Summaries of Ship Noise Impact Studies Conducted by WCS Canada: 2015-2019

WCS Canada

Our research focus:

- Seasonal patterns in ambient (naturally occurring) ocean noise near Sachs Harbour, Northwest Territories.
- Seasonal patterns in detections of marine mammals near Sachs Harbour using acoustic recording devices.
- Acoustic detections of Arctic marine mammals near Ulukhaktok, Northwest Territories.
- Potential impacts of shipping noise on marine mammals in the western Canadian Arctic.
- Management solutions for minimizing impacts of vessel traffic on whales in a changing Arctic region.
- Assessing the effectiveness of vessel slowdown for reducing auditory masking (interference) for marine mammals and fish of the western Canadian Arctic.
- Risks and management of tourist vessel traffic in important whale areas in the western Canadian Arctic.
- A comprehensive state of knowledge report on underwater noise in the Arctic.

For more information contact: Stephen Insley (sinsley@wcs.org)
or William Halliday (whalliday@wcs.org)

Insley SJ, Halliday WD, de Jong T (2017) Seasonal patterns in ocean ambient noise near Sachs Harbour, Northwest Territories. Arctic 70: 239-248.

What is the research about?

- Climate change can make the marine environment noisier than it currently is and impact marine mammal movement and behaviour (e.g., communication) in the Arctic Ocean.
- Sea ice dampens underwater ambient noise levels, helping keep the marine environment quiet. Warming temperatures reduce sea ice, which may lead to a noisier marine environment.
- Reduced sea ice enables shipping and industrial development in the Arctic. Marine traffic increases underwater noise levels, which can affect marine mammal movement and behaviour.

What we did:

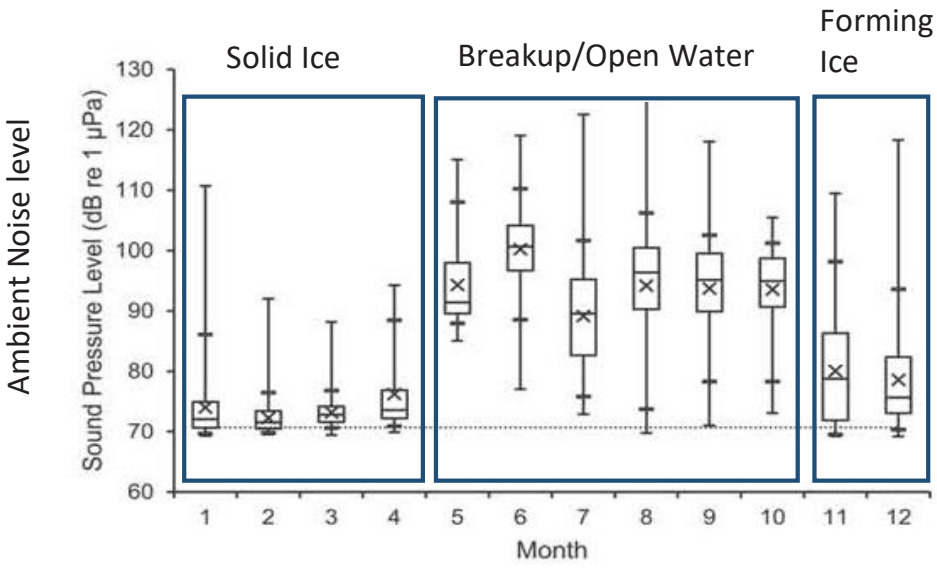
- We recorded local underwater ambient noise levels using two acoustic recorders (hydrophones) anchored to the ocean floor near Sachs Harbour from May 2015 to July 2016.
- We developed statistical models to determine what the best predictor of underwater ambient noise was in the study area.

What we found:

- During January-April, increased sea ice cover helped create quiet conditions underwater. During May to October, it was noisier underwater due to broken sea ice, wind activity, and the interaction of these factors.
- Overall, the underwater marine environment near Sachs Harbour is quiet, with ambient noise levels that are comparable to other places in the western Canadian Arctic and Alaska. Ambient noise levels are much lower than at places in the south.

Key result:

This figure shows the ambient noise levels (measured in decibels, dB) during different phases of ice formation near Sachs Harbour. The noisiest times underwater for marine mammals and fish are during breakup and open water and the quietest times are when ice concentration is highest during the winter.



