (Uniform (0, 1)) priors and compared the resulting estimates and posterior distributions. Results generated from the model initialized with uninformative priors were not used for making inference. We report the results below with direct comparisons.

Additional analysis – time constant and fixed effect models

To explore more parsimonious models, we compared our top model (M2) to one with the same age-sex structure assuming survival is constant over time. Such models are more commonly applied in the polar bear literature often due to data limitations. In most cases, sample size, the number of consecutive sampling years, and/or the duration between sampling periods precludes more in-depth exploration of temporal variation (e.g. year random effects) in polar bear survival. Our DS dataset was robust and allowed us to explore temporal variation in survival, which is more biologically accurate. However, we wanted to fully evaluate our top model's performance against models more commonly used in polar bear survival. This model included the same general structure as model M2 but did not include year random effects on subadult or adult survival (model M2X). We do not use this comparison for inference but report the results below with direct comparisons of the posterior estimates and distributions with our random effects top model (M2). All models were initialized using the same prior distributions and MCMC sampling specifications in JAGS (see Methods: Model implementation, fit, and evaluation).

Prior sensitivity analysis

Table SR1. Results of a prior sensitivity analysis comparing parameter estimates from Model M2 initialized with informative priors for adult and subadult survival compared with estimates from Model M2U initialized with uninformative (uniform) priors for adult and subadult survival. Model M2 includes the best fit model structure for survival, recovery, and recapture probabilities without environmental covariates. Demographic parameters are reported as the posterior mean, standard deviation, and 95% Bayesian credible intervals (CRI) on the probability scale for averages over time. Temporal variance estimates are reported on the logit scale.

	Model M2: informative priors for adult and subadult survival			**Model M2U: uninformative priors for adult and subadults**		
Parameter	Mean	SD	95% CRI	Mean	SD	95% CRI
Offspring survival	0.794	0.0353	(0.723, 0.861)	0.793	0.036	(0.721, 0.862)
Subadult survival	0.873	0.0230	(0.826, 0.914)	0.873	0.022	(0.827, 0.913)
Adult survival	0.871	0.009	(0.853, 0.892)	0.869	0.010	(0.849, 0.888)
Male recovery	0.248	0.017	(0.215, 0.282)	0.247	0.016	(0.216, 0.281)
Female recovery	0.072	0.010	(0.053, 0.093)	0.072	0.010	(0.053, 0.093)
Temporal variance: subadult survival	0.236	0.336	(0.0019, 1.093)	0.217	0.239	(0.0003, 0.894)
Temporal variance: adult survival	0.048	0.059	(0.000007, 0.215)	0.047	0.064	(0.0001, 0.219)

Figure SR1. Density plots of uniform (uninformative; gray line) and Beta (informative; blue line) prior distributions for subadult and adult polar bear survival developed using the mean and standard deviation of the mean across previous polar bear survival studies following the approach of Regehr et al. 2018 (see also Table SM1 and Table SM2).

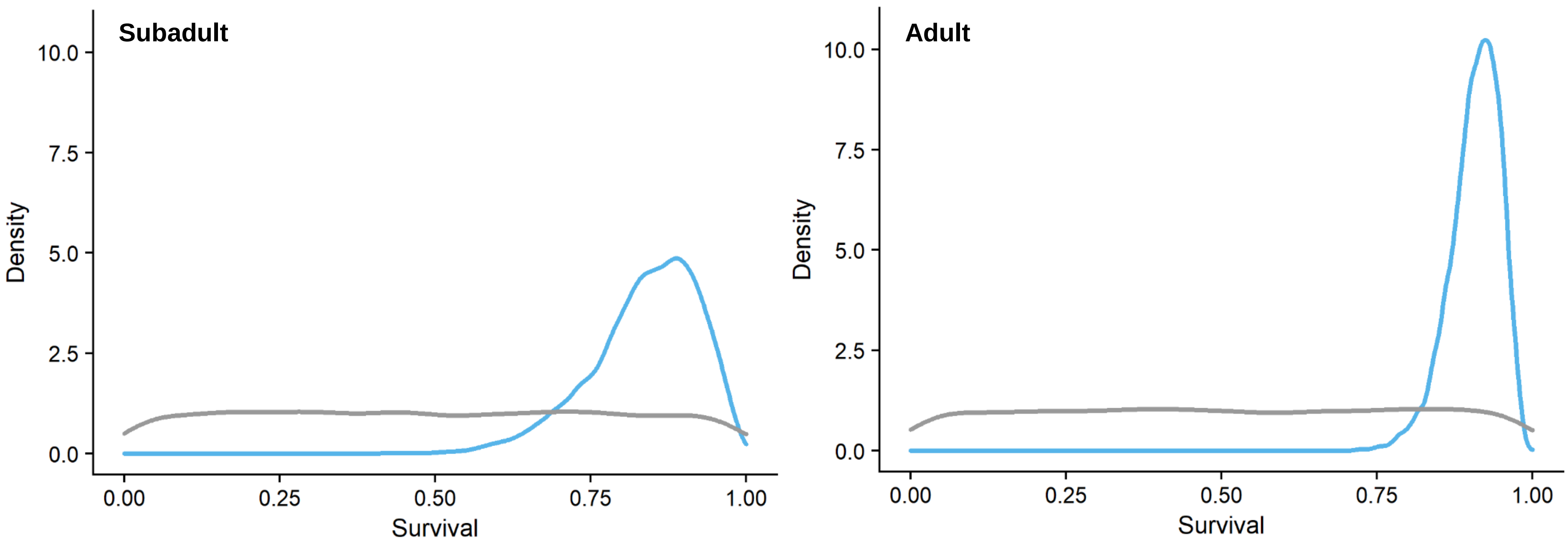
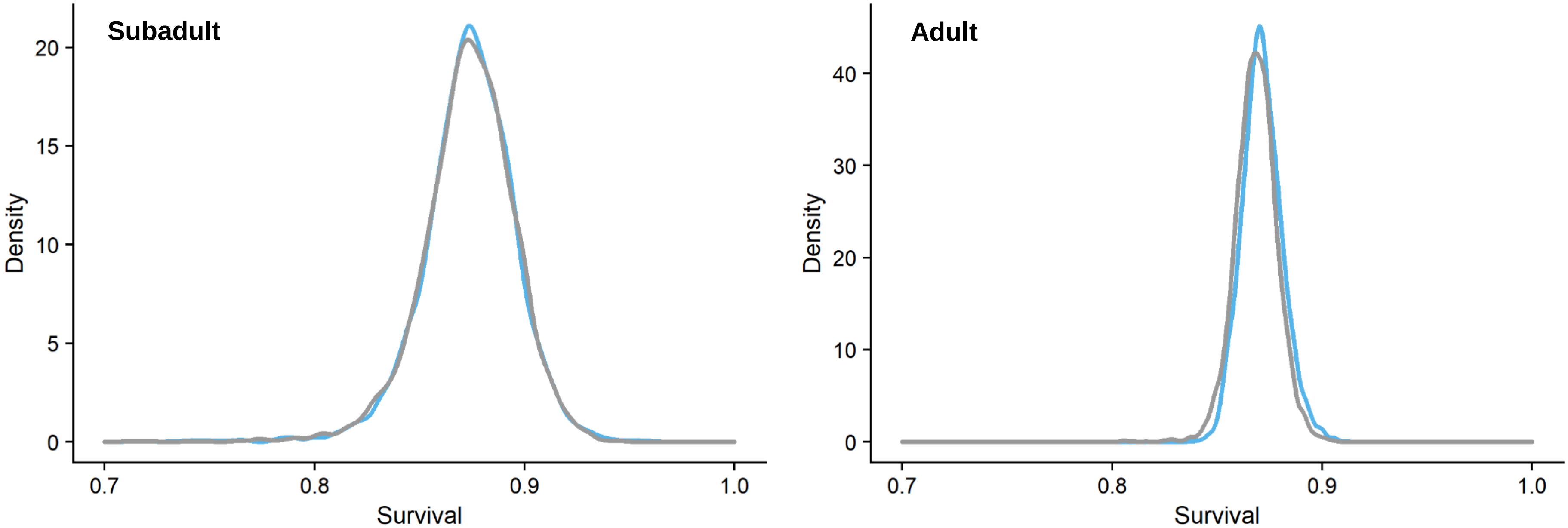


Figure SR2. Posterior distributions of subadult and adult survival from multistate model (M2) initialized with either uninformative (Uniform (0,1); gray line) or informative (Table SM1; blue line) priors for Davis Strait polar bear capture-recapture-recovery data.



Additional analysis – time constant and fixed effect models

Table SR2. Parameter estimates from the top model for Davis Strait polar bears with data from 2005 - 2018. Demographic parameters are reported as the posterior mean, standard deviation, and 95% Bayesian credible intervals (CRI) on the probability scale for averages over time. Temporal variances are reported on the logit scale.

	Model M2: includes year random effects for adult and subadult survival			**Model M2X: time-constant survival for adult and subadults**		
Parameter	Mean	SD	95% CRI	Mean	SD	95% CRI
Offspring survival	0.794	0.0353	(0.723, 0.861)	0.788	0.035	(0.717, 0.857)
Subadult survival	0.873	0.0230	(0.826, 0.914)	0.873	0.014	(0.845, 0.898)
Adult survival	0.871	0.009	(0.853, 0.892)	0.870	0.007	(0.856, 0.884)
Male recovery	0.248	0.017	(0.215, 0.282)	0.251	0.017	(0.219, 0.286)
Female recovery	0.072	0.010	(0.053, 0.093)	0.072	0.010	(0.054, 0.094)
Temporal variance: subadult survival	0.236	0.336	(0.0019, 1.093)			
Temporal variance: adult survival	0.048	0.059	(0.000007, 0.215)			

Davis Strait Polar Bear Subpopulation Status Report

Prepared by the Davis Strait Polar Bear Technical Working Group

July 6, 2023


Credit: Markus Dyck

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Executive Summary

This executive summary is intended to provide an overview of the Davis Strait Polar Bear Subpopulation Technical Working Group status report to non-specialist audiences. Further details, including citations and methodological details are documented in the full report.

The Davis Strait (DS) polar bear subpopulation includes much of the Labrador Sea, eastern Hudson Strait, Davis Strait south of Cape Dyer within Canada, and a portion of southwest Greenland. Management authority for the DS subpopulation is a shared responsibility of federal, provincial, and territorial governments within Canada, Wildlife Management Boards (WMBs) and similar entities, and land claims organizations that represent Indigenous rights holders.

Status and Abundance

The most recent scientific estimate of abundance for the DS subpopulation was 2,015 polar bears (95% CI: 1,603–2,588) for 2017-2018. The Canadian Polar Bear Technical Committee's (PBTC) 2022 assessment of the subpopulation was:

Status and Trend Assessment Type	Short Definition	Assessment Result	Primary Rationale
Historic Trend (scientific)	Change in abundance since the signing of the *Agreement on the Conservation of Polar Bears* (1973), according to western science methods	Likely increased	Comparison of most recent estimate of abundance to information collected in the 1970s.
Indigenous Knowledge (IK) Trend	The abundance trend in a specific area over a defined period of time based on available IK holders' experiences and observations	Increased	Interviews and consultations with Indigenous peoples describing changes over time in the number of polar bears observed, polar bear behavior, and other factors, for wherever indigenous peoples have observed polar bear across the subpopulation's area for several generations.
Most Recent Trend (scientific)	Changes in abundance over the last 15 years, according to western science methods	Likely declined	Comparison of the most recent estimate of abundance (2017-2018) to the previous estimate collected from 2005-2007. It is important to note that the population was managed for a population reduction in Nunavut.

Harvest Limits

In Nunavut, harvest in DS was managed according to the Flexible Quota System (FQS) until the 2019/2020 harvest year, which operated on a 2:1 male to female sex ratio. However, changes to the polar bear harvest administration were introduced in 2019/2020 based on community feedback. The sex ratio was changed where communities could harvest up to 1 female for every male. The base annual limit for Nunavummiut increased from 34 to 46 bears in 2004/2005. It was again changed to 61 bears in 2012/2013 with the aim to slightly reduce the DS subpopulation, per the management objective for a slight reduction. Although, the average annual removal from 2012/2013 to 2020/2021 harvest years has not increased with a higher annual limit.

The Labrador Inuit right to harvest polar bears in Nunatsiavut was increased from an annual limit of four to six bears in 1998/1999, and then increased from six to twelve bears in 2012/2013. The harvest season in Nunatsiavut occurs from February 1st to June 30th. There are no restrictions in the ratio of males to females that can be harvested each year. However, there are prohibitions on the harvest of females with cubs, and polar bear dens cannot be disturbed, which likely contributes to a larger proportion of males taken compared to females. Between 1989 and 2021, the provincial harvest was 76% male in Nunatsiavut.

Although there is no legal requirement for beneficiaries of the James Bay and Northern Québec Agreement to report human-caused polar bear mortalities in Québec, the Québec Government has been compiling harvest reports and issuing tags since 1985 to allow hunters to sell and export their polar bear hides. The proportion of the actual harvest being reported is currently unknown in Québec; however, there is likely a link between the probability of reporting a harvest and a harvester's interest in selling the hide. Although there are no regulations that impose a sex selective harvest ratio in Nunavik, the male to female ratio reported for the DS harvest in Nunavik for the 1994/1995 to 2021/2022 period has been approximately 2 males:1 female.

Overall harvest levels have usually been less than the annual limit (in Nunavut, Labrador, and Greenland) since the previous survey was conducted from 2005-2007. The following table reports the annual limits that have been in place and the harvest levels (H) reported to wildlife management officials, since the last survey conducted from 2005-2007:

Hunting Season	**Nunavut†**		**Newfoundland and Labrador‡**		**Québec ***		**Greenland**	
	Annual Limit	**H**	**Annual Limit**	**H**	**Annual Limit**	**H**	**Annual Limit**	**H**
2007/2008	46	47	6	4	None	13	Unk§	Unk
2008/2009	46	44	6	6	None	22	Unk	Unk
2009/2010	46	42	6	8	None	24	Unk	Unk
2010/2011	56	55	6	2	None	24	Unk	Unk
2011/2012	39	37	6	13	None	54	Unk	Unk
2012/2013	61	60	12	14	None	51	Unk	Unk
2013/2014	56	52	12	9	None	61	2	Unk
2014/2015	61	50	12	12	None	33	2	3
2015/2016	54	32	12	11	None	18	3	0
2016/2017	61	43	12	13	None	19	3	0

2017/2018	53	38	12	12	None	12	3	0
2018/2019	53	31	12	10	None	21	3	0
2019/2020	97	50	12	12	None	17	3	3
2020/2021	92	38	12	7	None	4	3	5
2021/2022	61	33	12	12	None	10	3	1

† In Nunavut, the annual limit reflects the annual harvest limit after all reductions or additions to limit have been made; the annual limit fluctuates to account for harvest that exceeds the base allocation and credit usage.
‡ In Newfoundland and Labrador, the annual limit reflects the annual take limit after all reductions and additions to the limit.
* In Québec, there is no annual limit for Nunavik Inuit harvesting polar bears within DS. Reporting of harvest remains voluntary.
§ Unk means unknown.
See full report for details about harvest limits, as well as areas where limits have been in place.

User-to-user Meetings

In 2010, a user-to-user workshop was held in Kuujjuaq, Québec. Participants at this meeting included representatives from all concerned provinces and territories, WMBs, Indigenous organizations/governments, and Inuit users from Nunavut, Nunatsiavut, and Nunavik. Some key outcomes from the meeting included the following: (1) a management objective should be established that meets Inuit subsistence needs and addresses human safety concerns, (2) population modelling suggested that an increase of 12 bears in the annual removal, at a subpopulation level, should not have a notable impact on the subpopulation, and (3) it was recommended that any increase in the harvest limit should be allocated to Nunatsiavut Inuit first, as their current share does not reflect an equitable allocation of harvest taking into account the population of hunters in Labrador.

In 2015, a user-to-user meeting was held in Montréal, Québec. Participants included Inuit representatives and hunters from Nunavut, Nunatsiavut, and Nunavik, as well as representatives from the governments of Canada, Nunavut, Newfoundland and Labrador, Québec, and Land Claims organizations. Some key outcomes from the meeting include the following: (1) management objective to reduce the number of polar bears in Davis Strait because of the high population size and density, (2) users agreed to a total removal of 116 polar bears at a subpopulation level to fulfill the management objective, and (3) participants agreed to the following allocations:

- Nunavut: 61 bears
- Nunavik: 35 bears
- Nunatsiavut: 20 bears

Indigenous Knowledge

In 2015, the Torngat Secretariat published a report that summarized current and past Inuit knowledge of polar bears. Knowledge was gathered from coastal communities throughout Nunatsiavut in 2012. Despite recently observed changes in environmental conditions, including reduced duration and amount of sea ice and prey availability, participants reported no change in body condition of polar bears suggesting that they are adapting to the changes. Polar bears did not show evidence of fidelity to any particular feeding area, but participants noted the diet of polar bears has changed to a diet absent of cod and an increased utilization of garbage from human settlements. Participants noted an increase in polar bears not only near communities, but throughout Labrador since the 1990s.

In 2019, the Nunavik Marine Region Wildlife Board published a report with the aim to record and document comprehensive Inuit knowledge and values related to polar bears across Nunavik communities within the Davis Strait subpopulation. Key findings included: (1) an increase in abundance of polar bears since the 1970s with bear condition described as healthy, (2) tangible benefits of polar bears (food – polar bear meat is shared amongst community members and resources – sale of polar bear hides provides an important source of income), (3) public safety concerns with the increased abundance and frequency of human-bear interactions, and (4) participants shared Inuit stewardship practices that are sufficient for conservation and suggest that the introduction of a quota can be counterproductive.

In 2022, the Nunavut Davis Strait Inuit Qaujimajatuqangit (IQ) report was published with the aim to document IQ on the health of the Davis Strait polar bear population in Nunavut. Knowledge summarized in the report resulted from a series of interviews (inclusive of participatory exercises and validation sessions) performed in 2019 in Kimmirut and Pangnirtung with a total of 35 Inuit polar bear experts (elders, hunters, and women). Interview results identified a substantial increase in polar bear abundance within the Nunavut portion of the DS polar bear population –polar bear abundance had approximately increased four-fold (or 73% [range: 70-75]) since the 1970s in the Kimmirut area. At the time interviews were conducted, polar bears appeared in good overall health, with high proportions of individuals in good body condition status, no change in cub productivity and survival over time, and only a few reports of abnormalities and non-hunting related mortality. However, subtle changes in polar bear health were observed over time, including a slight decrease in body condition status and occasional reports of a hair loss syndrome. Experts interviewed also reported substantial changes in polar bear habitat and ringed seal availability (main polar bear prey in the Pangnirtung and Kimmirut areas) – with an 80% decline in ringed seal abundance observed since the 1960s around Kimmirut. Participants described a progressive increase in human-polar bear interactions and unanimously voiced public safety concerns, which must be prioritized in management to find shared solutions for mitigation of potential negative impacts.

Scientific Assessment

Polar bear abundance in DS steadily increased from the 1970s through to 2005. The Government of Nunavut conducted a population survey from 2005-2007, resulting in an abundance estimate of 2,158 (95% CI: 1833-3442) bears. A two-year genetic mark-recapture study was conducted from 2017-2018, which involved all implicated jurisdictions and WMBs. Subsequently, the previous 2005-2007 data was re-estimated using live capture data, harvest recovery data, and recent genetic samples. This resulted in an estimate of 2,250 bears (95% CI: 1,989-2,512). The estimated abundance for the 2017-2018 study was 2,015 bears (95% CI: 1,603-2,588).

In addition to studies assessing polar bear abundance, research has been conducted to evaluate changes in polar bear survival, reproduction, body condition, and movement. Survival was found to be slightly lower in the most recent abundance estimate study compared to previous studies. However, this could be due to methodological differences between the 2005-2007 and 2017-2018 studies. The switch from a physical mark-recapture to a genetic mark-recapture loses resolution for age-specific survival estimates, since no tooth is obtained for aging the individual. The grouping of senescent bears (>20 years) with prime age bears (5-20 years old) likely reduced the overall estimate of adult survival but should be considered when interpreting results. The recruitment rates in the 2017-2018 study were lower than in previous studies and lower than adjacent subpopulations. As of 2017-2018, recruitment rates seem to be sufficient to sustain the subpopulation, although continued monitoring with changing environmental conditions is warranted, including the use of Inuit knowledge. Sea ice in DS has declined in both duration and summer sea ice area over the 1979-2014 period. However, net effects of changing environmental conditions on survival, reproduction, and distribution were not detected as of 2017-2018. Polar bears showed signs of improved body condition in the 2017-2018 study compared to 2005-2007. There has been no telemetry work since the 1990s within the DS subpopulation, although recovery data provided by harvesters has suggested that the current boundaries for DS are reflective of polar bear movement. Monitoring of these aspects of polar bear population ecology via science and Inuit knowledge could be informative going forward.

1 Background

1.1 Davis Strait Polar Bear Subpopulation Boundary

Based on the recapture or harvest of previously tagged animals and tracking adult female polar bears with satellite collars, the Davis Strait (DS) subpopulation is delineated in Canada within the Labrador Sea, eastern Hudson Strait, Davis Strait south of Cape Dyer, and along a portion of southwest Greenland (Figure 1; Stirling and Kiliaan 1980, Stirling et al. 1980, Taylor and Lee 1995, Taylor et al. 2001).

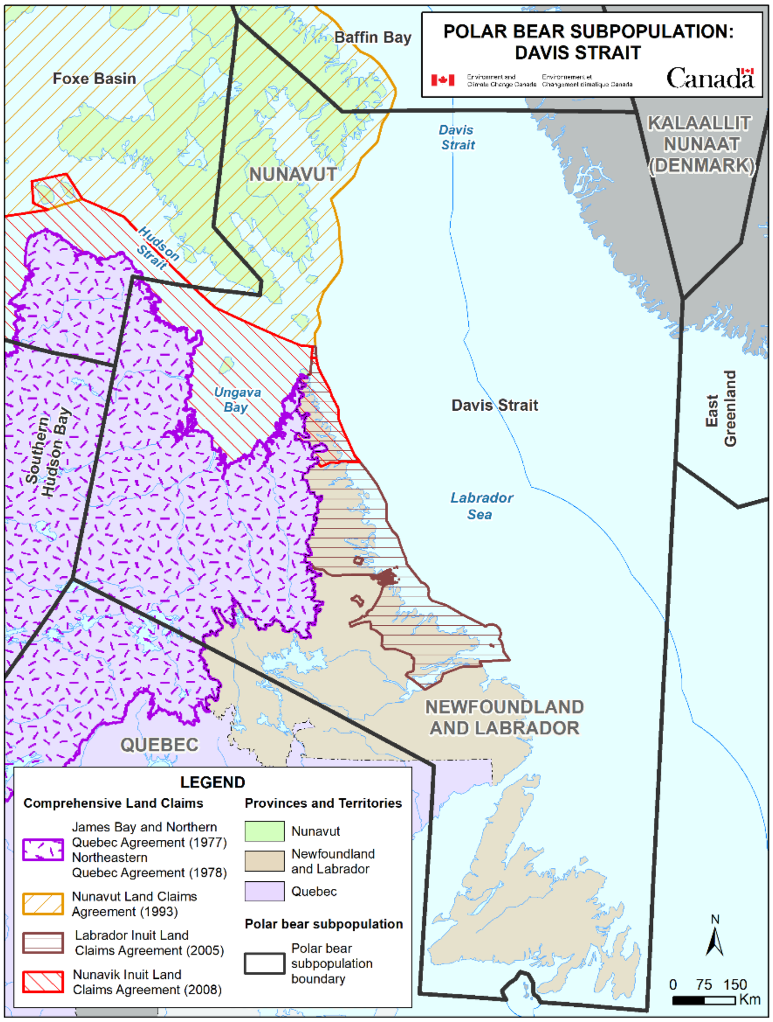

Figure 1. Davis Strait subpopulation and management unit map.

Several studies have examined the genetic structure of DS bears compared to adjacent subpopulations and examined gene flow patterns to determine if genetic variability across individual polar bears corresponds to the currently recognized subpopulation boundaries (see Paetkau et al. 1999, Crompton et al. 2008, 2014, Peacock et al. 2013). While genetic data indicate gene flow occurs, Paetkau et al. (1999) concluded that definition of a Management Unit (MU) was met in DS. Peacock et al. (2013) identified marked genetic differences between northern and southern DS bears and suggested that continued climate warming may increase that separation between those two groups of bears due to Hudson Strait ice dynamics. To date, the DS subpopulation boundary and management unit has been established based on western scientific studies and may not reflect Inuit knowledge related to polar bear distribution and seasonal movements.

1.2 Management Authority

The DS subpopulation is shared between Greenland, Nunavut, Nunatsiavut (Newfoundland and Labrador), and Nunavik (Québec) (Figure 1). Table 1 lists the organizations with management responsibility in DS, as well as the treaties/land claims agreements from which mandates are derived. In Nunavut, Nunatsiavut and the Nunavik Marine Region, Wildlife Management Boards (WMB) forward Total Allowable Take (TAT) / Total Allowable Harvest (TAH) decisions to applicable government Ministers for final decisions. The Hunting, Fishing and Trapping Coordinating Committee (HFTCC) in Québec is not a decisional body for polar bear but can recommend a TAT to the Québec government Minister, who has the discretion to act upon such recommendation, in accordance with the required consultations.

***Table 1**. Canadian management partners involved in polar bear harvest decision-making for the Davis Strait polar bear subpopulation and their current decision-making relationships.*

Agreement or Treaty	Area of Application	Wildlife Management Board or Similar Entity	Government Authority	Indigenous Government or Land Claims Organization
Nunavut Agreement	Nunavut Settlement Area	Nunavut Wildlife Management Board (NWMB)	Nunavut	Nunavut Tunngavik Inc.
Labrador Inuit Land Claims Agreement (LILCA)	Labrador Inuit Settlement Area	Torngat Wildlife and Plants Co-Management Board (TWPCB)	Newfoundland and Labrador	Nunatsiavut Government
Nunavik Inuit Land Claims Agreement (NILCA)	Nunavik Marine Region	Nunavik Marine Region Wildlife Management Board (NMRWB)	Canada (offshore) Nunavut (islands)	Makivik Corporation
James Bay and Northern Québec Agreement (JBNQA)	Mainland of Québec	Hunting, Fishing and Trapping Coordinating Committee (HFTCC)	Québec	Makivik Corporation

2 Canada’s Polar Bear Technical Committee Assessment of Status and Trend

The Polar Bear Technical Committee (PBTC) is composed of individuals who have scientific or Indigenous knowledge of polar bear biology and habitat and are appointed by the jurisdictions, management boards, or agencies that have legal responsibility for polar bear management in Canada. The PBTC meets annually to review scientific and Indigenous knowledge necessary to meet defined management needs in support of Canada’s national and international conservation responsibilities under the 1973 *Agreement on the Conservation of Polar Bears*. The PBTC helps facilitate coordination of research activities among Canadian jurisdictions that have polar bears, as well as the United States and Greenland for those subpopulations that are shared between Canada and these jurisdictions. The PBTC provides technical advice and recommendations to the Polar Bear Administrative Committee (PBAC), as required, on (1) design, collaboration, and conduct of polar bear research in Canada; (2) harvest and population trends; and (3) the need for management actions.

One of the key outputs of the PBTC is an annual status assessment report on Canadian polar bear subpopulations, including harvest, based on scientific information and Indigenous knowledge provided by member agencies.

2.1 Most Recent PBTC Status Assessment (2022/2023)

The ‘Historic Trend’ is an assessment of change in abundance that a subpopulation may have experienced since the signing of the 1973 *Agreement on the Conservation of Polar Bears* (1973) to the present estimate. This trend led to current management practices and research. The PBTC scientific assessment of the subpopulation is ‘likely increased’ and the Indigenous knowledge assessment of the subpopulation is ‘increased’.

In 2022, the ‘Most Recent Trend (Scientific)’ status for Davis Strait was reassessed based on the completed and public scientific survey conducted from 2017-2018. The Most Recent Trend status is an assessment of directionality of abundance according to the most recent estimates available. Ideally, a direct comparison of the previous abundance estimate with the most recent population abundance estimate is used to make the assessment. For Davis Strait, the 2017-2018 abundance estimate was comparable to the previous estimate derived from survey data collected 2005-2007. The PBTC assessed Davis Strait abundance as ‘likely declined’ relative to the previous study given that there was a 0.896 probability that subpopulation growth was <1 and thus the subpopulation most likely declined over this period (see section 6.1 subpopulation abundance for more details).

In 2023, the ‘Trend (Indigenous Knowledge)’ status for Davis Strait was assessed as ‘increased’. In addition to the 2017-2018 scientific study, IK studies occurred in Nunavut (Tomaselli et al. 2022), Nunavik (NMRWB 2019), and Nunatsiavut (York et al. 2015). In all studies, participants noted an increase in polar bear abundance since the 1970s (across Nunavik communities as well as hunting, camping, and traveling areas of Inuit from Kimmirut and Pangnirtung in Nunavut) and since the 1990s throughout Labrador.

2.2 Previous PBTC Assessments

Prior to the scientific study in 2017-2018 being completed, the Most Recent Trend assessment was ‘likely increased’ using a date range of 1980-2007 because there were no other comparable scientific abundance estimates from before the 2005-2007 abundance estimate. This assessment was based on multiple lines of evidence. According to mark-recapture studies conducted between 1974 and 1979, 700-900 bears were estimated to be present in the southern Baffin Island portion of the current delimitation of DS and 60-90 additional bears in the northern Labrador coast portion (Stirling and Kiliaan 1980, Stirling et al. 1980). In 1993, the PBTC established the DS subpopulation abundance estimate at 1,400 polar bears to account for the bias in sampling in the original studies. This estimate was subjectively raised again to 1,650 in 2005 based on the minimum population size that would be needed to sustain the harvest level occurring at that time and the fact that traditional knowledge suggested that more bears were being seen over the previous 20 years. In addition, the abundance of harp seals (*Pagophilus groenlandicus*) in the Northwest Atlantic, an important prey species for this population, had increased dramatically over the same period (Stenson et al. 2010), providing a much-enhanced potential prey base for polar bears. Because of the uncertainties surrounding the subpopulation status, the Government of Nunavut (GN) conducted another population inventory from 2005-2007, resulting in an abundance estimate of 2,158 (95% CI: 1833 – 2542) bears (Peacock et al. 2013). Those results appeared to support an important growth of the DS subpopulation between the 1980s and 2007. At the time of the 2005-2007 survey, the subpopulation was however displaying lowered reproductive rates. Polar bear survival in DS varied with time and geography and was related to factors that included reductions in sea ice habitat and increases of harp seal numbers (Peacock et al. 2013). It was suggested that the observed lowered reproductive rates and the decline in body condition of polar bears in DS could be a result of habitat changes and/or increased polar bear density (Rode et al. 2012, Peacock et al. 2013).

3 Harvest Levels

3.1 Current Harvest Levels

Current harvest regulations and levels are summarized in Table 2.

Table 2. *Summary of current management of polar bear harvest (2021-2022 hunting seasons) by area within the Davis Strait subpopulation and management unit.*

	Area				
Management consideration	**Nunavut Settlement Area**	**Nunavik Marine Region†**	**Québec (onshore region)**	**Newfoundland and Labrador**	**Greenland**
Hunting season	July 1 – June 30	July 1 – June 30 [6]	September 1 – May 31 [5]	February 1 – June 30	N/A[7]
Who can hunt	Nunavut Inuit with a tag [1]	Nunavik Inuit	Nunavik Inuit	Nunatsiavut Inuit	Greenland Inuit
Harvest limit (2021-2022)	61 [2]	None	None	12	3
Protection for females and cubs	Yes [3]	Yes [5]	Yes [5]	Yes [6]	N/A[7]
Protection for bears in dens	Yes [4]	Yes [5]	Yes [5]	Yes [6]	N/A[7]

[1] *Nunavut Wildlife Act*, s.18(1); [2] *Nunavut Wildlife Act,* s.120; [3] *Nunavut Wildlife Act*, s.195, r. 9(2) - Regulatory provisions on harvesting; [4] *Nunavut Wildlife Act*, s.195, r. 9(3) - Regulatory provisions on harvesting; [5] Hunting season, protection of mothers and cubs and protection of bears in dens is not legally mandated, but is regulated in accordance with a voluntary agreement between the Government du Québec and the Inuit (Anguvigak - Nunavik Hunters, Fishers and Trappers' Association, 1984); [6] Government of NL, in consultation with Nunatsiavut Government and the Torngat Wildlife and Plants Co-Management Board, are in the process of preparing a polar bear management plan that will provide a framework for harvest management implementation in accordance with the Labrador Inuit Land Claim Agreement (LILCA). Currently, the annual limit for Nunatsiavut is 12 bears of either sex, with no harvest of denning bears or females with young of the year permitted. For all bears harvested by Nunatsiavut beneficiaries, there is mandatory reporting.
[7]N/A: Information is either not available or not applicable.

3.2 Previous Harvest Levels and Reported Harvest

Table 3 summarizes harvest limits and reported harvest levels since 1994/1995 in Nunavut, Newfoundland and Labrador, and Québec and since 2013/2014 in Greenland. Additional information about harvest is provided for the respective Canadian jurisdictions in sections that follow.

***Table 3**. Polar bear harvest according to jurisdiction for the Davis Strait (DS) polar bear subpopulation from the 1994/1995 to the 2021/2022 hunting seasons. H denotes all human-caused removals, including the total number of polar bears reported as having been harvested or killed in defense of life and property situations each year. See Table 2 for details on hunting season for jurisdictions.*

Hunting Season	Nunavut†		Newfoundland and Labrador‡		Québec *		Greenland		Subpopulation-level
	Annual Limit	H	Annual Limit	H	Annual Limit	H	Annual Limit	H	H
1994/1995	34	34	4	6	None	9	None	Unk§	49
1995/1996	34	34	4	8	None	14	None	Unk	56
1996/1997	34	34	4	2	None	20	None	Unk	56
1997/1998	34	24	4	7	None	23	None	Unk	54
1998/1999	34	34	6	11	None	20	None	Unk	65
1999/2000	34	34	6	7	None	27	None	Unk	68
2000/2001	32	33	6	8	None	28	None	Unk	69
2001/2002	34	34	6	5	None	11	None	Unk	50
2002/2003	34	36	6	6	None	9	None	Unk	51
2003/2004	34	42	6	8	None	19	None	Unk	69
2004/2005	46	43	6	8	None	10	None	Unk	61
2005/2006	42	37	6	5	None	7	Unk	Unk	49
2006/2007	41	37	6	4	None	15	Unk	Unk	56
2007/2008	46	47	6	4	None	13	Unk	Unk	64
2008/2009	46	44	6	6	None	22	Unk	Unk	72
2009/2010	46	42	6	8	None	24	Unk	Unk	74
2010/2011	56	55	6	2	None	24	Unk	Unk	81
2011/2012	39	37	6	13	None	54	Unk	Unk	104
2012/2013	61	60	12	14	None	51	Unk	Unk	125
2013/2014	56	52	12	9	None	61	2	Unk	122
2014/2015	61	50	12	12	None	33	2	3	98
2015/2016	54	32	12	11	None	18	3	0	61
2016/2017	61	43	12	13	None	19	3	0	75
2017/2018	53	38	12	12	None	12	3	0	53

2018/2019	53	31	12	10	None	21	3	0	62
2019/2020	97	50	12	12	None	17	3	3	82
2020/2021	92	38	12	7	None	4	3	5	54
2021/2022	61	33	12	12	None	10	3	1	56

† In Nunavut, the annual limit reflects the annual harvest limit after all reductions or additions to the limit have been made; the annual limit fluctuates to account for harvest that exceeds the base allocation and credit usage. See 3.2.1 Nunavut for details regarding changes in the annual limits.
‡ In Newfoundland and Labrador, the annual limit reflects the annual take limit after all reductions and additions to the limit. See section 3.2.2 Nunatsiavut for details.
* In Québec, there has not been an annual limit in place for Nunavik Inuit harvesting within DS during the 1994/1995-2021/2022 period. Reporting of harvest by Nunavik Inuit is done on a voluntary basis. See section 3.2.3 Nunavik for details.
§ Unk means unknown.

3.2.1 Nunavut

Nunavut, previously Northwest Territories, has had a managed harvest with mandatory reporting for 40+ years. Community compliance and reporting is high (>98%) with Conservation Officers in each community to ensure proper monitoring of the polar bear harvest.

The TAH is the base allocation for number of bears harvested which is decided by the NWMB. Whereas the annual limit is an adjusted base allocation to account for credit use. Each community within, or near, the DS subpopulation boundary receives a share of the maximum sustainable harvest of bears allocated for DS as an annual baseline allocation from the Qikiqtaaluk Wildlife Board (QWB), which is the Regional Wildlife Organization responsible for the DS area. In Nunavut, three communities, Iqaluit, Kimmirut, and Pangnirtung harvest bears from the Davis Strait subpopulation. Locally, the Hunters and Trappers Organizations (HTO) manage and allocate the community harvest and quota among their members. Not every community will harvest their full allocation every year. Any unused portion is accumulated as credits — bears that were available to be harvested but were not taken. Credits may be used in subsequent years. An HTO may apply to the QWB for approval to use available credits for any type of legal harvest. If the numbers killed in a given harvest year exceed that year's annual quota for a given community, additional tags are issued based on any credits that the community's HTO may have available, or credits exchanged with another community's HTO that may also harvest DS bears. Tags from the annual limit may also be exchanged between the three HTOs, subject to QWB approval. When and if there is an excess harvest and no credits or exchanges are available, the excess will be deducted from the community's allocated portion of the annual limit in the following year (Government of Nunavut 2019). Credits are zeroed when a new subpopulation estimate is produced and a new TAH decision is made (Government of Nunavut 2019).

Harvest in DS was managed according to the Flexible Quota System (FQS) until the 2019/2020 harvest year. The FQS operated on a 2:1 male to female harvest sex ratio and was introduced in 1995/1996. However, after extensive consultations and public feedback from communities in Nunavut, and the development of the Nunavut Polar Bear Co-Management Plan, changes to the polar bear harvest administration were introduced in 2019/2020. With the new co-management plan, which was approved by the territorial Minister of Environment and the NWMB, the harvest sex ratio was changed where communities could harvest up to 1 female for every male. This ratio refers to the maximum number of females that may be killed, not the minimum. Up to 100% of the TAH could be males. Due to the protections that are in place for denning bears and females with offspring (family groups), the potential that this management change could cause a decline of the DS subpopulation is relatively low. Adult female polar bears are the most important contributors to population growth and continued monitoring of the harvest in Nunavut is a high priority.

The annual limit was increased from 34 to 46 bears in 2004/2005 and from 46 to 61 in 2012/2013. The aim was to slightly reduce the DS subpopulation due to concerns of Inuit for perceived public safety issues and perceived impacts of DS polar bears on the ecosystem. The average annual removal for the 2012/2013 – 2020/2021 period did not increase with the higher TAH. The harvest averaged 42.7 bears/year over the past 10 years.

Harvesters in Nunavut strictly followed the management quota system and rarely exceeded quota limits in any given year. Under the flexible quota system, credits accumulated for any unused portion of the harvest allocation and these credits would automatically be applied in an overharvest situation. If the female allocation was exceeded and no credits are available to apply, the reductions would be applied to the following year's harvest allocation. Thus, HTOs and their members often stopped harvesting bears when the female allocation was met. Since approximately 2015/2016, the harvest for DS in Nunavut has been well below the quota, mostly due to declines in harvesting by Inuit in Kimmirut and Iqaluit. Kimmirut has harvested four (4) out of the 63 allocated bears (6% harvest rate) from 2015/2016 to 2021/2022. Iqaluit, over the same time period had a harvest rate of 52% of their allocation (119 bears/231 quota). During the previous seven years (2008/2009 to 2014/2015), Inuit in Iqaluit and Kimmirut also harvested less than their allocations, taking 91% and 80% of their annual allocations, respectively. While it is unclear why harvesting dynamics have changed in recent years for these communities, some harvesters from Kimmirut and Pangnirtung have reported that the recent decline in the market value of polar bear hides created a disincentive to harvest polar bears (Tomaselli et al. 2022). The market for polar bear hides crashed in 2014 leading to an overall decline in the number of hides exported in the following years across Canada (Cooper 2022). Inuit in the three Nunavut communities continue to harvest DS polar bears for food, teaching youth about polar bears, local and personal use of skins, and other traditional Inuit values, despite the reduced commercial value of skins.

3.2.2 Nunatsiavut

The Labrador Inuit right to harvest polar bear was initially limited to four bears as a result of the abandonment of Port Burwell (Killiniq) in 1978 and the division of that community's quota of eight polar bears equally between Québec and Newfoundland and Labrador (Urquhart and Schweinsburg 1984). This initial Newfoundland and Labrador quota of four polar bears was later increased to six in 1998, and then to 12 in 2012.

The provincial Minister issues the 12 polar bear hunting licenses to the Nunatsiavut Government which then allocates the licenses to Inuit hunters. All bears have to be harvested within the Labrador Inuit Settlement Area. Three licences are allocated to Nain, three to Hopedale and two each to Makkovik, Postville, and Rigolet. The season starts on February 1st and continues until June 30th.

The Nunatsiavut Government Ministerial Directive identifies a number of conditions that Labrador Inuit must follow when hunting polar bear. Polar bears with cubs are not permitted to be taken and polar bear dens cannot be disturbed in any way. Bears of either sex may be harvested and successful hunters are required to ensure that the meat does not spoil and that care is taken to make sure the quality of the hide is maintained. Successful hunters are required to wait two years before they can re-apply for a polar bear licence and only one licence is permitted per household. This helps to ensure that the licences are distributed in a fair manner and are shared in the community as much as possible.

When a bear is harvested, the hunter is required to fill out a kill return form and submit it to the Nunatsiavut Government, along with the skull and biological samples from the animal. The location, date, condition, and sex of the bear are also recorded on the kill return form. The skull, tissue samples, and measurements are then provided to NL Wildlife Division which arranges for analyses on age determination and genetic markers and collates this information. The cleaned skulls are then returned to the hunters. This aspect of the program has proven helpful in garnering a near 100% level of reporting and submission of samples.

Harvest in Labrador is only partially managed by sex, with prohibitions on the harvest of females with cubs. At the same time, females that are still caring for cubs are not considered part of the breeding pool, and hence a smaller proportion of females than males are available for mating in a given year. Between 1989 and 2021, the provincial harvest was 76% male, calculated from 216 known-sex harvest records in Nunatsiavut.

3.2.3 Nunavik

Although there is no legal requirement for beneficiaries of the James Bay and Northern Québec Agreement to report human-caused polar bear mortalities in Québec, the Québec Government has been compiling harvest reports and issuing tags since 1985 to allow hunters to sell and export their polar bear hides, pursuant to provincial regulations, as well as to fulfill requirements related to international trade established under the *Convention of International Trade in Endangered Species of Wild Fauna and Flora* (CITES), which Canada implements through the Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act (WAPPRIITA).

The proportion of the actual harvest being reported is currently unknown in Québec. It is however likely that there is a link between the probability of reporting polar bear harvest and the harvester's interest to sell the hide, which is in turn influenced by the market price of polar bear hides. We can observe a strong increase in reported harvest from 2011/2012 to 2013/2014 when the average price for polar bear hides sold at auctions was at its highest. Following the strong reduction of market price of polar bear hides in 2014, we can notice a strong reduction of reported polar bears harvested in Nunavik, particularly within DS. It remains, however, difficult to establish how many of those changes in reported harvest are linked to a change in harvest levels versus a change in harvest reporting rate.

The distribution of polar bear harvest among Nunavik communities located within the boundaries of DS is far from being uniform. Most of the reported harvest in Nunavik is conducted within the Hudson Strait area by residents of Quaqtaq and Kangiqsujuaq, whose harvest represents approximately 60% and 15% respectively of the total reported harvest between 1994/1995 and 2021/2022. Another 15% of the reported DS harvest is conducted by residents of Kangiqsualujjuaq on the eastern side of Ungava bay.

Despite the absence of any regulations imposing a sex selective harvest ratio in Nunavik, the male to female ratio in the reported DS harvest in Nunavik for the 1994/1995 to 2021/2022 period is approximately 1.9 males : 1 female.

4. User-to-User Meetings and Agreements

4.1 2010 Interjurisdictional Meeting and User-to-User Workshop

In early 2010, polar bear co-management organizations in Newfoundland and Labrador (Government of Newfoundland and Labrador, Nunatsiavut Government, and Torngat Wildlife and Plants Co-Management Board) determined that harvest in DS was, from their perspective, disproportionately allocated across jurisdictions and that the needs of Nunatsiavut Inuit were not being met. Recognizing that formal mechanisms for joint management did not exist, a request was made that Environment and Climate Change Canada (then Environment Canada) assist in the establishment of a cooperative framework.

Representatives of all concerned Provinces and Territories, WMBs, and Indigenous organizations/governments formed the Interjurisdictional Davis Strait Committee (IDSC). The IDSC met in Montreal on February 3, 2010 to initiate a process. It was decided that a first step should be the determination of a management objective, so that harvest levels could be set in accordance with this objective. It was acknowledged that the management objective should take into account concerns relating to conservation and human safety, and that advice regarding harvest levels should be based on the best available western science and Indigenous knowledge.

A user-to-user workshop was subsequently convened in Kuujjuaq, Québec from September 13-16, 2010. At this meeting, participants representing the IDSC and Inuit users from the three Canadian jurisdictions heard presentations relating to the management system in each jurisdiction, as well as the most recent scientific and Indigenous knowledge information. Summary conclusions included:

- Polar bears from the DS subpopulation are abundant and, as of 2008, the population was probably stable. Population surveys conducted in the 1970s likely underestimated abundance and the available evidence suggested that the subpopulation had increased since that time.

- Inuit users have witnessed an increase in the number of polar bears and local communities and hunters were experiencing an unacceptable amount of negative impact from interactions with polar bears.

- Concerns were raised by users about the delineation of polar bears into subpopulations in general, and the current delineation of the DS subpopulation in particular. The advice of scientific advisors was that while fidelity to sub-regions is not absolute, there is regional variation in survival and recruitment and the current boundaries represent an appropriate, if imperfect, grouping for harvest management decision-making purposes.

- Some users noted that quota systems can create a perverse incentive to maximize harvest, whereas harvest management better aligned with traditional Inuit values may lead to lower overall harvest. Where quotas are used, the importance of flexibility, including the carry-over of unused harvest credits from one year to the next, was emphasized.

- Consensus was not achieved on the proposal that harvest be reduced in Nunavut and Nunavik to accommodate higher harvest in Nunatsiavut.

- It was agreed that a management objective should be established that meets Inuit subsistence needs and addresses human safety concerns.

- Population modelling suggested that an increase in TAH of 12 for the DS subpopulation should not have a notable impact on the subpopulation.

- It was recommended that any increase be allocated to Nunatsiavut Inuit first, as their current share does not reflect an equitable allocation of harvest taking into account the population of hunters in Labrador. An increase by six bears for a new TAH of 12 in Nunatsiavut could be supported by participants from Nunavut, Nunavik, and Nunatsiavut.

4.2 2015 User-to-User Meeting

From May 26-28, 2015, Inuit representatives from Nunavut, Nunatsiavut, and Nunavik met in Montréal to discuss the management of polar bears for the Davis Strait subpopulation. Representatives from the governments of Canada, Nunavut, Newfoundland and Labrador, and Québec participated in the first day of the meeting. Other participants included Inuit hunters, other government representatives, and Land Claims Organization representatives.

Inuit representatives agreed on consensus recommendations for management objectives, a total allowable level of harvest, the allocation of harvest among indigenous groups in the three jurisdictions, and numerous non-quota limitations. They recommended that the management measures and allocations determined by meeting participants should remain in effect until updated information about subpopulation status was available, noting that government representatives had informed them that a new subpopulation survey was scheduled to begin in 2017.

Key outcomes, which are described below, were forwarded by the Inuit representatives to the government Ministers, as well as the NWMB, the TWPCB, and the NMRWB to support Board decision-making.

- *Management objective*: Reduce the number of polar bears in the Davis Strait polar bear subpopulation because of the high population size and high population density.
- *Harvest reporting*: All jurisdictions should report all bears harvested, whether these bears are to be used solely for subsistence purposes or if the bears or any of their parts are ultimately destined to enter into international trade.
- *Defense of Life and Property Kills*: Should be deducted from any quotas or harvest limitations established or recommended by the respective Wildlife Boards.
- *Non-quota limitations*: Continued prohibition on harvesting of cubs and females accompanied by cubs; management practices should include a sex-selective harvest of polar bears based on the ratio of two males to one female; and females and cubs in dens should not be disturbed.
- *Research methods:* The prohibition on the use of chemical immobilization should remain.
- *Subpopulation name*: Should be changed to the original and historically accurate Inuktitut term.
- *Total allowable harvest*: Users agreed to a total removal of 116 polar bears at a subpopulation level, in order to reach the management objective to reduce the number of bears in the management unit. This value is based in part upon a Population Viability Analysis (PVA). Based upon western science, local knowledge, and Inuit traditional knowledge, participants agreed that maintaining high numbers is not only detrimental to polar bears and other species but also a safety concern.
- *Allocation:* Participants agreed to the following allocation:
  - Nunavut: 61 bears
  - Nunavik: 35 bears

    - Nunatsiavut: 20 bears
- *Meeting participants present for this agreement:*
    - Makivik Corporation
    - Nunavut Tunngavik Inc.
    - Qikiqtaaluk Wildlife Board
    - Nunavut hunters from Pangnirtung, Iqaluit, Kimmirut
    - Nunavik RNUK
    - Nunavik LNUKS from Kangiqsuallujjuaq, Kuujjuaq, Tasiujaq, Aupaluk, Kangirsuk, Quaqtaq, Kangiqsujuaq
    - Nunatsiavut Government
    - Nunatsiavut Hunters

Although the agreement was accepted at the user-to-user meeting, Nunavik communities never fully recognized it, and the voluntary harvest limit was never fully implemented. However, Nunavik's reported harvest for Davis Strait subpopulation has never exceeded 35 bears since 2015.

5. Indigenous Knowledge

5.1 Labrador Polar Bear Traditional Ecological Knowledge (2015)

Overview

This report summarizes current and past Inuit traditional ecological knowledge (TEK) relevant to polar bears collected from coastal communities throughout Nunatsiavut in 2012. This study, undertaken by the Torngat Secretariat, was the first comprehensive TEK study conducted on polar bears in Labrador. The survey data was analyzed by Lakehead University's Department of Geography and the report was written in collaboration between Lakehead University and the Torngat Secretariat. It was reviewed and approved by the Nunatsiavut Research Review Board and the Memorial University's Interdisciplinary Committee on Ethics in Human Research.

The TEK gathered provides insight on polar bear hunting practices, management perspectives, polar bear condition, behaviour, abundance, and distribution, as well as changes to climate and sea ice in Labrador from both short-term (recent decades) and long-term (elder knowledge) perspectives. The TEK was gathered in a verbal interview format consisting primarily of open-ended questions. Fifteen Labrador Inuit hunters from four communities (Nain, Postville, Hopedale, and Rigolet) were interviewed.

Key Findings

Polar bear health and physical condition – Interview participants did not report any changes in body condition despite recent changes to sea ice, climate, and the availability of prey species. TEK explanations for the apparent lack of effect from increased density or sea ice decline included a dramatic increase in harp seals (prey), continued seal hunting success in spite of sea ice decline, increased feeding on alternative (non-seal) food sources, and increased feeding during the open water season when most polar bears are onshore.

Polar bear range, distribution, and abundance – Interview participants generally agreed that the number of polar bears had increased in Labrador. Participants also noted an increase in general signs of polar bears everywhere, not only near communities. Recent recollections of hunting activities indicated an increase in the number of bear sightings since the 1990s.

Polar bear denning – Few dens were observed and reported by the interview participants and only a slight majority of participants had ever seen a polar bear den. However, interview participants shared knowledge on polar bear dens and the general location of denning areas in Labrador. They reported that denning was restricted to land and often occurred in areas of high snow accumulation such as hills and cliffs occurring on islands or capes along the coastline. Participants also associated northern Labrador as a general denning area.

Polar bear diet – Participants agreed that the main source of food for Labrador polar bears was seals of all types. There were however conflicting views about the condition of the seal populations. These views were influenced by an event that caused high mortality in harp seals from 2010-2011, but in 2013 continued monitoring efforts confirmed that harp seals are at their highest numbers since monitoring began. The mapping exercise for identifying polar bear feeding areas did not suggest any fidelity to specific locations as feeding areas were identified along most of the Labrador coastline. Interview participants reported that the only changes that they had noticed in the bears' diet were the absence of cod and the utilization of garbage from human settlements and dump sites, which has grown in recent decades.

Physical environment, weather, and climate – Weather was reported to have affected Labrador polar bears by reducing the amount and duration of sea ice and influencing changes in the location of prey species. The reductions in sea ice extent and availability were reported to have been caused by consistently warmer temperatures and strong winds. Despite this, most participants reported that the bears have been adapting to the changes in their environment. They reported that the number of seals being consumed was sufficient for their long-term viability and that the bears were able to consume alternative food sources or catch seals on land or in the water to make up for the shorter hunting season. The participants also reported that the bears were changing their travel routes because of recent changes in sea ice conditions.

Hunting, conservation, and elder hunting knowledge - Current Labrador Inuit polar bear hunters showed a strong interest in sharing their hunting knowledge with Inuit youth and relatives, stating that elders taught them the knowledge that they wished to pass down to the next generation. Most interview participants reported that they hunt less often than in the past and suggested this may be due to other employment, the costs of hunting (e.g., gear, gas, access to equipment), hunting regulations, and a lack of interest. Interview participants reported harvest restrictions to be the largest limiting factor for polar bear hunting, regardless of the recent quota increase. Several participants noted that Inuit had managed the harvest of polar bears in the past and that the quota system was unnecessary. Participants also noted that the bears were being immobilized more often than in the past and that tranquilizing bears causes sickness, impairs the bears' ability to hunt, and can sometimes cause death.

Labrador Inuit hunters indicated a general satisfaction for the relatively new co-management system for polar bears.

5.2 Nunavik Inuit Knowledge and Observations of Polar Bears: Polar Bears of the Davis Strait Sub-Population (2019)

Overview

The Nunavik Polar Bear Inuit knowledge study aimed to record and document comprehensive knowledge and values related to polar bears across all 14 Nunavik communities (Nunavik Marine Region Wildlife Board 2019). The project was split into subsections corresponding with the three polar bear subpopulations found in the Nunavik Marine Region (Southern Hudson Bay, Foxe Basin, and Davis Strait). For Davis Strait, a total of 76 participants from seven communities were engaged in interviews and mapping activities for this project. Local hunter/trapper organizations (Local Nunavimmi Umajulirijiit Katujjiqatigiinninga, or LNUKs) in each community helped identify local polar bear experts for interviews and mapping sessions. Participants spanned a range of ages, and years of experience. When applicable, participants were asked to specify the seasons and time periods within which the information they shared was relevant. Participants shared information on the ecology and biology of polar bears, including abundance, distribution, habitat, feeding, health, mating, and denning. Participants also spoke about the importance of polar bears, both to themselves and to Nunavimmiut in general, as well as about hunting practices, management, and stewardship of polar bears.

Key Findings

Biological – By far one of the most common pieces of ecological data reported by participants was the increase in abundance of polar bears over the last half century. In almost every interview, participants reported noticeable increases in polar bears since the 1970s, and before the 2000s, with many participants first noticing an increased bear population in the 1990s. Polar bears also seem to have widened their distribution, with some participants reporting seeing bears in areas that they did not occupy in the past. Participants also reported the use of inland areas, including the movement of some bears from the Ungava area, across Nunavik to the Hudson coast. Similar movements were reported from the Nunatsiavut coast towards Ungava, across the Québec-Labrador Peninsula. Most participants that had experience seeing polar bear dens indicated they were in deep snow drifts created by large hills and mountains, usually close to the coast, though they generally did not discount the possibility of bears denning inland. Participants indicated that bears prefer to eat ringed seals, but alternative food sources were common, with bird eggs and beluga being especially frequent alternatives in the polar bear diet. Overall, participants indicated bears seem very healthy; bears are fatter in the winter and skinnier in the summer, but rarely skinny enough for participants to be concerned about the bear's health.

Importance of polar bears to Nunavimmiut – Polar bears were reported to be important to Inuit in regards to culture and mental health, safety, sustenance, and economy. Participants described a sense of emotional wellbeing and excitement when seeing polar bears in their environment. They are seen as a symbol of the fortitude and strength of the people who live alongside them. As a tertiary consumer and apex predator, polar bears are often considered more similar to humans than any other animal and regarded as one of the most intelligent species. Participants also expressed safety concerns resulting from the increased abundance and frequency of interactions with polar bears. Hunting a polar bear remains an important rite of passage into manhood for young Inuit, and participants reported a sense of pride associated with every successful hunt. Hunting provides two of the most tangible benefits of polar bears: food and resources. Polar bear meat is eaten in each community, especially by elders, and usually shared amongst community members. However, when hunters have discovered that a kill was previously tranquilized and tattooed for research, the meat is deemed unsafe for consumption and left behind. The sale of polar bear hides is an important source of income for hunters and enables the purchase of materials such as ammunition, gasoline, rifles and snowmobiles, required to continue a subsistence hunting lifestyle. The importance of polar bear hunting has changed over time, as economic opportunities have changed, though the economic benefits have existed for many decades. Polar bear hides were traditionally used to make mattresses, snow pants, and mitts, or as important gifts (e.g., a first hide is often gifted to the hunter's sanijik, godparent) which still occurs today.

Management and stewardship – A very common sentiment among participants was that traditional stewardship practices were sufficient for conservation and that the introduction of a quota to limit polar bear hunting was unnecessary and possibly dangerous or counterproductive. Participants shared several stewardship practices that were common across the region. Without exception, hunting was based on need. While many participants expressed great enjoyment associated with being out on the land, their hunting activities were based on subsistence, not sport. Even when a hunter's own needs were met (and sometimes even before), hunting supplemented the needs of family, or the greater community. Some hunters mentioned prioritizing elders, who could no longer hunt, when distributing polar bear meat. More specifically, participants spoke about limiting their hunting to fully grown polar bears without small cubs. Participants also generally limited their hunting to winter, as well as late fall and early spring when bears have the best coat and the best meat. In some cases, especially in the past, a small amount of hunting outside of this season was done to sustain people on long expeditions (be it on the land, or on boat trips). Otherwise, virtually all kills during the warmer, ice-free seasons were due to safety concerns. Participants cautioned that the implementation of quotas can create a sense of competition between hunters or communities, and that this would likely increase the number of bears hunted: with a quota, hunters would rush to get their bears before the quota is filled. The competition created from a quota system could also inhibit traditional management practices, where hunters wait until prime hunting season to take bears. Participants suggested several ways that the detrimental effects of a quota could be mitigated, including considering seasons, and having quotas that are locally managed.

5.3 Nunavut Inuit Qaujimajatuqangit on the Health of the Davis Strait Polar Bear Population (2022)

Overview

This study aimed at gathering and documenting Inuit Qaujimajatuqangit (IQ) on polar bear health around the communities of Kimmirut, Pangnirtung and Iqaluit, Nunavut, to support management decisions and strategies for the Davis Strait polar bear subpopulation (Tomaselli et al. 2022). This collaborative research project was conducted as a partnership between the Government of Canada (Environment and Climate Change Canada and Polar Knowledge Canada), the Government of Nunavut (Government of Nunavut, Department of Environment), and local Hunters and Trappers Organizations (HTOs) from the communities of Pangnirtung and Kimmirut in the Qikiqtani region of Nunavut, with support from the Amarok Hunters and Trappers Organization (Iqaluit). The research team documenting, analyzing and interpreting information included: a veterinarian (wildlife health and participatory epidemiology specialist), a social scientist, community-based researchers, and polar bear biologists. The study explored the detailed historic and contemporary knowledge held by Inuit experts about polar bear ecology and health, as well as the importance of *nanuq* to Nunavut Inuit, and Inuit perspectives on polar bear management and stewardship. Polar bear health was considered broadly and holistically at the individual, population, and ecosystem levels; polar bear health was assessed considering multiple parameters, such as abundance and demography, habitat condition and distribution, diet and prey availability, body condition, and other Inuit-identified health indicators and metrics, in addition to mortality and disease.

Inuit Qaujimajatuqangit related to polar bear cultural importance, harvesting practices, health, ecology, and management was documented through a series of individual and group interviews (inclusive of participatory exercises) conducted in 2019 with a total of 35 Inuit contributors from Pangnirtung (n=14) and Kimmirut (n=21). Group interviews (n=4) were performed in Kimmirut only (with a total of 15 participants) and allowed obtaining quantitative information, as well as corroborating early findings. Group interviews planned in Pangnirtung were cancelled due to the COVID-19 pandemic. Overall, project contributors included 24 men and 11 women ranging in age from their early 40s to early 80s. Polar bear experts interviewed included Kimmirutmiut and Pangnirtungmiut who had experience harvesting and butchering polar bears (generally men), processing and cleaning polar bear hides (generally women), or otherwise significant experience on the land. Direct ecological observations reported by participants were made within approximately 420 kilometers from their community, and the earliest direct observations reported dated back to the 1940s. Before finalizing research results, analyzed information was presented to study contributors during feedback or validation sessions which occurred in 2021 in both communities. This key step ensured increased accuracy and confidence in results. Project results were also shared with board members from the Kimmirut and Pangnirtung HTOs prior to final report publication, providing additional community-based peer-review of research findings.

Key Findings

Importance of polar bears to Nunavut Inuit – Interview contributors shared a strong sense of the importance of *nanuq* (polar bear) to Inuit culture, identity, traditions, and well-being, and discussed their past and ongoing relationships with polar bears. *Nanuq* was described as a mighty, intelligent, and resilient animal that must be both respected and feared. Participants explained that IQ emphasizes the importance of harvesting only what one needs, not playing with bears, sharing polar bear meat, and avoiding waste. Today, polar bears are harvested in Kimmirut and Pangnirtung mainly for their meat and hide. Polar bears are a source of country food and a source of income through the selling of hides and guided sport hunts. In both communities, polar bear hides are generally sold or used for clothing, mattresses, and blankets. However, many participants commented that the economic value of polar bear hides has declined in recent years, which has created a disincentive to harvest polar bears. Importantly, contributors from both communities commented on the importance of maintaining polar bear harvest into the future to preserve Inuit ways of life and foster community well-being.

Polar bear health and ecology – Overall, interview contributors from Pangnirtung and Kimmirut reported that, within their area of observation, the local polar bear population is today generally healthy. Observations suggestive of a healthy polar bear population included: an increase in polar bear sightings systematically reported by participants over their lifetime suggestive of increased abundance; females with two cubs-of-the-year and females with two yearlings being most frequently observed suggestive of no change in cub productivity and survival over time; a high proportion of polar bears observed in good body condition and overall health; and rare reports of polar bear disease, abnormalities or non-hunting related mortality.

In both Kimmirut and Pangnirtung, all interview contributors (n=35) reported a substantial increase in polar bear abundance observed across their area of observation over their lifetime. In Kimmirut, group interview participants indicated that the polar bear population had increased by an average of approximately 73% (range: 70-75, n=3[1]) since the 1970s and 14% (range: 2-34, n=3) since 2005 within their area of observation. Contributors also shared detailed observations on the evolution of polar bear distribution over time within their area of observation; polar bear distribution appeared to have remained stable (Kimmirut area) or expanded (Pangnirtung area), with a progressive increase of sightings of polar bears closer to both communities starting from around the 2000s. Nearly all interview contributors from Pangnirtung and Kimmirut reported observing more cubs and juveniles, females, and/or females with cubs (family groups) over time. In addition, participants from both communities did not report any notable changes in cub productivity and survival and/or family group size over time. For example, in Kimmirut the relative proportion of cubs-of-the-year (COY) and yearlings per female had been constant from the 1990s onward, with two COYs/female and two yearlings/female most frequently observed (83% [range: 74-99, n=3] and 75% [range: 45-95, n=3] of the time, respectively). Collectively, this information coupled with targeted mapping exercises confirmed that the increase in polar bear sightings reported by all contributors corresponds indeed to a ‘true’ increase in the local abundance of polar bears rather than an ‘apparent’ increase driven by a shift in polar bear distribution or by changes in participant travel areas over time. In general, contributors from both Kimmirut and Pangnirtung reported that polar bears are in good body condition and good overall health. For example, in Kimmirut 94% (range: 92-96, n=3) of polar bears observed by group interview contributors over the 2016-2019 period exhibited healthy fat levels and 91% (range: 85-95, n=3) of polar bears observed over the same time period were described as overall healthy. Moreover, results indicated that these proportions have either remained stable or slightly declined since the 1990s. However, in recent years, Inuit contributors pointed to some subtle changes in polar bear health, including a slight decline in polar bear fatness and overall health noted by some participants and occasional reports of hair loss (alopecia) –which was also observed in some seals. In addition, participants had observed recent changes in polar bear prey availability and habitat condition over time, including changes in sea ice quality and quantity and a major decline in the abundance of ringed seals (main polar bear prey present throughout the year around Kimmirut and Pangnirtung) observed around both communities. In Pangnirtung and Kimmirut, all participants who commented on ringed seal abundance reported a major decline occurring over the last few decades. For example, contributors reported an 80% (range: 80-80, n=2[2]) decline in ringed seal abundance in the Kimmirut area occurring between the 1960 and 2019. Over the same timeframe, sightings of harp seal (only seasonally present) had increased by approximately 60% (range: 43-75, n=2), while the number of bearded seals had remained constant around Kimmirut. Contributors from both communities also noted that polar bears feeding on anthropogenic waste and other man-made items was a recent phenomenon. At the time interviews were conducted, changes in habitat condition and ringed seal availability were not reflected in observations related to cub productivity, which has remained stable according to contributors from both communities.

Management and stewardship – Contributors emphasized that *nanuq* is a resilient and opportunistic predator that is highly adaptable to changes in prey availability and habitat conditions. In addition, study results highlighted public safety concerns arising from increased human-polar bear interactions and encounters and suggested that polar bear management today must find ways to address public safety concerns while ensuring that polar bears persist into the future and remain available for future generations.

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[1] Here n=3 refers to three group interviews organized in Kimmirut with male polar bear harvesters in which a total of eight harvesters participated.

[2] Here n=2 refers to two group interviews organized in Kimmirut with male polar bear harvesters in which a total of six harvesters participated.

5.4 Other Inuit Knowledge Studies

Overview

A recent literature review gathered 23 sources that include Inuit Knowledge (IK) of the DS polar bear subpopulation (Hicks et al. 2022). These sources were published between 1976 and 2022 and included peer-reviewed articles, government and co-management board reports, academic theses, books, and film. They covered all three Inuit regions within the DS subpopulation (with 18 sources from Nunavut, six from Nunatsiavut, four from Nunavik, and one from Greenland).

Five regional IK reports specific to the DS subpopulation −including the three reports described in sections 5.1, 5.2 and 5.3 above − were the most comprehensive sources within the compiled documents (Kotierk 2010a, 2010b, York et al. 2015, NMRWB 2019, Tomaselli et al. 2022). Those five regional reports were reviewed, analyzed, and synthesized by the Polynya Consulting Group as part of the Nanuk Knowledge and Dialogue Project, which aimed to develop a shared understanding about the DS polar bear subpopulation amongst Inuit regions, and to mobilize this knowledge to strengthen polar bear co-management (Hicks et al. 2022). The Nanuk Knowledge and Dialogue Project is collectively led by the TWPCB in Nunatsiavut, the NMRWB in Nunavik, and the NWMB in Nunavut, in partnership with Nunavut Tunngavik Inc. (NTI) and the Nunatsiavut Government.

Key Findings

All five regional IK reports documented an overall increase in polar bear abundance observed by Inuit since the 1970s (within areas of travel around communities) and indicated that DS polar bears are generally healthy (Kotierk 2010a, 2010b, York et al. 2015, NMRWB 2019, Tomaselli et al. 2022). Impacts of increased abundance were noted across the three Inuit regions primarily through safety concerns associated with increased human-polar bear interactions (Hicks et al. 2022). In addition, changes in polar bear habitat and prey availability were reported across these regions, including: a decrease in sea ice quality and quantity observed in Nunavut, Nunavik and Nunatsiavut; an increase in harp seal abundance reported in Nunavut and Nunatsiavut; and a decline in ringed seal abundance observed in Nunavut (Hicks et al. 2022). Inuit participants also explained that polar bears are resilient and opportunistic predators highly adaptable to environmental change (Hicks et al. 2022). Importantly, Inuit participants reported that IK is key to understanding polar bear health and managing human-bear relationships; and some participants expressed a desire to have more control in decision-making related to the management of the DS polar bear subpopulation (Hicks et al. 2022).

Finally, one regional report assessed the social carrying capacity for polar bears within Nunavut communities harvesting from the DS subpopulation (Kotierk 2010b). Social carrying capacity can be defined as the level of human/wildlife interactions that meets social and cultural demands for positive interactions, such as harvesting of food and other resources, but does not exceed social tolerance of negative interactions, such as property damage (Peyton et al. 2001). Amongst Nunavut Inuit harvesters (n=33) who participated in a survey in 2007-08, 54 % thought that the DS polar bear subpopulation was above their preferred abundance level and 37% expressed the view that abundance was at their preferred level (Kotierk 2010b).

6. Scientific Assessment

6.1 Subpopulation Abundance

According to mark-recapture studies conducted between 1974 and 1979 on sea ice in the spring, 700-900 bears were estimated to be present in the southern Baffin Island portion of the current delimitation of DS and 60-90 additional bears in the northern Labrador coast portion (Stirling and Kiliaan 1980, Stirling et al. 1980). In 1993, the PBTC established the DS subpopulation abundance estimate at 1,400 polar bears to account for the bias in sampling in the original studies. This estimate was subjectively raised again to 1,650 in 2005 based on the minimum population size that would be needed to sustain the harvest level occurring at that time and the fact that Indigenous knowledge suggested that more bears were being seen over the last 20 years.

Because of the uncertainties surrounding the population status, the Government of Nunavut (GN) conducted another population inventory from 2005-2007, resulting in an abundance estimate of 2,158 (95% CI: 1833 – 3442) bears (Peacock et al. 2013).

A two-year genetic-mark-recapture (biopsy) study was conducted in 2017 and 2018 involving all of the DS management jurisdictions and Boards (Dyck et al. 2021a). The 2017-2018 study design resembled the 2005-2007 study in terms of coverage and timing to allow comparison to the earlier study to establish a population trend. In addition, the 2005-2007 study data was reanalyzed with the 2017-2018 study data and harvest data to improve accuracy of estimates.

The analysis included the previous 2005-2007 live-capture data, harvest recovery data from 2005 to 2018 and the genetic samples collected in 2017 and 2018. Using this larger dataset, DS abundance was re-estimated for the 2005-2007 at 2,250 bears [95% CRI 1,989 - 2,512], which falls within the confidence interval of the estimated abundance published by Peacock et al. (2013). Estimated abundance for the 2017-2018 period was 2,015 bears [95% CRI 1,603 - 2,588]. Geometric mean subpopulation growth between 2006 and 2018 was 0.989 [95% CRI 0.974 – 1.010] which corresponds to a 0.896 probability that subpopulation growth was <1, and thus the subpopulation most likely declined over this period.

Mean annual reported harvest from all jurisdictions combined increased from 64.1 ± 10.1 (SD) bears/year between 1999 and 2008 to 86.8 ± 23.6 between 2009 and 2019. Given the lack of complete harvest reporting within the DS subpopulation area, it is not possible to determine an exact number of the potential, annual allowable removal from the subpopulation. The increased harvest within the DS subpopulation area may be a factor explaining the lower abundance estimate in 2017-2018.

6.2 Supplementary Information - Reproduction, Body Condition, Survivorship, and Movement

Survival

The 2017-2018 genetic mark-recapture study estimated survival for the entire DS subpopulation area (Dyck et al. 2021a). This contrasts with Peacock et al. (2013) which included a geographic component model variation in survival and reproduction based on a bear's initial capture location (e.g., north, central, and south Davis Strait). However, Dyck et al. (2021a) found there was not sufficient evidence to warrant the inclusion of three distinct geographic subpopulations within the DS boundary and did not want to reduce the samples size of the 2017-2018 study.

In the most recent abundance estimate report (Dyck et al. 2021a), survival rates estimated for all segments of the population were slightly lower than those calculated by Peacock et al. 2013, but fell within their confidence intervals. Potential causes for the lower survival reported from the recent study include the grouping of senescent bears (>20 years old) with prime age adults. Senescent bears typically have lower survival rates compared to prime age adults. Methodologically, genetic capture-mark-recapture allows estimation of survival for age class bears but loses resolution for age-specific survival estimates because no tooth is obtained for aging. Thus, including the senescent bears with prime age adults likely reduced the overall estimate of adult survival. This increases the variability in the survival estimates and must be considered when evaluating the results. Inclusion of auxiliary information including satellite telemetry and harvest data with individuals aged and identified through genetic analysis can help overcome the weaknesses of genetic capture-mark-recapture.

Reproduction

Over the two comparable study periods (2005-2007 and 2017-2018), mean cub-of-the-year (COY) recruitment (number of COYs per adult females) ranged from 0.23 to 0.45 and mean yearling recruitment (number of yearlings per adult females) ranged from 0.23 to 0.41. The rates for COYs are notably lower than the adjacent Baffin Bay subpopulation where values were between 0.55 and 0.83 (Laidre et al. 2020a). Additionally, COY litter sizes were lower than other subpopulations including Baffin Bay (Laidre et al. 2020a), but did not differ from the previous study period in 2005-2007. The recruitment rates for yearlings were closer to reported recruitment of yearlings in Baffin Bay (Laidre et al. 2020a) and fall within a range that is generally considered adequate for population persistence (Regehr et al. 2017). While the mean values are low compared to other subpopulations, they appear to be sufficient to sustain the DS subpopulation. The relatively low reproductive rates have been noted as an area for continued monitoring in the face of ongoing climate change as impacts to recruitment remain unknown.

Body Condition

Body condition decreased based on data from 2005-2007 compared to earlier 1990s data. However, bears were less likely to be in poor body condition during the 2017-18 study period when compared to the 2005-07 study. Similar improvements in body condition for polar bear subpopulations have been noted in other studies in the last 10 years (e.g., 2011-2018), including Kane Basin (Laidre et al. 2020b), Gulf of Boothia (Dyck et al. 2022), and M'Clintock Channel (Dyck et al. 2021b). These subpopulations represent a range of ecosystems, though all have some amount of ice that persists through the summer and fall, whereas DS experiences a mostly ice-free summer (Stern and Laidre 2016).

Movement

Bears were fitted with telemetry sensors in the early and late 1990s (1991-1994 and 1997-1999) in the DS area. No telemetry work has been done since the 1990s in response to Inuit concerns with physical handling and telemetry of polar bears. There appears to be high fidelity to geographic location based on capture and recapture locations from fall on-shore survey data within the DS area (GN unpublished data). Telemetry data from other subpopulations (e.g., Baffin Bay and Kane Basin, Laidre et al. 2018, 2020a) indicated changes in range and distribution of polar bear subpopulations in the past 20 years that is correlated with sea ice changes. The telemetry work from Baffin Bay supported the northern boundary of the DS area, and the dead recovery data provided by harvesters in Nunavut indicates that over 85% of recovered bears were within the DS subpopulation boundary. These data indicate that the current boundaries for DS have remained generally relevant. However, any changes in movements, distributions, or fidelity that may have occurred in Davis Strait in relation to the ongoing sea-ice declines and other environmental change have remained unclear, except through insights that have been available through IK.

6.3 Environmental Conditions

Stern and Laidre (2016) evaluated changes in the timing of spring sea ice retreat and fall sea ice advance for all 19 polar bear subpopulations from 1979-2014, using a common set of sea ice metrics across subpopulations. Their methodology has been adopted by the Polar Bear Specialist Group (PBSG) as an indicator of the availability of sea-ice habitat in the PBSG's status table (http://pbsg.npolar.no/en/status/status-table.html). Full methodological details are provided in Stern and Laidre (2016).

In the 2017-2018 scientific study, environmental factors such as sea-ice duration were examined to evaluate if effects on interannual survival were present. Covariates investigated include the relationships between polar bear survival and 1) sea-ice decay rate following Lunn et al. (2016), 2) the number of ice-free days, and 3) the winter indices of the North Atlantic Oscillation (NAO) and Arctic Oscillation (AO; Dyck et al. 2021a). The NAO and AO are strong indicators of sea-ice extent during the spring to summer period as they influence regional climate (Stern and Heide-Jørgensen 2003, Heide-Jørgensen et al. 2007). The study used data during the 2005-2018 period and found no link between survivorship and the sea-ice parameters that were examined. Sea ice in Davis Strait has decreased both in duration and summer sea ice area (Table 5). Peacock et al. (2013) found that total survival increased when the mean summer sea-ice concentration was between 17% and 29% using their 2005-2007 study data and decreased below 17%. Mean summer sea-ice concentration did not exceed 8% during the last study period of 2017-2018.

In Davis Strait, harp seals, an important prey species for DS polar bear subpopulation (Iverson et al. 2006; Peacock et al. 2013), increased dramatically from the 1970s to 1990s, and appears to have remained relatively stable since the mid-1990s, with an increasing population in recent years (Stenson et al. 2010, Hammill et al. 2021). This abundance of harp seals probably provided a much-enhanced potential prey base for DS polar bears and was one potential mechanism behind Peacock et al.'s (2013) findings by which polar bear survival remained high since the 2000s. Similarly in the 2017-2018 scientific study, harp seal abundance was included as an environmental covariate to evaluate the effect on survival; however, the study found no relationship between harp seal abundance and survival. Since the initial increase in harp seal abundance between 2005 and 2018, the harp seal abundance has remained consistently high (> 5 million seals, Hammill et al. 2021). Dyck et al. (2021a) suggest that the increase of harp seal abundance over time may have contributed to an increase in polar bear survival in DS; however, as harp seal abundance has stabilized, and the likelihood of detecting an influence of harp seal abundance on polar bear survival has decreased.

Table 5. *Trends in sea ice metrics according to global polar bear subpopulations (PBSG 2018).*

Subpopulation	**Sea Ice Metrics†**		
	Change in spring ice retreat (days per decade)	**Change in fall ice advance (days per decade)**	**Change in summer sea ice area (percent change per decade)**
Arctic Basin	-3.2	8.0	-6.7
Baffin Bay	-7.3	5.2	-18.9
Barents Sea	-16.6	24.2	-16.0
Chukchi Sea	-3.4	4.2	-18.8
Davis Strait	**-7.7**	**9.7**	**-19.9**
East Greenland	-6.2	5.5	-6.5
Foxe Basin	-5.3	5.8	-14.2
Gulf of Boothia	-6.9	8.3	-12.2
Kane Basin	-7.2	5.6	-12.2
Kara Sea	-9.2	7.6	-18.6
Lancaster Sound	-5.6	5.1	-7.7
Laptev Sea	-8.2	6.5	-14.7
M'Clintock Channel	-3.9	5.8	-9.0
Northern Beaufort Sea	-5.8	3.3	-5.9
Norwegian Bay	-1.3	4.3	-2.3
Southern Beaufort Sea	-8.7	8.7	-20.5
Southern Hudson Bay	-3.1	4.1	-11.4
Viscount Melville Sound	-4.7	7.4	-6.1
Western Hudson Bay	-5.2	3.6	-16.3

† Sea ice metrics defined as follows by PBSG: (1) Change in date of spring sea ice retreat and change in date of fall sea ice advance (days per decade) over the period 1979-2014. Each year the area of sea ice reaches a maximum in March and a minimum in September. In order to measure the timing of the seasonal change in sea ice, we find the date each spring when the area of sea ice has dropped to a specific threshold and the date each fall when the area has grown back to that same threshold. The region-specific threshold is halfway (50%) between the mean March sea-ice area and the mean September sea-ice area over the period 1979-1988 for each subpopulation region. (2) Change in summer sea ice area (percent change/decade, June 1 – October 31) relative to the average summer sea ice area during 1979-1988. Sea ice area was calculated as the sum, over all grid cells with >15% sea ice concentration, of the grid cell area multiplied by the grid cell sea ice concentration.

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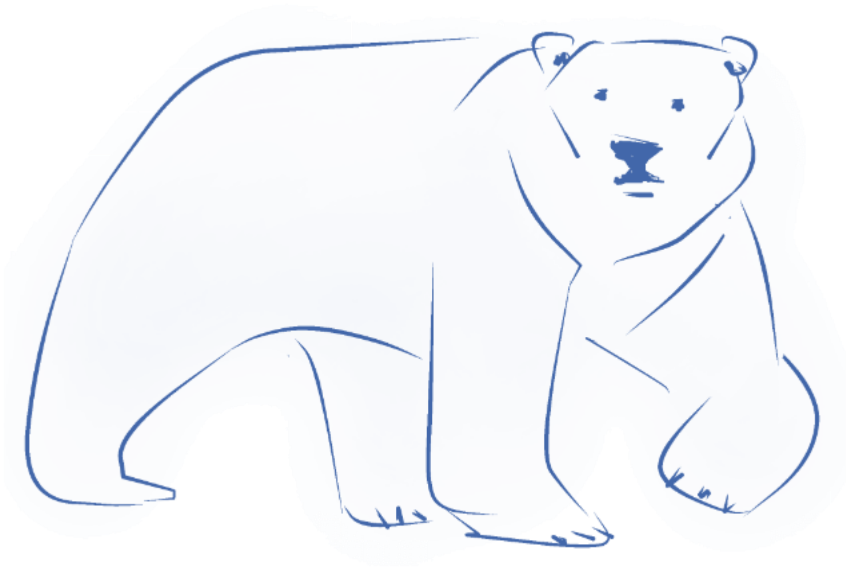
Nunavut Inuit Qaujimajatuqangit on the health of the Davis Strait polar bear population

Final project report – 2022



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All information and knowledge within this report are the product of a collaborative effort among government and community-based researchers, the Mayukalik Hunters and Trappers Organization, the Pangnirtung Hunters and Trappers Organization, the Amarok Hunters and Trappers Organization and 35 contributing authors.

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We dedicate this report to the memory of Markus Dyck who respected the Inuit way of life and worked tirelessly to help conserve polar bears in the Canadian Arctic.

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EXECUTIVE SUMMARY

Nanuq (polar bear; *Ursus maritimus*) is a key species of the Arctic ecosystem and is culturally important to Inuit. Nunavut Inuit have accumulated and developed a vast knowledge about polar bears through extensive observation of their environment and harvesting activities. Understanding the health status –including abundance– of polar bear populations is critical for effective polar bear management. In Nunavut, sustainable polar bears harvest quotas are established using both Inuit Qaujimajatuqangit (IQ; Inuit traditional knowledge) and Western scientific information.

This project aimed at gathering and documenting Inuit Qaujimajatuqangit on polar bear health around the communities of Kimmirut, Pangnirtung and Iqaluit, Nunavut, to support management decisions and strategies for the Davis Strait polar bear subpopulation. This collaborative research project was conducted as a partnership between the Government of Canada (Environment and Climate Change Canada and Polar Knowledge Canada), the Government of Nunavut (Government of Nunavut, Department of Environment), and local Hunters and Trappers Organizations (HTOs) from the communities of Pangnirtung and Kimmirut in the Qikiqtani region of Nunavut (Figure A), with support from the Amarok Hunters and Trappers Organization.

We documented Inuit Qaujimajatuqangit related to polar bear cultural importance, harvesting practices, health, ecology, and management through a series of individual and group interviews and participatory exercises conducted in 2019 with 35 Inuit participants from Pangnirtung and Kimmirut. Individual interviews were performed in both communities. Group interviews –which allowed obtaining quantitative information– were performed in Kimmirut only, with a total of 15 participants (including seven who were also interviewed individually and eight new participants) divided into four groups: three groups included male polar bear harvesters and one included women specialized in polar bear hide processing. Group interviews planned in Pangnirtung were cancelled due to limitations posed by the COVID-19 pandemic. In fall 2021, preliminary results were presented to participants for their validation and feedback, which was incorporated in this report. Overall, project contributors included 24 men and 11 women ranging in age from their early 40s to early 80s. Polar bear experts interviewed included Kimmirutmiut and Pangnirtungmiut who had experience harvesting and butchering polar bears (generally men), processing and cleaning polar bear hides (generally women), or otherwise significant experience on the land. Inuit Qaujimajatuqangit shared by participants over the course of this study was acquired through their direct individual experiences with polar bear harvesting, butchering and hide processing, as well as through their experience living and travelling on the land. Some of this knowledge was also obtained from other hunters, Elders and community members. Direct ecological observations reported by participants were made within a 420-kilometer radius from their community, and earliest direct observations reported dated back to the 1940s (see ‘range of direct observations’ represented in Figure A).

Here we summarize the knowledge that was shared by Inuit project contributors during interviews, and relevant to the assessment of polar bear health from an IQ perspective. In this study, polar bear health was considered broadly and holistically at the individual, population and ecosystem levels. We assessed polar bear health considering multiple parameters, such as abundance and demography, habitat condition and distribution, diet and prey availability, body condition and human-polar bear interactions, in addition to mortality and disease.

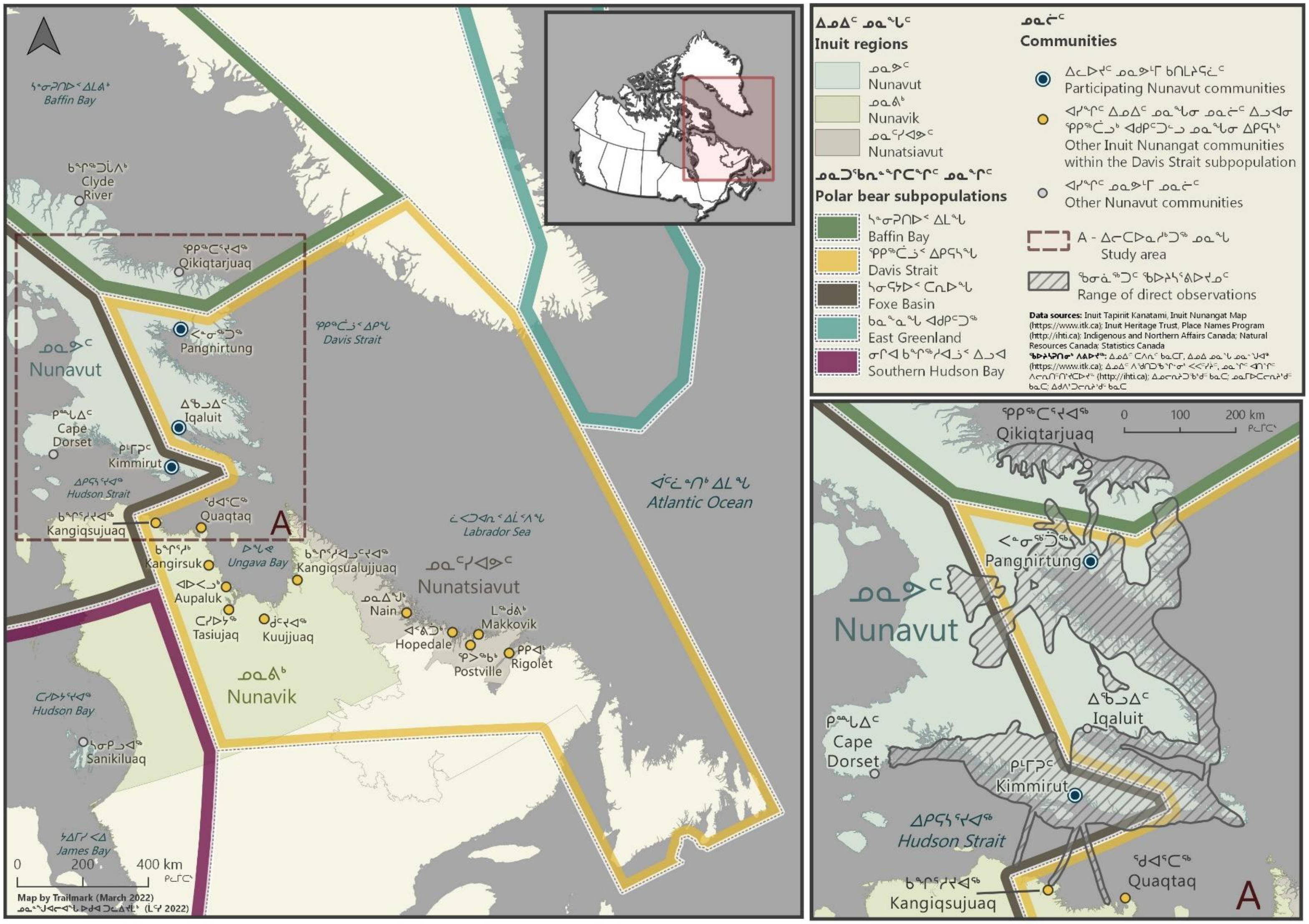


Figure A. Study area within the Davis Strait polar bear subpopulation and management unit. In the legend, 'range of direct observations' (dashed area in map A) refers to the geographic extent of the ecological observations made by participants interviewed as part of this study.

Given that Inuit Qaujimajatuqangit includes multiple dimensions (cultural values, practices, ethics, worldviews, as well as ecological observations) which cannot be dissociated from one another, Inuit observations related to polar bear ecology and health are presented alongside knowledge related to the cultural and economic importance of polar bears, and Inuit perspectives on polar bear management and stewardship. Particular attention was given to topics that could inform ongoing and future polar bear research, monitoring efforts, and management decisions.

Importance of polar bears to Nunavut Inuit

Interview contributors shared a strong sense of the importance of polar bears to Inuit culture, identity and traditions, and discussed their past and ongoing relationships with polar bears. *Nanuq* was described as a mighty, intelligent and resilient animal that must be both respected and feared. Participants explained that Inuit Qaujimajatuqangit emphasizes the importance of harvesting only what one needs, not playing with bears, sharing polar bear meat, and avoiding waste.

Prior to the introduction of the quota system in the 1960s, Inuit hunters could harvest any polar bear at any time of the year, including family groups (female with cubs) and denning female bears. Particularly around Pangnirtung, harvesting denning females was practiced along the east coast of the Cumberland Peninsula. In the past, polar bear meat and fat were shared among families and used as food for sled dogs, while polar bear hides were used for clothing, as mattresses and for trade. The establishment of harvesting quotas and the development of a cash economy associated with the selling of polar bear hides contributed to significant changes in polar bear harvesting practices in Pangnirtung and Kimmirut. Harvesting polar bears transitioned from being sporadic and mainly opportunistic to being seasonal, sex-selective (biased towards the harvest of big adult males or *angujuaq*) and limited by harvest quotas. Contributors from both communities explained that family groups and denning female bears are not harvested anymore.

Today, polar bears are harvested mainly for their meat and hide. Polar bears are a source of country food but also a source of income through the selling of hides and guided sport hunts. In Kimmirut and Pangnirtung, polar bear hides are generally sold or used for clothing, mattresses and blankets. However, many participants commented that the economic value of polar bear hides has declined in recent years, which has created a disincentive to harvest polar bears.

Polar bear hunters from Kimmirut and Pangnirtung reported that the months of March and April are best for harvesting bears because it allows obtaining hides of greater economic value (i.e., thicker, whiter and bigger hides). At that time of year, big male polar bears that mostly live in the pelagic environment are more accessible to harvesters as they come close to the coast to mate and hunt denning ringed seals. In both communities, polar bear hunting is mainly conducted by men, although some women also engage in polar bear hunts. Polar bears are generally butchered by hunters immediately after harvest and stomach contents are routinely inspected. Polar bear hide and meat are brought back to the community, while the organs are left at the kill site. Polar bear meat is shared among community members and the hide is thoroughly cleaned, stretched and dried –mainly by women– prior to being sold or used. Preparing polar bear hides is a work intensive process that women often conduct collaboratively.

Participants from both communities talked about the importance of maintaining polar bear harvest into the future to preserve Inuit ways of life. Polar bear harvesting was reported to contribute to community well-being as it connects Inuit to the land and cultural traditions.

Polar bear ecology and health

Contributors shared their knowledge of polar bear ecology and health, including observations and perspectives on: polar bear abundance and demography; habitat and distribution; diet and prey availability; body condition and general health; diseases and mortality; human-polar bear interactions; and the future of polar bears.

Abundance and demography

In both Kimmirut and Pangnirtung, all interview contributors (n=35) reported a general increase in polar bear abundance observed across their area of observation over their lifetime. In Kimmirut, group interview participants indicated that the polar bear population had increased by an average of approximately 73% (range: 70-75, n=3[1]) since the 1970s and 14% (range: 2-25, n=3) since 2005 within their area of observation (Figure B). We note that trend observations documented though group interviews seem to reflect a 'true' increase in the relative abundance of polar bears in the Kimmirut area and not an 'apparent' increase resulting from spatial and temporal changes in land use by participants and/or temporal changes in geographical distribution of polar bears within participants' range of direct observations.

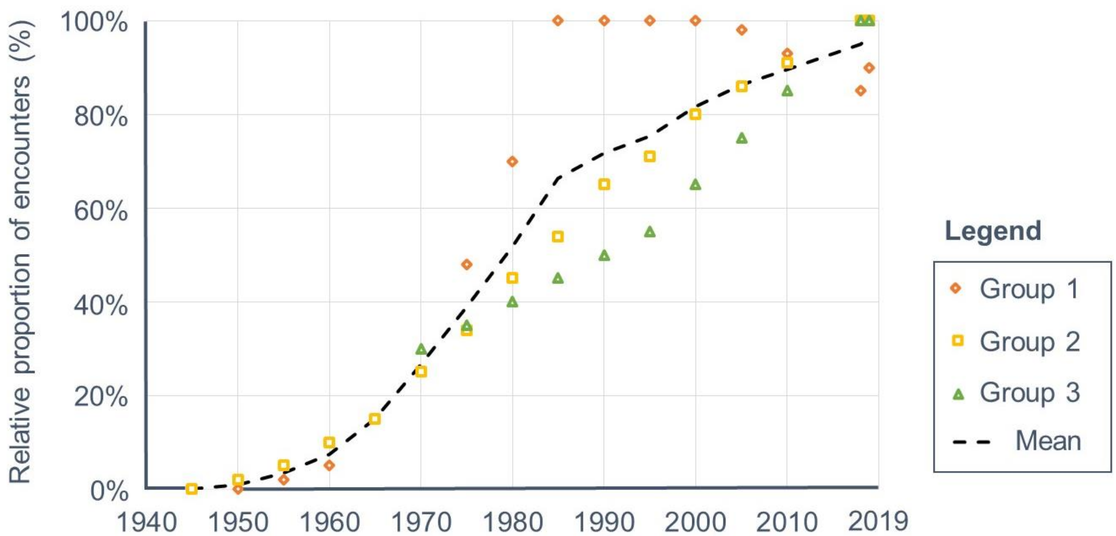


Figure B. Relative proportion of polar bear observations/encounters between 1945 and 2019 as observed by Kimmirut contributors during group interviews. This information can be used as a proxy for polar bear relative abundance in the Kimmirut area. Information presented is based on interviews with three groups of polar bear hunters from Kimmirut (n=3; totalling eight participants). Data points were obtained from drawing and proportional piling exercises; each group of participants reached consensus on the relative proportion of bears they had observed over time. The dashed black line is the mean value.

Nearly all interview contributors from Pangnirtung and Kimmirut reported observing more cubs, females, and/or females with cubs (family groups) over time. In addition, participants from both communities did not report any notable changes in cub productivity and survival and/or family

[1] Throughout the executive summary, when numerical information generated from group interviews is provided we indicate the number of group interviews 'n' from which the information was obtained through participatory exercises. In the context of this summary, n=3 therefore refers to three group interviews organized in Kimmirut in which a total of eight polar bear harvesters participated.

group size over time[2]. For example, in Kimmirut the relative proportion of cubs-of-the-year (COY) and yearlings per female had been constant from the 1990s onward, with two COYs/female and two yearlings/female most frequently observed (83% [range: 74-99, n=3] and 75% [range: 45-95, n=3] of the times, respectively)[3]. Contributors from both communities noted that female polar bears generally have one or two cubs, and three on rare occasions. They also stated that, over their lifetime of observations on the land, in general females with two cubs were most frequently observed.

Contributors referred to four key indicators which conjointly pointed to an increase in polar bear abundance over time: (1) encountering more bears while travelling on the land, particularly family groups and young or juvenile polar bears; (2) observing more polar bear tracks while travelling on the land; (3) increasing risks of conflicts between humans and polar bears and/or polar posing a greater safety concern today compared to the past; and (4) hunting trips being now shorter in duration and/or hunters no longer needing to travel as far to harvest polar bears. Participants also explained that observed changes in polar bear abundance could be linked to: harvest quotas and sex-selective harvest restrictions; polar bear prey availability; sea ice conditions; and changes in weather and climate. In Kimmirut, recent observations (likely made within the past 10 years) of polar bears that seem "smaller in size" were also reported. While contributors did not directly link these observations with the immigration of polar bears with a different phenotype (smaller size) from adjacent subpopulations into the Kimmirut area, we believe this possible explanation should be considered.

Many contributors highlighted that the observed increase in polar bear abundance has had significant impacts on their life on the land and in communities. Nowadays, Kimmirutmiut and Pangnirtungmiut have to be alert and prepared to encounter polar bears anywhere they go.

Distribution and habitat

Contributors shared detailed observations on the evolution of polar bear distribution over time within their areas of observation. In Kimmirut, group interview results suggested that the distribution of polar bears has not substantially changed since the 1960s with higher numbers of polar bears (about 70-80% of the total) observed along the shore of the Meta Incognita Peninsula (from York Sound to Barrier Inlet) and in Markham Bay. Therefore, in the Kimmirut area the probability of polar bear encounters has increased with time –from the 1960s to 2019– mainly as a function of increased polar bear numbers rather than as a result of shifts in polar bear distribution. Around Pangnirtung, individual interview results indicated that polar bears have progressively expanded their range –rather than shifting it– into central and upper Cumberland Sound, closer to the community, since around the 1990s. These observations also point to a 'true' increase in polar bear abundance in the Pangnirtung area rather than an apparent increase resulting from a shifting distribution within participants' area of observation.

Many participants from both communities also described a progressive increase in the number of bears observed within or close to their community starting from around the 2000s. They identified

[2] In this study, cub productivity (number of polar bears cubs produced in a population) and cub survival (number of polar bears cubs that survive the first year) were estimated using the indicators 'COY litter size' (number of COYs per female) and 'yearling litter size' (number of yearlings per female) assessed over the same time periods.

[3] For polar bears in the Pangnirtung area, this information was not documented as group interviews were not performed in Pangnirtung; however, notable changes in the number of yearlings observed over time did not emerge from individual interviews.

three potential causes that could explain why more polar bears are observed in or near communities: (1) an increase in polar bear abundance (and particularly an increasing number of juveniles that are more inquisitive and still learning how to hunt effectively); (2) polar bears being attracted by the smell of food in communities and at the dump and/or by the smell of carcasses from harvested animals near communities; and (3) changes in sea ice conditions leading to polar bears spending more time on the land and in coastal areas near communities. While any type of polar bear could be seen near or within communities, more inquisitive juveniles –which also tend to be more aggressive than adults– and sometimes mothers with cubs were the types of polar bears mostly observed around communities.

Contributors from Pangnirtung and Kimmirut indicated that polar bears can be encountered on the sea ice, in open water and on the land, depending on the season and prey availability. Many described the presence of sea ice, abundant preys, low anthropogenic disturbance, as well as the presence of both male and female polar bears and bears from different age categories (including young and mature individuals) as characteristics of a 'good' polar bear habitat that can sustain a healthy polar bear population. Participants noted seasonal polar bear distribution patterns that were mainly driven by sea ice dynamics and seal availability.

While contributors emphasized the importance of sea ice for polar bears, many reported changes in sea ice quantity and quality observed over recent decades. Changes observed included: thinner sea ice, bigger polynyas, changes in floe edge location (closer to coast), as well as earlier sea ice break-up in and later freeze-up. However, several contributors from both communities mentioned that while sea ice changes may have an effect on polar bears –notably because polar bears use sea ice to hunt seals– *nanuq* is highly adaptable to habitat and sea ice changes.

Lastly, contributors identified known polar bear denning areas and discussed polar bear denning behaviour and habitat. Some participants had directly observed polar bears dens over their lifetime and identified specific polar bear denning areas around Pangnirtung and Kimmirut. One participant from Pangnirtung noted a shift in maternity den location due to melting glaciers.

Diet and prey availability

Contributors from Pangnirtung and Kimmirut described the broad diet of polar bears and identified mainly ringed seal (*natsiq*) and their pups, as well as other types of seals (including bearded seal, harp seal, harbour seal and their pups) to be the main polar bear preys. According to group interview contributors from Kimmirut, seals accounted for 75% (range: 64-90, n=3) of the overall polar bear diet. Additional polar bear preys consistently mentioned were: walrus; ducks and bird eggs; whales (including belugas, narwhals and beached bowhead whales); fish (mainly Arctic char); seaweeds; and plants and berries. Preys or items occasionally mentioned as part of polar bear diet included: other polar bears; anthropogenic waste and man-made items; caribou; dogs; and Arctic foxes. Participants also described how polar bear diet varies throughout the year depending on prey availability, and highlighted seasonality in use of resources. Several contributors from both communities highlighted that *nanuq* is a highly adaptable and opportunistic predator. Many reported that polar bears are effective hunters on sea ice but also on the land and in open water. Contributors from both communities noted that polar bears feeding on anthropogenic waste and other man-made items was a recent phenomenon. Several participants had either directly observed or heard reports of cannibalism from other community members although such observations were overall rare. Some also indicated that more bears were feeding in duck colonies nowadays compared to the past, although this phenomenon was described as a function of the increased number of polar bears rather than as the result of a shift in polar bear diet (polar bears have been known for long time to feed in duck colonies).

Contributors commented on changes in seal abundance and health over their lifetime. In both communities, all participants who commented on ringed seal abundance reported a major decline in ringed seal occurring over the last few decades. For example, contributors reported an 80% (range: 80-80, n=2) decline in ringed seal abundance in the Kimmirut area occurring between the 1960 and 2019. Over the same timeframe, harp seal sightings had increased by approximately 60% (range: 43-75, n=2), while the number of bearded seals remained constant around Kimmirut (Figure C).

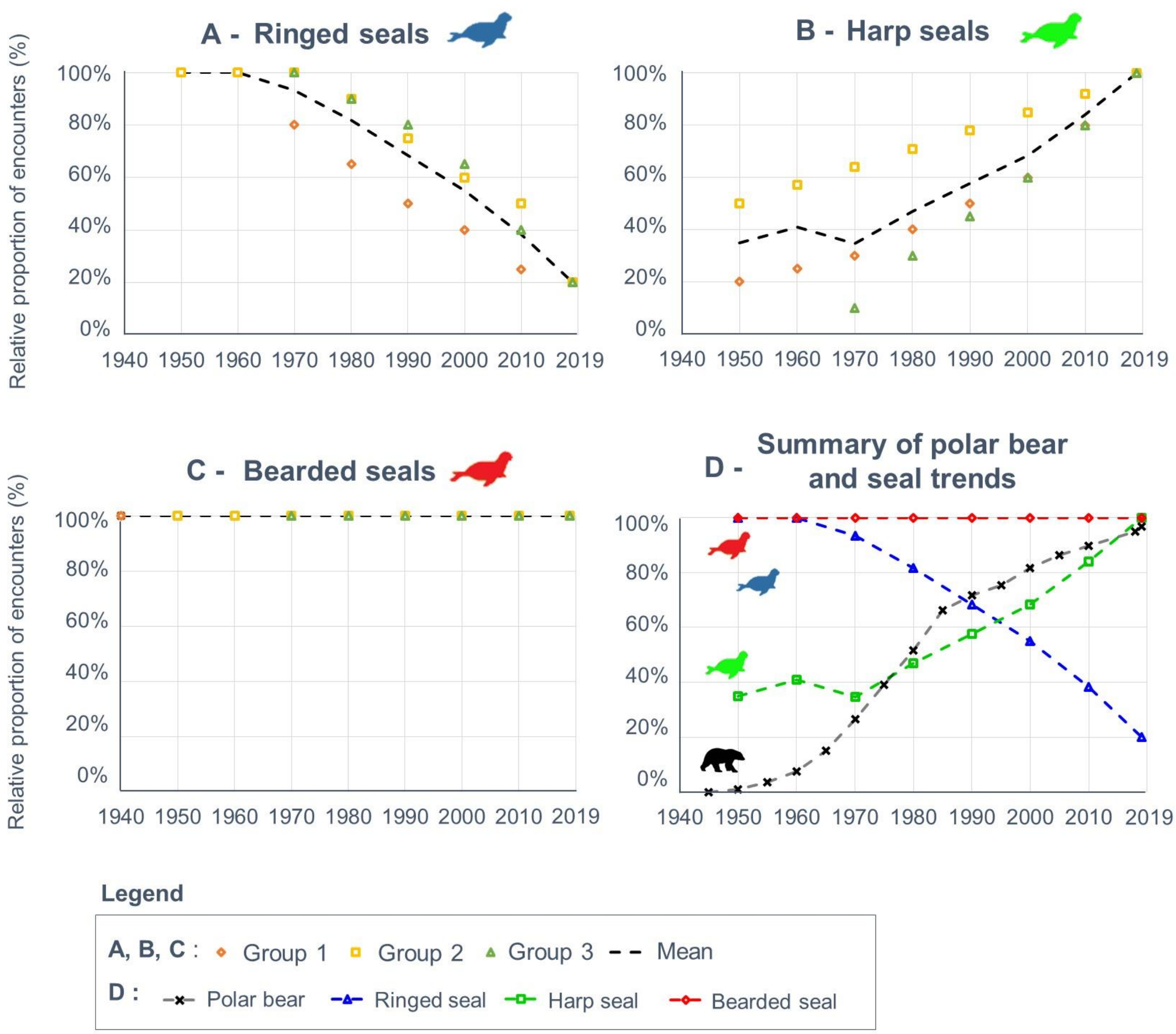


Figure C. Relative proportion of ringed seal (A), harp seal (B) and bearded seal (C) observations/encounters between 1940 and 2019 and summary of polar bear and seal trends (D) as observed by Kimmirut contributors during group interviews. This information can be used as a proxy for relative seal abundance in the Kimmirut area. Information presented is based on interviews with three groups of polar bear hunters from Kimmirut (n=3; totalling eight participants). Data points were obtained from proportional piling exercises; each group of participants reached consensus on the relative proportion of seals they had observed over time for each species. The dashed black line is the mean value. Polar bear trends presented in (D) are the same as those presented in more detail in Figure B.

Contributors from Pangnirtung and Kimmirut offered various explanations as to why they thought ringed seals had declined in recent decades around their community, including: increase in polar bear predation (especially around ringed seals denning areas during the pupping season); increase in local community harvest; ringed seal emigration into other areas (either following preys or due to displacement by other species); increase in maritime transport; lack of sea ice; warmer ocean waters; increase in fox predation; and changing winds. While some participants had not seen any changes in seal health over time, others noted that ringed seal are now skinner and described abnormalities observed in ringed seal fur over the last 20 years, including fur loss or alopecia and molting lasting longer than usual. Alopecia was also observed in bearded seals in the Kimmirut area.

Despite the observed decline in ringed seal abundance and reported changes in seal health, contributors generally indicated that polar bears have broad diets and that they can adapt to changes in prey availability. Many noted that they were not concerned about polar bear persistence related to ringed seal availability. However, it was also acknowledged that if ringed seals –the main resource polar bears rely on throughout the year– remain scarce, polar bears could move to areas where ringed seals and other suitable preys are more abundant.

Body condition and general health

Contributors shared information about what they are looking for (indicators) to assess the health of individual polar bears. Polar bear health indicators discussed included: polar bear body condition (fatness); behaviour and movement; fur colour and condition; meat and fat colour, smell and taste; stomach contents; teeth condition; and appearance of internal organs. While participants reported assessing the health of individual polar bears holistically, employing multiple indicators, they also highlighted that body condition (fatness) was the indicator that most reflected the overall health of individual polar bears as it correlated with many other indicators. Participants assessed the health of individual polar bears both before harvesting (while observing live polar bears on the land) and after harvesting (during butchering, hide processing and consumption of harvested bears). Interestingly, contributors also reported using direct and indirect indicators (or metrics) for polar bear health assessment, particularly to determine the fatness of individual animals. Some of these indicators (e.g., degree of consumption of seal carcasses) may be useful as early warning signs of impending changes in polar bear health at the population level. Assessing the health status of individual polar bears was important to participants as it guided their polar bear harvesting and consumption decisions. Many noted that they preferred harvesting and consuming ‘healthy’ polar bears that provide good quality meat and hides.

Contributors from both communities also shared their observations of temporal changes in polar bear body condition and general health. During individual interviews held in Kimmirut, contributors shared multiple perspectives on changes in polar bear fatness (body condition) observed over time. A majority of contributors reported observing more polar bears in poorer body condition compared to the past with some of them interpreting this as a general decline in polar bear body condition over time within the Kimmirut area. However, some expressed the view that polar bear body condition had remained stable or were uncertain about any change in polar bear body condition over time. Group interviews indicated that the increased number of ‘skinny bears’ reported by individual interviewees were likely a function of the population increase rather than the result of a substantial change in polar bear body condition status over time. Overall, proportions of polar bears observed per body condition type have remained similar since the 1990s (Figure D). However, in more recent years (2016-2019 period) group interview results also suggested a minor shift in polar bear body condition from the ‘fat’ to the ‘average’ type compared to levels measured in previous time periods (Figure D). Importantly, most polar bears being observed today in the Kimmirut area remain in 'good' body condition and 'healthy': 94% (range: 92-96, n=3) of polar bears observed by group interview contributors over the 2016-2019 period exhibited 'healthy' fat levels ('average', 'fat' or 'very fat' body condition) and 91% (range: 85-95, n=3) of polar bears observed over the same time period were described as overall 'healthy' (Figures D and E). Furthermore, group interview results indicated that these proportions have either remained stable or slightly declined since the 1990s (Figures D and E).

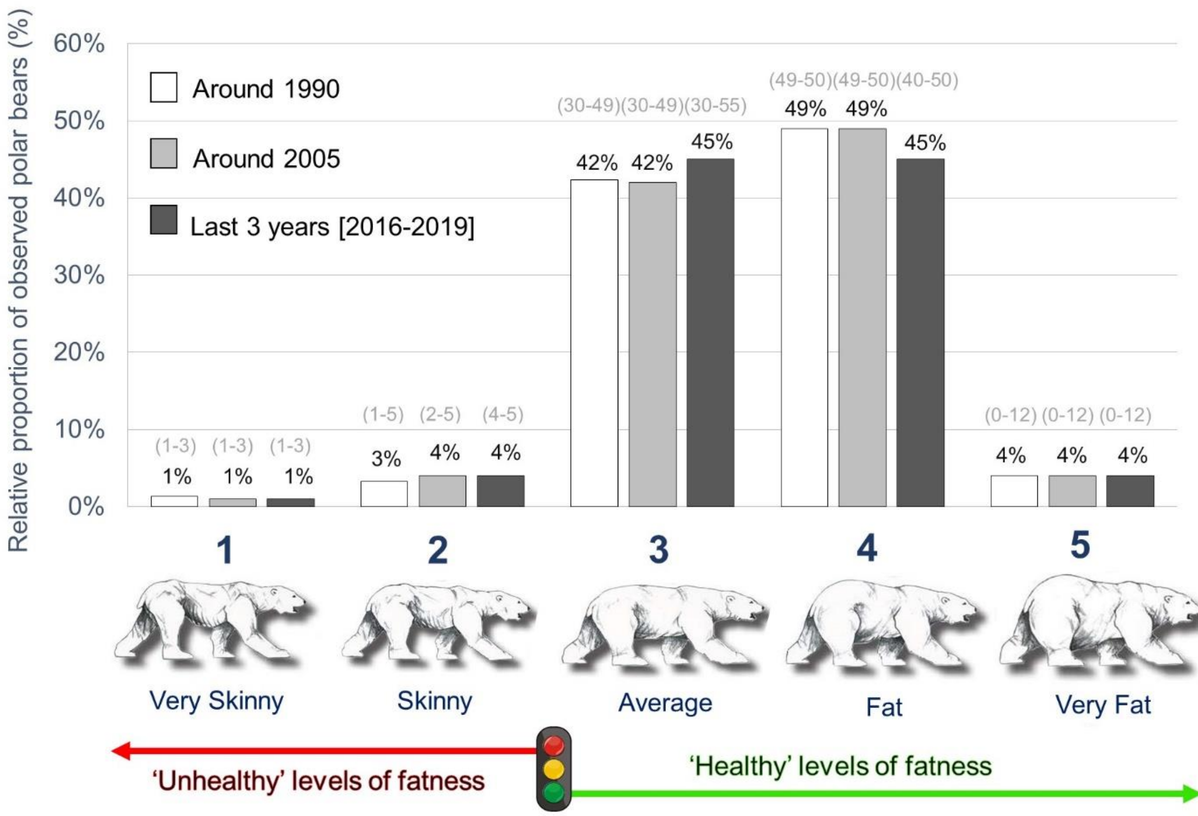


Figure D. Relative proportion of polar bears observed per body condition type (1 to 5 scale developed by Stirling et al. 2008) over three time periods (around 1990, around 2005, and last three years [2016 to 2019]) in the Kimmirut area. Percentages were derived from proportional piling exercises with three groups of contributors from Kimmirut (n=3; totalling eight participants). Mean values are presented over each bar with respective value ranges provided in brackets in light grey. Polar bear categories and drawings of body types are sourced from the Polar Bear Body Condition Index Card used by the Government of Nunavut, Department of Environment (Government of Nunavut, n.d.). All group interview contributors from Kimmirut indicated that polar bears exhibiting body condition types 1 and 2 were considered 'unhealthy' and that bears with body condition types 3, 4 and 5 were 'healthy' polar bears.

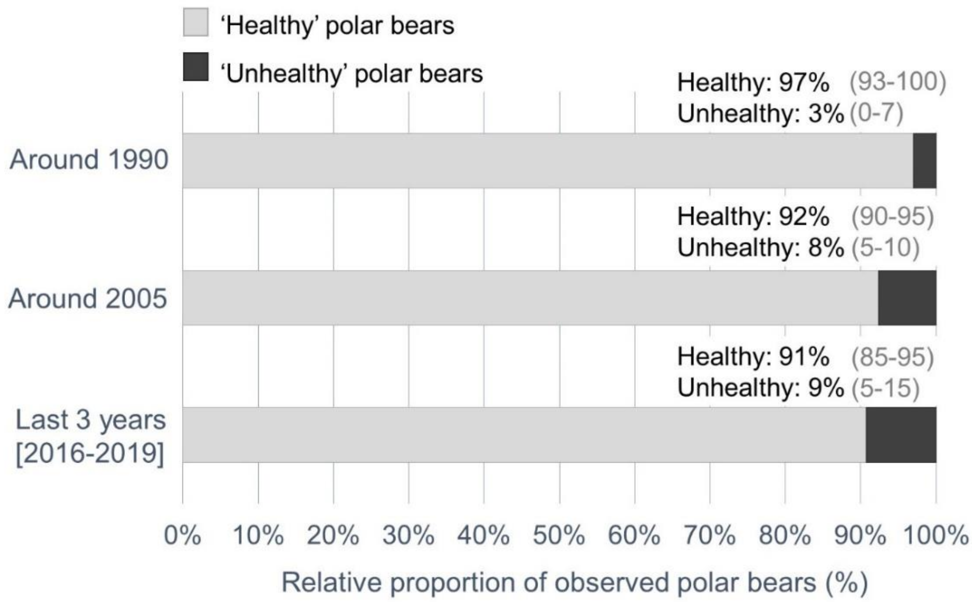


Figure E. Relative proportion of 'healthy' vs 'unhealthy' polar bears observed in the Kimmirut area over three time periods (around 1990, around 2005, and last three years [2016 to 2019]). Percentages were derived from proportional piling exercises with three groups of contributors from Kimmirut (n=3; totalling eight participants). Through discussion, each group reached consensus on the relative proportion of 'healthy' vs 'unhealthy' polar bears for each time period. Mean values are presented over each bar with respective value ranges provided in brackets in light grey.

In Pangnirtung, individual interview participants shared similar perspectives as individual interview contributors from Kimmirut. The majority of individual interviewees reported observing more polar bears in poorer body condition compared to the past with some of them interpreting this as a general decline in polar bear body condition over time within the Pangnirtung area, with earlier signs of change dating back to the 1980s but more consistently observed starting from the late 2000s. However, similarly to Kimmirut, some expressed the view that polar bear body condition had remained stable or were uncertain about any change in polar bear body condition over time. Among participants who had noticed a decline in polar bear body condition over time, some emphasized that many healthy and fat polar bears were observed today. When discussing overall polar bear health (considering polar bear fatness along with other health indicators), five contributors mentioned that polar bears observed around Pangnirtung were generally 'healthy' and three noted that bears are not as 'healthy' as they used to be. Based on individual interview results alone, we believe that changes in polar bear body condition and overall health status in the Pangnirtung area may follow a similar pattern to the one observed in Kimmirut. At the time interviews were conducted, a recent decline in polar bear body condition and overall health had been observed by some contributors; however, the magnitude of this decline may not have been substantial given that such observations were not unanimous. Group interviews would be required to clarify these uncertainties, including identifying the magnitude of changes in polar bear body condition and general health status in the Pangnirtung area.

Participants from both communities who had observed a decline in polar bear fatness over time mostly attributed this change to: an increase in polar bear abundance combined with a decline in ringed seal abundance leading to increased competition over preys; and changes in sea ice cover reducing polar bear access to seals.

Mortality, diseases and abnormalities

Contributors discussed polar bear non-hunting related mortality, disease and other abnormalities. Overall, participants considered these events to be rare or uncommon and offered detailed observations about what they saw, including where, when and type of animals involved.

In both communities, observations of polar bear mortality due to starvation or other natural causes were rare with five events observed around Kimmirut and 12 events around Pangnirtung. Mortalities suggestive of disease outbreaks were not reported. In fact, most participants had never directly observed mortality due to causes other than harvesting. Also, participants who recalled observing very skinny or starving polar bears noted that such observations were uncommon.

Similarly, conspicuous disease and sickness or signs of abnormalities were uncommon observations in polar bears with 16 contributors (n=8 in Kimmirut; n=8 in Pangnirtung) occasionally reporting: signs of fur loss or alopecia; limping or lame individuals; greenish lumps in the subcutaneous fat and in the meat; white spots in the liver; brown spots in subcutaneous fat; dull and soft claws; and/or posterior paralysis. Most contributors observed those as single events, and only five contributors had seen or heard of a few polar bears displaying a specific lesion/syndrome. Regarding observations of fur loss, wide areas of alopecia or thinning of the fur were only observed on the neck and shoulders (n=10) or on the side of the body (n=1). Gross appearance of the lesions was similar to signs of alopecia described in polar bears in southern Beaufort Sea, Alaska. Earliest observations of alopecia dated back to the 1980s in Pangnirtung and the 1990s in Kimmirut, while most recent ones were made in 2013-2015 in Pangnirtung and around 2010 in Kimmirut. Although these observations were sporadic, both female, male, adult and young polar bears were observed with alopecia. In some instances, hair loss was associated with poor body condition, but not always. Finally, ectoparasites were not observed on polar bear hides.

When invited to discuss other unusual observations, some participants also described hunting wounds and ice-related injuries, abnormal skin pigmentation and a three-legged polar bear. Others reported harvesting polar bears with lip tattoos and ear tags as abnormal events. In Kimmirut, one contributor had observed a polar bear with half-white and half-black fur, which he described as a hybrid bear. Lastly, seven contributors reported finding anthropogenic waste and/or plastics in the stomach of some harvested bears in recent years.

Human-polar bear interactions

Many participants from both Kimmirut and Pangnirtung described progressively more frequent human-polar bear interactions and encounters. They identified four main factors which could explain why human-polar bear interactions have increased in recent decades: an increase in polar bear abundance; greater distances traveled by community members today which increases their chances of encountering polar bears; more intensive use of coastal areas (where communities are located) by polar bears as a result of changing sea ice conditions; and change in polar bear behaviour. Several contributors from both communities indicated that polar bears nowadays tend to be less fearful and more aggressive towards humans than they were in the past, and reported increased damage to cabins, food caches and property caused by polar bears.

Importantly, all individual interview contributors (n=27) highlighted their concern for public safety resulting from increased human-polar bear encounters and more frequent bear aggressions. Many shared the view that polar bears posed a greater public safety concern today compared to the past and pointed to increasing risks of conflicts between humans and polar bears. Polar bears killed in defense of life and property were described as a recent phenomenon around both Pangnirtung and Kimmirut.

Participants also described how Pangnirtungmiut and Kimmirutmiut are now finding ways to adapt to increased polar bear presence by putting in place strategies to mitigate risks of dangerous interactions with polar bears and minimize damage to property. Some explained that, starting around the 2000s, residents from both communities have started to use more fixed cabins instead of tents when camping on the land. Some contributors emphasized the importance of teaching younger generations about how to coexist safely with polar bears.

Future of polar bears

Many participants indicated it was difficult to or would not comment on the future of polar bears explaining that one cannot predict the future. Participants who discussed what the future may look like for polar bears were not generally concerned about the ability of polar bears to adapt to changing environmental conditions associated with climate change. However, one contributor explained that while polar bears were highly adaptable, they may face difficulties finding suitable denning habitat if snow cover continues to decrease. Another noted that polar bear hide quality could be impacted in the future by changes in sea ice availability. Some also shared the view that a continued increase in polar bear abundance will pose an increasing threat to the safety of community members. Several contributors emphasized the importance of healthy polar bear populations for future generations and maintaining Inuit cultural traditions.

Management and stewardship

Contributors shared their perspectives and concerns related to polar bear management and stewardship. They also expressed their views on existing communications between polar bear researchers and Nunavummiut, and suggested ways to improve knowledge exchange and foster trust building between Nunavummiut, polar bear researchers and wildlife managers.

