# GLOBAL REVIEW OF MONODONTIDS

# REPORT

**13-16 March 2017**

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The content of this report contains the view of the Symposium Expert Group and do not necessarily represent the views of the NAMMCO Scientific Committee or Council.

NAMMCO Scientific Committee reviewed the draft report at its next meeting in November 2017 and NAMMCO Council was presented with the final report and the review results at its 26th meeting in March 2018.

**NAMMCO**
*Postbox 6453, Sykehusveien 21-23, N-9294 Tromsø, Norway,*
*+47 77687371,* nammco-sec@nammco.no, www.nammco.no, *www.facebook.com/nammco.no*

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# NAMMCO Global Review of Monodontids

## 13-16 March 2017, Hillerød Denmark

## Report

## 1. WELCOME AND MEETING INFORMATION

### 1.1 Introduction

Jill Prewitt, Scientific Secretary of NAMMCO, welcomed the participants (Appendix 1) to Hillerød and expressed the satisfaction of NAMMCO that this long-awaited review was taking place. She conveyed the deep regrets of the chair of the Planning Group, Arne Bjørge (IMR, Norway), who was not able to attend the meeting due to health issues, and thanked Rod Hobbs, the vice-chair, for agreeing to step in. She briefly introduced NAMMCO, summarized background for the Global Review, and acknowledged Christina Lockyer, the former NAMMCO General Secretary, for her efforts to launch this Global Review. She also thanked the other members of the Planning Group (Barry, Bjørge, Desportes, Ferguson, Guldborg-Hansen, Hobbs, Marcoux, Reeves, Shpak, Suydam) and noted that the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF) biodiversity working group had joined the effort to organise the review. Although Tom Barry (CAFF Secretariat) was unable to participate, his colleague Tom Christensen, co-chair of CAFFs Circumpolar Biodiversity Monitoring Program (CBMP), attended. She also thanked the funders who made the Global Review possible, primarily NAMMCO, the Government of Greenland, Shell Oil and the US Marine Mammal Commission.

### 1.2 Chair's welcome

Hobbs, the meeting Chair, welcomed the participants and noted that the International Whaling Commission's (IWC's) Scientific Committee had reviewed the status of belugas and narwhals in 1992 (IWC 1993) and conducted a more thorough updated review of beluga stocks in 1999 (IWC 2000). Additionally, the NAMMCO Scientific Committee's Working Group on the Population Status of Beluga and Narwhal in the North Atlantic carried out an extensive review in 1999 (NAMMCO 2000).

A significant amount of new information has become available since 1999 on both species – regarding stock identity, movements, abundance, and threats to populations. Importantly, new (or at least newly recognized) stressors have emerged, particularly those associated with climate change either directly or indirectly owing to increasing human activity in the Arctic.

The Chair stressed that the group had only 4 days to review more than 20 stocks of belugas and 13 stocks of narwhals and to identify knowledge gaps as well as discuss global and regional issues related to the conservation of belugas and narwhals. The group also expected to develop recommendations for research and cooperation.

### 1.3 Rapporteurs

Each stock was assigned rapporteurs, tasked to report on the discussion following the presentation of each stock and the concern level agreed upon. They were asked to note (a) comments on each submitted stock status review which needed to be addressed, (b) any data gaps and concerns expressed and (c) the group's evaluation of the status of the stock. Authors of the submitted stock status reviews were asked to provide summaries of their review for inclusion in the main body of the report.

The report was finalised by Prewitt and Reeves, with the assistance of Desportes and Hobbs, and finally adopted by the participants via email correspondence on 13 February 2018.

### 1.4 Review of Documents

The documents for the meeting, including stock reviews and published documents for information, were available on a OneDrive along with a draft list of stocks for review.

## 1.5 *Modus operandi* and Reporting

Several presentations were given as background to the Global Review and these are summarized below.

Each proposed stock was then presented by a regional expert and discussed in plenary (there were no breakout groups). Authors of the stock summaries were provided with notes from the discussion and expected to make necessary revisions before the summaries were finalized for inclusion in the report (Annexes 1-30). On the last day and a half, tables of stock discrimination, summary information, stock status, and comparison to previous monodontid reviews were prepared (Tables 1-4). Maps of beluga (Fig. 1) and narwhal (Fig. 2) stock distributions were prepared.

**Extralimital Records**

Both monodontid species, but especially belugas, are known to occasionally occur far outside what is considered the normal range of any recognised stock or population. Participants agreed that, in general, such records are properly regarded as extralimital and as such are not particularly significant. However, if they were to become more regular, they could signify actual shifts in species distribution in response to environmental change.

**Abundance Estimates**

Abundance estimates provided in the stock summaries were not reviewed and discussed in detail at the meeting, but it was recognised that they varied greatly in terms of methodology, completeness, precision and how up-to-date they were. Expert opinion was taken into account when no survey estimate was available, although more weight was generally given to survey data when assessing status. It was emphasized that abundance estimates based on surveys (rather than solely on expert opinion) are required to determine status whenever the monodontid stock is exploited directly or there are concerns over other threats (known or plausible) to the population.

**Sustainability of Removals[1]**

A major consideration for management is to determine whether rates of removal (e.g. by hunting, live-capture, or entanglement in fishing gear) are sustainable. Participants acknowledged that a number of approaches can be used to assess sustainability and that risk tolerance often varies according to the type of removal being considered. For example, management bodies may be willing to accept a higher level of risk (to the animal population) when the removals are part of a well-managed subsistence harvest than when they are incidental to commercial fishing or industrial development. Common scientific approaches to assessment of sustainability are risk assessment modelling, in which risk levels are estimated directly for different levels of removals, and Potential Biological Removal (PBR) which estimates a threshold number of removals below which there is little concern. Both methods use recent abundance estimates and estimated take levels and can account for changes in distribution and seasonal movements. Participants noted the value of traditional knowledge both as a historical record and for current observations of population behaviour which should be incorporated when available.

PBR has increasingly been used (in Canada and the United States at least) to assess the sustainability of subsistence harvest levels. One should bear in mind, however, that the PBR formula uses a relatively

[1] In the first circulated version of the report the second paragraph read from sentence 6 as follows:

*However, it is important to recognize that the PBR as calculated under the US Marine Mammal Protection Act uses Nmin, defined as the 20th percentile of a log-normal distribution based on an estimate of the number of animals in a stock, equivalent to the lower limit of a 60% 2-tailed confidence interval, rather than the central estimate of abundance derived from a distance sampling survey, whereas the PBR values reported in the present monodontid assessment were calculated using central ('best') estimates of abundance. Many of the stock summaries include PBR calculations in the expectation that they will provide useful guidance to managers.*

This misrepresented the way PBR calculations were made during the meeting, when they were in fact based on minimum estimates (Nmin) rather than point estimates (Nbest). The text of the report was therefore amended on 06 May 2018 as agreed via email correspondence by Hobbs, Reeves and Desportes, with explanations on the calculation of PBR added.

simplistic approach and was originally developed specifically to provide guidance for managing marine mammal bycatch in commercial fisheries. The PBR level for a given stock is set to be precautionary (risk-averse) and to allow the stock to return to, or to stay at or above, its optimum sustainable population size. The built-in emphasis is on recovery of depleted stocks and prevention of significant declines of healthy stocks. The PBR value is not necessarily an estimate of how many individuals can be taken sustainably each year but is often regarded as a ‘safe’ limit – as long as removals are below the PBR, they are expected to be sustainable. The PBR as specified in the US Marine Mammal Protection Act (Wade 1998) is calculated as,

$PBR = N_{min} * 0.5 * R_{max} * F_R$,

where $N_{min}$ is a conservative estimate of population size, $R_{max}$ is the maximum rate of population increase (unknown for belugas and assumed to be 0.04, the default for cetaceans), and $F_R$ is a recovery factor that varies between 0.1 and 1. When an abundance estimate (N) with a coefficient of variation (CV) is available, then $N_{min}$ is calculated using the 20th-percentile (z=-0.842) of the lognormal distribution as,

$N_{min} = (N/[\exp(-0.842*\mathrm{sqrt}[\ln(1+CV(N)^2)])])$.

In the formula above, $N_{min}$ is derived from an abundance estimate. However, in cases where an abundance estimate is not available, i.e., where counts are used, or numbers are estimated from surface density without correcting for submerged animals resulting in an estimate that is already known to be conservative, then this estimate of abundance may be used directly. Many of the stock summaries include PBR calculations in the expectation that they will provide useful guidance to managers.

**Scales of “Concern”**
For each of the stocks, the meeting agreed to assign a level of “concern” relative to other stocks within the species and between the two species. The scale was 1) most concern, 2) moderate concern and 3) least concern; notes are provided in Table 3 and in the stock summaries to explain the basis for these assignments of concern level.

## 2. CAFF/CBMP STATE OF THE ARCTIC MARINE BIODIVERSITY REPORT

Tom Christensen, from Aarhus University and co-chair of the Arctic Council’s (AC) Conservation of Arctic Flora and Fauna (CAFF) Circumpolar Biodiversity Monitoring Program (CBMP), made a short presentation on CAFF (the biodiversity working group of the AC) and the CBMP. The State of the Arctic Marine Biodiversity Report (SAMBR) covers sea ice biota, plankton, benthos, fish, birds and marine mammals.

Of direct relevance to this meeting is the marine mammal section, which reviews the status of stocks, the drivers behind observed trends, threats and current monitoring. It also identifies knowledge gaps and makes recommendations for future monitoring. The Marine Mammal Expert Network (MMEN) has added six Arctic endemic ice-dependant species (narwhal and bearded, harp, hooded, ribbon and spotted seals) to the five focal ecosystem components (FECs) accepted by CAFF (walrus, ringed seal, beluga, bowhead and polar bear) for better evaluating the changes taking place in the Arctic. The SAMBR was not available at the time of this meeting, but was subsequently released in May 2017 (available at https://www.arcticbiodiversity.is/marine). Christensen indicated that the information complied by the Global Review would be useful input to the next SAMBR and to the ongoing work of the CBMP.

It was noted that the geographical extent of the CBMP/CAFF area excludes some important areas for some Arctic species. For example, the Sea of Okhotsk is not included in the CBMP, yet this region provides year-round habitat for four species of Arctic seals (bearded, ribbon, ringed and spotted seals) and two Arctic cetacean species (beluga and bowhead whale). Christensen stated that recommendations to extend the CBMP area can be presented by individual countries, and the CAFF board then agrees upon any changes needed.

Species that migrate into the Arctic in the summer are currently not covered by the SAMBR. There has been discussion of this in each of the expert networks, but the consensus was that this is a baseline report, and the MMEN decided to focus only on endemic species. Seasonally migrating species could be a focal topic in the future, and future reports may include these species. The next meeting of the CBMP will be in autumn 2017, and it would be valuable to have a presentation from the Global Review of Monodontids at that meeting.

## 3. Stock Definition

Suydam summarised various criteria that are used to define stocks generally, with emphasis on how beluga and narwhal stocks have been defined in previous reviews. In its 1999 review, the IWC Scientific Committee used an essentially *ad hoc* approach. They used a variety of criteria including genetic relationships, distribution and movements (from surveys, catch statistics, tagging, and telemetry), patterns in exploitation, contaminant profiles, expert opinion and in a few cases traditional knowledge. A total of 29 putative beluga stocks were identified in that review. It is unclear how the participants in that review balanced or weighted the different types and strengths of evidence but in many cases the available data were deemed inadequate for delineating stocks with high confidence. The approach used by the NAMMCO Scientific Committee in its review of belugas and narwhals in the North Atlantic and adjacent waters was similarly *ad hoc*, identifying 25 major ‘aggregations’ of belugas and 17 of narwhals. It was acknowledged that these aggregations (summering, wintering or migrating areas) could be “discrete, or a mixture, of stocks.” As a guiding principle, the NAMMCO review group concluded that it was “prudent to base putative management units on local aggregations and/or harvesting areas until more information on stock structure is available.”

Previous reviews that focused on, or included, monodontids (IWC 1993, 2000; Laidre et al. 2015; SAMBR 2017) recognized different numbers of stocks. In order to clarify and justify differences between the 21 stocks of belugas and 12 stocks of narwhals identified in this Global Review, an attempt was made to explain the rationale for lumping or splitting previously recognised stocks (see Table 1).

The individuals who prepared stock summaries for the present Global Review were asked to be explicit and consistent in describing the evidence used to designate stocks and to comment on the strengths and weaknesses of their argument.

Rapid environmental change in the Arctic and sub-Arctic is presumably influencing the distributions and movements of monodontid species and stocks, which means that it may be important to re-evaluate some of the conclusions and assumptions regarding stock identity made in this and previous reports.

### 3.1 Genome Information on Belugas and Narwhals

Eline Lorenzen and Mikkel Skovrind from the Natural History Museum of Denmark, University of Copenhagen, presented their planned work using whole-genome sequencing to elucidate the genetic differentiation among geographic regions and stocks.

In range-wide biogeographic studies of belugas and narwhals, genome-wide DNA data from individuals sampled across the distribution range of each species will be generated using next-generation Illumina shotgun sequencing, to provide low-coverage nuclear genomes and complete mitochondrial genomes from ~200 individuals. Beluga and narwhal reference genomes have been generated and assembled *de novo*.

Levels of genetic diversity, differentiation and admixture among populations and regions will be investigated. Specifically, levels of genetic subdivision among the stocks recognized by the GROM meeting group will be assessed. Depending on levels of differentiation among stocks, levels of gene flow and admixture among the stocks will be estimated.

Beluga and narwhal populations have previously been surveyed with population genetic data – mitochondrial DNA (mtDNA) control region and microsatellites – but the degree of differentiation based on these data remains difficult to ascertain. The genome-wide data will aid in stock identification and will quantify their connectivity at an unprecedented resolution.

Depending on the biogeographic resolution among stocks, custom-designed SNP arrays of each species will be generated, which can be used for management purposes such as the further elucidation of the meta-population dynamics of the Canada/Greenland joint populations, or to determine the probable geographic origin of a given sample of interest.

The beluga reference genome will be analysed in a joint analysis with the corresponding narwhal reference genome to estimate divergence time and joint demographic history of the two species. Hybridization will be further investigated by analysing DNA retrieved from the anomalous skull believed to be a hybrid (Jørgensen and Reeves 1993).

***Discussion***

Genetic differentiation among geographic regions and stocks has so far been limited to mtDNA and microsatellites studies. There is significant interest in being able to identify which stock a specific individual originates from and delineate stock identity. The GROM participants acknowledged that whole-genome sequencing is a potentially very helpful tool. These high-resolution data will hopefully uncover biogeographically informative genomic regions in the form of SNPs (single nucleotide polymorphisms). By combining these in a custom-designed SNP-array for belugas and narwhals, it will be possible to provide a cost-effective and relatively easy way to discern their stocks, which could potentially be run in any lab with suitable equipment.

In addition to informing scientists and managers on stock identity, it may be possible to look at adaptation to changes in the environment. This could help in answering intriguing questions about how belugas and narwhals may have adapted to past changes in the environment, and possibly inform on how they may be able to adapt to changes in the environment that are presently occurring and will continue to happen. An example of where this type of analysis could be helpful is the Eastern Hudson Bay and St Lawrence Estuary belugas. Both of these stocks/summer aggregations are doing poorly, while nearby groups appear to be relatively stable, and a project such as this may be able to answer whether there could there be a genetic explanation for why this difference occurs.

## 4. BELUGAS

### Introduction to belugas

Beluga whales have a discontinuous circumpolar distribution throughout the Arctic and sub-Arctic (Figure 1). They usually exhibit some level of site fidelity, inhabiting the same summering and wintering areas year after year Caron and Smith 1990, Brennin et al. 1997, Brown Gladden et al. 1999, de March et al. 2004). Most belugas are migratory, however some of the smaller populations appear to be resident year-round in specific regions and do not undertake long-distance migrations (e.g. Cook Inlet, Cumberland Sound, St Lawrence Estuary).

The IUCN Red List classified the beluga as Near Threatened and noted that at least some populations should be assessed separately. The GROM recognized 21 extant stocks, one of which may be extirpated, plus one known to be extirpated stock. The beluga stocks recognised at this meeting as well as a comparison with the stocks listed in previous reviews are presented in Table 4.

As noted in Item 1.5, belugas are occasionally sighted outside of the recognized stock areas. There are occasional reports of sightings and catches of belugas in East Greenland, usually in the vicinity of Tasiilaq. A large proportion of these reports are unconfirmed, and it is likely that, at least in some cases, the whales were confused with other species, possibly narwhals. Two beluga catches in Ittoqqortormiit in 2012 are, however, well documented, and belugas were also seen in 2013 in Ittoqqortormiit and in 2016 in Tasiilaq Fjord. The few individuals that occur in East Greenland presumably belong to the population around Svalbard. Similarly, belugas (usually lone individuals) are known to wander into waters of the eastern United States (as far south as New Jersey) and into European waters to as far south as northeastern England and the Baltic Sea. In fact, there have been more observations of belugas in Denmark than in East Greenland.

Below are brief summaries for each stock of belugas. These summaries are based on more detailed individual stock reviews submitted to the meeting (Annex 1-34) and discussion among the workshop participants. Table 2 contains a summary of what is known about movements, abundance (with estimate of CV or CI), trend, removals, and threats/concerns.

**Pacific Arctic**

<u>Introduction to the belugas in the Western Okhotsk Sea</u>

Belugas in the Western Okhotsk Sea (Annex 1) were previously thought by Soviet scientists to consist of two stocks (reproductively isolated units, or biological populations): Sakhalin-Amur and Shantar (IWC 2000). Extensive studies began in this area in 2007. Based on aerial surveys and observations from boats and shore (Soloyev et al. 2015), the population consists of several summer 'nursery' aggregations: 1) Sakhalin-Amur, 2) Ulbansky, 3) Tugursky, and 4) Udskaya. Nikolaya Bay is also occupied by belugas, but in considerably lower numbers. In July, belugas from Sakhalinsky Bay were re-sighted in Nikolaya Bay. Satellite tracking of Sakhalinsky Bay belugas (n=20) showed that in autumn some animals move to Nikolaya Bay, where they spend up to several weeks, and some individuals briefly visit Ulbansky Bay before they leave coastal areas in late November and migrate offshore to wintering grounds. Genetic studies demonstrated that belugas summering in the western Okhotsk Sea share a single nuclear gene pool and thus represent a single stock. Analysis of mtDNA markers subdivided belugas summering in different areas into three demographic units: 1) Sakhalin-Amur and Nikolaya Bay, 2) Ulbansky Bay, and 3) Tugursky-Udskaya Bays. The status of Nikolaya Bay belugas (only 9 samples, 8 of which are from males) remains to be confirmed. Even though Nikolaya and Ulbansky Bays are, in geographical terms, the two 'arms' of Academii Bay, i.e. they share the same 'entrance' from the open sea, a comparison of the haplotype frequencies between Nikolaya and Ulbansky belugas resulted in the highest difference between any pair of bays (FST=32%, p=0.0006). Belugas in Nikolaya Bay also differ from Ulbansky whales in their response to boats, and, in this respect, they resemble Sakhalinsky Bay belugas.

Pairwise comparisons indicate that the maternal lineages of Sakhalinsky, Ulbansky and Udskaya belugas differ significantly (Fst=11-17%, p=0.0000). The lack of difference (0.6%, p=0.2530) in haplotype frequencies between Tugursky (32 samples) and Udskaya (90 samples) belugas cannot, by itself, be considered definite evidence of demographic unity. Historical data, together with multi-year shore, boat, and aerial observations, suggest that in summer belugas occupy estuarine areas in both bays, and fewer animals are detected outside the estuaries. Furthermore, behavioural differences between belugas concentrating in Tugursky and Udskaya Bays were noticed by two independent research teams. Lastly, the samples in Tugursky Bay were collected during the third week of September; at this time Western Okhotsk belugas start moving between the bays, thus it is possible that the samples were collected from a mixed aggregation. Until samples of sufficient and approximately equal size are analysed for genetic differences, and tracking studies of individuals' movements are conducted, Tugursky Bay belugas should be considered a separate stock for management purposes.

For Sakhalinsky, Ulbansky, and Udskaya Bay, intra- and interannual re-sightings suggest residential behaviour of at least some of the belugas during the summer, and fidelity to summering grounds.

Distribution of Sakhalin-Amur belugas was tracked using satellite telemetry during several winters. In winter-spring months they concentrated in the offshore zones, often in association with the ice-edge. No individuals were determined to have left the Okhotsk Sea in winter. There are no tracking data on seasonal movements from the other Western Okhotsk summer stocks, but the bays freeze during the winter, and the whales are forced to move offshore. Nuclear genetic analysis suggests that belugas from different summer stocks of the western Okhotsk Sea interbreed and thus constitute a single biological population.

***Discussion***

There is uncertainty around the differentiation of beluga stocks in the Western Okhotsk Sea, but the criteria applied for the structure proposed above (mtDNA frequency differences, observations of spatio-temporal occurrence and behaviour) are the same as or similar to those used for stock delineation in other areas. It was noted that despite its limitations, mtDNA is the only genetic marker that has been analysed for this region so far. With further investigation, and possibly the application of new tools (e.g. SNP arrays, see Item 3.1), the stock identity of belugas in this region should become clearer.

The meeting concluded that there was sufficient information available to consider belugas in the Western Okhotsk Sea to consist of four separate stocks.

## 4.1 Sakhalin-Amur

The Sakhalin-Amur stock (see Supplement to Annex 1) is the most extensively studied of the Western Okhotsk stocks. Work has included abundance estimation, genetic analyses, satellite tracking, health assessment, and an initial study of contaminant levels. An average abundance estimate based on three aerial line-transect surveys (2009 and 2010) is 1,977 (CV=0.24, 1,574-2,293). When corrected for availability bias in murky waters of the southern part of Sakhalinsky Bay and the Amur estuary (x=2), the estimate is 3,954 (CV=0.48) belugas.

Large-scale commercial hunting took place in the 20$^{th}$ century, primarily until the 1950s. Starting in the 1980s, live-capture operations were conducted in the southern part of Sakhalinsky Bay. The sex and age of captured belugas (primarily juveniles 2 or 3 years old, with a sex ratio skewed towards females) have not been incorporated into determination of sustainable take levels by the Russian authorities. Until 2012, annual live-capture removals were reportedly less than 40. From 2012 to 2015, however, belugas were taken annually in numbers ranging from 40 to over 100 (exact figures are not available). In 2016 there were no live captures, and starting in 2017, the Federal Fisheries Agency recommended that the annual live-capture take in the Sakhalin-Amur area be limited to 40 or fewer individuals.

Major concerns for the Sakhalin-Amur stock include interactions with coastal fisheries (including disturbance, entanglement, and shooting) and contamination of Amur Estuary waters. The carrying capacity of the region for belugas must have declined in recent decades given the intensive and constantly increasing fishing pressure, especially from the salmon fishery.

A relatively low number of belugas (based on two direct counts in 2009 and 2010: 34 and 54 whales) occupies Nikolaya Bay in summer, and it is unclear whether the aggregation is residential, or if different groups from Sakhalin-Amur stock visit the bay in summer. No differences in the mtDNA haplotype frequencies have been revealed between Sakhalin-Amur belugas and belugas biopsied in Nikolaya Bay (Fst=3.6%, p=0.1418).

***Discussion***

Although it may seem counterintuitive to lump Nikolaya Bay with Sakhalinsky-Amur, the balance of evidence (e.g., genetics, photo-ID, and response to boats) suggests that they should be combined. In the future, new information (e.g. genetic analyses of a larger number of samples) may indicate that they should be regarded as separate stocks.

A major concern for this stock is pollution from the Amur River, which contains both chemical contaminants (e.g. heavy metals, PCBs; Glazov et al. 2014) and infectious disease agents, especially during flood events (a spike in infections was observed in 2013; Alekseev et al. 2017, in press).

Of additional concern is the potential for competitive interactions with the salmon fishery which is expanding each year. Entanglement does not appear to be a serious problem despite the large fishing effort, including poaching of sturgeon, in the area (this appears to apply to belugas in all areas – they become entangled relatively rarely). Salmon fishermen likely shoot belugas at least occasionally.

The trend is unknown but based on a back-calculation analysis using commercial catch data there were once 13,200 to 20,800 belugas in this stock (Bettridge et al. 2016), it may now be at only 20-40% of its historical abundance.

***Status***
Numbers are thought to be fairly stable but the actual trend in abundance is unknown. The meeting judged this stock to be of moderate concern because it is still reasonably abundant and there are no immediate major threats. The primary concerns are the unknown trend in abundance, the previous live-capture removals above PBR, and habitat concerns that include discharge from the Amur River, which contains industrial and agricultural pollutants. Additionally, fisheries are increasing in the area and this may have altered the habitat carrying capacity.

