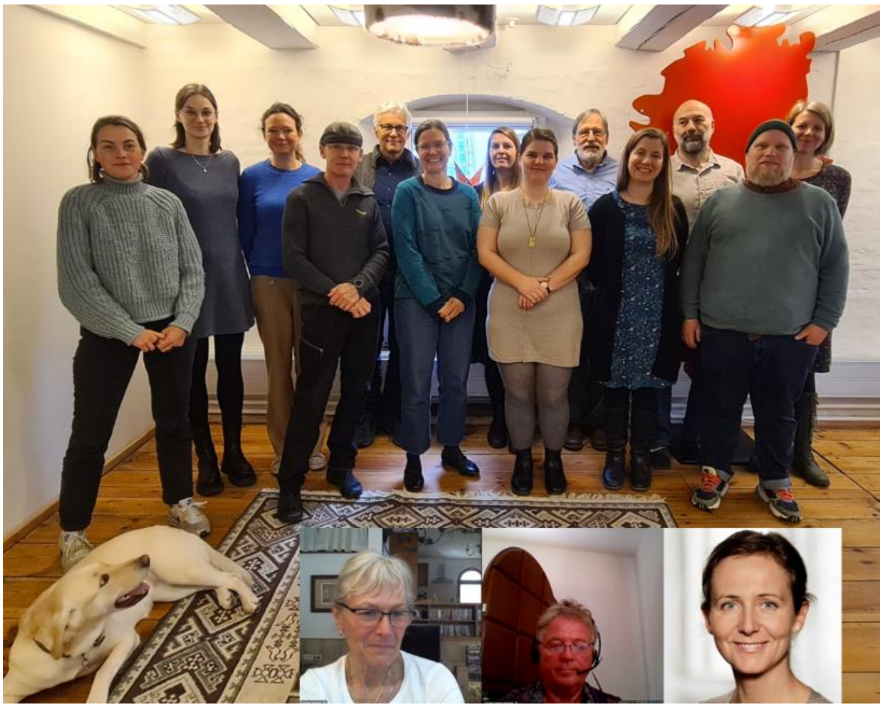
# SCIENTIFIC COMMITTEE
# AD HOC WORKING GROUP ON NARWHAL IN EAST GREENLAND

*December 12 – 15, 2023*
*Greenland Representation in Copenhagen, Denmark*

## REPORT

*Presented to the 30th Meeting of the Scientific Committee as NAMMCO/SC/30/10*



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**NAMMCO**

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# EXECUTIVE SUMMARY

The NAMMCO Ad hoc Working Group on Narwhal in East Greenland (NEGWG) met at the Greenland Representation in Copenhagen (Denmark), from 12 to 15 December 2023. The meeting was chaired by Roderick Hobbs (USA). This was the third meeting of the working group (WG), which updated the management units and assessments of narwhals in Southeast Greenland, as well as reviewing the latest information on belugas in East Greenland. Additionally, the WG discussed previous recommendations for research, which included outlining definitions and management frameworks for different stock statuses.

The Terms of Reference for this meeting were:

a) *To update the assessment of narwhals in Southeast Greenland using data from recent surveys.*
b) *To review the situation of belugas in East Greenland with participants from Norway.*
c) *To define suitable timeframes for abundance surveys and assessments for each specific case (species/stock). (Standard ToR as of NAMMCO 30).*

## <u>Previous recommendations for research</u>

### Alternative survey methods for narwhals

Areas with the highest known densities of narwhals should be the focus of monitoring. Survey methods could include targeted aerial surveys, land-based monitoring, passive acoustic monitoring, mark-recapture surveys, or combinations thereof. Furthermore, anecdotal reports of sightings from both locals and tourists should be encouraged and collected in a dedicated manner.

### Planning surveys in collaboration with hunters

A large-scale aerial survey of the southeastern coast of Greenland was conducted in August–September 2022, with direct input and participation of East Greenland hunters throughout the planning and execution of the narwhal survey. The consensus was that there had been a respectful collaboration and knowledge exchange between hunters and researchers, despite differences of opinion on certain topics. Such collaborations should be replicated, when possible, and translator experience should be prioritised to avoid miscommunication.

### Definitions and frameworks for advice and management

The WG proposed the following definitions of stock status (Box 2 of main report). For more detailed definitions and management advice for each status, see Item 5.3 of the main report.

**Box 2.** Five possible designations of stock status.

- **Maintained** (Not depleted): A stock for which the size estimate is at or greater than 60% of the equilibrium stock size.
- **Depleted:** A stock for which the size estimate is less than 60% of the equilibrium stock size.
- **Small:** A stock for which the size estimate is less than 1000 individuals or there are fewer than 400 reproductive age females in the stock.
- **Near extirpated:** A stock with 100 or fewer individuals (see Near extirpation definition in Box 1).
- **Undetermined:** Status of the stock can be undetermined due to insufficient data (data deficient), absence of assessment from the available data, or inability to conclude status from available data.

## Assessment of narwhals in East Greenland

### Stock identity

Genetic analyses corroborate indications from local knowledge, morphology, behavioural, and survey data that there is a clear distinction between narwhals hunted in spring and those hunted in summer in Management Area 1 (Scoresby Sound). The animals supplying the spring hunt are closely related to animals from Northeast Greenland and Svalbard, and should be treated as a discrete management unit from the animals supplying the summer hunt, which form a separate genetic aggregation more closely related to animals from Management Areas 2 and 3 (see Item 2 and Figure 2 of main report).

### Abundance estimation

A survey of narwhal wintering grounds beyond Scoresby Sound was conducted in 2022. The estimated narwhal abundance in the area presumably used by the animals supplying the spring hunt was 427 (CV=0.58, 95% CI: 148-1231). The abundance in the area where narwhals that summer in Scoresby Sound spend the winter was estimated at 891 whales (CV=0.97, 95% CI: 181-4835), however it is not known what other summer aggregations also use this winter ground.

The collaborative coastal aerial survey of Southeast Greenland in the summer of 2022 resulted in the lowest abundance of narwhals ever observed for all three management units (Item 3.1 and Figure 5 of the main report). No narwhals were seen south of Kangerlussuaq in Management area 2 and in all of Management Area 3 (Tasiilaq area). The abundance in Management Area 2 was 188 whales (CV=0.42, 95% CI: 85–417) and in Scoresby Sound (Management Area 1) was 176 whales (CV=0.68, 95% CI: 53–590). The total abundance was 365 whales (CV=0.40, 95% CI: 173–769).

### Anthropogenic impacts

Estimated total narwhal removals between 2019 and 2023 were 195, 91, and 60 animals in Management Areas 1, 2, and 3, respectively. Almost all reported catches in Management Area 1 occurred after July 1. Nets accounted for 55% of catches during 2019–2023 in Management Area 1, with the remainder caught during open-water hunts. In Management Area 2 and 3, net catches constituted 9% of total catches between 2019 and 2023, while kayak hunts and open-water hunts accounted for 6% and 85%, respectively. However, based on detailed observations of a hunt in summer 2023, and the lack of corresponding records for that location/period, the hunting methods appear to be misrepresented in the catch statistics.

Besides hunting and environmental change, narwhals in East Greenland are individually affected by underwater noise from vessels and seismic airgun activities, but neither the extent nor the population-level consequences of such disturbances are known.

### Population modelling and assessment

Population dynamic models were used to assess the sustainability of narwhal removals from the three Management Areas in Southeast Greenland, using updated catch statistics and abundance estimates. For the summer hunt in Management Area 1, there is a projected estimate of 173 (90% CI: 67–314) narwhals remaining in 2024 and a *90% risk that the stock will fall below 100 individuals by 2030* at the 2024 allocated quota. This qualifies as a small stock at risk of becoming near extirpated, but this risk is reduced to 24% if no narwhals are taken. For Management Area 2, the projected estimate is 138 (90% CI: 72–231) narwhals remaining in 2024, with a *90% risk that the stock will fall below 100 individuals by 2030* at the 2024 allocated quota. This also qualifies as a small stock at risk of becoming near extirpated, with that risk being reduced to 15% if no narwhals are taken. For Management Area 3, there is a projected estimate of 3 (90% CI: 0–65) narwhals remaining in 2024. This is already a near extirpated stock with a *91% risk that it will be extirpated by 2030* at the 2024 allocated quota. This risk is reduced to 33% if no narwhals are taken.

It was not possible to conduct a full assessment of the animals supplying the spring hunt in Management Area 1, however, the current abundance estimate qualifies it as a small management unit, with 80% certainty that the number of animals is less than 271. This does not meet the threshold of 300 individuals outlined in the management framework under Item 5.3, therefore no narwhals should be removed.

### Narwhal as meat supply

Estimates of the annual meat supply from large mammals, including narwhal, were calculated for East Greenland using 1993–2021 catch statistics. Narwhal meat has consistently contributed approximately 5–6% of the total meat quantity throughout this period. While acknowledging that this WG cannot accurately calculate the cultural and socio-economic value of narwhal mattak and tusks, in terms of meat quantity *per se*, narwhal meat can be replaced by other sources.

## Belugas in East Greenland

### Stock identity

Genetic analyses of 15 beluga samples collected in East Greenland between 2017 and 2023 indicate that the animals occurring in East Greenland have come from at least three different populations, including the Beaufort Sea, Kara Sea, and Svalbard. These animals have not yet established a permanent population in East Greenland, nor is it known why they appear to be moving into this new habitat in recent years.

### Occurrence and distribution

Beluga sightings and removals have been irregular and unpredictable in East Greenland. However, there is a confirmed increase in catches after 2017, reflecting a substantial increase in their overall presence in the area. This coincides with the invasive westward spread of pink salmon across the North Atlantic and tributaries in northern Europe and now East Greenland, which could be a new prey item that belugas are following.

No pregnant females or calves have been reported in East Greenland to date, and there is no information on the annual patterns of behaviour and migration. Whether or not the belugas occurring there are vagrants or in the process of establishing a new population, it is precautionary to treat the animals as a small aggregation of unknown size, with no removals until more information becomes available.

### Anthropogenic impacts

The cumulative beluga catches for 2022 and 2023 in East Greenland were 33 animals, a record for the area. There is currently insufficient information to determine or quantify other anthropogenic impacts on belugas in this region.

## Recommendations for narwhal

### GREENLAND

*Recommendations for research*

- Deploy satellite tags on animals supplying the spring hunt in Management Area 1, as well as in Northeast Greenland, to investigate the range of the animals supplying the spring hunt.
- Collect biological samples when available from East Greenland, including areas north of Scoresby Sound, to explore genetic connectivity of different stocks.
- Investigate alternative methods to monitor depleted stocks (e.g., using targeted aerial surveys, passive acoustic monitoring, land-based surveys, mark-recapture, collecting incidental observations).

- Conduct targeted aerial surveys of Kangerlussuaq, Nansen Fjord, southern Scoresby Sound, and other reported aggregation areas during summer of 2026.

*Recommendations for conservation and management*

- For Management Area 1, the WG recommends zero removals and immediate closure of the hunt, which reiterates the advice from the two previous assessments.
- For Management Area 2, the WG recommends zero removals and immediate closure of the hunt, which reiterates the advice from the two previous assessments.
- For Management Area 3, the WG recommends zero removals and immediate closure of the hunt, and additional management measures to reduce or eliminate other potential sources of lethal and sublethal takes when identified. This reiterates the advice from the two previous assessments.
- The next assessment of each Management Area should be conducted in 2026.

## Recommendations for beluga

### GREENLAND

*Recommendations for research*

- Collect incidental observations and biological samples when available, to monitor the occurrence of belugas in East Greenland.

*Recommendations for conservation and management*

- The WG recommends zero removals of beluga in East Greenland.
- The next assessment should coincide with the next narwhal assessment.

# MAIN REPORT

The NAMMCO *Ad hoc* Working Group on Narwhal in East Greenland (NEGWG) met at the Greenland Representation in Copenhagen (Denmark), from 12 to 15 December 2023. The meeting was chaired by Roderick Hobbs (USA). The meeting agenda and list of participants are available in Appendix 1 and 2, respectively.