Our recommendations:

- Maintain monitoring sites (e.g., WCS Canada, DFO) to develop a baseline level measurement of underwater ambient noise in the ISR.
- Expand monitoring sites (e.g., Amundsen Gulf, Darnley Bay, Viscount Melville Sound) to characterize and compare other regions in the eastern Beaufort Sea.
- Use these results to proactively plan for shipping corridors at the western entrance to the Northwest Passage shipping route *before* marine traffic increases. This data could inform the Shipping Working Group as well as Transport Canada and DFO.

Why is this research relevant to the Inuvialuit people?

- Marine mammals such as bowhead whales, beluga whales, bearded seals and ringed seals that live in the region use sound to communicate, find food, mates, and avoid predators. They are also a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Any increase in marine vessel traffic has implications not only for the conservation of marine mammals, but for all the Inuvialuit communities that depend on these mammals for nutrition, cultural, and spiritual values.
- Having scientific baseline information at this location will enable the Inuvialuit to make decisions regarding planning and mitigation due to impacts from increased noise and marine traffic on marine mammals in this region.

How was the community involved?

- This work was conducted out of Sachs Harbour. We are grateful to the Sachs Harbour Hunters and Trappers Committee, Wayne Gully, Betty Haogak, Terrence Lennie, Joe Kudak, and Jeff Kuptana for assistance.

Where can I get more information about this project?

- Stephen Insley and William Halliday are scientists with Wildlife Conservation Society (WCS) Canada (wcscanada.org). You can reach them at sinsley@wcs.org and whalliday@wcs.org.
- Other information:
  - http://data.nwtresearch.com/Scientific/16330
  - http://data.nwtresearch.com/Scientific/15470
  - www.arcticnoise.ca

Noise can disrupt the behaviour of marine mammals, such as bowhead whales

Halliday WD, Insley SJ, de Jong T, Mouy X (2018) Seasonal patterns in acoustic detections of marine mammals near Sachs Harbour, Northwest Territories. Arctic Science 4: 259-278.

What is the research about?

- The Arctic is changing rapidly and data are needed to assess how marine animals are responding.
- Species presence depends on sea ice, so sea ice loss caused by climate change could have important implications for the whereabouts of marine mammals.
- We collected data on marine mammal species distribution and composition as well as the timing of migration and movements within the study area.
- This information can be used to inform marine mammal conservation planning and management in the ISR.

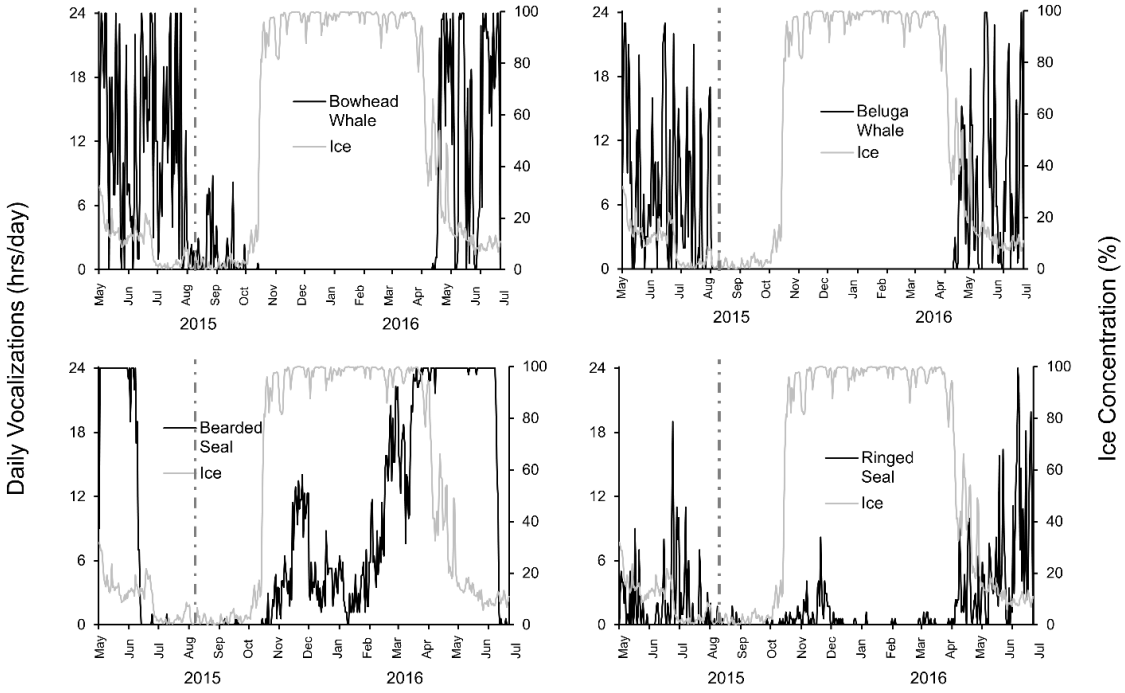
What we did:

- We used underwater passive acoustic monitoring to detect and classify marine mammals near Sachs Harbour from May 2015 to July 2016.
- We analyzed seasonal patterns in the presence of species as well as the effects of wind speed and ice concentration on species presence.

What we found:

- We detected bowhead and beluga whales as well as bearded and ringed seals.
- Both whales migrated into the region in late April as the ice broke up. Beluga whales migrated out in late August, while bowhead whales migrated out in October.
- Both whales migrated out of the area before ice formed in the autumn.
- Bearded seals started vocalizing in October as ice began to form, and started vocalizing 24 hours a day as ice started to break in the spring. They stopped vocalizing once the ice was mostly gone in July.
- Ringed seals were present, but they were generally quiet throughout the study period.

Key result:



In this figure, we can see the relationships between ice formation and break up (gray line) and number of each species

vocalizations (black line) throughout 2018. Both whale species were very vocal during ice breakup and open water periods. Both seals were vocal throughout the year, although bearded seals were quieter during July and the open water period compared to ringed seals.

Our recommendations:

- Continue data collection on species distribution and behaviour at key sites such as those established by WCS Canada and DFO in the ISR.
- Expand data collection and monitoring to more sites in the region (e.g., Amundsen Gulf, Darnley Bay, Viscount Melville Sound) to document the spatial and temporal distribution of these species.
- These data represent baseline information that can inform future work examining long-term patterns in distribution and migration timing and should be included in marine mammal management planning, such as the Beaufort Sea Beluga Management Plan[1] and the management plan for Bering-Chukchi-Beaufort bowhead whales[2] as well as marine spatial planning to protect marine mammals and areas of marine mammal concentration (e.g., AN MPA, TN MPA).

Why is this research relevant to the Inuvialuit people?

- Marine mammals such as bowhead whales, beluga whales, bearded seals and ringed seals live in the region and use sound to communicate, find food, mates, and avoid predators. They are also a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Any increase in marine vessel traffic has implications not only for the conservation of marine mammals, but all the Inuvialuit communities that depend on these mammals for nutrition, cultural, and spiritual values.
- Having scientific baseline information at this location will enable the Inuvialuit to make decisions regarding planning and mitigation due to impacts from increased noise and marine traffic on marine mammals in this region.
- Scientific baseline information on marine mammal behaviour could be complementary to Inuvialuit long-term observations and experiences of marine mammals to support conservation and management guidance and best practices in the ISR.

How was the community involved?

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1 https://www.beaufortseapartnership.ca/wp-content/uploads/2015/04/Beaufort-Sea-Beluga-Management-Plan-2013.pdf
2 https://www.sararegistry.gc.ca/virtual_sara/files/plans/mp_baleine_boreale_bowhead_1113_e.pdf

Halliday WD, Pine MK, Insley SJ, Soares RN, Kortsalo P, Mouy X (2019) Acoustic detections of Arctic marine mammals near Ulukhaktok, Northwest Territories. Canadian Journal of Zoology 97: 72-80.

What is the research about?

- The Arctic is changing rapidly, and data are needed to assess how marine animals are responding.
- Species presence depends on sea ice, so sea ice loss caused by climate change could have important implications for marine mammals.
- We collected data on marine mammal species distribution and composition as well as the timing of migration and movements within the study area.
- This information can be used to inform marine mammal conservation planning and management in the ISR.

