Symposium on the
Impacts of Human Disturbance on Arctic marine mammals, with a focus on Belugas, Narwhals & Walrus

REPORT

13–15 October 2015, University of Copenhagen, Denmark

Please cite this report as:

BACKGROUND

Human activity in the Arctic has increased in recent years, and will likely continue to increase with the effects of climate change, especially reductions in sea ice extent. These activities include oil and gas exploration, shipping, fisheries, tourism, etc. This Symposium was organized primarily due to concerns in Greenland over the effects that increased human activity may have on marine mammals such as narwhals, belugas, and walrus. However, NAMMCO recognized that these concerns are likely relevant for the entire Arctic and all Arctic marine mammals. With this in mind, the goals of the Symposium 1) present an overview of the information currently available; 2) identify and characterize possible sources of disturbance, and the effects on individuals and populations; 3) consider the need for possible mitigation measures to minimise sources of anthropogenic disturbances; and 4) reflect on future studies needed to assess long-term impacts of anthropogenic activities on both individual and population levels (particularly in the light of global warming).

There were 45 participants and 22 presentations covering the effects of various sources of disturbances including seismic exploration, shipping, and tourism on Arctic and sub-Arctic species—belugas, narwhals, walruses, bowhead whales, humpback whales, Caspian seals, and harbour seals. After each presentation there was a short question session, and longer discussion sessions were held each day. Over the course of the 2 ½ day Symposium, lists were created for general issues of risk assessment for all species (Table 1), and specific lists of risks, data gaps, and possible mitigation steps for the focal species. A breakout session was held on the last day to prioritize these lists.

The Symposium was funded by NAMMCO with generous contributions from World Wildlife Fund-Denmark and the Government of Greenland. The University of Copenhagen generously provided the meeting facilities.

Main topics of Discussion

The participants identified a number of issues that are general problems for assessing the risks for all marine mammal species in the Arctic.

- *Assessing impacts on international stocks*

Shared stocks often do not have shared scientific cooperation and/or management, and risk assessments are usually done on a national basis.

- *Industrial development changing activity plans post-assessment*

Risk assessments are critical during the development stage, but the Symposium identified cases where the projects had been changed after the risk assessment had been carried out. This creates a situation where a risk assessment has not *really* been performed for the actual project that is being implemented.

- *Lack of expertise on assessment boards in specialty fields*

The participants reported that the people asked to assess risks may not have the expertise needed to assess those particular risks, e.g., assessing the risks of a seismic project when the assessment board does not have an acoustics expert.

- *Defining levels of thresholds for unacceptable levels of risks*

In most cases, scientists (and managers) have not identified what level of risk will be acceptable, e.g., what percent decline in the population is tolerable.

- *Non-compliance with in-place conservation measures (e.g. narwhal hunting in the reserve)*

Conservations measures are often put in place without enforcement measures/strategy.

- *Response times in a changing Arctic*

In the situation of a rapidly changing Arctic, scientists and managers are faced with situations where responses to risks need to be addressed quickly. However, response times are often slowed due to challenges with variance and data precision, which do not allow for definitive answers. In these situations, the risk of inaction are great, and should be considered.

- *Technological advances in the "disturbance sources"*

The research being performed now is looking at the current typical sources of disturbance, however industry may develop new technological advances that are not well researched before they are used. For example, data may be collected on marine mammals' response to icebreakers that are currently in use, but the next generation of icebreakers may not be researched before being used.

- *Mitigation and monitoring*

Mitigation steps must be followed up with monitoring programs to determine whether the mitigation is actually effective and adjust them if needed.

- *Need for physiological studies*

It can be challenging to determine whether a potential disturbance is having an effect, and behavioural studies may not be enough to say whether there is an impact on the animal. However, physiological studies could detect effects before behaviour changes, or in cases when behaviour does not appear to change at all.

Table 1. Risks, known impacts, data gaps, and possible mitigation steps for all Arctic marine mammals

Threats/Risks	Known Impacts	Data gaps	Mitigation
1) Shipping *Noise and presence of ships in important habitat*	• Displacement from habitat (migration, foraging, resting, etc.) • Habitat disruption/ destruction; disruption of breeding/ moulting /haulout areas (particularly seals) • Physical impact (ship strikes for whales, collisions for seals)	• Effects detection- more research is needed to detect impacts, both on the individual and population level	• Speed restrictions/seasonal closures? • Routing lanes/no-go areas/marine reserves • Exclusion areas and buffer zones around sites of oil/gas leases as well as sites of particular types of activity, based on "biological sensitivity" • Quieting technology, e.g. bubble curtains for pile-driving and other construction activities; ship-silencing devices, designs, protocols • Speed/time of day/seasonal restrictions • Better logistical planning/ coordination between companies/ shippers to limit activities • Rapid/real-time mitigation (Caspian seal example of aerial surveys)
2) Seismic exploration	• Displacement from habitat (migration, foraging, resting, etc.). Narwhal were identified as being particularly sensitive to seismic activities.	• Effects detection- more research is needed to detect impacts, both on the individual and population level	• MMOs often used, but can be problematic for all species because animals may be impacted before detection • Determination of 'exclusion' ('safety') or 'mitigation' zones around noise-generating activities, monitored in 'real time' by visual observers and sometimes acoustic sensors (see summaries from Castellote et al. and Weissenberger) • Development and introduction of alternative technology, e.g. vibroseis to replace airgun seismic surveys
3) Fisheries	• Competition for prey • Displacement from foraging areas		• Seasonal closures • Gear modification

Threats/Risks	Known Impacts	Data gaps	Mitigation
	• Bycatch, e.g. increasing for humpbacks in Greenland (esp. pound nets, crab pods)		
4) Hunting (past and present)			• Enforcement of regulations • Ongoing need for monitoring (esp. walruses) • Shared stocks- international cooperation/responsibility
5) Tourism *Increasing throughout the Arctic*	• Seals and walrus- abandon haulout sites with disturbance (hunting or tourism)	• More information needed on behavioural responses to presence of tourists	• Development of guidelines/ education for tour guides and tourists • Walrus- recommendations for distance/downwind • Seals- calm tourists had less reaction from seals, guide information // Minimum distance for people
6) Multiple stressors/ cumulative impacts *Cook Inlet belugas are a serious example*		• Need for models to investigate cumulative impacts • E.g., Cook Inlet- not allowed to handle animals for tagging, physiological studies, etc.	• Implement mitigation for specific impacts above • For Cook Inlet, MMPA/ESA implementation is *not* working

Priorities for focal species: beluga, narwhal and walrus

Breakout sessions were held to discuss and rank the risks of the different types of human disturbance identified during the Symposium for the focal species. For all marine mammals in the Arctic, including the focal species, climate change was considered to be an overall risk for all species, and all of the additional threats were considered in the situation of a rapidly changing climate.

Hunting was also considered to be a potential threat to these species, however it was noted that NAMMCO has management procedures in place to mitigate the risks of hunting, such as systematic population assessments of all exploited stocks (including obtaining regular abundance estimates) and the implementation of quotas. For non-hunting anthropogenic threats such as industrial activities, the management procedures are less defined and were more of the focus of the Symposium, therefore the priority lists focused on these threats.

Multiple stressors described situations where an individual stressor was not necessarily considered a significant threat, but the cumulative impacts of the stressors was a significant threat to the species.

