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Science Response 2024/nnn

CONSERVATION IMPLICATIONS OF MOVING THE NORTHERN BOUNDARY OF THE BELCHER-ISLANDS AND EASTERN HUDSON BAY BELUGA TOTAL ALLOWABLE TAKE ZONE SOUTH OF ITS CURRENT LOCATION

Context

In 2020, the Nunavik Marine Region Wildlife Board (NMRWB) renewed the Nunavik Beluga Management Plan for a five year period (2021 to 2026). Existing management measures include a total allowable take (TAT) of 20 beluga in the Eastern Hudson Bay management area (Figure 1), and Non-Quota Limitations (NQL) in respect to beluga harvesting elsewhere within the Nunavik marine region.

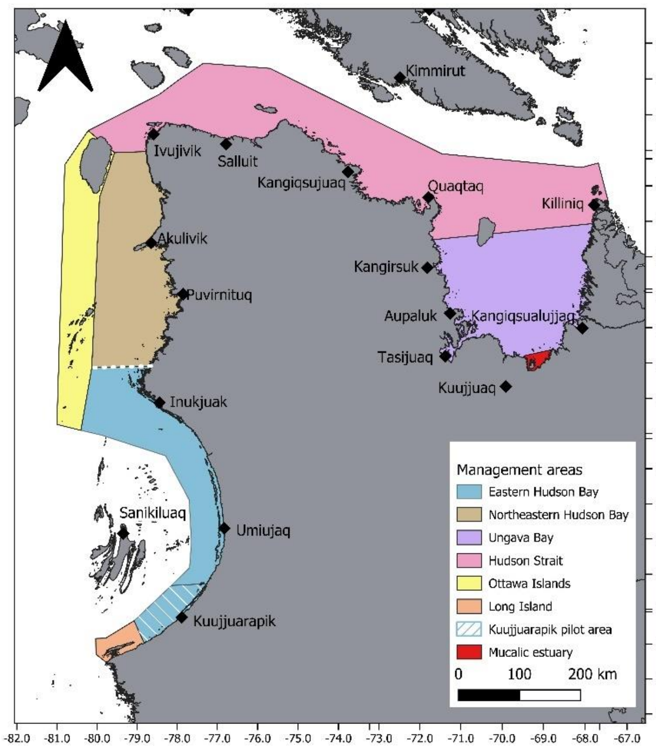


Figure 1. Beluga management areas within the Nunavik marine region. The white dashed line illustrates the northern boundary of the BEL-EHB beluga TAT zone. The Kuujjuarapik pilot area is part of the BEL-EHB beluga TAT zone, but with seasonal variations in the application of the TAT.

In December 2023, the Anguvigaq (regional hunters and trappers organization) informed the NMRWB that the location of the northern boundary of the Eastern Hudson Bay (EHB) beluga TAT zone is disputed by local knowledge holders, resulting in impacts on the affected communities, Inukjuak (58.45°N; 78.10°W) in particular. The Anguvigaq recommended that the northern boundary, located at 59°N of latitude, be reassessed based on the best available scientific information and Inuit Qaujimajatuqangit (IQ), and that moving the boundary further south be considered. In response to this request, the NMRWB elected to hold public hearings to consult with communities of the Eastern Hudson Bay area on the significance of changing the northern boundary of the EHB beluga TAT zone to beluga conservation and Inuit Rights.

In preparation for this public hearing, the NMRWB requested that DFO provide a scientific review of the conservation implications that such a change in the TAT zone would have for the EHB beluga stock.

This Science Response Report results from the regional peer review held April 12, 2024 on Conservation implications of moving the northern boundary of the eastern Hudson Bay Arc region total allowable take zone south of its current location. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Background

In Canada, beluga are managed on the principle that they form discrete summering aggregations, to which individuals show strong philopatry (Sergeant 1973, Finley et al. 1982; Richard et al. 1990). Evidence that beluga return annually to the same aggregation areas during summer has been supported by studies based on behavioural observations (Caron and Smith 1990), isotopes and trace elements (Rioux et al. 2012), telemetry (Bailleul et al. 2012) as well as genetic data (Brown Gladden et al. 1999; de March and Postma 2003; Postma et al. 2012; Turgeon et al. 2012; Colbeck et al. 2013; Parent et al. 2023). This has led to recognition that there are at least three beluga management stocks located within the Hudson Bay watershed: EHB, Western Hudson Bay (WHB), and James Bay beluga. Beluga may also summer along the Ontario coast of Hudson Bay, but little is known about these animals and it is not clear if they could be related to aggregations of animals observed in northwestern James Bay, to WHB beluga, or distinct (Richard 2004; Smith et al. 2007; Postma et al. 2012; Parent et al. 2023).

In 2016, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) identified three beluga Designatable Units (DU) within the Hudson Bay watershed, which generally agreed with the general framework of management stocks (COSEWIC 2016). Animals belonging to these DUs occur within the Nunavik marine region year round (i.e., EHB [Threatened], and James Bay [Not at Risk] DUs), or seasonally (i.e., WHB DU [Not at Risk]) (COSEWIC 2020). Management measures implemented in Nunavik since the mid-1980s have largely focused on protecting the EHB DU. EHB beluga are currently co-managed with Nunavik Inuit and Cree of Eeyou Istchee according to their respective land claim agreements. The current management objective for this stock is to maintain an abundance at or above the 2015 abundance of 3,400 animals estimated from the 2015 stock assessment (Hammill et al. 2017) after 5 to 10 years, with harvests levels set to correspond with a probability of a decline in abundance below this threshold of ≤ 50%.

Since the last COSEWIC beluga DU review and the renewal of the Nunavik beluga management plan in 2020, a genetic re-analysis of beluga samples by DFO has identified a distinct population in the Belcher Islands (BEL), i.e. within the geographic summer distribution area of the EHB DU (Parent et al. 2023). Aerial surveys in eastern Hudson Bay showed that there was a continuous distribution of beluga from the coast between Kuujjuarapik and Inukjuak, which extends as far offshore as the Belcher Islands (Smith and Hammill 1986; Kingsley 2000; Gosselin et al. 2002, 2009, 2013, 2017). In addition, most beluga equipped with satellite transmitters in estuaries in eastern Hudson Bay performed repeated inshore-offshore movements extending out to the Belcher Islands during summer (Bailleul et al. 2012). Therefore, there is likely spatial overlap between the distributions of BEL and EHB populations, and DFO suggested managing beluga summering in this area as a mixed (BEL-EHB) stock (DFO 2022).

The last BEL-EHB stock assessment was conducted in 2021. The demographic model estimated a 2021 abundance of 2,900-3,200 beluga, depending on model assumptions (Hammill et al. 2023). The stock is estimated to have been declining, albeit at a very slow rate (~1% per year) between 2001-2015 (Figure 2; Hammill et al. 2023). Since 2015, the rate of demographic decline has accelerated (~3% per year), leading to a decline in abundance from 3,700-3,900 in 2015 to 2,900-3,200 in 2021, depending on model assumptions (Figure 2; Hammill et al. 2023). It is noteworthy that including the 2021 aerial survey estimate and applying new availability and perception bias correction factors to the entire time series of abundance estimates for the 2021 stock reassessment resulted in changes in the historical model estimates of abundance compared to numbers from the 2015 assessment (Hammill et al. 2023). Particularly, the 2015 BEL-EHB stock abundance estimate used as a the management objective benchmark in the current management plan changed from 3,400 animals estimated from the 2015 stock assessment (Hammill et al. 2017) to 3,900 animals estimated from the 2021 stock assessment (Hammill et al. 2023).

