



# Plain Language Summaries of Ship Noise Impact and Marine Mammal Studies Conducted by WCS Canada

## Volume II: 2019-2021



### Our Research Focus:

- Beluga Vocalizations Decrease in Response to Vessel Traffic in the Mackenzie River Estuary
- The summer soundscape of a shallow-water estuary used by beluga whales in the western Canadian Arctic
- The coastal Arctic marine soundscape near Ulukhaktok, Northwest Territories
- Underwater noise and Arctic marine mammals: review and policy recommendations
- Fish sounds near Sachs Harbour and Ulukhaktok in Canada's Western Arctic
- Vocalizations of bearded seals (*Erignathus barbatus*) and their influence on the soundscape of the western Canadian Arctic
- Ringed seal diet and condition in the Amundsen Gulf region, eastern Beaufort Sea
- Potential exposure of beluga and bowhead whales to underwater noise from ship traffic in the Beaufort and Chukchi Seas

**For more information about these projects contact** William Halliday: [whalliday@wcs.org](mailto:whalliday@wcs.org),  
Stephen Insley: [sinsley@wcs.org](mailto:sinsley@wcs.org), or visit our project website: [www.arcticnoise.ca](http://www.arcticnoise.ca)

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## Where can I get more information about these projects?

- Email us:
  - William Halliday: [whalliday@wcs.org](mailto:whalliday@wcs.org)
  - Stephen Insley: [sinsley@wcs.org](mailto:sinsley@wcs.org)
- Visit our project website: [www.arcticnoise.ca](http://www.arcticnoise.ca)
- Visit WCS Canada's website: [www.wcscanada.org](http://www.wcscanada.org)
- Other information: <http://data.nwtresearch.com/Scientific/16330>;  
<http://data.nwtresearch.com/Scientific/15470>

Halliday WD, Scharffenberg K, MacPhee S, Hilliard RC, Mouy X, Whalen D, Loseto LL, Insley SJ (2019) Beluga Vocalizations Decrease in Response to Vessel Traffic in the Mackenzie River Estuary. *Arctic* 72: 337-346.

### What is the research about?

- Ship traffic is increasing throughout the Arctic and may impact marine life, such as beluga whales.
- Belugas have been shown to react to ships that are as far away as 50 km.
- Given that belugas will likely be exposed to an increasing numbers of ships in the future, it is important to understand how increased ship traffic will impact belugas.

### What we did:

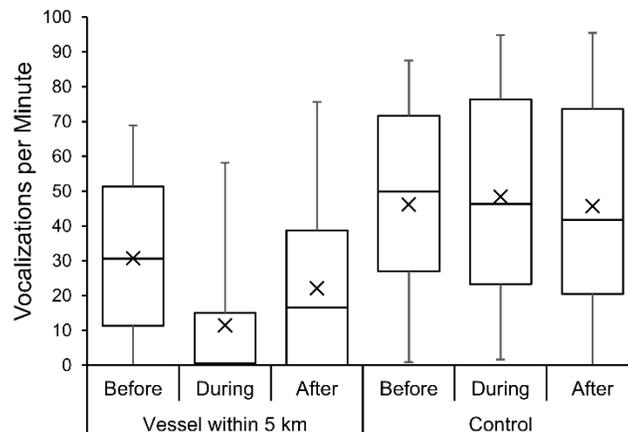
- We recorded underwater acoustic data in Kugmallit Bay of the Mackenzie River estuary each summer, between 2015 and 2018, at multiple sites.
- We counted the number of beluga vocalizations in all of the recordings.
- We used satellite tracking data of ships to see how close individual ships were to each recording site, and then compared the number of beluga vocalizations to the distance to the nearest ship.
- We tested statistically if the number of beluga vocalizations changed in response to ships.

### What we found:

- We counted 15 different times when belugas were actively vocalizing and ships were within 10 km and 11 different times when belugas were actively vocalizing and ships were within 5 km of the acoustic recorders.
- The number of beluga vocalizations decreased when ships were within 5 km of recorders.
- Belugas either stopped vocalizing when ships were nearby or they left the area.
- This result confirms observations by Inuvialuit people who have seen belugas actively moving away from ships.

### Key result:

This figure shows that the number of beluga vocalizations decrease when ships are within 5 km of the acoustic recorder, compared to a control period when no ships were within 30 km.



