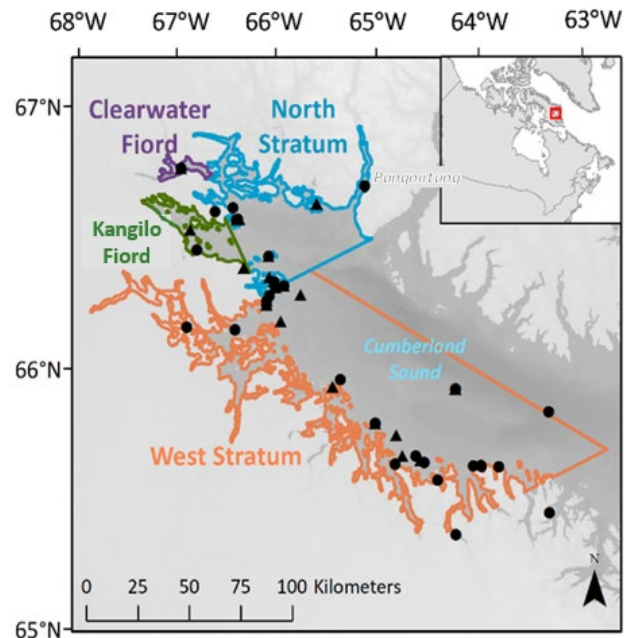




## GENETIC ASSESSMENT FOR DISCRIMINATION OF BELUGA WHALES IN CUMBERLAND SOUND



*Beluga (Delphinapterus leucas) in Cumberland Sound (DFO 2019).*



*Figure 1. Map indicating the four surveyed regions in Cumberland Sound, Nunavut, and the locations where harvest samples were collected. Circles indicate beluga with DNA that is shared with other reference populations, whereas triangles indicate DNA that is specific to a Cumberland Sound beluga population.*

### Context:

*There are many definitions for a population that vary widely across the biological sciences and the conservation and management disciplines. In an evolutionary context, one of the suggested definitions for population refers to a group of interbreeding individuals that exist together in time and space. A stock refers to a management unit defined geographically and temporally that may include more than one population if they overlap during the management or harvest season.*

*Cumberland Sound beluga (Delphinapterus leucas) are currently managed as a distinct stock based on genetic analyses and limited telemetry data. Telemetry data have shown that animals from the stock reside year-round in the sound, migrating into Clearwater Fiord in summer and to open water polynyas at the mouth of the sound in winter. The stock is hunted for subsistence by the community of Pangnirtung, and is co-managed by Fisheries and Oceans Canada (DFO), the Nunavut Wildlife Management Board, the local Pangnirtung Hunters and Trappers Association, and the Qikiqtaaluk Wildlife Board.*

*Currently, Cumberland Sound beluga is listed on the Species at Risk Act as “Threatened” (2017) and more recently, the Committee on the Status of Endangered Wildlife in Canada assessed Cumberland Sound beluga as “Endangered” (2020).*

*Local traditional and hunter knowledge has raised concerns that beluga from multiple distinct groups summer in Cumberland Sound, and that the current quota does not reflect this dynamic. DFO Fisheries Management, on behalf of the Cumberland Sound Beluga Working Group, has requested Science advice on the genetic population structure of beluga in Cumberland Sound that is being harvested by the hunters of Pangnirtung, and to identify what portion of the hunt is from the Cumberland Sound population. This advice will be used to inform future management decisions on the harvest of beluga in Cumberland Sound.*

*This Science Advisory Report is from the Review of Cumberland Sound Beluga (*Delphinapterus leucas*) Stock Delineation held on October 26-27, 2022. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.*