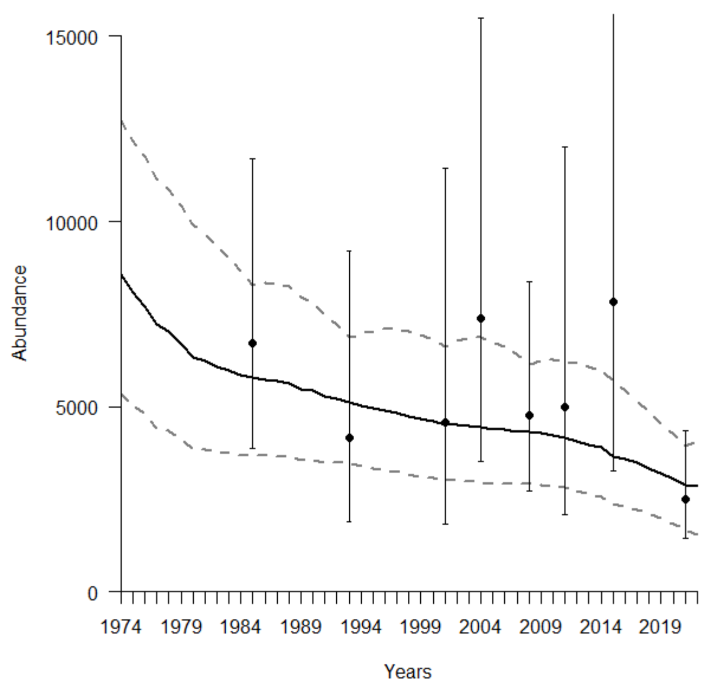


Figure 2 Estimated trajectory of the BEL-EHB beluga stock obtained by fitting a density dependent model to aerial survey abundance estimates, and accounting for reported harvests (1974-2022). Survey estimates (black circles ± 95% CI), median (black solid line) and 95% CI (grey dashed lines) are displayed. Beluga abundance estimates stated in the present document refer to estimates from the demographic model, corresponding to the black solid curve on this graph. Adapted from Hammill et al. (2023).

Description of the harvest

Historically, BEL-EHB beluga were thought to number around 12,500 animals in the 1800s. Commercial whaling during the eighteenth, nineteenth, and early twentieth centuries resulted in a sharp decline in abundance (DFO 2005; Lawson et al. 2006; Hammill et al. 2023), and continued high subsistence harvests have limited the recovery, with climate change and habitat modification being additional underlying factors. In 2001, a stock assessment estimated that if harvests were not reduced, the BEL-EHB stock would go extinct within two to three decades (Bourdages et al. 2002). A series of severe management measures to which a relatively high compliance was observed (Lesage et al. 2001) slowed the population decline.

It was estimated that harvest levels ranging between 0-70 BEL-EHB beluga per year, depending on model scenarios and stock abundance estimate used as the management objective benchmark, would respect the current management objective of ensuring a 50% probability that the stock would remain at or above the 2015 abundance estimate after 10 years (Table 1; Hammill et al. 2023). However, over the last decades, reported catches have exceeded recommended harvest levels (Figure 3). In 2023, it was estimated that 142 beluga from the BEL-EHB stock were harvested across Nunavik, using the latest genetic analysis presented in Parent et al. (2023) (Figure 3). Another 32 beluga were harvested in Sanikiluaq (Nunavut) (Figure 3), for a total of 174 BEL-EHB beluga harvested in 2023.

Table 1. Maximal harvest levels compatible with the current BEL-EHB stock management objective of ensuring a 50% probability of maintaining the stock at or above the 2015 abundance estimate over a timeframe of 5 to 10 years, depending on the 2015 BEL-EHB abundance estimate used as benchmark.

2015 BEL-EHB stock abundance estimate used as benchmark	Timeframe to respect the management objective	Maximum harvest level ensuring a 50% probability that the stock will the at or above the 2015 abundance estimate
3,400[1]	5 years	60
3,400[1]	10 years	70
3,900[2]	5 years	0
3,900[2]	10 years	35

[1]Estimated from the 2017 stock assessment (Hammill et al. 2017)
[2]Estimated from the 2021 stock assessment (Hammill et al. 2023)

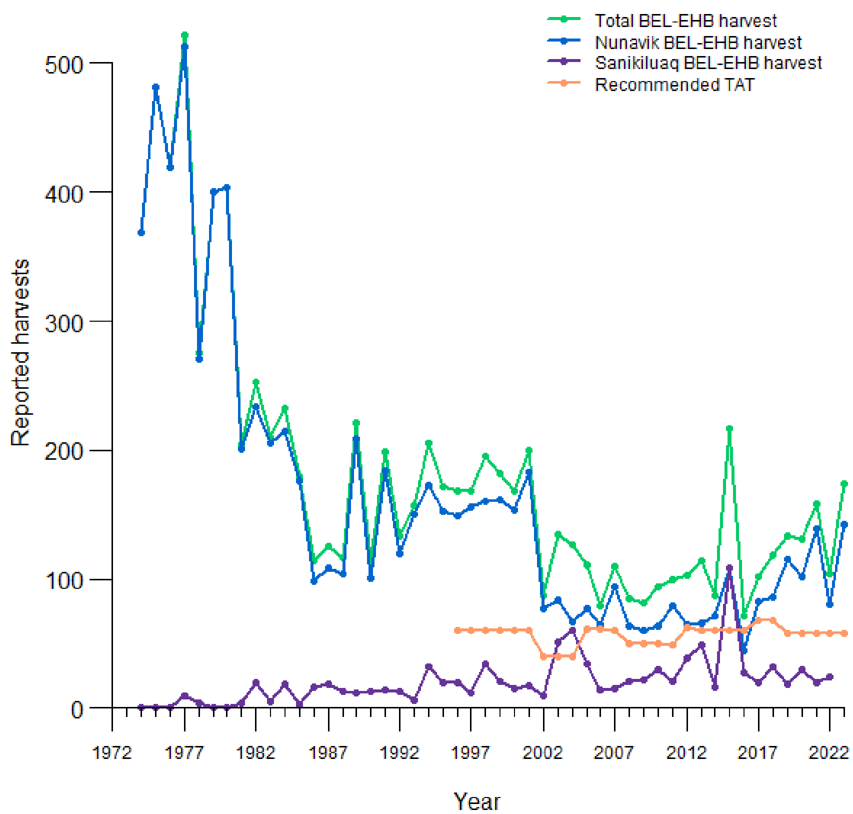


Figure 3. Season- and region-specific total landings from BEL-EHB animals based on genetic data (Hammill et al. 2023; Parent et al. 2023). The total allowable take (TAT) for BEL-EHB beluga is shown for reference.

Analysis and Response

In this Science Response Report, DFO reviews the existing data on BEL-EHB spatiotemporal distribution to quantify the seasonal occurrence of beluga whales in the northern portion of the eastern Hudson Bay management area. In addition, the uncertainties in the available data are examined and identified, and recommendations for future research that would improve our understanding of the conservation implications of moving the northern boundary of the BEL-EHB beluga TAT zone south of its current location are provided.

Throughout this document, the term beluga 'population' refers to a summer aggregation displaying a distinct genetic signature, while a 'stock' refers to beluga spatially and temporally located within a management unit, and may include more than one population or a subset of individuals from a population (Parent et al. 2023; Watt et al. 2023).

BEL-EHB beluga spatiotemporal distribution

Harvest and observational data

Since the mid-1990s, designated community members across Nunavik, today known as Uumajuit Wardens, have been mandated to report marine mammal harvests and sightings to DFO. Since 2006, they report these landings and observations on a weekly basis. While reporting of all beluga harvested and struck and lost to Uumajuit Wardens is a requirement in the beluga management plan, reporting of marine mammal sightings by community members is encouraged but voluntary.

The compilation of these weekly reports represents a rich timeseries of opportunistic sightings and reported harvests from each community across Nunavik. Figure 4 displays the cumulative number of beluga harvested and sighted by calendar date by and around the community of Inukjuak between 2006 and 2023.