**Our recommendations:**

- Maintain acoustic monitoring sites (e.g., WCS Canada, DFO) to track the distribution of beluga whales in the western Arctic and to see if belugas change locations when ships are around.
- Find ways to directly measure how belugas and other marine mammals respond to ships, such as by using data from satellite telemetry/tagging studies.
- Use these results to proactively plan for shipping corridors in relation to important marine mammal areas at the western entrance to the Northwest Passage shipping route *before* marine traffic increases. These data could inform the work of the Shipping Working Group as well as Transport Canada and DFO.

**Why is this research relevant to the Inuvialuit people?**

- Beluga whales and other marine mammals in the region are a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Any impacts of vessel traffic on marine mammals could negatively affect these populations of marine mammals, thereby impacting the Inuvialuit people who rely on them.
- Although this study confirms what the Inuvialuit people have known for years with respect to how belugas react to ships, it is a starting place for future investigations of how belugas and other marine mammals react to ship traffic.

**Was the community involved?**

- Yes. The fieldwork was conducted by DFO and NRCan out of Tuktoyaktuk. We are grateful to assistance in the field by E. Way-Nee, J. Pascal, D. Swainson, K. Tingmiak, A. Gordon Jr., J. Pokiak, A. Robertson, P. Lennie, and our camp hosts, C. Day, B. Joe, and F. Angasuk.

Halliday WD, Scharffenberg K, Whalen D, MacPhee S, Loseto LL, Insley SJ (2020) The summer soundscape of a shallow-water estuary used by beluga whales in the western Canadian Arctic. *Arctic Science* 6: 361-383.

#### **What is the research about?**

- Ship traffic is increasing throughout the Arctic and may impact marine life, such as beluga whales.
- The underwater soundscape is a critical component of marine mammal habitat, as marine mammals such as beluga use sounds for many aspects of their lives, including for communication and hunting.
- The Tarniutait Marine Protected Area (TN MPA) represents important habitat for beluga whales, and understanding the influences of both natural and human activities on underwater sound levels is an important aspect of conservation planning and understanding the influence of underwater noise on belugas within the TN MPA.

#### **What we did:**

- We recorded underwater acoustic data within the TN MPA in Kugmallit Bay of the Mackenzie River estuary each summer, between 2015 and 2018, at multiple sites.
- We measured underwater sound levels in all of the acoustic data, and then used statistical models to examine the influence of environmental variables (wind speed, water current, wave height), beluga vocalizations, and passing ships on underwater sound levels.

#### **What we found:**

- Wind speed and associated changes in wave height were very important drivers of natural underwater sound levels in low (200 Hz to 1 kHz) and medium (1 to 10 kHz) frequency bands
- Beluga whale vocalizations caused large increases to underwater sound levels in the high frequency band (10 to 48 kHz)
- Boat noise also added to underwater sound levels, particularly in the low and medium frequency bands, although only for relatively short periods of time. For example, boat noise was detected in between 0 and 5.2% of the acoustic data collected in 2017.

#### **Our recommendations:**

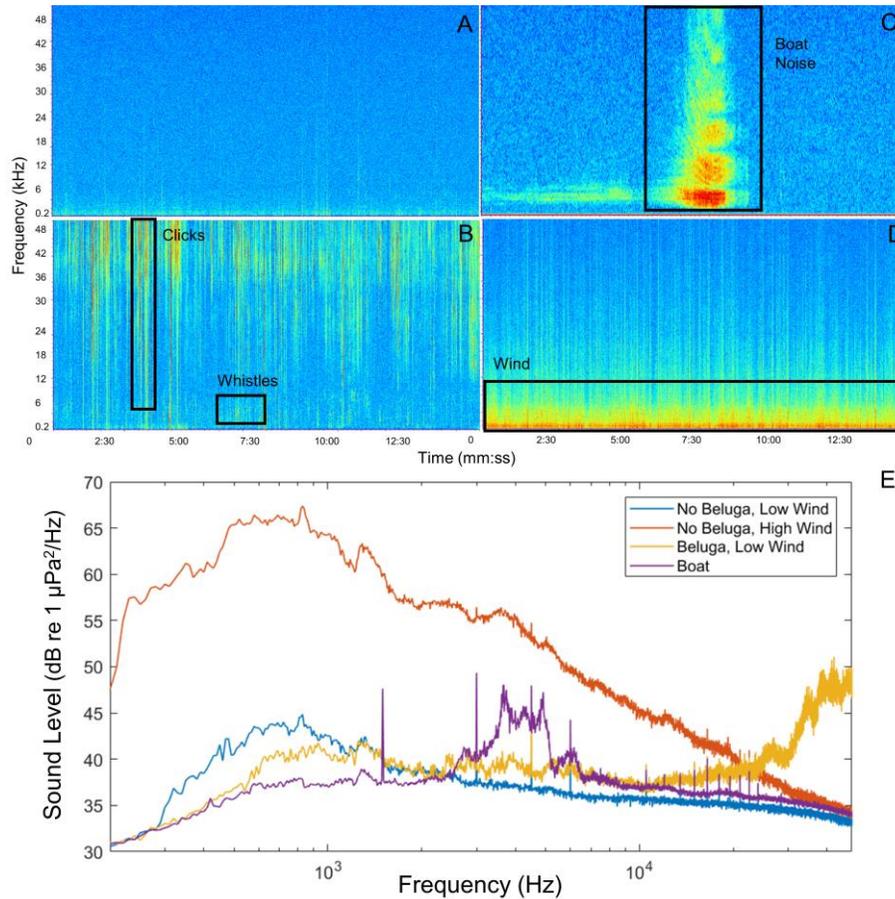
- Maintain acoustic monitoring sites (e.g., WCS Canada, DFO) to continue monitoring underwater sound levels, and in particular, the influence of boat noise on the soundscape.
- Continue monitoring beluga whales using acoustics within the TN MPA to examine changes in occupancy patterns.