Public safety concerns

Concerns over public safety emerged strongly during interviews. When prompted to discuss their concerns about polar bear management, all individual interview contributors (n=27) highlighted that they were especially concerned about increasing polar bear aggressions and human-polar bear encounters that posed a threat to human safety.

Harvest quotas and hunting regulations

Contributors shared perspectives on harvest quotas and hunting regulations primarily in the context of their concerns over public safety. Some explained that harvest quotas and hunting regulations should better accommodate increasing human-polar bear interactions and associated safety concerns. Several participants from both communities expressed the view that polar bear harvesting quotas should be increased to address concerns over public safety.

Many contributors also shared the view that polar bears killed in defense of life and property should not be subtracted from community harvesting quotas, and some suggested that hides from polar bears harvested in self-defence be returned to hunters. Two contributors from Kimmirut suggested extending the current polar bear harvest season into the summer, when human-bear interactions are likely. Some participants also expressed a desire to harvest polar bear cubs and suggested to increase the amount of females harvested[4].

Many contributors from both communities also noted that current polar bear management practices differed from how Inuit would traditionally manage their interactions with polar bears. Some shared the view that Inuit should have greater control over polar bear harvest management in order to ensure public safety. Participants emphasized the importance of IQ in polar bear management and stewardship.

Communications

Many participants from Pangnirtung and Kimmirut expressed their interest in scientific research conducted on polar bears. However, while acknowledging communication efforts made by polar bear researchers to date, several participants from both communities stated that they would like to receive or have access to more information about scientific research conducted on polar bears. Some mentioned that they were particularly interested in obtaining scientific information on the health, abundance and distribution of polar bears.

Several contributors from both communities highlighted that polar bear research communication with community members could be improved. Perspectives shared by participants highlighted that improving polar bear research communication was particularly important given the presence of some community mistrust towards scientific research methods and polar bear researchers, and the existence of some divergences between scientific and Inuit observations. Participants emphasized that relationship building and creating opportunities for dialogue between science and IQ was key to improving knowledge exchange and fostering trust building between Nunavummiut and polar bear researchers.

Conclusion

This report explored the detailed historic and contemporary knowledge held by Inuit contributors about polar bear ecology and health, as well as the importance of *nanuq* to Nunavut Inuit, and Inuit perspectives on polar bear management and stewardship.

Overall, interview contributors from Pangnirtung and Kimmirut reported that, within their area of observation, the local polar bear population is today generally healthy. Observations suggestive of a healthy polar bear population included: an increase in polar bear abundance systematically reported by participants over their lifetime, no change in cub productivity and survival over time, females with two cubs being most frequently observed, and rare reports of polar bear disease or non-hunting related mortality. However, in recent years, contributors pointed to some subtle changes –which could be early signs of change– in polar bear health, including a slight decline in polar bear fatness and overall health noted by some participants and occasional reports of hair loss (alopecia). Participants had also observed changes in polar bear prey availability and habitat condition over time, including changes in sea ice quality and quantity and a major decline in the abundance of ringed seals (the main polar bear prey) observed around both Kimmirut and Pangnirtung. At the time interviews were conducted, such changes were not reflected in observations related to cub productivity, which has remained stable according to contributors from both communities. Overall, participants from Pangnirtung and Kimmirut did not report any notable

[4] In Nunavut, the polar bear harvest sex ratio was adjusted in 2019 from two males harvested for every female (2:1) to up to one female for every male (up to 1:1 system) –male and female polar bears can now be harvested in any proportion up to a maximum of 50% females (Government of Nunavut 2019). Interviews were conducted before this change was implemented.

changes in cub productivity and survival and/or family group size over time. Regular documentation of Inuit observations will be required to understand how polar bear population health, including body condition status and population demographics, evolve over time.

Importantly, throughout the project contributors emphasized that *nanuq* is a resilient and opportunistic predator that is highly adaptable to changes in prey availability and habitat conditions.

In addition, study results highlighted public safety concerns arising from increased human-polar bear interactions and encounters, and suggested that polar bear management today must find ways to address public safety concerns while ensuring that polar bears persist into the future and remain available for future generations.

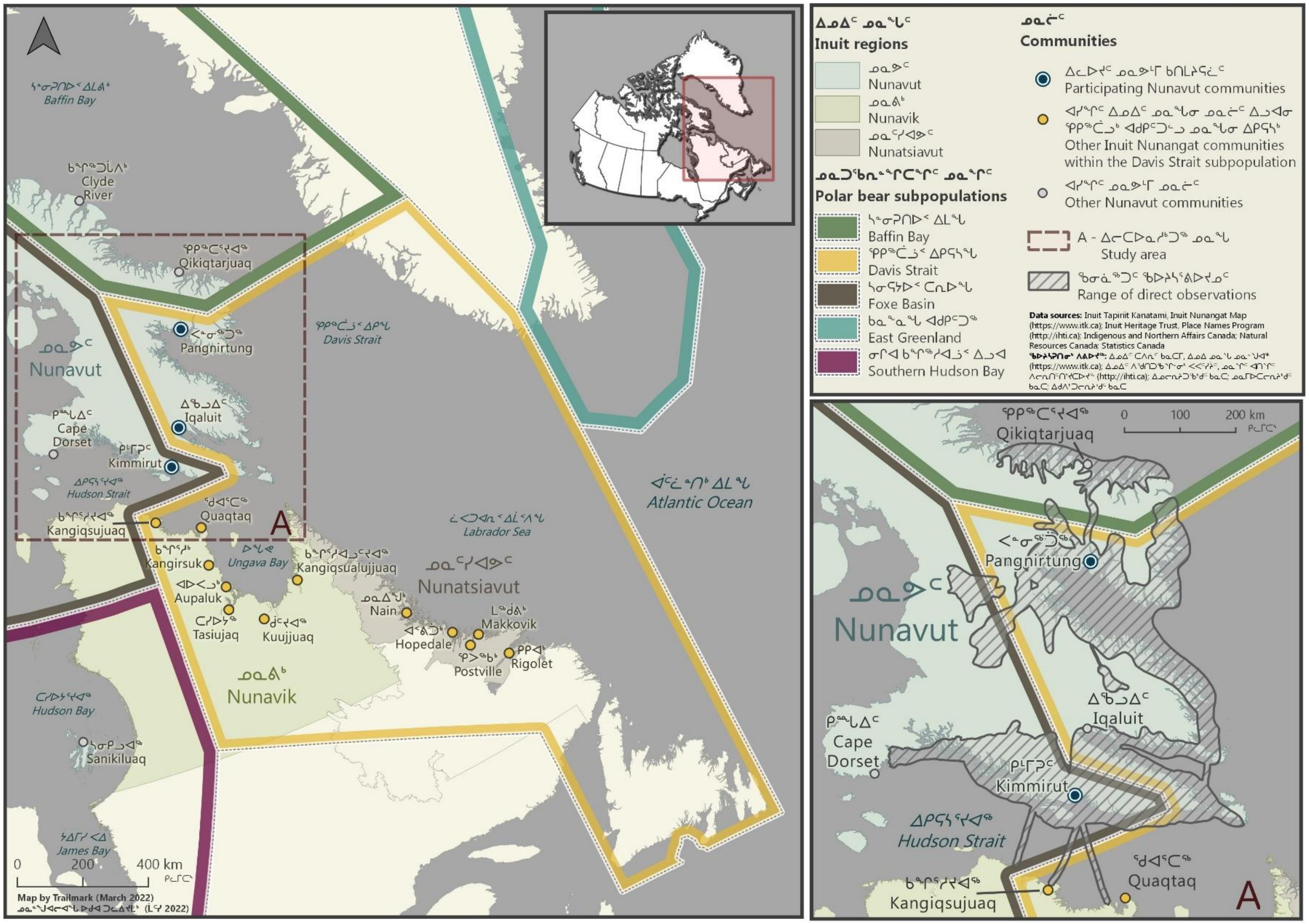
Inuit Qaujimajatuqangit highlights the importance of maintaining respectful relationships between humans and polar bears and reminds us of our collective responsibility towards *nanuq* and future generations. We therefore hope this work can serve to inform polar bear management and decision-making, as well as ongoing and future community-based monitoring and research efforts in Nunavut and beyond.

ᓇᐃᓈᖅᓯᒪᔪᖅ

ᓇᓄᖅ ᓂᕐᔪᑎᐅᔪᖅ ᐅᑭᐅᖅᑕᖅᑐᒥᑦ ᐱᑐᖅᐸᓪᓕᐊᓂᖃᖃᑎᒌᒃᑐᓂᑦ ᐃᑲᔪᐃᓂᖃᖅᖢᓂ ᐊᒻᒪᓗ ᐱᒻᒪᕆᐅᒋᔭᐅᔪᖅ ᐃᓄᖕᓄᑦ. ᓄᓇᕗᒻᒥ ᐃᓄᐃᑦ ᑲᑎᑦᑎᓯᒪᔪᑦ ᐊᒻᒪᓗ ᐊᖏᔪᒥᒃ ᖃᐅᔨᒪᓂᖅᑖᖅᐸᓪᓕᐊᓯᒪᑉᓗᑎᒃ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ ᑕᑯᖃᑦᑕᖅᓯᒪᔭᕆᑦᑎᒍᑦ ᐊᕙᑎᖓᓂᑦ ᐊᒻᒪᓗ ᒪᖃᐃᖃᑦᑕᖅᓯᒪᓂᕆᑦᑎᒍᑦ. ᑐᑭᓯᐊᓗᒋᑦ ᖃᓄᐃᖏᑦᑎᐊᕐᓂᕐᒧᑦ ᖃᓄᐃᖓᓂᕐᒥᑦ –ᐃᓚᐅᐸᓗᓂ ᐊᒥᓲᑎᒋᓂᕐᒥᑦ– ᓇᓄᐃᑦ ᐱᒻᒪᕆᐅᔪᖅ ᐊᑑᑎᖃᖅᑐᒃᑯᑦ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ ᐊᐅᓚᑦᑎᓂᐊᕐᓗᓂ. ᓄᓇᕗᒻᒥᑦ, ᐊᔪᙱᓐᓂᐊᕐᓗᑎᒃ ᓇᓐᓄᒃᑕᐅᔪᖕᓇᖅᑐᓄᑦ ᑭᒡᓕᐅᔪᑦ ᓴᖅᑭᑕᐅᓚᐅᖅᑐᑦ ᐊᑐᖅᖢᒋᑦ ᑕᒪᐃᓐᓂᒃ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖅᑎᑦ ᐊᒻᒪᓗ ᖃᑉᓗᓈᑦ ᓱᓇᑐᐃᓐᓇᓕᕆᓂᒃᑯᑦ ᑐᒃᓯᐅᒪᔾᔪᑎᖏᑦ.

ᐱᓕᕆᐊᖅ ᑐᕌᒐᖃᖅᑐᖅ ᑲᑎᖅᓱᐃᓂᐊᕐᓗᓂ ᐊᒻᒪᓗ ᑎᑎᕋᐅᓯᕆᓗᒋᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᓇᓄᐃᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᕐᒥᑦᑕ ᖃᓄᐃᓐᓂᕆᔪᕐᒥᓄᑦ ᖃᓂᑕᕐᒥᓂᑦ ᓄᓇᓖᑦ ᑭᒻᒥᕈᑦ, ᐸᖕᓂᖅᑑᖅ ᐊᒻᒪᓗ ᐃᖃᓗᐃᑦ, ᓄᓇᕗᒻᒥ, ᐃᑲᔪᐃᓂᐊᖅᑐᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐃᓱᒪᓕᐅᕆᓂᕐᓂᒃ ᐊᒻᒪᓗ ᖃᓄᖅᑑᕆᓂᕐᓄᑦ Davis Strait-ᒥᑦ ᓄᓇᐃᑦ ᖃᑉᓯᐅᓂᖏᓐᓂᑦ. ᐱᓕᕆᖃᑎᒌᖕᓂᒃᑯᑦ ᖃᐅᔾᔨᐃᓂᕐᒧᑦ ᐱᓕᕆᐊᕐᔪᓚᐅᖅᑐᖅ ᐱᓕᕆᖃᑎᒋᑉᓗᒋᑦ ᑲᓇᑕᒥᑦ ᒐᕙᒪᒃᑯᑦ (ᑲᓇᑕᒥᑦ ᐊᕙᑎᓕᕆᔨᒃᑯᑦ ᐊᒻᒪᓗ ᓯᓚᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᔪᓕᕆᔨᒃᑯᑦ), ᓄᓇᕗᒻᒥ ᒐᕙᒪᒃᑯᑦ (ᐊᕙᑎᓕᕆᔨᒃᑯᑦ), ᐊᒻᒪᓗ ᓄᓇᓕᖕᒥᑦ ᐆᒪᔪᕐᓂᐊᖅᑎᒃᑯᑦ ᓄᓇᓕᖕᓂᑦ ᐸᖕᓂᖅᑑᖅ ᐊᒻᒪᓗ ᑭᒻᒥᕈᑦ ᕿᑭᖅᑖᓗᖕᒥᑦ ᓄᓇᕗᒻᒥ (ᐊᔾᔨ A).

ᑎᑎᕋᐃᓚᐅᖅᑐᒍᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᒃ ᐱᔾᔪᑎᖃᖅᑐᓂᒃ ᓇᓄᐃᑦ ᐱᖅᑯᓯᕆᔭᖏᓐᓄᑦ ᐱᒻᒪᕆᐅᔪᓂᒃ, ᒪᖃᐃᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᓂᒃ, ᖃᓄᐃᖏᑦᑎᐊᕐᓂᖏᓐᓄᑦ, ᐱᑐᖅᐸᓪᓕᐊᓂᖃᕐᓂᕐᒥᒃ, ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᕐᒥᒃ ᐊᔾᔨᒌᙱᑦᑐᒃᑯᑦ ᐊᑕᐅᓯᐅᑉᓗᒋᑦ ᐊᒻᒪᓗ ᑲᑎᕐᒪᑉᓗᒋᑦ ᐊᐱᖅᓱᐃᓂᕐᓂᑦ ᐱᔭᐅᔪᓂᒃ ᐊᒻᒪᓗ ᐃᓚᐅᓚᐅᖅᑐᓂᑦ 2019-ᒥᑦ 35 ᐃᓄᐃᑦ ᐸᖕᓂᖅᑑᕐᒥᑦ ᐊᒻᒪᓗ ᑭᒻᒥᕈᒻᒥᑦ. ᐊᑕᐅᓯᐅᖃᑦᑕᖅᖢᒋᑦ ᐃᓄᐃᑦ ᐊᐱᖅᓱᖅᑕᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᐅᓚᐅᖅᑐᖅ. ᑲᑎᕐᒪᑉᓗᑎᒃ ᐊᐱᖅᓱᖅᑕᐅᔪᑦ - ᐱᔪᖕᓇᓚᐅᖅᑐᑦ ᐊᒥᓱᓂᒃ ᑐᑭᓯᐅᒪᔾᔪᑎᓂᒃ - ᑭᒻᒥᕈᒻᒥᑐᐃᓐᓇᐅᓚᐅᖅᑐᖅ, ᑲᑎᖅᖢᒋᑦ 15-ᖑᓚᐅᖅᑐᑦ (ᐃᓚᐅᔪᑦ 7 ᐊᑕᐅᓯᐅᖃᑎᒋᑉᓗᒋᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᐊᒻᒪᓗ 8 ᓄᑖᑦ ᐃᓚᐅᖃᑕᐅᓕᓚᐅᖅᑐᑦ) ᐊᕕᒃᖢᒋᑦ ᓯᑕᒪᐃᑦ ᑲᑎᕐᒪᑉᓗᑎᒃ: ᐱᖓᓱᑦ ᑲᑎᕐᒪᔪᓂᑦ ᐃᓚᐅᓚᐅᖅᑐᑦ ᐊᖑᑏᑦ ᓇᓄᖅᓯᐅᖅᑏᑦ ᐊᒻᒪᓗ ᐊᑕᓯᕐᒥᑦ ᐃᓚᐅᔪᖃᓚᐅᖅᑐᖅ ᐊᕐᓇᒥᒃ ᓇᓄᕋᕐᒥᒃ ᓴᓗᒻᒪᖅᓴᐃᖃᑦᑕᖅᑐᖅ. ᑲᑎᕐᒪᓗᒥᑦ ᐊᐱᖅᓱᖅᑕᐅᓂᐊᖅᑐᓂ ᐸᕐᓇᐅᑕᐅᓚᐅᖅᑐᑦ ᐸᖕᓂᖅᑑᕐᒧᑦ ᓄᖅᑲᖅᑎᑕᐅᓚᐅᖅᑐᖅ ᑭᒡᓕᖅᑲᖅᑎᑦᑎᓂᖓᓄᑦ ᓄᕙᒡᔪᐊᕐᓇᖅ-19. ᐅᑭᐊᒃᓵᖑᓂᑦ 2021, ᓯᕗᓪᓕᖅᐹᖑᔪᑦ ᖃᓄᐃᖓᓂᐅᔪᑦ ᑐᓂᔭᐅᓚᐅᖅᑐᑦ ᐃᓚᐅᖃᑕᐅᔪᓄᑦ ᓇᓗᓇᐃᕐᓂᐊᕐᓗᓂᒥᑦ ᓂᑉᓕᐅᑎᒋᖃᑦᑕᓚᐅᖅᑕᖅᑎᖏᑦ, ᐃᓚᓕᐅᑎᔭᐅᓚᐅᖅᑐᑦ ᑕᒡᕗᖕᓇ ᐅᓂᑉᑳᒍᑦ. ᐱᓕᕆᐊᕐᒧᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ 24 ᐊᖑᑏᑦ ᐊᒻᒪᓗ 11 ᐊᕐᓇᐃᑦ ᐅᑭᐅᖃᖅᖢᑎᒃ ᐊᑯᓐᓂᖏᓐᓂᑦ 40 ᖃᓂᑕᖓᓂᑦ 80 ᖃᓂᑕᖏᓐᓄᑦ. ᓇᓄᕐᓂᒃ ᖃᐅᔨᒪᓂᖃᖅᑐᓂᒃ ᐊᐱᖅᓱᖅᑕᐅᓚᐅᖅᑐᑦ ᑭᒻᒥᕈᕐᒥᐅᑕᐃᑦ ᐊᒻᒪᓗ ᐸᖕᓂᖅᑑᕐᒥᐅᑕᐃᑦ ᓇᓐᓄᖅᑲᑦᑕᖅᓯᒪᔪᑦ ᐊᒻᒪᓗ ᐋᒃᑐᖅᖢᒋᑦ (ᐊᖑᑏᑦ), ᕿᓯᓕᓇᐊᓇᓯᐅᑉᓗᑎᓪᓗ (ᐊᕐᓇᐃᑦ), ᐅᕝᕙᓘᓐᓃᑦ ᓄᓇᓕᐊᖅᓯᒪᒪᒐᔪᒃᑐᓄᑦ. ᖃᐅᔾᔨᓴᐃᓂᖃᖅᑎᓪᓗᒋᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᑐᓂᔭᐅᓚᐅᖅᑐᑦ ᐃᑲᔪᓚᐅᖅᑐᓂᑦ ᓇᖕᒥᓂᖅ ᐊᑐᖅᓯᒪᔭᖏᓐᓂᒃ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ, ᐱᓚᒃᑕᐅᑦᑎᓪᓗᒋᑦ ᐊᒻᒪᓗ ᕿᓯᓕᐊᖑᑎᓪᓗᒋᑦ, ᐊᒻᒪᓗ ᐊᑐᕐᓂᑯᒋᔭᖏᓐᓂᑦ ᓄᓇᒥᐅᑕᐅᑉᓗᑎᒃ ᐊᒻᒪᓗ ᐃᖏᕐᕿᔭᒡᕕᒋᑉᓗᒍ. ᐃᓚᖏᑦ ᖃᐅᔨᒪᓂᓇᔭᐅᔪᑦ ᐱᔭᐅᓚᐅᖅᒥᔪᑦ ᒪᖃᐃᑎᓂᑦ, ᐃᓇᓇᔭᐅᔪᓂᑦ ᐊᒻᒪᓗ ᓄᓇᓕᖕᒥᐅᑕᓂᒃ. ᐱᑐᖅᐸᓪᓕᐊᓂᖃᖃᑎᒌᒃᑐᓂᒃ ᖃᐅᔨᓴᔪᑦ ᐃᑲᔪᓚᐅᖅᑐᓂᑦ ᐱᔭᐅᓚᐅᖅᑐᑦ ᖃᓂᑎᒋᔭᖓᓂᐅᔪᑦ 420 ᑭᓛᒥᑕᐃᑦ ᐃᓗᐊᓂᑦ ᓄᓇᓕᖓᓂᑦ, ᐊᒻᒪᓗ ᖃᐅᔨᔭᐅᖅᑲᐅᑕᐅᓯᒪᔪᓂᑦ ᐅᖅᑲᐅᓯᐅᔪᑦ 1940-ᖏᓐᓂᑦ ᐱᒋᐊᖅᓯᒪᔪᑦ (ᑕᑯᓗᒍ ᐃᓂᐅᔪᑦ ᑕᑯᕝᕕᐅᒐᔪᒃᑐᑦ ᐊᔾᔨ A-ᒥᑦ).



ᑎᑎᕐᓯᒪᔪᖅ A. ᖃᐅᔨᓴᖅᑕᐅᓯᒪᔪᖅ ᑕᒪᓐᓇ ᕿᑭᖅᑕᓘᑉ ᐊᑯᑦᑐᐃᓪᓗ ᓄᓇᖓᑕ ᐃᑭᕋᓵᖓᓐᓂ ᓇᓄᐃᑦ ᐊᒥᓲᓂᖏᑦ ᐊᕕᑦᑐᖅᓯᒪᔾᑉ ᐊᐅᓚᑦᑎᔨᖏᓪᓗ. ᓇᓗᓇᐃᖅᓯᔾᖅ, 'ᐃᓂᐅᔪᑦ ᑕᑯᕚᐅᒐᔾᑐᑦ' (ᐊᕕᒃᑐᖅᓯᒪᑉᓗᒋᑦ ᑎᑯᓕᐊᖅᑐᑦ ᓄᓇᙳᐊᖅ A-ᒥᑦ) ᐱᔾᔪᑎᖃᖅᑐᖅ ᓄᓇᐅᑉ ᑎᑭᐅᑎᓯᒪᓂᖓ ᐱᕈᖅᐸᓪᓕᐊᓂᖃᖃᑎᒌᒃᑐᓂᒃ ᖃᐅᔨᕙᐅᓯᒪᔪᓄᑦ ᐃᓚᐅᖃᑕᐅᔪᓂᑦ ᐊᐱᖅᓱᖅᑕᐅᓚᐅᖅᑐᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ.

ᑕᒡᕙᓂ ᓇᐃᓈᖅᑎᖅᑕᕗᑦ ᖃᐅᔨᒪᓂᕆᔭᐅᔪᖅ ᑐᓂᔭᐅᓚᐅᖅᑐᖅ ᐃᓄᖕᓄᑦ ᐱᓕᕆᐊᕐᒧᑦ ᐃᑲᔪᖅᑐᓄᑦ ᐊᐱᖅᓱᖅᑕᐅᑎᓪᓗᒋᑦ, ᐊᒻᒪᓗ ᐱᔾᔪᑎᖃᖅᑐᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᓇᓄᐃᑦ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᒃ ᑕᐅᑐᒐᐅᔪᑎᒍᑦ. ᖃᐅᔨᓴᐃᓂᕐᒥᑦ, ᓇᓄᐃᑦ ᖄᓄᐃᓐᓂᖏᑦ ᐃᓱᒪᒋᔭᐅᓚᐅᖅᑐᖅ ᐃᓗᐃᑦᑑᖓᓪᓗᒍ ᐊᑕᐅᓯᐅᑉᓗᒋᑦ, ᓇᓄᕐᓄᑦ ᐊᒻᒪᓗ ᐱᕈᖅᐸᓪᓕᐊᓂᖃᖃᑎᒌᒃᑐᒃᑯᑦ. ᖃᐅᔨᓴᓚᐅᖅᑕᕗᑦ ᓇᓄᐃᑦ ᖄᓄᐃᓐᓂᖏᑦ ᐃᓱᒪᒋᐸᑦᑐᒋᑦ ᖃᑉᓱᐊᕐᔪᐃᑦ, ᓅᕐᓗ ᐊᒥᓲᓂᖏᑦ ᐊᒻᒪᓗ ᐊᕿᓪᓗᐃᓪᓗ ᐊᖑᓯᓪᓗᐃᓪᓗ ᐊᒻᒪᓗ ᐅᑭᐅᖏᑦ, ᐃᓂᒋᖃᑦᑕᖅᑕᖏᑦᑕ ᖄᓄᐃᓐᓂᖏᑦ ᐊᒻᒪᓗ ᓇᒧᖓᐅᓯᒪᖃᑦᑕᕐᓂᖏᑦ, ᓂᕆᖃᑦᑕᖅᑕᖏᑦ ᐊᒻᒪᓗ ᓂᕆᔭᒃᓴᖅᓯᐅᖅᑕᖏᑦ ᒪᓂᒪᓂᖏᑦ, ᑎᒥᖏᑦᑕ ᖄᓄᐃᓐᓂᖏᑦ ᐊᒻᒪᓗ ᐃᓄᐃᓪᓗ ᓇᓄᐃᓪᓗ ᑎᑭᐅᑎᔾᔪᑎᖃᑦᑕᕐᓂᖏᑦ, ᐃᓚᐅᕙᓪᓗᑎᒃ ᑐᕋᖃᑦᑕᕐᓂᖏᑦ ᐊᒻᒪᓗ ᐋᓂᐊᖃᖅᑐᑦ.

ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᑦ ᐃᓚᐅᕙᓪᓕᑦ ᐊᒥᓱᐃᑦ (ᐱᖅᑯᓯᕆᔭᐅᔪᒧᑦ ᐱᓪᒪᕆᐅᕆᔭᐅᔪᑦ, ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᑦ, ᐱᑦᑕᐅᔪᒃᑯᑦ, ᓄᓇᕐᔪᐊᕐᒥᑦ ᑕᐅᑐᒐᐅᔪᑦ, ᐊᒻᒪᓗ ᐱᕈᖅᐸᓪᓕᐊᓂᖃᕐᓂᕐᒧᑦ ᖃᐅᔮᔭᐅᔪᑦ) ᐊᒃᑐᐊᔾᔪᑎᓂᕐᒋᑦ ᐋᖅᑕᐅᔪᓐᓇᖅᑎᕐᓗᑎᒃ, ᐃᓄᖕᓄᑦ ᖃᐅᔮᔭᐅᔪᑦ ᓇᓄᐃᑦ ᐱᕈᖅᐸᓪᓕᐊᓂᖃᕐᓂᕐᒋᓐᓄᑦ ᐊᒻᒪᓗ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᕐᒋᓐᓄᑦ ᑕᐃᒪᐅᖃᑕᐅᔪᑦ ᐃᓚᒋᔭᐅᓪᓗᑎᒃ ᖃᐅᔨᒪᓂᕆᔭᐅᔪᓄᑦ ᐱᖅᑯᓯᕆᔭᐅᔪᒧᑦ ᐊᒻᒪᓗ ᐱᕈᖅᐸᓪᓕᐊᓂᕐᒧᑦ ᐱᓪᒪᕆᐅᔪᑦ ᓇᓄᕐᓄᑦ, ᐊᒻᒪᓗ ᐃᓄᐃᑦ ᑕᐅᑐᒐᖏᑦ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᒻᒪᓗ ᑲᒪᒋᔭᖃᕐᓂᕐᒧᑦ. ᑲᒪᒋᔭᐅᓗᐊᓚᐅᖅᑐᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᖃᐅᔨᒪᑎᑦᑎᓂᐊᕐᓗᑎᒃ ᑲᔪᓯᔾᔪᑎᒃ ᐊᒻᒪᓗ ᓯᕗᓂᒃᓴᒥᑦ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᓂᑦ, ᖃᐅᔨᓯᐊᖃᑦᑕᕐᓂᕐᒧᑦ, ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐃᓱᒪᓕᐊᕆᓂᐊᖅᑐᓄᑦ.

ᐱᓪᒪᕆᐅᓂᖏᑦ ᓇᓄᐃᑦ ᓄᓇᕗᒻᒥᑦ ᐃᓄᖕᓄᑦ

ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᐱᓪᒪᕆᐅᓂᕋᐃᓚᐅᖅᑐᑦ ᐃᓄᐃᑦ ᐱᖅᑯᓯᖏᓐᓄᑦ ᓇᓄᕐᓂᑦ, ᐃᓕᑕᕆᔭᐅᔾᔪᑎᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐃᓕᖅᑯᓯᕆᔭᐅᔪᓄᑦ, ᐊᒻᒪᓗ ᐅᖃᐅᓯᖃᓚᐅᖅᑐᑦ ᑕᐃᔅᓯᒪᓂᒥᑦ ᓖᓇᒨᓗ ᖃᓄᐃᓕᐅᖃᑦᑕᕐᓂᖏᓐᓂᒃ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ. ᓇᓄᖅ ᐅᖃᐅᓯᐅᓚᐅᖅᑐᖅ ᓴᙱᔪᐊᓘᔾᔪᓯᓐᓄᑦ, ᖃᐅᔨᒪᓂᕐᓗᓄᑦ ᐊᒻᒪᓗ ᐊᔪᙱᑦᑐᓐᓇᕐᓂᕐᓗᓄᑦ ᓂᕐᔪᑎᐅᓪᓗᓂ ᑕᒪᐃᓐᓂᑦ ᐃᒃᐱᒍᓯᓪᓚᐅᔭᕆᐊᖅᑐᖅ ᐊᒻᒪᓗ ᑲᐸᐊᕆᔭᐅᓗᓂ. ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᖅᑐᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᕆᖏᑦ ᐱᓪᒪᕆᐅᑎᑦᑎᔪᑦ ᓂᕐᔪᑎᓂᒃ ᐱᖃᑦᑕᕐᓗᑎᒃ ᐱᔭᕆᐊᖃᖅᑕᐃᓇᕐᓂᒃ, ᐱᙳᐊᕆᖃᑦᑕᙱᓐᓗᑎᑦ ᓇᓄᐃᑦ, ᓂᕿᖓ ᐊᕕᒃᑐᖅᑕᐅᓗᓂ ᐊᓯᕐᓂᐊᓄᑦ ᐃᓄᖕᓄᑦ, ᐊᒻᒪᓗ ᑕᒪᐅᖓᒥᐊᖅᑎᑦᑎᑦᑕᐃᓕᓗᓂ.

ᓇᓄᒃᑕᐅᔪᖕᓇᖅᑐᓂᒃ ᑭᓪᓕᖅᑎᑦᑎᓂᐊᕈᖅᑎᓗᑎᑦ 1960-ᖏᓐᓂᑦ, ᐃᓄᐃᑦ ᒪᖃᐃᑏᑦ ᓇᓄᒍᖕᓇᖃᑦᑕᓚᐅᖅᑐᑦ ᖃᖓᒃᑯᑐᐃᓇᖅ ᐅᑭᐅᖅ ᐃᓗᐊᓂᑦ, ᐃᓚᐅᕙᓪᓗᑎᒃ ᓇᓄᐃᑦ ᖃᑕᙳᑎᒌᑦ (ᐊᕐᓇᓗᐃᑦ ᐊᑎᖅᑕᖃᖅᑐᑦ) ᐊᒻᒪᓗ ᓯᑎᖏᓐᓃᑦᑐᒃ ᐊᕐᓇᓗᕐᓂᑦ ᓇᓄᕐᓂᑦ. ᐱᓗᐊᖅᑐᒥᑦ ᐸᖕᓂᖅᑑᐸ ᖃᓂᑕᙵᓂᑦ, ᐊᕐᓇᓗᐃᑦ ᓯᑎᖏᓐᓃᑦᑐᒃ ᓇᓄᖅᓯᐅᖃᑦᑕᓚᐅᖅᑐᑦ ᑲᓇᖕᓇᖓᓂᑦ ᓯᓪᓭᖏᓐᓂᑦ ᑲᓪᐳᓚᓐ ᐃᒪᖓᓂᑦ (Cumberland Peninsula). ᑕᐃᑉᓯᒪᓂ, ᓇᓄᐃᑦ ᓂᕿᖏᑦ ᐅᖅᓱᖏᓪᓗ ᑐᓂᐅᖃᐅᑕᐅᖃᑦᑕᓚᐅᖅᑐᑦ ᖃᑕᙳᑎᒌᓄᑦ ᐊᒻᒪᓗ ᕿᒥᒋᔭᐅᔪᓄᑦ ᓂᕆᑎᑕᐅᓪᓗᑎᒃ, ᓇᓄᕋᐃᑦ ᐋᓅᓕᐅᖅᑕᐅᕙᒃᓗᑎᒃ, ᐋᓕᐊᕆᔭᐅᓪᓗᑎᒃ ᐊᒻᒪᓗ ᑮᐳᑎᒋᔭᐅᓂᐊᓪᓗᑎᒃ. ᓇᓄᒃᑕᐅᔪᖕᓇᖅᑐᑦ ᑭᓪᓕᖅᑎᑕᐅᓕᕐᒪᑕ ᐊᒻᒪᓗ ᑮᓇᐅᔭᓕᐅᕋᓯᒃᑲᓕᕐᒪᑦ ᓇᓄᕋᕐᓄᑦ ᐊᓯᐊᙳᖅᓯᓂᖃᑎᓚᐅᖅᑐᖅ ᓇᓄᒃᑕᐅᒃᑲᓐᓂᖏᑦ ᐸᖕᓂᖅᑑᒥᑦ ᐊᒻᒪᓗ ᑭᒥᕈᒥᑦ. ᓇᓄᒃᑕᐅᒃᑲᓐᓃᑦ ᐊᓯᐊᙳᓕᐅᖅᑐᖅ ᖃᑯᑎᒃᑯᑦ ᐊᒻᒪᓗ ᑕᑯᔭᐅᔭᕇᖅᑐᑦ ᐅᑭᐅᑯ ᐃᓗᐊᓂᑦ ᓅᕐᓗ ᐅᑭᐅᒃᑯᑦ ᐊᐅᔭᒃᑯᓘᓐᓂᑦ, ᐊᖑᓯᓗᕐᓂᖅᑐᖅ ᐱᔪᒪᒃᓗᑎᒃ (ᐊᖏᔪᕐᔪᐊᓂᒃ ᐃᓇᕐᓂᑦ ᓇᓄᕐᓂᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐊᖑᔪᐊᖅ) ᐊᒻᒪᓗ ᑭᓪᓕᖅᑎᑕᐅᓕᖅᒪᑦ ᖃᐅᓯᓂᒃ ᓇᓄᒐᓛᖕᓄᑦ. ᐃᑲᔪᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓖᓐᓂᑦ ᐅᖃᓚᐅᖅᑐᑦ ᖃᑖᖑᑎᒌᑦ ᐊᑎᖅᑕᓖᑦ ᐊᒻᒪᓗ ᓯᑎᖏᓐᑐᑦ ᐊᕐᓇᓗᐃᑦ ᓇᓄᒃᑕᐅᔪᖕᓇᖅᑕᐅᖏᓐᓂᖅᑐᑦ.

ᐅᐸᒍᒥ, ᓇᓄᒃᑕᐅᔪᖕᓇᖅᑐᑦ ᓂᕿᖏᓐᓄᑦᑐᐊᖅ ᐊᒻᒪᓗ ᕿᓯᖏᓐᓄᑦ. ᓇᓄᐃᑦ ᐃᓄᐃᑦ ᓂᕿᒋᔭᖏᑦ ᑭᓯᐊᓂ ᑮᓇᐅᔭᓕᐅᕈᑕᐅᖏᓐᓂᐊᖃᑦᑕᕐᓂᖏᑦ ᓇᓄᕋᐃᑦ ᐊᐅᓚᑦᑎᔨᔪᖅᑕᐅᓯᒪᕗᑦ ᓇᓄᖅᓯᐅᖅᑐᓂᒃ. ᑭᒥᕈᒥᑦ ᐊᒻᒪᓗ ᐸᖕᓂᖅᑑᒥᑦ, ᓇᓄᕋᐃᑦ ᓂᐅᕕᖅᑕᐅᓚᐅᖅᑐᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐋᓐᓂᕋᐅᖅᑕᐅᓪᓗᑎᒃ, ᐋᓕᐊᕆᔭᐅᓪᓗᑎᒃ ᐊᒻᒪᓗ ᕿᐱᕆᔭᐅᓪᓗᑎᒃ. ᑭᓯᐊᓂ, ᐊᒥᓱᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᖅᑐᑦ ᐊᑭᖏᓐᓄᑦ ᑮᓇᐅᔭᐃᑦ ᐊᖏᒡᓗᐊᕈᓐᓃᖅᑐᑦ ᓇᓄᕋᕐᓄᑦ, ᑕᐃᒪᓐᓇᒎᑦ ᓇᓄᖅᓯᐅᓗᐊᖃᑦᑕᕈᓐᓃᖅᑎᒃ.

ᓇᓄᕐᓯᐅᕐᑏᑦ ᑭᒻᒥᕈᒻᒥᑦ ᐊᒻᒪᓗ ᐸᓐᓂᕐᑑᕐᒥᑦ ᐅᖃᓚᐅᕐᑐᑦ ᑕᕐᕿᑦ ᓇᑦᑎᐊᑦ (ᒫᑦᓯ) ᐊᒻᒪᓗ ᑎᑭᓪᓗᐃᑦ (ᐋᐳᕆ) ᐱᐅᓛᖑᔪᑦ ᓇᓐᓄᓪᓗᑎᒃ ᓇᓄᕋᖏᑦ ᐊᑭᑐᓛᖑᔪᓐᓇᖃᑦᑕᕐᒪᑕ ᓂᐅᕕᕐᑕᐅᓂᐊᕐᓗᑎᒃ (ᓱᕐᓗ, ᑐᕐᕈᓂᕐᓴᐃᑦ, ᖃᑯᕐᓂᕐᓴᐃᑦ ᐊᒻᒪᓗ ᐊᖏᓂᕐᓴᐃᑦ ᓇᓄᕋᐃᑦ). ᑖᒥᓂ ᐅᑭᐅᑉ ᐃᓗᐊᓂᐅᑎᓪᓗᒍ, ᐊᖏᔪᐊᓗᐃᑦ ᐊᖑᓯᓪᓗᐃᑦ ᓇᓄᐃᑦ ᑕᑭᐅᕐᒧᐊᕐ ᓇᓐᓄᑦᑕᐅᔪᓐᓇᕐᓂᕐᓯᐅᖃᑦᑕᓚᐅᕐᑐᑦ ᓇᓄᕐᓯᐅᕐᑎᓄᑦ ᓄᓇᒧᑦ ᖃᓪᓕᔭᕌᖓᑕ ᓄᓕᐊᕆᐊᕐᑐᕐᓗᑎᒃ ᐊᒻᒪᓗ ᓇᑦᑎᕐᓯᐅᕐᑎᓪᓗᒥᑦ. ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ, ᓇᓄᕐᓯᐅᓗᐊᖃᑦᑕᕐᑐᑦ ᐊᖑᔩᑦ, ᐃᓕᖕᒥᑦ ᐊᕐᓇᐃᑦ ᓇᓄᕐᓯᐅᖃᑦᑕᐅᕙᒃᑲᓗᐊᕐᓗᑎᒃ. ᒪᖃᐃᑏᑦ ᓇᓐᓄᒃᑳᖓᓚᑦ ᐱᓚᒃᑕᐅᑲᐅᑎᒋᖃᑦᑕᕐᑐᑦ ᐊᒻᒪᓗ ᐊᕿᐊᕈᕐᒋᓐᓃᑦᑐᓂᒃ ᖃᐅᔨᒋᐊᕋᔪᒃᑐᑦ. ᓇᓄᕋᐃᑦ ᐊᒻᒪᓗ ᓂᕿᖏᑦ ᓄᓇᓕᖕᒧᑦ ᐅᑎᕈᔾᔭᐅᖃᑦᑕᕐᑐᑦ, ᐃᓗᕐᒋᑦ ᕿᒪᒃᑕᐅᖃᑦᑕᕐᑐᑦ ᓇᓐᓄᒃᕕᐊᔪᒧᑦ. ᓇᓄᐃᑦ ᓂᕿᖏᑦ ᑐᓂᐅᕐᖃᐅᑕᐅᖃᑦᑕᕐᑐᑦ ᓄᓇᓕᕐᒥᐅᓄᑦ ᐊᒻᒪᓗ ᓇᓄᕋᖓ ᓴᓗᒻᒪᕐᓴᕐᑕᐅᑉᓗᓂ, ᑕᓯᑎᕐᑕᐅᑉᓗᓂ ᐊᒻᒪᓗ ᐸᓂᕐᓯᕐᑕᐅᑉᓗᓂ –ᐊᕐᓇᓄᓗᐊᕐ– ᓂᐅᕕᐊᒃᓴᐅᓂᐊᖅᕐᑎᓪᓗᒍ ᐊᑐᕐᑕᐅᓂᐊᖅᕐᑎᓪᓗᒍᓘᓐᓃᑦ. ᓇᓄᕋᖏᑦ ᐱᓕᕆᐊᕆᐸᓪᓗᑎᑦ ᐱᔭᕆᐊᑐᑦᑎᐊᕐᑐᑦ ᐊᑕᐅᓯᐅᕐᒥᑦᑐᒧᑦ ᓇᓂᕆᐊᕆᔭᐅᖃᑦᑕᕐᓗᑎᒃ.

ᐃᑲᔪᓚᐅᕐᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᓐᓂᑦ ᐅᖃᐅᓯᖃᓚᐅᕐᑐᑦ ᐱᒻᒪᕆᐅᓂᖓ ᓇᓐᓄᖃᑦᑕᕐᓂᕐ ᓯᕗᓂᒃᓴᒥᑦ ᐊᓯᐅᔨᑦᑕᐃᓕᓂᐊᕐᓗᒍ ᐃᓄᐃᑦ ᐃᓅᓯᕆᕙᒃᑕᖏᑦ. ᓇᓄᕐᓯᐅᕐᓂᕐ ᐅᖃᐅᓯᐅᓚᐅᕐᑐᕐ ᓄᓇᓕᖕᒥᑦ ᐃᑲᔪᐃᓂᖃᕐᑐᕐ ᖃᓄᐃᖏᑦᑎᐊᕐᓂᕐᒧᑦ ᑲᑎᑦᑎᖕᒪᑦ ᐃᓄᖕᓂᒃ ᓄᓇᒧᑦ ᐊᒻᒪᓗ ᐱᖁᓯᑐᖃᕆᔭᐅᔪᓄᑦ.

ᓇᓄᕐᓄᑦ ᐱᕈᕐᐸᓪᓕᐊᓂᖃᖅᑎᒋᖕᓂᕐ ᐊᒻᒪᓗ ᐋᓂᐊᖃᕐᑕᐃᓕᒪᓂᖏᑦ

ᐱᖃᑕᐅᓚᐅᕐᑐᑦ ᖃᐅᔨᒪᓂᕆᔭᖏᓐᓂᒃ ᑐᓂᓯᓚᐅᕐᑐᑦ ᓇᓄᐃᑦ ᐱᕈᕐᐸᓪᓕᐊᓂᖃᖅᑎᒋᖕᓂᖏᓐᓂᑦ ᐊᒻᒪᓗ ᐋᓂᐊᖃᕐᑕᐃᓕᒪᓂᖏᓐᓂᒃ, ᖃᐅᔨᔭᐅᓯᒪᔪᑦ ᐊᒻᒪᓗ ᐃᓱᒪᒋᔭᐅᔪᑦ ᐅᑯᓇᖕᓂ: ᓇᓄᐃᑦ ᐊᒥᓲᓂᖏᓐᓂᑦ ᐊᒻᒪᓗ ᐊᖑᓯᓪᓗᐃᑦ ᐊᕐᓇᓪᓗᐃᑦ ᐅᑭᐅᖏᓪᓗ; ᐃᓂᒋᕙᒃᑕᖏᑦ ᐊᒻᒪᓗ ᓇᒧᖕᒐᐅᖃᑦᑕᕐᓂᖏᑦ; ᓂᕆᕙᒃᑕᖏᑦ ᐊᒻᒪᓗ ᓂᕆᔭᒃᓴᕐᓯᐅᖃᑦᑕᖏᑦ ᒪᓂᒪᓂᖏᑦ; ᑎᒥᖏᑦ ᖃᓄᐃᓐᓂᖏᑦ ᐊᒻᒪᓗ ᐋᓂᐊᖃᕐᑕᐃᓕᒪᓂᖏᑦ; ᐋᓂᐊᕐᓃᑦ ᐊᒻᒪᓗ ᑐᕐᑯᖃᑦᑕᕐᓂᖏᑦ; ᐃᓄᐃᓪᓗ ᓇᓄᐃᓪᓗ ᑎᑭᐅᑎᔾᔨᖃᑦᑕᕐᓂᖏᑦ; ᐊᒻᒪᓗ ᓯᖁᓂᒃᓴᖏᑦ.

ᐊᒥᓲᓂᖏᑦ ᐊᒻᒪᓗ ᐊᖑᓯᓪᓗᐃᑦ ᐊᕐᓇᓪᓗᐃᑦ ᐅᑭᐅᖏᓪᓗ

ᑕᒪᐃᓐᓂᑦ ᑭᒻᒥᕈᒻᒥᑦ ᐊᒻᒪᓗ ᐸᓐᓂᕐᑑᕐᒥᑦ, ᐊᐱᕐᓱᕐᑕᐅᔪᒃᑖᑦ (35) ᐅᖃᓚᐅᕐᑐᑦ ᓄᓇᖏᑦᑕ ᖃᓂᑕᖕᒐᓂᑦ ᐊᒥᓱᙳᕐᓯᒪᓂᖏᓐᓂᒃ ᓇᓄᐃᑦ. ᑭᒻᒥᕈᒻᒥᑦ, ᑲᑎᕐᒪᔭᓂᒃ ᐊᐱᕐᓱᕐᑕᐅᔪᓂᑦ ᐅᖃᓚᐅᕐᑐᑦ ᓇᓄᐃᑦ ᐊᒥᓱᔪᖕᓂᕐᓯᒪᓕᕐᑐᑦ ᐊᒥᓱᑦ ᐊᑕᐅᓯᙳᕐᓗᑎᑦ 73%-ᒧᐊᓂᒃ (ᐊᒥᓱᑎᒋᔪᑦ: 70-75, n=3[5]) ᑕᐃᒪᙵᓂᑦ 1970-ᖏᓐᓂᑦ ᐊᒻᒪᓗ 14%-ᓂᒃ (ᐊᒥᓱᑎᒋᔪᑦ: 2-25, n=3) ᑕᐃᒪᙵᓂᑦ 2005-ᒥᑦ ᐃᓂᒋᔭᖏᓐᓂᑦ ᑕᑯᔭᐅᔪᓂᑦ (ᐊᔾᔨ B). ᖃᐅᔨᔪᒍᑦ ᖃᓄᐃᓕᐅᕐᐸᓪᓕᐊᓂᖏᓐᓂᒃ ᖃᐅᔨᔭᐅᔪᑦ ᑎᑎᕋᐅᓯᐅᓯᒪᔪᑦ ᐊᐱᕐᓱᕐᑕᐅᔪᓂᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᔭᕐᑐᕐ 'ᓯᓕᔪᕐ'-ᒥᑦ ᐊᒥᓱᓂᕐᓴᐅᓕᕐᑐᑦ ᓇᓄᐃᑦ ᑭᒻᒥᕈᑦ ᖃᓂᑕᖕᒐᓂᑦ ᐊᒻᒪᓗ 'ᖃᐅᔨᒪᓇᕐᑑᔭᕐᑐᕐ'-ᖑᙵᕆᑦᑐᕐ ᐊᒥᓱᙳᕆᐊᕐᓂᖏᑦ ᓂᐅᔪᒥᑦ ᐊᒻᒪᓗ ᐅᐸᓗᔪᓂᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᓄᑦ ᓄᓇᒥᑦ ᐊᑐᕐᑕᖏᓐᓂᑦ ᐃᓚᐅᖃᑕᐅᔪᑦ ᐊᒻᒪᓗ/ᐅᕙᓗᓐᓃᑦ ᐅᐸᓗᔪᓂᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᓄᓇᒥᑦ ᓇᒨᕐᒫᐅᓯᒪᖏᑦ ᓇᓄᐃᑦ ᐃᓚᐅᖃᑕᐅᔪᑦ ᐃᓂᐅᔪᓂᒃ ᑕᑯᕕᒋᓗᔾᔭᖏᓐᓂᑦ.

ᑕᒪᕐᒥᒃᑖᕐᑲᔭᕐ ᐱᖃᑕᐅᓚᐅᕐᑐᑦ ᐸᓐᓂᕐᑑᕐᒥᑦ ᐊᒻᒪᓗ ᑭᒻᒥᕈᒻᒥᑦ ᐅᖃᓚᐅᕐᑐᑦ ᑕᑯᖃᑦᑕᕐᓂᕐᓴᐅᓕᕐᑐᑦ ᐊᑎᕐᑕᓂᒃ, ᐊᕐᓇᓪᓗᕐᓂᑦ, ᐊᒻᒪᓗ/ᐅᕙᓗᓐᓃᑦ ᐊᕐᓇᓪᓗᐃᑦ ᐊᑎᕐᑕᖅᑯᕐᒥᒃ. ᐃᓚᒋᔭᐅᑉᓗᓂ, ᐃᑲᔪᓚᐅᕐᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᐅᖃᓚᐅᕐᑎᑦᑐᑦ ᐊᓯᐊᙳᕐᑐᓂᒃ ᐊᑎᕐᑕᓕᐅᖃᑦᑕᕐᓂᐅᔪᓂᒃ ᐊᒻᒪᓗ ᐊᓈᓇᒃᑐᕐᓂᒥᒃ ᐊᒻᒪᓗ/ᐅᕙᓗᓐᓃᑦ ᖃᑕᙳᑎᒌᑦ ᐊᖏᑎᒋᓂᖏᓐᓂᑦ[6]. ᐆᒃᑑᑎᒋᓗᒍ, ᑭᒻᒥᕈᒻᒥᑦ ᐊᑎᕐᑕᐃᑦ ᐊᒻᒪᓗ ᐅᑭᐅᓃᑦ ᐊᑕᐅᓯᕐ

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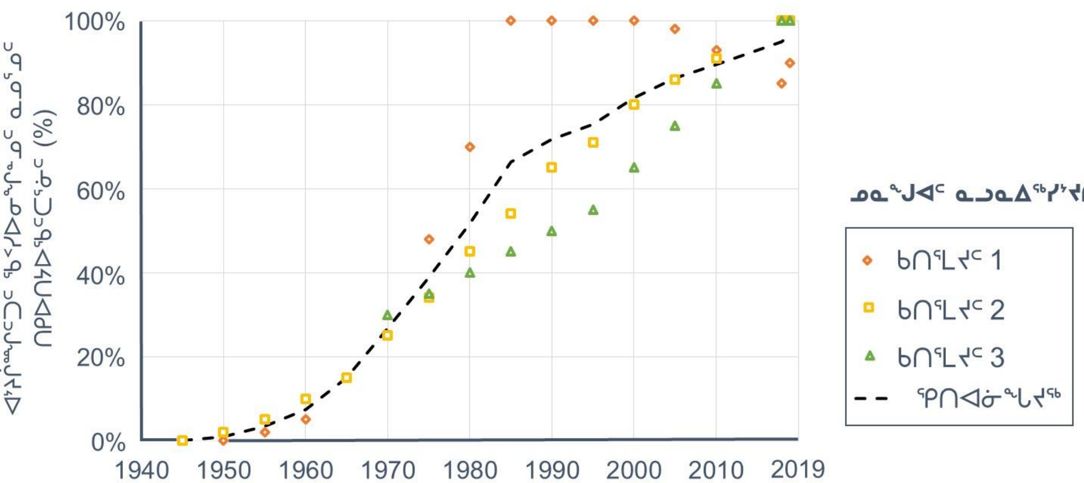
[5] ᑖᒃᑯᓂ ᓇᐃᓈᕐᓯᒪᔪᕐ ᐅᓂᒃᑳᒥᑦ ᓈᓴᐅᑎᐅᑉᓗᑎᒃ ᓈᓴᐅᑏᑦ/ᑎᑎᕐᖃᐃᑦ ᐱᔭᐅᔪᑦ ᑲᑎᕐᒪᔪᑦ ᐊᐱᕐᓱᕐᑕᐅᔪᓂᑦ ᑕᐃᒪᐅᔪᑦ, ᓇᒧᓇᐃᕐᓯᒪᔪᕐ ᖃᕝᕙᐅᓂᖏᑦ ᑲᑎᕐᒪᑉᓗᑎᒃ ᐊᐱᕐᓱᕐᑕᐅᔪᓂᑦ 'n' ᓇᓕᖏᓐᓂᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᕐᖃᐃᑦ ᐱᔭᐅᓚᐅᕐᓂᖏᓐᓄᑦ ᐃᓚᐅᖃᑕᐅᔪᑦ ᐱᓕᕆᑎᓪᓗᒋᑦ. ᑖᒃᑯᓂ ᐅᓂᒃᑳᒥᑦ, n=3 ᐱᔪᑎᖃᕐᑐᕐ ᐱᖓᓱᐃᑦ ᑲᑎᕐᒪᔪᑦ ᐊᐱᕐᓱᕐᑕᐅᔪᑦ ᑭᒻᒥᕈᒻᒥᑦ ᑲᑎᓪᓗᒋᑦ 8 ᒪᖃᐃᑏᑦ ᐃᓚᐅᖃᑕᐅᔪᓂᑦ.

[6] ᑕᐃᑲᓂ ᐃᓕᑕᐅᓇᓱᒃᑐᓂᒃ, ᐊᑎᒃᑕᑦ ᐃᓅᖃᑦᑕᕐᑐᑦ (ᐊᒥᓱᓂᖏᑦ ᓇᓄᐃᑦ ᐊᑎᒃᑕᐃᑦ ᐃᓅᔪᑦ ᑖᒃᑯᓄᖓ) ᐊᒻᒪᓗ ᐊᑎᒃᑕᑦ ᐆᒪᐃᓇᕐᑐᑦ (ᐊᒥᓱᓂᖏᑦ ᓇᓄᐃᑦ ᐊᑎᒃᑕᐃᑦ ᐆᒪᔪᑦ ᐊᕐᕋᒍᒥ ᓯᕗᓕᕐᐸᓪᓕᐊᓂᖏᑦ) ᓈᓚᐅᑖᕐᑕᐅᓯᒪᔪᑦ ᐊᑐᕐᓯᓪᓗᑎᒃ 'ᐊᑎᒃᑖᕐ-

ᐊᕐᓇᓪᓗᖅ ᓇᓄᕐᒧᑦ ᑕᐃᒪᓐᓇᐃᑭᔪᐃᓐᓇᖅᑐᑦ ᑕᐃᒪᙵᓂᑦ 1990-ᖏᓐᓂᑦ ᐅᖓᑖᓄᑦ, ᒪᕿᙵᓃᒃ ᐊᑎᖅᑖᓪᓚᑦ ᐅᑭᐅᕐᒥᑦ/ᐊᕐᓇᓪᓗᕐᒧᑦ ᐊᒻᒪᓗ ᒪᕿᒃ ᐅᑭᐅᓛᒃ/ᐊᕐᓇᓪᓗᕐᒧᑦ ᑕᑯᔭᐅᓚᔫᖑᐸᓗᑎᒃ (83% [ᐊᒥᓲᑎᒋᔪᑦ: 74-99, n=3] ᐊᒻᒪᓗ 75% [ᐊᒥᓲᑎᒋᔪᑦ: 45-95, n=3)[7]. ᑐᓂᓯᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓈᙵᓂᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐊᕐᓇᓪᓗᐃᑦ ᓇᓄᐃᑦ ᐊᑕᐅᓯᕐᒥᒃ ᒪᕿᙵᓂᓪᓘᓐᓃᑦ ᐊᑎᖅᑕᖃᑦᑕᖅᑐᑦ, ᐊᒻᒪᓗ ᐱᖓᓱᓂᒃ ᖃᑯᑎᒃᑯᑦ. ᐅᖃᓚᐅᕐᒥᔪᑦ, ᐃᓅᓯᖓᓐᓂᒃ ᑕᑯᖃᑦᑕᖅᓯᒪᔭᖏᑦ ᓄᓇᒥᑦ, ᐊᕐᓇᓪᓗᐃᑦ ᒪᕿᙵᓃᒃ ᐊᑎᖅᑕᖅᑐᑦ ᑕᑯᔭᐅᓚᔫᖑᓚᐅᖅᑐᑦ.



ᑎᑎᖅᓯᒪᔪᖅ B. ᐊᒥᓲᓂᖏᑦ ᓇᓄᐃᑦ ᑕᑯᔭᐅᓯᒪᔪᑦ ᑕᒫᓂ ᐊᑯᓐᓂᖏᓐᓂ 1945 ᐊᒻᒪᓗ 2019−ᒥ ᑭᒻᒥᕈᒻᒥ ᐅᓂᒃᑳᖅᑐᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᓂᒃ ᑕᐃᒪᐃᓕᓚᐅᖅᑐᑦ. ᑕᒪᓐᓇ ᐅᖃᐅᓯᐅᓚᐅᖅᑐᖅ ᐊᓯᖏᓐᓄᑦ ᐊᒥᓲᓂᖏᓐᓂ ᑭᒻᒥᕈᖅᐸᓯᕐᒥ. ᑐᑭᓯᖏᐊᕈᑏᑦ ᓴᖅᑭᖅᑕᐅᔪᑦ ᒪᓕᑦᑐᑎᑦ ᐊᐱᖅᓲᑎᒥᓂᕐᓂᑦ ᐱᖓᓲᓕᖅᑲᖓᔪᓂᒃ ᐊᖅᑐᖅᓯᒪᔪᓂᑦ ᓇᓂᐊᓲᕐᓂᑦ ᑭᒻᒥᕈᒻᒥ (n=3; ᑲᑎᑦᑐᒋᑦ ᑎᓴᒪᐅᔪᖅᑐᑦ ᐱᖃᑕᐅᓪᓗᑎᑦ).

ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᓯᑕᒪᓂᑦ ᖃᐅᔾᔪᑎᖃᖅᑐᑦ ᐊᒥᓲᖅᐸᓪᓕᐊᓂᖏᓐᓄᑦ ᓇᓄᐃᑦ: (1) ᓇᓄᕐᓄᑦ ᑎᑭᐅᑎᒐᔪᙱᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᓄᓇᓕᐊᖅᓯᒪᑎᓪᓗᒋᑦ, ᐱᓗᐊᖅᑐᒥᑦ ᖃᑖᒃᑎᑦᑏᑦ ᐊᑎᖅᑕᕇᑦ ᑲᑎᕐᒪᔪᑦ ᐊᒻᒪᓗ ᐃᓇᕈᐊᓂᒃᑭᑦᑐᑦ ᓇᓄᐃᑦ; (2) ᑐᒥᖏᑦ ᑕᑯᔭᐅᒐᔪᙱᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᓄᓇᒨᒃᑲᐅᓯᒪᑎᓪᓗᒋᑦ;
(3) ᑲᐱᐊᓇᕐᓂᖅᓴᐅᓕᖅᑐᖅ ᐃᓄᐃᓪᓗ ᓇᓄᐃᓪᓗ ᑎᑭᐅᑎᔾᔪᑎᓂᖏᑦ ᐊᒻᒪᓗ/ᐅᕝᕙᓘᓐᓃᑦ ᓇᓄᕐᓄᑦ ᑎᑭᑕᐅᔭᕆᐊᒃᓴᖅ ᐃᓱᓖᓗᓐᓇᕐᓂᖅᓴᐅᓕᖅᑐᑦ ᐅᐸᓗᒥᐅᔪᖅ ᑕᐃᐸᓯᒪᓂᒥᐅᖓᓂᑦ; (4) ᐊᒻᒪᓗ ᓄᓇᓕᐊᖅᓯᒪᖃᑦᑕᕐᓃᑦ ᓇᐃᓐᓂᖅᓴᐅᖃᑦᑕᓕᖅᑐᑦ ᐊᒻᒪᓗ/ᐅᕝᕙᓘᓐᓃᑦ ᒪᖃᐃᑏᑦ ᐅᖓᓯᒃᑐᓕᐊᕆᐊᖃᑦᑕᕈᓐᓃᖅᑐᑦ ᓇᓄᖅᓯᐅᕐᓂᐊᕐᓗᑎᒃ. ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᕐᒥᔪᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᓂᒃ ᑕᑯᔭᐅᔪᑦ ᓇᓄᐃᑦ ᐊᒥᓲᓂᖏᓐᓄᑦ ᐊᒃᑐᐊᓂᖃᕈᓐᓇᕐᓂᖓᓄᑦ ᐅᑯᓄᖓ: ᑭᒡᓕᖃᕐᓂᖓᓄᑦ ᖃᐸᓯᑦ ᓇᓄᒃᑕᐅᔭᕆᐊᓖᑦ ᐊᒻᒪᓗ ᐊᖑᓴᓪᓗᕐᓂᒃ ᐱᔭᕆᐊᖃᕐᓂᖏᑦ; ᓇᓄᐃᑦ ᓂᕆᔭᒃᓴᖏᑦ ᒪᓂᒪᓂᖏᓐᓄᑦ; ᑕᕆᐅᑉ ᓯᑯᐊ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ; ᐊᒻᒪᓗ ᐊᓯᐊᙳᕐᓂᖓᓄᑦ ᓯᓚᖅ. ᑭᒻᒥᕈᒻᒥᑦ, ᒫᓇᓵᖅ ᖃᐅᔨᔭᐅᓯᒪᔪᑦ (ᖁᓕᑦ ᐅᑭᐅᑦ ᐃᓗᐊᓂᐅᔫᒃᓴᐅᔪᖅ) ᓇᓄᐃᑦ "ᐊᖏᑎᒋᓂᖏᑦ ᒥᑭᓂᖅᓴᐅᔫᔭᕐᖅᑐᑦ" ᐅᖃᓚᐅᖅᑐᑦ. ᐃᑲᔪᓚᐅᖅᑐᑦ

ᐊᕿᒍ-ᐃᓗᐊᓂ ᐊᓇᖅᑕᖏᑦᑕ ᐊᖏᓂᖏᑦ (ᐊᒥᓲᓂᖏᑦ ᐊᑎᒃᑕᐃᑦ-ᐊᕿᒍᒥ ᐊᑕᐅᓯᖅ ᐊᕐᓇᕕᐊᖅ) ᐊᒻᒪᓗ 'ᐊᕿᒍᒥ ᐃᓅᔪᕕᓃᑦ ᐊᓇᖏᑦᑕ ᐊᖏᓂᖏᑦ' (ᐅᓄᕐᓂᖏᑦ ᐊᕿᒍᒥ ᐃᓅᔪᑦ ᐊᑕᐅᓯᖅ ᐊᕐᓇᕕᐊᖅ) ᖃᐅᔨᓴᖅᑕᐅᔪᑦ ᑕᐃᑲᓂᑦᑕᐃᓐᓇᖅ ᐊᑯᓂᐅᔫᒃᑯᑦ.

[7] ᓇᓄᖏᑦ ᐸᓂᖅᑑᖅ ᓄᓇᖓᓂ, ᐅᓇ ᑐᓴᖅᑕᐅᔪᒪᓯᒪᔪᖅ ᓱᓕ ᑎᑎᕋᖅᑕᐅᓯᒪᓐᖏᑦᑐᖅ ᑕᐃᒪᓗ ᑲᑎᒪᔨᓂᒃ ᐊᐱᖅᓱᓚᐅᓐᖏᑦᑐᑦ ᐸᓂᖅᑑᒥ; ᑕᐃᒪᓐᓇᐅᓚᓗᐊᖅᑎᓪᓗᒍ, ᖃᐅᔨᒪᓇᖅᑐᑦ ᐊᓯᕈᖅᑐᑦ ᐊᒥᓲᓂᖏᑦ ᐊᕿᒍᒥ ᐃᓅᔪᕕᓃᑦ ᑕᑯᔭᐅᓯᒪᔪᑦ ᐊᑯᓂᐅᔪᒥ ᓴᕿᓚᐅᓐᖏᑦᑐᑦ ᐊᑐᓂ ᐊᐱᖅᓱᖅᑕᐅᔪᓂᑦ.

ᐊᑦᑐᐊᓂᖃᖅᑎᑦᑎᓚᑦᑖᓚᐅᖏᑦᑑᒐᓗᐊᑦ ᖃᐅᔨᔭᖏᓐᓂᒃ ᑕᒪᐅᖓ ᑎᑭᓐᓂᖏᓐᓄᑦ ᒥᑭᓂᖅᓴᐃᑦ ᓇᓄᐃᑦ ᐊᓯᖏᓐᓂᓖᖅᓱᑎᒃ ᑭᒥᕈᒧᐊᖅᑐᑦ, ᐅᒃᐱᕈᓱᒃᑐᒍᑦ ᑕᐃᒪᓐᓇᐃᑦᑐᓐᓇᕐᓂᖓ ᐃᓱᒪᒋᔭᐅᔭᕆᐊᖃᖅᑐᖅ.

ᐊᒥᓱᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐊᒥᓲᓂᖅᓴᐃᑦ ᓇᓄᐃᑦ ᑕᑯᔭᐅᖃᑦᑕᓕᖅᑐᑦ ᐊᖏᕋᒥᒃ ᐊᒃᑐᖅᓯᓯᒪᔪᑦ ᐃᓅᓯᖏᓐᓄᑦ ᓄᓇᒦᑎᓪᓗᒋᑦ ᐊᒻᒪᓗ ᓄᓇᓕᖕᓄᑦ. ᐅᑉᓗᒥᐅᓕᖅᑐᖅ, ᓇᒧᑐᐃᓈᖅᓯᑎᓪᓗᒋᑦ ᑭᒥᕈᒥᐅᑕᐃᑦ ᐊᒻᒪᓗ ᐸᖕᓂᖅᑑᕐᒥᐅᑕᐃᑦ ᖃᐅᔾᓴᐃᓐᓇᕆᐊᖃᓕᖅᑐᑦ ᐊᒻᒪᓗ ᐸᕐᓇᒃᓯᒪᓗᑎᒃ ᑎᑭᑕᐅᔭᕆᐊᒃᓴᖅ ᓄᓇᕐᓄᑦ.

ᐃᓂᒋᔭᖏᑦ ᐊᒻᒪᓗ ᓇᒨᕆᐅᖃᑦᑕᕐᓂᖏᑦ

ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᑐᓂᓯᓚᐅᖅᑐᑦ ᓇᓗᓇᐃᔭᖅᓯᒪᔪᓂᒃ ᑕᑯᔭᐅᓯᒪᔪᓂᒃ ᓇᓄᐃᑦ ᓇᒨᕆᖅᐸᓪᓕᐊᓯᒪᓂᖏᓐᓂᑦ ᐃᓂᐅᔪᓂᑦ ᑕᑯᕝᕕᒋᓯᒪᔭᖏᓐᓂᑦ. ᑭᒥᕐᕈᒥᑦ, ᑲᑎᕐᒪᔪᓂᒃ ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᒨᕆᐅᖃᑦᑕᕐᓂᖏᑦ ᓇᓄᐃᑦ ᐊᓯᗑᕐᔪᐊᖅᓯᒪᖏᑦᑐᖅ ᑕᐃᒪᙱᓂᑦ 1960-ᖏᓐᓂᒃ ᐊᒥᓲᓂᖅᓴᐃᑦ ᓇᓄᕐᓄᑦ (70-80% ᖃᓂᑕᖓᓄᑦ ᑲᑎᕝᕗᒋᑦ) ᓄᓇᖅᐸᓯᖓᓂᑦ ᒥᑕ ᐃᓐᑲᒃᓂᑕ ᐃᒪᖓᓂᑦ (Meta Incognita Peninsula) (ᔪᐊᒃ ᓴᐅᓐᒥᑦ (York Sound) ᐱᐅᕆᔪ ᑲᖏᖅᕗᖑᑦ (Barrier Inlet) ᐊᒻᒪᓗ ᒪᒃHᐊᒻᒪ ᐸᐃ (Markham Bay). ᑕᐃᒪᓐᓇᒧᑦ, ᑭᒥᕈᑦ ᖃᓂᑕᖓᓂᑦ ᓇᓄᖅᓯᔪᖕᓇᕐᓂᐅᔪᖅ ᐊᖏᒡᓕᒋᐊᖅᐸᓪᓕᐊᓯᒪᔪᖅ - 1960-ᖏᓐᓂᑦ 2019-ᒧᑦ - ᐊᒥᓱᙳᕆᐊᕐᓂᖏᓐᓄᑦ ᓇᓄᐃᑦ ᐊᓯᐊᙳᕐᓂᖓᓅᖏᑦᑐᖅ ᓇᓄᐃᑦ ᓇᒨᕆᐅᖃᑦᑕᕐᓂᖏᓐᓄᑦ. ᐸᖕᓂᖅᑑᑉ ᖃᓂᑕᖓᓂᑦ, ᐊᑕᐅᓯᐅᑉᓗᒋᑦ ᐊᐱᖅᓱᐃᓂᕐᓂᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᑎᑭᐅᑎᖃᑦᑕᖅᑕᖏᑦ ᐅᖓᓯᒃᓯᕗᓪᓕᐊᓯᒪᔪᑦ - ᐊᓯᐊᙳᙳᖏᓛᖅᑯᒍ - ᕿᑎᕈᔪᐊᓄᑦ ᐊᒻᒪᓗ ᖁᑦᑎᖕᓂᖅᓴᖓᓄᑦ ᑲᒻᐳᓚᓐ ᓴᐅᓐ (Cumberland Sound), ᓄᓇᓕᖕᒧᑦ ᖃᓐᓂᖅᓴᐅᔪᒧᑦ, ᑕᐃᒪᙱᓂᑦ 1990 ᖃᓂᑕᖓᓂᑦ. ᖃᐅᔨᔭᐅᔪᓂᑦ ᐱᓂᕋᐃᖏᔪᑦ 'ᓱᓕᔪᖅ'-ᒥᑦ ᐊᒥᓲᓂᖅᓴᐅᓕᖅᑐᑦ ᓇᓄᐃᑦ ᐸᖕᓂᖅᑑᑉ ᖃᓂᑕᖓᓂᑦ ᐊᒻᒪᓗ ᖃᐅᔨᒪᓇᖅᑑᔭᖅᑐᖅ-ᖑᙳᖏᑦᑐᖅ ᐊᒥᓱᙳᕆᐊᕐᓂᖏᑦ ᐊᓯᐊᓄᐊᕐᓂᖏᓐᓄᑦ ᓇᒨᕆᐅᖃᑦᑕᕐᓂᖏᑦ ᐃᓚᐅᖃᑕᐅᔪᑦ ᖃᐅᔨᓯᒪᔭᖏᓐᓂᑦ ᐃᓂᐅᔪᒥᑦ.

ᐊᒥᓱᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᐅᖃᐅᓯᖃᓚᐅᕐᒥᔪᑦ ᖃᐅᔨᓯᒪᔪᑦ ᐊᒥᓱᙳᖅᐸᓪᓕᐊᓂᖏᑦ ᓇᓄᐃᑦ ᑕᐃᑲᓂ ᖃᓂᑕᖓᓂᓪᓘᓐᓃᑦ ᓄᓇᓕᖏᑦᑕ ᐱᒋᐊᖅᕗᓂ 2000-ᖏᓐᓂᑦ. ᓇᓗᓇᐃᖅᓯᓚᐅᖅᑐᑦ ᐱᔾᔪᑕᐅᔪᖕᓇᖅᑐᓂᒃ ᓲᖅ ᐊᒥᓲᓂᖅᓴᐃᑦ ᓇᓄᐃᑦ ᑕᑯᔭᐅᖃᑦᑕᕐᓂᖅᓴᐅᓕᕐᒪᙱᑕ ᓄᓇᓕᖕᓂᑦ ᖃᓂᑕᖏᓐᓂᓪᓘᓐᓃᑦ: (1) ᐊᒥᓱᙳᕐᓂᖅᓴᐅᔪᑦ ᓇᓄᐃᑦ (ᐊᒻᒪᓗ ᐱᓗᐊᖅᑐᒥᑦ ᐊᒥᓱᙳᕆᐊᖅᑐᑦ ᐃᓇᕈᐊᓂᖏᑦᑐᑦ ᖃᐅᔨᔪᒪᓂᖃᓗᐊᖃᑦᑕᖅᑐᑦ ᐊᒻᒪᓗ ᐃᓕᑦᑎᕙᓪᓕᐊᓕᕚᖅᑎᑦ ᓂᕆᔭᒃᓴᖅᓯᐅᕐᓂᕐᒥᒃ); (2) ᓇᓄᐃᑦ ᓂᕿᓂᒃ ᓇᐃᒪᖃᑦᑕᕐᓂᖏᓐᓄᑦ ᓄᓇᓕᖕᓂᑦ ᐊᒻᒪᓗ ᐊᒃᑕᑯᓂᑦ ᐊᒻᒪᓗ/ᐅᕝᕙᓘᓐᓃᑦ ᒪᖃᐃᑕᐅᓚᐅᖅᑐᓂᒃ ᓂᕐᔪᑎᕝᕕᓂᕐᓂᒃ ᓇᐃᒪᑉᓗᑎᒃ ᓄᓇᓖᑦ ᖃᓂᑕᖏᓐᓃᑦᑐᓂᑦ; (3) ᒻᒪᓗ ᐊᓯᐊᙳᕐᓂᖓᓄᑦ ᑕᕆᐅᑉ ᓯᑲᖓ ᓇᓄᕐᓂᒃ ᓄᓇᒦᓚᔪᖕᓂᖅᓴᐅᓕᖅᑎᑦᑎᑉᓗᓂ ᐊᒻᒪᓗ ᓯᖃᔭᓂᑦ ᓄᓇᓖᑦ ᖃᓂᑕᖏᓐᓂᑦ. ᖃᓄᐃᑦᑐᑐᐃᓐᓇᐃᑦ ᓇᓄᐃᑦ ᑕᑯᔭᐅᖃᑦᑕᖅᑎᓪᓗᒋᑦ ᖃᓂᑕᖓᓂᑦ ᐅᕝᕙᓘᓐᓃᑦ ᓄᓇᓕᖓᓂᑦ, ᐊᒥᓲᓂᖅᓴᐃᑦ ᖃᐅᔨᔪᒪᓂᖃᖅᑐᑦ ᐃᓐᓇᕈᐊᓂᖏᑦᑑᖃᑦᑕᖅᑐᑦ - ᐃᖅᓯᓇᕐᓂᖅᓴᐅᖃᑦᑕᖅᑲᑎᒡᓗ ᐃᓐᓇᐅᔪᓂᐅᖓᓂᑦ - ᐃᓛᓐᓂᒃᑯᓪᓗ ᐊᓇᓇᐅᔪᑦ ᐊᑎᖅᑕᖃᖅᑲᑎᒃ ᑕᑯᔭᐅᒐᔪᖕᓂᖅᓴᐅᖃᑦᑕᖅᑐᑦ ᓄᓇᓖᑦ ᖃᓂᑕᖏᓐᓂᑦ.

ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐸᖕᓂᖅᑑᕐᒥᑦ ᐊᒻᒪᓗ ᑭᒥᕈᒥᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᕐᓂᑦ ᑕᑯᔪᓐᓇᖅᑐᑦ ᑕᕆᐅᑉ ᓯᑯᖓᓂᑦ, ᐃᒪᕐᒥᑦ ᐊᒻᒪᓗ ᓄᓇᒥᑦ, ᐅᑭᐅᑉ ᐃᓗᐊᓃᑦᑐᑦ ᓲᕐᓗ ᐅᑭᐅᒃᑯᑦ ᐊᐅᔭᒃᑯᓪᓗᓐᓃᑦ ᒪᓕᒡᓗᒋᑦ ᐊᒻᒪᓗ ᓂᕆᔭᒃᓴᖅᓯᐅᖃᑦᑕᖅᑕᖏᑦ ᒪᓂᒪᓂᖏᑦ. ᐊᒥᓱᑦ ᐅᖃᖅᑐᑦ ᑕᕆᐅᕐᒥᑦ ᓯᑯᓂᑦ, ᐊᒥᓯᐃᑦ ᓂᕆᔭᒃᓴᖅᓯᐅᖅᑐᑦ, ᐃᓄᖕᓄᑦ ᐃᓗᐃᕐᓵᖅᑕᐅᓂᖃᑐᐊᖏᕝᕗᑎᒃ, ᐊᒻᒪᓗ ᑕᐃᒪᐅᓂᖏᑦ ᑕᒪᕐᒥᒃ ᐊᖑᓯᓪᓗᐃᑦ ᐊᒻᒪᓗ ᐊᕐᓇᓪᓗᐃᑦ ᓇᓄᐃᑦ ᐊᒻᒪᓗ ᐊᔾᔨᕐᒥᖏᑦᑐᓂᒃ ᐅᑭᐅᓖᑦ (ᐃᓚᐅᑉᓗᑎᒃ ᐃᓐᓇᕈᐊᓂᙱᑦᑐᑦ ᐊᒻᒪᓗ ᐃᓐᓇᕈᖅᓯᒪᓕᖅᑐᑦ) ᖃᓄᐃᓕᐅᕐᓂᖏᓐᓄᑦ 'ᐱᑦᑕᐅᔪᖅ' ᓇᓄᐃᑦ ᐃᓂᒋᖃᑦᑕᖅᑕᖏᑦ ᐊᔪᙱᑎᑦᑎᔪᓐᓇᖅᑐᑦ ᖃᓄᐃᖏᑦᑎᐊᕐᓂᖓᓄᑦ ᓇᓄᐃᑦ. ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐅᑭᐅᑉ ᐃᓚᖓᒍᑦ ᓇᓄᐃᑦ ᓇᒨᕆᐅᖃᑦᑕᕐᓂᖏᑦ ᐱᔾᔪᑕᐅᓗᐊᖅᑐᑦ ᑕᕆᐅᑉ ᓯᑯᖃᑦᑕᕐᓂᖓᓄᑦ ᐊᒻᒪᓗ ᓇᑦᑏᑦ ᒪᓂᒪᓂᖏᓐᓄᑦ.

ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐅᖃᖅᑎᓪᓗᒋᑦ ᐱᒪᕆᐅᓂᖓ ᓇᓄᕐᓄᑦ ᑕᕆᐅᕐᒥᑦ ᓯᑯᐃᑦ, ᐊᒥᓱᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐊᓯᐊᙳᕐᓂᖓ ᑕᕆᐅᑉ ᓯᑯᖃᕐᓂᖓ ᐊᒻᒪᓗ ᖃᓄᐃᓐᓂᖓ ᖃᐅᔨᔭᐅᓯᒪᓕᖅᑐᑦ ᖃᐸᓯᐊᕐᔫᓕᖅᑐᑦ ᐅᑭᐅᒐᓴᖓᓂᑦ. ᐊᓯᐊᙳᖅᑐᑦ ᑕᑯᔭᐅᓯᒪᔪᓂᑦ ᐃᓚᐅᔪᑦ: ᓵᓂᖅᓴᐅᓕᖅᑐᖅ ᑕᕆᐅᑉ ᓯᑯᖓ, ᐊᐅᓚᓂᖅᑕᖅᐅᕐᓂᖅᓴᐅᓕᖅᑐᖅ, ᐊᓯᐊᙳᕐᓂᖓ

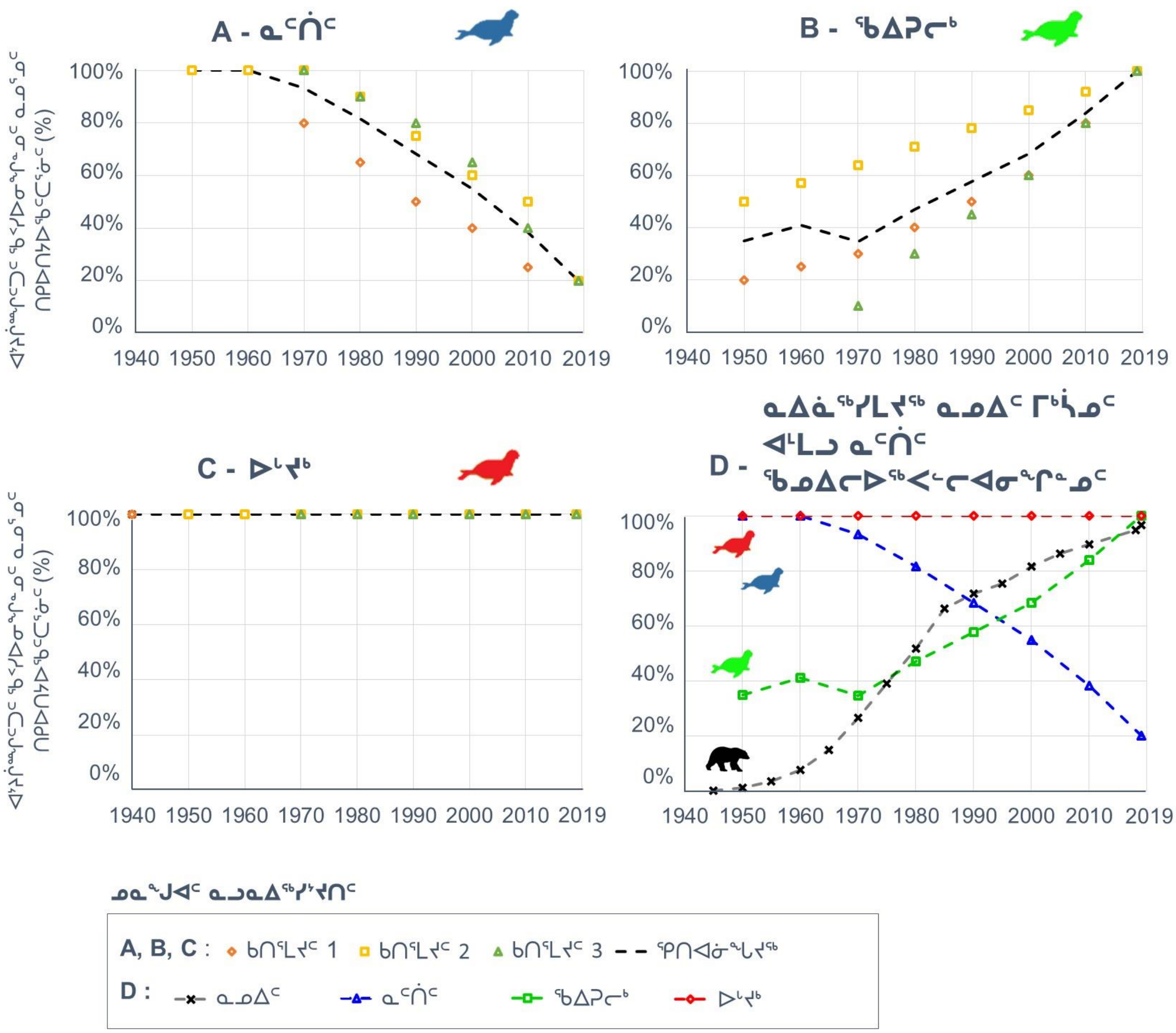
ᐅᖓᓯᒃᑎᒋᓂᖓᑕ ᓯᓈᑉ (ᖃᓂᓐᓂᖅᓴᐅᓕᖅᑐᖅ), ᐊᒻᒪᓗ ᓯᑯ ᓯᖁᑉᑎᖅᓵᓕᓂᖅᓴᐅᖃᑦᑕᓕᕐᓂᖓ ᐊᒻᒪᓗ ᓯᑯᓇᓲᕐᓂᖅᓴᐅᖃᑦᑕᓕᕐᓂᖓ. ᑭᓯᐊᓂ, ᖃᑉᓯᐊᕐᔪᐃᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᐅᖃᓚᐅᖅᑐᑦ ᑕᕆᐅᑉ ᓯᑯᖓ ᐊᓯᐊᙳᕐᓂᖓᓄᑦ ᐊᒃᑐᖅᓯᓂᖃᖅᑐᖅ ᓇᓄᕐᓄᑦ –ᐱᓗᐊᖅᑐᒥᑦ ᓇᓄᐃᑦ ᑕᕆᐅᑉ ᓯᑯᖓᓂᒃ ᐊᑐᖃᑦᑕᖅᑐᑦ ᓇᑦᑎᖅᓯᐅᖅᓱᑎᒃ– ᓇᓄᖅ ᐊᔪᕆᓴᕋᐃᑦᑐᖅ ᐃᓂᐅᔪᒥᑦ ᐊᒻᒪᓗ ᑕᕆᐅᕐᒥᑦ ᓯᑯᐃᑦ ᐊᓯᐊᙳᕐᓂᖏᓐᓂᑦ.

ᑭᖑᓪᓕᖅᐹᖅ, ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᓇᓗᓇᐃᓚᐅᖅᑐᑦ ᖃᐅᔨᒪᔭᐅᔪᓂᒃ ᓇᓄᐃᑦ ᓯᑎᖃᕐᕕᖏᓐᓂᑦ ᐅᖃᐅᓯᕆᑉᐳᒋᓪᓗ ᐱᖅᑯᓯᕆᔭᖏᑦ ᐊᒻᒪᓗ ᐃᓂᒋᔭᖏᑦ. ᐃᓚᖏᑦ ᐃᓚᐅᖃᑕᐅᓚᐅᖅᑐᑦ ᐃᓅᓯᖏᓐᓂᑦ ᓇᖏᓂᖅ ᖃᐅᔨᖃᑦᑕᖅᓯᒪᔪᑦ ᓇᓄᐃᑦ ᓯᑎᖏᓐᓂᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓯᒪᔪᑦ ᓇᓄᕐᓄᑦ ᓯᑎᖃᕐᕕᐅᔪᓂᒃ ᖃᓂᑕᖓᓂᑦ ᐸᖓᓂᖅᑑᑉ ᐊᒻᒪᓗ ᑭᒥᕉᑉ.ᐊᑕᐅᓯᖅ ᐃᑲᔪᓚᐅᖅᑐᖅ ᐸᖓᓂᖅᑑᒥᑦ ᐅᖃᓚᐅᖅᑐᖅ ᐊᓯᐊᙳᕐᓂᖏᑦ ᐱᐊᓛᒃᓴᓖᑦ ᓯᑎᖏᑦᑕ ᐃᓂᖏᑦ ᐊᐅᒃᐸᓪᓕᐊᓂᖏᓐᓄᑦ ᓯᕿᑦ.

ᓂᕿᖏᑦ ᐊᒻᒪᓗ ᓂᕆᔾᔪᓯᖏᑦ ᒪᓂᒪᓂᖏᑦ

ᐃᑲᔪᓚᐅᖅᑐᖅ ᐸᖓᓂᖅᑑᕐᒥᑦ ᐊᒻᒪᓗ ᑭᒥᕈᒻᒥᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓂᕆᖃᑦᑕᖅᑕᖏᓐᓂᒃ ᓇᓄᐃᑦ ᐅᖃᖅᓱᑎᓪᓗ ᓇᓄᐃᑦ ᓂᕆᔪᓗᐊᕆᖃᑦᑕᖅᑕᖏᑦ ᓇᑦᑏᑦ ᐊᒻᒪᓗ ᓇᑦᑎᐊᖏᑦ, ᑭᓯᐊᓂᑦᑕᐅᖅ ᐊᓯᖏᓐᓂᒃ ᓇᑦᑎᕐᓂᑦ ᓂᕆᖃᑦᑕᕐᒥᔪᑦ (ᐃᓚᐅᑉᓗᑎᒃ ᐅᒡᔪᐃᑦ, ᖃᐃᕈᓖᑦ, ᖃᓯᒋᐊᑦ ᐊᒻᒪᓗ ᐱᐊᓛᖏᑦ), ᓇᓄᕐᓄᑦ ᑕᒻᒃᑯᐊ ᓂᕆᔾᔭᖅᓯᐅᖅᑕᐅᓗᐊᖃᑦᑕᖅᑐᑦ. ᐅᖃᖅᑐᑦ ᑲᑎᕐᒪᑉᓗᑎᒃ ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᑭᒥᕈᒻᒥᑦ, ᓇᑏᑦ 75%-ᖑᔪᑦ (ᐊᒥᓲᑎᑦᔪᑦ: 64-90, n=3) ᑕᒪᐃᓐᓅᖓᔫᒃᑯᑦ ᓇᓄᐃᑦ ᓂᕆᖃᑦᑕᖅᑕᖏᓐᓂᑦ. ᓇᓄᐃᑦ ᓂᕆᖃᑦᑕᕐᒥᔭᖏᑦ ᐅᖃᐅᓯᐅᓚᐅᕐᒥᔪᑦ ᐅᑯᐊ: ᐊᐃᕖᑦ; ᒥᑏᑦ ᐊᒻᒪᓗ ᑎᖏᐊᑦ ᒪᓐᓂᖏᑦ; ᕿᓇᓗᒐᐃᑦ (ᐃᓚᐅᔪᑦ ᕿᓇᓗᒐᐃᑦ, ᑑᒑᓖᑦ ᐊᒻᒪᓗ ᐊᕐᕖᑦ ᓄᓇᓕᓯᒪᔪᑦ); ᐃᖃᓗᐃᑦ (ᐃᖃᓗᒃᐱᓗᐊᑦ); ᕿᑦᖁᐊᑦ; ᐊᒻᒪᓗ ᐱᕈᖅᑐᐃᑦ ᐊᒻᒪᓗ ᐸᐅᖕᖓᐃᑦ. ᓂᕆᔾᔪᖅᓯᐅᖅᑕᐅᔪᑦ ᖃᑯᑎᒃᑯᑦ ᐅᖃᐅᓯᔪᑦ ᐃᓚᒋᔭᐅᑉᓗᑎᒃ ᓇᓄᕐᓄᑦ ᓂᕿᒋᔭᐅᔪᓂᑦ ᐃᓚᐅᔪᑦ: ᐊᓯᖏᓐᓂᑦ ᓇᓄᕐᓂᑦ; ᐃᓄᖕᓂᑦ; ᐃᓄᖕᓄᑦ ᐊᒃᑕᒍᖅᑕᐅᔪᓂᒃ ᐊᒻᒪᓗ ᐃᓄᖕᓄᑦ ᓴᓇᔭᐅᔪᓂᒃ; ᑐᒃᑐᓂᒃ; ᕿᒻᒥᕐᓂᑦ; ᐊᒻᒪᓗ ᑎᑎᕋᓂᐊᓂᑦ. ᐃᓚᐅᖃᑕᐅᔪᑦ ᐅᖃᐅᕐᒥᔪᑦ ᓇᓄᐃᑦ ᓂᕆᖃᑦᑕᖅᑕᖏᑦ ᐊᔾᔨᒌᙱᖃᑦᑕᖅᑐᑦ ᐅᑭᐅᑉ ᐃᓗᐊᓂᑦ ᒪᓕᒃᓱᒋᑦ ᒪᓂᒪᓂᖏᑦ ᓂᕆᔾᔭᖏᓐᓂᒃ ᐱᔪᓐᓇᖅᑕᖏᑦ, ᐊᒻᒪᓗ ᐅᑭᐅᑉ ᐃᓚᖓᓂᑦ ᐊᑐᖅᑕᐅᔪᓂᒃ ᐊᓯᖏᓐᓄᑦ. ᖃᑉᓯᐊᕐᔪᐃᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᓇᓄ*ᐃᑦ*ᐊᔪᕆᑦᑐᖓᓇᑦᑎᐊᕐᒪᑕ ᐊᒻᒪᓗ ᐱᕕᖃᓕᑐᐊᕈᑎᒃ ᓂᕆᔾᔭᖕᖏᓐᓂᒃ ᐱᔪᖕᓇᖅᓱᑎᒃ. ᐊᒥᓱᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᓯᑯᒥᑦ ᐱᑕᕈᖕᓇᑦᑎᐊᖅᑐᑦ ᓂᕆᓂᐊᖅᑕᒥᖕᓂᒃ ᑭᓯᐊᓂ ᐊᔪᙱᑦᑐᑦᑕᐅᖅ ᓄᓇᒥᑦ ᐊᒻᒪᓗ ᐃᒪᕐᒥᑦ. ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᓂᕆᖃᑦᑕᖅᑐᑦ ᐃᓄᖕᓄᑦ ᐊᒃᑕᒍᖅᑕᐅᔪᓂᒃ ᐊᓯᖏᓐᓂᓪᓗ ᐃᓄᐃᖕᓄᑦ ᓴᓇᔭᐅᓯᒪᔪᓂᒃ ᑕᒪᓐᓇᓗ ᖃᐅᔨᔭᐅᖃᑦᑕᓖᓵᖅᓱᓂ. ᖃᑉᓯᐊᕐᔪᐃᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᓇᖏᓂᖅ ᖃᐅᔨᓯᒪᑉᓗᑎᒃ ᐅᕙᓘᓐᓃᑦ ᑐᓴᖅᓯᒪᔪᑦ ᓇᓅᖃᑎᖏᓐᓂᒃ ᓂᕆᖃᑦᑕᖅᑐᓂᒃ - ᑭᓯᐊᓂ ᑕᑯᔭᐅᔪᑦ ᑕᒪᐃᓅᖓᔫᒃᑯᑦ ᑕᑯᔭᐅᒐᔭᙱᓐᓂᖅᓱᑎᒃ. ᐃᓚᖏᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐅᐸᓗᒥᐅᓕᖅᑐᖅ ᐊᒥᓲᓂᖅᓴᐃᑦ ᓇᓄᐃᑦ ᓂᕆᖃᑦᑕᖅᑐᑦ ᒥᑎᕐᓄᑦ ᑲᑎᕝᕕᐅᖃᑦᑕᖅᑐᓂᑦ ᑕᐃᑉᓱᒪᓂᒥᐅᓚᐅᖅᑐᒥᐅᖓᓂᑦ, ᑕᐃᒪᓐᓇᐃᓐᓂᖅ ᐅᖃᐅᓯᐅᓚᐅᖅᑎᓪᓗᒍ ᐃᓚᒋᔭᐅᑉᓗᓂ ᓇᓄᐃᑦ ᐊᒥᓲᕐᓂᖏᓐᓄᑦ ᐊᓯᐊᙳᕐᓂᖏᓐᓃᙶᖏᑦᑐᖅ ᓇᓄᐃᑦ ᓂᕆᖃᑦᑕᖅᑕᖏᑦ (ᐊᑯᓂᐊᓗᒃᖃᐅᔨᒪᔭᐅᔪᑦ ᒥᑏᑦ ᑲᑎᕝᕕᖏᓐᓂᑦ ᓇᓄᐃᑦ ᒥᑎᕐᓂᑦ ᓂᕆᖃᑦᑕᖅᑐᑦ).

ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᓂᒃ ᓇᑦᑎᖅᑕᖃᐅᕐᓂᕐᒥᒃ ᐊᒻᒪᓗ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᑦᑕ ᖃᓄᐃᓐᓂᑦᔪᖏᓐᓂᒃ. ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ, ᐃᓚᐅᖃᑕᐅᔪᓗᒃᑖᑦ ᓂᑉᓕᐅᑎᖃᓚᐅᖅᑐᑦ ᓇᑏᑦ ᐊᒥᓲᑎᒋᓂᖏᓐᓂᑦ ᐅᖃᖅᑐᑦ ᓇᑦᑎᖅᑕᖃᐅᕆᓐᖑᕐᓂᖓᓄᑦ ᖁᓕᒐᓴᐃᑦ ᐅᑭᐅᓂᐅᓕᖅᑐᖅ. ᐆᒃᑑᑎᒋᓗᒍ, ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ 80%-ᖑᔪᑦ (ᐊᒥᓲᑎᑦᔪᑦ: 80-80, n=2) ᐊᒥᓲᔪᙳᖅᓯᒪᔪᑦ ᓇᑏᑦ ᑭᒥᕉᑉ ᖃᓂᑕᖓᓂᑦ ᖃᐅᔾᔨᐅᓯᒪᔪᑦ ᐊᑯᓐᓂᖏᓐᓂᑦ 1960 ᐊᒻᒪᓗ 2019. ᑖᑉᑯᓇᓂ ᐅᑉᓗᕐᓂᑦ, ᖃᐃᕈᓖᑦ ᑕᑯᔭᐅᖃᑦᑕᖅᑐᑦ ᐊᒥᓲᙳᓇᐊᖅᑐᑦ 60%-ᓗᐊᓂᒃ (ᐊᒥᓲᑎᑦᔪᑦ: 43-75, n=2), ᖃᑉᓯᐅᑎᒋᓂᖏᑦ ᐅᒡᔪᐃᑦ ᓲᖁᓯᐊᓯᒪᙱᑦᑐᑦ (ᐊᑎᐅ C).



ᑎᑎᖅᓯᒪᔪᖅ C. ᖃᐸᓯᐅᑎᒋᓂᖏᑦ ᓇᑦᑏᑦ (A), ᖃᐃᕿᓖᑦ (B) ᐊᒻᒪᓗ ᐅᒡᔪᐃᑦ (C) ᑕᑯᔭᐅᖃᑦᑕᖅᑐᑦ ᐊᑯᓐᓂᖏᓐᓂᑦ 1940 ᐊᒻᒪᓗ 2019 ᐊᒻᒪᓗ ᓇᐃᓈᖅᓯᒪᔪᖅ ᓇᓄᐃᑦ ᐊᒻᒪᓗ ᓇᑦᑏᑦ ᖃᓄᐃᓕᐅᖅᐸᓪᓕᐊᓂᖏᓐᓄᑦ (D) ᖃᐅᔾᔭᐅᓯᒪᔪᑦ ᑭᒻᒥᕈᒻᒥᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᓄᑦ ᑲᑎᕐᒪᐸᓗᑎᒃ ᐊᐱᖅᓱᖅᑕᐅᑎᓪᓗᒋᑦ. ᑐᑭᓯᐅᒪᔾᔪᑏᑦ ᐊᑐᖅᑕᐅᔪᓐᓇᖅᑐᑦ ᓇᑦᑏᑦ ᐊᒥᓲᑎᒋᓂᖏᓐᓄᑦ ᑭᒻᒥᕈᑦ ᖃᓂᑕᖖᓂᑦ. ᑐᑭᓯᐅᒪᔾᔪᑏᑦ ᑕᑯᒃᓴᐅᔪᑦ ᐱᔭᐅᔪᑦ ᐊᐱᖅᓱᐃᓂᕐᓂᑦ ᑖᑉᑯᓂᙵ ᐱᖓᓱᓂᑦ ᑲᑎᕐᒪᔪᓂᒃ ᓇᓄᕐᓂᑦ ᒪᖃᐃᑎᓄᑦ ᑭᒻᒥᕈᒥᑦ (3; ᑲᑎᙵᓕᑦ 8 ᐱᖃᑕᐅᓚᐅᖅᑐᑦ). ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᐱᔭᐅᓚᐅᖅᑐᑦ ᖃᐸᓯᐅᓂᖏᓐᓄᑦ ᑲᑎᖅᓱᐃᓂᖃᖅᑎᙱᓗᒋᑦ; ᐊᑐᓂ ᑲᑎᕐᒪᔪᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᓂᑦ ᐊᖏᕈᑎᖃᓚᐅᖅᑐᑦ ᖃᐸᓯᐅᓂᖏᓐᓄᑦ ᖃᓂᖓᓃᑦᑐᒍᑦ ᓇᑦᑏᑦ ᑕᑯᖃᑦᑕᖅᓯᒪᔭᖏᓐᓂᑦ ᑕᒪᐃᓐᓄᑦ ᓂᕐᔪᑎᓄᑦ. ᐊᕕᒃᓯᒪᐸᓗᑎᒃ ᑎᑯᓕᐊᖅᓯᒪᔪᑦ ᑐᑭᖃᖅᑐᖅ ᕿᑎᐊᓃᖓᔪᖅ ᓈᓴᐅᑎ. ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ ᖃᓄᐃᓕᐅᖅᐸᓪᓕᐊᓃᑦ (D)-ᒥᑦᑐᑦ ᐊᔾᔨᒋᔭᖏᑦ ᑕᐃᒪᐅᔪᓂᑦ ᓇᓗᓇᐃᔭᖅᓯᒪᒃᑲᓂᖅᑐᑦ ᐊᔾᔨ B-ᒥᑦ.

ᐃᑲᔪᓚᐅᖅᑐᑦ ᐸᓂᖅᑑᕐᒥᑦ ᐊᒻᒪᓗ ᑭᒻᒥᕈᒻᒥᑦ ᐊᔾᔨᒌᙶᒋᑦᑐᓂᒃ ᐅᖃᖃᑦᑕᓚᐅᖅᑐᑦ ᓱᖑᒪᖖᑦ ᐃᓱᒪᒋᔭᖏᑦ ᓇᑦᑏᑦ ᐊᒥᓲᔪᙵᕐᓂᖏᓐᓄᑦ ᕿᓚᑦ ᐅᑭᐅᓵᐃᑦ ᐊᓂᒍᖅᑐᓂᑦ ᓄᓇᓕᖏᑦᑕ ᖃᓂᑕᖏᓐᓂᑦ, ᐃᓚᐅᐸᓗᑎᒃ:
ᐊᒥᓱᙶᓇᐊᕐᓂᖏᓐᓄᑦ ᓇᓄᐃᑦ (ᐱᓗᐊᖅᑐᒥᑦ ᓇᑦᑏᑦ ᓇᑦᑎᐊᓕᐅᕐᕕᖏᓐᓂᑦ ᓇᑦᑎᐊᖃᓕᖅᑎᓪᓗᒋᑦ);
ᐊᒥᓱᙶᓇᐊᕐᓂᖏᓐᓄᑦ ᓄᓇᓕᖏᒥᐅᑦ ᒪᖃᐃᖃᑦᑕᖅᑐᑦ; ᓇᑦᑏᑦ ᐊᓯᐊᓄᑦ ᑕᓇᐅᕐᒍᐊᖅᑐᑦ (ᒪᓕᒃᑐᑦ ᓂᕆᔭᒃᓴᖏᓐᓂᒃ ᐅᕝᕙᔾᔪᓐᓂᑦ ᐊᓯᐊᓄᐊᖅᑎᑕᐅᔪᑦ ᐊᓯᖏᓐᓄᑦ ᓂᕆᔭᒃᓴᖅᓯᐅᖅᑎᓄᑦ); ᐊᒥᓱᙶᓇᐊᕐᓂᖏᓐᓄᑦ ᐅᒥᐊᕐᔪᐊᑦ

ᐃᖏᕐᕋᔭᒃᑐᑦ; ᓯᑯᖃᑦᑎᐊᖏᓕᕐᓂᖓᓄᑦ; ᐆᓇᕐᓂᖅᓵᓕᕐᓂᖓᓄᑦ ᑕᕆᐅᑉ ᐃᒪᖏᑦ; ᐊᒥᓱᙳᕆᐊᕐᓂᖏᓐᓄᑦ ᑎᕆᒐᓂᐊᑦ ᓂᕆᔭᒃᓴᖅᓯᐅᖅᑐᑦ; ᐊᒻᒪᓗ ᐊᓯᐊᙳᖅᓯᒪᓕᕐᓂᖓᑕ ᐊᓄᕆᐅᑉ. ᐃᓚᖏᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᐊᓯᐊᙳᖅᑐᓂᒃ ᑕᑯᓯᒪᙱᑦᑐᑦ ᓇᑦᑏᑦ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ, ᐊᓯᖏᑦ ᐅᖃᖅᑐᑦ ᓇᑦᑏᑦ ᓴᓪᓘᓂᖅᓵᓕᖅᑐᑦ ᐊᒻᒪᓗ ᐊᔾᔨᐅᖏᑦᑐᖃᑦᑕᖅᓗᑎᒃ ᕿᓯᖏᓐᓂᑦ ᐊᕙᑎᑦ (20) ᐅᑭᐅᑦ ᐊᓂᒍᖅᑐᓂᑦ, ᐃᓚᐅᔪᑦ ᒥᖅᑯᐃᑭᑎᓯᒪᓃᑦ ᐊᒻᒪᓗ ᒪᓖᕐᓂᖓᑦ ᐊᑯᓂᐅᓂᖅᓵᐅᖃᑦᑕᓕᕐᓂᖓᓄᑦ. ᒥᖅᑯᐃᑭᑎᓯᒪᔪᓂᒃ ᖃᐅᔨᔭᐅᓚᐅᕐᒥᔪᖅ ᐅᒡᔪᖕᓂᑦ ᑭᒻᒥᕈᑦ ᖃᓂᑕᖓᓂᑦ.

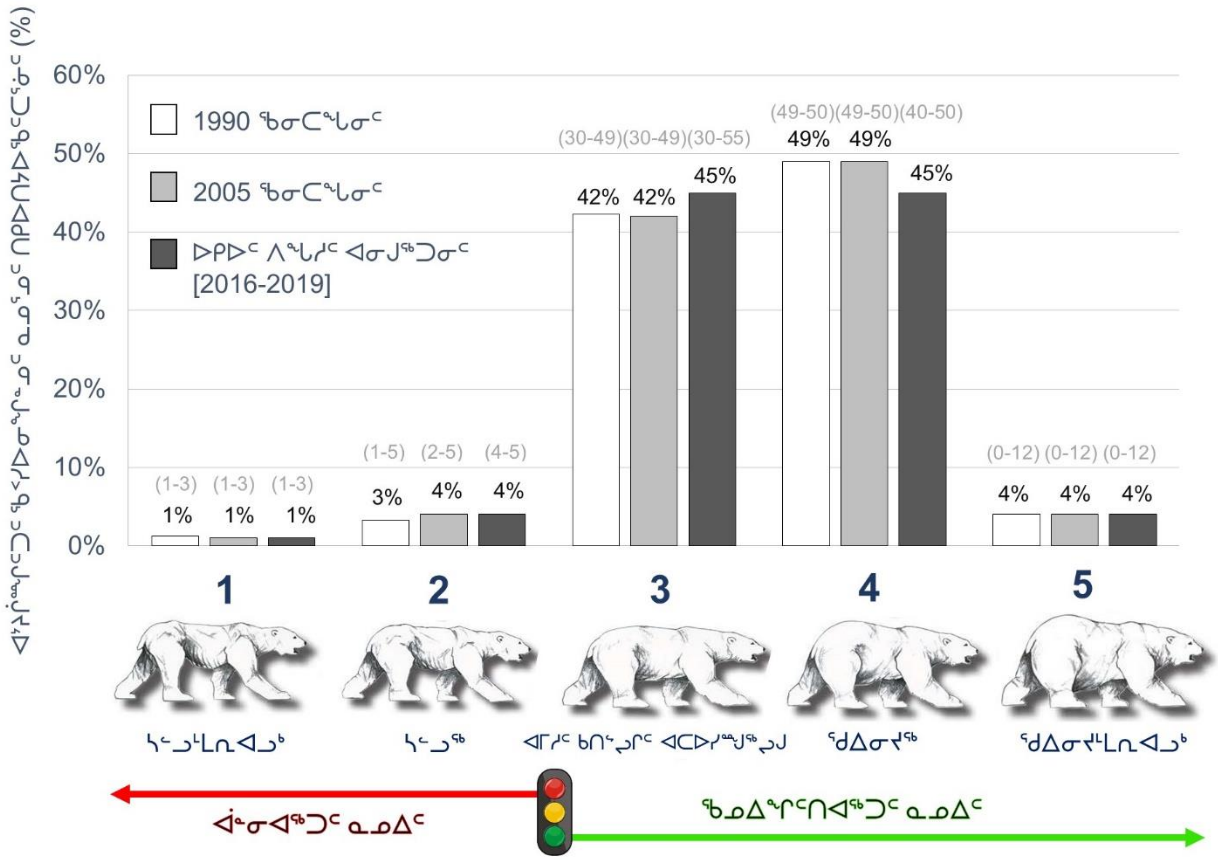
ᓇᑦᑎᕐᓂᑦ ᐊᒥᓲᔪᓐᓃᕐᓂᖅᓵᐅᔪᓂᒃ ᖃᐅᔨᓯᒪᒐᓗᐊᖅᑎᓪᓗᒋᑦ ᐊᒻᒪᓗ ᐊᓯᙳᕐᓂᕋᐃᑉᓗᑎᒃ ᓇᑦᑏᑦ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ, ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᐊᒥᓱᓂᒃ ᓂᕆᖃᑦᑕᖅᑐᑦ ᐊᒻᒪᓗ ᐊᔪᕆᑦᑐᙵᖅᑐᑦ ᐊᓯᐊᙳᖅᑐᓄᑦ ᓂᕆᔭᒃᓴᖏᑦ ᒪᓂᒪᓂᖏᓐᓄᑦ. ᐊᒥᓱᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐃᓱᒫᓘᑎᖃᙱᑦᑐᑦ ᓇᓄᐃᑦ ᐱᓇᓱᖕᓂᕆᔭᖏᓐᓄᑦ ᐱᔾᔪᑎᖃᖅᑐᓂᒃ ᓇᑦᑏᑦ ᒪᓂᒪᓂᖏᓐᓄᑦ. ᑭᓯᐊᓂ, ᓇᓗᓇᐃᖅᑕᐅᓚᐅᖅᑐᖅ ᓇᑦᑏᑦ - ᓇᓄᐃᑦ ᓂᕿᒋᔭᑐᐊᓇᒃᐸᒋᑦ ᐅᑭᐅᓗᒃᑖᕐᒥᑦ - ᐊᒥᓲᔪᓐᓃᖅᓯᒪᐃᓐᓇᖅᐸᑕ, ᓇᓄᐃᑦ ᐊᓯᐊᓄᐊᕈᓐᓇᕐᒥᔪᑦ ᓇᑦᑎᖅᑕᖃᕐᓂᖅᓵᐅᔪᒧᑦ ᐊᓯᖏᓐᓄᓪᓗ ᓂᕆᔭᒃᓴᖅᑕᖃᐅᕐᓂᓴᐅᔪᓄᑦ.

ᑎᒥᖏᑦ ᖃᓄᐃᓐᓂᖏᑦ ᐊᒻᒪᓗ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᖃᓄᐃᓐᓂᖏᑦ

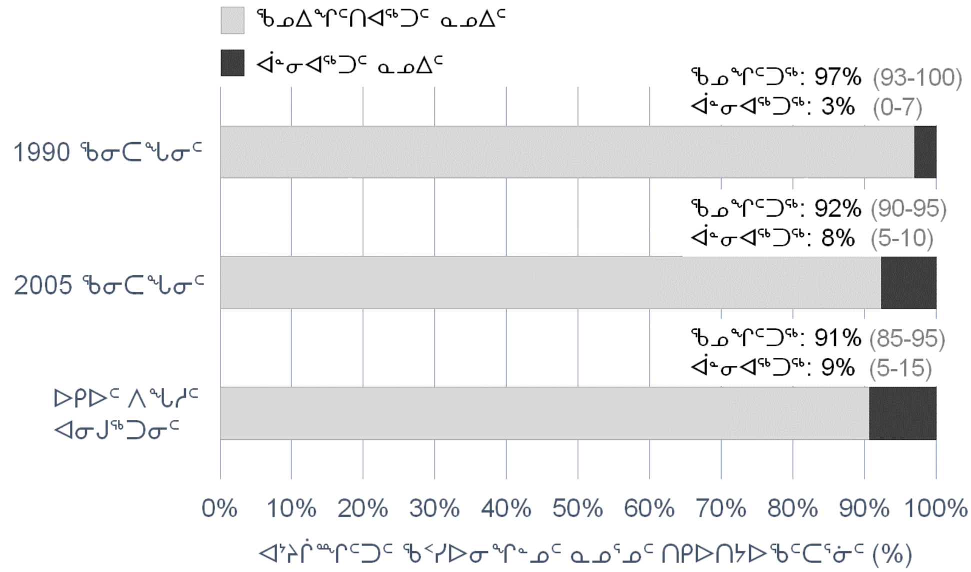
ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᑐᑭᓯᐅᒪᔾᔪᑎᓂᒃ ᑐᓂᓯᓚᐅᖅᑐᑦ ᓱᓇᓂᒃ ᕿᓂᕐᒪᖔᑕ (ᓇᓗᓇᐃᖅᓯᔾᔪᑎᓂᒃ) ᖃᐅᔨᓴᕐᓂᐊᕐᓗᒋᑦ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᑦ ᓇᓄᐃᑦ. ᓇᓄᕐᓄᑦ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᓇᓗᓇᐃᖅᓯᔾᔪᑎᓂᑦ ᐃᓚᐅᔪᑦ: ᓇᓅᑉ ᑎᒥᖓᑕ ᖃᓄᐃᓐᓂᖓ (ᖁᐃᓂᓂᖓ); ᐱᖅᑯᓯᖓ ᐊᒻᒪᓗ ᐊᐅᓚᓂᖓ; ᒥᖅᑯᖓᑕ ᑲᓚᖓ ᐊᒻᒪᓗ ᖃᓄᐃᓐᓂᖓ; ᓂᕿᖓᑕ ᐊᒻᒪᓗ ᐅᖅᓱᖓᑕ ᑲᓚᖓ, ᓇᐃᒪᑉᓗᒍ ᐊᒻᒪᓗ ᑎᐱᖓ; ᐊᕿᐊᕈᕐᒥᐅᑕᖏᑦ; ᑭᒍᑎᖏᑦ; ᐊᒻᒪᓗ ᐃᓗᓕᖏᑦ. ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐅᖃᖅᑎᓪᓗᒋᑦ ᖃᐅᔨᓴᐃᓂᖃᑦᑕᖅᑕᖏᓐᓂᑦ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᓐᓂᑦ ᓇᓄᐃᑦ ᐃᓗᐃᑦᑑᙵᔪᒃᑯᑦ, ᐊᑐᖅᓗᑎᒃ ᖃᑉᓯᐊᕐᔪᖕᓂᒃ ᓇᓗᓇᐃᖅᓯᔾᔪᑎᓂᒃ, ᐅᖃᓚᐅᕐᒥᔪᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᑦ (ᖁᐃᓂᓂᖓ) ᓇᓗᓇᐃᖅᓯᔾᔪᑕᐅᔪᖅ ᑕᑯᒃᓴᐅᑎᑦᑏᙳᓂᖓᓄ ᑕᒪᐃᓐᓄᑦ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᓇᓄᐃᑦ. ᐃᑲᔪᓚᐅᖅᑐᑦ ᖃᐅᔨᓴᐃᖃᑦᑕᖅᑐᑦ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᓐᓂᑦ ᓇᓄᐃᑦ ᑕᒪᐃᓐᓂᑦ ᓇᓐᓄᖅᓯᐅᖅᑎᓪᓗᒋᑦ (ᓄᓇᒥᑦ ᖃᐅᔨᓴᖅᓗᒋᑦ ᐆᒪᔪᑦ ᓇᓄᐃᑦ) ᐊᒻᒪᓗ ᓇᓐᓄᒃᑕᕆᔭᐅᖅᑳᖅᑎᓪᓗᒋᑦ (ᐱᓚᒃᑕᐅᑎᓪᓗᒍ, ᕿᓯᖓ ᐱᓕᕆᐊᖑᑎᓪᓗᒍ ᐊᒻᒪᓗ ᓂᕆᔭᐅᑎᓪᓗᒍ ᓇᓐᓄᒃᑕᐅᓯᒪᔪᑦ). ᖃᐅᔨᔪᒪᓇᖅᑐᖅ, ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐊᑐᖃᑦᑕᕐᓂᖏᓐᓂᒃ ᑕᐃᑲᙵᑦ ᐊᒻᒪᓗ ᑕᐃᑲᙵᐅᖏᑦᑐᖅ ᓇᓗᓇᐃᖅᓯᔾᔪᑎᓂᒃ ᓇᓄᐃᑦ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᓐᓂᒃ ᖃᐅᔾᔪᑎᓂᒃ, ᐱᓗᐊᖅᑐᒥᑦ ᖃᐅᔨᓂᐊᕐᓗᑎᒃ ᖁᐃᓂᓂᖏᓐᓂᒃ ᐊᑐᓂ ᓂᕐᔪᑏᑦ. ᐃᓚᖏᑦ ᓇᓗᓇᐃᖅᓯᔾᔪᑕᐅᔪᑦ (ᓱᕐᓗ, ᐊᖏᑎᒋᓂᖓ ᓂᕆᔭᖏᓐᓂᒃ ᓇᑦᑎᕐᓂᑦ) ᐊᑑᑎᖃᕐᓇᖅᑐᑦ ᖃᐅᔨᑎᑦᑎᕙᓕᕐᓂᕐᒧᑦ ᓇᓗᓇᐃᒃᑯᑕᓂᒃ ᐊᓯᐊᙳᕐᓂᐅᔪᓂᒃ ᐊᒥᓲᓂᕆᔭᖏᓐᓂᒃ ᓇᓄᐃᑦ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ. ᖃᐅᔨᓴᐃᓂᖅ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᖃᓄᐃᓐᓂᖓ ᓇᓄᐃᑦ ᐱᒻᒪᕆᐅᒋᔭᐅᔪᖅ ᐃᑲᔪᓚᐅᖅᑐᓄᑦ ᐊᑐᕐᒪᔾᔪᒃ ᓇᓄᖅᓯᐅᕐᓂᐊᕐᓗᒋᑦ ᐊᒻᒪᓗ ᓂᕆᔭᒃᓴᐅᖕᒪᖔᑦ. ᐊᒥᓱᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓐᓄᒍᒪᔪᑦ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᓐᓂᑦ ᖃᓄᐃᖏᓐᓂᖅᓵᐅᔪᓂᒃ ᐊᒻᒪᓗ ᓂᕆᓗᑎᒃ 'ᖃᓄᐃᖏᑦᑐᓂᒃ' ᓇᓄᕐᓂᑦ ᐱᑦᑕᐅᔪᒥᒃ ᓂᕿᖃᖅᑐᓂᒃ ᐊᒻᒪᓗ ᓇᓄᕋᖅᑐᓂᑦ.

ᐃᑲᔪᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᐅᖃᓚᐅᕐᒥᔪᑦ ᖃᐅᔨᔭᖏᓐᓂᒃ ᐅᑉᓗᒥᐅᔪᖅ ᐊᓯᐊᙳᕐᓂᐅᔪᓂᒃ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ ᐊᒻᒪᓗ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᖏᓐᓂᑦ. ᐊᑕᐅᓯᐅᑉᓗᒋᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᓂᒃ ᑭᒻᒥᕈᒻᒥᑦ, ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ ᖃᑉᓯᐊᕐᔪᖕᓂᒃ ᐃᓱᒪᒋᔭᖏᓐᓂᒃ ᐊᓯᐊᙳᕐᓂᐅᔪᓂᒃ ᓇᓄᐃᑦ ᖁᐃᓂᓂᖏᓐᓄᑦ (ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᑦ) ᖃᐅᔨᓴᐅᑎᓯᒪᔪᓂᒃ ᑕᐃᒪᙵᓂᒥᑦ. ᐊᒥᓲᓂᖅᓴᐃᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ ᖃᐅᔨᓯᒪᓕᕐᓂᐅᔪᒃ ᐊᒥᓲᓂᖅᓴᐃᑦ ᓇᓄᐃᑦ ᐅᕝᕙᓘᓐᓃᑦ ᑎᒥᖏᑦ ᐱᐅᓗᐊᕆᑦᑐᑦ ᑕᐅᑐᙳᕐᒥᓗᑎᒃ ᑕᐃᑉᓱᒪᓂᒥᑦ ᐅᕝᕙᓘᓐᓃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᑦ ᐱᑦᑕᐅᖏᓐᓂᖅᓵᓕᖅᑐᑦ ᑕᐃᒪᙵᓂᒥᑦ ᑭᒻᒥᕈᒻᒥᑦ ᖃᓂᑕᖓᓂᑦ, ᖃᑉᓯᐊᕐᔪᐃᑦ ᐅᖃᖅᑐᑦ ᖃᓄᐃᓐᓂᕆᓂᒃ ᓯᕐᑯᓯᐊᓗᐊᕐᒪᔾᔭᖅᓯᒪᖏᑦᑐᖅ ᐅᖅᑲᐅᓯᖏᓐᓂᒃ ᓇᓗᑦ ᐊᓯᐊᙳᖅᑐᓂᒃ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᑕᐃᒪᙵᓂᒥᑦ. ᑲᑎᕐᒪᔪᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᐊᖏᖃᑕᐅᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᑎᒥᖏᑦ ᖃᓄᐃᓐᓂᖏᑦ ᐱᐅᓗᐊᕐᓂᖅᓵᐅᓚᐅᖅᑐᑦ ᑭᒻᒥᕈᒻᒥᑦ ᖃᓂᑕᖓᓂᑦ (ᓯᕗᓪᓕᖅᐹᖅ ᖃᐅᔨᓴᐅᖅᑐᖅ 2005 ᖃᓂᑕᖓᓂᑦ), ᑕᒪᐃᓐᓃᖅᑲᔭᒃᑯᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᐅᖃᐅᓯᐅᔪᑦ ᑲᑎᕐᒪᔪᓂᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᓂᑦ ᒥᑭᔪᓂᕋᐃᓚᐅᖅᑐᑦ (ᐊᔾᔨ D). ᒥᑭᔪᖅ

ᐊᖏᔫᔪᒥᒃ ᐊᓯᐊᙳᕐᓂᐅᔪᖅ ᖃᐅᔨᓴᐅᔪᖅ ᐱᔾᔪᑕᐅᑐᐃᓐᓇᕆᐊᖃᖅᑐᖅ ᓇᓄᓇᕐᓂᖓᓄᑦ ᐊᒻᒪᓗ ᐊᖏᖃᑎᒌᙱᓐᓂᖏᓐᓄᑦ ᐊᑕᐅᓯᐅᕐᓗᑎᒃ ᐊᐱᖅᓱᖅᑕᐅᔪᓂᑦ. ᐱᒻᒪᕆᐅᔪᖅ, ᑲᑎᖕᒪᔪᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᓂᑦ ᐅᖃᖅᑐᑦ ᑕᒪᓐᓇᒃᑖᕐᓚᖓᒥᑦ ᓇᓄᐃᑦ ᖃᐅᔨᓴᐅᖃᑦᑕᖅᑐᑦ ᐅᐸᓗᒥᐅᔪᖅ 'ᐱᑦᑕᐅᔪᑦ' ᑎᒥᖓᑦᑕ ᖃᓄᐃᓐᓂᖓᑦ ᐊᒻᒪᓗ 'ᖃᓄᐃᖏᑦᑎᐊᖅᑐᑦ': 94% (ᐊᒥᓲᑎᓯᔪᑦ: 92-96, n=3) ᓇᓄᐃᑦ ᑕᑯᔭᐅᔪᑦ ᑲᑎᖕᒪᔪᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᓂᑦ 2016-2019 ᐅᑭᐅᓂᑦ ᖃᐅᔨᖃᑦᑕᖅᓯᒪᔭᖏᑦ 'ᖃᓄᐃᖏᑦᑎᐊᖅᑐᑦ' ᖁᐃᓂᖏᑦ ('ᐊᒥᓱᑦ ᐊᑕᐅᓯᙳᖅᓱᑎᑦ', 'ᖁᐃᓂᔪᖅ' ᐅᕝᕙᓘᓃᑦ 'ᖁᐃᓂᔫᒪᓇᐊᓗᒃ' ᑎᒥᖓᑕ ᖃᓄᐃᓐᓂᖓ) ᐊᒻᒪᓗ 91%-ᖑᔪᑦ (ᐊᒥᓲᑎᓯᔪᑦ: 85-95, n=3) ᓇᓄᐃᑦ ᖃᐅᔨᓴᐅᔪᑦ 2016-2019-ᒥᑦ ᐅᖃᐅᓯᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓅᖓᔪᒃᑯᑦ 'ᖃᓄᐃᖏᑦᑎᐊᖅᑐᑦ' (ᐊᔾᔨ D ᐊᒻᒪᓗ E). ᐊᒻᒪᓗᒃᑲᓂᖅ, ᑲᑎᖕᒪᔪᓂᑦ ᐊᐱᖅᓱᐃᓂᕐᒥᑦ ᓇᓄᓇᐃᖅᓯᓚᐅᖅᑐᑦ ᐊᔾᔨᒌᙱᑦᑐᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᓯᕐᖁᓯᐊᖏᑦᑐᑦ ᐅᕝᕙᓘᓃᑦ ᒥᒃᓯᑎᐊᖅᓯᒫᕐᔪᒃᑐᑦ ᑕᐃᒪᙵᓂᑦ 1990-ᖏᓐᓂᑦ (ᐊᔾᔨ D ᐊᒻᒪᓗ E).