Beluga

The group agreed that the identified stressors should be prioritized under the umbrella that combines Cumulative Impacts/Multiple Stressors and Climate Variability. In that perspective, the prioritization is as follows:

1. Cumulative Impacts
2. Seismic (which could probably be changed as the Walrus Group proposed to oil and gas related activities)
3. Fisheries
4. Shipping
5. Tourism
6. Hunting

1. Cumulative Impacts

Impacts: Reduced fecundity, habitat degradation

Data Gaps: It was proposed that a good way to start addressing cumulative impacts would be to map the various stressors and their intensity. This type of assessment was conducted for 23 different stressors at the scale of the globe (Halpern et al. 2007), but was also refined for specific region, overlaid with marine mammal densities, and adapted to account for their vulnerability to each of the stressors (e.g., Maxwell et al. 2013).

Mitigation: Once areas with multiple stressors and high intensity are identified, actions may be taken that are specific to the stressor and species involved.

2. Oil and Gas Exploitation/Exploration

Impacts: Acoustic, displacement, other less detectable sub-lethal effects

Data Gaps: impacts of oil and gas activities including seismic on belugas; route and timing of beluga migration (e.g., West Greenland); limited information exists for impact thresholds at close range, but none exists for impacts at long range (disturbance); efficiency of several of the mitigation measures (e.g., ramp-up, visual vs PAM detection, visual detection vs Beaufort, etc.)

Mitigation: avoid redundancy in seismic operations in an area, exclusion zone, ramp-up, etc.

3. Fisheries

Impacts: Competition for food resource; entanglement and bycatch

Data Gaps: beluga diet and foraging areas; inability to identify potential developing interests in resource exploitation to avoid competition for resource

Mitigation: Observer program on board fishing vessels to document bycatch and other interactions; gear research to reduce bycatch if deemed necessary

4. Shipping

Impacts: Oil spills; invasive species; displacement; acoustic impacts of a chronic increase in ambient noise; alteration of ice cover; infrastructures associated with shipping

Data Gaps: Thresholds for impacts from chronic noise sources; data availability on traffic; efficient way of dealing with oil spill in ice, and behaviour of oil in cold water conditions

Mitigation: Noise reduction (vessel speed, noise reduction technology for construction, improved maintenance, etc.); route planning; strategic planning of coastal infrastructures associated with shipping (e.g., ports, etc.)

5. Tourism

Impacts: Disturbance; sewage dumping in fjords

Data Gaps: long-term effects of repeated disturbance; knowledge of distribution, sex segregation, birth and feeding areas, migration routes for belugas; mapping of tourism activity distribution and volume; documented interactions and level of effects

Mitigation: area/time closures; regulations; education of guides and the public

Narwhal

1. Seismic

Impacts: range contraction/shifts in distribution (which could also alter their vulnerability to hunting pressure)

Data Gaps: behavioural and physiological responses, long-term sub-lethal effects

Mitigation: restrict timing and/or location of seismic activities

2. Shipping

Icebreaking during winter shipping activities was identified as particularly detrimental to narwhal.

Impacts: range contraction/distributional shifts, habitat disruption

Data Gaps: hearing sensitivity, physiological effects

Mitigation: restricting shipping spatially and/or temporally

3. Fisheries

The participants ranked fisheries as a relatively low risk for narwhals at this time. However, it was also discussed that fisheries will likely increase in the future, especially the halibut fishery, which could affect narwhals (competition for prey, displacement from foraging areas, etc.). Therefore, the potential impacts of fisheries on narwhal should be monitored.

4. Tourism

The levels of tourism in narwhal habitat remain low enough that this was not seen as a high risk. However, as with fisheries, any increases in tourism should be monitored.

Walrus

The walrus breakout group agreed that the category of “seismic activities” should include all oil and gas activities. They ranked the risks based on the populations of interest to NAMMCO- West Greenland, East Greenland and Svalbard.

For all areas, the group noted that seismic activities have unknown effects on walrus prey species. Scientists and managers should consider requiring industry to cooperate on studies and share data before and after seismic surveys.

West Greenland

1. Oil and Gas Activities

The main oil and gas activities considered to be significant risks to walrus in West Greenland were shipping and seismic activities.

Impacts: displacement from habitat, sub-lethal effects

Data Gaps: hearing sensitivity, behavioural responses to shipping and seismic, unknown effects of oil spills

Mitigation: Seasonal/location restrictions for critical times/areas

2. Shipping

Shipping activities in general are a risk factor for walrus in West Greenland, and the Mary River-Baffinland project was identified as a major risk to walrus in Baffin Bay.

Impacts: displacement from habitat, sub-lethal effects

Data Gaps: hearing sensitivity, behavioural responses to shipping and seismic

Mitigation: Restricting the quantity and/or timing of shipping through Baffin Bay, in particular the Mary River-Baffinland project.

3. Fisheries

Impact: displacement from foraging areas

Data gaps: it is unknown whether the presence of fishing vessels may be displacing animals

Mitigation: close/reduce fishing activity in critical foraging areas
East Greenland

Oil and gas activities, and seismic in particular, were identified as the only significant risk to walrus in East Greenland. The impacts, data gaps, and possible mitigation measures are the same as for West Greenland.

Svalbard

The group noted that this population is relatively stable, however less is known about the status of the population and potential stressors in the Pechora Sea and farther east, and there may be significant oil and gas development in those areas.

Seismic activities were identified as the most significant risk. There may also be some risk associated with potential grounding and/or oil spills from ships involved in tourism and supply shipping.

PRESENTATION SUMMARIES

Welcome from NAMMCO
Jill Prewitt, NAMMCO Secretariat

NAMMCO is a regional organisation concerned with the conservation, management and study of marine mammals in the North Atlantic. This includes both large and small cetaceans, and also seals and walruses. Our member countries are Norway, Iceland, Greenland, and the Faroe Islands. NAMMCO was founded in 1992 on the principles that we:

- Recognise
  - ✓ the rights and needs of coastal communities
- Are committed to the
  - ✓ Effective Conservation of marine mammals
  - ✓ Sustainable and responsible use of marine mammals
  - ✓ Ecosystem-based approach
- Base our management decisions on the best available scientific advice and user knowledge

As NAMMCO's members are all Arctic nations, we have a strong interest in Arctic issues. This Symposium stems primarily from concerns in Greenland over how increased human activity may affect marine mammals such as narwhals, belugas, and walrus, but NAMMCO recognised that these concerns are likely relevant for the entire Arctic and all Arctic marine mammals.

Therefore we look forward to the many interesting talks and fruitful discussions this week that will help us in providing the best possible management advice for the marine mammals in our waters.

Status of selected Arctic marine mammals
Mads Peter Heide-Jørgensen, Greenland Institute of Natural Resources

There are between 20 and 24 more or less discrete populations of belugas worldwide. The size of the various populations varies from very low numbers in Cook Inlet and St. Lawrence River to significant populations in the Canadian high Arctic, Beaufort and Chukchi Seas. Abundance along the Russian coast could potentially be very large as typical beluga habitat is present. The beluga populations apparently separate into two different types; those that migrate long distances between summer and winter areas, and those that are stationary in the same area year-round. From a disturbance perspective, belugas live to a varying degree with habituation to human activities. In central Siberia belugas are often found at shipping lanes or close to towns (e.g. Dikson and Anadyr). In Greenland belugas avoid human presence as they are often subject to hunting. When it comes to population effects, it is difficult for all species to discriminate between effects caused by hunting and those caused by disturbances.