#### **Why is this research relevant to the Inuvialuit people?**

- Beluga whales and other marine mammals in the region are a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- The soundscape is a critical aspect of beluga habitat based on their high reliance on vocalizations for communication and hunting. Understanding the soundscape and the influence of human activity on the soundscape is important for the conservation of belugas.

### Key result:

This figure shows the influence of beluga vocalizations (B), boat noise (C), and wind (D) on underwater sound levels. Wind has by comparison the highest impact on underwater sound levels, particularly at low and medium frequencies, whereas beluga vocalizations have a large influence on high frequencies. Boat noise can have a strong signal in low to medium frequencies, but can easily be overpowered by wind noise. Listen to some of the sounds that we recorded at <http://www.arcticnoise.ca/arctic-sounds.html>.



### Was the community involved?

- Yes. The acoustic data was collected by DFO and NRCan out of Tuktoyaktuk. We are grateful to assistance in the field by E. Way-Nee, J. Pascal, D. Swainson, K. Tingmiak, A. Gordon Jr., E. Amos, J. Pokiak, A. Robertson, P. Lennie, and our camp hosts, C. Day, B. Joe, and F. Angasuk.

Halliday WD, Pine MK, Mouy X, Kortsalo P, Hilliard RC, Insley SJ (2020) The coastal Arctic marine soundscape near Ulukhaktok, Northwest Territories. *Polar Biology* 43: 623-636.

### What is the research about?

- Ship traffic is increasing throughout the Arctic and may impact marine life, such as beluga whales.
- The underwater soundscape is a critical component of marine mammal habitat, as marine mammals such as beluga use sounds for many aspects of their lives, including for communication and hunting.
- Understanding the natural and human-caused influences on underwater sound levels in an important aspect of conservation planning and understanding the influence of underwater noise on marine life.

### What we did:

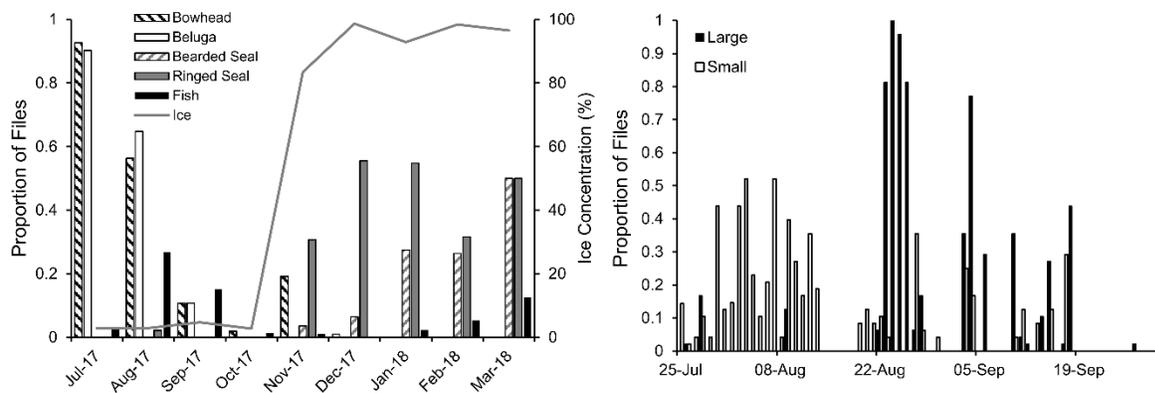
- We recorded underwater acoustic data near Ulukhaktok from July 2017 to March 2018.
- We analyzed the data for the presence of marine mammal and fish vocalizations and for noise from small boats and ships.
- We measured underwater sound levels, and determined how different factors, including environmental factors (wind speed and ice concentration), biological factors (animal vocalizations), and human noise (boats) influenced sound levels.