ᑎᑎᖅᑐᖑᖅᓯᒪᔪᖅ D. ᐊᒥᓲᑎᓯᓂᖏᓐᓄᑦ ᓇᓄᐃᑦ ᑕᑯᔭᐅᓂᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓂᖏᓐᓄᑦ (ᐊᑕᐅᓯᕐᒥᑦ ᑖᓚᒪᓄᑦ ᐊᑐᖅᓱᒍ ᐋᖅᑭᒃᑕᐅᔪᖅ ᓯᑑᓕᖕ (Stirling) et al. 2008 – (ᐅᖃᓚᐆᒪᖅ)) ᐱᖓᓱᓂᑦ ᐅᐸᓗᖕᔪᐅᔪᑦ (1990-ᒧ, 2005-ᒧ ᖃᓂᑕᖓᓂᑦ, ᐊᒻᒪᓗ ᐱᖓᓱᐃᑦ ᐅᑭᐅᓂᑦ ᑭᖑᓪᓕᖅᐹᓂᑦ [2016-ᒥᑦ 2019-ᒧᑦ]) ᑭᒻᒥᕈᑦ ᖃᓂᑕᖓᓂᑦ. ᐳᓴᖑᑎᖏᑦ ᐱᔭᐅᓚᐅᖅᑐᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᑲᑎᖅᓯᒪᐃᓂᖃᖅᑎᓪᓗᒋᑦ ᐱᖓᓱᑦ ᑲᑎᖕᒪᔪᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᓂᑦ ᑭᒻᒥᕈᒻᒥᑦ (3; ᑲᑎᓪᓗᒋᑦ 8-ᖑᔪᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ). ᒥᑭᔪᐃᑦ ᓈᓴᐅᑏᑦ ᑕᐃᒪᐅᔪᑦ ᐊᑐᓂ ᐱᔾᔪᑕᐅᔪᑦ ᓈᓴᐅᑏᑦ ᑎᑭᐅᑎᓯᒪᓂᖏᓐᓄᑦ ᐊᕙᓗᓯᒪᐅᓗᑎᒃ ᓯᐊᕐᓇᕐᓚᖏᒥᑦ ᑲᓚᖏᒥᑦ. ᓇᓄᕐᓄᑦ ᐃᓂᓕᐊᖓᔪᑦ ᐊᒻᒪᓗ ᑎᑎᕋᐅᔭᖅᓯᒪᔪᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᑦᑑᓂᖏᓐᓄᑦ ᐱᔭᐅᓯᒪᔪᑦ ᓇᓄᐃᑦ ᑎᒥᖏᑦ ᖃᓄᐃᓂᖏᓐᓄᑦ ᐃᓂᓕᐅᖅᓯᒪᔪᑦ ᐊᓕᓚᔪᕐᒥᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᓄᓇᕗᒻᒥ ᒪᕿᒪᒃᑯᑦ, ᐊᕙᑎᓕᕆᔨᒃᑯᖏᓐᓄᑦ (ᐊᑐᖅᑕᐅᔪᖅ ᓄᓇᕐᔪᐊᕐᒥᑦ ᓂᕐᔪᑎᓄᑦ ᑮᓇᐅᔭᖅᑎᑦᑎᔨᓄᑦ ᐊᒻᒪᓗ ᓇᓄᐃᑦ ᓄᓇᕐᔪᐊᕐᒥᑦ). ᑲᑎᖕᒪᔪᓗᒃᑖᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᓂᑦ ᑭᒻᒥᕈᒻᒥᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᖃᐅᔨᓇᖅᑐᓂᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᑦ 1 ᐊᒻᒪᓗ 2 ᐃᓱᒪᒋᔭᐅᔪᑦ 'ᐋᓂᐊᖃᑕᐃᓚᒪᓂᖏᑦ ᓈᒻᒪᙱᑦᑐᑦ' ᐊᒻᒪᓗ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᑦ 3, 4 ᐊᒻᒪᓗ 5 'ᖃᓄᐃᖏᑦᑐᑦ' ᓇᓄᐃᑦ



ᑎᑎᖅᑐᒐᖅᓯᒪᔪᖅ E. ᖃᓂᒌᒃᑐᓄᑦ ᖃᐸᔨᐅᓂᖏᑦ 'ᖃᓄᐃᖏᑦᑐᑦ' ᑕᐅᑐᙵᖅᓗᒋᑦ 'ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᑦ ᓈᒻᒪᙱᑦᑐ' ᓇᓄᕐᐃᑦ ᑕᑯᔭᐅᓯᒪᔪᑦ ᑭᒥᕈᑦ ᖃᓂᑕᖓᓂᑦ ᐱᖓᓱᐃᑦ ᐅᑉᓗᓇᔭᐅᔪᓂᑦ (1990-ᓗ, 2005-ᓗ ᖃᓂᑕᖓᓂᑦ, ᐊᒻᒪᓗ ᐱᖓᓱᐃᑦ ᐅᑭᐅᓂᑦ ᑭᖑᓪᓕᖅᐸᓃᑦ [2016-ᒥᑦ 2019-ᒧᑦ]). ᐳᓴᓐᑎᖏᑦ ᐱᔭᐅᓚᐅᖅᑐᑦ ᖃᐸᔨᐅᓂᖏᓐᓄᑦ ᑲᑎᖅᓱᐃᓂᖃᖅᑎᓪᓗᒋᑦ ᐱᖓᓱᑦ ᑲᑎᕐᒪᔪᓂᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᓂᑦ ᑭᒥᕈᒥᑦ (3; ᑲᑎᕝᕙᒋᑦ 8-ᖑᔪᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ). ᐅᖃᓪᓗᓇᒃᓴᐅᑎᓂᒃᑯᑦ, ᐊᑐᓂ ᑲᑎᕐᒪᔪᑦ ᐊᖏᕈᑎᖃᓚᐅᖅᑐᑦ ᖃᓂᒌᒃᑐᑦ ᖃᐸᔨᐅᓂᖏᓐᓄᑦ 'ᖃᓄᐃᖏᑦᑐᑦ' ᑕᐅᑐᙵᖅᓗᒋᑦ 'ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᑦ ᓈᒻᒪᙱᑦᑐ' ᓇᓄᐃᑦ ᐊᑐᓂ ᐅᑉᓗᓇᔭᐅᔪᓂᑦ. ᒥᑭᔪᐃᑦ ᓈᓴᐅᑏᑦ ᑕᐃᒪᐅᔪᑦ ᐊᑐᓂ ᐱᑦᔪᑕᐅᔪᑦ ᓈᓴᐅᑏᑦ ᑎᑭᐅᑎᓯᒪᓂᖏᓐᓄᑦ ᐊᕙᓗᓯᒪᕐᓗᑎᒃ ᓯᐊᕐᓇᕐᓚᖏᑦ ᑲᓚᓕᖏᑦ.

ᐸᖓᓐᑑᕐᒥᑦ, ᐊᑕᐅᓯᐅᕐᓗᒋᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐊᔾᔨᕐᓚᖏᓐᓂᒃ ᑕᐅᑐᒐᐅᔪᓂᒃ ᐊᑕᐅᓯᐅᕐᓗᑎᒃ ᐊᐱᖅᓱᖅᑕᐅᔪᓂᑦ ᑭᒥᕈᒥᑦ. ᑕᒪᓗᒃᑖᕐᓚᒃ ᐊᑕᐅᓯᐅᕐᓗᒋᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᐅᖃᓚᐅᖅᑐᑦ ᑕᑯᓯᒪᔪᑦ ᐊᒥᓲᓂᖅᓴᓂᒃ ᐱᐅᓗᐊᖏᑦᑐᓂᒃ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ ᑕᐅᑐᙵᖅᓗᒋᑦ ᑕᐃᑉᓯᒪᓂᒥᑦ ᐅᕙᓘᓐᓂᑦ ᐱᑦᑕᐅᔭᓅᖅᐸᓪᓕᐊᓂᖏᑦ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᑦ ᐅᐸᓗᒥᒧᑦ ᑎᑭᕝᕙᒍ ᐸᖓᓐᑑᑉ ᖃᓂᑕᖓᓂᑦ, ᓇᓗᓇᙱᕝᕙᓂ ᐊᓯᐊᙳᖅᐸᓪᓕᐊᓂᖏᓐᓂᒃ 1980-ᖏᓐᓂᒃ ᐱᒋᐊᖅᕙᓂ ᑭᓯᐊᓂ ᑕᐃᒪᐅᓚᔪᖅᓂᖅᓴᐅᓕᖅᕙᑎᒃ ᖃᐅᔨᔭᐅᔪᑦ ᐱᒋᐊᖅᕙᓂ 2000-ᖏᑦ ᓄᖑᐸᓪᓕᐊᓕᖅᑎᓪᓗᒋᑦ. ᑭᓯᐊᓂ, ᐊᔾᔨᕐᓚᖓ ᑭᒥᕈᒧᑦ, ᐃᓚᖏᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᑕᐅᑐᒐᐅᔪᑦ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ ᓱᕐᑯᓯᐊᓗᐊᖅᓯᒪᙱᑦᑐᑦ ᐅᕙᓘᓐᓃᑦ ᓇᓗᓇᖅᑐᖅ ᐊᓯᐊᙳᖅᓯᒪᓂᖃᕐᒪᖔᑕ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ ᓖᓐᓇᒧᑦ ᑎᑭᕝᕙᒍ ᑕᐃᑉᓯᒪᓂᒥᑦ. ᐃᑲᔪᖃᑕᐅᓚᐅᖅᑐᓂᑦ ᖃᐅᔨᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ, ᐅᖃᓚᐅᖅᑐᑦ ᐊᒥᓱᑦ ᖃᓄᐃᖏᑦᑐᑦ ᐊᒻᒪᓗ ᐅᖅᓱᓇᒃᑐᑦ ᓇᓄᐃᑦ ᖃᐅᔨᔭᐅᖃᑦᑕᖅᓯᒪᔪᑦ ᐅᑉᓗᒥᐅᔪᖅ. ᐅᖃᐅᓯᖃᖅᑎᓪᓗᒋᑦ ᑕᒪᐃᓐᓄᑦ ᓇᓄᐃᑦ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓂᑦ (ᐃᓱᒪᒋᐸᓗᒋᑦ ᓇᓄᐃᑦ ᖁᐃᓂᓂᖏᑦ ᐃᓚᐅᐸᓗᑎᒃ ᐊᓯᖏᑦ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᖃᐅᔾᔪᑏᑦ), ᑕᑦᑕᒪᐃᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᖃᐅᔨᔭᐅᔪᑦ ᐸᖓᓐᑑᑉ ᖃᓂᑕᖓᓂᑦ 'ᖃᓄᐃᖏᑦᑐᑦ' ᐊᒻᒪᓗ ᐱᖓᓱᑦ ᐅᖃᖅᕙᑎᒃ ᓇᓄᐃᑦ ᖃᓄᐃᖏᓐᓂᕆᓚᐅᖅᑕᖏᑦ ᐱᐅᖏᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᑕᐃᑉᓯᒪᓂᒥᐅᖓᓂᑦ. ᐱᔭᐅᔪᓂᒃ ᐊᐱᖅᓱᖅᑕᐅᔪᓂᑦ ᐊᑕᐅᓯᐅᕐᓗᒋᑦ, ᐅᒃᐱᕆᔅᑐᒍᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᑕᒪᐃᓐᓅᖓᔪᒃᑯᑦ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᐸᖓᓐᑑᑉ ᖃᓂᑕᖓᓂᑦ ᐊᔾᔨᕐᓚᖓᓂᒃ ᖃᓄᐃᓕᐅᖅᐸᓪᓕᐊᓂᖃᑐᐃᓇᓈᖅᑐᑦ ᖃᐅᔨᔭᐅᔪᒥᒃ ᑭᒥᕈᒥᑦ. ᐊᐱᖅᓱᐃᓂᖅᑎᓪᓗᒋᑦ, ᐱᐅᓗᐊᖏᓕᕐᓂᖏᑦ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᑕᒪᐃᓐᓅᖓᔪᒃᑯᑦ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᖃᐅᔨᔭᐅᖃᑦᑕᓕᓴᓚᐅᖅᑐᖅ ᐃᓚᖏᓐᓄᑦ ᐃᑲᔪᓚᐅᖅᑐᓄᑦ. ᑭᓯᐊᓂ, ᐊᖏᑎᒋᓂᖓ ᐱᐅᓗᐊᕈᓐᓃᖅᓯᒪᓂᐅᑉ ᐊᖏᔫᙱᑦᑐᖓᖅᑐᖅ ᖃᐅᔨᔭᐅᔪᑦ ᑕᐃᒪᓐᓄᓗᒃᑖᖑᓚᐅᖏᒪᑦ. ᑲᑎᕐᒪᔪᓂᒃ ᐊᐱᖅᓱᐃᓂᖅᑕᖃᓇᐊᖅᖃᖅᑐᖅ

ᓇᓗᓇᐃᕐᓂᐊᕐᓗᒋᑦ ᑕᒪᒃᑯᐊ ᓇᓗᓇᕐᓂᐅᔪᑦ, ᐃᓚᐅᓗᑎᒃ ᖃᐅᔨᓗᒍ ᐊᖏᑎᒋᓂᖓ ᐊᓯᐊᙵᕐᓂᐅᔫᑉ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐋᓐᓂᐊᖅᑕᐃᓕᒪᓂᕆᔭᖏᓐᓄᑦ ᐸᖕᓂᖅᑑᑉ ᖃᓂᑕᖓᓂᑦ.

ᐃᓚᐅᖃᑕᐅᔪᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᖃᐅᔨᓯᒪᔪᑦ ᐱᐅᔪᖅᓅᖅᓯᒪᓂᖏᓐᓂᒃ ᓇᓄᐃᑦ ᖁᐃᓂᓂᖏᓐᓂᒃ ᐅᑉᓗᒥᒧᑦ ᑎᑭᕝᓗᒍ ᐱᔾᔪᑎᖃᓗᐊᖅᑐᖅ ᐊᓯᐊᙵᕐᓂᖏᓐᓄᑦ ᐅᑯᐊ: ᐊᒥᓱᙵᕐᓂᖏᓐᓄᑦ ᓇᓄᐃᑦ ᐃᓚᐅᑉᓗᓂ ᓇᑦᑎᖅᑕᖃᓗᐊᖏᓐᓂᖅᓴᐅᓕᕐᓂᖓ ᐱᔾᔪᑕᐅᑉᓗᓂ ᐱᒡᒎᖅᓂᖏᑦ ᓂᕆᔭᒃᓴᖅᓯᐅᖅᑕᐅᔪᓄᑦ; ᐊᒻᒪᓗ ᐊᓯᐊᙵᖅᑐᑦ ᑕᑭᐅᑉ ᓯᑭᖑᓐᓄᑦ ᓇᓄᐃᑦ ᓇᑦᑎᕐᓄᐊᕐᓂᖅ ᐊᔪᓕᕐᓂᖅᓴᐅᓂᖏᓐᓄᑦ.

ᑐᖁᔪᑦ, ᐋᓂᐊᖅᑐᑦ ᐊᒻᒪᓗ ᐊᔾᔨᐅᖏᑦᑐᑦ ᐋᖅᑭᐅᒪᓂᖃᙱᑦᑐᓄᑦ

ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᐅᓯᖃᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᒪᖃᐃᑕᐅᖏᕝᓗᑎᒃ ᑐᖁᔪᓂᒃ, ᐋᓂᐊᕐᓂᕐᒧᑦ ᐊᒻᒪᓗ ᐊᓯᖏᓐᓄᑦ ᐊᔾᔨᐅᖏᑦᑐᑦ ᐋᖅᑭᐅᒪᙱᑦᑐᑦ. ᑕᒪᐃᓅᖓᔪᒃᑯᑦ, ᐃᑲᔪᓚᐅᖅᑐᑦ ᐃᓱᒪᒋᔭᖏᑦ ᐱᑕᖃᔪᙱᓐᓂᖏᓐᓄᑦ ᐅᕝᕙᓘᓐᓃᑦ ᑕᐃᒪᓐᓇᐃᓚᔪᙱᑦᑐᑦ ᐊᒻᒪᓗ ᓇᓗᓇᐃᔭᖅᓯᒪᔪᓂᒃ ᖃᐅᔨᔭᐅᔪᓂᒃ ᑐᓂᓯᔪᒪᒡᓗᑎᒃ ᑕᑯᓯᒪᔭᖏᓐᓂᑦ, ᐃᓚᐅᔪᑦ ᓇᓂ, ᖃᖓ ᐊᒻᒪᓗ ᖃᓄᐃᑦᑑᓂᖏᑦ ᓂᕐᔪᑏᑦ ᐃᓚᐅᔪᑦ.

ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ, ᖃᐅᔨᔭᐅᔪᑦ ᓇᓄᐃᑦ ᑐᖁᓯᒪᔪᓂᒃ ᐱᕐᓕᕐᓂᕐᒧᑦ ᐅᕙᓘᓐᓃᑦ ᐊᓯᖏᓐᓄᑦ ᐃᒥᖏᓐᓂᒃ ᐱᔪᓂᒃ ᐱᑕᖃᕋᔪᙱᓐᓂᖁᐃᓚᐅᖅᑐᑦ. ᑐᖁᔪᑦ ᐋᓂᐊᕐᓂᖅᑖᖅᑐᕐᓂᖏᓐᓄᑦ ᐅᖃᐅᓯᐅᓚᐅᖏᑦᑐᑦ. ᐃᒪᓐᓇᐃᑦᑐᖅ, ᑕᒪᓗᒃᑖᕐᓚᒃ ᐃᓚᐅᖃᑕᐅᔪᑦ ᓇᖏᓂᖅ ᖃᐅᔨᓚᐅᖅᓯᒪᙱᑦᑐᑦ ᑐᖁᖓᔪᓂᒃ ᐊᓯᐊᑕ ᒪᖃᐃᑕᐅᖏᕝᓗᑎᒃ ᑐᖁᑕᐅᔪᓂᒃ. ᐃᑲᔪᓚᐅᖅᑐᑦ ᐃᖅᑲᐅᒪᔪᑦ ᑕᑯᓯᒪᔭᖏᓐᓂᑦ ᓴᓗᒻᒪᓇᐊᓗᖏᑦ ᐅᕙᓘᓐᓃᑦ ᐱᕐᓕᓕᖅᑐᓂᒃ ᓇᓄᕐᓂᑦ ᐅᖃᓚᐅᖅᑐᑦ ᑕᐃᒪᓐᓇᐃᑦᑐᓂᒃ ᑕᑯᔪᙱᑦᑐᑦ.

ᐊᔾᔨᕐᓚᖓ, ᓇᓗᓇᐃᖅᑐᑦ ᐋᓂᐊᕆᔭᖏᑦ ᐊᒻᒪᓗ ᐊᓂᐊᕐᓃᑦ ᐅᕙᓘᓐᓃᑦ ᓇᓗᓇᙱᑦᑐᑦ ᐋᖅᑭᐅᒪᙱᓐᓂᖅᑐᑦ ᑕᑯᔭᐅᓚᙱᑦᑐᑦ ᓇᓄᕐᓂᑦ. ᐃᑲᔪᖅᑐᑦ ᖃᐅᑎᒃᑯᑦ ᐅᖃᖃᑦᑕᓚᐅᖅᑐᑦ ᐋᓂᐊᕐᓂᕆᔭᐅᔪᓂᒃ ᐃᓚᐅᑉᓗᑎᒃ: ᒥᖅᖁᖃᙱᓐᓃᑦ; ᑐᖑᔪᖅᑐᓂᒃ ᓯᑎᔪᐃᑦ ᐅᖅᓱᖓᓂᑦ ᐊᒻᒪᓗ ᓂᕿᖓᓂᑦ; ᖃᑯᖅᑐᖃᐅᖅᑐᑦ ᑎᖑᖏᓐᓂᑦ; ᑲᔪᖅᑐᖃᐅᖅᑐᑦ ᐅᖅᓱᖏᓐᓂᑦ; ᕿᓯᖓᓂᑦ ᑕᖅᓴᖃᐅᖅᑐᑦ; ᓇᑉᒍᐊᖏᑦ ᐳᕕᑦᑐᑦ ᐊᒻᒪᓗ ᑐᓯᐊᑦᑐᑦ ᐅᕙᓘᓐᓃᑦ ᓇᓕᖏᑦ ᓂᐅᖃᙱᑦᑐᑦ ᓇᓄᐃᑦ. ᖃᐅᔨᓯᒪᓇᖅᑐᖅ, ᑕᑯᔭᐅᔪᑦ ᓇᓄᐃᑦ ᒥᖅᖁᖃᙱᓐᓂᖃᖅᑐᑎᒃ, ᖁᖓᓯᓂᖏᑦᑕ ᐃᓂᖓᓂᐅᓗᐊᖃᑦᑕᓚᐅᖅᑐᑦ, ᒫᓇᕌᓚᐅᕐᓗᓂ ᑭᒥᕈᑦ ᖃᓂᑕᖓᓂᑦ, ᐱᒋᐊᖅᑐᓂ 2007-ᒥᑦ. ᐸᖕᓂᖅᑑᑉ ᖃᓂᑕᖓᓂᑦ, ᐊᔾᔨᕐᓚᖏᓐᓂᒃ ᑭᓚᖅᑐᑦ ᑕᑯᔮᓚᐅᖅᑐᑦ ᒪᕿᐃᖅᑕᖅᑐᑎᒃ 1980-ᖏᓐᓂᑦ ᐊᒻᒪᓗ 1990-ᖏᓐᓂᑦ, ᐊᒻᒪᓗ ᓇᓄᐃᑦ ᒥᖅᖁᖃᙱᓐᓂᖃᖅᑐᑦ ᖁᖓᓯᓂᖏᑦᑕ ᖃᓂᑕᖓᓂᑦ ᑕᑯᔮᖃᑦᑕᓚᐅᕐᒥᔪᑦ ᒫᓇᕌᓚᐅᓚᐅᖅᑐᒥᑦ 2015-ᒥᑦ. ᖃᐅᔨᔭᐅᓯᒪᔪᑦ ᖃᐅᔨᒃᑰᖃᑦᑕᕋᓗᐊᖅᑎᓗᒋᑦ, ᑕᒪᐃᓐᓂᑦ ᐊᕐᓇᓗᐃᑦ, ᐊᖑᓴᓗᐃᑦ, ᐃᓇᐃᑦ ᐊᒻᒪᓗ ᐃᓇᕈᕆᕞᖅᑐᑦ ᓇᓄᐃᑦ ᖃᐅᔨᔭᐅᖃᑦᑕᖅᓯᒪᔪᑦ ᒥᖅᖁᖃᙱᓐᓂᖃᕐᓂᖏᓐᓄᑦ. ᐃᓚᖏᓐᓂᑦ, ᒥᖅᖁᐃᕈᑎᓯᒪᓂᖅ ᐱᔾᔪᑎᖃᖃᑦᑕᓚᐅᖅᑐᖅ ᑎᒥᖏᑦ ᐱᐅᓗᐊᖏᓐᓂᖏᓐᓄᑦ, ᑭᓯᐊᓂ ᑕᐃᒪᓐᓇᐃᖏᓐᓇᖃᑦᑕᙱᓐᓂ. ᑭᖑᓪᓕᖅᐸᕐᒌᖅ, ᖁᐱᕈᓕᖕᓂᒃ ᓇᓄᕋᕐᓂᑦ ᐅᖃᖅᑐᖃᓚᐅᖏᑦᑐᖅ.

ᐅᖃᐅᓯᖃᖁᔭᐅᖓᑕ ᐊᔾᔨᐅᖏᑦᑐᓂᒃ ᑕᑯᓯᒪᔾᔨᓂᑦ, ᐃᓚᖏᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᐅᓯᖃᓚᐅᕐᒥᔪᑦ ᑭᓚᖅᑐᓂᒃ, ᕿᑦᑐᖅᓂᖃᖅᑐᓂᒃ ᐊᒻᒪᓗ ᑭᓚᖅᑐᓂᒃ ᐅᓇᑕᖃᑎᖃᕐᓗᑎᒃ ᐊᓯᖏᓐᓂᑦ ᓇᓄᕐᓂᑦ, ᓂᕆᔭᒃᓴᖅᓯᐅᕐᓗᑎᒃ ᐋᓐᓂᕐᓂᑯᖏᓐᓂᑦ ᐊᒻᒪᓗ ᓯᑯᒧᑦ ᐱᔪᓂᒃ. ᐊᓯᖏᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᖅᓯᐅᕐᓗᑎᒃ ᓇᓄᐃᑦ ᒥᖑᐊᖅᑕᐅᓯᒪᔪᑦ ᖃᓂᖓᒍᑦ ᐊᒻᒪᓗ ᓯᐅᑎᖏᑦ ᐃᓕᓯᕚᐅᓯᒪᔪᑦ ᐊᔾᔨᐅᖏᑦᑑᓂᕋᕐᓗᒋᑦ. ᑭᒻᒥᕐᒥᑦ, ᐊᑕᐅᓯᖅ ᐱᖃᑕᐅᓚᐅᖅᑐᖅ ᖃᐅᔨᓚᐅᖅᑐᖅ ᓇᓄᖅ ᐃᓚᖓᓂᒃ ᖃᑯᖅᑐᓂ ᐊᒻᒪᓗ ᕿᕐᓂᖅᑐᓂ ᒥᖅᑯᖓ, ᓇᓄᕐᓗ ᐊᓯᖓᓗ ᓂᕐᔪᑎᐅᓂᕋᖅᑕᐅᔪᖅ.

ᐃᓄᐃᑦᓗ ᓇᓄᐃᑦᓗ ᑎᑭᐅᑎᔾᔪᑎᖃᑦᑕᕐᓂᖏᑦ

ᐊᒥᓱᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᑭᒻᒥᕐᒥᑦ ᐊᒻᒪᓗ ᐸᖕᓂᖅᑑᕐᒥᑦ ᐅᖃᐅᓯᖃᓚᐅᖅᑐᑦ ᐃᓄᐃᑦᓗ ᓇᓄᐃᑦᓗ ᑎᑭᐅᑎᔾᔪᑎᖃᑦᑕᕐᓂᖏᓐᓂᑦ. ᓇᓗᓇᐃᓚᐅᖅᑐᑦ ᐱᖓᓱᓂᒃ ᐱᔾᔪᑕᐅᓗᐊᖅᑐᓂᒃ ᓱᒃ ᐃᓄᐃᑦᓗ ᓇᓄᐃᑦᓗ ᑎᑭᐅᑎᔾᔪᑎᖃᑦᑕᕐᓂᖅᓴᐅᓕᕐᒪᖔᑕ ᐅᑭᐅᓕᓴᐅᓕᖅᑐᓂᑦ: ᐊᒥᓱᙵᕐᓂᖏᓐᓄᑦ ᓇᓄᐃᑦ; ᐅᖓᓯᖕᓂᖅᓴᓄᑦ

ᓄᓇᓕᖕᒥᐅᑕᐃᑦ ᐃᖏᕐᕿᔭᖃᑦᑕᓕᕐᓂᖏᓐᓄᑦ ᐅᐸᓗᒥᐅᔪᖅ ᓇᓄᕐᓂᒃ ᑕᑯᔪᖕᓇᕐᓂᖅᓵᓕᖅᓱᑎᒃ; ᐊᒻᒪᓗ ᐊᑐᖅᑕᐅᓂᖅᓵᓕᕐᓂᖏᓐᓄᑦ ᓯᓭᐃᑦ (ᓄᓇᓕᖕᓂᑦ) ᓇᓄᕐᓄᑦ ᐊᓯᐊᙳᖅᐸᓪᓕᐊᓂᖖᒍᓄᑦ ᑕᕆᐅᕐᒥᑦ ᓯᑯᖖ. ᖃᐸᓯᐊᕐᔪᐃᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᐅᖃᓚᐅᕐᒥᔪᑦ ᓇᓄᐃᑦ ᐅᐸᓗᒥᐅᓕᖅᑐᖅ ᑲᐸᐊᓱᙱᓐᓂᖅᓵᐅᖃᑦᑕᓕᖅᑐᑦ ᐊᒻᒪᓗ ᐃᓄᖕᓄᑦ ᐃᖅᓴᕐᓂᖅᓵᐅᓕᖅᓱᑎᒃ ᑕᐃᐸᓱᒪᓂᒥᐅᓂᖖᓂᑦ, ᐊᒻᒪᓗ ᐅᖃᖅᓱᑎᒃ ᐃᒡᓗᕐᔪᐊᕿᓵᓂᒃ ᓯᕐᑯᐸᑎᓇᖃᑦᑕᕐᓂᖅᓵᐅᓕᖅᑐᑦ, ᐱᕈᔭᕐᓂᑦ ᐊᒻᒪᓗ ᐱᕐᑯᑎᒋᔭᐅᔪᓂᒃ ᓱᕿᒃᑕᐅᔪᑦ ᓇᓄᕐᓄᑦ.

ᐱᓪᒪᕆᐅᐸᓗᓂ, ᑕᒪᕐᒥᓗᒃᑖᖅ ᐊᑕᐅᓯᐅᐸᓗᑎᒃ ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ (27) ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐃᓱᒫᓘᑎᒋᔭᕆᓐᓂᑦ ᐃᓄᓗᒃᑖᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᓐᓂᖏᓐᓄᑦ ᐃᓄᐃᑦ ᐃᖅᓯᓇᖅᑐᓄᑦ ᓇᓄᕐᓄᑦ ᑎᑭᐅᑎᖃᑦᑕᕐᓂᖅᓵᓕᕐᓂᖏᓐᓄᑦ. ᐊᒥᓱᑦ ᐃᓱᒪᕆᔭᖏᓐᓂᒃ ᑐᓂᓯᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᐃᓄᓗᒃᑖᓄᑦ ᐅᓗᕆᐊᓇᕐᓂᖅᓵᓕᕐᒪᑕ ᐅᐸᓗᒥᐅᔪᖅ ᑕᐃᐸᓱᒪᓂᒥᐅᖖᓂᑦ ᐊᒻᒪᓗ ᖃᐅᔨᑎᑦᑎᐸᓗᑎᒃ ᑎᑭᐅᑎᔾᔪᑎᖃᑦᑕᕐᓂᖅᓵᓕᖅᑐᑦ ᐃᓄᐃᑦ ᐊᒻᒪᓗ ᓇᓄᐃᑦ. ᓇᓄᐃᑦ ᑐᖁᑕᐅᔪᑦ ᐃᓅᓯᕐᒥᒃ ᒥᐊᓂᖅᓯᓂᖅ ᐱᔾᔪᑎᒋᐸᓗᒍ ᐅᖃᐅᓯᐅᓚᐅᖅᑐᑦ ᑕᐃᒪᓐᓇᐃᖃᑦᑕᓖᕐᓂᖖᓄᑦ ᑕᒪᐃᓐᓂᑦ ᐸᖕᓂᖅᑑᕐᒥᑦ ᐊᒻᒪᓗ ᑭᒻᒥᒃᑭᒻᒥᑦ.

ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᐅᓯᖃᓚᐅᕐᒥᔪᑦ ᐸᖕᓂᖅᑑᕐᒥᐅᑕᐃᑦ ᐊᒻᒪᓗ ᑭᒻᒥᒃᑭᒻᒥᐅᑕᐃᑦ ᖃᐅᔨᕙᓪᓕᐊᔪᑦ ᐊᑐᕈᖕᓇᖅᑕᖏᓐᓂᒃ ᓇᓄᖅᑕᖃᓕᖅᐸᑦ ᖃᓄᖅᑑᕈᑕᐅᔪᓂᒃ ᐅᓗᕆᐊᓇᖅᑐᖃᙱᓐᓂᖅᓵᐅᓂᐊᕐᓗᓂ ᓇᓄᕐᓄᑦ ᐊᒻᒪᓗ ᓯᕐᑯᐸᑎᓇᓂᖅᑕᖃᙱᓐᓂᖅᓵᐅᓗᓂ ᐱᕐᑯᑎᒋᔭᐅᔪᓄᑦ. ᐃᓚᖓᑦ ᐅᖃᓚᐅᖅᑐᑦ, ᐱᒋᐊᖅᓱᓂ 2000 ᖃᓂᖓᓂᑦ, ᓄᓇᓕᖕᒥᐅᑕᐃᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᐊᑐᖃᑦᑕᖖᓕᓚᐅᖅᑐᑦ ᐃᒡᓗᕐᔪᐊᕿᓵᓂᑦ ᑐᐱᕐᓂᒃ ᐊᑐᖃᑦᑕᕈᖕᓅᖅᓱᑎᒃ ᓄᓇᐃᑦ ᐱᔾᔪᑎᒋᐸᓗᒋᑦ ᑕᖖᓚᕆᐊᖅᑐᕌᖖᒥᒃ. ᐃᓚᖓᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐱᓪᒪᕆᐅᓂᖖ ᐃᓕᓐᓂᐊᖅᑎᓪᓗᒋᑦ ᒪᒃᑯᒃᑐᐃᑦ ᖃᓄᐃᓕᐅᕆᐊᖃᕐᓂᕐᒧᑦ ᐅᓗᕆᐊᓇᙱᑦᑐᒃᑯᑦ ᓇᓄᕐᓄᑦ.

ᓯᕗᓂᒃᓴᖏᑦ ᓇᓄᐃᑦ

ᐊᒥᓱᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᓇᓗᓇᐃᓚᐅᖅᑐᑦ ᐊᔪᕐᓇᕐᓂᖖᓄᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐅᖃᕈᖕᓇᓚᐅᖏᑦᑐᑦ ᓯᕗᓂᒃᓴᖏᓐᓂᑦ ᓇᓄᐃᑦ ᐅᖃᖅᓱᑎᒃ ᑭᓇᑐᐃᓐᓇᕐᒧᑦ ᖃᐅᔨᒪᔭᐅᖏᑦᑐᖅ ᓯᕗᓂᒃᓴᕗᑦ. ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᐅᓯᖅᑐᑦ ᖃᓄᖅ ᓯᕗᓂᒃᓴᖅ ᑕᐅᑦᑐᖃᕿᔭᕐᒪᖖᓖᑦ ᓇᓄᕐᓄᑦ ᐱᔾᔪᑎᖃᓗᐊᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᐊᔪᓇᑦᑐᖕᓇᕐᓂᖏᓐᓂᒃ ᐊᓯᐊᙳᖅᐸᓪᓕᐊᔪᖅ ᐊᕗᑎᕗᑦ ᓯᓚᐅᐸ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖖᓄᑦ. ᑭᓯᐊᓂ, ᐊᑕᐅᓯᖅ ᐱᖃᑕᐅᓚᐅᖅᑐᖅ ᐅᖃᓚᐅᖅᑐᖅ ᓇᓄᐃᑦ ᐊᔪᓇᑦᑐᖕᓇᑦᑎᐊᖅᑎᓪᓗᒋᑦ, ᐊᔪᕐᓇᖅᑐᒃᑯᕈᖕᓇᖅᑐᑦ ᓯᑎᒋᓂᐊᖅᑕᖕᒋᓐᓂᒃ ᐃᓂᒥᒃ ᓇᓂᓯᓂᐊᕐᓗᑎᒃ ᐊᐳᑎᖃᓗᐊᕈᖕᓅᖅᐸᓪᓕᐊᖏᓐᓇᖅᐸᑦ. ᐊᓯᖓ ᐅᖃᖅᓱᓂ ᓇᓄᐃᑦ ᖅᑭᓯᖏᑦ ᓇᓄᕋᐃᑦ ᖃᓄᐃᓐᓂᖏᑦ ᐊᒃᑐᖅᑕᐅᔪᖕᓇᖅᑐᑦ ᓯᕗᓂᒃᓴᒥᑦ ᐊᓯᐊᙳᖅᐸᓪᓕᐊᓂᖖᓄᑦ ᑕᕆᐅᐸ ᓯᑯᖖ. ᐃᓚᖓᑦ ᐃᓱᒪᒋᔭᕐᒥᖕᓂᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐊᒥᓯᙳᖅᐸᓪᓕᐊᖏᓐᓇᖅᐸᑕ ᓇᓄᐃᑦ ᐅᓗᕆᐊᓇᖅᓯᕙᓪᓕᐊᖏᓐᓇᕐᓂᐊᖅᑐᖅ ᓄᓇᓕᖕᒥᐅᓄᑦ. ᖃᐸᓯᐊᕐᔪᐃᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐱᓪᒪᕆᐅᓂᖖᓄᑦ ᐊᒥᓃᓐᓂᖏᑦ ᖃᓄᐃᖏᑦᑐᑦ ᓇᓄᐃᑦ ᓯᕗᓂᒃᓴᐸᑎᖖᓂᑦ ᐊᒻᒪᓗ ᐊᑐᕐᓗᒋᑦ ᐃᓄᐃᑦ ᐱᖅᑯᓯᖏᑦ.

ᐊᐅᓚᑦᑎᓂᖅ ᐊᒻᒪᓗ ᑲᒪᔪᖃᕐᓂᖅ

ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐃᓱᒪᒋᔭᕐᒥᖕᓂᒃ ᑐᓂᓯᓚᐅᖅᑐᑦ ᐊᒻᒪᓗ ᐃᓱᒫᓘᑎᒋᔭᖏᓐᓂᒃ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ ᐊᐅᓚᑦᑎᓂᕐᒥᒃ ᐊᒻᒪᓗ ᑲᒪᔭᖃᕐᓂᕐᒥᒃ. ᖃᐅᔨᑎᑦᑎᐸᓗᑎᒡᓗ ᐃᓱᒪᒋᔭᖏᓐᓂᑦ ᑕᐃᒪᐅᔪᓂᒃ ᑐᓴᐅᒪᑎᑦᑎᓂᐅᔪᓂᒃ ᓇᓄᕐᓂᒃ ᖃᐅᔨᓴᐃᔨᓂᑦ ᐊᒻᒪᓗ ᓄᓇᕗᒻᒥᐅᓂᑦ, ᐊᒻᒪᓗ ᐱᐅᓯᕆᐊᖅᓯᔾᔭᑕᐅᔪᖕᓇᖅᑐᓂᒃ ᖃᐅᔨᒪᓂᕆᔭᐅᔪᓂᒃ ᑐᓂᓯᖃᑦᑕᕐᓂᐅᔪᓂᒃ ᐊᑐᕐᓗᒍᓗ ᑕᑎᒋᔭᐅᓂᕐᒧᑦ ᐱᕈᐃᑎᑦᑎᓂᕐᒥᒃ ᓄᓇᕗᒻᒥᐅᓄᑦ, ᓇᓄᕐᓂᑦ ᖃᐅᔨᓴᐃᔨᓄᑦ ᐊᒻᒪᓗ ᓂᕐᔪᑎᓂᒃ ᐊᐅᓚᑦᑎᔨᓄᑦ.

ᐃᓄᓗᒃᑖᑦ ᐅᓗᕆᐊᓇᖅᑑᑎᖏᓐᓂᕐᒧᑦ ᐃᓱᒫᓗᑏᑦ

ᐃᓱᒫᓗᑕᐅᔪᑦ ᐃᓄᓗᒃᑖᑦ ᐅᓗᕆᐊᓇᖅᑑᑎᙱᓐᓂᕐᒧᑦ ᓴᖅᑭᑎᑕᐅᑎᐊᓚᐅᖅᑐᖅ ᐊᐱᖅᓱᐃᓂᖃᖅᑎᓗᒋᑦ. ᐅᖃᐅᓯᖃᕐᑯᔭᐅᖕᒪᑕ ᐃᓱᒫᓗᑎᒋᔭᕆᓐᓂᑦ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ, ᐊᑕᐅᓯᐅᐸᓗᒋᑦ ᐊᐱᖅᓱᖅᑕᐅᔪᒃᑖᑦ

ᐱᖃᑕᐅᓚᐅᖅᑐᓂᑦ (27) ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐃᓱᒫᓘᑎᖃᓗᐊᕐᓂᖏᓐᓂᒃ ᓇᓄᐃᑦ ᐃᖅᓯᓇᖅᑐᑦ ᐊᒻᒪᓗ ᐃᓄᖕᓄᑦ ᑎᑭᐅᑎᒐᔪᒃᓯᕙᓪᓕᐊᓂᖏᓐᓂᑦ ᐅᓗᕆᐊᓇᖅᑑᑉᓗᓂ ᑕᒪᓐᓇ ᐃᓄᓗᒃᑖᓄᑦ.

ᓇᓄᒃᑕᐅᔪᖕᓇᖅᑐᓄᑦ ᑭᒡᓕᒋᔭᐅᔪᑦ ᐊᒻᒪᓗ ᒪᖃᐃᓐᓂᕐᒧᑦ ᒪᓕᒑᕿᓛᑦ

ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐃᓱᒪᒋᔭᖏᓐᓂᒃ ᑐᓂᓯᓚᐅᖅᑐᑦ ᓇᓄᒃᑕᐅᔪᖕᓇᖅᑐᑦ ᑭᒡᓕᖏᓐᓂᑦ ᐊᒻᒪᓗ ᒪᖃᐃᓐᓂᕐᒧᑦ ᒪᓕᒑᕿᓛᓂᒃ ᐃᓱᒫᓘᑎᒋᔭᖏᓐᓂᒃ ᐃᓄᓗᒃᑖᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑎᙱᓐᓂᕐᒧᑦ. ᐃᓚᖏᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᒃᑕᐅᔪᖕᓇᖅᑐᓄᑦ ᑭᒡᓕᐅᔪᑦ ᐊᒻᒪᓗ ᒪᖃᐃᓐᓂᕐᒧᑦ ᒪᓕᒑᕿᓛᑦ ᐱᑕᖃᒃᑲᓐᓂᕆᐊᖃᖅᑐᑦ ᐃᓄᐃᓪᓗ ᓇᓄᐃᓪᓗ ᑎᑭᐅᑎᔾᔪᑎᖃᑦᑕᕐᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐅᓗᕆᐊᓇᖅᑐᒦᑎᑦᑎᙱᓐᓂᕐᒧᑦ. ᖃᕐᓯᐊᕐᔪᐃᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓖᖕᓂᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐃᓱᒪᒋᔭᖏᓐᓂᒃ ᓇᓄᒃᑕᐅᖃᑦᑕᖅᑐᓄᑦ ᑭᒡᓕᐅᔪᑦ ᐊᒥᓱᙳᕆᐊᖅᑕᐅᔪᕆᐊᖃᖅᑐᑦ ᑲᒪᒋᓂᐊᕐᓗᒋᑦ ᐃᓱᒫᓗᑕᐅᔪᑦ ᐃᓄᓗᒃᑖᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑎᙱᓐᓂᐊᕐᓗᒋᑦ.

ᐊᒥᓱᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᑐᓂᓯᓚᐅᕐᒥᔪᑦ ᐃᓱᒪᒋᔭᖏᓐᓂᑦ ᓇᓄᐃᑦ ᑐᖁᑕᐅᔪᑦ ᐋᓇᒃᑐᐃᓂᕐᒧᑦ ᐃᓅᓯᕐᒥᑦ ᐊᒻᒪᓗ ᐱᖁᑎᒋᔭᐅᔪᓂᒃ ᐲᖅᑕᐅᔭᕆᐊᖃᙱᑦᑐᑦ ᓄᓇᓕᖕᒥᑦ ᓇᓄᒐᒃᓴᓂᑦ, ᐊᒻᒪᓗ ᐃᓚᖏᑦ ᐅᖃᖅᐳᑎᒃ ᓇᓄᐃᑦ ᕿᓯᖏᑦ ᓇᓄᕌᑦ ᓇᓄᒃᑕᐅᔪᓂᑦ ᐃᖕᒥᖕᓂᒃ ᒥᐊᓂᕆᑉᓗᑎᒃ ᐅᑎᖅᑎᑕᐅᔭᕆᐊᖃᖅᑐᑦ ᒪᖃᐃᑎᓄᑦ. ᒪᕐᕈᒃ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᑭᒻᒥᑭᒻᒥᑦ ᐅᖃᖅᑐᑦ ᒫᓇᐅᔪᖅ ᓇᓄᓕᓱᖕᓇᐅᔪᖅ ᐅᐃᒍᕆᐊᕐᓗᒋᑦ ᐊᐅᔭᕐᒧᑦ, ᐃᓄᐃᓪᓗ ᓇᓄᐃᓪᓗ ᑎᑭᐅᑎᔾᔪᑎᖃᑦᑕᕐᓂᐊᕐᒪᑕ ᓇᓗᓇᙱᑦᑐᖅ. ᐃᓚᖏᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᕐᒥᔪᑦ ᐊᑎᖅᑕᓂᒃ ᓇᓄᒍᖕᓇᕐᓗᑎᒃ ᐊᒻᒪᓗ ᐊᒥᓱᙳᕆᐊᕐᓗᒋᑦ ᐊᕐᓇᓪᓗᐃᑦ ᓇᓄᒃᑕᐅᔪᖕᓇᖅᑐᑦ[8].

ᐊᒥᓱᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᐅᖃᓚᐅᖅᑐᑦ ᒫᓇᐅᔪᖅ ᓇᓄᐃᑦ ᒥᒃᓴᓄᑦ ᐊᐅᓚᑦᑎᓃᑦ ᐊᔾᔨᙱᑦᑕᖏᑦ ᐃᓄᐃᑦ ᐱᖅᑯᓯᖏᓐᓂᑦ ᑎᑭᐅᑎᖃᑦᑕᐅᑎᓂᕐᓄᑦ ᓇᓄᕐᓂᑦ. ᐃᓚᖏᑦ ᐃᓱᒪᒋᔭᖏᓐᓂᒃ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐃᓄᐃᑦ ᐊᖏᓂᖅᓴᒥᑦ ᐊᐅᓚᑦᑎᓂᖃᕐᓗᑎᒃ ᓇᓄᐃᑦ ᒪᖃᐃᑕᐅᓂᖏᓐᓂᓕᕆᓂᕐᓂᑦ ᐃᓄᓗᒃᑖᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑎᓐᓂᐊᖏᓪᓗᒋᑦ. ᐃᑲᔪᓚᐅᖅᑐᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐱᒻᒪᕆᐅᓂᖏᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᓇᓄᓕᕆᑎᓪᓗᒋᑦ ᐊᒻᒪᓗ ᑲᒪᔭᖃᖅᑎᓪᓗᒋᑦ.

ᑐᕴᐅᒪᑎᑦᑎᓃᑦ

ᐊᒥᓱᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᐸᖕᓂᖅᑑᕐᒥᑦ ᐊᒻᒪᓗ ᑭᒻᒥᑭᒻᒥᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐱᔪᒪᓂᖏᓐᓂᑦ ᓇᓄᕐᓂᑦ ᓱᓇᑐᐃᓐᓇᓕᕆᓂᒃᑯᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᒃ. ᑭᓯᐊᓂ, ᓇᓗᓇᐃᖅᓯᓂᖅ ᑐᕴᐅᒪᑎᑦᑎᓂᖏᓐᓂᒃ ᓇᓄᕐᓂᒃ ᖃᐅᔨᓴᐃᔨᐅᔪᑦ ᐅᑉᓗᒥᒧᑦ ᑎᑭᖦᖢᒍ, ᖃᕆᐊᕐᔪᐃᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᐅᖃᓚᐅᖅᑐᑦ ᑐᓂᔭᐅᔪᒪᔪᑦ ᐅᕝᕙᓘᓐᓃᑦ ᐱᔪᖕᓇᕐᓗᑎᒃ ᑐᑭᓯᐅᒪᔾᔪᑎᓂᒃ ᐱᔾᔪᑎᖃᖅᑐᓂᒃ ᓱᓇᑐᐃᓐᓇᓕᕆᓂᒃᑯᑦ ᑲᐅᔨᓴᐃᓂᐅᔪᓂᒃ ᓇᓄᕐᓄᑦ. ᐃᓚᖏᑦ ᐅᖃᖅᑐᑦ ᐱᔪᒪᓂᖃᓗᐊᖅᑐᑦ ᐱᓗᑎᒃ ᓱᓇᑐᐃᓐᓇᓕᕆᓂᒃᑯᑦ ᑐᑭᓯᐅᒪᔾᔪᑎᓂᒃ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓂᑦ, ᐊᒥᓲᓂᕆᔭᖏᓐᓂᑦ ᐊᒻᒪᓗ ᓇᒨᖓᐅᓯᒪᓂᖏᑦ ᓇᓄᐃᑦ.

ᖃᕐᓯᐊᕐᔪᐃᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᓇᓄᕐᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᑐᕴᐅᒪᑎᑦᑎᓃᑦ ᓄᓇᓕᖕᒥᐅᓄᑦ ᐱᐅᓯᕆᐊᖅᑕᐅᔪᖕᓇᖅᑐᖅ. ᑕᐅᑐᒐᐅᔪᓂᒃ ᐱᔭᐅᔪᑦ ᐃᑲᔪᓚᐅᖅᑐᓂᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐱᐅᓯᕆᐊᕐᓗᒋᑦ ᓇᓄᐃᑦ ᖃᐅᔨᓭᖅᑕᐅᓂᖏᓐᓄᑦ ᑐᕴᐅᒪᑎᑦᑎᓃᑦ ᐱᒻᒪᕆᐅᔪᖅ ᐃᓚᖏᑦ ᓄᓇᓕᖕᒥᑦ ᐅᒃᐱᕈᙱᓐᓂᖅᑲᖅᑎᓪᓗᒋᑦ ᓱᓇᑐᐃᓐᓇᓕᕆᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᓂᒃ ᐊᒻᒪᓗ ᓇᓄᕐᓂᒃ ᖃᐅᔨᓴᐃᔨᓂᒃ, ᐊᒻᒪᓗ ᐊᔾᔨᒌᙱᓐᓂᖅᑕᖅᖢᑎᒋᓪᓗᒋᑦ ᓱᓇᑐᐃᓐᓇᓕᕆᓂᒃᑯᑦ ᐊᒻᒪᓗ ᐃᓄᐃᑦ ᖃᐅᔨᓯᒪᔭᕆᑦ. ᐃᑲᔪᓚᐅᖅᑐᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐱᓕᕆᖃᑎᒌᖕᓂᕐᒧᑦ ᐱᕈᐃᓂᖅ ᐊᒻᒪᓗ ᐱᓈᖅᑎᑦᑎᓂᕐᒥᒃ ᐋᖅᑭᒃᓯᓗᓂ ᓱᓇᑐᐃᓐᓇᓕᕆᓂᕐᒧᑦ ᐊᒻᒪᓗ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᑦ ᐃᑲᔫᑕᐅᓇᔭᖅᑐᖅ ᐱᐅᓯᕆᐊᖅᓯᓂᕐᒥᒃ ᖃᐅᔨᒪᓂᕆᔭᐅᔪᓂᒃ ᑐᓂᓯᖃᑦᑕᐅᑎᓂᕐᒧᑦ ᐅᒃᐱᕈᓯᖕᓂᖅᑕᖃᕐᓂᓗ ᐊᑯᓐᓂᖏᓐᓂᑦ ᓄᓇᕗᒻᒥᐅᑕᐃᑦ ᐊᒻᒪᓗ ᓇᓄᕐᓂᒃ ᖃᐅᔨᓴᐃᔨᐅᔪᑦ.

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[8] ᐊᐱᖅᓱᐃᓚᐅᖅᑐᑦ 2019-ᒥᑦ ᐋᖅᑭᑦᑎᐊᖅᑕᐅᓂᐊᕌᖅᑎᓪᓗᒍ ᓇᓄᒃᑕᐅᖃᑦᑕᕆᐊᖃᖅᑐᓂᒃ ᐋᖅᑭᐅᒪᔪᑦ ᐊᑕᐅᓯᖅ ᐊᖑᓴᓪᓗᕐᒥᑦ ᐊᑕᐅᓯᖅ ᐊᕐᓇᓪᓗᕐᒥᑦ (1:1) ᓄᓇᕗᓗᒃᑖᕐᒥᑦ.

ᖃᐅᔨᔭᐅᔪᑦ

ᑖᓐᓇ ᐅᓂᑉᑳᖅ ᕿᓂᖅᓴᐃᓚᐅᖅᑐᖅ ᓇᓗᓇᐃᔭᖅᓯᒪᔪᓂᒃ ᐱᓐᓂᑯᓂᒃ ᐊᒻᒪᓗ ᐅᑉᓗᒥᐅᔪᖅ ᖃᐅᔨᒪᓂᕆᔭᐅᔪᓂᒃ ᐱᔭᐅᓯᒪᔪᑦ ᐃᓄᖕᓄᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᓄᑦ ᓇᓄᐃᑦ ᐱᕈᖅᐸᓯᐊᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ, ᐊᒻᒪᓗ ᒻᒪᕆᐅᕆᔭᐅᓂᖓ ᓇᓄᖅ ᓄᓇᕗᒻᒥ ᐃᓄᖕᓄᑦ, ᐊᒻᒪᓗ ᐃᓄᐃᑦ ᑕᐅᑐᒐᖏᑦ ᓇᓄᐃᑦ ᐊᐅᓚᑕᐅᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᑲᒪᒋᔭᐅᓂᖏᓐᓄᑦ.

ᑕᒪᐃᓐᓅᖓᔪᒃᑯᑦ, ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐸᖕᓂᖅᑑᒥᑦ ᐊᒻᒪᓗ ᑭᒻᒥᕈᒻᒥᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᐅᑉᓗᒥᐅᔪᖅ ᖃᓄᐃᖏᑦᑐᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᑦ ᑕᑯᕝᕕᒋᖃᑦᑕᖅᑕᖏᓐᓂᑦ. ᑕᑯᕝᕕᒋᖃᑦᑕᖅᑕᖏᓐᓂᑦ. ᖃᐅᔨᔭᐅᔪᓂᑦ ᖃᓄᐃᖏᓐᓂᖏᓐᓄᑦ ᓇᓄᐃᑦ ᐃᓚᐅᔪᑦ: ᐊᒥᓲᙳᕆᐊᖅᓯᒪᓂᖏᑦ ᐊᔾᔨᒌᒃᑐᓂᒃ ᐅᖃᐅᓯᐅᔪᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᐃᓅᓯᖏᓂᑦ, ᐊᓯᐊᙳᙱᑦᑐᑦ ᐊᑎᖅᑕᓕᐅᕋᑦᑕᕐᓂᖏᑦ ᐊᒻᒪᓗ ᐋᓇᒃᑐᕐᓂᕐᒧᑦ ᐅᓂᑉᑳᕆᔭᐅᔪᑦ ᑕᐃᒪᙵᓂᑦ, ᐊᕐᓇᓗᐃᑦ ᒪᕐᕉᖕᓂᒃ ᐊᑎᖅᑕᖃᖅᑐᑦ ᑕᑯᔭᐅᒐᔮᖑᑉᓗᑎᒃ, ᐊᒻᒪᓗ ᐱᑕᖃᕋᔪᙱᓂᕋᖅᑕᐅᔪᑦ ᐋᓂᐊᕐᓂᕋᖅᑐᑦ ᓇᓄᕐᓂᒃ ᑕᑯᔭᐅᕋᑦᑕᕐᓂᖏᑦ ᐅᕙᓘᓐᓃᑦ ᓈᓄᒃᑕᐅᖏᓪᓗᑎᒃ ᑐᕐᑯᔪᑦ. ᑭᓯᐊᓂ, ᒫᓐᓇᓵᖅ ᐅᑭᐅᖑᔪᓂᑦ, ᐃᑲᔪᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐊᓯᐊᙳᖅᓯᒪᓂᖄᖅᔫᒃᑐᓂᒃ - ᐱᕆᐊᓕᕚᖅᑑᔪᖕᓇᖅᑐᖅ ᐊᓯᐊᙳᕐᓂᕐᒥᒃ - ᓇᓄᐃᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ, ᐃᓚᐅᑉᓗᑎᒃ ᖁᐃᓂᙱᓂᖅᓴᐅᕖᕐᔪᖕᓂᖏᑦ ᐊᒻᒪᓗ ᑕᒪᐃᓐᓅᖓᔪᒃᑯᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᐅᖃᐅᓯᐅᓚᐅᖅᑐᖅ ᐃᓚᖏᓐᓄᑦ ᐃᓚᐅᖃᑕᐅᓚᐅᖅᑐᓄᑦ ᐊᒻᒪᓗ ᖃᑯᑎᒃᑯᑦ ᒥᖅᑯᖃᖃᑦᑕᙱᓂᖏᑦ. ᐃᓚᐅᖃᑕᐅᔪᑦ ᖃᐅᔨᓚᐅᕐᒥᔪᑦ ᓇᓄᐃᑦ ᓂᕆᔭᒃᓴᖅᓯᐅᖃᑦᑕᖅᑕᖏᓂᒃ ᒪᓂᒪᓂᖏᓂᒃ ᐊᒻᒪᓗ ᐃᓂᐅᔪᑦ ᖃᓄᐃᓐᓂᖏᑦ ᐊᓯᐊᙳᖅᑐᓂᒃ ᒫᓐᓇᒧᑦ ᑎᑭᖦᖢᒍ, ᐃᓚᐅᔪᑦ ᐊᓯᐊᙳᖅᑐᑦ ᑕᓇᐅᑉ ᓯᑯᖓᑕ ᖃᓄᐃᖏᓂᖓ ᐊᒻᒪᓗ ᓯᑯᓯᒪᓂᐅᑉ ᑎᑭᐅᑎᓯᒪᓂᖓ ᐊᒻᒪᓗ ᐊᒥᓲᖅᓃᑦᑎᐊᕐᓂᖏᑦ ᓇᑦᑏᑦ (ᓇᓄᐃᑦ ᓂᕿᒋᓗᐊᖅᑕᖏᑦ) ᖃᐅᔨᔭᐅᓯᒪᔪᑦ ᑕᒪᐃᓐᓂᑦ ᑭᒻᒥᕈᒻᒥᑦ ᐊᒻᒪᓗ ᐸᖕᓂᖅᑑᕐᒥᑦ. ᐊᐱᖅᓱᐃᓂᖅᑎᓪᓗᒋᑦ, ᑕᐃᒪᓇᐃᑦᑐᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᑕᑯᒃᓴᐅᑎᑕᐅᓚᐅᖅᑎᑦᑐᑦ ᖃᐅᔨᔭᐅᔪᓂᒃ ᐊᑎᖅᑕᓕᐅᕆᓂᕐᓄᑦ, ᑕᒪᓇ ᖃᓄᐃᓗᐊᕐᒋᓯᒪᕖᔭᖅᑐᖅ ᑕᒪᐃᓐᓂᑦ ᓄᓇᓕᖕᓂᑦ. ᑎᑎᕋᐃᔭᕆᐊᖃᕐᓂᐊᖅᑐᑦ ᐃᓄᐃᑦ ᖃᐅᔨᓯᒪᔭᖏᓂᒃ ᑐᑭᓯᐊᓂᐊᕐᓗᒋᑦ ᖃᓄᖅ ᓇᓄᐃᑦ ᑎᒥᖏᑦᑕ ᖃᓄᐃᓂᕆᔭᖏᑦ ᐊᒻᒪᓗ ᑕᒪᐃᓐᓅᖓᔪᒃᑯᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᑦ ᐱᕙᓪᓕᐊᓯᒪᖕᒪᖔᑕ ᐅᑉᓗᒥᒧᑦ ᑎᑭᖦᖢᒍ.

ᐱᒻᒪᕆᐅᔪᖅ, ᐱᓕᕆᓂᕐᒥᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᓇᓄᖅ ᐅᑎᕈᖕᓇᖅᑑᖕᒪᑦ ᐊᒻᒪᓗ ᐱᕕᖃᕈᓂ ᓂᕆᔭᒃᓴᖅᓯᐅᕈᓐᓇᖅᑐᖅ ᐊᔪᕈᑦᑐᕐᓇᑦᑎᐊᖅᑯᓂ ᐊᓯᐊᙳᕐᓂᐅᔪᓂᒃ ᓂᕆᔭᒃᓴᐃᑦ ᒪᓂᒪᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐃᓂᐅᔪᑦ ᖃᓄᐃᓂᕆᔭᖏᓐᓄᑦ.

ᐃᓚᒋᔭᐅᔪᖅ, ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᖃᓄᐃᖓᓂᐅᔪᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᖅ ᐃᓄᓗᒃᑖᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᙱᓂᖏᓐᓄᑦ ᐃᓱᒫᓘᑕᐅᔪᑦ ᐃᓄᐃᓪᓗ ᓇᓄᐃᓪᓗ ᑎᑭᐅᑎᓚᔾᔪᓯᕙᓪᓕᐊᑎᓪᓗᒋᑦ, ᐊᒻᒪᓗ ᓇᓄᕐᓄᑦ ᐊᐅᓚᑦᑎᓂᖅ ᐅᑉᓗᒥ ᓇᓂᓯᔭᕆᐊᖅᑐᖅ ᐱᓕᕆᐊᕆᓂᐊᖅᑐᒥᑦ ᐃᓄᓗᒃᑖᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᙱᓂᖏᓐᓄᑦ ᐃᓱᒫᓘᑕᐅᔪᑦ ᐊᑕᐅᑦᑎᒃᑯᑦ ᓇᓄᐃᑦ ᐊᓯᐅᔨᑦᑕᐃᓕᓗᒋᑦ ᓯᕗᓂᒃᓴᒥᑦ ᐊᒻᒪᓗ ᒪᓂᒪᑎᓪᓗᒋᑦ ᓯᕗᓂᒃᓴᖅᑎᑦᑕ ᑭᖑᕚᑉᑕ.

ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᑦ ᐱᒻᒪᕆᐅᓂᖓ ᐃᒃᐱᒍᓱᒻᕕᖃᖅᓂᒃᑯᑦ ᐱᓕᕆᖃᑎᒌᙳᓂᖏᑦ ᐃᓄᐃᑦ ᐊᒻᒪᓗ ᓇᓄᐃᑦ ᐊᒻᒪᓗ ᐃᖅᑲᐃᑎᑦᑎᔪᖅ ᐅᕙᑉᑎᖕᓂᑦ ᐊᑕᐅᑦᑎᒃᑯᑦ ᐱᔭᕐᓴᐅᑎᖃᕈᑦᑕ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ ᐊᒻᒪᓗ ᓯᕗᓂᒃᓴᖅᑎᑦᑕ ᑭᖑᕚᑉᑕ. ᑕᐃᒪᓐᓇᒧᑦ ᓂᕈᐅᒃᑐᒍᑦ ᐱᓕᕆᐊᖅᐳᑦ ᐃᑲᔪᕐᓂᐊᕐᓗᓂ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ ᐊᐅᓚᑦᑎᓂᕐᒥᒃ ᐊᒻᒪᓗ ᐃᓱᒪᓕᐅᕆᓂᕐᓂᑦ, ᐊᒻᒪᓗ ᑲᔪᓯᔪᒥᑦ ᐊᒻᒪᓗ ᓯᕗᓂᒃᓴᒥᑦ ᓄᓇᓕᖕᒦᙳᓕᐅᔪᓂᑦ ᖃᐅᔨᕆᐊᖃᑦᑕᕐᓂᒥᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᐃᓂᐅᔪᓂᒃ ᓄᓇᕗᒻᒥ ᐊᓯᖏᓂᓗ.

INTRODUCTION

Nanuq (polar bear; *Ursus maritimus*) is a key species of the Arctic ecosystem and plays an important role in Inuit culture. Understanding the health status –including abundance– of polar bear populations is critical for effective polar bear management. In Nunavut, sustainable polar bears harvest quotas are established using both Inuit Qaujimajatuqangit (Inuit traditional knowledge) and Western scientific information (Government of Nunavut 2019). Under the Nunavut Land Claims Agreement, Inuit play an active role in polar bear co-management. Nunavut Inuit have accumulated a vast knowledge about polar bears through extensive observation of their environment and harvesting activities.

The *Inuit Qaujimajatuqangit study on the health of the Davis Strait polar bear population* was a collaborative research project between the Government of Canada (Environment and Climate Change Canada and Polar Knowledge Canada), the Government of Nunavut (Government of Nunavut, Department of Environment), and local Hunters and Trappers Organizations (HTOs) from the communities of Pangnirtung, Kimmirut and Iqaluit in the Qikiqtani region of Nunavut.

This project aimed at gathering Inuit Qaujimajatuqangit on the health of polar bears around the communities of Kimmirut, Pangnirtung and Iqaluit to support management decisions and strategies for the Davis Strait polar bear subpopulation. The communities of Kimmirut, Pangnirtung and Iqaluit are the three Nunavut communities located within or near the boundaries of the Davis Strait polar bear subpopulation and management unit and, as such, have assigned harvesting quotas for that specific subpopulation (Figure 1).

Specific project objectives were:

(1) to gather and document Inuit Qaujimajatuqangit from Nunavut Inuit on polar bear health, abundance and distribution for the Davis Strait polar bear population to support decision-making and co-management;

(2) to compare, contrast and weave together Inuit Qaujimajatuqangit and Western scientific knowledge available for the Davis Strait polar bear population and discuss implications for polar bear research, monitoring, and co-management; and

(3) to enhance community capacity for polar bear and wildlife research and monitoring in Nunavut.

As part of this study, Inuit Qaujimajatuqangit related to polar bear cultural importance, ecology, and management were documented through a series of individual and group interviews with 35 polar bear experts from Pangnirtung and Kimmirut.

The purpose of this report to communities and project partners is to summarize the knowledge that was shared by Inuit project contributors during interviews, and discuss implications for ongoing and future polar bear research, monitoring and co-management. We hope that this report can contribute to sharing the extensive and holistic knowledge held by Nunavummiut about polar bears and, in doing so, honour the unique relationship between Inuit and polar bears. Through this work, we wish to support the meaningful inclusion of Inuit Qaujimajatuqangit in polar bear research, monitoring and co-management.

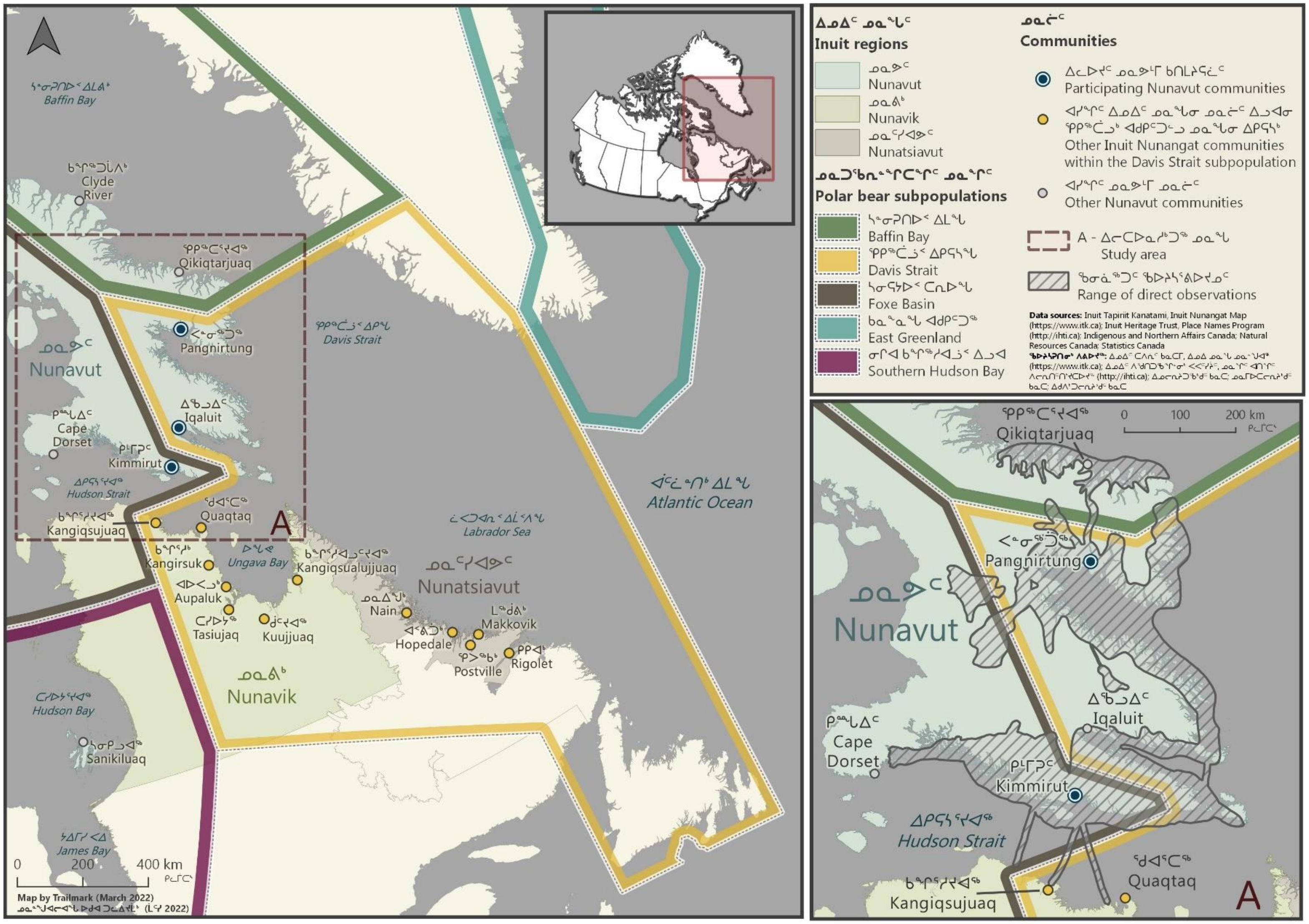


Figure 1. Study area (map A) within the Davis Strait polar bear subpopulation and management unit. In the legend, 'range of direct observations' (dashed area in map A) refers to the geographic extent of the ecological observations made by participants interviewed in this study.

METHODS

Inuit Qaujimajatuqangit

In Nunavut, Inuit traditional knowledge is referred to as Inuit Qaujimajatuqangit (IQ). IQ reflects Inuit extensive knowledge and experience passed from generation to generation (Wenzel 2004; Tester and Irniq 2008). It incorporates cultural values, practices, ethics, and worldviews, and has been recognized in co-management: "[IQ] is an ethical framework and detailed plan for having a good life. It is a way of thinking, connecting all aspects of life in a coherent way" (Karetak et al. 2017:3). IQ can be defined as "the Inuit way of doing things, and includes the past, present and future knowledge of Inuit society" (Tester and Irniq 2008:49). IQ includes ethical principles (*maligarjuat*; literally "big things that must be followed"). The four main *maligarjuat* are: (1) working for the common good; (2) living in respectful relationships with every person and thing that one encounters; (3) maintaining harmony and balance; and (4) planning and preparing for the future (Karetak et al. 2017:3).

In this report, we employ the term Inuit Qaujimajatuqangit to refer to Inuit knowledge and perspectives documented through this project, as well as to the principles that guided the research process.

Project team and approach

Our project team included: researchers from Environment and Climate Change Canada (ECCC), Polar Knowledge Canada (POLAR), and the Government of Nunavut (GN); community researchers from Kimmirut and Pangnirtung; HTO managers and board members from Pangnirtung and Kimmirut; and a consultant (see Appendix 2 for list of team members).

We employed a community-based participatory research approach to document Inuit Qaujimajatuqangit on polar bear health and management (Grimwood et al. 2012; Tomaselli et al. 2018). In this study, polar bear health was considered broadly and holistically at the individual, population and ecosystem levels (Patyk et al. 2015). We viewed polar bear health as resulting from interacting biological, social and environmental determinants that promote and maintain health as a capacity to cope with change over time (Stephen 2014). We therefore assessed polar bear health considering multiple parameters, such as population trends and demographics, body condition, behaviour, habitat condition, prey availability, in addition to mortality and disease.

Our project comprised four main phases (Figure 2). Throughout the research process, progress meetings between researchers and board members and managers of the Mayukalik (Kimmirut), Pangnirtung and Amarok (Iqaluit) HTOs were organized to establish project objectives and direction, share project updates, and ensure project co-development among partners.

Figure 2. Schematic of project phases and associated timeline.

Project planning

This project was initiated in fall 2016 when Markus Dyck (polar bear biologist, GN) met with HTO board members and managers in Kimmirut, Pangnirtung and Iqaluit to assess interest in this project and ask for HTO advice and support. Following these community visits, the Mayukalik (Kimmirut), Pangnirtung and Amarok (Iqaluit) HTOs all expressed their formal support to this study. In collaboration with project partners, Dominique Henri (researcher, ECCC), Matilde Tomaselli (researcher, POLAR) and Markus Dyck then proceeded to secure funding required to conduct the project.

In 2018, researchers worked together with the HTOs to establish project objectives and outline the role of the HTOs in implementing research and supporting activities taking place in communities. In November 2018, our project team conducted a second round of community visits (led by Matilde Tomaselli) to incorporate HTO guidance and feedback into project planning and design. Both the Pangnirtung HTO and the Mayukalik HTO agreed to organize interviews with polar bear experts in Pangnirtung and Kimmirut, respectively; the Amarok HTO requested more time to formalize their participation in the project. A draft interview guide was provided to the HTOs and input from HTO board members was incorporated to produce a final interview guide.

In April 2019, a follow-up meeting was organized between Matilde Tomaselli and the Amarok HTO to discuss project implementation in Iqaluit. At the time, the HTO could not provide a definite response about its participation in organizing interviews. In early 2020, due to time and logistical constraints, researchers from the project team decided not to conduct interviews in Iqaluit for the time being and to keep the Amarok HTO informed about research results and progress given that the HTO had initially supported the project in 2016.

Gathering Inuit Qaujimajatuqangit

Between March and December 2019, individual and group interviews were conducted in Kimmirut and Pangnirtung with a total of 35 Inuit participants identified as local ‘polar bear experts’; that is, persons recognized by their peers as knowledgeable about polar bears (Ferguson and Messier 1997).

Individual interviews were designed to gather a vast range of knowledge and observations on polar bears that spanned from their cultural importance to human-polar bear interactions, historic and contemporary observations related to polar bear health, and finally community concerns and management considerations. Individual interviews were followed by group interviews that were designed to validate and refine the information previously documented through individual interviews. Group interviews also aimed to collect additional quantitative information on polar bear health using targeted participatory exercises.

Polar bear experts interviewed included local residents who had experience harvesting polar bears (generally men), processing and cleaning polar bear hides (generally women), or otherwise significant experience on the land (e.g., park wardens, outfitters, harvesters, soapstone miners). Interview contributors included 21 Kimmirutmiut (seven women and 14 men) and 14 Pangnirtungmiut (four women and ten men) ranging in age from their early 40s to early 80s (see Appendix 1 for biographies). Eleven Elders were interviewed in Kimmirut and 13 in Pangnirtung.

In each community, polar bear experts were identified by the local HTO and community researchers (purposeful sampling) and by asking interview contributors to recommend other potential participants (snowball sampling; Patton 2005). We stopped recruiting participants when no new information was documented following a thematic saturation approach (Saunders et al. 2018).

All interviews were conducted by Matilde Tomaselli and facilitated by community researchers: Naomi Akavak and Pudloo Pitsiulak in Kimmirut; and Rosemary Kanayuk and Doreen Kanayuk in Pangnirtung. Matilde Tomaselli provided informal training to community researchers on qualitative research methods prior to performing interviews and throughout the process. Community researchers offered guidance on how to conduct research in their community.

Prior to interviews, we used invitation letters to explain project scope to participants. All contributors provided their consent to be interviewed, and specified how they wanted their information to be used and shared (see Appendix 3 for invitation letter and consent form). Participants who agreed to be interviewed could choose to remain anonymous; they could also decide if they wanted their information archived in the community for future use (heritage, education or research purposes).

All interviews were conducted in participants' language of choice (Inuktitut or English). Community researchers were present during all interviews to translate on an as-needed basis. Interview contributors were remunerated for their time at a rate set by the HTOs. Interviews lasted on average 2.5 hours. In Pangnirtung, all interviews were conducted at the HTO. In Kimmirut, interviews scheduled outside regular working hours were performed at the Mayukalik HTO; they were otherwise carried out in rooms made available by the Qaqqalik School.

Interviews were conducted in two stages. First, individual interviews were carried in Kimmirut and Pangnirtung in March and April 2019. Then, group interviews were conducted in Kimmirut only in November and December 2019. Our project team had planned to conduct group interviews in Pangnirtung in March 2020. Unfortunately, these group interviews had to be cancelled due to the COVID-19 pandemic and associated travel restrictions.

Individual interviews

Between March and April 2019, individual interviews were conducted in Kimmirut and Pangnirtung with a total of 27 Inuit polar bear experts; 13 contributors were interviewed in Kimmirut and 14 in Pangnirtung.

Individual interviews followed a semi-directed format, allowing for open and flexible conversations (Huntington 1998). During interviews, an interview guide comprising 44 questions was employed to support discussions (see Appendix 4). Community researchers translated the interview guide into the local Inuktitut dialect and worked to clarify questions and concepts as needed during interviews. Interview questions were piloted once and jointly revised by Matilde Tomaselli and community researchers to improve clarity (Agee 2009).

We customized interviews to capitalize on the experience of participants who could add or skip topics depending on their expertise. General themes discussed included: (1) participant life history and land use; (2) experience with polar bear hunting, butchering and/or hide processing; (3) knowledge related to polar bear ecology and health; (4) perspectives on polar bear management and stewardship; and (5) concerns about polar bears. Under the polar bear ecology and health theme, we discussed topics that allowed a comprehensive exploration of polar bear health from an Inuit Qaujimajatuqangit perspective, including: polar bear distribution and abundance (historic and contemporary), cub productivity and survival, body condition (fatness), disease and mortality events, behaviour, diet, denning, habitat, as well as changes observed over time. Indicators employed by Inuit polar bear experts to assess polar bear health were also specifically discussed. Interviews were audio recorded with permission, and biogeographical information was collected on topographic maps using mapping conventions described in Tobias (2009). Maps were also used to determine the geographic range of direct observations of each contributor (such range comprised the areas and routes that contributors had regularly traveled through over their lifetime), as well as to support and contextualize their narratives by representing relevant observations spatially (e.g., polar bear distribution, sightings of dens, sightings of sick polar bears).

Group interviews

Group interviews were organized after we completed a preliminary analysis of individual interviews (see 'Analysis and validation' section below). Group interviews were conducted in Kimmirut in November and December 2019. A total of 15 participants took part in these interviews, including seven contributors who had been previously interviewed individually and eight new project participants. New participants were included in group interviews as a way to increase the quality and validity of our results. We divided participants into four different groups based on their age, level and type of experience with polar bears, and hunting area of preference when applicable. We also took into account whether each participant was comfortable to share their knowledge with other selected contributors and accommodated participant requests in this regard. Three groups were composed of polar bear hunters (men) and one group included women specialized in polar bear hide processing and cleaning. In some cases, groups met during multiple sessions over a two-week period in order to cover the full extent of the interview.

The objective of group interviews were twofold: (1) validate and further refine information summarized from individual interviews; and (2) gather quantitative information on polar bear relative abundance, distribution, demography, diet, health status and body condition (fatness). Group interviews were designed to capitalize on the specific expertise of participants. For example, women specialized in polar bear hide processing and cleaning were asked questions that allowed to share their extensive experience with polar bear hides; while polar bear hunters were asked questions that relied on their direct observations of polar bears on the land. Moreover, participatory exercises were designed using specific timescales and categories (e.g., when exploring demography and body condition status) informed by the scientific data available for the Davis Strait polar bear subpopulation so as to maximize complementarity and comparability of the quantitative information generated though this study.

Matilde Tomaselli led group interviews in Kimmirut with the assistance of Dominique Henri and community researchers (Naomi Akavak and Pudloo Pitsiulak). Group interview discussions were guided by the use of a number of visual and interactive participatory exercises, including: mapping, temporal line, drawing, proportional piling and their combination (see Appendix 5 for more information about participatory exercises). These exercises were developed by adapting methods described by Tomaselli and colleagues (2018) and Mariner and Paskin (2000). Notes and pictures were taken with permission during group discussions.

Table 1. Themes discussed and associated participatory exercises employed during group interviews conducted in Kimmirut.

Themes	Associated participatory exercises
Participants' range of direct observations and travel intensity	Mapping exercises
Polar bear relative distribution	Proportional piling & mapping exercises
Polar bear relative abundance	Proportional piling, drawing & temporal line exercises
Seal relative abundance	Proportional piling, drawing & temporal line exercises
Polar bear cub productivity and survival	Proportional piling exercises with visual cues
Polar bear body condition (fatness)	Proportional piling exercises with visual cues
Polar bear general health	Proportional piling exercises
Polar bear diet	Proportional piling exercises & seasonal calendar with visual cues

Analysis and validation

Upon individual interview completion in Pangnirtung and Kimmirut, Matilde Tomaselli, Pamela Wong (consultant, Trailmark Systems) and Dominique Henri selectively transcribed audio recordings and produced a detailed interview summary for each interview. Summaries covered all themes discussed and included representative quotes. Interview summaries were initially coded and analyzed independently by both Matilde Tomaselli and Dominique Henri. Dominique Henri finalized the coding of interview summaries using NVivo Pro 11 (Version 11, 2012) and completed their analysis using thematic content analysis (Creswell 2009).

Matilde Tomaselli analyzed group interview results based on field notes and the outcome of each exercise performed. Quantitative information generated during group interviews was analyzed using Excel. Descriptive statistics (i.e., means and value ranges, specifying minimum and maximum values) were used to summarize quantitative information.

The softwares QGis 10.2 and ArcGis 10.2 were used to transpose, visualize and analyze georeferenced information gathered during individual and group interviews. Heath maps representing travel intensity of contributors within their range of direct observations (Figure 7) and the distribution of polar bears (Figure 13) were generated using the kernel density estimation method.

Validation of preliminary results

In Pangnirtung and Kimmirut, preliminary results were reported to all study participants for validation. From September to December 2021, community researchers and HTO managers from Pangnirtung and Kimmirut led results validation in their respective community. Government researchers were unable to travel to communities in person to validate preliminary results due to the COVID-19 pandemic and associated travel restrictions. In both communities, a draft project report (available in both English and Inuktitut) was shared with all available interview contributors, as well as with HTO board members. Contributors were specifically invited to review and approve the quotes presented in this report. In Kimmirut, 15 out of 21 project contributors participated to results validation. In Pangnirtung, all 14 contributors were involved. Feedback and comments received were addressed and incorporated into our final analyses.

Limitations

Some potential limitations applicable to this study should be acknowledged. First, the information collected through interviews represented a partial sample of all knowledge held about polar bears in Pangnirtung and Kimmirut. In addition, responses received during interviews might have been influenced by the level of familiarity of the interviewer with the local culture, the personality and gender of the interviewer, the lack of recall of specific factual information by interviewees, and some loss of information through the translation process. However, we felt that having community researchers facilitate interviews contributed to making interviewees feel comfortable sharing their knowledge, and ensured that interviews were conducted in a culturally appropriate manner following local protocols.

Ensuring quality and reliability of results

Over the course of this study, we implemented various strategies to ensure that our results were robust and trustworthy. Given that Inuit observations and perceptions are rooted in and directly influenced by land use over time, we ensured to capitalize on the experience and knowledge of contributors by conducting detailed individual life histories and mapping of land use over time and space, and adjusting our interview questions and methods accordingly. Additionally, we relied on 'triangulation' which is a process of verification that increases validity by incorporating several viewpoints and methods (Yeasmin and Rahman 2012). We implemented several triangulation techniques to increase the quality and reliability of our analyses. For example, the robustness of our findings was increased by adding new participants at the group interview stage and by combining individual and group interviews results on similar themes. We also produced detailed interview summaries that were independently analyzed by two researchers to increase the reliability of our interpretations. In addition, we consulted polar bear harvest data from Kimmirut and Pangnirtung available from the Government of Nunavut, as well as documentation available at local HTOs and from local Conservation Officers for additional context in which to ground our analyses. Lastly, the validation of preliminary and final results by interview contributors and HTO board members was key to ensure that our analyses were robust and reliable.

Results sharing

Our project team ensured that Inuit Qaujimajatuqangit documented through this project was shared back to participating communities. Prior to public release, this report was shared with all project partners and interview contributors. In Pangnirtung and Kimmirut, community researchers and HTO managers led report distribution and dissemination of project results in their respective community. In Iqaluit, researchers shared this report with the Amarok HTO.

School engagement

This project was presented in local high schools as a way to foster intergenerational knowledge sharing and enhance community engagement in polar bear research. In Kimmirut, community researcher Pudloo Pitsiulak, Elder Eliyah Padluq and researcher Matilde Tomaselli co-presented the project to a group of high school students from the Qaqqalik School. In Pangnirtung, Rosemary Kanayuk and Doreen Kanayuk presented the project at the Attagoyuk High School. Rosemary and Doreen Kanayuk had both graduated from the Attagoyuk High School and were encouraged to elaborate on what it meant for them to be part of this project and what they learned throughout the process.

Ethics

This study was performed under the Social Research License N 01 028 18 issued by the Nunavut Innovation and Research Institute. It followed ethical guidelines for working with Inuit communities (ITK 2018; ITK and NRI 2007; Owlijoot 2008), as well as guidelines from the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council of Canada and the Social Sciences and Humanities Research Council of Canada for conducting research involving Indigenous peoples in Canada (2018).

Project partners established a research agreement outlining how project data would be stored, accessed and archived according to the Ownership, Control, Access and Possession (OCAP®) principles which support Indigenous data sovereignty (First Nation Information Governance Centre 2014). OCAP® is a registered trademark of the First Nations Information Governance Centre (www.FNIGC.ca/OCAP). All project data were archived at the Pangnirtung and Mayukalik HTOs and can be accessed with permission by third parties for non-commercial purposes. Should any person or organization wish to access archived project data, they must first provide written justification to the Mayukalik and Pangnirtung HTOs, receive their approval, and agree to terms of use outlined by the HTOs.

COMMUNITY CONTEXT

Kimmirut

Kimmirut (62°53'N; 69°53'W) is located on Baffin Island's Meta Incognita on the northern shore of the Hudson Strait in the Qikiqtaaluk region of Nunavut (Figure 1). Kimmirut (formerly known as Lake Harbour) means "heel", and refers to a rocky outcrop across the harbour from the community. Archeological evidence shows that the vicinity of Kimmirut has been a site for human settlement for over 4,000 years. Since establishment of a whaling station in 1900, there has been continuous occupation of the community site. By 1909, the Anglican Church had set up a mission in the community. A Hudson Bay Company trading post was established in 1911, followed by a Royal Canadian Mounted Police (RCMP) detachment in 1927 (CNWTEDA, n.d.). Between the 1940s and the 1960s, the federal government began supplying healthcare and establishing a schooling and administrative presence, encouraging families living in camps to move into the community. Settlement of Inuit from surrounding camp locations intensified in the late 1960s following an epidemic that killed most of the dog population. As of 2016, Kimmirut population was 389 (93% Inuit; Statistics Canada 2017a). Today, Kimmirutmiut maintain a lifestyle connected to the seasonal harvest of wildlife. Carving, outfitting and guiding through the nearby Katinnilik Territorial Park also provide a significant contribution to the local economy.

Wildlife harvesting

Based on interviews with Kimmirut residents and discussions with community researchers and HTO board members and manager, we constructed a calendar of seasonal harvesting activities in which Kimmirutmiut engaged in throughout the year (Figure 3). This calendar provides further context to understand the type of harvesting activities undertaken in the community and the wildlife present around Kimmirut.

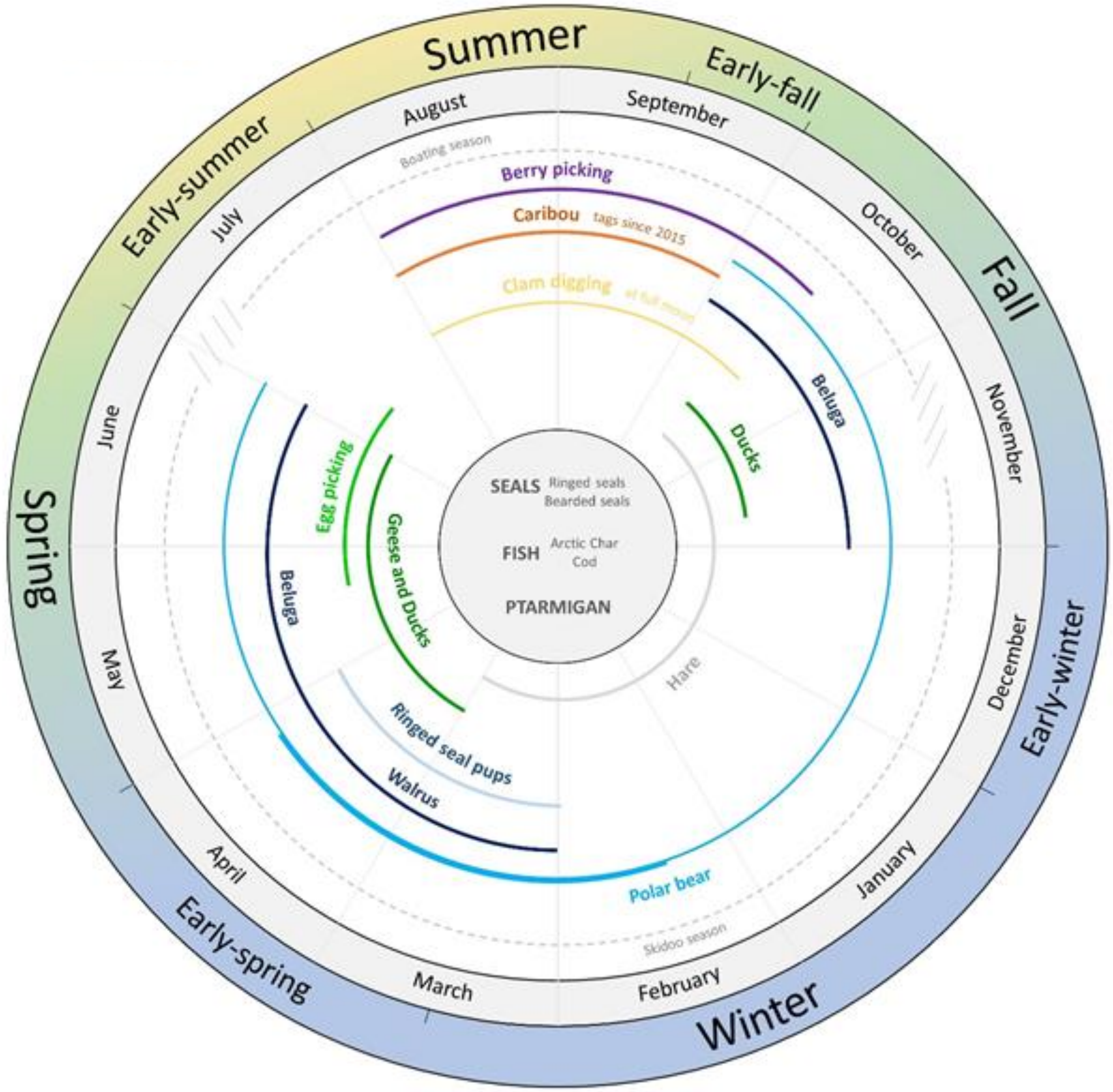


Figure 3. Seasonal harvesting activities in Kimmirut. Overview of harvesting activities that Kimmirutmiut engage in throughout the year and typical modes of transportations used seasonally. Four diagonal grey lines are used to identify usual sea ice break up and freeze up times in early spring and fall, respectively.

Polar bear harvesting

In Nunavut, polar bear harvest is subjected to a quota system (Government of Nunavut 2019). Local HTOs are responsible for establishing the timing and duration of the polar bear hunting season in each community[9]. In Kimmirut, polar bears from both the Davis Strait (DS) and the Foxe Basin (FB) subpopulations and management units are harvested (harvest quotas for 2018/2019 were nine polar bears for DS and 13 for FB; Figure 1). Generally, the polar bear hunting season opens in October each year and ends the following June. Polar bears are most commonly harvested between mid-February to mid-April (see thicker blue line on Figure 3) when fur quality

[9] As per the Nunavut Wildlife Act (Government of Nunavut 2003), the polar bear harvest season in Nunavut is year-round (July 1-June 30) and local HTOs are responsible for establishing seasonal limitations for their respective communities.

is at its best and chances to harvest a large polar bear are greater. This time of year coincides with the ringed seal pupping season when polar bears hunt seal pups in their birth lairs.

In the past several years, the decreased economic value of polar bears hides has been a strong disincentive to hunt polar bears in Kimmirut. The last time the polar bear quota was fully used in this community was in 2013-2014. Since then, annual harvesting quotas have not been fully used and unused tags resulted in harvest credits. As of November 2019, Kimmirut had a total of 24 harvest credits for polar bears accumulated since 2013 (Kimmirut Conservation Officer, personal communication).

Pangnirtung

Pangnirtung (66°7'N, 65°55'W) is located on the Cumberland Peninsula on the southeastern shore of Pangnirtung Fjord and off the northeastern end of Cumberland Sound in the Qikiqtaaluk region of Nunavut (Figure 1). Community name derives from the Inuktitut word *panniqtuuq* (meaning 'place of the bull caribou') (Harper 2004).

Cumberland Sound has been home to Inuit for over 1,000 years, with seals, walrus, beluga whales, and bowhead whales frequenting the waters. Organized whaling activities have taken place in the area since 1818 (Laidler et al. 2008). A Hudson Bay Company (HBC) trading post was opened in Pangnirtung in 1921, followed shortly by a detachment of the Royal Canadian Mounted Police (Kemp 1976). From the mid-1950s to the early 1960s, the federal government began establishing a schooling and administrative presence, encouraging families in outlying camps to move into the community (Harper 2004). Currently with a population of approximately 1,481 (94% Inuit) (Statistics Canada 2017b), Pangnirtung is known for its commercial turbot fishery, the nearby Auyuittuq National Park and its unique weaving artistry (Laidler et al. 2008).

Wildlife harvesting

Based on interviews with Pangnirtung residents and discussions with community researchers and HTO board members, we constructed a calendar of seasonal harvesting activities in which Pangnirtungmiut engaged in throughout the year (Figure 4).

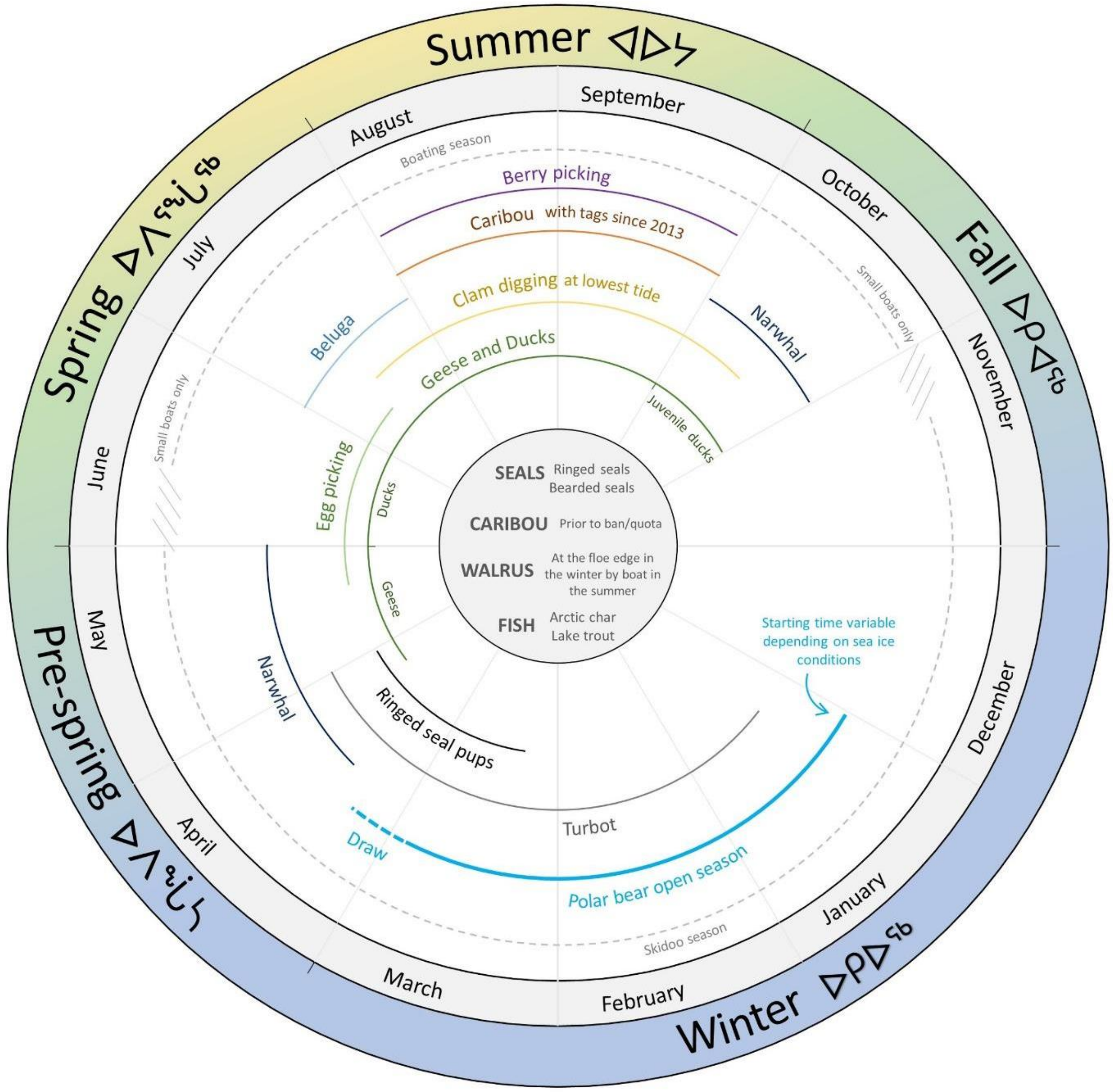


Figure 4. Seasonal harvesting activities in Pangnirtung. Overview of harvesting activities that Pangnirtungmiut engage in throughout the year and typical modes of transportations used seasonally. Four diagonal grey lines are used to identify usual sea ice break up and freeze up times in early spring and fall, respectively.

Polar bear harvesting

In Pangnirtung, polar bears from the Davis Strait subpopulation and management unity are harvested (harvest quota for 2018/2019 was 16 polar bears). The polar bear hunting season opens in January each year (timing may vary depending on sea ice conditions) and ends when all polar bear tags have been fully used, which generally happens by April.

RESULTS AND DISCUSSION

We summarized below the knowledge that was shared by 35 Inuit polar bear experts from Kimmirut and Pangnirtung over the course of individual and groups interviews. Contributors shared diverse perspectives about the cultural importance of polar bears, polar bear ecology and health, and polar bear management.

Representative quotes from contributors are provided for each theme that was discussed during interviews. Some quotes were anonymized to reflect participant wishes. For certain themes, we indicated how many contributors made similar comments on a given topic (n). However, because interviews were semi-directed, not all themes were discussed by all participants. Therefore, failure to discuss a theme did not necessarily imply lack of agreement with and/or knowledge of the subject. With this consideration, numbers of interviewees reported below represent minimum numbers of individuals who shared similar views on specific topics. We also highlighted areas where contributors shared different views.

Interview results from Kimmirut and Pangnirtung are presented together, except when the knowledge shared was specific to a community. In these cases, perspectives from each community are presented separately. A glossary of Inuktitut polar bear terms is presented in Appendix 6.

Polar bear cultural importance, uses and practices

General importance

Interview contributors described their past and ongoing relationships with polar bears and shared a strong sense of the importance of polar bears to Inuit culture, identity and traditions, and their persistence for future generations. They also highlighted the economic importance of polar bears through the selling of hides. Participants explained that *nanuq* is a mighty and majestic animal. Polar bears are top predators that may be both respected and feared.

> *"Polar bears are very important to us, because they're living with us…on this land of Nunavut and Baffin Island." (Meeka Alivaktuk, Pangnirtung)*

> *"Polar bears are very important…This is the land of the polar bears. They are on top of the food chain, their meat is very good, their hide is worth money and it helps pay for food and other things." (Anonymous 02, Kimmirut)*

> *"Polar bears are important to us because all the animals are very important to us. Polar bears provide us with meat and food, and it has been this way through all my life." (Eliyah Padluq, Kimmirut)*

> *"Polar bears are important to me. They are important for the future generations and they should be around for our young children." (Geetee Maniapik, Pangnirtung)*

In Pangnirtung and Kimmirut, many participants explained that polar bears are intelligent and resilient animals that respond to how humans interact with and talk about them. Some participants highlighted that bears are "much like humans" and that they must be approached and talked about with respect.

> *"Polar bears live like humans and think like humans. They are very important to me because they are like humans." (Itee Temela, Kimmirut)*

> *"I have a lot of respect for polar bears. I don't like to talk about polar bears...We have to be really respectful to them." (Meeka Alivaktuk, Pangnirtung)*

> *"I was told that we should not ask to see a polar bear because they are near and they hear you and they might just show up when they are least expecting this. This has always been our tradition…I used to take tourists down to my cabin, and one time two tourists kept saying: "I want to see polar bears, I want to see polar bears." And my son kept telling them: "Don't say this. It is our tradition not to ask to see a polar bear because they are always around the corner when you are least expecting them." So one of them said: "I don't believe in that. I still want to see a polar bear." And then during the night two polar bears got to our cabin and they got so close to these tourists that they didn't want to see a polar bear ever again. Those two tourists learned their lesson." (Eliyah Padluq, Kimmirut)*

> *"Polar bears are very mighty and they could do anything…they could be vicious to humans, and because we are talking about them they are listening. I know this from long ago. I was told that they could listen. Just by mentioning them, they know that they are being talked about. I have learned this from the Elders." (Joe Arlooktoo, Kimmirut)*

Some contributors explained that Inuit Qaujimajatuqangit emphasizes the importance of harvesting only what one needs, not playing with bears, and avoiding to waste polar bear meat.

> *"The traditional knowledge passed down to me from my family and Elders is don't overkill, don't leave the meat, don't leave anything and don't waste." (Isaac Temela, Kimmirut)*

> *"I was always told that they're animals and that you cannot play with [polar bears], they're very important." (Leopa Akpalialuk, Pangnirtung)*

In Pangnirtung and Kimmirut, stories about polar bears have been passed down through generations.

> *"There was a man who was not a very good hunter and could not catch seals. He was eating the catch of other and he was always left with the smallest pieces. Once he got back to his camp with a small piece of seal and he saw a polar bear. The polar bear had a seal and a rabbit and he offered his catch to the man. From that moment onwards the man became a skillful hunter…This story was passed down from my grandfather." (Lazarusie Ishulutaq, Pangnirtung)*

> *"I heard an old story that somebody used to have a pet polar bear, they had killed the mother and kept the small pups. It is an old story but I believe it! The human raised the cub that turned into [an adult] polar bear." (Isaac Temela, Kimmirut)*

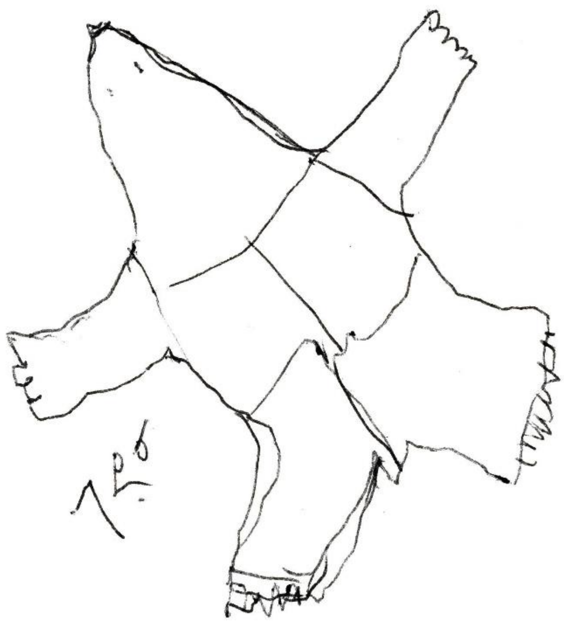
Finally, stories shared by participants from Kimmirut and Pangnirtung emphasized the symbolic importance of polar bears. Some commented on how hunting a first polar bear –the top predator of the Arctic– marked passage from youth to adulthood for a young Inuk man and hunter (see also 'Polar bear harvesting' section).

Polar bear uses

In the past, polar bear meat and fat were shared among families and used as food for sled dogs.

> *"Back then, [Inuit] used their knowledge like 'kill [the bear] once you see it' because food was very important. Everyone was very happy when someone caught a polar bear because that meant that everyone had food and the food was going to last." (Lazarusie Ishulutaq, Pangnirtung)*

> *"Back then we would harvest a bear, nothing was wasted, all the meat was harvested except the intestines…Back then the hide was divided amongst the hunters who participated in the hunt…The organs were given to the dogs and if the bear was fat, the fat itself was used to light the qulliq [oil lamp] to provide heat." (Eliyah Padluq, Kimmirut)*



> *"My father had his share of catch of polar bear hide. The hide was divided into seven parts."*
>
> – Joannie Ikkidluak, Kimmirut

Figure 5. In the past, Inuit hunters would divide the polar bear hide into parts. The hide was shared among the hunters who participated in the hunt. Drawing by Joannie Ikkidluak (shared with permission).

Traditionally, polar bear hides were divided into parts and shared among the group of hunters who participated in the hunt (Figure 5). In the past, hides were used for clothing, as mattresses and for trade. One contributor from Kimmirut explained that polar bear hides were also used to smooth off *qamutiik* [sled] runners.

> *"[My grandparents] used [the hides] for mattresses or cover...And trade with Hudson Bay for supplies, trade the pelt with supplies like flour." (Geetee Maniapik, Pangnirtung)*

> *"Even a small portion of the skin would be useful in the old days. It would be used on the qamutiik runners…People would collect moss and soil and when it was cold out they would use water to mix it altogether and put it on the runners of the qamutiik. Then they would let [the mixture] freeze on the runner. They would use their knife to smooth it out and finally*

take a piece of the polar bear skin [to smooth the surface]. They would have water in their mouth because in the winter the water would freeze, they would spit the water on the fur and use it to smooth the runners. I have seen it and done it before." (Itee Temela, Kimmirut)

In Pangnirtung and Kimmirut, polar bears contribute still to this day to sustain local food security, traditional lifestyle, and the local cash economy. Polar bears are harvested today mainly for their meat and hide. Polar bears are a source of country food that is shared among community members. Contributors explained that polar bear meat should not be wasted and highlighted the importance of sharing meat with relatives and community members. Participants highlighted that polar bears hides can be sold but also used for clothing (for pants or kamiit [boots]) and as mattresses or blankets mainly utilized when camping. In both communities, polar bear skulls, carvings and jewelry (made of polar bear teeth and claws) are sometimes sold.

"Some people go on the radio and say: "There's polar bear meat, you can pick it up!" and people go up there. And the meat is gone within an hour or so…The more fat it has, the more people want it. So the whole meat is brought home and it's gone." (Davidee Nowyuk, Pangnirtung)

"[In the past], if someone got a polar bear they would divide the hide and would share the meat with the community. Nowadays they don't divide the hides anymore but the meat is still really shared. I still have some meat that was given to me by other families." (Jeannie Padluq, Kimmirut)

"It is important to keep the polar bears forever for food security." (Johnny Mike, Pangnirtung)

"The fur provides everyday income and [is also] used for clothing for the cold weather. People sell the fur when they need some income and they have no other means of getting it." (Anonymous 01, Kimmirut)

"We like using the skins for clothing like pants...My parents have always had a polar bear skin that they use for under their mattresses, when they're out camping." (Anonymous 04, Pangnirtung)

"[Polar bear hides can be used] as a mattress. The fur part on the floor because it doesn't get wet on top…Fox furs when they get wet, it takes a while for them to dry but polar bear hide it's nothing like it." (Leesee-Mary Kakee, Pangnirtung)

"The teeth are used to make crafts nowadays by younger generations, those who are carvers, and the claws are also useful." (Itee Temela, Kimmirut)

Some participants reported that the meat of polar bears that were tranquillized, that are too skinny, or that visited the dump is not always eaten.

"Now, researchers put them to sleep [tranquillize polar bears] and study the polar bear. People sometimes are scared because the bears they harvest might have been the ones that were tested on. People are scared to eat it." (Lazarusie Ishulutaq, Pangnirtung)

“I would not harvest one or let people eat a bear that has a tag [which means] it has been tranquillized. If I catch a bear with a tag, I would not distribute the meat. I would just probably give it to the dogs or throw it away because it has been tranquillized and I am not sure what has been done to it.” (Ejetsiak Padluq, Kimmirut)

“If the carcass of the bear looks good to eat we won’t waste it. We will use the meat as a meal as long as it’s not skinny, if it’s healthy enough.” (Itee Temela, Kimmirut)

“When polar bears go to the dump, people don’t want to eat their meat.” (Eliyah Padluq, Kimmirut)

In both Kimmirut and Pangnirtung, polar bears have been for decades and continue to be today a source of income through the selling of hides. Contributors explained that selling polar bear hides was a strong motivation to hunt polar bears especially in the 1980s and 1990s when polar bear hides were in high demand and consequently their economic value was high. However, many participants commented that the economic value of polar bear hides has declined in recent years (especially over the past 10 years) and that hides are now more difficult to sell; some explained that this situation created a significant disincentive to hunt polar bears.

“Around the 80s and 90s when the Conservation Officers started coming up here is when the price increased for the hides. Those Conservation Officers had contacts to sell the hides for auction...the price of the hides would vary based on how big it was and how clean it was. The condition of the hides were graded and the price was higher if the hide was bigger and cleaner. The biggest polar bear I ever got was a 13 footer and I sold that for $10,000.” (Sandy Akavak, Kimmirut)

“In the 1960s and 1970s it was really important to hunt polar bears because we could sell hides to whoever wanted to buy them and the meat was important to us...now I don’t hunt polar bear anymore but when somebody gets a polar bear they share the meat with everybody, but polar bear hides don’t sell very much anymore.” (Jawlie Akavak, Kimmirut)

“I rarely go [polar bear hunting] now because the price for polar bears is not as high as it used to be...maybe five years ago the price dropped.” (Matiusie Maniapik, Pangnirtung)

In Kimmirut, some contributors explained that fewer community members are experienced with preparing hides today, and this constitutes a further disincentive to harvest polar bears in addition to the decreased economic value of polar bear hides. Hide preparation requires a lot of work.

“Lately people have not been really going after bears maybe because there are less ladies that clean the hides for them because the bear hides are not easy to clean...you have to be really skilled to clean polar bear hides.” (Joe Arlooktoo, Kimmirut)

“They are not as important to me because the cost of their hides has gone down and I don’t have a wife that can clean the skins for me.” (Sandy Akavak, Kimmirut)

Polar bear harvesting

Contributors discussed how polar bears were harvested in the past and how harvesting is done today. Harvesting preferences and practices provide insight on incentives (and disincentives) for hunting polar bears and how knowledge of polar bears is acquired.

Prior to the introduction of the quota system in the 1960s, Inuit hunters could harvest any polar bear at any time of the year, including family groups (female with cubs). Polar bears were most often hunted opportunistically.

> *"No matter the time of the year, they used to harvest…because they didn't have any quota or anything at that time." (Akeego Killiktee, Kimmirut)*

> *"In the past, we could eat all types of polar bears. The biggest male polar bear was more food for the dogs and the female or the cubs were more delicious." (Leesee-Mary Kakee, Pangnirtung)*

In Pangnirtung, harvesting denning females in the winter was reported as a traditional practice carried out up until approximately the 1960s, especially in denning sites located on the Cumberland Peninsula. In Kimmirut, contributors had not directly experienced or were not aware about the practice of harvesting denning females in the Kimmirut area and a few participants reported that they were taught not to hunt bears in dens. However, one Elder recalled his father telling him stories of hunters harvesting denning females.

> *"My father shot a mother [polar bear] when he was approaching the den. And then my father told me to go inside the den. With the rifle I shot the one year old cub. So that was my first polar bear." (Simeonie Keenainak, Pangnirtung)*

In the past, polar bears were hunted by dog teams.

> *"My mother used to tell me that her father would not use a rifle to hunt a polar bear, but only a harpoon. That was his way of hunting polar bears at that time...At that time they had dogs with them and [dogs] were part of their hunting method for polar bears." (Joe Arlooktoo, Kimmirut)*

> *"Men used to [cover themselves with a polar bear hide]…and then they went to their dogs…The dogs used to bark a lot when [the men] covered themselves in polar bear hide pretending to be a polar bear to train [their dogs] to know what to do if they encountered a polar bear." (Michael Kisa, Pangnirtung)*

The establishment of harvesting quotas in the 1960s and the development of a cash economy associated with the selling of polar bear hides has contributed to significant changes in polar bear harvesting practices in both Pangnirtung and Kimmirut. Harvesting polar bears transitioned from being sporadic and mainly opportunistic to being seasonal and sex-selective. Harvesting quotas today limit the number of bears that can be harvested. Sex-selective harvest regulations[10] have

[10] In Nunavut, the polar bear harvest sex ratio was adjusted in 2019 from two males harvested for every female (2:1) to up to one female for every male (up to 1:1) –male and female polar bears can now be harvested in any proportion up to a maximum of 50% females (Government of Nunavut 2019). Interviews were conducted before this change was implemented.

also encouraged the harvesting of big adult males or *angujuaq*. Participants also explained that the traditional practices of hunting denning females or family groups are not in use anymore.

> *"When we see one [polar bear] that is when the hunt starts. We go after it once we see one. I observe if it is a female or a male first, I observe the gender if we were going to go ahead with the kill...I try to harvest only the males. I stay away from harvesting females." (Ejetsiak Padluq, Kimmirut)*

> *"Back in the day, not very many young people would go hunting for polar bears. But today, anybody is out hunting with their kids or young hunters who are learning how to kill a polar bear." (Abraham Keenainak, Pangnirtung)*

> *"Today, there are more bears and faster machines and better rifles. The two things combined [make polar bear hunting easier nowadays]. Better equipment and more bears." (David Kooneeliusie, Pangnirtung)*

Today, hunters harvest polar bears using snowmobiles, except for guided sport hunts which are done exclusively by dog teams. Polar bear hunting is mainly conducted by men, although some women also engage in polar bear hunts.

> *"I was the first woman to hunt [polar bears] in this community when they picked names [using a draw system after the quotas were implemented]...My name was picked, so I had to go in February, it was the coldest month of the year." (Meeka Alivaktuk, Pangnirtung)*

In addition to providing a source of income, sport hunting allows Inuit to maintain strong connections with the land and Inuit traditional ways of life.

> *"I am the only one with a dog team in town right now and polar bear sport hunts have to be done by dog team. When I get the chance, I try to go on a hunt. It helps me and the community with much needed wages [as I have other people coming along]...If you hunt bears by dog team it is very fulfilling. You can hear the dogs make a call or cry and no other time they will do [the same]: the sound is different." (Anonymous 02, Kimmirut)*

Polar bear hunters from both communities reported that the months of March and April are best for harvesting bears because it allows obtaining hides of greater economic value. At this time of year, polar bear fur quality is at its best (longer, thicker) and there are increased chances of harvesting large polar bears (*angujuaq* and *tulajuituq*) as male bears come to the stable ice to hunt seals pups and find a mate.

> *"This time of the year [spring] is the best, especially for their fur...It's mating season too. If you want to get a big one, this time is the best to find a big male." (Leopa Akpalialuk, Pangnirtung)*

Contributors from both Kimmirut and Pangnirtung also reported that polar bears have been harvested in defense of life and property in recent years (see also 'Impacts of increased polar bear abundance' and 'Polar bear distribution near communities' sections).

> *"I had to kill that one [bear] because it was ruining the cabins there. It was a small bear. It was alone and hungry in the fall." (Leopa Akpalialuk, Pangnirtung)*

"[I am concerned about] the safety of the town when [bears] came in. When they [my neighbours] made a defence kill [in 2015-16] is when I realized about the possibility of them [polar bears] coming into town and I have heard that polar bears are coming in more into town." (Anonymous 01, Kimmirut)

Many interview contributors vividly recalled harvesting their first polar bear or accompanying relatives on a polar bear hunt for the first time. For a young Inuk hunter, hunting a first polar bear marked passage from youth to adulthood.

"My first polar bear catch was here in the Markham Bay area and I was 16 years old and it was February. A beautiful day and really cold. It was a 13 and a half [feet] polar bear." (Isaac Temela, Kimmirut)

"I was maybe three or four years old. It was early fall. There was a polar bear that was spotted by our camp...My father wanted to leave me behind when he was going after the polar bear, but I wanted to go so badly that I cried…We walked towards the polar bear and my father and I were pretending to be seals and just waited for the polar bear to come. As the polar bear kept coming, it was going down...ready to attack putting its head up and down. I was so scared…When the polar bear was reaching us, my father shot it." (Leesee-Mary Kakee, Pangnirtung)

Participants from both communities talked about the importance of maintaining polar bear harvest into the future to preserve Inuit ways of life. Polar bear hunters interviewed explained that harvesting polar bears is an important activity that connects Inuit to the land.

"You have to be really careful but it is a lot of fun looking for polar bears and catching them." (Matiusie Maniapik, Pangnirtung)

"I am hunting a lot because it is calming and it reminds me of the old days." (Lazarusie Ishulutaq, Pangnirtung)

Polar bear butchering practices

Contributors from both Pangnirtung and Kimmirut reported that it is a common practice for Inuit polar bear hunters to butcher polar bears immediately after harvesting before the carcass freezes. In both communities, polar bear butchering is mainly performed by men. First, harvested polar bears are skinned; some contributors explained that polar bear paws and sometimes the head are generally left attached to the skin to be carefully cleaned afterwards by the 'hide cleaners' (i.e., women specialized in processing and cleaning polar bear hides). Then, the carcass is butchered: organs are discarded and the remaining carcass is divided into portions. Polar bear hunters may also collect tissue samples for polar bear research. Polar bear hide and meat are brought back to town, while the organs are left on the kill site. The only organ that is thoroughly inspected is the stomach, which is almost always cut open to check its content. In town, polar bear meat is shared among community members and the hide is given to hide cleaners to be thoroughly processed (cleaned, stretched and dried) prior to be sold or used. Polar bears harvested during sport hunts are processed similarly to bears harvested for subsistence. The difference is that the hide (and often head) of polar bears harvested through sport hunts is often exported right away to be processed by taxidermists.

“We make sure [the polar bear] is dead and it is not playing dead, first of all. Then we cut it up. It takes at least one hour, one hour and a half to [process the carcass of] a bear. Then we wrap the hide and put the bear hide in the bag [the sport hunters] provide. Then we take some of the meat and some of the meat we do not take, and then we go back to the camp and then back to the community after that, at the earliest possible time, weather permitting.” (Anonymous 02, Kimmirut)

“We butcher [the polar bear] right away, right after it dies because the carcass freezes [fast]. I don’t check much the organs, except for the stomach. I open it up to observe what the bear has eaten.” (Ejetsiak Padluq, Kimmirut)

“I check [polar bear stomachs] and what they usually have in their stomach is seal skin and fat. Sometimes meat. No bones. Hardly. Only when they’re really hungry sometimes they’ll eat the bones. [Polar bears] are similar to us, like, some people are good at hunting, some are not. Same with polar bears.” (Davidee Nowyuk, Pangnirtung)

“I take everything with me [but] the organs…I leave [those] to the ravens to eat. [But I look at the stomach and] there is always seal in it.” (Lazarusie Ishulutaq, Pangnirtung)

Polar bear hide processing

In Kimmirut and Pangnirtung, women mainly process polar bear hides. Contributors explained that preparing polar bear hides is a work intensive process that is often done collaboratively. Polar bears hides are generally processed soon after butchering. To clean a hide, fat is scrapped off manually using traditional tools including an *ulu* [knife] and a *saligut* [dull knife used to clean the leftover fat]. Once the hide is cleaned and washed, it is hung, dried and stretched with an *inniuti* [rope], onto the *innivik* [frame].