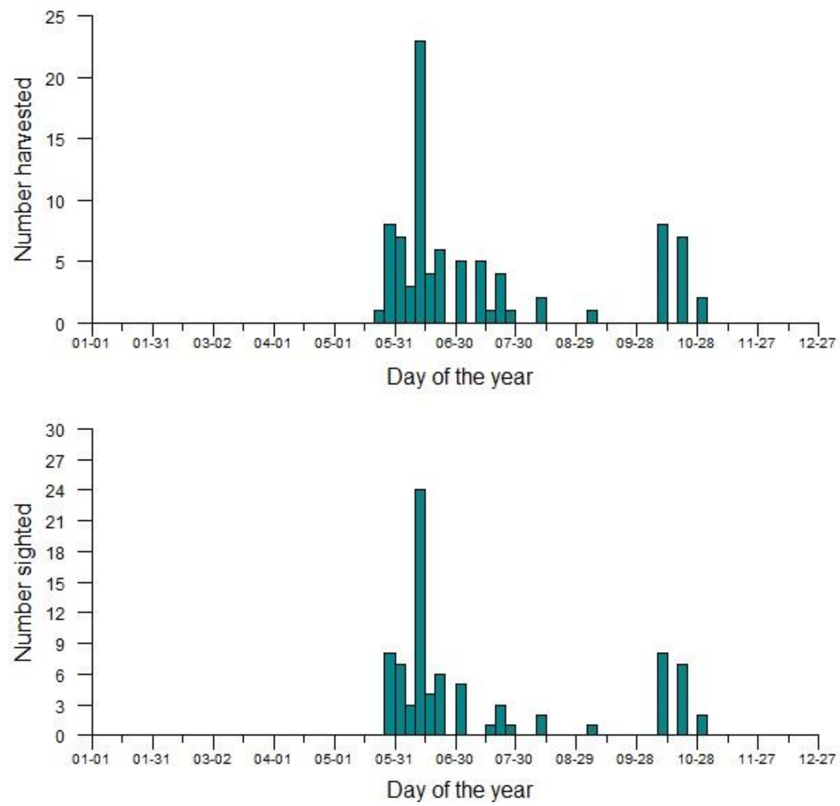


Figure 4. Cumulative number of beluga harvested (top panel) and sighted (lower panel) by calendar date reported by and around the community of Inukjuak from 2006 to 2023.

The temporal distributions of reported beluga harvests and sightings are correlated, with a first peak in mid-June and a second peak in mid-October, which likely corresponds to the timing of beluga migration. Nevertheless, beluga have been harvested and sighted in vicinity of the community of Inukjuak throughout the month of July, and occasionally in August, suggesting that some individuals summering in eastern Hudson Bay extend their distribution as far north as the community of Inukjuak. The location of beluga harvested and sighted during summer (i.e., July and August) reported by Inukjuamiut in the vicinity of their community extended from 58.5°N to 58.9°N, which corresponds to 7- 52 km north of Inukjuak. However, 50% of reports did not include the location of the harvest or sighting, limiting the potential to further explore the summer distribution of beluga along the Eastern Hudson Bay coastline using this database.

Aerial survey data

Eight systematic, visual aerials surveys have been flown between 1985 and 2021 to estimate the abundance of the BEL-EHB beluga stock (Smith and Hammill 1986; Kingsley 2000; Gosselin et al. 2002, 2009, 2013, 2017; DFO 2022). These surveys covered the Eastern Hudson Bay area from the coastline to 81°W longitude, which extends to 60 km west of the Belcher Islands (Figure 5). Aerial surveys were designed to estimate the abundance of beluga stocks in their summering grounds and were consistently flown between mid-July and September.

During visual surveys, marine mammal observers recorded time, group size, inclination angle along with position and altitude recorded by a GPS during flights, which allows to calculate the position of each marine mammal sighting. Figure 5A displays the spatial distribution of beluga sightings detected during aerial surveys between 1985 and 2021.

A gaussian density kernel function was fitted to the latitudinal distribution of these aerial survey sightings. This density function was weighted by the number of individuals observed in each sighting, and by latitude-specific survey effort (Table 2) to ensure beluga detected in areas covered more intensively were not overrepresented. Despite substantial inter-annual variation in beluga distribution (Figure 6), overall 95%, 97.5% and 99% of sightings occurred south of 57.8, 58.0 and 58.1°N, respectively (Figure 5B). The northernmost beluga detected during these surveys was located at 58.4°N of latitude, corresponding to ~9 km south of the community of Inukjuak.

Table 2. Beluga systematic survey effort between mid-July and early September 1985 to 2021 in Eastern Hudson Bay. Eastern Hudson Bay was divided into high and low coverage strata (Figure 5) which were flown with lines spaced 9.3 km (5 nautical miles) and 18.5 km (10 nautical miles) apart, respectively. The northern limits of the high coverage stratum, which lie in regions of relatively low density, slightly changed over time based on previous aerial surveys, satellite tracking of beluga (Bailleul et al. 2012), and IQ (Lewis et al. 2009).

Year	Number of passes in low coverage stratum	Number of passes in high coverage stratum	North boundary of high coverage stratum
1985	1	1	57°45’N
1993	1	1	57°45’N
2001	1	1	57°45’N
2004	1	1	57°45’N
2008	1	2	57°45’N
2011	1	1	58°04’N
2015	1	2	58°04’N
2021	1	2	58°04’N