## 4.2 Ulbansky

The Ulbansky stock (see Supplement to Annex 1) is considered a separate demographic unit based on multi-year observations of summer aggregations in the bay and on genetic evidence (Yazykova et al. 2012, Meschersky et al. 2013). In autumn, belugas from Sakhalinsky Bay, which have moved into Nikolaya Bay, may also visit Ulbansky Bay, but overall beluga numbers in the bays decrease at this time. Winter migratory routes and feeding grounds are unknown. Nonetheless, composition and frequencies of the maternal lineages represented in Ulbansky Bay differ from those in the other bays: pairwise $F_{ST}$ values are 17% for Udskaya bay, 14% for Sakhalinsky and 18% for Tugursky bays (p= 0.0000 for all pairs). For Nikolaya Bay, which is geographically the closest to Ulbansky Bay, this difference is the highest and reaches 32% (p=0.0006, though this is from a small sample, n=9).

A direct count of 1,167 belugas during an aerial survey in August 2010 was corrected for availability using a correction factor of 2 (due to the murky estuarine water), resulting in an abundance estimate of 2,334 whales. The stock is not known to have been commercially exploited nor have live captures occurred in this area. Although beluga kills by killer whales (*Orcinus orca*) have not been observed directly, researchers have witnessed panic escape reaction of the entire aggregation upon approach by a group of killer whales on numerous occasions. A fishing plant deploys salmon nets along the coast and in the Ulban river mouth, and a gold-mining company (with a mining target on the Ulban river arm) uses an area on the coast to load/unload machinery and fuel. The main concerns, neither of them major at present, are the likely low numbers of entanglement and shooting by fishermen and the habitat contamination by gold-mining discharge.

***Discussion***
A beluga satellite-tagged in September 2015 on a shallow shoal in Ulbansky Bay was observed to be ‘more skittish than usual’ for an Ulbansky beluga (according to Shpak). The animal travelled to Nikolaya Bay and the researcher suspected it to be from the Sakhalin-Amur stock.

***Status***
Numbers are thought to be fairly stable but the actual trend is unknown. The meeting had moderate concern for this stock, with the primary concerns being the unknown trend in abundance and the potential impacts of fishing activities and of resource extraction and development in the area.

## 4.3 Tugursky

The identity of the Tugursky stock (see Supplement to Annex 1) as a separate demographic unit within the western Okhotsk population is based on information provided by local residents and on multi-year observations of beluga summer aggregations in the bay. Genetic analysis also supports geographic isolation from all the other bays in the Western Okhotsk, except Udskaya Bay.
In summer, belugas are regularly seen in the upper part of the bay and occasionally along the west coast, but none have been observed between the Tugursky and Udskaya bays. Small groups have been reported near the south coast of Big Shantar Island and along the northeast coast of Tugursky Bay. Behavioural differences (e.g. response to boats) were noted between beluga groups in Tugursky and Udskaya bays. Winter migratory routes and feeding grounds are unknown.

The composition and frequencies of the maternal lineages represented in Tugursky Bay differ from those in Sakhalinsky (FST = 9.5%, p=0.0000) and Ulbansky (FST = 18%, p=0.0000) bays. However, no difference was found between Tugursky and Udskaya in a comparison of 32 and 90 specimens respectively (Fst=0.6%, p=0.2530). More genetic samples collected in Tugursky Bay in summer months would help to find out whether Tugursky belugas are genetically differentiated from the Udskaya summer stock, since the initial sample was collected in the middle of September from a possibly mixed autumn aggregation.

An abundance estimate of 1,506 whales (corrected for availability bias) was derived from a direct count during an aerial survey of Tugursky Bay in August 2010. The stock was exploited both by locals and by commercial hunting from the late 1800s and until the 1950s. Belugas are still taken occasionally by locals, either as a result of by-catch in salmon nets followed by a kill, or by shooting. No live-captures have been made from this stock. There is a settlement, a fish plant, and a coastal gold-mining company based in the bay. The main concerns for Tugursky belugas are 1) fisheries, 2) potential habitat contamination caused by gold ore mining (heap leaching), and 3) discharges of human and livestock waste.

***Discussion***
The meeting discussed whether the Tugursky stock should be lumped with the Udskaya stock or considered as a separate unit. No direct evidence of differentiation between Tugursky and Udskaya belugas is currently available, but what is known about summer distribution and differences in behaviour support the idea of managing the whales that summer in the two bays separately. It was agreed that genetic studies should be continued to clarify the stock identity of belugas summering in Tugursky Bay.

***Status***
Abundance of Tugursky belugas is thought to be fairly stable but the actual trend is unknown. The meeting had moderate concern for this stock, primarily due to the uncertainty surrounding stock identity and trends in abundance as well as the issues related to fishing and pollution.

## 4.4 Udskaya

The identity of the Udskaya stock (see Supplement to Annex 1) as a separate demographic unit within the Western Okhotsk population is based on local knowledge, multi-year observations of summer and autumn aggregations in the bay, and genetic analysis. Belugas are present in the estuarine area from June to October and often enter the Uda river. They are also known to concentrate in the estuary of the Torom river. There are no genetic samples from the Torom estuary, but regular sightings between the two rivers (ca. 45 km distance between the mouths) suggest that all animals in the bay belong to the same stock. Upon ice formation in the Uda estuary, belugas move along the entire south coast of the bay but keep near the coastline. Winter migratory routes and feeding grounds are unknown.

The composition and frequencies of the maternal lineages represented in Udskaya Bay strongly differ from those in the other bays (pairwise $F_{ST}$ values in comparison with Sakhalinsky, Nikolaya, and Ulbansky bays are 11-17%, p=0.0000 for all pairs). However, no difference was found between the Udskaya and Tugursky samples (Fst=0.6%, p=0.2530). A larger genetic sample from Tugursky Bay collected before late August and sampling in the Torom River estuary in Udskaya Bay are required to better understand the summer stock structure of Tugursky and Udskaya belugas. Differences in behavioural responses to the presence of a boat were noted between Tugursky and Udskaya beluga groups.

Abundance of the Udskaya stock was estimated as 2,464 whales based on a direct count of 1,232 belugas during aerial survey in August 2010, corrected for availability bias in murky waters (x=2). The stock was hunted both by locals and commercially until the 1950s. At present, belugas are occasionally taken by locals, either as a result of by-catch in salmon nets followed by a kill, or by shooting, even though all such taking is illegal. No live captures have been attempted from this stock. There are two settlements, three fishing plants with multiple fishing camps, three coastal gold-mining bases, and one gold ore loading terminal in the bay. Diesel fuel is unloaded in at least four locations. The main concerns for this stock are the potential impacts of fisheries, habitat contamination by toxic river discharge (discharges from gold mining and of human and livestock waste), and ship traffic (noise, leaks of diesel fuel).

***Discussion***
The Udskaya stock is a medium-sized stock, with an unknown trend in abundance.

***Status***
The meeting had moderate concern for this stock, mainly due to ship traffic and pollution in the area.

## 4.5 Shelikhov
Reproductive isolation of belugas summering in the northeastern Okhotsk Sea – specifically in Shelikhov Bay and along the west coast of the Kamchatka peninsula – was confirmed by genetic studies (Annex 2). Strong differences in the mtDNA haplotype frequencies were found for Shelikhov belugas when compared to Sakhalin-Amur and the Shantar region stocks (Fst=34-35%, p=0.0000 for both pairs). Summer aerial surveys also showed discontinuity in the coastal distribution of these whales and those in the Western Okhotsk population. In summer, Shelikhov belugas concentrate both in river estuaries and along the coastline. Neither genetic data nor observations which would allow delineation of stocks within this population are available. Very limited information exists on the winter distribution of Shelikhov belugas. In the 1980s, belugas were found along the ice edge in Shelikhov Bay and along the Kamchatka Peninsula in January, and in Shelikhov Bay in April. A satellite-tagged beluga remained at the mouth of Shelikhov Bay in December. Presumably, the winter distribution of Shelikhov belugas does not overlap that of the Western Okhotsk population.

A direct count by an aerial survey in August 2010 found 1,333 belugas. This was multiplied by 2 to correct for whales submerged in the murky waters to estimate abundance of the Shelikhov (Northeastern Okhotsk) population at 2,666 belugas. From 2006-2017, the total allowable take (TAT) level for the West Kamchatka fishing subzone varied from 0 to 400 belugas, but no beluga harvest or live-capture effort is known to have taken place, other than temporary captures for tagging followed by release. The annual illegal take by locals is likely no more than 10 whales, if any. Population trend is unknown. The only potential threat is competition with fisheries in a few populated areas.

***Discussion***
This stock is isolated geographically and reproductively. The survey covered only a portion of the range of this stock so the abundance estimate (ca 2,666) may be negatively biased.

The small numbers of direct removals are likely sustainable. TAT levels have been set and they include live captures, however the TAT has not been reached and there are only a few small human communities in the region. There is likely some illegal killing of belugas (for human consumption or dog food) by hunters without a license but the numbers they take are likely low.

This area is sparsely settled, with little fishing activity, and therefore by-catch is considered negligible. There are no current development projects in the region. Climate change will likely result in a reduction of sea ice, which could open the area up to development.

***Status***
The stock is small/medium with no trend data. The quota issued has not been used, but there are a few illegal removals. At present there is little development. There was some concern about the poor knowledge of population structure but overall, the level of concern was low.

## 4.6 Anadyr
The Anadyr beluga stock (Annex 3) consists of a single summer aggregation, which congregates in the shallow waters of the Anadyr River Estuary (western Bering Sea), and which is separated genetically (Borisova et al. 2012, Meschersky et al. 2012, Meschersky et al. 2013) and geographically from other stocks. In the Anadyr Estuary, some of the same individuals (based on unique markings such as scars) were re-sighted within-season and in different years (Prasolova et al., 2014; Prasolova et al., unpubl). Together with results of genetic analysis, observations suggest that in summer belugas form a residential aggregation in the estuary and return to the same area summer after summer.

During the ice-free period, belugas occupy all reachable parts of the estuary. They can move as far as 300 km upstream of the Anadyr Estuary but concentrate in the river deltas (Litovka 2001, Litovka 2002, Smirnov and Litovka 2001).

Belugas spend the summer-autumn feeding period in the Anadyr Estuary (total of 5-6 months, with the latest sighting in late November). According to satellite tracking data, the whales begin to leave the area with the beginning of ice formation in the Estuary. First, they move north along the coast to Kresta Bay, and later to the middle and southern parts of the Anadyr Gulf (Litovka et. al. 2013). Anadyr belugas spend the winter around Cape Navarin, in regions with ice coverage of up to 80-90% (Litovka 2013).

Results of telemetry and aerial surveys suggest that in the winter-spring feeding areas off Cape Navarin, Anadyr belugas overlap with some of the Bering-Chukchi-Beaufort (B-C-B) region stocks (see Annex 4: B-C-B pool for more information), most likely the Eastern Beaufort Sea stock in particular (Litovka et al. 2006, Citta et al. 2017). Results of genetic analysis show that this stock is the most similar to the Anadyr stock.

Genetic analysis of the samples collected in summer shows that the Anadyr belugas are seasonally geographically isolated from the other stocks recognized in the B-C-B region and should be managed as a separate demographic unit. More studies are required to understand its degree of reproductive isolation from the B-C-B stocks.

No summer aerial counts of Anadyr Gulf belugas have been conducted. An expert estimate of the size of this summer stock is ca. 3,000 animals (Litovka 2002).

The TAT for the Anadyr Estuary and Anadyr Gulf is 40 belugas. The known subsistence harvest is generally around 2 belugas per year (average of 1.8 from 1997-2016), and no live-capture operations have been conducted in this region since 2007. Incidental mortality is considered insignificant, probably only 1-3 belugas per year.

The population trend is unknown. Habitat and other concerns include potential competition with fishermen, increasing ship traffic, and reduced ice period with global warming.

***Discussion***

There is large uncertainty around the abundance estimate, which is based on expert opinion from about 15 years ago (founded on an opportunistic survey in about 2002). The current expert opinion is that abundance has been stable for the last 15 years, but there have not been any surveys.

Although the level of exploitation of the Anadyr stock is low (fewer than 10 animals removed per year), a more rigorous baseline abundance estimate is needed given concerns regarding the potential for oil spills and the increasing ship traffic in the Bering Strait region.

***Status***

There was moderate concern for the Anadyr stock even though it is of moderate size and the level of exploitation is low. Concern centred on the lack of more rigorous abundance data and the potential impacts of increasing ship traffic, urban expansion, and associated noise and pollution.

## 4.7 Cook Inlet

Cook Inlet belugas (Annex 5) are typically concentrated near river mouths in upper Cook Inlet, Alaska (AK), during ice-free months (Rugh et al. 2010). The fall-winter-spring distribution of this stock is not fully determined; however, the whales in this population appear to inhabit upper Cook Inlet year-round (Hansen and Hubbard 1999, Rugh et al. 2004, Hobbs et al. 2005, Lammers et al. 2013, Shelden et al. 2015a, Castellote et al. 2015). This stock is geographically isolated from the nearest beluga stock in Bristol Bay (Laidre et al. 2000, Hobbs et al. 2005, Goetz et al. 2012a, Shelden et al. 2015a) and mitochondrial DNA shows it to be distinct from other stocks in Alaska (O'Corry-Crowe et al. 2002). Aerial surveys were conducted by NMFS each year from 1993 to 2012 (Rugh et al. 2000, 2005; Shelden et al. 2013) after which NMFS began biennial surveys in 2014 (Hobbs 2013, Shelden et al. 2015b). The June 2016 survey resulted in an estimate of 328 whales (CV=0.08; Shelden et al. 2017)). An unregulated subsistence hunt of these whales resulted in a documented, significant decline (47%) between 1994 and 1998 from 653 whales to 347 (Hobbs et al. 2000) at which time hunting was limited to just 1 or 2 whales per year and no hunt has been allowed since 2005 (Mahoney and Shelden 2000, NMFS 2016). During the period that the hunt has been limited, 1999 to 2016, the population has continued a declining trend of -0.4% per year (Shelden et al. 2017) indicating that other factors besides the unsustainable subsistence hunt are preventing the recovery of this stock.

The Cook Inlet stock is small, fewer than 350 whales, and stable or declining, with a 17-year (1999-2016) trend of -0.4% per year. This stock was designated as "depleted" under the US Marine Mammal Protection Act (MMPA) in May 2000 (65 FR 34590, May 21, 2000), and on October 22, 2008, NMFS listed Cook Inlet belugas (having defined the stock as a distinct population segment under the US Endangered Species Act (US ESA)) as "endangered" under the US ESA (73 FR 62919, October 22, 2008). Therefore, the Cook Inlet stock is considered "strategic" under the MMPA. NMFS completed a Recovery Plan for Cook Inlet Belugas in December 2016 (NMFS 2016).

Habitat concerns include shipping activity, competition with fisheries, anthropogenic noise, development, pollution and cumulative effects of multiple stressors. Effects of climate change with loss of winter ice cover, changes in prey base, and new parasites and diseases, are also of concern.

***Discussion***

There is an unusually high number of live-strandings in Cook Inlet. The large tidal heights (ca 9.2 m) can cause the whales to be stranded in the tidal cycles (Vos and Shelden 2005). There was an anecdotal report of a stranding of killer whales at the same time as a mass stranding of belugas, and the belief is that the belugas stranded while avoiding the killer whales. Predation by killer whales may be a significant source of mortality for Cook Inlet belugas (Vos and Shelden 2005, Burek-Huntington et al. 2015). Most killer whales in the inlet are the fish-eating ecotype, although mammal-eating killer whales also appear from time to time.

The recovery goal of the harvest plan, which would allow limited hunting if the population was greater than 350 animals (and met other criteria including a high probability of recovering to 780 whales by 2099), was considered too low by some meeting participants (i.e., the plan states that hunting can continue once this level is reached). This number (350) was originally designated because of the desire to continue the cultural practices of beluga hunting and use of products as soon as possible, and it was believed that if the population reached 350, it would be an increasing population able to sustain a small harvest. This number of 350 was chosen before the population had been designated as endangered under the Endangered Species Act (US-ESA).

Waste from the city of Anchorage (the largest city in AK, ca 250,000 people) requires only "primary treatment" (removal of solids) before being discharged into Cook Inlet (Norman et al. 2015). In addition, de-icer from the Anchorage airport flows directly into the Inlet (Norman et al. 2015). The large tidal flow in Cook Inlet may substantially dilute the sewage and de-icer in 2 tidal cycles, however this probably applies only to the main parts of Cook Inlet and not smaller offshoots such as Knik Arm, Turnagain Arm, etc., which are parts of the designated beluga "critical habitat" (Moore et al. 2000, Lowry et al. 2006, Hobbs et al. 2015b, Norman et al. 2015). Additionally, these sources are continuous so although they are likely flushed out, they are replaced by subsequent outfall (Norman et al. 2015). In addition, there have been no studies of sediment composition and deposition processes in the Inlet. Studies in the 1990s showed that Cook Inlet belugas had low levels of contaminants in their tissues compared to belugas in other parts of Alaska (with the exception of elevated copper levels in the kidneys), but there have been no more recent studies (Norman et al. 2015).

In addition to possible contaminants and infectious agents, this stock is subjected to a large amount of disturbance from human activities (shipping, aircraft noise, oil and gas development, commercial and sport fishing etc.), much of which occurs within the designated "critical habitat." A gas leak that began in December 2016 and was ongoing at the time of the meeting, could not be repaired until the Inlet was ice-free (DeMarban 2017), and is a cautionary example of the risks of oil and gas development in an ice-covered area where belugas are present.

***Status***

This very small population continues to decline (-0.4%/yr). It is subject to many anthropogenic stressors, which may have a cumulative negative impact, and this may explain the lack of recovery. Therefore, the meeting expressed a high level of concern for this stock.

## 4.8 Eastern Bering Sea

Eastern Bering Sea belugas (Annex 6) aggregate near the mouth of the Yukon River and in Norton Sound in western Alaska throughout the summer (Lowry et al. 2017). During the autumn as ice forms, they move farther offshore to wintering areas west of the Kuskokwim River Delta and east of Saint Matthew Island in the western Bering Sea (Citta et al. 2017). In stock structure studies of mtDNA, these belugas were found to be genetically distinct from adjacent stocks (O'Corry-Crowe et al. 1997, 2002; Brown-Gladden et al. 1997, Meschersky et al. 2008).

An aerial survey was flown across Norton Sound and adjacent to the Yukon River Delta in 2000 (Lowry et al. 2017). The resulting population estimate was 6,994 (CI= 3,162-15,472) whales. No previous surveys are available for assessing trend.

Belugas from this stock are an important subsistence resource for at least 21 villages in western Alaska. From 2007 to 2016, an average of 190 belugas were landed per year (not including struck and lost). There are several commercial fisheries in State of Alaska and Federal waters that have the potential to catch belugas incidentally, but no such catches have been reported. However, at least one beluga is known to have been taken in a subsistence fishing net. Based on the population estimate from 2000, the PBR for this stock is 103, which is considerably lower than the reported catches in subsistence hunts. Despite this, the harvest has been judged by US authorities to be sustainable because the 2000 survey estimate is thought to be biased low and because local and traditional knowledge indicate that there has not been any decrease in abundance. Nonetheless, an updated population estimate is needed.

There are concerns about how belugas may be impacted by climate change, commercial shipping, and commercial fishing. It is not clear how they will respond to the rapid changes now occurring but there is some evidence that they have a great deal of flexibility to deal with at least some of the changes.

The hunting of Eastern Bering Sea belugas is co-managed by the Alaska Beluga Whale Committee and the US National Marine Fisheries Service. This co-management has resulted in improved availability and understanding of the information (i.e., population estimates, harvest levels, and various measures of health) that is needed to make sound management decisions.

***Discussion***

The single abundance estimate for this stock is believed to be negatively biased due to 1) the use of an availability bias correction (2.0) that was considered conservative, 2) survey coverage that did not include some offshore and in river areas where belugas are known to occur, and 3) some of the survey effort took place in sea states greater than Beaufort 3 which likely decreased the sighting rate. A new abundance survey was planned for 2017.

Although the harvest level is above the PBR, no risk assessment has been conducted. Noteworthy is that struck and lost belugas are not accounted for in the harvest numbers. Also, while 21 communities report takes other communities may hunt belugas and not be reporting. Thus, this take level is likely biased low.

***Status***

This is a moderate-sized stock; however, the abundance estimate is 17 years old, and no information is available on trend. Given the harvest levels and the outdated abundance estimate, this stock is of moderate concern. The new estimate expected from the planned survey in 2017 should be helpful in reassessing the status of this stock.

## 4.9 Bristol Bay

Belugas of the Bristol Bay stock (Annex 7) are typically found in Nushagak and Kvichak bays and tributaries in the east end of Bristol Bay during the summer (Frost et al. 1984, 1985, Lowry et al. 2008, Citta et al. 2016) and range widely in the northern and eastern region of Bristol Bay in the winter (Citta et al. 2016). Satellite telemetry studies indicate that Bristol Bay belugas remain in the greater Bristol Bay region throughout the year (e.g., Citta et al. 2016, 2017).

MtDNA analyses support the idea that Bristol Bay belugas are distinct from other stocks that summer or winter in the Bering Sea. Satellite tagging and a comparison of mtDNA from whales in Nushagak and Kvichak bays found no indication of population substructure within Bristol Bay (O'Corry-Crowe et al. 1997, 2002; Muto et al. 2016).

Aerial surveys were conducted periodically between 1993 and 2016 and the estimate of abundance for Bristol Bay belugas in 2016 was 2,040 (CV =0.22, 95% CI=1,541-2,702), $N_{min}$ = 1,809 (Lowry et al. 2008, Alaska Beluga Whale Committee (ABWC) unpublished data). The trend in abundance estimated from the uncorrected aerial survey counts was 4.8% per year over the 12-year period from 1993-2005. The recent survey gave an estimate similar to 2005, suggesting that the population was stable.

An abundance estimate using genetic mark-recapture from repeated annual biopsy surveys over the period 2002-2011 estimated 1,928 belugas (95% CI = 1,611-2,337; Citta et al. in review). This method is known to be biased low but provides a verification of the aerial survey abundance.

Data on Alaska Native subsistence harvests within Bristol Bay since 1987 indicate that over the last ten years (2007-2016; Frost and Suydam 2010, ABWC unpublished data), the annual harvest averaged 23 belugas (95% CL = 21–25). Fishery by-catch is not well documented. A PBR of 43 belugas (1,809 × 0.024 × 1.0) was calculated for this population, nearly twice the current annual reported subsistence harvest, which however is not adjusted to account for struck-and-lost ($\bar{x}$ = 23/yr).

Habitat and other concerns include loss of sea ice and climate warming, fisheries by-catch, oil and gas development, and mining.

***Discussion***

The genetic mark-recapture estimate and the survey estimates are in general agreement. The aerial survey estimate is the most recent, but concern was expressed regarding the analysis methods. The aerial survey abundance estimate presented at the meeting was based on the largest of repeated survey counts, the GROM recommended using the average of all the counts because the correction factors are intended to represent average dive behaviour. The abundance from the 2016 survey has since been revised to be based on the average of all of the survey counts. The abundance estimate from the genetic mark-recapture also is lower due to changes in the analysis in response to reviewer comments.

This population is considered medium-sized, with a trend that appears to be stable (and may be increasing). The removals by hunting and by-catch appear to be sustainable, and there are no major habitat concerns. There is a large salmon fishery in Bristol Bay, and while there is little by-catch or conflict, the fishery occurs in areas where belugas feed and also further offshore, and commercial fishermen and belugas target the same species (e.g., red salmon). This area has only small human communities (Dillingham with a population of 2400, and others a few 100's at most), but there are plans for more development (e.g., gold mining has been proposed).

***Status***

The Bristol Bay stock is a medium sized stock, and is one of the most data-rich, with a time series of credible abundance and trend estimates and reliable data on removals. Therefore, concern for this stock is low.

## 4.10 Eastern Chukchi Sea

Eastern Chukchi Sea belugas (Annex 8) aggregate along Kasegaluk Lagoon in northwestern Alaska in late June and early July (Frost et al. 1993). During summer, they occur in the Beaufort Sea and Arctic Ocean and can venture to as far north as 81°N, but regularly use the continental slope. They migrate south into the Bering Sea in autumn and spend the winter between Saint Lawrence Island and the Chukotka Peninsula. In studies of mtDNA, these belugas were found to be genetically distinct from other stocks in the B-C-B region (O'Corry-Crowe et al. 1997, 2002; Brown-Gladden et al. 1997, Meschersky et al. 2008). Previously, it was believed that the belugas in Kotzebue Sound in mid-June migrated north to near Kasegaluk Lagoon and that the whales in these two locations belonged to the same stock. Genetic data from tissue samples obtained during the late 1970s and early 1980s showed that the animals from the two areas were actually from different stocks (O'Corry-Crowe et al. 2016).

Numbers of belugas in Kotzebue Sound declined markedly in the mid-1980s. The small number of animals sampled for genetics in Kotzebue Sound since the 1990s may have come from the Eastern Beaufort Sea stock.

A recent abundance estimate from aerial surveys flown in 2012 estimated the stock size at 20,675 (CV=0.66) animals (Lowry et al. 2017), including correction for animals outside the survey area and below the surface based on satellite tag data. The previous abundance estimate from 1992 was 3,710, but it was negatively biased as it included only belugas seen near shore. Therefore, no information is available on population trend.