What we did:

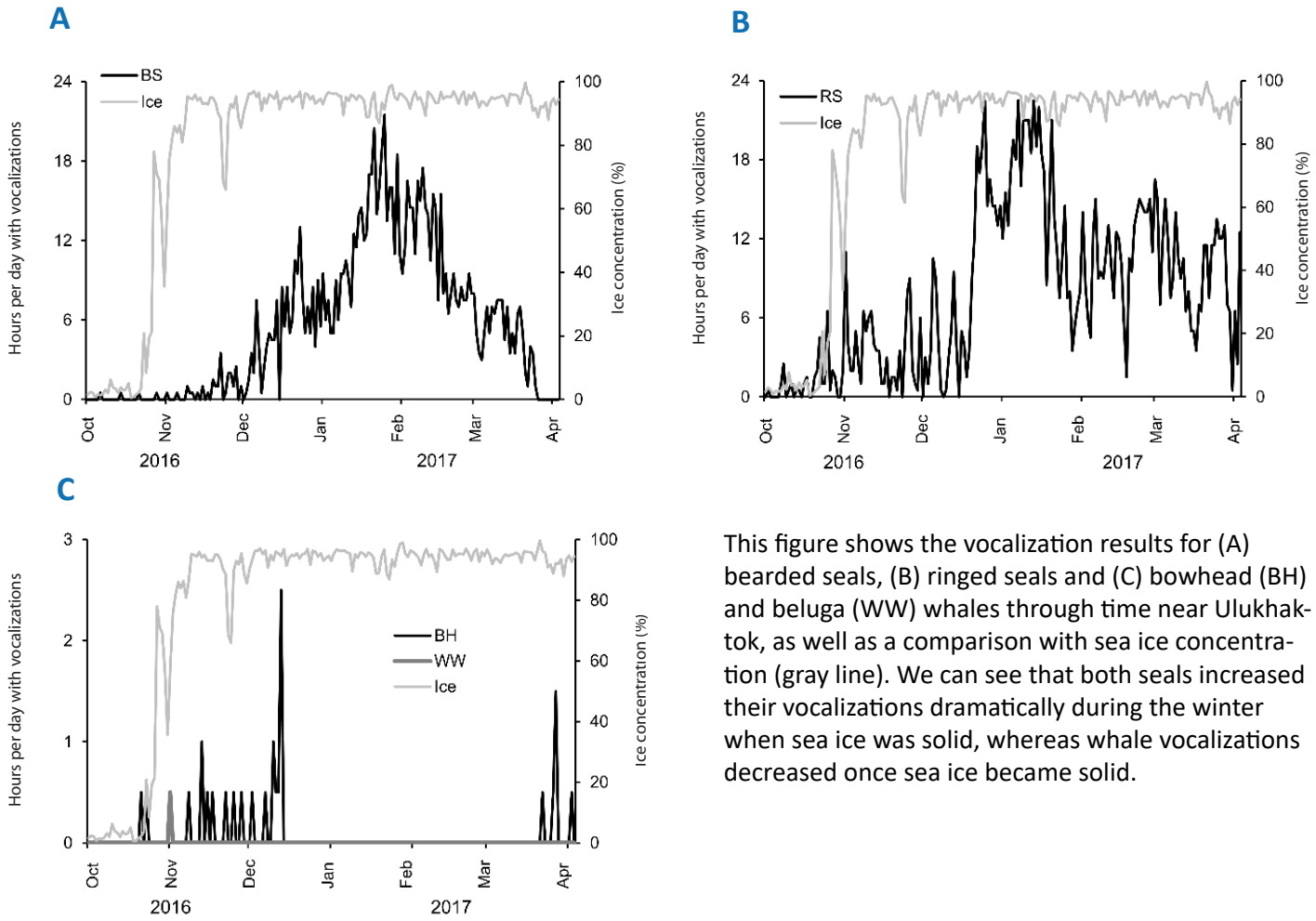
- We used underwater passive acoustic monitoring to detect and classify marine mammals from October 2016 to April 2017 near Ulukhaktok, Northwest Territories.
- We analyzed seasonal patterns in the presence of species, and also the effects of wind speed and ice concentration on species presence.

What we found:

- We detected bowhead and beluga whales, and bearded and ringed seals.
- Both whales were detected later into the autumn, but were not detected again in the winter. We detected bowheads again in early April.
- Both whales were detected later into the autumn than expected, with the last beluga detected on Nov. 12, 2016, and the last bowhead detected on Dec. 24, 2016.
- Bearded seals had rare vocalizations in November, were more common in December, and hit peak activity in January and February, with less vocalizations in March and April.
- Ringed seals were incredibly vocal at this site, with low vocalizations throughout the autumn, but very high levels of vocalizations throughout January, and many vocalizations from February through April.
- Overall, these data identify late season migrations of whales -- a unique scientific finding.
- The seal data are quite different than data from Sachs Harbour. Here, we have more ringed seal vocalizations, and fewer bearded seal vocalizations, in the recordings.