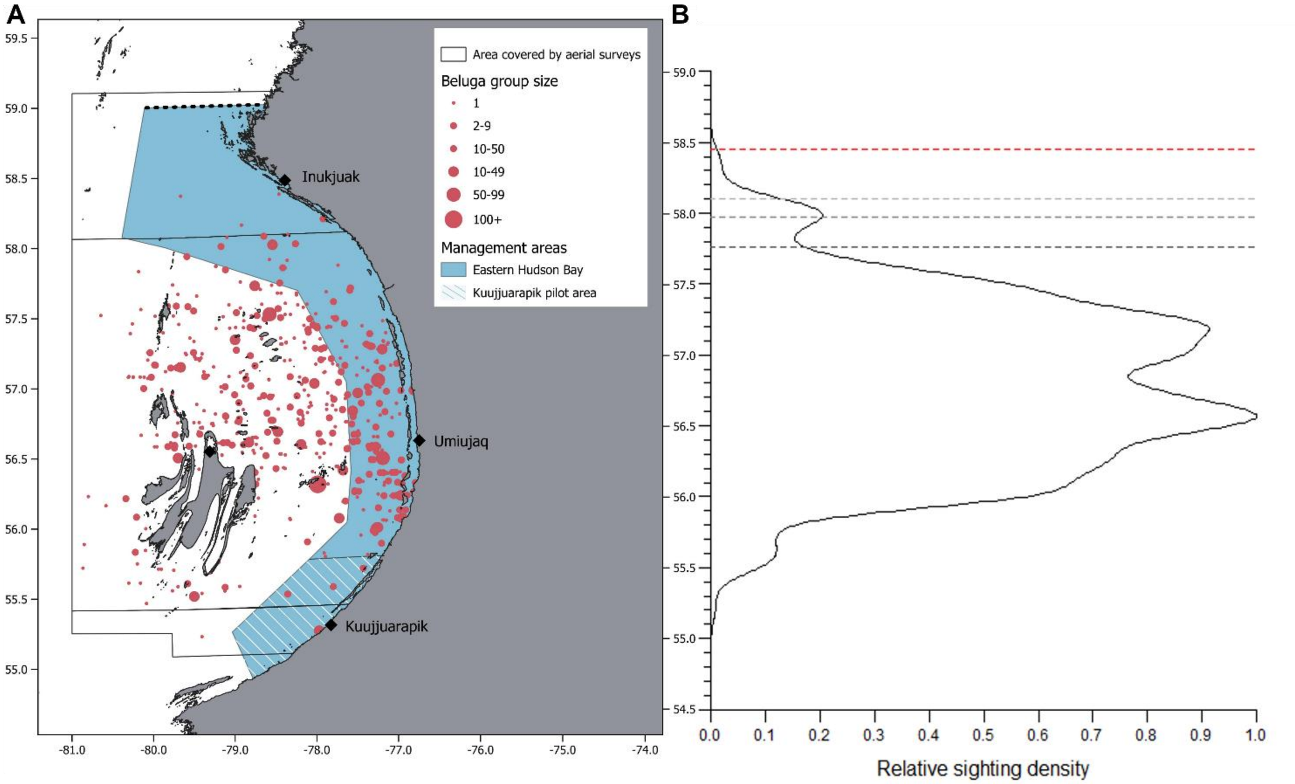


Figure 5. (A) Spatial distribution of beluga sightings detected during aerial surveys conducted in eastern Hudson Bay from mid-July to early September from 1985 to 2021. For the 2011, 2015 and 2021 surveys, which were flown using a double platform design, only sightings from primary observers are shown to avoid duplicates. The area covered by aerial surveys is divided into a high coverage stratum (center) and two low coverage strata to the south and the north. The northern boundary of the northern low coverage strata changed over the years (Table 2) and the most recent (2011-2021) survey design is displayed. The black dashed line illustrates the northern boundary of the BEL-EHB beluga TAT zone. (B) Density function fitted to the latitudinal gradient of beluga sightings detected during eight systematic visual surveys flown in Eastern Hudson Bay from 1985 to 2021. Latitude-specific survey effort varied between survey years and beluga group size ranged from 1 to 177 animals. Group size and survey effort were used as weights in the density function. The red dashed line indicate the latitude of the Inukjuak community, while black, dark grey and light grey dashed lines illustrate 95%, 97.5% and 99% quantiles.

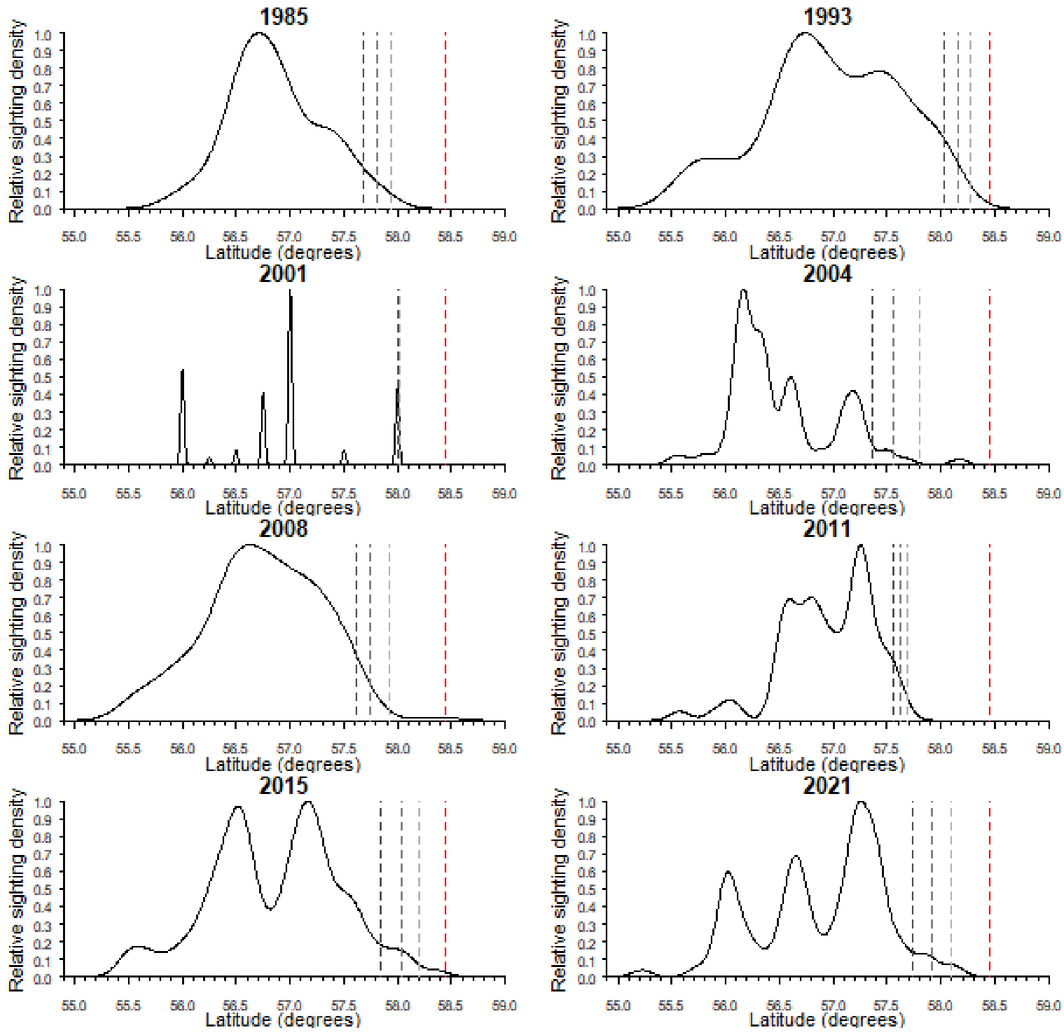


Figure 6. Density function fitted to the latitudinal gradient of beluga sightings detected during each of the eight systematic visual surveys flown in Eastern Hudson Bay from 1985 to 2021. Survey effort varied along the latitudinal gradient and beluga group size ranged from 1 to 177 animals. Group size and survey effort were used as weights in the density function. The red dashed line indicates the latitude of the Inukjuak community, while black, dark grey and light grey dashed lines illustrate 95%, 97.5% and 99% quantiles, respectively.

Aerial survey data collected from 1985 to 2021 therefore suggest that beluga in Eastern Hudson Bay and Belcher Islands are mostly (i.e., > 95%) distributed south of 57.8°N in summer. Nevertheless, some sightings were made as far north as 58.4°N latitude. Because aerial surveys were consistently conducted during summer months (i.e., mid-July to September), beluga observed on transect lines are unlikely to represent migrants from other stocks. While no trend suggests that beluga summering distribution has shifted over the years, important inter-annual variation in the distribution of sightings are likely due to the dynamic nature of beluga space use. Each survey is a sample that covers approximately 8%[1] of the surveyed area and provides a snap shot of beluga abundance and distribution at a given time. A variety of factors are thought to influence beluga aggregation and space use behaviour during summer, including winds and waves (Scharffenberg et al. 2020), bathymetry (Hornby et al. 2016), seabed composition (Whalen et al. 2020), currents and upwellings (Williams et al. 2006; Hauser et al. 2015), tides (Simard et al. 2014), and anthropogenic disturbances (Halliday et al. 2020).

Satellite tracking data

Between July and August of 1993, 1999, and 2002 to 2004, a total of 35 beluga were captured in estuaries of Eastern Hudson Bay (i.e., Nastapoka and Little Whale Rivers) and equipped with satellite tags [SPOT, SDR-16 (Wildlife Computers Ltd, Redmond, Washington, USA) or SMRU (Sea Mammal Research Unit, St. Andrews, UK] secured to the dorsal ridge. Locations were obtained via the ARGOS satellite system, and filtered as described in Bailleul et al. 2012. Track durations ranged from days to seven months, with a mean of 129 days.

Mapping the location data collected by these tags at various periods of the year provide information on the seasonal space use of tracked individuals. Figure 7 shows that from mid-July to early-September, beluga made repeated inshore-offshore movements between the Eastern Hudson Bay shoreline and the Belcher Islands, with a latitudinal distribution extending through most of the eastern Hudson Bay management area. Fitting a gaussian density kernel function to the latitudinal distribution of these satellite locations (Figure 8) revealed that beluga distribution along the latitudinal axis was very similar between mid-July and mid-September, with 95%, 97.5% and 99% of locations occurring south of 58.4, 58.5 and 58.6°N, respectively (Table 3). Two individuals tagged in Little Whale River (LWR) in 2003 made repeated trips north of the northernmost aerial survey sightings (58.4°N) from August 1 to September 5, using waters up to 58.6°N, i.e. approximately 12 km north of the community of Inukjuak. Starting mid-September, beluga initiated a northward migration, passing in front of Inukjuak between September 24 and November 6 and following the Nunavik coast towards Ungava Bay and eventually the Labrador Sea during winter (not shown, but see Bailleul et al. 2012).