## SUMMARY

- Beluga whales in Cumberland Sound are harvested by hunters from the hamlet of Pangnirtung. Assessments in 2016 and 2019 indicated the current harvest is not sustainable. Harvest changes have not been implemented, in part, because there are questions regarding the number of beluga whale populations that inhabit Cumberland Sound.
- Genetic variation among beluga whales harvested in Cumberland Sound was assessed against samples from other Canadian populations using DNA inherited from both parents and from mothers only.
- Genetic analyses revealed that there is a distinct population specific to Cumberland Sound, hereafter identified as the Cumberland Sound Beluga (CSB) population.
- Whales harvested in Cumberland Sound comprise two populations. Of the 27 samples evaluated from DNA inherited from both parents, the majority were from the CSB population (74%). The remainder (26%) were most similar to whales from the Western Hudson Bay (WHB) population.
- It is unknown whether whales most similar to WHB were temporary or permanent migrants in Cumberland Sound. The frequency of possible migration is also unknown.
- Because these two populations cannot be distinguished visually during abundance surveys, management should recognize that the distinct CSB population is likely smaller than previously estimated.
- Future genetic assessments of beluga in Cumberland Sound would benefit from including DNA inherited from both parents.

## INTRODUCTION

Previous genetic, contaminant, morphometric, dietary, and satellite telemetry data suggest Cumberland Sound beluga form a distinct population that remain within the sound year-round. However, questions and concerns persisted about the origin of the beluga that visit Cumberland Sound in the summer, which in part, has delayed sustainable management. To address these concerns, a new genetic assessment using recent harvest samples, longer sequences of DNA inherited from mothers only (mitochondrial DNA), and genome-wide sequencing of DNA inherited from both parents (nuclear DNA) was undertaken.

## ASSESSMENT

Using mitochondrial DNA analysis, beluga samples collected throughout Cumberland Sound (N = 189; Figure 1) were used to assess their genetic distinctiveness from four other populations in eastern Canada (N = 657). A subsample of whales harvested in Cumberland Sound (N = 27) and Western Hudson Bay (N = 121) were also genotyped using nuclear DNA to investigate distinctiveness.

Both types of DNA identified that there is a distinct population specific to Cumberland Sound, hereafter identified as the Cumberland Sound Beluga (CSB) population. However, both CSB and whales from another population are harvested in Cumberland Sound during summer (Figure 2). The results using mitochondrial DNA confirmed that DNA sequences of approximately 35% of beluga harvested in July and August from Cumberland Sound were unique, or private, to this region. The rest of the harvested whales had DNA sequences shared with other Canadian beluga populations. Comparatively, nuclear DNA identified two populations in Cumberland Sound during summer with approximately 74% of the whales belonging to the CSB population; the remainder (26%) were most similar to whales from the Western Hudson Bay (WHB) population. The difference between the proportion of CSB whales comprising the harvest samples as assessed using the two types of DNA shows that using only private mitochondrial DNA sequences underestimates the proportion of CSB whales in the harvest.