“Cooking [polar bear meat], cleaning [the hide] and putting it on the drying frame, taking it off and then whenever we need to turn it into clothing, stretching it out, sewing it: that’s my responsibility.” (Anonymous 04, Pangnirtung)

“I have never helped with butchering the animals but I was given the task to clean the hide if a hunter harvested a polar bear. Just clean, stretch and dry and then I would give it back...When I was younger I used to be able to clean the whole hide in one day but since I started aging I normally just remove the fat then [work on] the paws and the head parts the next day. It is a very heavy task. First, you have to remove all the fat so that the skin will not yellow or smell from the fat. Then when I have removed all the fat I do the head and the paws which is the hard part of cleaning of the hide. When I finish all of that, I then remove all the excess fat and water from the fur...We use the woman’s knife, the ulu, to scrape the fat from the hide, and then there is a tool that is called saligut that is used to remove the excess fat and water from the fur...Then I would wash the hide and remove the excess water with the saligut again. When that is finally done we would make holes and put it out to dry out, after [mending] all the holes. Then you finally leave it out to dry during the winter. Sometimes we leave it out longer so that the fur would turn whiter.” (Akeego Killiktee, Kimmirut)

“After I wash [the hide in the washing machine] I usually get my boys to pull the skin with a skidoo, like get it all covered in snow…so it dries faster. After the washing machine, I cover [the hide] with snow because the fur dries faster by stepping on the fur. And then I

have [my boys] pull it on a rope by skidoo on the ice. That way it's cleaner and it gets all the oil off of it...[After that I] hang it to get the fur dry and then after, they dry very easily, they dry quickly...And then we stretch them onto the frame." (Geetee Maniapik, Kimmirut)

Many contributors specialized in polar bear hide processing explained that polar bear body condition (fatness) is reflected on how difficult it is to clean a hide. Hides with a lot of fat and those from bears that were just butchered are generally easier to clean and process.

"[How easy or hard it is to clean a hide] all depends on the quality of the skin –like how much fat it's got on it– and it also depends on how it was stored: the sooner you clean it, the easier it is. So if [the hide] was put in a freezer right away and it was frozen for a long time, then it's also hard to clean. But generally, as long as it's got a fair amount of fat on it then it's usually pretty easy to clean." (Anonymous 04, Kimmirut)

In summary, the role and importance of polar bears in Inuit culture, identity and traditions highlights Inuit unique relationship to polar bears. This relationship may shape how interview contributors talk about and share their knowledge about polar bears. Information shared by contributors on polar bear harvesting, butchering and hide processing practices also sheds light on how Inuit Qaujimajatuqangit is acquired and is crucial to contextualize and understand the depth of insight interview participants can provide related to polar bear ecology and especially health.

Polar bear ecology and health

Contributors shared their knowledge of polar bear ecology and health, including their observations and perspectives on: polar bear abundance and demography; habitat and distribution; diet and prey availability; body condition and general health; disease, mortality and unusual events; human-polar bear interactions; and the future of polar bears. Prior to presenting contributors' knowledge about polar bear ecology and health, we first discuss the temporal depth and geographic scope of their knowledge and ecological observations, as well as modes of IQ acquisition, so that the information presented herein can be adequately contextualized.

Temporal and spatial scope of Inuit Qaujimajatuqangit

Inuit Qaujimajatuqangit shared by participants over the course of this study was acquired through their direct individual experiences with polar bear harvesting, butchering and hide processing, as well as through their experience living and travelling on the land. Some of the knowledge they shared was also obtained indirectly though discussions with other hunters, Elders and community members.

While IQ that participants had learned from relatives and other community members could date back many generations, the temporal depth of their direct ecological observations varied depending on the age of each contributor. Earliest direct ecological observations reported by participants dated back to the 1940s. Direct polar bear observations reported by participants were made during polar bear harvesting and hide processing activities but also while they were hunting other species (e.g., seals, beluga, walrus, birds, caribou, fish) or travelling on the land and at sea.

The geographic scope of IQ that was gathered through this study mainly corresponds to the areas where contributors had travelled and conducted land-based activities over their lifetime. Figure 6 illustrates participants 'range of direct observations'; this area corresponds to the geographic extent of the aggregated areas where contributors from Pangnirtung and Kimmirut had travelled and conducted land-based activities in spring, summer, fall and winter over their lifetime. Although some contributors may have acquired knowledge derived from other geographic areas (e.g., when living in another community), most of their direct ecological observations and experience relevant to polar bear ecology were made within the areas highlighted in Figure 6. The geographic extent of ecological observations made by participants also varied within their lifetime according to changes in land use patterns and modes of transportation. For example, by the 1970s, most Inuit living in outpost camps along the coast of the Cumberland Sound and Peninsula and the north shore of Hudson Strait were relocated to the communities of Pangnirtung and Kimmirut (then Lake Harbour), respectively. In addition, while travel by dog teams and by foot was a predominant mode of transportation up until the 1960s, motorized transportation (snowmobiles, all-terrain vehicles and motorized boats) is mostly used today.

During group interviews conducted with polar bear harvesters from Kimmirut (n=3; totalling eight participants), contributors participated in mapping exercises to record in detail their individual areas of observation over four specific time periods: (1) during the 1960s; (2) during the 1990s; (3) around 2005; and (4) over the last three years (2016-2019). All participants (n=8) mapped individually the areas they regularly travelled to and observed for each of these four time periods (Appendix 5). Individual maps were then aggregated to produce heat maps that provide an indication of land use intensity in space and time (see Figure 7). It is important to note from Figure 7 that contributors' overall range of direct observations has remained relatively stable since the 1960s. This information is crucial to support the interpretation of contributors' observations of temporal changes in polar bear abundance in the Kimmirut area, as well as analyses related to polar bear distribution (see 'Polar bear distribution over time' section). Particularly, Figure 7 indicates that changes in the frequency of observation of polar bears over time are not influenced by temporal changes in land use by study participants.

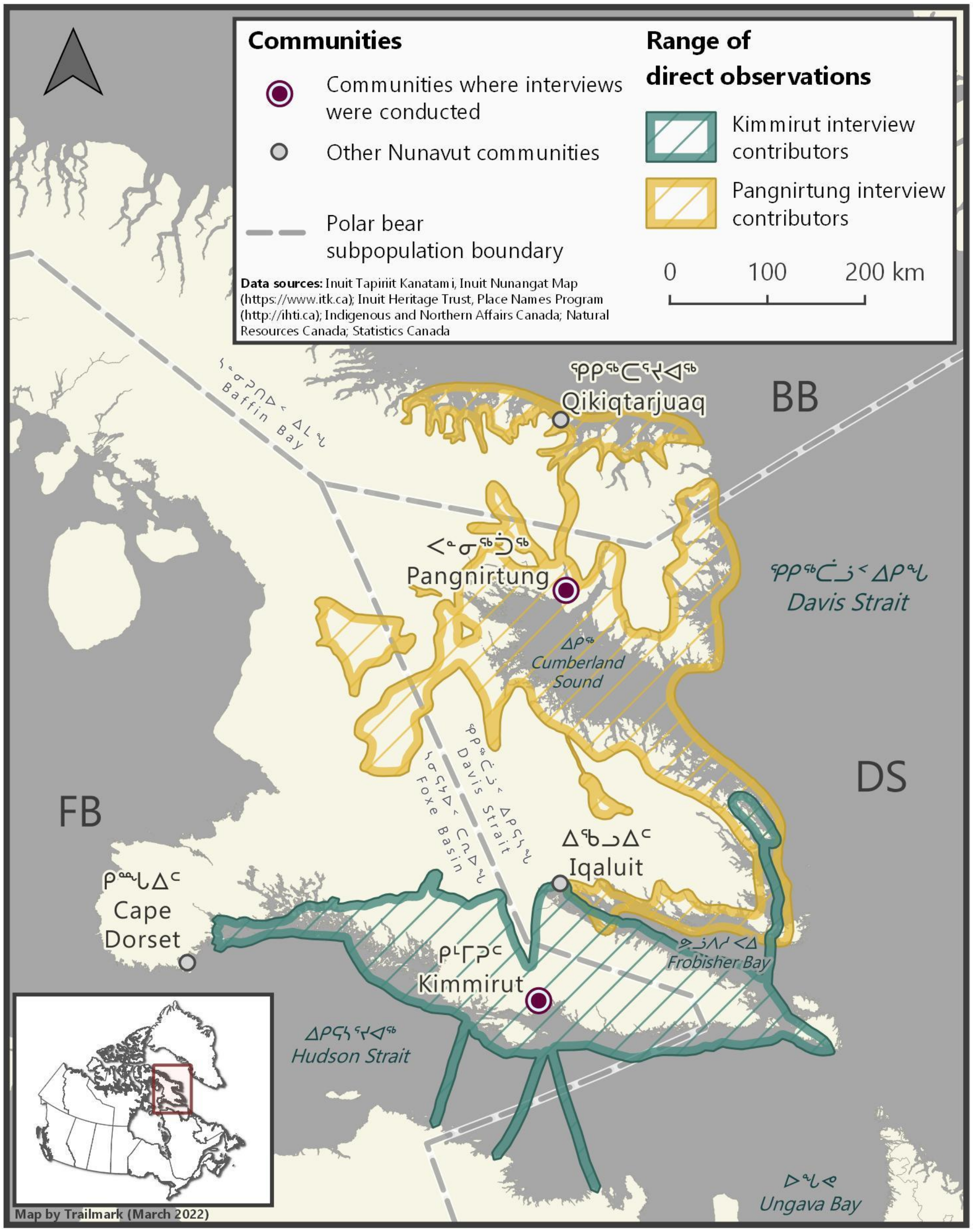


Figure 6. Contributors' geographic range of direct observations. This range was obtained by aggregating areas where participants from Kimmirut (n=21) and Pangnirtung (n=14) had travelled and conducted land-based activities in spring, summer, fall and winter over their lifetime. DS: Davis Strait polar bear subpopulation and management unit; FB: Foxe Basin polar bear subpopulation and management unit; BB: Baffin Bay polar bear subpopulation and management unit.

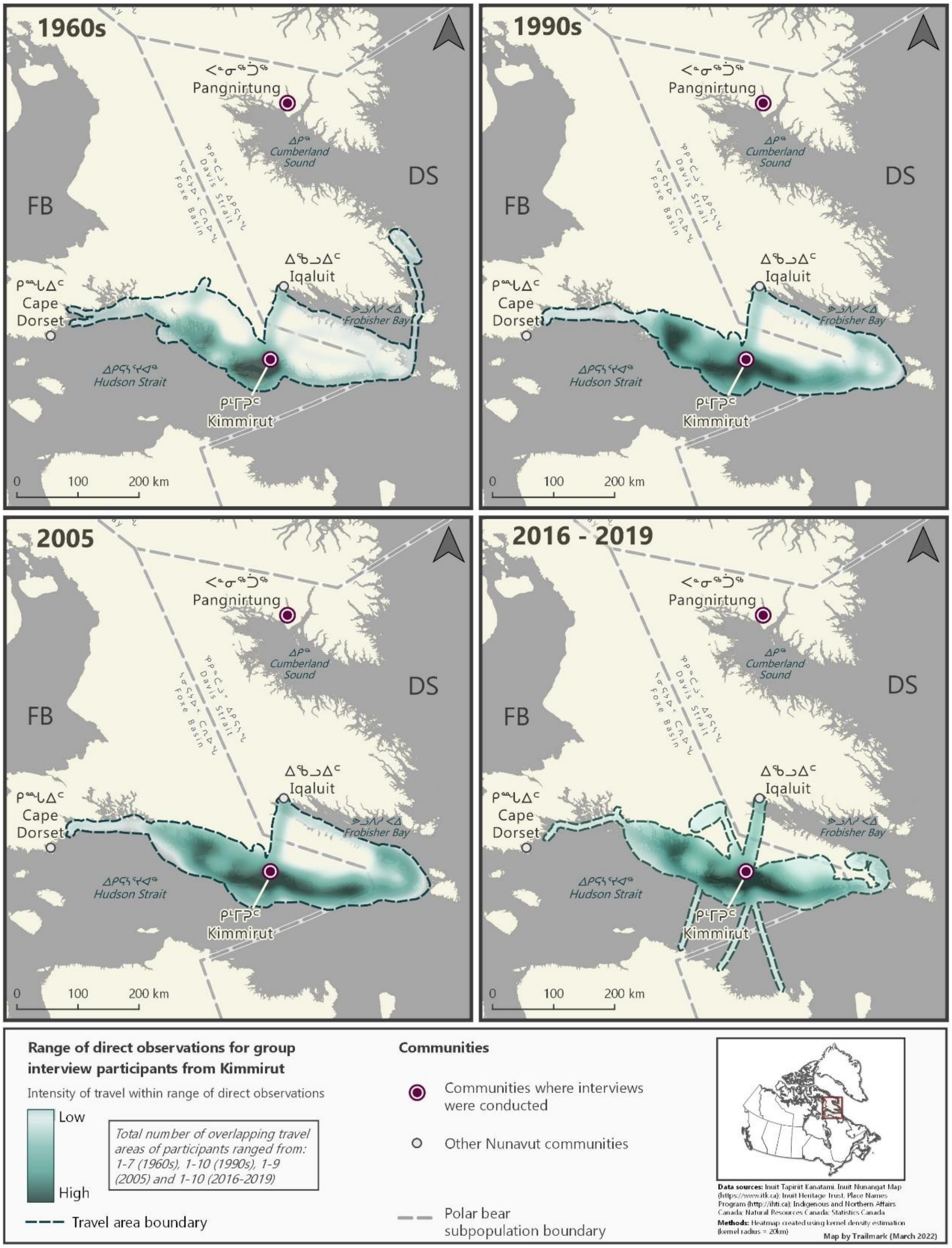


Figure 7. Travel intensity within range of direct observations around Kimmirut over four time periods according to group interview contributors from Kimmirut (n=8). Contributors used both polygons and lines to indicate areas of travel during each time period. Heat maps were generated employing a kernel density estimation using travel areas (polygons and lines) buffered by 20 km. DS: Davis Strait polar bear subpopulation and management unit; FB: Foxe Basin polar bear subpopulation and management unit; BB: Baffin Bay polar bear subpopulation and management unit.

Abundance and demography

Interview contributors described changes in polar bear abundance observed over their lifetime. Participants also provided explanations as to why polar bear abundance has changed over time and discussed the various indicators they employ to assess bear abundance. Contributors commented on the size of family groups (female polar bear with cubs), cub productivity (number of polar bear cubs produced in a population) and cub survival (number of polar bear cubs that survive their first year) and discussed changes observed over time in the number of bears observed for certain sex and age groups.

Observed changes in abundance

In both Kimmirut and Pangnirtung, all participants reported a steady increase in polar bear abundance observed across their entire area of observation over their lifetime. Many contributors also described a progressive increase in the abundance of bears observed within or close to their community starting from around the 2000s. Figure 8 summarizes polar bear abundance trends reported by contributors during individual interviews conducted in Pangnirtung and Kimmirut.

During interviews, contributors indicated that polar bear encounters in the past were rare. Some participants reported second hand information and stories from their Elders who explained that polar bear abundance was lower in the past.

> *"My great grandfather, my grandma's father, had told stories of going all the way down here [south Okalik Bay] to hunt polar bears and there would never be any polar bears." (Lazarusie Ishulutaq, Pangnirtung)*

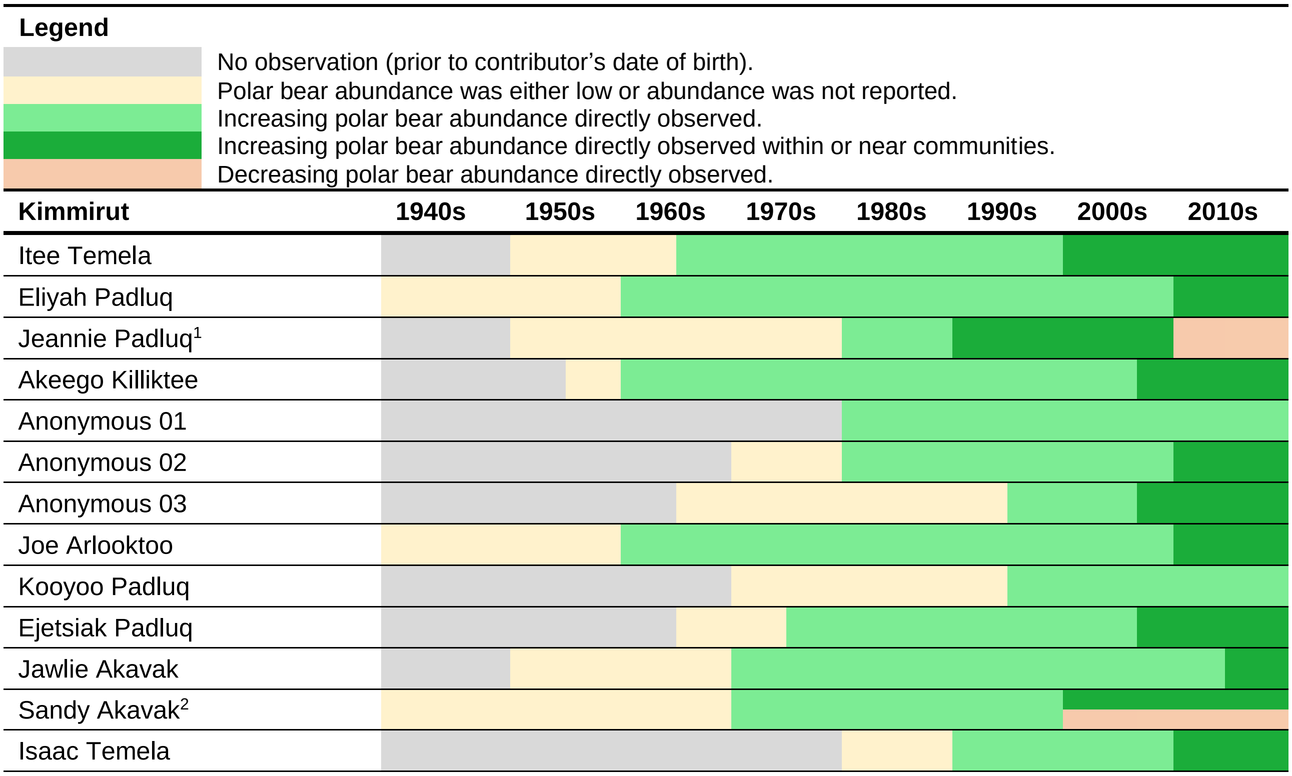
> *"According to the people that have been living here much longer than me, they say they'd rarely see polar bears when they were out camping...You know, [Elders] say that when they were out camping they would barely see bears in those years, now every time we go out we can see a polar bear, almost every time." (Anonymous 03, Kimmirut)*

All individual and group interview participants (n=35) reported first hand observations pointing to a general increase in polar bear abundance observed over their lifetime within their area of observation (Figure 8). Earliest observations of this increase were made in the 1970s in the Pangnirtung area and in the 1960s around Kimmirut (Table 2).

> *"There was not a lot of polar bears back then [in the 1960s]. People living on the coast were not going polar bear hunting because there was no polar bears around at that time; that was around the 60s...And as the years progressed towards the 2000s the population increased and [we could hunt polar bears] closer to town...It is easier to hunt them nowadays than it was back then. If you were to go polar bear hunting to either side [you] would not have a problem harvesting one." (Sandy Akavak, Kimmirut)*

> *"In those days [70s and 80s] there was hardly any polar bears around Pang. In those days, we'd see polar bears here and there whereas these days we see them where we go for seal hunting 30 km out, 40 km out of Pangnirtung. Whereas before, we'd go all the way down [the Cumberland Sound] and there would be hardly any polar bears out there…But in the 90s the polar bear population kind of exploded. The polar bears were interfering with humans and also with the equipment and up to today they are doing that so there are a lot more polar bears than before." (Johnny Mike, Pangnirtung)*

Table 2. Perception of polar bear abundance trends based on direct observations of individual interviewees from Kimmirut (n=13) and Pangnirtung (n=14) over their lifetime within their area of observation. Information on polar bear abundance observed within or near communities (dark green bars) was inductively obtained meaning that direct questions focused on abundance within or near communities were not consistently asked; therefore, absence of information on abundance (no dark green bars) within or near communities does not indicate that participants did not observe an increase of polar bears in the immediate vicinity of their own community.



[1] Participant observed an increase from the 1980s up until five to ten years ago. However, she was unsure about this recent decline as she did not travel on the land as much over this period. [2] Participant observed a slight decline in abundance since the 2000s. He also reported that polar bear abundance level is still higher today than it was back in the 1960s.

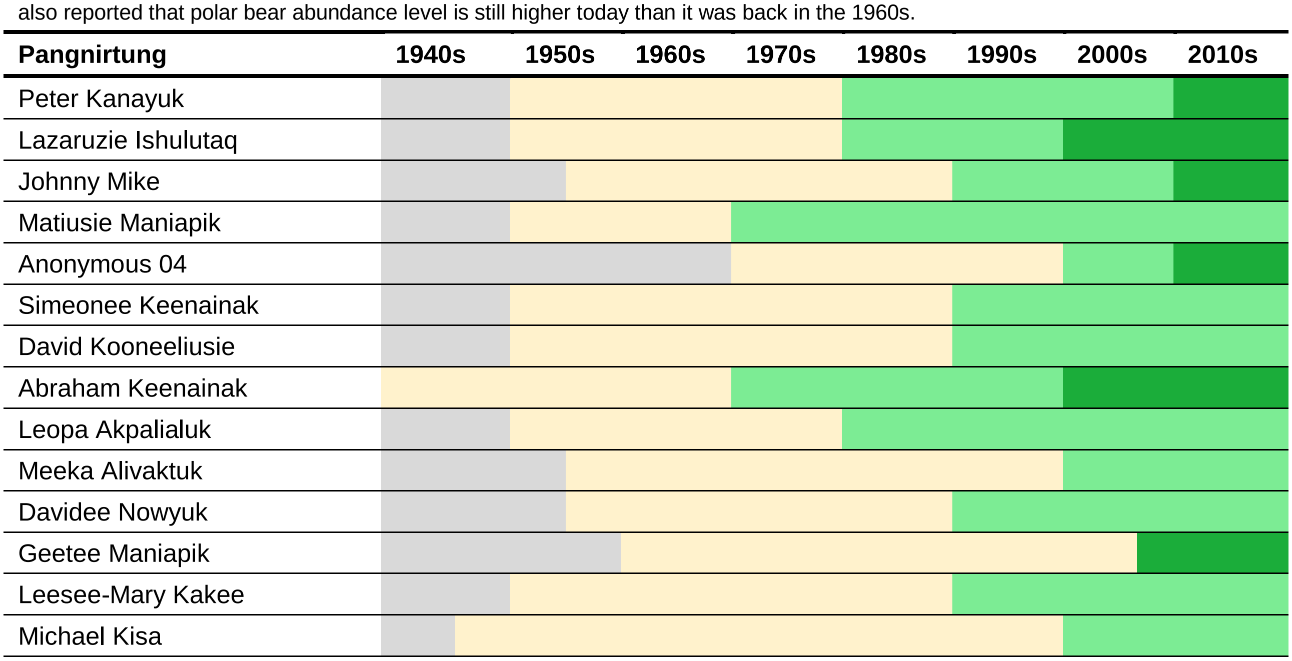


Figure 8. Group interview contributors participating in polar bear abundance exercise in Kimmirut. From left to right: Matilde Tomaselli (interviewer), Mikidjuk Kolola, Sandy Akavak and Joannie Ikkidluak.

In Kimmirut, group interview discussions also suggested an increase in polar bear sightings over time; groups reported the polar bear population had increased by an average of approximately 73% since the 1970s and 14% since 2005 (Figures 8 and 9). Narratives were highly consistent between the three groups. For the majority of group interviewees, 2019 (year of the interview) was considered the year of highest abundance for the population. However, one group of hunters (Group 1; Figure 9) reported that peak polar bear abundance had occurred between the mid-1980s and the early 2000s in the Kimmirut area, and that bear abundance then slightly declined between 2005 and 2018 before increasing again between 2018 and 2019. Nonetheless, this group reported that polar bears were much more abundant today than they were in the 1950s to the early 1980s.

We note that abundance trend information documented though group interviews seems to reflect a 'true' increase in the relative abundance of polar bears in the Kimmirut area and not an 'apparent' increase resulting from spatial and temporal changes in land use by participants and/or temporal changes in geographical distribution of polar bears (see Figures 7 and 14, respectively).

In Pangnirtung, group interviews were not conducted and quantitative information on polar bear abundance was not collected. However, narratives from individual interviews were highly consistent: all individual interview contributors from Pangnirtung (n=14) described a major increase in polar bear abundance observed over their lifetime within their area of observation (Figure 8).

We also note that Elders interviewed in both Kimmirut and Pangnirtung –with the exception of contributors living on the east coast of the Cumberland Peninsula (in Inuktitut known as 'the area where the ice never melts')– mentioned that they did not recall eating polar bears in their young age or polar bears being a common country food in the past. This further confirms historical low numbers of polar bears in the Kimmirut and Pangnirtung areas, except for the Cumberland Peninsula area. Such historical recollections are also highly contrasting with subsequent observations pointing to a major increase in polar bear numbers over time in both areas.

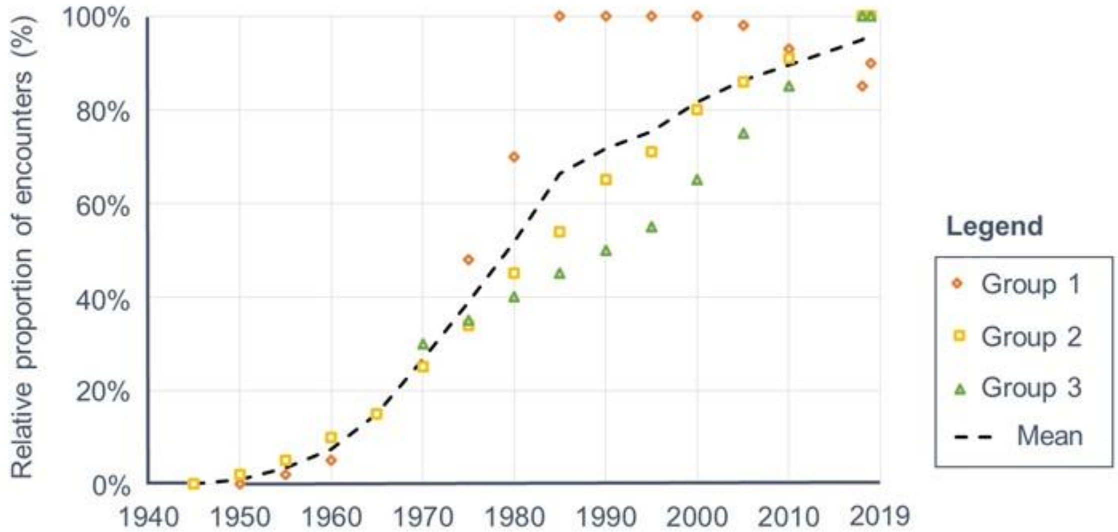


Figure 9. Relative proportion of polar bear observations/encounters between 1945 and 2019 as observed by Kimmirut contributors during group interviews. This information can be used as a proxy for polar bear relative abundance in the Kimmirut area. Information presented is based on interviews with three groups of polar bear hunters from Kimmirut (n=3; totalling eight participants).

Explanations for changes in abundance

In addition to provide polar bear abundance observations over time, contributors discussed reasons that could explain why polar bears have increased in their region.

Many contributors from both Pangnirtung and Kimmirut strongly agreed that harvest quotas and sex-selective harvest restrictions were primary drivers of an increase in polar bear abundance.

> *"In the past, I remember that the hunters had to go everywhere looking for polar bears, days could turn into weeks and into months trying to hunt a polar bear back then. Now, with the system of quotas in place, the bears are coming to the community and I find that they are getting aggressive toward humans or communities...I find that since the quotas are in place and sometimes when the quota are finished, the bears seem to know that they [community members] cannot do anything to them when they are coming to the community." (Itee Temela, Kimmirut)*

> *"My father helped the RCMP travel from place to place by dog team. When my father retired, I took over in 1967 around the last time there were dog teams around. When I became an RCMP officer, I recall the first time I knew about the quota. There was a quota of three polar bears to be harvested. Back then, there was no Conservation Officer but it was the RCMP who enforced quotas and management. This area didn't have a lot of bears and the RCMP without having knowledge about the population of polar bears because this area didn't have much at the time they gave a quota of three polar bears. This was in 1967. This is when I first noticed the quota being in place and ever since [polar bears] have been gradually increasing." (Sandy Akavak, Kimmirut)*

> *"[There are more bears now] because you can't kill a female, and especially if they have a cub, you can only kill a male. That's why there's a lot of polar bears now...they seem to*

show up more in the spring and the fall. In the spring for mating, a lot of males come close to the land to find females and [look] for seal pups, and in the fall just before the ice forms." (Matiusie Maniapik, Pangnirtung)

"[Polar bears have increased] because we're not allowed to shoot them. We manage them too good." (Simeonie Keenainak, Pangnirtung)

Some contributors from both communities also explained that observed changes in polar bear abundance could be linked to polar bear prey availability, sea ice conditions and changes in weather and climate. Some further indicated that the observed increase in polar bear abundance within their area of observation could also be related to greater use of coastal areas by polar bears searching for preys (see also 'Habitat and distribution' section).

"[Before polar bears] were mostly in the water and now they are getting closer to land and [they are] more on land. [They are coming closer to the coast because] there is not enough other animals [polar bear preys] here. Because they always have to eat." (Lazarusie Ishulutaq, Pangnirtung)

"Maybe because there's lack of ice...ice melts faster now, maybe…I'm not too sure but that's how I feel because the ice breaks quicker…[So polar bears] come closer to the land." (Geetee Maniapik, Pangnirtung)

"I feel there are more bears compared to the past…I think this has to do with the ice conditions. The hunting areas of the polar bears are not as great as before and their hunting grounds have expanded. That is why we see more of them." (Ejetsiak Padluq, Kimmirut)

"From the knowledge of my ancestors it has always been said that the bears or any other animals will go to the areas where there is plenty of their prey and their main food and it varies: some years [there are] lots [of animals in an area] and some other years [there are not] as much. It is the movement of the animals…when it is seal pup season [bears] will be around more." (Jeannie Padluq, Kimmirut)

Two Kimmirut Elders shared more recent observations, possibly made within the past 10 years, of polar bears that were 'smaller in size'. While such observations were not directly linked by contributors to the potential immigration of polar bears exhibiting a different body size phenotype from adjacent subpopulations into the Kimmirut area, we believe this possibility cannot be ruled out (see also 'Sea ice changes' section). From contributors' narratives, smaller body size could be also a function of shorter interbreeding times or reduced food availability for some polar bears.

"I have noticed that the bears seem to have gotten smaller in size. There seems to be more bears wandering around without their mothers or the mother seems smaller and they seem to be less fat. Some bears are fatter than others but...I don't really remember when I started to notice the change but lately I have noticed that all polar bears I have seen seem to be smaller and not as fat...maybe the bears that had lost their mother or accidentally got lost from their mother tend to be smaller in size because of the nurturing they did not have growing up." (Joe Arlooktoo, Kimmirut)

"I don't know how you would call the polar bears that are not fully grown up yet. I have seen them alone without a mother. I think they looked small enough that they [should have

been] with the mother but I have seen them more without their mom […] I would call them Atiqtaq. They are slightly smaller than the mother and they are in between these two categories [Atiqtaq and Naliqtigiit]. I have seen more of them and [I started to] notice this may be about ten years ago. I have no idea why is that." (Jawlie Akavak, Kimmirut)

When discussing polar bear abundance, some contributors explained that polar bear abundance varies between years and highlighted that wildlife abundance follows a cyclical pattern.

"And each year is different, like, some years there's more polar bears than other years and some years there's less than others. It's not always the same." (Leopa Akpalialuk, Pangnirtung)

"I personally think that the bears will be gone [again]. I am noticing that back in the 60s and later there was not many polar bears and it was [in the] 80s and 90s that the population went up and from then I noticed another decline of polar bears, as well as seals. Compared to the 60s, there are more polar bears today, a noticeable amount more polar bears today than in the 60s...I think that the peak of polar bears was between the 80s and 2000 then around 2000 I noticed a decline. If I was to further graph [the population trend] I think that the population would likely go back down to what it was in the 60s. It is not due to climate change that the numbers are the way they are. The bears can live a long time, they are good hunters and they are able to adapt. They can eat anything, not just ringed seals, sea weed, [other] seals, berries. Those are possible foods that bears can eat. The graph I draw is like a cycle that keeps going." (Sandy Akavak, Kimmirut)

Finally, in Pangnirtung, an Elder who used to live in the Cumberland Peninsula (an area where polar bears have been historically abundant) explained that her Elders used to say that removing mature polar bear males from an area can lead to an increase in polar bear numbers in subsequent years. This is because without dominant males, less dominant and juvenile bears tend to disperse more and immigrate into 'vacant' areas. This contributor explained that male-biased sex-selective harvest could therefore be a driver of the observed increase in polar bear abundance.

"I grew up around men and I remember a story that was told…[King polar bears or angujuaq] were like the watch for other polar bears, younger polar bears. [Hunters thought that] when [king polar bears] are gone, younger polar bears or female polar bears would be going [to] more places without being scared [by the king polar bears]. So today, that's how it is. I think there's less [king polar bears] watching today…[From my knowledge, I tried] to pass on information to people who are controlling the polar bear harvesting quotas only for males to be hunted. I tried to tell them not to only hunt males because [king polar bears] are almost gone. If they are gone, then polar bears will be more everywhere, I guess…[King polar bears] were on the watch...Not only males should be harvested. Also females should be. If all [king polar bears] are gone, more polar bears are coming. If females are harvested more often, it would stop, the coming part would stop." (Leesee-Mary Kakee, Pangnirtung)

Abundance indicators

During individual interviews, contributors referred to four key indicators of increases in polar bear abundance observed over time: (1) encountering more bears while travelling on the land, and particularly family groups and juveniles (n=13 in Pangnirtung; n=11 in Kimmirut); (2) observing more polar bear tracks while travelling on the land (n=5 in Pangnirtung; n=4 in Kimmirut); (3) increasing risks of conflicts between humans and polar bears and/or polar posing a greater safety concern today compared to the past (Pangnirtung, n=9; Kimmirut, n=7); and (4) hunting trips being now shorter in duration and/or hunters no longer needing to travel as far to harvest polar bears (n=8 in Pangnirtung; n=7 in Kimmirut).

> *"According to the people who live here all their lives they have seen more bears, they heard more about bears or heard more tracks being seen, observed. There's more bears in this area now. I know that by talking to the people who live here all their lives." (David Kooneeliusie, Pangnirtung)*

> *"It seems [the number of bears] is going up more either because there is less ice…or they are more used to people...My wife says that they just used to go hiking without any rifles or anything...but now we are told not to go anywhere without a rifle...Even in the 1980s we didn't really worry that much but lately we are encouraged to go with the rifle for our protection or to scare off bears." (Anonymous 02, Kimmirut)*

> *"Now, polar bears even break [into] cabins. Because there are so many they seem to be getting more dangerous, going into cabins and trying to look for food." (Lazarusie Ishulutaq, Pangnirtung)*

> *"When they pull a name from the bag, whoever is going out hunting [has] five days [or] one week. Years [ago], we'd go out, five days [passed] and sometimes we didn't get nothing because we didn't see anything. [This was back] in the 1970s and early 1980s. But right now all you need is two days, really." (Peter Kanayuk, Pangnirtung)*

Indicators one (1) and three (3) were explored in greater depth during interviews (see following two sections). In-depth probing of indicator one provided further insights into the productivity and recruitment of the local polar bear population which is key to interpret observations related to abundance and assess polar bear population health. Indicator three was important to assess the impacts of increased polar bear abundance at the community and individual levels which represents crucial information for management decisions.

Impacts of increased polar bear abundance

Many contributors expressed that the observed increase in polar bear abundance has had significant impacts on their life on the land and in communities (see also 'Concerns over public safety' section). Participants reported increased damage to cabins and property attributable to polar bears in recent years. Some contributors explained that, starting around the 2000s, residents from Kimmirut and Pangnirtung started to use more fixed cabins instead of tents when camping on the land due to concerns for their safety around polar bears. Polar bears killed in defense of life and property were also described as increasing around both communities. Nowadays, Kimmirutmiut and Pangnirtungmiut have to be alert and prepared to encounter polar bears anywhere they go.

> *"You have to basically keep watch at all times. It's hard to get a rest when you're always thinking of polar bears, that they might show up." (Leopa Akpalialuk, Pangnirtung)*

> *"Nowadays, when we are going camping overnight, anywhere, we always have to keep the thought of polar bear. It might show up or it might not. You always have to be*

careful...Even now, in the summer when they're camping, they're going to have to make sure someone is always on the watch...In the spring, when we go seal pup hunting, we always have to make sure there's someone awake during the night, just so we don't get attacked by a polar bear...Now when we catch a whale or anything and we are going to cut it up, we have to have one person on watch just in case a polar bear comes." (Lazarusie Ishulutaq, Pangnirtung)

"Now it is dangerous to camp in a tent. We do not wish to be in tents anymore unless we have aggressive dogs." (Itee Temela, Kimmirut)

"In the past 10 years, everything has really changed. In springtime, we have polar bear encounters and we have killed I don't know how many for self-defence. When a polar bear keeps coming back somebody is going to have to kill it...they may be coming looking for leftover meat because they can't catch any or maybe they will be going to the dump." (Isaac Temela, Kimmirut)

Size of family groups, cub productivity and survival

Contributors commented on the size of family groups (female polar bear with cubs), cub productivity (number of polar bear cubs produced in a population) and cub survival (number of polar bear cubs that survive their first year), and discussed changes observed over time in the number of bears observed for certain sex and age groups.

During individual interviews, nearly all contributors from both Pangnirtung (n=13) and Kimmirut (n=11) reported having observed more cubs, females, and/or females with cubs (family groups). Many explained that increased sightings of females, cubs and family groups resulted from a general increase in polar bear abundance in the Kimmirut and Pangnirtung areas.

"We see more [cubs], we see more...than ever...We see them more now, since we see more bears." (Simeonie Keenainak, Pangnirtung)

"I think we're seeing more females with cubs now because a lot of the males are being hunted, right. So all I notice is that whenever there's a polar bear close to the community it's often a female with a cub…or a cub by itself." (Anonymous 04, Pangnirtung)

"Today it's more common to see polar bears with cubs." (Davidee Nowyuk, Pangnirtung)

"Within the last five years, I have been hearing that the number of polar bears is climbing and with more cubs observed." (Itee Temela, Kimmirut)

"The bears that we have encountered seem to be mostly females. The knowledge I have learned from my Elders [is that] if you do not hunt more females you will have more females." (Joe Arlooktoo, Kimmirut)

"I think I have seen more females with cubs. A lot more than the other [polar bears]. [I started to notice more family groups] I think about 15 years ago. [Nowadays] most times [females] have two cubs and before some had two cubs and some [only] one cub. [Recently] I see more females with two cubs but we still see single cubs. I think we [have] see[n] more [females] with two cubs in the last 15 years than [females] with single cubs." (Jawlie Akavak, Kimmirut)

When discussing the size of family groups, there was consensus among contributors that females generally have one or two cubs, and three on rare occasions. Some participants from both communities (n=9 in Pangnirtung; n=5 in Kimmirut) stated that females with two cubs were most frequently observed.

> "*We mainly see a [female] bear with two cubs, on rare occasions there is three." (Anonymous 01, Kimmirut)*

> *"[Females have generally] two cubs and sometimes they lose one." (Lazarusie Ishulutaq, Pangnirtung)*

Some contributors (n=7 in Pangnirtung; n=6 in Kimmirut) also reported having encountered females with three cubs. According to one contributor who had worked to monitor polar bears in the Auyuittuq National Park over many years, 1993 was the best year for cub productivity in the Pangnirtung area; that year, he saw females with three cubs and tracks of a female polar bear with four cubs.

> *"The time when I was young, we'd see two polar bears maybe one of them had two little cubs. Right now, we see 28 [bears] in one day. Maybe 18 of them are with a little cub…Some of them with one, two or three. Mostly two…We see three every now and then in spring and summer." (Peter Kanayuk, Pangnirtung)*

> *"Once I have come across a mother and three cubs. [When] I saw that I thought I had seen dogs walking on the land because I never saw a mother with three cubs before…Normally they have two cubs or one cub. I have never seen three cubs. I have seen this only once… It is rare that they get three cubs…maybe within the last six years." (Jeannie Padluq, Kimmirut)*

> *"Me and an old guy, we came from Cape Dorset one time in February or March and we came across the tracks of a mother bear and three cubs. That is kind of rare, usually it is two or one cubs, but that only one time I saw a mother bear with three cubs. That was years ago in the 1990s." (Anonymous 02, Kimmirut)*

Some contributors from both communities (n=8 in Pangnirtung; n=3 in Kimmirut) reported the increased observations of family groups were likely due to harvest regulations protecting females and family groups (in particular, sex-selective harvesting and restrictions on harvesting denning bears).

> *"Seems to have more cubs. The family groups have increased since the time I have started to observe polar bears. Mother and cubs have increased a lot since then. One reason for this is could be that females are not to be harvested and, therefore, they are producing more cubs...and females with two cubs are seen more regularly now than before, within the past five years." (Kooyoo Padluq, Kimmirut)*

> *"Because we're not allowed to hunt female, cubs, he sees more of that and they're growing in population. Female with cubs." (Davidee Nowyuk, Pangnirtung)*

> *"I think we're seeing more females with cubs now because a lot of the males are being hunted, right. So all I notice is that whenever there's a polar bear close to the community it's often a female with a cub…or a cub by itself." (Anonymous 04, Pangnirtung)*

While sightings of family groups, cubs and females have increased in recent decades, contributors from both Kimmirut and Pangnirtung did not report any notable changes in cub productivity and survival over the years. According to results from proportional piling exercises conducted during group interviews held in Kimmirut, there was no difference in litter size and cub survival between the contrasted time periods (around 1990, around 2005 and 2016-2019; Figures 10 and 11). Around Kimmirut, mothers were observed more commonly with two cubs-of-the-year and two yearlings (Figure 11). While quantitative information on litter size over time is available for Kimmirut only, contributors from Pangnirtung offered qualitative observations related to changes in cub productivity and survival over time. Nine contributors reported that throughout their lifetime female polar bears with two cubs were more commonly observed. Three participants further specified that while more family groups had been observed in the Pangnirtung area, they had not noticed any changes in family group size (both females with cubs and females with yearlings) over time.

Figure 10. Mikidjuk Kolola (left), Sandy Akavak (centre) and Joannie Ikkidluak (right) participating in proportional piling exercises on cub productivity and survival around Kimmirut. Contributors expressed the relative proportion of family groups they had observed with one, two or three cubs using piles of beans distributed along an axis picturing three family group types (female with one cub, female with two cubs, female with three cubs).

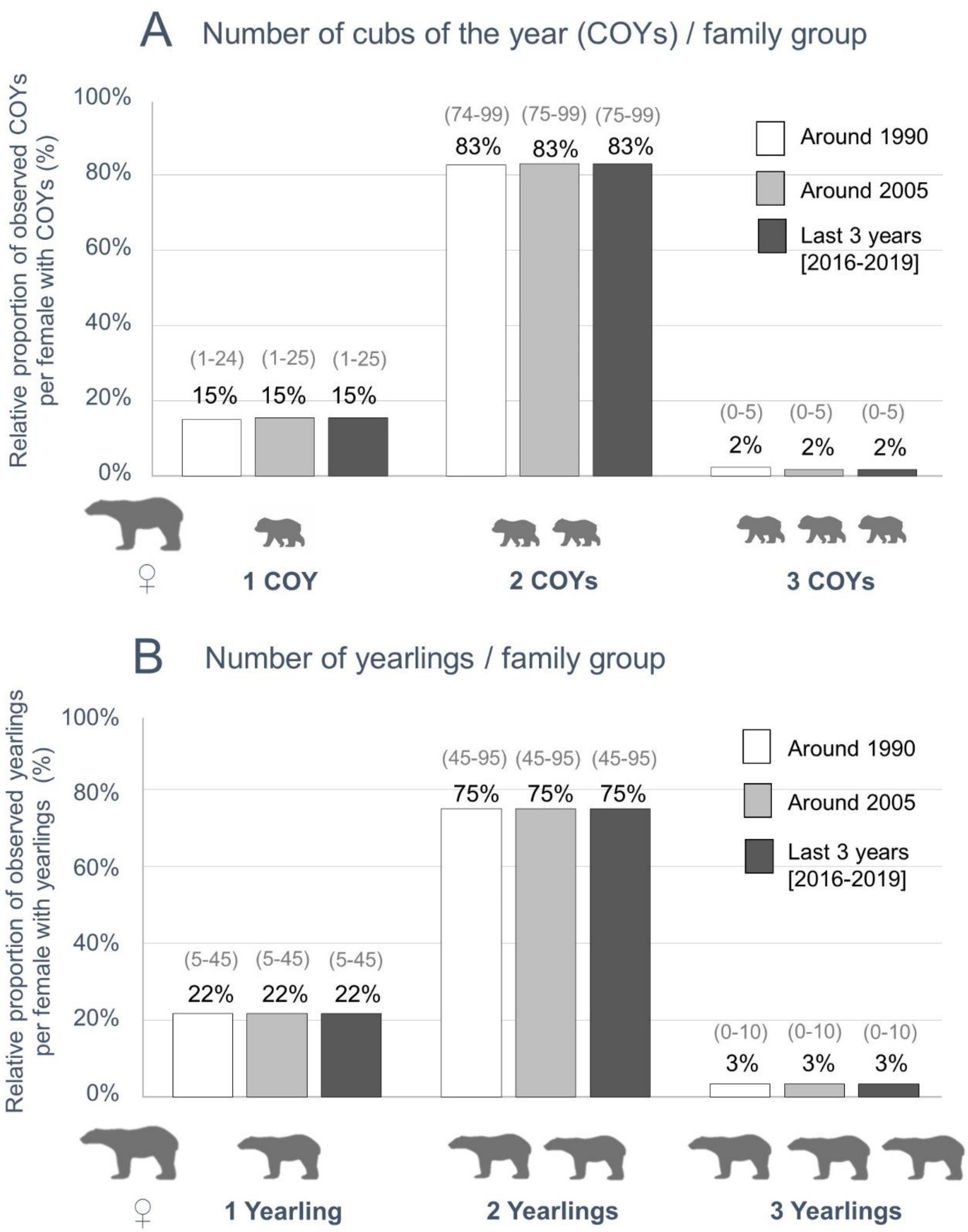


Figure 11. Relative proportion of cubs-of-the-year [COYs] (A) and yearlings (B) observed per female (♀) polar bear with COYs and yearlings, respectively, observed over three time periods (around 1990, around 2005 and last three years [2016-2019]) in the Kimmirut area. Percentages were derived from proportional piling exercises with three groups of contributors from Kimmirut (n=3; totalling eight participants). Each group reached consensus on the relative proportion of each type of family groups observed over three time periods. Final percentages were calculated using mean values across the groups. While there was some variability in proportions identified by the three groups within the same time period, each group was consistent in reporting no changes in litter size over time.

Distribution and habitat

Contributors shared observations on the historical and contemporary distribution of polar bears around Pangnirtung and Kimmirut. They indicated that more polar bears have been observed near communities and offered explanations as to why this phenomenon may be happening. Contributors also shared perspectives on what constitutes a ‘good’ polar bear habitat and commented on polar bear seasonal distribution. They reported changes in sea ice observed over their lifetime and discussed potential effects on polar bear distribution. Finally, participants discussed polar bear denning behaviour and identified denning areas.

Polar bear distribution over time

Contributors shared perspectives on the changes in polar bear distribution observed over time with their areas of observation. Perspectives from Kimmirutmiut and Pangnirtungmiut are presented separately below.

Kimmirut

Through proportion piling exercises conducted with three groups of contributors from Kimmirut (Figure 12), we were able to map polar bear relative distribution within participants’ range of direct observations over time (Figures 13). Relative proportion of polar bear sightings was used as a proxy for polar bear distribution and provided insights into differences in polar bear relative density at different locations. Observations on polar bear distribution around Kimmirut are available for four time periods: (1) during the 1960s; (2) during the 1990s; (3) around 2005; and (4) over the last three years (2016-2019). Table 3 offers a descriptive summary of historical polar bear distribution around Kimmirut. Narratives from individual interviews were consistent with information collected during group interviews (Figure 13).

Figure 12. Jawlie Akavak (left) and Eliyah Padluq (right) participating in mapping and proportional piling exercises on polar bear distribution around Kimmirut. Participants expressed changes in the distribution of polar bears they had observed over four time periods using piles of rice distributed over topographic maps. Through discussions, participants from each group reached consensus on the relative proportion of polar bears they had observed in specific areas during each time period.

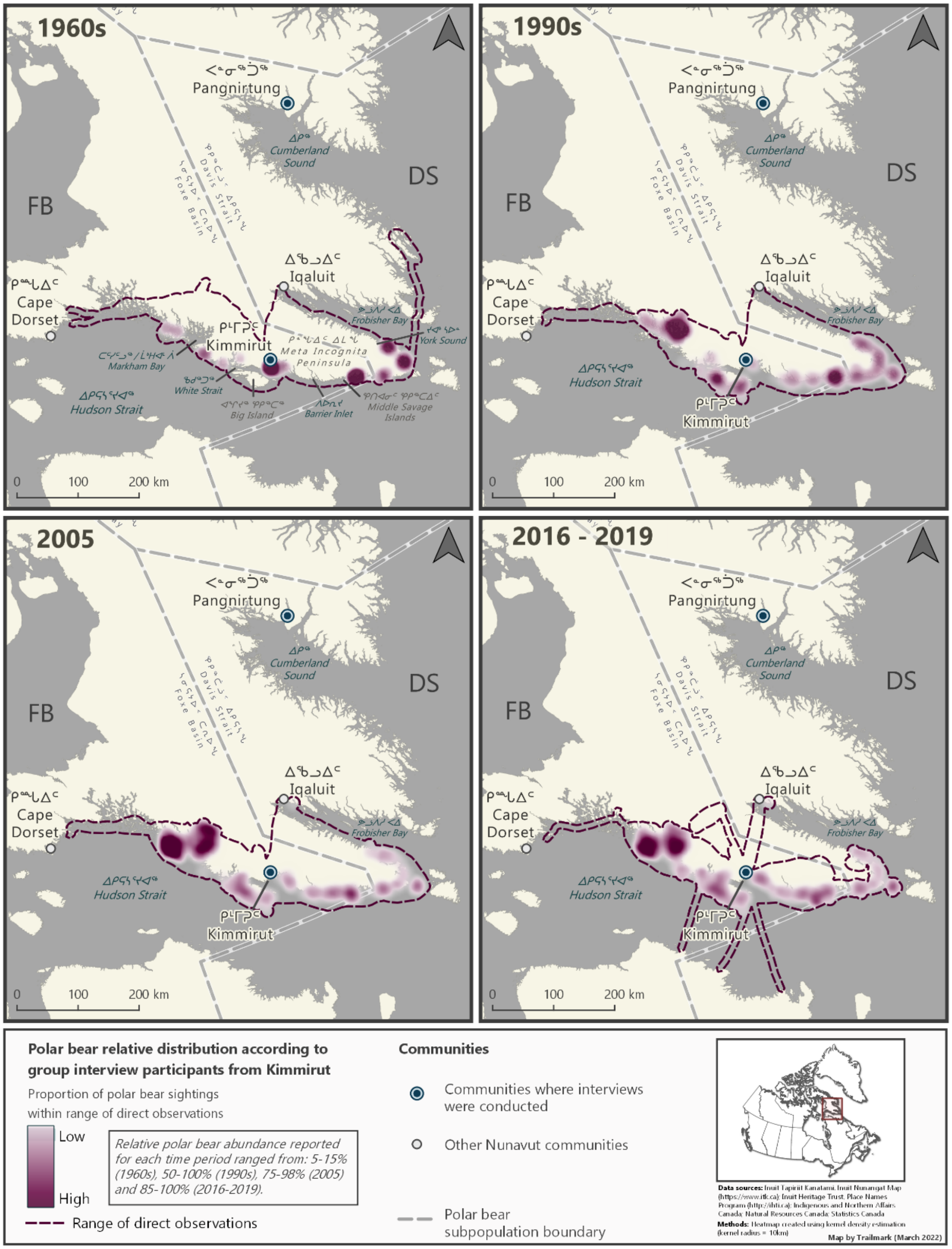


Figure 13. Polar bear relative distribution in the Kimmirut area between the 1960s and 2019 as reported by contributors during group interviews. Information presented is based on interviews with three groups of polar bear hunters from Kimmirut (n=3; totalling eight participants). From each time period considered, data points were obtained from mapping and proportional piling exercises and were transposed on QGIs along with the 'range of direct observations' obtained by aggregating areas of observation of individual participants (n=8) (see also Figure 7). Heat maps were generated for each time period by averaging distribution information provided by each group and employing a kernel density estimation with data points buffered by 10 km.

Table 3. Descriptive summary of historical and contemporary polar bear relative distribution and relative abundance in the Kimmirut area. Table content was developed by coupling information presented in Figure 13 with group interview results related to polar bear relative abundance (represented under the polar bear icon as a progressively increasing bar).

Period		**Polar bear relative distribution around Kimmirut**
1960s		Although in the 1960s encounters with polar bears were rare, about 60% of the encounters happened along the south shore of the Meta Incognita Peninsula particularly towards its eastern tip. That area was also a known denning site for female polar bears (see 'Denning' section). About 15% of bears encountered were observed close to Markham Bay and about 25% were seen close to the community.
1990s		By the 1990s, the number of polar bear encounters had substantially increased and about 75% of bears encountered were observed distributed along the south shore of the Meta Incognita Peninsula (from Barrier Inlet to York Sound) and in Markham Bay. The remaining 25% of polar bear encounters occurred close to the community, especially in White Strait and around Big Island.
Around 2005		From the 1990s until around 2005 polar bear numbers continued to increase and, around 2005, about 77% of polar bear encounters took place along the south shore of the Meta Incognita Peninsula (30%) and in Markham Bay (47%). The remaining 23% occurred between White Strait, Big Island and the inlets located close to town.
2016-2019		During the 2016-2019 period, about 73% of polar bears encountered were observed along the shore of Meta Incognita Peninsula (32%) and Markham Bay (41%) while the remaining 27% were observed between White Strait, Big Island and the inlets in close proximity to the community.

Around Kimmirut, common areas where contributors reported encountering polar bears were: Markham Bay, Big Island, White Strait, Middle Savage Islands, south shore of the Meta Incognita Peninsula, and the floe edge.

> *"In my experience there are more bears around here [along the south coast of Meta Incognita Peninsula]. The further you go down [along the coast], the more bears…Whenever you are going further down [along the coast of Meta Incognita Peninsula] you can see more bears. [In general] there are more bears here [in the Markham Bay area] and here [along the coast of Meta Incognita Peninsula] and polar bears do travel so whenever they come around [closer to town] we see them. I guess [in Markham Bay and along the south coast of the Meta Incognita Peninsula] there's more seal population and more sea ice and there [are] more polynyas and of course the polar bears take advantage of that." (Anonymous 03, Kimmirut)*

Figure 13 and Table 3 illustrate that while the abundance of polar bears kept increasing in the Kimmirut area between the 1960s and 2019, their distribution does not seem to have substantially changed during this period within contributors' range of direct of observations (which has also remained stable over time around Kimmirut; see 'Temporal and spatial scope of Inuit Qaujimajatuqangit' section). In particular, since the 1960s, group interview contributors had observed higher numbers of polar bears (about 70-80% of the total) along the shore of the Meta Incognita Peninsula (from York Sound to Barrier Inlet) and in Markham Bay. From these observations, it appears that the probability of polar bear encounters within or close to the community area has increased with time (from the 1960s to 2019) as a function of increased polar bear numbers rather than as a result of shifts in polar bear distribution within participants' range of direct observations.

Pangnirtung

In Pangnirtung, group interviews were not conducted and quantitative information on polar bear relative distribution was not systematically collected. Nonetheless, combining narratives from individual interview contributors (n=14) allowed to produce a qualitative account of polar bear distribution over time within participants' areas of observation. Figure 14 and Table 4 offer a summary of temporal changes in polar bear distribution and polar bear harvesting areas in the Pangnirtung area.

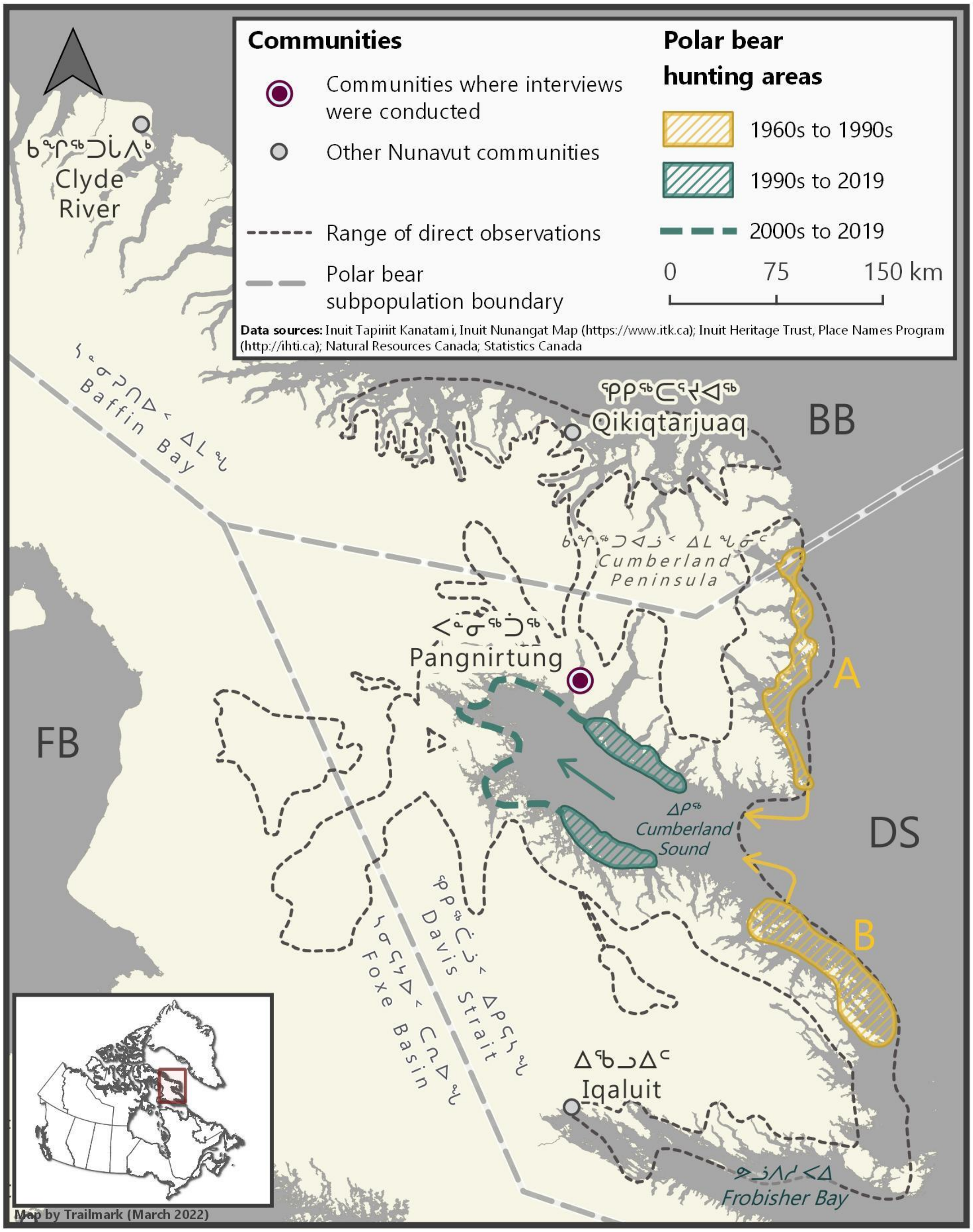


Figure 14. Summary of main polar bear harvesting areas from the 1960s to 2019 with arrows showing the directionality of expansion of polar bear range over time according to individual interview contributors from Pangnirtung (n=14). For complete interpretation, refer to Table 4. DS: Davis Strait polar bear subpopulation and management unit; FB: Foxe Basin polar bear subpopulation and management unit; BB: Baffin Bay polar bear subpopulation and management unit.

Table 4. Descriptive summary of historical polar bear distribution around Pangnirtung. Table content was developed by aggregating individual interview (n=14) results related to polar bear distribution and abundance in the Pangnirtung area.

Period	Polar bear distribution around Pangnirtung
From 1960s to 1990s	Around the 1960s (when families living in camps around the Cumberland Sound were relocated to Pangnirtung), encounters with polar bears were generally rare. Polar bears were mostly distributed outside Cumberland Sound. Few polar bears were seen around Pangnirtung and hunters would have to travel further away from the community to harvest polar bears compared to today (see yellow areas, Figure 14). Seeing polar bears or harvesting them was rare for families living in camps in the upper Cumberland Sound but more frequent for families located on the south shore of the Cumberland Sound towards its mouth (where polar bears were spring hunting in seal pupping areas). Observing and harvesting polar bears was then more common also for families living on the Cumberland Peninsula on the north side of the Sound. From the 1960s up until the early 1990s, main polar bear hunting areas were located along the eastern shore of the Cumberland Peninsula (yellow area marked with A, Figure 14) and along the south shore of the lower Cumberland Sound (yellow area marked with B, Figure 14). One contributor who lived with her family in the Cumberland Peninsula reported that Inuit were hunting polar bears (including denning females) in this area even before the 1960s as polar bears had been there for a long time. By the 1990s, the number of polar bear encounters had substantially increased. Polar bear sightings and signs of bear presence had become more common in areas where they were previously rare, in particular they started to be consistently found in the central part of the Cumberland Sound.
From 1990s to 2019	From the 1990s until 2019, polar bear sightings continued to increase and polar bears progressively expanded their range into the central and upper Cumberland Sound closer to Pangnirtung. This resulted from the mid-1990s onwards in a progressive shift in the location of main polar bear hunting areas closer to the community (green areas, Figure 14). From the early/mid2000s, polar bears have also been consistently and increasingly seen in the upper Cumberland Sound where harvesting has also been reported in recent years (green dashed line, Figure 14). While polar bears continue to be found in great numbers within their historic distribution range (outside and in the lower part of Cumberland Sound), today polar bear hunters from Pangnirtung do not need to travel as far from the community in order to harvest or see a polar bear. Coastal areas in the central Cumberland Sound, particularly on the south shore, are prime polar bear harvesting areas (where bears hunt for ringed seal pups in the spring).

Individual narratives were highly consistent (n=7) in reporting a progressive shift in the location of polar bear harvesting areas closer to the community (Figure 14), as well as an increase in polar bear sightings in the central and upper Cumberland Sound which started approximately around the 1990s and 2000s, respectively.

> *"[Back in the 1960s] people from this area [Qimmisuuq area located on south shore of the Cumberland Sound towards its mouth] used to get polar bear every year, people from*

there [Cumberland Peninsula] used to get more than this area. People here [upper Cumberland Sound] never used to get any polar bear. [There were] lots of camps around here [upper Cumberland Sound] but they didn't usually go out polar bear hunting; only a few maybe but it was very rare. But right now you are guaranteed to see polar bear or tracks." (Peter Kanayuk, Pangnirtung)

"When we moved to Pang [in the 1960s], there was no polar bears in this area, so not a lot of hunting…When snowmobiles were introduced to Pang [in the 1960s] and they were used more often, by snowmobiles hunters would go polar bear hunting from Pang [to other places]." (Leesee-Mary Kakee, Pangnirtung)

"Even back then in the 1960s we knew these areas [eastern shore of Cumberland Peninsula and south shore of the lower Cumberland Sound] were known to have lots of polar bears. [Those are] areas with open water…There's a lot of seals, whales around this area [eastern shore of Cumberland Peninsula], that's why there was always lots of polar bears…It seems like polar bears getting close to Pangnirtung…[Since] 2000, even end of 90s. You see polar bear tracks everywhere, all [along] this coast [upper Cumberland Sound], [and] all the way down." (Simeonie Keenainak, Pangnirtung)

In addition, two contributors who visited the eastern shore of Cumberland Peninsula and the south shore of the lower Cumberland Sound (see Figure 14; areas A and B, respectively) in the 2000s mentioned that polar bears were still abundant in those areas at that time. One of them mentioned that he had stopped travelling to his cabin in the Cumberland Peninsula in the early 2000s due an increase in polar bears in the area, making it unsafe.

"I don't go to my cabin anymore [in the Cumberland Peninsula]…because there are too many polar bears now…[Last time I was there] it was early 2000s." (Simeonie Keenainak, Pangnirtung)

In summary, all these observations suggest that as the local polar bear population increased, polar bears have, from the 1990s onwards, progressively expanded their historic distribution range into the central and upper Cumberland Sound closer to Pangnirtung, where historically polar bears were encountered only sporadically. Prior to the 1990s, polar bears were mainly observed along the south shore of lower Cumberland Sound and the eastern shore of the Cumberland Peninsula. We note that observations from Pangnirtung contributors suggest that the polar bear distribution range has expanded –rather than shifted– towards the community of Pangnirtung in the timespan of a few decades.

Polar bear distribution near communities

Many contributors from both communities described a progressive increase in the number of bears observed within or close to their community starting from around the 2000s (see also 'Abundance' section). Indeed, most individual interview participants (n=13 in Kimmirut; n=9 in Pangnirtung) indicated seeing more bears in or near communities today than in the past (see also Table 5). While any type of polar bear could be seen in the vicinity of or within communities, contributors reported that more inquisitive juveniles, which also tend to be more aggressive than adults, and sometimes mothers with cubs are the types of polar bears most frequently observed near communities.

"In the last few years, we have seen polar bears that come closer to town…[I have noticed this] in the past 15 years. As per my knowledge, [they come closer to town] more in the fall…When there is less sea ice, they go close to town for food…They go into town in the summer and winter time [too] but not as much as in the fall…[I have noticed] maybe more mothers and cubs [coming close to town]." (Anonymous 03, Kimmirut)

"About five years ago, three [came into town] in one summer season, other times would be twice [in a season. I think they have been coming closer to town] in the past three years. I think it has been happening only during spring and summer. I think that those young ones again [are coming into town], the atiqtaq. The grown up bears I don't think they never come close." (Jawlie Akavak, Kimmirut)

"The younger bears seem to have more courage and be less afraid than the bigger and older bears. [Also] females with cubs would normally come into the community." (Joe Arlooktoo, Kimmirut)

"Nowadays a bear would not hesitate to approach something moving thinking that is food and they come after the food that is stored in town and this is more often these days…It is more likely that bears come into town in fall and winter when there is enough ice. Any kind of bear could come into town." (Ejetsiak Padluq, Kimmirut)

During individual interviews, participants identified three potential causes that could explain why more polar bears are observed in or near communities: an increase in polar bear abundance (n=11 in Kimmirut; n=6 in Pangnirtung); polar bears being attracted by the smell of food in communities and at the dump and/or by the smell of carcasses from harvested animals near communities (n=3 in Kimmirut; n=1 in Pangnirtung); and changes in sea ice leading to increased use of coastal habitat by polar bears (n=2 in Kimmirut; n=1 in Pangnirtung).

"In the past 10 years, everything has really changed. In spring time, we have polar bear encounters and we have killed I don't know how many for self-defence. When a polar bear keeps coming back somebody is going to have to kill it...They may be coming looking for leftover meat because they can't catch any or maybe they will be going to the dump." (Isaac Temela, Kimmirut)

"Today when there's a whale hunt here and [community members] leave the carcass…it attracts polar bears." (Michael Kisa, Pangnirtung)

"[Polar bears are closer to communities] maybe because there's lack of ice...Ice melts faster now…I'm not too sure but that's how I feel because the ice breaks quicker…[So bears] come closer to the land." (Geetee Maniapik, Pangnirtung)

Habitat and seasonal distribution

During individual interviews, contributors from Pangnirtung and Kimmirut indicated that polar bears can be encountered on the sea ice, in open water and on the land, depending on the season and prey availability. Many participants associated sea ice (n=10 in Pangnirtung; n=7 in Kimmirut) and abundant preys (n=6 in Pangnirtung; n=6 in Kimmirut) with 'good' polar bear habitat. One contributor mentioned that low anthropogenic disturbance and the presence of both male and female polar bears were also important habitat conditions for polar bears. Another participant also highlighted that the presence of polar bears of different age categories (including young and mature individuals) is a characteristic of a 'good' polar bear habitat that can sustain a healthy polar bear population.

> *"The land and the sea ice would be an ideal place for the bears…where their preys are abundant. The polar bears would be in the inlets more so than out in the open because the preys are more abundant there." (Eliyah Padluq, Kimmirut)*

> *"Polar bears can be on land, ice, water. They're able to swim and basically they can live off anything." (Lazarusie Ishulutaq, Pangnirtung)*

> *"[A good polar bear habitat is where] there's less people and good hunting for them, like lots of seals and clean environment and lots of females to mate with." (Anonymous 02, Kimmirut)*

> *"[Their distribution] varies [with] the sea ice: when the sea ice if formed the bears are out on the ice more, when the ice is gone you cannot tell where the bears are…[Where polar bears are] depends of their preys, they will be around where there is enough seals and where they find a washed up [bowhead] whale on the shore." (Joe Arlooktoo, Kimmirut)*

Individual interview participants described seasonal polar bear distribution patterns that were mainly driven by sea ice dynamics and seal availability. Many contributors (n=9 in Pangnirtung; n=7 in Kimmirut) commented on the importance of sea ice to polar bears –notably for hunting, mating and traveling– and explained how sea ice formation influences polar bear distribution and seasonal movements.

> *"When the pressure ice or the broken up ice would land to the mainland there would be more bears coming in. The ice packs are bringing in bears…The current and the wind are the main causes of the movement of the ice packs…Normally if it had been a lot of wind coming from one direction for so long the ice packs would come in and stay in and that creates the bears to come up [on the mainland]. Or the freeze over of the ocean would be the other one for having the bears coming in. The bears would start coming to the mainland side during the pup seal season, in March." (Eliyah Padluq, Kimmirut)*

> *"It's different ever year. This winter we got lots of northwest wind, that's why there's been blue sky almost all winter. And some years we get southeast wind…we get more clouds and we get more snow with southeast winds. Some years we get both…but this winter we got northwest winds a lot more so we might get lots of ice this summer, [old] ice from the north. That's what they say, we get [old ice] with northwest wind. [Northwest winds] push all the old ice from the High Arctic down to eastern Arctic. When spring comes, we change from [northwest to] southeast wind, [and this] shoves all the old ice [towards our shores]…If we get southeast wind, [winds] put the polar bears into the shores more." (Simeonie Keenainak, Pangnirtung)*

> *"It's easier to find bears on the coastline when there's a floe edge. They stay close to the floe edge. That's where you see them more…They can hunt better when the ice is thin because the seal holes are not quite shut yet. They're still open and so for seals, [polar bears] sit there and for long time wait for the seals to come up and just grab them…Once [the annual ice] gets thicker they'll go open sea because on the open sea there's more floe edge and thin ice and all that." (David Kooneeliusie, Pangnirtung)*

Participants mainly observed polar bears on the sea ice (on the pack ice, at the floe edge or around polynyas) in winter, in ringed seal pupping areas in spring (March and April), and in coastal areas (on the shore, on islands, on floating ice or swimming in open water) in summer and fall until freeze-up.

> *"In the winter, [polar bears] are out at the floe edge or out in the pack ice...When I am close to town hunting, I see lots of tracks here around the floe edge…In the spring, they are going after seal pups so they are more in the fjords and places like Markham Bay, looking for seal pups or looking for mates. In the summer, they are along the coast, not so much inland but sometimes…They could be on glaciers too from what I have heard, like when it gets very hot they spend time on glaciers where they can cool off…In the summer, you can see them from the boats in the water or along the coast all the way through there [Markham Bay area] and even through here [coast of Meta Incognita Peninsula]…We see them on the islands mostly, even on small islands. They want to get out of the water and rest on the land and there's a lot of islands here that have potential for bears or where bears might be." (Anonymous 02, Kimmirut)*

> *"In the winter, we see bears on the sea ice and very rarely on the land. In the summer sometimes we see them swimming and most of the times [we see them] along the shore." (Jawlie Akavak, Kimmirut)*

> *"[Polar bears are] where there is a good population of seals and where the sea ice is and the floe edge area and where there [are] polynyas, where there's open water. Whenever I go there [Markham Bay area], there are lots of tracks [close to] the polynyas so that's a good place for them." (Anonymous 03, Kimmirut)*

> *"[Where] there's more ice that's where the bears will hang out more or on thin ice…And then when there's completely no ice, they go into the fjords or open sea, stay in the water for a while…When there's big waves coming in, swells, [polar bears] all head up to the land and then from there they wandered off onto the land…If there's been big waves that means there'll be more bears on the land… And then I used to say well, right now [there are] big waves. Now is a good time to hunt bears, right after that." (David Kooneeliusie, Pangnirtung)*

> *"On the land in summertime, wintertime on the ice...They're very smart, polar bear...They know what they're doing." (Meeka Alivaktuk, Pangnirtung)*

Some contributors mentioned that polar bears of certain sex or age types have specific habitat preferences, although this topic was not explored in detail. Three contributors noted that some big male polar bears (mostly referred to as *tulajuituq* in Inuktitut) spend most of their time at sea. These large pelagic bears were described as solitary polar bears which live on the moving sea ice and in open water, coming to shore only occasionally for mating. Participants indicated that these 'sea bears' also have distinctive morphological characteristics, including a very large size, a grey or silver stripe on their neck back, and long fur on their front legs due to constant swimming.

> *"Polar bears that stay out at sea most of their time are larger and have a grey stripe on their back. There is a different Inuktitut name for these males." (David Kooneeliusie, Pangnirtung)*

"There are the big angujuaq, bigger than a 13-footer and going up to 20 feet. They stay at sea and we very rarely see them. People say that. They stay mainly in the sea and they can eat their own kind, the smaller polar bear. The size of their head is massive, they are amazing...I have only seen them a couple of times...They barely go to the land, they go to the land only when they have to." (Isaac Temela, Kimmirut)

Sea ice changes

While contributors emphasized the importance of sea ice for polar bears, many (n=9 in Pangnirtung; n=8 in Kimmirut) also reported changes in sea ice quantity and quality observed over recent decades. Changes observed included: thinner sea ice, bigger polynyas, changes in floe edge location (closer to coast), as well as earlier sea ice break-up in and later freeze-up.

"The ice started to break up a lot earlier than it used to do. Like maybe a month earlier or a month and a half…I feel sometimes that the water is warm because we don't get the ice like it used to be." (Peter Kanayuk, Pangnirtung)

"The ice around here [Pangnirtung area] never melted until July but now it melts the fastest…Now already in April the ice is getting thinner and some part melts fast and it can be dangerous [to travel]...I started noticing these changes from the 1980s…I used to go turbot fishing here [in the middle of Cumberland Sound], but now it's always open water." (Matiusie Maniapik, Pangnirtung)

"[Freeze-up is] also happening later than it used to. Even one year they were still able to go out boating in December and even into January…That was not normal…It used to happen late October, early November. Now it only happens in early December." (Anonymous 04, Pangnirtung)

"[Now] there is possibly less ice and even in summer there seems to be less ice, like pieces of ice floating around where seals usually are sunning on top in the summer. [I have also noticed] maybe [less ice in the winter] because right now the ice floe edge is pretty close. And from what my buddy said when he went to the Markham Bay to go fishing [this year], like he said that the polynyas were very big and he has never seen them that way: the ice didn't really form that much and there's hardly any snow too…Within the past ten year it seems to be less ice even in the spring, maybe it melts quickly." (Anonymous 02, Kimmirut)

"When I was growing up, during the month of December we would be traveling by dog team. Nowadays we are traveling by boats [in December]…on the same routes…This is how much a difference there is now from back then! The ice used to be really thick back then…This may have affected some polar bears in a way because it has been affecting the humans. When it has impact on the humans I am sure it has an impact on the bears too in a way." (Eliyah Padluq, Kimmirut)

Several participants from both communities mentioned that while sea ice changes may have an effect on polar bears, *nanuq* is highly adaptable to habitat and sea ice changes (see also 'Future of polar bears' section). For example, some contributors mentioned that polar bears are able to effectively hunt seals also in open water (see also 'Feeding behaviour' section). However, others noted that hunting seals on sea ice may be 'easier' for polar bears. Overall, participants shared the view that while polar bears are highly adaptable predators able to effectively hunt a broad spectrum of preys available at different times of the year and in different environments (on sea ice, on land, and in open water), polar bears are not all equally able to effectively hunt in every situation as 'some polar bears are better hunters than others'. Therefore, the apparent diversity of responses under this theme does not reflect a disagreement between contributors but instead highlights that the adaptability of individual polar bears to a changing environment varies along a spectrum and is influenced by local prey availability and polar bear feeding behavior (see 'Diet and prey availability' section).

> *"Some bears are still as fat as before, but some are not as fat as they used to be…You know, some bears are good hunters so they are very fat, others that are not so fortunate. It is just like humans: the good hunters provide themselves good meals regularly, those that are not as good hunters are not as fat." (Eliyah Padluq, Kimmirut)*

> *"There is less ice meaning that [polar bear] hunting area on the sea ice is smaller in the winter. It's so different. But there is floating ice all the time and [polar bears] got no problem living on that floating ice." (Johnny Mike, Pangnirtung)*

> *"[Change in sea ice] doesn't affect the polar bears and it never will affect. Like I said, [polar bears] pretend to be ice [in open water] and a seal comes to them and they tend to be in areas where there's fish. And they also go for the young walrus, the baby ones…When there is no more ice, the polar bear pretends to be a piece of ice and stays still in the water for a long time, until a seal comes." (Leopa Akpalialuk, Pangnirtung)*

> *"The more experienced hunter usually passes word of mouth to everyone to tell how thick the ice is and if it is safe. I have started to notice [thinner sea ice] within the last ten years...I imagine that this has an effect on the bears because they hunt on the ice. Their hunt depends on the ice conditions but I believe they are adaptable. They are predators and they eat what they can hunt." (Anonymous 01, Kimmirut)*

> *"People have been worried about ice going but one other Elder told me: 'There's always going to be ice in the fjords'. Maybe less ice in the open areas but we have lots of fjords and he said that there will always going to be ice in those fjords. So bears will have somewhere to hunt their preys [but] maybe less areas for them. I believe that guy. It is always going to be cold here and there is always going to be ice in the fjords." (Anonymous 02, Kimmirut)*

> *"We know that the polar bears use the ice for their advantage to catch seals. If the sea ice melts faster then there will be less time for the easier hunts, but they have other means to hunt...I am sure they will be able to adapt because they are animals but I guess time will tell." (Anonymous 03, Kimmirut)*

In Pangnirtung and Kimmirut, several participants (n=4 in Pangnirtung; n=2 in Kimmirut) reported that polar bears are now spending more time on the land and in coastal areas near communities as a result of changes in sea ice conditions.

> *"Now, they are getting closer to land and more on land." (Lazarusie Ishulutaq, Pangnirtung)*

> *"When the ice is melting or when there is no more ice, the polar bears seem to be going more inland." (Matiusie Maniapik, Pangnirtung)*

> *"The ice is a lot thinner nowadays...Polar bears normally hunt on the ice and out there the ice is not as stable as it was and as a result the polar bears are coming in the coastal areas, where towns are, looking for food. Nowadays there is more polar bears coming into town in search of food." (Ejetsiak Padluq, Kimmirut)*

> *"[Polar bears] are coming more into town. They have always been around but lately they have been around more, within the past 10 years. The Elders here know more about [the reasons why polar bears are coming into town] but from what they say the polar bears are always looking for food and they rely on the ice [for hunting]. If the ice forms that is where they are more likely to hunt…They are searching for food, so if there is no ice I guess they are bound to be anywhere within the coast or the land." (Anonymous 01, Kimmirut)*

In Kimmirut, one participant also indicated that because of sea ice changes, some polar bears may now be immigrating from northern Québec across the Hudson Strait. Another indicated that polar bears may be coming into the Kimmirut area from the west in search for preys.

> *"I have noticed that the temperatures [have changed], the winters were colder back then. Nowadays is not as cold. I believe that climate change has an effect on the bears…because polar bears go to wherever ice conditions are good and there is cold weather. If the climate is changing there too, I think that the bears of northern Québec area may be also coming up [here]. I have seen clean bears with white fur out in the middle of the ocean far from land swimming [from south to north into the Hudson Strait]." (Ejetsiak Padluq, Kimmirut)*

> *"I believe that the bears are coming [to the Kimmirut area] from that direction, from the west [Markham Bay area] or they could be coming from the [open] ocean. Even other hunters have stated that too. If it is true that the bears are coming from that direction and going towards that direction [movement from the west to the east] maybe the bears in this area [in the west] will decline because [the bears] are moving. I know that they are following their preys, the seals, and this is true for all the animals. All the animals follow where their preys are." (Joe Arlooktoo, Kimmirut)*

Denning

During individual interviews, contributors from both communities identified known polar bear denning areas and discussed polar bear denning behaviour and habitat.

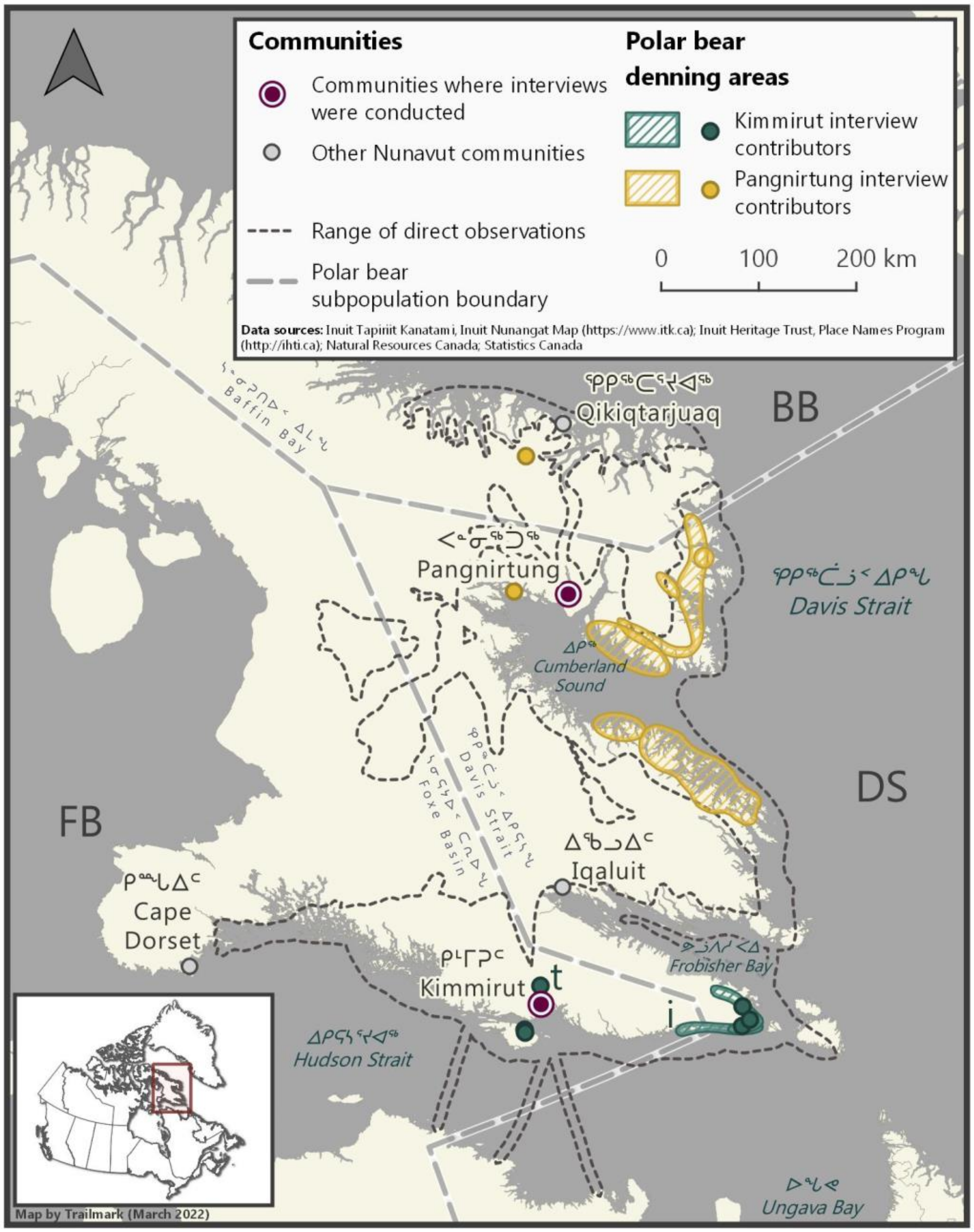


Figure 15. Polar bear denning areas identified by individual interview contributors from Kimmirut and Pangnirtung. Polar bear denning areas were obtained by aggregating the specific areas where participants from Pangnirtung (n=7) and Kimmirut (n=7) had directly observed polar bear dens over their lifetime. One contributor from Kimmirut also shared indirect knowledge on general location of dens passed on by Elders (polygon on the south shore of Meta Incognita Peninsula marked with i). Denning areas represented include both maternity dens and a temporary den (t). DS: Davis Strait polar bear subpopulation and management unit; FB: Foxe Basin polar bear subpopulation and management unit; BB: Baffin Bay polar bear subpopulation and management unit.

Fourteen participants (n=7 in each of Pangnirtung and Kimmirut) had directly observed polar bears dens over their lifetime or learned their general locations from Elders, and identified specific polar bear denning areas around Pangnirtung and Kimmirut (Figure 15). Some also noted that it was uncommon for them to come across polar bear dens and that dens were often difficult to spot or access. Contributors who described the characteristics of a 'good' polar bear denning habitat and explained that they generally observe maternity dens in hilly or mountainous coastal areas with good snow coverage (including in proximity of glacier complex), landscape features facilitating snowdrift formation, and abundant preys.

> *"My dad and my older friend told me that there are lots of dens down here [along the southern coast of the Meta Incognita Peninsula]. [Those are good denning spots for bears because] there's lots of walrus and seals there and fish." (Anonymous 02, Kimmirut)*

> *"I have seen dens on Big Island most times. Last year I was looking to see if there may be a den in the same spot where it used to be but last year it wasn't there. It is on a high hill [with] a snow area that never melts during the summer. It is not a glacier, it is just snow but it doesn't melt. I don't recall [seeing other dens]. [I haven't noticed any changes in the time of denning], usually the denning [happens] at the same time." (Jawlie Akavak, Kimmirut)*

> *"The mountains are higher and there's more snow in these areas…Not many people go in these areas, so they're a really good spot for polar bears to have dens, because no one goes there…[The den] looks like an igloo. You kind of have to be bent down [to stand inside]...It's ice inside. From the [polar bear] breath, [ice forms] inside the den." (Leopa Akpalialuk, Pangnirtung)*

> *"[Polar bears] use the fjords to go inland [to their] denning areas to give birth…They always go back [because] there's more snow in [the] backcountry. Like being closer to the glaciers and all that. But they don't use the glaciers…They just use the snow that's close to the glaciers...And I have noticed that [polar bear dens] always seem to be always facing southeast…I don't know why. I know we used to [track dens] with helicopter and sometimes [we saw dens at] 3,000 feet. That's really high…this is because the snow is drier higher up." (David Kooneeliusie, Pangnirtung)*

Some participants explained that females typically give birth to cubs in maternity dens in December and January, and leave their dens around March or April at the time of year when ringed seal pups are born.

> *"Some of the polar bears make a den and stay there all winter. And they're permanent, that's for sure. They stay there until March…all the pregnant ones do that. They come out of the den in March when the baby seals start to be born and they go out on the ice for the seals." (Peter Kanayuk, Pangnirtung)*

> *"I have seen [polar bear] dens in Kagitukutaa [Nanuq Harbour] and Isuqtuq [Noble Inlet] areas [at the tip of Meta Incognita Peninsula]. The timing of denning could vary but around winter they start denning and come back out around March or April. Dens are likely on slanted slopes." (Sandy Akavak, Kimmirut)*

Some contributors reported that adult males use temporary dens.

> *"Even angujuait [big adult male polar bears] do that too sometimes. If they are really fat, I guess. They make a den in the snow and stay there. Sometimes even three or four months…That is what the Elders told us and I believe it." (Peter Kanayuk, Pangnirtung)*

> *"Temporary [dens are] not really shut [covered] because they're just temporary ones. Mostly big males would use the temporary ones a lot. I found if there's a good snow bank…they will go in just to use it temporarily…Maybe just to relax, wait for the ice to freeze up or something...In October [before freeze up] we see many temporary dens and you could even see [that] the bear is in there because it's not shut...It's a big male most of the time that uses those temporary ones." (David Kooneeliusie, Pangnirtung)*

While changes in timing of denning were not reported, one participant from Pangnirtung noted a shift in maternity den location due to melting glaciers.

> *"I have seen a couple dens. I would look up in the mountains and a polar bear would show up for a bit and then go back in [the den]…They keep their dens in the glacier areas, but now there is nothing here anymore [showing an area where a glacier used to be]. It melted. The more the glaciers are melting, the more they move." (Lazarusie Ishulutaq, Pangnirtung)*

One contributor described how, in the past, harpoons were used to locate maternity dens when hunting denning females.

> *"I watched my father looking for dens. They were looking for dens [using harpoons]. If [the harpoon] went all the way [through snow], there's no [den]. But if you touch ice, that's when they knew there's a den in there. When they touch ice and you keep poking it, if it goes through, that's the den." (Leesee-Mary Kakee, Pangnirtung)*

Diet and prey availability

Contributors discussed polar bear diet and feeding behaviour, and reported changes in prey abundance and availability around Pangnirtung and Kimmirut.

Diet

Contributors described the broad diet of polar bears and all individual interview participants (n=27) identified ringed seals (*natsiq*) and their pups, but also other species of seals (including bearded seals, harp seals, harbour seals) to be the main polar bear preys (Figure 16), together accounting for approximately 75% (range: 64-90, n=3) of polar bear overall diet according to contributors from Kimmirut (Figure 17). Additional polar bear preys consistently mentioned were: walrus, ducks and bird eggs (including eider ducks and their eggs and seagull eggs), whales (including belugas, narwhals and bowhead whales), fish (including Arctic char), plants and berries (including seaweed, mountain sorrel [*qunguliit; Oxyria digna*], crowberries [*paungaq; Empetrum nigrum*] and blueberries) (Figures 18 and 19). Preys or diet items that were occasionally part of the polar bear diet were also mentioned and included: other polar bears, anthropogenic waste and man-made items, caribou, dogs and Arctic foxes (Figure 16). In Kimmirut, the overall proportion of each prey in the annual polar bear diet (Figure 17), the seasonality of prey availability (Table 5), and changes in the availability of prey species (see 'Changes in seal abundance and health' section), particularly seals, were also explored during group interviews.

Participants from both communities reported that polar bears prey on live animals, but also feed from carcasses of harvested animals (particularly belugas and narwhals) and whale carcasses that have washed ashore (particularly bowhead whales). Importantly, a majority of contributors from both communities highlighted that *nanuq* is a highly adaptable and opportunistic predator that can “eat anything”.

> *“The bears can live a long time, they are good hunters and they are able to adapt. They can eat anything not just ringed seals, seaweed, [other] seals, berries. Those are [all] possible foods that [polar] bears can eat.” (Sandy Akavak, Kimmirut)*

> *“They will eat anything. They eat all types of seals and even walrus. They eat fish, they eat anything...they eat berries, anything. They could eat even other bears and sometimes when they are coming into communities they would start eating dogs.” (Itee Temela, Kimmirut)*

> *“Their main meals are seals, walrus and whale carcasses. They eat berries and plants. I have seen a bear that had a whole bunch of plants in its stomach, you know those sour plants [mountain sorrel], they look like sugar cane but they are sour. This is what they love to eat. They eat fish too. We left a whole box of chocolate in our cabins, the bears came and eat them all...they like eggs very much too, and now and then they will have also the ducklings and the adults that cannot fly.” (Eliyah Padluq, Kimmirut)*

> *“[Polar bears eat] seal, walrus, whale too if they can get close enough, fish. Those are the main ones, I think, but seals are the most common preys, any kind of seals…[As for fish], they eat mostly char. They go to a river and when the fish are going upstream they would catch them. That would be in August, when the dark season starts.” (Anonymous 02, Kimmirut)*

> *“I’ve seen polar bear eating walrus, bearded seal, ringed seals and dead carcasses of bowhead whales, whale meat after the hunters have hunted whales. I think they eat anything they can get their hands into...I haven’t seen a polar bear eating a polar bear [except] when we went bowhead hunting in 2013…There was a big polar bear just starting to eat up a male polar [bear]. That’s the only time I’ve seen that.” (Johnny Mike, Pangnirtung)*

> *“I saw a polar bear [that had] just killed a caribou in 1995 when I was caribou hunting.” (Abraham Keenainak, Pangnirtung)*

> *“[Polar bears] also eat berries, blackberries and blueberries in the summer and seaweed quite a bit.” (Simeonie Keenainak, Pangnirtung)*

> *“I don’t know what they don’t eat…polar bears eat anything.” (Leesee-Mary Kakee, Pangnirtung)*

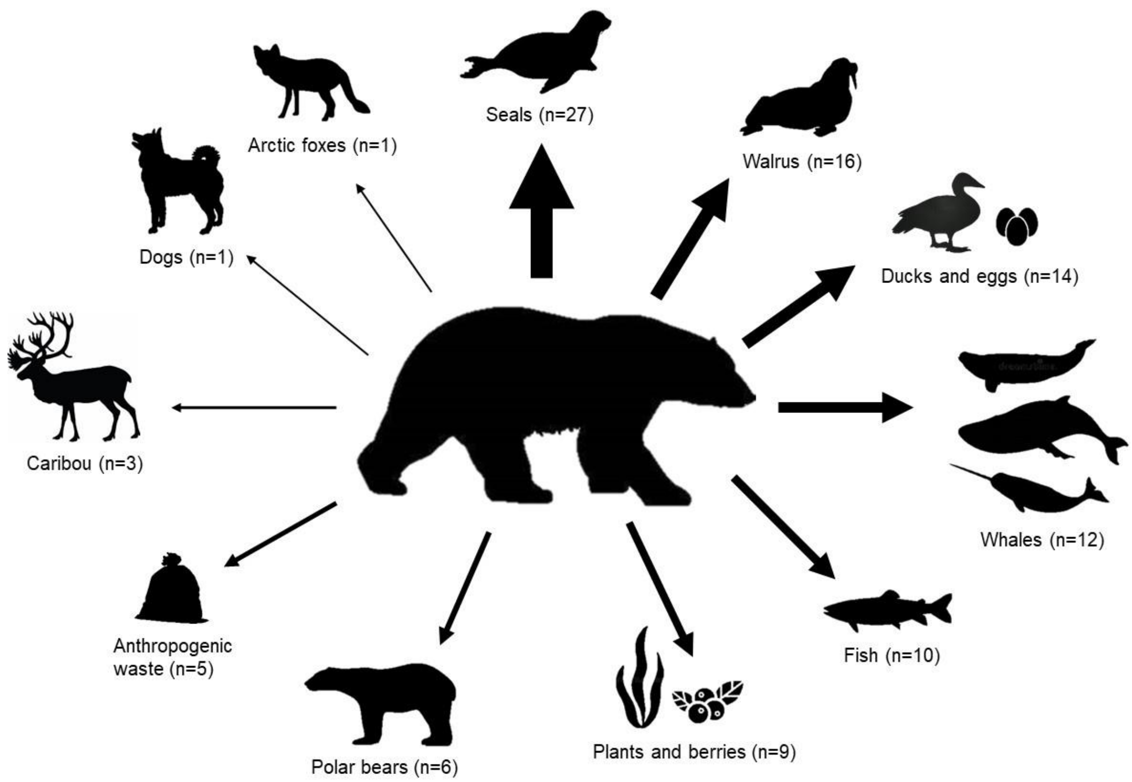


Figure 16. Polar bear preys or diet items identified by individual interview contributors from Kimmirut and Pangnirtung (n=27). Arrow thickness indicates frequency of mention by participants with thickness increasing with number of participants (n) who mentioned the prey/diet item.

Participants from Kimmirut explained that polar bear diet varies seasonally throughout the year depending on prey availability and the specific ecology and phenology of prey species. For example, while polar bears consume ringed seals throughout the year (and especially in March and April when ringed seal pups are born), they will only prey on ducks and bird eggs during the summer months. Table 5 describes the seasonality and availability of various polar bear prey species around Kimmirut.

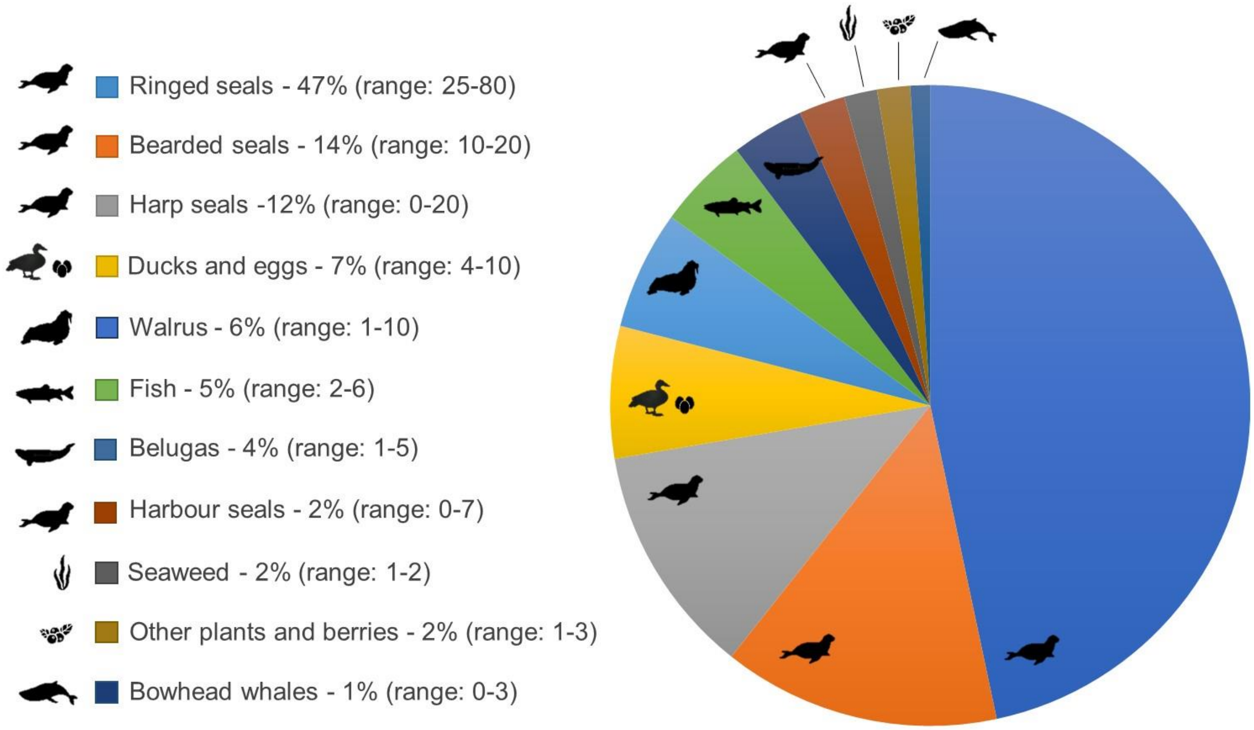
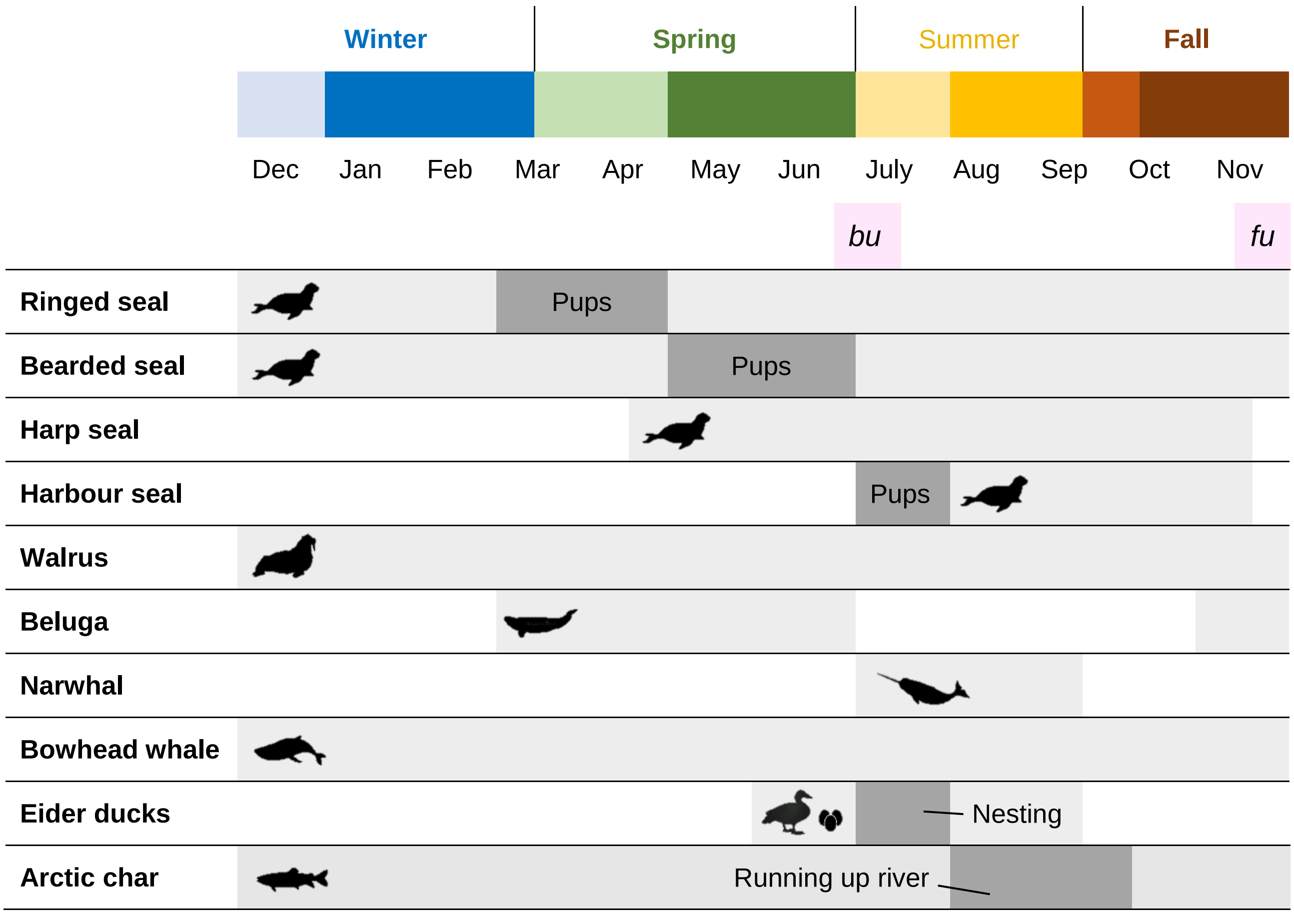


Figure 17. Relative proportion of preys in annual polar bear diet in the Kimmirut area. Percentages were derived from proportional piling exercises with three groups of contributors from Kimmirut (n=3; totalling eight participants). Each group reached consensus on the relative proportion of each prey item within the annual polar bear diet. Final percentages were calculated using mean values across the groups. Some polar bear preys/diet items identified by participants during individual interviews (i.e., narwhal, other polar bears, anthropogenic waste, caribou, dogs and Arctic foxes; see Figure 16) were not included in this figure as group interview contributors considered their importance to be marginal in the diet of polar bears of the Kimmirut area.

Kimmirut contributors also commented on changes in the abundance trends of some polar bear preys. Importantly, they highlighted a major decline in local ringed seal abundance (see 'Changes in seal abundance and health' section) which may contribute to explain variability in responses related to the relative proportion of ringed seals in the annual polar bear diet (see Figure 17, data range: 25-80). Participants also noted that beluga whales may have slightly declined in recent years while the number of bowhead whales seems to have increased in the area. Within the past five years, some had also observed a local decline in eider duck abundance with fewer nesting birds and colonies that have moved. Contributors reported that polar bears were increasingly preying on eggs in eider duck colonies. They also mentioned that one eider colony located in the Middle Savage Islands was displaced by walruses in recent years. Finally, contributors mentioned that the seasonal presence (from spring to summer) of orcas appears to have increased in the Kimmirut area within the last five years. They further explained that when orcas are in the area, seals and whales –which are their targeted preys– move into shallow waters to escape the orcas but in turn become more accessible to other predators, including humans and polar bears. All these important observations provided by knowledge holders contribute to better understand the complexity and interconnectedness of the ecological system, and how *nanuq* is situated within this system.

Table 5. Seasonality of some polar bear prey species present in the Kimmirut area according to contributors from Kimmirut. For each season, early phases can be identified (early winter, early spring, early summer and early fall) and are represented by the lighter colour bars. For each species, grey bars represent presence or availability and white bars indicate absence; information of interest is highlighted in dark grey bars. *Fu*: sea ice freeze-up; *bu*: sea ice break-up.



Feeding behaviour

Contributors who discussed polar bear feeding behaviour explained that polar bears are effective seal hunters on sea ice but also on the land and in open water. Polar bears are tactical when hunting seals modifying their hunting techniques depending on the specific hunting environment (sea ice, land, or open water). It is important to note some contributors also pointed out that some polar bears are better hunters than others "just like for humans", meaning that polar bears are not all equally able to be effective hunters in every situation.

> *"Polar bears are really good at sea ice hunting for seals, and also in open water and on the land too for sure…I have experienced just once [seeing] a polar bear catching a [ringed] seal through a [breathing] hole on the sea ice...When that seal came up to breathe the female polar bear cut that seal hole with its front paw...It cut off the nose of the seal along with the ice. When [the seal has such an injury on the nose] it cannot dive. So the polar bear technique was to [injure] the nose of the seal so it could not go underwear anymore. It caught the seal with this strong jaws, it grabbed its head and pulled the whole*

seal through a head sized hole. There is an old saying that says 'a polar bear can pull out an entire seal out of a head sized seal hole' and I witnessed that one time." (Johnny Mike, Pangnirtung)

"Polar bears can float anywhere in the water and seals think they're a piece of ice. They wait for seals to come to them, acting like they're ice. Since they're white and they look like ice, some seals believe that it's a piece of ice and go to them." (Lazarusie Ishulutaq, Pangnirtung)

"They catch their prey in the water. They pretend to be ice to catch seals. They are professional hunters." (Isaac Temela, Kimmirut)

"I know that the bears could eat their catch in the water. Bears could eat anywhere they are comfortable. Some bear would drag the seal up to the land to eat it [on the land] and some would eat their catch in the water right there. I have seen bears eating seals on the land." (Eliyah Padluq, Kimmirut)

Some participants reported that polar bears prefer to feed on fat from seals and sea mammals. They also noted that bears will only eat meat "if they are really hungry" and tend not to consume the bones of their preys.

"Once we came across a bear that had killed a seal and that bear…seems to have just ate the fat of the seal so I was thinking, I guess, they eat more the fat than the meat of a seal". (Akeego Killiktee, Kimmirut)

"When [bears] are fat they rather eat fat of other animals. If they are really healthy they eat some of the fat and leave the rest of the carcass behind." (Peter Kanayuk, Pangnirtung)

"Polar bears eat fat. They can kill seals, they don't eat the meat, just the fat. They eat meat only when there's no other [food]…Last week my brother shot a polar bear. I checked the stomach and there was nothing but fat, just like oil, a little bit of skin there and there. The polar bears don't chew bones, they don't. You can see the dead seal with all the bones in them…[Bears prefer] fat, seal fat or any sea mammal fat like whale fat, bearded seal fat, walrus fat." (Simeonie Keenainak, Pangnirtung)

"[Polar bears] have big teeth, but they don't eat bones. Even if it's a fish, they won't eat the bones...They only eat the meat of the fish, they leave the bone and the head." (Leopa Akpalialuk, Pangnirtung)

Four contributors indicated that polar bears can camouflage themselves when hunting for seals on the land in summer.

"When polar bears hunt seals in the summer, they cover themselves with mud to blend in with their surroundings, and get the seals as they are lying on rocks. They hunt seals in the summer too without ice. Because the seals in the lovely days they usually sit on top of the rocks when there's no ice, and the polar bears hunt them." (David Kooneeliusie, Pangnirtung)

> *"In the summertime, some [polar bears] can also make themselves dirty to camouflage...Polar bears are capable of camouflaging themselves, rolling around dirt and mud to [disguise] their white presence. I have seen a bear that looked almost like a rock." (Ejetsiak Padluq, Kimmirut)*

When commenting on polar bears preying on ducks and eggs, some participants who had been picking eggs around their community noted that while this was not a new phenomenon, there has been evidence that more bears are feeding in duck colonies nowadays. Up until 2019 (when interviews were performed) this phenomenon seemed to be a function of the increased number of polar bears present in the area –which determined an increasing pressure on resources overall– rather than resulting from a change in polar bear prey species or dietary habits.

> *"When I was younger, I have heard my father talking about polar bears that were upon the bird colonies nesting grounds. When [hunters] go egg hunting sometimes there would be [egg] shells on those islands. Although at that time, when I was younger, there were not many bears to be seen or many bears to be heard of. [But I remember] my parents and my father talking about bears upon those islands going after eggs." (Akeego Killiktee, Kimmirut)*

> *"[Bears] have seen [bears disturbing bird colonies] you know. It's already been disturbed a lot really badly by polar bears eating eggs like from eider ducks eggs…It's always probably been ongoing for so many years but people seem to be noticing that more today." (David Kooneeliusie, Pangnirtung)*

A total of seven contributors (n=5 in Pangnirtung; n=2 in Kimmirut) had either directly observed polar bears feeding on other polar bears or heard reports of cannibalism from other community members.

> *"Some [polar bears] eat polar bear meat…The hungry ones would hunt another polar bear. I have seen the polar bears with the young ones run away from other bears. In summer and winter, I have seen them. We saw them running [and thought] why are they running? All of a sudden, there's something behind: a bigger bear is after them." (Peter Kanayuk, Pangnirtung)*

> *"There are so many polar bears, now, some of them attack other polar bears and kill them and eat them because there's not enough food…I saw a dead polar bear attacked by another polar bear. That must not be the only one, there should be more than that; [but] I saw only that one." (Lazarusie Ishulutaq, Pangnirtung)*

> *"When there was a bowhead whale hunt in 2013, there was a polar bear at the site where the bowhead whale was killed. It was eating another polar bear. I didn't see it [directly], but it was on the pictures [from the bowhead hunt]." (Abraham Keenainak, Pangnirtung)*

> *"I haven't seen a polar bear eating another polar bear. [Although once] we saw a polar bear eating on the carcass [of] a bear we [had harvested and] skinned the [previous] day." (Anonymous 02, Kimmirut)*

In both Pangnirtung and Kimmirut, contributors had not observed any significant change in polar bear diet items over time, except for anthropogenic waste. Some noted that polar bears feeding on garbage and other man made items is a recent phenomenon. A total of seven participants (n=5 in Kimmirut; n=2 in Pangnirtung) had directly observed anthropogenic waste or man-made items in polar bear stomachs while checking polar bear stomach contents (see also ‘Antropogenic waste and other unusual observations’ section).

> *“When we open the [polar bear] stomach, we find ringed seals or their pups, more likely we see ringed seals or any kind of food they have eaten. I have seen some bears, not a lot, but I have seen some bears that had come into town that had garbage [in their stomachs].” (Anonymous 01, Kimmirut)*

> *“[Polar bears] go to the dump, that’s never happened before. Even here sometimes in the fall they go to the dump and anything they can get, they eat…A few years ago we saw a polar bear at the dump in the fall.” (Peter Kanayuk, Pangnirtung)*

Changes in seal abundance and health

While all individual interview participants (n=27) identified ringed seals or seals in general as primary polar bear preys, many contributors had also observed and commented on changes in seal abundance and health over their lifetime.

In Kimmirut, all contributors who commented on changes in ringed seal abundance (n=11) during individual interviews reported a decline in ringed seal abundance occurring within the last few decades.

> *“The number of seals has really declined. In our harbour here, there used to be hundreds of seals on top of the newly formed ice. Now, I don’t see [them] anymore. Our seals are the ringed seals. I have noticed this in our harbour in the past ten years...because bears are coming from the west. In the last five years the ringed seals have really declined in this area.” (Joe Arlooktoo, Kimmirut)*

> *“[Polar bears] are healthy. Their numbers are up and there is food for them. It does not seem to be as many seals as before though, lately, in the past few summers. Before there used to be hundreds and hundreds of seals but you don’t really see that anymore. I have noticed this in the past ten, 15 years...and the seals are skinny and not very healthy.” (Anonymous 02, Kimmirut)*

Participatory exercises conducted during group interviews held in Kimmirut also pointed to a major decline in ringed seal sightings over time, a substantial increase in harp seal sightings, and no change in the number of bearded seals encountered (Figure 18: plates A, B and C). Groups interviewed reported that ringed seal abundance had declined by 80% (range: 80-80) since 1960, and that harp seal abundance had increased by approximately 65% (range: 50-80) since 1950 (Figure 18: plates A and B). Narratives were highly consistent across the three groups. The coupling of seal and polar bear abundance trends obtained from group interviews conducted in Kimmirut (Figure 18: plate D) further illustrates that while contributors reported a 92% (range: 90-95) increase in polar bear relative abundance over the 1960-2019 period within their area of observation, ringed seal relative abundance (polar bear main prey) had declined by 80% (range: 80-80) over the same time period.

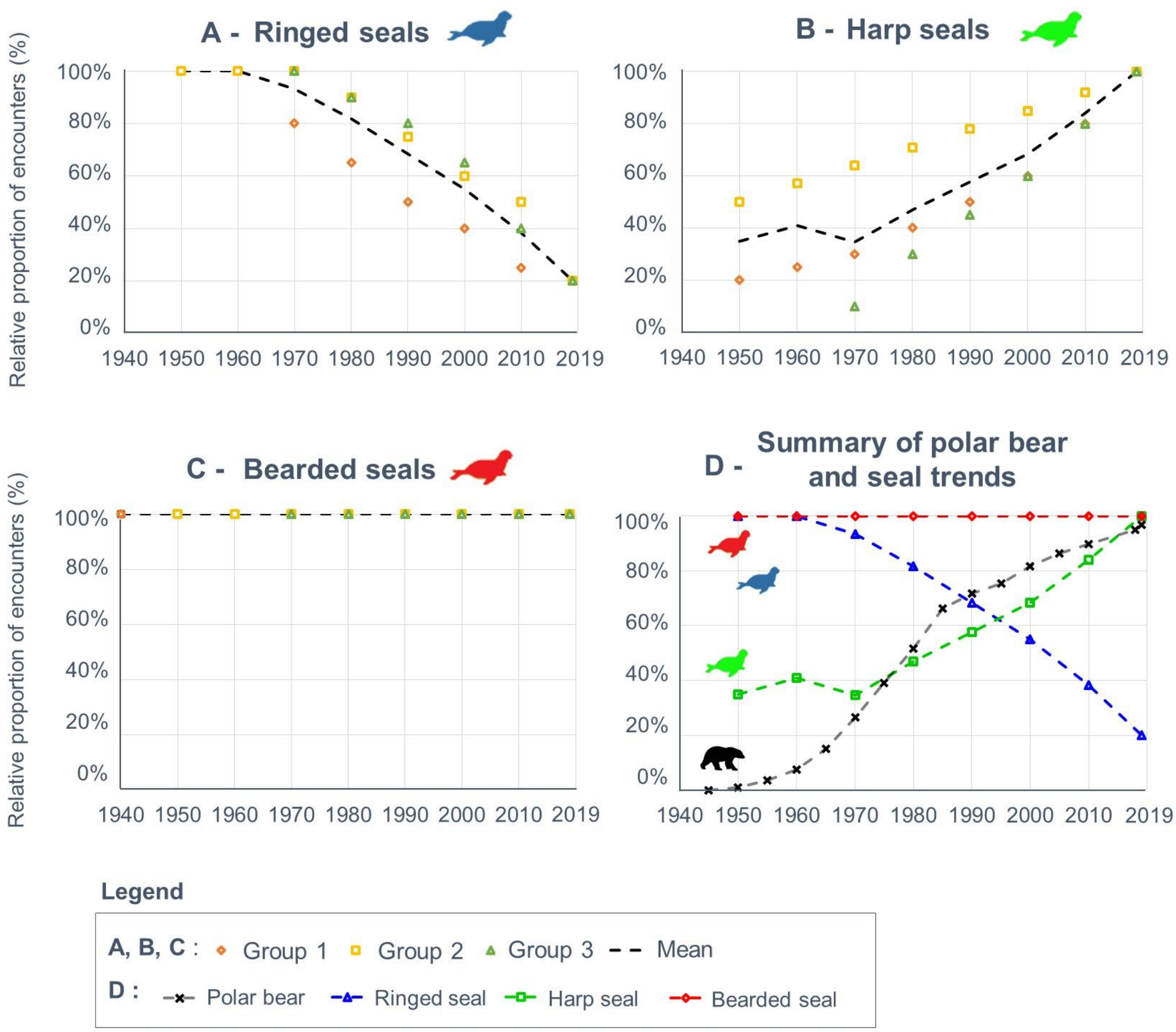


Figure 18. Relative proportion of ringed seal (A), harp seal (B) and bearded seal (C) observations/encounters between 1940 and 2019 and summary of polar bear and seal trends (D) as observed by Kimmirut contributors during group interviews. This information can be used as a proxy for seal relative abundance in the Kimmirut area. Information presented is based on interviews with three groups of polar bear hunters from Kimmirut (n=3; totalling eight participants). Data points were obtained from proportional piling exercises; each group of participants reached consensus on the relative proportion of seals they had observed over time for each species (see Appendix 5 for details). The dashed black line is the mean value. Polar bear trends presented in (D) are the same as those presented in more detail in Figure 9.

Although quantitative information on relative abundance trends for specific seal species is not available for Pangnirtung, many individual interview participants provided qualitative observations on changes in seal abundance around Pangnirtung. Similar to Kimmirut, there was a strong consensus that the ringed seal population around Pangnirtung had declined in recent decades. All contributors who commented on ringed seal abundance around Pangnirtung (n=13) reported a decline with the earliest observation of this phenomenon dating back to the 1980s. Regarding bearded and harp seal abundance trends, individual interview results were inconclusive as questions related to bearded and harp seal abundance were not asked systematically and only two contributors offered contrasting observations. Additional group interviews would be necessary to further document directionality and magnitude of local seal abundance trends in the Pangnirtung area.

> *"Ever since I was young, it seems [ringed seals] have declined somewhat. [I] go out hunting all the time, like every month, every week, and [I] see less and less [seals] every year…In the last 10 or 15 years I say [ringed seals have declined]. Right now, [there is] hardly any young seals in this area…So many polar bears hunt them every year. So seal started to move out somewhere else. If the seals lose their young ones every year, they won't stay in the same area. They'll move away." (Peter Kanayuk, Pangnirtung)*

> *"Now, here, there's not as much [ringed] seals, anymore. Because polar bears are here hunting [them]…There are so much polar bears, now, they're hunting a lot of seals. So people aren't catching as much seals as they used to." (Lazarusie Ishulutaq, Pangnirtung)*

> *"Because there's too many polar bears eating the seals, there's not many seals anymore...All kinds, any type, even if it's an adult, even if it's a mother, if it's a ringed seal or bearded seal, it doesn't matter." (Leopa Akpalialuk, Pangnirtung)*

> *"There are a lot less ringed seals since I was a boy. [Now] we get more harp seals but they stay in the summer only and they go back to Newfoundland in the winter… and there is about the same [number] of bearded seals [compared to when I was a boy], some years more some years less but it is normal [fluctuation]." (Simeonie Keenainak, Pangnirtung)*

During individual interviews, contributors from Pangnirtung and Kimmirut offered various explanations as to why they thought ringed seals had declined in recent decades around their community. Potential causes of decline cited by participants included: increase in polar bear predation, especially around ringed seal pupping areas (n=11); increase in local community harvest (n=3); ringed seal emigration into other areas (either following preys or due to displacement by other species) (n=3); increase in maritime transport (n=2); lack of sea ice (n=1); warmer ocean waters associated with climate change (n=1); increase in fox predation (n=1) and changing winds (n=1).