Belugas from this stock are an important subsistence resource for several villages in northern Alaska, especially Point Lay and Wainwright. From 2007 to 2016, an average of 57 belugas was harvested (i.e. landed) annually by these two villages (ABWC, unpublished data). No interactions with commercial fisheries have been documented or are suspected. Some animals are caught in subsistence fishing nets, but they are reported as part of the harvest, which is considered sustainable. The PBR set using the 2012 population estimate suggests that removal of 249 belugas per year would be sustainable, and this is well above the current harvest level.

Concerns about habitat include possible impacts from climate change, commercial shipping, oil and gas activities, scientific studies, and tourism. Commercial activities, scientific studies on a wide variety of topics, and tourism have increased as sea ice has diminished due to climate change. It is not clear how belugas will respond to the rapid changes now occurring but there is some evidence that they have some flexibility and therefore might manage to deal with the changes (Laidre et al. 2008, Heide-Jørgensen et al. 2010a).

***Discussion***

The group discussed whether there might be one segment of the population that comes close to shore and is therefore more susceptible to harvest. It appears that most or all of the stock moves to nearshore waters to moult. This occurs over a 2 to 4 weeks time period with groups of belugas moving between nearshore and offshore habitats. They do not seem to be coming to shore to feed as most that are harvested rarely have prey in their stomachs.

The group discussed whether there is one segment of the population that comes close to shore and is therefore more susceptible to harvest. This is unlikely as it appears from satellite telemetry that individual whales repeatedly move towards the shelf break and then back inshore. It is likely that they are coming inshore to moult, as whales that are caught rarely have any stomach contents.

***Status***

There are no previous abundance estimates that would allow assessment of trend, but this relatively large stock is thought to be stable, and the small number of removals is likely sustainable. Therefore, there is a low level of concern for the Eastern Chukchi stock.

### 4.11 Eastern Beaufort Sea

Belugas of the Eastern Beaufort Sea (EBS) stock (Annex 9) summer in the Beaufort Sea (see Richard et al. 2001a, Harwood et al. 2014a, Norton and Harwood, 1985, Harwood and Kingsley 2013, Citta et al. 2017), and over-winter in the Bering Sea (Citta et al. 2017). Mitochondrial DNA analyses of samples from harvested belugas identified EBS belugas as distinct from other western Arctic stocks (Alaska and Russia), and from central and eastern Canadian Arctic stocks, most likely due to maternally directed annual philopatry to the Beaufort Sea region (O'Corry-Crowe et al. 1997, Brown Gladden et al. 1997, O'Corry-Crowe et al. 2002). Additional analyses of nuclear DNA microsatellite loci indicated that there is some interbreeding with other stocks within the Bering Sea beluga population that also includes the Bristol Bay, eastern Bering (Norton Sound), and eastern Chukchi (Point Lay) stocks around Alaska (Brown Galdden et al. 1999, Postma and Frasier in prep).

The only large-scale effort to estimate abundance of the EBS stock was an aerial survey conducted in 1992, resulting in a near-surface abundance estimate of 19,629 (CV=0.229; Harwood et al. 1996), corrected to 39,258 to account for availability bias (Allen and Angliss 2015). The 1992 survey, however, did not sample the complete summer range of the stock, and is therefore considered to be negatively biased.

There has been a long history of beluga hunting by the Inuvialuit and their ancestors in the western Canadian Arctic, and by the Iñupiat in Alaska (Harwood et al. 2002). Based on annual harvest numbers reported by Canada and the USA, the mean estimated subsistence take (landed plus struck and lost) from the EBS stock between 1987 and 2015 was 164 whales (See Table 1 in Annex 9 for list of data sources), which is well below the PBR of 487 (using a recovery factor of 0.75, given that the survey estimate is outdated). Although the population trajectory for this stock is unknown, the annual harvest is well below the PBR level. However, size-at-age of belugas landed in the Mackenzie Delta has declined from 1989 and 2008. The subtle changes in growth of belugas over the time series may reflect ecosystem changes that have reduced the availability or quality and quantity of their prey (Harwood et al. 2014b).

***Discussion***

The EBS stock is hunted by the Inuvialuit during the summer in the Mackenzie River estuary and by the Iñupiat in Alaska during the spring migration (see Item 4.11.1).

The estimated total of direct removals by hunting prior to 2000 was 186/yr (DFO 2000), which includes a correction for struck/lost; the catch was strongly biased toward males comprising 60-80% of the removals. This assessment concluded that annual harvest was considered to be far below the level which might negatively affect the population.

Harvest levels have been declining since 1980. There is some evidence of a decline in body length at age which might signify nutritional stress.

Evidence of trends in this stock is inconclusive and will remain so until more surveys have been done.

***Status***

This is a very large stock (although the most recent abundance estimate is 25 years old); the trend is unknown but there is no evidence to suggest that the stock is declining. The level of removals appears low relative to the stock's size and the concern level is low.

Migrating belugas taken in spring in Chukotka were generally considered in the assessment of the large EBS stock.

### 4.11.1 Inuvialuit Settlement Region

Gerald Inglangasuk presented information from the six communities in the Inuvialuit Final Agreement (IFA) area along the eastern Beaufort Sea of Canada who hunt belugas. Co-management is practiced under the IFA which created the Joint Fisheries Management Committee (FJMC), composed of two Inuvialuit and two Federal government representatives appointed by the Minister of Fisheries.

The Inuvialuit harvest between 2010 and 2015 averaged 90 belugas per year. Harvest data for the region are relatively complete going back to the 1970s. Back in the 1980s belugas were taken only in the Delta whereas currently they are harvested by hunters from all six communities. The FJMC conducts a harvest monitoring program.

Tourism guidelines and a multi-agency action plan have been developed by the Habitat Research Program for dealing with beluga entrapments in the Eskimo Lakes (often caused by strong onshore winds in July).

The Alaska and Inuvialuit Beluga Whale Committee (AIBWC) was formed in 1988 following the 'model' of the Alaska Eskimo Whaling Commission. The AIBWC provided hunters in both countries with a good mechanism for information sharing (an 'early warning system'). Because their concerns were specific to only one B-C-B stock, the Inuvialuit withdrew from the AIBWC (which became the ABWC) in 1995, and since then harvest from the Eastern Beaufort Sea stock has been managed by an Inuvialuit/Inupiat agreement between the North Slope Borough (Alaska) and the Inuvialuit Game Council (Canada).

There is concern in the region (Northwest Passage) about the impacts of cruise ship and other ship traffic, including for research (by researchers from many nations not only US and Canada), as it may drive belugas (and narwhals) into or through narrow passages. Some belugas (and narwhals) that occur in the central Arctic may not be adequately considered in the current stock assessments (i.e. they have 'fallen through the cracks').

***Discussion***

The exceptionally low struck/lost rate in the hunt in Canada (6%) can be explained by the fact that there is a local by-law requiring that hunters harpoon whales before shooting them. Also, Inglangasuk noted that hunters are required to select for males and avoid killing females and young whales. Suydam pointed out that during spring migration at Point Hope, belugas are normally shot first and then harpooned because a hunter was pulled from the ice edge into the water and drowned after becoming entangled in a harpoon line. That event discouraged hunters at Point Hope from harpooning first.

## 4.12 Eastern High Arctic – Baffin Bay (Somerset Island) and West Greenland

Belugas in the Eastern High Arctic-Baffin Bay stock (Annex 10) consist of aggregations summering in the Canadian High Arctic Archipelago, and, to a minor extent, in Smith Sound. Telemetry information has shown that the stock is divided in winter into a portion that resides in the North Water polynya and a larger portion that resides in coastal ice-free areas along the Baffin Bay sea ice edge in West Greenland (Doidge and Finley 1993, Heide-Jørgensen and Laidre 2004). In summer, groups that presumably are matrilineal return to the same summer aggregation areas located in estuaries, inlets, and small bays around Somerset Island in the Canadian Arctic Archipelago (Koski and Davis, 1980; Smith and Martin, 1994). Specific locations include Radstock Bay, Maxwell Bay, and Crocker Bay on Devon Island; Cunningham Inlet, Creswell Bay, and Elwin Bay on Somerset Island, and Coningham Bay on east Prince of Wales Island.

Abundance on the summering grounds was estimated by an aerial survey in 1996 to be 21,213 belugas (95% CI 10,985 to 32,619; Innes et al. 2002). This is the only estimate for this population and should be updated. A recent (2012) abundance estimate, which refers only to belugas that winter in West Greenland was 9,072 whales (95% CI 4,895 to 16,815; Heide-Jørgensen et al. 2016). Although the population trajectory can be interpreted as suggesting an increasing population, the stock as a whole is still considered depleted. Data on past commercial whaling of this stock are being summarized for use in a revised estimate of the pre-commercial whaling population size.

The belugas that summer in Nunavut are hunted in Nunavut by a number of communities and then by communities in Greenland when the whales winter close to the west coast. Canada does not hunt many belugas from this population, ca. 100/year, relative to the winter Greenlandic hunt of about 300 beluga/year. Harvest within Canada and Greenland has declined recently (non-quota and quota harvest in Canada and Greenland, respectively; NAMMCO 2017) suggesting that the population should be growing. In total the harvest is considered sustainable; however, the pristine, pre-commercial harvesting stock abundance was estimated to have been at least twice the current population abundance, based on modelling efforts that are now 25 years old (Innes and Stewart 2002).

There are few habitat concerns for this population other than climate change effects that may influence the carrying capacity. Recent loss of winter sea ice in Baffin Bay has reduced access to this population by Greenlandic hunters in winter (Heide-Jørgensen et al. 2010a). Continued ice loss may reduce the carrying capacity of this population depending on the adaptability of beluga to change their summer and winter aggregation sites and migration timing.

***Discussion***

Surveys flown in summer 2015 did not cover most of the estuaries where this stock is known to occur at that time of year, and therefore no new abundance estimate is available. The main concern for management of this stock is how to determine which portion of the harvest in West Greenland is from the Eastern High Arctic-Baffin Bay (Somerset Island) stock.

Some modelling efforts have led to the suggestion that carrying capacity has increased, although the mechanism that would have caused such increase is unknown. More information is needed about areas that are important for foraging, especially in Baffin Bay, as prey populations may have changed. For example, Atlantic cod (*Gadus morhua*) were important prey of belugas during the "cod invasions" in West Greenland in the 1920s but their importance as prey declined with the disappearance of cod in this region (Degerbøl and Nielsen 1930). It is unknown if the recent increase in cod abundance in West Greenland has benefitted the belugas. Additionally, capelin (*Mallotus villosus*) are increasing in Cumberland Sound and off Labrador (Rose and Rowe 2015), and this may represent a new food resource for Baffin Bay belugas.

There are habitat concerns related to the Baffinland Mary River Mine project (NAMMCO 2017), which has proposed to use ice breaking in winter and spring to resupply the mine and transport iron ore. The implications of this activity for belugas migrating through Lancaster Sound are unclear at present.

Another uncertainty is the stock affinity of belugas in Foxe Basin that may overlap in range with Somerset Island belugas at least during the summer.

***Status***

It is not clear whether the abundance of the Somerset Island stock is stable or increasing, although winter surveys off West Greenland indicate an increase since the imposition of catch limits, and continued population growth is projected (Heide-Jørgensen et al. 2017). This is a large stock (possibly 20,000 animals) and removals are considered sustainable, so the level of concern for this stock is low.

## 4.13 Western Hudson Bay

Western Hudson Bay (WHB) belugas (Annex 11) overwinter in Hudson Strait (Turgeon et al. 2012). Their summer distribution is centred around the Seal, Churchill, and Nelson River estuaries, although belugas occur along the entire west coast of Hudson Bay. The distribution of WHB belugas overlaps that of the Eastern Hudson Bay (EHB) stock during the spring and fall migrations and on the wintering grounds in Hudson Strait (COSEWIC 2004). WHB belugas are genetically more diverse than other Canadian beluga stocks but are genetically distinct from the neighbouring EHB stock (de March and Postma 2003).

WHB beluga abundance was estimated using data from visual and photographic aerial surveys in 1987, 2004, and 2015 (Richard et al. 1990, Richard 2005, Matthews et al. 2017). The most recent estimate (adjusted for availability bias) is 54,473 (cv = 0.098; CI = 44,988–65,957). Notably, this estimate excludes the coast of Ontario, where ~14,800 belugas were estimated during the 2004 survey.

The average annual harvest of WHB belugas by communities around Hudson Bay and Hudson Strait from 1977 to 2015 was 503 (range 252-784, including struck and lost; Hammill et al. 2017). This harvest level is well below the PBR of 1,004 as calculated using the most recent abundance estimate and a recovery factor of 1. The WHB beluga stock is large and the similar near-surface counts during aerial surveys conducted in 2004 and 2015 suggest that the size of this stock is stable.

***Discussion***

The abundance estimates are biased low because there are areas with belugas farther to the north and outside of the area where aerial surveys were conducted. There are some genetic samples from belugas that summer outside the core areas that are surveyed. The genetic results suggest that those belugas are most similar to WHB belugas. It was pointed out that some belugas tagged in Hudson Bay have ventured into what has been called a "donut hole" in the middle of the bay, where most distribution maps indicate that belugas do not occur. Apparently, they do move into this area, at least during migration.

Ship traffic is a concern. About 2,000-3,000 belugas occur in the Churchill River Estuary where the port of Churchill is located, and shipping that connects communities along the west coast of Hudson Bay occurs throughout the main summer aggregation areas. Icebreaking in Hudson Strait, where the WHB and EHB belugas overwinter, is also a concern for these stocks. Hydroelectric development affecting seasonal river discharge rates into estuaries frequented by belugas in summer is an additional concern.

***Status***
There is low concern for this stock because the stock is large and stable, and the harvest appears sustainable.

## 4.14 James Bay

The James Bay (JB) stock (Annex 12) apparently occurs in the James Bay area year-round (Bailleul et al. 2012). Twelve animals tagged in the southeastern part of the bay showed no evidence of directional long-distance migration. Genetic analysis confirmed that JB belugas are distinct from the other stocks in Hudson Bay (Postma et al. 2012). However, the differentiation is weak, suggesting recent divergence.

Seven visual surveys conducted from 1985 to 2015 demonstrated the occurrence of large groups of belugas in the north-western part of James Bay (Gosselin et al. 2017). Belugas are also seen along the Ontario coast to the west of James Bay but the stock affinities of these individuals are unknown. The abundance estimates from aerial surveys suggest an increase in the population size, however large inter-annual variability in the survey results suggests that there is an influx of animals, possibly from the Ontario coast, in some years. The aerial survey in 2015 resulted in an estimate of 10,615 (CV=0.25) which is used as the current estimate for the James Bay stock (Gosselin et al. 2017).

No assessment of trends in abundance was attempted from survey data because of concerns about the inter-annual variability, possibly related to influxes of animals from other Hudson Bay stocks.

There was a limited commercial hunt for JB belugas in the 19$^{th}$ century but this lasted only a few years, and there was also a limited hunt from some Cree communities (Reeves and Michell 1989). Since the early 2000s, management plans have encouraged Inuit from Nunavik to harvest belugas in James Bay to reduce the pressure on the endangered EHB stock (see section 4.15). However, the Inuit hunting in James Bay has removed only ~10 whales/year due to the large distance of the whales from the nearest community.

The PBR is set at 173 individuals using a recovery factor of 1. While there is no major concern about this relatively large stock that is exposed to little hunting pressure, knowledge about the stock is limited. Hunters have observed belugas in winter along the southern Belcher Islands, indicating potential northward movement of JB animals during this season. The impact of changes in the hydrological cycle in the JB habitat caused by hydroelectric development is unknown.

***Discussion***
It was generally agreed that JB belugas should be considered as a separate stock although there is some uncertainty due to the fact that all belugas tagged to date in James Bay have been on the eastern side and therefore there is no information on the movement patterns of whales on the western side. The suggestion was made during discussion that the habitat in James Bay for belugas may be improving with the decrease in sea ice, possibly because of increased primary productivity.

The wide variation in abundance estimates and the possible influxes of belugas from other stocks are concerns for assessing trend. The population dynamics model presented in the stock review assumed that all surveyed belugas were from the James Bay stock and it gave rather wide uncertainty regarding the trend in abundance and carrying capacity for this stock. Development of a population model that considers that in some survey years belugas from other Hudson Bay stocks are present in the survey area would be useful, however, efforts to determine the stock affiliation(s) of the belugas in northwestern James Bay would be needed to resolve this issue.

***Status***
There is low concern for this stock because it appears to be fairly large despite the uncertainty about which animals are being surveyed in James Bay at times. Additionally, the harvest numbers are low.

## 4.15 Eastern Hudson Bay

In summer, the EHB beluga stock (Annex 13) occupies an area bounded by the Hudson Bay arc in the east extending westward to 60 km west of the Belcher Islands. Satellite telemetry tracking of belugas showed that this stock does not mix with other stocks in Hudson Bay during the summer (Lewis et al. 2009) but moves into Hudson Strait and the Labrador Sea during the fall and winter, where the animals mix with belugas from the WHB stock (Lewis et al. 2009; Hammill 2013). Genetic analysis showed that EHB and WHB belugas are from the same breeding population, however, maternally transmitted migration patterns limit mixing of summering aggregations (Turgeon et al. 2012, Colbeck et al. 2012).

Abundance estimates obtained from seven surveys conducted between 1985 and 2015 (Gosselin et al. 2017) suggest that the EHB stock's size has remained stable. The current abundance estimate is 3,819 animals (CV=0.43); Gosselin et al. 2017). Even though the intensity of commercial hunting lessened in the 1870s, by which time beluga numbers in the Little Whale and Great Whale River estuaries had declined sharply (Reeves and Mitchell 1989), subsistence harvesting continued and probably limited the recovery potential of the EHB stock. Harvest limits and seasonal closures were not implemented until the 1980s, and the EHB area was closed to hunting from 2001 to 2006. Harvesting resumed in 2007 but the Nastapoka and Little Whale River estuaries remained closed.

The beluga sampling program in northern Quebec, which has been operating since 1995, allows samples to be collected from approximately 30% of the belugas landed. Genetic mixture analysis uses those samples to define the proportions of EHB and WHB belugas taken in the various hunts, both spatially and temporally. These proportions are used to determine catch limits for each community and each hunting period. Also, based on those proportions, an average of 63 EHB belugas per year (landed catch) were taken during the last 3-year (2014-2016) management plan.

A population dynamics model incorporating information on removals, proportions of each stock in the catch, and aerial survey estimates of abundance suggests that the EHB stock declined between 1974 and 2001 and then increased slightly (3,078 to 3,408) until 2016 (Hammill et al. 2017). The recent apparent increase or stabilization of the population may have been due to the efforts to focus the harvesting in Hudson Strait where EHB animals represent a lower proportion of the animals hunted. Harvest limits were set by the Nunavik Marine Region Wildlife Board using an objective of a maximum 50% probability of population decline over a 10-year period, corresponding to a maximum harvest (landed catch) of 67 animals/year. The objective for the new management plan has yet to be defined.

Genetic analysis has revealed the summer presence of belugas around the Belcher Islands that may come from one or more stocks other than the EHB stock (Mosnier et al. 2017). However, waters around the Belcher Islands are included in the summering area overflown during the aerial surveys conducted to estimate abundance and obviously EHB belugas cannot be distinguished from others, which means there is potential for the size of the EHB stock to be overestimated.

***<u>Discussion</u>***

The harvest of belugas in winter at Sanikiluaq, where recent catch levels appear to be higher than in the past, may include ice-entrapped whales. It is not clear from genetic analyses whether the winter-harvested animals are from only the EHB stock, from only another stock, or from a mixture of stocks.

Concern was expressed regarding the management objective of achieving a probability of 50% or less of population decline over a 10-year period. Although this management objective appears to be maintaining a stable population, meeting participants commented that it provides little flexibility for quick response in the event of a population decline, makes no allowance for errors in allocation of harvested animals to the appropriate stock, and fails to incorporate a margin of precaution to ensure population recovery (in keeping with a central feature of the PBR approach).

Icebreaking activities in Hudson Strait during winter and spring to meet the transportation needs of remote mines are cause for concern. Additionally, hydroelectric dams in the Great Whale and La Grande river drainages may have impacts on belugas, as large volumes of fresh water are released into Hudson Bay and James Bay during winter due to the high demand for electricity in that season. The freshwater plumes from these discharges change the nature of the sea ice in the estuaries and coastal areas, making it much less pliable or friable and thus more difficult for the whales to gain or maintain access to air. The freshwater plume from the Great Whale River may also affect those belugas (if any) from James Bay that overwinter near the Belcher Islands.

***Status***
There was considerable discussion both during the meeting, and via email correspondence after the meeting, over the concern level for the EHB stock, therefore the stock was given a concern of high/moderate (1/2). While it is medium-sized and appears to be stable or slowly increasing, the abundance estimates from surveys may include animals from multiple stocks. If this were true, it would confound conclusions regarding abundance, harvest apportionment, and sustainability of harvest. Additional information is needed on the stock identity of belugas observed during the aerial surveys used for abundance estimation. Besides the harvest, the possible impacts of icebreaking activities in Hudson Strait and of the flux in freshwater flow into the belugas' nearshore habitat in eastern Hudson Bay caused by the hydroelectric project in the Great Whale River drainage are concerns.

## 4.16 Ungava Bay

Sizeable annual estuarine aggregations of belugas occurred in southern and western Ungava Bay (Annex 14) until the end of the 19th century, by which time commercial hunting had caused a severe decline in numbers (Boulva 1981, Finley et al. 1982). Subsistence hunting continued until the late 20th century when regional hunting closures came into effect. Based on commercial catch data, this stock numbered ~1,900 individuals in the 1800s (DFO 2005) and catches and direct observations in the 1960s and 1970s suggested that only a few hundred belugas were still present in the region. A quota system was implemented in 1986 and the Mucalic River estuary was closed to hunting (Lesage et al. 2001).

Five aerial surveys were conducted between 1982 and 2008, and no belugas were seen on-transect in the surveys after 1985 (Smith and Hammill 1986; Hammill et al. 2004, Gosselin et al. 2009). Off-transect observations in 1993 suggested that there were far fewer than 200 individuals in the region (Kingsley 2000). In 2012, a mean estimate of abundance based on the last 4 surveys was 32 belugas (95% CI 0-94; Doniol-Valcroze and Hammill 2012).

No trend can be estimated from the currently available data. There are still occasional sightings in the area of the Mucalic estuary and the Whale River; however, there is no information on the frequency of use of these areas by belugas, and no recent estimate of abundance or genetic information is available to help assess the status of this stock.

***Discussion***
Very little is known about this stock of belugas and it may be extirpated. The occasional sightings during the summer in Ungava Bay and nearby parts of Hudson Strait raise questions about whether they are of animals from the Ungava Bay stock. No genetic material from the whales that historically congregated in the Ungava Bay estuaries is known to be available, thus it is not possible to make comparisons with (1) neighbouring stocks or (2) recent samples collected from belugas in Ungava Bay should they become available. The possibility may exist to extract DNA from old tissue or bone samples, but it is not clear how thoroughly this possibility has been explored. Aerial surveys have been flown since 1992 but no belugas have been seen on transect. However, whales have been seen off transect on some surveys. Flying additional surveys would not be cost-effective until more is known about Ungava Bay belugas or until there are signs that the stock may be recovering.

***Status***
There is high concern about this stock because it is extremely small and is possibly extirpated.

## 4.17 Cumberland Sound

Cumberland Sound (CS) belugas (Annex 15) are restricted to Cumberland Sound, with a large aggregation occupying Clearwater Fiord during the summer months (Richard and Stewart 2008). Aerial surveys of the summer range, however, have found up to ~50-60% of the total abundance estimate occurred in the northern portion of Cumberland Sound outside of Clearwater Fiord (Richard 2013, Marcoux et al. 2016).

Genetics and contaminant analyses show CS belugas to be distinct from other Canadian beluga stocks, including belugas harvested in other southeastern Baffin Island communities (Brown-Gladden et al. 1997, de March et al. 2002, de March et al. 2004, Turgeon et al. 2012). Inuit traditional knowledge, however, indicates that there is more than one type of beluga found within Cumberland Sound, with differences noted in body size and shape, coloration, and the taste of the skin (mattaq; Kilabuk 1998).

Nine aerial surveys of the CS beluga stock's range were conducted between 1980 and 2014 (Richard and Orr 1986, Richard 1991a, 2013, Marcoux et al. 2016), and the most recent abundance estimate was 1,151 (CV=0.21; Marcoux et al. 2016). Direct comparisons among surveys to assess trends is not possible because the earlier surveys focused only on Clearwater Fiord and may therefore be negatively biased. A population model fit to the survey data (1990-2014) and the reported harvest data (1960-2015, landings only) indicated a declining population with a current abundance of ~1,000 animals (Marcoux and Hammill 2016). Using the modelled CS beluga abundance and a recovery factor of 0.5, which DFO has used as a standard in the past for populations assessed by COSEWIC as 'threatened', the PBR for this stock was set at 7 whales (Marcoux and Hammill 2016).

***Discussion***

This stock has been previously considered migratory, but belugas seem to remain in Cumberland Sound throughout the year and there was general agreement that this stock is non-migratory.