### What we found:

- Bowhead and beluga whales were present in the summer, but were not recorded much after ice formation. Conversely, seals were the most vocal after the ice had formed. Boat and ship noise occurred in July through September, with a peak in small boat noise in early August and a peak in ship noise in late August.
- Boat and ship noise elevated sound levels significantly above background levels.

### Key result:

This figure shows the seasonal patterns in marine mammal and fish presence (left) and presence of small and large boats (right) in the passive acoustic data collected near Ulukhaktok in 2017-2018. Listen to sounds of Arctic marine animals at <http://www.arcticnoise.ca/arctic-sounds.html>.



**Our recommendations:**

- Maintain acoustic monitoring sites (e.g., WCS Canada, DFO) to track the distribution of marine mammals and fish in the western Arctic, as well as monitor underwater noise from ship traffic.

**Why is this research relevant to the Inuvialuit people?**

- Marine mammals and fish in the region are a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Exposure to underwater noise from ships can negatively affect these species, so monitoring marine animals and their exposure to underwater noise is a crucial step in understanding the impacts of underwater noise on these species.

**Was the community involved?**

- Yes. The acoustic data were collected near Ulukhaktok, and we are grateful to A. Kudlak for assistance in the field, and support from the Olokhaktomiut Hunters and Trappers Committee to conduct this research.

Halliday WD, Pine MK, Insley SJ (2020) Underwater noise and Arctic marine mammals: review and policy recommendations. *Environmental Reviews* 28: 438-448.

**What is the research about?**

- The Arctic is undergoing rapid changes, which is allowing for increased ship traffic and industrial development. These human activities can create significant underwater noise, which may impact marine mammals.
- To manage and mitigate the impacts of underwater noise on marine mammals, we must first understand how underwater noise affects these species, and in particular, must understand what activities and noise levels elicit different responses.

**What we did:**

- We conducted a literature review to examine what is known about the impacts of underwater noise on Arctic marine mammals.

**What we found:**

- A number of studies have been conducted on underwater noise and bowhead whales, but only a few on beluga, narwhal, and ringed seals, and none on bearded seals or walrus. Most studies focused on the effects of seismic surveys on bowheads.
- Few studies quantified the underwater noise levels when an animal changed its behaviour.
- Some Arctic species appear to be extremely sensitive to underwater noise, showing reactions when the sound would barely be audible.
- Better quantification of the reactions of different Arctic marine mammals to varying levels of underwater noise from different types of noise sources (ships, seismic surveys) is required.

**Our recommendations:**

- More research on this topic is required, but in the meantime, a precautionary approach should be taken by those trying to manage underwater noise in the Arctic, where they should assume that low levels of noise will elicit responses in Arctic species.

**Why is this research relevant to the Inuvialuit people?**

- Inuvialuit actively hunt belugas and seals, and should be interested in any human activities that may impact these species.

**Was the community involved?**

- No

Pine MK, Halliday WD, Insley SJ, Juanes F (2020) Fish sounds near Sachs Harbour and Ulukhaktok in Canada's Western Arctic. *Polar Biology* 43: 1207-1216.

#### **What is the research about?**

- The Arctic marine environment is undergoing rapid change due to climate change and human activities. Monitoring the species that live in this environment is an important aspect of understanding and managing the impacts of climate change and human activities.
- Passive acoustic monitoring (underwater listening) is a powerful tool for monitoring species that make sounds, and in non-Arctic waters, acoustics are used to monitor fish species that vocalize.
- Cod species, including Arctic cod (*Boreogadus saida*), are known to vocalize, so passive acoustic monitoring could be used to monitor populations of Arctic cod and other Arctic fishes.

#### **What we did:**

- We recorded underwater acoustic data near Sachs Harbour in 2015-2016 and near Ulukhaktok in 2016-2017.
- We manually analyzed the acoustic data and looked for sounds made by fish.

#### **What we found:**

- We found 47 fish calls in the approximately 1.5 years of acoustic data collected between the two sites, and the majority of these calls were from Ulukhaktok during January.
- Three different call types were detected, with different seasonal patterns in these call types, which suggests that either different species were producing the calls, or there were specific seasonal functions for certain call types.

#### **Our recommendations:**

- Maintain acoustic monitoring sites (e.g., WCS Canada, DFO) to continue looking for locations and times when fish sounds are common. This may help to identify key monitoring sites for different fish species, and can serve to track populations of fish species.