The narwhal is restricted to the Atlantic sector of the Arctic where they persist in relatively small and isolated populations east and west of Greenland. Track of individual whales show that they use strict migratory corridors and have high site fidelity to certain winter and summer areas and can be separated into discrete summering stocks. Narwhals are considered highly sensitive to disturbances and especially ice breaking and seismic investigations are considered to be potentially harmful for narwhals that show little behavioural plasticity in migratory patterns.

Bowhead whales have a circumpolar distribution and exist in 4-5 populations with the smallest population in the Okhotsk Sea. The Bering-Chukchi-Beaufort sea stock is slightly increasing at 3-4% and the Foxe Basin-Hudson Bay and the Baffin Bay-Davis Strait stocks have shown a major increase over the past 15 years. The stock in East Greenland has recently shown signs of recovery after a survey in the Northeast Water revealed an abundance of 100 whales hiding in the polynya. In Alaska satellite tracking has been used to demonstrate how bowhead whales passed through oil and gas lease areas during their fall migrations to illustrate the potential conflict with industrial activities. In Baffin Bay bowhead whales winter in several different areas and they seem to be very flexible in movement patterns. Important concentration areas include Disko Bay and the West Greenland coast as well as Hudson Strait.

By far the largest abundance of walruses occurs in the Bering Sea. In Greenland they are found in a separate population in East Greenland that is also believed to be separate from those occurring around Svalbard. In West Greenland there is one population in the Thule area that is connected to walruses in the Canadian Archipelago. Another population in mid West Greenland crosses Davis Strait in spring and move to east Baffin during the summer and they only occur in West Greenland in winter. A small population is found in Hudson Bay and a large - or perhaps two large - populations occur in Foxe Basin. In winter they are widely dispersed in Hudson Strait, Foxe Channel and around Southampton Island. In Svalbard the walrus population is growing and the status for stocks in the Pechora and Kara Seas is unknown but recent surveys indicate population of several thousand animals in the Pechora Sea. Walruses are particularly sensitive to disturbance on their haul-out sites and many terrestrial haul-outs have been abandoned in the North Atlantic due to human activities.

Concerns and opportunities

Kit Kovacs, Norwegian Polar Institute

Abstract not available.

Case Studies

Oceans of noise: Assessing risks to marine mammals in the face of uncertainty

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Human activities are increasing the level of noise in the oceans, causing widespread concern about the potential effects on marine mammals and marine ecosystems. Sound propagates efficiently through water and marine mammals rely on the use of sound to communicate with conspecifics, for predator avoidance, to locate and capture prey, mate selection and social interactions. Coupled with this, they have an acute sense of hearing with a high sensitivity over a wide frequency range. This reliance on sound in their general ecology makes marine mammals particularly vulnerable to the effects of underwater noise. Many marine activities generate significant underwater noise into the marine environment (e.g. explosive use, pile-driving, geophysical surveys, ship propeller noise etc.). Exposure to noise can have a range of effects depending on the sound type or received level. Loud, intense noise sources such as explosions have the potential to cause lethal physical non-auditory injury to marine mammals, while other noise sources can cause auditory damage or elicit behavioural responses (e.g. displacement and/or habitat exclusion). It is widely acknowledged that short-term behavioural responses may become biologically significant if animals are exposed for sustained periods of time, but the interpretation of the biological consequences of disturbance is limited by uncertainty about what constitutes a meaningful response, both at the individual and the population level.

As the Earth's population grows, there is an increased demand for energy. The potential for the exploitation of both fossil fuels and renewable energy sources in the Arctic is being considered. With increased development and shipping, comes the need for impact assessment at project and strategic levels to determine the most sustainable path ahead. Risk assessment provides a framework to allow scientists, regulators, decision-makers, sound producers and conservationists to better understand of the effects of noise and to manage those effects, both on an individual and cumulative basis. In addition, such frameworks be used to identify key sensitivities and knowledge gaps to be filled and crucially the data that need to be collected, thus prioritising future research.

Consequences of speed limits and partial rerouting of shipping traffic on habitat acoustic quality and beluga exposure to noise pollution in the St. Lawrence Estuary, Canada: Science in support of risk management

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Noise associated with human activities has become ubiquitous in the world oceans, and has dramatically changed their acoustic landscape. Anthropogenic noise may interfere with marine mammal vital functions in a number of ways, e.g., by altering behaviour or disrupting prey, reducing communication space, foraging efficiency, or predator detection, by temporarily or permanently impairing hearing, by causing stress through changes in physiological functions, habitat avoidance or even death. Research efforts have been largely dominated by studies examining effects from acute sounds. However, there is a growing recognition that long-term (i.e., chronic), large-scale, low intensity noise exposures may also affect individual fitness and population conservation. Of particular concern is the chronic exposure to shipping noise.

The St. Lawrence Estuary (SLE) marine shipping lane currently overlaps with the main aggregation area for large baleen whales, male beluga and whale-watching activity, raising concerns for potential whale/ship or whale-watch vessel/ship collisions. Motivated by the desire to reduce collision risks, local authorities proposed to reduce ship speed to 10 kt within a particularly sensitive area in the North Channel (NC), leaving pilots the option of diverting their route to the South Channel (SC), thereby avoiding most of the speed-reduction zone and areas of whale aggregation. However, shifting part of the commercial traffic to the SC may alter patterns of exposure of St. Lawrence Estuary (SLE) beluga to marine traffic. The present study indicates that commercial traffic transiting through the SLE exposes many times daily a substantial proportion (15-53%) of the SLE beluga population, of which the vast majority (72-81%) are females with calves or juveniles, to noise levels likely to induce negative behavioural responses in a majority of the exposed individuals. Diverting shipping to the SC not only increases the proportion of the population and its habitat (including designated Critical Habitat) exposed to noise levels in excess of the threshold for negative behavioural responses, but also contributes to the acoustic degradation of beluga habitat previously relatively lightly exposed to shipping noise. We therefore conclude that maintaining or concentrating commercial traffic as much as possible in the NC constitutes the scenario which minimizes impacts on beluga and their habitat. A reduction in vessel speed or size, changes in vessel designs, or any other measure that might make vessels quieter, would contribute to reducing potential negative effects on SLE beluga. We also emphasize the need for putting forward conservation measures for sites important for marine mammals but that are currently quiet and of little political or socio-economical interest (referred to as 'Opportunity sites' by Williams et al. in press., Mar. Poll. Bull.).

Overview of the Department of Fisheries and Oceans' comments on the environmental impact statement of Baffinland's Mary River Project

Marianne Marcoux, Department of Fisheries and Oceans Canada

The Mary River Project is a proposed iron ore mine operated by Baffinland located at Mary River, on North Baffin Island, Nunavut. In the early phase of the project, 18 million tonnes of iron ore will be shipped annually through Milne Inlet. Based on the evaluation conducted by the Department of Fisheries and Oceans Canada (DFO), three shortfalls of the environmental impact assessment prepared by Baffinland will be reviewed. First, Baffinland underestimated the impact of noise on marine mammals. Baffinland did not consider the total impact of several simultaneous sources of noise even though they indicated that sometimes two ships or more will be present at the same time in Milne Inlet. As a result, Baffinland should have provided sound propagation models taking into account noise from multiple sources. In addition, noise has been recognized as a chronic stressor, and thus, their evaluation of the impact of noise should have been based on cumulative noise exposure over time. Second, Baffinland predicted that their ships would not strike any narwhals or bowhead whales. DFO considered that this assessment greatly underestimated the number of whales at risk to be struck by ships and proposes using a modelling approach to predict this risk. Third, Baffinland claimed that a perturbation affecting 10% of the individuals in a marine mammal population is an acceptable level of impact. This threshold is hard to evaluate because it does not provide any temporal or spatial scale. In addition, this threshold has no empirical basis and does not take into account the different life histories of marine mammals in the Arctic. DFO suggests using quantitative approaches, such as the potential biological removal or population dynamic models, to determine an acceptable level of impact. Lastly, a change of 10% would be hard to detect through regular monitoring given the confidence intervals of most monitoring techniques.