The stock was depleted by commercial hunting in the 1800s and early 1900s. The results of population modelling based on aerial survey results and available information on removals (Marcoux and Hammill 2016) have proven difficult to interpret. For example, the model generates a 30% chance of decline in abundance even if there is no harvest. It was agreed that the model results in this case are not reliable to inform management. Local people acknowledge that there has been a decline in beluga numbers but they believe that this was mostly due to commercial hunting. Interestingly, blubber cortisol levels are higher for CS belugas than for other stocks, but it is not clear why (Trana 2014).

Another aerial survey was planned for July-August 2017. Regular meetings are held between managers and users from the communities surrounding Cumberland Sound to share and discuss information on the stock and the catch limits.

***Status***

The CS stock is small in both numbers and range, it is believed to be declining, and recent harvest levels are considered unsustainable. For those reasons the concern level is high.

## 4.18 St Lawrence Estuary

The current distribution of the St Lawrence Estuary (SLE) beluga stock (Annex 16) represents a fraction of its historical range (see Mosnier et al. 2010 for a review). This population can be differentiated using both nuclear and mtDNA markers (Brown Gladden et al. 1997, 1999; de March and Postma 2003). Significant ongoing immigration is considered unlikely. The belugas sighted occasionally along the south coast of Labrador and off Newfoundland have proven to be from the Arctic or have been of uncertain origin (DFO, unpublished data).

Eight aerial photographic surveys conducted between 1988 and 2009 were used to estimate abundance. More recently, a large number of visual aerial surveys (38 surveys between 2001 and 2016) were used to produce another time-series of abundance estimates. An age-structured population model that incorporates abundance estimates from aerial photographic surveys along with information on proportion of young and number of deaths documented through carcass monitoring was used to estimate the 2012 population size at 889 (Mosnier et al. 2015).

The SLE beluga population was severely depleted by a sustained hunt from the late 1800s to the mid-1900s, and hunting was finally prohibited in 1979 (Reeves and Mitchell 1984). From 1983, a carcass monitoring program (reviewed in Lesage et al. 2014) documented 472 deaths, 222 of which were investigated through necropsies. From the 222 carcasses that were necropsied, it was estimated that 5% of the mortality was related to human activities (Lair et al. 2016).

A model using the catch history suggested that the SLE beluga population numbered 5,000 to 10,000 individuals in the 1800s but only 1,000 in the late 1970s. As recently as 2007 the population was considered stable (Hammill et al 2007), but subsequent carcass monitoring showed an increase in mortality of young-of-the-year and in perinatal mortality of adult females. This triggered a detailed review of the stock's status in 2013 (DFO 2014). The population model in Mosnier et al. (2015) suggested a period of relative stability until 1999, followed by a period of demographic instability (2000-2012) including peaks of high neonatal mortality interspersed with peaks of high pregnancy rates. The current view is that the population was stable or increasing very slowly (0.13%/year) until 2000, then declined (~-1%/year) until 2012, with a population of 889 individuals in 2012. Using this estimate and a recovery factor of 0.1 (for an endangered species or population) resulted in a PBR of one.

SLE belugas live in one of North America's major commercial waterways, which means they are exposed to elevated sound levels (McQuinn et al. 2011; Gervaise et al. 2012) and the risk of ship strikes in some parts of their range. Whale-watching tourism sometimes targets belugas (Ménard et al. 2014) and this is regarded as an additional source of potential disturbance, particularly in calving and nursing areas. The SLE beluga stock is also exposed to numerous contaminants due to the highly industrialized nature of the St Lawrence watershed (DFO 2012a). While the prevalence of some contaminants such as PCBs seems to have declined, that of others such as PBDEs has increased or remained high. Although the effects of contaminants on belugas are difficult to demonstrate conclusively, impacts on reproduction, offspring development, and immune system function have been shown in other mammals (Martineau et al. 2010; Lair et al. 2016). Environmental perturbations such as recurrent harmful algal blooms are suspected to be affecting SLE belugas as well. For example, a bloom in 2008 was implicated in the deaths of seven animals (both adults and calves) in one week (Scarratt et al. 2014). Moreover, a study combining several physical and biological indices indicated that the quality of beluga habitat has been relatively poor since the late 1990s and may have worsened since 2009 (Plourde et al. 2014).

***Discussion***

There appears to be considerable inter-annual variation in reproductive output in SLE belugas, and it was noted that high levels of certain contaminants can act as endocrine disruptors. Also, it was suggested that the variable rates of pregnancy and calf mortality may be related to cumulative impacts from several environmental stressors. For example, harmful algal blooms in combination with other stressors, such as contaminants, may affect belugas in some years, whereas in other less stressful years, reproduction may improve. Cancer rates in this population were previously reported to be high but recent evidence suggests that the rate has declined, and the timing corresponds to a decline in environmental PCB levels.

Concerns were expressed regarding potential impacts of whale-watching activities that target belugas. These activities are not permitted within designated beluga critical habitat, but no restrictions apply outside it. Therefore, unregulated whale-watching may contribute to cumulative impacts on SLE belugas.

***Status***

The SLE beluga population is small and it has been declining in recent years. There is a high level of concern for this stock because of its small size, declining trend, and chronic exposure to relatively intensive industrial and other commercial activity within much of its habitat.

## 4.19 Southwest Greenland (extirpated)

The Southwest Greenland beluga stock, which is effectively extirpated, migrated south in autumn, arrived in Nuuk between October–December, and went at least as far south as Qeqertarsuatsiaat (Fiskenæsset). [Editor's note: There is no "Status Review Annex" available for this stock.] However, belugas were also frequent visitors in South Greenland in the 19$^{th}$ century, which has been confirmed from reports and catch statistics. Large numbers were also seen in winter in fjords between 61°N and 63°N, although the main distribution was farther north in Nuuk and Maniitsoq. The northward migration started in February and the last individuals had left the southern districts by June or July (Winge 1902; Møller 1928, 1964). Degerbøl & Nielsen (1930) mentioned another pulse of migrating whales arriving in South Greenland in December. These were apparently fatter and in better condition and had fresh bullet wounds. It is possible that these animals were of Canadian origin.

There were large catches of belugas in Greenland from the middle and late 1800s until the late 1920s. The largest catches (up to 1500 individuals in a single year) were in Maniitsoq, but Nuuk also had large catches. The season of catches in Nuuk was mainly in spring and early summer. In the 20$^{th}$ century the whales were caught by netting and driving. In Maniitsoq, driving started in 1917. The cumulative catch in Maniitsoq between 1917-1930 was 8,000-10,000 belugas. During this time, most of the catches were of whales on their southward migration, contrary to previous catches that had been mainly of animals on their northward migration. Møller (1928) stated that the occurrence of belugas in Godthåb Fjord changed dramatically and after 1920 they left the fjord earlier in the spring and were caught only occasionally. A decline in catches was evident during the late 1920s. Following this decline, local people in Greenland referred to a change in the timing of migration of belugas from Uummannaq and Upernavik district. Other local people claimed that the disappearance of belugas from Nuuk and Maniitsoq was due to changes in sea temperatures after 1926.

The hypothesis that there was a connection between the 'extinct' stock of belugas in Southwest Greenland and the Cumberland Sound stock in Canada could be investigated further with DNA from museum specimens.

***Status***

This stock was likely extirpated more than 80 years ago.

## 4.20 Svalbard

A study of genetic differences between the belugas around Svalbard (Annex 17) and those in West Greenland revealed limited gene flow over ecological time (O'Corry-Crowe et al. 2010). The same study suggested that Svalbard and Beaufort Sea belugas diverged 7,600-35,000 years ago, but experienced recurrent periods with gene flow since then, most likely via the Russian Arctic during warm periods.

Telemetry data show that Svalbard belugas are extremely coastal in their distribution during the ice-free seasons. They spend most of their time close to glacier fronts, and when they move from one front to another they do so in an apparently directed and rapid manner very close to shore (Lydersen et al. 2001). When sea ice forms in the winter, the whales are "pushed" offshore but still stay in the Svalbard area, often occupying areas with more than 90% ice cover (Lydersen et al. 2002). A multi-species cetacean survey in the marginal ice zone north of Svalbard during August 2015 detected no belugas in this area; only bowhead whales and narwhals (Vacquié-Garcia et al. 2017). However, during the same time period belugas were observed (as is normal) along the coast of Svalbard, further documenting the lack of affiliation with sea ice for this whale species in Svalbard during summer.

There is no abundance estimate or trend information from this area, and the status of this stock is unknown. It is classified as Data Deficient on the Norwegian Red List. A first-ever survey is planned for July-August 2018. Belugas in Svalbard have been totally protected since the 1960's, with no removals allowed. Prior to being given protected status, they were heavily hunted by commercial operations and were certainly depleted at the time when protection came into place.

The impacts of climate change on sea ice conditions, prey base composition, competition from more boreal marine mammal species, and exposure to parasites and diseases are a general concern. Levels of some pollutants in belugas from Svalbard are very high and for many compounds higher than what are found in polar bears in the area (Andersen et al. 2001, 2006, Villanger et al. 2011, Wolkers et al. 2004, 2006). These levels are in many cases also higher than what has been shown to affect the physiology and especially the immune systems of laboratory animals.

A diet study based on analyses of fatty acids in the blubber of Svalbard belugas found the composition to be most similar to that of polar cod (*Boreogadus saida*; Dahl et al. 2000).

***Discussion***

There was no significant discussion.

***Status***

There was moderate concern about this stock because of the lack of information (specifically on abundance, though this was expected to change soon following the planned 2018 survey), the high levels of pollutants, and the possible impacts from climate change.

## 4.21 Barents-Kara-Laptev Seas

The information on belugas from the Barents, Kara and Laptev seas (Franz Josef Land, Ob Gulf, Yenisey Gulf and southwestern Laptev Sea) presented in previous assessments (IWC 2000, Belikov and Boltunov 2002, Boltunov and Belikov 2002) was based primarily on opportunistic observations and expert opinions, which were not always reliable and are now outdated. [Editor's note: There is no "Status Review Annex" available for this stock.] Sightings data from 2001-2016 came mostly from opportunistic observation during oil/gas exploration, tourist cruises, and scientific expeditions. Based on this information, belugas are thought to concentrate in summer mostly in the estuaries of large rivers (Ob, Yenisey) and in the waters of the archipelagos (Franz Josef Land, south of Novaya Zemlya, Severnaya Zemlya). Satellite tracking of one individual tagged in the north-eastern Ob Gulf (Kara Sea) demonstrated that during the summer and autumn months beluga mostly stayed in shallow coastal waters. No data are available on seasonal migratory routes. Most of the recent observations of belugas in winter were recorded in the Kara Sea. The winter distribution likely depends at least partly on ice conditions (polynyas and ice cracks) which in turn could be influenced by the intensive ice-breaker traffic, and consequently, an increased observation effort, in certain areas.

Analysis of mtDNA from 16 harvested or beached belugas from the Kara and western Laptev Seas revealed the same haplotypes as found in Svalbard belugas. However, the number of genetic samples of belugas from the Russian Arctic is too small to make any conclusions on stock structure. It is likely that there are several different beluga stocks tied to the major bays, estuaries, and archipelago waters (e.g., Franz Josef Land).

Major anthropogenic threats include oil/gas (Barents and Kara seas) and military (all seas) activities, increasing vessel traffic (oil/gas fleet, tourism, military vessel traffic, shipping on the Northern Sea Route), and chemical and radioactive contamination from river discharge.

***Discussion***

The meeting concluded that there is not enough information to delineate stocks in the western and central Russian Arctic except within the White Sea (see item 6.22 below). Belugas appear to have a broad distribution across the entire region, likely at low densities in many areas, with concentrations around Franz Josef Land and in some river mouths. There is no information on current abundance and trends, genetic difference between groups, etc., but the stocks in this region may have been depleted by historical commercial whaling. Although stock structure within the region is likely to exist, it will be difficult to delineate stocks without additional information.

There is no information to suggest a link between belugas in this area to Svalbard belugas other than sharing some haplotypes. Information from tagged belugas in Svalbard indicates that this population is independent from the Siberian population.

The quotas set by Russian authorities for allowable removals of belugas in this region are reportedly based on information from prior to 1995, and no more recent information on abundance (or catch levels) is available.

There are concerns that considerable development and shipping activity in the region is increasing, with potentially significant impacts on belugas. There may also be increased military activity in the region.

***Status***

The concern level is high for belugas in this region in part because of how little is known about, e.g. stock structure, current abundance (numbers may be depleted), and removals, and in part because of the rapid increase in development and other human activity as the climate across the Northern Sea Route becomes less forbidding to navigation.

## 4.22 White Sea

Data on distribution and movements (stationary coastal observations, ship-based and aerial surveys, satellite tracking) suggest that belugas in the White Sea (Annex 18) form a resident population which may comprise several stocks (Chernetskiy et al. 2002, Andrianov et al. 2009, Alekseeva et al. 2012, Glazov et al., 2010, Svetochev and Svetocheva, 2012, Glazov et al. 2012, Kuznetsova et al. 2016). Field observations indicate that White Sea belugas occur in discrete summer nursery aggregations associated with major bays: Onezhsky, Dvinskoy and Mezen'sky. However, more data are necessary to understand population structure in greater detail.

Data on White Sea beluga abundance in different seasons were obtained from aerial surveys conducted in 2005 – 2011. The lowest (minimum) summer abundance estimate from these surveys was more than 5,000 animals (Glazov et al. 2008, 2010a,b). The winter (March) estimates were 3.5-4 times lower than the July estimates in the corresponding years. Reports on earlier surveys do not contain enough information on survey design, analysis methods and area coverage to enable comparison of the results and assess population trends. The estimates from the 6 surveys conducted from 2005-2011 show a slight decline within this period, but the general pattern is variable from year to year.

In recent years, belugas were occasionally live-captured in the Varzuga river mouth for scientific research and 'cultural display' purposes (exact numbers are unavailable, but usually not more than 5-6 during capture operations). No information is available on illegal killing of belugas by local people. If this occurs at all, it probably does not exceed several whales in a year. The total allowed take of belugas in the White Sea, issued annually by the Ministry of Agriculture, has been 50 for at least the last 5 years. No information is available on incidental mortality.

Habitat and other concerns include direct disturbance of nursery aggregations by tour boats and other boat traffic, conflict with salmon fishermen, coastal oil storage bases and oil transport, pollution mostly from discharge from the Severnaya Dvina River. No official status at the state level is assigned to this stock but the general expert opinion of Russian scientists is that the White Sea stock should be closely monitored due to the increasing human activity and high pollution levels in the region. Certain resident nursery groups of belugas, especially the one near Bolshoy Solovetsky Island (Solovetskoe local aggregation), require special protection.

***Discussion***

Although the IWC review in 1999 listed 3 stocks of belugas in the White Sea, and subsequent notes and publications have recognised up to 8 different aggregations (Chernetskiy et al. 2002), the participants in this meeting concluded that although the White Sea stock likely consists of several nursery aggregations, but that more data are needed to determine whether, and how, these should be separated. Genetic studies have detected differences between belugas in the Varzuga River estuary and Onezhysky Bay (Meschersky et al. in prep.), but these differences are not significant due to the small sample sizes. Additionally, researchers in the area note that there is movement between the bays, and that these belugas all appear to remain in the White Sea throughout the winter. The relationship of White Sea belugas to those around Svalbard is unknown.

***Status***

The White Sea stock appears to be stable, but overall it is of moderate concern. The main reasons are the insufficiency of data (specifically the uncertainty around stock structure) and habitat concerns related to pollution (especially discharge from the Severnaya Dvina River), ship traffic (one of the major ports for the Northern Sea Route traffic is Arkhangelsk), and tourist activities.

## 5. NARWHALS

### Introduction to narwhals

Narwhal distribution is centred within the Atlantic Arctic. Narwhals are most numerous in the eastern Canadian Arctic and along the west coast of Greenland but are also found in lower densities in East Greenland and the northern parts of the Svalbard and Franz Josef Land archipelagos. There are rare sightings outside this range, particularly in both High Arctic Russian and Alaskan waters (see distribution map, Figure 2). Narwhals are mostly migratory, and closely associated with the seasonal distribution of sea ice.

Narwhals have remarkably low levels of genetic diversity based on mtDNA (Palsbøll et al. 1997), a condition which may date back 50,000 years (Garde 2011). The low levels of genetic variability in populations in Greenland and Canada suggest a bottleneck in 'recent' history (Palsbøll et al. 1997). Studies using ancient DNA to determine when this bottleneck occurred, and to infer the reasons behind it are on-going. While it is possible to distinguish different populations of narwhals on a broad scale (e.g., Baffin Bay vs. East Greenland), it is currently not possible, due to the lack of genetic diversity, to tease apart stocks on smaller scales (e.g., to differentiate separate stocks within Baffin Bay). New genomic sequencing techniques may be used for this purpose in the future (see Item 3.1.1).

Stable isotope analyses on carbon ($\delta$13C) and nitrogen ($\delta$15N) found the three narwhal populations of Baffin Bay, Northern Hudson Bay and East Greenland to have distinct stable isotope values, suggesting that these populations are feeding on different prey (Watt et al. 2013).

Narwhals are migratory, and the concept of "summer aggregation" has been used as the primary basis for identifying separate stocks, particularly in Baffin Bay (Heide-Jørgensen et al. 2013). The meeting recognized 12 stocks of narwhals (Figure 2, Tables 1-3), and a comparison of this list with those from previous reviews is presented in Table 4.

Extralimital sightings, or what may be changes in narwhal distribution and movements in response to changing environmental conditions, were discussed. Observations have become more frequent in recent years in the Inuvialuit Settlement Area of the eastern Beaufort Sea, which is further west than the normal distribution of the closest stock, the High Arctic-Baffin Bay (Somerset Island) stock. In addition, there have been a few scattered sightings in eastern Siberia, and along the north coasts of Chukotka (including a few tusks found) and Alaska. It is unknown whether narwhals sighted in these latter areas are from the population centred further west – what is referred to here as the Svalbard-Russian High Arctic stock.

**Introduction to Baffin Bay narwhals**
Narwhals in Baffin Bay are divided into 8 stocks, or summer aggregations, that migrate between, and are susceptible to hunting in, Greenland and Canada. These stocks are: Somerset Island, Eclipse Sound, Admiralty Inlet, Eastern Baffin Island, Jones Sound, Smith Sound, Inglefield Bredning, and Melville Bay. A bilateral management body, the Canada/Greenland Joint Commission on the Conservation and Management of Narwhal and Beluga (JCNB), is responsible for managing the exploitation and ensuring conservation of these narwhals. The JCNB Scientific Working Group meets jointly with the NAMMCO Scientific Committee Working Group on the Population Status of Narwhal and Beluga in the North Atlantic. The NAMMCO-JCNB Joint Scientific Working Group has developed a "catch-allocation model" to assign the catches of narwhals by different hunting communities in Canada and Greenland to stocks (NAMMCO 2015). The model is based on information on narwhal migrations/movements (e.g. satellite tracking, TEK, expert knowledge) and on where the hunting occurs.

***Discussion***
It was noted that this type of model requires a population dynamics model for each summering aggregation, but many of the Baffin Bay summer aggregations have just one abundance estimate. In these cases, a modified form of PBR is applied *ad hoc* when there is a lack of information.

Hunting loss (often termed 'struck and lost') is implemented in the model for a given hunt by adjusting the catches by either an estimate of the struck-and-lost rate in that hunt (if available) or a general estimate. Struck-and-lost can also be incorporated as a prior into the modelling.

The model results can help determine where more research, e.g. satellite tagging, is needed. The model can be used to test for sensitivity to things like sample size in the case of tagging.

The ability to assign individuals to their appropriate summer aggregation via genetic data would greatly improve the input data for the model.

## 5.1 Somerset Island

The stock identity of the Somerset Island narwhal stock (Annex 19) is based on consistent summer aggregation reported in TEK, telemetry tracking, aerial surveys, genetics and stable isotopes. Satellite-tagged narwhals remain in the region during summer and return there after spending the winter (Heide-

Jørgensen et al. 2003) in an area of Baffin Bay slightly north of where other summer aggregations spend the winter (Heide-Jørgensen et al. 2003, Dietz et al. 2008). The Somerset Island stock is the largest narwhal stock in both area of distribution and number of whales. The summering area includes Prince Regent Inlet and the Gulf of Boothia, Peel Sound, Barrow Strait, and northern Foxe Basin, and in recent years the summer distribution has occasionally extended further west to the Cambridge Bay area. There is some genetic support for delineation of this stock (Petersen et al. 2011) and stable isotope values from skin samples of whales harvested in the region differ from some of the other Baffin Bay whales hunted in other regions, suggesting a degree of separation based on foraging (Watt et al. 2012a).

The most recent (2013) abundance estimate for this stock is 49,768 (CV=0.20; estimate adjusted for perception and availability bias; Doniol-Valcroze et al. 2015). This stock, or portions thereof, has been surveyed in 1981, 1984, 1996, 2002-2004 and 2013 with variable coverage, and a trend based on four surveys conducted with the primary goal of assessing abundance over the past 30 years suggests an increasing stock (NAMMCO 2015, Witting 2016).

This stock is hunted primarily in Canada on the summering grounds in the central Canadian Arctic by the communities of Gjoa Haven, Hall Beach, Igloolik, Kugaaruk, Resolute & Creswell Bay, and Taloyoak (Heide-Jørgensen et al. 2013); however, there are opportunities for hunters from other communities to hunt these whales on their migration to and from the summering grounds in Nunavut and on the wintering grounds in Greenland (see below; NAMMCO 2015). The current Canadian quota is set at 532 for this stock, based on the abundance estimate from the 2002 survey; whereas a new quota recommendation (which has not yet been implemented) based on the 2013 aerial survey results is 658. The annual take (including struck-and-lost values determined for open-water hunting) in the summer region during 1970-2015 ranged from 0 to 220 whales.

The stock is hunted on the wintering grounds in Greenland where 97% of the hunt in Uummannaq (yearly quota=61) in November is believed to be from the Somerset Island stock. Since the official catch reporting began in 1949 and before narwhal catch limits were introduced at Uumannnaq in 2004, hunters in Greenland took up to 1,000 animals in some years (e.g., 1990).

Although abundance estimates vary across surveys, the Somerset stock is considered stable, if not increasing, and current removals are considered sustainable (NAMMCO 2015).

***Discussion***

This stock is the largest narwhal stock, numbering around 100,000 animals. The summer distribution can be extremely variable, depending on pack ice movements as narwhals with young calves show a strong preference for staying near the ice. It was also noted that given the vast total summer range of narwhals in the Canadian Arctic, this stock may be subdivided as more becomes known.

Removals from this and other stocks in the Baffin Bay population are managed according to the JCNB–NAMMCO catch allocation model and are likely sustainable (NAMMCO 2015). Although Uummannaq has been subject to a quota since 2004, attention is still needed there to documentation and reduction of struck/lost rates. Also, substantial numbers of animals from this stock are taken in the floe edge and ice crack hunts at Pond Inlet and Arctic Bay which can have relatively high associated loss rates.

There is no definitive evidence of a trend, but the stock is generally thought to be either stable or increasing slightly.

In recent years, because of reduced sea ice (possibly exacerbated by icebreaking) narwhals presumed to be from this stock have been appearing more regularly and in larger numbers in settlements to the west of Somerset Island. This has required reallocation of the quota tags used to control and monitor removals by Canadian hunters. According to residents of the Gulf of Boothia region (Kugaruuk – formerly Pelly Bay) whose communities were formerly supplied by aircraft, in recent years icebreaking to enable ship navigation to replace airborne resupply has meant that narwhals are appearing there more regularly than in the past.

***Status***
Although removals are significant, they appear to be well below what can be sustained given the apparent size of the stock. There are environmental concerns related to the loss of sea ice, icebreaking, and development in some areas. Overall, there is a low level of concern for this stock.

## 5.2 Jones Sound

Narwhals from Jones Sound (Annex 20) are considered to be a distinct stock as they appear to be genetically distinguishable from other Canadian stocks, and from narwhals sampled in Inglefield Bredning, Greenland (Petersen et al. 2011), the geographically nearest stock. Additionally, organochlorine contaminant profiles in whales sampled in Grise Fiord, which are believed to be from the Jones Sound stock, were notably different from those in whales sampled in Pond Inlet (Eclipse Sound stock; de March and Stern 2003).

Little is known about movements/migration or dive behaviour of narwhals from Jones Sound since there have been no telemetry studies. Lee reported that narwhal hunters based from Grise Fiord have provided local knowledge on the narwhals frequenting this area. It is expected that this information will provide useful model input, contribute to survey design, and help in identifying important habitat areas (e.g. observations of newborn narwhals or of narwhals giving birth).

An aerial survey conducted in 2013 resulted in an abundance estimate for the Jones Sound stock of 12,694 (CV = 0.33) narwhals (Doniol-Valcroze et al. 2015). This is the only survey that has been conducted in the area, and therefore there is not enough information to determine a trend for this stock.

The Jones Sound stock is hunted primarily by the Inuit of Grise Fiord in summer (Heide-Jørgensen et al. 2013). A Total Allowable Landed Catch (TALC) recommendation of 40 has been in place since 2013, but the community has not been able to meet this quota as of 2016, and the removal levels have been low (less than 20 per year). Hunters from other communities (including communities in Greenland) have opportunities to hunt these whales along their migration route to and from the summering grounds, and on the wintering grounds. However, there is no satellite-tagging data from Jones Sound, and their migration corridors and wintering area is not known.