#### **Why is this research relevant to the Inuvialuit people?**

- Arctic cod and other marine fishes are important prey for marine mammals, including beluga whales, ringed seals, and bearded seals, all three of which are important species for Inuvialuit subsistence hunting. Changes in the abundance of fish species may negatively impact these marine mammals, therefore monitoring fish populations is important for the conservation and management of these marine mammals.

#### **Was the community involved?**

- Yes. The acoustic data collected in this study was from Sachs Harbour and Ulukhaktok, and the Hunters and Trappers Committees in both communities, as well as A. Kudlak, G. Kudlak, W. Gully, B. Hoagak, T. Lennie, J. Kudlak, and J. Kuptana were involved in the data collection.

**Heimrich AF, Halliday WD, Frouin-Mouy H, Pine MK, Juanes F, Insley SJ (2021) Vocalizations of bearded seals (*Erignathus barbatus*) and their influence on the soundscape of the western Canadian Arctic. *Marine Mammal Science* 37: 173-192.**

**What is the research about?**

- Bearded seals are highly vocal throughout their mating season and can produce calls of long duration and large frequency ranges.
- Bearded seal vocalizations might even be an important driver of underwater sound levels during the mating season, as their vocalizations seem to be a dominant source of underwater sound.
- Given that ice-free periods in the Arctic might get longer, vocalization periods of bearded seals might also change. Therefore, monitoring of bearded seal vocalizations is required to track any changes in their vocalizations and in the timing of their mating season.

**What we did:**

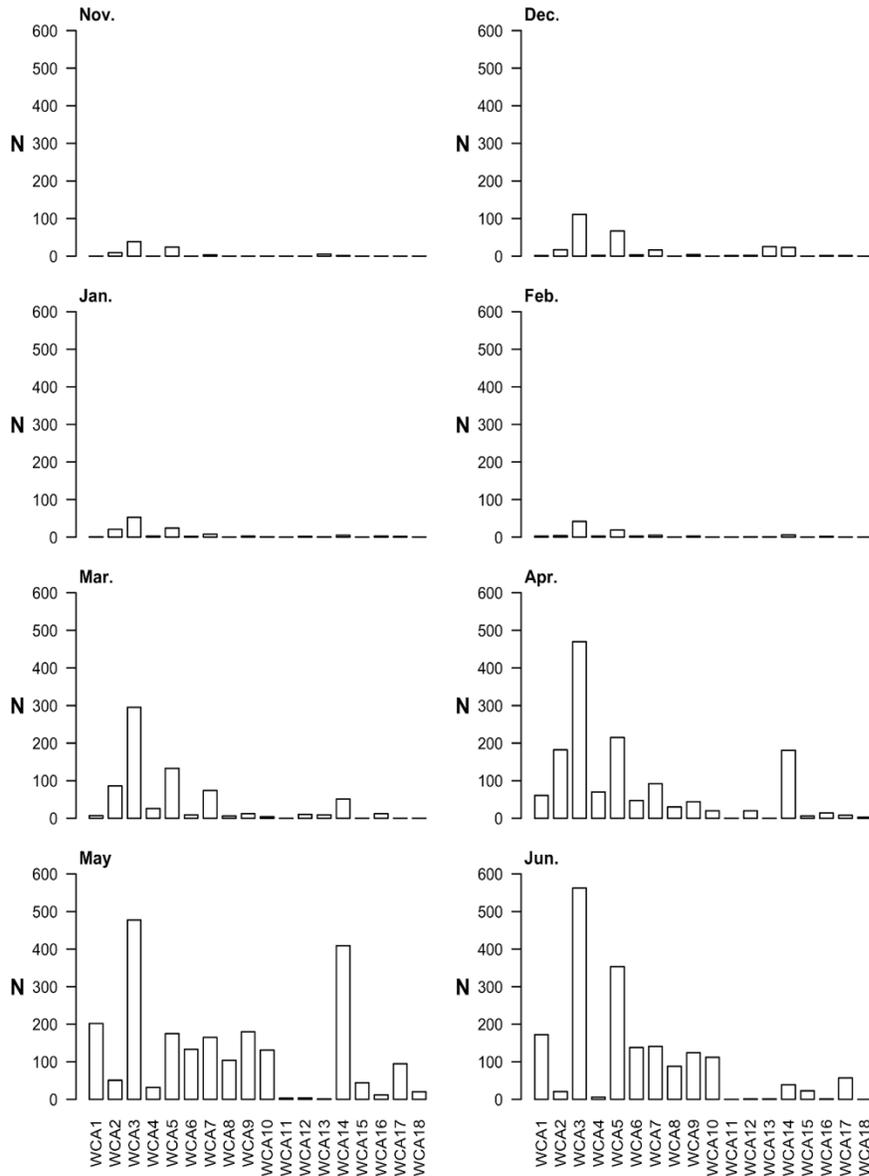
- We recorded underwater acoustic data near Sachs Harbour, southern Banks Island between August 2015 and July 2016.
- Data were analyzed manually and automatically using a 'bearded seal' detector.
- All clearly visible vocalizations were manually measured in 10% of the recordings.
- All vocalizations were compared based on their parameters to previous studies from other areas and consequently classified into different call types.
- Underwater sound levels were measured and the influence of bearded seal calls on sound levels was examined.