## 1. OPENING OF MEETING

The Chair welcomed participants to the third meeting of the NEGWG 2023 and called for a round of introductions. He followed with the background and focus of the working group (WG) meeting, as described in the Terms of Reference (ToR) established by NAMMCO 30 (2023):

a) *To update the assessment of narwhals in Southeast Greenland using data from recent surveys.*
b) *To review the situation of belugas in East Greenland with participants from Norway.*
c) *To define suitable timeframes for abundance surveys and assessments for each specific case (species/stock). (Standard ToR as of NAMMCO 30).*

The Management Committee for Cetaceans (NAMMCO 2022) endorsed recommendations for research with respect to narwhals, beyond the collection of genetic, life history, and survey data. These recommendations, which were discussed under Item 5, were as follows:

a) *that different approaches to counting narwhals in the fjords be examined further, but only to the extent that new approaches will be compatible with the existing time-series of abundance estimated from aerial surveys;*
b) *that the planning of surveys continues to be done in collaboration with the hunters and survey methodology (including the design of the track lines) continues to be done according to internationally accepted survey standards, to ensure that abundance estimates derived from the survey can be accepted by NAMMCO and used in assessments;*
c) *that definitions be developed for what constitutes small stocks, depleted stocks, and stocks at risk of extirpation, and that frameworks for advice and management then be articulated for what actions should be taken for these different categories.*

It was noted that the recommendations of the previous NEGWG assessment for narwhals (NAMMCO 2021) were not endorsed by the NAMMCO Management Committee for Cetaceans (MCC), primarily on the grounds of food security issues. A response to the MCC is included under Item 4.1.

The available documents, listed in Appendix 3, were reviewed, and the agenda was adopted without modifications.

NAMMCO Deputy Secretary Maria Garagouni was appointed as the primary rapporteur, to be assisted by NAMMCO Intern, Marina Metić, as well as other participants as necessary. Participants were asked to submit written summaries of presentations and interventions on agenda items, as needed.

## 2. EAST GREENLAND NARWHAL STOCK STRUCTURE

### 2.1. GENETIC ANALYSES

<u>Range-wide genetic structure of narwhals</u>

Marie Louis presented recent findings on genetic structuring and demographic histories of narwhal populations in the NAMMCO region and beyond.

*Summary:*
Based on 24 individual samples providing 274,847 unlinked SNPs sequenced to medium-high coverage, three distinct populations of narwhals were found in a Principal Component Analysis: Canadian Arctic Archipelago and West Greenland (CAA/WG), Northeast Greenland and Svalbard (NEG/Sv), and Southeast Greenland (SEG, Figure 1a).

To infer the timing and drivers of the observed population structuring, demographic histories of the three narwhal populations were reconstructed. Each had a low long-term effective population size ($N_e$), followed by an increase at the start of the Last Glacial period (around 100,000 years ago) and a post-glacial decrease (9,000–6,000 years ago) for the two populations east of Greenland (Figure 1b). Changes in ($N_e$) reflect rates of coalescence, which may reflect either a change in population size or a change in population structure. These analyses indicate that the three populations diverged less than 10,000 years ago, although this should be interpreted with caution as gene flow is not considered in the model.

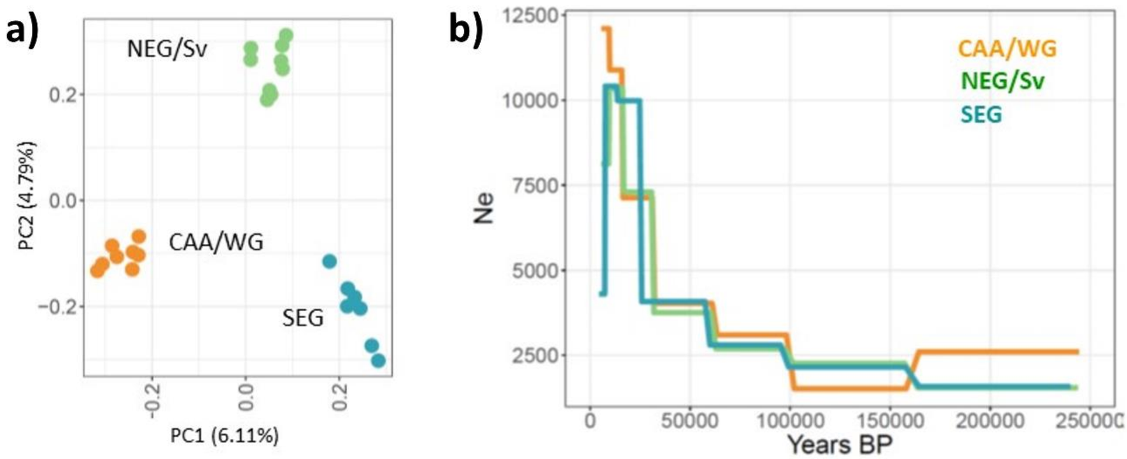


**Figure 1. a)** Principal component analysis of the 24 narwhals displaying first and second principal components (PCs), with the proportion of genetic variance captured by each component indicated. **b)** Changes in effective population size through time inferred for each narwhal population using SMC++. Populations are: Canadian Arctic Archipelago and West Greenland (CAA/WG); Northeast Greenland and Svalbard (NEG/Sv); Southeast Greenland (SGE).

Very low levels of diversity were found in all three populations, with mean heterozygosity levels (He) of ~0.00038, which is amongst the lowest recorded for any mammal species.

Diversity levels among populations were also investigated by estimating runs of homozygosity (ROH), which are stretches in the genome with no variation. They arise when an offspring receives two copies of the same ancestral haplotype from its parents. The SEG population has the longest proportion of their genome in ROH, while the CAA/WG has the lowest. This is consistent with the SEG population currently having the lowest abundance estimate among the three populations.

## Fine-scale genetic structure in East Greenland

Louis then presented findings on the fine-scale genetic structure of narwhals in East Greenland (NAMMCO/SC/30/NEGWG/09).

*Summary:*
Inferring the level of connectivity among narwhals in East Greenland and assessing the overall population structure of narwhals in the region is crucial for improving the scientific basis for informed species management. This study used whole genome re-sequencing to assess the genetic structure of narwhals in East Greenland based on 80 individual samples from all hunting areas between Tasiilaq and Ittoqqortoormiit (Figure 2a), and non-hunted areas in Northeast Greenland and Svalbard from various seasons.

Based on a Principal Component Analysis (PCA) of ~500,000 unlinked variable sites, and 62 samples (after removing close relatives present in the 80 samples) there were three clusters of narwhals with different levels of distinctness (Figure 2b):

i) Northern cluster (lower right corner; PC1 > 0.05): All individuals from Svalbard (N=4); all individuals from Northeast Greenland (N=12), all individuals sampled in the spring, apart from one, at the mouth of Scoresby Sound (N=10); one narwhal sampled in July at the entrance of Scoresby Sound; two individuals from Kangerlussuaq; one individual from Nansen Fjord;
ii) Scoresby Sound summer cluster (lower left corner; PC1 < -0.05): All individuals sampled in the summer in Scoresby Sound (N=17); individuals from other locations further south (three individuals from Kangerlussuaq, one from Nansen Fjord, one from Nuuaalik and one from Sermilik/Kuummiut);
iii) Southern cluster (central strand; -0.05 < PC1< 0.05): Three individuals from Sermilik/Kuummiut; four from south of Sermilik; one from Nuuaalik; one from the entrance of Scoresby Sound in the spring. This cluster was not as well defined as the others and needs further investigation (such as removing one individual from south of Sermilik for which there was little data).

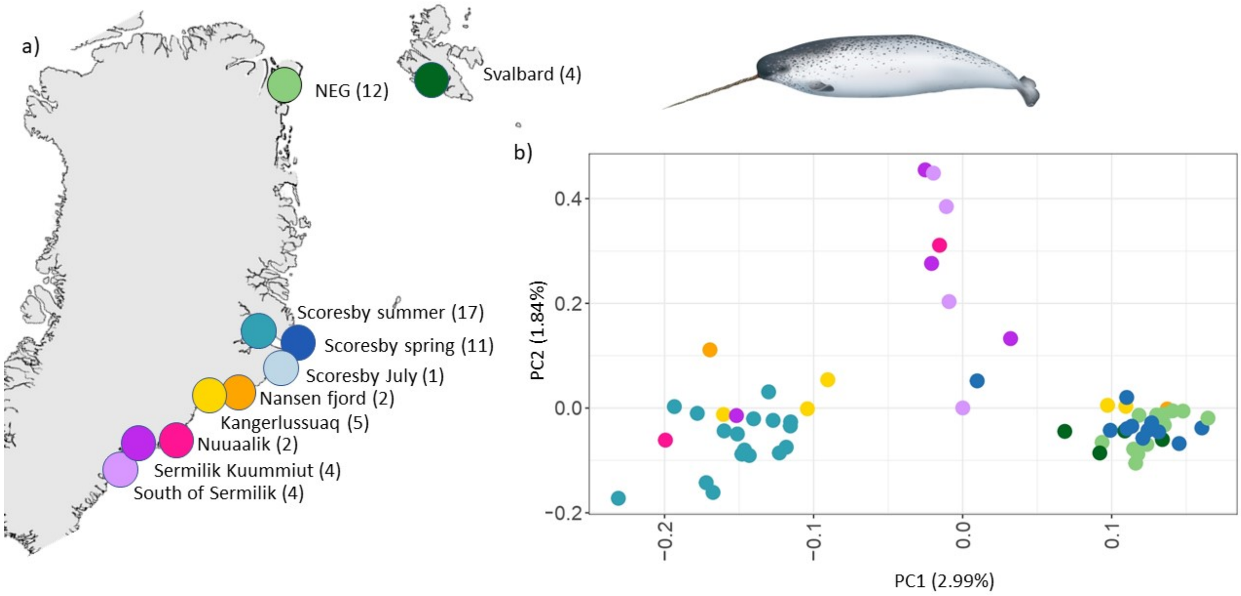


**Figure 2.** Narwhal sampling localities and population structure. **a)** Sample locations of the 62 narwhals analysed. **b)** Principal Component Analysis of the 62 narwhals with relatedness coefficient lower than 0.08, displaying first and second principal components (PCs), with the proportion of genetic variance captured by each component indicated in brackets. Narwhal illustration by Uko Gorter.

Importantly, narwhals harvested in summer within Scoresby Sound are genetically distinct compared to the majority of animals harvested in the spring at the entrance of Scoresby Sound, confirming observations from local hunters that they are from different aggregations, which had been previously suggested based on differences in morphology. Mean relatedness was significantly higher in narwhals inhabiting Scoresby Sound in summer compared to animals in Northeast Greenland and Svalbard. This observation is consistent with a small size of the summer Scoresby Sound aggregation, where the chances of sampling relatives is high. Remaining analyses of this dataset will include estimating levels of diversity and inbreeding, and genetic sexing of the sampled individuals.

*Discussion:*
In answer to questions about the certainty of the clustering outputs, Louis confirmed consistency in assigning individuals to the correct spring or summer cluster in Scoresby Sound (Management Area 1),

and that the data best fit into three clusters, rather than two or four. She highlighted that one individual with low coverage could have affected the admixture results somewhat and agreed to run the PCA without that individual, later confirming that the PCA output remains unchanged when that sample is excluded. It was suggested that clustering and assignment tests should be run to further assess the robustness of the results.

The WG concurred that these results were expected, based on local hunters' knowledge and sighting data. It was noted that Scoresby Sound is the largest fjord system in East Greenland and has remained cooler than other fjords along the coast—as such, it can support resident narwhals, thus explaining the genetic stability shown in the results from the Scoresby Sound summer aggregation. It was suggested that it might be possible to distinguish temporal signals of animal movement between locations in the present dataset, e.g., by separating the first 15 years of samples from the rest. A longer-term dataset might serve the same purpose in the future. Both the admixture and PCA results indicate two very distinct clusters and a third, less defined, one. Specifically, the animals hunted in spring in Scoresby Sound are closely related to animals from Northeast Greenland and Svalbard. Individuals from Kangerlussuaq and Nansen Fjord (Management Area 2) appear related to animals hunted in both spring and summer in Scoresby Sound. The group discussed whether this calls for a redefinition of Management Area 2, given that the animals sampled there do not fall into a single cluster. It was proposed that this pattern could be explained by males from Management Area 2 migrating longer distances and, therefore, the analysis could be improved by incorporating the sex of sampled individuals. It was further noted that there is likely a distinction between foraging grounds, with animals from different aggregations foraging separately, and mating grounds, which could attract animals from multiple aggregations. It would therefore be beneficial to conduct more targeted sampling during the mating period, to account for the mixing of different aggregations.

**Conclusion:**
The genetic evidence confirms indications from local knowledge, morphology, behavioural, and survey data that there is a clear distinction between animals hunted in spring and summer in Management Area 1.