There are some habitat concerns, as changes in sea ice conditions may be resulting in changes to carrying capacity.

***Discussion***
The only current habitat concern for the Jones Sound stock is the loss of sea ice, although the potential development of a coal mine on northern Ellesmere Island was discussed in Canada several years ago. It is likely that additional development projects will occur in the area in the future as sea ice declines.

***Status***
The level of concern for this fairly large stock of around 12,000 animals, which is not heavily hunted, is low. There is little development in the area thus far, although this is likely to change as sea ice declines.

## 5.3 Smith Sound

Stock identity of the Smith Sound narwhals (Annex 21) is based on observations and catches of narwhals in Smith Sound during the summer. No tissue samples have been collected nor have any telemetry studies been carried out on narwhals in Smith Sound, and whether they are separate from narwhals in Inglefield Bredning remains uncertain.

An aerial survey conducted in 2013 resulted in an abundance estimate for the Smith Sound stock of 16,360 (CV=0.65) narwhals (Doniol-Valcroze et al. 2015). As this is the only survey of this area, there is not enough information to determine a trend.

Little is known about movements or the range of these narwhals. There has been only one tagging attempt on a male from the ice edge at Renselaer Bay on the Greenland side of Smith Sound. The tracking lasted three days but demonstrated movement across Smith Sound as the whale moved to Cape D'Urville on the Canadian side (DFO, unpublished data).

No communities in Canada are known to hunt narwhals from the Smith Sound stock, however this stock is hunted by Greenlandic hunters from Qaanaaq. A TALC of 77/yr was recommended in Canada based on the abundance estimate from the 2013 survey. The current quota for narwhals taken from the Smith Sound stock in Greenland (Etah hunting region) is 5 animals per year.

There is a small amount of development in the area, and always the possibility of future interest in further development.

***Discussion***
In the complete absence of sampling and analysis, there is no basis for establishing whether the Smith Sound stock can or cannot be genetically differentiated from other Canadian stocks and the Inglefield Bredning stock. This is a stock of moderate size, at around 16,000.

***Status***
As with the Jones Sound stock, there is low concern for this fairly large stock that is subjected to little, if any, hunting.

## 5.4 Admiralty Inlet

The stock identity of narwhals in Admiralty Inlet (AI; Annex 22) is based on consistent summer aggregation reported in TEK, telemetry tracking, and aerial surveys. Satellite-tagged narwhals have remained in Admiralty Inlet during the summer and returned there after spending the winter in the Baffin Bay region (Dietz et al. 2008, Watt et al. 2012b). There is not strong genetic support for delineation of this stock, however, stable isotope values from skin samples of individual whales in Admiralty Inlet differed significantly from those of whales in other regions, indicating a degree of separation based on foraging tendencies (Watt et al. 2012a).

The most recent (2013) abundance estimate for this stock was 35,043 (CV=0.42; estimate adjusted for perception and availability bias; Doniol-Valcroze et al. 2015). Five surveys of the AI stock have been conducted over the past 30 years, indicating no significant change in abundance over time (Richard et al. 2010, Asselin and Richard 2011, Witting 2016).

The stock is hunted primarily by the community of Arctic Bay (Heide-Jørgensen et al. 2013); however, there are opportunities for hunters from other communities to hunt these whales on their migration to and from the summering grounds and on the wintering grounds (NAMMCO 2015, Witting 2016). While the current TALC for this stock is 233, the recommended TALC based on the 2013 aerial survey is 389 whales. The reported annual take (including struck and lost values applied for open-water hunting) from the summering grounds during 1970-2015 ranged from 32 to 276 whales. The stock is also hunted on the wintering grounds in Greenland where 2% of the hunt in Uummannaq (yearly quota=61) and 32% of the hunt in Disko Bay (yearly quota=108) are believed to be from the Admiralty Inlet stock (NAMMCO 2015).

The AI narwhal stock likely overlaps with the Eclipse Sound (ES) stock during summer, as the 2013 abundance estimate for AI went up by approximately the same number as the ES abundance estimate went down, and 4 of 12 narwhals tagged during summer in Eclipse Sound in 2010 and 2011 travelled into Admiralty Inlet in September/October of the same year (n = 3), or during the following summer (n = 1; Watt et al. 2012b). However, a precautionary approach has been used to minimize the risk of stock depletion and the whales in AI and ES continue to be managed as separate stocks pending stronger evidence in support of combining them into a single stock.

Ship traffic in Baffin Bay may affect this stock in its winter range. Although abundance estimates vary across surveys, the AI stock is considered to be stable, and current removals sustainable (NAMMCO 2015, Witting 2016).

***Discussion***
This is a shared stock, and animals are hunted in summer by Inuit from Arctic Bay and at the floe edge in spring by Inuit from Pond Inlet, and in Greenland in at least the Disko Bay area in the winter. Hunters

from Arctic Bay previously took many narwhals at the Admiralty Inlet floe edge, which included whales from both the Somerset Island and Admiralty Inlet stocks, but now much more of the Arctic Bay hunting occurs in summer, which means greater pressure on the Admiralty Inlet stock to supply the relatively large Arctic Bay quota.

The time series of abundance estimates suggests that this stock is relatively stable, although the estimates are quite variable across years (over 10,000 animals in difference) and have large confidence intervals.

There are concerns over increased disturbances in the summer habitat, at a level not seen even five years ago, with the combination of disturbance from freighters, cruise ships and supply vessels. However, closure of the Nanisivik lead-zinc mine in 2002 may have resulted in lessened icebreaking activity in and immediately outside the Inlet.

***Status***

In spite of the habitat concerns related to shipping and icebreaking, the concern level for this stock is low because of its relatively large size and the assumption that removal levels are sustainable.

## 5.5 Eclipse Sound

The stock identity of Eclipse Sound narwhals (Annex 23) is supported by telemetry studies which show that most narwhals tagged in Eclipse Sound stay there during the summer (Dietz et al. 2001, Heide-Jørgensen et al. 2002, Watt et al. 2012b). However, as discussed above, 4 out of 12 narwhals tagged in Eclipse Sound during summer moved into neighbouring Admiralty Inlet in late summer, and one whale tagged in Eclipse Sound returned the following year to Admiralty Inlet after overwintering in Baffin Bay (Watt et al. 2012b).

The most recent (2013) abundance estimate for this stock was 10,489 with a CV of 0.24 (Doniol-Valcroze et al. 2015). With only two surveys of the ES stock, a trend in abundance cannot be determined. In Canada, the stock is hunted primarily by the community of Pond Inlet (Heide-Jørgensen et al. 2013); however, there are opportunities for hunters from other communities in both Canada and Greenland to hunt ES narwhals on their migration to and from the summering grounds, and on the wintering grounds (NAMMCO 2015, Witting 2016). The current Canadian TALC is set at 236 for this stock, although a new TALC of 134 was recommended (but has not yet been implemented) based on the 2013 aerial survey results. The reported annual take (including struck and lost) by Pond Inlet hunters from 1970-2015 ranged from 41-256. As such, this does not include takes from communities outside of the summer range.

The stock is hunted on the wintering grounds in Greenland where 1% of the hunt in Uummannaq (yearly quota=61) and 52% of the hunt in Disko Bay (yearly quota=108) are believed to be from the ES stock (NAMMCO 2015).

As noted in the section above, the summer and autumn range of ES and AI narwhals apparently overlaps. The ES stock abundance declined in 2013 by approximately the same amount as the AI abundance estimate declined (Richard et al. 2010, DFO 2012b; Doniol-Valcroze et al. 2015). In addition, 4 of 12 narwhals tagged in Eclipse Sound in 2010 and 2011 travelled into Admiralty Inlet in late summer/early autumn (September/October; Watt et al. 2012b). Eclipse Sound has been identified as an important area for narwhal calving (Mathewson 2016), and increased shipping and icebreaker traffic associated with resource development are potential threats to this stock on both its summer and winter range.

***Discussion***

Telemetry results and the summer residency of narwhals in Eclipse Sound constitute the basis for distinguishing the Eclipse Sound and Admiralty Inlet stocks. There is some movement of animals between these two summering areas, including the ‘switching’ from Eclipse Sound the first year to Admiralty Inlet the next year by the one whale whose tag continued transmitting long enough to monitor its return northward migration after being tagged in Eclipse Sound in summer. Inuit in the area strongly believe that two different kinds of narwhals that differ in appearance visit Eclipse Sound. Additional telemetry work is therefore important to clarify movement patterns.

Like the SI and AI stocks, animals from this stock are subject to hunting at the Lancaster Sound floe edge in spring (by hunters from Pond Inlet) and in West Greenland in winter.

There are multiple environmental concerns for this stock. Narwhals are hunted intensively in summer in Eclipse Sound, and, in addition, they are exposed to heavy and increasing traffic by large vessels traveling to and from the Baffinland-Mary River iron mine and by cruise ships. Pond Inlet has long been a favourite destination for tourists and tour activity is increasing. The increased vessel traffic, with up to 112 vessels observed in summer 2015, may have significant impacts on the behaviour and distribution of the whales in this important summering ground, with temporary changes in distribution already having been observed.

***Status***
Although a trend in abundance cannot be determined, this stock appears to be stable at around 10,000 narwhals and removals are considered sustainable. However, there is considerable uncertainty about the abundance estimates and some uncertainty about stock differentiation (vs the Admiralty Inlet stock). A major and growing concern is ship traffic related to the Baffinland-Mary River iron mine and tourism. Overall, the Eclipse Sound stock of narwhals is of moderate concern.

### 5.6 Inglefield Bredning
Identity of the Inglefield Bredning narwhal stock (Annex 24) is based on consistent summer aggregation, aerial survey results, local knowledge and hunting patterns. Migration patterns for this stock are unknown but a portion of the whales that winter in the North Water polynya (NOW) could be the same narwhals that summer in Inglefield Bredning. An aerial survey conducted in April 2014 resulted in an estimate of 3,059 narwhals (95 % CI 1,760–5,316) wintering in the eastern part of the NOW (Heide-Jørgensen et al. 2016).

Genetic differences have been found between Melville Bay narwhals and narwhals from the Avernersuaq district which includes Inglefield Bredning (Palsbøll et al. 1997). Hence little gene flow is occurring between the Inglefield Bredning and Melville Bay stocks.

The most recent abundance estimate for the Inglefield Bredning stock was 8,368 (cv=0.25; 95% CI 5,209-13,442) from a visual aerial line transect survey conducted in 2007 (Heide-Jørgensen et al. 2010b). The distribution of narwhals in Inglefield Bredning is in good agreement with what was documented during aerial surveys in 1985–1986 and 2001– 2002 (Born et al. 1994; Heide-Jørgensen 2004).

Abundance estimates have been stable for this population over time. The estimated trajectory for the stock comes from a population dynamics model based on a Bayesian framework that is age- and sex-structured (Witting 2016). According to the model, the Inglefield Bredning stock is depleted to below its Maximum Sustainable Yield Level (MSYL), indicating that future harvest levels should be set to ensure an increasing number of narwhals.

The stock is hunted in the Qaanaaq region during April-September (by hunters from the communities of Qaanaaq, Qeqertat, and possibly Siorapaluk). Quotas are set on the basis of the JCNB – NAMMCO catch allocation model (NAMMCO 2015). In the municipality of Qaanaaq, local hunting rules require the attachment of hand-harpoons on the whales before they can be shot. This reduces the loss rate considerably. A loss rate of 5% is arbitrarily applied to the catches to account for both whales that are killed-but-lost and calves that lose their mothers.

The total allowable take for the Inglefield Bredning stock is 98 individuals per year (2015-2020) with 70% probability of a larger population size in 2020.

Concerns include changes in the sea ice regime, ship traffic, seismic surveys and competition with fisheries for halibut.

***Discussion***
The stock appears stable, but there are several environmental concerns, as mentioned in the above, and the modelled depletion level is also a concern.

***Status***
This is a moderate-sized, apparently stable stock. Current removal levels that are considered sustainable. Overall, the concern level for this stock is low, assuming no major change in human activities in the region.

## 5.7 Melville Bay

Stock identity of narwhals in Melville Bay (Annex 25) is based on consistent summer aggregation, telemetry tracking, genetics, aerial surveys and local knowledge and hunting patterns. The most recent (2014) abundance estimate for this stock was 3,091 (cv=0.50; 95% CI 1,228-7,783; Hansen et al. 2015). The estimate was corrected for both perception and availability bias. The correction factor for at-surface availability was based on monitoring of five tagged whales from August-September in Melville Bay ($a$=0.22; $cv$=0.09).

Animals in this stock are hunted primarily by communities in the Upernavik region during July-October but are also exposed to hunting in Uummannaq during November-May and Disko Bay during December-April. Quotas were first implemented in 2004 and are set on the basis of the JCNB – NAMMCO catch allocation model (NAMMCO 2015).

For Greenland overall, it is assumed that a struck-and-lost correction factor of 1.30 covers both the open-water hunt and the hunt from ice cracks and the ice edge (for the Melville Bay-Upernavik area a factor of 1.15 is used). Catches of Melville Bay narwhals, however, are made in both the municipality of Qaanaaq and in Upernavik. Roughly half of the narwhals taken in Upernavik and Melville Bay are taken under the harpoon-first requirement (5% loss rate) and the other half is taken in ice edge and open water situations where the loss rate is higher (Heide-Jørgensen and Hansen 2015).

The Melville Bay stock is considered depleted to below MSYL, implying that future removal levels should be set to ensure an increasing number of narwhals. The estimated total allowable take for the Melville Bay stock is 84 individuals per year (in the period 2015-2020) with 70% probability for a larger population size in 2020 (NAMMCO 2015).

The greatest concern for this stock is that removals in the Upernavik hunting region exceed levels recommended by the NAMMCO-JCNB JWG. Other concerns include changes in the sea ice regime, ship traffic, seismic exploration and commercial fishing of halibut in central Baffin Bay.

***Discussion***
The abundance of Melville Bay narwhals appears fairly stable. The hunt allocation is likely sustainable, but quotas set by Greenland do not follow the advice of the NAMMCO-JCNB JWG.

The main concerns are increased halibut fishing, possible over-harvesting, and the possible resumption of seismic survey activities in Baffin Bay. During 2012-2014 there was extensive seismic survey activity in the summering area of this stock. Observational studies during those years suggested that habitat use by narwhals was affected, but estimated numbers pre- and post-seismic did not differ significantly.

***Status***
There is a high level of concern for this stock. Although the abundance appears to be fairly stable, the stock is small and likely overexploited (i.e., catches above recommended quotas), and it is subject to multiple potential threats besides hunting (e.g., disturbance from seismic surveys, ice-breaking in winter).

## 5.8 Eastern Baffin Island

The delineation of Eastern Baffin Island narwhals (Annex 26) as a separate stock is based mainly on the consistent summer aggregation reported in traditional knowledge. No tagging studies have been carried out on narwhals in eastern Baffin Island. Although there is no genetic support for the recognition of this stock, organochlorine contaminant (de March and Stern 2003) and stable isotope profiles (Watt et al. 2012a) for the whales in eastern Baffin Island differ significantly from those of other narwhal stocks.

This stock has been surveyed twice: in 2003 yielding an abundance estimate of 10,073 ± 3,487 and in 2013 yielding an estimate of 17,555 ± 0.35 (both adjusted for availability and perception bias; Doniol-Valcroze et al. 2015). It is not possible to determine a trend from these data. The stock is hunted primarily by the Canadian communities of Clyde River and Qikitarjuak in the summer (Heide-Jørgensen et al. 2013). Removal levels in these two communities are low, about 130 landed per year since 2000: However, the communities hunt primarily in autumn when narwhal from other stocks are migrating along the Baffin Island coastline making it difficult to know which stock is being harvested (NAMMCO 2015). Other communities may hunt Eastern Baffin Island whales on their migration to and from the summering grounds and on the wintering grounds which are presumably in Baffin Bay-Davis Strait making them available for hunting in Greenland in winter (NAMMCO 2015). However, no narwhals have been tagged in the EBI region and therefore it is not possible to determine which communities hunt them or where they go in winter. The stock is quite large with no major conservation concerns at this time, however there is relatively little information available to inform stock assessment.

***Discussion***

This moderate-sized stock's status is uncertain in a number of ways. In the absence of satellite tracking studies, it is not known how much movement there is between the various fjords along the Baffin Island coast, and the animals' wintering range is unknown. Different groups of narwhals may affiliate with different fjords, and therefore as more becomes known, this stock may require subdivision.

Although recent catch levels appear to have been sustainable and relatively constant (97 to 183 landed, 2000-2015), there is considerable uncertainty about stock structure. The current TALC is set at 122, but annual catches have been about 160 (using a 1.23 S/L correction factor). The new TALC recommendation based on the 2013 aerial survey result is 206. The stock is thought to be available to Greenland hunters for part of the year even though there is no direct evidence of movement between eastern Baffin Island and Greenland.

If, as is assumed, the whales use central Baffin Bay in winter, they may be affected there by icebreaker activity. Also, with climate change the fjords may become less suitable as summering habitat for the whales. Lee reported that communities in Nunavut have expressed concerns about the effects of seismic survey activities off the east coast of Baffin Island on marine mammals, and especially narwhal.

***Status***

Although the Eastern Baffin Island stock is fairly large and removals relatively low, there is moderate concern for the stock. These concerns relate mainly to the lack of data on movements and stock structure, and the possibility several stocks, rather than only one, inhabit the region in summer.

## 5.9 Northern Hudson Bay

The Northern Hudson Bay (NHB) narwhal stock (Annex 27) is considered distinct from the other narwhal stocks based on genetic differences (de March and Postma 2003; Petersen et al. 2011), telemetry results (Westdal et al. 2010), and contaminant and biomarker profiles (de March and Stern 2003, Watt et al. 2012). This stock was surveyed in the early 1980s, 2000, and 2011 at different spatial scales, with different data collection methods (visual or photographic), and with different estimation procedures (whether perception and availability bias was accounted for or not; Richard 1991b). To provide comparability, the 2011 visual survey data were re-analysed using the methods of the visual surveys in 1982 and 2000. This yielded surface estimates of 1737 (95% CI: 1002-3011) in 1982, 1945 (95% CI: 1089-3471) in 2000, and 4452 (95% CI: 2707-7322) narwhals in 2011 (Asselin et al. 2012).

NHB narwhals are hunted in Cape Dorset, Chesterfield Inlet, Coral Harbour, Kimmirut, Rankin Inlet, Repulse Bay and Whale Cove (DFO unpublished data and Kingsley et al. 2013). Results of the earlier surveys raised concerns about the sustainability of harvest levels; however, the fully corrected abundance estimate from 2011 has allayed these concerns.

Modelling of the aerial survey data from the early 1980s, 2000, 2008, and 2011 using a stock dynamic model with Bayesian methods and using adjustments for different survey methods suggested a rate of increase of 1.2% per year and a population that could support a landed catch of no more than 75 narwhals per year (Kingsley et al. 2013). The considerable uncertainty about population trend and another survey is needed to corroborate the comparatively high abundance estimated obtained in 2011. Reported landings from this stock increased from an average of 21 (SD=8.6) whales per year over the period 1979-1998 to an average of 102 (SD=55) whales per year over the period 1999-2001, and then declined to 83 (SD=30) over the period 2002-2015. A Loss Rate Correction (LRC) of 1.28 has been used for this stock (Asselin et al. 2012). Using the estimated LRC =1.28 we have an average total removal of 106 per year for the period 2002-2015.

PBR is 201 animals. With the PBR value and a LRC of 1.28 a Total Allowable Landed Catch (TALC) for the Northern Hudson Bay narwhal stock is 157 narwhals (Asselin et al. 2012). With the average landed catch of 83 narwhal for the period 2002-2015 the removals are considered sustainable. However, this region is undergoing considerable environmental change due to climate warming and loss of sea ice as well as increases in human activity (mining, shipping) which may impact the future growth of this population.

***Discussion***

This stock is spatially separated from the Baffin Bay population in winter and summer. It may be found to consist of multiple stocks once more information becomes available.

Harvest monitoring in Canada is the responsibility of local Hunters and Trappers Organizations and the Repulse Bay narwhal hunt is generally regarded as one of the better-managed narwhal hunts. Hunters from Arviat often travel to the Repulse Bay area to catch narwhals. Repulse Bay has relatively strict bylaws concerning hunting practices (e.g. a harpoon-first requirement).

The loss of multiyear ice in this population’s summer range means that it is increasingly vulnerable to predation by killer whales. Another concern is that shipping, often including icebreaking, is increasing rapidly in Hudson Strait. Existing or planned mines in Baker Lake and Rankin Inlet require freight shipment and resupply vessels.

As the most southerly stock of narwhals in the world, the Northern Hudson Bay stock needs to be monitored closely for impacts of climate change.

***Status***

This is a fairly large stock of around 12,500 animals (assuming the 2011 estimate can be corroborated with another survey), with no clear evidence of a trend. The current level of hunting removals is considered sustainable. Although the loss of sea ice and concomitant increases in shipping and other industrial activities are of concern, overall concern for this stock is low.

## 5.10 East Greenland

The East Greenland stock of narwhals (Annex 28) occurs along the coast from about 64°N to 72°N. In summer, East Greenland narwhals are mainly found in particular fjords and bays, the most important being the Tasiilaq fjords (north of 65°N), Kangerlussuaq (fjord south of Scoresby Sound, 68°N), and Scoresby Sound (north of 70°N), although many smaller fjords also have narwhals in the summer (Heide-Jørgensen et al. 2010b, NAMMCO 2017; Editorial Note: The NAMMCO-JCNB Joint Scientific Working Group recognizes three management units in this area). Hunting takes place regularly only in Tasiilaq and Scoresby Sound, although narwhals in Kangerlussuaq have been hunted in the past and are still exploited occasionally.

Aerial surveys have only been conducted at the hunting grounds (Scoresby Sound in 1983-84, Tasiilaq to Scoresby Sound in 2008 and 2016) and indicate a widely scattered population totalling less than 1,000 animals (Heide-Jørgensen et al. 2010b). A decline has been observed over the past decade and reductions in the quotas (first established in 2010) have been recommended by the NAMMCO-JCNB Joint Scientific Working Group (NAMMCO 2017). Planned surveys in 2017 were designed to provide more complete information on abundance in East Greenland. It is uncertain if hunting alone is causing the observed decline as especially the southern region of East Greenland has experienced a dramatic decline in sea ice and an increase in sea temperature with the intrusion of several boreal cetacean and fish species into the narwhal’s habitat (NAMMCO 2017).

***Discussion***

There are at least two identified concentrations, one centred on Scoresby Sound and one on Tasiilaq. The total abundance for the two areas is presently unknown, but the numbers are fairly small and the catch quotas are presently higher than the recommended takes. The planned spring/summer 2017 East Greenland survey was expected to be informative.

Multiple environmental changes are occurring in the area, including increased sea surface temperatures, rapidly retreating ice cover, and disappearance of tidewater glaciers. This may be degrading and reducing narwhal habitat. The confirmed arrival of tropical species in the area is likely affecting narwhals through competition for prey, exposure to novel diseases, etc. Humpback whales are now being observed in areas where narwhals were previously present. Given such changes, it is, and will continue to be, difficult to tease apart the effects of hunting versus climate change.

***Status***

There is a high level of concern for narwhals in East Greenland due to the lack of data (particularly on stock structure), low abundance, declining trend, likely overharvest, and the numerous climate-related changes in habitat.

## 5.11 Northeast Greenland

North of Scoresby Sound, narwhals are frequently found in Young Sound (74°N), Dove Bay (76°N), and along the coast as far north as Nordost Rundingen (82°N; Boertmann and Nielsen 2009 and 2010; see Annex 29). Narwhals are thought to occur infrequently between Greenland and Svalbard but there is little supporting data. Given the long coastline, it is possible that there are several stocks in Northeast Greenland, however there is currently very little (or no) data to determine stock structure. There could be as many as four stocks, three in fjord systems and one offshore.

The narwhals north of Scoresby Sound are protected by the Northeast Greenland National Park. No hunting takes place in marine waters along the Park’s boundary and no attempt has been made to assess narwhal abundance there. The planned surveys in 2017 were designed to provide more complete information on abundance in Northeast Greenland.

Northeast Greenland is subject to some exploration for oil and gas resources and small-scale seismic survey work has been conducted there over the past decade.

***Discussion***

The coastline is long, and it is likely that there are multiple stocks, however there is little to no information to separate them at this time. More information is needed on abundance, distribution, and movements.

***Status***

There is a moderate level of concern for narwhals in Northeast Greenland. While there is a similar lack of data for abundance, stock structure, and climate change related habitat concerns to narwhals as in East Greenland, narwhals in Northeast Greenland are currently protected by the National Park and have been until now un-accessible for hunters (protection, remoteness and ice coverage).

## 5.12 Svalbard-Northwest Russian Arctic

### Svalbard

Narwhals are only rarely observed along the coasts of Svalbard (see Annex 30). Three juvenile narwhals were satellite-tagged in 1998 in the Walenberg fjord, west of Nordauslandet, but the tags operated for only short periods (4-46 days). The two animals that moved the longest distances went to the north and east of Nordauslandet (Lydersen et al. 2007).