Table 3. Latitudes corresponding to 95, 97.5 and 99% quantiles and descriptive statistics of the density functions fitted to the latitudinal gradients of beluga locations recorded by satellite-linked tags. Records from a total of 35 beluga captured in Little Whale or Nastapoka Rivers in 1993, 1999, 2002, 2003 and 2004 are included.

Period	Latitude (95% quantile)	Latitude (97.5% quantile)	Latitude (99% quantile)	Number of locations (*n*)	Number of beluga tracked
July 16-September 15	58.44	58.54	58.60	7676	34
September 16-30	61.24	61.40	61.50	1811	25
October 1-15	62.61	62.81	62.92	1746	22

[1] Calculated as the effective strip half-width (ESHW) divided by spacing between transects, and weighted for the contribution of the high and low coverage strata to the total surveyed area (see Gosselin et al. 2017 for details regarding survey methods and design). Considering that in 2008, 2015 and 2021, the high coverage area was covered twice, the total survey coverage for those years was ~15%.

This tracking data provides evidence that beluga that were tagged in estuaries in Eastern Hudson Bay in July or August remained in the area throughout summer, and therefore satisfied the definition of the EHB DU (COSEWIC 2016). While individuals largely (i.e., > 95%) remained south of 58.4°N, some individuals extended their summer range as far north as 58.6°N. Therefore, satellite tracking revealed a slightly wider summer range for BEL-EHB beluga compared to aerial survey sightings. This is not surprising, since satellite tags continuously monitor individuals' locations, and are thus more likely to capture uncommon space use events than one-time surveys conducted every 5 years that cover only 4.2% of the northern EHB stratum. Nevertheless, the low number of beluga (n = 35) for which movement data is available may underestimate the extent of BEL-EHB beluga summering grounds. In addition, because all tracking data from BEL-EHB beluga are from whales tagged along the Nunavik coast, it may underestimate the summer distribution of beluga from the BEL population, which summers around the Belcher Islands area.

BEL-EHB beluga tracking data also provides evidence that beluga summering in the Eastern Hudson Bay area follow the Nunavik coastline particularly close during their fall migration, especially between the community of Inukjuak and the northern boundary of the Eastern Hudson Bay management area (Figure 6).

Beluga from the WHB stock may also use this migration corridor during fall (Figure 9). However, telemetry data from beluga captured in the Nelson or Seal Rivers between June and August of 2002 to 2015 and equipped with satellite transmitters suggest that WHB beluga use multiple alternative migration routes during fall, particularly along the west coast of Hudson Bay or west of the Belcher Islands (Figure 9; Smith et al. 2007; COSEWIC 2016). Only one out of the 14 beluga tagged in WHB, for which migration data is available, followed a migration route that brough it along the Inukjuak community coastline between November 18 and the last day of transmission on November 20 2003 (Figure 9). The limited number of WHB beluga for which satellite tracking data covering the fall migration is available warrants against generalizing the proportion (1/14; 7%) of individuals migrating along the Nunavik coastline to the migration behaviour of the WHB stock. However, given its high abundance (~54,000 beluga; Matthews et al. 2017), any fraction of the WHB stock migrating close to the eastern Hudson Bay coast is likely to represent a non-negligeable number of animals.

In contrast, satellite tracking from beluga tagged during summer in James Bay (n =14) from 2007 to 2009 did not migrate along the Nunavik coastline in the fall (Bailleul et al. 2012). Instead, JB beluga remained within James Bay until tag failure in the winter.

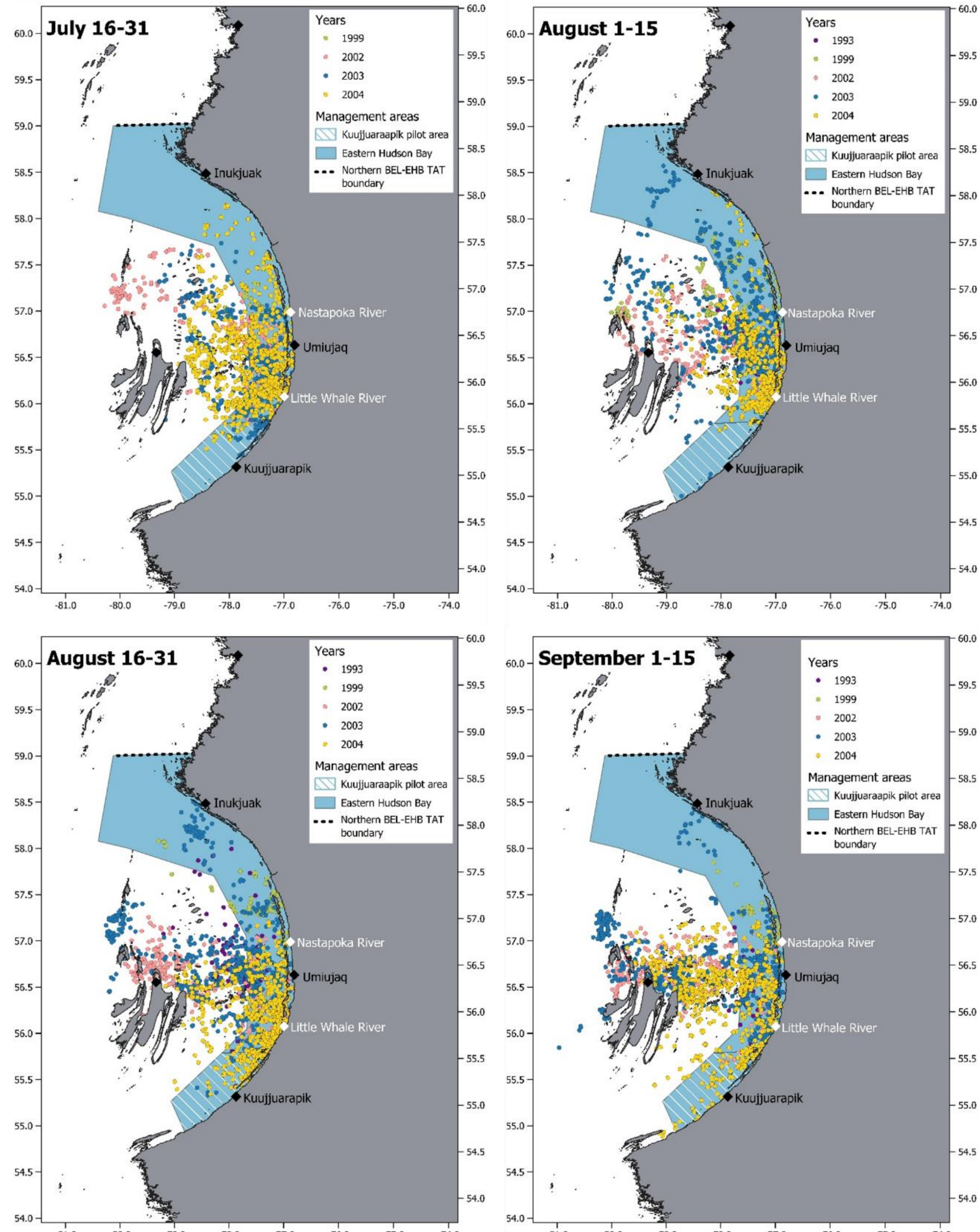


Figure 7. Locations from 35 beluga captured and equipped with satellite-linked recorders in July or August in Little Whale or Nastapoka Rivers. Marker colors indicate the year tracked individuals were tagged. Pannels display 2-weeks periods between mid-July and late November to illustrate the seasonal variation in beluga distribution.