## 2.2. SEASONAL DISTRIBUTIONS OF NARWHALS IN EAST GREENLAND

### Distribution in East Greenland

Mads Peter Heide-Jørgensen gave an overview of narwhal distribution along the East Greenland coast, based on previous surveys and anecdotal observations.

*Summary:*
Along East Greenland, narwhals are found in a broadly continuous distribution from 64°N to 82°N. While summer aggregations in Scoresby Sound and to the south are well documented, little is known about the population structure to the north, which may be separated into several more or less isolated aggregations. There is uncertainty about the abundance of narwhals in areas north of Scoresby Sound (i.e., the Northeast Greenland National Park), however, a recent survey has documented a summer abundance of ~2000 narwhals in Dove Bay. There are no indications that Dove Bay has been a major summer ground for narwhals historically. For the other areas north of Scoresby Sound there are only opportunistic observations that document the presence of narwhals.

Off the East Greenland coast in the Greenland Sea, there are scattered observations of narwhals both from old whaling vessels and modern surveys for seals and polar bears. In the Greenland Sea, narwhals are distributed over large areas.

The animals hunted during the summer in Scoresby Sound have been studied extensively, with several abundance estimates available since 1983. There is also extensive tracking of narwhals that summer in Scoresby Sound and winter in areas off the coast southeast of Scoresby Sound.

Along the Blosseville Coast, several small groups of narwhals occur in the fjords and bays along the coastline. For Kangerlussuaq and south to Tasiilaq, there are several abundance estimates, while no narwhals have been detected during the two most recent surveys in the area south of Tasiilaq.

*Discussion:*

Anecdotal reports from north of Scoresby Sound indicate changes in both distribution and abundance of narwhals in recent years, e.g., animals moving into Dove Bay, an area from which they have been absent historically. The WG discussed whether there is a spatial distinction between the spring and summer hunts in Scoresby Sound, in addition to the temporal lag between the two. Given their occasional temporal overlap in July (see also Item 2.3), a geographical boundary between the two might be useful for determining quotas. Logistical difficulties in sailing north-south across this fjord in a dinghy would suggest that hunters are unlikely to cross such a boundary, regardless. However, some WG members commented that the precautionary approach should account for exceptional years during which the ice and weather conditions might allow atypical hunting effort to take place. Furthermore, it is unclear at present to what extent the temporal overlap between the two hunts might change with continued warming. It was also pointed out that setting an arbitrary cut-off date between the spring and summer hunts might influence the results of the genetic clustering described above.

## Winter habitat use

Rikke Guldborg Hansen presented a preliminary analysis of narwhal habitat use in winter, based on combined sightings from various surveys and historical whaling records (NAMMCO/SC/30/NEGWG/17).

*Summary:*

Observations of narwhals (N=92) made offshore from 1888 to 2023 during the months between March and July, when ice cover is at the maximum (February being the month with the highest ice concentration) were compiled from both dedicated and opportunistic surveys. 95% of all observations were made in waters with depths greater than 500 m, with a median distance of 34 km from the shelf break (max distance: 143 km). Assuming that the habitat conditions do not vary between the offshore wintering grounds of the summer Scoresby Sound narwhal and the Greenland shelf—and thus that they can support consistent narwhal densities—the available habitat north of Scoresby Sound (95% home range) is ~165,000 km² (Figure 3). Further assuming the same winter density for the Greenland shelf as for that of the Scoresby Sound stock, based on the abundance levels pre-exploitation (year 1955), that 95% home range could theoretically support ~9,400 narwhals. Assuming that individuals from Scoresby Sound and Kangerlussuaq winter in the same area, then the winter density (pre-exploitation) increases and the winter habitat to the north on the Greenland shelf could support ~14,000 narwhals.

*Discussion:*

The group discussed several assumptions and caveats to this analysis. The first assumption is that environmental conditions do not vary across this region, and therefore the estimated carrying capacity is based solely on the size of each sub-area, rather than, e.g., prey availability. This estimate is, therefore, primarily useful as an upper limit to how many narwhals there could be in the region, and as an indication that the sighting surveys are not missing significant narwhal numbers. It was noted that, if there have been environmental changes between the historical records and the sighting surveys, the historical data may skew the kernel density estimates. Furthermore, although both datasets show a distribution hiatus between north and south, this gap might be due to lower whaling/survey effort in the area.

Acknowledging the assumptions made in this analysis, the group agreed that these results corroborate other evidence of small population sizes of narwhals in East Greenland. The WG reiterated that these are approximate calculations of the maximum number of animals there could be in the region, not an estimate of actual abundance.

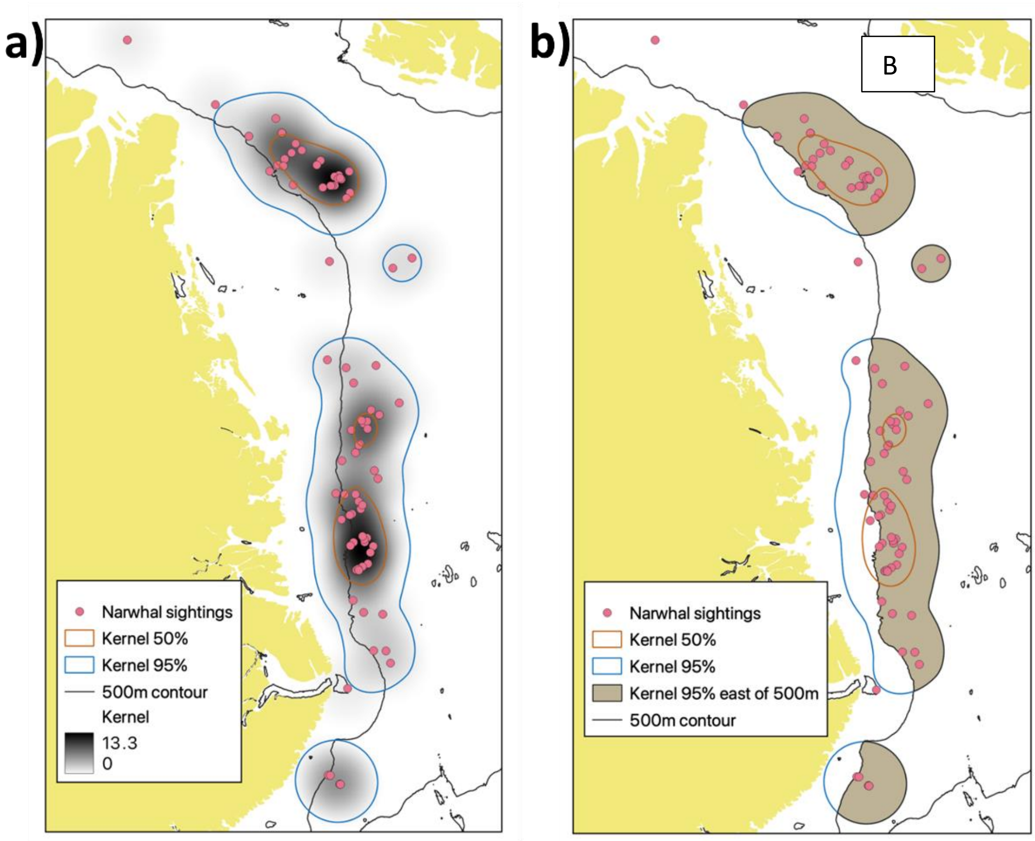


**Figure 3. a)** Observations of narwhals from all surveys and associated kernel home ranges of 50% and 95%. **b)** Observations of narwhals from all surveys and associated kernel home ranges of 50% and 95% at depths greater than 500m (brown shading).

Plans to collect data from NE Greenland and Svalbard

The Norwegian Polar Institute will conduct narwhal tagging efforts during an expedition north of Svalbard in July/August 2024 that will travel up through the marginal ice zone and well into the Arctic Ocean. It is an oceanographic expedition with a fixed path, but an onboard helicopter will facilitate searching for ice whales. Limpet tags will be deployed; the anchoring mechanism is still under development and will be tested in January/February and revised if necessary. Additionally, it is hoped that survey efforts for bowhead whales and narwhal (and polar bears) will be undertaken in 2025—starting at the Norwegian-Russian border and moving west to East Greenland.

## 2.3. STOCK DEFINITION AND MANAGEMENT UNITS

Based on the genetic evidence (Item 2.1) and combined survey and telemetry data from previous years, the WG **agreed** that the narwhals supplying the spring hunt (January to July) in Scoresby Sound (Management Area 1) should be managed separately from the narwhals supplying the summer hunt (July to December). At present, there is no information on the northernmost range of the animals hunted in spring.

Fernando Ugarte presented a short overview of NAMMCO/SC/26/NEGWG/15, showing the spatial and temporal distribution of narwhal catches in Scoresby Sound between 2011 and 2019. These data show a fairly clear geographical distinction, with the spring catches occurring in the north of the fjord and summer catches in the south. Moreover, tagged animals wintering off the Blosseville Coast do not appear to approach the northern part of Scoresby Sound during the spring and therefore are not available for the spring hunt. However, a fixed geographic boundary between the two hunts would have to be drawn arbitrarily. Except for the month of July, there is a temporal segregation between the animals taken in each hunt.

**Conclusion:**
There are two distinct groups of narwhals hunted in Scoresby Sound, one in spring (January–July) and one in summer (July–December), and, following the precautionary approach, they should be managed separately. The WG **recommended** that the hunt should be closed in July, when it is not easy to distinguish between the two groups of narwhal, to protect the animals that reside in Scoresby Sound in summer.

# 3. ABUNDANCE OF EAST GREENLAND NARWHAL

## 3.1. LATEST ABUNDANCE ESTIMATES

### Survey of winter grounds

Heide-Jørgensen presented the results of an aerial survey beyond Scoresby Sound in 2022. (NAMMCO/SC/30/NEGWG/06).

*Summary:*
Following a recommendation from NAMMCO's Scientific Committee, an aerial survey of narwhals in the region outside Scoresby Sound was conducted in May 2022. This survey encompassed both the wintering area of the animals hunted in summer in Scoresby Sound and the potential wintering area of the animals hunted in spring in Scoresby Sound. The primary objective was to determine whether a supposed northern and a supposed southern stock are spatially distinct and to assess the abundance of narwhals in both areas. During the survey, a total of nine sightings were recorded, along survey lines covering a distance of 3,385 km (Figure 4). It was decided that a strip width of 500 m could be applied to the analysis of the survey, leaving one sighting outside the search area. Abundance estimates were corrected for animals that were submerged during the survey, and density estimates were extrapolated to areas of 12,306 km$^2$ for the putative northern stock and 6,144 km$^2$ for the putative southern stock. The estimated narwhal abundance in the area presumably used by the animals supplying the spring hunt was 427 (CV=0.58, 95% CI: 148–1231), while the winter ground of the animals that spend their summers in Scoresby Sound had an estimated abundance of 891 whales (CV=0.97, 95% CI: 181–4835). The sightings were unevenly distributed, with 5 sightings on one transect in the southern stock area and 3 sightings on three other transects in the northern stock area. The low number of sightings and their clumped distribution on a few transects is the reason for the large variance of the abundance estimates.


**Figure 4.** Strata, transect lines, and positions of narwhal sightings during the aerial survey outside Scoresby Sound in May 2022.

*Discussion:*

The WG highlighted the lack of precision (high CV values) of these abundance estimates, which are, however, consistent with previous summer surveys of the aggregation that winters in the southern part of the surveyed area. These data did not confirm a gap in narwhal distribution, although other surveys have suggested such a pattern. It was noted that most of the sightings occurred at the eastern ends of the transect lines, but it was clarified that beyond these survey strata there is only open water, which is an unlikely habitat for narwhal. The WG **agreed that** this survey provides an abundance estimate of the proportion of narwhals available for the spring hunt in Management Area 1, which can be used in a calculation of Potential Biological Removal (PBR).

## Summer survey

Hansen presented the results of an aerial survey that was conducted in collaboration with the local hunters in Southeast Greenland in 2022 (NAMMCO/SC/30/NEGWG/12).