**What we found:**

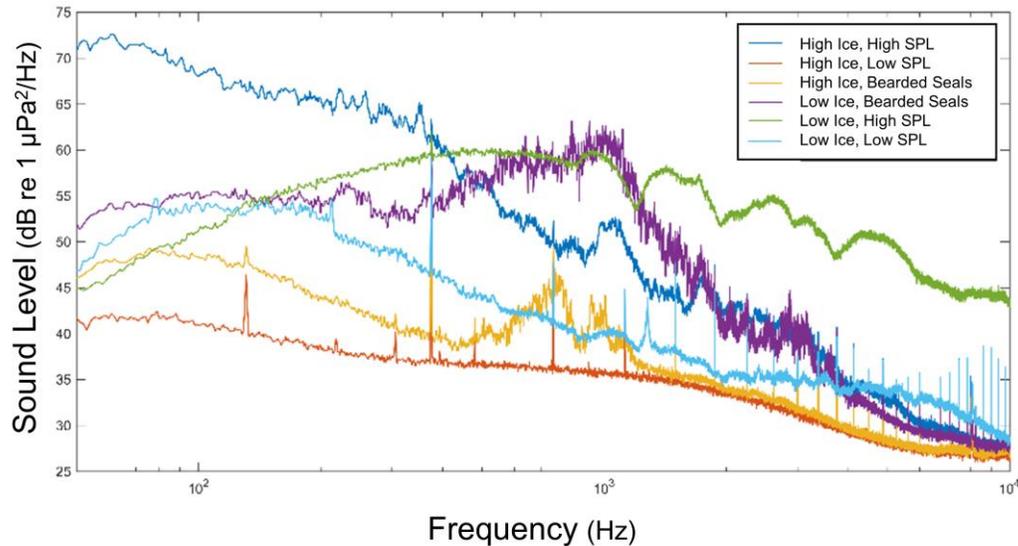
- We identified 18 different call types for bearded seals at Sachs Harbour, and 7 of these call types were new additions for the region.
- Bearded seals made 4 broad types of calls: trills, moans, ascents, and sweeps. Trills were the most common type of call, and one particular type of trill was only detected during the mating season.
- Vocalizations throughout the mating season impacted the underwater sound environment, especially on calm days when wind and ice noise were absent.
- Sea ice dynamics play a key-role in regulating underwater sound levels, and are highly related to the timing bearded seal vocal behaviour.

## Key results:

This figure shows the prevalence of different call types (WCA1 to WCA18) in each month between November and June, with very clear peaks in call counts in April to June. The trill labelled WCA3 is the dominant call type in all months. Listen to sounds of bearded seals and other marine animals at <http://www.arcticnoise.ca/arctic-sounds.html>.



This figure shows the distribution of sound levels over different frequencies in low and high sea ice conditions compared to the absence and presence of bearded seal vocalizations. Bearded seal vocalizations during the mating season (purple line) show a very clear spike in underwater sound levels that can even surpass the levels caused by high wind during the open water season.



#### Our recommendations:

- Maintain long-term acoustic monitoring for bearded seal vocal behaviour to track any changes in how this species responds to changes in sea ice dynamics.

#### Why is this research relevant to the Inuvialuit people?

- Bearded seals are an important focus of Inuvialuit subsistence hunting.
- Changes in sea ice dynamics could negatively affect the population status of bearded seals and therefore have an impact on the Inuvialuit people who rely on them.

#### Was the community involved?

- Yes. This work was conducted with the help of the people of Sachs Harbour, specifically the Sachs Harbour Hunters and Trappers Committee, W. Gully, B. Hoagak, T. Lennie, J. Kudak, and J. Kuptana.