Hudson Strait: a case study with the shipping industry

Peter J. Ewins and Andrew Dumbrille, WWF-Canada

Canada's Hudson Strait region provides important conditions for globally-significant marine mammal populations in every season, reflecting regular open-water access to relatively productive Arctic foodwebs. Three Ecologically and Biologically Significant Areas (EBSAs) cover the entire area of Hudson Strait. The Strait is also a destination and gateway for commercial shipping, and vessel traffic is expected to increase as the length of the open water season increases as a result of climate warming. In the absence still of any Marine Protected Areas (MPAs), or zoned marine plans for the region, or high quality specific guidance from regulators on anthropogenic noise or other disturbances, WWF-Canada worked with a large shipping company, FedNav – Canada's largest ocean-going bulk cargo transportation company. Our ultimate aim is to identify the key risk areas, and then the suite of measures necessary to minimize risks to wildlife and marine habitats, that can be expected to arise from commercial shipping activities in Hudson Strait. We completed a preliminary risk assessment for Hudson Strait, based on a regional collation of oceanographic, ecological, socio-cultural, and economic values, and all available information. We present a series of summary maps for these aspects, including for Beluga, Narwhal and Walrus, as well as a series of recommendations arising from the first phase of this work, relating to: 1) measures to address key data gaps; 2) measures to address higher risks; 3) measures to promote best practices.

Monitoring narwhals in Melville Bay in relation to seismic surveys

Rikke Guldborg Hansen, Greenland Institute of Natural Resources

Baffin Bay has been the scene of a massive seismic exploration scheme during the last decade and in 2012 intensive 3D seismic exploration was carried out by multiple companies close to the summering grounds of narwhals in Melville Bay. Monitoring studies of the hunting activity and occurrence of narwhals in Melville Bay included aerial surveys before, during and after the seismic in 2012 followed by another aerial survey in 2014. Aerial surveys conducted in 2012 gave an indication, but no clear evidence, that there were more narwhals present inside the Melville Bay during the early part than in the late part of the period with seismic exploration. Compared to a similar survey from 2007, the abundance of narwhals in 2012 was lower but not significantly different, while the distribution in 2012 was more clumped and closer to shore. In 2014, an even larger proportion of the whales were found close to the coast and glaciers compared to both 2007 and 2012 surveys. Although the abundance seem to remain at the same level, the distribution has changed. The contraction of whales is reflected both in the trend of larger group sizes but most evidently in the drop of distance between narwhal individuals or groups. The main concern is the contraction in the range as the narwhals have virtually disappeared from their previous outer distribution boundaries in the bay.

The narwhal's sense of silence
Mads Peter Heide-Jørgensen, Greenland Institute of Natural Resources

There are a number of characteristics of narwhals from Canada, East and West Greenland that illustrate their extreme specialisations. They utilize strict migratory corridors when travelling from summer to wintering grounds, and they have specialised feeding behaviour with few potential prey species. During winter they focus their diving activity to great depths for 6-8 months. The dives are probably targeting concentrations of Greenland halibut because winter samples of narwhals stomachs show they are filled with halibut remains and sometimes contain up to 35 kg of prey items. There is considerable overlap between narwhal occurrence and the catches of halibut and it is estimated that thousands of tons of halibut are consumed by narwhals. In summer, narwhal stomachs are often empty or contain very few remains of polar cod and squids.

Few accurate measurements of ambient noise levels at the narwhal habitats exist but there are a couple from the early 80's collected during the Arctic Pilot Project assessment process. Measurements at the narwhal summering ground in the Thule area are from the open water period but show that even though there is noise from wave activity ambient noise levels are still low compared to most other measurements in the Arctic. Measurements from the narwhal pack ice winter habitats show very low noise levels especially at the higher frequencies where narwhals concentrate most of their energy in the echolocation clicks.

Ongoing studies of the effects of seismic exploration focuses on four items. First thing is to estimate the direct reactions of the whales to airgun pulses and compare movements to past tracking in the same area. Next part of the studies is to look at the noise levels received by the whales and the changes in vocal activities from the whales during seismic. Another important parameter is the changes in diving behaviour and the feeding rates observed from stomach temperature pills. It is important to measure both the dive changes and the acoustic response of the whales but ultimately we need to know how their physiology is impacted by the disturbance. One measure of physiological impact is the changes in heart rate during dives with and without exposure to seismic.

Cook Inlet beluga Abundance, Distribution and Potential Sources of Disturbance
Rod Hobbs, National Marine Mammal Laboratory, USA

The Cook Inlet beluga population had declined to around 350 individuals in 1999 from and estimated size of 650 in 1994 and 1300 in 1979. Much of this decline prior to 1999 can be attributed to unregulated subsistence hunting which exceeded 70 takes per year in the mid 1990's. Since 1999 the population has failed to increase despite the limitation of hunting takes to a total of 5 between 2000 and 2005 and none since then. In addition to the decline in abundance the Cook Inlet beluga has shown a substantial contraction in summer range with the current population occupying only 39% of the range observed in 1979. One hypothesis to explain the failure to recover from excessive hunting takes and changes in distribution are increasing levels of disturbance from anthropogenic noise as well as vessel interaction from shipping, fishers and other water craft. Anthropogenic noise sources include vessel and aircraft, in water construction including pile driving, drilling and dredging and seismic surveys. Some of these sources have increased substantially between 1979, 1994 and 2015 but the population level consequences are poorly understood. The US National Marine Fisheries Service (NMFS) has begun a process to develop a PCoD model (Population Consequences of Disturbance) which will provide a method to quantify the impacts of disturbance from noise on the life history parameters of this population and its potential for recovery. The PCoD model considers the belugas behavioural and physiological response to each disturbance event and then quantifies the cost to health and condition of each individual and the resulting impact on fecundity and survival. These impacts to individual life history parameters are then summed over the whole population to determine the effects on population growth or decline and risk of extinction or probability of recovery. While the intent of the model is to relate disturbance to population level consequences we can also use the model in reverse to estimate the size of the impact that if removed would allow the population to recover. Population models of the Cook Inlet beluga have shown that an increase of 2% to the growth rate would be sufficient to change probability of recovery 10%to 90%. This would result from an increase in fecundity of 30% and an increase in survival of 1-2%.