> *"The population of polar bear has grown so much and I believe there are a bit too many now to sustain the seal populations. The seal population has declined very much over the last 40 years, 30 years because of the increase in polar bear population." (Johnny Mike, Pangnirtung)*

> *"All I can say is that there's more of the people hunting and with more noise today. They got better equipment and polar bears are also really harvesting them, like pups. More polar bears. More seals like being killed and today foxes are not being trapped. Nobody's doing trapping anymore. Also, [foxes are] better hunters than polar bears for seal pups. Polar bears, people, foxes. Everybody's going after the seals. That's why the numbers go down." (David Kooneeliusie, Pangnirtung)*

> *"I think that [ringed seals] had declined because of the global climate change. [Ringed] seals are more comfortable in in cold waters. I think that they are searching for cold waters and I suspect that the decline [is noticeable] in warmer waters [because of] climate change." (Ejetsiak Padluq, Kimmirut)*

"Especially in the fall there used to be hundreds of [ringed] seals and you could almost see them everywhere during their mating season. But we have also seen these man made [devices] that drive away wildlife because of the ship traffic. We have seen a few of those around town and maybe [this] has something to do with [declining seals]...[These devices] make sounds to scare away the wildlife…That's what the shipping companies or somebody put in the ocean. We have seen them close to town...That is what some of us think, [that these devices] are driving away the marine mammals. We thought that those devices in the ocean were one [cause of decline] but, I don't know, maybe another reason could be less ice...One Elder said that seals seem to want to go against the wind and we have been getting quite a bit of south wind in the past years. That one Elder thought that the seals tend to want to go against the waves or against the current or tide. I heard him say that one time but he is no longer with us…a very knowledgeable Elder. So [ringed seals] may be going to different areas. If we keep getting the south wind [ringed seals] may be going somewhere else. That is what he was thinking: out in the open ocean or closer to Quebec or Labrador...[Before] we used to get more north wind." (Anonymous 02, Kimmirut)

In addition to discuss seal abundance, contributors commented on seal health. While five participants had not seen any changes in seal health over time (n=3 in Pangnirtung; n=2 in Kimmirut), nine contributors (n=5 in Kimmirut; n=4 in Pangnirtung) described abnormalities observed in ringed seal fur over the last 20 years, including fur loss (alopecia) and molting lasting longer than usual. One contributor from Kimmirut observed alopecia also in bearded seals and reported a case of severe fur loss in an adult bearded seal in which the animal appeared completely without fur and lethargic. Furthermore, three participants (n=2 in Pangnirtung; n=1 in Kimmirut) reported that ringed seals are now skinnier than they were in the past. One contributor highlighted that unusual molting patterns could be related to an increase in ocean temperatures and possibly other changes (e.g., salinity). Others explained that because sea ice break up is now occurring earlier, seals spend less time on the ice and more time on the shore, which can impact fur molting and growth. We note here that the topic of seal health was not explored in depth during interviews. Additional interviews would be required to document the extensive IQ available on this subject.

"[Ringed seals] have always being good, there is no difference. Now and then, it is the same thing as any other animals, they would either being skinny when they are supposed to be fat or they are sick when they are not supposed to be sick. It is the same thing as in any other animals." (Jeannie Padluq, Kimmirut)

"I am noticing a change in the condition of the seals that I have seen within my lifetime. A lot of them are losing fur and at one point I have noticed that the whole seal had no fur and I think that this is due to climate change...this was maybe in 2002. I have seen this in seals that are in between young seals and adults...Fur loss could be anywhere on the body. I have noticed it more in the summer and have only noticed it in ringed seals...The meat and the fat of the seals are always good." (Ejetsiak Padluq, Kimmirut)

"Sometimes I would notice that the seal has fur but then it has some sort of oil on the fur. Ringed seals are likely to have less fur and if they do have fur we have been noticing grease or some sort of oil. This is mainly in summer time, the boating season. I have noticed this in seals that are in between an adult and a young...the seals are in pretty much normal health except for the fur condition. I would not know why [seals] are like this.

I have started to notice the first seals with these fur conditions about ten years ago." (Sandy Akavak, Kimmirut)

"We have seen [ringed] seals that we shot with no fur on their back or on their belly but we still eat them considering that when we cut them up they look healthy inside. That could be [caused by] being on rocks and rubbing on to them. That is what I think but I don't know. I see it very rarely and I see it in the summer [not in the winter]. I haven't seen other seals that are like that [apart from ringed seals]." (Jawlie Akavak, Kimmirut)

"Some of the ringed seals don't change their fur properly every year…because [sea] ice breaks up too early. To change the fur, ringed seals have to go on top of the ice. If one year there is not enough ice or it breaks up too early they don't have time to change their fur so they have two furs: the old fur that keeps shedding and the new [fur that] starts to grow. We call them maqoalik, 'two hair' [seals]…There are more ['two hair' seals] now. It used to be [that] maqoalik [were seen] only in the springtime, when they start to lay on top of the ice…That is the time when there are 'two hair' [types] on them: the old and the new growing hair. They are skinny then because they don't eat anything when they're lying [on the ice] for almost two months. When they go in the water with the new hair, brand new, they are fattening up, they're eating. They're starting to be fat…I see maqoalik throughout the summer and the winter and it used not to be like that…The ice started to break up a lot earlier than it used to do. Like maybe a month earlier or a month and a half…I feel sometimes that the water is warm because we don't get the ice like it used to be... Now, ringed seals are usually skinnier than used to be. [In the] winter, ringed seals they are always fat. Right now, even in winter, some seals are skinny. At the floe edge [when] we shoot them, they sink under water." (Peter Kanayuk, Pangnirtung)

"The fur of ringed seals might be a little different because they have to stay on top of the ice to sun tan to get new fur. If there is less ice, the fur doesn't molt properly. Inside the animal there is an organ [spleen] that looks like a liver attached to the stomach…and every year it gets red and big in certain times of the year. When [the spleen] is swollen and becomes red that is when the [ringed] seal wants to be on top of the ice and the fur starts to get loose…I am not a scientist but I know because every year I get [ringed] seal to eat and I notice any little changes that happen in the body of the seal in the different seasons. That organ [spleen] normally has a bluish dark color and it's thin, but at certain times of the year [it can get] swollen and turn with blood inside. When that happens, the [ringed seal] fur starts to brown and get loose. But the seal has to rub himself on top of the ice to help get rid of that old fur. And when that happens, [ringed seals] don't want to eat. The stomach is completely empty for two months and they lose weight. This is in June, July. As soon as the ice is all gone in fjords and the seals have new fur on them they then disappear down to Davis Strait to feed on the shrimps and they stay there up until October and they are fat when they come back…So when they have new fur on, they all move. Well, not every single one of them move but I would say 90% of the [ringed] seals go out to the deeper ocean where they can find the shrimps. Since we get a lot less ice, we get more skinny seals in early summer…We lose more seals [when we hunt them] in the summer. When we shoot them in the summer they have no fat on them [so] they drown. We see also some seals with no fur on them because they go on rocks to sun bathe if there is no ice. Rocks are not like ice so when seals move around they lose the fur plus the nails, they don't have sharp nails anymore. I have started to notice these changes since 20 years ago, since the ice has started to melt earlier." (Simeonie Keenainak, Pangnirtung)

Despite the observed local decline in ringed seal abundance and reported changes in seal health, contributors generally indicated that polar bears have broad diets and that they can adapt to changes in prey availability. Many indicated that they were not concerned about polar bear persistence related to changes in local prey availability; however, some participants also acknowledged that if ringed seals remain scarce, polar bears could move to areas where ringed seals and other suitable preys are more abundant.

General health and body condition status

Polar bear health indicators

During individual interviews (n=27), contributors from both Kimmirut and Pangnirtung shared information about what they are looking for (indicators) to assess the health of individual polar bears, how they assess these indicators, and when. Polar bear health indicators discussed included: polar bear fatness (n=22); behaviour and movement (n=18); fur and/or hide colour and condition (n=15); meat/fat colour, smell and taste (n=7); stomach contents (n=3); teeth condition (n=1); and appearance of internal organs (n=1). Contributors also reported using direct and indirect measures (or metrics) for assessing these indicators, particularly to determine fatness of individual polar bears. Some of these metrics may be useful as early warning signs of impending population changes. Participants assessed the health of individual polar bears both before harvesting (while observing live polar bears on the land) and after harvesting (during butchering, hide processing and consumption of harvested bears). Figure 19 describes in detail polar bear health indicators mentioned by contributors, as well as how these indicators are assessed. Table 6 provides a summary of the polar bear health assessment process, including stages at which each indicator is assessed.

Importantly, participants reported assessing the health of individual polar bears holistically, employing multiple indicators and adapting their scale of assessment to take into account seasonal variability in polar bear condition. However, contributors highlighted that fatness was the indicator that most reflected the overall health of individual polar bears as it correlates with many other indicators. Seasonal variability, and in some instances also geographic variability, of indicators were important observations made by contributors, highlighting that the assessment of the health of individual polar bears needs to take into account such variability.

Contributors explained that assessing the health status of individual polar bears was important to them as it guided their polar bear harvesting and consumption decisions. Many noted that they preferred harvesting and consuming ‘healthy’ polar bears that provide good quality meat and hides.

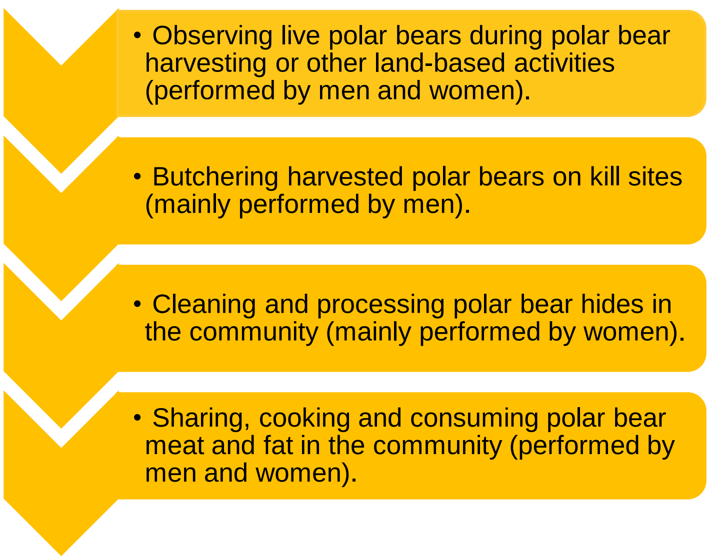
> *“[I know when a bear is healthy] by observing the bear: if it is fat it seems to be healthy. I tell people who go harvest bears to only get bears that are fat and not to harvest bears that seem skinny.” (Kooyoo Padluq, Kimmirut)*

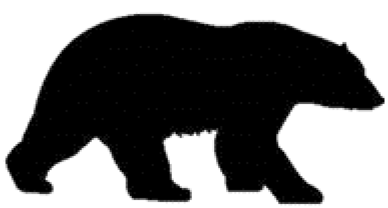
> *“[To eat] we prefer a fat polar bear [rather] than a skinny one. The skinny ones are not so healthy so they are not very good to eat.” (Anonymous 02, Kimmirut)*

> *“We were able to tell that the one that I caught was healthy because of how much fat it had on it. It was chubby, you could say that. And also the coat was very white.” (Anonymous 04, Pangnirtung)*

Table 6. Polar bear health indicators and their associated assessment stages according to contributors from Pangnirtung and Kimmirut (n=27).

Polar bear health assessment stages





The health of an individual polar bear is determined holistically by using various indicators at multiple stages.

Polar bear health assessment stages	Pre-harvesting	Post-harvesting		
Indicators	Observing live polar bears	Butchering	Hide processing	Food sharing, preparation and consumption
Fatness	✓	✓	✓	
Behaviour and movement	✓			
Fur colour and condition	✓	✓	✓	
Stomach contents		✓		
Internal organs condition		✓		
Teeth condition		✓	✓	
Meat and fat colour, smell and taste		✓	✓	✓

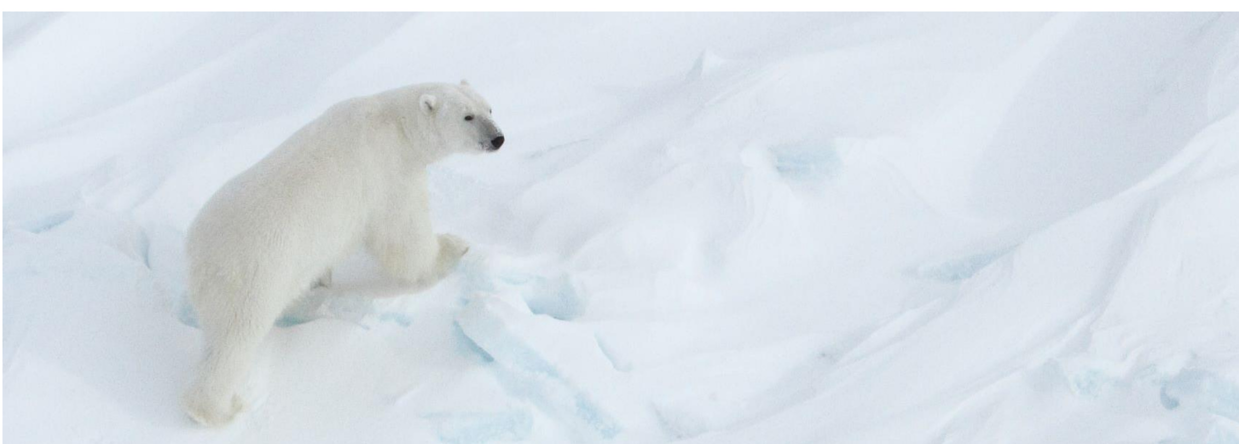


Figure 19. Summary of pre- and post- harvesting indicators employed to assess the health of individual polar bears and their specific assessment metrics according to contributors from Pangnirtung and Kimmirut (n=27).

Polar bear health indicators

Pre-harvesting indicators of health

Fatness

- *Fat polar bear = Indicates good health*
- *Skinny polar bear = Indicates poor health*

Shape and weight (direct assessment) – Fat bears have a round belly and thick limbs; skinny bears have a more apparent bone structure, long neck and thin limbs.

Track shape (indirect assessment) – Fat bears drag their feet and leave claw and fur marks.

Scat appearance (indirect assessment) – Fat bears will have runny droppings; droppings from skinny bears will be more compact.

Seal carcass condition (indirect assessment) – Skinny and hungry bears will eat seal meat as well as fat; fat left on seal carcasses can indicate good bear health.

Behaviour and movement

Movement – Bears that are fast and energetic are healthier than slower bears; however, fat bears can move and run slower than skinny bears due to their weight.

Human/bears interactions – Bears that interact with humans may be hungry or aggressive which can indicate poor health.

Fur colour and condition

White and clean fur – Indicates good health*.
Yellow and dirty fur – Can indicate poor health*.
Thick leg fur – Indicates good health.

** There is natural and seasonal variability in fur color and condition which may not relate to health.*

Post-harvesting indicators of health

Fatness

- *Fat polar bear = Indicates good health*
- *Skinny polar bear = Indicates poor health*

Carcass fatness – Healthy bears are big and fat; unhealthy polar bears are skinny.

Ease of hide cleaning – Hides from fat and healthy bears are easier to clean than hides from skinny bears; however bears harvested in fall are more difficult to clean, even when they are fat.

Hide colour and condition

White, clean, thick fur – Indicates good health*.
Yellowish fur – Can indicate poor health*.

** There is natural and seasonal variability in fur color and condition which may not relate to health.*

Stomach contents

Fat – Presence of liquefied fat indicates good health.
Seal meat – Presence of seal meat indicates hungry bear.
Garbage – Can indicate extreme hunger and/or poor health.

Internal organs

Lesions or abnormalities – Can indicate poor health.

Teeth condition

Broken or missing teeth – Can indicate poor health and/or old age.

Meat and fat colour, smell and taste

Meat colour – Pale meat can indicate poor health.
Fat colour – White fat indicates good health; yellow fat may indicate poor health.
Meat and fat smell and taste – Good taste and smell indicates good health.

Body condition (fatness)

Fatness was consistently used by contributors as an integrated indicator of polar bear health (n=22). Fatness was considered by contributors as a synonym of health, with fatter bears consistently described as healthier bears. Participants indicated that fatness could be assessed using direct but also indirect measures or metrics (Figure 19). Metrics used could provide a measure of fatness at the individual or population level (e.g., visual assessment of polar bear roundness and visual assessment of degree of consumption of seal carcasses, respectively).

Fatness can be determined directly by looking at a polar bear shape (roundness) and weight. When commenting on a standardized polar bear fatness scale conventionally used for in polar bear research in Nunavut, contributors further identified 'unhealthy' versus 'healthy' levels of fatness for individual polar bears (Figure 20).

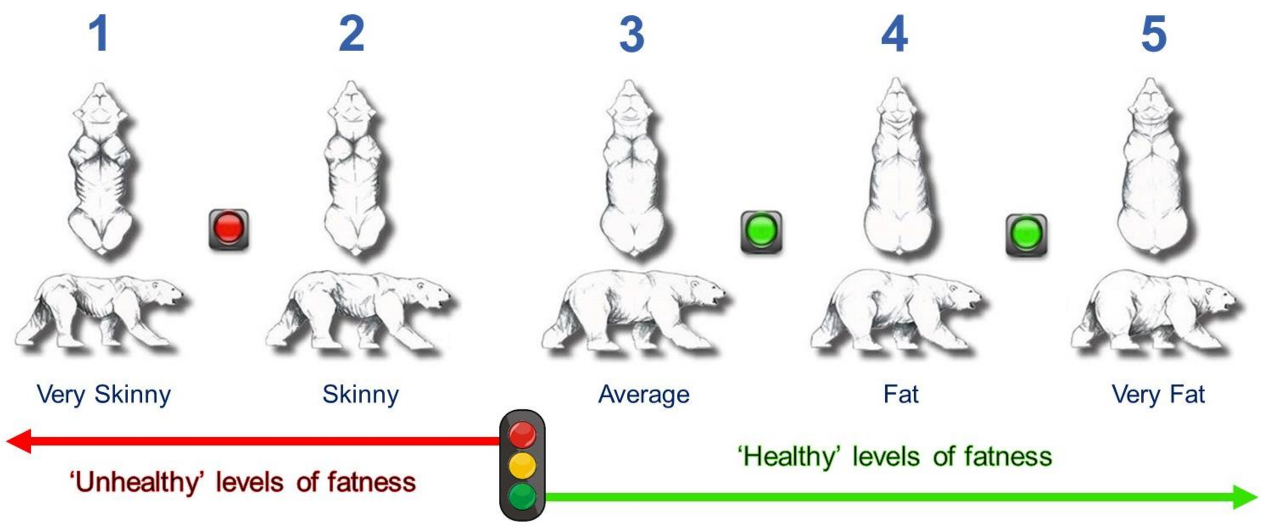


Figure 20. 'Unhealthy' versus 'healthy' levels of fatness of individual polar bears classified based on their body condition status using the fatness index on a 1 to 5 scale developed by Stirling et al. 2008. Polar bear categories and drawings of body types are sourced from the Polar Bear Body Condition Index Card used by the Government of Nunavut, Department of Environment (Government of Nunavut, n.d.).

> *"The healthy polar bears are nice and fat, while unhealthy polar bears are usually very skinny…Heathy males show the belly nice and fat." (Johnny Mike, Pangnirtung)*

> *"The size and the width [indicate health]. You know, if [a polar bear] has a long big belly hanging out it's healthy." (David Kooneeliusie, Pangnirtung)*

> *"If you see a polar bear from the distance, you could tell if it is fat and healthy or skinny. It is very noticeable to see how it looks. The healthy bears are big and fat. A fat bear has its stomach almost touching the ground while walking, while a skinny bear has just skin and bones. It is very noticeable." (Itee Temela, Kimmirut)*

> *"I have seen all kinds of bears, the ones that are healthy are normally the fat healthy bears. And the skinny ones, when you see and observe them you can tell that they are not healthy bears, just by seeing them...When you see a skinny bear you can see the bones sticking out on the body and they are not healthy." (Jeannie Padluq, Kimmirut)*

“One good way to tell [if a polar bear is healthy] is by [assessing] its weight and its fat[ness]. [If it is fat], you know, [this means that the bear] has been catching preys like seals and other game. When it is fat, we know it is healthy. The hair is good and it is a young healthy bear hunter that would catch preys. That is one sure way to tell whether a bear is heathy or not: when it is fat.” (Anonymous 02, Kimmirut)

Some participants from both communities indicated that fatness could be determined also indirectly by looking at the shape of polar bear tracks. In particular, fat polar bears tend to drag their feet which is reflected in tracks with dragging marks (Figure 21). One contributor explained that these types of polar bear tracks are typically seen in the spring.

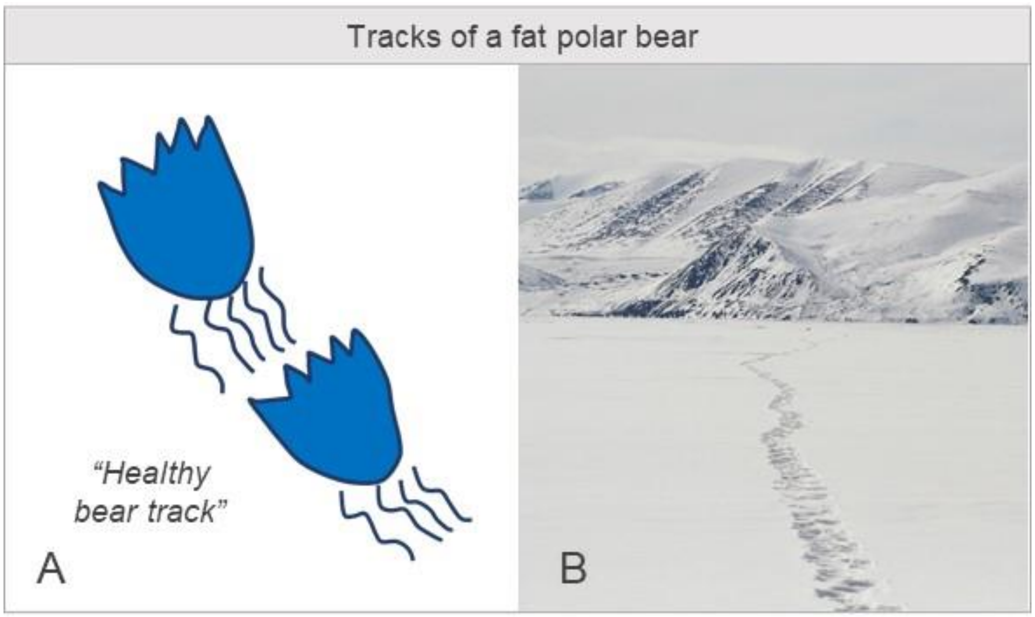


Figure 21. A: Schematic by Sandy Akavak representing a typical polar bear track with dragging marks indicating a ‘fat’ or ‘healthy’ bear; B: picture of polar bear tracks on the frozen ocean (courtesy of David McGeachy).

“I would know by looking at the footprints whether a polar bear is healthy and fat or [if] it is skinny. You can tell by looking at its footprints...As it walks along, a healthy fat bear would drag along the fur and a bit of the claws. I would be able to tell if it was a fat, healthy bear. If it was skinny bear it would not show the same dragging marks. It would be just the footprint without the dragging marks. I can also easily tell by its appearance...If the polar bear is fat I would notice the jiggle [of the fur] and the fur of the legs would also likely be thicker. I would be able to tell if a polar bears is skinny or not by looking at its joints, the high parts of the animals where there is less meat [the shoulders and the hips]. In skinny [polar bears] those joints would likely be showing…I would be able to tell also by looking at its neck. In a skinny bear, the neck is really narrow and long and its limbs would be thin.” (Sandy Akavak, Kimmirut)

“I can tell by the tracks. When they’re healthy, they’re kind of drag their paws. It’s really fun when you can tell they are big by [looking] at their paws...Since I was a little boy, I was told that when they are dragging [their feet] it’s a big polar bear. But when they’re not dragging and [leave] just perfect paw [marks] then that’s when it’s always skinnier.” (Lazarusie Ishulutaq, Pangnirtung)

One contributor indicated that the appearance of polar bear scats could reflect fatness and overall health of a polar bear, although he also added it extremely rare to find scats. In particular, scats of ‘healthy fat’ bears is runny as polar bears eat mostly fat, while ‘unhealthy skinny’ bears will have more compacted scats. We note that, while these observations are important for the broad understanding of health indicators and their multiple measures of assessment, given the difficulties in finding polar bear scats on the land this metric is less suitable for the systematic monitoring of polar bear body condition status.

“The droppings of a healthy bear would likely be runny as opposed to a skinny bear that would have the droppings a bit more compact.” (Sandy Akavak, Kimmirut)

Other two participants mentioned that the degree of consumption of a seal carcass preyed upon by a polar bear provides indirect insights on the level of hunger of that polar bear, which in turn relates to its body condition status and overall health. They explained that finding leftover fat on seal carcasses could indicate the presence of fat and healthy polar bears, while seal carcasses on which both meat and fat have been consumed could indicate the presence of skinny and hungry polar bears. Assessing the degree of consumption of seal carcasses in an area could therefore provide additional information on the nutritional stress that the local polar bear population may be subjected. We believe this measure of assessment may be well suited to serve as an early warning signal for changes in the local polar bear population.

“If [polar bears are] really healthy, they’ll eat some of the fat and leave the carcass behind. They just eat the fat, mostly fat.” (Peter Kanayuk, Pangnirtung)

“If they’re really hungry they’ll eat [seal] meat too but they’ll go for just the fat…first. Sometime when you open the gut of a polar bear mostly you can see it’s liquid, just the fat.” (David Kooneeliusie, Pangnirtung)

Finally, participants reported that polar bear fatness can be assessed while observing live polar bears on the land, when butchering harvested bears on kill sites but also during polar bear hide processing. Women specialized in polar bear hide processing highlighted that polar bear fatness can be determined based on ease of hide cleaning. They explained that polar bear body fat content is reflected in how difficult it is to scrape fat off a hide: hides from skinny bears are more difficult to clean than hides from fat bears. However, one contributor also explained that the hides of polar bears harvested in the fall tend to be more difficult to clean than those harvested in winter, even when they are fat. This last comment highlights natural seasonal variability that has to be taken into account when utilizing specific assessment metrics.

“When I’m cleaning the skin that’s when I know [if the bear was fat]…It’s harder to scrape the excess fat from the skin [if the bear] was not fat…When [a bear is] healthy it’s easy to scrape off the fat and the fur is white.” (Meeka Alivaktuk, Pangnirtung)

“If it is a skinny bear, the hide is harder to clean.” (Jeannie Padluq, Kimmirut)

"Hides of fat bears are easier to clean and skinny bears are very hard to clean and there is more work to do because you are not scraping [the fat] but you are trying to cut through it…Some of the bears harvested in the fall have less hair [in the paws area] because [the bears] have been walking during the summer and part of the fall. In the winter their fur grows back and [the paws] are easier to clean. I have done so many [hides] that I know what they go through. And the bears that are harvested in the fall are dirtier than the bears that are harvested in the winter and this has always been like this. Even if they are not skinny, the bears harvested in the fall are a bit harder to clean than the bears harvested in the winter." (Akeego Killiktee, Kimmirut)

Behaviour and movement

Many contributors stated that how a polar bear moves and behaves is also an indicator of health (n=18). In general, healthy bears are fast and energetic, whereas significantly slow movements can be indicative of poor health. Some participants indicated that fat bears can also move slowly due to their weight.

"Sometimes you see very skinny polar bears that are not moving as heathy polar bears…Just by the movements you can tell that they are not as healthy: they don't move as fast as a healthy polar bear. It is a very lazy type of walk." (Matiusie Maniapik, Pangnirtung)

"The unhealthy ones will be like more slow or may limp." (Geetee Maniapik, Pangnirtung)

"[I can tell if a bear is healthy] by looking at the way it moves. When they are fast when they are start running, that is a healthy bear. I know that if it is a starving or unhealthy bear they won't move as quick." (Akeego Killiktee, Kimmirut)

"It is pretty obvious, a healthy bear, it is more alive [and has] more energy compared to an unhealthy one, which is skinny and slow. It is pretty easy to tell the difference by the outlook appearance." (Anonymous 01, Kimmirut)

"Healthy fat bears would run slower, and skinny bears would be a lot faster. A skinny bear runs fast while a fat bear moves slow." (Sandy Akavak, Kimmirut)

When discussing polar bear health, some contributors further noted that polar bears that interact with humans and come near communities may be hungry and aggressive which could indicate poor health. We also note here that when talking about 'problem bears' many contributors mentioned healthy juvenile individuals that tend to be more inquisitive and aggressive (see 'Human-polar bear interactions' section).

"The polar bear that I have observed are healthy but the bears that are hungry are the ones that tend to come to the community…The ones that come to the community some are hungry but bears nowadays coming in the communities are more aggressive and attack humans even if they are not hungry." (Itee Temela, Kimmirut)

"If we see an unhealthy [bear] it is likely in the time when there is no ice, in the summer or the early fall when there is no ice...I have seen both young ones and older ones that looked unhealthy." (Anonymous 01, Kimmirut)

"When you see a polar bear that is not running away then it is not as healthy as the others, it is hungry. Even if you scare it off, it keeps returning. That is a hungry polar bear." (Matiusie Maniapik, Pangnirtung)

Fur colour and condition

Fur or hide colour and quality was also identified as an indicator of polar bear health (n=15) which can be assessed while observing live bears, as well during butchering and hide processing. Contributors reported that white, clean and thick fur generally indicates good health while yellow and dirty fur could be indicative of poor health.

"[Healthy bears have clean fur] because I think they move in ice and water when they're healthy, they swim a lot and they clean themselves a lot." (Simeonie Keenainak, Pangnirtung)

"They are very noticeable when their yellow fur is not really healthy." (Michael Kisa, Pangnirtung)

"Sometimes they are dirty, sometimes they are clean. I would think that a good healthy bear is clean, it is more white. [Unhealthy bears are] more dirty, not as white, and skinny looking." (Anonymous 01, Kimmirut)

We note that participants also reported natural seasonal and geographic variability in polar bear fur colour and condition which may not relate to health. For example, one participant specialized in processing polar bear hides explained that polar bears harvested in fall generally have dirtier fur than those harvested in winter. A hunter also noted that polar bear fur is generally yellower in summer when bears spend more time on the land. In addition, some participants highlighted that fat stains on polar bear neck and head indicated that bears had been preying on large animals. Others mentioned that bears may camouflage by covering in dirt and mud as they look for preys on the land. Finally, one contributor mentioned that polar bears from the Pangnirtung area are 'yellower' than polar bears from the Qikiqtarjuaq area, thus highlighting the geographic variability of this indicator. Therefore, although related to polar bear health in some context, fur colour in itself was not described as a definitive indicator of health.

"To us, anything that has an ugly looking hair, it's not healthy…[Unhealthy bears have] very brownish colour of hair...Healthy [bears] look like fat and [have] really clean [fur]. Really nice, white…Sometimes they get brown hair in the neck area because they have been eating fat, maybe bowhead whale." (Peter Kanayuk, Pangnirtung)

"The younger it is, the more white. It's not because bad health or good health...some are really yellow even when they're adult." (Davidee Nowyuk, Pangnirtung)

"If the fur is really clean you can tell [the bear] has been eating good and if the coat is really good [clean and white] you can maybe tell that the bear has been swimming out in the ocean a lot... [But in the summer, when polar bears hunt on land they] look pretty dirty. That is their way to camouflage themselves when they hunt on land so they won't be as visible: they dirty themselves up in the mud when they hunt on land." (Anonymous 02, Kimmirut)

"A healthy polar bear has nice fur: all white, not too yellow. That's a healthy bear. Yellow ones or dirty [can be] healthy too." (Isaac Temela, Kimmirut)

Meat and fat colour, taste and smell

Polar bear meat and fat colour, taste, smell and overall quality was identified as an additional indicator of health (n=7) that can be assessed during butchering, hide processing and/or during food preparation and consumption. Contributors explained that white fat generally indicated good polar bear health while the presence of yellow fat and pale meat suggested poor health. Good meat/fat taste and smell were also perceived as a sign of good health.

> *"If the carcass of the bear looks good to eat, we won't waste it as long as the bear looks healthy enough…if the carcass is fat enough and by looking at the colour of the meat. If the meat has a good colour and it is not pale, it means it is a good meat, but if the meat is kind of pale it does not look good and we won't eat it…[I can tell] if a bear is healthy by its look, and the taste and smell of its meat." (Itee Temela, Kimmirut)*

> *"It has always been mentioned that some bears have really bad smell [while] others don't have any smell. Inuit have the knowledge that it's always been like that. [I mean] the smell of the meat." (Joe Arlooktoo, Kimmirut)*

> *"[When] fat is really white, that's healthy. [And when] you don't see any brown spots on the fat area, we feel that's healthy." (Peter Kanayuk, Pangnirtung)*

> *"A healthy polar bear often will have nice fat on [its hide]. It's easy to scrape off, it's not really yellow. It's easier to clean…I've worked on one that wasn't really very healthy, the fat looks a little more yellow and it's harder to scrape off." (Anonymous 04, Pangnirtung)*

Stomach contents, internal organs and teeth condition

Some participants reported that stomach contents (n=3) and internal organs (n=1) from harvested polar bears can be examined during butchering as indicators of health. They noted that healthy polar bears would have seal remains and mostly liquefied fat –looking almost like water– in their stomachs. The presence of anthropogenic waste or unusual prey items may indicate poor health or hunger and may correlate with poor body condition. One participant further explained that the presence of lesions or abnormalities on internal organs can also be indicative of poor health.

Lastly, one contributor highlighted that broken or missing teeth could be signs of poor health and/or old age. Poor teeth status was also correlated with poor body condition.

> *"The bears with less or broken teeth would be skinny or skinnier bears...I have seen bears with no [canines] and they are skinnier. I have seen that twice." (Joe Arlooktoo, Kimmirut)*

Changes in polar bear body condition and general health

Contributors shared their observations of changes in polar bear fatness (body condition) and overall health over time. These are presented below per community. In this section, polar bear fatness is discussed alongside general polar bear health given that 'fatness' was identified as the main indicator of health by participants from both communities (see 'Polar bear health indicators' section).

Kimmirut

In Kimmirut, changes in polar bear body condition and health were discussed during both individual and group interviews. Qualitative individual interview results are presented and discussed together with quantitative findings from group interviews.

Temporal changes in body condition status

During individual interviews (n=13), when discussing temporal changes observed in polar bear fatness (body condition status), contributors shared multiple perspectives which are summarized in Table 7. While it was acknowledged that level of fatness differs from polar bear to polar bear – depending on the hunting skills of individual bears–, a majority of contributors reported observing more polar bear in poorer body condition compared to the past. Some participants interpreted this observation as indicative of a general decline in polar bear body condition over time in the Kimmirut area, although some also specified that the change they had observed was slight. However, some contributors expressed the view that polar bear body condition had remained stable or were uncertain about any change in polar bear body condition over time.

Table 7. Observations on temporal changes in polar bear body condition status in the Kimmirut area based on individual interviews (n=13).

Type of observation	Frequency of responses	Notes
More "skinny bears" or polar bears in poorer body condition compared to the past	7	Five contributors interpreted this observation as a general decline of polar bears' body condition status with one of them noticing this change within the past 10 years.
Body condition may have declined but it is still unclear at this point	1	The contributor noted that more time was required for a definitive answer.
No change observed	3	Two women specialized in hide processing and one hunter provided this answer.
Unknown	2	One contributor (Elder) was not confident in commenting on this aspect as he was not actively harvesting anymore at the time of the interview. However, he also mentioned observing a decline in body condition while still harvesting.

Figure 22. Mikidjuk Kolola (left), Sandy Akavak (centre) and Joannie Ikkidluak (right) participating in proportional piling exercises on polar bear body condition around Kimmirut.

Group interviews with active harvesters (n=3, totalling eight participants) were important to clarify some of these uncertainties, minimizing potential biases[11], as well as understand the degree of change observed. Changes in polar bear fatness were determined using proportional piling exercises over the 1 to 5 body condition types used in conventional monitoring (developed by Stirling et al. 2008) and repeated over three time periods: (1) around 1990; (2) around 2005; and (3) within the last three years (2016-2019) (Figure 22). Group interviews indicated that the increased number of ‘skinny bears’ reported by individual interviewees were likely a function of a population increase rather than the result of a substantial change in polar bear body condition status over time. Group interview results highlighted that overall changes in polar bear body condition status in the Kimmirut area were very minor across the three time periods examined (Figure 23). This finding likely explains uncertainty in individual interviewees’ responses (Table 7).

In summary, based on proportional piling exercises, for each time period (around 1990, around 2005, and last three years [2016-2019]) most polar bears observed were classified within ‘average’ or ‘fat’ body condition categories and, overall, proportions of polar bears observed per body condition type had remained similar since the 1990s (Figure 23). Starting from 2005, there was a small increase in the proportion of ‘skinny’ bears –about one percentage point from the 1990 level. Over the 2016-2019 period, there was also a shift of a few percentage points from the ‘fat’ to the ‘average’ body condition type compared to 2005 (Figure 23). In particular, there was a slight decline in the proportion of ‘fat’ polar bears from 49% (range: 48-50) observed around 2005 to 45% (range: 40-50) observed in 2016-2019. This decline was mainly compensated by a small increase in the proportion of ‘average’ bears from 42% (range: 30-49) observed around 2005 to 45% (range: 30-55) observed in the 2016-2019 period. However, overall, across the time periods examined, changes were minor with the majority of bears (over 94%; range: 92-98) classified within ‘healthy’ fat levels (Figure 23). In fact, there was a consensus among group interviews contributors (n=4, totalling 15 participants) that polar bears exhibiting body condition types 1 and 2 had ‘unhealthy’ fat levels and that polar bears with body condition types 3, 4 and 5 had ‘healthy’ fat levels (Figures 20 and 23).

[11] The presence of skinny bears attracted to food available in or near communities could magnify perceptions of poor body condition among community members who do not travel far from the community.

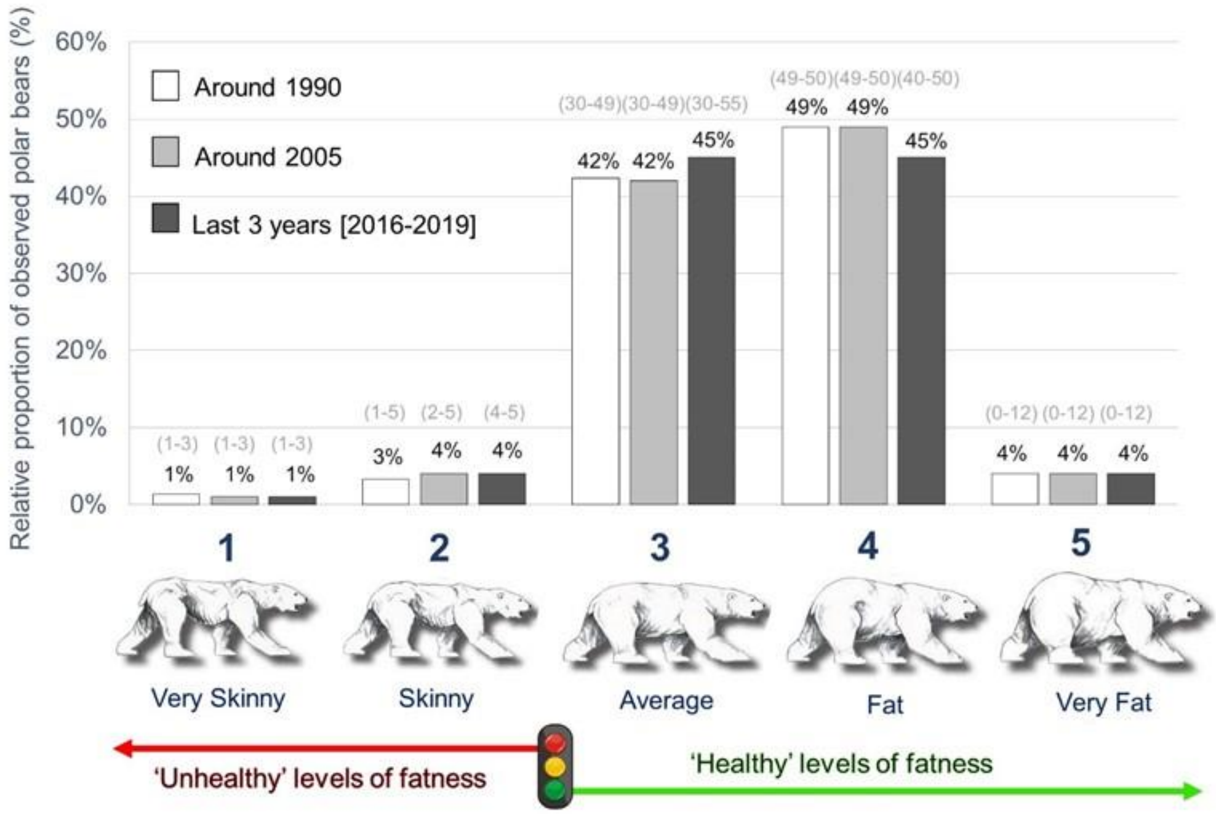


Figure 23. Relative proportion of polar bears observed per body condition type (1 to 5 scale developed by Stirling et al. 2008) over specific time periods (around 1990, around 2005, and last three years [2016 to 2019]) in the Kimmirut area. Percentages were derived from proportional piling exercises with three groups of contributors from Kimmirut (n=3; totalling eight participants); mean values are presented over each bar with respective value ranges provided in brackets in light grey. Polar bear categories and drawings of body types are sourced from the Polar Bear Body Condition Index Card used by the Government of Nunavut, Department of Environment (Government of Nunavut, n.d.).

Contributors who had observed a decline in polar bear fatness over time mostly attributed these changes to an increase in polar bear abundance combined with a reduction in the abundance of ringed seals (polar bear main prey) and changes in sea ice conditions reducing polar bear access to seals.

Some participants also highlighted that skinny or 'unhealthy' polar bears tended to be observed close to the community in the summer and fall when there is less sea ice and hunting is more difficult for polar bears.

Some contributors linked poor body condition with young polar bears being abandoned by their mothers or with old age. In particular, two Elders shared observations of polar bears that were "smaller in size". While this change could be related to a true decrease in body size possibly due to shorter interbreeding times (i.e., polar bears that invest less in growth and mature early to increase their reproductive potential) or reduced food availability (i.e., polar bears that are born in cohorts with reduced food resources and therefore that did not grow as large), it could also be a sign of immigration of polar bears exhibiting a different body size phenotype from adjacent subpopulations into the Kimmirut area (see also 'Sea ice changes' section).

Finally, participants highlighted that whether observations of polar bears in poor body condition have implications for population persistence remained uncertain at the time interviews were performed.

> *"Not from my personal experience but from what I hear from other people, polar bears [are] skinnier nowadays...I have an idea that could explain why [polar bears] may be skinnier: back then the bears were a lot healthier because this area had more ringed seals for them to eat. Nowadays, there is less ringed seals. When the bear population was high, likely the polar bears hunted the seals until the numbers declined. I recall baby seals and younger seals within their first year of age coming in a lot around the end of July and back then there was a lot of those young seals coming in, whereas today there are a lot less, almost next to none. When I was hunting back then, I would likely be catching about 20 to 30 seals in a day whereas today they are catching less, like one, two or three in a day hunt." (Sandy Akavak, Kimmirut)*

> *"When I was a child, in the 70s, there were hardly any bears...but in the 70s and 80s polar bears were fatter compared to today...In particular, during the summer polar bears are not as fat and they seem skinnier also during the fall and winter. In the spring, some bears could be skinny and some bears could be fat...Nowadays, [polar bears] seem to be not as fat as they used to be. One of the reason could be [related to changes in] the sea ice conditions because sea ice provides [a platform for the polar bears to hunt] the seals that are sun bathing or that are under the ice. I know this since the time my grandfather used to tell us stories [about polar bears] and up to this day I have seen that the polar bears are doing the same as my grandfather told me." (Kooyoo Padluq, Kimmirut)*

> *"Some [polar bears] seem to be way too skinny, probably there is not much in their stomach. One Elder had to shoot a bear for defence since it was close to his cabin and he had never seen a skinny bear, it was a very unhealthy bear. But there's some healthy ones too but we start to see a bit more skinny bears here and there. In the past 10 years or less...I may be seeing them more in the summer when it is harder hunting for them, when there is no ice...The skinnier bears are at the dump or they come close to town looking for food...I have always seen healthy bears there [Markham Bay area]." (Anonymous 02, Kimmirut)*

> *"Mostly young bears that I have seen that are quite skinny. But that other one I saw was a female, but it could have been from old age too like an old bear, very skinny and unhealthy...I think that [skinny young bears] have either lost the mother or the mother pushed them away. There are more bears coming into town and sometimes a mother bear may be harvested not knowing that it has cubs, sometimes we can't see cubs. We are not supposed to hunt family groups and I know people respect that. If it has cubs nobody hunts that but if it had cubs that we did not know about that we don't see maybe a mother bear may be harvested without not knowing about the cubs." (Anonymous 02, Kimmirut)*

> *"All the bears that I have caught were in good shape from the first to now...and the bears I have observed some are skinny and you can tell they are hungry....I think it is fair to say that they are the same [as the past] but I guess maybe we will wait and see what we will observe in the next five years. My thinking anyway if we get less sea ice we will be able to find out if we start to see more skinny bears. But for now most of them are in relatively good shape." (Anonymous 03, Kimmirut)*

Temporal changes in overall health

When invited to discuss general polar bear health (considering polar bear fatness along with other health indicators; see ‘Polar bear health indicators’ section), individual interview contributors often noted that both ‘healthy’ and ‘unhealthy’ bears are encountered today. Similarly to observations of body condition status, there was a general sense that in recent year the proportion of unhealthy polar bears may have increased compared to the past, however the odds of encountering unhealthy polar bears continued to be low.

> *“Some of them are really skinny and hungry. The first polar bear we saw last year, the six footer male, was all bony; that was the first one we saw last year. Then a couple of days later we saw a healthy male, it seemed healthy. We see healthy looking ones and not healthy looking ones, bad hunters and good hunters...polar bears seem getting to be hungrier. I started to notice that about eight years ago.” (Isaac Temela, Kimmirut)*

> *“I have seen my share of unhealthy ones and also healthy ones too...it is less likely to see unhealthy ones than we do healthy. The odd bear here and there are unhealthy and I see more frequently healthy bears…If we see an unhealthy [bear] it is likely in the time when there is no ice, in the summer or the early fall when there is no ice […] I have seen both young ones and older ones that looked unhealthy.” (Anonymous 01, Kimmirut)*

> *“The polar bears that I have observed are healthy but the bears that are hungry are the ones that tend to come to the community.” (Itee Temela, Kimmirut)*

Group interviews with active harvesters (n=3, totalling 8 participants) were then performed to further explore temporal changes in overall health status of polar bears in the Kimmirut area. Proportional piling exercises were used to record the relative proportion of ‘healthy’ vs ‘unhealthy’ polar bears observed around Kimmirut over three time periods: (1) around 1990; (2) around 2005; and (3) within the last three years (2016-2019) (Figure 24). During group interviews, ‘health’ was assessed and understood as a general characteristic going beyond the fatness (body condition) indicator alone. Participants expressed proportions of ‘healthy’ vs ‘unhealthy’ polar bears employing all of the pre- and post-harvest indicators they were familiar with (see ‘Polar bear health indicators’ section). While over 90% of the polar bears observed by contributors were considered ‘healthy’ across the three time periods, group interview participants reported a slight increase in the proportions of ‘unhealthy’ polar bears since 2005 (Figure 24). In particular, around 2005 the proportion of ‘unhealthy’ bears had increased to 8% (range: 5-10) from to the 2% (range: 0-7) level recorded around 1990, and further increased to 9% (range: 5-15) in the 2016-2019 period (Figure 24).

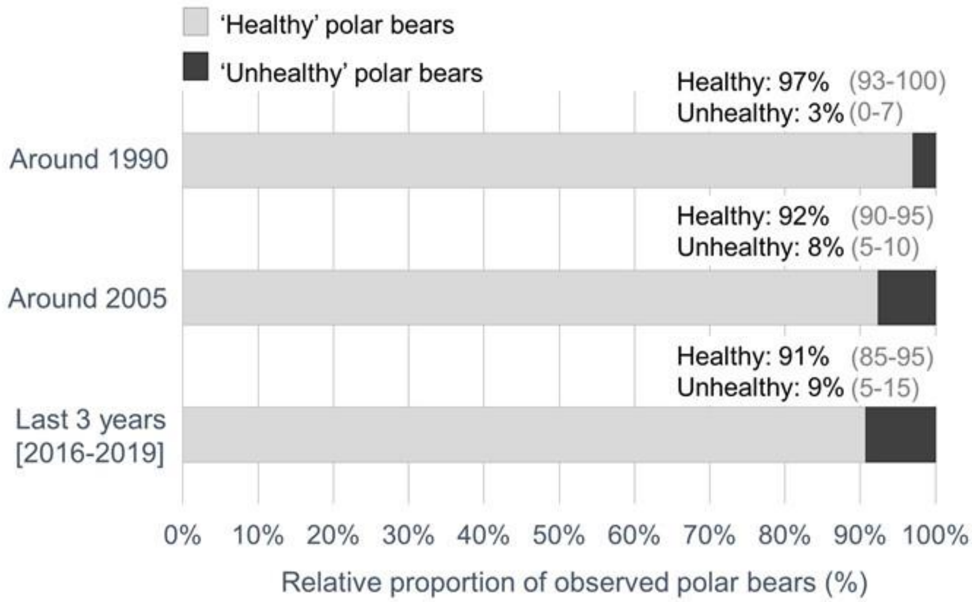


Figure 24. Relative proportion of 'healthy' vs 'unhealthy' polar bears observed in the Kimmirut area over three time periods (around 1990, around 2005, and last three years [2016 to 2019]). Percentages were derived from proportional piling exercises with three groups of contributors from Kimmirut (n=3; totalling eight participants).

<u>Section summary: temporal changes in body condition status and overall health</u>

In summary, based on individual and group interviews performed in Kimmirut, from around 1990 to 2019, over 90% of the locally observed polar bear population had been within 'healthy' fatness levels and 'good' overall health (Figures 23 and 24). However, in more recent years –within the 2016-2019 period– minor changes had been observed from previous years, including a shift of a few percentage points from the 'fat' to the 'average' body condition type and a small increase in the proportion of polar bears considered 'unhealthy' (Figures 23 and 24). At the time interviews were conducted, such changes were not reflected in observations related to cub productivity and survival which had been stable since the 1990s (Figure 11; see 'Size of family groups, cub productivity and survival' section). Given the rate of environmental change reported by participants –including observations of major declines in local ringed seal abundance and changes in sea ice conditions–, continuous documentation of Inuit observations will be required to understand how polar bear body condition and health will evolve over time.

Pangnirtung

In Pangnirtung, participants discussed changes in polar bear body condition and overall health during individual interviews only (n=14); therefore, unlike for Kimmirut, quantitative information generated though group interviews is not available for this community. Observations specific to changes in polar bear fatness over time are presented below, followed by comments made by contributors regarding general polar bear health.

Temporal changes in body condition status

Contributors from Pangnirtung shared similar perspectives as individual interview contributors from Kimmirut as summarized in Table 8. Pangnirtung participants acknowledged that polar bear fatness levels vary on an individual basis due to differences in hunting skills/success but possibly also due to body type, with this making it difficult to assess temporal changes. Despite these limitations, a majority of individual interviewees reported observing more polar bears in poorer body condition compared to the past with some of them interpreting this observation as indicative of a general decline in polar bear body condition over time within the Pangnirtung area. Earlier signs of change dated back to the 1980s but were more consistently observed starting from the late 2000s. However, similarly to Kimmirut, some expressed the view that polar bear body condition had remained stable or were uncertain about any change in polar bear body condition over time. (Table 8).

Table 8. Observations on temporal changes in polar bear body condition status in the Pangnirtung area based on individual interviews (n=14).

Type of observation	Frequency of responses	Notes
More “skinny bears” or polar bears in poorer body condition compared to the past	7	More “skinny bears” were noticed starting from: the 1980s (n=1), the late 2000s (n=1), 2010 (n=1), the last 2 years [2017-2019] (n=1). Six contributors interpreted this observation as indicative of a general decline in polar bear body condition status.
No change observed	5	Two women specialized in hide processing and three hunters provided this answer.
Unknown	2	One contributor explained that it was difficult to identify a general trend given individual variation in polar bear fatness.

“Some polar bears are really good hunters and some are not. Some polar bears do better than others.” (Johnny Mike, Pangnirtung)

“It doesn’t matter what animal they are, some of them live to be skinny, just like people. You know, it doesn’t matter what they eat, how much they eat, they’ll be skinny. But I think the polar bears are like that too.” (Simeonie Keenainak, Pangnirtung)

“They used to be fat all the time [back in the 1960s] … [Today], when we go boating, we see lots of polar bears during the summer. In summer, we see lots of very, very skinny bears. We even worry about them. They might not make it through the winter because they are so skinny… [Within the past 10 years] some of them [polar bears] seem to be skinnier. Because we see a lot more bears, we see more skinny bears too. Even when we don’t look for them or we don’t expect to see polar bears, we see them.” (Peter Kanayuk, Pangnirtung)

“There’s not much change to the fat…People don’t want to eat the meat if there’s not much fat in it.” (Michael Kisa, Pangnirtung)

Similarly to Kimmirut, Pangnirtung contributors who had observed a decline in polar bear fatness over time reported three main potential causes, acting alone or in synergy, that could explain this phenomenon: an increase in polar bear abundance leading to increased competition over and reduced access to preys (mainly ringed seals), less sea ice cover leading to reduced access to preys, and a decline in ringed seal abundance observed around Pangnirtung.

> *"Polar bears are getting skinnier because there is not enough food and the polar bear population has grown more." (Matiusie Maniapik, Pangnirtung)*

> *"[Polar bears] seem to be getting smaller and I think they're hungry. Now, there are too many polar bears and it's harder for them to catch food, like seal. And that's why they're getting smaller and smaller because they're not eating as much as they used to do before…They're smaller and, when they're smaller, they don't have much fat. It's harder for the smaller ones to hunt compared to the bigger polar bears…[Polar bears are] not as energetic as they used to be. They are slowly losing [their energy]. I think this is because they don't catch much food anymore…Each year, there is not much ice anymore so they can't hunt as much. And with too many polar bear [there is] not enough food." (Lazarusie Ishulutaq, Pangnirtung)*

> *"Polar bears they tend to get skinnier now too because there's hardly any seals left in this whole Cumberland Sound." (David Kooneeliusie, Pangnirtung)*

Some participants also mentioned that the poor hunting success of older bears and the chemical immobilization of polar bears for scientific research could explain why some individual bears were observed in poor body condition.

> *"When [polar bears are] not active as hunters anymore they get skinnier and myself, I don't want to harvest big males…Sometimes there's hardly any fat [on older bears]." (David Kooneeliusie, Pangnirtung)*

> *"The ones that have been put to sleep are the ones that are usually skinny. There is no specific gender or age." (Matiusie Maniapik, Pangnirtung)*

Three contributors explained that skinny polar bears observed within close proximity of the community tended to be juvenile bears and seen more often in spring and summer.

> *"[Today] some [polar bears] are healthy [but] we keep seeing kind of skinny polar bears, especially younger ones. Young ones alone, maybe three or four years old, are usually skinny. Females are usually fatter or big…I see the skinny ones like in the spring and the summer…more skinny bears in the late 2000s. When you go around you see more skinny bears now. There is not enough food and they are having hard time catching seals, I guess some of them." (Peter Kanayuk, Pangnirtung)*

> *"I've seen some [healthy bears] too but the ones I've seen that…interact with this community in the past years haven't been really fat." (David Kooneeliusie, Pangnirtung)*

Temporal changes in overall heath

When asked to discuss general polar bear population health (considering polar bear fatness along with other health indicators), five contributors mentioned that polar bears observed around Pangnirtung were generally 'healthy' and three highlighted that bears are not as 'healthy' as they used to be.

Two participants further noted regional differences in polar bear body condition and health, explaining that bears living on the northern side of the Cumberland Peninsula and that do not come inland are usually healthier.

> *"[Polar bears] seem to be healthier along the coastline [northern side of the Cumberland Peninsula] instead of [Cumberland Sound] here because there's more plenty of sea mammals along the north side of Baffin Island and that's why the bears are healthier…I would say the [bears] that stay out at sea, way out there, that almost live off their own icebergs, I'd say they're always healthy."" (David Kooneeliusie, Pangnirtung)*

In addition, one male polar bear hunter and one female contributor specialized in hide processing both observed a greater number of polar bears with yellow fur (which are not preferred for harvesting), particularly in the Cumberland Sound area. However, based on contributors' narratives, this difference appears more likely as a function of geographic variation rather than reflecting a true difference in health status (see 'Polar bear health indicators' section).

> *"I have noticed more [bears] in [the Cumberland Sound] area [with fur that is] kind of really yellowish… I have never seen anything like that on the north side [of the Cumberland Peninsula]. Just here in this Cumberland Sound." (David Kooneeliusie, Pangnirtung)*

> *"The fur got more yellow and it's skinny...But the whiter it is, the fatter the polar bear is…If you see a yellow skin, it's skinner, too. But if it's white, it's fat. That's the change." (Leesee-Mary Kakee, Pangnirtung)*

Although the proportion 'healthy' vs 'unhealthy' polar bears observed over time was not systematically explored in Pangnirtung through group interviews, one male polar bear hunter estimated at 80% the proportion of 'healthy' polar bears he had observed in recent years and one female contributor did not notice any change in polar bear health over time from cleaning and processing hides.

> *"I would say 80% of it [local polar bear population] are healthy…In the past we don't see much polar bear like we do now... but it seems like the polar bear that we caught down there, most of it was pretty healthy bears." (Simeonie Keenainak, Pangnirtung)*

> *"I don't think there is any difference between then and now." (Meeka Alivaktuk, Pangnirtung)*

Section summary: temporal changes in body condition status and overall health

Based on individual interview results alone, we believe that changes in the body condition status and overall health of polar bears in the Pangnirtung area may follow a similar pattern to what was observed in Kimmirut. At the time interviews were conducted, a recent decline in body condition status and overall health had been observed by some contributors; however, the magnitude of this decline may not have been substantial given that observations were not unanimous and also considering that some participants who had noticed a decline in polar bear body condition stressed that healthy and fat polar bears were still observed. Group interviews would be required to clarify these uncertainties, including confirming changes in body condition and general health status of polar bears in the Pangnirtung area and identifying their magnitude.

Mortality, diseases and abnormalities

In this section, all quotes related to polar bear mortality, diseases and abnormalities were anonymized to preserve confidentiality.

All interviewees (n=35) discussed polar bear non-hunting related mortality, diseases and other abnormalities they had directly observed or heard about from relatives and Elders. We specifically probed on fur loss (alopecia) lesions, asking direct questions supported by pictures (see Appendix 4, interview guide) given such occurrences were reported in other subpopulations, particularly in the southern Beaufort Sea, Alaska (see Atwood et al. 2015). In general, contributors were able to provide detailed observations about what they saw, including where, when and type of animal(s) involved (adult vs. young polar bear; female vs. male). The level of detail provided by participants suggested a strong ability to detect and recall unusual polar bear observations.

Overall, participants considered non-hunting related mortality (including starvation), diseases (including fur loss or alopecia) and other abnormalities to be rare or uncommon. As such, single occurrences could be recalled almost one by one.

In addition, most contributors did not recall Elders talking about dead or sick polar bears in the past. Only one contributor from Kimmirut mentioned learning about starving polar bears from his Elders when he was young (around the 1950s); those starving bears were described as “polar bears that died” and considered a rare occurrence. One contributor from Pangnirtung recalled Elders saying not to eat polar bear liver which was known from experience to be source of toxicity (scientifically known as vitamin A poisoning).

> *“No, they [Elders] didn’t [talk about polar bear abnormalities or diseases], but they [Elders] just told us not to eat the liver or we will lose our hair. That’s what they said. They told us to never eat the polar bear liver.” (Interviewee 01, Pangnirtung).*

Tables 9 to 11 summarize signs of diseases (lesions and syndromes) or abnormalities reported by contributors from Kimmirut and Pangnirtung and provide differential diagnosis based on scientific veterinary knowledge. Figure 26 specifically displays locations of some cases of fur loss or alopecia observed by contributors.

Non-hunting related mortality and starvation

Among Kimmirut and Pangnirtung contributors (n=35), 23 of them (n=16 in Kimmirut; n=7 in Pangnirtung) had never directly observed or heard of mortality due to causes other than harvesting. Observations of polar bear mortality due to starvation or other natural causes were reported by a total of 12 participants (n=7 in Pangnirtung; n=5 in Kimmirut) as rare and single occurrences with five events observed around Kimmirut and 12 events around Pangnirtung (Appendix 7, Table 3S). The first occurrence recalled dated back to the 1960s and the most recent one was made in 2019 (the year interviews were performed). Polar bear mortalities were often reported to local conservation officers. Importantly, mortalities suggestive of disease outbreaks – that is, involving more than one animal and/or multiple species at once– were not observed.

While causes of polar bear mortality events observed by contributors remained mostly unknown, participants mentioned old age, starvation, severe traumas (e.g., polar bear falling in an avalanche), drowning (e.g., polar bear trapped by ice when hunting seals), and killing by another polar bear as some potential causes of death (Appendix 7, Table 3S).

> *"I saw a dead polar bear that was washed up on the shoreline. I went on the site with the wildlife officer who went to investigate and got the skull and everything. There is so many things that could have happened: sometimes when they are seal hunting, they can really sneak up and get really close [to the seal], the seal then goes down and the bear would go in there to and sometimes they cannot get up and cannot back out and they drown because of the ice. During the springtime [especially] in May, June. And one time a good friend of mine in Iqaluit was tracking a polar bear by dog team and saw [a similar thing], he saw polar bear tracks disappearing into a seal hole and never came back out and drowned. You know, those things happen." (Interviewee 08, Pangnirtung)*

When discussing episodes of cannibalism, contributors reported that "it's been known for a long time that polar bears eat other polar bears." One contributor from Pangnirtung mentioned that this phenomenon may be happening more often now since polar bear numbers have increased.

> "*Sometimes we see lonely cubs and we know a male polar bear killed the mother. Well, I think the male polar bear tried to kill the young ones and the mother tried to protect them and ended up being killed…I heard in my younger age that the polar bear do that but from then, since there is more polar bear, we start to see more. I think I have been noticing this [cubs alone] more in the last five years...and we know that the cubs won't make it alone but we just leave them because we are not allowed to kill small polar bears but that is just wasted." (Interviewee 06, Pangnirtung)*

Seventeen of the 35 Inuit experts we interviewed (n=9 in Kimmirut; n=8 in Pangnirtung) reported having seen or heard about starving or severely skinny polar bears (Appendix 7, Table 4S). However, those occurrences were uncommon. For example, one contributor specified he had seen "very skinny" polar bears only six times in the last 40 years.

> *"We see some that don't look like healthy, they look like very skinny but not many. I would say six altogether in the last 40 years. You could tell that they were sick just by looking at them." (Interviewee 11, Kimmirut)*

Signs of diseases, syndromes or abnormal lesions

When talking about observations of polar bear diseases or sicknesses, contributors mostly referred to ‘skinny’ or ‘very skinny’ polar bears, including old individuals or polar bears that were unfit for human consumption.

> *“Sick bears are really skinny. I would not know if it was from sickness or from starvation, but it is really obvious from the appearance. I have seen a few sick bears in my time, but it is the odd one.” (Interviewee 05, Kimmirut)*

> *“Sick polar bears are very noticeable, they have yellow fur, and they are skinny. It was rare to see sick skinny polar bears [in the past] and it is still rare [today].” (Interviewee 14, Pangnirtung)*

> *“I have never seen or heard of a sick polar bear but of very old polar bears with teeth falling off. I have seen that only once when I was living in the outpost camp.” (Interviewee 13, Pangnirtung)*

Overall, observations of conspicuous polar bear disease and sickness were rare with 16 contributors (n=8 in each of Kimmirut and Pangnirtung) reporting specific lesions or syndromes they saw while examining harvested polar bears or while observing live individuals. These included: signs of fur loss or alopecia; limping or lame individuals; white spots in the liver; greenish lumps in the subcutaneous fat and in the muscles; brown spots in subcutaneous fat; dull and soft claws; and posterior paralysis. Eleven contributors observed those as single events; over their lifetime, only five contributors had seen or heard of a few polar bears displaying a specific lesion/syndrome. Table 9 provides a list of possible causes, or differential diagnosis, based on scientific veterinary knowledge for the lesions and syndromes described by participants. Tables 10 and 11 include a description of disease occurrences reported by contributors.

> *“Some bears do not look healthy at all now…I notice from the meat that sometimes it does not look healthy and sometimes it is not even edible. I notice that the fat sometimes has some lumpy or infected areas, they are kind of greenish in color. They are mainly in the fat, between the skin and the meat, but sometimes I have seen it in the meat too…I have noticed this in three bears that I have harvested in the years 2016 and 2017…I have seen them in both female and male bears that were adult but younger that the big polar bears...I have never seen those before, and I have heard that other people mentioned they had encountered those type of lesions too…I have taken some samples to the Conservation Officer, but they have never reported back what it was.” (Interviewee 02, Kimmirut)*

> *“Sometimes liver’s got big white stuff on it and through it…We just say tigulluk [which in Inuktitut means] ‘bad liver’. Even seals have it sometimes and even caribou…You don’t see this often, only [in] a few [polar bears]. And you can see some little round brown spots when you cut the fat under the skin. It is not only in polar bears but also seals and whales. They are small, about a quarter inch. I see it sometimes.” (Interviewee 01, Pangnirtung)*

Interestingly, one contributor told us that Elders had known for a long time that posterior paralysis is a sign of rabies in polar bears; he had learned this in 1970s when he saw a polar bear with paralyzed hind legs. Scientific information of rabies in polar bears, including its presentation in the paralytic form, are more recent (Taylor et al. 1991). This example, amongst others, highlights the value of IQ to understand and assess polar bear health.

"I have never seen a sick polar bear. Except for one time when I saw a polar bear that was dragging his back legs. He was walking only with his front legs, and it was a big bear [too]. I asked the Elders 'Why is the polar bear doing that?' and the Elders said 'He got rabies'. When the polar bear gets rabies, the back legs are numb, so he drags them." (Interviewee 06, Pangnirtung)

While specific questions regarding trichinosis were not asked, only one contributor specifically mentioned being aware that polar bears can be infected with *Trichinella spp*., which has implications for human health.

"*I have been hearing in other areas that they [polar bears] have trichinosis. Last year, I think one tested positive for trichinosis here in [Cape] Dorset and then more recently in Sanikiluaq area polar bears [have been found] with trichinosis." (Interviewee 07, Kimmirut)*

Lastly, ectoparasites were not observed on polar bear hides.

"I have seen other animals with little bugs on them but never on a bear. If they [polar bears] had little bugs we may not even touch them." (Interviewee 03, Kimmirut)

Table 9. Types of lesions and syndromes observed in polar bears by participants interviewed in Kimmirut and Pangnirtung (n=35), including a list of possible causes –or differential diagnosis– based on scientific veterinary knowledge.

Observed lesions or syndromes	Possible causes
Fur loss or alopecia	✓ Ice-related injuries ✓ Infectious diseases ✓ Endocrine disfunctions ✓ Nutritional deficiencies ✓ Chronic stress ✓ Congenital disease affecting hair development ✓ Disorders of the molt cycle ✓ Pollutants ✓ Mange
Limp or lameness	✓ Traumas ✓ Bacterial diseases that can cause joint/bone infections or arthritis (e.g., *Brucella spp., Erysipelothrix rhusiopathiae*) ✓ Systemic bacterial diseases causing thrombosis (e.g., *E. rhusiopathiae*) ✓ Viral encephalitis (e.g., distemper virus) ✓ Protozoan encephalitis (e.g., *Sarcocystis* spp., *Toxoplasma* spp.) ✓ Heavy metal toxicity ✓ Fluoride toxicity
Brownish round spots (about 0,6 cm) in the subcutaneous fat Also observed in seals and whales	✓ Parasites (e.g., granulomas of tapeworm larvae – polar bears serving as aberrant hosts) ✓ Systemic bacterial diseases causing thrombosis (e.g., *E. rhusiopathiae*) ✓ Hemorrhages
Big white spots on and throughout the liver Also observed also in seals and caribou	✓ Parasites (e.g., liver flukes, hydatid cysts of *Echinococcus granulosus*) ✓ Abscesses or granulomas of bacterial origin ✓ Tumors
Greenish lumps in the subcutaneous fat and muscles Also observed in beluga whales	✓ Older traumas ✓ Inflammation of fat tissue
Dull and soft claws with layers of keratin splitting	✓ Nutritional deficiencies ✓ Traumas ✓ Viral infection (e.g., distemper virus) ✓ Congenital defect that affects keratin production
Paralysis of hind legs	✓ Traumas ✓ Rabies ✓ Other encephalitis (e.g., distemper virus, protozoan infections, neurotoxins)

Table 10. Occurrences of lesions and syndromes –except fur loss– observed in polar bears by participants interviewed in Kimmirut and Pangnirtung (n=35), including type of lesions observed, number of contributors reporting the observation (n), timing of observation (when available; otherwise marked as 'NA') and detailed description of the observation made by individual contributors. Fur loss observations are reported in Table 11.

Observed lesions or syndromes	N	Timing	Description of occurrence
Limping polar bears	n=3	Early 1990s	One adult male polar bear walking with a limp (the back leg could not bend). Direct observation close to Qikiqtarjuaq. *Interviewee 14, Pangnirtung*
		2015	One polar bear observed limping, '*the back leg joint could not bend'*. Direct observation made in summer. *Interviewee 07, Pangnirtung*
		Recent years	Knowledge of limping polar bears reported from other hunters. *Interviewee 02, Kimmirut*
Small brownish round spots in the subcutaneous fat	n=1	NA	A few harvested polar bears with small brown spots (approximately ¼ inch) in the subcutaneous fat. Similar lesions also observed in seals and whales. Direct observation. *Interviewee 01, Pangnirtung*
Big white spots in the liver	n=1	NA	A few harvested polar bears with big white spots on and throughout the liver. Similar lesions also observed in seals and caribou. Direct observation. *Interviewee 01, Pangnirtung*
Greenish lumps in the subcutaneous fat and muscles	n=1	2016-2017	Three harvested polar bears (adults, females and males) with greenish lumps in the subcutaneous fat (mostly) and meat. Similar lesions also observed in beluga whales. Direct observation (first time these lesions are observed) and reports of similar lesions from other hunters in recent years. *Interviewee 02, Kimmirut*
Dull and soft claws with layers of keratin splitting	n=2	Recent years	One harvested polar bear (7-footer) with '*weird claws'* on the rear feet. The hide was easy to clean meaning the polar bear was likely in good body condition. Direct observation made during hide processing (same bear observed by two contributors). *Interviewees 01 and 02, Group 4, Kimmirut*
Paralysis of hind legs	n=1	1970s	One adult polar bear observed dragging its back legs. Direct observation. *Interviewee 06, Pangnirtung*

Fur loss lesions or alopecia

Fur loss or alopecia was explored by asking direct questions supported by pictures showing specific fur loss lesions (see Appendix 4, interview guide). Most participants (n=23) had not observed lesions consistent with the pictures shown. However, these contributors had sometimes noticed polar bears with small furless spots on the neck, head and paws associated with scars and injuries, including ice-related traumas. These observations were considered as normal occurrences that were seen in healthy individuals both in recent years and in the past. Adult males in particular were reported to often display furless scars on the neck and head that were likely caused by fighting with conspecifics during the mating season (Appendix 7, Table 5S).

> *"[Polar bears] have lots of scars in the neck area from fighting, playing around, trying to get a female and these kinds of things." (Interviewee 06, Pangnirtung)*

> *"I have seen scars maybe [due to] males fighting together…I have seen mostly in males because when they start mating, they fight...and with any polar bears because they use their head and neck to go through the ice." (Interviewee 07, Kimmirut)*

> *"The males tend to fight [during mating season for the female], that's why they have no more fur, from fighting. I have caught a polar bear that's fought another polar bear before, and had no fur, like from the scratches." (Interviewee 04, Pangnirtung)*

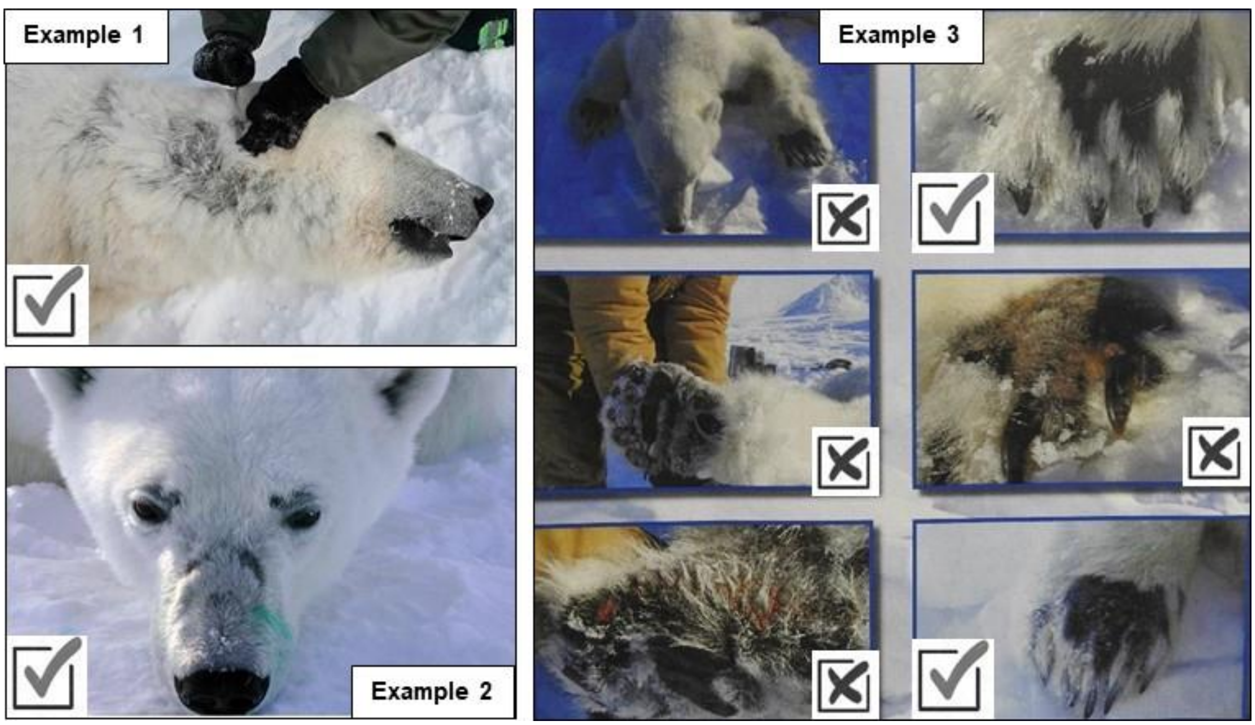


Figure 25. Pictures of fur loss in polar bears. These pictures were used as prompts during interviews in Pangnirtung and Kimmirut (n=35). See Appendix 4 for full picture set used during interviews. Presentations similar to check marked pictures were observed by contributors, while lesions similar cross marked pictures were not observed. Image sources: Atwood et al. 2015 (example 1); USGS (example 2); Government of Nunavut (example 3).

Twelve of the 35 participants interviewed (n=7 in Pangnirtung; n=5 in Kimmirut) reported observing polar bears with fur loss similar to the pictures used, varying in severity and localization. Lesions observed included extensive alopecia localized in the neck, shoulders and body; symmetrical alopecia on the head; and large areas of alopecia on the paws without scars and skin overgrowth (Figure 25). These observations were sporadic and mostly reported as single events (Table 11 and Figure 26).

> *"I have seen in an old bear something like this [referring to example 1 in Figure 25], they weren't scars, but the fur was coming off [in the neck area] due to be so old. That was the only time I saw something strange. That bear was a big male, angujuaq...It was some time ago, I don't remember the year…I have [also] seen areas on the paws with no fur whatsoever, maybe because it was an old bear. There were no scratches, but it was just no fur on it. It was just a male bear, not a big one. I have seen it only one time. It was some time ago, not recent." (Interviewee 01, Kimmirut)*

> *"In early spring 2007, I saw close to town a mother bear that had two cubs. The cubs were OK, but the mother was so skinny. That was the only [sick bear] I have [ever] seen…it was wobbling and acting like it was [almost] drunk. I have [also] noticed that some part of the fur was missing. The condition of the fur was not normal…it had bold spots on the neck…about 20 cm in diameter and only on one side. [It looked] exactly like this picture [referring to example 1 in Figure 25]" (Interviewee 10, Kimmirut)*

> *"I recall I have seen polar bears with abnormalities twice. [Description of a severely skinny polar bear]. The other one, I don't remember exactly, but I think [I saw it] right around 2010. It was a cub, atiqtaq. It was the only bear, it was alone [without the mother]. I noticed some abnormalities in the fur with bold spots around the neck. It looked like that one [pointing at example 1 in Figure 25]." (Interviewee 12, Kimmirut)*

> *"I have seen one like that [referring to example 1 in Figure 25]. That was maybe around the 1980s…I was out polar bear hunting [on the north side of the Cumberland Peninsula]. I saw the bear and I got closer. It was a big bear. I saw a bold, naked area [on its neck] and I decided not to kill it. That was not good for nothing…it was not that fat but was not that skinny either. It was a male. [I think it was] smaller than a nukauq. It was around February…I haven't seen anything like that again. [The hair loss] was mostly on one side [of the neck] and a little bit on the other side too. It was completely black [It appeared even more severe than example 1]. I was thinking that maybe it was scratching all the time, [maybe it was] itchy or something. No [there was no blood visible]." (Interviewee 01, Pangnirtung)*

> *"I saw a polar bear that was harvested, and its side was black. It had a wide area with no fur, and it was all scarred. It was a really poor skin. It was something like that [example 1 in Figure 25] but it was on the side [of its body]. The area was about 20 cm wide." (Interviewee 07, Pangnirtung)*

> *"I have seen something like this [fur loss on the paw, similar to example 3 in Figure 25] but not too many. Sometimes they hit rocks and they lose the fur." (Interviewee 09, Pangnirtung)*

Wide areas of alopecia or thinning of the fur were only observed on the neck and shoulders (n=10) or on the side of the body (n=1). Gross presentation of lesions was similar to signs of alopecia described in polar bears of the southern Beaufort Sea, Alaska (Atwood et al. 2015). Earliest observations dated back to the 1980s in Pangnirtung and the 1990s in Kimmirut, while most recent observations were made in 2013-2015 in Pangnirtung and around 2010 in Kimmirut.

Both female, male, adult and young polar bears, including cubs-of-the-year, had been observed with alopecia. In some instances, fur loss was associated with poor body condition, but it was also observed in healthy individuals.

Some contributors considered fur loss lesions as a normal condition in polar bears, especially in adults and likely resulting from ice-related or hunt-related injuries, fighting with other polar bears and, more in general, old age (Table 11). Lastly, one contributor commenting on pictures of fur loss localized on polar bear paws (see example 3 in Figure 25) recalled that sled dogs used to have similar lesions, especially in the spring when rubbing the surface of their paws on the thawing and freezing ice.

> *"When the ice is melting, like the first layer is slush, and the top freezes a bit just slightly, a thin layer. Dogs used to hunt and very quite often in the springtime they were going on the slush. So, I think that's what happens too with polar bears. After a warm sunny day in the springtime, it becomes slushy, and at evening, night-time and early morning that slush freezes. So it can scratch [the fur and skin on the paws], like it used to scratch dogs." (Davidee Nowyuk, Pangnirtung)*

Table 11. Occurrences of fur loss (alopecia) lesions observed in polar bears by participants interviewed in Kimmirut and Pangnirtung (n=35), including timing of observation, detailed description of what was observed by individual contributors, localization of fur loss lesion on the animal, interviewee reporting the observation, and code used in Figure 26 for observations associated to a specific location (NA: information not available).

Timing	Description of observation	Area	Interviewee	Code
Around 2010	One lone cub with extensive fur loss area on neck. Direct observation.	Neck	Interviewee 12, Kimmirut	K12
2007	One very skinny adult female with unstable posture and fur loss area on one side of the neck (about 20 cm in diameter). The female had two cubs that looked healthy. Direct observation made in spring.	Neck	Interviewee 10, Kimmirut	K10
1990s	One polar bear hide difficult to clean because a lot of fur was missing on the neck and she had to remove a large area of the hide. Direct observation made during hide processing.	Neck	Interviewee 03, Group 4, Kimmirut	NA
NA	One harvested adult male with fur coming off easily from the neck area and one harvested adult male with furless areas on the feet. Considered to be associated with old age. Direct observation (not recent) made during hide processing.	Neck Feet	Interviewee 01, Kimmirut	NA
NA	A few polar bears observed with alopecia on the neck, head and feet (but without scars and skin overgrowth). Considered a normal condition associated with polar bears going through ice.	Neck Head Feet	Interviewee 01, Group 1, Kimmirut	NA
2013-2015	One harvested polar bear with furless area on the side of its body (approximately 20 cm in diameter). Direct observation.	Body	Interviewee 07, Pangnirtung	NA
2013-2015	One harvested polar bear with symmetrical hair loss on the snout possibly due to an ice related injury and considered normal. Direct observation.	Snout	Interviewee 07, Pangnirtung	NA
Around 2010	One harvested male that was quite skinny and with extensive fur loss on the neck. Direct observation.	Neck	Interviewee 08, Pangnirtung	P08
Early 2000s	One harvested skinny young female polar bear with small area of fur loss close to claws of one foot (approximately 6x1cm - similar to example 3 but not as extensive). Considered to be associated with walking on deep snow covered with ice. Direct observation made in April.	Foot	Interviewee 01, Pangnirtung	P01(a)
1990s	One harvested polar bear with extensive fur loss on neck and shoulders. Observation made by a relative.	Neck	Interviewee 05, Pangnirtung	NA
1990s	One adult male polar bear in good body condition with fur loss on one side of the neck (similar to example 1, but not as extensive). Considered to be associated with fighting with other polar bears. Direct observation made in spring.	Neck	Interviewee 14, Pangnirtung	P14
1980s	One adult male polar bear with extensive fur loss area on the neck and in good body condition. Direct observation made in February along the shore of the Cumberland Peninsula.	Neck	Interviewee 01, Pangnirtung	P01(b)
NA	A few polar bears observed with fur loss areas on the feet (similar to example 3, but without scars and skin overgrowth). Considered to be associated with traumas. Direct observation.	Feet	Interviewee 09, Pangnirtung	NA
NA	Adult or old polar bears with thinner fur on the neck and head, likely caused by fighting with other bears and hunting seals. Direct observation.	Neck Head	Interviewee 11, Pangnirtung	NA

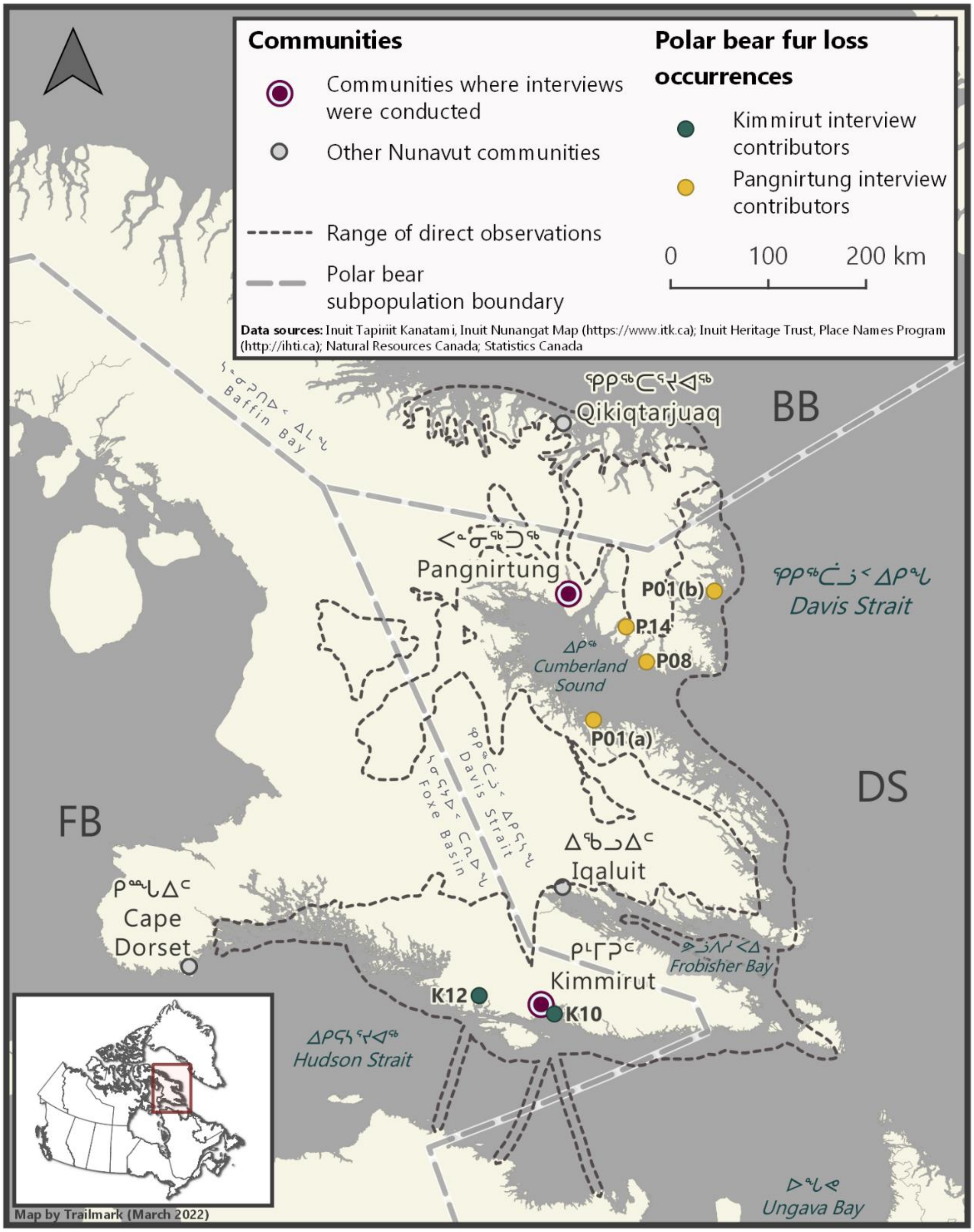


Figure 26. Location of some polar bears with fur loss (alopecia) observed in the Pangnirtung and Kimmirut areas. Codes reported on the figure refer to occurrences described in Table 11. This figure only includes occurrences that were associated to a specific geographic location. Table 11 offers a comprehensive list of polar bear fur loss occurrences discussed by participants that were consistent with fur loss pictures used for probing during the interviews. DS: Davis Strait polar bear subpopulation and management unit; FB: Foxe Basin polar bear subpopulation and management unit; BB: Baffin Bay polar bear subpopulation and management unit.

Anthropogenic waste and other unusual observations

Some contributors (n=7) reported finding anthropogenic waste and/or plastics in the stomachs of some harvested bears (Appendix 7, Table 6S). Participants from both communities described polar bears found with plastics and other waste in the stomach as sick or unhealthy bears. Observations of polar bears scavenging at the dump or found with garbage or man-made items in their stomach were made in more recent years, approximately within the last 10 years.

> *"[Polar bears] go to the dump. That's never happened before. Even here sometimes in the fall they go to the dump and anything they can get, they eat…A few years ago we saw a polar bear at the dump in the fall." (Interviewee 01, Pangnirtung)*

> *"Back then [in the past], when I opened them up I would notice their main diet which is seal meat. That's what I would notice back then. But nowadays I am noticing leather gloves or other garbage in the stomach. I think that this is happening because they are hungry. [The first time I saw some garbage in the stomach of polar bears] was around 2010."*

> *"In 2015, I have harvested a bear that had skidoo parts in his stomach. That was the only thing that was in his stomach…I have encountered another bear with skidoo parts inside him. They were both close to my camp. When I noticed that they had skidoo parts inside –plastic, part of the skidoo seat– I would just leave the meat…they were in between a young bear and an adult bear, they looked healthy enough otherwise." (Interviewee 02, Kimmirut)*

> *"When my buddy opened the stomach to see its content we saw nothing but white plastic shopping bags in there and it was sad and bad to see...that was last summer [2018] July or August. Was very close to town [at the] dump. We were coming back to town and they wanted to harvest it before it hurt somebody. It might have been a young female, maybe three, four years [old]. But we still got the meat." (Interviewee 06, Kimmirut)*

> *"In the later years I have heard of [polar bears] foraging in dumps but normal bears would have ringed seals in their stomach as opposed to unhealthy ones that would have whatever they could get their paws on." (Interviewee 05, Kimmirut)*

Lastly, when invited to discuss other unusual observations or abnormalities, three participants described injuries or non-healed wounds (Appendix 7, Table 7S). Two participants reported harvested polar bear bears with lip tattoos and ear tags as abnormal events. One participant had seen a bear with abnormal pigmentation of the skin and another one observed a three-legged polar bear. Finally, in Kimmirut, one contributor had observed a male polar bear with half-white and half-black fur, which he described as a hybrid bear or *aktak nanuq*.

> *"The Elder shot, the defence kill, it seemed to have a wound in the back, maybe that had something to do with being so skinny. It was maybe a [natural] injury or maybe it got away from somebody, somebody maybe shot it, wounded it but didn't get it. That is possible. It was close to town. There was no Wildlife Officer in town so I had to go take a photo and he had a written statement that is why I know a bit about it. That was about five years ago." (Interviewee 06, Kimmirut)*

> *"There hasn't been any change other than one time I harvested a bear with a tag number. That's the only abnormality." (Interviewee 14, Pangnirtung)*

"I had encountered a polar bear with white [skin on the] paws…all four paws were white and one of the paws had some black spots on it. This got me to think: "Why is this like that?" I have seen this just in one bear…it looked heathy there was nothing wrong with it… It was just the colour of the paws and the [colour] of the nose was normal…I have seen this maybe within the last 10 years…The hide was given to me [to be cleaned] and the hunter didn't tell me where he got the bear from. He [the hunter even] asked my late father why the bear was like that. He [my father] didn't know why. This [seeing a bear with white paws] was unusual and my father didn't know anything about that." (Interviewee 03, Kimmirut)

"Eight years ago I observed [a polar bear that was] somewhat black and white. The fur looked funny, white on the back and black in the front. It was a half-breed or something. I saw it one time in this area [pointing to Big Island]. We thought it was a mixed breed, a black bear with a polar bear or a polar bear with a grizzly, I don't know. It was years ago [at the end of] the springtime, turning into summer days. We were going at the floe edge hunting [when we saw this bear]. It was a male, someone said it was about eight feet…It was climbing up and then it went down again. I wish I took a picture but I didn't. I wasn't the only one seeing it, also my late parents saw it…The Elders would say in Inuktitut: "We haven't seen that kind of polar bear before, don't catch it! You may get sick!" We call it [that kind of bear] aktak nanuq: aktak means black bear and nanuq means white bear." (Interviewee 13, Kimmirut)

Human-polar bear interactions

During individual interviews, contributors from both Pangnirtung and Kimmirut discussed changes in human-polar bear encounters and interactions. Participants described more frequent encounters with polar bears; changes in how polar bear behave towards humans; increased damage caused to cabins and property by bears; increased concerns over public safety; as well as some strategies put in place by Pangnirtungmiut and Kimmirutmiut to minimize risks associated with polar bear presence both on the land and in communities. Collectively, observations on human-polar bear interactions indirectly corroborate abundance information documented thought this study. In addition, information presented here can be useful to co-develop targeted mitigation strategies.

Most participants indicated they encountered and observed more polar bears today than in the past (see also 'Abundance and demography' and 'Habitat and distribution' sections). Contributors identified four main factors which could explain why human-polar bear encounters have increased in recent decades: an increase in polar bear abundance; greater distances traveled by community members today which increases their chances of encountering polar bears; more intensive use of coastal areas by polar bears as a result of changing sea ice conditions; and a change in the behaviour of polar bears which have become less scared of humans and noises.

"There is more polar bear-human interference now than before also because hunters can travel long distances. So we tend to run into more polar bears as we hunt and the population has grown so much." (Johnny Mike, Pangnirtung)

"In the 50s and 60s, there were hardly any polar bears. I hardly saw them maybe because I was not grown up enough to go hunting by dog team. In the 70s, probably they were starting to increase, again that may be because we had more equipment to travel with

[instead of using] dog teams. The equipment allow us to travel further." (Jawlie Akavak, Kimmirut)

"I have noticed changes in the ice condition. Way back the ice used to be really thick and as times progress [the sea ice] is getting thinner. The ice is a lot thinner nowadays...This is affecting [polar bear hunting] behaviour. Polar bears normally hunt on the ice and out there the ice is not as stable as it was and as a result the polar bears are coming in the coastal areas, in town areas, looking for food." (Ejetsiak Padluq, Kimmirut)

Many participants commented on changes in how polar bear behave in relation to humans. In both communities, several contributors (n=9 in Pangnirtung; n=7 in Kimmirut) reported that polar bears nowadays tend to be less fearful and more aggressive towards humans than they were in the past. Many also mentioned that juvenile polar bears are generally more inquisitive and aggressive than older bears.

"When a bear comes approaching sometimes we have to fend it off and we will fire a warning shot to warn the bear and scare it off. Back then, if you were to fire a warning shot it was likely to scare the bear off. But now if you were to fire a warning shot towards a bear it would just keep approaching. I started to notice this around the year 2000. I think that they are hungry. [I have noticed] this pretty much [in] all the seasons...It looks like there is more young bears than long time ago...and likely the young ones are harder to fend off than adult bears. The young ones have less fear and less experience." (Ejetsiak Padluq, Kimmirut)

"I have observed and heard outside of the community [that polar bears] are more aggressive and tend to kill humans more often than in the old days…The bears that have really silky and white furs are the aggressive ones, the clean ones. They are called kakirait nanuit. They could be either females or males, they are not too old and not too young." (Itee Temela, Kimmirut)

"The bigger [polar bears] are not so aggressive compared to the smaller ones…It's kind of like teenagers, when you're a teenager you don't really listen to the rules…Polar bears have the mind of a human, like you're not allowed to bother them as they might fight back like a human would do...Polar bears are getting more and more and they are not scared at all when you shoot at them. Even if you almost shoot them they won't move, and sometimes they'll leave but then they'll come right back." (Matiusie Maniapik, Pangnirtung)

Participants offered various explanations as to why polar bears have become less fearful and more aggressive towards humans. Some contributors mentioned that polar bears have become accustomed to being around people and hearing noise from human activity. Others suggested that polar bears are no longer afraid of humans in part due to having been handled in the past for bear research. Some noted that hunger may cause polar bears to be more inquisitive or aggressive. Lastly, two contributors from Pangnirtung also suggested that hunting mostly adult male polar bears (*angujuaq*) could be the reason why polar bears, including juveniles, "would go in places they should not go" and interact more with humans. We also note that an increased number of juvenile polar bears as a function of the population increase could also partly explain contributors' observations of less fearful polar bears.

"Back then, when you saw a polar bear, they would run away right away, like, they were scared of people back then. And now when they see people, they're not scared, even if

you try to scare them off, they won't run off. So they're not as scared as they used to be…I think it's because of the biologists who put them to sleep. Like, maybe because of that, they're not as scared as they used to be." (Leopa Akpalialuk, Pangnirtung)

"When I was young, as soon as [polar bears] see, hear, or smell anything they used to run…They started to run from a long ways away. [People] used to let a few dog loose to stop the bear. Right now, you could drive almost right close to them and they don't even notice you. They're pretty different…Since the 1990s, maybe even earlier than that…Some of them just look towards you and they keep doing their own [things]. I don't know why, they got used to the noise, I guess." (Peter Kanayuk, Pangnirtung)

"[Polar bears] aren't scared of noises or people anymore. In the past, they don't even want to see the tracks, human tracks, let alone the man there. As soon as they cross the human tracks they usually run away. But now they can follow the human tracks or skidoo tracks. They're too many noises in this world now. Wild animals are used to hearing noises so they don't get scared anymore with noises. It's with all the animals… and particularly young male polar bears, like four or five years old. I have started to notice this change within the past 20 years." (Simeonie Keenainak, Pangnirtung)

"It seems like [polar bears] got mad. They like to smash things more than ever: cabins, people leave their skidoos out on the land and polar bears would smashed them. Maybe because they were put to sleep, it seems they are mad at the humans." (Simeonee Keenainak, Pangnirtung)

"At the time I was a boy, polar bears were afraid of humans but now they are not as afraid of humans anymore. Maybe this is happening because they have put them to sleep and they became angry for being handled by humans, so therefore, they became more aggressive...I have noticed this change when they started to tranquilize them in 1979, that is when they started to put them to sleep...My father was one of the people who would go out with the biologists to help tranquillize the bears so that is why I remember." (Kooyoo Padluq, Kimmirut)

"Some people say that [bears] that were tranquillized changed after and became angry but I don't know if that's true. I don't have any proofs...There's more bears coming and they don't seem too scared of people anymore. Maybe it was the case also before, in the past. Maybe we are just seeing more bears and maybe some bears are hungry or more hungry than others and that can change their behaviour." (Anonymous 03, Kimmirut)

"Today, when a polar bear comes, it doesn't get killed. Back then, it had to be killed because if it doesn't get killed they would come back all the time… there was a man who got killed because that polar bear probably kept going back and it wasn't afraid anymore. Any polar bear that comes to camps or places where there's people they should be killed." (Leesee-Mary Kakee, Pangnirtung)

"The angujuaq is the leader and if there are less of them the females and young polar bears would go in places they should not go to." (Michael Kisa, Pangnirtung)

In both communities, contributors also reported increased damage to cabins, food caches and property caused by polar bears.

“Polar bears have been damaging a lot of cabins in the recent years, coming into camp and damaging cabins. I don’t know why, even when they are not hungry they damage camping areas and I don’t know why…We started to build cabins in the year 2000s… before there were no cabins and everybody was living in tents when they were out camping…[Damage to cabins] mostly happens to some people’s cabins while others in almost the same areas do not get damaged...Bears were coming into camps even when people were camping in tents…Back then it was a problem but not as big of a problem [as it is now].” (Jeannie Padluq, Kimmirut)

“Now, polar bears even break cabins because there are so many. They seem to be getting more dangerous going into cabins trying to look for food…We can’t even have food caches anymore because there’s a lot of polar bears that just go after it. [Once we] left our cache there, went to Pang for a bit and came back and the polar bears had gotten it.” (Lazarusie Ishulutaq, Pangnirtung)

In addition, participants acknowledged that increased human-polar bear interactions can happen as a consequence of other harvesting activities that can attract polar bears, especially narwhal and beluga whale harvest. In the Pangnirtung area, polar bear tags are usually finished by the time whale harvesting takes place. Contributors from Pangnirtung also reported that in recent years turbot fishing processing practices have changed with more fish scraps left on the ice (tails and organs) with this contributing to potentially attracting more polar bears in the upper Cumberland Sound where commercial turbot fishing takes place in the winter.

Some participants reported that ‘problem bears’ are more likely to be juvenile polar bears which have a more inquisitive behaviour and may be hungry because they are still learning how to hunt effectively. However, participants also reported that bears of any age or sex category can become a ‘problem bear’ when drawn by hunger, which makes them interact with humans more closely than they would otherwise.

Importantly, all individual interview contributors (n=27) highlighted their concern for public safety resulting from increased human-polar bear encounters and more frequent bear aggressions. Many shared the view that polar bears posed a greater public safety concern today compared to the past and pointed to increasing risks of conflicts between humans and polar bears.

“Back in the days when we were hunting animals we were not afraid to be anywhere. We were used to even sleep outside beside our qamutiik [sled] because the bears were not around…At that time we had no worries to encounter a bear or being attacked by a bear.” (Eliyah Padluq, Kimmirut)

“Now you can see polar bear [around] like even in the summer. We’re scared to camp, set the tent anywhere. The polar bears are everywhere now. We are an endangered species other than polar bear.” (Simeonie Keenainak, Pangnirtung)

“Since there’s more polar bears now, it’s harder to relax when you’re out on the land. From what I can remember as a little boy, there were barely any polar bears back then, and now there are a lot…It’s hard to relax.” (Leopa Akpalialuk, Pangnirtung)

“When it comes to humans and polar bears, it’s more dangerous nowadays because polar bears attack. And we have heard stories of polar bears attacking and killing humans.” (Abraham Keenainak, Pangnirtung)

Participants highlighted that polar bears are now posing a public safety concern both on the land and in or near communities. Polar bears killed in defense of life and property were described as a recent phenomenon around both Pangnirtung and Kimmirut.

> *"[I am concerned about] the safety of the town when [bears] came in. When [my neighbours] made a defence kill [in 2015-16] is when I realized about the possibility of them [polar bears] coming into town. And I have heard that polar bears are coming in more into town. My main concern would be about the safety of the town's people." (Anonymous 01, Kimmirut)*

> *"I am concerned about the community and if a bear comes in on a regular basis then children are endangered because children play outside. This has become my concern for the past ten years…Another concern I have is for those younger boys or younger hunters using only small guns [rifles], like the 222, when they go on the land. That type of gun [rifle] could become dangerous because…the 222 cannot kill a bear even if you hit it in the head and the bear could turn [against you] and end up killing [you]." (Joe Arlooktoo, Kimmirut)*

> *"When I see people going up to the hills [around Pangnirtung], I hope they have a protection or something like that, you know. I'm always worried about that. And even when my daughter and my people, my families, when they go into the end of the road there for fishing with a rod during summertime, I keep telling them you know, hope you guys have protection…Right now my safety's really concerned because as I said earlier, people say: "No, there's no bears, I have not heard nothing." Well, I said you only got two legs, they got four legs." (David Kooneeliusie, Pangnirtung)*

Several contributors shared stories of dangerous encounters with polar bears.

> *"Once I was with my wife and family down here go caribou hunting and a polar bear came to our camp and it was close to killing my family. That happened in early 2000s. My wife is now terrified [of polar bears] after that encounter...Around 2000, I was here to go hunting caribou. I woke up around 4:00 in the morning and the boat was rocking, and there was a polar bear on my boat. We had just cooked seal meat that night and we woke up with a polar bear on the boat. We didn't want to shoot it because there was a big possibility that I was going to shoot the motor. I heard that when you yell as loud as you can, you can scare the polar bear. So I yelled from the top of my lungs and it got scared and it fell off the boat…It was a female and it had cubs, atiqtalaaq." (Lazarusie Ishulutaq, Pangnirtung)*

> *"We were camping with my sister-in-law, she was sleeping in the tent and we were in a cabin…That's how she grew up too, in summertime to be sleeping in tent. She didn't want to sleep anymore in the tent, because she was hearing these footsteps from polar bear and my dog was barking in the cabin. The next day we were told that there was a polar bear on our area. Not just one time, almost every other year they've been coming…I hear some people [say] they don't like to be sleeping in tents anymore, because polar bears are close and they can come at night where they are camping. Or even in summertime if we are camping down here, we would sleep in the boat anchored, not on the land, anchored in the water." (Meeka Alivaktuk, Pangnirtung)*

> *"People get killed by polar bears these days. They are unpredictable so we just have to know them...I know there have been a couple of very serious [incidents here]. One was a tourist who was camping by the river and one was a local guy who was guiding [caribou*

sport hunters]. They got attacked by bears and during the night. [Those were] close calls. Those are the ones I know of but in the region last year there have been even a couple of deaths." (Anonymous 03, Kimmirut)

Participants also described how Pangnirtungmiut and Kimmirutmiut are now finding ways to adapt to increased polar bear presence by putting in place strategies to mitigate risks of dangerous interactions with polar bears and minimize damage to property. Some explained that, starting around the 2000s, residents from both communities have started to use more fixed cabins instead of tents when camping on the land.

"*I don't recall when I first noticed defence kills but the bears that come in [the community] are normally killed to make sure that the community is safe from bear attacks and I find that the community is working really well in this area and people defend each other from bear attacks." (Joe Arlooktoo, Kimmirut)*

"Even back then, my mother would tell me to be safe and always carry a gun [rifle], just in case there might be a polar bear. They can just pop up at any time." (Lazarusie Ishulutaq, Pangnirtung)

"Like for our cabins what we do is we put nails to our cardboard and cover the windows...board it up." (Geetee Maniapik, Pangnirtung)

"We always bring dogs when we go out anywhere, mostly for fishing. We always bring two dogs [with us] and when a polar bear is coming in [the camp] they would start barking. We always do that, even if it is only for an overnight [trip]. If we don't bring a dog we won't sleep overnight out there. It is too risky! Before when I was a kid they were not as many polar bears as there is now. There is a lot more polar bears now therefore we need to bring dogs [with us]." (Jawlie Akavak, Kimmirut)

Contributors shared tips on how to handle encounters with polar bears but also emphasized the importance of teaching younger generations about how to coexist with polar bears safely.

"I am not sure if [polar bears] have changed but I know that they have always been known to be dangerous and scary. When we were really young, we would be told how to act when we encounter a polar bear because they've always been dangerous and scary…We were always told if a person has a child and you encounter a polar bear, to not look at your child. Because if you look at your child they'll go after it. And when a polar bear is ready to attack, it stands up. When it's standing and it goes to you, you pick up [an object], grab it and scream really loud…The loudest sound you can make. I don't know, if a polar bear is running after you, you got to make a sound, hoo, hoo, hoo, hoo, and then it can go right back." (Leesee-Mary Kakee, Pangnirtung)

"The only concern I have now is when our young children and our young teenagers go out hunting smaller game at a walking distance from the community. Knowing that the bears are everywhere now, they need to be more cautious. They have to be taught to be more cautious when they are walking away from the community. And they have to be taught more nowadays to make sure they are safe because we are hearing that the bears are attacking humans every now and then since we started having bears around…When we hear that the bear is sighted right near our community or coming into the community, I am

afraid when my small children are out there not knowing if the bear is actually in the community." (Akeego Killiktee, Kimmirut)

Future of polar bears

Many contributors indicated it was difficult to or would not comment on the future of polar bears. Some explained one cannot predict the future and therefore preferred not to comment on this theme.

"I don't know [the future]. You don't know what's going to happen in the future." (Matiusie Maniapik, Pangnirtung)

"[The future] is what I would like to know too, so I can't say." (Anonymous 01, Kimmirut)

Participants who discussed what the future may look like for polar bears were not generally concerned about the ability of polar bears to adapt to changing environmental conditions associated with climate change.

"I am not worried about polar bears because they're healthy and really good. When we hear people say they're going hungry and dying because of climate change, I think otherwise. They have plenty of food to eat. We hear very often that polar bears are endangered, that when the ice melts they say there won't be any more polar bears. I think otherwise...because they have plenty to eat…[Polar bears are] better than humans when it comes to hunting because that's all they do, right? Always looking for food, even if they're not hungry." (Abraham Keenainak, Pangnirtung)

"I believe a little bit that if there is less ice, [polar bears] get less food but I think that it is an ongoing [aspect] of polar bear life, you know some day they get old but in the last few years we have seen polar bear that come closer to town. They are like human beings: they try to harvest seals and some of them are luckier than others. The unlucky ones tend to [harvest less preys] and that's when their health starts to kind of deteriorate...In the last few years we have seen polar bears that come closer to town...When there is less sea ice they go close to town for food...but you know, polar bears can catch fish and eat other things other than seal…The ones that I have seen are mostly healthy, there may be a rare one that is a really skinny one. But most of them they look healthy." (Anonymous 03, Kimmirut)

However, one contributor explained that while polar bears were highly adaptable, they may face difficulties finding suitable denning habitat if snow cover continues to decrease. Another noted that polar bear hide quality could be impacted in the future by changes in sea ice availability.

"I am aware of the weather changes today: it is a lot warmer with the climate change. I think the bears will be able to survive the global climate change, maybe because they are top predators. I have not noticed polar bears being affected by climate change. Today there is a lot less snow and I think that polar bears may not have a place to den because of lack of snow. If the bears will be unable to nurse because of lack of snow where they can den, I am uncertain of what would happen to them." (Sandy Akavak, Kimmirut)

"My only concern is that the ice goes out, the land, you know, and everything goes out and melts a lot faster now. That means [polar bears] are going to spend more time on the land

and…my question is how the skin will turn out in the future, you know. They seem to have been eating more [from the land] than they were before, like eggs." (David Kooneeliusie, Pangnirtung)

Several participants from Pangnirtung and Kimmirut shared some perspectives on human-polar bear interactions and how these may evolve into the future. Some indicated that a continued increase in polar bear abundance will pose an increasing threat to the safety of community members.

"It seems like [we're] getting more and more, another 20 years and we would have polar bears everywhere." (Simeonie Keenainak, Pangnirtung)

"It will get more dangerous if the [polar bear] population keeps growing and growing." (Lazarusie Ishulutaq, Pangnirtung)

"Nowadays I am noticing [polar bears] coming into town more and my concern would be what if they start eating people and hunting people." (Ejetsiak Padluq, Kimmirut)

"For the future, I would be concerned if polar bears are overpopulated that would not be too good for the humans but it is hard to predict the future." (Akeego Killiktee, Kimmirut)

Several contributors also emphasized the importance of healthy polar bear populations for future generations and maintaining Inuit cultural traditions.

"I hope there will be enough [polar bears] for the future. I know there are, I can say there are more [bears] than there were before. But according to the researchers they're saying there's less, but I would say there's more from my experience. I hope that numbers stay because it's for the younger generation…At a very young age, men, young teenagers start hunting. They have to learn, they have to, for their kids. There should be hunting, there should be. The numbers shouldn't be too low. But still, from what I know, there's a lot more polar bears now." (Geetee Maniapik, Pangnirtung)

"For what I have been hearing internationally they are saying that polar bear habitat is [withering] and I guess in the future it may become harder to harvest bears. Although I think that we are going to keep harvesting bears. We may not going to be able to sell the hide but we will still harvest them for the meat." (Anonymous 02, Kimmirut)

"I don't like…polar bears to be [extinguished], I want them to be increased...Same with all animals…We live with, we live on seals and all the wild animals, like polar bear, seal, caribou, fish. We mostly live with, live on those." (Meeka Alivaktuk, Pangnirtung)

Polar bear management and stewardship

During individual interviews, contributors voiced their perspectives and concerns related to polar bear management and stewardship. They also shared their views on existing communications between polar bear researchers and Nunavummiut, and suggested ways to improve knowledge exchange and foster trust building between Nunavummiut, polar bear researchers and wildlife managers.

Concerns over public safety

Concerns over public safety emerged strongly during interviews. When prompted to discuss their concerns about polar bear management, all individual interview contributors (n=27) highlighted that they were especially concerned about increasing polar bear aggressions and human-polar bear encounters that posed a threat to human safety (see also 'Human-polar bear interactions' section).

> *"Now, there's so many polar bears you hear stories of people being attacked by polar bears in different communities." (Lazarusie Ishulutaq, Pangnirtung)*

> *"My only concern is about the safety of the community and people that go out. The safety is my highest concern. I have this concern since the 90s." (Sandy Akavak, Kimmirut)*

> *"Polar bears have increased in numbers and they start to come to communities more often. This is my concern!" (Kooyoo Padluq, Kimmirut)*

Harvest quotas and hunting regulations

Contributors shared perspectives on harvest quotas and hunting regulations primarily in the context of their concerns over public safety. While many participants acknowledged polar bear management efforts, some felt harvest quotas and hunting regulations should better accommodate increasing human-polar bear interactions and associated safety concerns. Several contributors from both communities also noted that current polar bear management practices differed from how Inuit would traditionally manage their interactions with polar bears. Some expressed the view that Inuit should have greater control over polar bear harvest management in order to keep people safe. The importance of IQ in polar bear management and stewardship was emphasized.

When commenting on the quota system, many contributors recognized that management efforts have been successful in increasing polar bear abundance (see also 'Abundance' section).

> *"I think the management system is working properly because [polar bears] are increasing, they are not decreasing. People follow the management and listen." (Peter Kanayuk, Pangnirtung)*

However, several participants from both communities expressed the view that polar bear harvesting quotas should be increased to address concerns over public safety (n=7 in Pangnirtung; n=3 in Kimmirut), as well as to support healthy seal populations and Inuit food security (n=1 in Pangnirtung). None of the participants suggested a reduction in existing harvest levels.

“[The quota system] has worked pretty well so far because if there were no quotas in the past then we wouldn’t be seeing polar bears as often as we do now. But I think some changes need to be made so that polar bears don’t endanger the lives of human beings.” (Anonymous 04, Pangnirtung)

“Nowadays with the quotas being in place and with sometimes bears coming into camps and into the community and needing to be scared off, they [management partners] would need to work on getting quotas up higher than the normal quota range.” (Itee Temela, Kimmirut)

“It would be nice if there can be more harvesting so the [bear] numbers can decline a bit because for younger generations and like, to whoever goes out hunting it’s worrisome...It can be worrisome to encounter a polar bear, like you want to enjoy yourself out there but on the side of that you have to worry about polar bears coming. I would like that [population] to drop a bit.” (Michael Kisa, Pangnirtung)

“For the sake of the seal pups, the quota should increase...If there is no immediate management put in place to increase the harvesting of polar bears in Nunavut, I am afraid that the seal population is going to be very low. So therefore food security for human beings is going to be endangered, that is what I think.” (Johnny Mike, Pangnirtung)

Some contributors nonetheless emphasized that harvest management should remain sustainable.

“I’d like to see maybe a bit decrease in population for safety reasons but not to the extent [polar bears] would become an endangered species. And hopefully the polar bears can survive whatever the changes we go through.” (Anonymous 03, Kimmirut)

Three contributors from Pangnirtung also expressed their lack of support for the quota system in place and suggested reverting to traditional Inuit polar bear stewardship practices to ensure public safety.

“*I talked to other people in different communities and they all think that if we did it like back then, like killed polar bears whenever they come and it doesn’t matter how much, it would be safer for everyone. It wouldn’t be as dangerous…Other Elders in other communities think that’s how it should be now because there’s too many.” (Lazarusie Ishulutaq, Pangnirtung)*

“The Inuit knowledge should not be touched. If it’s been touched, Inuit way back then would say don’t...or even today. And they should not put any quotas on polar bears.” (Leesee-Mary Kakee, Pangnirtung)

When discussing polar bears killed in defense of life and property, several participants stated that how ‘problem bears’ and defence kills are managed nowadays was not sufficient to keep people safe, goes against Inuit ways, and contributes to making bears less fearful of humans. Many contributors (n=5 in Pangnirtung; n=1 in Kimmirut) specifically explained that “scaring polar bears” that come into camps and communities as opposed to harvesting them –as Inuit traditionally did– was not an adequate way to address concerns over public safety.

"Inuit have a culture. When the polar bear comes into the community…the law will say 'try to scare them off before you shoot them'. In Inuit law, there's no such thing as 'scare them off'. You harvest it. Kill it. Why try to scare it off? He's coming back anyway. Might end up coming back during the night, not during the day, you know. It doesn't work really…In the older days, a bear comes into the camp it's a dead bear. Instead of try to scare it off…That's not Inuit way. That's not Inuit law or nothing…When we do that, we just try to making that bear smart who'll go visit again next time." (David Kooneeliusie, Pangnirtung)

"Today, when a polar bear comes, it doesn't get killed. Back then, it had to be killed because if it doesn't get killed they would come back all the time and damage anything that's old. We've heard stories...that there was a man who got killed because that polar bear probably kept going back and it wasn't afraid, anymore. Any polar bear that comes to camps or places where there's people they should be killed." (Leesee-Mary Kakee, Pangnirtung)

Some explained that Inuit are often reluctant to kill polar bears in self-defence, thus putting their safety at risk. This tension was highlighted in a story shared by a participant from Pangnirtung.

"The polar bear was very close to one of the tents and the family woke up because their dog was barking. And they woke up and left the tent right away but they had forgotten their baby in their tent and the polar bear was so close they had to kill it to protect their baby. When I heard the yelling, I thought it was because of a wolf. So I grabbed my gun [rifle]. There was other people there with their guns and I kept telling them to shoot [the bear] before it attacks the baby. But the other people kept saying that the government says we can't shoot them. The polar bear was getting ready to jump on the tent where the baby was. And since no one would shoot it, I had to fight one of the guys who had the gun. And we were fighting over the gun. He got it and had the chance to shoot [the bear] before it jumped." (Lazarusie Ishulutaq, Pangnirtung)

Several contributors (n=5 in Kimmirut; n=1 in Pangnirtung) also shared the view that defence kills should not be subtracted from community harvesting quotas. Some suggested that hides from polar bears harvested in self-defence should be returned to the hunter rather than being kept by the local Wildlife Officer (n=2 in Kimmirut; n=1 in Pangnirtung).

"Back in the old days, any polar bear was harvested without having to have a tag. Nowadays with the tags and quotas in place, it is very difficult. Bears come in and out and having no tags and having to encounter a bear it is not a very pleasant experience. Having to defend your life and cannot kill a bear because of the quotas or the tags being used up [makes things] much more difficult now than in the past...Defence kills should not be used [to determine] the quota for the next hunting season and the hide is taken away…They should make change in these areas, too." (Eliyah Padluq, Kimmirut)

"When we harvest a 'defence kill' that comes from the quota, the hunter doesn't get to keep the hide. The hide should be given to the person who killed the bear for defence." (Kooyoo Padluq, Kimmirut)

"[Defence kills] should not come out of the quota system. Because it's self-defence. When that happens, you lose your quota, that polar bear skin. The polar bear is usually taken, skinned by the Wildlife Officer. We don't want anybody to take what we catch, if we want

to use it. Because it's not endangering the polar bear. If we've only got a few polar bears, yes get it out of the quota, but there's so many polar bears." (Peter Kanayuk, Pangnirtung)

When discussing hunting regulations, two contributors from Kimmirut suggested extending the current polar bear harvest season into the summer, when human-bear interactions are likely. Some contributors (n=2 in Kimmirut; n=1 in Pangnirtung) also expressed a desire to harvest polar bear cubs[12].

"Some of the management decisions are not too accurate. During the summer time when it is not harvest season the bear will come up to the community and has to be chased away. But then when it is chased away it'll come back and it has to be called a defence kill. Why can't we have the year round quotas or something similar in place? Because if we could hunt the bears during the summer season we won't be too afraid…Why can't they have something put in place for the summer too? Maybe that way we won't be too afraid to be out [on the land]." (Akeego Killiktee, Kimmirut)

"If the management could include summer harvesting quotas that would be beneficial, as well as to include in the management to harvest cubs. I heard Elders saying that they would like to have cubs and I would like to experience that myself too, the taste of the meat of a cub...Long before I was born they did harvest cubs and my grandparents used to mention that they would love to be able to harvest cubs." (Kooyoo Padluq, Kimmirut)

Five participants (n=3 in Pangnirtung; n=2 in Kimmirut) further suggested changes to sex-selective harvesting practices[13] that would lead to an increase in the amount of females harvested.

"I know they're protecting [female polar bears] for the future but if [hunters are] not going to get females, [polar bears are] just going to grow...more numbers. Because just males are being harvested. I feel there are more polar bears around because cubs are growing up…More males are caught than females. There are being more and more polar bears." (Geetee Maniapik, Pangnirtung)

Throughout discussions related to harvest quotas and hunting regulations, participants emphasized the importance of Inuit Qaujimajatuqangit in polar bear management and stewardship.

"I think Inuit IQ should be used to manage [polar bears]. IQ should be given a chance like science knowledge that has been ruling polar bear quota. I think IQ should be put in place to manage the polar bear population as much as science has been used for quite some time…I think IQ should be given better consideration for managing polar bear populations." (Johnny Mike, Pangnirtung)

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[12] The harvest of polar bear cubs and family groups is permitted in Nunavut under certain conditions. Hunters must request and obtain a permit in order to be allowed to harvest polar bear cubs. Some contributors were not aware of the existence of this provision which speaks to the need for greater information dissemination on this topic among Nunavut harvesters.

[13] Interviews were conducted in 2019 soon before the polar bear harvest sex ratio was adjusted to one male for every female (1:1) across Nunavut.

Communication

Many participants from Pangnirtung and Kimmirut expressed their interest in scientific research conducted on polar bears. However, while acknowledging communication efforts made by polar bear researchers to date, several participants from both communities stated that they would like to receive or have access to more information about scientific research conducted on polar bears. Many highlighted that polar bear research communication with community members could be improved (n=8 in Kimmirut; n=6 in Pangnirtung).

> *"I did not receive information from scientists, I have never talked to a scientist before. [When I was part of the bear survey], I was just counting the bears and I did not receive information back. We were just counting and they did not forwarded the conclusions. They didn't tell me." (Anonymous 01, Kimmirut)*

> *"I think that scientists do provide good information because that's their duties to do, whenever they do science they should share all the information so that everybody is aware. Or at least give them to the HTOs and they can provide them to the public." (Anonymous 03, Kimmirut)*

> *"Because scientists don't report to us directly, we hear the information through the news first before the information comes back to the community...They seem to conduct studies more often by helicopter and then we would hear back information through the news first before we are given [information] to us directly." (Kooyoo Padluq, Kimmirut)*

> *"Whenever we harvest a polar bear, we let the HTO know, we give them samples, all the samples that they require. Other than that, I don't know of any other reporting system...If [communication] was better, then the community would be more aware of what the situation is, the community as a whole...I don't know what's already happening now, but that information needs to be shared with not only the HTO but with the community itself, through maybe community consultations or community information sessions." (Anonymous 04, Pangnirtung)*

Perspectives shared by participants highlighted that improving polar bear research communication was particularly important given the presence of some community mistrust towards scientific research methods and polar bear researchers, and the existence of divergences between scientific and Inuit observations.