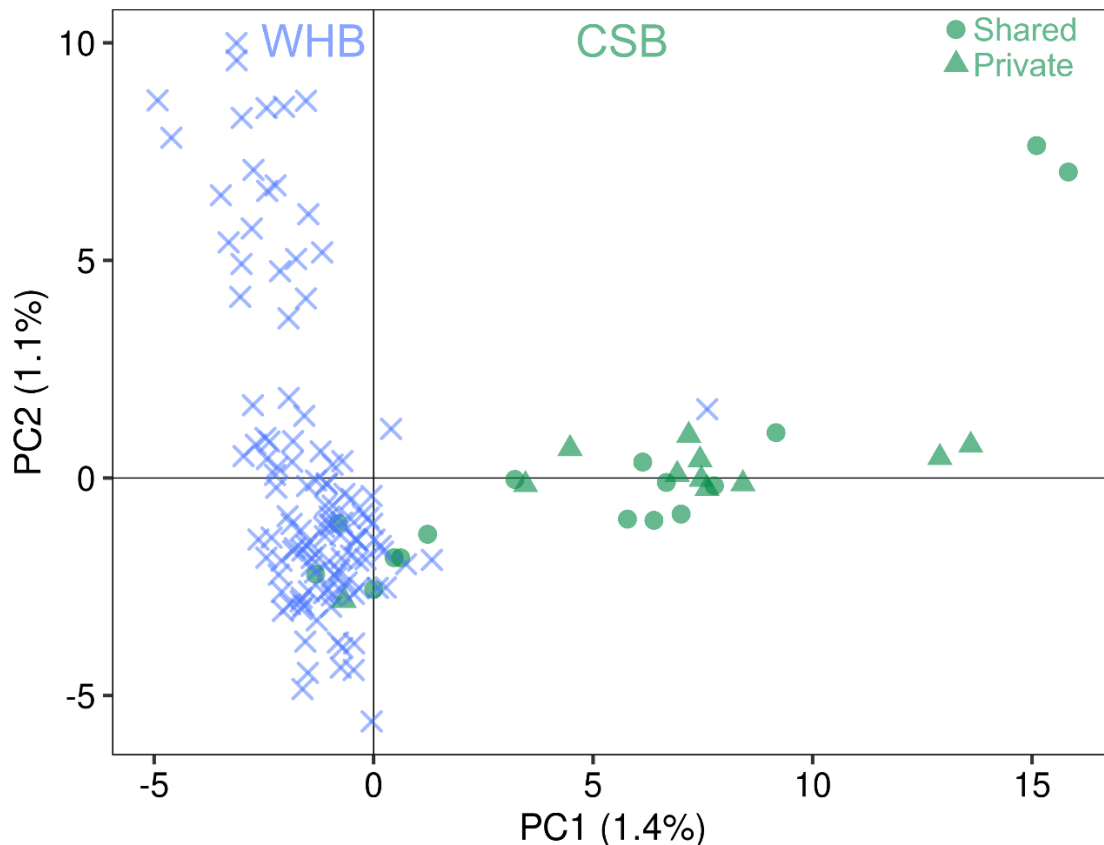


Figure 2. Principal Component Analysis (PCA) using nuclear DNA inherited from both parents showing genetic distinctiveness between Cumberland Sound (CSB, green) and Western Hudson Bay (WHB, blue) beluga populations. Within CSB, mitochondrial DNA that is unique or private to CSB (triangles) or shared with other beluga populations (circle) is indicated.

Both beluga from CSB and those most similar to WHB whales were hunted within the area that is surveyed during summer. It is unknown, however, whether the non-CSB belugas harvested in Cumberland Sound were temporary migrants or permanent immigrants. It is also unknown how frequently migration occurs, or if interbreeding between the two populations is taking place. Genetic variation in nuclear DNA needs to be studied with larger sample sizes from Cumberland Sound to provide this information. These factors may all influence population assessments and subsequent harvest advice.

### **Sources of Uncertainty**

Sample size for the analyses of nuclear DNA was sufficient to discriminate the CSB population from other populations but the current number of samples is too small to fully characterize possible gene flow between populations.

The majority of samples analyzed were from harvested animals, which may introduce temporal, spatial, and selective harvesting biases and, thus, they may not represent the overall genetic diversity of whales present in Cumberland Sound.

## **CONCLUSIONS AND ADVICE**

In this study, genetic analyses support the presence of two genetically distinct populations of beluga inhabiting Cumberland Sound. The majority of samples were from the CSB population, while the remaining were most similar to the WHB population. These results indicate that the distinct CSB population is likely smaller than previously estimated.

Beluga from the two populations cannot be distinguished visually during aerial abundance surveys. Spatial or temporal characteristics associated with the populations that could allow selective harvesting of the two populations in Cumberland Sound have also not yet been identified. As a result, these two populations can only be assessed as a single stock.

Future genetic assessments of beluga in Cumberland Sound should include nuclear DNA (inherited from both parents). Using only private mitochondrial (maternally-inherited) DNA sequences underestimates the proportion of CSB population present in Cumberland Sound during summer.