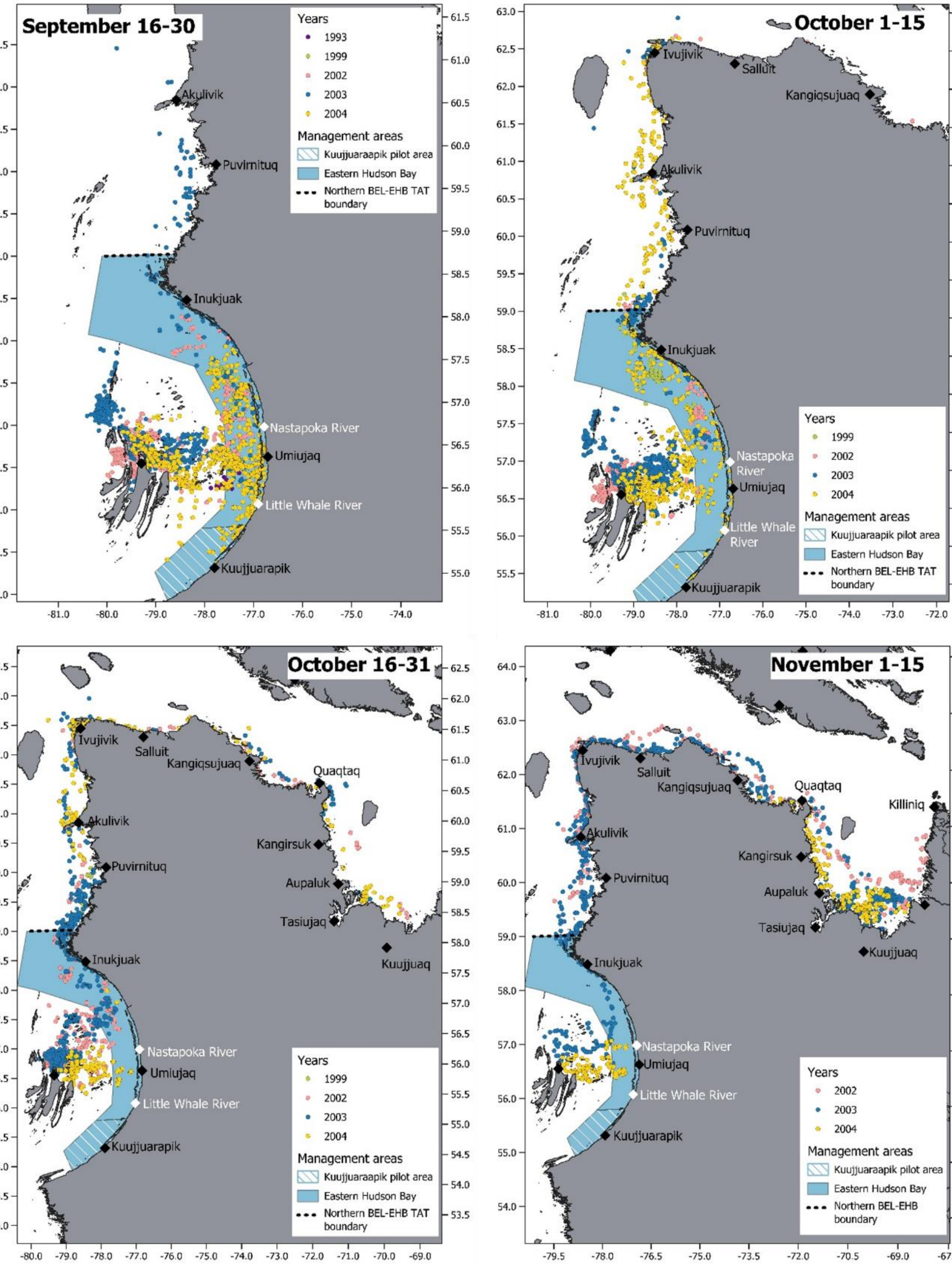
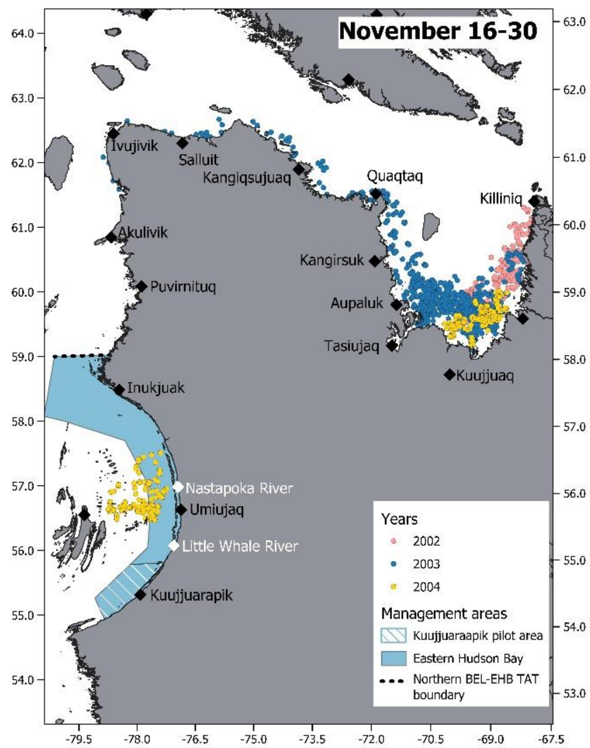


Figure 7 (continued). Locations from 35 beluga captured and equipped with satellite-linked recorders in July or August in Little Whale or Nastapoka Rivers. Marker colors indicate the year tracked individuals were tagged. Pannels display 2-weeks periods between mid-July and late November to illustrate the seasonal variation in beluga distribution.



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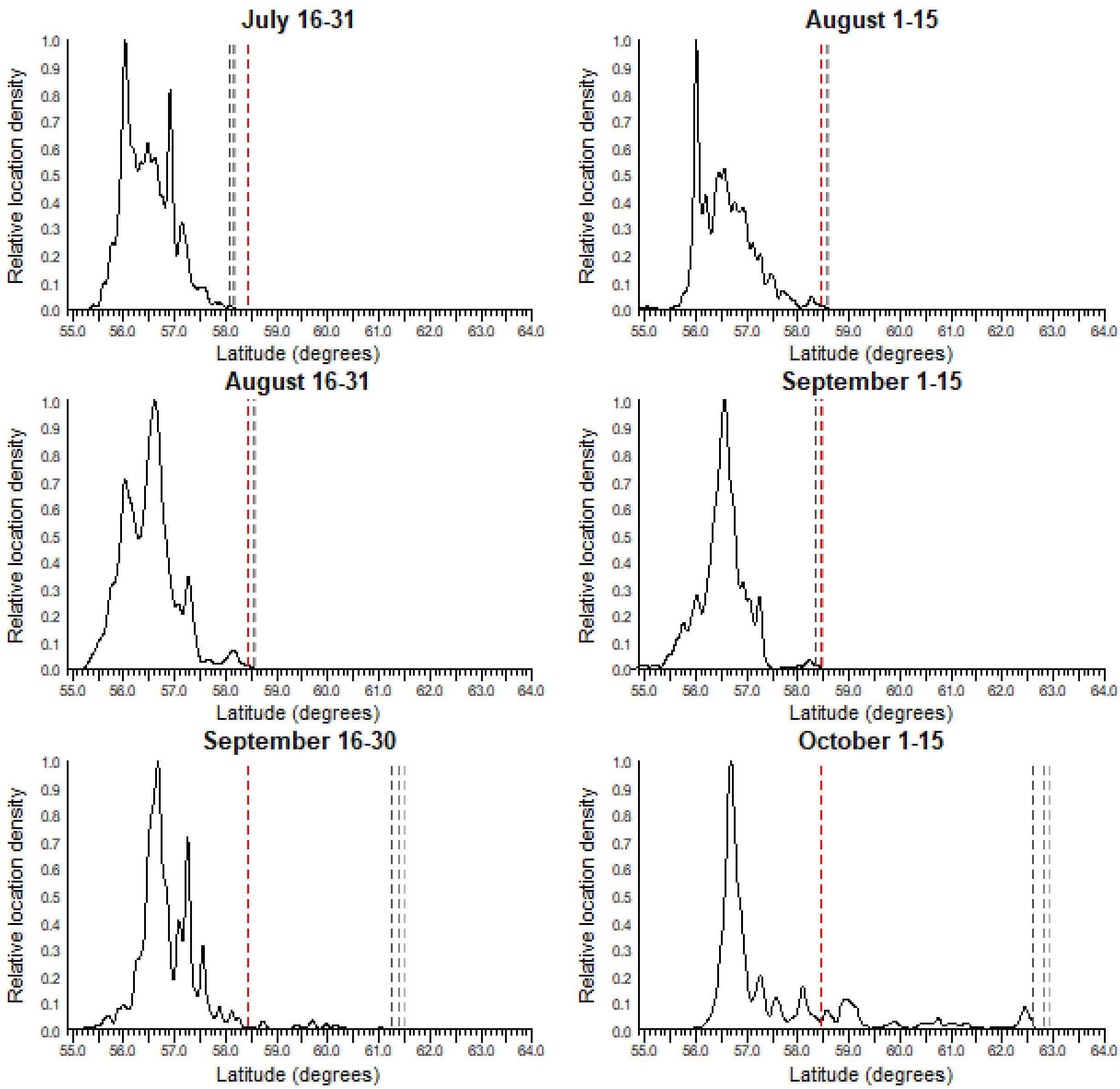