> *"People down South say that the polar bears are becoming extinct, that is because they have never been up here and when they are counting the population, they do not check all the places. They just go to some places but not all." (Matiusie Maniapik, Pangnirtung)*

> *"And information [from polar bear scientists] is sometimes provided and sometimes it's not really true at all. That's my concern. Number of bears are not going down. They're not starving yet. The population's still going up so which just means [bears are] still eating good…I have heard so many times on the news or talking to the people that polar bears are not actively hunting in open water. To me, that's not so…That's not true…I see [polar bears] all the time and then when I hear on the news that there is no ice, that polar bears will be starving, they'll be all gone, no way. Where do they get that information from? It's not true. Someone is giving out not true information at all to the world. It's really wrong." (David Kooneeliusie, Pangnirtung)*

"People that count the bears and study the bears they do not normally consult back to the town's people…When they do bear observations in the summertime, if they say that the numbers are declining that's where I would debate. Sure they are white and easy to be seen in the summer time but some of them can also make themselves dirty to camouflage. I think that people that survey the area by helicopter there is a certain percentage that they don't see, compared to what we see. Polar bears are capable of camouflaging themselves, rolling around dirt and mud to [disguise] their white presence. I have seen a bear that looked almost like a rock…I am kind of on defence when they are stating what they see compare to what I see." (Ejetsiak Padluq, Kimmirut)

"Scientists who don't live in our communities and who live down South say that they have a lot of knowledge about our animals but yet the Inuit are the ones who would know more because we are in the community and are the observers of our animals. We are telling, you know, what we know. But the scientists who come up will say 'I know these'. But we say no, you don't." (Itee Temela, Kimmirut)

Many contributors (n=9 in Kimmirut; n=4 in Pangnirtung) offered concrete suggestions for improving communications and fostering trust building between community members, polar bear researchers and wildlife managers. Several participants highlighted the need for polar bear researchers to share more information with and seek input from community members. Some suggested that information on polar bear research could be made more readily available to community members –including youth– through different media (e.g., community radio, reports, social media, community meetings, school presentations) in both English and Inuktitut.

"Scientists could help out by providing documentation of their studies or [communicating information through] the local community radio." (Ejetsiak Padluq, Kimmirut)

"We hear information from the scientist through the radio but they don't give reports…[I would like] if they could keep us informed about what they did. I like to know what is going on in my surroundings, so if I have to do a lot of reading I can do so. If they could [provide reports] to the community that would be helpful, in Inuktitut…If they report back to me in English, I will have to have someone help me." (Akeego Killiktee, Kimmirut)

"[Researchers should be] providing documentation of what they know [more widely] even videos." (Anonymous 01, Kimmirut)

"[Scientists can improve the communication of information about bears with me and the community] by making [information] more readily available online…[They] can give us the links of the websites where we can look [the information] up." (Anonymous 02, Kimmirut)

"Right now we have Facebook…to find out now which community [has] been interacting with the polar bears [and when bears] are coming into the community. We find out now a lot faster than before." (David Kooneeliusie, Pangnirtung)

"I don't know if scientist have met with the member of the public each time or if they ever have. I think that they should inform the public themselves [through] community meetings." (Jawlie Akavak, Kimmirut)

"What scientists can share? What they know, what they've done, what they've studied. And maybe [share their knowledge] even to the high school. If they can come and share

what they've learned and what's going on, the students will know what's happening to the polar bear population up here." (Meeka Alivaktuk, Pangnirtung)

"If the scientists themselves cannot come to the community, [they can] work with the HTO and then they will pass [the information]. What information they got, they can pass it onto the community with the local radio station or something like that…What is taken from the North should come back to the community as information." (David Kooneeliusie, Pangnirtung)

Participants also mentioned that they were particularly interested in obtaining scientific information on the health, abundance and distribution of polar bears.

"[I am interested to know] if [polar bears] are sick or not, you know? And we could give [samples] to them [researchers] so they can find out if something is wrong with the bear or anything like that. That's important." (Peter Kanayuk, Pangnirtung)

"[I am interested to know about] their health because they're our meat, like we only hunt [polar bears] for food, not just for fun." (Geetee Maniapik, Pangnirtung)

"I have strong concerns there because our Elders say polar bears hunt even better in the summertime because that's when they're building up the fat for the winter, right, and there's no ice during the summertime unless there's that multi-year ice coming in. So there has to be better knowledge, this needs to happen." (Anonymous 04, Pangnirtung)

"I think that looking at the heath of polar bear would be very helpful and I have just heard that some polar bears may have more chances of getting PCBs [contaminants]. It would be interesting to receive more information about that." (Anonymous 03, Kimmirut)

"I would be interested in knowing if they are declining [or] if they are still the same. If they are more healthy or if they are less healthy. This would be good to know." (Anonymous 01, Kimmirut)

"I would like to know the population numbers of polar bears...I think I have the right to know the population numbers, the health [of bears] and what management does." (Ejetsiak Padluq, Kimmirut)

Several contributors emphasized that relationship building and creating opportunities for dialogue between science and IQ was key to improving knowledge exchange and fostering trust building between Nunavummiut and polar bear researchers. Some encouraged polar bear researchers to engage more with Nunavut communities in order to develop greater mutual understanding and ensure that accurate information was shared.

"The scientists have to work with community members to give accurate information." (Kooyoo Padluq, Kimmirut)

“I think there should be, like I said earlier, a better relation between the researchers or the scientists and the people in the community so that information is accurate and that the community knows what the scientists know because we often say ‘this is the truth because this is what we’re hearing’ or ‘this is our knowledge’. If we’re not hearing the scientist side then the truth may not be the whole truth...Because we’re not hearing what they’re saying...There’s always studies saying that polar bears are decreasing and that they’re becoming endangered and all that but us, we’re seeing more [polar bears]. So there has to be better communication…between the two so that the information is accurate.” (Anonymous 04, Pangnirtung)

“All the information are in the community…[Scientists should] work with the people along the coastline of Baffin Island. That’s where the bears are. And the kids start seeing polar bears when they are still on their mother’s back. So that’s a good information...If scientists work together [with communities] I know more people will listen or myself, I would.” (David Kooneeliusie, Pangnirtung)

CONCLUSION

This study explored the detailed historic and contemporary knowledge held by Nunavut Inuit about polar bear ecology and health, as well as the importance of *nanuq* to Inuit and perspectives on polar bear management and stewardship.

Overall, interview contributors from Pangnirtung and Kimmirut reported that polar bears they encounter are today generally healthy. Observations suggestive of a healthy polar bear population included: an increase in polar bear abundance systematically reported by participants over their lifetime, no change in cub productivity and survival reported over time, females with two cubs being most frequently observed, and rare reports of polar bear disease or non-hunting related mortality. However, in recent years, contributors pointed to some subtle changes –which could be early signs of change– in polar bear health, including a slight decline in polar bear fatness and overall heath noted by some participants and occasional reports of hair loss (alopecia). Participants had also observed changes in polar bear prey availability and habitat condition over time, including changes in sea ice quality and quantity and a major decline in the abundance of ringed seal (the main polar bear prey) observed around both Kimmirut and Pangnirtung. At the time interviews were conducted, such changes were not reflected in observations related to cub productivity and survival, which had remained stable according to contributors from both communities. Contributors emphasized that *nanuq* is a resilient and opportunistic predator that is highly adaptable to changes in prey availability and habitat conditions. Regular documentation of Inuit observations will be required to understand how polar bear population health, including body condition status and population demographics, evolve over time.

Importantly, results from this study highlighted public safety concerns arising from increased human-polar bear interactions and encounters. Public safety both in the community and on the land was unanimously raised by participants as a primary concern that should be addressed. Testimonies from project contributors suggested that polar bear management today must find ways to address public safety concerns, while ensuring that polar bears persist into the future and remain available for future generations.

This study illustrated that Inuit Qaujimajatuqangit offers unique year-round historical and contemporary ecological observations which can enhance our collective understanding of *nanuq*, and provides key insight and perspectives on polar bear management and stewardship. Polar bears experts interviewed demonstrated a strong ability to detect and observe ecological changes over time and recall unusual events; they also identified polar bear health indicators employed to guide their harvesting and consumption decisions. Furthermore, this report explored the specialized knowledge held by Inuit women and men, who can both make unique contributions to our understanding of polar bear health. Collectively, our findings therefore highlight the substantial contributions that IQ holders can make to polar bear research, monitoring and adaptive co-management.

Inuit Qaujimajatuqangit emphasizes the importance of maintaining respectful relationships between humans and polar bears and reminds us of our collective responsibility towards *nanuq* and future generations. To this end, generating opportunities for knowledge and information exchange among Nunavummiut, polar bear researchers and wildlife managers will be important. We therefore hope this work can serve to inform polar bear management and decision-making, as well as ongoing and future community-based monitoring and research efforts in Nunavut and beyond.

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APPENDIX 1. Contributing authors – biographies

Biographies and pictures are provided below with permission. Please refer to 'Contributing authors' section for a comprehensive list of contributing authors.

KIMMIRUT

Jawlie Akavak

Jawlie was born on April 6, 1951 right on the other side of the bay of Kimmirut (at that time named Lake Harbour). Jawlie lived all his life in Kimmirut and vividly recalls that the community was quite different when he was a child. In the winter, only 20 people lived in the community. In the summer, other Inuit living in outpost camps further away would come into town and, for a week or two during sealift time, the population of Lake Harbour would double. Although Jawlie does not consider himself a polar bear hunter, he has been observing polar bears all his life. He has been regularly travelling on the land and harvesting country food since his youth, and continues to do so today. When he goes on the land, Jawlie always brings along his dogs that alert him and his family when polar bears are close by, and help them to stay safe while traveling and camping on *nuna*.

Sandy Akavak

Sandy Akavak was born on June 14, 1941 in the outpost camp of *Nuvuktiqpaaraluk*, the "outermost point on the land". He was raised on the land. During his childhood, he was always on the move traveling between his family's summer, spring and winter camps. When his father starting working with the RCMP in 1947, he and his family relocated to Kimmirut. His father helped RCMP officers travel from place to place by dog team and boat, and Sandy followed along. In 1967, his father retired and Sandy took over the job, becoming an RCMP officer himself at a time when the last few dog teams were used to travel. Sandy has been mainly based in Kimmirut ever since, and worked for a few years in Iqaluit and Pangnirtung in the 1970s. Similar to his father, his job was to help RCMP officers travel on the land and between communities. Back then, there was no Conservation Officer; the RCMP was responsible for polar bear management, including quotas. In the late 1960s, Sandy remembers that there was a quota of only three polar bears for the Kimmirut area. He vividly remembers the first polar bear he harvested in 1962 as it was the same day his daughter was born. At that time, he sold the hide –a 9 footer– for $50 in Iqaluit, which is much lower than prices obtained in the 1980s and beyond. Although Sandy does not harvest polar bears anymore, he still enjoys travelling on the land and harvesting country foods.

Rosemary Allen

Rosemary was born in 1964 in an outpost camp near Qikiqtarjuak. At the age of two, she went to Toronto for health reasons and then moved to Inuvik as her father was working for the DEW line sites. Rosemary moved back to Qikiqtarjuak in 1979, and then to Kimmirut in 1984 where she has lived ever since. In 2018, she started to clean polar bear hides. She has prepared two polar bear hides to date.

Joe Arlooktoo

Joe was born on the land in one of the earlier Hudson's Bay Company trading posts located on the north side of Frobisher Bay. His father worked for the Company, and travelled with Joe and his family. At the age of three, Joe moved to Kimmirut with his family; they travelled all the way by boat crossing Frobisher Bay first, and then following the coast up to Kimmirut (at that time known as Lake Harbour). Joe and his family lived in Kimmirut for about ten years, then moved to Cape Dorset, and two years later returned back to the Kimmirut area. At that time, Joe was a young boy eager to learn more about his culture, and how to hunt the 'Inuit way'. In the outpost camp of *Qijujuaq*, he learned the traditional lifestyle living in sod houses made with moss, soil, and a bit of drift wood. There, he also learned how to hunt seals on his own in a kayak.

In the early 1960s, he moved to Kimmirut and has lived in the community ever since. Although Joe now does not actively hunt polar bears anymore he still goes out on the land, and uses the hide of the last polar bear he harvested as a warm mattress to sit on in the *qamutiik*. Joe holds a wealth of knowledge about *nuna* and its wildlife. He is eager to pass on what he has learned over his lifetime to the young Nunavummiut, tomorrow's leaders.

Joannie Ikkidluak

Joannie was born on June 10, 1945. He grew up in an outpost camp in the Markham Bay area. At that time, he was traveling by dog team, by boat, and also walking long distances on the land.

Joannie recalls seeing his first polar bear in the 1970s. He harvested a polar bear for the first time in 1987 –this bear was a 13 footer which was going after the bait he had used for his trapline. Since then, Joannie has been polar bear hunting almost every since then. He was a board member for the Nunavut Wildlife Management Board for a number of years.

Akulujuk Judea

Akulujuk was born in 1949 in Kimmirut. She started cleaning polar bear hides in the early 1970s and has been cleaning polar bear hides up to this day.

Akeego Killiktee

Akeego Killiktee was born on September 5, 1952 in an outpost camp located in *Kugalik*. She grew up on the land living with her family in *Qijujuaq*, a place named after a tree log. She moved to Kimmirut in 1979 and has been living in the community since then. In her adult life, she has enjoyed living on the land especially during the spring. Akeego has been cleaning polar bear hides since 1979. She has cleaned and stretched so many hides that she is not even sure how many she has done to this date. She now wishes she had counted them from the start! Today, Akeego enjoys traveling on the land whenever she has the opportunity and she is thankful whenever she can eat country foods.

Mikidjuk Kolola

Mikidjuk was born on November 19, 1949. He grew up in an outpost camp in the Kimmirut area and started to travel on the land at the age of nine.

In the 1950s, Mikidjuk never heard anyone talking about polar bears in the Kimmirut area. He recalls observing his first polar bear in the early 1960s when he used to camp in tents during the warmer season. At that time, Mikidjuk was not worried about polar bears but nowadays travelling on the land can be dangerous due to the presence of polar bears.

Mikidjuk is a polar bear hunter who enjoys travelling on the land and observing wildlife.

Pitsiula Michael

Pitsiula was born on January 18, 1965 in Iqaluit. He spent his childhood in Kimmirut and lived in an outpost camp in the Markham Bay area from 1977 to 1990 – going back to the community by boat and skidoo during that time. Pitsiula then moved to Cape Dorset in 1990, and back to Kimmirut in 1993 where he has lived ever since.

Pitsiula started observing polar bears around 1970s, and regularly travels to his preferred hunting grounds in the Markham Bay area. He also occasionally travels to the south shore of the Meta Incognita Peninsula.

Pitsiula harvested his first polar bear when he was 16 years old. Since then, he has participated in many polar bear hunts and has been helping with polar bear sport hunts in Kimmirut.

Saimata Onalik

Saimata was born in a tent on the shore of Lake Harbour on July 11, 1958. She has cleaned three polar bear hides over her lifetime.

Eliyah Padluq

Eliyah was born in an outpost camp on March 12, 1941. Eliyah grew up on the land and throughout his childhood he lived with his family in over seven different camps located along the south shore of Baffin Island, on Meta Incognita peninsula, and on Big Island. Eliyah has lived in the Kimmirut area all his life and he knows the land surrounding Kimmirut as if it was his backyard! In his lifetime, Eliyah has harvested over 30 polar bears: the first one was “at a time when counting time was not needed” and the last polar bear he harvested was just last year, in 2018. Eliyah continues to enjoy traveling on the land and the ocean and harvesting wildlife, including the mighty polar bears, up to this date.

Ejetsiak Padluq

Ejetsiak was born on April 1966 in the outpost camp of *Qijujuaq*, about 55 km east from Kimmirut. He lived in *Qijujuaq* with his family until 1982. His grandfather was the leader of the outpost camp; when he passed away in 1982, Ejetsiak moved to Kimmirut with his family where he has lived ever since. Ejetsiak is an avid hunter. He has been harvesting polar bears since the age of 17 and even lost count of how many he has harvested.

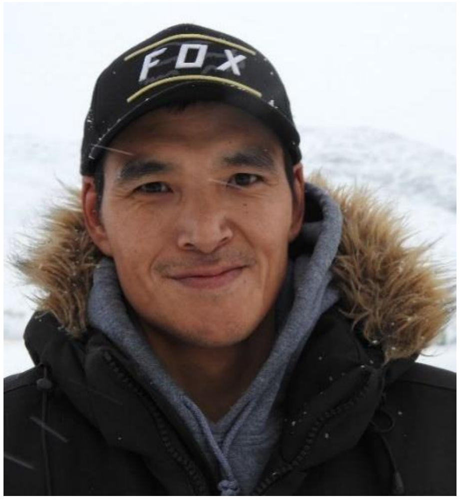
Jeannie Padluq

Jeannie Padluq was born on June 9, 1949 in Kimmirut right in town where the nursing station is now located. She grew up in Kimmirut and *Itinnaapik*, a camp close by town at the mouth of the harbour. Throughout her life, Jeannie has cleaned and prepared over 60 polar bear hides and she does it up to this date. Jeannie is very active in the community. She very much enjoys going to the school and sharing her knowledge with young Kimmirumiut. Amongst other things, Jeannie enjoys going out on the land. She likes going to lakes “especially if they have fish”.

Kooyoo Padluq

Kooyoo was born in Iqaluit. He grew up on the land in the outpost camp of *Qijujuaq* until he was 16, and then moved to Kimmirut with his family. Since then, he has been living in Kimmirut. Kooyoo loves country foods and regularly goes on the land to harvest seals, caribou when possible, fish, birds, whales, bird eggs, and polar bears. He has been working at the Hamlet for over 30 years.

Davidee Temela



Davidee was born in Kimmirut in 1984. Since the early 1990s, he has been travelling on the land with his father, observing and harvesting wildlife. Today, Davidee is a very active harvester who provides country food for his family.

Isaac Temela

Isaac was born on November 24th, 1978 in Iqaluit, at that time known as Frobisher Bay and still part of the Northwest Territories. Isaac has lived in Kimmirut since his early childhood. He started hunting at the age of twelve using an old fashion Chipmunk .22 rifle. Even before then, since he was nine, Isaac has been mining soapstone in the Markham Bay area. Every summer, Isaac goes together with other miners from Kimmirut and Iqaluit to *Tatsittut* (Inuktitut name for Markham Bay): the place of mist and fog. He has been doing so for over thirty years and sometimes he has traveled by tugboat to bring the mined soapstone from Kimmirut to Iqaluit. Isaac harvested his first polar bear when he was sixteen years old in a cold day in January. He enjoys his land and observing all the wildlife that lives in it, including the majestic polar bears.

Itee Temela

On September 2, 1948, Itee Temela decided it was time 'to see the world' once her mom was in Kimmirut during one of the regular trips she was doing from the outpost camp of *Ukialivilut* where she was living with her family. Itee grew up on the land, in *Ukialivilut* during her early childhood and in *Qijujuaq*, closer to Kimmirut, in her young adult life. She still goes to *Qijujuaq* every fall to wait for the whales to come back; four years ago, she visited *Ukialivilut*, a place where she holds strong connection to, since her mother was buried there.

Itee is still an active hunter and goes regularly out on the land to harvest country foods. Seals are her favourite. Since her childhood, she has been helping scraping and stretching polar bear hides and she still does it today.

PANGNIRTUNG

Leopa Akpalialuk

Meeka Alivaktuk

Meeka was born in *Nunataq* and lived there until she was eight years old. From there, her family moved to and lived at another camp for two years before Meeka and her family were relocated to Pangnirtung by the federal government. In 1969, Meeka went to residential school in Churchill, Manitoba, for one year. She lived in Iqaluit from 1994 to 1996 to receive training for a job at a school.

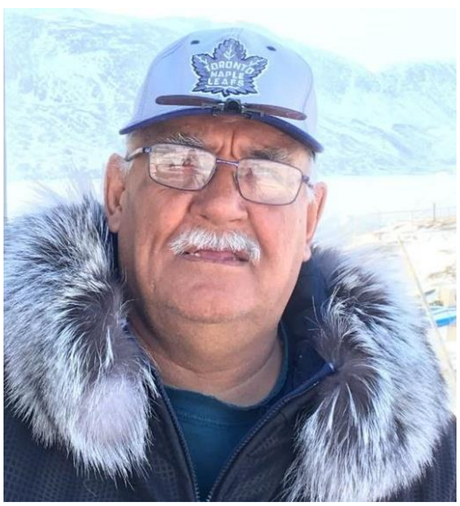
After polar bear quotas were established, Meeka was the first woman in her community to harvest a polar bear (in the 1980s). At that time, she had to travel further from the community to harvest polar bears than where people travel to harvest them today. Although she has not harvested polar bears since, she has cleaned many hides over her lifetime and is experienced with polar bears through that work. She also participates in polar bear hunts with other community members. Meeka enjoys traveling on the land to go hunting (for seals, beluga and caribou) and fishing almost every year. Two years ago, she built a cabin and has been traveling there mostly in the summertime.

Leesee-Mary Kakee

Leesee-Mary was born in an igloo and grew up in *Ujjuituq* (“place of bearded seal”) until she was nine years old. She began hunting with her father at a very young age. In the summertime, she would go fishing and seal hunting with her father. Leesee would also accompany her father whenever he went polar bear hunting: “My father wanted to leave me behind when he was going after the polar bear, but I wanted to go so badly I cried.” She was eight years old at the last time she went polar bear hunting with her father. When she was 14 years old, Leesee moved to Pangnirtung. At that time, she and her father stopped hunting. She would travel back and forth between areas where each side of her parents’ family lived. She would travel by foot or boat in the summer, and dog team in the winter and spring. She moved to Pangnirtung in 1962 and has lived there since.

In her lifetime, Leesee has helped cleaned polar bear hides on two occasions. Today, she still actively travels on the land. She has a cabin that is accessible by boat in the summertime.

Peter Kanayuk



Peter Kanayuk was born in 1951 at *Usualuk*, an outpost camp located close to Pangnirtung. He spent his childhood and early life in *Qimmisuuq* on the south shore of Cumberland Sound. Peter grew up on the land, hunting with his family and travelling by dog team. He remembers a time when many dogs in camps were sick and dying; because of that, families were forced to relocate to Pangnirtung. His family was one of the last few to be relocated to Pangnirtung in the mid-1960s. After attending residential school in Manitoba, Peter worked briefly for the RCMP. He then settled permanently in Pangnirtung where he became a heavy equipment operator.

Peter has spent his life hunting and traveling on the land surrounding Pangnirtung. He has been hunting polar bears since he was about 20 years old and continues to go hunting with his son-in-law. He travels on the land year-round and has had to scare polar bears away from approaching his camps. Throughout his lifetime, he has gained considerable experience observing, hunting, and butchering polar bears.

Abraham Keenainak

Abraham was born on the land and moved to the *Nunataq* area, where he lived until he was 21 years old. When he married, Abraham moved to *Iqalulik* and lived there for about five years before moving to Pangnirtung in the late 1960s. In Pangnirtung, he was introduced to the snowmobile; up until then he had only travelled by dog team. Abraham worked for the Hudson Bay Company for about five years, trading sealskin, polar bear hides, as well as wolf and fox pelts. He then worked as a heavy equipment operator.

Abraham caught his first polar bear when he was in his 30s, and harvested his last polar bear in 2018. He has caught six polar bears over his lifetime. Today, in the spring and summer, Abraham goes camping on the land to hunt caribou, seal, fox, walrus and polar bear, as well as goes fishing. He also harvests beluga and narwhal. He has seen bowhead whale on his trips but has never harvested one himself. Since retiring in 2006, Abraham has had more time to go hunting: “The only thing that stops me from hunting is bad weather!”

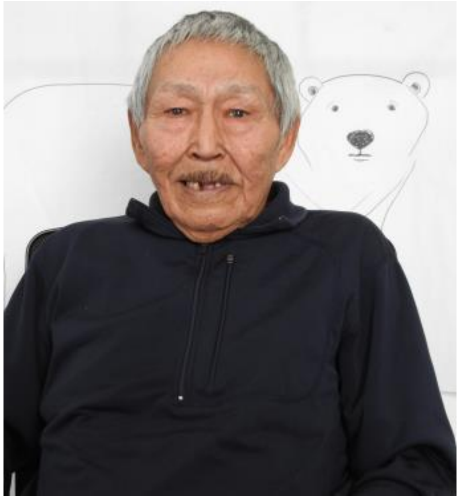
Simeonee Keenainak

Simeonee learned how to hunt polar bears from his father in the 1960s, and has spent most of his time camping and traveling on the land around Pangnirtung and Iqaluit. Until the 1980s, he worked as an RCMP officer, moving from community to community every two years. In the past, he would travel by dog team. Today, he travels by boat and skidoo, depending on the season. He has travelled on the land wherever he has lived.

Simeonee is experienced with all of Cumberland Sound, from wildlife to sea ice and travel conditions. His first polar bear hunt was with his father, and since then he has gone hunting for polar bears around Pangnirtung and Iqaluit; his most recent harvest was in 2005.

In addition to polar bears, he has harvested a range of wildlife – “anything that moves” – across broad areas where he has lived. He continues to go camping all year round. In addition to hunting, Simeonee also observes and encounters wildlife through photography. Since 2017, he has been the Chairperson of the Pangnirtung Hunters and Trappers Organization.

Michael Kisa



Michael Kisa was born during the summer in a sod house at *Qarmakuluk*. After his mother passed away during childbirth, his godmother brought him to Pangnirtung. He has lived there since, although he lived in a camp with his parents for three years when he was a teenager.

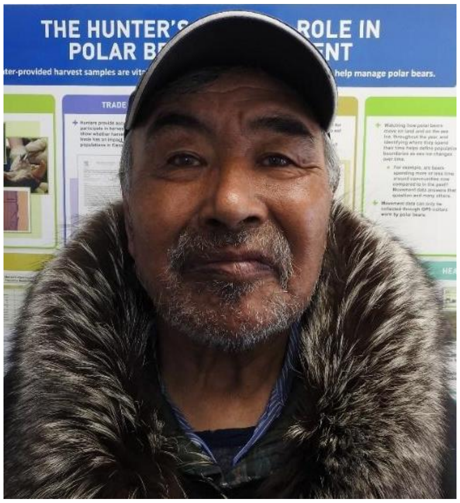
In the 1990s and 2000s, Michael worked as a Conservation Officer in Pangnirtung. He would spend time tracking polar bears and measuring their tracks. Michael caught his first polar bear at 19 years old and has harvested approximately 15 polar bears since. He harvested his last polar bear two years ago. Michael has also had three personal encounters with polar bears. Today, he enjoys travelling by boat to catch fish and narwhal.

David Kooneeliusie

David was born on *Nunataq*, just outside of Pangnirtung. He and his family have lived in many places, including Ikaluktutiak (Cambridge Bay), Qikiqtaq, Pelican Island, North Pangnirtung Fjord, and Qikiqtarjuaq. He went to residential school in Churchill, Manitoba, from 1965 to 1968.

David learned how to hunt and butcher polar bears at a young age from his father. He also worked for Parks Canada for 25 years. During this time, he became experienced with observing polar bears through bear surveys and research by helicopter and snow machine. These surveys included making observations at dens, recording tracks and sightings, and mark-recapture. David was transferred to Pangnirtung in 1997, where he started working full time. He has lived in Pangnirtung since then, apart from traveling for Parks Canada training. After moving to Pangnirtung, he has not been hunting as much, except to teach his children how to hunt. David retired in 2009.

Lazarusie Ishulutaq



Lazarusie was born on the land in *Usualuk* in 1948. He grew up on the land in Cumberland Sound, traveling with his family by dog team between winter, summer and spring camps. He also grew up hunting seal and caribou amongst other country foods. The first polar bear he saw was in the 1950s and, back then, it was a rare event. Lazarusie lived many years in *Qipisa* (an outpost camp located on the south shore of Cumberland Sound) harvesting seals to sell their skin. When the sealskin market collapsed in the early 1980s, he was forced to relocate to Pangnirtung. That was also the time when polar bears started to increase in the area.

Lazarusie has experience with hunting, butchering and living with polar bears. He has harvested over 10 polar bears since the 1970s and continues to harvest them today (last harvest in 2017). Because of his experience, he guides sport hunters on their polar bear hunts around Pangnirtung. Lazarusie has also harvested other wildlife such as seals, caribou, fish, walrus, beluga, ducks, and he continues to travel in the Cumberland Sound year-round. He shared insights about relationships with polar bears that were gathered from both his own observations and the experience of family members.

Geetee Maniapik

Geetee Maniapik was born on the north side of Cumberland Sound, and lived there until she was four or five years old. Her father would travel by dog team at least once a year along the north side of Cumberland Sound, where her mother's parents were living. Geetee moved to Pangnirtung when her parents had to relocate into a settlement. She also lived at a permanent camp on the land near Pangnirtung, where she would travel back and forth to the community. She lived for a couple of years in Iqaluit around 1966 and would travel there by boat. She moved to Pangnirtung permanently in the 1970s, when her father had tuberculosis.

Over her lifetime, Geetee has cleaned or helped clean over thirty polar bear hides. Geetee started working on polar bear hides at a very young age while helping her grandmother and sister clean hides. Geetee has also hunted three polar bears. Today, she harvests seal, beluga, and fish. In the spring, she goes fishing almost every weekend.

Matiusie Maniapik

Matiusie was born on 20 January 1950 in the outpost camp of *Qipisa* on the south shore of Cumberland Sound. His family then moved north to the outpost camp of *Iqalulituuq* in the upper part of Cumberland Sound, and Matiusie grew up there until he was a teenager. Around 1966, the government relocated him and his family to Pangnirtung where he has lived since.

Matiusie spends time on the land hunting caribou and fishing and has different cabins that he uses according to the hunting season. He had been hunting polar bears since he was 19 years old, and has harvested over seven polar bears in his lifetime; his last polar bear harvest was in winter 2015 at the dump in Pangnirtung. Since polar bears hide prices have declined about five years ago, Matiusie has lost interest in polar bear hunting. However, he is still aware of polar bear hunting activities taking place around Pangnirtung. He enjoys traveling year-round on the land and observing and hunting other wildlife.

Johnny Mike

Johnny Mike was born in Pangnirtung in 1955. He lived in the outpost camp of *Illungajuk* in the mid-1960s in the upper part of the Cumberland Sound. He has lived mostly in Pangnirtung except for brief periods in the 1970s, late 1990s, early 2000s, and from 2016 to 2018, when he was located mostly in Iqaluit. During those periods, he still travelled frequently to Pangnirtung. Johnny also lived for a short time in Qikiqtarjuak.

Johnny served as MLA of Iqaluit and Minister of Environment for the Government of Nunavut between 2014 and 2018. He is an active and experienced hunter and enjoys travelling regularly within the Cumberland Sound to harvest and observe different animals (seals, walrus, caribou, beluga, narwhal, and fish): “That is my experience and it is quite of an experience!” He began hunting polar bears in 1992, when he shot his first young female in self-defence while caribou hunting, and continues to harvest polar bears whenever he has the chance. He has harvested bears on the north and south of Cumberland Sound, as well as around Iqaluit while living there in 2004. Johnny shared his knowledge about polar bears, which he learned from his own observations, as well as from his family and Elders.

Davidee Nowyuk

Davidee was born in *Qipisa* and lived there until 1980, when he was almost 30 years old. His family was one of the last to remain on the land. Davidee moved to Pangnirtung in the early 1980s and has lived there since. When he first moved into the settlement, there was a school and hospital (due to many people getting sick). The Hudson Bay Company was also purchasing pelts and furs at the time.

Davidee is an active polar bear hunter and goes polar bear hunting whenever he has the chance. He harvested his first polar bear at a young age, when polar bear hunting was rare. He has harvested five to six polar bears over his lifetime, with his last harvest four years ago. He continues polar bear hunting when he gets the chance. In addition to polar bears, Davidee often goes turbot fishing, as well as general fishing, clam digging, seal hunting, berry picking, and caribou hunting. He also participates in whale hunts with other hunters from the community.

Anonymous

The project contributor was born in and has lived most of her life in Pangnirtung. As a child, she spent some time in Igloolik and Iqaluit. While growing up, her family always harvested polar bears and she remembers hunting polar bears with her family around Pangnirtung.

Since 2008, she has cleaned over eight polar bear hides for her family and other community members. She has also harvested one polar bear (in 2014). Over her lifetime, she has harvested various wildlife (caribou, seals, fish, ducks, beluga and narwhal) and has encountered polar bears when travelling on the land, whether by skidoo or boat. Her husband and sons hunt polar bears and, as a family, they encounter polar bears on the land throughout the year. Today, she still travels on the land near Pangnirtung, depending on the season.

APPENDIX 2. Project team

Dominique Henri – Environment and Climate Change Canada

Dominique is an environmental social scientist with expertise in traditional/local knowledge research. Through her work, she strives to support community-identified research priorities and wildlife co-management in Inuit Nunangat. As project co-leader, Dominique contributed to project initiation and design, funding applications, fieldwork, data analysis, results sharing, and overall project management. She lives in Montréal, QC.

Matilde Tomaselli – Polar Knowledge Canada

Matilde is a veterinarian with expertise in participatory wildlife health surveillance and participatory epidemiology. As project co-leader and community research lead, Matilde contributed to funding applications, project design and execution, including data collection, analysis and results sharing. She conducted all the interviews with community-based researchers from Kimmirut and Pangnirtung. Matilde recently relocated to Prince Edward Island from Cambridge Bay, NU where she worked and lived since 2013.

Markus Dyck – Government of Nunavut

Markus is a polar bear biologist. He led the initial community engagement, contributed to project design and funding applications, and provided assistance in project execution.

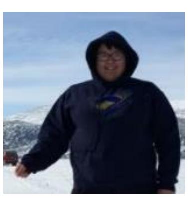
Naomi Akavak – Kimmirut

Naomi is a community-based researcher and interpreter with expertise and interest in oral history. She facilitated and translated interviews conducted in Kimmirut and contributed to report validation and results sharing in her home community.

Pudloo Pitsiulak – Kimmirut

Pudloo is a community-based researcher and youth interested in learning about Inuit Qaujimajatugangit. He facilitated and translated interviews conducted in his home community.

Doreen Kanayuk – Pangnirtung



Doreen is a community-based researcher and youth interested in learning about Inuit Qaujimajatugangit. She facilitated and translated interviews conducted in Pangnirtung and contributed to report validation and results sharing in her home community.

Rosemary Kanayuk – Pangnirtung

Rosemary is a community-based researcher and youth interested in learning about Inuit Qaujimajatugangit. She facilitated and translated interviews conducted in her home community.

Board members of the Mayukalik Hunters and Trappers Organization – Kimmirut

Board members contributed to project design and offered guidance throughout the project.

Pitsiulala Akavak – Kimmirut

Pitsiulala is a former Manager at the Mayukalik HTO. She contributed to project planning and logistics in her home community.

Board members of the Pangnirtung Hunters and Trappers Organization – Pangnirtung

Board members contributed to project design and offered guidance throughout the project.

George Qaqqasiq – Pangnirtung

George is a Manager at the Pangnirtung HTO. He contributed to project planning and logistics in his home community.

Pamela Wong – Trailmarks Systems

Pamela is a researcher trained in polar bear biology and social sciences with expertise in traditional/local knowledge research. She contributed to data analysis and report writing.

Evan Richardson – Environment and Climate Change Canada

Evan is a polar bear research scientist that has worked across the Canadian Arctic in support of polar bear conservation. He contributed to research design, offered input during the preparation of this report and reviewed the final draft.

APPENDIX 3. Invitation letter and consent form

Invitation Letter

Dear______________________________

You are invited to participate in the research project *Inuit knowledge about polar bear health for the Davis Strait polar bear population*. The main goal of our project is to document Inuit knowledge about polar bear health, abundance and distribution to support management decisions for the Davis Strait polar bear population. This research has potential to assist your community in communicating Inuit perspectives on polar bear health and hunting.

The project is being conducted by Environment and Climate Change Canada and the Government of Nunavut, Department of Environment. This research is supported by local HTOs in Iqaluit, Kimmirut and Pangnirtung. It is also partly funded by the Nunavut Wildlife Management Board.

Procedures

To fully participate in an interview, you will need to provide approximately two hour(s) of your time. The discussion will be audio recorded, photographed, and notes will be taken. We will be meeting at _______________________ on ________________ at ___________.

You will offered the amount of $__________ for your participation in the interview. Light refreshments and snacks will be provided.

The information and opinions that you share during the interview will be included in the results of this project and will be shared publicly in the form of reports, publications, or related project outputs (e.g., maps, posters, presentations, news items, postings on the internet). During analysis of the interviews, original audio, photo, transcript, and/or map recordings will be securely stored at both Matilde Tomaselli and Dominique Henri's offices. Following analysis, with your permission, this information will also be stored in this community and made publicly accessible for heritage, education or research purposes.

Contact information

If you have any questions or concerns about this project, or the consent you have provided, please contact Matilde Tomaselli, Dominique Henri or your local HTO.

Matilde Tomaselli (Lead Researcher)
Polar Knowledge Canada
matilde.tomaselli@polar.gc.ca
CHARS campus, Cambridge Bay, NU
(867) 391-0056

Dominique Henri (Project Leader)
Environment and Climate Change Canada
dominique.henri@canada.ca
105 McGill Street, 7th Floor, Montreal, QC
(514) 496-9024

Thank you for your participation!

Consent Form

I have received the invitation/information letter that goes along with this consent form. I understand the interview will be audio recorded, and that photographs will be taken with my permission. I understand that the information I share during the interview will be used by the research team in reports and publications related to this project.

I have been fully informed of the objectives of this project. I understand these objectives and consent to being interviewed for the project. I understand that steps will be undertaken to ensure that this interview will remain confidential unless I consent to being identified. I also understand that, if I wish to withdraw from the study, I may do so without any repercussions. However, withdrawal from this study cannot happen after publication of the information documented through this project.

I would like my name and the information I provide used as follows (please tick four boxes):

- ☐ I want to be identified by name, image and/or voice in research findings, reports and publications related to this project.
- ☐ I wish to remain anonymous. My name, image or voice will not be used in communicating the finding of this study.

- ☐ I want to provide a brief personal biography to the research team and I give permission for it to be included in any reports and publications related to this project.
- ☐ I DO NOT want to provide a brief personal biography to the research team.

- ☐ I want to provide a photograph of myself to the research team and I give permission for it to be included in any reports and publications related to this project.
- ☐ I DO NOT want to provide a photograph of myself to the research team.

- ☐ I want my original audio, photo, transcript, and/or map recordings to be publicly accessible and stored for future use in this community for heritage, education or research purposes.
- ☐ I DO NOT want my original audio, photo, transcript, and/or map recordings to be publicly accessible.

Participant consent: ____(print name)

____(sign name)

Verbal consent, check here: ☐

Date(s) of consent: ____

Witness signature: ____

APPENDIX 4. Interview guide – individual interviews

Questions included in the interview guide were designed with the primary objective of collecting robust information that can (a) help understand polar bear health over time within the study area, (b) complement existing scientific information, and (c) allow for comparisons with other traditional knowledge studies conducted on polar bears for the Davis Strait subpopulation.

Interview questions were co-developed among project team members. Feedback and input was also provided by other polar bear researchers with the intent of making this project relevant for a wide range of stakeholders.

It is important to note that the interview guide was used as a flexible support tool. Themes were explored with contributors in such a way that their narrative guided the interview. Interviews were also customized to capitalize on the experience of contributors. Contributors could add or skip topics depending on their expertise.

The abridged version of the interview guide is presented below.

SECTION 1. PROJECT INFORMATION

Project intro and team introduction.

SECTION 2. GENERAL INFORMATION AND LIFE HISTORY

2(1) Personal information.

SECTION 3. CULTURAL SIGNIFICANCE OF POLAR BEARS

3(1) Are polar bears important to you? Why?

3(2) What have you used polar bears for throughout your lifetime?

SECTION 4. EXPERIENCE WITH POLAR BEAR HUNTING AND LAND USE

4(1) Have you ever hunted polar bears or participated in a polar bear hunt?

4(2) Apart from hunting polar bears, have you done any activities that allow you to see polar bears?

4(3) Can you show us on the map the area(s) of land and ocean where you regularly travel to and you are most familiar with (no matter if it is for hunting polar bears or other activities such as fishing, seal hunting, egg picking or camping)? Can you tell us when do you do these activities over the different seasons?

SECTION 5. POLAR BEAR HEALTH AND ECOLOGY

5(1) How do you know that a polar bear is in a good shape or healthy?

5(2) In your opinion, what are the types of things you look for to know that polar bears are doing well? (i.e., what factors make polar bears healthy)

5(3) Do you think that polar bears around this community are doing well or are healthy?

5(5) Can you describe what polar bears do and where they are at different times of year?

5(6) Are you seeing any changes in what polar bears do and where polar bears travel now compared to the past?

5(7) Over the time you have spent in this community, has the number of polar bears changed (increased, decreased or remained the same) according to your observations?

5(8) Over the last 10 years, has the number of polar bears changed (increased, decreased or remained the same) according to your observations?

5(9) Do you see the same number of cubs, young and adult polar bears as in the past?

5(10) Do you think that the number or size of the family groups have changed from the past?

5(11) Where do polar bears den and why do they go there? Can you show us on the map where you have seen dens?

5(12) Have you observed any changes in dens?

5(13) Have you observed changes in how many cubs female polar bears have compared to the past?

5(14) Have you observed changes in how many cubs survive after their first years?

5(15) Have you observed any changes in how polar bears behave in the mating season?

5(16) How do you know if a polar bear is fat or skinny (assess fatness)? Are the polar bears that you see/hunt now are as fat as the polar bears you saw/hunted in the past?

5(17) Over the time you spent in this community and surrounding area, have you observed any changes in the behaviour of polar bears?

5(18) Can you describe what polar bears eat (their diet)?

5(19) Do you see differences between what males and females eat? Between adult bears and younger bears?

5(20) Have you noticed any changes in what/where polar bears eat now compared to the past?

5(21) Have you noticed any changes in the number or health of the animals that polar bear eat?

5(22) Have you ever seen polar bears eating other polar bears? Do you see it more or less now than in the past?

5(23) What makes a good polar bear habitat (or place to live)? Why?

5(24) Have you noticed any changes in polar bear habitat?

5(25) How would you describe a sick bear? Have you ever seen a sick bear?

5(26)* Have you ever seen anything strange in the polar bears that you have observed or hunted so far?

5(27) Have you ever seen a dead polar bear which had not been intentionally harvested?

5(28) Apart from hunting, are there any other causes of death for polar bears that you know of?

5(29) Have you seen any other changes related to polar bears that you would like to talk about?

SECTION 6. GENERAL CONCERNS ABOUT POLAR BEARS

6(1) Do you have any concerns related to the polar bears around this community?

SECTION 7. MANAGEMENT AND COMMUNICATION

7(1) What do you think about the current polar bear management system?

7(2) Are there traditional ways (values/practices) about harvesting bears? Are these still being used since quotas came in?

7(3) Do you think polar bear population boundaries for the Davis Strait population accurately represent polar bear movements in this region?

7(4) Have you received information from scientists who conduct research about polar bears?

7(5) How do you think the future looks like for polar bears and people?

SECTION 8. FINAL QUESTIONS

8(1) Is there anything else that you think is important and that you want to tell us about polar bears?

8(2) Who else in the community is knowledgeable about polar bears?

8(3) If you were interviewing other Nunavummiut about polar bear, is there a question you would ask them that you are curious about?

8(4) That is all the questions we have for you. Do you have any questions for us?

SECTION 9. CONCLUSION

Thank-you note, honorarium and other.

*Pictures used to probe on observations of lesions and abnormalities for question 5(26).

Alopecia or hair loss on body – Example 1

From:

Atwood et al. 2015. Prevalence and spatio-temporal variation of an alopecia syndrome in polar bears (*Ursus maritimus*) of the southern Beaufort Sea. *Journal of wildlife diseases* 51(1): 48-59. https://doi.org/10.7589/2013-11-301

Alopecia or hair loss on face – Example 2

From:

USGS Technical Announcement: Polar Bears in Alaska Observed wtih Patchy Hair Loss and other Skin Lesions. http://www.north-slope.org/departments/wildlife-management/studies-and-research-projects/polar-bears/polar-bear-health

Hair loss, overgrown skin and bloody lesions on the paws – Example 3

From:

Communication prepared by the Department of Environment of the Government of Nunavut posted at the Amarok Hunters and Trappers Organization, Iqaluit, NU.

APPENDIX 5. Participatory exercises – group interviews

Group interviews were performed after individual interviews and were designed with intent to: (1) corroborate and refine qualitative information documented though individual interviews; and (2) document complementary quantitative information to improve the assessment of polar bear health and interpret IQ in context.

A series of participatory exercises was designed using methods and techniques from the participatory epidemiology tradition and adapted to the wildlife research context (see Mariner and Paskin 2000; Tomaselli et al. 2018). Various themes were explored through participatory exercises (Table 1S). Here we provide a description of the main exercises and techniques used during group interviews (for more information on participatory epidemiology methods see references provided above). Proportional piling was one participatory exercise that was utilized – either alone or in combination with other types of exercises– to generate quantitative information (Figure 1S and Table 1S).

Table 1S. Themes discussed and associated participatory exercises employed during group interviews conducted in Kimmirut.

Themes	Associated participatory exercises
Participants' range of direct observations and travel intensity	Mapping exercises
Polar bear relative distribution	Proportional piling & mapping exercises
Polar bear relative abundance	Proportional piling, drawing & temporal line exercises
Seal relative abundance	Proportional piling, drawing & temporal line exercises
Polar bear cub productivity and survival	Proportional piling exercises with visual cues
Polar bear body condition (fatness)	Proportional piling exercises with visual cues
Polar bear general health	Proportional piling exercises
Polar bear diet	Proportional piling exercises & seasonal calendar with visual cues

In general, participatory exercises were performed by all participants from a group with the objective of collaboratively 'solving' the exercise, reaching consensus and providing a common answer when possible. Mapping exercises designed to explore the geographic range of participants' direct observations were the only exercises performed individually. Importantly, quantitative results generated by combining information provided by each group were validated with study contributors in feedback sessions to ensure sure summary results accurately reflected participants' observations.

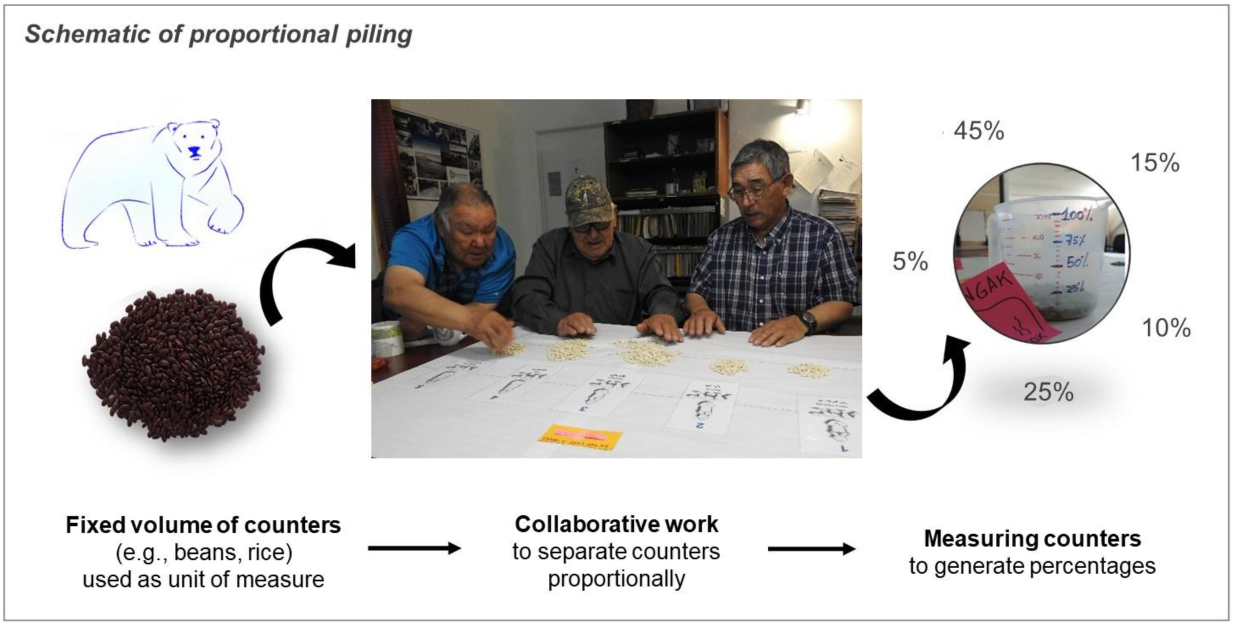


Figure 1S. Schematic of the proportional piling technique. One group of participants (from left to right: Mikidjuk Kolola, Sandy Akavak, Joannie Ikkidluak) solving together a participatory exercise on polar bear body condition using the proportional piling technique. A fixed volume of counters (0.5 kg of beans) was used to generate proportions. Beans were then measured using a measuring cup to generate percentages. When proportional piling was used in combination with mapping exercises (i.e., polar bear relative distribution exercises), a smaller counter (rice) was used to account for map size. Grains of rice were counted manually to generate percentages. Figure adapted from Tomaselli et al. 2018 (Appendix B).

Participants' range of direct observations and travel intensity – mapping exercises

First, we determined the spatial extent of the ecological observations of group interview contributors (or 'range of direct observations') over four predetermined time periods: (1) during the 1960s; (2) during the 1990s; (3) around 2005; and (4) over the last three years (2016-2019). These time periods were used to optimize complementarity and comparability with scientific data available for the Davis Strait polar bear subpopulation. For each time period (as applicable depending on contributors' age), individual participants were asked to draw on a topographic map the areas or routes they had regularly travelled through. A maximum of four hand-drawn maps were generated per contributor, representing the temporal evolution of individual travel habits or areas of observations (Figure 2S). Hand-drawn maps were then transposed in QGIS and ArcGIS and combined for each group and time period to create maps representing: (1) the geographic range of direct ecological observations for all participants interviewed; and (2) travel intensity within this range (see Figure 7).

We note that maps representing the range of direct ecological observations of individual contributors were also obtained during individual interviews. Individual interviews maps were combined with group interview maps to display the overall 'range of direct observations' (see Figure 6) which provides the spatial context for interpretation of the information documented through this study.

Figure 2S. Example of hand-drawn maps representing the geographic range of direct observations for three group interview participants over three time periods.

Polar bear relative distribution – proportional piling & mapping exercises

For each group of participants, hand-drawn maps representing the geographic range of participants' direct observations were produced. This information provided the basis for determining polar bear relative distribution using proportional piling exercises conducted collaboratively by each group. Counters (grains of rice) were used to represent polar bears. Participants were free to determine the total number of counters to use for each exercise but had to place them on a topographic map in a proportional way, such that more counters corresponded to more observations of polar bears. A maximum of four maps were generated per group, representing the temporal evolution of polar bear relative distribution within participants' range of observations and providing insights into differences in polar bear relative density at different locations (Figure 3S).

After the exercises were completed, maps were photographed, and grains of rice used in each map were counted manually so that proportions could be drawn. Maps were transposed in QGIS and ArcGIS and counters substituted with data points. For each time period, final polar bear relative distribution maps were produced in ArcGIS using the kernel density estimation method (see Figure 13). By having the 'range of direct observations' clearly delineated for each group of participants within our distribution maps, we were able to account for differences in observations across groups. In particular, we were able to discriminate between areas where polar bears were not observed (corresponding to zero number of counters) versus areas where participants did not go (corresponding to data not available) (see Martinez-Levasseur et al. 2017).

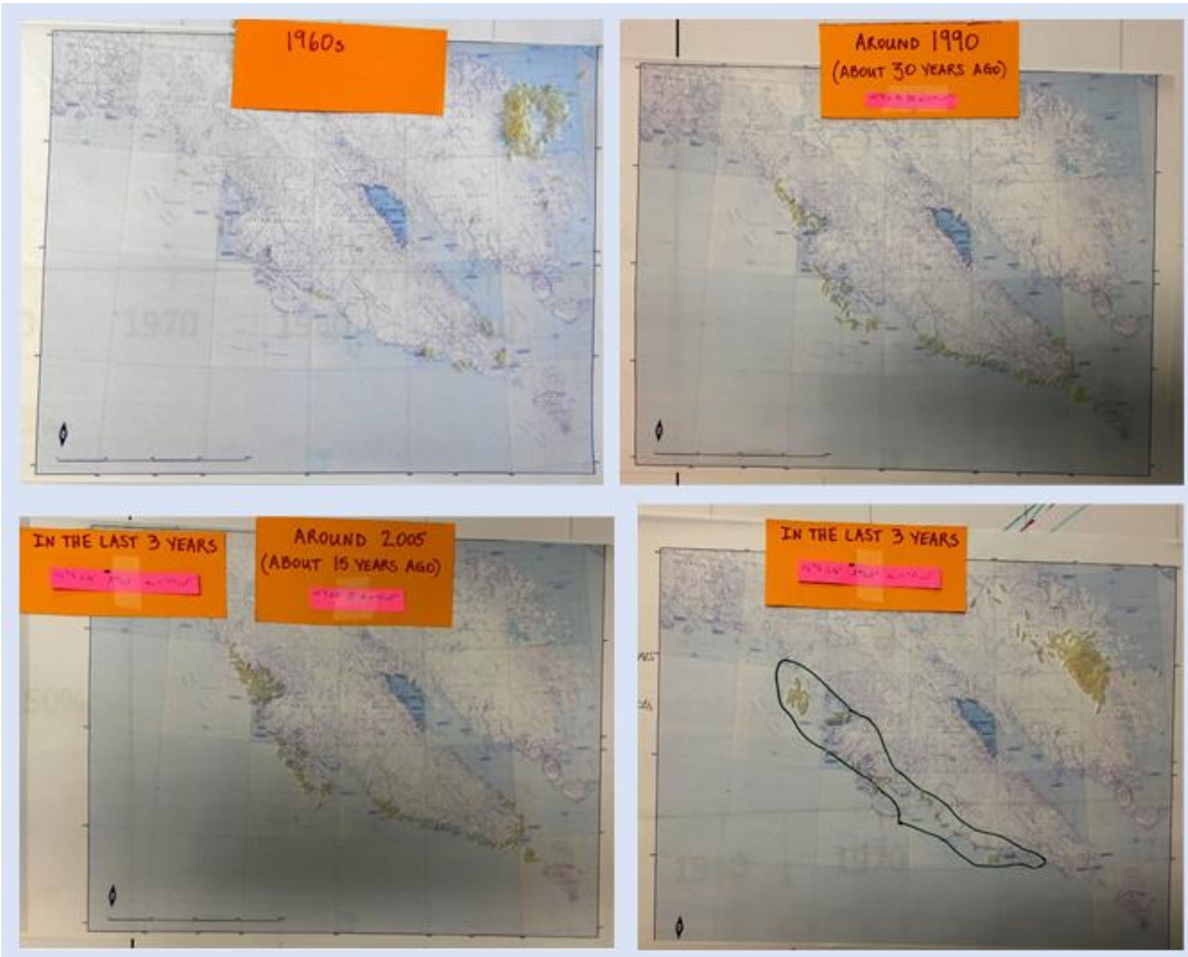


Figure 3S. Examples of polar bear relative distribution maps generated during group interviews. The last map of the set (bottom right corner) also shows the geographic ‘range of direct observations’ of a group marked as a polygon. The piles of rice on the top right corner of the first and last maps correspond to unused grains of rice, while in the second and third maps all the rice provided (100 grains) was used to complete the exercise.

Polar bear and seal relative abundance – proportional piling, drawing & temporal line exercises

Contributors expressed changes in the relative abundance of polar bears and seals they had observed over their lifetime by drawing a trend line along a timeline which was modified according to participants’ age and experience on the land (Figure 4S, A). Proportional piling was used in combination to the drawing exercise to corroborate results or facilitate the execution of the exercise as needed. Through discussions, participants from each group reached consensus on the relative proportion of polar bears they had observed over specific time periods. Data points were extrapolated from the final graphs drawn by each group. To summarize results, group values were then averaged generating trend lines representing the relative abundance of the local polar bear and seal populations.

Polar bear cub productivity and survival – proportional piling exercises with visual cues

In this study, cub productivity and cub survival were estimated using the indicators 'COY litter size' (number of cubs-of-the-year per female) and 'yearling litter size' (number of yearlings per female) assessed over the same time periods.

Proportional piling exercises were repeated for three time periods (during the 1990s, around 2005, and over the last three years [2016-2019]) in order for participants to express any changes in cub productivity and survival observed over time. For each time period, two separate series of exercises were conducted: one for family groups with COYs to assess the relative proportion of cubs produced per females and one for family groups with yearlings to assess the relative proportion of cubs that survived their first year (Figure 4S, B). For each exercise, contributors divided fixed volume of beans to represent the relative proportions of polar bear females observed with one, two or three COYs, or one, two or three yearlings.

For clarity, pictures were used throughout the exercises to ensure consistency of responses as we found no direct equivalence between Inuktitut and English terms to describe polar bear age classes (see Appendix 6 for Inuktitut polar bear terminology).

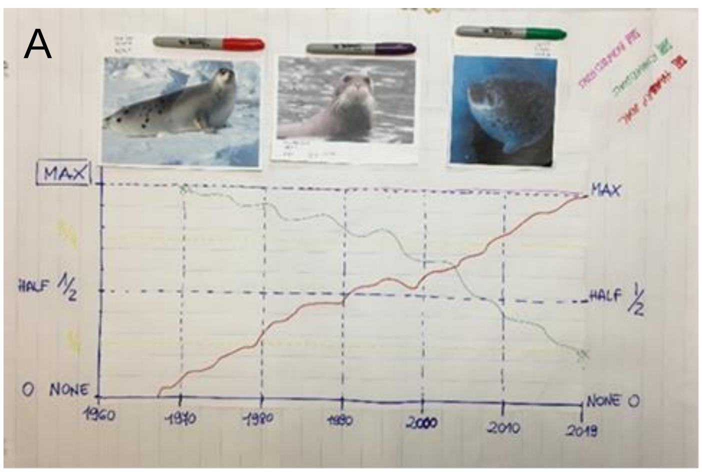


Figure 4S. A: Example of a relative abundance exercise for ringed, bearded and harp seals. B: Example of a proportional piling exercise to explore cub productivity measured using the indicator 'COY litter size'.

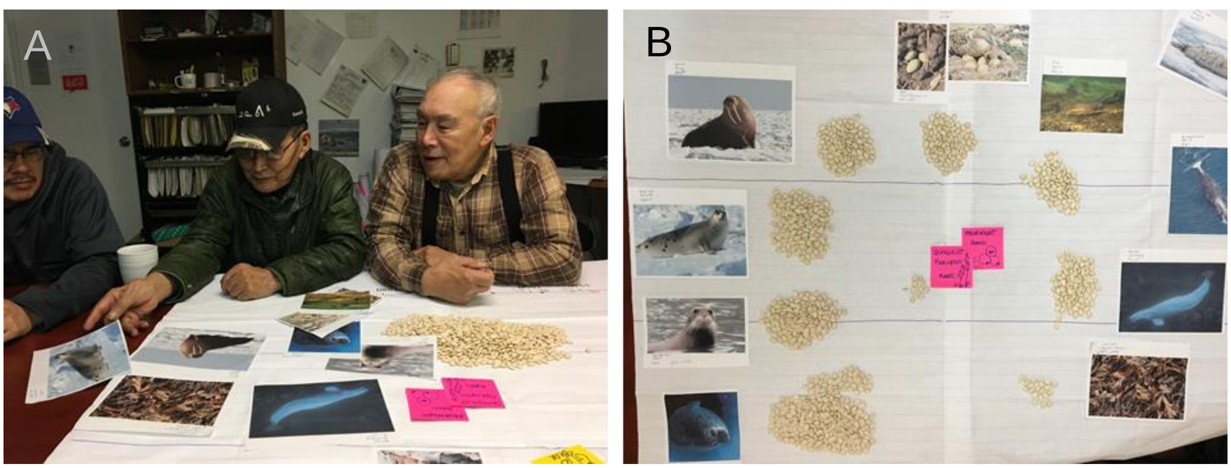
Polar bear body condition (fatness) and general health assessment – proportional piling exercises with visual cues

Contributors expressed the relative proportion of polar bears they had observed per five body condition types ('very skinny', 'skinny', 'average', 'fat', 'very fat') using a fixed volume of beans. Through discussions, each group reached consensus on the proportion of beans to allocate under each body condition type. The exercise was repeated for three time periods (during the 1990s, around 2005, and over the last three years [2016-2019]) in order for participants to express any changes observed over time. Polar bear pictures used to illustrate body condition types were the ones employed as part of the Government of Nunavut polar bear harvest monitoring program; most contributors were therefore familiar with pictures used.

For each time period, proportional piling exercises were also used to determine the relative proportion of ‘healthy’ vs ‘unhealthy’ polar bears. Through discussion, each group reached consensus on the proportion of beans to allocate under each category. Beans were then measured to generate percentages.

Polar bear diet – proportional piling exercises & seasonal calendar with visual cues

For this exercise, participants had to first select preys or diet items they considered relevant for polar bears from a selection of pictures provided. Contributors could also add additional items that were not available in picture format by writing them on post-it notes. After a list of polar bear diet items was finalized, participants collaborated to express the relative proportion of each item in the annual polar bear diet by dividing a fixed volume of beans (Figure 5S). Due to time constraints, this exercise was not repeated for different time periods; however, qualitative information on changes in polar bear diet was documented by asking participants whether the relative proportion of each item had significantly changed over time. Finally, a seasonal calendar exercise was utilized to explore the seasonal availability of prey or diet items for polar bears (Figure 5S, C). During the exercise, qualitative information on changes observed in different wildlife species were also documented.



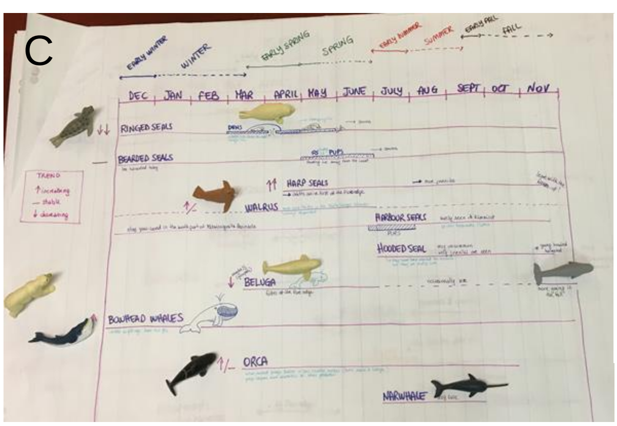


Figure 5S. A: Eliyah Padluq (centre) selecting polar bear diet items with Jawlie Akavak (right) and Padloo Pitsiulak (left, community researcher). B: Example of a completed proportional piling exercise representing the relative proportion of diet items in the annual polar bear diet. C: Example of a seasonal calendar exercise representing the seasonal availability of polar bear preys as well as the seasonal presence of marine wildlife species around the Kimmirut area.

APPENDIX 6. Glossary – Inuktitut polar bear terminology

Table 2S includes some Inuktitut terms employed by interview contributors to describe polar bears of various age and sex classes. The terms presented are by no means exhaustive. 'K' refers to terms in use in Kimmirut and 'P' to terms used in Pangnirtung.

Table 2S. Inuktitut polar bear terminology.

Inuktitut term	Description
Term related to life stage	
K/P – Atiqtalaaq	Smallest cub (new born); first period outside of the den; it is implied that female is present.
K/P – Atiqtaq	Cub of the year; it is implied that female is present.
P – Atiqtaminiq	Young bear without its mother; either female or male; young bear which is not as small as *atiqtaq.*
P – Avinnaaku	A cub who is alone but that should be with its mother.
K – Nalimutigik K/P – Naliqtigik	Cub that is the same size as its mother; grown cub; either male or female; it is implied that female is present.
P – Nukatugaq, akunaqijuq	Juvenile bear; either male or female.
K – Kakiraq	Juvenile or young adult bear (intermediate age) with white clean fur; either male or female; tends to be aggressive.
K/P – Nukauq	Adult male but smaller than *angujuaq.*; adult male which is not fully grown.
K/P – Angujuaq	Big adult male bear (with long neck).
K – Arnaq / P – Arnaluk	Female.
P – Atiqtalik	Female with cubs.
K – Atausilik	Female with one cub.
K – Marruulik	Female with two cubs.
K – Pingasulik	Female with three cubs.
P – Atiqtaituq	Female without cubs; female which did not get pregnant, lost cubs or is too old to have cubs.
Term related to morphological characteristics	
K – Salluminaaluk / P – Angusuiq	Skinny bear.
K – Qunijuminaapik	Nice fat bear.
K/P – Tulajuituq	Very big polar bear that rarely comes on land and stays at sea; grey fur on back; long fur on front legs; biggest adult male.
P – Tigagutilik	Bear with long fur on front legs.

APPENDIX 7. Mortality, disease and abnormal occurrences

Table 3S. Direct and indirect observations of non-hunting related mortality of polar bears documented though interviews in Kimmirut and Pangnirtung (n=35), including description of occurrences by participants and possible explanation for what was observed. NA: information is not available.

Timing	Description of occurrence	Contributor
2019	One juvenile male found dead, floating in the water with a severe trauma on the head (either cause of death or happened after death). He skinned the bear and provided hide and samples to the wildlife officer. Direct observation made in summer.	Interviewee 01, Group 4, Kimmirut
2005	One adult found dead, possibly from starvation. Direct observation made in summer.	Interviewee 11, Kimmirut
1990s	One adult found dead, possibly from starvation or old age. Direct observation made in spring along the shore of White Strait.	Interviewee 13, Kimmirut
1960s	One cub found dead, partly scavenged. Direct observation.	Interviewee 12, Kimmirut
Long time ago	One dead polar bear found at the end of the Meta Incognita Peninsula. Observation reported by an Elder long time ago.	Interviewee 02, Kimmirut
2017	One dead polar bear *"a fair size animal not a cub"* observed in the water. Direct observation made in the summer.	Interviewee 06, Pangnirtung
Known in the past but increasingly observed since early 2000s and the past 5 years	Two females (possibly more) killed by males while protecting their cubs. Direct observations (one occurrence also referenced by Interviewee 08), inference by observing lone cubs, and knowledge shared by Elders.	Interviewee 06, Pangnirtung
2015	One juvenile male polar bear found dead in the water close to shore in the upper Cumberland Sound. Observation made around May by a relative.	Interviewee 05, Pangnirtung
2013	One polar bear eating another polar bear. Observations made by other hunters (event referenced also by interviewee 06).	Interviewee 08, Pangnirtung
Early 1990s	One big male washed up ashore close to Qikiqtarjuaq. Direct observation in spring. One yearling killed and partly eaten by another polar bear. Direct observation made in the fall. One adult killed by an avalanche. Observation made by a relative.	Interviewee 07, Pangnirtung

Timing	Description of occurrence	Contributor
NA	One polar bear carcass found on the land. The carcass was very old since the bones were clean and white. Direct observation.	Interviewee 01, Pangnirtung
NA	One polar bear found dead with a whole in the head, possibly due to attack by another polar bear. Observation made by another hunter.	Interviewee 01, Pangnirtung
NA	One dead polar bear eaten by another polar bear. Direct observation made on Kekertukdjuak Island.	Interviewee 02, Pangnirtung
NA	One polar bear carcass found on the land. The carcass was very old since the bones were clean and white. Observation made by relatives.	Interviewee 05, Pangnirtung
NA	One dead polar bear found in walrus gathering area, possibly due to attack by another polar bear. Direct observation.	Interviewee 14, Pangnirtung

Table 4S. Direct and indirect observations of 'very skinny' or starving polar bears documented though interviews in Kimmirut and Pangnirtung (n=35), including timing and description of occurrences with possible explanation provided by participants. NA: information is not available.

Timing	Description of occurrence	Contributor
2014-2015	One starving and *"dying"* bear observed in the community and one very hungry, and possibly starving, polar bear observed close to the community. Direct observations.	Interviewee 07, Kimmirut
2012	One sub-adult looking severely skinny and dizzy (possibly due to starvation) with no fur loss. Direct observation.	Interviewee 12, Kimmirut
Early 2000s	One starving adult female that was very weak with *"only skin and bones and sunk in the snow"*. Direct observation.	Interviewee 02, Kimmirut
1990s onward	A few sick skinny polar bears observed since he has been an active hunter (from the 1990s onward). Direct observations.	Interviewee 02, Group 4, Kimmirut
1979	One very skinny or starving polar bear. Direct observation made during hide processing (first hide she ever cleaned).	Interviewee 04, Kimmirut
NA	A few very skinny polar bears observed, likely from sickness or starvation in all his time traveling on the land. Direct observations.	Interviewee 05, Kimmirut
NA	Very skinny polar bears observed about six times over the last 40 years. Direct observations.	Interviewee 11, Kimmirut
NA	One starving female polar bear.	Interviewee 01, Group 1, Kimmirut
NA	Starving polar bears described as *"polar bears that died"*. Stories reported from Elders.	Interviewee 08, Kimmirut
2015	One very skinny adult possibly because of old age. Direct observation in the winter.	Interviewee 14, Pangnirtung
Around 2010	One very skinny male hunted close to the community in the summer. Direct observation.	Interviewee 10, Pangnirtung
Early 2000s	One very skinny adult male. Direct observation made around March in the upper Cumberland Sound.	Interviewee 08, Pangnirtung
1990s	One big adult polar bear very skinny possibly because of old age. Direct observation.	Interviewee 03, Pangnirtung

Timing	Description of occurrence	Contributor
1950s onward	Some very skinny, slow moving polar bears looking sick. Direct observation made in summer.	Interviewee 01, Pangnirtung
1980s onward	Some very skinny starving polar bears, generally juveniles, barely moving. Direct observation made mostly during summer months.	Interviewee 02, Pangnirtung
NA	One very skinny adult “*just covered with skin”*. Direct observation in the summer.	Interviewee 06, Pangnirtung
NA	Some very skinny bears observed. Direct observation.	Interviewee 09, Pangnirtung

Table 5S. Direct and indirect observations of minor fur loss lesions in polar bears from the Kimmirut and Pangnirtung areas documented through interviews (n=35), including timing and description of occurrences with possible explanation provided by participants. These observations were not consistent with fur loss pictures used for probing (see interview guide, Appendix 4) and were considered normal occurrences by contributors. NA: information is not available.

Timing	Description of occurrence	Contributor
2019	One harvested female *"looking nice and healthy"* with small fur less area on one foot (3 cm in diameter). Direct observation.	Interviewee 09, Kimmirut
2010s	One harvested male with small furless spot (a few cm wide) on the top of the neck right behind the head. The area was small so that she was able to patch the hide. Direct observation made during hide processing.	Interviewee 03, Kimmirut
2010	One harvested male with scars, likely caused by fighting with other polar bears or breaking through the ice. Direct observation.	Interviewee 07, Kimmirut
NA	One harvested polar bear with small fur loss in some areas of the feet. Direct observation made during hide processing. Observation is not recent.	Interviewee 01, Kimmirut
NA	Many harvested males with scars around the neck, likely due to fighting with other bears during mating season. Direct observation made during hide processing.	Interviewee 03, Kimmirut
NA	Many harvested polar bears with small loss of hair on their hides likely the results of scars. Direct observation made during hide processing.	Interviewee 04, Kimmirut
2010 onward	Some harvested polar bears (mainly males) with scratches usually around the head and neck, likely due to fighting with other bears during mating seasons. Direct observation made during hide processing.	Interviewee 12, Pangnirtung
1990s-2000s	One harvested male with fur loss (small spots) and scaring, likely due to fighting with other bears during mating season. Direct observation.	Interviewee 04, Pangnirtung
Mid-1995	Two males with marks on the snout and open wounds, caused by fighting during mating season. Direct observation.	Interviewee 08, Pangnirtung
NA	Many polar bears observed with scars likely caused by fighting with other bears or hunting on the ice and considered a normal occurrence. Direct observation.	Interviewee 06, Pangnirtung
NA	A few polar bears, mainly males, observed with small fur loss areas on the neck or body, possibly caused by ice when seal hunting and/or fighting with other bears. Direct observation but doesn't remember the timing.	Interviewee 09, Pangnirtung
NA	Polar bears observed with small fur loss, likely due to scratches. Direct observation made during hide processing.	Interviewee 10, Pangnirtung

Table 6S. Direct and indirect observations of anthropogenic waste or plastics in the stomach of harvested polar bears from the Kimmirut and Pangnirtung areas documented though interviews (n=35), including timing and description of occurrences. NA: information is not available.

Timing	Description of occurrence	Contributor
2018	One young sub-adult female harvested at the dump (summer months) with plastic bags in its stomach. Observation made by another hunter.	Interviewee 06, Kimmirut
2015	Two harvested sub-adults with plastic and snowmobile parts found in their stomach, looking healthy otherwise. Direct observation close to his camp.	Interviewee 02, Kimmirut
2010 onwards	Some harvested polar bears with garbage (leather gloves and other items) in their stomach. Direct observation.	Interviewee 10, Kimmirut
Recent years	A few polar bears harvested close to the community with garbage in their stomach. Direct observations made recently and also made by other hunters.	Interviewee 05, Kimmirut
NA	Some harvested polar bears found with plastic and garbage in their stomachs. Observations made by other hunters.	Interviewee 07, Kimmirut
Recent years	Some harvested polar bears with food from the dump in their stomachs. Direct observation made recently.	Interviewee 01, Pangnirtung
Recent observation	One polar bear harvested in the Qikiqtarjuaq area found with a t-shirt in its stomach. Observation made by a relative.	Interviewee 07, Pangnirtung

Table 7S. Direct and indirect observations of other abnormalities or unusual events observed in polar bears from the Kimmirut and Pangnirtung areas documented though interviews (n=35), including timing and description of occurrences with possible explanation provided by participants. NA: information is not available.

Timing	Description of occurrence	Contributor
2015	One harvested polar bear (defence kill) quite skinny and with a wound, possibly from gunshot or natural causes. Direct observation.	Interviewee 06, Kimmirut
2011	Male polar bear (eight-footer) with half-white and half-black fur. Direct observation made on Big Island.	Interviewee 13, Kimmirut
2010s	One harvested polar bear with white paws and one harvested bear with a cut on the front paw. Both looked healthy otherwise. Direct observation made during hide processing.	Interviewee 03, Kimmirut
1995	One polar bear with three legs observed running away, otherwise healthy. Direct observation.	Interviewee 12, Kimmirut
Early 1990s	One big polar bear found dead and likely shot: *"It was shot by helicopter or something…it had a huge hole and nobody had that kind of gun [in the community]'*. Direct observation made in summer in the Glenooe Island/Strathcona Island area.	Interviewee 13, Kimmirut
NA	Sometimes harvested polar bears observed with non-healed wounds, likely caused by other polar bears or walrus. Direct observation made during hide processing.	Interviewee 04, Kimmirut
NA	A few harvested polar bears with lip tattoos and ear tags. Direct observation made during hide processing.	Interviewee 04, Kimmirut
1990s	One harvested polar bear with bear fat and skin in stomach (cannibalism). Direct observation.	Interviewee 08, Pangnirtung
1980s	One harvested male that looked somewhat sick with yellowish fur and the skin of the paws quite rough with scratches. Observation made during hide processing.	Interviewee 10, Pangnirtung
NA	One harvested polar bear with ear tag. Direct observation.	Interviewee 14, Pangnirtung

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Polar Knowledge Canada
Savoir polaire Canada

Consultation with Pangnirtung, Amaruq, and Mayukalik Hunters and Trappers Association on Re-estimating the Abundance of the Davis Strait Polar Bear Subpopulation by Genetic Mark-Recapture 2022 Report and the Nunavut Inuit Qaujimajatuqangit on the Health of the Davis Strait Polar Bear Population 2022 Report

May 8, 2023

May 9, 2023

May 11, 2023

Department of Environment
Government of Nunavut
Iqaluit, Nunavut

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Nunavut

Executive Summary

Government of Nunavut (GN), Department of Environment (ENV) representatives conducted in-person consultations with Pangnirtung Hunters and Trappers Association (HTA), Amaruq HTA, and Mayukalik HTA on May 8, May 9, and May 11, 2023, respectively.

The intent of this consultation was to ensure the GN and HTAs could discuss the results of the Re-estimating the Abundance of the Davis Strait Polar Bear Subpopulation (DS) by Genetic Mark-Recapture 2022 Report, led by the GN, and the Nunavut Inuit Qaujimajatuqangit on the Health of the Davis Strait Polar Bear Population 2022 Report, with GN collaboration. The abundance report collected data in 2017-2018 and the *Inuit Qaujimajatuqangit* (IQ) report collected data in 2019. The previous abundance data for DS was collected in 2005-2007. The goals of the consultations and presentations were to provide co-management partners with an overview of the results of the reports, collect feedback on the results presented, collect additional IQ, and to discuss the ENV harvest recommendation.

Polar bear biologists met with each community's respective HTA that hunts from the DS subpopulation.

Support for ENV's harvest recommendation ranged from enthusiastic support to less involved participation. At the end of the consultation, HTAs were left with questions to discuss and send their feedback to ENV.

The feedback and IQ collected during these consultations will be considered when forming Total Allowable Harvest (TAH) recommendations for the DS 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.

Preface

This report represents the Department of Environment's best efforts to accurately capture all of the information that was shared during consultation meetings with the Hunters and Trappers Associations of Pangnirtung, Iqaluit, and Kimmirut on May 8, May 9, and May 11, 2023, respectively.

The views expressed herein do not necessarily reflect those of the Department of Environment, or the Government of Nunavut.

Table of Contents

1.0 Report Purpose and Structure

This report is intended to collate and summarize comments, questions, concerns and suggestions provided by the Pangnirtung HTA, Amaruq HTA, and Mayukalik HTA regarding the results of the Re-estimating the Abundance of the Davis Strait Polar Bear Subpopulation by Genetic Mark-Recapture 2022 Report, led by the GN, and the Nunavut Inuit Qaujimajatuqangit (IQ) on the Health of the Davis Strait Polar Bear Population 2022 Report, with collaboration from the GN.

Representatives from the Department of Environment (GN) attended the consultation along with other co-management partners and interested parties.

2.0 Purpose of Consultation

The purpose of the consultation was to discuss the newest scientific and IQ information regarding the DS polar bear subpopulation as reported in the GN scientific study report and the IQ report, both in part produced by 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 evenings and ran for approximately 2 - 3 hours. Government of Nunavut Polar Bear Biologist, Alyssa Bohart, Associate Deputy Minister, Jason Aliqatuqtuq, and Senior Wildlife Advisor, Jonathan Pynn, facilitated and led the meetings. Each presentation started with opening remarks from A. Bohart, J. Pynn, and J. Aliqatuqtuq on who they are and what organization they are representing as well as the purpose of the consultation. This was followed by a PowerPoint presentation with historic management background, and a detailed overview of the results from the 2017-2018 polar bear abundance study and 2019 IQ study conducted in DS (Appendix 1). The participants were invited to ask questions, raise concerns, or provide recommendations throughout the meetings. At the end of the meeting, the GN position on the TAH for DS was presented. After the presentations, questions/discussion continued until no further questions were raised, or until the HTAs adjourned the meeting. HTAs were left with discussion questions regarding the studies and DS management objectives from ENV to internally discuss and send responses to ENV. The Pangnirtung and Amaruq HTAs expressed support at the end of the meeting for the recommended TAH.

3.0 Summary of Consultations

This summary combines the general themes and ideas generated from the three HTAs. For specific commentary and participants in each consultation, please see Appendix A.

Comments and questions:

- HTAs expressed general support for the proposed TAH recommendation or did not comment at the time.
- HTAs reported decreased polar bear harvest in DS was due to low hide prices.
- HTAs reported concerns about the increase of bears since the 1970s and risks to public safety.
- HTAs expressed that they would like more collaboration in future studies.

Appendix A

Davis Strait Polar Bear Abundance and IQ Reports Consultation Meeting Notes

Location: Pangnirtung HTA office
Date/Time: May 8, 2023
Start time: 19:00
End time: 22:42

Participants
Mark Kilabuk (HTA Manager)
Simeonie Keenainak (HTA Chairperson)
Billy Etuangat (HTA Vice-Chairperson)
Kelly Kilabuk (HTA Secretary-Treasurer)
Lazarusie Ishulutuq
Patrick Kilabuk
Jaco Ishulutuq
George Qaqqasiq
Manasie Maniapik
Alyssa Bohart, Polar Bear Biologist, GN ENV
Jason Aliqatuqtuq, Associate Deputy Minister, GN ENV
Jonathan Pynn, Senior Wildlife Advisor, GN ENV
Dominique Henri, Research Scientist, Environment and Climate Change Canada – call-in
Denis Ndeloh, Director of Wildlife Management, Nunavut Wildlife Management Board
Michael Ferguson, Director of Wildlife and Environment, Qikiqtaaluk Wildlife Board
Margaret Qumuatuq, Translator

Goal of meeting:

Provide an overview of the newest scientific and IQ information regarding the DS polar bear subpopulation as reported in the GN scientific study report and the IQ report. Discuss the GN TAH recommendation. Discuss any questions HTA has for both studies. Collect feedback and IQ on DS management.

Next Steps and Action Items:

Short term Action Items (within 4-6 weeks):

- **Jaco** asked: Do you biopsy mothers or cubs or both?
- **Mike**: Questions about the graph. 2017-2018 what is the exact number from those graphs?
- Email HTAs the harvest management questions.

The Department is looking into questions and concerns raised during the consultations and are working to resolve them.

Longer term Action Items (next 2-3 months):

- NA

Meeting Notes:

Question to Group after Introductions:

The meeting began with introduction of participants. **Alyssa Bohart** presented slide show with background on the transition at the GN polar bear research group due to the loss of biologist Markus Dyck. She then presented an overview of the polar bear study process including the planning stages up to when a TAH management decision is accepted by the minister and harvest tags are distributed to communities. She then noted that the purpose of this meeting was to provide a summary of the results from the abundance and IQ study and to hear HTA feedback.

Abundance study background slides: Review

- **Kelly**: Why the decision was made to not cover the same area that was covered in the 1970s, just to do a comparison?
- **Alyssa**: So my understanding of it is that in the 1970s, they didn't cover some of the areas that were covered in the 2005-2007 survey. I know in the 1970s, they found a pretty low estimate and then in the 1990s survey, it showed a doubling of the population. So we really don't compare to the 1970s because now we are able to cover more area and the methods have improved to get a better estimate.
- **Lazarusie**: I want to comment on the 1960s. Back in the 1960s you didn't see polar bears even when travelling far, across the Cumberland Sound. In the 1980s when caribou were abundant, that's when you really started to see a lot of polar bears. It was like being greeted by many dogs or many people when you reach the land after boating. That is how it is now compared to the 1960s. It's a worrisome matter now and a safety issue. I am very concerned for youth because of the abundancy of the polar bears. I was very close to death last year. My wife luckily saw the polar bear, so therefore we saw the bear before it attacked.
- **Alyssa**: Thank you for sharing.

Abundance study methodology/field work: Review

- **Billy**: Do you mark all bears?

- **Alyssa**: No. We try to mark as many as we can, but there are times, such as females with cubs, that we don't want to mark because it would stress them and we want to avoid that.
- **Jaco**: Can you talk more about cubs? Why don't you mark cubs?
- **Alyssa**: For an example in the Davis Strait area, cubs are often climbing with females near steep areas, so there may be a chance of them falling or being injured. In those situations, we avoid them altogether for the bears safety. I'm not sure if that answers your question?
- **Jason**: I think he is asking do you biopsy mothers or cubs or both?
- **Alyssa**: I'll have to double-check the report, but I think in some cases they will biopsy dart cubs, but not in a dangerous situation. Another example is that if the helicopter has taken awhile to try and get close to the female and they have been running more than 2-3 minutes, they won't biopsy because they don't want the bears to overheat.
- **Jaco**: Thank you for the clarification and I'm sharing of IQ concerns: cubs they are a special category. Because of that, we are told to not play with them, and not to biopsy them. That's been a long Inuit tradition understanding is to not disturb the cubs at any point. It's not something to play around with.
- **Lazarusie**: Before any kind of research was conducted and after research began in the mid 1970s, it started affecting the food. Because they are being researched and they are being darted, to me the food and taste is different. It is affecting the gathering together of a family, of a community. Once it was caught, it would be consumed by everyone and enjoyed thoroughly. But since they are darted and research is having conducted, it has affected the way we eat polar bears. Before I would make stew, but now I do not eat it. It is my choice to not eat it anymore.
- **Alyssa**: Thank you for sharing.

- **Alyssa** stressed we don't handle or drug bears with the biopsy darting. Collects a bit of fur, skin and fat when it falls out.

- **Simeonie**: How many polar bears does your department want to see to be satisfied that there is enough bears?

20:30 – 20:45 Break

Abundance study results & harvest: Review

- **Alyssa**: I don't know exactly what's been done in the past, but at least during this process, we looked at the health of the population. We're not necessarily looking for an exact number of bears per survey. We'll take a number of factors into consideration when we go out for a survey. For this study, we looked several things including the number of bears.
- **Simeonie**: Please understand and know the polar bears as they are now, with the abundancy of polar bears on our environment and our ice, it's a big safety concern. They are putting people in danger, with the abundancy of polar bears in Davis Strait. Please know now that as a polar bear biologist, know these facts that this is a big safety concern. You are teaching bears to not be afraid of humans as they had been. It's becoming more and more that they are not scared of humans at all, so you are putting human lives at risk with the abundancy of polar bear.
- **Alyssa**: Thank you.

- **Jaco**: I would like to know the paper I am holding onto, who are they? (The IQ Summary).

- **Alyssa**: I'm not quite sure of the question.
- It was mutually discovered and discussed by the room participants that they were who participated in the IQ Study.

- **Kelly**: Do you find any carcasses along the way doing the survey?
- **Alyssa**: I don't believe they found any dead bears as it wasn't noted in the report. I don't believe they found any dead bears during this research.
- **Peter**: Do the polar bears live up to 12 years?
- **Alyssa**: Bears can at least live up to 12 years. We use the age we first find them at; then we look at what happens when we find the bears again. Sometimes they've been found to live up to 30 years based on science, but that isn't the norm, based on science.

- **Kelly**: No offspring in some years. Some years with no sub-adults. Did you not see them or not do any biopsies?
- **Alyssa**: This is a bit of a complicated graph. We only collected field data in 2005-2007 and 2017-2018. Otherwise we use what we get from harvest samples. We use simulations to fill in the time periods. The reason we don't have much cub data is because they age up into subadults and adulthood, so we only know of cubs when we collect data and use the simulations to help fill in the information.
- **Jaco**: How about the teeth that are sent for samples? How are they used in research?
- **Alyssa**: We send those for age testing by cutting them and counting growth rings.
- **Mike**: Questions about the graph. 2017-2018 what is the exact number from those graphs?
- **Alyssa**: I don't have the exact numbers but they're in the report and I can send them to you.

- **Mike**: Follow up question. Biologists can't say we don't know how many animals are on the land. I believe Alyssa can say what she believes, but I can't say that. There are some dotted lines on the graph that mean a confidence interval. The confidence intervals don't really show, based on my interpretation of these graphs, that the population decreased. I'm giving you this information as a biologist. I want to point out that the hunters are saying that there are more and more bears. I don't think there is disagreement between biologists, there may be disagreement in the data they are seeing may contradict what hunters are seeing on the land. The science presented is the best that we have but may not be the best that can be done.
- **Alyssa**: I wouldn't compare the science and the IQ. Dominique can provide some of that information when she speaks. The methods aren't confidence intervals, they're credible intervals because it's a Bayesian method. We consider the probability that the population falls in this range. It is important to point out the range and that the numbers can fall somewhere in between these dots, but the chances are highest that the estimate is in the middle, not at the ends. We consider this the most confident and most defendable estimate.
- Abundance is just one thing we looked at. We also looked at the health of the bears and other considerations when we are making management decisions.

- **Mike**: It says there is no quota from Quebec. But then you say these numbers. How confident are you that the Quebec hunters are reporting every harvest.
- **Alyssa**: There is no requirement for reporting in Quebec. They get those numbers from hunters who go to get an export permit. I can't speak to Quebec's management system.

Their scientists, in speaking with them, are pretty confident that the export permits are a good way of tracking Quebec harvest.

- **Lazarusie**: Before the quota system was introduced, hunters could freely hunt bears, but didn't because you didn't see them all the time. Now we can sell the pelts and we get compensated. Today we have no economic value from polar bear hides. Today, we can't even sleep in tents nor igloos anymore because of the abundancy of polar bears. There's a quota, and we can't sell, what do we do now?
- **Alyssa**: That's a really good question. Thank you for your comments. I can't speak to the price of the hides, unfortunately it is not something that we can control. I've heard that the price of hides and other types of fur has decreased in value across the world. I'm hopeful that the prices will eventually go back up and hunters can get money from hides, but that's not within our control and it is definitely an issue we recognize.
- I wanted to show you this graph of DLP kills. There are spikes in some years but generally less than 10 per year since 2000-now.

21:25 – 21:40 Break

Dominique Henri presented slide show with brief background and results on the IQ study. These slides were not reviewed in advance, but done as a separate, but included section. Dominique had met with the HTA Board in March and provided physical copies of the IQ report with the HTA. Dominique presented on some key points from the report and how the findings from the abundance and IQ study fit together to provide a more complete picture of DS polar bears.

IQ study: Review, no questions

Alyssa Bohart presented slide show with the GN TAH recommendation. She gave the HTA Board options to provide answers to discussion questions via email at a later date, but the board could also share initial thoughts within the current meeting.

Questions from presentation:

- Do you agree that the number of polar bears stayed relatively the same over time?
- Are there enough bears to harvest? Are there too few? Too many?
- What did you observe in the bears' body condition over time?
- Is there anything special that you observed and wanted to share with us?
- Where do you agree/disagree with our findings?
- Think about how your HTO would like to manage the Davis Strait subpopulation?

Harvest management and TAH recommendation: Review

- **Denis**: When you look at the actual harvest, the average harvest has been 44 bears per year. So with this below TAH, how does this factor into meeting the management objective to reduce the populations?
- There's a slide that shows there may be interjurisdictional processes. You're also saying there could be other processes. Maybe we can have this discussion after. How does the Government of Nunavut see this moving forward? How does that factor in when we go into the multi-jurisdictional decision-making processes?
- Translator stated she's losing her voice.
- **Simeonie**: Would like to comment that the Pangnirtung residents are happy with the system as it is now. It's working for everyone. If you see a polar bear, you can hunt it. We

follow the guidelines and don't overharvest. The population of Pangnirtung is increasing so you need to factor this into consideration. The Pangnirtung hunters are happy with how the system is now.

- To the researchers so far, this is something that is going to happen now. This is something that will go on maybe forever now, whether it increases or decreases. But we all have to work together. It's for the future and we need to work together.
- **Jason**: Here's an opportunity for western science and Inuit knowledge to be amalgamated. We also have to go meet with two other HTOs. Here's a chance for this HTO to make their voice known. The *Nunavut Agreement* states that Inuit must be given equal opportunity and we all provide that input to the *Nunavut Agreement* to the NWMB as a main instrument who will make that decision.
- **Mike**: For multiple communities that harvest from the same subpopulation, it's the role of the RWO to make a presentation to NWMB on what's in the *Nunavut Agreement* to make a valid conservation purpose for DS polar bears. There's a disagreement between the science and the IQ. Is the rate of the decrease good enough to satisfy the public safety concerns? I'll take what I hear here and the other communities and bring it to NWMB.

Participants were thanked for attending, and their feedback.

22:42 Meeting End

Davis Strait Polar Bear Abundance and IQ Reports Consultation Meeting Notes

Location: Amaruq HTA office
Date/Time: May 9, 2023
Start time: 19:00
End time: 21:42

Participants

Sally Mikijuk (HTA Manager)
Jimmy Akavak (HTA Chairperson)
Noah Alookie (HTA Vice-chairperson)
Adamee Itorcheak (HTA Secretary/Treasurer)
Kathy Hanson
Archie Angnakak
Nash Sagiatook
Jetaloo Kakee
Dinos Tikivik
Alyssa Bohart, Polar Bear Biologist, GN ENV
Jason Aliqatuqtuq, Associate Deputy Minister, GN ENV
Drikus Gissing, Director of Wildlife Research, GN ENV
Dominique Henri, Research Scientist, Environment and Climate Change Canada – video call-in
Denis Ndeloh, Director of Wildlife Management, Nunavut Wildlife Management Board
Bert Dean, Assistant Director, Nunavut Tunngavik Inc.

Michael Ferguson, Director of Wildlife and Environment, Qikiqtaaluk Wildlife Board
Jacopoosie Peter, Translator

Goal of meeting:

Provide an overview of the newest scientific and IQ information regarding the DS polar bear subpopulation as reported in the GN scientific study report and the IQ report. Discuss the GN TAH recommendation. Discuss any questions HTA has for both studies. Collect feedback and IQ on DS management.

Next Steps and Action Items:

Short term Action Items (within 4-6 weeks):

- **Mike**: How many bears were sampled from 2005 – 2007 and from 2017, were they also sampled in 2018? What are those numbers?
- **Jetaloo**: The oldest data is 2005-2007, are you able to report on the older studies? Knowledge of the past?
- **Mike**: 2 Requests – says here during 2017 – 2018 you captured 177 bears, originally captured in 2005/07 this is only my suggestions, this is only a request, I appreciate seeing a map to show where they have been marked. The second map I would like to see is 2017 and recaptured 2018 the one year period, so we can see where the marked bears only. How much movement that took place. Maybe you can send the maps to the HTOs please.
- Email HTAs the harvest management questions.

The Department is looking into questions and concerns raised during the consultations and are working to resolve them.

Longer term Action Items (next 2-3 months):

- NA

Meeting Notes:

Question to Group after Introductions:

The meeting began with introduction of participants. **Alyssa Bohart** presented slide show with background on the transition at the GN polar bear research group due to the loss of biologist Markus Dyck. She then presented an overview of the polar bear study process including the planning stages up to when a TAH management decision is accepted by the minister and harvest tags are distributed to communities. She then noted that the purpose of this meeting was to provide a summary of the results from the abundance and IQ study and to hear HTA feedback.

Abundance study background slides: Review

- **Archie** in reference to the 2005-2007 estimates: the estimates seem to be out-dated. That's 16 years ago in Davis Strait. That was a great loss of that biologist.
- **Alyssa**: I am presenting from 2005-2018 and comparing the old numbers that show the health of the population. This will tell us the health of the population. I will be happy to discuss again after the presentation.

Abundance study methodology/field work: Review

- **Mike Ferguson**: How many bears were sampled from 2005 – 2007 and from 2017, were they also sampled in 2018? What are those numbers?
- **Alyssa**: I do not have those numbers, I will look at those numbers and email them to you. We have the 2005-2007 collar data, new biopsy data, and also harvest samples from hunters. Those are the data we are able to use right now.
- **Jetaloo**: The oldest data is 2005-2007, are you able to report on the older studies? Knowledge of the past?
- **Archie**: I think he was touching up on commercial, baseline information. 2005/07 that history.
- **Alyssa**: I do not know, this is my first time hearing it. I can look into it.
- **Jetaloo**: I was not born in the 1800's. I was born in 1942, used to think that Pangnirtung had no polar bears, only in Cumberland sound. In 1960 moved to Iqaluit, there were bears here in Iqaluit before it became populated. None here to be seen like my ancestors knew about bears, they seem to have no fear of humans when DEW Line came. These elders have a lot of knowledge.
- **Jimmy**: Can you combine Inuit oral history and your studies?
- **Archie**: Inuit Knowledge is included, wildlife is very clear in there. Very valid as far as he is concerned.
- **Jetaloo**: the experts – when does the cubs tooth emerge? Nobody knew, I didn't know.

Abundance study results & harvest: Review

- **Mike** in reference to the survival graph: How did you get those results?
- **Alyssa**: The model will generate all the numbers, it predicts this pattern. It could be similar to how scientist look at climate change.

- **Kathy**: what are the differences between Newfoundland bears and Nunavut bears? How does this pattern model your predictions?
- **Alyssa**: Great questions. There could be differences. I don't have an answer. I think it could tie in with the IQ study. Dominique can answer that question.
- **Jimmy**: Bears numbers in Newfoundland Labrador?
- **Alyssa**: We only have an estimate for bears in Davis Strait as a whole. I'm not sure what local hunters have seen in that area.
- **Mike**: Go back to the slide presentation. Very few in Hopedale.
- (Slideshow reversed)
- **Alyssa:** thank you Mike.
- **Adamee**: 2017 – samples data, does that go to the baseline, where the numbers are, the more you put in, the more you get. Where does the data come from? I understand, doesn't really change, when we go out there we see more.
- **Alyssa**: Are you talking about the sampling you get from hunters?
- **Jetaloo**: IQ, there are more bears, helicopter counts, the quota doesn't change, the money watchers government too obstacle or delays funds, elders are getting a little credit. It seems that it wasn't really listened to.
- **Alyssa**: Thank you.

20:00 – 20:15 Break

- **Jimmy**: we can start again. Alyssa you are going to present more?

- **Alyssa**: Yes. I was just reminded by a collegue that harvest samples from 2005 – 2018 provides data when a bear dies from harvest, this also goes into the survival estimate. The last thing we calculated was the abundance. There was a slight decrease from 2,250 to 2,015 bears, possibly due to increased harvest. In the IQ studies elders have identified ring seals numbers have gone down, less seals might also mean less bears. When we look at recommending a management decision, we use all that information [survival, body condition, reproduction] on top of the abundance to make decisions. Any questions?
- **Jetaloo**: I don't have similar knowledge, I don't worry about seals, but now I think about it more, seals diet are shrimp and fish. All wildlife follow their diet. I would also thought of scientist like that too, only seeing. I used to think like that, I no longer think like that. When you become older you will realize this as well.
- **Alyssa**: This estimate is for the whole Davis Strait area, so it doesn't necessarily mean that the bears aren't increasing in your area. Any other questions?
- **Archie**: With the notion you gave us, we know that bears harvest bearded seals, and ringed seals are less, possibility that they are out in the ocean. The numbers you are collecting are from August to October is coastal, there is a possibility they are out in the ocean. They could be out in the ocean. The population of the harp seal numbers, right now are great. They can easily go to another zone because they are known to swim 200 miles just by swimming. Previous studies, studies we heard in the past using collars, is there was one region where bears move. We have seen videos of them harvesting harp seals, bearded seals, seen them eating tons of eggs. They've moved. Results, scientists say they are decreasing, other line/zones might be increasing, that's where they are going. Elders knowledge is not in here, it should be. We've seen videos of them harvesting a harp seal. Should check to see if they moved to another zone. They eat eggs where the birds nest. With the elders knowledge you get to learn more. They moved to the adjacent zone, for that particular zone to be increasing. You should be open to that. Using that to determine the tags, maybe they moved to the adjacent zones.
- **Jimmy**: Thank you Archie.
- **Alyssa**: Thank you for sharing what your observation is. You make a good point on the collar data. It is the most precise data we can collect to see where bears are moving. What's been done in the past, is they used the old collar data to make the boundaries for Davis Strait. They've done genetic studies in the different areas, using that data too, and that's the best outline we can make using that data. You are right, bears don't see that line, we do not know exactly when they move over the boundary. For the most part, they usually stay in the same areas.
- **Archie**: My concern is when the scientists say they are doing well. We should work together since day one: the systematics, drones, watching whales, wildlife. We have a commercial industry that exists, a lot more expensive than helicopters collecting data. I prefer collaring as it is more accurate. Collaring is the best. Come to a consensus [with methods]. Invasive [methods, bears] can get scarred, and aggressive. Technology can be organized for proper polar bear management, responsibilities as well. We need a harvest study with planning stages, consulting, need a lot of improvement. Pretty close to getting proper numbers. Something well rounded for our members, asserting our rights as an HTO. We were supposed to be involved in the study, making sure it is thorough. That's our right. To do it, we need to work together.

- **Dinos**: Stories I heard growing up, 1970's to now, my relatives lived down in outpost camps, 1960/1970 were lucky to see a bear every 2 years. His uncle lived in Minngutuuq, saw polar bears live in water. Between March and May, come inland to hunt seal pups on the ice. Between January and May, chance of finding on the ice. Last year I went to

Alingatuq near Tinituqajaq during late fall. We saw 15 – 16 bears, 5 with cubs. Late fall hunting in shallow water. I usually go in April or May when they are hunting on the ice. I find there are more cubs, now a lot more.

- **Mike**: 2 Requests – says here during 2017 – 2018 you captured 177 bears, originally captured in 2005/07 this is only my suggestion, this is only a request, I appreciate seeing a map to show where they have been marked. The second map I would like to see is 2017 and recaptured 2018 the one year period, so we can see where the marked bears only. How much movement that took place. Maybe you can send the maps to the HTOs please.
- The vertical lines are 90% chance, real numbers of bears. 2005 crudely where the other dots are, my interpretation, she probably has her reasons why the numbers vary, biologists included bears overall. I just want to let the hunters know that estimates that come from these studies, very good graph/picture that Alyssa has shown credible intervals, the estimates are among those lines. Bears might die some are born, science manages, that's my comment.
- **Alyssa**: For the map, I can't give you a timeline of that due to low staffing. I might have to compare and put that together. I can get back to you on that. Time consuming, but will look into it. I'd like to point out and talk about collaring and "credible intervals" data. The credible intervals are shorter in the 2005-2007 estimate because this used collar data, it is more precise. When they consulted with the HTO for the 2017-2018 survey, they indicated to move away from collars and use biopsy genetic data, we do get a wider interval, but the area covered was same for both. Comparison between the two, keeping them the same. There is always a level of uncertainty with numbers. We look for a trend.
- **Archie**: Timing intervals August and October, polar bears are apex predators, the seals pups are born in spring. This has been the same year after year. From August to October is when they migrate, they aren't there. The prime is spring when the seal pups are born far from August to October. You should do these studies during spring when they are going for prey based on Inuit Knowledge, you should use it. Prime time is a month while the ice is still there. Respectively studying should be now, Spring, rather than August to October.
- **Jetaloo**: You have a burden and you will carry it. Polar bears destroy duck nests are destroyed and cabins, government (insurers) always need proof.
- **Alyssa**: Thank you.
- **Jetaloo**: (Pointing to slideshow) That hide is not cut up properly. Explains why it was cut wrong.

- **Archie**: Thank you Chair. Do defense kills come from quotas?
- **Alyssa**: Yes.
- **Archie**: That is a defence kill not allowable harvest. That contradicts under the Land Claim.
- **Jetaloo**: Take away from quota, as elders, if a person is stranded and hungry, they should not have to look at numbers. They should not have taken off the quota under the land claim.
- **Adamee**: Two things - Satellite technology is one thing that can be used. Two, direct recipients. We were not HTO members because we were dealing with researchers, Peregrine, polar bear, geologists, caribou biologists, minerals overlapping. Four helicopters going off at the same time so many helicopters that disrupted the animals and made them move to where there were no helicopters/noise. It's nice to have studies, but they are going to do that.

- **Mike**: Allocations – defense kills how can it impact your quota? Defense kills come off the credit. They had to come through the board. Credits should not be coming off the quota.
- **Archie**: Recipient of that claim – nothing. Total allowable harvest. Is total allowable harvest asserting ourselves? This has nothing to do with the credit, quota. Defense, that is not total allowable harvest. That is completely separate. Asserting ourselves under the claim.
- **Mike**: When credit system was developed in the 1980's, 1990's, through the Nunavut agreement, credits carry forward from unused bear tags, quotas were not related to defense kills. People ask for and it was what it was about.

- **Jetaloo**: I'll be good. Credible, anywhere it has been getting blizzardy, the cycle is getting unpredictable, it may be snowing a lot but not ice, the ice is getting uncertain, our trails climate should be considered in the process. We lived at a time when weather is not a concern. Back then, we depended on oil (seal), now it is fossil fuel.

21:15 – 21:30 Break

Dominique Henri presented slide show with brief background and results on the IQ study. These slides were not reviewed in advance, but done as a separate, but included section. Dominique had mailed physical copies of the IQ report to the HTA Board in March. Dominique presented on some key points from the report and how the findings from the abundance and IQ study fit together to provide a more complete picture of DS polar bears.

IQ study: Review

- **Archie**: Thank you very much Dominique for your presentation, very interesting. There are less of ring seals. In the 1960's I was 200 miles due west from Resolute Bay, still moving to Russia. Like every other animal like birds, moving with the magnetic field, we see more mallard ducks, snowy owls, bumble bees, warble flies. Change is happening in the animal kingdom. All wildlife is all connected to the magnetic field, keep that in mind. Goes right down to insects. I also believe the elders saying that the polar bears are increasing. Keep that in mind that the magnetic field is moving, further north they are even seeing mosquitoes when there never used to be any before.

Alyssa Bohart presented slide show with the GN TAH recommendation. She gave the HTA Board options to provide answers to discussion questions via email at a later date, but the board could also share initial thoughts within the current meeting.

Questions from presentation:

- Do you agree that the number of polar bears stayed relatively the same over time?
- Are there enough bears to harvest? Are there too few? Too many?
- What did you observe in the bears' body condition over time?
- Is there anything special that you observed and wanted to share with us?
- Where do you agree/disagree with our findings?
- Think about how your HTO would like to manage the Davis Strait subpopulation?

Harvest management and TAH recommendation: Review

- **Archie**: Involvement with managing polar bear with harvesting area. When it comes to making a decision on Davis Strait, I would love to see other areas. One zone decreased, the two adjacent ones increased, because the bears travelled to those zones. Culling program, one decreased one increased. Hitting the mark. Keep in mind, like our elder said, the younger generation, there is ton of preparing, losing culture, different polar bears, like he pointed the hide that he was talking about. A lot of our younger generation won't understand when you say "naglitugit". Start developing, younger generation with an elder, we have that power, we have to start now how to work together, get extra funds, we heard you, we can help you. Sake of life, only to shoot only when the bears are looking at you, don't shoot it when it isn't looking. Cultural erosion. Ensure GN help them get funds, drones, these are the things we can do. This will be a sound. Thank you, Mr. Chairperson.

- **Jetaloo**: In Iqaluit, our hunting season for polar bears is from July to June. We can get reports on the ice conditions from the radio.
- **Mike**: Thank you on behalf of QWB, QWB is actually made up of chairmen of the HTOs so HTOs are QWBs bosses. Continue to work with you to coordinate everything.
- **Adamee**: We have not seen this type of meeting in quite a few years. We dealt with a lot of researchers and finances. This is the first in a long time we have actually dealt with wildlife issues. Our cultures, our mandate is to serve our members and deal with wildlife. We have to touch on a little bit. We need to deal with a long of things.
- **Jimmy**: Thank you Alyssa you did not throw anything at us. We just need to work better. If you need space or the boardroom just let Sally know. Work together more, it was very informative for me.

Participants were thanked for attending, and their feedback.

22:05 Meeting End

Davis Strait Polar Bear Abundance and IQ Reports Consultation Meeting Notes

Location: Mayukalik HTA office
Date/Time: May 11, 2023
Start time: 19:08
End time: 22:14

Participants

Killiktee Padluq (HTA Chairperson)
Rosie Akavak (HTA Vice-Chairperson)
Sandy Akavak
Jawlie Akavak
Jawlie Mingiriak
Nathan Padluq
Alyssa Bohart, Polar Bear Biologist, GN ENV
Jason Aliqatuqtuq, Associate Deputy Minister, GN ENV
Matilde Tomaselli, Wildlife Researcher, Polar Knowledge Canada
Denis Ndeloh, Director of Wildlife Management, Nunavut Wildlife Management Board
Kolola Pitsiulak, Executive Director, Qikiqtaaluk Wildlife Board

Michael Ferguson, Director of Wildlife and Environment, Qikiqtaaluk Wildlife Board
Naomi Akavak, Translator

Goal of meeting:

Provide an overview of the newest scientific and IQ information regarding the DS polar bear subpopulation as reported in the GN scientific study report and the IQ report. Discuss the GN TAH recommendation. Discuss any questions HTA has for both studies. Collect feedback and IQ on DS management.

Next Steps and Action Items:

Short term Action Items (within 4-6 weeks):

- **Mike**: Another point, a request to Alyssa, is she mentioned at one point that maybe in Nunavut, well she didn't say this exactly, but the population is increasing in Nunavut, but decreasing in Quebec and Labrador. Well the reality is that they did studies in both places and I would ask the government to provide us with their two sets of estimates, their estimates for the population in Quebec and Newfoundland and what the changes were between 2005 and 2018, and I think they have the data or they could generate the results to answer that question.
- Email HTAs the harvest management questions.

The Department is looking into questions and concerns raised during the consultations and are working to resolve them.

Longer term Action Items (next 2-3 months):

- NA

Meeting Notes:

Question to Group after Introductions:

The meeting began with introduction of participants. The IQ study was presented first because the presenter was in a time zone ahead of Eastern Daylight Time. **Matilde Tomaselli** presented slide show with brief background and results on the IQ study. These slides were not reviewed in advance, but done as a separate, but included section. Dominique Henri (a co-author on the IQ report) had tried to meet with the HTA Board in March 2022, but weather did not permit it. Alternatively, she sent physical copies of the IQ report to the HTA and Matilde was presenting the content of the report relevant to Kimmirut, that Dominique had tried to present in March, in this meeting. Matilde presented on some key points from the report.

IQ study: Review, no questions

- **Sandy**: Would you know or was there any report on what happened or why there was fur loss?
- **Matilde**: Thank you for the question, we asked that question and people reported that it could be related to ice injuries and there is a wide range of things that could cause that, but we cannot know for sure.

- **Sandy**: I asked the question so the other members could understand what could have caused the fur loss. Yes, I understand it could be coming off from being around the ice for too long. Sometimes when they've been swimming too much and they have to go through thin ice coming in and out of that causes fur loss.
- **Matilde**: Yes, we recorded that in interviews and it was included in the full report. Thank you for sharing that with us.

19:58 – 20:16 Break

Alyssa Bohart presented slide show with background on the transition at the GN polar bear research group due to the loss of biologist Markus Dyck. She then presented an overview of the polar bear study process including the planning stages up to when a TAH management decision is accepted by the minister and harvest tags are distributed to communities. She then noted that the purpose of this meeting was to provide a summary of the results from the abundance and IQ study and to hear HTA feedback.

Abundance study background slides: Review, no questions.

Abundance study methodology/field work: Review

- **Killiktee**: What do you mean by mark? Do you physically mark it?
- **Alyssa**: On my next slide I'll explain, that's a great question.

- **Mike**: The lines of the study area, doesn't include Greenland, but on the map [in the room] Greenland is apart of Davis Strait. Has this changed? If Greenland is part of it, was a similar study done in Greenland in 2017-2018?
- **Alyssa**: What I do know is that we do have to work with Greenland on this subpopulation, but I'm not familiar if they did sampling in their region. For this report, we're just talking about the Canada results. I'd have to look into that further for you.
- After the next break **Alyssa:** I checked and Greenland doesn't really harvest out of DS and so we don't have to be concerned about their harvest and therefore don't survey that area for management purposes. We do have to work with Greenland when we work on Kane Basin and Baffin Bay.

Alyssa presented on the key results and how the findings from the abundance and IQ study fit together to provide a more complete picture of DS polar bears.

Abundance study results & harvest: Review, no questions.

21:03 – 21:15 Break

Abundance study results & harvest continued: Review

- **Mike**: Just to give an example, Baffin Bay was surveyed years ago and they said the population was definitely decreasing and so they reduced the quota. And after that, the Inuit in that area kept on insisting polar bears were increasing not decreasing. So biologists reanalyzed the old data in a new way and the biologists found that the population actually had increased, so the quota went up. Inuit are often right.

- **Sandy**: What I know, there's an increase of polar bears up to today. When they first started surveying in 1970, 1965, up to this day there is an abundance of bears. When I was younger, as a boy, I never heard or know no polar bears here. Long ago there was lots of polar bears, but at the time I was born, there was no polar bears. I don't want to, but I predict that the polar bears might start declining again.

- I think, because around here there are hardly any more seal in our hunting areas, I want seal meat, but we can't get it because there's none around. It's hard, we come home empty handed. Now, seals are a polar bear's main meal. Knowing that, not much seals in this area, polar bears may move away from our area or decline. This has happened to other animals, for example the caribous were declining so much faster than before. Now there is hardly any caribou, but I know they will become abundant one day.
- You as biologists are not getting enough help from the locals, they're not providing you with enough information about the polar bears. They could be funding the local HTOs for the ground survey. The community hunters could go out and collect. That way if there is funding from sources, the locals could help with the survey that you do. We could be a great help if we were given funding to do a ground survey on polar bears. The locals could start going by skidoos down towards south and they could also go northside. This would be a great help to you, I'm sure. Before when they started doing ground surveys, they were funded by the government to take the biologists out with them. I don't know what happened, it just kind of suddenly stopped. I know for a fact that it would be a great help to you as biologists if we start doing a ground study from each community. I'm sure it would be a lot less expensive to do a ground survey.
- **Alyssa**: Thank you very much and we will be coming back for the Foxe Basin survey, so that is something we can think about for that survey.
- **Sandy**: I know that it worked that time we did a ground survey.
- **Denis**: The NWMB has some funding for the community or HTO to do some of the work that Sandy is talking about. It's not a lot, up to $50,000 to fund wildlife studies or $50,000 for IQ studies.

Alyssa Bohart presented slide show with the GN TAH recommendation. She gave the HTA Board options to provide answers to discussion questions via email at a later date, but the board could also share initial thoughts within the current meeting.

Questions from presentation:

- Do you agree that the number of polar bears stayed relatively the same over time?
- Are there enough bears to harvest? Are there too few? Too many?
- What did you observe in the bears' body condition over time?
- Is there anything special that you observed and wanted to share with us?
- Where do you agree/disagree with our findings?
- Think about how your HTO would like to manage the Davis Strait subpopulation?

Alyssa presented on how the findings from the abundance and IQ study fit together to provide a more complete picture of DS polar bears.

Harvest management and TAH recommendation: Review

- **Sandy**: We don't really hunt polar bears anymore because there are not much buyers for the hides. If we could ship them out raw, not dry, we might do that. We don't really want to hunt polar bears anymore because there's not a lot of ladies to clean the hides and at the same time the cleaners will ask for a high price to clean the hide. A lot of hunters are seeing polar bears, but not hunting them anymore. In the older days, they would've hunted everything they saw, but not now.

- **Denis**: Just a comment on how TAH decisions are made. NWMB has 8 board members. They are from different communities and help make decisions. The information will come from the government, requesting that a decision is made. I work for the board, I'm not a member. You can make a submission to the government who will send their submission to us, or you can send it to us directly. The board will make a decision on the science and IQ information.

- **Mike**: There are three points I'd like to make. As Alyssa has somewhat said, the numbers in these studies are not exact. There's a lot of variability in them and, so they can be interpreted using IQ and come up with different conclusions. Your conclusions from the IQ study seems to be that the population is increasing in your area and that's what all three communities have said.
- Another point, a request to Alyssa, is she mentioned at one point that maybe in Nunavut, well she didn't say this exactly, but the population is increasing in Nunavut, but decreasing in Quebec and Labrador. Well the reality is that they did studies in both places and I would ask the government to provide us with their two sets of estimates, their estimates for the population in Quebec and Newfoundland and what the changes were between 2005 and 2018, and I think they have the data or they could generate the results to answer that question.
- My last point I want to make is that the QWB and regional wildlife boards in general including the Kivalliq and the Kitikmeot, their role is to group together the points of view when there is more than one HTO involved, which in this case there are three HTOs involved. So, one of our roles is to work with you and the government on a view. So, for those questions that the GN is asking you to answer, for example, I don't know if the question is there, but do you think that the TAH should be increased? Well, that could be something that we discuss among the HTOs and through the QWB and the QWB provide the answer. I believe the question should be answered by the QWB working with the HTOs because that's our job. Not that you can't answer the GN directly, you can, if you wish, but we might be able to come up with better ideas with three HTOs and have a stronger view. That's all.

- **Sandy**: NWMB have the final say in the TAH**?**
- **Denis**: The NWMB makes the decision and forwards it to the government. The government has the ultimate responsibility. They can change the NWMB decision, but they would have to explain why.
- **Alyssa**: And for example, all recent decisions for polar bear management, the Minister has accepted what NWMB proposes. So there's not usually a discrepancy.

- **Mike**: Another example of how QWB may be able to help in all of these issues, is through what has happened recently with the Baffin island caribou. QWB has been effective with 10 HTOs on Baffin Island to get increases in caribou TAH on Baffin Island.

- **Sandy**: The question I have now was answered earlier. If the HTO works with QWB, I now understand that we can work with QWB and it can be handled that way when they are trying to make a quota.

- **Killiktee**: From QWB, it goes to NWMB?
- **Mike**: Yeah, QWB will send to NWMB.
- **Alyssa**: And the information that you guys provide us, the answers from the questions, we will include that in our consultation report that goes to NWMB. So, they'll also have that information from us.

- **Denis**: Question to Alyssa, do you have an idea on when the government will make its recommendation to NWMB for the Total Allowable Harvest?
- **Alyssa**: I can write up the report and I imagine the timing will depend on when we get feedback from the HTOs to include in the report. When would the deadline be Denis, for the next submission?
- **Denis**: Early August, first week of August.

- **Jawlie**: Further up north, how do they do theirs for the Foxe Basin area? How many do they harvest? Do they harvest all of the tags up there?
- **Alyssa**: I have the harvest table on my computer and can pull it up.
- **Denis**: Generally, the harvesting of polar bears in Nunavut is lower than the TAH, generally.
- **Jawlie**: The reason why I ask that question is because some other communities have requests to see if they can get their Kimmirut credits.
- **Alyssa** showing the harvest table: So this is the total, 123 for the whole of Foxe Basin. Last year, only 109 of the 123 were harvested. And this is Kimmirut, out of the 12, only 6 were harvested.
- **Killiktee**: The other communities will ask us for tags.
- **Mike**: I am told that some communities have no credit switch. Some communities, in the Kivalliq have no credits because they've had a lot of defence kills and that's why they're asking you for tags, because you have credits.
- If your community is interested in exchanging or just giving credits to other communities, or tags, you do that through the QWB, that's one of the roles we have. If you are willing to give tags to a community, you discuss it with them and how you're going to do it and when and then you send a request attached with a motion from your HTO and their HTO to the QWB. The QWB will indicate if it can happen or not, then the QWB will send that to the government and ask them to make the change in their documents. In most cases, it doesn't have to go to the NWMB.
- **Kolola**: If you want, you can always tell me and I can send your information to the department.
- **Killiktee**: Yes, we do get requests and they must go through the QWB, even before Kolola was here.
- **Mike**: Yes, I've been working with QWB since 2017 and I saw one request from Kivalliq communities requesting credits from here, but it wasn't very clear what they wanted. So, I asked them some questions on what exactly they wanted to do and I never got a reply from them.

Participants were thanked for attending, and their feedback.

22:14 Meeting End

Davis Strait 2017 – 2018 genetic mark-recapture study results

This study report was completed as a collaboration between:

- Markus Dyck, Government of Nunavut
- Kylee Dunham, University of Alberta
- Aaron Dale, Torngat Wildlife, Plants & Fisheries Secretariat
- Andrew Derocher, University of Alberta
- David Hosmer, University of Massachusetts
- David Koons, Colorado State University
- John Pisapio, Government of Newfoundland & Labrador
- Eric Regehr, University of Washington
- Guillaume Szor, Gouvernement du Québec
- Jasmine Ware, Government of Nunavut

Thank you!