Anthropogenic noise on Cook Inlet and Bristol Bay beluga habitat: potential for negative effects

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Anthropogenic noise has been identified as a major threat for the recovery of the endangered Cook Inlet beluga population. NOAA Fisheries is currently regulating noise exposure to marine mammals under the Marine Mammal Protection Act and the Endangered Species Act; however regulation and noise impact mitigation is limited to close range effects defined by specific acoustic exposure thresholds (120 dB for non-impulsive noise sources and 160 dB for impulsive sources). Cook Inlet beluga habitat is in close proximity to the greatest concentration of Alaska's human population and the largest urban area in the state, exposing belugas to a wide variety of noise stressors including fishing, mining, shipping, dredging, renewable energy development, military operations, oil and gas development, air and water transportation, and residential and industrial shore development. All these activities occur within Cook Inlet beluga critical habitat, and many of them are intensified during their main foraging season when ice is absent (May to October). Bristol Bay, Alaska, is a similar estuarine environment but with minimal human influence and a pristine soundscape. Beluga hearing obtained on 17 temporarily restrained belugas in Bristol Bay show lower thresholds than previously reported for this species. When these results are compared to quantitative results from the altered Cook Inlet beluga soundscape, it can be concluded that all the anthropogenic noise sources identified in Cook Inlet habitat are within hearing range at very considerable distances from the source, and often regulatory noise thresholds occur at distances where mitigation is difficult to achieve or unfeasible. As examples, a standard seismic survey in Cook Inlet generated 180 dB at 2.9 km and 160 dB at 7.2 km in radius around the seismic vessel. A pile driving operation near shore generates 180 dB at 2.3 km, 160 dB at 29 km and 120 dB exceeding 100 km. The majority of the Cook Inlet beluga critical habitat would be ensonified by these activities, lasting several months. Ongoing experimental studies on captive belugas in aquaria exposed to Cook Inlet ship and pile driving noise below regulatory levels indicate shifts in masked hearing over 20 dB and concurrent significant changes in cortisol levels. These results suggest that Cook Inlet acoustic disturbance below the 120 or 160 dB regulatory levels, occurring on a daily basis and for a large portion of the beluga critical habitat, affects beluga hearing capabilities and stress levels. This widespread disturbance has the potential to negatively affect vital acoustic related functions such as prey and predator detection, reproduction success and survival in general, and thus the recovery of this declining population. This spatial and temporal concentration of stressors and their cumulative effects in a subarctic population of belugas might well reflect the consequences of future changes in rapidly shifting arctic ecosystems.

Detecting the effects of seismic exploration on the behaviour of whales: what we've learned from bowheads and hope to learn about narwhals

Susanna Blackwell, Greeneridge Sciences, Inc.

One of the main challenges in assessing the effects of anthropogenic sounds on the behaviour of marine mammals is being able to match up the dose of anthropogenic sound of interest received by an animal with the reaction of the animal. Sounds of interest can include, for example, airgun pulses, vessel sounds, or construction sounds, and reactions of the animal include measurable behavioural or physiological parameters such as a change in the course of migration, a change in calling behaviour, or changes in heart rate or the level of stress hormones.

Two different ways to deal with the challenge of pairing up received sounds and animal reactions will be discussed below: first, by using particle velocity sensors to localized calling bowhead whales, and second by tagging narwhals with acoustic tags.

We investigated the effects of sounds from airgun pulses on migrating bowhead whales in a four-year study (2007–2010) in the Beaufort Sea, using data collected by 40 directional autonomous seafloor acoustic recorders (DASARs). The key to this study was the ability to localize the calling whales, for two important reasons: (1) it meant that we could restrict our samples to whales that were calling near the DASARs (within 2 km), where the probability of detection of a call was not dependent on background levels; (2) it meant that we could use the recorded levels of sound from airgun pulses at the DASARs as a proxy for received sound at the whales. Our results showed that bowhead whales modify their calling rates as a function of the received levels (RLs) of airgun sound. Compared to times when no airgun pulses were detected, whales called more when RLs were low and the seismic operations were distant (up to hundreds of km away). Fifty to 100 km from the seismic ship in our study, calling rates started decreasing, and within tens of km of the seismic ship the whales were virtually silent. The whales therefore showed a dual threshold of behavioural reaction to received sounds from airgun pulses: at low received levels they increased their calling rates, but beyond a certain threshold, calling rates dropped to zero.

We are planning to study the effects of sounds from airgun pulses on East Greenland narwhals, using a similar principle, but a different technology: acoustic recording tags (Acousondes™). At the cost of small sample sizes, such tags provide tremendous detail in the behaviour of the animals carrying them, including changes in vocalization and in three-dimensional diving behaviour (e.g., depth, stroking rates, etc.). Several deployments of acoustic tags have been performed on adult female narwhals in East Greenland since 2012. The tags have remained on the animals for several days, and have provided a wealth of information on diving behaviour, feeding behaviour, including echolocation and buzzing, and three-dimensional movement patterns.

Monitoring programs in Eclipse Sound: increased shipping and potential effects on narwhals

Kristin Westdal, Oceans North

Marine shipping traffic associated with the Baffinland iron ore mine off the north coast of Baffin Island in Nunavut Canada is a concern for northern residents that rely on the marine mammals of the region as part of a subsistence harvest. As of 2015, the mining operation has begun seasonal shipping of bulk ore in the open water season and now seeks to ship ten months of the year (June-March), breaking sea ice in Eclipse Sound in winter months starting in 2017.

This area is the summering ground of a portion of the estimated 60,000 narwhals that belong to the Baffin Bay narwhal population. The community of Pond Inlet and the regional Inuit Association (QIA) are interested in monitoring the narwhal population that summers in the area ahead of the shipping increases expected with the mine. Over the last two years Oceans North has been working with the Mittimatalik Hunters and Trappers Organization in Pond Inlet Nunavut and local community members to monitor ecological changes in the greater Lancaster Sound region.

The work has two components – monitoring effects of shipping on the summering narwhal population and monitoring and characterizing landfast ice covering Eclipse Sound before, during and after its break up in advance of proposed winter shipping. The first part of the monitoring program uses passive acoustic recording devices to determine presence of narwhals in the Milne Inlet area and reaction to ship traffic during the shipping season. Local hunters deployed and retrieved two devices in 2014 in Milne Inlet and four in 2015 in Eclipse Sound, Milne Inlet and Tremblay Sound. The second part of the program involves photographic monitoring of the Eclipse Sound floe edge before, during and after its break-up in late spring and early summer, by way of two autonomous time-lapse camera systems deployed on high lands on both sides of the eastern end of Eclipse Sound. Each system consists in an insulated box containing the camera and hardware powered by one battery and one solar panel. Equipment was brought on sites by snowmobiles in May, and recovered by boat and helicopter with the help of hunters from Pond Inlet.

Analysis of the photographic work and acoustic analysis of 2015 data is underway. Preliminary results from 2014 acoustic data suggest that narwhal respond to an increase in overall background noise by modifying some of their call parameters. In addition, preliminary findings indicate that in the presence of distinguishable anthropogenic noise (ships, small boats, and gun shots) narwhal acoustic detections were less frequent which may suggest that narwhal leave the area or go silent in the face of perceived threats.

Research in Svalbard related to human disturbance of marine mammals

Christian Lydersen and Kit M. Kovacs, Norwegian Polar Institute

The Norwegian Polar Institute (NPI) is conducting two long-term monitoring projects specifically related to potential human disturbance impacts on wildlife. One is focused on passive acoustic monitoring of ocean sounds and the other involves camera monitoring of selected walrus haul-out sites in Svalbard. Highlights of key preliminary findings are presented below.

AURALs (**A**utonomous **U**nderwater **R**ecorder for **A**coustic **L**istening) have been used to monitor underwater sound in the Svalbard area since 2008. Currently NPI has 4 of these instruments deployed, two offshore at continental slopes sites and two inside fjord-systems. These instruments are mounted on oceanographic rigs and sample sound from marine mammals and noise throughout the year. Key results include the documentation of airgun noise, which is present on a year-round basis with a peak in the summer season as far north as in the Fram

Strait at about 79° N. A new Postdoctoral position started mid-2015 to analyze this vast dataset, from both an ocean noise perspective and in order to catalogue the seasonal presence of various marine mammal species, particularly the three Arctic endemic whale species.