There has not been a whale survey around Svalbard specifically designed to learn about narwhals, but a multi-species survey in the marginal ice zone north of Svalbard in August 2015 resulted in an abundance estimate of 837 narwhals (CV= 0.501) within the 52,919 km$^2$ study area, with many observations close to the distal ends of the transects, indicating that more narwhals likely would have been found even further north (Vacquié-Garcia et al. 2017).

Effects of climate change with impacts on sea ice conditions, prey base composition, competition from boreal marine mammal species, new parasites and diseases are general concerns. Also, tissue levels of some pollutants in narwhals at Svalbard are even higher than the levels recorded in white whales from this region (Wolkers et al. 2006).

**Northwest Russian Arctic**

Information on narwhal sightings in the northwestern Russian Arctic (Barents and Kara Seas) comes mostly from the annual National Park "Russian Arctic" monitoring program, as well as opportunistic observations during oil/gas geological explorations, a few scientific expeditions, and tourist cruises. [Editor's Note: there is no "Status Review Annex" for narwhals in the Northwest Russian Arctic.] Most narwhal sightings were recorded in the waters of the western Franz Josef Land from May to September with a peak in August (1990-2013) and one sighting southeast of Franz Josef Land in April 2013. Several sightings were recorded in the Kara Sea in autumn (September and October 2012-2013). Most sightings were of small groups with a maximum group size of 50 whales. Presumably, narwhal movements to the waters of Franz Josef Land are related to their feeding on polar cod. There is no information on abundance of narwhals in this region. No studies on migratory routes and stock structure have been conducted. Until more information is available, narwhals in the Russian northwestern Arctic may be considered a separate stock.

There have been several sightings and tusk findings of narwhal in the Chukotka region in the last 20 years, which led to listing the narwhal in the Red Book of Chukotka. There is no evidence for a separate stock, rather it is supposed that individual whales (vagrants) occasionally enter Chukotka waters. There is no traditional harvest or live-captures of narwhals in Chukotka.

Major anthropogenic threats in the Barents and Kara Seas include various oil/gas activities, increasing tourist and military vessel traffic in Franz Josef Land waters, oil/gas fleet, and other vessel and cargo traffic along the Northern Sea Route.

***Discussion***

Narwhals are present recurrently if not regularly in this region, but there is no detailed information on their distribution, movements, stock identity, or abundance. It is impossible to determine whether there are multiple stocks and whether any of the narwhals in the region are affiliated with stocks in East or Northeast Greenland.

Most of the recent sightings of narwhals in Svalbard have been in fjords in Nordaustlandet or in Hinlopenstretet in the northeastern part of the archipelago. But, observations of individual narwhals have also occurred in recent years on the west coast of Spitsbergen (e.g. innermost Kongsfjorden and deep within Adventfjorden). Narwhal are detected regularly on Passive Acoustic Monitoring devices to the west of Svalbard in the Fram Strait (Moore et al. 2012). There also seems to be a concentration of sightings around Franz Josef Land, and there are recent sightings in the Kara Sea. There are no sightings in the Laptev Sea although it must be mentioned that there has been no dedicated search effort there for narwhals and there are very few human inhabitants in the area. Most ships pass through the Laptev Sea where it is shallow and there is low productivity. It is possible that narwhals are present further offshore, but at this point it appears that the gap in narwhal distribution between the Laptev Sea and the Beaufort Sea far to the east is real.

The stock(s) in this area is(are) likely small but may be distributed primarily in areas not well surveyed. Therefore, there is considerable uncertainty regarding abundance and distribution as well as stock identity.

***Status***

There is moderate concern for narwhals in this region, mainly due to the lack of detailed information and the possibly low abundance. Narwhals are protected in Svalbard and Russia.

## 6. BELUGAS AND NARWHALS: GLOBAL AND REGIONAL ENVIRONMENTAL ISSUES

As the Arctic warms, the decrease in sea ice cover is enabling access to once-remote areas. The resultant increase in human activity is of overall concern for monodontid populations, as it invariably leads to increased disturbance, habitat degradation and disruption, noise, and chemical pollution (NAMMCO 2017). A changing Arctic also brings other challenges, such as possible impacts on prey for belugas and narwhals, exposure to novel diseases in the area, and competition from other species. The level of concern varies from area to area, and there are regionally specific concerns that are currently having impacts on, or are likely to have impacts on, individual monodontid stocks. The meeting discussed climate change, related ecosystem changes, and human activities that are the main concerns for belugas and narwhals, both globally and regionally.

In general, the northernmost stocks of belugas appear to be of less concern than the more southern stocks. This north-south trend in concern may be largely explained by the higher levels and broader range of human activities in lower latitudes, and the potentiating effects of climate change. However, the largest beluga stock, centred in western Hudson Bay, is ‘southern’ and apparently in good shape. The diet of belugas is quite diverse. This diversity and flexibility may make belugas more resilient to Arctic warming.

Narwhals have a more restricted range but are almost as numerous as belugas, many of their aggregations are quite large, and their summering grounds tend to be more remote than those of belugas, making them somewhat less susceptible to disturbance. The main concerns for narwhals are overharvesting in some parts of their range and the loss of sea ice, as narwhals are more directly ice-associated than belugas.

**Environmental changes**

Warming of Arctic waters leads to sea ice decline and changes in the timing and sequence of freeze up and thaw, which is associated with physical (ice distribution, characteristics and movement but also protective cover) as well as biotic (associated species) changes of the habitat (see CAFF 2017). Warmer water and reduced sea ice enables boreal species to move into higher latitudes, which means that the species endemic to the Arctic experience changes in prey composition and availability, increased competition for food, greater pressure from predators, and exposure to novel pathogens. Both monodontid species, but especially narwhals, are closely associated with sea ice, and the movement and migratory patterns of some stocks may have already been altered by the observed reductions in sea ice (e.g., Hauser 2016). Novel ice conditions are less predictable for these species, putting them at greater risk of ice entrapment (Laidre and Heide-Jørgensen 2005). Alternatively, reductions in sea ice may lead to increased productivity that could contribute to an increase in abundance of monodontid prey species.

***Belugas - Areas impacted:***

- Global concern
- Cook Inlet where there has been a contraction of the range. The range occupied in the last five years is smaller than that occupied in the previous ten years, and the range continues to contract. It is unknown whether this range contraction is due to a smaller population or represents a response to changes in the environment.
- Okhotsk, Bering, Chukchi and Beaufort Seas where climate change has brought considerable change in sea ice. Behavioural changes, e.g. in the timing of migrations, have been observed that are likely related to changes in sea ice.

***Narwhals - Areas impacted:***

- All stocks will be affected by changes in distance to the ice and the warming of water, as narwhals exhibit a seasonal movement pattern that follows the distribution of the ice through much of the year.
- Southern stocks will likely be affected sooner. Presumably, warmer waters are uninhabitable for narwhals, which are associated with polar water. Therefore, they will lose habitat in the southern parts of their range. This may already be evident in Southeast Greenland where narwhals have disappeared.

**<u>Pathogens</u>**
Positive titers for *Vibrio* have been found in belugas from Bristol Bay. In Cook Inlet and the Okhotsk Sea the exposure of belugas to human pet pathogens is of concern. In addition, even pathogens that have been in the Arctic for a considerable time may become virulent if lowered immune response is induced by environmental stressors such as increased pollution or toxic algal blooms, causing individuals to become more susceptible to both local and novel pathogens (Burek et al. 2008).

**<u>Industrial activities generally</u>**
Most industrial activities in the Arctic result in disturbance of some kind to monodontids, e.g. noise, chemical pollution, displacement, habitat modification.

***Both species - Areas impacted:***

- Mainly the southernmost areas, however as sea ice declines and opens up more areas to development, this will affect northernmost areas as well.

**<u>Shipping/Vessel traffic</u>**
Shipping is increasing in the Arctic (see Arctic Council 2015). The Russian Northern Sea Route (NSR) and the Canadian-US Northwest Passage (NWP) in many cases offer faster routes between North Pacific ports and North Atlantic ports than the traditional southern routes. Major shipping routes are developing from Asia and the west coast of the USA in the south, heading north towards the Bering Strait, and then west through the Russian Arctic and east through the Canadian Arctic. Development of these routes requires construction of support harbours – with associated disturbances.

Shipping has several potential negative impacts on belugas and narwhals, such as from noise disturbance (see Finley et al. 1990; Cosens and Dueck, 1993; Lesage et al. 1999), displacement, and fuel or oil spills. Also, ballast water discharged from ships can introduce invasive species or novel pathogens that can survive in the warmer ocean temperatures.

In open waters, the whales have more ability to avoid ships, but in more restricted areas (e.g. inlets, small bays, fjords) there is less room for avoidance. Severity of the impacts of shipping likely depends on whether the animals are resident or migratory. Shipping in restricted habitat, especially in areas with major ports, is often associated with elevated levels of noise and chemical pollution, which can lead to disturbance and displacement of the animals from critical habitat, such as foraging, nursing, resting or socialising areas.

Some degree of habituation apparently has occurred in some areas, especially where vessel traffic is regular and somewhat predictable. Commercial shipping generally follows standard routes, but tour vessel traffic and recreational boating is less predictable and is expanding both spatially and temporally. This trend is becoming a major concern issue in some areas, such as Pond Inlet (Canada), West Greenland and the White Sea (Russia).

There is increased military activity and presence in all northern waters (Wezeman 2016).

***Belugas - Areas impacted:***

It appears that belugas are rarely struck by ships, even when exposed to high levels of traffic, likely because they are noise sensitive and avoid the ships. Such avoidance, however, can be viewed as a problem in itself because it can mean they are easily displaced from habitat that is critical to them in one way or another.

- Cook Inlet: all shipping into and out of Anchorage, the biggest port in Alaska, goes through beluga habitat. There is also in increased military vessel traffic.
- Eastern Bering Sea: The southern approach to the Bering Strait passes through or adjacent to beluga habitat.
- Bering Strait: Both the Northern Sea Route and Northwest Passage pass through the strait. Shipping can therefore affect stocks that use the strait as a migration corridor.
- Chukchi Sea: The northern approach to the Bering Strait passes through or adjacent to beluga spring, summer and fall habitat.

- Beaufort Sea and western channels of the Canadian Archipelago: The NWP passes through or adjacent to beluga spring summer and fall habitat.
- Western Hudson Bay: affecting all stocks that use this region.
- Baffin Bay: with increasing industrial development and associated shipping.
- St Lawrence Estuary and Gulf: a situation similar to Cook Inlet.
- Northeast Atlantic Arctic: shipping is increasing in East Greenland and around Svalbard.
- White sea: shipping from Arkhangelsk (Severnaya Dvina) through the White Sea to the Northern Sea Route.
- Russian western and central Arctic (Barents, Kara, and Laptev Seas): heavy and increasing shipping. The likely impact is difficult to assess, as very little is known concerning how belugas use these waters.
- Okhotsk Sea: shipping of ore and cargo is increasing and of concern.
- Russian waters generally: hovercraft shipping, which is very noisy, is developing.

***Narwhals - Areas impacted:***

Generally, narwhals are very susceptible to ship noise, more so than belugas, and they will be affected in all areas according to shipping intensity.

- Baffin Bay, especially and most immediately in Eclipse Sound and Pond Inlet but also throughout Lancaster Sound
- Hudson Strait

**Icebreaking**

Icebreaking and the associated ship traffic are increasing throughout the circumpolar Arctic. The loudest sounds are created by cavitation from the ship's propellers when it backs and rams ice, but can also be produced from the engines and physically breaking ice. When icebreaking occurs in newly accessible areas it may lead to belugas and narwhals abandoning important habitat (Finley et al. 1990). The impact will depend on the nature and scale of the operation, with large-scale continuous or repeated icebreaking in heavy pack ice being of greatest concern, both as a source of continuous noise disturbance and with an associated increase in the risks of ice entrapment. Smaller-scale icebreaking, e.g. for port or harbour maintenance or when the ice is already breaking up, is of less concern.

The noise from icebreaking activity may affect belugas' and narwhals' sensory capabilities and make it more difficult for them to find breathing holes, communicate, and use echolocation to find prey. Besides increasing underwater noise, icebreaking changes ice characteristics and movement. Both of these factors can increase the likelihood of ice entrapment.

***Belugas - Areas impacted:***

Shifts in distribution associated with icebreaking have been observed, although belugas have also shown an ability to habituate under some circumstances.

- Hudson Strait: impact has been modelled (DFO 2014), but no empirical data have been collected
- Baffin Bay – Davis Strait: icebreaking has been proposed to service the Mary River iron mine project
- White Sea: icebreakers pass through the wintering area

***Narwhals - Areas impacted:***

Given their sensitivity to noise, narwhals are likely to be affected by icebreaking, particularly when it occurs on their wintering grounds.

- All wintering grounds
- Baffin Bay (including Eclipse Sound and Lancaster Sound)
- Hudson Strait
- Northeast Greenland: possible icebreaking associated with the "Citronen" ore project

## Oil and gas and mining activities

### Seismic surveys

Oil and gas development generally depends on seismic surveys to explore for deposits and monitor their exploitation over time. Such surveys generate a large amount of high-energy underwater noise, sometimes for months and often in areas that are largely pristine. Seismic operations are planned in advance but take place sporadically in any given area and therefore are not necessarily amenable to habituation by wildlife.

Sound can travel long distances in Arctic waters, and although few studies have addressed this issue directly, both belugas and narwhals appear to react to seismic survey noise being conducted hundreds of kilometres away (Finley et al. 1990). If belugas and narwhals abandon areas as a response to disturbance by seismic surveys, this is equivalent to a loss of habitat. Seismic surveys in the fall or winter are problematic because they can delay migration or force the animals into sub-optimal areas and may also increase the risk of ice entrapment (Heide-Jørgensen et al. 2013).

The long distances at which monodontids respond to noise creates cross-border problems, as both belugas and narwhals move across international borders and into and out of international waters. Ideally, seismic survey planning should be carried out on a regional, coordinated basis and include consideration of the potential impacts on belugas and narwhals.

### Construction and production

Besides shipping (for supply and export) and seismic surveys, offshore oil and gas development normally requires construction or upgrading of infrastructure (e.g. platforms, drilling rigs, pipelines, sometimes artificial islands). This becomes a nearly constant localized source of underwater noise for years or decades. The rigs themselves are a constant source of noise. Port development involves dredging, pile-driving, as well as support shipping.

### Oil spills

Oil spills in the Arctic are of great concern, especially in ice-covered waters. Arctic conditions make spills difficult or impossible to control and clean up, and the cold temperatures slow the breakdown of spilled oil. Any spill carries the potential of having a major impact, especially as the capacity for emergency response remains limited. Oil spills can harm whales as a result of both direct exposure and prey contamination through ingestion or smothering. Additionally, the sounds from cleanup activities may impact belugas and narwhals.

***Belugas - Areas impacted:***

- All areas where exploration or development occurs
- Cook Inlet has extensive oil and gas development in a constrained area. Besides being the passageway into and out of Anchorage, it has rigs in the middle of the inlet with pipelines transporting the oil and gas to onshore storage areas where tankers are loaded for shipment. Cook Inlet is an area with significant seismic and volcanic activity oil and gas infrastructure remains vulnerable to these events and may compound their impact on the belugas. Oil spill response plans are being developed and updated but are unlikely to protect the population in the event of a major spill.
- Ungava Bay: Construction of a port, and subsequent shipping, in conjunction with an iron ore mine (Oceanic Iron Ore Corp.).
- St Lawrence Estuary: port development.
- Russian western and central Arctic: the Pechora Sea is of special concern because of major coastal oil development projects in areas of beluga concentrations.
- Western Okhotsk Sea: increasing ore development leading to construction of terminals and to shipping.

***Narwhals - Areas impacted:***

Narwhals are very sensitive to seismic survey noise, which increases the risk of ice-entrapment. Increased ice entrapment in summering areas (Eclipse Sound and Inglefield Bredning) outside the normal range of ice-entrapment events have been linked to seismic noise on the migration route at the time of migration to the offshore wintering areas. By delaying or preventing the late summer or early fall migration from the coastal summering areas, the animals are forced to remain in areas with fast ice. Seismic exploration should be avoided at the start of or during migration periods.

- All areas with seismic surveys will be affected
- Eclipse Sound: port development in Pond Inlet
- Melville Bay
- East Baffin Island
- East Greenland: current plans for more exploration and eventual development
- Russian Arctic

**Hydroelectric development**

Hydroelectric development is of particular concern in Canada, especially with dam construction in rivers flowing into Hudson Bay and James Bay (damming of rivers along the north shore of the Estuary and Gulf of St Lawrence was essentially completed by around 1970). These dams change the hydrographic characteristics of estuaries and coastal waters, potentially affecting belugas because they associate with estuaries. The altered flow regime downstream of dams can influence seasonal temperature and salinity in estuaries and make them less suitable for belugas, and change distribution and abundance of prey species. Dams interrupt the flow of sand and silt down rivers which over time can result in changes to the substrate and distribution of shallow areas which belugas occupy. Freshwater releases in late fall or winter can affect the timing of freeze-up, making the structure of the sea ice (less labile), and thereby may increase the risk of ice entrapment.

***Belugas - Areas impacted:***

- St Lawrence Estuary
- Eastern Hudson Bay

**Interactions with fisheries**

Injury and entanglement in fishing gear does not appear to be a major problem for belugas or narwhals, although in many areas there is little or no monitoring and incidents are unlikely to be reported. In some areas where there is subsistence hunting, incidentally caught whales might be reported as catch rather than reported as by-catch (e.g. in Greenland and Alaska).

Competition for resources, including preferred prey items, is the main issue with regard to fishery interactions. Narwhals have a restricted diet and increased commercial fishing for their dominant prey, Greenland halibut (*Reinhardtius hippoglossoides*), is of concern, particularly in Baffin Bay. Halibut have traditionally been harvested in the fjords of Northwest Greenland using long-lines and gillnets. An additional offshore fishery developed in the 1960s in Davis Strait. This fishery continues to expand to the deep waters of central Baffin Bay, where narwhals spend the winter feeding.

Another issue is the likely destruction of habitat caused by trawling through the corals inhabited by the halibut. As the fisheries expand northward, more and more habitat is likely to be degraded or destroyed.

***Belugas - Areas impacted:***

Belugas can swim backwards, and fishing nets are “visible” to their echolocation capabilities, perhaps partly for these reasons, entanglement does not appear to occur as frequently as might be expected given the intensity of fishing, particularly for halibut and salmon, in beluga feeding grounds. In St Lawrence Estuary, for example, where there is significant fishing activity in beluga habitat, very few beluga by-catches are reported (Bailey and Zinger 1995; Lair 2007), suggesting that the whales can avoid entanglement. In the Okhotsk Sea entanglements are recorded annually, but they are very infrequent.

Belugas typically forage in the shallow upper parts of estuaries, whereas fishing tends to be concentrated in the mouths of the estuaries, which could limit the amount of prey available to the whales. This is of particular concern for the belugas in the Pacific Arctic and for populations that have a fairly narrow summer diet of anadromous fish species. Resource competition, however, does not seem to occur between belugas and char fisheries in Canada.

Better information is needed on diet for many stocks of belugas to better assess competition with fisheries.

***Narwhals – Areas impacted:***

Competition occurs with several fisheries but notably the Greenland halibut fisheries, which are expanding northwards because of ice recession.

- Baffin Bay: competition with Greenland halibut and shrimp fisheries, thus affecting all stocks wintering in Baffin Bay.
- Hudson Strait: competition with Greenland halibut and shrimp fisheries.
- Davis Strait: competition with Greenland halibut and shrimp fisheries.
- East Greenland: competition with Greenland halibut fisheries.
- Svalbard: competition with polar and Arctic cod and Greenland halibut fisheries.

**Organic Contaminants and Heavy Metals**

Pollution is a concern for belugas and narwhals in some areas, especially heavy metals, polychlorinated biphenyls (PCBs), plastics, and microplastics. Some contaminants (particularly organic contaminants) are transported from lower latitudes (via the atmosphere or ocean currents) and may also originate from local run-off, sewage, and mine outfalls. Another consideration is that prey species that are now occurring more regularly in the Arctic from lower latitudes because of warming water temperatures in the north are more likely to have relatively high levels of PCBs and mercury.

Pollution is a more acute problem in some areas, however, studies are limited in narwhals. A few directed studies have been conducted in the St Lawrence Estuary, Svalbard, and the western Okhotsk. Svalbard belugas have been found to have relatively high levels of contaminants, and a pilot study in the Western Okhotsk Sea has shown that belugas summering in the estuaries of the large rivers are more contaminated with pesticides. More information is needed on plastics and microplastics.

***Belugas - Areas impacted:***

- Cook Inlet– runoff from roadways, airport, agriculture and military facilities. Sewage outfalls from Anchorage and other municipalities and private septic systems.
- Canadian waters - particularly in the Eastern Beaufort Sea, where there was previously a high mercury concentration, although it seems to be declining.
- St Lawrence
- Svalbard
- White Sea
- Amur River

***Narwhals - Area impacted***

- Studies on contaminants in narwhals are needed.

**Cumulative Impacts**

Independently, individual stressors might have impacts on individual animals or populations, but stressors rarely occur in isolation. The repetitive and combined pressure of multiple stressors may not be simply additive but have synergistic effects. These effects can lead to severe impacts on individuals and populations, either directly, or by way of sub-lethal effects such as reduced foraging success and reproductive capacity, increased mortality, decreased immune function, etc.

**Both species - Areas impacted:**

- Global concern

**Impact assessment of different threats**

A meaningful quantitative analysis of the cumulative impacts multiple threat sources should be required for impact assessment, but this is usually not the case. Currently, authorisation requests from ore and oil and gas operators, for example, focus on the impacts of individual projects or activities in isolation, while not considering the cumulative impacts of other projects and activities occurring in the animal population's habitat. Methods for quantitatively assessing cumulative impacts for any species are not well developed. Additional effort is needed to improve assessment methods that understandable, quantitative, meaningful, and repeatable.

In all areas, the impact assessment and approval process and the response plans for development activities are of concern. The results of impact assessment studies are often "inconclusive" which usually allows development projects to continue. The meeting emphasized that the precautionary approach is often used in harvest management (as it should be), but that companies are generally not held to the same standard of precaution as the communities. For example, the beluga and narwhal harvests in Canada and Greenland are closely monitored and managed. Yet development projects are rarely halted or significantly modified even though they are known to have, or will likely have, significant impacts on monodontid stocks and the companies' impact assessments rarely quantify or acknowledge this.

## 7. RECOMMENDATIONS FOR RESEARCH AND COOPERATION (BELUGAS AND NARWHALS)

**Abundance Estimates**

There are several areas where no dedicated surveys have been conducted, where the available data are outdated, or there is a single estimate and therefore it is not possible to assess trends. Reliable information on abundance is critical to assessment of status. New technology (satellite imagery, drones, genetic mark-recapture, etc.) is becoming available that could collect data less expensively and more quickly (and safely) than aerial surveys. The meeting **recommended** that the stocks listed in the table below be assigned high priority for obtaining abundance data.

| | No Survey Data | Older than 10 years | Older than 5 years |
|---|---|---|---|
| Beluga Stocks | ▪ Svalbard (planned 2018)<br>▪ Barents-Kara-Laptev Seas<br>▪ Anadyr | ▪ Eastern Beaufort Sea (1992)<br>▪ High Arctic-Baffin Bay (1996)<br>▪ Eastern Bering Sea (2000; survey planned for 2017) | ▪ Sakhalin-Amur (2010)<br>▪ Ulbansky (2010)<br>▪ Tugursky (2010)<br>▪ Udskaya (2010)<br>▪ Shelikov (2010) |
| Narwhal Stocks | ▪ Northeast Greenland (planned 2017)<br>▪ Svalbard-Russian Arctic | ▪ Inglefield Bredning (2007) | ▪ Northern Hudson Bay (2011) |

**Stock Identity**

There is a need for more information on monodontid stock structure and substructure. As a practical matter, the ability to assign individual whales to their correct stock stands out as a particular priority. This is especially important for narwhals in all areas where they are hunted, but it is important as well for specific beluga stocks, including Svalbard, Barents-Kara-Laptev Seas, Eastern Hudson Bay, White Sea, Western Hudson Bay. The genome sequencing project presented to the meeting by Lorenzen and Skovrind (see item 3.1) is expected to address this critical research need. Collection of tissue samples from areas where narwhals and belugas are harvested is important, but it will also be important to obtain samples from across the range for both species.

**Movements and distribution: Satellite tracking**

Shifts in the movements and distribution of belugas and narwhals have been observed over the last 20 years, and there is a need for additional satellite tagging not only to obtain information on areas where no data is available on movements, and better information on areas like James Bay where previous tagging was limited, but also to evaluate how distribution and movements have changed in recent years (or indeed if they have changed significantly). Information obtained from satellite tagging can be used in many specific ways, such as investigating the effects of oil and gas activities or shipping on whale behaviour and providing a basis for designing aerial surveys for abundance estimation. Tag-derived data can be used to identify important areas and times to conduct surveys, determine where and when different stocks overlap spatially, and help prevent overestimation of abundance due to "double counting." Importantly, dive data from satellite tags are used in developing correction factors to account for availability bias in data from aerial surveys, and these factors have a large influence on abundance estimates. The movement data from satellite tagging also provide a valuable supplement to genetic analyses for defining stocks and provides data on both hunted and non-hunted stocks. Tagging methods have steadily improved and are now much less invasive than they were several decades ago.