Nunavut

Québec

Newfoundland Labrador CANADA

NUNATSIAVUT kavamanga Government

TORNGAT WILDLIFE PLANTS & FISHERIES SECRETARIAT

Société Makivik Makivik Corporation

WWF

Nunavut Wildlife Management Board

Nunavut General Monitoring Plan
Nunavunmi Tamainni Takuurivangnikkut Parnaiyautaanni
Plan de surveillance générale du Nunavut

Iqaluit

NUNAVIK MARINE REGION WILDLIFE BOARD

Kimmirut

Canada

MUNICIPALITY OF PANGNIRTUNG

The University of Vermont

Environment and Climate Change Canada
Environnement et Changement climatique Canada

UNIVERSITY OF ALBERTA

UNIVERSITY of WASHINGTON

Colorado State University

Introductions

Alyssa Bohart
Polar Bear Biologist
Department of Environment
Government of Nunavut

Transition

- Since 2021 there has been a transition at the Department of Environment in the Government of Nunavut
  - Tragic loss of our Polar Bear Biologist Markus Dyck in an accident
  - Two Polar Bear Biologists resigned last year
  - There are two new biologists continuing the program

Survey Process

1. Create a study design

Survey Process

2. Consult on study design and get feedback

Survey Process

3. Incorporate feedback into study design

Survey Process

4. Fly the survey

Survey Process

5. Analysis & Writing Final Report

Survey Process

6. Consulting on Final Report

Survey Process

Final Report &
Total Annual Harvest
Recommendation

Inuit
Qaujimajatuqangit (IQ)
Final Report

Total Annual
Harvest
Decision

Minister of Environment

Accept or Reject
Total Annual Harvest
Decision

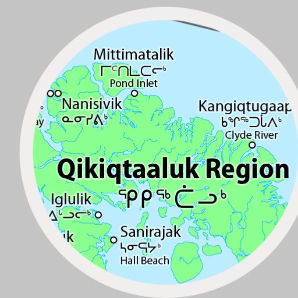
7. Total Allowable Harvest Decision-Making

Survey Process

Minister of Environment

Accepts

Regional Wildlife Boards



Accept or Reject Total Annual Harvest Decision

Decide how many tags each community gets

Send tags to communities

7. Total Allowable Harvest Decision-Making

Survey Process

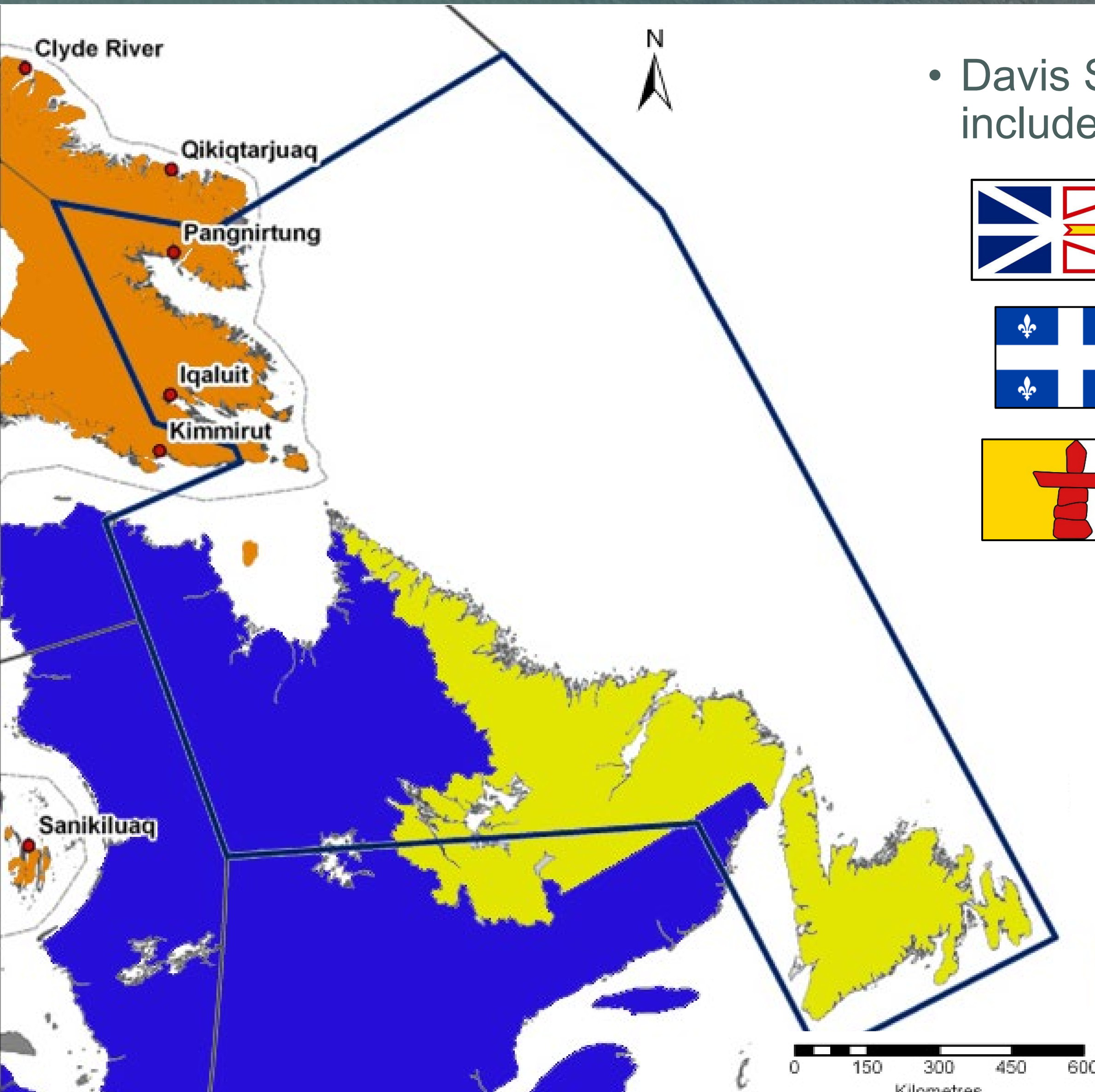
Purpose of this presentation

Provide summary of the results from the study

Obtain feedback from your HTO

Next steps

Background



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Avatiliqiyikkut
Department of Environment
Ministère de l'Environnement
By: M Marriott, 19 April 2012
Datum: NAD83
Projection: Lambert Conformal Conic
Data Source: Department of Environment

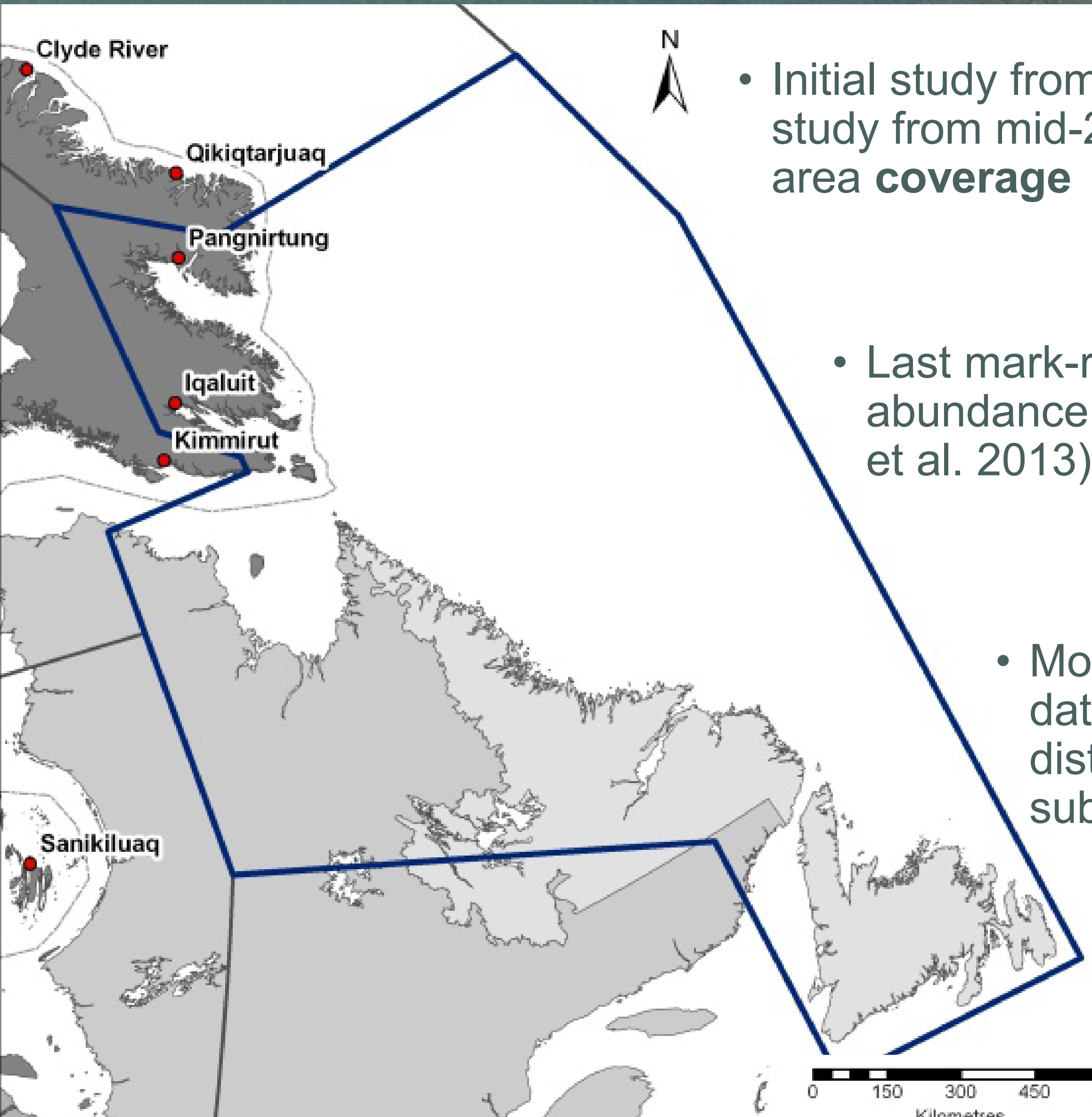
- Davis Strait polar bear subpopulation includes several jurisdictions

Newfoundland & Labrador

Québec

Nunavut

Background



- Initial study from mid-70s **cannot be compared** to study from mid-2000s because of **different** study area **coverage**

- Last mark-recapture study 2005 – 2007 with abundance estimate of **2,158 bears** (Peacock et al. 2013)

- Movement data and mark-recapture data indicate the subpopulation was distinct from surrounding subpopulations

Background

- Bear numbers **increased** significantly since mid 1970s
  - local knowledge
  - impacts on other species (birds, seals)
- **Higher density** than most populations
  - relatively low harvest
  - lots of harp seals
- Communities generally wanted to **decrease** abundance since 2005-07 study.

Objectives of study

1

Estimate current population size & compare with past estimates to evaluate population trend and status.

2

Estimate survival and reproduction parameters for the 2005-2018 period.

3

Provide updated information to all management authorities that share this subpopulation for management decisions.

Study Design

Davis Strait Polar Bear Study Timeline

Planning & Consultations

2015-16

- Study design
- Method choice
- Logistics planning
- Consultations with co-management partners

Field Work

2017-18

- NL, NU, Nunatsiavut, QC, Torngat Secretariat, and HTO/LNUK members
- August-October
- 2 years

Analyses, Report, & Consultations

2019-23

- Compile data
- Analyze data
- Prepare final report
- Community consultations

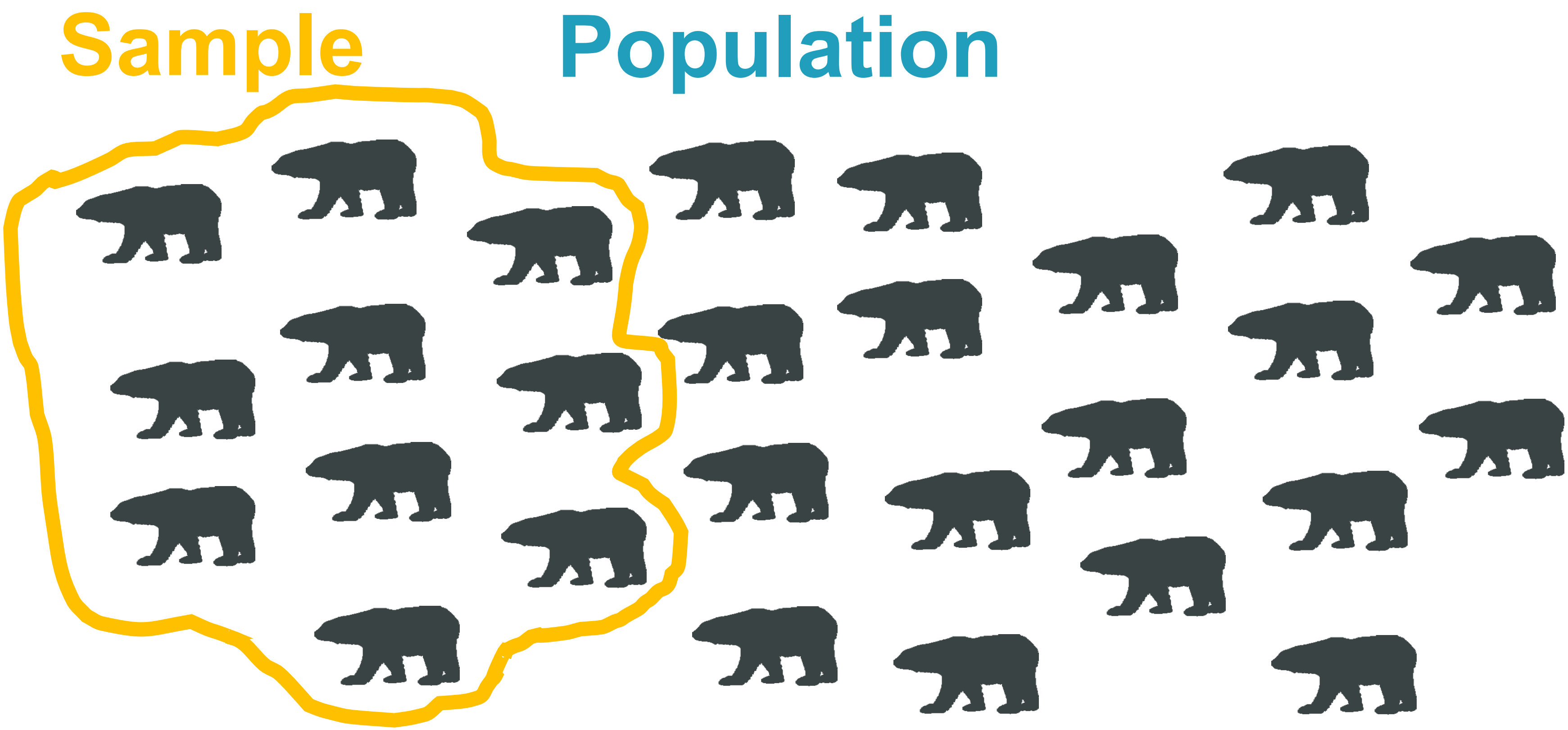
Study Design

Community Participation

- **2016** — Survey design and method choice
- **2017 2018** — Survey observers
- **2023** — Review & evaluation of results

Planning & Consultations

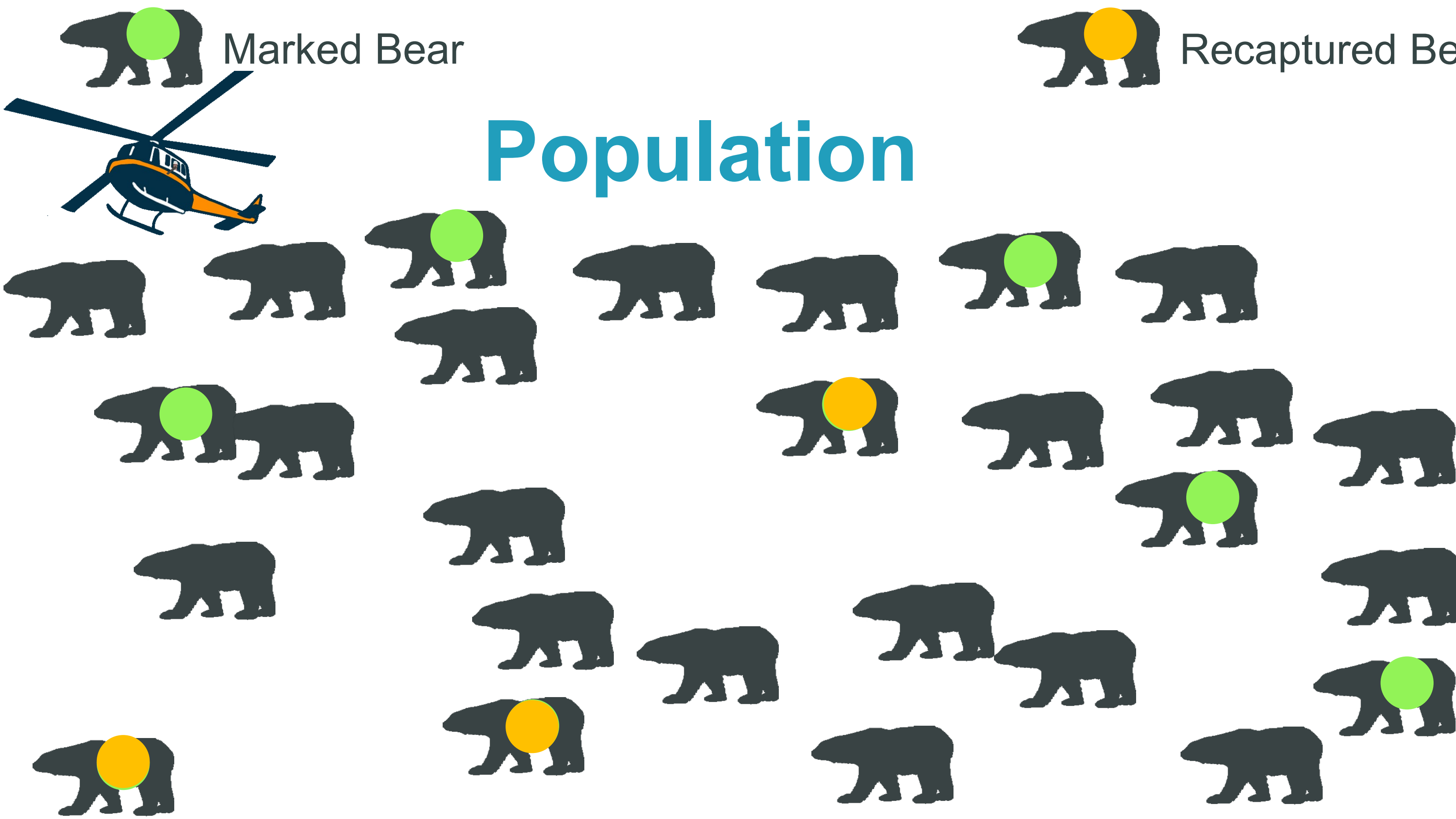
- How do we estimate **how many bears** are in a population?
  - We can't count ALL bears
  - Instead, we **take a sample** and then **calculate** an approximate number → **<u>Mark-Recapture Method</u>**



Planning & Consultations

Example of Mark-recapture method (calculating population abundance)

2021 – Mark Year → 2022 → 2023 – Recapture Year



Planning & Consultations

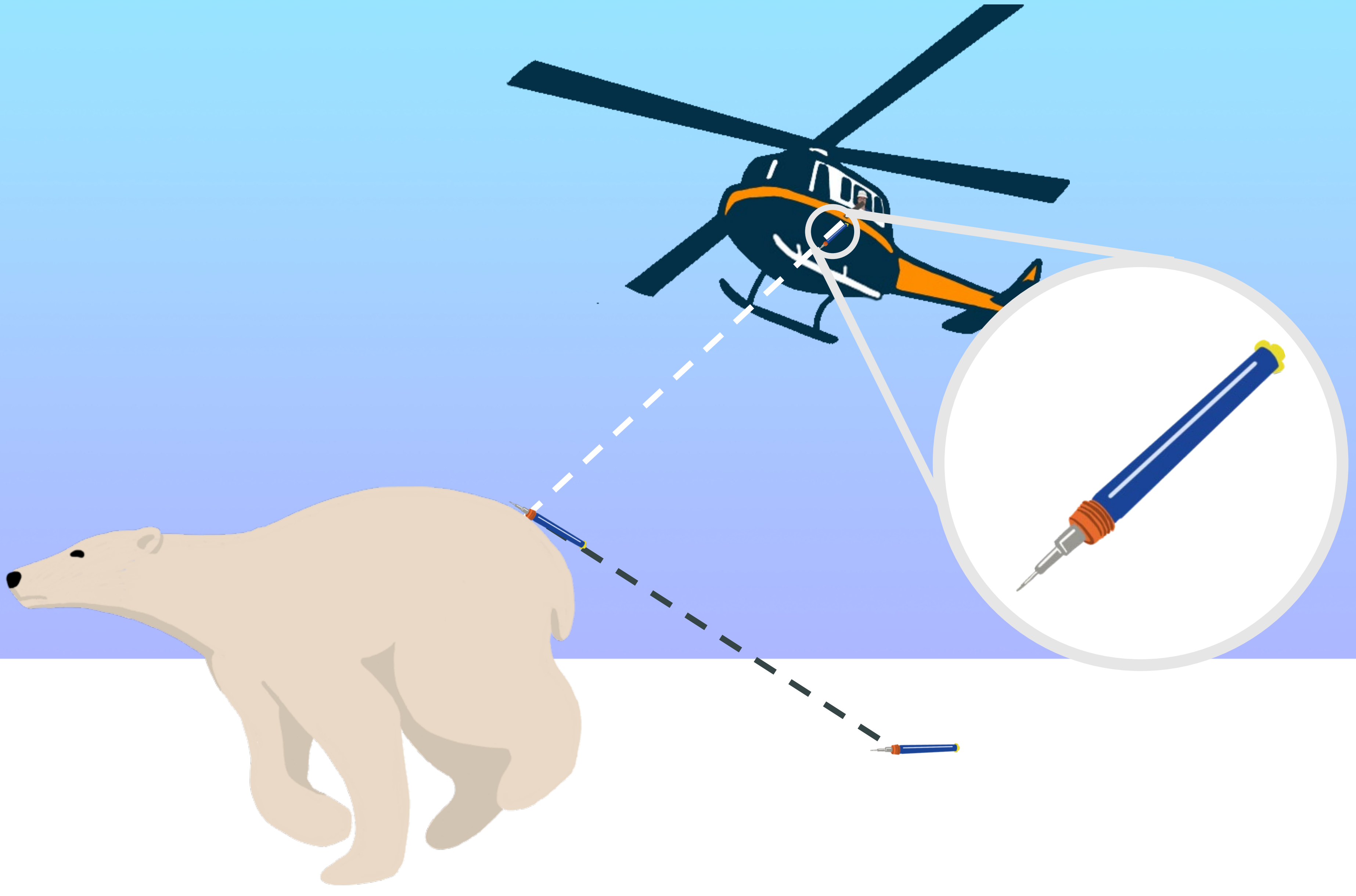
Mark-recapture method (calculating population abundance)

- How do we mark bears?
  - Tag and Collar
    - This was done in 2005-2007 DS study
  - Collect DNA
    - Biopsy darting
    - Harvest samples

Planning & Consultations

- Consultations in 2016
- Captured and collared bears in 2005-2007 study
- 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
  - Biopsy darting

Genetic Mark-Recapture = Biopsy Darting



Field Work

Genetic Mark-Recapture

- Biopsy sampling – bears **not physically handled** or **sedated**

- Project happened in August – October 2017 and 2018

Field Work

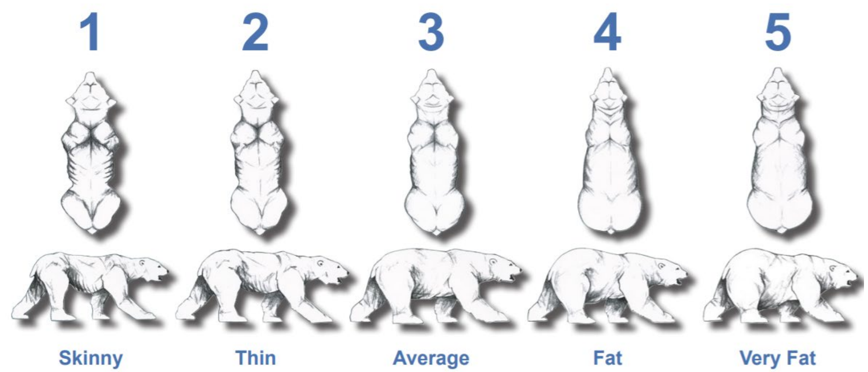
Genetic Mark-Recapture

- Looked for bears based on **Inuit Qaujimajatuqangit (IQ)** and **science**
  - **High-density:** up to 5km from coast
  - **Medium:** 5-10km inland
  - **Low:** 10-30km
- Also flew over **off-shore islands**
- Same technique applied in Baffin Bay study and **worked very well**

Field Work

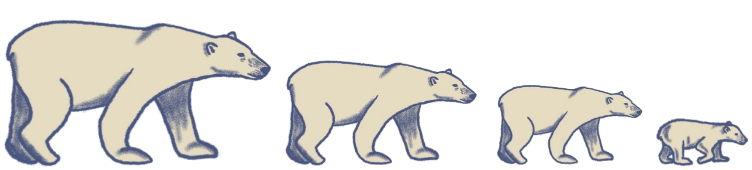
Data Collected

Biopsy/Genetics

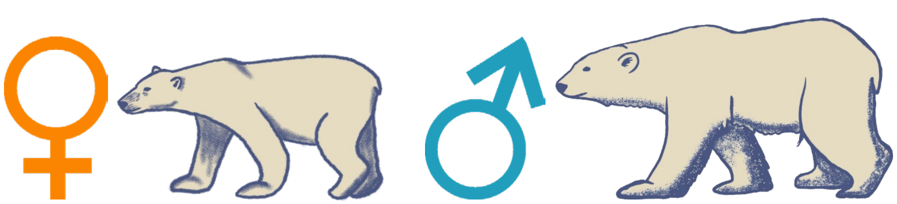


Body Condition

Location

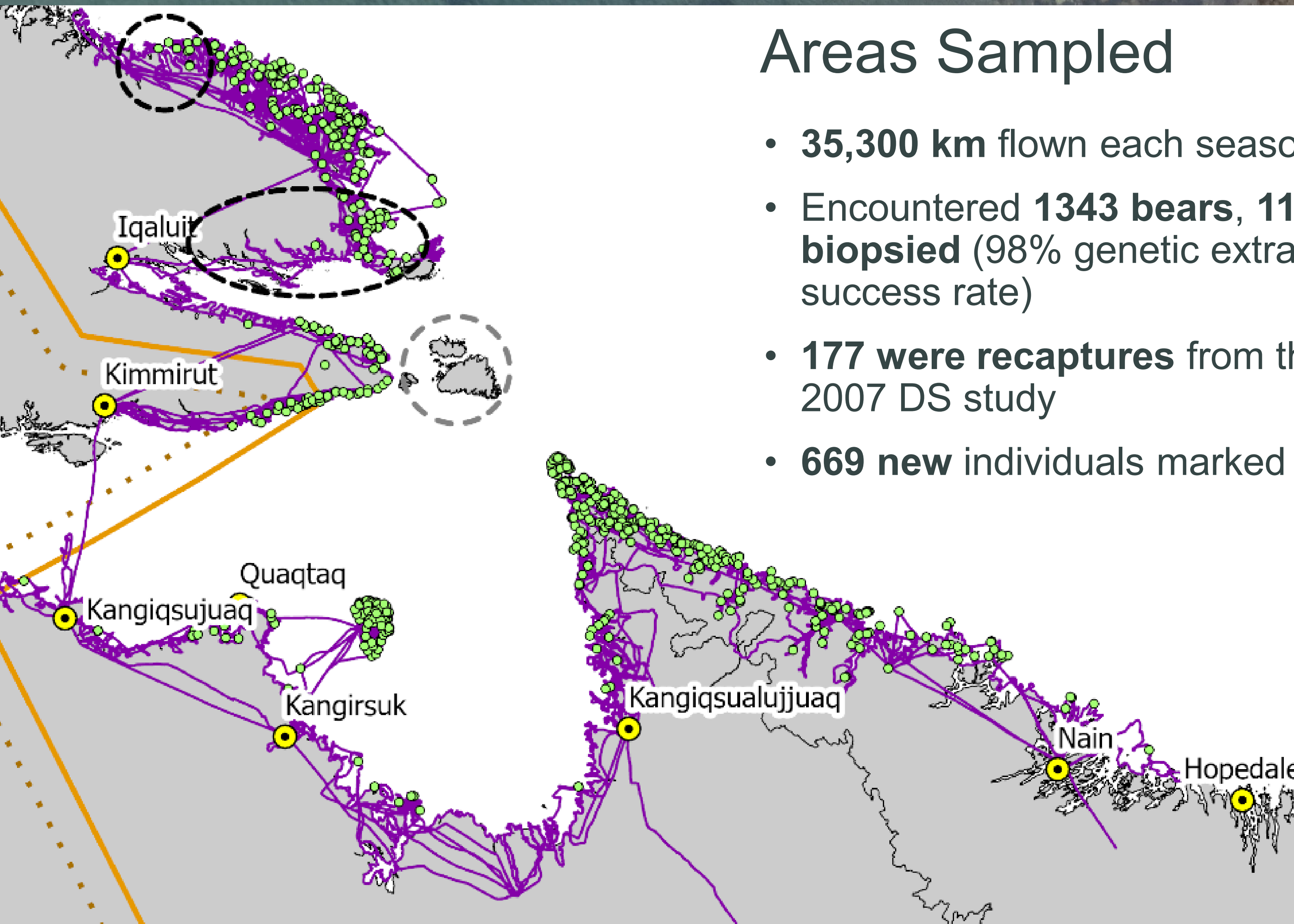


Age Class



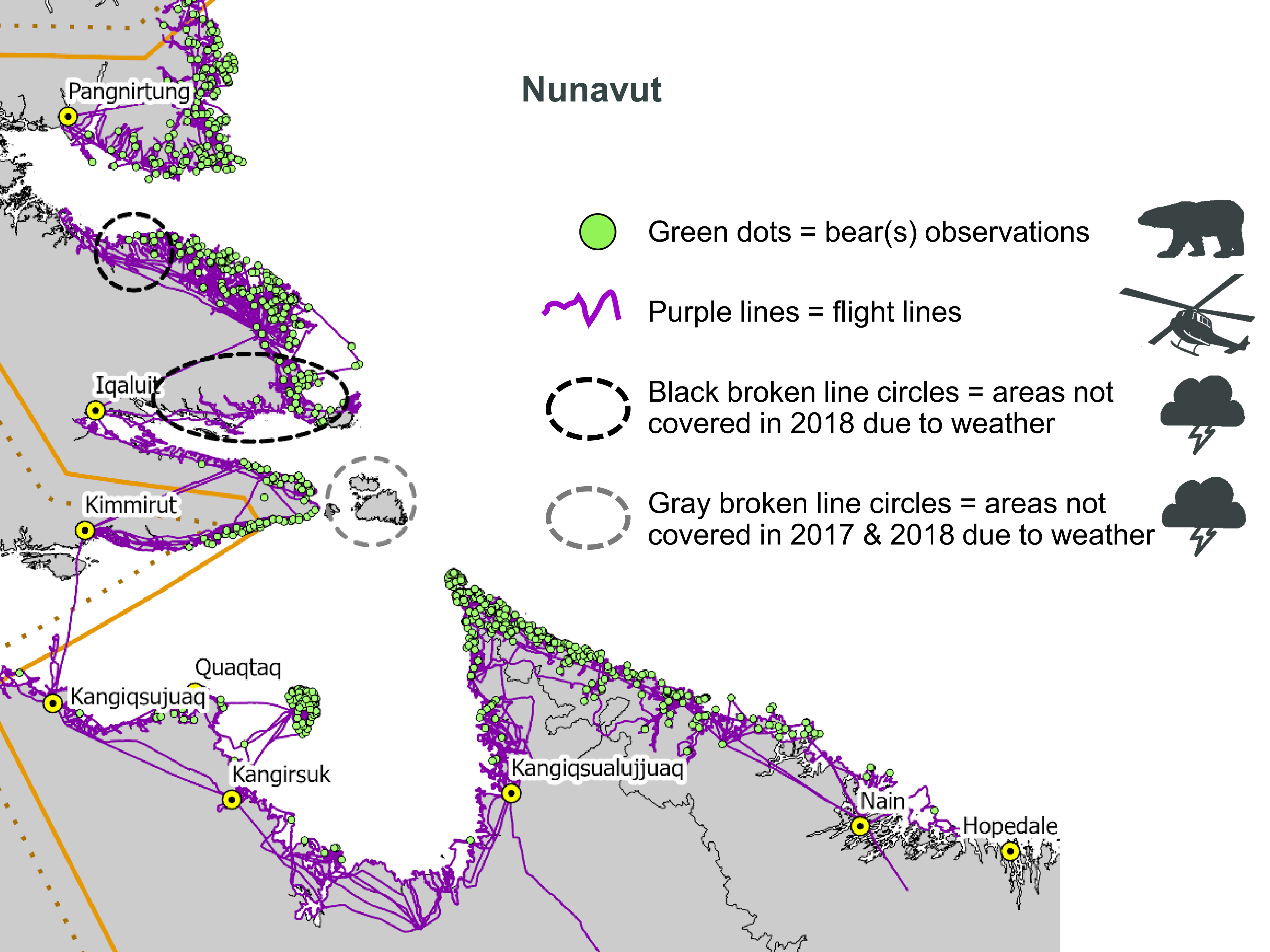
Sex

Field Work



Areas Sampled

- **35,300 km** flown each season
- Encountered **1343 bears**, **1139 were biopsied** (98% genetic extraction and ID success rate)
- **177 were recaptures** from the 2005 – 2007 DS study
- **669 new** individuals marked


Nunavut
Pangnirtung
Iqaluit
Kimmirut
Kangiqsujuaq
Quaqtaq
Kangirsuk
Kangiqsualujjuaq
Nain
Hopedale
Green dots = bear(s) observations
Purple lines = flight lines
Black broken line circles = areas not covered in 2018 due to weather
Gray broken line circles = areas not covered in 2017 & 2018 due to weather

Analyses

Dataset

- Included all available data for analysis:

Collars

Biopsies

Live-capture bears

- 2,513 live capture bears
- Collars 2005-2007
- Biopsies 2017-2018

Harvest Samples

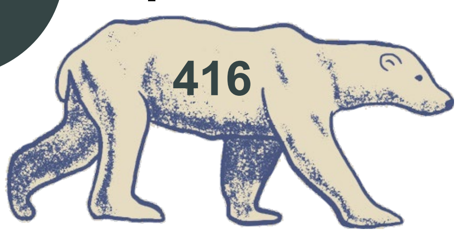
- 1,623 harvest samples submitted
- 445 Baffin Bay, 460 Davis Strait, 718 Foxe Basin

Analyses

Body Condition

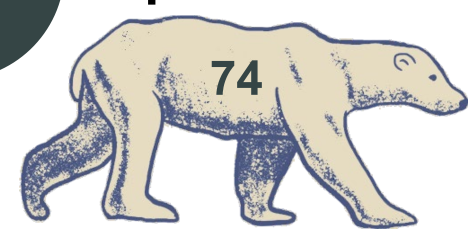
- Bears were assigned a Body Condition in both studies
  - Physical handling (2005 - 2007)
  - Aerial observation (2017 - 2018)
- Bears were in better body condition in 2017-2018

20% **in poor condition**



2005-2007

8% **in poor condition**



2017-2018

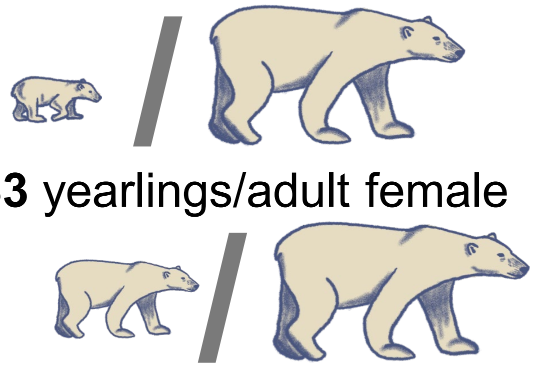
Analyses

Reproduction – What do scientists look at?

- **Number of offspring** compared to **all adult females**

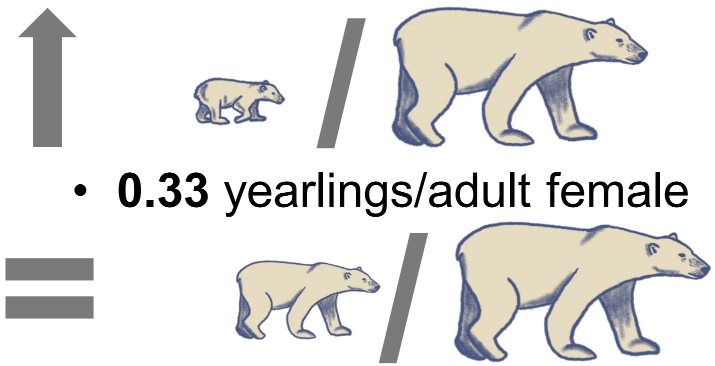
2005-2007

- **0.30** COYs/adult female
- **0.33** yearlings/adult female



2017-2018

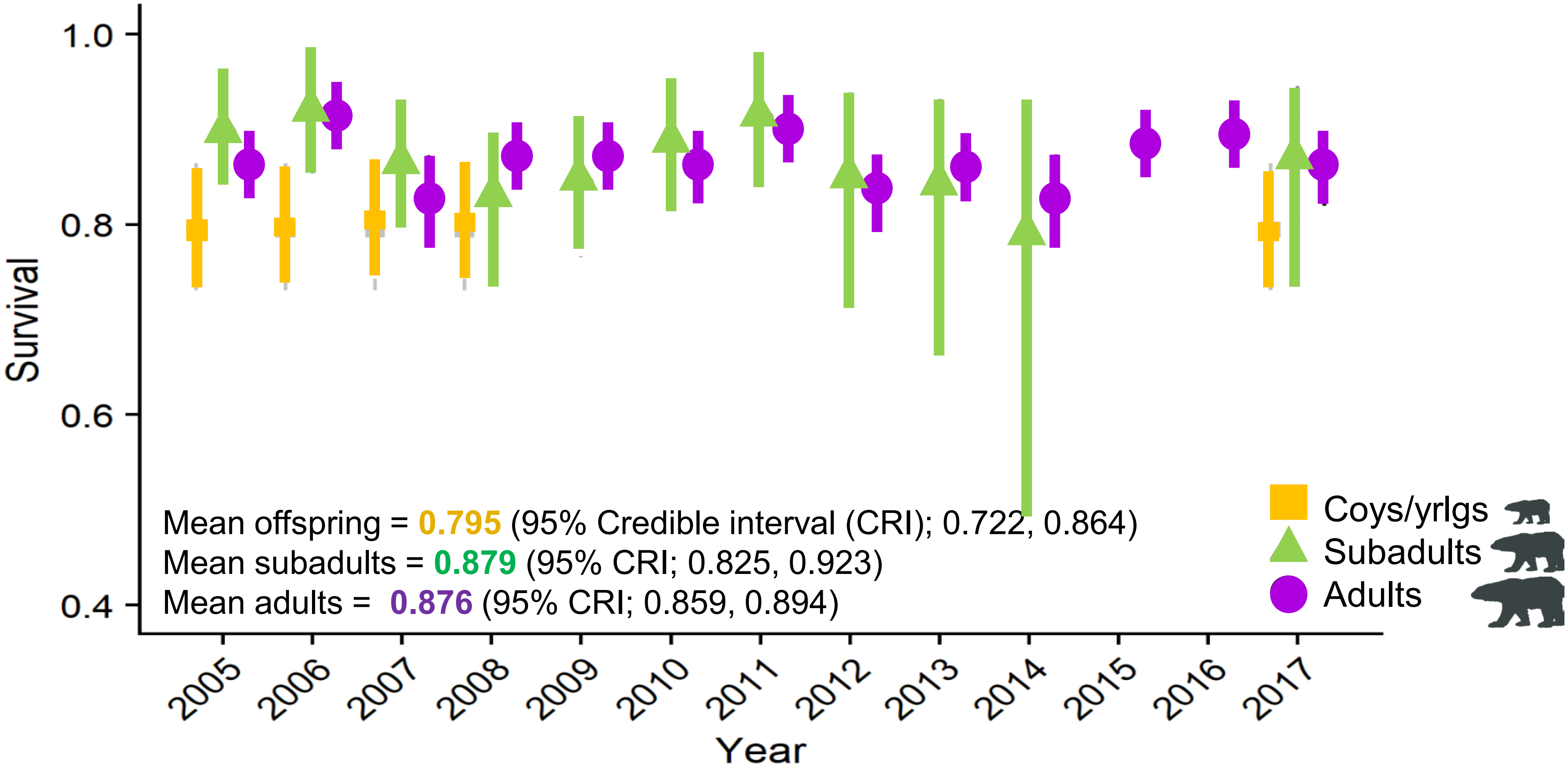
- **0.41** COYs/adult female
- **0.33** yearlings/adult female



- Number of yearlings for each adult female is important because it shows how many cubs-of-the-year **survive to be yearlings**

Analyses

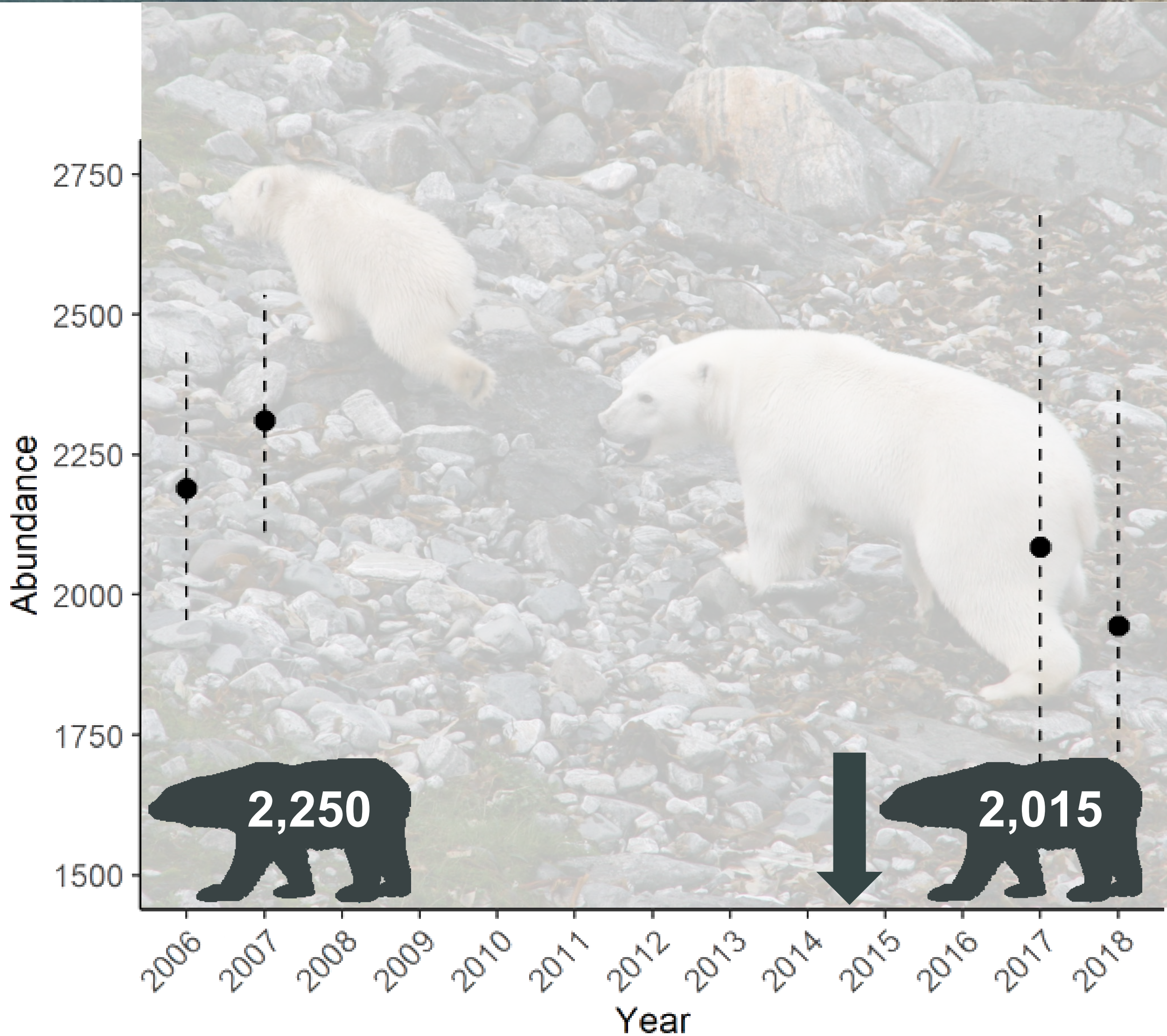
Survival



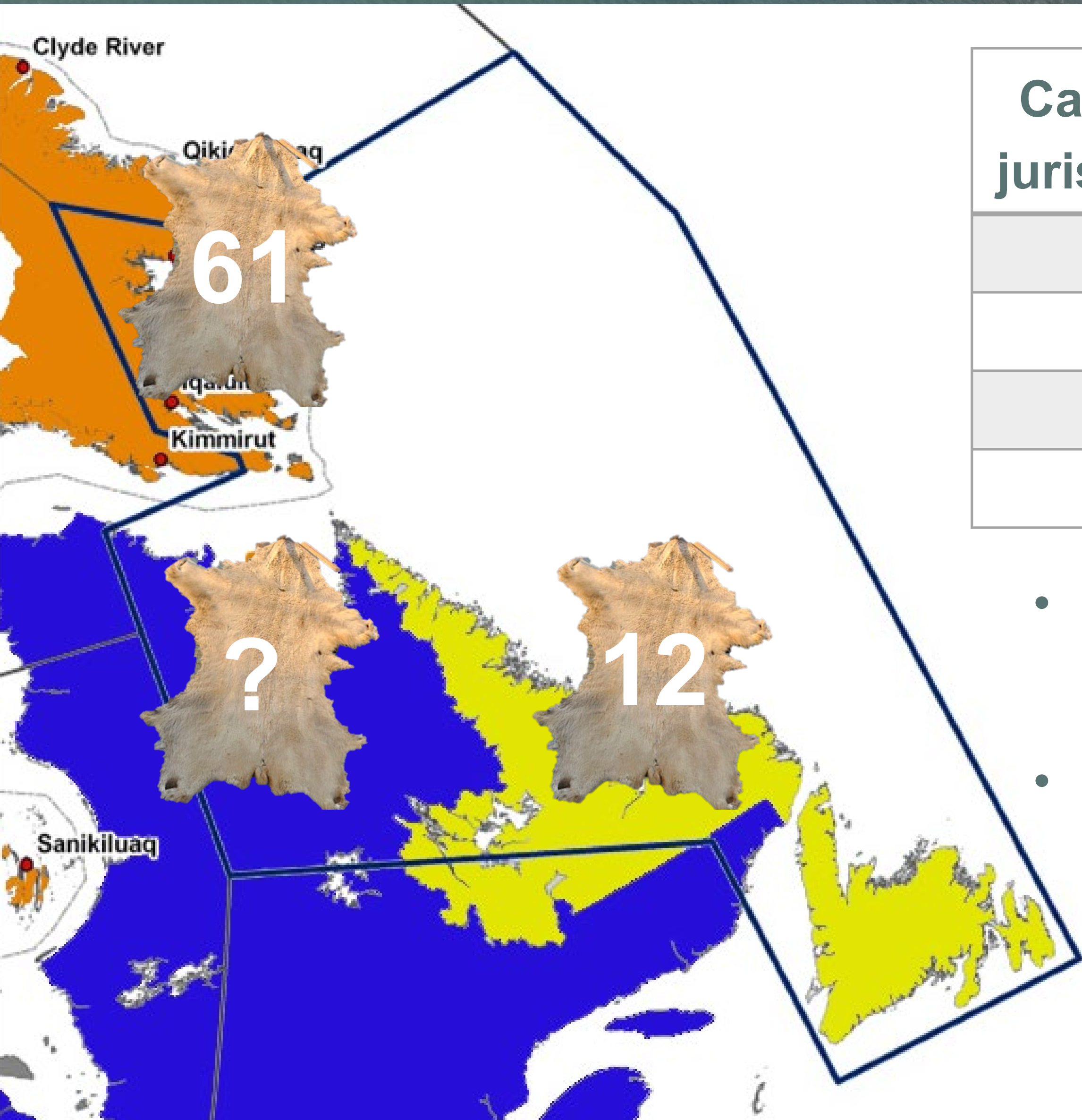
Analyses

Abundance

- Less abundance in 2017-2018 than in 2005-2007
- Why?
  - Increased harvest
  - Nunavut community objective to slightly decrease population size



Davis Strait Harvest Overview



Canadian jurisdiction	Harvest quotas	
	2005-07	**2017-18**
NL	6	12
QC	No quota	No quota
NU	46	61

- Nunavut harvest averaged: **44 bears/year** since quota increase to 61.
- Overall DS harvest **increased**
  - 1998-2008 = 64.1
  - 2009-2019 = 86.8

Davis Strait Harvest Overview

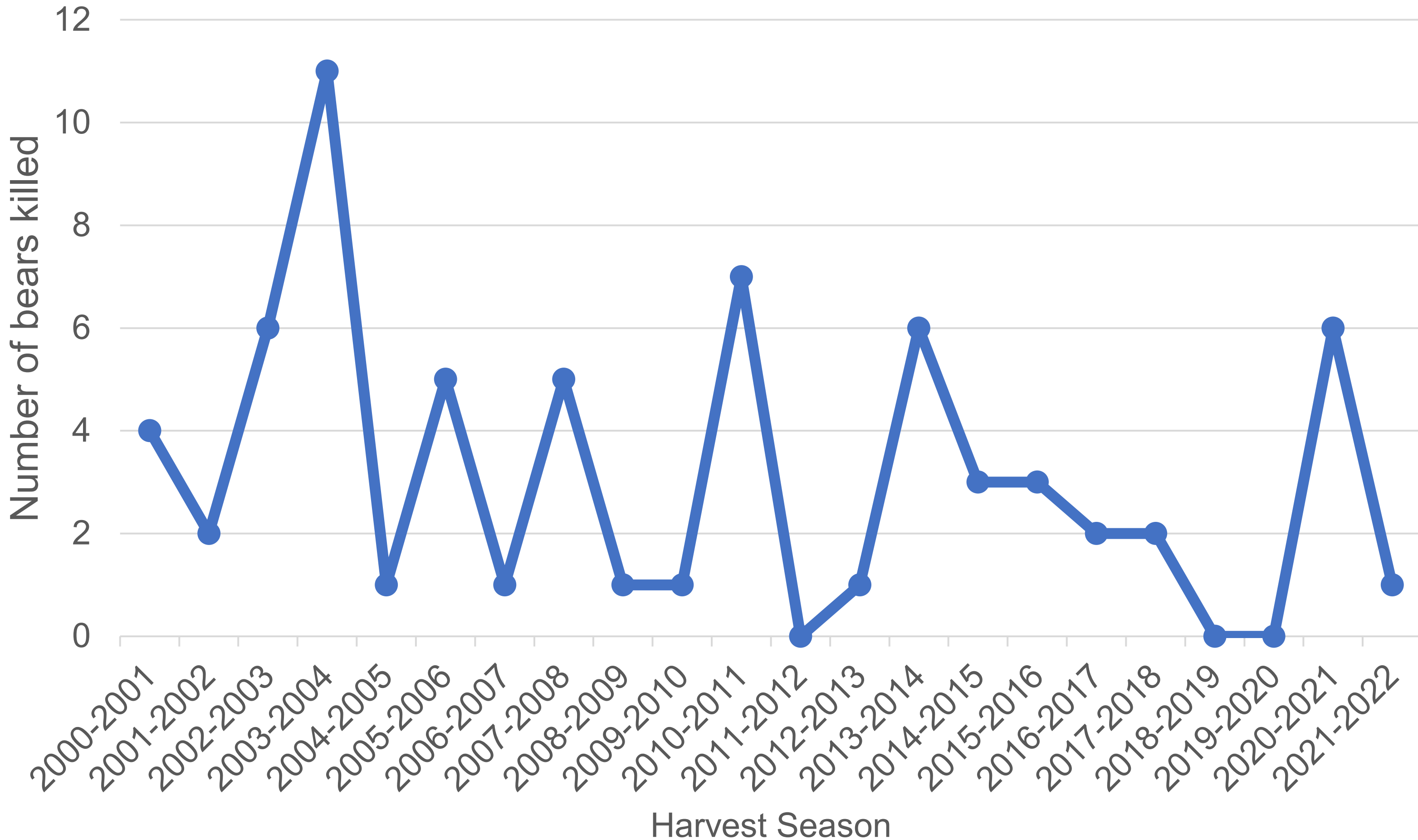
Harvest in Different Jurisdictions

Harvest Years	Jurisdiction				DS Mean	Proportion Female
	NU	Quebec	NL	GL		
1999-2008	39.4 ± 4.6	16.5 ± 8.4	5.9 ± 1.4	2.3 ± 2.0	64.1 ± 10.1	0.345
2009-2019	44.2 ± 10.1	30.2 ± 5.9	10.9 ± 3.5	1.5 ± 1.5	86.8 ± 23.6	0.350

- Nunavut **quota is 61,** but harvest has been about **44 bears a year** for last 10 years.
- 67 credits converted to tags in 2019/20 and 2020/21 and **none of those were used.**

Davis Strait Harvest Overview

Defence of Life and Property Kills (DLPK) in DS Nunavut



Nunavut Inuit Qaujimajatuqangit on the health of the Davis Strait polar bear population

ᓄᓇᕗᒻᒥ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᕿᑭᖅᑖᓗᒃ ᐃᑭᖓ ᐃᒪᖓᓂᑦ ᓇᓄᐃᑦ ᒥᒃᓵᓄᑦ

Dominique Henri
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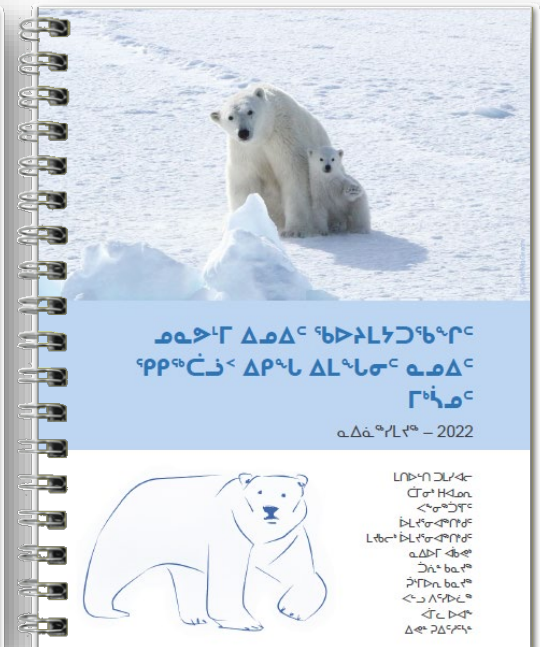

Environment and Climate Change Canada | Environnement et Changement climatique Canada

Polar Knowledge Canada | Savoir polaire Canada

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ᔮᓕ ᐋᑲᕚᒃ – ᓵᓐᑎ ᐋᑲᕚᒃ – ᕉᔅᒥᐊᓕ ᐊᓚ – ᔫ ᐋᕐᓗᖅᑐᖅ – ᔪᐊᓂ ᐃᑭᑦᓗᐊᖅ – ᐋᑯᓗᒃᔪᒃ ᔫᑕᐃᑦ – ᐊᑭᒍ ᖅᑭᓕᖅᑎ – ᒥᑭᔾᔪᒃ ᑯᓗᓛᖅ – ᐱᑦᓯᐅᓛ ᒪᐃᑯ ᓴᐃᒪᑕ ᐅᓇᓕᒃ – ᐃᓚᐃᔭ ᐸᑦᓗᖅ – ᐃᔾᓯᐊᖅ ᐸᑦᓗᖅ – ᔩᓂ ᐸᑦᓗᖅ – ᖅᑰᔪ ᐸᑦᓗᖅ – ᑕᐃᕕᑎ ᑎᒥᓛᖅ – ᐊᐃᓴᒃ ᑎᒥᓛᖅ – ᐊᐃᑏ ᑎᒥᓛᖅ – ᓕᐅᐸ ᐊᑉᐸᓕᐊᓗᒃ ᒦᑲ ᐊᓕᕙᖅᑕᖅ – ᓕᓯ ᒥᐊᓕ ᑲᒃᑭᒃ – ᐲᑕ ᑲᓇᔪᖅ – ᐊᐃᕝᕙᓚᕼᐊ ᑮᓇᐃᓐᓇᖅ – ᓯᒥᐅᓂ ᑮᓇᐃᓇᖅ – ᒪᐃᑯ ᑭᓴ – ᑕᐃᕕᑎ ᑰᓂᓘᓯ – ᓛᓴᓘᓯ ᐃᓱᑦᓗᑕᖅ – ᔫᑎ ᒪᓐᓂᐊᐱᒃ – ᒫᑎᐅᓯ ᒪᓐᓂᐊᐱᒃ – ᔫᓂ ᒪᐃᒃ – ᑕᐃᕕᑎ ᓇᐅᔪᖅ – ᑕᓪᓚᒪᑦ ᐊᑎᖃᙱᑦᑐᑦ ᐃᓚᒋᔭᐅᓚᐅᖅᑐᑦ

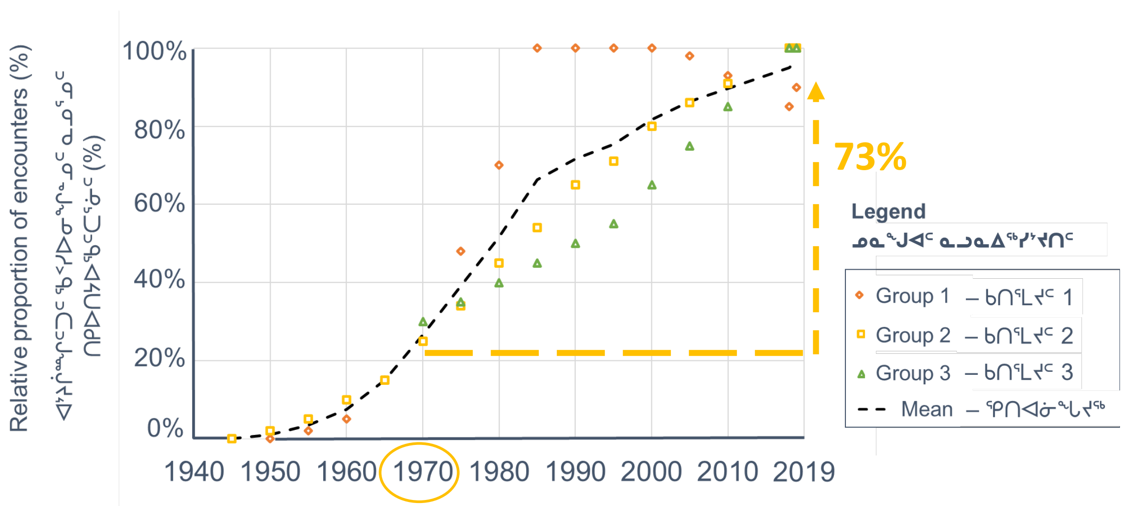
RESULTS

ᖃᓄᐃᖓᓂᐅᔪᑦ ᐊᒻᒪᓗ ᐅᖃᓪᓗᓇᒃᓴᐅᑎᓃᑦ

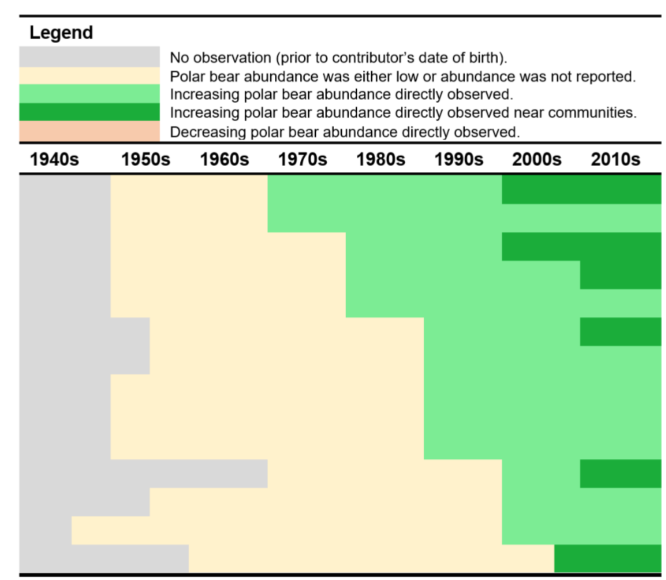
Overall, interview contributors from Pangnirtung and Kimmirut reported that polar bear numbers have greatly increased in both the Pangnirtung and Kimmirut areas.

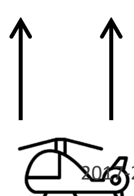
ᑕᒪᐃᓐᓅᖓᔪᒃᑯᑦ, ᑕᒪᐃᓐᓂᑦ ᑭᒻᒥᕈᒻᒥᑦ ᐊᒻᒪᓗ ᐸᖕᓂᖅᑑᕐᒥᑦ, ᐊᐱᖅᓱᖅᑕᐅᔪᓗᒃᑖᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓄᓇᖏᑦᑕ ᖃᓂᑕᖓᓂᑦ ᐊᒥᓱᙳᖅᓯᒪᓂᖏᓐᓂᒃ ᓇᓄᐃᑦ.

Kimmirut – ᑭᒻᒥᕈᑦ



Pangnirtung – ᐸᖕᓂᖅᑑᖅ





2005-2007 = 2,158 bears

Source: Peacock et al. 2013

2017-2018 = 2,015 bears

Source: Dyck et al. 2022

Results
ᖃᓄᐃᖓᓂᐅᔪᑦ ᐊᒻᒪ ᐅᖃᑦᓗᓇᒃᓴᐅᑎᓅᑦ

Overall, interview contributors from Pangnirtung and Kimmirut reported that the polar bears they see today are generally in good body condition and healthy.

ᑕᒪᐃᓐᓅᖕᒐᔪᒃᑯᑦ, ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐸᖕᓂᖅᑑᒥᑦ ᐊᒻᒪ ᕿᒻᒥᕈᒻᒥᑦ ᐅᖃᓚᐅᖅᑐᑦ ᓇᓄᐃᑦ ᐅᑉᓗᒥᐅᔪᖅ ᖃᓄᐃᖕᒋᑦᑐᑦ, ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖕᒋᑦ ᑕᑯᕝᕕᒋᖃᑦᑕᖅᑕᖕᒋᓐᓂᑦ.

- ✓ an increase in polar bear numbers systematically observed by participants over their lifetime

  ᐊᒥᓱᖖᒍᓇᐊᖅᓯᒪᓂᖕᒋᑦ ᐊᔾᔨᒌᒃᑐᓂᒃ ᐅᖃᐅᓯᐅᔪᑦ ᐃᑲᔪᓚᐅᖅᑐᑦ ᐃᓅᓯᖕᒋᓐᓂᑦ

- ✓ females with two cubs most frequently observed

  ᐊᖅᓇᓗᐃᑦ ᒪᖅᕉᖕᓂᒃ ᐊᑎᖅᑕᖅᑐᑦ ᑕᑯᔭᐅᒐᔪᓛᖖᒍᑉᓗᑎᒃ

- ✓ rare reports of polar bear disease or non-hunting related mortality

  ᐊᒻᒪ ᐱᑕᖃᕋᔪᖖᒋᓐᓂᕋᖅᑕᐅᔪᑦ ᐋᓐᓂᐊᖅᓂᖅᑲᖅᑐᑦ
  ᓇᓄᖅᓂᒃ ᑕᑯᔭᐅᖃᑦᑕᖅᓂᖕᒋᑦ ᐅᕝᕙᓘᓐᓃᑦ
  ᓇᓐᓄᒃᑕᐅᖕᒋᔅᓱᑎᒃ ᑐᖁᔪᑦ

Results
ᖃᓄᐃᖓᓂᐅᔪᑦ ᐊᒻᒪᓗ ᐅᖃᑦᓗᓇᒃᓴᐅᑎᓃᑦ

However, contributors pointed to some subtle changes in polar bear health, including a slight decline in polar bear fatness noted by some participants and occasional reports of fur loss (alopecia).

ᑭᓯᐊᓂ, ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᐅᖃᓚᐅᖅᑐᑦ ᐊᓯᐊᙳᖅᓯᒪᓂᐊᕐᔪᖕᓂᑦ ᓇᓄᐃᑦ ᖃᓄᐃᖏᓐᓂᖏᓐᓄᑦ, ᐃᓚᐅᑉᓗᑎᒃ ᓇᓄᐃᑦ ᐅᖅᓱᖃᓗᐊᖏᓐᓂᖅᓴᐅᓕᖅᑐᑦ ᖃᐅᔨᓴᐅᔪᑦ ᐃᓚᖏᓐᓄᑦ ᐃᑲᔪᓚᐅᖅᑐᓄᑦ ᐊᒻᒪᓗ ᖃᑯᑎᒃᑯᑦ ᒥᖅᑯᖃᙱᓐᓂᖏᑦ.

Participants had also observed changes in polar bear prey availability and habitat condition over time, including changes in sea ice quality and quantity and a decline in the number of ringed seal observed around both Kimmirut and Pangnirtung.

ᐃᑲᔪᓚᐅᖅᑐᑦ ᖃᐅᔨᓯᒪᖕᒥᔪᑦ ᐊᓯᐊᙳᖅᑐᓂᑦ ᓇᓄᐃᑦ ᓂᕆᔭᒃᓴᖅᓯᐅᖃᑦᑕᖅᑕᖏᑦ ᒪᓂᒪᓂᖏᓐᓂᑦ ᐊᒻᒪᓗ ᐃᓂᖏᔭᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᓐᓂᑦ, ᐃᓚᐅᔪᑦ ᐊᓯᐊᙳᖅᑐᖅ ᑕᕆᐅᑉ ᓯᑯᖓᑕ ᖃᓄᐃᓐᓂᖓ ᐊᒻᒪᓗ ᓯᑯᑕᖃᐅᕐᓂᖓ ᐊᒻᒪᓗ ᓇᑦᑏᑦ ᐊᒥᓲᔪᖕᓃᕐᓂᖅᓴᐅᔪᑦ ᖃᐅᔨᓴᐅᔪᑦ ᖃᓂᑕᖏᓐᓂᑦ ᑭᒻᒥᕈᑦ ᐊᒻᒪᓗ ᐸᖕᓂᖅᑑᑉ.

Results
ᖃᓄᐃᖓᓂᐅᔪᑦ ᐊᒻᒪᓗ ᐅᖃᓪᓗᕆᒃᓴᐅᑎᓃᑦ

Contributors emphasized that *nanuq* is a resilient and opportunistic predator that is highly adaptable to changes in prey availability and habitat conditions.

ᐱᖃᑕᐅᓚᐅᖅᑐᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᖅ ᓇᓄᐃᑦ ᐊᔪᙱᓕᒃᑲᓐᓂᕈᓐᓇᖅᑐᑦ ᐊᒻᒪᓗ ᐱᕙᖅᑲᓕᑐᐊᕈᑎᒃ ᓂᕆᔭᒃᓴᖅᓯᐅᖅᑎᐅᔪᑦ ᐊᔪᕆᑦᑐᖕᓇᑦᑎᐊᖅᖤᑎᒃ ᐊᓯᐊᙳᖅᑐᓄᑦ ᓂᕆᔭᒃᓴᖏᑦ ᒪᓂᒪᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐃᓂᒋᖃᑦᑕᖅᑕᖏᑦᑕ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ.

Results from this study highlighted public safety concerns arising from increased human-polar bear interactions and encounters.

ᖃᓄᐃᖓᓂᐅᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᖅ ᐃᓄᓗᒃᑖᑦ ᐊᑦᑕᕐᓇᖅᑐᖅᑲᖕᒋᑦᑐᒦᑎᑕᐅᓂᖕᒋᑦ ᐃᓱᒫᓘᑎᓂᒃ ᐃᓄᐃᓪᓗ ᓇᓄᐃᓪᓗ ᑎᑭᐅᑎᔾᔭᑎᖃᑦᑕᖅᓂᖏᓐᓄᑦ.

QUJANNAMIIK / NAKURMIIK / Thank you
ᖁᔭᓐᓇᒦᒃ / ᓇᑯᕐᒦᒃ

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Environnement et Changement climatique Canada

Polar Knowledge Canada
Savoir polaire Canada

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ᑕᒪᓐᓇ ᐱᓕᕆᐊᖅ ᑮᓇᐅᔭᖃᕐᓇᓚᐅᖅᑐᖅ ᐊᕙᑎᓕᕆᔨᒃᑯᓐᓂ ᓯᓚᒧ ᐊᓯᔾᔨᐸᓪᓕᐊᓂᖓᓂ ᑲᓇᑕᒥ, ᐊᕙᑎᓕᕆᔨᒃᑯᓐᓂ ᓄᓇᕗᑦ ᒐᕙᒪᒃᑯᖏᓐᓂ, ᐆᓗ ᖃᐅᔨᒪᓂᖏᑦ ᑲᓇᑕᒥ, ᓄᓇᕗᑦ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᑦ, ᐊᒻᒪᓗ ᓄᓇᕗᑦ ᐅᔾᔨᓯᖅᑏᑦ ᐸᕐᓇᒃᑎᖏᑦ.

Next Steps – Harvest Management

	Western Science Study	Inuit Qaujimajatuqangit Study
Question	**Result**	**Result**
Body Condition	Better in 2017-2018	Good condition
Cubs	Relatively stable	Females with 2 cubs most often observed
Survival	Relatively stable	Stable
Polar bear abundance	Stable/slight decline	Increased
Health		Hair loss sometimes
Prey abundance		Ringed seals declined
Sea Ice		Changes in quality & quantity

Next Steps – Harvest Management

- Do you agree that the number of polar bears **stayed relatively the same** over time?

- Are there **enough** bears to harvest? Are there **too few**? **Too many**?

- What did you observe in the bears' **body condition** over time?

- Is there anything **special** that you observed and wanted to share with us?

- Where do you **agree/disagree** with our findings?

Next Steps – Harvest Management

- Think about **how your HTO would like to manage** the Davis Strait subpopulation?

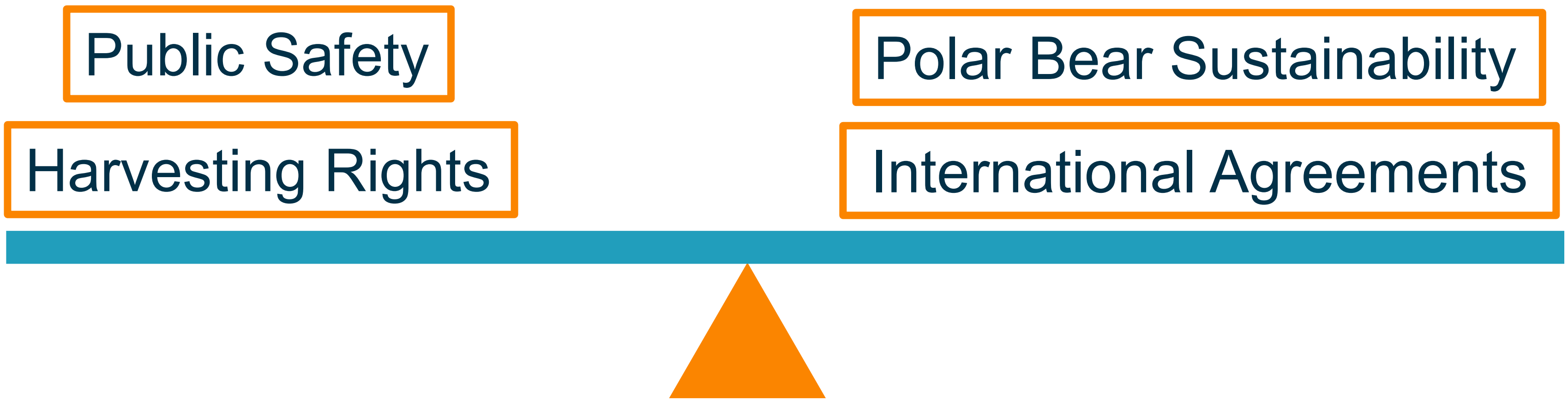
- Davis Strait is **a shared subpopulation** between Canada and Greenland
  - Within Canada: Newfoundland and Labrador, Nunavut, and Québec

- Decisions on management will **likely be a multi-jurisdictional process** so Nunavut should have a clear position on the management goal for Davis Strait
  - We will keep you and other partners informed as this process develops

Next Steps – Harvest Management

Job of the Department of Environment

- Balancing act



Draft Total Allowable Harvest (TAH)

- The current TAH for Davis Strait in Nunavut is 61 bears per year.
- Department of Environment at this time is **not recommending a change** to the TAH
    - This is because of
        - Management objective of a **slight decrease** and **slight population decline**
        - **Overall DS stable** (body condition, reproduction, survival)

Dedicated to Markus Dyck.

Thank you for all of your hard work.

Thank you!

Questions?

August 8, 2023

Tommy Palliser
Executive Director
Nunavik Marine Region Wildlife Board

Miles Smart
Executive Secretary
Hunting, Fishing and Trapping Coordinating Committee

Re: New information related to the Davis Strait polar bear subpopulation for consideration

Dear Tommy Palliser and Miles Smart,

As you know, management authority for the Davis Strait (DS) polar bear subpopulation is a shared responsibility of the governments of Nunavut, Québec, Newfoundland and Labrador, Canada, and Greenland as well as the Wildlife Management Boards and Advisory Councils, including Nunavik Marine Region Wildlife Board (NMRWB), Hunting, Fishing and Trapping Coordinating Committee (HFTCC), Nunavut Wildlife Management Board (NWMB), and Torngat Wildlife and Plants Co-Management Board (TWPCB). The Government of Canada will continue to inform Greenland of new information as it becomes available.

We are writing to inform you that new scientific information is available on the DS polar bear subpopulation. Additionally, the DS Technical Working Group has prepared a subpopulation status report to summarize existing information (scientific and Indigenous knowledge) about DS polar bears, habitat/environmental conditions, and harvest levels. The Government of Nunavut has prepared a submission for a request for decision to the NWMB to reassess the DS Total Allowable Harvest for their regular meeting on August 30, 2023. As there is a need to consider neighbouring jurisdictions in decisions, we are requesting that this new information is considered by the NMRWB and HFTCC in relation to harvest by Nunavik Inuit within the DS subpopulation. In the absence of a coordinated process among jurisdictions involved to establish a harvest sustainable at a subpopulation level, and subsequently allocate harvest among stakeholders, we encourage the NMRWB and the HFTCC to share any information and/or recommendations regarding current harvest levels and needs of the Nunavik Inuit, with respect to the DS polar bear subpopulation with the NWMB. Such information, views, and recommendations may feed into discussions within the NWMB, while being responsive to other party's in the management of this shared resource.

The following attachments are provided for your consideration:

1. Dyck, M., Dunham, K.D., Ware, J.V., Koons, D.N., Regehr, E.V., Hosmer, D.W., Derocher, A.E., Dale, A. Pisapio, J., and Szor, G. 2022. *Re-estimating the abundance of the Davis Strait polar bear subpopulation by genetic mark-recapture.* Final Report, Government of Nunavut, Department of Environment, Iglulik.

2. *Davis Strait Polar Bear Subpopulation Status Report (hereafter, Subpopulation Status Report).*

Re-estimating the abundance of the Davis Strait polar bear subpopulation by genetic mark-recapture

A two-year genetic mark-recapture (biopsy) study was conducted in 2017 and 2018 involving all co-management partners with authority in DS to re-estimate the abundance of the DS polar bear subpopulation. The study included genetic biopsy samples collected in 2017 and 2018, live-capture data collected 2005-2007, and harvest recovery data collected annually from 2005-2018. Estimated abundance for the 2017-2018 period was 2,015 bears [95% CRI 1,603 - 2,588]. Polar bears were less likely to be in poor body condition in 2017-2018, compared to previous 2005-2007 physical mark-recapture, adult males and solitary females were in better body condition than subadults and females with dependent offspring. Mean cub-of-the-year and yearling recruitment appears to be sufficient to sustain the subpopulation.

Subpopulation Status Report

The Subpopulation Status Report was prepared by the DS technical working group, which comprises of representatives with management authority in DS (including governments, Indigenous Land Claims Organizations, and Wildlife Management Boards). It includes information about the current and historical abundance estimates, current and historical harvest levels, Indigenous knowledge, and scientific studies completed for the subpopulation.

Some additional considerations

Subpopulation status

- **In 2022, Canada's Polar Bear Technical Committee (PBTC) assessed the recent scientific trend in abundance for DS polar bear subpopulation to be "likely declined" based on scientific data.** The PBTC assessed DS abundance as 'likely declined' relative to the previous study (2005-2007) given that there was a 0.896 probability that subpopulation growth was <1 and thus the subpopulation most likely declined over this period. The PBTC also considered the potential for high harvest, at the time of the survey the DS subpopulation had been managed in Nunavut for a population reduction.

- **The PBTC's Indigenous knowledge trend of the DS subpopulation is 'increased'.** The assessment is based on information from a number of published sources, including the report completed by the NMRWB in 2019. In all studies, participants noted an increase in polar bear abundance since the 1970s (across Nunavik communities as well as hunting, camping, and traveling areas of Inuit from Kimmirut and Pangnirtung in Nunavut), and since the 1990s throughout Labrador.

Current harvest quotas and reported harvest (see full DS subpopulation status report for more details)

- Current harvest quotas for the DS subpopulation are as follows:
    - 61 polar bears per year in Nunavut (established in 2012/2013 under an assumption of 2:1 male to female harvesting). The current Total Allowable Harvest of 61 can include up to 50% female bears based on a 2019 decision from the NWMB.

    - 12 polar bears from February 1st to June 30th in Labrador (established in 2012, managed partially by sex with prohibitions on the harvest of females with cubs).

- 3 polar bears in Greenland (established in 2006 with mandatory reporting).

- There is no current annual limit in place for Nunavik Inuit harvesting within DS. Since the 2007/2008 harvest season (after the 2005-2007 study period), reported Nunavik take has averaged 25.5 polar bears per year with a sex ratio of approximately 1.9 males to 1 female from 1994/95 to 2021/22.

- Thus, the combined annual limit for Nunavut (61), Labrador (12), Greenland (3), and the average annual reported take by Nunavik Inuit (25.5) is **approximately 101 polar bears per year for the subpopulation as a whole.** Under the previous 2005-2007 abundance estimate of 2,158 bears, this equates to a removal rate of 4.7%. Under the current 2017-2018 abundance estimate of 2,015, this equates to a removal rate of 5%.

- However, an annual harvest of 63.4 polar bears per year has been estimated based on data reported to management authorities for the 5-year interval extending from 2017/18 to 2021/22 (38.0 in Nunavut, 10.6 in Labrador, 13.0 in Nunavik, and 1.8 in Greenland). Under the previous 2005-2007 abundance estimate of 2,158 bears, this equates to a removal rate of 2.9%. Under the current 2017-2018 abundance estimate of 2,015, this equates to a removal rate of 3.1%.

We would like to acknowledge the hard work and collaboration by co-management partners to complete the Polar Bear Management Plan for Québec, the Eeyou Marine Region and the Nunavik Marine Region (hereafter the QC-EMR-NMR Management Plan). Approach 1.3 of the QC-EMR-NMR Management aims to *revise the harvest registration process with the goal of achieving complete reporting of all human-caused mortality of polar bears.* Effective management and the long-term persistence of polar bears relies on the collection of accurate harvest information. The governments of Canada, Nunavut, and Québec are committed to continuing to work with co-management partners toward an effective polar bear management system in Nunavik Marine Region and Mainland Québec.

We look forward to hearing from you with respect to your consideration of the provided information.

Sincerely,

Caroline Ladanowski
Director, Wildlife Management and Regulatory Affairs Division, Canadian Wildlife Service
Environment and Climate Change Canada

Sébastien Lefort
Directeur, Direction de l’expertise sur la faune terrestre, l’herpétofaune et l’avifaune
Direction générale de la gestion de la faune et des habitats
Ministère de l’Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs

Jonathan Pynn
Acting Director, Wildlife Research and Management
Department of Environment
Government of Nunavut

cc Barrie Ford, Director, Wildlife and Research, Department of Environment, Makivvik Corporation
Jason Akearok, Executive Director, Nunavut Wildlife Management Board

SUBMISSION TO THE

NUNAVUT WILDLIFE MANAGEMENT BOARD

FOR

Information: **Decision:** **Recommendation: X**

Issue: Total allowable catch levels and 100 tonne inshore quota for Greenland Halibut in Subarea 0 for the 2024 fishing season.

Greenland Halibut (*Reinhardtius hippoglossoides*)

Background

A fishery for Greenland Halibut (GHL) exists in Northwest Atlantic Fishery Organization (NAFO) Subarea (SA) 0 which is divided into a northern region, Division 0A (Baffin Bay) and a southern region, Division 0B (Davis Strait), outside of the Nunavut Settlement Area (NSA). The commercial fishing season for GHL starts on January 1st and ends December 31st. A map illustrating NAFO Subareas and Divisions relevant to the Greenland Halibut fishery can be found in Appendix 1.

The GHL stock in SA0 is a part of transboundary stock shared between Canada (Division 0A and 0B) and Greenland (Division 1A to F offshore). At the request of both countries, the NAFO Scientific Council (SC) provides advice on sustainable harvest levels. NAFO does not regulate this stock; Canada and Greenland are responsible for regulation in their own domestic waters. Canada and Greenland have a longstanding informal agreement that the Total Allowable Catch (TAC) levels established on NAFO SC advice be divided 50/50 between the two countries.

For 2023 the SA0 GHL TAC is 16,502.5 tonnes (t), as set by the Minister of Fisheries and Oceans Canada. A breakdown of the current TAC between Divisions is as follows:

Fishing Area	**Fleet/Interest**	**2023 Allocation (t)**
NAFO Division 0A	Nunavut	8,604.99
	Inshore fisheries development	100.00
	Total 0A TAC	*8,704.99*

Fishing Area	**Fleet/Interest**	**2023 Allocation (t)**

NAFO Division 0B	Nunavut	3,840.59
	Nunavik	402.82
	Enterprise Allocation Holders	2,654.09
	Fixed Gear Competitive	900
	Total 0B TAC	*7,797.51*

In 2022, the TAC was almost fully prosecuted in both Divisions 0A and 0B.

Since 2006, 100 t from the Division 0A TAC has been allocated for inshore fisheries development to be utilized within the Nunavut Settlement Area within NAFO division 0A.

The Division 0A Greenland Halibut (GHL) fishery is a commercial fishery entirely designated to Nunavut (NU) interests. In 2006 and in accordance with the decision making process set out in the Nunavut Agreement (NA), the Nunavut Wildlife Management Board (NWMB) motioned to allocate 100 t of the Division 0A TAC for inshore fisheries development within the Nunavut Settlement Area (NSA); the motion was supported by the Minister of Fisheries and Oceans Canada (the Minister) and was allocated for the 2006 fishing season. Since the initial decision, the 100t inshore quota has consistently been maintained and deducted from the Division 0A TAC.

Once the 100 tonnes is allocated to the inshore, it is technically no longer considered commercial offshore quota and is to be fished in the 0A portion inside the NSA. The NWMB gives authority to the Qikiqtaaluk Wildlife Board (QWB) to suballocate the 100 tonnes through the NWMB Allocation Policy.

Consultation

An engagement meeting with Eastern Arctic Groundfish Stakeholder Advisory Committee (EAGSAC) members (including NWMB staff) to share their views on the SA0 GHL TAC and allocations for 2024, occurred on July 12, 2024. A meeting summary, including views presented, can be found in Appendix 2.

Science Information

NAFO SC advice:

In February, Canada and Greenland requested that the Northwest Atlantic Fisheries Organization (NAFO) Scientific Council (SC) evaluate whether data collected in 2022 is sufficient to reconsider the harvest level recommendation for 2024. If so, the NAFO SC was requested to provide an updated assessment of status and trends in the total stock area throughout its range and to advise on the 2024 TAC level.

The NAFO SC responded that the main surveys for Greenland halibut 0+1 Offshore in 2022 were carried out using a new vessel and gear. These data are not calibrated to the previous survey series and therefore, insufficient to update advice on appropriate TAC levels for 2024. As such, the advice from 2022 stands, and is as follows:

The main index for this stock has not been updated since 2017, consequently stock status is increasingly uncertain. However, SC notes that the stock varied without trend between 2013-17 while the fishery was increasing. Average catches during this period were 29,640t [for SA0 and SA1]*; therefore, SC recommends catches not to exceed this value in 2023 and 2024.*

The NAFO SC summary sheet for GHL in SA 0+1 offshore can be found in Appendix 3. The NAFO SC Research document for GHL in SA 0+1 offshore can be found in Appendix 4.

Recommendation

TAC decisions take into account many factors including: conservation; science advice; economic impacts; co-management and stakeholder views; land claim obligations and international considerations.

Potential options when the science is advising a decrease in harvest levels:

- Implement a TAC in line with the science advice (i.e. a reduction of 10.19% from 2023 level)
- Implement a lesser TAC reduction than advised by the science
- Maintain the previous year's TAC (i.e. 16,502.5 t)

As per Article 15, Part 3.4 of the *Nunavut Agreement*, DFO is seeking the advice of the NWMB for management decisions with respect to:

1. the TAC for Greenland Halibut in SA0 (offshore);
2. TAC distribution between 0A and 0B; and
3. the allocation of quota between fleets, including the inshore quota for fisheries development.

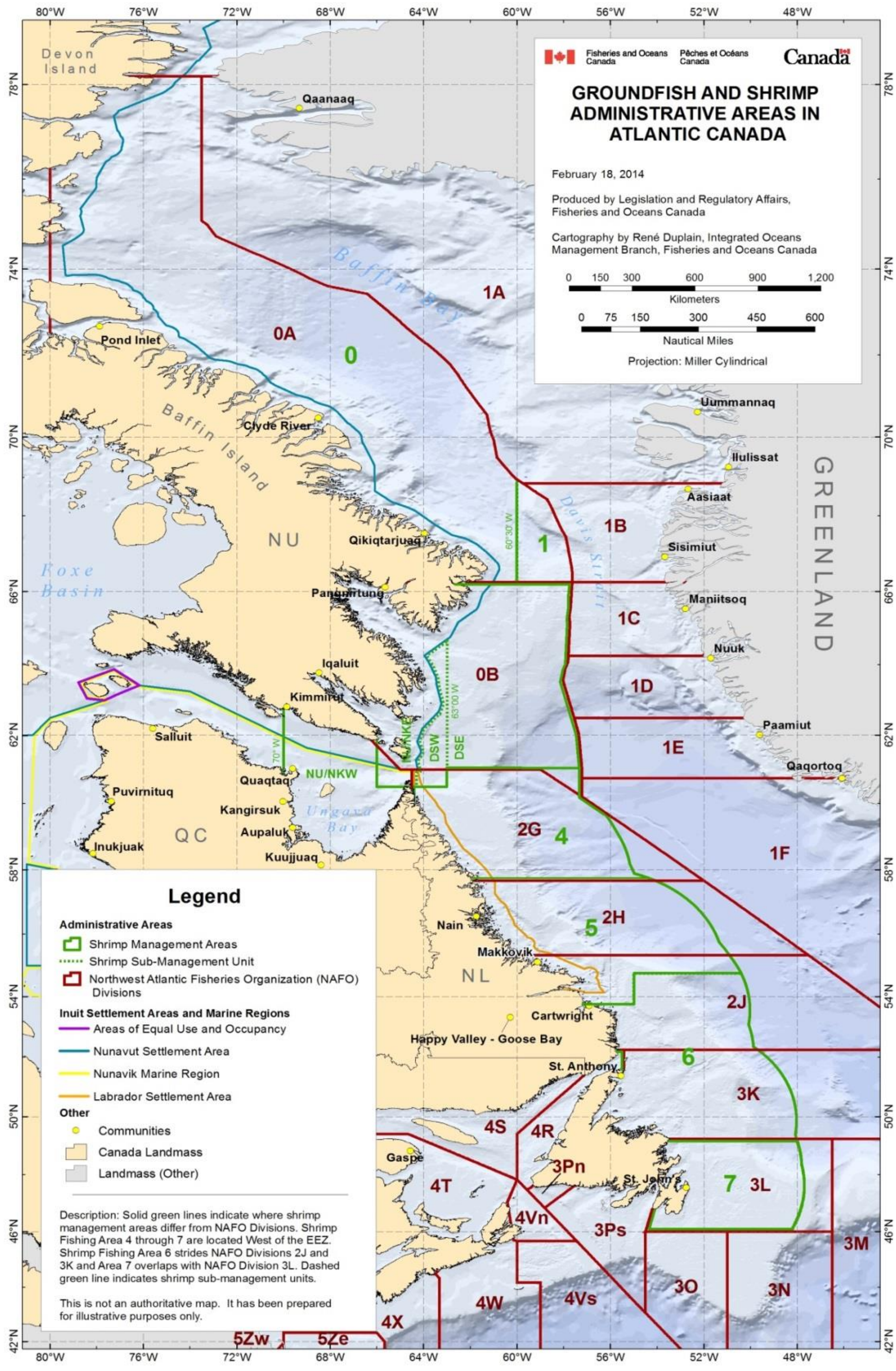
Prepared by: Fisheries Management, Fisheries and Oceans Canada

Date: August 03, 2023

Appendices

Appendix 1 – Map of groundfish and shrimp administrative areas in Atlantic Canada
Appendix 2 – Meeting summary of EAGSAC member views on 2024 Greenland Halibut total allowable catch
Appendix 3 – NAFO SC summary sheet
Appendix 4 – NAFO SC research (SCR) documents

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
Baffin Island
Clyde River
NU
Qikiqtarjuaq
Pangnirtung
Foxe Basin
Uummannaq
Ilulissat
Aasiaat
GREENLAND
1B
Davis Strait
Sisimiut
60°30' W
1
1C
Maniitsoq
Nuuk
1D
0B
Iqaluit
Kimmirut
63°00' W
Paamiut
Salluit
70° W
NU/NKE
DSW
DSE
1E
Qaqortoq
NU/NKW
Quaqtaq
Puvirnituq
Kangirsuk
Ungava Bay
Aupaluk
QC
2G
4
Inukjuak
Kuujjuaq
1F
Nain
2H
5
Makkovik
NL
2J
Cartwright
Happy Valley - Goose Bay
St. Anthony
6
3K
4S
4R
Gaspe
3Pn
St. John's
4T
7
3L
4Vn
3Ps
3M
3O
3N
4W
4Vs
4X
5Zw
5Ze

2024 GHL TAC – EAGSAC Member Views

Meeting Summary

July 12, 2023

Chair – Christi Friesen, Senior Regional Fisheries Management Officer, Arctic Region (AR), Fisheries and Oceans Canada (DFO)

EAGSAC Member Participants

Co-Management Organizations:

- Nunavut Wildlife Management Board (NWMB)– Leigh Gustafson

Commercial Fishery Associations:

- Nunavut Fisheries Association (NFA) – Derek Butler, representing:
    - Arctic Fishery Alliance (AFA)
    - Baffin Fisheries Coalition (BFC)
    - Cumberland Sound Fisheries Ltd (CSFL)
    - Qiqiktaaluk Corporation (QC)
- Northern Coalition (NC) – Alastair O'Rielly, representing:
    - Makivik Corporation
    - Labrador Fishermen's Union Shrimp Company Ltd.
    - Torngat Fish Producers Co-operative Society Ltd.
    - Nunatsiavut Group of Companies
- Atlantic Groundfish Council (AGC) – Bruce Chapman, representing:
    - EcoSound Fisheries
    - Ueushuk Fisheries
    - Harbour Grace Shrimp Co. Ltd
    - Ocean Choice International
    - Mersey Seafoods Ltd
    - Clearwater Seafoods Ltd
    - Nordic Ltd.

Commercial Fishers

- AFA – Dave Bollivar
- QC – Jerry Ward
- BFC – Chris Flanagan
- Cumberland Sound Fisheries Ltd. (CSFL) – Brittany MacLellan
- Ueushuk Fisheries/Innu Nation – Derrick Dalley
- Andrew Daley
- Niqitaq Fisheries – Paul Loder

Government Organizations

- Government of Nunavut (GN) - Zoya Martin

- Environment and Climate Change Canada - Jennifer Provencher
- DFO – Kevin Hedges, Research Scientist
- DFO – Kate Johnson, International Fisheries Policy

Observers

- QC – Brian Burke
- AFA - Harry Earle, Joeli Qamanirq, Devan Archibald, Lootie Toomasie
- GN – Delia Young
- DFO – Sandra Moore (FM-AR), Margaret Treble (SCI-O&P), Chantelle Sawatzky (SCI-O&P), Robyn Lee (RM-NL), Robyn Morris (RM-NL); Leigh Edgar (RM-NCR)

Purpose of Meeting:
For EAGSAC members to share their views on the Subarea 0 Greenland Halibut TAC and allocations for 2024.

A presentation was given by DFO Science (Kevin Hedges) to provide background to the (unpublished) NAFO SC response shared by DFO in early July. The science presentation included:

- Subarea 0 + 1 survey summary: the 2022 survey was completed, the 2023 survey is scheduled to start two weeks earlier to allow for better spatial coverage.
- NAFO SC response to the results of the CSAS meeting on bridging time series data gaps: positive responses, considerable interest in seeing model-based calibration tested further, contract being developed to conduct analyses for presentation at the 2024 NAFO SC meeting.
- The “SPICT” model: under development by Greenland Institute of Natural Resources, not accepted by SC in 2023 but shows merit and further development encouraged.
- Biomass Index and chart: DFO noted that the 2019 and 2022 data points should not be compared against the old time series because of the changes in vessel and gear without standardization. The Carruthers model is being further developed as a model based calibration. This model is to be presented to the NAFO SC at its June, 2024 meeting.

The Chair noted that timelines are being pushed a little earlier than they have been in past (e.g. sharing the unpublished NAFO SC response) to get on track for an earlier Ministerial decision.

Discussion:

- NC asked when NAFO SC might be in a position to provide a full stock assessment
    - DFO Science responded that two years of data is short, typically it’s 3 to 5 years, with 5 preferred.
- It was proposed by AGC that, before Canada next requests harvest level advice from NAFO SC on GHL in SA 0 + 1 offshore, that there be a discussion (including stakeholders) on whether NAFO SC is the best way to obtain science advice for this stock.

    - In lieu of a NAFO SC assessment, a “bilateral assessment process” was suggested, similar to what is done for other bilateral stocks on the east and west coasts. Some of these processes comprise invited experts, including from outside the two implicated parties.
    - The proposal for a separate conversation on this topic was supported by QC, NFA, NC, AFA, GN.
    - NC commented that as the management authority for Canada’s fishery, Canada is not required to follow the NAFO SC advice.

- GN inquired whether Greenland had been engaged regarding the TAC for 2024 and whether DFO can share what was discussed.
    - DFO International Fisheries Policy noted that a broader bilateral call took place on July 5, including to discuss early views, and that the next call specific to this issue is scheduled for August 18. This August 18 call is expected be the first of two to three, as stakeholder and partner consultations will not have concluded by then. DFO will consider what information from these discussions can be shared with stakeholders.
    - AGC felt (with others in agreement) that Canada’s TAC decision should not be ‘jammed’ into Greenland’s timeline and recommended that discussions with Greenland on setting the 2024 TAC should be postponed until after stakeholders have provided their views to DFO in writing.

- GN requested that the Department explain how the impacts (economic?) to Indigenous peoples specifically were taken into consideration in the decision making process to reduce the 2023 TAC.
    - DFO to follow up in writing.

TAC Views presented:

- Disagreement with the harvest level advice provided by NAFO SC in 2022 (AFA, NFA, GN, AGC):
    - Members re-iterated views presented last year (on the 2023 and 2024 TAC amounts), that there has been no evidence of stock decline and/or problems with stock health. No reasons to warrant a decrease to the 2022 harvest levels.
    - The biomass index from the 2022 survey (presented during the meeting) also does not indicate an issue with stock health.
    - An absence of scientific information, especially when there are no other negative indicators, is not a reason to apply harvest level decreases.
    - The decision to reduce the TAC was not based on sustainability.

- Views were presented that the NAFO SC advice is not in alignment with the Government of Canada’s description of precautionary approach and that the precautionary advice provided by NAFO SC did not consider economic impacts (AGC, AFA, NC, NFA).

- A number of members noted that they would like to review all of the NAFO SC information before providing DFO with a written submission of views.
    - DFO agreed and cancelled the July 28 due date. Once information is available, DFO will share the information and set a new deadline for written submissions.
- Action:
    - Christi (DFO) to follow up on GN question.

- DFO to provide NAFO SC information as soon as possible and follow up with a different deadline for written submissions.
- Meeting summary will be provided.

Greenland halibut in Subarea 0+1 (offshore)

Request by Canada and Denmark (Greenland): *Advice on Greenland Halibut, Offshore in Subareas 0 and 1 was provided in 2022 for the 2023 and 2024 fishing seasons. The Scientific Council is asked to evaluate whether the data collected in 2022 is sufficient to reconsider the harvest recommendation for 2024. If so, the Scientific Council is requested to provide updated advice on appropriate TAC levels for 2024, taking the new data into account.*

Scientific Council responded:

The main surveys for Greenland halibut 0+1 Offshore in 2022 were carried out using a new vessel and gear. These data are not calibrated to the previous survey series and therefore, insufficient to update advice on appropriate TAC levels for 2024.

The advice from 2022 is as follows:

The main index for this stock has not been updated since 2017, consequently stock status is increasingly uncertain. However, SC notes that the stock varied without trend between 2013-17 while the fishery was increasing. Average catches during this period were 29 640 t; therefore, SC recommends catches not to exceed this value in 2023 and 2024.

Data collected during 2022 have been evaluated by the SC. A survey series started in 2022 with a new vessel R/V Tarajoq, also using a new trawl gear (Bacalao 476). The deep surveys in Subarea 0 (expanded survey area in 2022 to include Division 0B and 0A-South) and Divisions 1CD were conducted; unfortunately, no comparative experiments between the different vessels and gears could be performed, as the former vessel R/V Paamiut was retired following the 2017 surveys.

Survey abundance and biomass indices were calculated but cannot be put into context with preceding data to examine trends. A model-based calibration (Huynh and Carruthers 2023) of survey data will be further explored for application with the current survey series, including validating using data from historic comparative towing experiments in other DFO regions. This work is expected to inform the scheduled 2024 assessment of this stock.

The new Bacalao trawl is expected to have different catchability from the previous Alfredo trawl used with the R/V Paamiut. The survey length frequency distribution has a similar range to preceding years, but relative catchability at length between the new and old gear is unknown. Higher numbers of small fish were observed in the catch, likely because of the change to using a Bacalao trawl, which has a smaller mesh size than the previous Alfredo trawl. A Stochastic Surplus Production Model In Continuous Time (SPICT; SRC Doc 23/031) that uses as input catches the combined deep-survey 0A-1CD index (1999-2017, and the 2019 index with uncertainty), and the shallow 1AF survey index of the biomass of fish > 35 cm was presented. SC noted concerns regarding the biomass scaling, especially at the start of the time series, raised questions about some parameter estimates (e.g. r), and suggested that priors be investigated further. The model was not accepted but model development is continuing.

NAFO SC determined that there is not sufficient new information from the 2022 surveys in Subareas 0 and 1 to reconsider the harvest recommendation for 2024. The SPICT model and model-based calibration work showed promise and will be developed further for the 2024 assessment.

Reference:

Huynh, Q.C., and Carruthers, T. 2023. Development of Spatial Operating Models to Test Survey Design and Calibrate a New Survey Index for Northwest Atlantic Fisheries Organization Subarea 0+1 (offshore) Greenland Halibut (*Reinhardtius hippoglossoides*). DFO Can. Sci. Advis. Sec. Res. Doc. 2023/038. iv + 35 p.

Appendix 4

NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N7423 **NAFO SCR Doc. 23/034**

SCIENTIFIC COUNCIL MEETING – JUNE 2023

Data available for the Greenland Halibut Stock Component inNAFO Subarea 0 + 1 (offshore)

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Abstract

The paper presents the data available for Greenland halibut in Northwest Atlantic Fisheries Organization (NAFO) Subareas 0 and 1 (offshore) that can be used for stock assessment. Since 1995 catches have been near the TAC, increasing in step with increases in the TAC. Greenland and Canada have conducted buffered random stratified bottom trawl surveys in Div. 1CD and 0A-South which are combined for the stock assessment. Surveys were not conducted in 2018, 2020 or 2021 and the 2019 survey was conducted with a charter vessel which after review of gear performance measures was not considered comparable to previous surveys. In 2022, a new survey index starts in 1CD and 0A-South with a new vessel and a new gear. As a result there has been no data from offshore surveys that could be used to give advice, since 2017. The combined 1CD-0A-South biomass index had been relatively stable from 1999 to 2017 and all values were above the Blim for the survey series. Abundance followed a similar pattern. An updated index of abundance of age 1 Greenland halibut from the shallow survey, in1AF, was available for 2022. An index of the exploitable biomass > 35 cm from that survey is also available and can be used for surplus production models. A CPUE index for trawlers fishing in SA 0+1 has been declining since a peak in 2018, and the gillnet CPUE for SA0 declined in 2021 after a continued increase from the beginning of the series in 2003 to 2020. It has been stable from 2020 to 2021. However, CPUE is known to have limitations as an index of population status.

1. Overview of the fishery

1.1.TAC Regulation

Greenland halibut in Subarea 0+1, including 1A inshore, came under quota regulation in 1976 when a TAC of 20,000 t was established (Fig. 1). TAC increased to 25,000 t in 1979. In 1994 analysis of tagging and other biological information resulted in the creation of separate management areas for inshore Div. 1A and Subarea 0+1A (offshore) and 1B-F. The portion of the TAC allocated to Subarea 0+1A (offshore) and 1B-F was 11,000 t and the TAC remained at this level from 1995-2001, during which time the TAC was fished almost exclusively in Div. 0B and Div. 1CD. A series of surveys took place during 1999-2004 in areas of Div. 0A and 1AB that had not been surveyed before. This new information on biomass in the stock area resulted in increases in the overall TAC of 4,000 t in both 2001 and 2003 and 5,000 t in 2006 that were allocated to Div. 0A and 1AB. From 2006 to 2009 the advised TAC in Div. 0A+1AB was 13,000 t and the TAC for 0B and 1C-F remained at 11,000 t. Based on an observed positive trend in the 1CD survey index the TAC for Div. 0B+Div. 1CF was increased by 3,000 t in 2010 and the overall TAC for Subarea 0+1 (offshore) remained at 27,000 t from 2011-2013. In 2014 the TAC for Div. 0A+Div. 1AB was increased by 3,000 t to 16,000 t based on positive trends in the survey indices and the overall TAC of 30,000 t remained through 2016. In 2016 an index based harvest control rule (HCR) was accepted as the basis for TAC advice and an increase of 2,300 t was advised for the entire Subarea 0+1A (offshore) and 1B-F stock area for 2017 and 2018. Scientific Council allocated the increase equally to Div. 0A+1A(offshore) and 1B, and 0B+1C-F. In 2018 the HCR was used to advise an increase of 4,070 t for the whole of Subarea 0+1A(offshore) and 1B-F with allocation among divisions left to the managers. In 2020 separate management areas were established for inshore fishing areas in 1B-F and the TAC for Subarea 0+1A-F (offshore) was maintained at 36,370 t for 2021 and 2022. However, in 2022, SC was unable to assess stock status because of a lack of usable survey data from 2018-2021, which followed a TAC increase in 2018. SC noted that the stock had varied without trend between 2013-2017, prior to the most recent TAC increase, and recommended that the TAC for 2023 and 2024 not exceed the average catch during period, 29,640 t. In 2023 both Canada and Greenland asked SC to determine if surveys conducted in 2022 provided sufficient new information to reconsider TAC advice for 2024; SC reviewed the new data and considered efforts to develop a model-based framework for this fishery, and determined that there was not sufficient new information to provide new TAC advice.

1.2.Catches in Subarea 0 + 1 (offshore)

Catches were first reported in 1964 and rose to 18,303 t in 1975 before declining to 187 t in 1986 (Fig. 1). Catches then increased to 17,888 t in 1992 due to a new trawl fishery in Div. 0B with participation by Canada, Norway, Russia and Faeroe Islands, and an expansion of the 1CD fishery with participation by Japan, Norway and Faeroe Islands (Tables 1 and 2). Catch declined from 1992 to 1995 primarily due to a reduction of effort by non-Canadian fleets in Div. 0B. Since 1995 catches have been near the TAC, increasing in step with increases in the TAC (Fig. 1). The TAC was 36,370 t from 2019 to 2022. In 2022 catches were 36,485 t. In 2023 the TAC was reduced by 9.25% to 33005 t.

Fisheries and Oceans Canada does not include the J-cut, tail off product in its list for Greenland halibut but an interim conversion factor of 1.49 was provided in at-sea observer manuals and used by vessel operators and observers since 2007. In 2021, at the request of the Canadian fishing industry, the CF for J-cut, tail off product was lowered from 1.49 to 1.4. Based on a review of at-sea observer experiments conducted in Subarea 0 the appropriate value to estimate round weight from J-cut, tail off, dressed weight is 1.5 (round weight = J-cut weight x 1.5), which is comparable with J-cut, tail off CF values used by other countries that fish in the SA0+1 stock area (Treble and Hedges 2022). In 2021 the difference amounted to the removal of an additional 1,129 t (round weight) of Greenland halibut (DFO statistics indicated 87% of Arctic Region catch and 90% of Newfoundland Region catch was processed as frozen, gutted, head and tail off, which describes J-cut product). The 2021 SA 0 catches have been adjusted accordingly , but not in 2022(Table 1). In 2022 the two conversion factors were used for quota reconciliation (1.4) and to determine the total biomass removed (1.5), with the difference resulting in the removal of an additional 653 t (round weight) of Greenland halibut.

Inshore fisheries in the fjords of Div. 1A-F and in Cumberland Sound in Div. 0B are managed separately. However, there is no way to differentiate or separate inshore from offshore catch in the totals reported for these divisions in STATLANT 21A statistics, so it is necessary to rely on the Greenland and Canadian authorities to determine the offshore catch for Subareas 0 and 1.

1.3.Distribution of catches

The Greeland halibut fishery took place in two localized areas: the Baffin Bay (North area in 0A and 1AB) and the David Strait (South area in 0B and 1CD). Fishing occurred in comparable areas in 2022 relative to preceding years (Figures 2 and 3). In Subarea 0 fishing was concentrated along the Baffin Island shelfbreak between approximate 61°N and 72°N (Figure 2). In Subarea 1 fishing effort was concentrated on the shelf break in Div. 1A-B and within the David Strait in Div.1C-D (Figure 3).

1.4 Landing trends

Landings split by areas and countries are only available from 1987 (Figure 3). The fishery in the Northern area (0A1AB), in Baffin Bay, started around 2000s. Only very small landings were reported in 0A by foreign countries. In 0A, all landings since the 2000s are from Canada, and in 1AB, 90-95 % by Greenland. In the South area, split data from Canada are available only from 1999. Until 1995, in 0B, catches were caught by foreign countries (Russia, Norway and Faroes) and in Greenland waters, most of the landings are from Japan and Norway. From 1995, all landings in 0B are from Canada. In Greenland, landings in 1CD are a mixture of Greenland and foreign countries (Norway, Faroes, Germany and Russia) (Figure 4, 5 and 6).

Bottom otter trawl gear is primarily used in the Subarea 1 fishery while the Subarea 0 fishery is a mix of trawl and gillnet (30-40% of the catch in recent years has been from the gillnet fleet). Longline gear is used occasionally in both Subareas (Figure 7 and 8). The trawlers have been using both single and double trawl configurations since about 2000. The gillnet fishery in Subarea 0 began in 2005 and has been using baited gillnets since about 2015. These baited gillnets have recently been reported to increase catch of Greenland halibut by 150% to 250%, depending on how the bait is attached to the gear (Bayse and Grant 2020).

All landings in the Northern area from the third and fourth quarters of the year. In the Southern area, a small portion is caught in the first and second quarters (Figure 9).

1.5.Catch per unit of effort:

Subarea 0 + 1 (offshore) Trawl CPUE

The trawl catch rate is standardized using a General Linear Model. Data were aggregated by Year, Month, Gear, catches (t) and hours fished. Values less than 10 are removed. CPUE observations were log-transformed prior to the GLM analysis. Data were fit in R v. 4.40.40. (R Core Team, 2020) and least squares means were estimated with package "emmeans" (Lenth et al. 2018).

Catch rates for SA1 were available from logbooks submitted by all countries to the Greenland authorities. Until 2008 the fleets in the catch rate analysis have been grouped by nation, but information about gross tonnage is now available in the Greenland logbook database and the fleets are grouped based on size and gear. This has not changed the trends in the CPUE series, but the SE and CV of the estimates have been reduced significantly.

The standardized CPUE for trawlers in SA 0 and 1 increased from 1999 to 2018 and has declined since then (Fig. 10) (Appendix 2).
The gillnet catch rate is also standardized using a General Linear Model. Data were aggregated by Year, Month, Gear, Country/region (Newfoundland and Arctic), catches (t) and nets fished (per 100 nets). Gillnet CPUE increased from the beginning of the series in 2003 to 2020, then declined in 2021. It has been stable from 2021 to 2022 (Fig. 11) (Appendix 3).

CPUE indices should be interpreted with caution:

1) It is not known how the technical development of fishing gear has influenced the catch rates. For example the catch from single and double trawl gear was often aggregated as “otter trawl” catch when this gear was first introduced to the fishery in the early 2000s and bait has been attached to the gill nets in SA0 beginning in 2015;
2) Coding of gear type in the log books is not always reliable, which can influence the estimation of catch rates;
3) Changes in fleets and fishing grounds have occurred in both SA0 and SA1.

2. Sampling from Greenland halibut landings

Distribution of the samples

Information on fisheries and sampling in SA 1 for 2022 were available from Greenland (Nogueira and Nyggard, 2022) and Russia (Fomin and Pochtar 2022) research reports. The distribution of commercial samples in 2022 is shown in Figure 12.

<u>2.1 Length Distribution</u>

Trawler

Length frequency samples available from SA0 and SA1 fisheries have been combined to create an overall length frequency. Given the differences observed in length frequencies between Baffin Bay (Div. 0A+1AB) and Davis Strait (Div. 0B+1CD) plots of these areas are also provided. In SA0 and SA1 the modal length has varied from 49 to 51 cm (Fig. 13). From 2004 to 2014 the mode was at or below 50 cm, since 2014 the mode has remained above 50 cm. In the Baffin Bay area (0A+1AB) the length frequency range is typically 20 to 90 cm with a mode fluctuating between 45-51 cm (Fig. 14). In the Davis Strait area (0B+1CD) the length frequency range is typically 30 to 100 cm, with a mode varying between 45 and 53 cm (Fig. 15).

Gillnet

Length samples were available from gillnet fisheries in SA0 and are plotted for 2006 to the present. Lengths typically range from 40 to 90 cm. Prior to 2014 modal size was approximately 61 cm, from 2015 to 2020 it varied around 59 cm. The 2020 sample was much lower than in other years that may have affected the results for that year. In 2021 there was a decline to approx. 56 cm (Fig. 16).

Longline

There is occasionally a longline fishery in SA1. Length frequencies were available from Greenland for Divs. 1AB (2001 and 2016) and 1CD (2001, 2005-2009 and 2013). The longline length frequencies have been combined for the whole SA1. Longlines typically catch larger fish (40 to 100+ cm) and in Div. 1CD the modal length has been in the range of 55 cm (Figure 17).

<u>2.2 Age Distribution</u>

Preliminary results from otoliths sampled during the 2019 SA 0 fishery ranged in age from 4 to 26 years, with a modal age of 12 years (Fig. 18).

<u>2.3 Bycatch and Discards</u>

Discards of Greenland halibut in the trawl fishery in both Subareas is small, normally 1- 2% of retained Greenland halibut. Discards in the Subarea 0 gillnet fishery are slightly higher but usually not more than 3% of the retained catch.

By-catch is estimated by observers on board vessels in SA 0. The targeted at-sea observer coverage is 100% for both the trawl and gillnet fisheries in Div. 0A, 100% for the trawl fishery in Div. 0B and 20% for the gillnet fishery in Div. 0B. The 20% gillnet target is has not always been met, particularly in 2020 and 2021, due to the COVID-19 pandemic. A summary of by-catch was done for 2021 fishing trips licensed by Fisheries and Oceans Arctic Region. Overall bycatch was <2 % of the observed Greenland halibut catch. Bycatch in the gillnet fleet was 2-3%, slightly higher than in the trawl fleet (1-2%). Bycatch in SA0 was mainly comprised of 4 species, Greenland shark, roughhead grenadier, Arctic skate and northern wolffish.

By-catch was available from a number of logbooks of Greenland vessels fishing in SA 1 during. These data are not complete but do provide a rough estimation of the primary by-catch species for 2017 to 2019. The highest in terms of biomass was Greenland shark (*S. microcephalus*), followed by Redfish (Sebastes species), skate species and roundnose grenadier (*C. rupestris*) (Treble et al 2022).

3. Research Survey Data

3.1 Surveys conducted during 1987 to 1996

Surveys began in SA0 and SA1 in the mid 1980's with surveys conducted in 0B by Russia and Germany and in 1BCD jointly by Greenland and Japan (Fig. 18). Since 1997 surveys have been conducted in 0B and 0A-South by Canada and in 1CD by Greenland using the same research vessel (Fig. 18).

3.2 Greenland and Canada Surveys in Divisions 1CD (Davis Strait) and 0A-South (Baffin Bay)

Greenland and Canada have conducted buffered stratified random bottom trawl surveys at depths 400 m to 1500 m in Div. 0A-South (to approximately 72^{o} N) (since 1999) (Figure 20 and in Div. 1CD (since 1997) (Figure 21 (using the GINR RV Paamiut and fishing with an Alfredo bottom trawl gear. The 0A-South area was re-stratified in 2008 to include the full extent of Division 0A and to match the depth categories used in the Greenland Subarea 1 stratification. In 2019 there was a change in the research vessel (CV Helga Maria) and in the survey timing; August instead of Sept for Div. 1CD and August instead of September-October for 0A-South (Treble 2020, Nogueira and Estevez-Barcia 2020, Wheland et al. 2020). The vessel used the same Alfredo gear but comparative analysis shown that the gear performed differently at depths > 700 m. As a result the 2019 index is not comparable with the rest of the time series (Nogueira and Treble 2020). No surveys were conducted in 2018, 2020 and 2021. In 2022, a new survey times series started in 0A and 1CD with a new reseach vessel owned by GINR, R/V Tarajoq and using a different gear, Bacalao bottom trawl.

Given the common research vessel and survey protocols it was possible to develop a combined biomass and abundance time series index for 1CD and 0A-South for years 1999, 2001, 2004, 2008, 2012, 2014-2017 with R/V Paamiut. The combined index was also estimated in 2019 with C/V Helga Maria and in 2022 with R7V Tarajoq although they are not comparable the indices from the different vessels(see Nogueira and Estévez-Barcia 2022, Hedges 2022 for individual survey details). The combined biomass indices from the 3 vessels and the length distributions are in figures 20 and 21. Biomass in 1CD and 0A-South combined was relatively stable from 1999 to 2014, varying between 124,000 t and 172,000 t. It then increased to 213,000 t in 2016, followed by a decline to 138,000 t in 2017. In 2019 biomass was 164,000 t and in 2022, it was 222 400 t (Figure 22).

The overall length distribution (weighted by stratum area) in 1CD was dominated by a mode at 51cm from 2006 to 2017, an increase from a mode of 45 cm observed in 2000. In 2019 and 2022 the mode was 53 cm (Nogueira and Estévez-Barcia 2020, Nogueira and Estévez-Barcia 2022). There has been more variability in the 0A-south length frequency, with a primary mode around 45 cm and secondary modes varying between 20 and 30 cm (Treble 2020). The frequency distribution for 1CD and 0A-South combined typically ranges from 5 cm to just over 100 cm. In 2019 length ranged from 5 to 108 cm. Modal length has varied between lows of 42 cm and 43 cm in 1999 and 2001, respectively, to a high of 51 cm in 2015. In 2019 the modal length was 51cm. Secondary modes are clearly present in 2008, 2012-2017. In 2022, distribution has a similar range to preceding years but there were higher numbers of small fish in the catch, likely because of the change to using a Bacalao trawl. (Fig. 23).

3.3 Greenland Shrimp and Fish shallow survey

Since 1988 surveys with a shrimp trawl at shallow waters have been conducted off West Greenland during July-September. The survey covers the area between 59º N and 72º 30' N (Div. 1A-1F) from 50 m to 600 m (Figure 24). The survey area was re-stratified in 2004 based on better information about depths. All biomass and abundance indices have been re-calculated. The re-calculation did not change the trends in the development of the different stocks. The Skjervoy trawl was changed to a Cosmos trawl in 2005. Calibration experiments were conducted (Rosing and Wieland, 2005), and data from 1988 to 2004 were converted so the time series are comparable. The RV Paamiut was used for the survey from 1991 to 2017. In 2018 the CV Sjuderberg was used to conduct the survey, in 2019 and 2020 the CV Helga Maria and in 2022 the new vessel R/V Tarajoq. An examination of gear parameters found that the effects of these vessel changes had a minimal effect on trawl performance (Nogueira and Treble 2020, Nogueira et al. 2022). No survey was conducted in 2021.

Greenland halibut is widely distributed throughout the 1A-F survey area, but highest concentrations are found in nursery areas in Division 1A, 1B-North and Disko Bay (Fig. 19). Biomass has varied with a general increasing trend from 2014to 2022 (Fig. 25). Abundance of age 1 has been more variable (Fig. 26), with notable peaks of high abundance in 2011, 2013 and 2017. Abundance is mainly driven by year to year variability in the number of one- and two-year old recruits, which typically constitute 80-90% of the Greenland halibut caught during the survey (Nygaard and Nogueira, 2022).

Clear modes can be found in the length distribution at 12-15 cm and 23 cm (fig. 27), corresponding to fish at age 1 and 2, using the Peterson method to assign age based on length frequencies (Nygaard and Nogueira, 2021). This allows for the development of an age-1 index. Since 2003 there has been an overall declining trend, with the exception of three large year classes producing high abundances of age 1 fish in 2011, 2013 and 2017. The index declined from 2017 to 2019 but in 2020 and 2022 it had increased to a level near average for the last 10 years. It is unclear if the age 1 abundance index is representative of future recruitment.

Greenland halibut larger than 35 cm forklength in the Greenland shrimp and fish survey were examined separately as these fish are available to the Subarea 0+1 (offshore) fishery, and was used to explore a Stochastic Surplus Production Model in Continous Time (SPICT) (Nogueira et al. 2023). A biomass index for fish >35 cm increased from 1991 to a peak in 2004, subsequently declined and has varied without trend from 2006 to 2022. Length frequency data for these fish showed gradual increases in the maximum length observed and number of fish between 35 and 45 cm forklength prior to 2004 (Fig. 28 and 29). Since 2004 the maximum length has been relatively stable and the majority of fish have fallen between 35 and 55 cm forklength.

3.4.Survey Age distribution

There has been uncertainty in the accuracy of age determination methods for Greenland halibut which were resolved at a workshop held in Iceland in 2016 (ICES 2017). Effort is currently under way to age the back log of otoliths in order to provide age data for future assessments. Growth curves are available for male and female Greenland halibut for 2017. Female ages ranged from 3-32 years and males from 3-28 years. Age at 45 cm was approximately 10 years for both males and females.

Survey Length-at-maturity

Maturity information collected during surveys in SA0 were examined in 2006 and updated in 2009 (Harris et al. 2009). Few fish were found to be mature. For females in 0A-South and 0B the length at 50% maturity (L50) ranged from 67-84 cm and 62-67 cm, respectively. Males don’t grow to be as large as females and their L50s in 0A-South were 54-65 cm and in 0B it was 39-43 cm.

6. Conclusion

The surveys that provide the main index for this stock were not conducted in 2018, 2020 or 2021. The survey in 2019 was conducted with a charter vessel and after review of gear performance measures it was not considered comparable to previous surveys. In 2022, a new time series started with a new research vessel, R/V Tarajoq, using a new trawl gear, Bacalao. As a result there has been no data from offshore surveys since 2017. From 1999-2017 the 0A-South+1CD combined survey biomass index had been relatively stable with more variability observed near the end of the time series and all values were above Blim.

There is an update from 2022 for the Greenland fish and shrimp survey in Divs. 1A-F. Although the survey experienced vessel changes during 2018-2020 and 2022, the results are considered comparable with previous years. Since 2003 the abundance index has had an overall declining trend, with the exception of three large year classes in 2011, 2013 and 2017. Abundance of age-1 fish was near average in 2020. It is unclear if the age-1 abundance index is representative of future recruitment. An index of exploitable biomass > 35 cm has been estimated from that survey and it has been used as input in a surplus production model,

Since 1995, catches have been near the TAC, increasing in step with increases in the TAC, reaching a high of 36,446 t in 2019. The TAC from 2019 to 2022 has been 36,400 t and catches in 2022 were 36 400 t.

The surveys and trawl fisheries have almost all seen slight increases in modal lengths over the last 10 to 15 years, from values below 50 cm (48-49cm) to values above 50cm (51-52cm). However, the modal size in the SA0 gillnet fishery has declined, from approx. 61 cm to 59 cm, and in 2021 it was approx. 56 cm.

A standardized CPUE index for trawlers fishing in SA 0+1 has been declining since a peak in 2018 and the gillnet CPUE for SA0 declined in 2021, after a continued increase from the beginning of the series in 2003 to 2020. In 2022, the CPUE was stable. However, CPUE is known to have limitations as an index of population status.

Data collected in 2022 are not sufficient to give a new advice in 2023.

7. Research Projects

Fisheries and Oceans has undertaken research on geospatial and other population models that could be used to improve the stock assessment. Preliminary findings were reviewed during a DFO meeting to be held in late fall 2022. Outcomes of the DFO meeting, with particular details regarding an approach for a model-based survey calibration, were presented to STACFIS in June 2023. The model-based calibration approach will be furthere developed during 2023-2024 for consideration during the next stock assessment at the NAFO SC meeting in June 2024 (Huynh and Carruthers, 2023).

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Table 1. Greenland halibut catches (metric tons) by year and country for Subarea 0, 1987 to 2019. Based on STATLANT, with information from Canada used to exclude 0B inshore catch.

	0A			0B			SA0
Year	CAN	Other[a]	TOT 0A	CAN	Other[a]	TOT 0B	Total
1987					388	388	388
1988				2	1022	1024	1024
1989				180	907	1087	1087
1990				844	8909	9753	9753[b]
1991				395	8350	8745	8745
1992				2624	10164	12788	12788
1993	681		681	592	6605	7197	7879[c]
1994				402	4274	4676	4676
1995	82		82	1859	1292	3151	3233
1996		576	576[d]	2354	1678	4032	4608
1997	3		3	3868	452	4320	4323
1998				3924		3924	3924
1999	517		517	4267		4267	4784
2000				5438		5438	5438[e]
2001	2628	445	3073	5034		5034	8107
2002	3561		3561	3910		3910	7471[f]
2003	4142		4142	5059		5059	9201
2004	3751		3751	5771		5771	9522
2005	4209		4209	5789		5789	9998
2006	6634		6634	5585		5585	12219
2007	6173		6173	5318		5318	11491
2008	5257		5257	5175		5175	10432
2009	6627		6627	5622		5622	12249
2010	6390		6390	6941		6941	13331
2011	6365		6365	6814		6814	13179
2012	6365		6365	7257		7257	13622
2013	6314		6314	7352		7352	13666
2014	7934		7934	7003		7003	14937
2015	7922		7922	7491		7491	15413
2016	7559		7559	6402		6402	13961
2017	8458		8458	7932		7932	16390
2018	8408		8408	7563		7563	15971
2019	9708		9708	8619		8619	18327[g]
2020	9429		9429	8489		8489	17918[g]
2021	10061		10061	9033		9033	19094[gh]
2022	9582		9582	9033		9033	18616[i]

a Other countries may include Faroe Islands, Poland, Russia, Estonia, Latvia, Japan, or Norway.
b Norwegian catch double reported.
c The Russian catch is reported as area unknown, but has previously been reported from Div. 0B
d Caught under a Canadian charter.
e STACFIS estimate
f Excluding 782 tons reported by error
g STATLANT 21A data are not available
[h] STACFIS estimate using 1.5 conversion factor for J-cut, tailed product; 1,129 t increase over reported catch.
[I] Logbook data

Table 2. Greenland halibut catches (metric tons) by year and country for Subarea 1 from 1987 to 2019, not including inshore areas. Based on STATLANT, with information from Greenland used to exclude 1A-F inshore catch.