*Summary:*

A wide-ranging survey for narwhals (*Monodon monoceros*) was conducted in Southeast Greenland in August–September 2022. Timing, coverage, and survey design were decided after consultation with hunters from the two communities in Southeast Greenland and hunters also participated in the execution of the survey. A total of 4,564 km were covered under optimal survey conditions and 25 sightings of narwhals were obtained from a total stratum area of ~27,500 km$^2$ (Figure 5). No narwhals were seen south of Kangerlussuaq in the Tasiilaq area (Management Area 3). The abundance in Kangerlussuaq (Management Area 2) was 188 whales (CV=0.42, 95% CI: 85–417) and in Scoresby Sound (Management Area 1) was 176 whales (CV=0.68, 95% CI: 53–590). The total abundance was 365 whales (CV=0.40, 95% CI: 173–769). This is the lowest abundance of narwhals detected for all management units in Southeast Greenland and it underscores serious concerns about the status of these stocks.

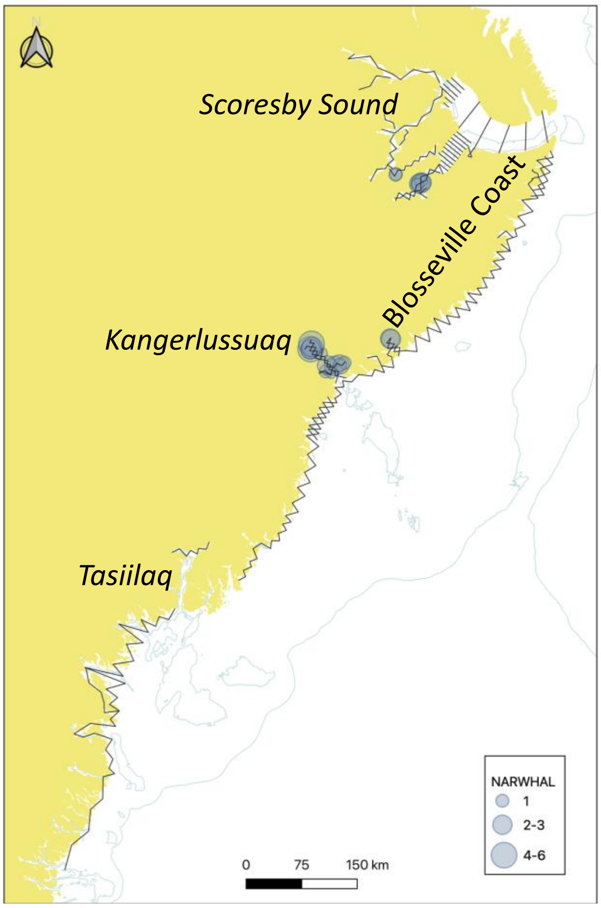


**Figure 5.** Transect lines and sightings of narwhals during a visual aerial survey in Southeast Greenland conducted between 25 August and 10 September 2022.

*Discussion:*
The abundance estimates presented were deemed suitable for the purposes of stock assessments.

In choosing the most appropriate abundance estimate model for the assessment, it was decided that the most statistically sound model is that with the lowest variance (CV). It was highlighted that the highest abundance estimated from any model was still lower than the abundance estimate included in the previous NEGWG assessment model (NAMMCO 2021).

## Estimating abundance from low-density surveys

Heide-Jørgensen presented a method of estimating maximum narwhal abundance in areas with very low sighting densities (NAMMCO/SC/30/NEGWG/08).

*Summary:*
There is likely a lower limit of narwhal densities that can be detected by aerial surveys. In some cases of zero narwhal detections, it may therefore still be assumed that a small number of whales can, with some probability, be present in the area.

A total of 98 estimates of narwhal densities are available from aerial surveys of various narwhal strata in West and East Greenland between 1981 and 2021. The densities vary from 0 to 1.6 narwhal groups per $km^2$, depending on the actual abundance of whales in the strata. The coverage of the strata can be estimated by using the effort flown in kilometres, multiplied by the survey specific effective search width, which usually ranges from 500 to 700 m on either side of the plane. Based on this, the coverage of the individual strata varies from 2% to—in a few cases—over 100% when the stratum has been surveyed multiple times. In all cases with coverage <5% of the stratum area the density was >0 whales per $km^2$ and the lowest density detected with an effort of <5% was 0.0288 whales per $km^2$.

Assuming that 0.0288 is the Minimum Detection Density of narwhals, a Maximum Potential Abundance of narwhals can be calculated for the strata surveyed in summer and winter in East Greenland in 2022. These are whales that potentially could remain undetected during the surveys, but whether there is a realistic chance that these whales actually exist must be based on additional information. For instance, based on hunting effort, past surveys, and opportunistic observations nothing suggests that there are likely to be substantial numbers (up to 269) of narwhals south of Tasiilaq and in the area between Tasiilaq and Kangerlussuaq (up to 170). For the other areas surveyed during the summer in 2022, the Maximum Potential Abundance estimates are all very low.

The winter survey had low coverage of large areas and thus it is possible that low densities of narwhal could have been missed during the survey. However, the limited information and observations from these areas in winter do not suggest any major concentrations of narwhals outside the well-known areas that are used by narwhals supplying the summer hunt in Scoresby Sound.

*Discussion:*
The working group expressed interest but noted that for large areas the upper bound could number in the hundreds and that the method did not account for the percent coverage of the stratum. Hobbs proposed a method that used the percent coverage and estimated a binomial probability that a number of groups were missed and provided examples. The WG noted that this method had been discussed at other meetings. This binomial method is independent of survey area and the group noted that it would not work as well as the density method for small areas. Later, Hobbs provided further information showing how it could be used to determine if survey areas with zero counts represented near extirpated stocks and provide limits for the likelihood estimates in the assessment model. The WG accepted the method for use in the assessments and it was subsequently summarised in NAMMCO/SC/30/NEGWG/18.

The group **agreed** that, regardless of which estimate (point estimate or confidence intervals) is included in the assessment, the presented results suggest that aerial surveys do not have sufficient power to determine narwhal numbers when they occur at very low densities, highlighting the need to consider alternative survey methods.

## 4. ANTHROPOGENIC IMPACTS ON EAST GREENLAND NARWHAL

### 4.1. REMOVALS

Observations of hunting methods in East Greenland

Eva Garde reported on fieldwork as part of the TOPLINK project in the Tasiilaq area during July and August 2023. In the past 15 years, there are increasing numbers of temperate and subarctic whale species visiting Southeast Greenland including: minke whales, killer whales, humpback whales, fin whales, pilot whales, sperm whales, white beaked dolphins, and white sided dolphins. Belugas occasionally visit the area during early spring. Narwhals are also present in the area, but the population is small and decreasing. In the fieldwork period, the following cetaceans were being hunted in the area: pilot whales, white beaked dolphins, killer whales and minke whales. These species are usually hunted with rifles from fast-moving dinghies. A single hunter from Tasiilaq was observed using a semi-automatic rifle. Humpback whales, fin whales, and sperm whales are not hunted in this area.

In the area of Scoresby Sound, narwhals, minke whales, and killer whales are present and available for hunters from Ittoqqortoormiit in the summer and early fall. In this area, narwhals are hunted with nets or with rifles from fast-moving dinghies. In August 2023, hunters shot at a humpback whale near Ittoqqortoormiit, but the animal was not landed, and the hunt itself was illegal.

Carsten Egevang, biologist and professional photographer, was invited to present his experiences from a hunting trip to Kangerlussuaq Fjord (Management Area 2) with local hunters in July 2023, where five narwhals (three adult males, a young male and an adult female) were landed using kayaks. The period spent in Kangerlussuaq was 7–8 days and the whales were landed between 12 and 17 July.

In December 2022, narwhal mattak from Kangerlussuaq Fjord was for sale (via a Facebook "auction"). Two kilos of mattak were sold to the highest bid at a price of 4,200 DKK. (2,100 DKK per kilo). The price for a kilo in the grocery stores is ~500 DKK.

*Discussion:*
Certain recurring issues regarding catch reporting became apparent. For instance, hunters are legally obligated to provide biological samples of their catches of large whales, narwhals, and polar bears, but clearly this does not always happen. Furthermore, although Egevang documented consistent hunting from kayaks in Kangerlussuaq Fjord in 2023, no catch records from that period included this method.

Egevang's observations corroborate low struck and lost rates for the kayak hunt, although time to death following the first harpoon strike can be long. It was also highlighted that both hunting methods and hunting products vary by hunter, not just by area. Care should be taken, therefore, when making generalisations about what is or is not typical for the hunt in any given region.

Narwhal as meat supply

Heide-Jørgensen presented estimates of the annual meat supply from different large mammals, including narwhal, in East Greenland (NAMMCO/SC/30/NEGWG/05).

*Summary:*
In East Greenland, the recommendations for the closure of the narwhal hunt (*Monodon monoceros*) coincide with a pressing demand to continue hunting for meat supply to local communities. By analysing catch statistics and estimating average meat yields, the available meat from marine

mammals, polar bears, and muskoxen in East Greenland spanning the period from 1993 to 2021 can be assessed. On average, there were approximately 318 tonnes of meat available per year during this period. However, there has been a decline due to reduced catches of hooded seals (*Cystophora cristata*) and ringed seals (*Phoca hispida*) after 2009. This decline was somewhat offset by the inclusion of new species in the hunt, such as dolphins, killer whales, and pilot whales.

Simultaneously, the human population (and thus the number of hunters) in East Greenland also declined after 2009. As a result, the average annual meat availability per inhabitant decreased from 130 kg before 2009 to 101 kg afterward. Notably, narwhals consistently contributed around 5-6% of the total annual meat supply throughout the entire period. However, it is important to highlight that there is evidence suggesting that little meat is brought back to the communities from the narwhal hunting grounds. Instead, the primary hunting product from narwhals is the highly prized and commercially traded mattak or skin. The inclusion of the need for a meat supply in the advisory process regarding sustainable harvest levels remains a topic of controversy, especially in situations where an urgent halt in hunting is necessary for a stock's conservation.

*Discussion:*
It was reiterated that, although hunters are legally obligated to bring back all products of any catch, this does not always happen, due to a combination of logistical, financial, and cultural factors. This renders it difficult to quantify how narwhals contribute to the availability of food. For example, the percent contribution of narwhal meat alone to the total annual estimates indicates a low (about 5%) but rather stable meat source availability regardless of fluctuations in human population size or availability of other meat sources. However, the non-negligible number of hunters observed returning from successful hunts without meat suggests that the meat itself is not the reason they target narwhals, but rather the commercial and cultural value of mattak and tusks.

The argument put forward by the NAMMCO MCC (NAMMCO 2022) regarding the importance of narwhal as a source of food security *per se* has not been used regarding other marine mammal hunts in NAMMCO member countries. It is beyond the expertise of the current WG to assess the socio-economic and nutritional benefits of the narwhal hunt in East Greenland, and thus the assessment of the NEGWG deals only with the supply of meat.

**Conclusion:**
Acknowledging caveats surrounding nutritional value and cultural/traditional preferences, the calculations of raw meat quantity available from different large mammals hunted in East Greenland show that narwhal meat is only a small fraction (around 5%) of total meat supply and could be replaced by other sources.

## Catch statistics

Heide-Jørgensen presented catch statistics, including struck and lost incidents, from the narwhal hunt in East Greenland spanning from 1955 to 2023 (NAMMCO/SC/30/NEGWG/11).

*Summary:*
Since 2018, catches in East Greenland have been categorized into three Management Areas and two seasons (Management Area 1). For the five years from 2019 through November 15 2023, there were total reported catches of 149 animals for Management Area 1 (Ittoqqortoormiit), 65 for Management Area 2 (Kangerlussuaq), and 41 for Management Area 3 (Tasiilaq). Estimated total removals for the same period were 195, 91, and 60 animals in each area, respectively. During 2019-2023, almost all catches in Management Area 1 occurred after July 1, suggesting the entire hunt was from the Scoresby Sound putative summer stock of narwhals. Nets accounted for 55% of catches during 2019-2023 in Management Area 1, with the remainder caught during open-water hunts. In Management Areas 2 and 3, net catches constituted 9% of total catches during 2019-2023, while kayak hunts and open-water hunts accounted for 6% and 85%, respectively. The catch reporting scheme includes information

on sex, length (age), and presence of foetuses, but the accuracy of this information remains unvalidated. Analyses of the reported data suggest an increasing length of whales recorded in both Management Areas 1 and 2, with less clear trends in Management Area 3 due to limited data. Sex ratio data from 2006 to 2023 reveal a declining number of females in catches in Management Area 1, and the opposite trend in Management Areas 2 and 3, where the sex ratio is consistently below 1 female/male for most years.