Bearded seal vocalizations peaked in January and February

Key Result:



This figure shows the vocalization results for (A) bearded seals, (B) ringed seals and (C) bowhead (BH) and beluga (WW) whales through time near Ulukhaktok, as well as a comparison with sea ice concentration (gray line). We can see that both seals increased their vocalizations dramatically during the winter when sea ice was solid, whereas whale vocalizations decreased once sea ice became solid.

Our recommendations:

- These data represent baseline information that can inform future work examining long-term patterns in distribution and migration timing and should be included in marine mammal management planning, such as the Beaufort Sea Beluga Management Plan[3] and the management plan for Bering-Chukchi-Beaufort bowhead whales[4]. This information is also important for current marine protected area management plans (e.g., AN MPA, TN MPA) as well as in the planning and management of any future MPAs.
- Research should include continued year-round monitoring for marine mammals at this site, as well as targeted and strategic deployment of acoustic recorders at other sites including farther south and west in the Amundsen Gulf and north in Viscount Melville Sound.

Why is this research relevant to the Inuvialuit people?

- Marine mammals such as bowhead whales, beluga whales, bearded seals and ringed seals live in the region and use sound to communicate, find food, mates, and avoid predators. They are also a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Any increase in marine vessel traffic has implications not only for the conservation of marine mammals, but all the Inuvialuit communities that depend on these mammals for nutrition, cultural, and spiritual values.
- Having scientific baseline information at this location will enable the Inuvialuit to make decisions regarding planning and mitigation due to impacts from increased noise and marine traffic on marine mammals in this region.

3 https://www.beaufortseapartnership.ca/wp-content/uploads/2015/04/Beaufort-Sea-Beluga-Management-Plan-2013.pdf
4 https://www.sararegistry.gc.ca/virtual_sara/files/plans/mp_baleine_boreale_bowhead_1113_e.pdf

- Scientific baseline information could be complementary to Inuvialuit long-term observations and experiences of marine mammal behaviour to support conservation and management guidance and best practices in the ISR.

How was the community involved?

- Yes. This work was conducted out of Ulukhaktok. We are grateful to Adam Kudlak, Bessie Inuktalik, and the Olokhaktomiut Hunters and Trappers Committee.

Where can I get more information about this project?

- William Halliday, Matt Pine, Piia Kortsalo, and Stephen Insley are scientists with Wildlife Conservation Society (WCS) Canada (wcscanada.org). You can reach them at sinsley@wcs.org and whalliday@wcs.org.
- Other information:
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    - www.arcticnoise.ca

Ulukhaktok community members Adam and Mary Kudlak with a recently recovered acoustic recorder

Halliday WD, Insley SJ, Hilliard RC, de Jong T, Pine MK (2017) Potential impacts of shipping noise on marine mammals in the western Canadian Arctic. Marine Pollution Bulletin 123: 73-82.

What is the research about?

- Sea ice is present throughout much of the Arctic Ocean for most of the year and helps keep the underwater marine environment quiet, while restricting marine shipping to the open ice season between August and October.
- We wanted to know what the current underwater noise levels are from ships in the region and how these could impact marine mammals, specifically in the proposed shipping corridor through the eastern Beaufort Sea and Amundsen Gulf.
- We also wanted to know how the noise levels might affect marine mammals in two marine protected areas (MPAs) near the corridor: Tarium Niryutait (TN), intended to protect habitat for beluga whales; and Anguniaqvia Niqiqyuam (AN), intended to protect biodiversity including cultural keystone species.