	1AB				1CF							SA1
Year	GRL	RUS	FRO	TOT 1AB	GRL	RUS	FRO	EU	NOR	JPN	TOT 1CD	Total
1987					1646					855	2501	2501
1988					605					1576	2181	2181
1989					540					1300	1840	1840
1990					841		54			985	1880	1880
1991					933		123		611	673	2340	2340
1992					191		151		2432	2895	5669	5669
1993					186	5	128	46	2344	1161	3870	3870
1994					872		780	266	3119	820	5857	5857
1995					1399	296		527	2472	323	5017	5017
1996					1876	254		455	1785		4370	4370
1997					2312		127	446	1893		4778	4778
1998			117	117	2295	543	125	350	1338		4651	4768
1999					2529	552	116	330	1360		4887	4887[a]
2000			96	96	2059	792	147	444[b]	1590		5032	5128
2001	340	85	150	575	2012	829	150	537[b]	1550		5078	5653
2002	1619	279	150	2048	2284	654	150	536	1734		5358	7406
2003	3558	259	117	4007	2059	1328	135	543	1423		5488	9495[cd]
2004	3500	241	153	4035	2102	1214	150	665f	1364		5495	9530[ce]
2005	3363	549	125	4037	2380	1147	149	549	1456[b]		5681	9718[e]
2006	5530	565	128	6223	2430	1222	147	544	1379		5722	11945[e]
2007	5596	575	125	6296	1805	689	150	1516	1441		5601	11897[e]
2008	5524	570	149	6243	1592	763	184	1517	1452[b]		5508	11751
2009	6094	517	124	6735	1457	1057	149	1511	1514		5688	12423
2010	5682	654	126	6462	2491	1214	152	1818	1581		7256	13718
2011	5722	648	102	6472	2493	865		1824	1720		6902	13374[e]
2012	5810	546	103	6459	2660	1227		1784	1761		7432	13891
2013	5865	546	102	6513	3514	1223		2017	1496		8250	14763[e]
2014	7333	550	102[b]	7985	4072	1224		1751	1464		8511	16496[f]
2015	7366	548	102	8016	3834	1215		1880	1503		8432	16448[f]
2016	7682	550	103	8335[g]	4367	1215		1885	1382		8849	17184[f]
2017	8003	549	103	8655	4968	1224		1929	1495		9616	18271[f]
2018	7953	550	104	8607	3079	1121		1878	1488		7566	16173
2019	8821	550	103	9474	3995	1119		1881	1526		8521	17995
2020	7107	550	105	7762	5932	1118		1883	1429		10362	18124[f]
2021	7791	550	104	8445	4902	893		1673	1429		8897	17342
2022	8052	442	100	8594	5577	693		1556	1449		9275	17869[h]

a Excluding 7603 t reported to STATLANT in error

b Catch reported to the Greenland Fisheries License Control Authority.

c Includes Spanish research fishery catch, 75 t in 2003 and 272 t in 2004.

d Excludes 1366 t reported for Div. 1A in error

e STATLANT 21A data for Div. ICD from Greenland includes double reporting.

f STATLANT unknown catches for Greenland were distributed based on information from Greenland authorities or assumed to come from Div. 1A inshore.

g Norway STATLANT 21A reported catch in Div. 1A that was actually caught in 1D.

[h] GLKF catches

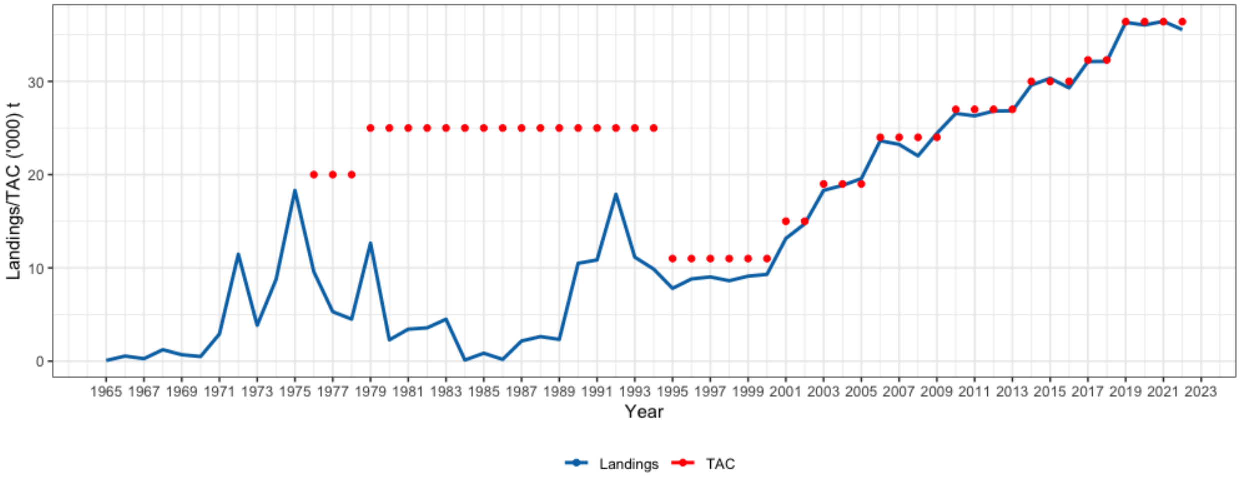

Figure 1. Catches and recommended TAC for SA0+1 (offshore) Greenland halibut.

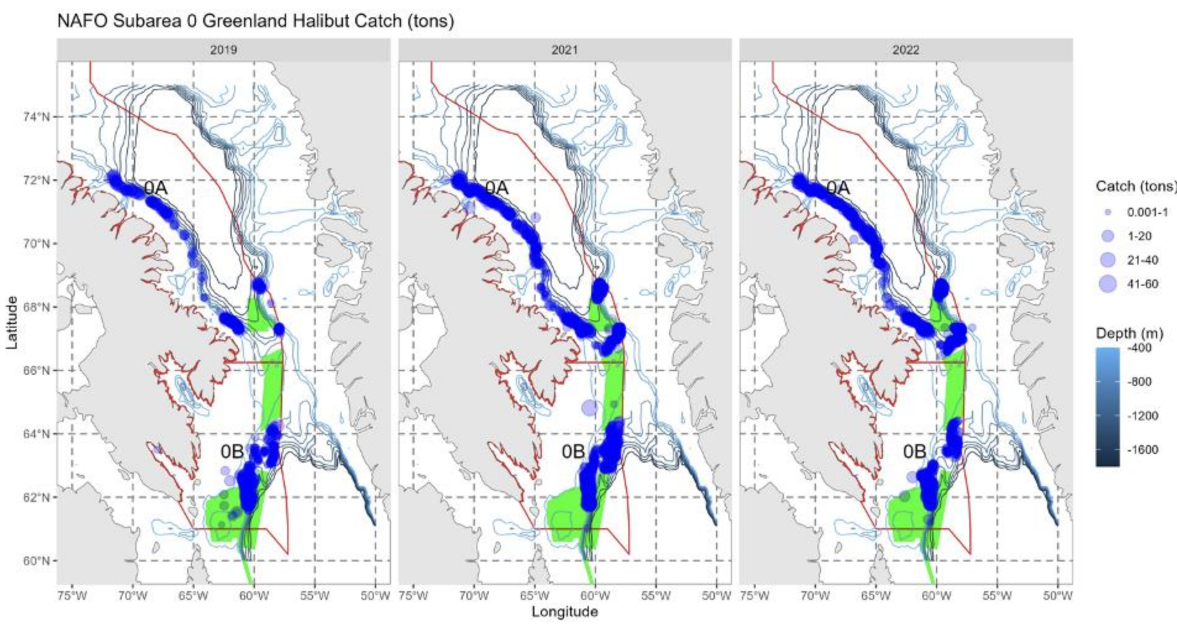

Figure 2. Greenland halibut. Catches distribution in Sub 0 years 2019, 2021 and 2022.

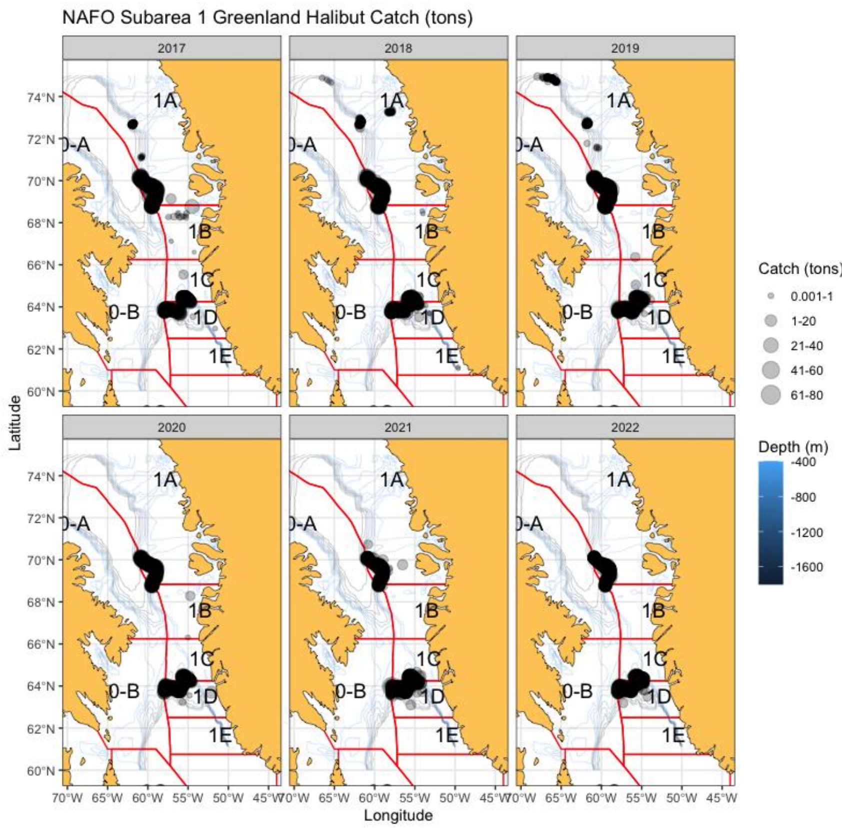

Figure 3. Greenland halibut. Catches distribution in Sub 1 years 2019- 2022.

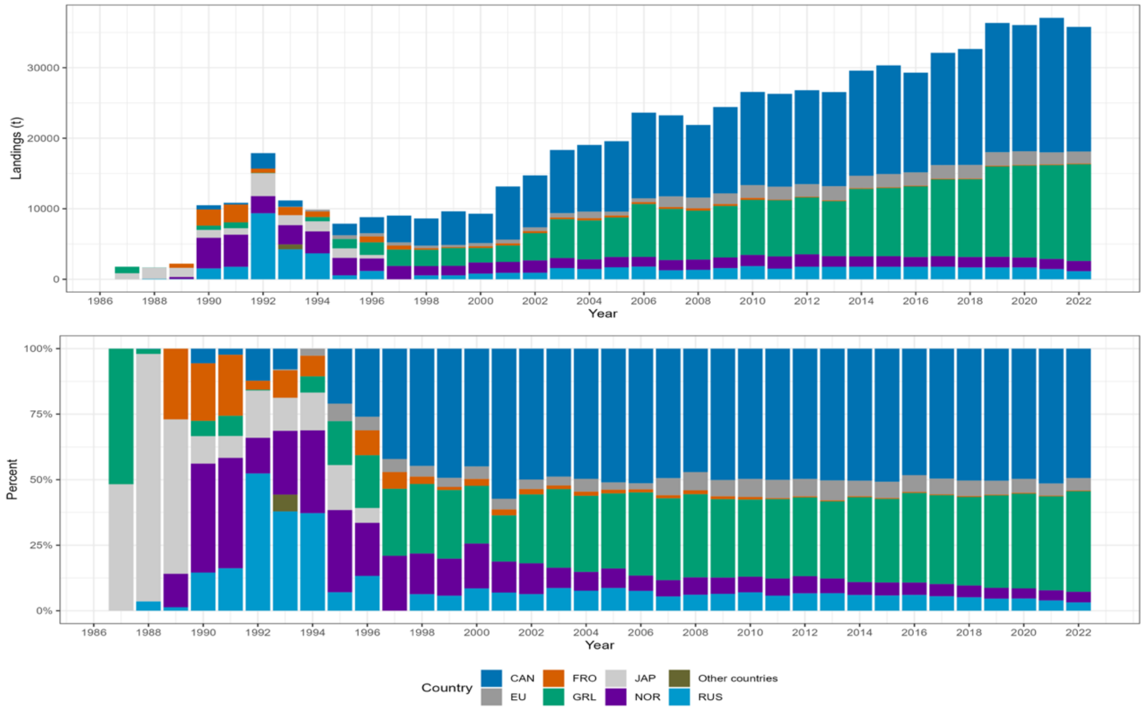

Figure 4. Greenland halibut. Landings from NAFO 0+1 offshore by nations (Canada, Greenland, Faroes, Japan, EU, Norway and Russia) in 1987-2022. All gears combined.

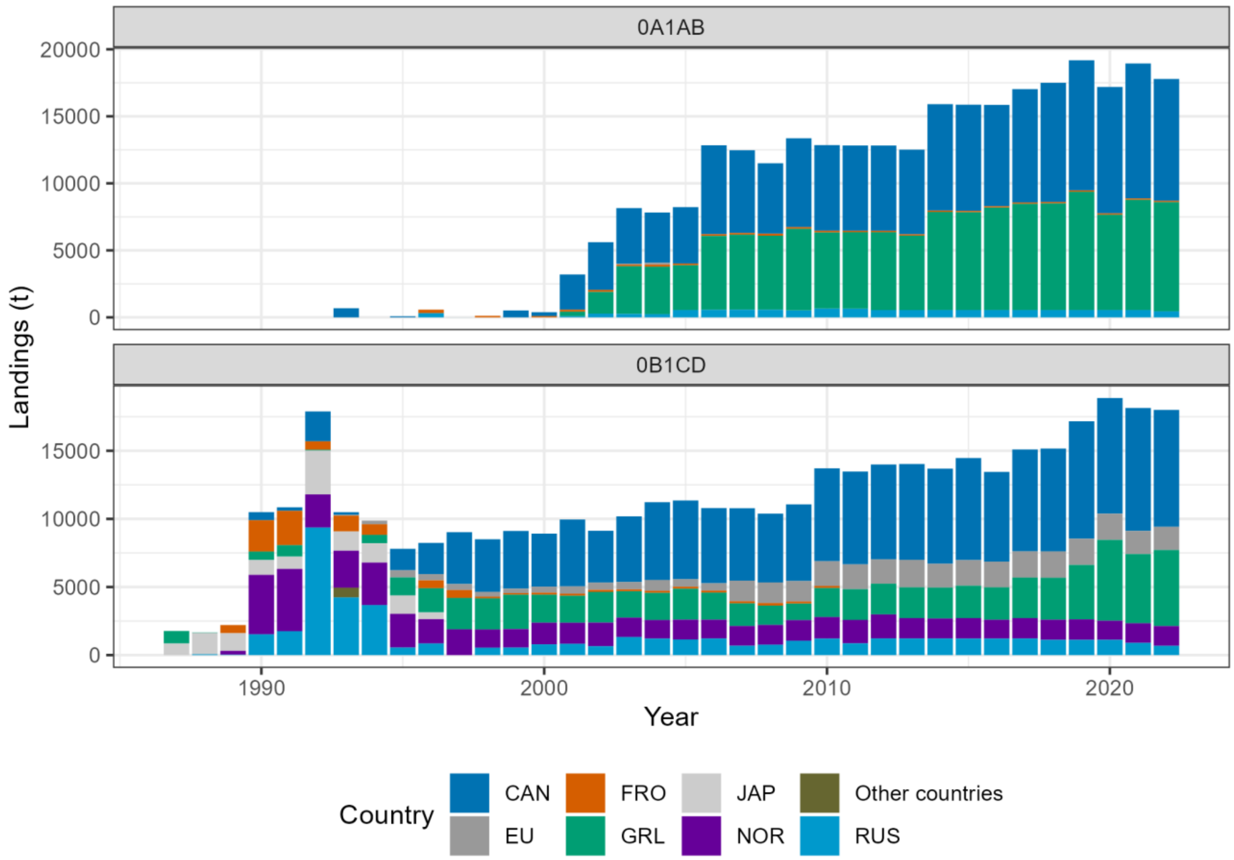

Figure 5. Greenland halibut. Landings from NAFO 0+1 offshore by nations (Canada, Greenland, Faroes, Japan, EU, Norway and Russia) and by areas (South and North) in 1987-2022. All gears combined.

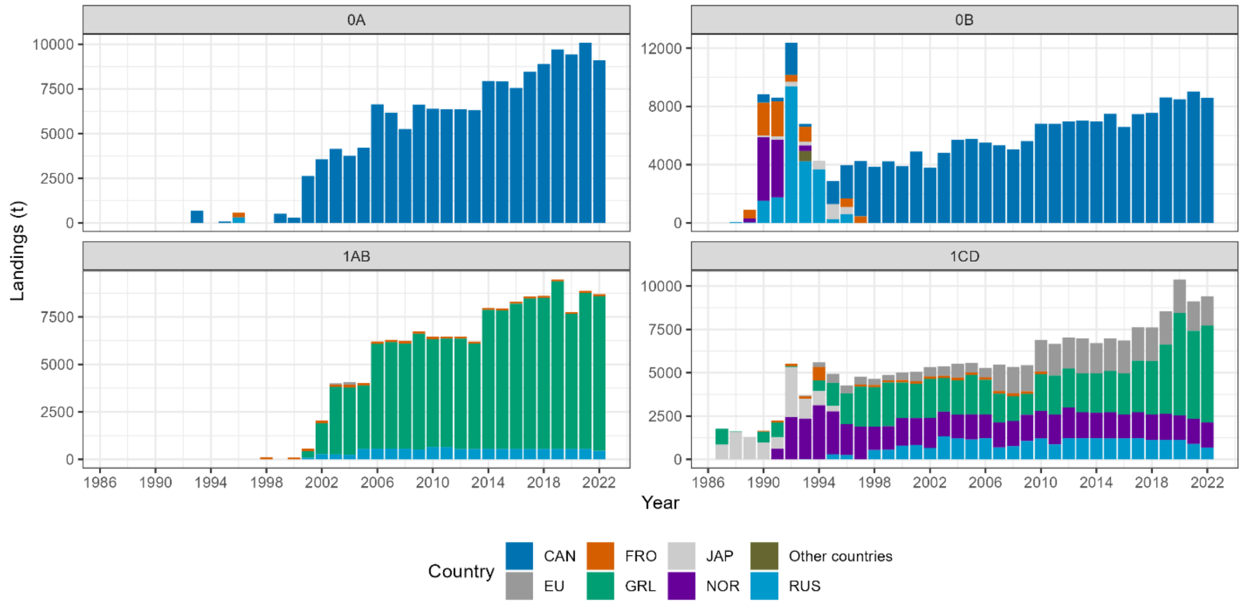

Figure 6. Greenland halibut. Landings from NAFO 0+1 offshore by nations (Canada, Greenland, Faroes, Japan, EU, Norway and Russia) and by divisions (0A, 0B, 1AB and1CD) in 1987-2022. All gears combined.

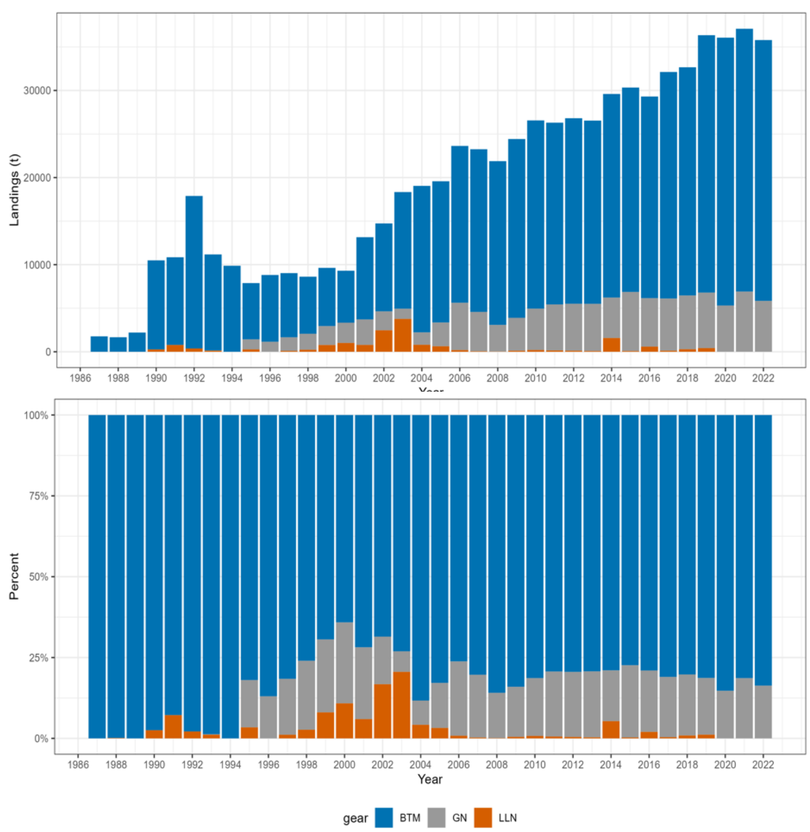

Figure 7. Greenland halibut. Landings from NAFO 0+1 offshore by gear (Trawl, Gillnet and Longliners) in 1987-2022.

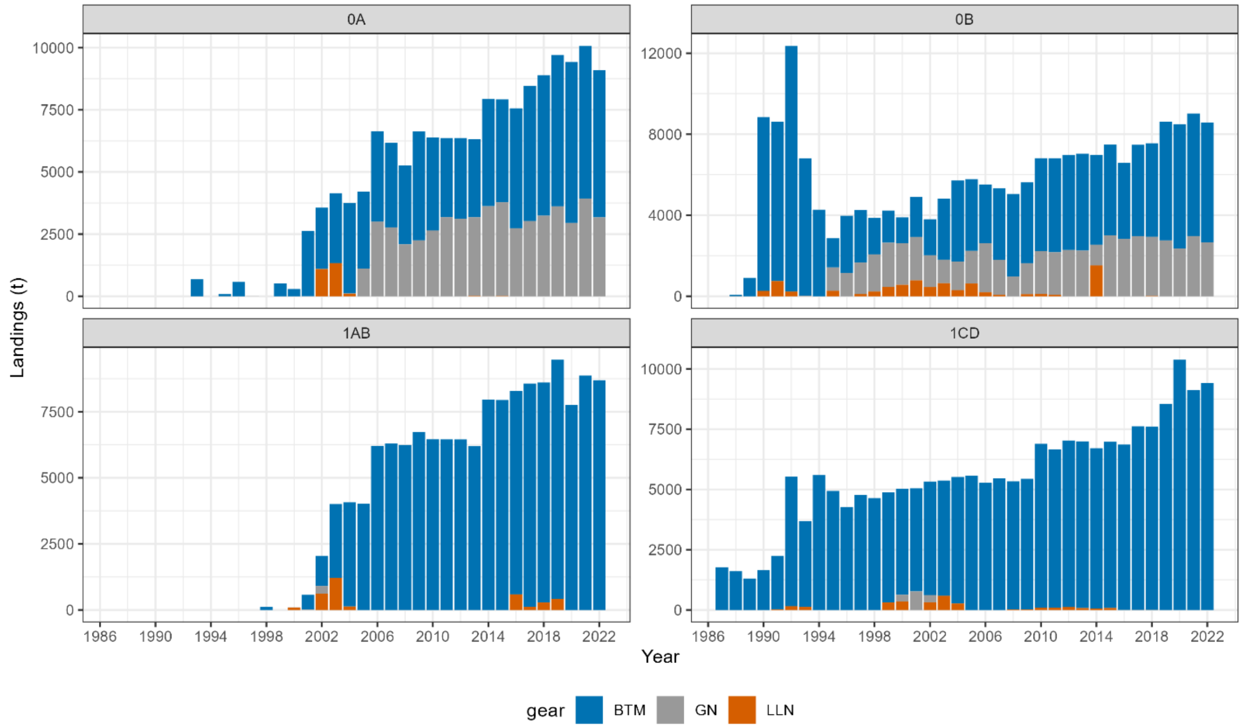

Figure 8. Greenland halibut. Landings from NAFO 0+1 offshore by gear (Trawl, Gillnet and Longliners) and divisions (0A, 0B, 1AB and 1CD) in 1987-2022.

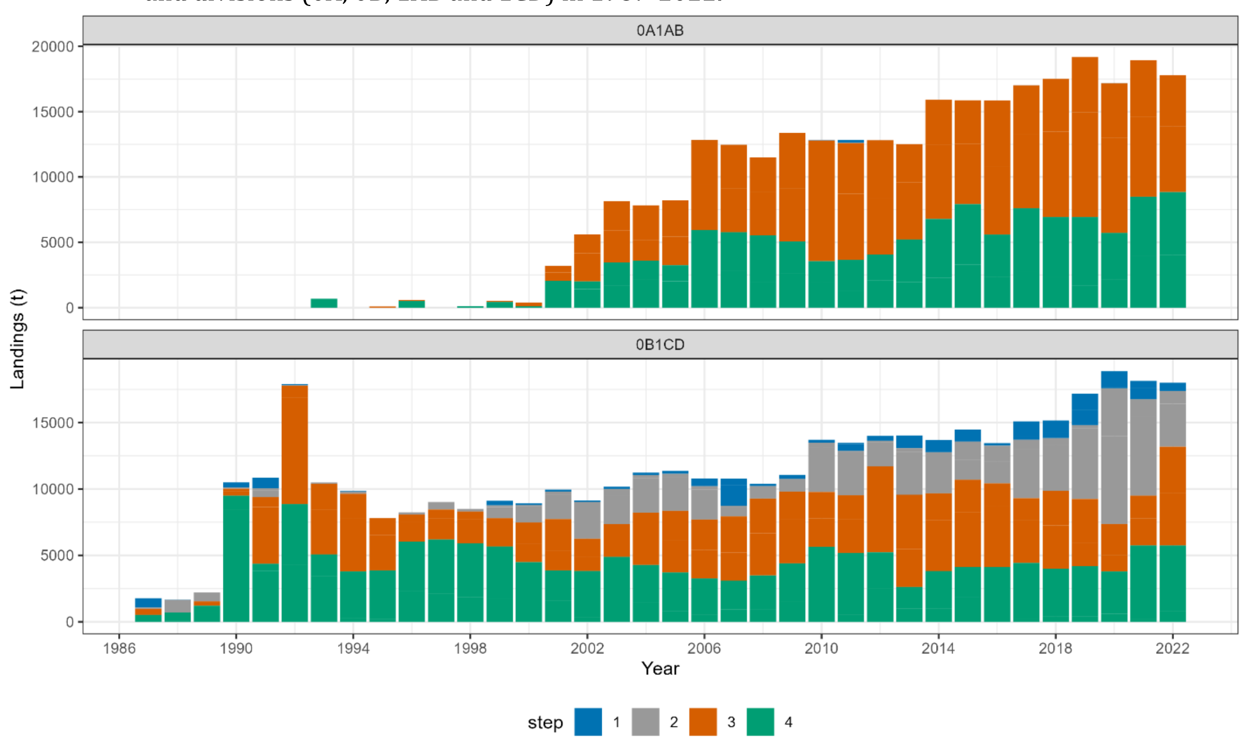

Figure 9. Greenland halibut. Landings from NAFO 0+1 offshore quarter in both aras (South and North) in 1987-2022.

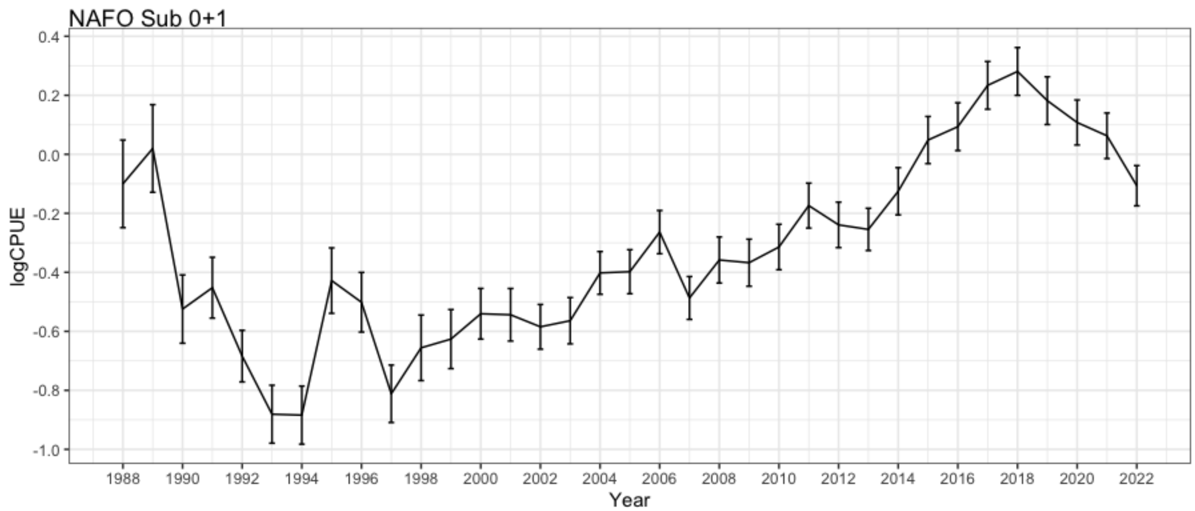

Figure 10. Greenland halibut. Standarize CPUE for trawlers years 1988-2022.

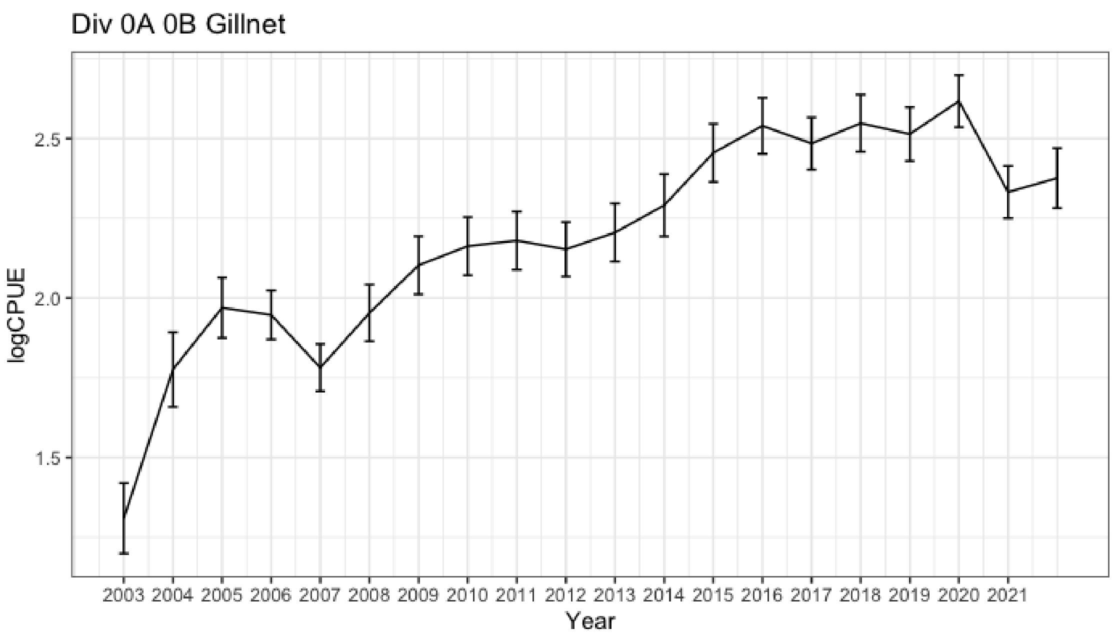

Figure 11. Greenland halibut. Standarize CPUE for gillnets in Sub.0 years 2003-2022.

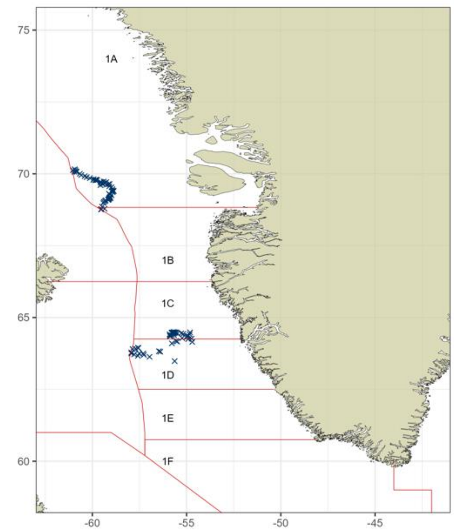

Figure 12. Greenland halibut. Commercial samples in 2022.

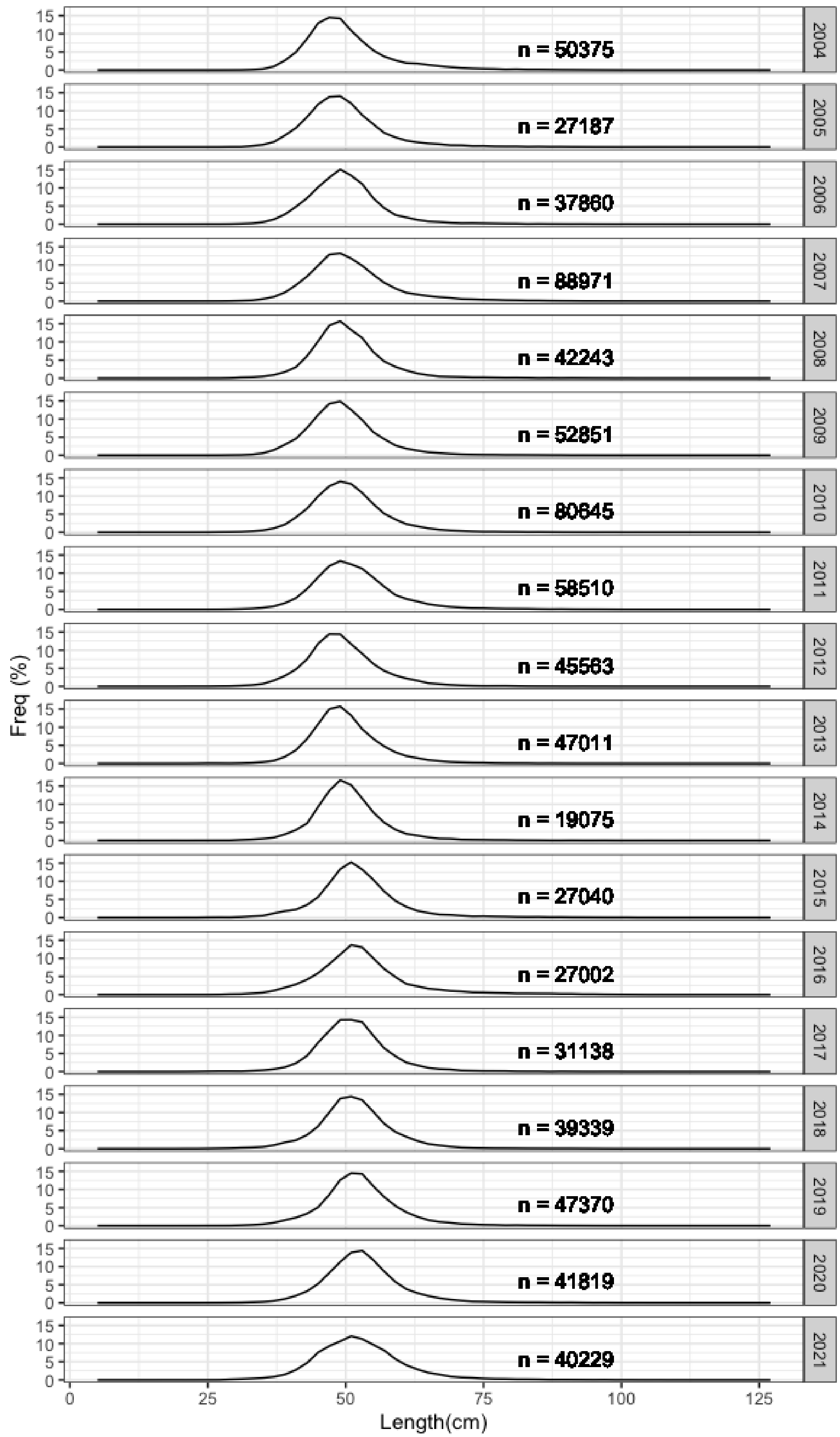

Figure 13. Length distribution from the trawl fisheries in Subarea 0+1 (offshore).

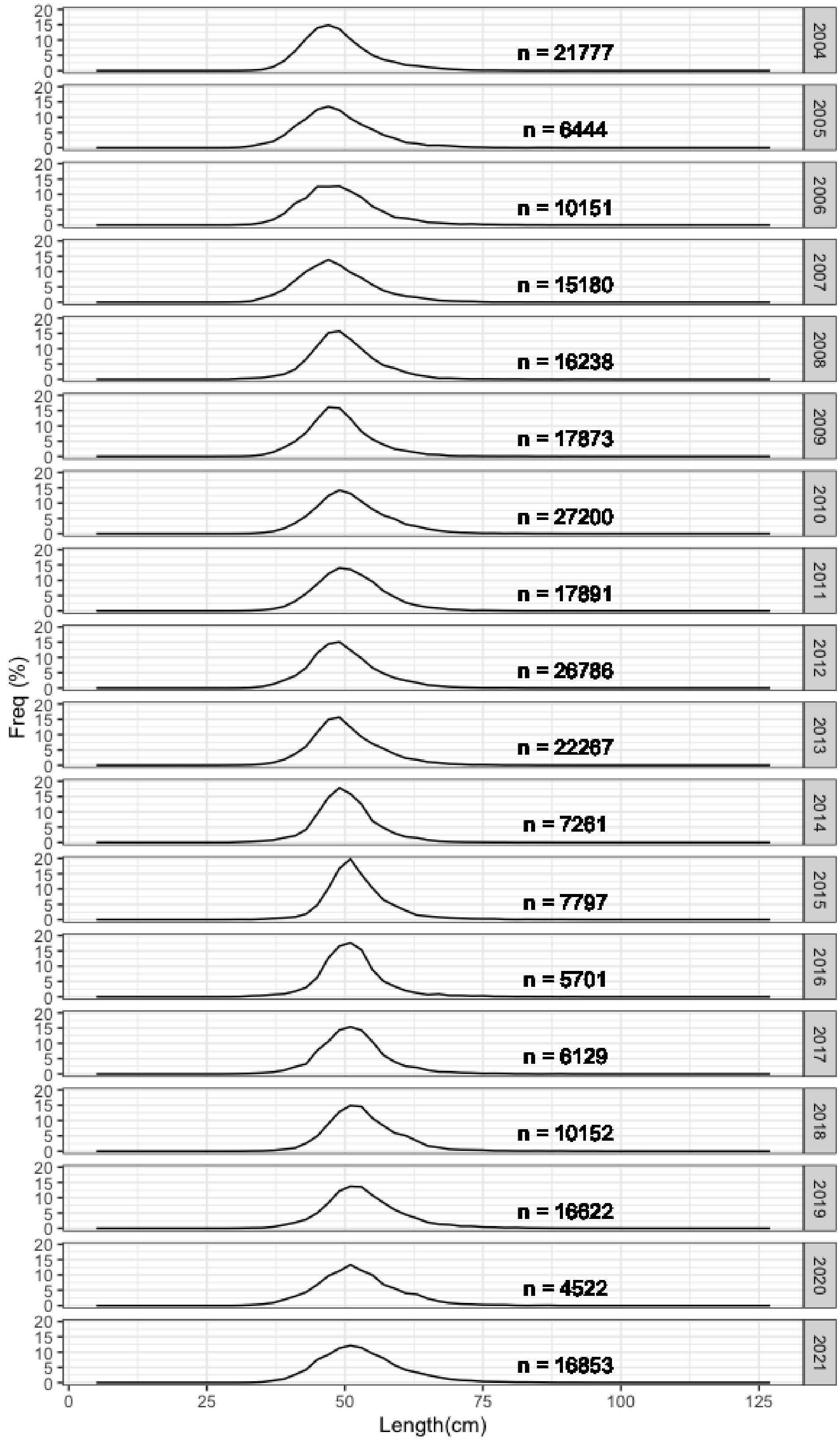

Figure 14. Length frequencies in commercial catches from trawlers in Div. 0A and 1AB .

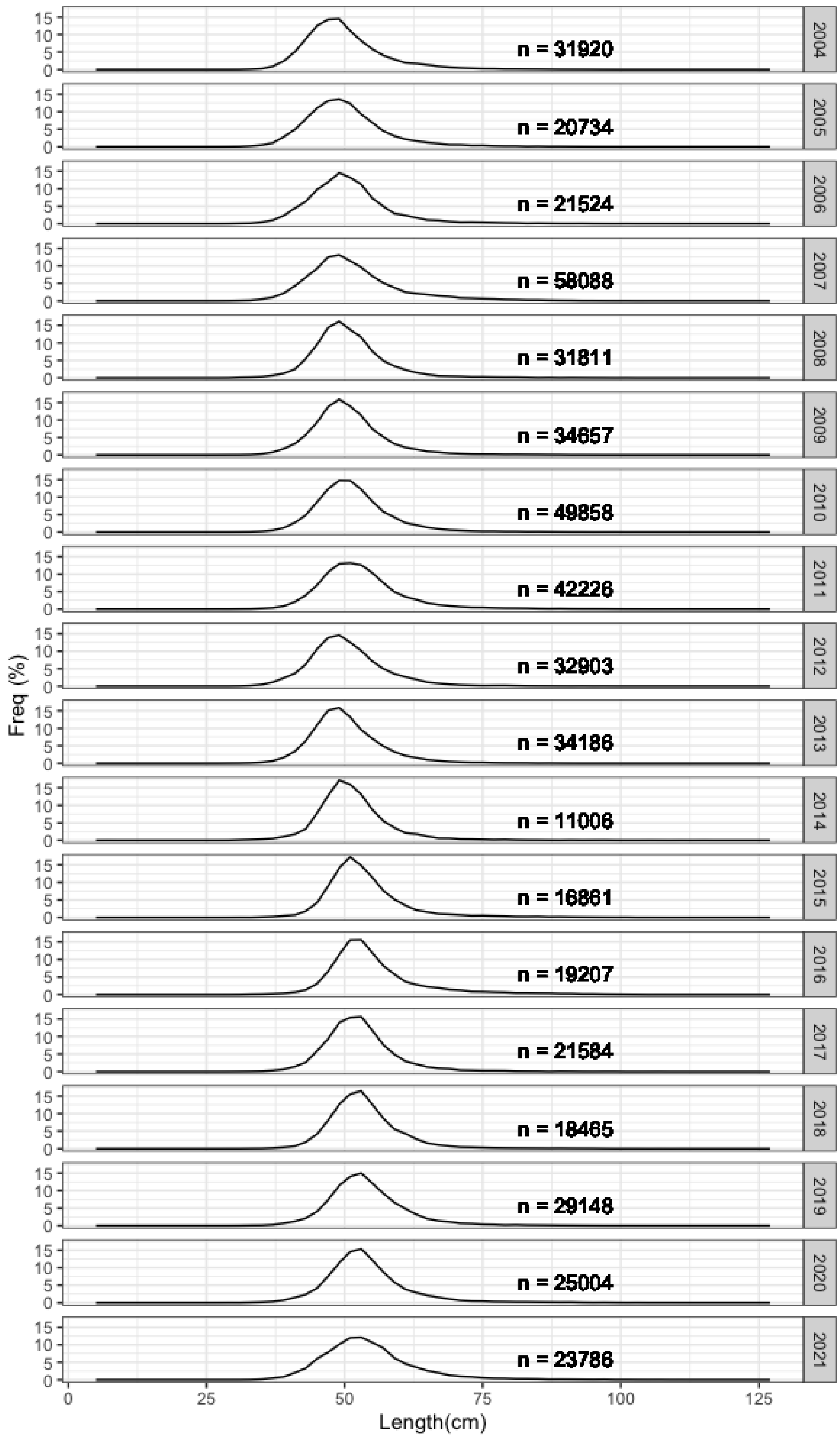

Figure 15. Length frequencies in commercial catches from trawl gear for Div. 0B and 1CD.

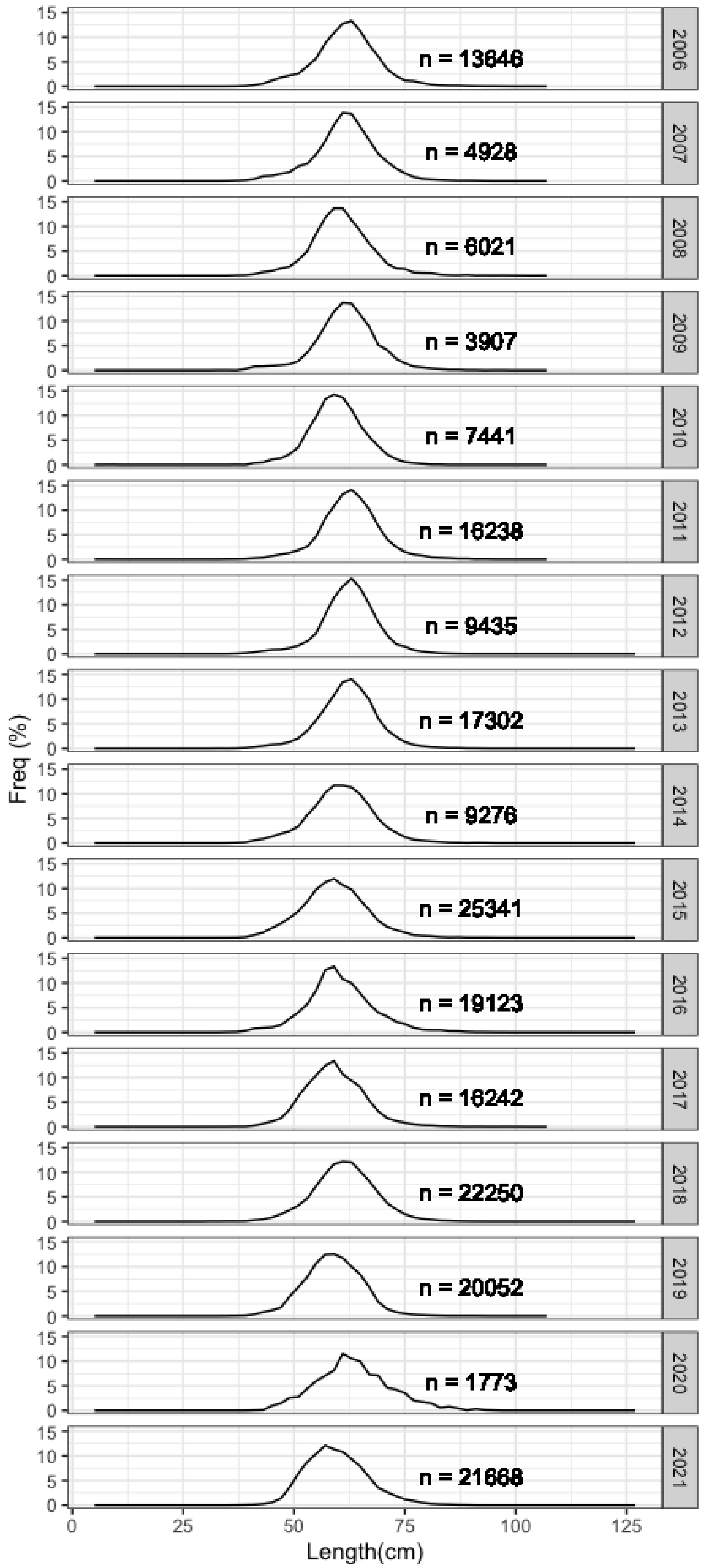

Figure 16. Length frequencies in commercial catches from gillnet gear for Subarea 0.

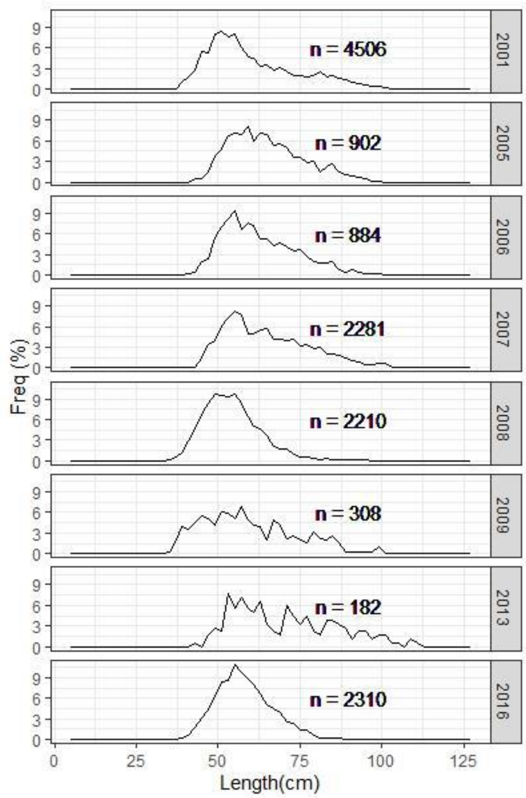

Figure 17. Length frequencies in commercial catches from longline gear for Division 1A-D.

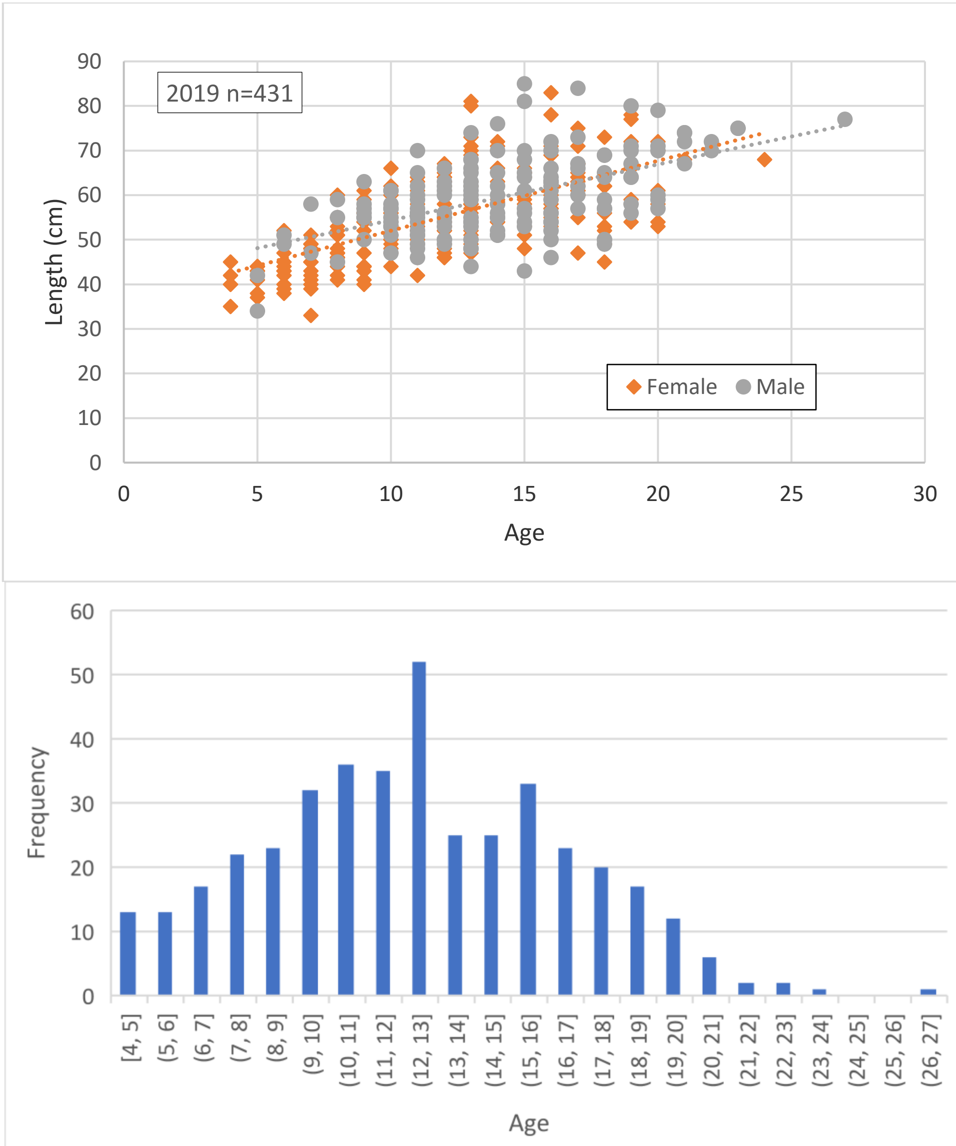

Figure 18. Age-length distribution (top) and frequency (bottom) for samples from commercial trawl and gillnet vessels fishing in SA0 in 2019.

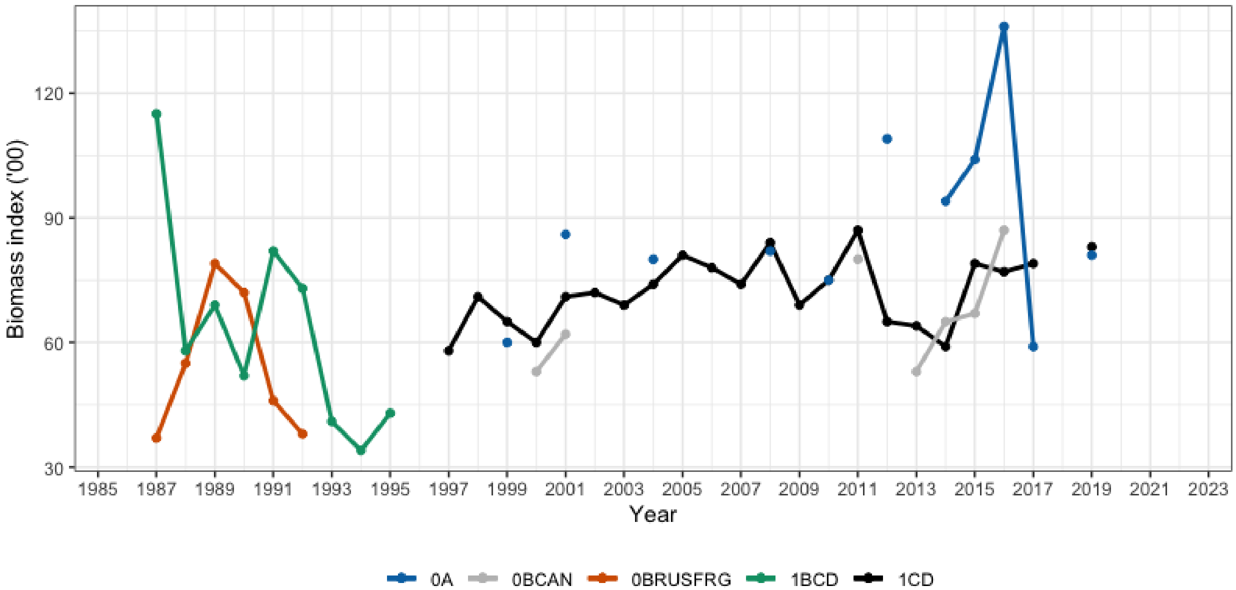

Figure 19. Biomass estimates from surveys conducted in SA 0 and 1 since 1986. There was a change in vessel for the 2019 surveys in 1CD and 0A-South and these estimates are not considered comparable to previous years.

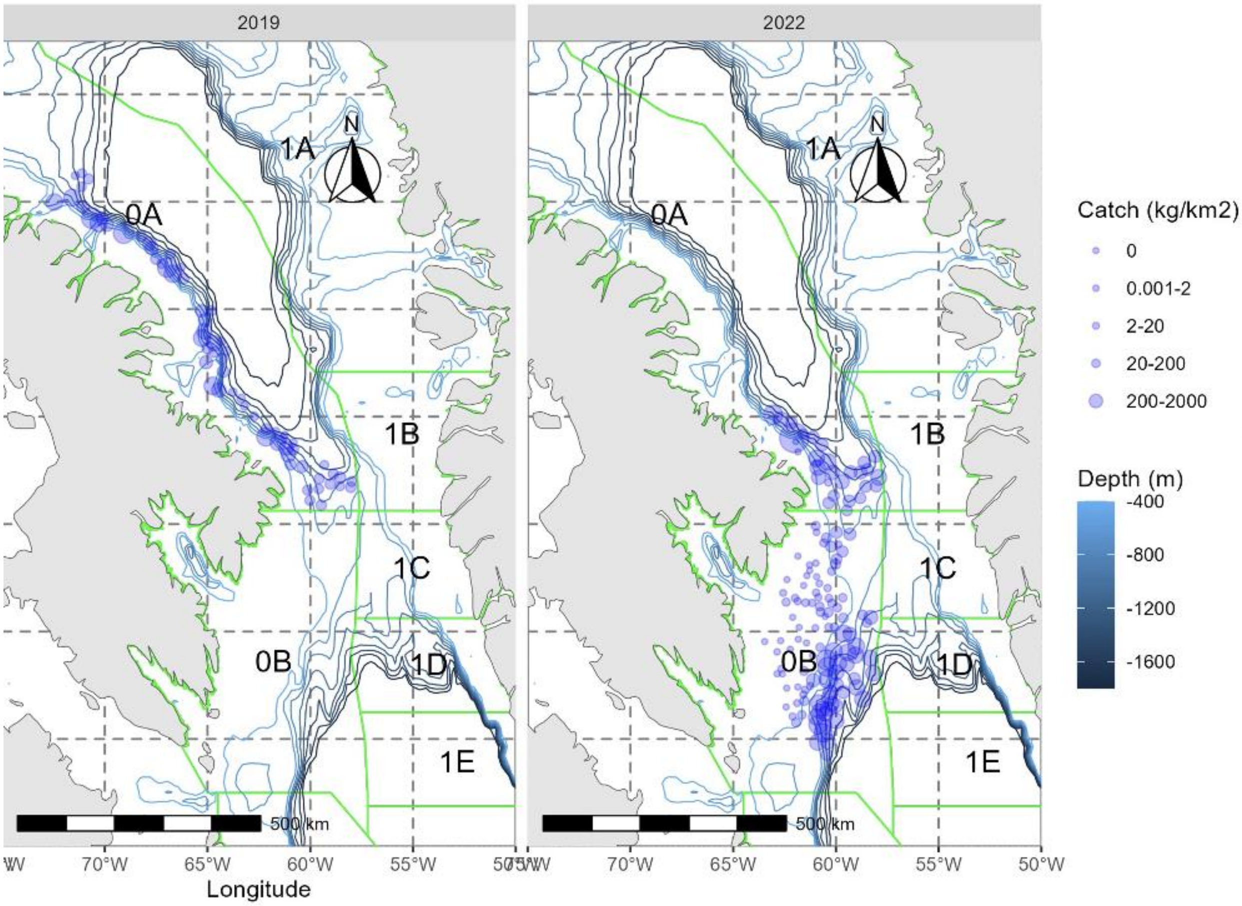

Figure 20. Distribution of the GHL density (kg/km2) during the 0A survey in 2019 and the 0A0B survey in 2022.

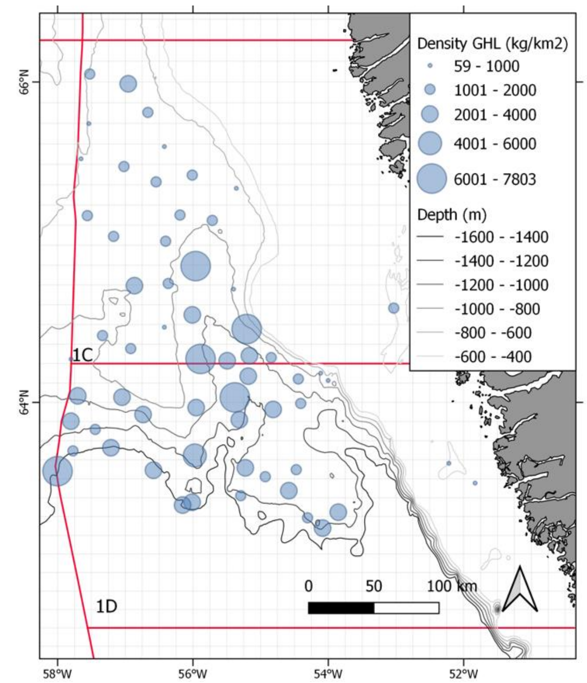

Figure 21. Distribution of the GHL density (kg/km2) during the 1CD survey in 2022.

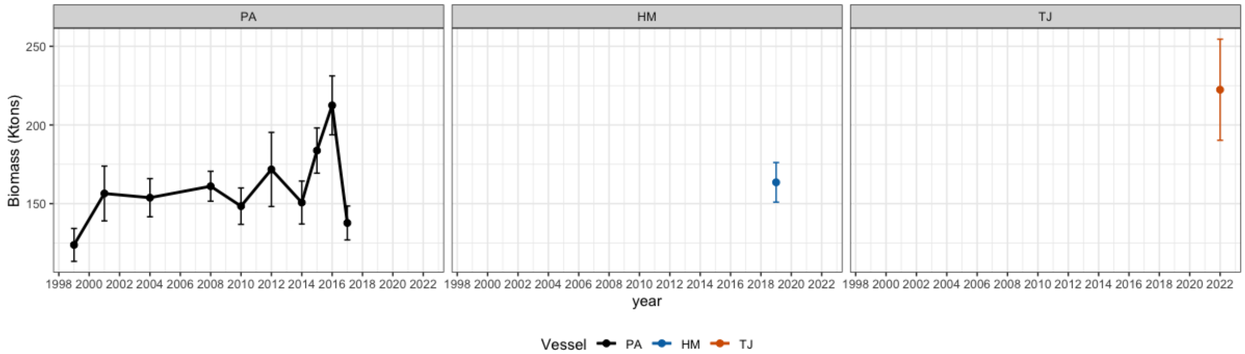

Figure 22. Combined survey biomass index for Div. 0A-South+Div. 1CD for the 3 surveys series: R/V Paamiut and Alfredo III gear (left panel), C/V Helga Maria and Alfredo III gear (midle panel) and R/V Tarajoq and Bacalao 476 gear (right panel).

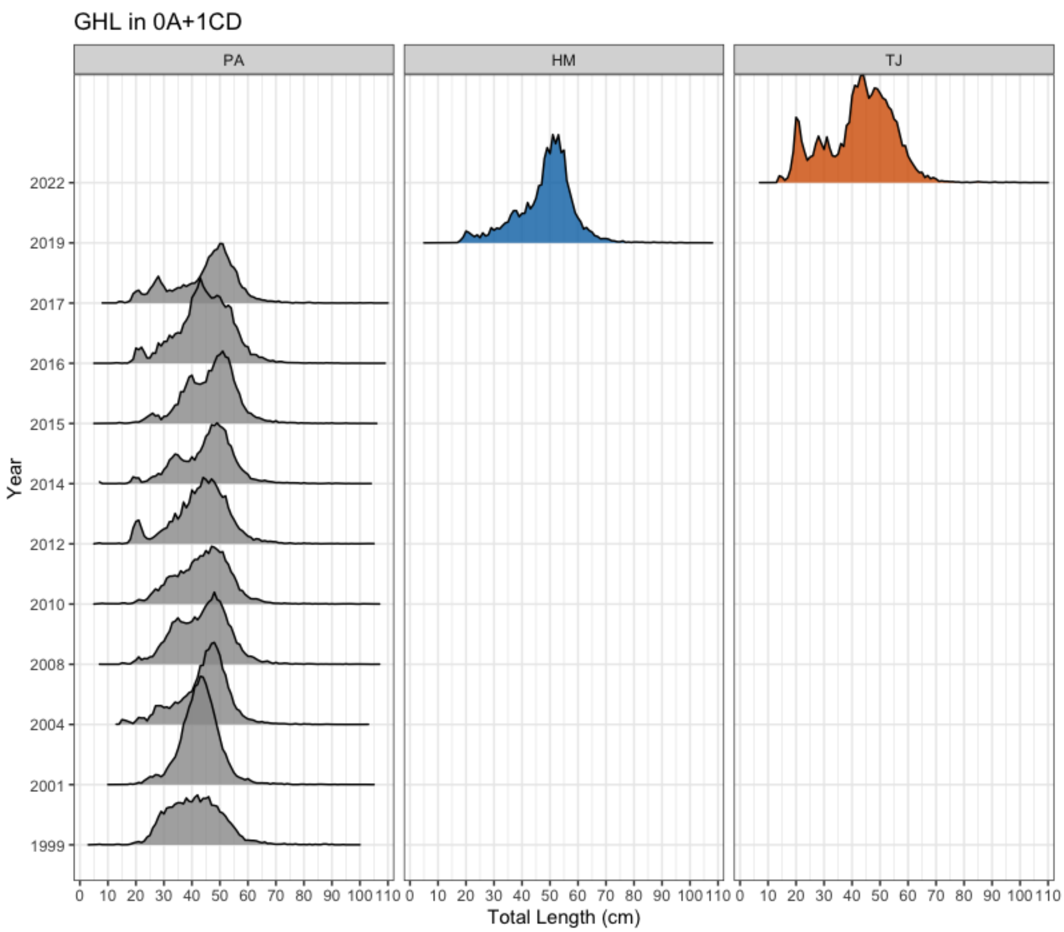

Figure 23. Length distribution of Greenland halibut (numbers weighted by stratum area) for the Div. 0A-South+Div. 1CD for the 3 surveys series: R/V Paamiut and Alfredo III gear (left panel), C/V Helga Maria and Alfredo III gear (midle panel) and R/V Tarajoq and Bacalao 476 gear (right panel).

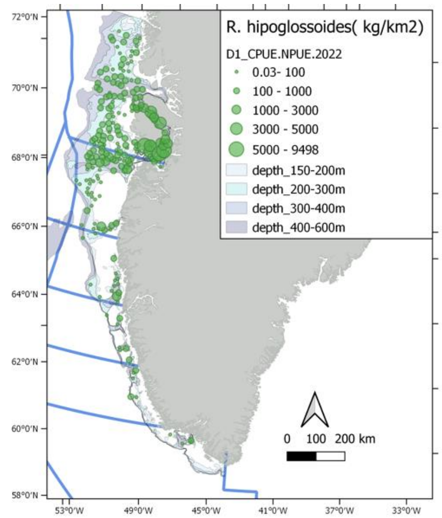

Figure 24. Distribution of the GHL density (kg/km2) during the 1AF survey in 2022.

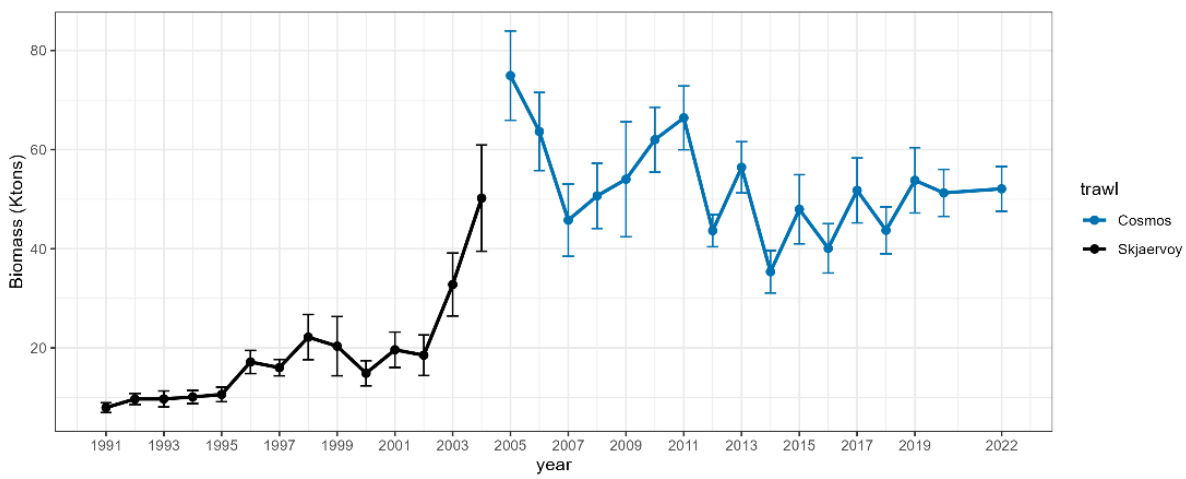

Figure 25. Greenland halibut biomass indices from the Greenland Fish and Shrimp Survey in 1A-F (50-600 m). Change of gear in 2004 is not calibrated in this plot.

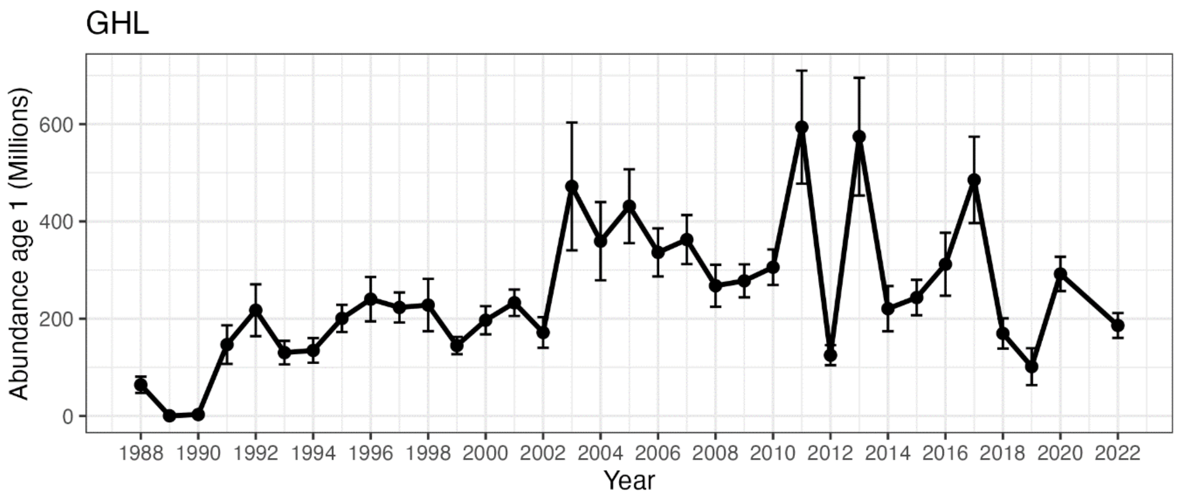

Figure 26. Abundance of age 1 Greenland halibut from the Greenland Fish and Shrimp Survey, for the entire survey area, including inshore Disko Bay, Div. 1A (North of 70○37.5'N) and several sets on the adjacent shelf in 0A. The indices 1988- 2004 have been calibrated with conversion factor due to the change of gear.

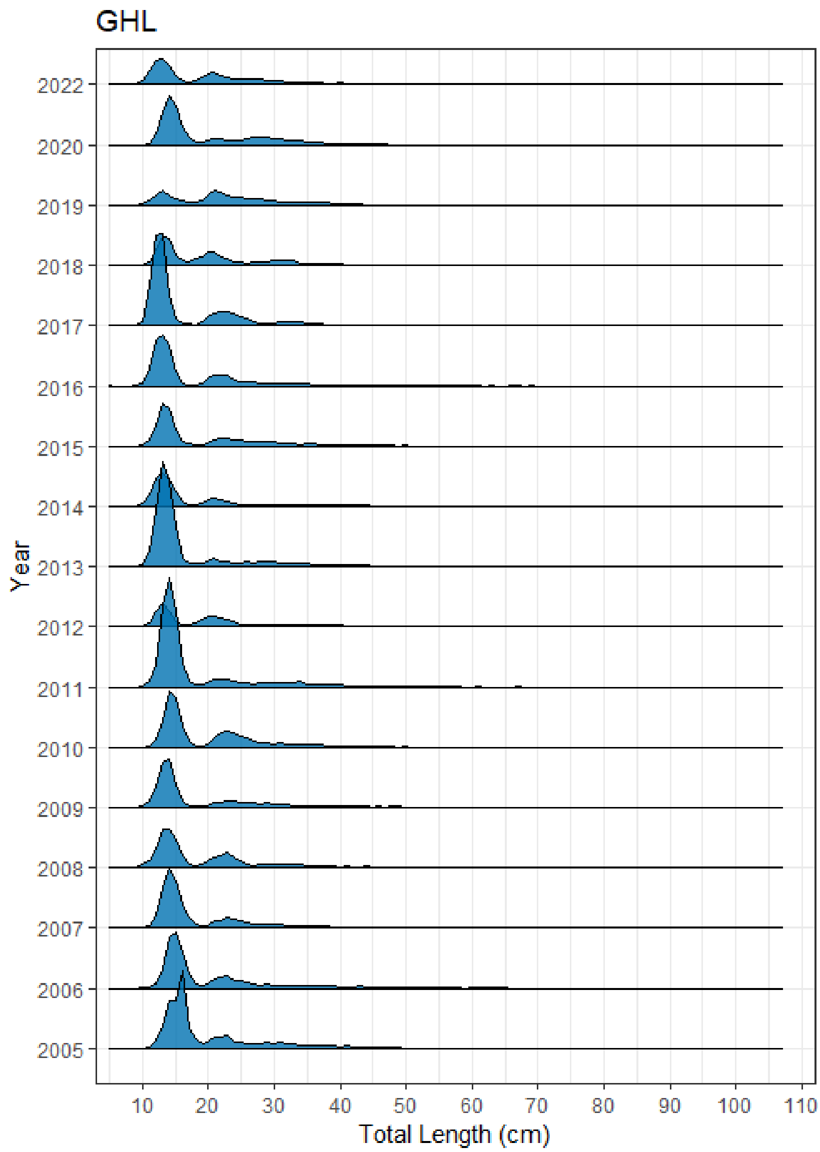

Figure 27. Length distribution of Greenland halibut (numbers weighted by stratum area) for the Div. 1AF surveys. The indices 1988- 2004 have been calibrated with conversion factor due to the change of gear.

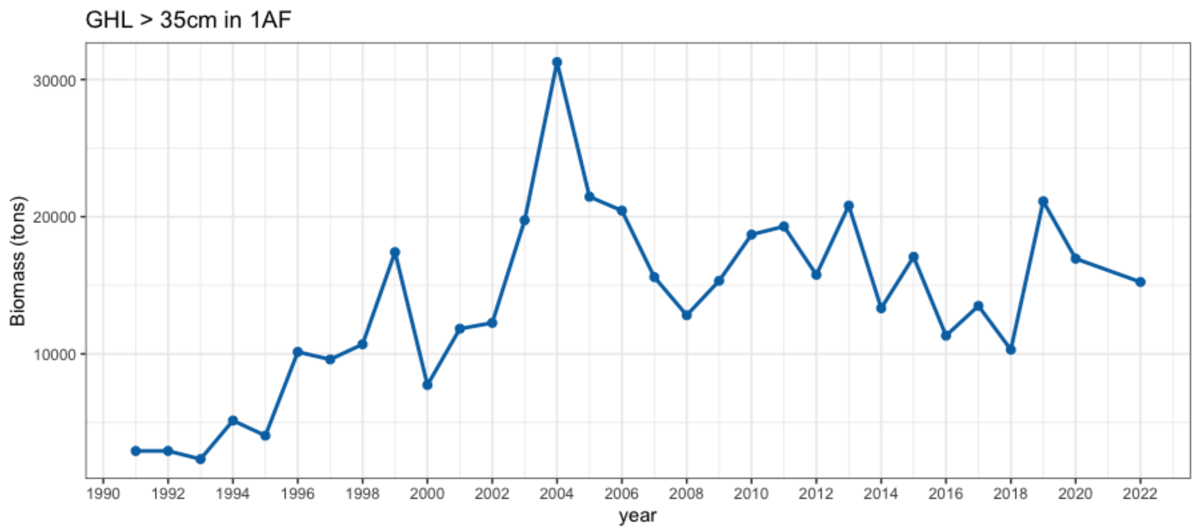

Figure 28. Biomass index of Greenland halibut > 35 cm(numbers weighted by stratum area) for the Div. 1AF surveys. The indices 1988- 2004 have been calibrated with conversion factor due to the change of gear.

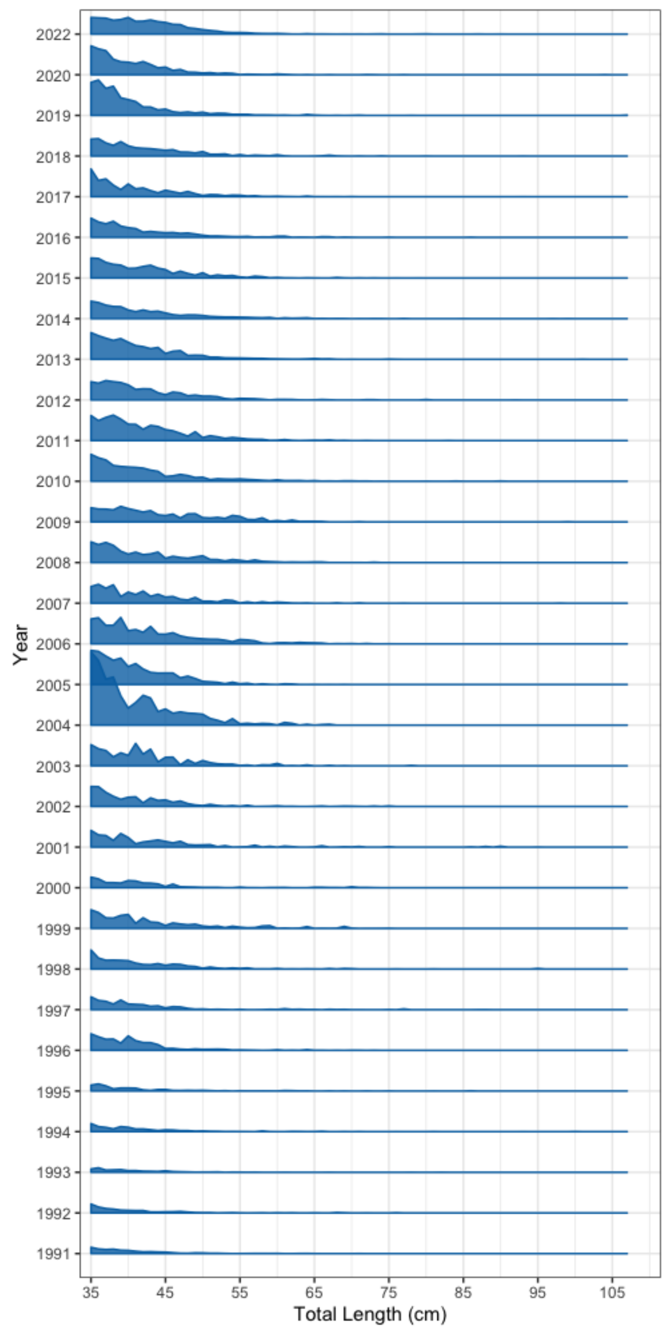

Figure 29. Length distribution of Greenland halibut > 35 cm (numbers weighted by stratum area) for the Div. 1AF surveys. The indices 1988- 2004 have been calibrated with conversion factor due to the change of gear.

Appendix 1. NAFO codes used in the CPUE standardization.

Code for Trawl Gear
Bottom otter trawl (charters), 8, OTB
Bottom otter trawl (side or stern not specified), 10, OTB
Bottom otter trawl, 12, OTB-2
Otter twin trawl, 192, OTT

Code for Boat (Tonnage)
0 Not known
2 0-49.9
3 50-149.9
4 150-499.9
5 500-999.9
6 1000-1999.9
7 2000 and over

e.g. BoatC1924 = vessel (BoatC), twin trawl (192), class (4)
Boat3414= Newfoundland region vessel (Boat3), gillnet (41), class (4)
Boat40413= Arctic region vessel (Boat 40), gillnet (41), class (3)

Appendix 2. Standardized CPUE index for trawlers in SA 0+1

```
Call:
lm(formula = lcpue ~ Year + Month + Boat)

Residuals:
    Min      1Q  Median      3Q     Max
-1.19437 -0.17290  0.01111  0.17743  1.10557

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.901795   0.351038  -2.569 0.010404 *
Year1989     0.119963   0.196165   0.612 0.541037
Year1990    -0.424381   0.174609  -2.430 0.015326 *
Year1991    -0.351937   0.167204  -2.105 0.035657 *
Year1992    -0.583928   0.158465  -3.685 0.000246 ***
Year1993    -0.780740   0.165115  -4.728 2.73e-06 ***
Year1994    -0.783843   0.164940  -4.752 2.44e-06 ***
Year1995    -0.327910   0.172149  -1.905 0.057209 .
Year1996    -0.401260   0.165791  -2.420 0.015759 *
Year1997    -0.711488   0.163199  -4.360 1.50e-05 ***
Year1998    -0.555734   0.171290  -3.244 0.001232 **
Year1999    -0.526122   0.164373  -3.201 0.001432 **
Year2000    -0.440313   0.156526  -2.813 0.005043 **
Year2001    -0.443720   0.158584  -2.798 0.005281 **
Year2002    -0.484515   0.154237  -3.141 0.001751 **
Year2003    -0.463850   0.152586  -3.040 0.002453 **
Year2004    -0.301842   0.149697  -2.016 0.044140 *
Year2005    -0.297780   0.150867  -1.974 0.048792 *
Year2006    -0.163521   0.150507  -1.086 0.277641
Year2007    -0.386722   0.151101  -2.559 0.010692 *
Year2008    -0.258009   0.152690  -1.690 0.091514 .
Year2009    -0.267205   0.153996  -1.735 0.083149 .
Year2010    -0.214008   0.152205  -1.406 0.160145
Year2011    -0.073670   0.151728  -0.486 0.627442
Year2012    -0.139003   0.152235  -0.913 0.361510
Year2013    -0.154361   0.150057  -1.029 0.303979
Year2014    -0.025133   0.153806  -0.163 0.870245
Year2015     0.148477   0.153486   0.967 0.333691
Year2016     0.193838   0.154112   1.258 0.208888
Year2017     0.333870   0.153963   2.169 0.030451 *
Year2018     0.381015   0.154036   2.474 0.013611 *
Year2019     0.282048   0.153961   1.832 0.067378 .
Year2020     0.208005   0.151558   1.372 0.170358
Year2021     0.163007   0.152365   1.070 0.285050
Year2022    -0.006287   0.153550  -0.041 0.967350
Month2      -0.203459   0.088001  -2.312 0.021062 *
Month3      -0.131595   0.131395  -1.002 0.316917
Month4       0.041299   0.096639   0.427 0.669254
Month5       0.220384   0.071223   3.094 0.002050 **
Month6      -0.258506   0.067024  -3.857 0.000125 ***
Month7      -0.286213   0.065168  -4.392 1.29e-05 ***
Month8      -0.154059   0.062615  -2.460 0.014116 *
Month9      -0.064483   0.061612  -1.047 0.295643
```

```
Month10     -0.070246   0.061443  -1.143 0.253312
Month11     -0.079764   0.061679  -1.293 0.196359
Month12      0.079940   0.064564   1.238 0.216067
BoatC107     1.543831   0.328933   4.693 3.22e-06 ***
BoatC1126    0.871220   0.389629   2.236 0.025660 *
BoatC124     0.760988   0.327830   2.321 0.020554 *
BoatC125     0.370703   0.320223   1.158 0.247400
BoatC126     0.748364   0.316910   2.361 0.018473 *
BoatC127     1.096325   0.316791   3.461 0.000571 ***
BoatC1926    1.193070   0.319085   3.739 0.000200 ***
BoatC1927    1.310119   0.316960   4.133 4.00e-05 ***
---
Signif. codes:
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3089 on 710 degrees of freedom
Multiple R-squared:  0.7142,      Adjusted R-squared:  0.6928
F-statistic: 33.47 on 53 and 710 DF,  p-value: < 2.2e-16
```

Appendix 3. Standardized CPUE index for gillnets in SA 0

```
Call:
lm(formula = lcpue ~ Year + Month + Boat)

Residuals:
    Min       1Q   Median       3Q      Max
-1.37624 -0.11479  0.00772  0.14298  0.67326

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.379860   0.294705   4.682 5.04e-06 ***
Year2004     0.466697   0.139604   3.343 0.000978 ***
Year2005     0.660309   0.128951   5.121 6.78e-07 ***
Year2006     0.637708   0.121815   5.235 3.93e-07 ***
Year2007     0.472506   0.115892   4.077 6.43e-05 ***
Year2008     0.643940   0.119474   5.390 1.86e-07 ***
Year2009     0.793456   0.121619   6.524 4.86e-10 ***
Year2010     0.853206   0.121619   7.015 2.97e-11 ***
Year2011     0.870761   0.121619   7.160 1.28e-11 ***
Year2012     0.843473   0.118164   7.138 1.45e-11 ***
Year2013     0.896243   0.121619   7.369 3.68e-12 ***
Year2014     0.981446   0.126119   7.782 3.01e-13 ***
Year2015     1.145891   0.121619   9.422  < 2e-16 ***
Year2016     1.230666   0.120077  10.249  < 2e-16 ***
Year2017     1.175194   0.118138   9.948  < 2e-16 ***
Year2018     1.238820   0.122913  10.079  < 2e-16 ***
Year2019     1.204761   0.119704  10.065  < 2e-16 ***
Year2020     1.308040   0.119770  10.921  < 2e-16 ***
Year2021     1.022786   0.118739   8.614 1.56e-15 ***
Year2022     1.066809   0.124013   8.602 1.68e-15 ***
Month5       0.007056   0.265376   0.027 0.978811
Month6      -0.377830   0.265021  -1.426 0.155424
Month7      -0.473596   0.264743  -1.789 0.075046 .
Month8      -0.099807   0.264053  -0.378 0.705819
Month9      -0.058652   0.264390  -0.222 0.824651
Month10     -0.032619   0.265957  -0.123 0.902501
Month11     -0.152410   0.267185  -0.570 0.568986
Month12     -0.324854   0.368005  -0.883 0.378364
Boat3414    -0.166058   0.082196  -2.020 0.044601 *
Boat3415     0.334294   0.119860   2.789 0.005763 **
Boat40413    0.143295   0.109313   1.311 0.191308
Boat40414    0.175659   0.083150   2.113 0.035799 *
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Signif. codes:
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2505 on 214 degrees of freedom
Multiple R-squared:  0.7427,     Adjusted R-squared:  0.7054
F-statistic: 19.92 on 31 and 214 DF,  p-value: < 2.2e-16
```

Appendix 4: DFO CSAS meeting documents

Terms of Reference

Review of candidate stock assessment frameworks for the Northwest Atlantic Fisheries Organization Subarea 0+1 (Offshore) Greenland Halibut stock

Regional Peer Review – Ontario & Prairie Region

December 12-15, 2022
Winnipeg, MB and Virtual Meeting

Chairperson: Mary Thiess

Context
Fisheries and Oceans Canada (DFO) Science and the Greenland Institute of Natural Resources conduct multi-species bottom trawl surveys in Northwest Atlantic Fisheries Organization (NAFO) Subareas 0 and 1 to support assessment of the Subarea 0+1 (offshore) Greenland Halibut stock. The vessel and gear (*RV Paamiut*, Alfredo trawl) used for the surveys during 1999-2017 was retired in 2018 without opportunity to conduct paired trawling experiments with an interim or replacement vessel. An interim vessel and the Alfredo trawl were used in 2019 and a new long-term vessel (*RV Tarajoq*) and new gear (Bacalao trawl) will be used in 2022 and beyond. Typically, the ability to assess time series data relies on an assumption that consistent methods and effort are used over time to ensure inter-year comparability (i.e., any differences in gear or sampling effort are known or can be estimated). Survey time series are typically standardized through periods of change in data collection methods by conducting paired trawling experiments.

Given the absence of these experiments, DFO Fisheries Management has requested DFO Science to explore analytical method(s) and/or frameworks for the Subarea 0+1 (offshore) stock assessment that could incorporate data collected by multiple vessels and gears, including fishery-independent surveys and commercial fishery data. This review aims to support the NAFO Scientific Council's assessment of this stock and industry led Marine Stewardship Council certification process.

Objectives
The main objectives of the Canadian Science Advisory Secretariat (CSAS) process is to identify potential analytical methods and/or frameworks that could be used to improve the Subarea 0+1 (offshore) Greenland Halibut stock assessment. Specifically, the review will include:

1. Identify factors contributing to differences in catchability of Greenland Halibut and other fish and invertebrate species; and,
2. Examine analytical methods and/or frameworks that could allow integration and/or comparison of data collected by different vessels and gear configurations.

Expected Publications
- Science Advisory Report
- Proceedings
- Research Documents

Expected Participation
- Fisheries and Oceans Canada (DFO) (Ecosystems and Oceans Science and Fisheries Management sectors)
- Academia
- Industry
- Other invited experts

Resulting Publications

DFO. 2023. Proceedings of the Regional Peer Review on the Review of Candidate Stock Assessment Frameworks for the Northwest Atlantic Fisheries Organization Subarea 0+1 (Offshore) Greenland Halibut Stock; December 12-15, 2022. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2023/015.
Proceedings 2023/015

DFO. 2023. Review of candidate stock assessment frameworks for the Northwest Atlantic Fisheries Organization Subarea 0+1 (Offshore) Greenland Halibut stock. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2023/020.
Science Advisory Report 2023/020

Hedges, K.J., and Raffoul, D. 2023. Summary of factors that affect survey and fishing catchability and data available regarding the NAFO Subarea 0+1 (offshore) Greenland Halibut (*Reinhardtius hippoglossoides*) stock and fishery. DFO Can. Sci. Advis. Sec. Res. Doc. 2023/037. iv + 11 p.
Research Document 2023/037

Huynh, Q.C., and Carruthers, T. 2023. Development of Spatial Operating Models to Test Survey Design and Calibrate a New Survey Index for Northwest Atlantic Fisheries Organization Subarea 0+1 (offshore) Greenland Halibut (*Reinhardtius hippoglossoides*). DFO Can. Sci. Advis. Sec. Res. Doc. 2023/038. iv + 35 p.
Research Document 2023/038

Johnson, S.D.N, and Cox, S.P. 2023. A modeling framework for stock assessment and harvest strategy evaluation for the NAFO 0+1 (offshore) Greenland Halibut (*Reinhardtius hippoglossoides*) fishery. DFO Can. Sci. Advis. Sec. Res. Doc. 2023/039. iv + 88 p.
Research Document 2023/039

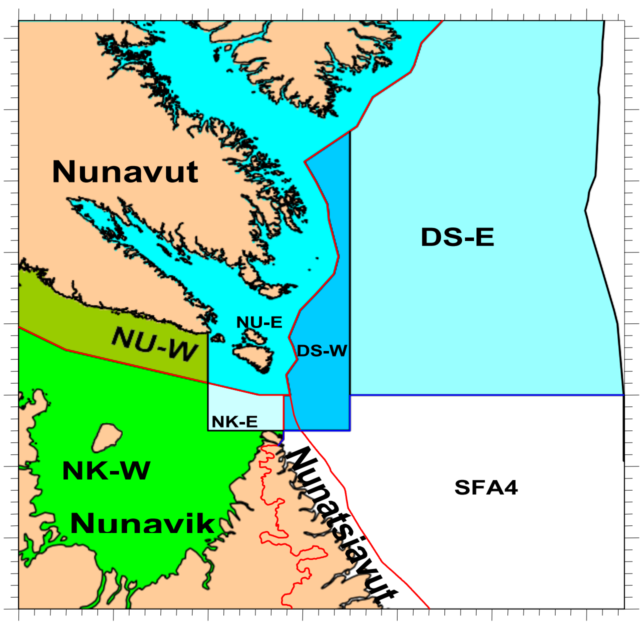
SUBMISSION TO THE
NUNAVUT WILDLIFE MANAGEMENT BOARD
AND NUNAVIK MARINE REGION WILDLIFE BOARD

FOR

Information: X **Decision:** **Recommendation:**

Issue: Development of Harvest Decision Rules as part of the Precautionary Approach Frameworks for Northern (*Pandalus borealis*) and Striped (*P. montagui*) Shrimp in the Western and Eastern Assessment Zones

Map:
Blue areas – Eastern Assessment Zone (EAZ)
Green areas – Western Assessment Zone (WAZ)



Northern shrimp (*Pandalus borealis*)

Striped shrimp (*Pandalus montagui*)

Background

The purpose of this information note is to provide an update on Fisheries and Oceans Canada's (DFO) work to develop and implement a Precautionary Approach (PA) Framework that will guide fisheries management decisions for *P. montagui* and *P. borealis* in the Western Assessment Zone (WAZ), and update the existing PA Framework for these species in the Eastern Assessment Zone (EAZ). The primary components of the generalized framework are; reference points to define stock status zones (Healthy, Cautious and Critical) and harvest decision rules (HDRs). A map of Shrimp Fishing Areas (SFAs) is at Appendix 1.

As provided in previous briefings to the Boards, new Limit Reference Points (LRP) for *P. montagui* and *P. borealis* in the WAZ and updates to the previous LRPs for stocks in the EAZ were established by DFO Science through a Canadian Science Advisory Secretariat (CSAS) peer review process in the spring of 2020. Through this same process, DFO Science proposed Upper Stock Reference (USR) points for these stocks.

In Fall 2020, DFO Resource Management established the Northern Precautionary Approach Working Group (NPAWG), the objectives of which were to develop and recommend the outstanding components of the WAZ and EAZ PA Frameworks, namely, USRs and HDRs. Members of the NPAWG include DFO Science and Resource Management sectors, provincial governments, indigenous groups, industry representatives as well as Board staff.

In June 2021, DFO brought forward NPAWG recommendations to seek decisions and recommendations from the NMRWB and NWMB on USRs for EAZ and WAZ stocks. DFO's request was rejected with the condition that the Boards would not would not establish or recommend USRs until the PA Framework could be presented as a full and comprehensive amendment to the Integrated Fisheries Management Plan (IFMP). USRs recommended by DFO Science have been used to help inform management decisions since 2020, though have not been formally established.

Work to develop HDRs is ongoing. HDRs will provide direction on harvest rates and other management procedures for each stock status zone. More recently, this work has proceeded through an industry-led working group that was established following a recommendation at the Northern Shrimp Advisory Committee (NSAC) meeting in February 2023. This working group was struck to, among other things, advance the development of candidate HDRs that may have applicability for all shrimp stocks (e.g. EAZ, WAZ, SFAs 4, 5, and 6). Participants in the working group include DFO Science and Resource Management sectors, the provincial government of Newfoundland and Labrador, Nunatukavut Community Council, and fishing industry representatives (inshore and offshore). It is understood that this working group is not fully representative of the NSAC and is not considered to replace NPAWG.

Progress to Date

The industry-led working group has held a series of meetings since March 2023 to explore and collaborate on HDR approaches for shrimp stocks. The working group has discussed the implementation of HDRs that maximize economic benefits from the resource in an ecologically sustainable manner, ensuring the approach is consistent with the guidelines of the PA.

In the context of this working group, DFO Resource Management has developed and tabled a draft HDR approach termed ‘Base Total Allowable Catch (TAC)’ for intended application in the EAZ and WAZ. Key features of this HDR approach include the establishment of a set (Base) TAC level for each stock based on the geometric mean of the Fishable Biomass (FB) from a recent time series. The approach considers the most recent stock status in the Healthy, Cautious and Critical Zones and potential exploitation rate (ER) of the Base TAC to inform adjustments to the TAC in a given year. The Base TAC approach was derived from advice received in previous discussions with the NPAWG in 2020 and 2021. The Base TAC approach continues to evolve in conjunction with feedback provided by members of the industry-led working group.

Industry stakeholders (Canadian Association of Prawn Producers, Northern Coalition and, Nunavut Fisheries Association) have also tabled a HDR approach first presented to DFO in March 2022. The HDR approach termed ‘50% or Finish’ is applicable for shrimp stocks in the EAZ as well as in SFAs 4 and 5. Its applicability in the WAZ is also being considered. Key features of this HDR approach are to limit the increases or decrease of the annual TAC change to 50 per cent of what could otherwise be pursued by applying set ERs to the most recent estimate of FB. The balance of the TAC change would be applied in the second year, unless the TAC change would amount to greater than 50 per cent (in which case 50 per cent of this new difference would be pursued).

The industry-led group continues to consider the effectiveness of the two candidate HDR approaches in meeting PA objectives.

Next Steps

The industry-led working group has two additional meetings scheduled over the coming months with the aim of concluding its discussions on the candidate HDR approaches by Fall 2023. To ensure full representation of NSAC in the development of HDRs, discussion will transition to the NPAWG thereafter.

Development of HDRs will also include discussion of season bridging protocols for Nunavut, Nunavik, and Offshore allocations in the WAZ and EAZ.

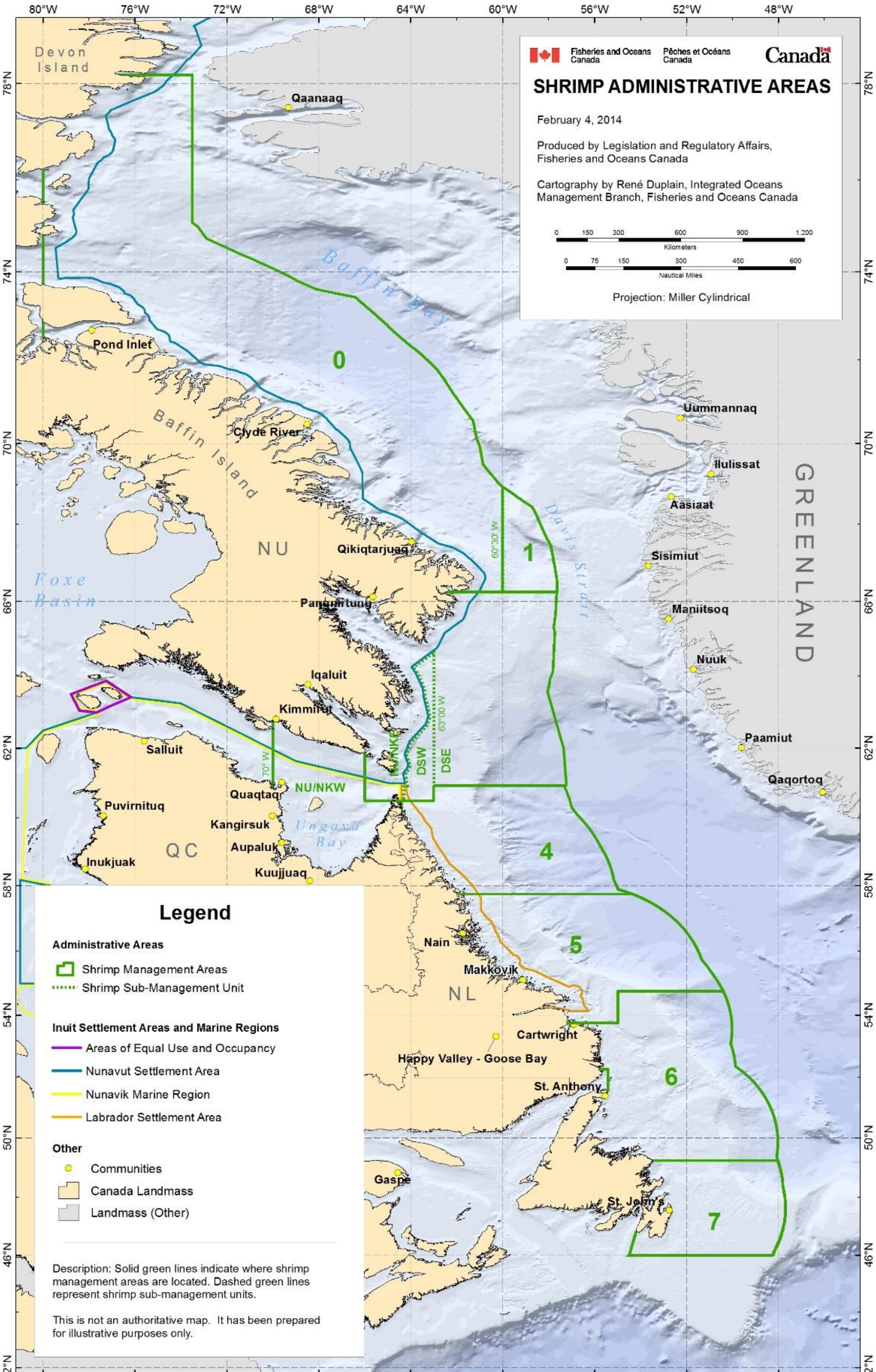
Pending NPAWG support for one or both of the candidate HDR approaches with associated USRs, DFO will present these at a special session of NSAC in Winter 2023. NSAC support for a candidate HDR is required prior to DFO’s seeking decisions and recommendations from the NWMB and NMRWB to establish the HDRs and USRs for EAZ and WAZ stocks (anticipated in Spring 2024 - March Board meetings). If approved by the Boards, HDRs could first be applied in TAC decisions and recommendations for the 2024-25 fishing season.

DFO acknowledges outstanding work on the development of a biomass projection model and possible changes to the LRPs for Northern shrimp in SFAs 4-6 (with potential applicability for northern stocks). This work is tentatively scheduled for completion and CSAS review in Fall 2024 and will not be available ahead of the 2024-25 management decision cycle. However, the development and implementation of HDRs are not contingent upon the completion of this work.

Should the full suite of PA components for stocks in the EAZ and WAZ, including the HDRs, not be finalized in time for use in 2024-25 TAC decisions, established LRPs will provide guidance for sustainable harvest decisions.

Prepared by: Fisheries Resource Management, Fisheries and Oceans Canada

Date: July 21, 2023


Fisheries and Oceans Canada
Pêches et Océans Canada
Canada
SHRIMP ADMINISTRATIVE AREAS
February 4, 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
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 are located. Dashed green lines represent shrimp sub-management units.
This is not an authoritative map. It has been prepared for illustrative purposes only.
Devon Island
Baffin Bay
Baffin Island
Davis Strait
Foxe Basin
Ungava Bay
GREENLAND
NU
QC
NL
0
1
4
5
6
7
NU/NKE
NU/NKW
DSW
DSE
Qaanaaq
Pond Inlet
Clyde River
Qikiqtarjuaq
Pangnirtung
Iqaluit
Kimmirut
Salluit
Quaqtaq
Puvirnituq
Kangirsuk
Aupaluk
Inukjuak
Kuujjuaq
Nain
Makkovik
Cartwright
Happy Valley - Goose Bay
St. Anthony
Gaspe
St. John's
Uummannaq
Ilulissat
Aasiaat
Sisimiut
Maniitsoq
Nuuk
Paamiut
Qaqortoq

SUBMISSION TO THE NUNAVUT WILDLIFE MANAGEMENT BOARD AUGUST 2023

FOR

Information: X **Decision:**

Issue: Information regarding plans for consultation and decision-making regarding the possible addition of the Harbour Porpoise (Northwest Atlantic population) to the List of Wildlife Species at Risk on the *Species at Risk Act* (SARA).

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 Harbour Porpoise (Northwest Atlantic population).

The Harbour Porpoise
The Harbour Porpoise is widely distributed in eastern Canadian marine waters. Surveys in 2016 indicated about 350,000 porpoises. Incidental catch (bycatch) in fishing gear, especially gillnets, was a major source of mortality, and considerably reduced some populations in eastern Canada and elsewhere. While gillnet fishing has likely declined over the last 25 years, mortality levels in Canada are unknown because there is virtually no monitoring. The species is very sensitive to ocean noise and noise levels are increasing in some areas. Although the population remains abundant, the species' particular susceptibility to bycatch in fishing gear represents a potentially severe threat. The species may become Threatened if these threats are not effectively mitigated or managed.

COSEWIC assessed the Harbour Porpoise as Threatened in April 1990 and April 1991. The status was re-examined and designated Special Concern in May 2003, April 2006, and May 2022.

Figure 1: Harbour Porpoise

Distribution
Canada has two separate populations (designatable units) of Harbour Porpoise: Northeast Pacific and Northwest Atlantic. On the east coast, Harbour Porpoises occur from the Bay of Fundy north to Niaqonaujang (Cape Aston) on northern Baffin Island, at approximately 70°N. The southern range of the species in the western Atlantic extends to North Carolina. Individual porpoises equipped with satellite-linked radio transmitters have been found to move frequently between Canadian and U.S. waters. Three subpopulations in eastern Canada are provisionally recognized: Newfoundland–Labrador, Gulf of St. Lawrence, and Bay of Fundy–Gulf of Maine. Figure 2 shows the distribution of Harbour Porpoise in eastern North America.

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.

Consultation and Approval
DFO is planning to consult with Hunters and Trappers Organizations in Nunavut adjacent to the distribution of the Harbour Porpoise to ensure that any listing decision is made in full consideration of their views. DFO may be holding workshops in the fall on the potential listing of multiple species, including Harbour Porpoise. Comments received will be used by the Minister to decide whether to recommend legal listing of the Harbour Porpoise. A consultation summary will be provided to the NWMB when consultations are complete.

Approval
After public consultations are completed, a summary of consultations will be provided to the Board. The Minister of Environment and Climate Change Canada (with support from DFO) will seek a 5.2.34(f) decision from the Board with regard to the listing.

Prepared by:
Christine Lacho, Species at Risk Biologist, DFO, Ontario & Prairie Region, supporting the Arctic Region, Winnipeg

Date:
June 19, 2023

Figure 2. Distribution of Harbour Porpoise in Eastern North America. Reprinted from COSEWIC (2022).

SUBMISSION TO THE NUNAVUT WILDLIFE MANAGEMENT BOARD August 2023

FOR

Information: X **Recommendation:** **Decision:**

Issue: Update on New Walrus Sport Hunt Licencing Process

Background:

On behalf of the Nunavut Walrus Working Group (NWWG), Fisheries and Oceans Canada (DFO) is providing information on an updated Walrus Sport Hunt Licencing Process (the Process) that will replace the Interim Nunavut Wildlife Management Board (NWMB) Policy for Walrus Sport Hunts.

Following the NWMB's decision to discontinue their Interim Walrus Sport Hunt Policy after the 2023 season, the NWWG has been meeting and co-developing an updated process to ensure the sustainable management and efficient licencing of walrus sport hunts in Nunavut with Inuit outfitters. Walrus will continue to be sustainability harvested by Inuit and sport hunters while providing economic benefits to Nunavut communities.

The NWWG has drafted and is working on finalizing the Process, which currently includes five steps as follows:

1. **Call for Applications:** The call for applications will be issued by Regional Wildlife Organizations (RWOs) with the timing associated with each RWO's Annual General Meeting (AGM). This is a familiar process for Hunters and Trappers Organizations (HTO) and outfitters as it is currently used for the bowhead hunt call for applications. Applications will be submitted to HTOs.
2. **HTO Review and Support of Applications:** Each HTO board will review applications and, if it is complete and they approve, they will send the application and a letter of support from the HTO to their RWO.
3. **RWO Review and Approval of Applications:** The RWOs will review the applications sent by HTOs and ensure all required information has been submitted. In their review of applications, the RWOs may consider conservation concerns, RWO by-laws related to walrus hunting, the apparent capacity and experience of the outfitter to successfully carry out the sport hunt as planned, consistency of the proposed sport hunt with the principles and objectives of the *Nunavut Agreement*, and any other information the RWO finds pertinent to the evaluation of the

application. The RWO will then send a letter of approval or rejection for each application to DFO with copies to the HTO and outfitter.

4. **DFO Review:** DFO will review the RWO and HTO letters and any applicable information contained in the sport hunt applications to ensure compliance with all Acts and Regulations under their purview. DFO will notify applicants, HTOs, and RWOs via email if their application has been approved.
5. **Issuance of the Marine Mammal Fishing Licence:** Upon receiving the completed documents and licence fee, DFO Fisheries Management staff will issue a Marine Mammal Fishing Licence for walrus pursuant to Section 4(1) of the *Marine Mammal Regulations*.

The NWWG acknowledges that capacity at the RWOs may be limited and has identified that in the event an RWO cannot fulfil their duties as outlined above, DFO will fulfil these duties.

In the NWMB's decision to discontinue the Interim Walrus Sport Hunt Policy, the NWMB stated that the policy presented a prohibitive timeline to Inuit outfitters. The Process proposes to alleviate this issue by having DFO's Regional Director General (RDG) approve walrus sport hunt applications instead of DFO's Minister. The NWWG will work together to update the Walrus Integrated Fisheries Management Plan to reflect this new process for sport hunts.

Barring any significant issues or concerns raised by the NWMB at this Regular Meeting, the NWWG will continue to work on and finalize the Process. At the same time, DFO staff will prepare a memorandum for the Minister outlining the Process and request the Minister delegate her authority to approve walrus sport hunts to the RDG. With these concurrent processes underway, it is anticipated that the call for walrus sport hunt applications will occur this fall in conjunction with the RWO's AGMs as indicated in the current draft Process.

Consultation:

The NWWG includes participation from:

- Nunavut Tunngavik Inc.;
- Qikiqtaaluk Wildlife Board;
- Kitikmeot Regional Wildlife Board;
- Kivalliq Wildlife Board;
- Nunavut Wildlife Management Board; and
- Fisheries and Oceans Canada- Fisheries Management and Science (as required).

The NWWG met most recently on July 11, 2023, and will meet again in September.

Recommendation:

At the July 11 NWWG meeting, NWMB representatives identified that a NWMB decision on the Process would not be required. DFO, on behalf of the NWWG, wanted to present the Process at this time to afford the NWMB the opportunity to provide any feedback prior to finalizing the Process.

Prepared by: Fisheries Management, Arctic Region – Fisheries & Oceans Canada

Date: July 24, 2023

SUBMISSION TO THE NUNAVUT WILDLIFE MANAGEMENT BOARD

August 2023

FOR

Information: X **Decision:** **Recommendation:**

Issue: Proposed multi-species marine mammal fall survey in Ungava Bay and Hudson Strait

Project Leaders: Caroline Sauvé and Arnaud Mosnier (Fisheries and Oceans Canada, Quebec)
Emails: caroline.sauve@dfo-mpo.gc.ca; arnaud.mosnier@dfo-mpo.gc.ca

Funding sources: DFO Science, Marine Conservation Target project (Québec Region)

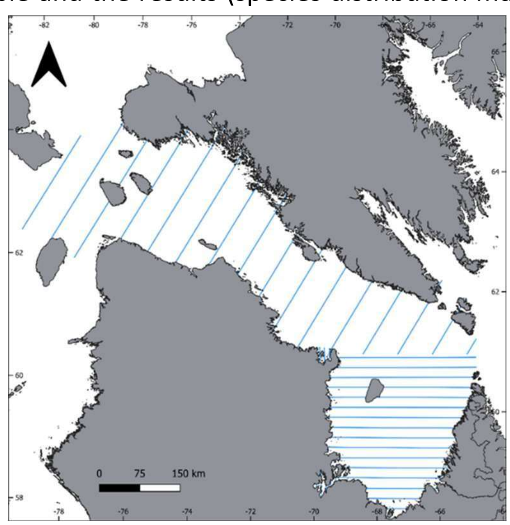
Project rationale: The Marine Conservation Target program within Fisheries and Oceans Canada (DFO) gathers data on biodiversity and species distribution in Canadian waters, particularly to fill in gaps where necessary. Knowledge of the occurrence and distribution of several marine mammal species in Hudson Strait and Ungava Bay in autumn is very limited, especially in offshore waters where no Inuit observational data is available.

In spring 2023, DFO Science (Québec Region) visited several Hudson Strait communities in Nunavik and learned from the Local Nunavimmi Umajulivijiit Katujiqatigininga (LNUKs) and hunters that marine mammals were present in their area and suggested that DFO should consider surveying there. Feedback from other communities across Nunavik indicated their interest in surveys conducted outside of the summer period.

To fill this information gap, DFO Science (Québec Region) is considering a multi-species aerial survey between late October and early December 2023 in Hudson Strait and Ungava Bay. This would be a systematic line transect aerial survey involving two aircraft, to account for limited daylight hours. DFO has offered to train two Inuit who would participate as marine mammal observers, one for each aircraft. The data from this survey would be analyzed as soon as possible and the results (species distribution maps) shared with the communities

Time period: October 20 to December 1, 2023.

Location: This project would take place in the Nunavik and Nunavut Marine Regions over Ungava Bay and Hudson Strait (see map attached). The entire survey will be conducted above the sea and long-distance displacements above land may occasionally be undertaken to shorten the travel distance. No low altitude flights susceptible to disturb Inuit activities will be flown.



Objectives: To collect information on marine mammal distribution, abundance and diversity at the time when many marine mammal species migrate. Our survey may help identify important migration areas for different species.

Survey methods: The proposed survey involves two small aircraft (e.g., Cessna 337 or Partenavia P68C), and an estimated total flight time of 82 hours (41 hours/plane), corresponding to 5 flying days in Ungava Bay and 4 flying days in Hudson Strait. A systematic visual line transect design is proposed, with survey lines flown at a target altitude of 800 to 1000 feet and a target airspeed of 100 knots. Survey observers will record all marine mammal sightings on transects. No circling back is planned, i.e., when animals are observed, the aircrafts will not deviate from their trajectory.

A training period will be offered at the beginning and during the survey. Local Inuit that wish to participate as marine mammal observers will be invited to attend the training sessions before joining the survey team. All marine mammal observations will be recorded, including large whales, beluga, narwhals, seals, walruses, and dolphins.

Community consultation plan:

This project description and a feedback form will be shared with the Regional Nunavimmi Umajulirijiit Katujiqatigininga (RNUK), LNUKs from the Ungava Bay and Hudson Strait areas, the Nunavut Marine Region Wildlife Board (NMRWB), the NWMB, the Kimmirut and Kinngait HTOs, and the Qikiqtaaluk Wildlife Board. The DFO Science (Québec region) team traveled through all Hudson Strait and Ungava Bay communities between May and June 2023 to discuss marine mammal research with LNUKs, Uumajuit wardens, and community members. Although this proposed survey project was not presented at that time, many communities expressed an interest in having marine mammal surveys conducted in the Hudson Strait area, and during periods outside of the usual stock evaluation surveys conducted by DFO.. A permit application will be submitted to the Nunavik Marine Region Planning Commission, as well as to the Nunavut Impact Review Board.

Prepared by: Caroline Sauvé, Research Scientist, DFO Quebec Region – Fisheries & Oceans Canada
Patt Hall, Fisheries Management, DFO Arctic Region – Fisheries & Oceans Canada

Date: August 4, 2023

Submission to the Nunavut Wildlife Management Board

August 2023

FOR

Information : X **Decision:**

Issue: Fisheries and Oceans Canada (DFO) Update – Southampton Island Area of Interest

Background:

DFO and the Kivalliq Inuit Association (KIA) have partnered to advance the Southampton Island Area of Interest for potential designation as a new *Oceans Act* Marine Protected Area (MPA). The Southampton Island Area of Interest encompasses the nearshore ocean 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 and consultation.

Updates:

- DFO and partners are planning to engage five communities in the Kivalliq region (Baker Lake, Chesterfield Inlet, Coral Harbour, Naujaat and Rankin Inlet) on two community tours to present and seek feedback on the Southampton Island Area of Interest (AOI) MPA proposal. These are the five communities adjacent to or near the AOI. The first tour will be in Fall 2023, and will help refine the draft MPA proposal based on consultations. The second community tour is scheduled for Winter 2024, and will be to seek feedback on a more finalized MPA proposal.

- DFO and partners have been working closely with the adjacent communities of Chesterfield Inlet and Coral Harbour, and these tours will broaden engagement to include Baker Lake, Naujaat and Rankin Inlet.

- The draft MPA proposal will be a document and presentation outlining the AOI's proposed boundary, conservation objectives, key information from AOI assessments, and proposed measures to mitigate potential negative impacts from activities on species and habitats. The proposed measures may regulate, restrict, allow with conditions or allow activities, while respecting the Nunavut Agreement. Proposed measures will be based on the Southampton Island AOI Ecological Risk Assessment and AOI assessments.

- All Inuit rights under the Nunavut Agreement, including harvesting rights, would be respected in establishment and management of an MPA. The Nunavut Wildlife Management Board's (NWMB) powers, duties and functions would be respected.

- The first set of consultations (Fall 2023) will include an overview of all the assessment reports completed to date (Inuit Qaujimajatuqangit Workshop, Biophysical and Ecological Overview, Socioeconomic Overview, Fisheries related info and analyses, quantitative Resource Assessment of petroleum potential, and Marine Vessel Traffic Review), conservation objectives, and a draft MPA proposal most likely with options.

- The second set of consultations (Winter 2024) will be to seek feedback on a refined MPA proposal, based on what was heard during the first community tour. Following these two tours, a summary report will be submitted to parties (DFO, KIA and the Government of Nunavut) for recommendation to proceed with a regulatory process to establish a Marine Protected Area. If MPA establishment is recommended, partners would aim to designate an MPA by 2025. Obligations under the Nunavut Agreement will apply, including establishment of an Inuit Impact and Benefit Agreement.

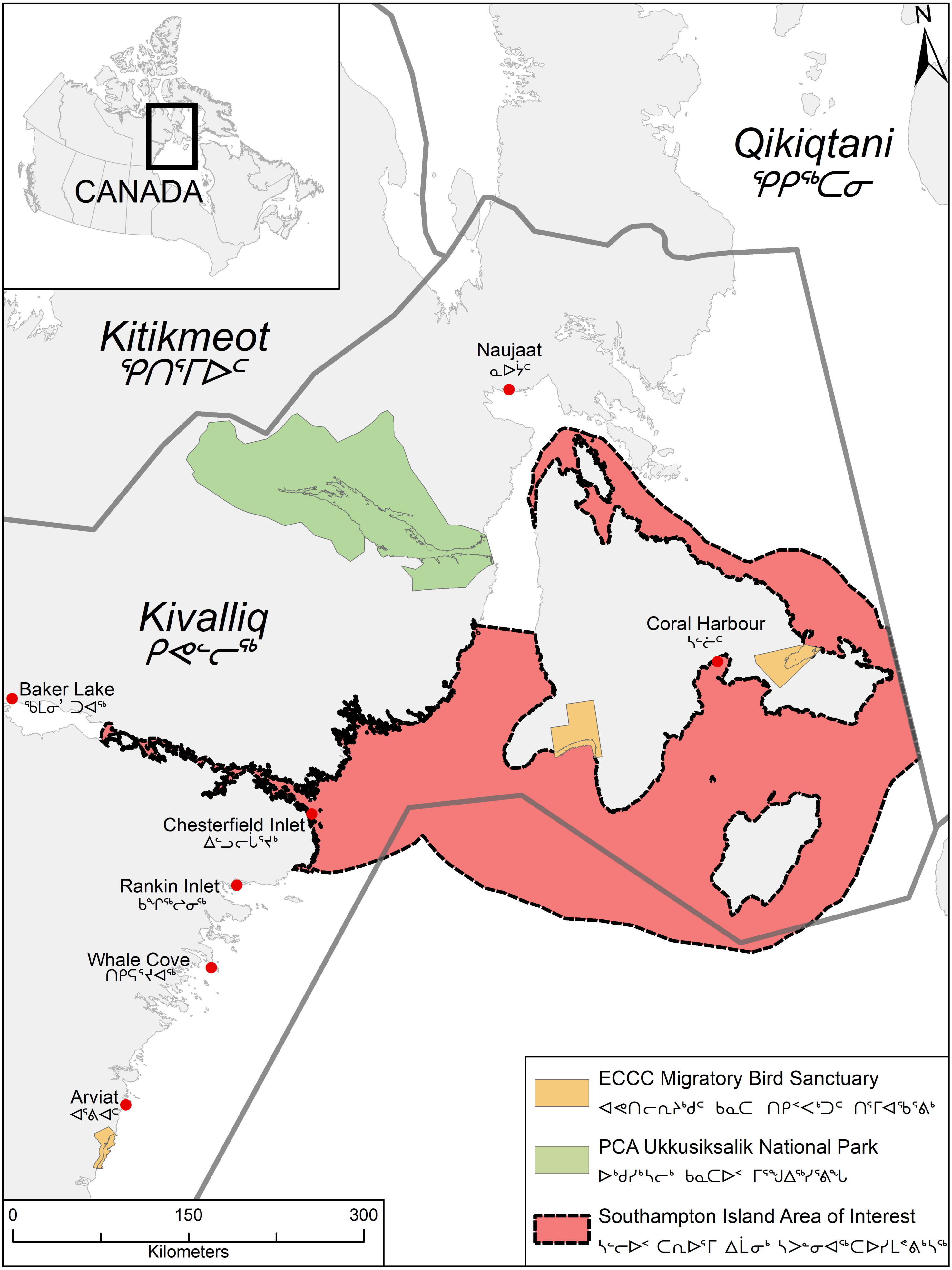
- Concurrently to the community consultations, partners will seek stakeholder feedback on the draft MPA proposal. Identified stakeholders include the shipping, mining and fishing industries and cruise operators. To date, the above stakeholders have been engaged for awareness of the AOI and process, but have not yet been provided the opportunity to review the relevant AOI assessments or draft MPA proposal.

Request:

At this time, DFO is inviting the NWMB to provide any recommendations on the above approach to consultations.

Prepared by: Andrew Tucker, Arctic Region – Fisheries and Oceans Canada, Marine Planning and Conservation Program

Date: August 2, 2023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PCA Ukkusiksalik National Park
ᐅᒃᑯᓯᒃᓴᓕᒃ ᑲᓇᑕᐅᑉ ᒥᕐᖑᐃᖅᓯᕐᕕᖓ
Southampton Island Area of Interest
ᓴᓪᓕᐅᑉ ᑕᕆᐅᕐᒥ ᐃᒫᓂᒃ ᓴᐳᓐᓂᐊᖅᑕᐅᓯᒪᕚᒃᓴᖅ