*Discussion:*
The group discussed potential reasons for the observed trends in the proportion of females caught in each Management Area. Local preferences for different hunting methods may influence the ratio of males to females. That is, nets are not selective for either sex, whereas open water and kayak hunts may target one sex over the other. Moreover, changes in abundance are likely to determine which sex is targeted—when there are more animals available, the hunters are likely to target males, which are especially prized for their tusks, whereas when there are fewer animals to choose from, more females are caught. It may also be the case that females are slower and, therefore, easier to catch than males, or that decreasing birth rates expose more females to the hunt (as opposed to mother-calf pairs, which may be spared).

The reported catch percentages likely differ from the actual numbers removed, taking into account the misreporting of certain hunting methods. It is unclear whether this misreporting stems from a lack of concern on the hunters' part or from poorly formulated data sheets. For the purposes of the present stock assessment, it was agreed that the removal rates should be calculated using the standard correction factors, rather than attempting to determine the levels of misreporting in all previous years. The correction factor to account for struck and lost currently applied to open-water hunts from dinghies is 1.3, whereas it is assumed to be 1.05 for kayak hunt and 0 for net catches.

**Conclusion:**
The WG agreed that the catch statistics as presented are suitable for use in the stock assessment, distinguishing between the spring and summer management units in Scoresby Sound. The WG further **recommended** that the information on hunting locality and methods be improved.

## 4.2. OTHER THREATS

Outi Tervo gave a brief overview of the conclusions of the recent Disturbance Workshop (NAMMCO/SC/30/NEGWG/FI15).

*Summary:*
NAMMCO arranged a workshop in December 2022 in Copenhagen focusing on anthropogenic effects on narwhals. In this workshop, results from a sound exposure study in East Greenland were presented showing behavioural and physiological responses by narwhals to airgun and ship sounds. After the workshop, Tervo et al. published results (NAMMCO/SC/30/NEGWG/FI18) showing that narwhals also react to ship noise alone. In summary, narwhals have been shown to be extremely sensitive to sound disturbance. During the workshop, Marianne Marcoux and Lars Witting also presented results showing a near complete displacement of narwhals from the Eclipse Sound summering ground due to iron ore–carrier traffic to and from the Mary River iron ore mine. The plan moving forward is to collect these findings in a joint publication lead by Tervo and Marcoux.

*Discussion:*
Local hunters have repeatedly expressed concerns about the daily levels of tourist vessel traffic in Scoresby Sound; some of their comments are provided in NAMMCO/SC/30/NEGWG/FI19. There is currently a new Executive Order being drafted by the Greenlandic Government, which aims to implement severe restrictions on shipping traffic in specific areas of East Greenland, including Scoresby Sound.

Regarding the inclusion of shipping impacts in the assessment model, it was noted that any direct effects on birth rates or emigration are already accounted for by the model, without specifying the source of the impacts. Moreover, a thorough quantification of the levels of disturbance caused by marine traffic should include all vessel types and sizes, including hunting boats. At the present time, East Greenland is thought to be exposed to one of the lowest levels of marine traffic in the Arctic. If there are concerns about the effects of increasing traffic in the future, a comprehensive analysis of vessel disturbance could be conducted for the region, but the WG noted that areas with higher traffic levels are more relevant for such analyses.

Other threats to East Greenland narwhals include the effects of climate change, via changes in water temperature, ice coverage, and prey distribution.

**Conclusion:**
It is currently not known whether narwhals in East Greenland are impacted at a population/stock level by other anthropogenic activities besides hunting and environmental changes.

# 5. DISCUSSION OF PREVIOUS RECOMMENDATIONS FOR RESEARCH

## 5.1. DIFFERENT APPROACHES TO COUNTING NARWHALS

This point was discussed under Items 3.1. and 6.2. It was noted that the large-scale aerial surveys in their current format result in few sightings and in several strata with zero sightings in areas where narwhals are known to occur. Abundance estimates resulting from recent surveys are either zero or have high variance, both cases with limited monitoring value. Analysis of the zero sightings result in Management Area 3 suggested that survey effort would have to be increased by a factor of three to have confidence of achieving some sightings if narwhal continue to reside in the area. A similar increase of survey effort in other areas is necessary to reduce variance estimates (NAMMCO/SC/30/NEGWG/19). An increase in effort of this magnitude was not considered feasible either financially or logistically. With region-wide surveys considered ineffective, the WG discussed the need for continued monitoring of areas with the highest known densities of narwhals (Kangerlussuaq, Nansen Fjord, southern Scoresby Sound). This could be achieved with more targeted aerial surveys, land-based monitoring, passive acoustic monitoring, mark-recapture surveys, or combinations of these methods. Furthermore, anecdotal reports of sightings from both locals and tourists should be encouraged and collected in a more structured manner, such as with the use of citizen science applications and continued collaborations with hunters.

## 5.2. PLANNING SURVEYS IN COLLABORATION WITH HUNTERS

Hansen described the procedure and outcomes of an aerial survey that was conducted in close collaboration with local hunters (NAMMCO/SC/30/NEGWG/13).

*Summary:*
In 2021, Inatsisartut (the Greenlandic Government) requested that Pinngortitaleriffik (the Greenland Institute of Natural Resources) count narwhals in Southeast Greenland, covering the three management areas: Area 1, including Scoresby Sound and the northern Blosseville Coast; Area 2, centred on Kangerlussuaq Fjord; and Area 3, centred on Tasiilaq. Pinngortitaleriffik was tasked with ensuring that the results could be used by NAMMCO to update the advice on sustainability of narwhal hunting. A two-day workshop between Pinngortitaleriffik and hunters from all towns and settlements in East Greenland was held in Iceland in June 2022. The aim was to develop a final—agreed upon—proposal for planning that Pinngortitaleriffik could use to organize a survey. The hunters' designation of the time for counting, areas for counting, and the weighting of these areas were included in the planning of the survey. Track lines were hand drawn, then digitized, and during the survey, all transects were flown as planned on the agreed-upon dates. Data on the distribution and number of narwhals were collected through a systematic aerial survey, allowing narwhal abundance to be used in assessment models of narwhal stocks. Post-survey meetings were held between hunters and

Pinngortitaleriffik during summer and fall 2023. The general conclusion from the meetings was that hunters and researchers appreciated the exchange of knowledge and that there was a respectful collaboration throughout the process. There was an agreement that cooperation reduces misunderstandings and increases mutual understanding, trust, and respect and that there is satisfaction in allowing for disagreements as it lays the groundwork for greater cooperation moving forward. The group recommended sharing knowledge as beneficial for both hunters and researchers. It was emphasised that the translator made several errors leading to misunderstandings between biologists and hunters, causing frustration among participants, and therefore translator experience should be prioritised. There is consensus that there has been a decline in the number of narwhals (in the summer months) over the past 50 years south of Kangerlussuaq to and including Skjoldungen and similarly during the last 10 years in Scoresby Sound/Hjørnedal. According to researchers, the cause of the decline in distribution and the number of narwhals in Southeast Greenland is overharvesting, while hunters believe it is mainly due to climate change and anthropogenic disturbance from large vessels (such as cruise ships).

*Discussion:*
The WG commended the efforts made to conduct this exercise and expressed their gratitude to the hunters for their active participation throughout. It was **agreed** that this survey design and implementation was a good application of the recommendation for collaboration with hunters and that efforts should be made to replicate it when possible.

## 5.3. DEFINITIONS AND FRAMEWORKS FOR ADVICE AND MANAGEMENT

The WG proposed a series of definitions (Box 1 and Box 2) related to stock size and status and, following those, proposed a Management Framework to generate advice for stocks of each status. The WG noted that the definitions and management framework were developed with narwhal and beluga stocks in mind and may require modification if applied to other species for which NAMMCO provides advice. The WG considers this to be a preliminary version and plan to review and revise this draft at its next meeting or the next meeting of the Joint NAMMCO-JCNB Working Group on Narwhals and Belugas, pending further refinement and feedback by the NAMMCO Scientific Committee.

**Box 1.** General definitions to be used when discussing stock status and assessments (continued on next page).

**Allowable take:** Maximum landed catch that when summed with estimates of struck and lost and other anthropogenic removals, equal the maximum sustainable removals estimated for a stock.

**Critical habitat:** Habitat that is necessary for the survival or recovery of a stock.

**Depletion level:** The stock size divided by the equilibrium stock size (ESS) expressed as a percentage.

**Near extirpation:** A near extinction of a stock, i.e., a stock at such low densities that groups or individuals are rarely or no longer encountered within the range of the stock. For management purposes, a stock numbering less than 100 individuals.

- **At risk of Near extirpation:** A stock with a 10% or greater probability of near extirpation.
- **Insignificant risk of Near extirpation:** A less than 1% probability of near extirpation.

**Equilibrium Stock Size (ESS):** The population dynamic equilibrium abundance in the absence of removals and other anthropogenic impacts.

**Removals:** Individuals removed from the population due to anthropogenic activities including hunting (landed catch and struck and lost), by-catch, live-capture for display or research, vessel strikes and other sources of human-caused mortality.

**Box 1.** General definitions to be used when discussing stock status and assessments (continued from previous page).

**Struck and lost:** Animals killed as a result of hunting activities that were not landed and thus not included in the reported catch. Typically estimated as proportional to allowable take or landed catch.

**Sustainable removals:** Levels of total removals by hunting and other human actions that allow the stock abundance to remain above 60% of ESS or recover to 60% of ESS.

**Stock:** A unit of a species or population; should be designated and managed in such a way that the population and/or species as a whole persists throughout its range; often comprises a breeding population that occupies the same regions annually.

**Stock size:** point estimate of the stock abundance.

**Box 2.** Proposed definitions of stock status, with five possible designations.

- **Maintained** (Not depleted): A stock for which the size estimate is at or greater than 60% of the ESS.
- **Depleted:** A stock for which the size estimate is less than 60% of the ESS.
- **Small:** A stock for which the size estimate is less than 1000 individuals or there are fewer than 400 reproductive age females in the stock.
- **Near extirpated:** A stock with 100 or fewer individuals (see Near extirpation definition in Box 1).
- **Undetermined:** Status of the stock can be undetermined due to insufficient data (data deficient), absence of assessment from the available data, or inability to conclude status from available data.

The following management frameworks were proposed, with advice regarding sustainable removals depending on stock status.

Small stocks should be assessed every three years, all others should be assessed at least every five years. <u>Each assessment should include:</u>

i) Reviews of new data on abundance, distribution, removals, life history, non-lethal anthropogenic impacts, and habitat changes.
ii) Review of the stock definition and structure.
iii) A data-based population assessment model or data requirements necessary to complete one.
iv) Conclusions on stock status when possible, including estimates for ESS, depletion level, and risk of (near) extirpation when relevant.
v) Recommendations on allowable take, seasonal and area closures to hunting, and mitigation of other anthropogenic impacts.
vi) Recommendations for timing of the next abundance survey.
vii) Requests for research and user data and observations.

Allowable take should be set to meet the following criteria using a data-based population assessment model:

**For Maintained stocks**: A probability of at least 70%/80% that total removals are less than 90% of the maximum possible removals that can be sustained at 60% of the ESS.

<u>Rationale:</u> Will ensure that the stock will remain above 60% ESS with a high probability but allow takes that will result in some decline if the population is approaching ESS.

**For Depleted stocks**: A probability of at least 70%/80% that the stock will not decline.

Rationale: Will allow recovery to 60% ESS in a reasonable time period and ensure that the stock will not decline further.

**For Small stocks**: No removals, unless a data-based assessment model can show a probability of at least 90% that the stock will not decline and 80% certainty that the abundance is above 300 individuals.

Rationale: It is possible that a small stock may be otherwise healthy (Maintained) and can tolerate sustainable removals. However, because small stocks are at risk from a number of threats that do not affect larger stocks and at risk of falling below levels where Allee effects, predation levels, loss of genetic diversity, loss of habitat experience, stochastic demographic variation or catastrophic events can make recovery substantially more difficult (see Hobbs et al. 2015, Hobbs et al. 2019), it is important to ensure that the stock recovers quickly and remains near its ESS. In addition to limiting hunting, other anthropogenic threats to recovery should be addressed and reduced or eliminated and critical habitat should be identified and protected.