Cameras have been used to monitor walrus haul-out behaviour at selected haul-out sites in Svalbard since 2007. The cameras (two at each site) are mounted at the top of a 5 m high mast with battery boxes and solar panels. Each camera takes one high quality picture each hour during the summer season when the animals use their terrestrial haul-out sites. More than 60,000 pictures from a total of 5 different haul-out sites have been collected thus far. The purpose of this monitoring is to study the natural dynamics in the haul-out pattern of walruses, and also to see whether this pattern is changed due to visitations by tourists. Data on visitations are available from statistics from the Governor in Svalbard, in addition to what we see of visitors on the pictures themselves. It is impossible to count the exact numbers of walruses hauled out at any given time because of the way the walruses haul-out, in dense groups almost on top of each other given the camera angles. However, dynamics with regards to how the group size increases and decreases is possible to detect, and it will be the trends in these relative measures that will be analyzed both for the general dynamics and possible effects of visitors. A quick analysis of the pictures indicates that very few, if any, of the visitations by tourists had any impact on the haul-out pattern. However, polar bear visitations at haul-out sites where walrus females and calves are present do have impacts on this behaviour. This database is currently being analyzed as part of an MSc thesis.

Pacific Walrus Population Response to Reduced Sea Ice and Human-caused Disturbance
Chadwick V. Jay, U.S. Geological Survey, Alaska Science Center

The Pacific walrus ranges throughout much of the Bering and Chukchi seas. In the Chukchi Sea, the extent of summertime sea ice has rapidly declined and periods of open water over the continental shelf have increased. The loss of sea ice has simultaneously caused a change in walrus distribution and habitat use and allowed greater access for human activities. Primarily due to concerns about the cumulative effects of sea ice loss on walruses, the U.S. Fish and Wildlife Service made an initial determination to list the species as threatened under the U.S. Endangered Species Act and will make a final listing determination in 2017. The effect of increased human activities such as air and ship traffic on the Pacific walrus population is unknown and might be best understood by using a modelling framework linking sea ice availability, energy expenditure, body condition, and walrus demography.

"Incidental Take Regulations" for walrus in Alaska
Christopher Putnam, US Fish and Wildlife Service

Abstract not available.

Disturbance of walrus in Greenland
Mads Peter Heide-Jørgensen, Greenland Institute of Natural Resources

Walruses in the North Atlantic have the most pertinent history of conflicts with human activities of all marine mammals. Several terrestrial haul-out sites were abandoned after the arrival of humans over a millennium ago. In West Greenland at least three haul-out sites were abandoned before 1900 and the last haul-out site was abandoned in 1954. In East Greenland several haul-out sites were abandoned after establishment of settlements and increased hunting pressure, whereas other more remote sites are still used by walruses. There are no signs of re-colonization of the terrestrial haul-out sites in areas where disturbances have been eliminated and it illustrates the extreme sensitivity of walruses to human activities. Today walruses in West Greenland use the shallow banks during winter for feeding and breeding, and the drifting pack-ice is used for haul-out. Hunting and fishing on the coastal banks constitute the main source of disturbances in this area and the prospects of shipping activities during winter with ice-breaking vessels along West Greenland is a potential new source of disturbance that will interfere with the walrus' preference for the eastern part of Baffin Bay. In North Greenland the abandonment of a hunters' settlement in Wolstenholme Fjord has reduced the disturbance of walruses at this important feeding ground at the same time as a reduction in fast-ice in spring has opened new shallow areas for feeding by walruses. In East Greenland walruses primarily occur in very remote areas, however tourists and cruise ships may with declining sea ice coverage reach these areas during summer. Current regulations require that tourists must keep a distance of 400m from walruses that are hauled out on land 75 m for walruses in water. Seismic investigations and shipping to and from mining areas also constitute potential sources of disturbance of walruses in East Greenland as well as in some areas in West Greenland.

Sound from oil industry activities – some research projects related to habitat modelling for risk assessment of acoustic disturbance and detectability of marine mammals as part of mitigation measures
Jürgen Weissenberger, Statoil, Norway

Underwater sound created by activities form oil industry during exploration and production contribute to the anthropogenic sound in the ocean. The potential impact of anthropogenic sound on marine mammals is topic of many research activities. Statoil has for many years conducted research that has strengthened the industries abilities to perform risk assessment of acoustic disturbance and also mitigate possible risks. One example of a larger effort is the joint industry program (JIP) involving several companies and vendors (JIP Sound and Marine Life) where audiograms of ice seals are produced, through studies performed at Long Marine Lab, Santa Cruz. Statoil has also conducted some sole projects to prepare for and ensure safe operations in assets we operate. Since marine mammals are highly mobile and move quickly, the probability of impact is therefore also determined by their own behaviour, e.g. by moving in or out of a sound field. As part of our preparation for operations in the Chukchi Sea (Alaska), Statoil developed a risk assessment modelling framework where the movement of marine mammals (beluga and walrus) was taken into account. Disturbance of subsistent hunt is one of the possible risks raised by the local communities related to our operations in Alaska. As part of the risk assessment study Statoil teamed up with three communities on the North Slope Alaska to learn more on behavioural reactions of marine mammals when exposed to sound stimuli. Statoil has also conducted work to improve marine mammal detection, ether during seismic surveys or as part of a scientific density estimate. Field trials have been conducted of two types of sophisticated IR cameras that showed promising results. We have also testes active acoustics. Examples and results of all these studies will be presented.

Recent relevant work on Human Disturbance on Arctic marine mammals within the IWC with emphasis on guidelines for responsible seismic survey practices
Greg Donovan, International Whaling Commission

Donovan presented a summary of recent IWC work related to human disturbance on cetaceans with a focus in the Arctic. There have been several relevant workshops since 2008, on climate change, ship strikes, marine debris (plastics, microplastics and abandoned and lost fishing gear), 'soundscape' modelling, spatial and habitat modelling, chemical pollution and one specifically on the Arctic (IWC, 2010; 2011; 2012; 2014; 2015; In press a, b, c). He focussed particularly on one (Reeves et al., in Press) that related to the potential impacts of predicted increases in marine activities in the Arctic at which NAMMCO was represented.

The workshop considered changes in the Arctic environment leading to changes in human activities there and aimed to (a) identify stakeholder concerns; (b) identify knowledge gaps in order to assist to prioritise threats and identify mitigation measures; and (c) assist in coordinating international efforts. In addition to industry perspectives, emphasis was given to the views of indigenous peoples. The primary potential threats to cetaceans identified were: oil and gas (noise, oil spills, leakage, habitat damage); shipping (strikes, noise, discharge and pathogens); fishing (entanglement, noise, prey depletion, habitat); and hunting (over-exploitation if not managed properly).

The following key scientific needs were identified: additional quantitative data and spatial modelling analysis (for cetaceans and humans) to identify high risk areas at the correct geographical and temporal scales; population level evaluation of 'non-direct' threats including uncertainty (such as used in the IWC's management procedure approach); and the development of methods to examine synergistic and cumulative effects. Emphasis was placed on the need for collaborative and pragmatic recommendations with respect to data requirements and monitoring for the Arctic region.

It was recognised that cetacean organisations such as the IWC (and NAMMCO) could not effectively address these issues in isolation. Collaboration with existing initiatives (e.g. Arctic Council; IMO; FAO; CBD; national bodies and industry) was required to ensure that cetacean 'interests' were included. This requires increased communication and data sharing with those involved in existing and new developments in the Arctic, and with indigenous people.