**Insley SJ, Tauzer LM, Halliday WD, Illasiak J, Green R, Kudlak A, Kuptana J (in press) Ringed seal diet and condition in the Amundsen Gulf region, eastern Beaufort Sea. *Arctic*.**

**What is the research about?**

- The Arctic marine environment is changing rapidly due to climate change, and these physical changes are leading to subsequent changes in species occurrence and abundance
- Studying resident predators, such as ringed seals (*Pusa hispida*), present an opportunity to track changes in prey species in this region, while simultaneously tracking the health and condition of these predators while their diet changes

**What we did:**

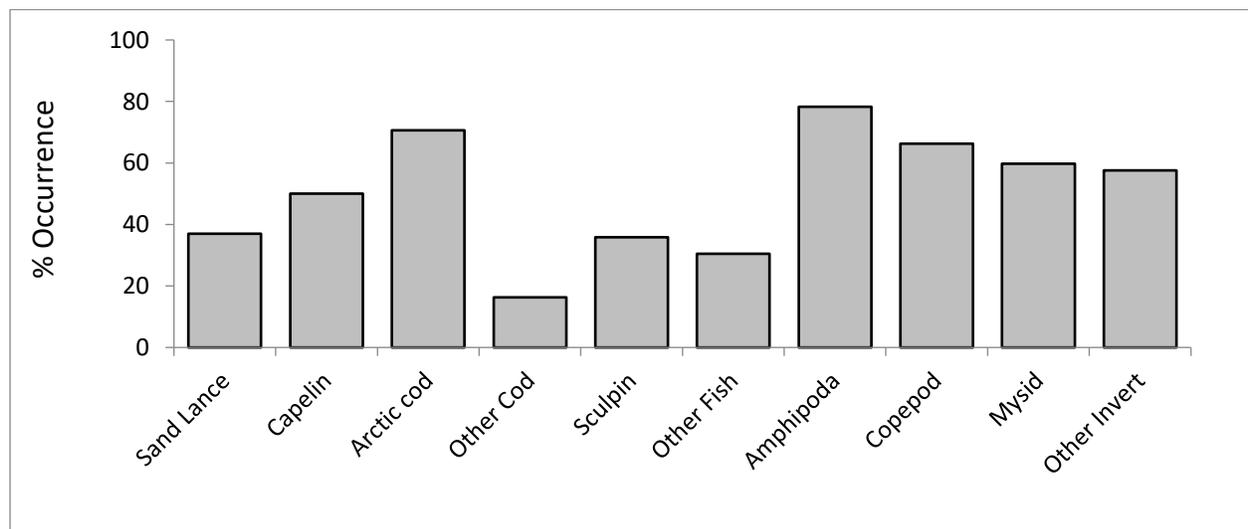
- We collected stomachs of ringed seals harvested in the communities of Paulatuk, Sachs Harbour, and Ulukhaktok between 2015 and 2018, and also took morphometric measurements of the harvested seals.
- We analyzed the prey content of all stomachs, identifying stomach contents to species when possible.

**What we found:**

- Seals harvested in the autumn had the fullest stomachs compared to seals harvest in other months
- 93 different prey species were identified, 17 fishes and 76 invertebrates. Arctic cod (*Boreogadus saida*), capelin (*Mallotus villosus*), sand lance (*Ammodytes haxaperus*), and hyperiid amphipods (*Themisto* spp.) were the most common prey species.
- Seals had the highest body condition (thickest blubber) during the autumn and winter
- Compared to the 1980's, seal diets had more subarctic species such as sandlance and capelin

**Key result:**

This figure shows the percent occurrence of different prey items found in ringed seal stomachs, showing clear peaks for Arctic cod over other fishes, and amphipods over other invertebrates. Capelin and sand lance, two fish species that were not historically part of ringed seal diet, do show up in large quantities at some sites.



**Our recommendations:**

- Continue research on harvested seals in the ISR, in particular, monitoring the prey consumption of both ringed seals and bearded seals.

**Why is this research relevant to the Inuvialuit people?**

- This research demonstrates that harvested seals can be used to track changes in the diet of seals, and shows a signal of the changing food web in this region.
- Tracking changes in the health of these seals as they change their diet in response to the changing food web will allow for a better understanding of the impacts of climate change on these seals, which are so important to Inuvialuit people.

**Was the community involved?**

- Yes. This work was based on seal harvesting by hunters in Paulatuk, Sachs Harbour, and Ulukhaktok. J. Illasiak, R. Green, A. Kudlak, and J. Kuptana were all directly involved in managing the collection of seal stomachs and measurements of seals in these communities, and are all co-authors on this study.