**For Near extirpated stocks**: No removals.

Rationale: Near extirpated stocks are at risk of becoming extinct and a loss of even one animal from the stock results in a significant increase in this risk. A number of threats besides hunting including Allee effects, predation levels, loss of genetic diversity, loss of habitat experience, stochastic demographic variation or catastrophic events can make recovery substantially more difficult and should be addressed (see Hobbs et al. 2015, Hobbs et al. 2019). In addition to protection from hunting, other anthropogenic threats to recovery should be addressed and reduced or eliminated and critical habitat should be identified and protected.

**For stocks of Undetermined status**: Until numbers can be estimated and an assessment completed, the precautionary principle should be used to provide advice on a case-by-case basis.

## 6. STOCK ASSESSMENT FOR EAST GREENLAND NARWHAL

### 6.1. POPULATION ASSESSMENT MODELS

Witting presented population dynamic models for each of the three narwhal Management Areas in East Greenland. The models were refined, following discussions during the meeting, and the final versions are summarised here. The catch quotas for 2024 are provided in NAMMCO/SC/ 30/NEGWG/FI20).

#### Management Area 1: Summer aggregation of narwhals in Scoresby Sound

NAMMCO/SC/30/NEGWG/14 updates the assessment of the East Greenland summer aggregation of narwhals in Scoresby Sound using a population dynamic model that reconciles a diverse set of data. These include three absolute and three relative abundance estimates, an age-structure of 119 individuals, the age of maturity of six females, an observed deteriorating birth rate (Figure 6), and an updated history of total removals starting in 1955. The new abundance estimate, from 2022, was included in the assessment, and it is concluded that the stock is depleted, declining, and immediately threatened by unsustainable hunting. There currently remains only 11% (depletion level) of the original stock of 1,570 (90% CI:1,180–1,910) narwhals from 1955. The 2022 abundance estimate is approximately half of the last absolute estimate from 2016, and one third (i.e., 71 individuals) of the 2022 point estimate (214 narwhals) was removed by the hunt in 2022 and 2023 (Figure 6). With an assessment estimate of 173 (90% CI:67–314) narwhals remaining in 2024, if annual catches continue at the 2024 quota-level, there is 90% risk that the stock will become near extirpated by 2030 (falling below 100 individuals). This risk is reduced to 24% if no narwhals are taken (Table 1).

**Table 1.** Probability that abundance will drop below 100 individuals between now and 2030, given different levels of total removals (R).

| R | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| **22** | 0.24 | 0.39 | 0.58 | 0.77 | 0.85 | 0.90 |
| **20** | 0.24 | 0.37 | 0.54 | 0.73 | 0.83 | 0.88 |
| **15** | 0.22 | 0.29 | 0.44 | 0.60 | 0.75 | 0.83 |
| **10** | 0.21 | 0.25 | 0.30 | 0.44 | 0.55 | 0.66 |
| **5** | 0.19 | 0.23 | 0.26 | 0.30 | 0.40 | 0.48 |
| **0** | 0.17 | 0.18 | 0.20 | 0.22 | 0.22 | **0.24** |

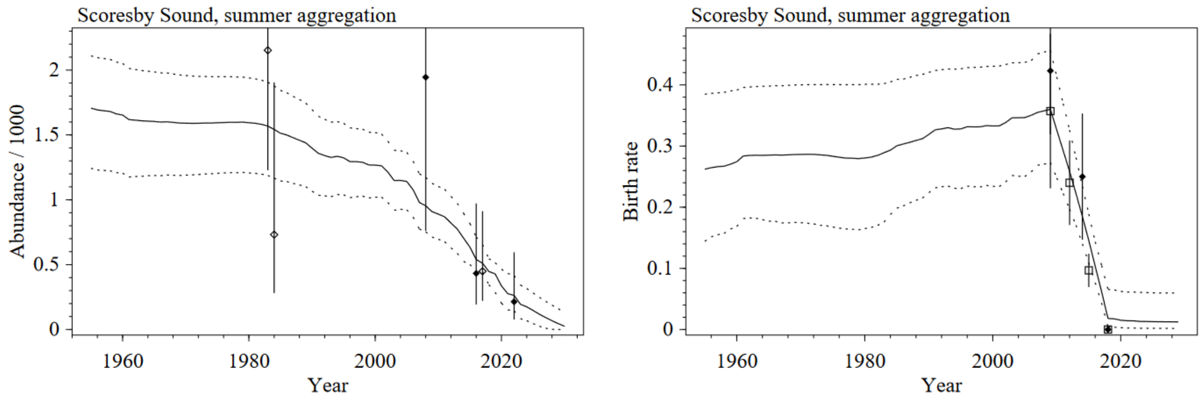


**Figure 6.** Projected medians and 90% credibility intervals of narwhal abundance and birth rates in Management Area 1, based on the best-fitting population assessment model.

## Management Area 2: Summer aggregation of narwhals around Kangerlussuaq

NAMMCO/SC/30/NEGWG/15 updates the assessment of the summer aggregation of narwhals around Kangerlussuaq in East Greenland (from 67°00'N to 68°30'N). The catch history is updated, and demographic variation and a new 2022 estimate of abundance are included in the age-structured assessment model. A density regulated model estimates a ten-fold decline in abundance, from a pre-exploitation abundance of approximately 1,150 (90% CI:774–1,630) animals in 1955, to a small and depleted stock of 138 (90% CI:72–231; depletion level: 12%) remaining in 2024. The stock continues to decline, and it is immediately threatened by an unsustainable hunt. The projected decline after 2008 is somewhat flatter than indicated by the abundance data, with the additional decline being consistent with estimates from the assessment model of 11% emigration and 11% underreporting (Figure 7). Stock status is relatively unaffected by this uncertainty, with the density regulated model estimating 90% risk of near extirpation by 2030 (decline below 100 individuals) if annual removals continue at the 2024 quota-level. This risk is reduced to 15% if no narwhals are taken (Table 2).

**Table 2.** Probability that abundance will drop below 100 individuals between now and 2030, given different levels of total removals (R).

| R | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| **22** | 0.34 | 0.51 | 0.66 | 0.77 | 0.85 | 0.90 |
| **20** | 0.32 | 0.48 | 0.62 | 0.73 | 0.81 | 0.87 |
| **15** | 0.28 | 0.39 | 0.49 | 0.59 | 0.68 | 0.74 |
| **10** | 0.25 | 0.31 | 0.39 | 0.46 | 0.52 | 0.58 |
| **5** | 0.22 | 0.24 | 0.27 | 0.29 | 0.31 | 0.33 |
| **0** | 0.17 | 0.17 | 0.16 | 0.16 | 0.15 | **0.15** |

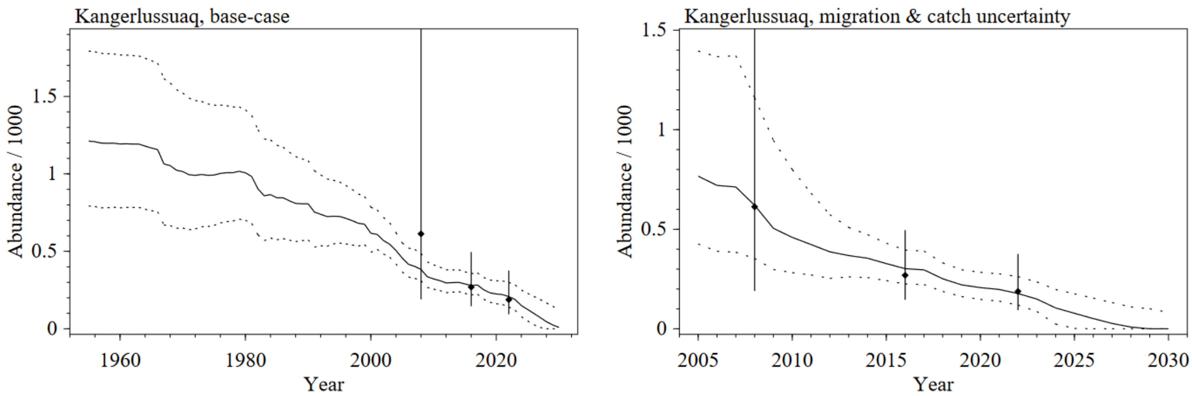


**Figure 7.** Projected medians and 90% credibility intervals of narwhal abundance in Management Area 2, based on abundance estimates alone and when incorporating correction factors for emigration and underreporting of catches.

## Management Area 3: Summer aggregation of narwhals around Tasiilaq

NAMMCO/SC/30/NEGWG/16 updates the assessment of the summer aggregation of narwhals in the Tasiilaq area south of 67°00'N in East Greenland. Demographic variation is incorporated into the age-structured population dynamic model, the catch history is updated, and two zero estimates of abundance from 2016 and 2022 are included in addition to the 206 (CV=0.55) animals estimated for 2008. With estimated local removals increasing to an average of 24 narwhals per year from 1980 to 2020, the aggregation declined almost continuously from 769 (90% CI:575–1,110) individuals in 1955 to an estimated abundance of only 3 (90% CI:0–65) narwhals in 2024 (Figure 8). Given the extreme low estimate of current abundance, the stock must be considered near extirpated from a sustainable management point of view. A few individuals may still be found in the area, but it is estimated that there is 91% risk that the stock will be extirpated by 2030 if annual catches continue at the 2024 quota-level. This risk is reduced to 33% if no narwhals are taken (Table 3). Any hope for stock recovery and a future sustained stock in the area requires an immediate cessation of removals.

**Table 3.** Probability that there will be no individuals left between now and 2030, given different levels of total removals (R).

| R | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| **15** | 0.60 | 0.76 | 0.85 | 0.90 | 0.93 | 0.95 |
| **11** | 0.57 | 0.71 | 0.80 | 0.86 | 0.89 | 0.91 |
| **7** | 0.53 | 0.64 | 0.71 | 0.77 | 0.82 | 0.85 |
| **3** | 0.47 | 0.54 | 0.59 | 0.62 | 0.66 | 0.69 |
| **0** | 0.32 | 0.32 | 0.33 | 0.33 | 0.33 | **0.33** |

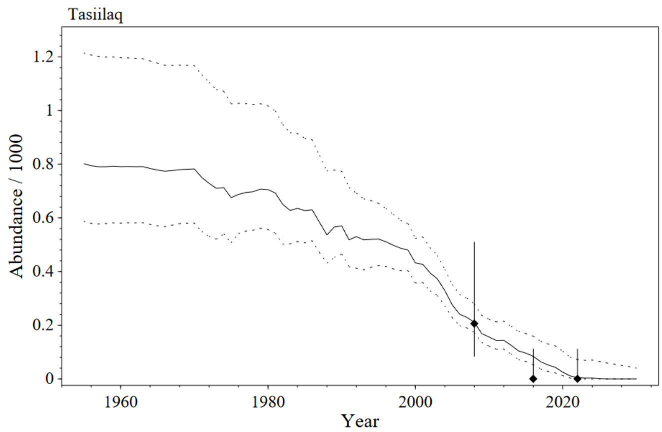


**Figure 8.** Projected medians and 90% credibility intervals of narwhal abundance in Management Area 3.

## 6.2. ADVICE FOR MANAGEMENT AREA 1

### 6.2.1. JANUARY 1 TO JUNE 30 (SPRING HUNT)

Genetic evidence shows that the narwhals supplying the spring hunt in Management Area 1 are related to animals in Northeast Greenland and distinct from the animals taken in the summer hunt within the Scoresby Sound fjord (for the rationale defining the end of the spring hunt, see Item 2, NEGWG/09). However, the summer aggregation(s) and abundance of the animals supplying the spring hunt are uncertain. Available information suggests that the spring hunt is supplied partially or fully by animals detected during surveys east of Liverpool Land (Item 3, NEGWG/06). For this area, the abundance estimate is 427 (CV=0.58, 95% CI: 148–1231) individuals, supporting the designation of this management unit's status as small. From this estimate, we calculate with 80% certainty that the number of animals is above 271, which does not meet the threshold of 300 outlined in the management framework under Item 5.3. Therefore, the WG **recommends** zero removals, which is also consistent with a Potential Biological Removal approach.

The WG **agreed** that further research could inform about the ranging patterns and relatedness of the animals supplying the spring hunt.

### 6.2.2. JULY 1 TO DECEMBER 31 (SUMMER HUNT)

Genetic evidence supports that the narwhals supplying the summer hunt in Management Area 1 are a distinct unit (item 2, NEGWG/09). The aerial survey estimates in 2022 of 176 (CV=0.68) indicate a continued decline in the number of narwhals summering in Scoresby Sound (NEGWG/12) compared to previous estimates, e.g., the estimate in 2016 of 433 (CV=0.49). An assessment model using all information on abundance, removal rates, and life history parameters indicates that continued removals at any level are not sustainable. This is a small stock at risk of extirpation. Therefore, the WG

**recommends** zero removals and immediate closure of the hunt, which reiterates the advice from the two previous assessments.