Stakeholders stressed the need for common standards across the Arctic with respect to: environmental impact assessments; mitigation measures and ensuring compliance/ effectiveness; collaborative research programmes to assess threats, develop mitigation and monitor populations; common resources/plans to deal with catastrophic events such as oil spills; and common agreements on conflicting activities. Successful mitigation must be based upon robust science and agreed objectives but it is also dependent upon early stakeholder participation in the process from an early stage with respect to identifying problems, priorities, mitigation measures and compliance.

Finally, Donovan referred to the guidelines for seismic surveys that had been developed in Nowacek et al.(2013) which have been adopted by IUCN and the IWC.

Shipping disturbance impacts on ice-breeding seals: research from the Caspian Sea

Susan C. Wilson[1], Evgeniya Dolgova[2], Irina Trukhanova[3], Lilia Dmitrieva[4], Imogen Crawford[1] and Simon J. Goodman[4]

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Icebreaker operations in the Arctic and other areas are increasing rapidly to support new industrial activities and shipping routes, but the impact on marine mammals in these habitats is poorly explored. We present the first quantitative study of icebreakers transiting the habitat of an ice-breeding seal and evaluation of potential mitigation measures. Vessel impacts were recorded during seven ice seasons 2006-2013, for Caspian seals (*Pusa caspica*) breeding on the winter ice-field of the Caspian Sea. Impacts included vessel-seal collisions, breakage of birth or nursery sites, displacement of mothers and pups, mother-pup separation and pups being wetted or forced into the water. Separation distances of pups from mothers were greatest for seals less than 30m from the vessel path, and collisions and other events were significantly more frequent at night. Vessel cruising speeds above 4 knots increased the relative risk of mother-pup separation and collisions 1.77 and 6.4 times respectively. A cruising speed limit of 3.5kn is therefore recommended while traversing seal breeding areas, and thermal imaging equipment is essential for night-time transits. This study in the Caspian provides a template for determining and quantifying types of impact on different ice-breeding pinniped species from larger vessels operating in Arctic habitats.

Evidence-based mitigation of shipping disturbance of ice-breeding seals: experience from the Caspian Sea

Lilia Dmitrieva[1], Susan C. Wilson[2], Evgeniya Dolgova[3], Irina Trukhanova[4], Imogen Crawford[2] and Simon J. Goodman[1]

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Ice breaker transit through ice breeding seal habitat has potential to cause direct physical impacts and habitat disruption. Such impacts can be avoided or reduced by a mitigation hierarchy including logistics strategies to reduce icebreaker usage during critical periods (e.g. breeding seasons), and route planning to avoid transits through sensitive habitat areas.

To ensure the most effective seal mitigation vessel route planning it is important to develop practical systems of data collection for seal distributions in vessel corridors. We present a system for industrial icebreaker route planning, which has been developed for the Caspian Sea over the last 9 years, based on an integrated approach to seal observation data from both the aerial survey and vessel based observations. Data collection and mitigation attempts were carried out during the Caspian seal breeding season which extends from late January to early March each year in the Kazakh sector of the northern Caspian Sea.

In this system, trained seal observers (SOs) on each icebreaker collect data on seal presence and vessel/seal encounters along the vessel route, while aerial surveys of the vessel navigation corridor area are conducted regularly throughout the breeding season. Data are used to generate qualitative Seal Index maps for breeding seal density, on rapid turn-around - daily from vessel data and within 2-3 hrs after completion of aerial surveys.

The maps are transferred to ice charts as overlays, giving seal warning zones coloured according to seal density and potential for negative vessel impacts. Maps may be used by logistics officers to plan routes avoiding seal aggregations and to issue navigation advisories. Seal warning charts can be updated on a daily basis according to new seal data received and ice conditions, and distributed to vessels and other Parties along with route advisories.

Emergency reports on locations of large seals colonies are immediately transmitted to all vessels on the route to ensure quick response and prevent further disturbance of the colony.

End-of-trip summary impact assessment reports on all vessel-seal encounters during the trip are provided by SOs for quantitative route planning success assessments, and demonstration of impact reduction against specified mitigation targets.

Towards a quantitative risk assessment framework for icebreaker impacts on Holarctic pinnipeds

Simon J. Goodman[1], Irina Trukhanova[2], Evgeniya Dolgova[3], Imogen Crawford[4], Lilia Dmitrieva[1], and Susan C. Wilson[4]

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Traffic from tanker, cargo, industrial support and cruise ships is increasing in Arctic waters, driven by expansion of oil and gas industry related activity, mineral extraction, tourism, and the opening of new trans-polar shipping routes allowed by reduce sea-ice cover. This rapid escalation in shipping is predicted to lead to increased physical interactions with ice-bound marine mammals. While noise impacts from shipping on marine mammals, particularly cetaceans, have been a concern for some time, understanding of direct impacts on species and ice habitats of pinnipeds is in its infancy.

Here we present a risk assessment framework incorporating life history, ecological and behavioural traits, together with spatial information on the distribution of ten Holarctic pinniped species, shipping traffic and industrial infrastructure, in four main Arctic transport routes, Alaskan coastal waters, the Baltic and the Caspian. This can be used to identify species, habitats, locations and seasons sensitive to impacts from shipping traffic, highlight where further research is required and guide development of mitigation measures and policy.

Direct vessel impacts include not only fatal collisions, but also separation and displacement of mother-pups pairs, wetting of lanugo pups and disruption of ice habitats, which may impose stress and energetic costs also leading to mortality. Life history and behavioural traits predisposing to vulnerability include sedentary pupping on ice, lanugo pups at pre-aquatic stage, short flight distance, maternal foraging during lactation, and subnivean lairs. An impact mitigation hierarchy should include 1) Logistical planning to avoid the need for icebreakers in high risk areas/seasons, 2) pre-planning of routes to avoid aggregations of vulnerable animals; 3) Using marine mammal observers to document route planning success and vessel interactions with animals and to advise crews on avoidance of direct impacts when 1 and 2 fail. Mitigation measures must have measurable indicators in order to demonstrate reduction of impacts against stakeholder targets.

The effect of whale watching and whaling in Nuuk Fjord, West Greenland

Tenna Boye, Malene Simon and Lars Witting
Greenland Institute of Natural Resources

Photo-identifications of humpback whales in the Godthaabsfjord area were collected from 2007 to 2012 and divided into individuals and number of sightings per individual. Monte Carlo simulations were performed on the sighting distributions of individual humpback whales to investigate the potential impact that local removals (e.g. ship strikes, subsistence hunt) could have on the sighting rate of humpback whales in Godthaabsfjord. Half of the sightings were based on the same six individuals during the six-year period. Sighting rate was likely to drop regardless of when (spring, summer or autumn) an individual was removed due to the large degree of site fidelity of several humpback whales in Godthaabsfjord. Removals could affect the whalewatching industry in Godthaabsfjord where humpback whales constitute a key species. The least impact may be achieved by conducting the hunt outside the fjord system or minimising summer or autumn hunts within the fjord, as spring removals tend to have the least effect on summer sighting rates.