Figure 8. Density function fitted to the latitudinal gradient of beluga locations recorded by satellite-linked tags deployed on 35 beluga captured in Eastern Hudson Bay in July or August 1993, 1999, 2002, 2003 or 2004. The red dashed line indicates the latitude of the Inukjuak community, while black, dark grey and light grey dashed lines illustrate 95%, 97.5% and 99% quantiles, respectively.

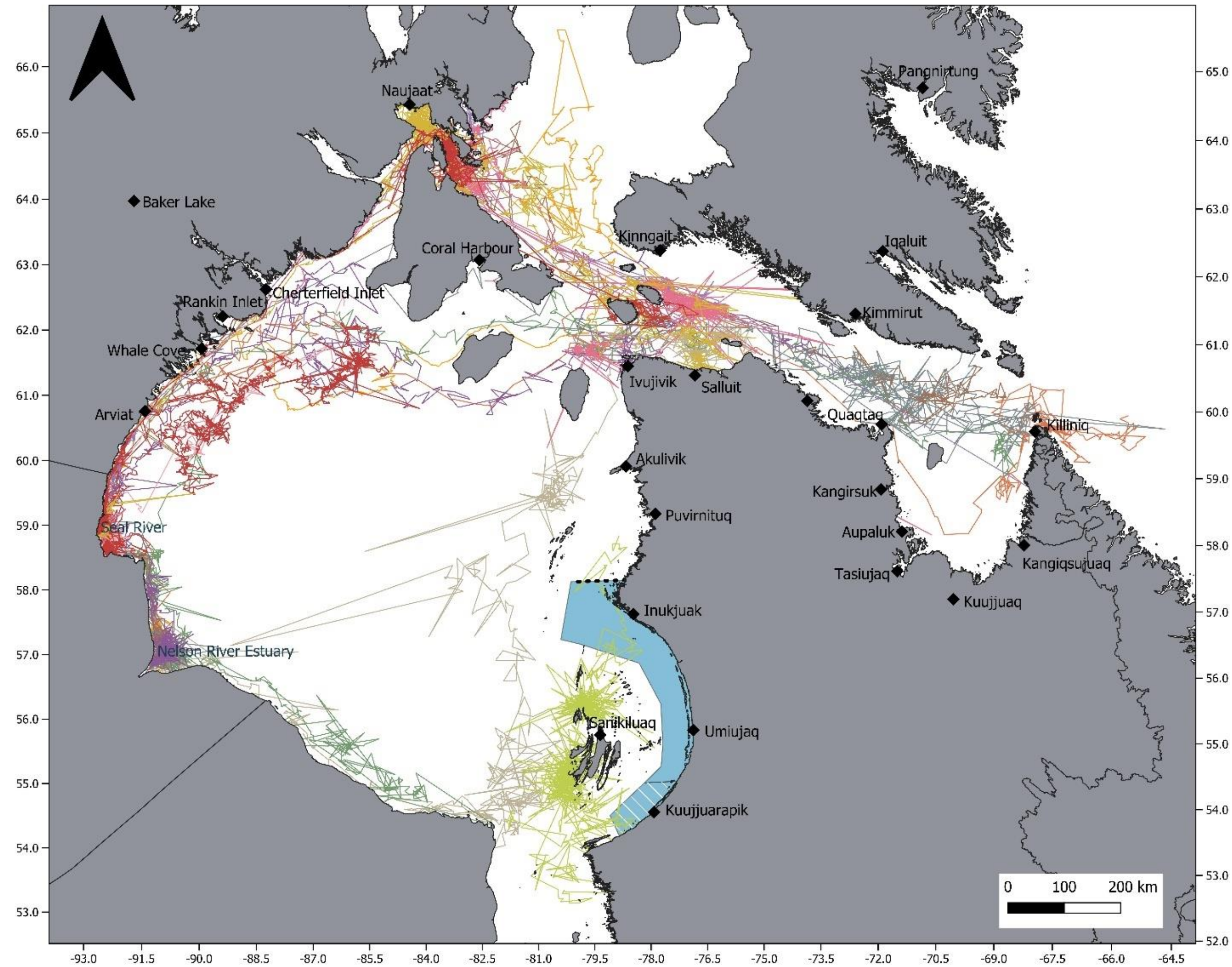

Figure 9. Satellite tracking data from 14 beluga captured in the Nelson (n = 10) or Seal (n =4) Rivers, Western Hudson Bay, between late June and August of 2002 to 2015. A total of 27 beluga were tracked during these studies, but only individuals from which recorders provided location data during their fall migration are displayed. Colors represent tracks from the different individuals. Only one tracked individual (represented by the light green track) traveled along the Eastern Hudson Bay coastline during its fall migration. This individual passed in the vicinity of Inukjuak and the northern boundary of the EHB management area between November 18 and 20, 2003.

Genetics data

Summer aggregations of beluga within the Hudson Bay watershed are genetically distinct and thus considered individual populations (Brennin et al.1997; Brown Gladden et al. 1997, Brown Gladden et al. 1999, de March and Maiers 2001, de March et al. 2002, de March and Postma 2003; Turgeon et al. 2009, Parent et al. 2023). These populations differ in the composition of their mitochondrial haplotypes, with some haplotypes being strictly found in a single population (i.e., private haplotypes). The haplotype compositions proper to each population were used as 'reference populations' to estimate the population contribution to the harvest in management areas where beluga from different populations are suspected to mix, i.e., along migratory routes shared by populations (de March and Maiers 2001, de March et al. 2002, de March and Postma 2003, Turgeon et al. 2009, Parent et al. 2023).

For management purposes, the analytical tool used to estimate the proportion of each reference population contributing to a group composed of individuals from all or a subset of these reference populations is the genetic mixture analysis (GMA; Turgeon et al. 2009; Parent et al. 2023). Unlike individual assignment methods, GMA does not allocate each individual from a mixed sample to one of the reference populations. Instead, it takes into account the probability of each individual sample belonging to the different reference populations. The mixed sample composition then is estimated as the mean of these probabilities among individuals. This approach is more accurate and appropriate when individual assignment is associated with uncertainty, for instance when some haplotypes are shared among different populations (Pella and Masuda 2005; Manel et al. 2005; Turgeon et al. 2009). Beluga genetics is particularly amenable to the application of GMA, as although samples from distinct summering grounds are genetically differentiated, there are few private haplotypes, such that individual assignment cannot be made with high confidence (Turgeon et al. 2009; Doniol-Valcroze et al. 2016; Mosnier et al. 2017).