What we did:

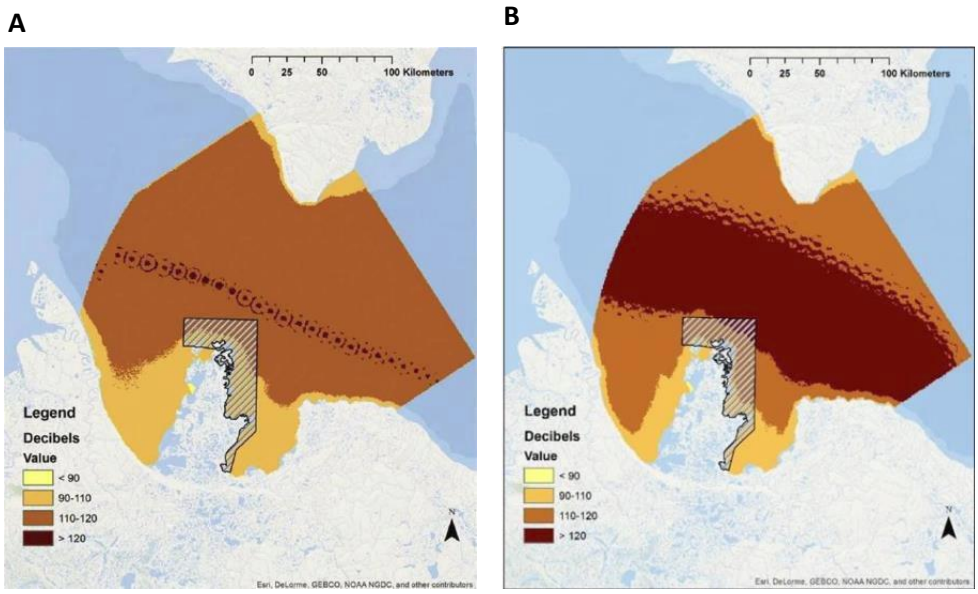
- We recorded underwater noise levels between 2014 and 2016 from acoustic recorders (hydrophones) near Sachs Harbour; we detected ships during August 2015.
- We used Automated Identification System (AIS) vessel data to determine which vessels were within 100 km of the hydrophones, and paired AIS data with our acoustic data to estimate how loud individual ships were.
- We developed sound wave models to describe the "noise footprint" of ships traveling in the corridor under calm and windy conditions, applying the noise levels from a ship recorded at Sachs Harbour and a tanker recorded elsewhere that could represent future traffic through the region.
- We applied the model to see where ship noise exceeded the threshold for behavioural disturbance (120 dB) throughout the south, central, and northern portions of the corridor when the ships were near the two MPAs.
- We considered how this "noise footprint" could impact marine mammal behaviour in the corridor and the two MPAs under calm and windy conditions.

What we found:

- The hydrophones recorded two vessels: a Canadian Coast Guard ice-breaker vessel conducting research, and a Canadian military ship. Six other vessels were recorded on the AIS, but not detected by our equipment.
- The ship noise model predicted that ship noise would be audible beyond 100 km under quiet conditions and that ship noise could change the movement behaviour of beluga and bowhead whales and ringed and bearded seals as far as 52 km from the ship.
- The "noise footprint" affects a large area of the AN MPA under windy and calm conditions, and behavioural disturbance thresholds were exceeded in a small portion of this MPA. Ship noise would only be audible in a small portion of the TN MPA and behavioural disturbance thresholds were never exceeded in this MPA.

Key Result:

In this figure, we show the noise footprint of the coast guard icebreaker (A) and the tanker (B) traveling along the shipping corridor near the AN MPA. The darkest colours show areas where behavioural disturbance threshold (120 dB) is exceeded, the next darkest colour shows audibility under windy conditions (ambient noise = 110 dB), and the next lightest colour shows audibility under calm conditions (ambient noise = 90 dB).



Our recommendations:

- Detailed acoustic modeling should be undertaken to address noise impacts in the proposed shipping corridor and inform the AN MPA management plan.
- Ensure that noise impacts are considered in the development of the AN MPA management plan. Specific actions could include:
    - Shift vessel traffic towards the northern edge of the shipping corridor to reduce behavioural disturbance in the AN MPA.
    - Redirect all vessels that do not need to travel in the MPA.
- Outside of the MPA, include marine mammal observers on ships traveling in areas where marine mammal migrations or congregations parallel ship traffic routes. In addition, ships should reduce speed at these times and locations to reduce their noise footprint.
- Consider shifting the entire shipping corridor further north.

Why is this research relevant to the Inuvialuit people?

- Marine mammals such as bowhead whales, beluga whales, bearded seals and ringed seals live in the region and use sound to communicate, find food, mates, and avoid predators. They are also a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Any increase in marine vessel traffic has implications not only for the conservation of marine mammals, but all the Inuvialuit communities that depend on these mammals for nutrition, cultural, and spiritual values.
- The Inuvialuit will be collaboratively developing the new management plan for the AN MPA and considering various planning options for shipping corridors. These data enable better decision making based on potential impacts to marine mammals.
- Having scientific baseline information at this location will enable the Inuvialuit to make decisions regarding planning and mitigation due to impacts from increased noise and marine traffic on marine mammals in this region.