The meeting identified key areas where satellite tagging is needed.

*Belugas*

- James Bay (especially the west coast)
- Eastern Hudson Bay
- Belcher Islands
- Cumberland Sound
- Okhotsk Sea
- Russian Arctic

*Narwhals*

- Eastern Baffin Island
- Jones and Smith Sound
- Franz Josef Land, northern Russia

**Response to Disturbance**

Considering the increase in human activities in the Arctic, there is a need for controlled studies on the behavioural and physiological responses of monodontids to disturbance, particularly in relation to ship traffic, ice-breaking, oil and gas activities, and human-generated noise generally. Studies should include, for example, investigating the movements, heart rate, stress hormone levels, and sleep/rest rhythm of tagged animals in the presence vs the absence of potentially disturbing stimuli. Baffin Bay was identified as a particularly important area for such studies although it was recognized that findings from robust studies of monodontids regardless of the study site could have considerable generic value; that is, they should be applicable anywhere, with due allowance for differences in history of exposure and thus the potential for habituation. The meeting was pleased to learn of a controlled study of the behavioural and physiological responses of narwhals to seismic survey noise in East Greenland planned for summer 2017.

Although controlled experiments with wild monodontids to elucidate details concerning their responses to various types of vessel traffic, seismic surveys, and icebreaking activities are lacking, the observational evidence that is available suggests that belugas and narwhals are very sensitive to anthropogenic sounds and those sounds can disrupt normal behaviour, cause the animals to move away from preferred habitat, and increase the risk of ice entrapment (NAMMCO-JCNB 2017). Therefore, meeting participants recommended that seismic surveys and icebreaking activities be avoided, at least in areas and during times when the whales are likely to be most vulnerable (e.g. when they are migrating towards wintering areas and while they are in wintering areas where there is limited access to open water).

**Health assessments**

The meeting recognised the value of health assessment studies, which can provide useful information to managers on the status of beluga and narwhal populations as well as to human communities that rely on these animals for food concerning the benefits and risks of consuming the whales' skin, meat, and organs. Although no health assessment projects are currently underway on narwhals, several such projects on belugas are ongoing in Alaska, notably in Bristol Bay, Point Lay (Eastern Chukchi) and Cook Inlet, and the Russian Far East, specifically on the Sakhalin-Amur stock.

**Traditional knowledge**

Participants encouraged the continued collection of traditional knowledge on monodontids, especially in locations where little scientific field research on monodontids has been or is being carried out. Such knowledge has been used to inform stock delineation and will continue to do so, and it can also provide valuable information on stock status, impacts from disturbance, and environmental changes, both short-term and long-term and both natural and human-caused. In Canada, the Species At Risk Act recognizes Aboriginal Traditional Knowledge (ATK) in the process of assessing risks and assigning species and populations to different levels of concern. ATK and Aboriginal Peoples also play an important role in the development and implementation of protection and recovery measures.

**Cumulative Impacts and Management Advice**

The importance of integrating consideration of cumulative impacts into management advice is widely recognized but such integration is rarely achieved. In the case of monodontids, management advice has historically focused on hunting, although it is increasingly recognized that these whales face multiple threats and that various threats in addition to hunting must be considered and addressed. Restrictions on hunting are often necessary to enable populations to recover and to prevent them from decreasing, but other human activities that are known or suspected to have serious impacts on monodontid populations are rarely subject to meaningful restrictions. This situation needs to change. A precautionary approach should be applied equally to the management of harvesting, industrial and commercial activities, tourism, scientific exploration, etc.

The NAMMCO-JCNB Joint Scientific Working Group plans to focus on this issue at its next meeting (planned for March 2019).

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**STOCK DISTRIBUTION MAPS**

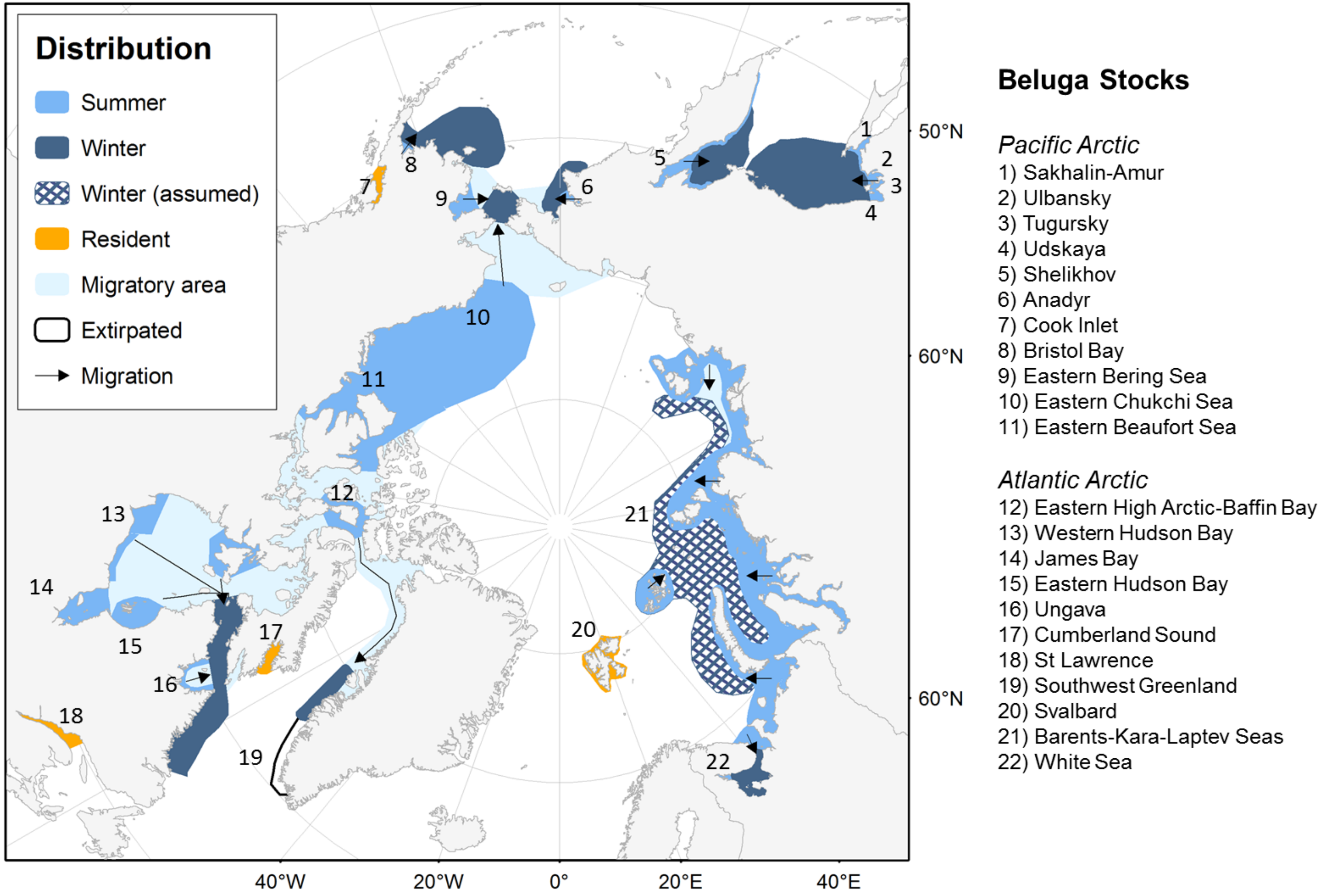
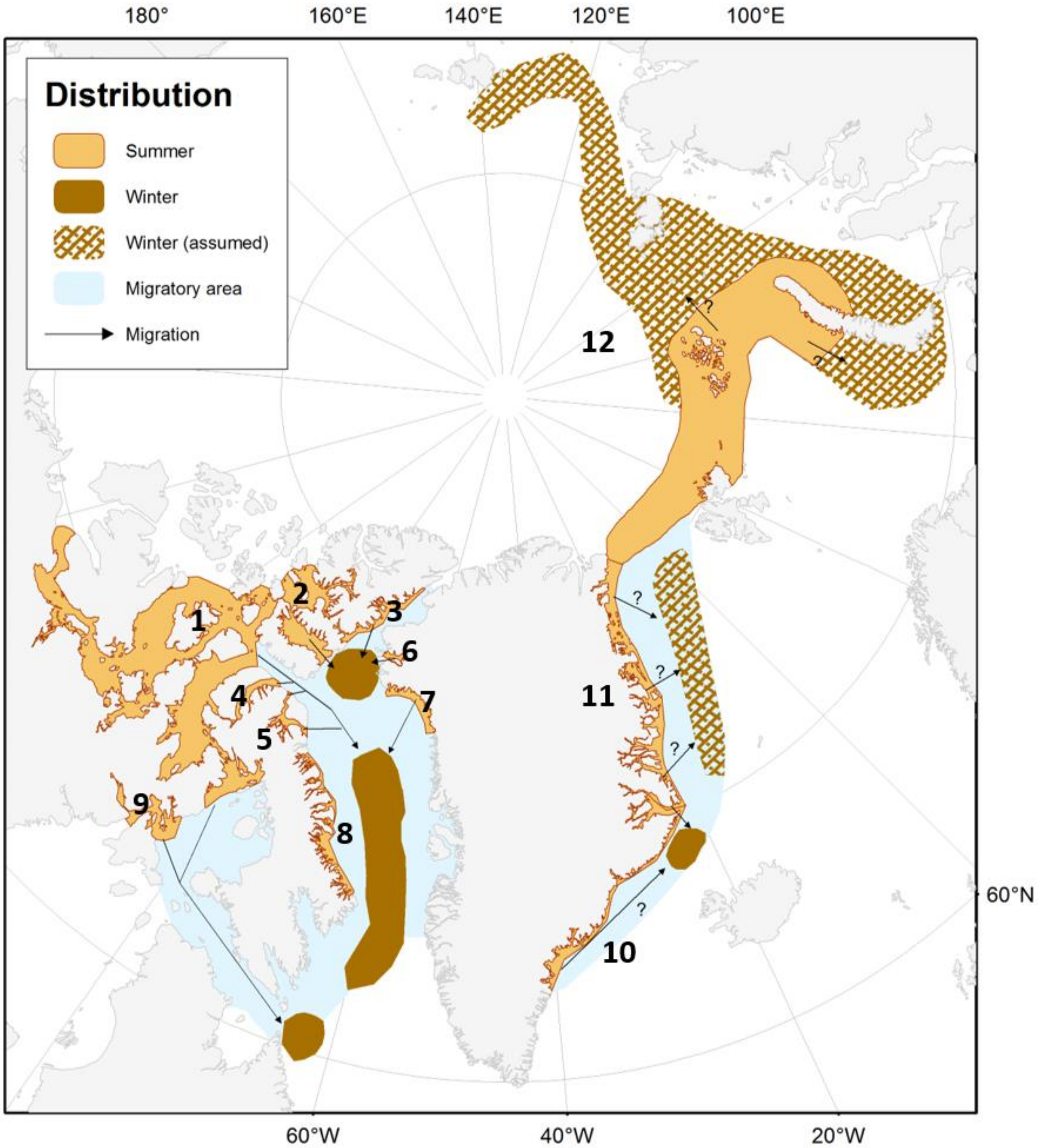



**Figure 1.** Beluga stocks recognized at this meeting.




**Narwhal Stocks**

1) Somerset Island
2) Jones Sound
3) Smith Sound
4) Admiralty Inlet
5) Eclipse Sound
6) Inglefield Bredning
7) Melville Bay
8) Eastern Baffin Island
9) Northern Hudson Bay
10) East Greenland
11) Northeast Greenland
12) Siberian-Russian Arctic

**Figure 2.** Narwhal stocks recognized at this meeting.

## SUMMARY TABLES

**Table 1.** Evidence supporting stock discrimination of A) belugas (*Delphinapterus leucas*) and B) narwhals (*Monodon monoceros*). Y = available data support stock discrimination; + = available data provide some support for stock discrimination; N = available data do not support stock discrimination or is inconclusive; – = no data are available.

| A<br>Beluga Stocks / Evidence | Summer distribution | Winter distribution | Movement, behaviour, or life history traits | Genetics (mt DNA) |
|---|---|---|---|---|
| 1. Sakhalin-Amur | Y | + | + | Y |
| 2. Ulbansky | Y | – | + | Y |
| 3. Tugursky | Y | – | + | N |
| 4. Udskaya | Y | – | + | Y |
| 5. Shelikhov | Y | + | + | Y |
| 6. Anadyr Gulf | Y | Y | Y | Y |
| 7. Cook Inlet | Y | Y | Y | Y |
| 8. Bristol Bay | Y | + | Y | Y |
| 9. Eastern Bering Sea | Y | + | Y | Y |
| 10. Eastern Chukchi Sea | Y | + | Y | Y |
| 11. Eastern Beaufort Sea | Y | + | Y | Y |
| 12. High Arctic – Baffin Bay | Y | + | + | + |
| 13. Western Hudson Bay | Y | + | Y | + |
| 14. James Bay | Y | Y | + | + |
| 15. Eastern Hudson Bay | Y | + | Y | + |
| 16. Ungava Bay | Y | + | + | + |
| 17. Cumberland Sound | Y | Y | Y | + |
| 18. St. Lawrence Estuary | Y | Y | + | Y |
| 19. Southwest Greenland | – | Y | Y | – |
| 20. Svalbard | Y | Y | Y | Y |
| 21. Barents-Kara-Laptev Seas | + | + | – | – |
| 22. White Sea | Y | Y | Y | + |

| B<br><br>Narwhal Stocks | Evidence | Summer distribution | Winter distribution | Movement, behaviour, or life history traits | Genetics (mt DNA) |
|---|---|---|---|---|---|
| 1. Somerset Island | | Y | + | Y | N |
| 2. Jones Sound | | Y | + | + | Y |
| 3. Smith Sound | | Y | + | + | N |
| 4. Admiralty Inlet | | Y | + | + | N |
| 5. Eclipse Sound | | Y | + | + | N |
| 6. Inglefield Bredning | | Y | + | – | N |
| 7. Melville Bay | | Y | + | Y | N |
| 8. East Baffin Island | | Y | + | + | N |
| 9. North Hudson Bay | | Y | Y | Y | Y |
| 10. East Greenland | | Y | Y | Y | N |
| 11. Northeast Greenland | | Y | – | – | – |
| 12. Svalbard-Russian High Arctic | | – | – | – | – |

**Table 2.** Summary of information provided for the status review.

**Belugas**

| | **Stock/Unit/ Summer Aggregation** | **Movements** (e.g. winter, summer migrations, to/from location) | **Abundance (Year)** *a*: availability bias; *p*: perception bias | **Trend** | **Removals** | **Threats and/or Concerns** | **National Legal Status** |
|---|---|---|---|---|---|---|---|
| 1 | Sakhalin-Amur | summer in Sakhalinsky bay and Amur estuary, winter in northern and central Okhotsk Sea (offshore) | 3,954 (CV = 0.48) (average for 2009,2010a,2010b); corrected for *a*; Shpak and Glazov (2013) | unknown | recently above PBR, current quota set close to PBR | pollution/infectious agents from Amur River, competition with fisheries, ship traffic, noise | none |
| 2 | Ulbansky | summer in Ulbansky Bay and river estuaries, winter movements unknown but presumably similar to Sakhalin-Amur | 2,334 (from direct count, corrected for *a*) (2010); Shpak and Glazov (2013) | unknown | no direct removals | fishery interactions, mining activities/pollution | none |
| 3 | Tugursky | summer in Tugursky bay, winter movements unknown but presumably, similar to Sakhalin-Amur | 1,506 (from direct count, corrected for *a*) (2010); Shpak and Glazov (2013) | unknown | no direct removals | fisheries, mining activities/pollution, discharge of human and livestock waste | none |
| 4 | Udskaya | summer in Udskaya Bay and river estuaries, found along south coast at ice formation, winter in areas unknown but presumably similar to Sakhalin-Amur | 2,464 (from direct count, corrected for *a*) (2010); Shpak and Glazov (2013) | unknown | no direct removals | fisheries, mining activities/pollution, discharge of human and livestock waste, ship traffic/noise, leaks during diesel fuel transit | none |
| 5 | Shelikhov | summer in Gizhiginskaya and Penzhinskaya Bays of Shelikhov Bay in river estuaries and along west coast of Kamchatka Peninsula, presumably winter along ice | 2,666 (from direct count, corrected for *a*) (2010); Shpak and Glazov (2013) | unknown | no direct removals | decreasing sea ice, future development in the area | none |

| Stock/Unit/ Summer Aggregation | | Movements (e.g. winter, summer migrations, to/from location) | Abundance (Year) *a*: availability bias; *p*: perception bias | Trend | Removals | Threats and/or Concerns | National Legal Status |
|---|---|---|---|---|---|---|---|
| | | edge in Shelikhov Bay and along Kamchatka | | | | | |
| 6 | Anadyr | summer and autumn in Anadyr estuary, winter in western Bering Sea | unknown but expert opinion indicates c. 3,000 (Litovka 2002) | unknown but expert opinion that it is stable | small numbers of harvested | competition from fisheries, ship traffic, reduced sea ice | none |
| 7 | Cook Inlet | summer in river mouths in upper inlet, likely remain in upper inlet year-round (range reduction from historical) | 328 (CV = 0.08) (2016); corrected for *a* and *p*; Shelden et al. (2017) | declining | Reduced to 1-2/year in 2000, prohibited since 2005 | very small numbers, decreasing trend, cumulative impacts (of competition from fisheries, industrial development, ship traffic, climate change, sewage discharge, etc.) | US ESA “Endangered” (2008) |
| 8 | Bristol Bay | summer in Nushagak and Kvichak bays and tributaries, winter in northern and eastern Bristol Bay | aerial survey: 2,040 (CV=0.22, 95% CI: 1,541-2,702) (2016); corrected for *a*; genetic mark-recapture: 1,928 (95% CI: 1,611–2,337); Citta et al. (in prep.) | stable | ~ 20-25, stable in recent years, below PBR | climate warming, loss of sea ice, competition from large fishery for salmon, development plans (gold, Pebble Mine) | none |
| 9 | Eastern Bering Sea | | 6,994 (95% CI= 3,162-15,472) (2000); corrected for *a*; Lowry et al. (in prep.) | unknown | average 190/yr landed, well above PBR of 103 | fisheries (competition, not by-catch), declining populations of Pacific salmon | none |
| 10 | Eastern Chukchi Sea | summer in Beaufort Sea and Arctic Ocean to as far north as 81°N, particularly along the shelf break; fall/winter move south to Bering Sea; winter | 20,675 (CV = 0.66) (2012); corrected for *a* and *p*; Lowry et al. (2017) | unknown | ca 50/yr, below PBR | Ship traffic, oil and gas development, sea ice changes | none |

| Stock/Unit/ Summer Aggregation | | Movements (e.g. winter, summer migrations, to/from location) | Abundance (Year) *a*: availability bias; *p*: perception bias | Trend | Removals | Threats and/or Concerns | National Legal Status |
|---|---|---|---|---|---|---|---|
| | | between St Lawrence Island, US, and Chukotka Peninsula, Russia | | | | | |
| 11 | Eastern Beaufort Sea | summer in Beaufort Sea, winter in Bering Sea | 39,258 (1992); corrected for *a*; Duval 1993 | unknown | ca 166/yr, below PBR | summer tourism, ship traffic, ecosystem changes (climate change) | Canada: “Not at Risk” (COSEWIC 2015) |
| 12 | High Arctic-Baffin Bay | summer in estuaries, inlets, and small bays along and around Somerset Island in Canadian Arctic Archipelago; late summer/fall and spring migration through Lancaster Sound; some overwinter in North Water polynya, some off West Greenland | 21,213 belugas (95% CI 10,985 to 32,619) (1996); corrected for *a,p*; Innes et al. (2002) | likely stable (but old abundance estimate); relative abundance in West Greenland is increasing | ca 400/yr (Canada + Greenland), considered sustainable | loss of sea ice, ship traffic and icebreaking | Canada: “Special Concern” (COSEWIC 2004) |
| 13 | Western Hudson Bay | summer concentrations in Seal, Churchill, and Nelson River estuaries, found along entire WHB coast; winter in Hudson Strait (overlap with Eastern Hudson Bay stock) | 54,473 (CV = 0.098; CI 44,988 to 65,957) (2015); corrected for *a*; Matthews et al. (2017) | stable | average 503/yr, below PBR | icebreaking in Hudson Strait | none |
| 14 | James Bay | remain in James Bay year-round | 10,615 (CV = 0.25) (2015); corrected for *a*; Gosselin et al. (2017) | unknown; possibly increasing, but uncertainty regarding abundance estimates | limited (ca 10/yr) | hydroelectric development | none |

| Stock/Unit/ Summer Aggregation | | Movements (e.g. winter, summer migrations, to/from location) | Abundance (Year) *a*: availability bias; *p*: perception bias | Trend | Removals | Threats and/or Concerns | National Legal Status |
|---|---|---|---|---|---|---|---|
| 15 | Eastern Hudson Bay | summer in eastern Hudson Bay, winter in Hudson Strait and Labrador Sea (overlap with Western Hudson Bay stock) | Aerial survey: 3,819 (CV=0.43) (2015) corrected for *a*; Gosselin et al. (2017)<br><br>Modelling: 3,443 (95% CI: 2014-5471) (2016); Hammill et al. (2017) | stable | ca 63/yr | uncertainties around abundance estimates, stock structure (and stock identity of removals), habitat issues (ship traffic, icebreaking, hydroelectric development) | assessed as “Endangered” (COSEWIC 2004) but not legally listed |
| 16 | Ungava Bay | previous summer aggregation, winter unknown | modelling: 32 (95% CI: 0-94) (2008); Doniol-Valcroze and Hammill (2011) | unknown; possibly extirpated | previous removals | possibly extirpated | assessed as “endangered” (COSEWIC 2004) but not legally listed |
| 17 | Cumberland Sound | remain within Cumberland Sound, concentrate in Clearwater Fiord in summer | 1,151 (CV = 0.214, 95% CI 761 to 1744) (2014); corrected for *a*; Marcoux et al. (2016) | declining | removals higher than PBR | hunting removals, ecosystem changes (diet shift), stress (possibly due to anthropogenic noise, cumulative impacts) | “threatened” (COSEWIC 2004, SARA 2017) |
| 18 | St Lawrence Estuary | limited to northwestern Gulf of St. Lawrence and estuary (reduced from historical range) | modelling: 889 (95% CI 672 to 1167) (2012); Mosnier et al. (2015) | declining (-1%/yr) | no direct removals since 1979 | vessel traffic, disturbance (whale-watching), contaminants, environmental changes | “endangered” (COSEWIC 2014, SARA 2016) |
| 19 | Southwest Greenland | n/a | Extinct | n/a | likely driven to extinction by overharvest | Extinct | none |
| 20 | Svalbard | coastal around Svalbard in summer, further offshore in winter | unknown | unknown | no direct removals | changes in sea ice, pollution, development | Protected since 1960s |
| 21 | Barents-Kara-Laptev Seas | summer in waters of archipelagos (Franz Josef | unknown (widespread in low density), | unknown | none since ca. 1990 | uncertainty around stock structure (likely several | none |

| Stock/Unit/ Summer Aggregation | | Movements (e.g. winter, summer migrations, to/from location) | Abundance (Year) *a*: availability bias; *p*: perception bias | Trend | Removals | Threats and/or Concerns | National Legal Status |
|---|---|---|---|---|---|---|---|
| | | Land), in estuaries of large rivers, along mainland coast; movements unknown; very few observations in winter, mostly in Kara Sea | probably significantly depleted by commercial whaling | | | stocks), may have been greatly overexploited in the past, considerable new development and ship traffic, military activity | |
| 22 | White Sea | Summer aggregations in 3 main bays, late summer distribution more scattered in and near White Sea; winter in White Sea, mostly in central part | 5,593 (CV = 0.135) (2011); not corrected for a; (Solovyev et al., 2012) | likely stable | total allowable take 50, removals limited to live-captures (several whales, not every year) | uncertainty around stock structure (could be several stocks), habitat issues (major shipping route through White Sea, pollution from oil storage and tankers, river discharge from northern Dvina River) | none |