## **OTHER CONSIDERATIONS**

The Canadian Arctic is experiencing environmental changes related to climate change. There is little mechanistic understanding of how these changes may impact beluga distribution, migration, and reproduction. Continued monitoring of these populations through a strong sampling program is needed to evaluate population changes related to environmental factors.

Inuit knowledge from the Pangnirtung community indicated multiple beluga groups are present in Cumberland Sound. It would be worth investigating any possible association between genetic, morphological, and behavioural traits in future studies to avoid local depletion of beluga.

Although the study found there was distinction between samples from Cumberland Sound and Western Hudson Bay it would be valuable to include other beluga populations, including those from High Arctic Baffin Bay, in future assessments.

**LIST OF MEETING PARTICIPANTS**

<b>Name</b>	<b>Organization/Affiliation</b>
Sean MacConnachie (Chair)	DFO – Science, Pacific Region
Cortney Watt (Science Lead)	DFO – Science, Ontario and Prairie Region
Genevieve Parent (Science Lead)	DFO – Science, Quebec Region
Joclyn Paulic	DFO – Science, Ontario and Prairie Region
Estelle Couture	DFO – Science, National Capital Region
Chantelle Sawatzky	DFO – Science, Ontario and Prairie Region
Christine Abraham	DFO – Science, National Capital Region
Lianne Postma	DFO – Science, Ontario and Prairie Region
Lisa Loseto	DFO – Science, Ontario and Prairie Region
Marianne Marcoux	DFO – Science, Ontario and Prairie Region
Veronique Lesage	DFO – Science, Quebec Region
Mike Hammill	DFO – Science, Retired
Arnaud Mosnier	DFO – Science, Quebec Region
Jean-Francois Gosselin	DFO – Science, Quebec Region
Anne Provencher St-Pierre	DFO – Science, Quebec Region
Luca Montana	DFO – Science, Quebec Region
Xavier Bordeleau	DFO – Science, Quebec Region
Caroline Sauve	DFO – Science, Quebec Region
Thomas Doniol-Valcroze	DFO – Science, Pacific Region
Strahan Tucker	DFO – Science, Pacific Region
Sheena Majewski	DFO – Science, Pacific Region
Chad Nordstrom	DFO – Science, Pacific Region
Steve Ferguson	DFO – Science, Ontario & Prairie Region
Cory Matthews	DFO – Science, Ontario & Prairie Region
Jack Lawson (Rapporteur)	DFO – Newfoundland and Labrador Region
Garry Stenson	DFO – Science, Retired
Shelley Lang	DFO – Newfoundland and Labrador Region
Lee Sheppard	DFO – Newfoundland and Labrador Region
Pierre Goulet	DFO – Newfoundland and Labrador Region
Damian Lidgard	DFO – Science, Maritimes Region
Nell den Heyer	DFO – Science, Maritimes Region
Tim Tinker	University of California
David Lee	Nunavut Tunngavik Inc.
Phillip Morin	National Oceanic and Atmospheric Administration
Colin Garroway (Written Review) Stephen Petersen	University of Manitoba Assiniboine Park Conservancy
Johnny Mike	Pangnirtung Hunters and Trappers Association
Jennie Ryman	DFO – Fisheries Management, Arctic Region
Christine Lacho	DFO – Species At Risk, Ontario and Prairie Region

## SOURCES OF INFORMATION

This Science Advisory Report is from the regional peer Review of Cumberland Sound Beluga (*Delphinapterus leucas*) Stock Delineation held on October 26–27, 2022. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

DFO. 2019. [Sustainable harvest advice for Cumberland Sound beluga based on the 2017 aerial survey and modelled abundance estimates](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2019/024.

Richard, P., and Stewart, D.B. 2008. [Information Relevant to the Identification of Critical Habitat for Cumberland Sound Belugas \(\*Delphinapterus leucas\*\)](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2008/085: iv + 24 p.