The WG agreed that, in order to continue monitoring this stock, suitable survey methods should be defined. While region-wide surveys were no longer considered feasible, monitoring should be conducted in a manner comparable to existing survey methods. Thus, a targeted aerial survey of southern Scoresby Sound is the only viable option in the near term.

In light of the quotas allocated by the Greenlandic Government for 2024 (NEGWG/FI20), the WG **recommends** a new assessment be completed no later than 2026, to which end a targeted aerial survey of southern Scoresby Sound and any other documented aggregation areas be conducted in the summer of 2026.

### 6.3. ADVICE FOR MANAGEMENT AREA 2

Genetic evidence shows that the narwhals supplying the hunt in Management Area 2 have a complex population structure (Item 2, NEGWG/09). The aerial survey estimates in 2022 of 188 (CV=0.42) indicate a continued decline in the number of narwhals (NEGWG/12) in the area compared to previous estimates, e.g., the estimate in 2016 of 269 (CV=0.37). An assessment model using all information on abundance, removal rates, and life history parameters indicates that this stock is near extirpated and continued removals at any level are not sustainable. Therefore, the WG **recommends** zero removals and immediate closure of the hunt, which reiterates the advice from the two previous assessments.

The WG agreed that, in order to continue monitoring this stock, suitable survey methods should be defined. As for Management Area 1, a targeted aerial survey of Kangerlussuaq and Nansen Fjord is the most appropriate monitoring option in the near term. In light of the quotas allocated by the Greenlandic Government for 2024 (NEGWG/FI20), the WG **recommends** a new assessment be completed in 2026 and a targeted aerial survey of Kangerlussuaq, Nansen Fjord, and any other documented aggregation areas be conducted in the summer of 2026.

### 6.4. ADVICE FOR MANAGEMENT AREA 3

Aerial surveys in 2016 and 2022 resulted in an estimate of zero animals, acknowledging that the density of narwhals is too low to be reliably enumerated with this method. An assessment model which incorporated this uncertainty estimates that the current abundance is 3 (90% CI: 0–82) individuals. These estimates classify the stock as near extirpated (<100 individuals) and removals at any level will drive the stock to extinction. Therefore, the WG **recommends** zero removals and immediate closure of the hunt and additional management measures to reduce or eliminate other potential sources of lethal and sublethal takes when identified. This reiterates the advice from the two previous assessments.

In light of the quotas allocated by the Greenlandic Government for 2024 (NEGWG/FI20), the WG **recommends** a new assessment be completed in 2026. The WG **agreed** that reports of sightings from local residents and tourists could inform on the presence of narwhals.

## 7. EAST GREENLAND BELUGA STOCK STRUCTURE

### 7.1. UPDATES ON GENETIC ANALYSES

Mikkel Skovrind presented findings on the fine-scale population structure of East Greenland belugas (NAMMCO/SC/30/NEGWG/10).

*Summary:*
While beluga harvests in East Greenland prior to 2017 are uncertain, between 2017 and 2023 there have been 37 confirmed takes. To investigate the geographic origin of the East Greenland belugas, a genomic dataset of 15 belugas collected on the east coast of Greenland between 2017 and 2023 was generated. These belugas were compared with an unpublished range-wide genomic reference dataset

of 75 individuals. The Principle Component Analysis (PCA) plot based on all 90 samples showed that Pacific and Atlantic belugas are separated by the first principle component (PC1), which captured 4.5% of the total variation. The Ittoqqortoormiit 2023 samples (N=4) clustered with the Beaufort Sea samples (Figure 9b, upper left) while the Ittoqqortoormiit 2017 (N=1) and 2020 (N=2) as well as the Tasiilaq 2022 (N=8) samples clustered together with the Svalbard and Kara Sea samples (upper centre). A subset of the dataset was selected including only samples from Kara Sea, Svalbard, and East Greenland (excluding the samples that clustered with the Beaufort Sea samples; four 2023 Ittoqqortoormiit samples and one 2021 Tasiilaq sample). A PCA run on this subset showed that the 2017 Ittoqqortoormiit sample clustered with the Svalbard samples, while the two 2020 Ittoqqortoormiit and seven Tasiilaq samples clustered with the Kara Sea samples (Figure 9d). The pattern shown in the two PCA plots was supported by the unrooted neighbour-joining tree based on the pairwise distance matrix (Figure 9c) leading to the most likely conclusion that the 15 beluga samples collected in East Greenland between 2017 and 2023 originated from three different populations, one from Svalbard, ten from the Kara Sea and four from the Beaufort Sea.

*Discussion:*

The clustering of the East Greenland belugas with several other populations, as observed in the PCA and phylogenetic analysis, was deemed robust, as multiple techniques and subsets of the available data gave consistent results.

The directness of the link between Kara Sea and East Greenland animals was questioned. Sighting surveys east of the Kara Sea have rarely detected belugas. Additionally, research on several other Arctic species has indicated a contiguous relatedness between Russian and Norwegian populations, therefore there may exist an intermediate beluga population between the Kara Sea and East Greenland, which has not yet been sampled. It was also noted that no similar contiguous distribution has been found for other species west of Svalbard, due to the abrupt differentiation of the marine environment beyond the archipelago. Furthermore, satellite telemetry and sighting surveys indicate that belugas in Svalbard move neither east nor west of that vicinity; this is further supported by the complete absence of beluga sightings reported by tourists between Svalbard and East Greenland. The genetic proximity of an East Greenland beluga to the Svalbard population is not strong enough to prove a direct link. However, considered in the context of the range-wide analysis, the clustering results do not appear to stem from isolation by distance.

The WG discussed possible migration routes that would allow belugas from the Beaufort Sea to reach East Greenland. One route lies north of Greenland, where the concentration of multi-year pack ice has been decreasing in recent years. The other route is via more open waters between the Beaufort Sea and Siberia. Some belugas tagged in northern Alaska have been observed travelling towards Russia, with male animals sometimes travelling thousands of kilometres. It was also noted that such a migration could occur over several years, rather than within a single year.

It is unclear what the driving factor is for belugas to move into these new habitats. If it is a result of their established habitats having been degraded, declines in abundance would be expected in those areas. No such obvious decline has been recorded yet in most of these areas, therefore the more likely explanation is that new habitats have only recently become available.

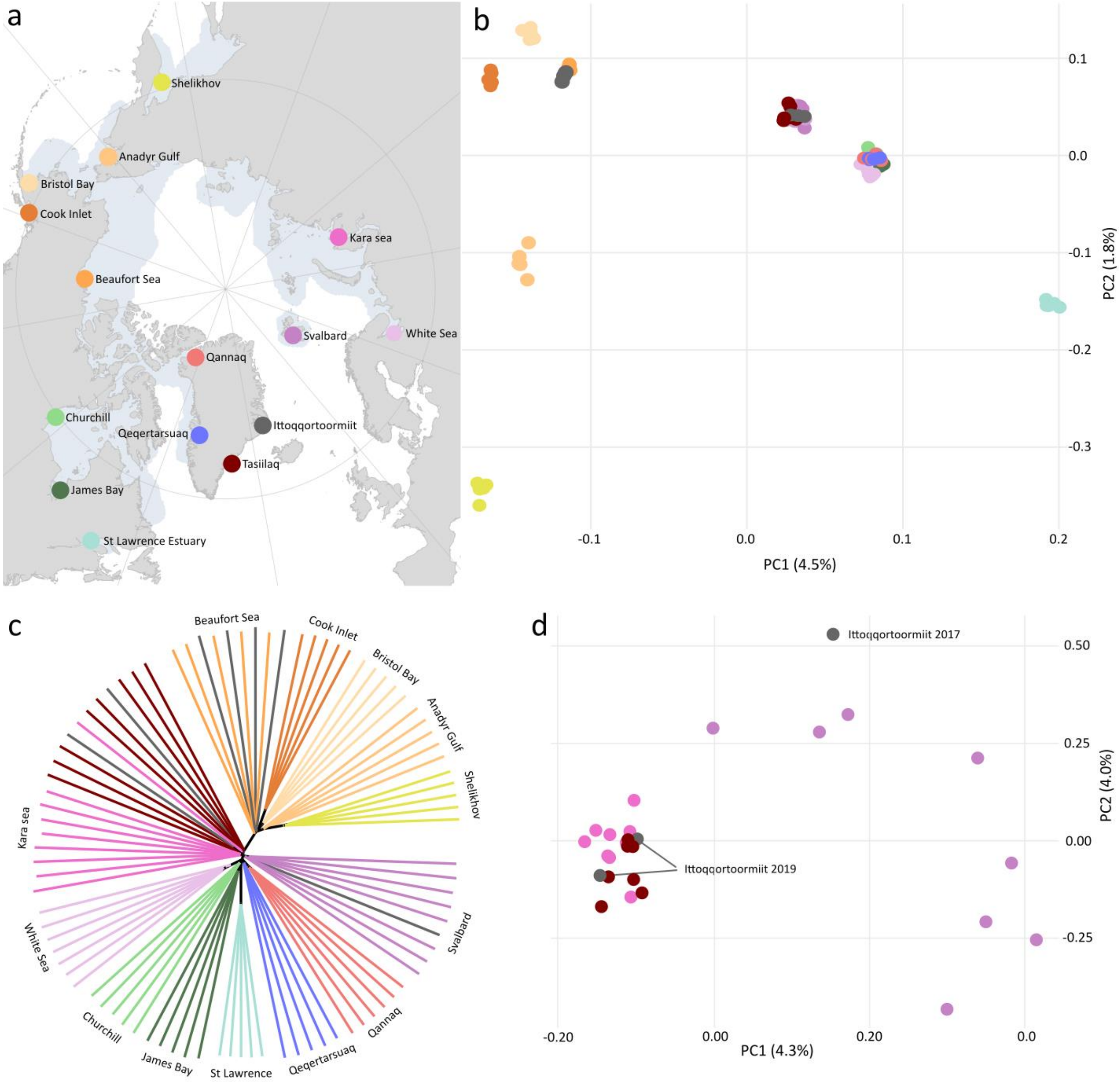


**Figure 9.** Sample localities and genetic clustering. **a**) Map of sampling localities of the 90 beluga genomes included in our analyses. Coloured circles indicate the sample localities. Light blue shading indicates the distribution of the species, which has not been observed in east Greenland waters until recently. **b**) Principal Component Analyses of 90 beluga genomes including 15 individuals from east Greenland sampled between 2017 and 2023. **c**) Neighbor-joining tree based on pairwise distance matrix. **d**) Principal Component Analysis of beluga genomes from east of Greenland, incl. Ittoqqortoormiit 2017 (N=1), Ittoqqortoormiit 2020 (N=2), Tasiilaq 2022 (N=7), Kara Sea (N=10), and Svalbard (N=8). Colors of b, c and d correspond to the localities on the map (a).

## 7.2. ABUNDANCE, DISTRIBUTION, AND REMOVALS

Heide-Jørgensen presented an overview of catch statistics and occurrences of belugas in East Greenland (NEGWG/04).

*Summary:*

Catch statistics for belugas in East Greenland have been a source of confusion, because the species is often mistaken for narwhals in catch records, and interview studies have failed to validate the reported catches. Regardless of the uncertain catch statistics, there were very few documented sightings of belugas in East Greenland before 2017. However, confirmed catches of belugas after 2017 indicate a substantial increase in their presence in East Greenland. This increase, when compared to the previous

100 years, suggests a major influx of belugas from other populations. Catch data for 2022 and 2023 are preliminary, but the accumulated catches for the two years was 33, which is a record for East Greenland.

The closest stock is the Svalbard population; however, these belugas are known for their exceptionally high site fidelity to coastal areas of the Svalbard Archipelago. Alternative sources for the belugas in East Greenland may include the west coast of Greenland or, more likely, the western Siberian stock that summers in estuaries of the large Siberian rivers, such as the Kara and Lena Rivers, and around Franz Josef Land.