Halliday WD, Pine MK, Citta JJ, Harwood L, Hauser DDW, Hilliard RC, Lea EV, Loseto LL, Quakenbush L, Insley SJ (in press) Potential exposure of beluga and bowhead whales to underwater noise from ship traffic in the Beaufort and Chukchi Seas. *Ocean and Coastal Management*.

#### **What is the research about?**

- Ship traffic is increasing throughout the Arctic and underwater noise from these ships will likely impact marine life, such as beluga and bowhead whales.
- How often whales are exposed to ships and ship noise is currently unknown in the Beaufort and Chukchi Seas, yet is important information for understanding and managing potential impacts.

#### **What we did:**

- We used satellite tag data to estimate the monthly distribution of bowhead and beluga whales between July and October in the Beaufort and Chukchi Seas.
- We modeled how underwater noise spreads through the ocean around ship tracks throughout the region, and estimated the number of noise exposure events that would happen in each month between 2015 and 2017. We then overlaid these noise exposure data with the beluga and bowhead distribution data to estimate potential noise exposure to both species in each month.

#### **What we found:**

- Belugas and bowheads were distributed in the Inuvialuit Settlement Region (eastern Beaufort Sea and Amundsen Gulf) in July, August, and September, and would potentially be exposed to relatively low ship noise in July, with a maximum of 2-3 ships transiting this region during July. However, noise exposure would increase more during August, and even more in September, as more ships transit the region in those months.
- As bowheads and belugas migrate west into Alaskan and Russian waters, particularly in the western Beaufort Sea near Utqiagvik and into the Chukchi Sea in September and October, both species would potentially be exposed to much higher levels of ship noise. More ships travel along the Alaskan and Russian coastlines from Bering Strait, and this leads to the highest levels of potential noise exposure events in the region.

#### **Our recommendations:**

- Further research is needed on the impact of noise on belugas and bowheads when they are actually exposed to noise, including developing noise threshold guidelines. Research is also needed on how often individual whales are exposed to ship noise.
- Management measures can focus on limiting ship noise in important areas for these species. The Notice to Mariners in the Inuvialuit Settlement Region is a good example of how to limit underwater noise exposure to these species.

#### **Why is this research relevant to the Inuvialuit people?**

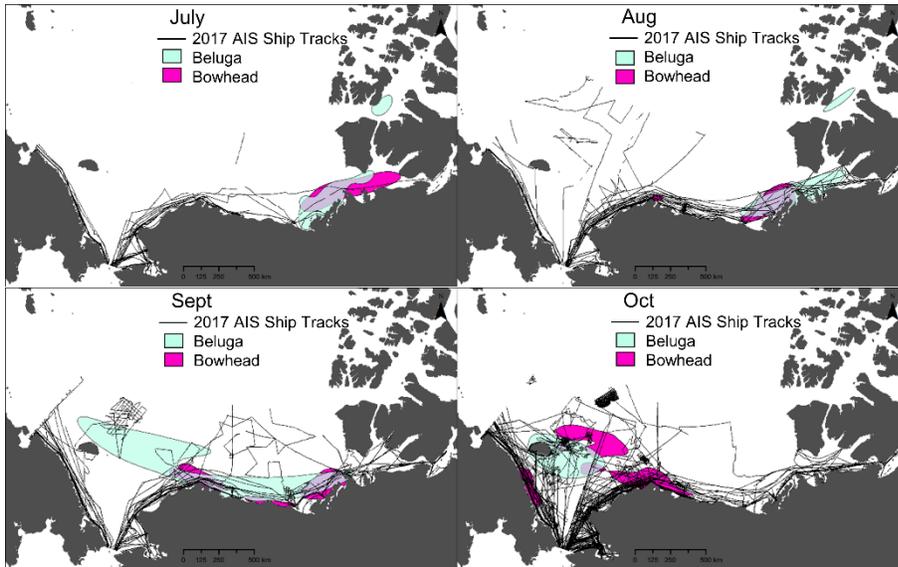
- Beluga whales and other marine mammals in the region are a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Understanding the exposure of these species to underwater noise from ships is an important aspect of managing these species.

**Was the community involved?**

- Yes. Community members in Tuktoyaktuk and Aklavik were involved in tagging some of the bowhead and beluga whales with DFO.

**Key result:**

This figure shows the ship tracks throughout the region in each month of 2017, and overlap with the monthly distributions of bowhead and beluga whales.



This next figure shows the average potential ship noise exposure events, which shows clear trends that the most ship noise is occurring in the Chukchi Sea closer to Bering Strait. However, it does highlight that all monthly bowhead and beluga areas experience some ship noise, including in the Inuvialuit Settlement Region, particularly in August and September.