Effects of wildlife watching tourism on Arctic marine mammals, with a special note on harbour seal watching in Iceland

Sandra M. Granquist[1,2]

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The interest for wildlife watching activities such as whale- and seal watching is widely increasing and has spread to new remote Arctic locations. More accessibility to those regions due to climate change has been considered as a contributing factor to this development. However, negative effects due to anthropogenic disturbance, including wildlife tourism, have often been described in the literature. Such disturbance can result in changes of the natural behaviour and distribution of the animals, which in some cases can have severe effects on general fitness and reproduction. Never the less, marine mammal watching is often economically important to stakeholders and society, resulting in a need to balance the use and protection of marine mammal species. In this talk, effects on marine mammals due to wildlife tourism will be summarized and results from a case study on the effect of land-based seal watching on harbour seals in Iceland will be presented. The seals were found to change their distribution and be more vigilant during periods with high tourist presence. However, disturbance depended on the behaviour of tourists and was lower when tourists behaved in a calm way. The necessity of interdisciplinary co-operations to reach sustainable management strategies to reduce negative impact due to marine mammal tourism is underlined. Since the behaviour of individual tourists and the approach of tourist operators play important roles in reducing negative impact on the wild animals, education should be implemented, preferably through codes of conducts on how to behave in the presence of marine mammals. A worldwide overview of existing codes of conduct for seal watching is presented. Developing an international recognized seal watching code of conduct is suggested and important factors to consider during this development will be discussed.

Physiological and behavioural observations to assess the influence of vessel encounters on harbour seals

Shawna Karpovich, Alaska Department of Fish and Game

In southeast Alaska, USA, harbour seals *(Phoca vitulina*) were fitted with data loggers to measured diving behaviours and heart rates in response to vessels. A complex assortment of factors, other than disturbance, affected heart rates and careful consideration of these factors must be included in disturbance studies. Changes in harbour seal heart rates were examined in response to two levels of vessel disturbances; ‘incidental traffic’ defined as presence of vessels in the area while seals were hauled out; and ‘experimental disturbance’ defined as direct vessel approaches to seals until the seal entered the water. In response to incidental traffic, heart rate increased by up to 4 bpm per vessel while seals were hauled out, and small vessels caused the largest increase in heart rate. Experimental disturbances resulted in a 5 bpm increase in heart rate upon the head-lift behaviour. In-water heart rate was significantly lower after an experimental disturbance compared to other water entries, indicating a shift to an energetically conservative mode in response to these disturbances. During the haulout following an experimental disturbance, seal heart rate was significantly higher than other haulouts, suggesting that there is an added energetic cost of disturbance. Furthermore, the average time between haulouts was 12 ± 5 hours indicating that the energetic disruption incurred during a disturbance persists over an extended period. Whereas previous findings have shown that vessel encounters alter seal behaviour, this study presents evidence that encounters have energetic and physiological consequences while the seals are hauled out and these consequences persist long after the water entry behaviour. Accordingly, exposure of harbour seals to increased vessel traffic may result in altered behaviour, increased energetic expenditures, and increased exposure to stress, negatively affecting the health, condition, and reproductive success of harbour seal populations that reside in glacial fjords.

Heart rate studies are time consuming, expensive, and may not be feasible in some situations. Therefore, we present whisker hormone analysis as an alternate method to measure the influence of disturbances. Whiskers are composed of keratin and steroid hormones are incorporated into the whisker as it grows. To date, both cortisol (stress hormone) and progesterone (reproductive hormone) have been measured in harbour seal whiskers highlighting the utility of whiskers to assess physiological impacts of potential stressors. Further, analysis of serial sections of whiskers may provide insight into changes of steroid hormones in response to stress and reproduction over time.

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Programme

Tuesday, 13 October

1300 **Jill Prewitt** — *Welcome from NAMMCO*

1305 **Mads Peter Heide-Jørgensen** — *Status of selected Arctic marine mammals*

1330 **Kit M. Kovacs** — *Concerns and opportunities*

Case Studies

1400 **Cormac Booth** — *Oceans of noise: Assessing risks to marine mammals in the face of uncertainty.*

1420 **Veronique Lesage** — *Consequences of speed limits and partial rerouting of shipping traffic on habitat acoustic quality and beluga exposure to noise pollution in the St. Lawrence Estuary, Canada: Science in support of risk management.*

1440 **Marianne Marcoux** — *Overview of the Department of Fisheries and Oceans' comments on the environmental impact statement of Baffinland's Mary River Project*

1500 *Coffee*

1530 **Peter Ewins** — *Hudson Strait: a case study with the shipping industry*

1615–1700 Discussion

1730-1900 (or later) Evening Event: Icebreaker with light food and drink

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Wednesday, 14 October

0900 **Rikke Guldborg Hansen —** *Monitoring narwhals in Melville Bay in relation to seismic surveys*

0930 **Mads Peter Heide-Jørgensen —** *The narwhal's sense of silence*

0950 **Rod Hobbs** — *Cook Inlet beluga Abundance, Distribution and Potential Sources of Disturbance*

1010 **Manuel Castellote** — *Anthropogenic noise on Cook Inlet and Bristol Bay beluga habitat: potential for negative effects*

1030 *Coffee*

1100 **Susanna Blackwell** — *Detecting the effects of seismic exploration on the behaviour of whales: what we've learned from bowheads and hope to learn about narwhals*

1120 **Kristin Westdal** — *Monitoring programs in Eclipse Sound: increased shipping and potential effects on narwhal*

1140 **Christian Lydersen —** *Research in Svalbard related to human disturbance of marine mammals*

1200–1330 *Lunch*

1330 **Chad Jay** — *Pacific Walrus Population Response to Reduced Sea Ice and Human-caused Disturbance*

1350 **Christopher Putnam —** Title to come, topic: "Incidental Take Regulations" for walrus in Alaska

1420 **Mads Peter Heide-Jørgensen** — *Hunting and disturbance of walrus in Greenland*

1440 *Coffee*

1500 **Jürgen Weissenberger** — *Sound from oil industry activities – some research projects related to habitat modelling for risk assessment of acoustic disturbance and detectability of marine mammals as part of mitigation measures.*

1530 **Greg Donovan —** *Recent relevant work on Human Disturbance on Arctic marine mammals within the IWC with emphasis on guidelines for responsible seismic survey practices.*

1600–1700 Discussion Session

Thursday 15 October

0900 **Sue Wilson** — *Shipping disturbance impacts on ice-breeding seals: research from the Caspian Sea*

0930 **Evgeniya Dolgova** — *Evidence-based mitigation of shipping disturbance of ice-breeding seals: experience from the Caspian Sea*

1000-1015 *Video from Dolgova*

1015 **Simon Goodman** — *Towards a risk assessment for shipping disturbance of Arctic ice-breeding pinnipeds and associated conservation strategy to be developed*

1045 *Coffee*

1100 **Tenna Boye —** *The effect of whale watching and whaling in Nuuk fjord, West Greenland*

1120 **Sandra Granquist —** *Effects of wildlife watching tourism on Arctic marine mammals, with a special note on harbour seal watching in Iceland*

1140 **Shawna Karpovich —** *Physiological and behavioural observations to assess the influence of vessel encounters on harbour seals*

1200-1330 *Lunch*

1330 **Randy Reeves** — *Concerns, Evidence, Approaches to Mitigation, and Research Needs Related to Human Disturbance of Belugas, Narwhals and Walruses*

1415-1500 Discussion, Part 1

1500-1515 *Quick coffee*

1515-1630 Discussion, Part 2: Finalise lists of risks/research priorities/mitigation priorities

We would like to thank our Sponsors: World Wildlife Fund Denmark, Government of Greenland, and the University of Copenhagen