The drivers of movements of belugas to East Greenland remain unknown. Pink salmon, a Pacific species, has been introduced to the Atlantic by Russian stocking programs in the White Sea. In 2017, an invasion of pink salmon was observed in the North Atlantic and tributaries in northern Europe, where it appears the species has established functioning wild populations. It is an attractive hypothesis that belugas from western Siberia, including the White, Kara, and Laptev seas, have followed the movements of pink salmon from Siberia to East Greenland. A potential migration of belugas from Siberia to East Greenland could have been facilitated by the recent reduction in winter sea ice extension in the Barents Sea and along East Greenland.

*Discussion:*
The WG concurred that the historical catch data should be treated with caution. However, the increase of beluga catches in recent years is a fact that reflects an influx of animals from other areas. Although still low in absolute numbers, the hunters' reports of catches are consistently higher in Tasiilaq than in Ittoqqortoormiit, possibly due to greater ice cover in the latter area.

The migration of pink salmon from Russia towards Greenland opens the possibility that the belugas can make the same migration, perhaps directly following groups of salmon. It is confirmed that pink salmon have started breeding in at least one river in East Greenland, but their establishment throughout the area and how this might influence beluga behaviour is still unclear. While some of the putative origin stocks of the East Greenland belugas are known to feed on anadromous fish, it was noted that the Beaufort Sea belugas rely primarily on arctic cod and capelin, as is the case for belugas in Svalbard. It was further observed that the abundance of pink salmon in Norway (including Svalbard) is considerably higher than in Greenland, which would indicate that there is no need for belugas to migrate between Russia and East Greenland merely to feed on this prey item.

It is not currently possible to estimate the abundance of belugas in East Greenland, considering how irregular and unpredictable the sightings have been, as well as the genetic evidence that they come from different populations. The genetic provenance analysis does not indicate whether the animals are sporadically passing through the area. To date there have been no records of pregnant females or calves in the area. There is no reason to believe that only males are occurring in East Greenland; genetic sexing of the sampled individuals has not been completed yet, but it will provide some further insights into sex ratios in the harvest. Whether or not they are vagrants, or a new population is being established, the precautionary approach is to treat them as a small aggregation of unknown size with no hunting until more information is available. A further reason to be cautious is the potential link with the Svalbard population, which is classified as Endangered on the Norwegian national Red List (Eldegard et al. 2021). If animals from that small, protected, population are moving between there and East Greenland, the removal of any individuals would put that population at greater risk.

**Conclusion:**
Belugas have recently appeared more regularly in East Greenland, although still in small numbers. Genetic analyses strongly suggest that these animals have come from different populations, including the Beaufort Sea, Kara Sea, and Svalbard. Their arrival coincides with the arrival of pink salmon in East Greenland, but the diet of these animals has not been verified. There is no evidence to determine

whether they are establishing a new population or not, and there are no data yet for annual patterns of behaviour and migration for belugas in East Greenland.

### 7.3. OTHER THREATS

Compared to other Arctic cetacean species, belugas show more plasticity in relation to environmental changes and shifts in prey distribution. There is insufficient information at present to determine other anthropogenic impacts on the belugas occurring in East Greenland, besides direct removals.

### 7.4. ADVICE FOR EAST GREENLAND BELUGA

Despite recent takes of beluga in East Greenland, there is no evidence that they form a permanent stock. Genetic evidence indicates that these belugas originated from three different stocks (NEGWG/10). It is unknown whether these animals are vagrants or new residents in East Greenland, and the frequency of migration is also unknown. The WG **recommends** zero catches for two reasons: a) because removals will impede the establishment of a new stock in East Greenland and b) one of the likely source stocks (Svalbard) fits the definition of a small stock and should not be hunted without an assessment.

## 8. RECOMMENDATIONS FOR RESEARCH AND MANAGEMENT

### 8.1. RECOMMENDATIONS FOR RESEARCH

#### 8.1.1. FOR NARWHAL

- Deploy satellite tags on animals supplying the spring hunt in Management Area 1, as well as in Northeast Greenland, to investigate the range of the animals supplying the spring hunt.
- Collect biological samples when available from East Greenland, including areas north of Scoresby Sound, to explore genetic connectivity of different stocks.
- Investigate alternative methods to monitor depleted stocks (e.g., using targeted aerial surveys, passive acoustic monitoring, land-based surveys, mark-recapture, collecting incidental observations).
- Conduct targeted aerial surveys of Kangerlussuaq, Nansen Fjord, southern Scoresby Sound, and other reported aggregation areas during summer of 2026.

#### 8.1.2. FOR BELUGA

- Collect incidental observations and biological samples when available, to monitor the occurrence of belugas in East Greenland.

### 8.2. RECOMMENDATIONS FOR CONSERVATION AND MANAGEMENT

#### 8.2.1. FOR NARWHAL

- For Management Area 1, the WG recommends zero removals and immediate closure of the hunt, which reiterates the advice from the two previous assessments.
- For Management Area 2, the WG recommends zero removals and immediate closure of the hunt, which reiterates the advice from the two previous assessments.
- For Management Area 3, the WG recommends zero removals and immediate closure of the hunt, and additional management measures to reduce or eliminate other potential sources of lethal and sublethal takes when identified. This reiterates the advice from the two previous assessments.
- The next assessment of each Management Area should be conducted in 2026.

#### 8.2.2. FOR BELUGA

- The WG recommends zero removals of beluga in East Greenland.
- The next assessment should coincide with the next narwhal assessment.

## 9. OTHER BUSINESS

There was no other business.

## 10. REVIEW AND ADOPTION OF REPORT

A preliminary draft of the report was approved by the WG on December 15 2023. The final report was recirculated and accepted by the group on January 4 2024.

## 11. CLOSE OF MEETING

The WG congratulated the Chair and rapporteurs on their commendable work throughout the meeting and expressed particular thanks to the invited experts for sharing their knowledge and interest on a subject so geographically distant from their own.

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NAMMCO-North Atlantic Marine Mammal Commission (2022). Report of the Meeting of the Management Committee for Cetaceans, September 2022, Oslo, Norway. Available at https://nammco.no/management-committees-reports/

NAMMCO-North Atlantic Marine Mammal Commission (2021). Report of the Ad hoc Working Group on Narwhal in East Greenland. October 2021, Copenhagen, Denmark. Available at https://nammco.no/topics/narwhal_beluga_reports/

# APPENDIX 1: DRAFT AGENDA

*Tuesday 12 December*

**1. Opening of Meeting**

1.1. Welcome and Opening Remarks from the Chair and Introductions

1.2. Review of Terms of Reference and Recommendations for Research

1.3. Review of available documents

1.4. Appointment of rapporteurs

1.5. Adoption of agenda

**2. EG Narwhal stock structure**

2.1. Updates on genetic analyses

2.1.1. Fine-scale population structure

2.2. Seasonal distributions

2.2.1. From aerial surveys

2.2.2. Tracking data

2.2.3. User observations, removal records

2.2.4. Data from NE Greenland and Svalbard

2.3. Stock definition and Management units

2.3.1. Are current stock definitions supported by new fine scale data?

2.3.2. Consider separating Scoresby Sound stock into two seasonal stocks—Definition

2.3.3. Connection with Svalbard narwhal

**3. Distribution and abundance of EG Narwhal**

3.1. Survey review and results

3.2. Distribution

3.3. Latest abundance estimates

3.4. Discussion of Recommendations 2.2 and 2.3.

**4. Anthropogenic impacts on EG Narwhal**

4.1. Catch and by-catch

4.2. Other threats

*Wednesday 13 December*

**5. Discussion of Recommendation 2.4**

5.1. Develop definitions and frameworks for advice and management

5.2. Apply frameworks to EG Narwhal assessment

**6. Stock assessment for EG Narwhal**

6.1. Review of the EG Narwhal Population Model

6.1.1. Review of model structure: multiple stocks or seasons

6.1.2. Review of population model: age-, time- or habitat-dependent parameters

6.1.3. Review of model priors

6.2. Updating the EG Narwhal Population Assessment Model

6.2.1. Draft assessment model

6.2.2. Revise stock assessment model (if necessary)

6.3. Implementation of previous advice

*Thursday 14 December*

**7. Distribution and abundance of EG Beluga**

7.1. Occurrence

7.1.1. Aerial surveys

7.1.2. Hunter and user data

7.2. Abundance estimates

**8. EG Beluga stock structure**

8.1. Updates on genetic analyses

8.1.1. Connectivity with Svalbard population

8.2. Distribution (surveys, catch locations, user observations)

8.3. Stock definition and Management units

**9. Abundance**

9.1. Estimate from narwhal surveys

9.2. User observations

**10. Anthropogenic impacts on EG Beluga**

10.1. Catch and by-catch

10.2. Other threats

**11. Stock assessment for EG Beluga**

11.1. Population Assessment Model

11.1.1. Review of available data

11.1.2. Data gaps that need to be filled before conducting an assessment

**12. Recommendations for Research & Management**

12.1. Recommendations for Research

12.1.1. For Narwhal

12.1.2. For Beluga

12.2. Recommendations for Conservation & Management

12.2.1. For Narwhal

12.2.1.1. Suitable regularity of abundance surveys and assessments

12.2.2. For Beluga

12.2.2.1. Suitable regularity of abundance surveys and assessments

*Friday 15 December*

**13. Any other business**
**14. Review and Adoption of Report**
**15. Close of meeting**

For information:

**The Terms of Reference for the Meeting are:**

a) *To update the assessment of Narwhals in South-East Greenland using data from recent surveys.*
b) *To review the situation of Belugas in East Greenland with participants from Norway.*
c) *To define the suitable regularity of abundance surveys and assessments for each specific case (species/stock). (Standard ToR as of NAMMCO30)*

**Recommendations for Research regarding East Greenland, endorsed by SC28:**

***Rec. 2.2*** *That different approaches to counting Narwhals in the fjords be further examined, but only to the extent that new approaches will be compatible with the existing time-series.*

***Rec. 2.3*** *That, although the planning of surveys should be done in collaboration with the hunters, the survey methodology (including the design of the track lines) continues to be done according to internationally accepted survey standards, to ensure that abundance estimates derived from the survey can be accepted by NAMMCO and used in the assessment.*

***Rec. 2.4*** *That definitions be developed for what constitutes small stocks, depleted stocks and stocks at risk of extirpation, and that frameworks for advice and management then be articulated for what actions should be taken for these different categories.*

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# APPENDIX 3: LIST OF DOCUMENTS

**Working Documents**

| Doc. No. | Title | Agenda item |
|---|---|---|
| SC/30/NEGWG/01 | Draft Agenda | 1 |
| SC/30/NEGWG/02 | Draft List of Participants | 1 |
| SC/30/NEGWG/03 | Draft List of Documents | Several |
| SC/30/NEGWG/04 | Movement of belugas to East Greenland | 7, 8 |
| SC/30/NEGWG/05 | Narwhal as meat supply in East Greenland | 4, 11 |
| SC/30/NEGWG/06 | Survey of winter grounds of Scoresby Sound narwhal | 3 |
| SC/30/NEGWG/07 | Stock definitions and management frameworks | 5 |
| SC/30/NEGWG/08 | Detection of extreme low densities of narwhals | 3 |
| SC/30/NEGWG/09 | Fine-scale genetic structure of narwhals in East Greenland | 2 |
| SC/30/NEGWG/10 | Genetic provenance of East Greenland belugas | 8 |
| SC/30/NEGWG/11 | East Greenland narwhal catch statistics since 1955 | 4.1 |
| SC/30/NEGWG/12 | East Greenland narwhal abundance summer 2022 | 3 |
| SC/30/NEGWG/13 | Collaboratively planned narwhal survey in East Greenland | 5 |
| SC/30/NEGWG/14 | Narwhal assessment model for Management Area 1 | 6 |
| SC/30/NEGWG/15 | Narwhal assessment model for Management Area 2 | 6 |
| SC/30/NEGWG/16 | Narwhal assessment model for Management Area 3 | 6 |
| SC/30/NEGWG/17 | Winter habitat availability for narwhals in East Greenland | 3 |
| SC/30/NEGWG/18 | Binomial method for zero-sighting surveys | 3 |

**For Information Documents**

| Doc. No. | Title | Agenda item |
|---|---|---|
| SC/30/NEGWG/FI01 | Report of the 2021 NEGWG meeting | 1, 11 |
| SC/30/NEGWG/FI02 | Report of the 2019 NEGWG meeting | 1, 11 |
| SC/30/NEGWG/FI03 | Laidre et al. (In Press) Beluga ice entrapment incident | 7.1 |
| SC/30/NEGWG/FI04 | Biopsies & tagging of narwhal in northeast Greenland | 2 |
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