Reference populations are defined as the samples from beluga harvested in summering areas during July and August (Turgeon et al. 2009; Parent et al. 2023). In other management areas and seasons, GMA has been conducted on mixed samples to determine the composition of the harvest. Beluga harvested from Nunavik communities are grouped into four Nunavik management areas (Hudson Strait, Northeast Hudson Bay, Southeast Hudson Bay, and Ungava Bay; Figure 1) and two seasons (i.e., Spring: February 1 – August 31 and Fall: September 1 – January 31). A minimal sample size of 10 individuals is required for a season and/or area to be analyzed using GMA (Turgeon et al. 2009; Parent et al. 2023).

According to the current beluga management plan, beluga harvested in Eastern Hudson Bay across all seasons are considered to be taken from the BEL-EHB stock. Investigating the genetic composition of beluga harvested outside summer (i.e., in other months than July and August) in the vicinity of the Inukjuak community is limited. From all samples collected between 1982 and 2022 and successfully genotyped, only six were collected in the Inukjuak area during spring, while a single sample was collected during fall. These sample sizes are largely insufficient to attempt any genetic re-analysis of the stock composition from the harvest conducted at the northern end of the current BEL-EHB TAT zone. In the nearby Northeastern Hudson Bay management area, 50.1% of beluga harvested during fall are considered taken from the BEL-EHB stock (Parent et al. 2023). As of 2021 when the last genetic analysis was conducted, sample size from beluga harvested in the northeastern Hudson Bay area during spring was insufficient to estimate the relative contribution of the BEL-EHB stock (Parent et al. 2023).

Sources of uncertainties

There are major sources of uncertainty for which additional information is required to better characterize the conservation implications of changing the northern boundary of the BEL-EHB beluga TAT zone south of its current location.

First, only 50% of beluga harvests and sightings reported to Uumajuit Wardens were associated with an informative location. Encouraging Nunavimmiut to report the exact location of their harvests and sightings using geographic coordinates or specific place names would greatly enhance the value of this community-based data to address conservation questions related to marine mammals in the Nunavik marine Region.

Second, the beluga satellite tracking data available for BEL-EHB and WHB beluga dates from 1993 to 2004 and 2002 to 2015, respectively. Nunavik is particularly vulnerable to climate warming, notably in the Hudson Bay area, which is warming two times faster than the rest of polar regions (Brand et al. 2014). Among the first noticeable changes are the lengthening of the ice-free season and the increase in sea surface temperatures. Between 1995 and 2010, the fall migration of beluga from the eastern Hudson Bay coast has been observed to be delayed by 18 days per decade, while spring migration has been occurring eight days earlier every decade (Hammill 2013). Similarly, the last two decades are likely to have been associated with changes in beluga migration phenology and possibly routes in response to changes in the timing of autumn freeze-up and spring break-up, as well as ice coverage. In addition, because existing telemetry data on BEL-EHB beluga is limited to animals captured in rivers along the Nunavik coast, it may underestimate the distribution range of beluga from the BEL population. Repeating BEL-EHB as well as WHB beluga satellite tracking studies, including the tagging of beluga from the Belcher Islands area, would allow updating the existing data on the seasonal distribution of these two stocks. Moreover, no beluga telemetry study examined the spring migration routes of beluga into the Hudson Bay watershed. Tagging individuals during the spring migration along the northeast Hudson Bay coastline would yield unprecedented information on the summering grounds of beluga migrating through this area.

Finally, as highlighted previously, the genetic sample size from the Inukjuak community is insufficient to examine the genetic contribution of beluga landed in this community. The TAT in place over the previous decades may have contributed to limiting the number of beluga harvested, and therefore sampled in this area. However, non-lethal sampling methods, such as biopsies, would represent a potential way of increasing sampling in that area without promoting removals on the declining BEL-EHB beluga stock. Promoting sampling in northeast Hudson Bay communities, particularly during spring, would also allow for estimating the stock contribution of beluga harvested in nearby communities.

Conclusions

Taken together, the sightings reported from the community of Inukjuak, the aerial survey data, and the beluga satellite tracking data suggest that the Inukjuak area represents the northern end of the summering distribution of the BEL-EHB beluga stock and that from the science data, there is no justification to move the northern limit of the EHB TAT zone further south. In addition, there is no recognized beluga stock summering north of the BEL-EHB beluga TAT zone, and genetic sample sizes are currently largely insufficient to test alternative hypotheses regarding the stock contribution of beluga harvested at the northern portion of the BEL-EHB beluga TAT zone. Consequently, any beluga harvested during summer up to mid-September in the northern portion of that zone is most likely to consist of BEL-EHB beluga. Considering the estimated downward trend in the BEL-EHB beluga stock and the consistent surpassing of target harvest levels since its implementation in 2021, any modification to the management plan that may result in an increase in the BEL-EHB harvests would be considered risky for a conservation and to maintain a sustainable harvest of the population. Such modifications could jeopardize the sustainability of beluga harvesting in the Eastern Hudson Bay region, with consequences on Inuit harvesting in upcoming decades.

Through IQ gathering in the southeastern Hudson Bay area, the Anguvigaq reported that Inukjuak hunters identify mixed groups of whales. Satellite tracking data from BEL-EHB individuals clearly identifies the Inukjuak area as a migration route for this beluga stock. In contrast, satellite tracking data from WHB beluga suggest most animals migrate to Hudson Strait along routes further west from the Nunavik coastline. However, the very limited sample size from tracked WHB beluga impedes generalizing the observed WHB migration routes. Genetic analysis of beluga harvested by northeast Hudson Bay communities estimates that 50.1% of beluga landed during fall originated from the BEL-EHB stock, while 37.3% were from the WHB population, 8.2% were from the James Bay population, and 4.4% were identified as unknown (Parent et al. 2023). Genetic sample size from the northeast Hudson Bay area during spring is currently insufficient to estimate the stock contribution of the harvest for that season (Parent et al. 2023). Likewise, current genetic sample sizes from beluga landed in Inukjuak is insufficient to assess whether the stock composition of beluga harvested outside of summer months by this community is more similar to the northeast Hudson Bay harvest or to that of Umiujaq and Kuujjuaraapik. It therefore appears that although some beluga from the WHB stock (based on one beluga tagged in Nelson River) travel along migration routes that may reach the Nunavik coastline as far south as Inukjuak outside of the summer months, there is currently insufficient data to quantify their contribution relative to BEL-EHB beluga.

Given sample size limitations, estimating the stock composition of beluga harvested at the northernmost end of the BEL-EHB beluga TAT zone would be speculative. However, best- and worst-case scenarios could be simulated in the BEL-EHB demographic model, and consequences for the stock trend associated with varying harvest levels could be projected. However, such scenarios would require revisiting the latest harvest advice for the stock. This can be considered in upcoming BEL-EHB stock assessments that generate Science Advice.

Contributors

Name	Affiliation
Cyr, Charley	DFO Science
Gosselin, Jean-François	DFO Science
Hale, Michael	DFO Fisheries Management
Marcoux, Marianne	DFO Science
Mosnier, Arnaud	DFO Science
Parent, Geneviève	DFO Science
Postma, Lianne	DFO Science
Provencher St-Pierre, Anne	DFO Science
Sauvé, Caroline	DFO Science
Watt, Cortney	DFO Science

Approved by

Jean-Yves Savaria
Regional director, Science
Quebec Region
Fisheries and Oceans Canada

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C.P. 1000
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Canada G5H 3Z4

E-Mail: dfo.csaquebec-quebeccas.mpo@dfo-mpo.gc.ca
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