**Narwhals**

| Stock/Unit/ Summer Aggregation | | Movements (e.g. winter, summer migrations, to/from location) | Abundance (Year) a: availability bias; p: perception bias | Trend | Removals | Threats and/or Concerns | National legal listing status |
|---|---|---|---|---|---|---|---|
| 1 | Somerset Island | summer around Somerset Island, distributed more widely in late summer (follow ice as it breaks up), fall migration into central Baffin Bay for overwintering | 49,768 (CV = 0.20) (2013); corrected for *a* and *p*; Doniol-Valcroze et al. (2015) | possibly increasing | considerable numbers (Canada and Greenland) but considered sustainable | loss of sea ice, icebreaking, and development in some areas | "Special Concern" (COSEWIC 2004) but not legally listed |
| 2 | Jones Sound | summer in Jones Sound, wintering area unknown | 12,694 (CV = 0.33) (2013); corrected for *a* and *p*; Doniol-Valcroze et al. (2015) | unknown | low numbers, considered sustainable | icebreaking, loss of sea ice, potential development | "Special Concern" (COSEWIC 2004) but not legally listed |
| 3 | Smith Sound | summer in Smith Sound, wintering area unknown | 16,360 (CV = 0.65) | unknown | few (if any) | icebreaking, loss of sea ice, potential development | "Special Concern" |

| Stock/Unit/ Summer Aggregation | | Movements (e.g. winter, summer migrations, to/from location) | Abundance (Year) a: availability bias; p: perception bias | Trend | Removals | Threats and/or Concerns | National legal listing status |
|---|---|---|---|---|---|---|---|
| | | | (2013); corrected for *a* and *p*; Doniol-Valcroze et al. (2015) | | | | (COSEWIC 2004) but not legally listed |
| 4 | Admiralty Inlet | summer in Admiralty Inlet, winter in Baffin Bay | 35,043 (CV = 0.42) (2013); corrected for *a* and *p*; Doniol-Valcroze et al. (2015) | stable | considerable numbers (Canada and Greenland) but considered sustainable | ship traffic, icebreaking | "Special Concern" (COSEWIC 2004) but not legally listed |
| 5 | Eclipse Sound | summer in Eclipse Sound, winter in central Baffin Bay | 10,489 (CV = 0.24) (2013) corrected for *a* and *p*; Doniol-Valcroze et al. (2015) | unknown | considerable numbers in Pond Inlet (Canada) and other areas along migration route | uncertainty about abundance estimates and stock identify (vs Admiralty Inlet stock); ship traffic, particularly related to the Baffinland-Mary River iron mine; tourism | "Special Concern" (COSEWIC 2004) but not legally listed |
| 6 | Inglefield Bredning | summer in Inglefield Bredning, wintering area unknown but narwhals seen in the North Water polynya in winter may be from this stock | 8,368 (CV = 0.25, CI 5209 to 13,422) (2007); corrected for *a* and *p*; Heide-Jørgensen et al. (2010) | stable | Considerable numbers (Greenland) but considered sustainable | loss of sea ice, seismic surveys (in parts of non-summer range), ship traffic, icebreaking, increased halibut fishing in summering area (competition for prey) | "Special Concern" (COSEWIC 2004) but not legally listed |
| 7 | Melville Bay | summer in Melville Bay, winter in central Baffin Bay | 3,091 (CV = 0.50; 95% CI 1,228 to 7,783) (2014); corrected for *a* and *p*; Hansen et al. (2015) | stable | above quota advice | overharvested, seismic surveys, icebreaking (winter), halibut fishing | none |
| 8 | Eastern Baffin Island | summer in fjords along eastern Baffin Island wintering area(s) | 17,555 (CV = 0.35) (2013); corrected for *a* and *p*; | stable? | hunted by various communities, | uncertainty around abundance estimates, stock structure (could be several stocks), and | "Special Concern" (COSEWIC |

| Stock/Unit/ Summer Aggregation | | Movements (e.g. winter, summer migrations, to/from location) | Abundance (Year) a: availability bias; p: perception bias | Trend | Removals | Threats and/or Concerns | National legal listing status |
|---|---|---|---|---|---|---|---|
| | | unknown but assumed to be in Baffin Bay | Doniol-Valcroze et al. (2015) | | increasing since 1970s but still considered sustainable | movements; habitat loss related to climate change, icebreaking | 2004) but not legally listed |
| 9 | Northern Hudson Bay | summer in northwestern Hudson Bay, winter in eastern Hudson Strait | 12,485 (CV = 0.26) (2011); corrected for *a* and *p*; Asselin et al. (2012) | likely stable | ca 83/yr, likely sustainable | uncertain sustainability of harvest, loss of sea ice, proposed development in area, ship traffic | “Special Concern” (COSEWIC 2004) but not legally listed |
| 10 | East Greenland | summer in Scoresby Sound in summer, elsewhere in fall/winter, smaller wintering range than that of Baffin Bay narwhals | 6,444 (CV = 0.51; 95% CI 2,505 to 16,575) (2008); corrected for *a* and *p*; Heide-Jørgensen et al. (2010) | declining | recently overharvested, advice for reduction in quotas | recent overharvest; climate change – warmer temperatures, loss of sea ice and tidewater glaciers may mean loss of habitat; new species in area – may mean competition for prey, exposure to novel diseases | none |
| 11 | Northeast Greenland | no information | unknown, there are regular sightings, survey planned for 2017 | unknown | none | loss of sea ice and tidewater glaciers may mean loss of habitat; new species in the area may mean competition for prey, exposure to novel diseases; future development | none |
| 12 | Svalbard-Northwest Russian Arctic | unknown | unknown | unknown | none | lack of data (abundance, movements, etc.), climate change, development, military activity | Protected in Norway and Russia |

**Table 3.** Status of A) beluga and B) narwhal stocks. The global review took into account population size and trend, quality of data available, sustainability of removals, and habitat concerns. The statuses (i.e. levels of concern) are comparative to other beluga stocks and narwhal stocks, respectively, and are listed as 1= highest concern, 2= moderate concern, 3= lowest concern. More information on abundance, stock identity, etc. can be found in Table 2.

**A**

| Beluga Stock | Trend | Status | Comments on Status |
|---|---|---|---|
| Southwest Greenland | n/a | Extinct | likely driven to extinction more than 80 years ago |
| Ungava Bay | **?** | **1** | possibly extirpated |
| Cook Inlet | ↘ | **1** | very small stock (ca 300), decreasing trend, multiple known or potential threats, cumulative impacts |
| St Lawrence Estuary | ↘ | **1** | small stock (ca 900), decreasing trend, multiple known or potential threats, cumulative impacts |
| Cumberland Sound | ↘ | **1** | small stock (ca 1,100), likely decreasing trend, likely overharvest |
| Eastern Hudson Bay | ↔ | **1 / 2*** | uncertainty concerning abundance, stock structure, and sustainability of removals; habitat concerns (icebreaking, hydroelectric dam) |
| Barents-Kara-Laptev Seas | **?** | **1 / 2*** | data deficient (unknown size, trend, stock structure, likely several stocks), high past removals, rapidly changing habitat |
| Svalbard | **?** | **2** | data deficient (unknown size and trend) but protected |
| Ulbansky | **?** | **2** | unknown trend, no direct removals, some concerns about fishing and resource extraction/development |
| Tugursky | **?** | **2** | unknown trend in abundance, low numbers of removals, habitat concerns (fishing and pollution) |
| Udskaya | **?** | **2** | unknown trend in abundance, low numbers of removals, habitat concerns (ship traffic, pollution) |
| Shelikov | **?** | **2** | unknown trend in abundance, zero to low numbers of removals, some concerns about fishing and habitat loss due to climate change |
| Anadyr Gulf | ↔ | **2** | data deficient (uncertain abundance, appears stable based on expert opinion), concerns over ship traffic |
| Sakhalin-Amur | **?** | **2** | unknown trend in abundance, recent removals (live-capture) exceed PBR, habitat concerns (large and increasing fisheries, pollution) |
| White Sea | ↔ | **2** | data deficient (uncertainty around stock structure, could be several stocks), low numbers of removals (live-capture), habitat concerns (ship traffic, pollution) |
| Eastern Bering Sea | **?** | **2** | outdated abundance estimate (from 2000), harvest exceeds PBR and may be underestimated due to limited struck and lost reporting and possible non-reporting of takes. |
| Bristol Bay | ↗↔ | **3** | although not a large stock, it is data-rich (reliable abundance estimates, likely stable or increasing, reliable data on sustainability of removals, etc.) |
| James Bay | **?** | **3** | |

| Beluga Stock | Trend | Status | Comments on Status |
|---|---|---|---|
| Eastern Chukchi Sea | **?** | **3** | large stock with relatively low harvest level. |
| Eastern High Arctic-Baffin Bay | ↔ | **3** | |
| Eastern Beaufort Sea | **?** | **3** | |
| Western Hudson Bay | ↔ | **3** | may be several stocks but less of a concern because of high abundance |

* Participants were unable to reach consensus. See Item 4.15 (Eastern Hudson Bay) and 4.21 (Barents-Kara-Laptev Seas) for discussions.

**B**

| Narwhal Stock | Trend | Status | Comments on Status |
|---|---|---|---|
| Melville Bay | ↔ | **1** | small stock, overharvest |
| East Greenland | ↘ | **1** | low abundance, data deficient, possibly several stocks, overharvest, climate change related habitat concerns |
| Eastern Baffin Island | ↔**?** | **2** | data deficient (stock structure, movements), low removals but likely several stocks |
| Eclipse Sound | **?** | **2** | may be part of Admiralty Inlet stock, concerns about icebreaking/shipping related to mining projects |
| Svalbard / NW Russian Arctic | **?** | **2** | data deficient (abundance, stock structure), likely several stocks, protected |
| North East Greenland | **?** | **2** | data deficient (abundance, stock structure), likely several stocks, climate change related concerns, protected |
| Inglefield Bredning | ↔ | **3** | small-medium sized stock with low removals, general habitat concerns related to climate change, future development |
| Jones Sound | **?** | **3** | medium sized stock with low removals, general habitat concerns related to climate change, future development |
| Smith Sound | **?** | **3** | medium sized stock with little to no removals, general habitat concerns related to climate change, future development |
| Northern Hudson Bay | ↔ | **3** | medium sized stock, removals sustainable but concerns regarding climate warming and loss of sea ice and more anthropogenic activity (mining, shipping) |
| Admiralty Inlet | ↔ | **3** | large stock, stable trend, may be connected to Eclipse Sound stock, sustainable removals, some concerns regarding icebreaking/shipping |
| Somerset Island | ↗**?** | **3** | large stock, likely increasing, removals sustainable, general habitat concerns related to climate change, future development |

**Table 4.** Comparison of A) beluga and B) narwhal stocks recognized by status reviews by IWC (2000), Laidre et al. (2015), CAFF (CBMP-SAMBR), and this meeting – GROM. The CAFF review only considered stocks within the CAFF area. The NAMMCO (1999) review is not included in this table because that meeting considered only the Atlantic arctic stocks and included wintering and mixed aggregations. The grey shading indicates when stocks were recognized by all reviews. Y= recognized as an independent stock, N= not recognized as an independent stock, dd= not enough information to delineate stocks. Comments are provided when there are differences between GROM and the other reviews.

**A**

| **Beluga Stocks** / **Review** | **IWC 2000** (nbr. in IWC report) | **Laidre et al. 2015** | **CAFF (CBMP, SAMBR)** | **GROM** (nbr. in this report) | **Comments from GROM** |
|---|---|---|---|---|---|
| Cook Inlet | Y (1) | Y | outside | Y (7) | |
| Bristol Bay | Y (2) | Y | Y | Y (8) | |
| Eastern Bering Sea | Y (3) | Y | Y | Y (9) | |
| Eastern Chukchi Sea | Y (4) | Y | Y | Y (10) | |
| Eastern Beaufort Sea | Y (5) | Y | Y | Y (11) | Called “Beaufort Sea” by IWC 2000 |
| Eastern High Arctic-Baffin Bay | N | Y | Y | Y (12) | Also called “Somerset Island” and “Canadian High Arctic” stock in previous reviews; includes the West Greenland winter and North Water Polynya winter aggregations used by CAFF |
| North Water | Y (6) | N | N | N | Included in Eastern High Arctic-Baffin Bay |
| West Greenland | Y (7) | Y | Y | N | Included in Eastern High Arctic-Baffin Bay; called West Greenland winter by Laidre et al. 2015 and CAFF |
| Foxe Basin | Y (11) | N | N | N | Included in Eastern High Arctic-Baffin Bay |
| Southwest Greenland | N | N | Y | Y (19) | Extinct; called “South Greenland- Qaqortoq to Maniitsoq” in NAMMCO 1999 |
| Cumberland Sound | Y (8) | Y | Y | Y (17) | |
| Frobisher Bay | Y (9) | N | N | N | Included in Western Hudson Bay |
| Ungava Bay | Y (10) | Y | Y | Y (16) | Possibly extirpated |
| Western Hudson Bay | Y (12) | Y | Y | Y (13) | |
| South Hudson Bay | Y (13) | N | N | N | Included in Western Hudson Bay |

| Beluga Stocks / Review | IWC 2000 (nbr. in IWC report) | Laidre et al. 2015 | CAFF (CBMP, SAMBR) | GROM (nbr. in this report) | Comments from GROM |
|---|---|---|---|---|---|
| James Bay | Y (14) | Y | Y | Y (14) | |
| Eastern Hudson Bay | Y (15) | Y | Y | Y (15) | |
| St Lawrence | Y (16) | Y | outside | Y (18) | |
| Svalbard | Y (17) | Y | Y | Y (20) | |
| Barents-Kara-Laptev Seas | N | N | N | Y (21) | Isolated population with likely several stocks, however GROM decided that there was not enough evidence to separate belugas in this area into any of the putative stocks recognized in past reviews. |
| Franz Joseph Land | Y (18) | N | N | dd | |
| Kara and Laptev Seas | N | Y | Y | dd | |
| Kara Sea | N | N | N | dd | |
| Ob Gulf | Y (19) | N | N | dd | |
| Yenisey Gulf | Y (20) | N | N | dd | |
| SW Laptev Sea | Y (24) | N | N | dd | |
| White Sea (WS) | N | Y | Y | Y (22) | Isolated population with likely several stocks, however not enough evidence to separate belugas in this area into any of the 3 putative stocks recognized by IWC (2000) |
| Onezhsky Bay | Y (21) | N | N | dd | |
| Mezhenskyi Bay | Y (22) | N | N | dd | |
| Dvinsky Bay | Y (23) | N | N | dd | |
| Western Chukchi-Eastern Siberian Seas | Y (25) | Y | Y | N | Belugas present in fall, winter, and spring, but likely a migration route; belugas are likely from several stocks, mainly Eastern Beaufort, Chukchi and Bering Sea stocks |
| Anadyr Gulf | Y (26) | Y | Y | Y (6) | |

| Beluga Stocks | Review | IWC 2000 (nbr. in IWC report) | Laidre et al. 2015 | CAFF (CBMP, SAMBR) | GROM (nbr. in this report) | Comments from GROM |
|---|---|---|---|---|---|---|
| Okhotsk Sea | | N | Y | outside | N | Okhotsk Sea separated into 5 stocks (Shelikhov, Sakhalin-Amur, Ulbansky, Tugursky, and Udskaya) |
| Shelikhov Bay | | Y (27) | N | outside | N | |
| Sakhalin-Amur | | Y (28) | N | outside | Y (1) | |
| Shantar | | Y (29) | N | outside | N | |
| Ulbansky Bay | | N | N | outside | Y (2) | Previous reviews included this stock in a larger stock called “Shantar” |
| Tugursky Bay | | N | N | outside | Y (3) | Previous reviews included this stock in a larger stock called “Shantar” |
| Udskaya Bay | | N | N | outside | Y (4) | Previous reviews included this stock in a larger stock called “Shantar” |

**B**

| Narwhal Stocks | Review | IWC 2000 (nbr. in IWC report) | Laidre et al. 2015 | CAFF (CBMP, SAMBR) | GROM | Comments from GROM |
|---|---|---|---|---|---|---|
| Svalbard – NW Russian Arctic | | Y; Called “East Greenland - Barents Sea” | N | N | Y (12) | Likely several stocks but not enough data to separate |
| Svalbard, Franz Joseph Land | | | N | Y | N | Included in “Svalbard – NW Russian Arctic” |
| Svalbard | | | Y | N | N | Included in “Svalbard – NW Russian Arctic” |
| North East Greenland | | | N | N | Y | |
| East Greenland (EGL) | | | Y | Y | Y | |
| Melville Bay | | Y; called “Baffin Bay Region” | Y | Y | Y | |
| Inglefield Bredning | | | Y | Y | Y | |
| Eastern Baffin Island | | | Y | Y | Y | |
| Jones Sound/Smith Sound | | | Y | N | N | Separated into two stocks (Smith and Jones) |
| Jones Sound | | | N | Y | Y | |

| Narwhal Stocks / Review | IWC 2000 (nbr. in IWC report) | Laidre et al. 2015 | CAFF (CBMP, SAMBR) | GROM | Comments from GROM |
|---|---|---|---|---|---|
| Smith Sound | | N | Y | Y | |
| Somerset Island | | Y | Y | Y | |
| West Greenland winter aggregation | | Y | Y | N | Not a separate stock but a fractional winter aggregation of the Somerset Island stock |
| Admiralty Inlet | | Y | Y | Y | |
| Eclipse Sound | | Y | Y | Y | |
| Northern Hudson Bay | Y | Y | Y | Y | |

**Global Review of Monodontids**
**PARTICIPANT LIST**

| Name | Institution | Email |
|---|---|---|
| Kaitlin Breton-Honeyman | Nunavik (Nunavik Marine Region Wildlife Board) (Canada) | kbretonhoneyman@nmrwb.ca |
| Tom Christensen | Circumpolar Biodiversity Monitoring Programme (CBMP, CAFF) | toch@bios.au.dk |
| Geneviève Desportes | NAMMCO | genevieve@nammco.no |
| Steve Ferguson | Department of Fisheries and Oceans (Canada) | Steve.Ferguson@dfo-mpo.gc.ca |
| Eva Garde | Greenland Institute of Natural Resources (Greenland) | evga@mail.ghsdk.dk |
| Maha Ghazal | Government of Nunavut (Canada) | mghazal@gov.nu.ca |
| Dmitri Glazov | Severtsov Institute of Ecology and Evolution (Russia) | glazovd@gmail.com |
| Rikke Hansen | Greenland Institute of Natural Resources (Greenland) | rgh@ghsdk.dk |
| Mads Peter Heide-Jørgensen | Greenland Institute of Natural Resources (Greenland) | mhj@ghsdk.dk |
| Rod Hobbs | Marine Mammal Laboratory, Alaska Fisheries Science Center, NOAA Fisheries (USA) | rod.hobbs@noaa.gov |
| Gerald Inglangasuk | Inuvialuit (Canada) | Tuck-tuck@hotmail.com and email to Laura Murray at fjmc-rp@jointsec.nt.ca |
| David Lee | Nunavut Tunngavik, Inc. (Canada) | dlee@tunngavik.com |
| Denis Litovka | Chukot TINRO (Russia) | dennis.litovka@gmail.com |
| Eline Lorenzen | University of Copenhagen (Denmark) | elinelorenzen@snm.ku.dk |
| Cory Matthews | Department of Fisheries and Oceans (Canada) | Cory.Matthews@dfo-mpo.gc.ca |
| Ilya Mescherskiy | Severtsov Institute of Ecology and Evolution (Russia) | meschersky@rambler.ru |
| Arnaud Mosnier | Department of Fisheries and Oceans (Canada) | Arnaud.Mosnier@dfo-mpo.gc.ca |
| Jill Prewitt | NAMMCO | jill@nammco.no |
| Randall Reeves | US Marine Mammal Commission | rrreeves@okapis.ca |
| Olga Shpak | Severtsov Institute of Ecology and Evolution (Russia) | ovshpak@gmail.com |
| Mikkel Skovrind | University of Copenhagen (Denmark) | mikkelskovrind@gmail.com |
| Robert Suydam | North Slope Borough, Alaska (USA) | Robert.Suydam@north-slope.org |

**Global Review of Monodontids**
**AGENDA AND PROVISIONAL SCHEDULE**

**Monday, 13 March 2017**

| | |
|---|---|
| **8:30** | ***Registration and breakfast*** |
| **9:00** | 1. Welcome and Meeting Information<br>1.1. NAMMCO<br>1.2. Chair's welcome<br>1.3. Rapporteur(s)<br>1.4. Review of documents<br>1.5. Plans for meeting report production and distribution, review of drafts, timetable etc. |
| **10:00** | 2. CAFF/CBMP presentation- State of Arctic Marine Biodiversity Report |
| **10:20** | 3. Stock Definition |
| **10:40** | 3.1 Genome information on belugas and narwhals |
| **11:00** | ***Break*** |
| | 4. Belugas<br>• *Distribution and Stock Identity*<br>• *Abundance*<br>• *Anthropogenic Removals*<br>• *Population Trajectory*<br>• *Potential biological removals or other information on safe (sustainable) limits of anthropogenic removals*<br>• *Habitat and Other Concerns*<br>• *Status of the Stock*<br>• *Recommendations for Research/Cooperation* |
| | 4.1 Pacific Arctic<br>*Russia* |
| **11:15** | ▪ Okhotsk Sea |
| **11:45** | ▪ Western Okhotsk/Sakhalin-Shantar |
| **12:15** | ***Lunch*** |
| **13:15** | ▪ Shelikhov (North-Eastern Okhotsk) |
| **13:45** | *Gulf of Alaska*<br>▪ Cook Inlet |
| **14:15** | *Russia/Alaska*<br>▪ Gulf of Anadyr |
| **14:45** | ▪ Bering-Chukchi-Beaufort |
| **15:15** | ▪ Bristol Bay |
| **15:45** | ***Break*** |
| **16:00** | ▪ Eastern Bering Sea |
| **16:30** | ▪ Eastern Chukchi Sea |
| **17:00** | ▪ Eastern Beaufort Sea |
| | ○ Inuvialuit presentation |
| **17:30** | Adjourn |

**Tuesday, 14 March 2017**

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|---|---|
| **8:30** | Review discussion/Recap of Opening Day |
| | 4.2 Eastern Canada |
| **9:00** | ▪ St Lawrence River |

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|---|---|
| **9:30** | ▪ Ungava Bay |
| **10:00** | ▪ Eastern Hudson Bay |
| **10:30** | ***Break*** |
| **10:45** | ▪ James Bay |
| **11:15** | ▪ Western Hudson Bay |
| **11:45** | ▪ Cumberland Sound |
| **12:15** | ***Lunch*** |
| **13:15** | ▪ High Arctic-Baffin Bay (*shared with Greenland*) |
| **13:45** | ▪ Nunavut Tunngavik presentation<br>▪ Greenlandic hunter's presentation |
| | 4.3 Greenland |
| **14:15** | ▪ East Greenland |
| **14:30** | ▪ West Greenland summer (likely extirpated) |
| | 4.4 Norway |
| **14:45** | ▪ Svalbard |
| **15:00** | ***Break*** |
| | 4.5 Russia |
| **15:15** | ▪ White Sea |
| **15:45** | ▪ Siberian-High Arctic Russia |
| **16:15** | Review Discussion |
| **17:00** | Adjourn |

**Wednesday, 15 March 2017**

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|---|---|
| **8:30** | Recap Day 2, Introduction to Narwhals (Chair) |
| | 5. Narwhals<br>• *Distribution and Stock Identity*<br>• *Abundance*<br>• *Anthropogenic Removals*<br>• *Population Trajectory*<br>• *Potential biological removals or other information on safe (sustainable) limits of anthropogenic removals*<br>• *Habitat and Other Concerns*<br>• *Status of the Stock*<br>• *Recommendations for Research/Cooperation* |
| | 5.1 Canada |
| **9:00** | ▪ Northern Hudson Bay |
| **9:30** | ▪ Somerset Island (shared with Greenland) |
| **10:00** | ▪ Admiralty Inlet (shared with Greenland) |
| **10:30** | ***Break*** |
| **10:45** | ▪ Eclipse Sound (shared with Greenland) |
| **11:15** | ▪ Eastern Baffin Island (shared with Greenland) |
| **11:45** | ▪ Jones Sound (shared with Greenland) |
| **12:15** | ***Lunch*** |
| **13:15** | ▪ Smith Sound (shared with Greenland) |
| | 5.2 Greenland |
| **13:45** | ▪ Inglefield Bredning |
| **14:15** | ▪ Melville Bay |
| **14:45** | ▪ Nunavut Tunngavik presentation<br>▪ Greenlandic hunter's presentation |

| | |
|---|---|
| **15:15** | ▪ Northeast Greenland |
| **15:45** | ***Break*** |
| **16:00** | ▪ East Greenland |
| | 5.3 Norway |
| **16:30** | ▪ Svalbard |
| | 5.4 Russia |
| **16:15** | ▪ Info on sightings |
| **16:30** | Review Discussion |
| **17:00** | Adjourn |

**Thursday, 16 March 2017**

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|---|---|
| **8:30** | 6. Discussion of regional and global issues— Belugas:<br>6.1 Climate Change<br>6.2 Shipping, Development, Fisheries |
| **9:30** | 7. Discussion of regional and global issues— Narwhals:<br>7.1 Climate Change<br>7.2 Shipping, Development, Fisheries |
| **10:30** | ***Break*** |
| **11:00** | 8. Summary of Recommendations for Research/Cooperation |
| **12:00** | ***Lunch*** |
| **13:00** | 9. Review of report schedule and completion |
| **14:00** | 10. Any other business |
| **14:15 —<br>16:00** | 11. Closing Discussion and Remarks |