- Scientific baseline information on marine mammal behaviour could be complementary to Inuvialuit long-term observations and experiences of marine mammals to support conservation and management guidance and best practices in the ISR.

How was the community involved?

- Part of this work was conducted out of Sachs Harbour. We are grateful to the people of Sachs Harbour, particularly the Sachs Harbour Hunters and Trappers Committee, Wayne Gully, Betty Haogak, Terrence Lennie, Joe Kudak, and Jeff Kuptana.

Where can I get more information about this project?

- Stephen Insley, Bill Halliday, and Matt Pine are scientists with Wildlife Conservation Society (WCS) Canada (wcscanada.org). You can reach them at sinsley@wcs.org and whalliday@wcs.org.
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    - http://data.nwtresearch.com/Scientific/15470
    - www.arcticnoise.ca

Ship traffic is projected to increase with an increasingly ice-free Arctic

McWhinnie L, Halliday WD, Hilliard C, Insley SJ, Canessa R (2018) Vessel traffic in the Canadian Arctic: management solutions for minimizing impacts on whales in a changing northern region. Ocean and Coastal Management 160: 1-17.

What is the research about?

- Approaches to managing vessel traffic varies throughout the world. We looked at measures that have been successful in reducing impacts on whales.
- Vessel traffic in the ISR is predicted to increase with a warming Arctic.

What we did:

- We reviewed vessel management tools used to reduce the impacts of vessels that are being applied in 33 MPAs, including at least one Arctic MPA.
- We identified multiple tools, but two tools could be applied in the immediate future in the eastern Beaufort Sea: voluntary exclusion zones and voluntary speed reduction zones.
- We addressed *voluntary exclusion zones* by modelling buffer zones (10 km, 50 km, 100 km) around the AN MPA and TN MPA.
- We considered *speed reduction schemes* of 15, 10, and 5 knot speed restrictions given mean and/or maximum speed.
- We used satellite Automated Identification System (AIS) data between 2012 and 2016 to quantify how many and what kind of vessels were in the area and what routes they took.
- We derived vessel use areas and calculated overlap within each MPA and buffer zone and quantified speed traveled by vessels in each buffer.
- We examined three vessels as a case study: a tug boat, a cruise ship (Crystal Serenity), and a bulk carrier. We then assessed how these vessels would be affected if voluntary avoidance and slow down schemes where implemented near important marine mammal areas and MPAs in the region.

What we found:

- Despite the known impacts of vessels on marine mammals, vessel management plans have been developed in implemented in only a few MPAs.
- We identified 14 tools used worldwide to reduce the impacts of vessels on whales in MPAs.
- There were 67 vessels in the study area in the ISR between 2012 and 2016: 18% were government/research vessels; 18% were tug boats; 15% were passenger vessels; 13.5% were recreational vessels; 10.5% were container vessels; 6% were naval vessels; 4.5% were tankers; as well as a dredger and fishing vessel.
- Buffer zones would affect 3-40% of the vessel use area around Arctic MPAs if implemented. The 100 km buffer zone was not practical given geographical and navigational issues.
- Over half of the vessels transiting through MPAs were traveling at more than 10 knots and would be affected by the most restrictive voluntary speed reduction.
- Reductions in speed had different effects on journey times for each of the three types of vessels examined.
- The most effective tool would be a mandatory exclusion zone for vessels within MPAs. However, a total ban would be difficult in the ISR since communities rely on shipping for resupply and the TN MPA is part of the community supply route between Inuvik and Tuktoyaktuk. As well, the AN MPA is directly outside of Paulatuk, and many smaller resupply vessels regularly travel through it.
- A combination of voluntary avoidance within the AN MPA and slowdowns for vessels that must travel through the AN MPA would be a good way to reduce vessel impacts on marine mammals within the AN MPA.

Key Result:

Overview of tools used to manage vessels in and near MPAs.

Spatial	Vessel	Monitoring	Outreach
Mandatory Exclusion Zone	Pilotage	Passive acoustic monitoring	On Ship
Restricted Access	Code of Conduct	Marine Mammal Observers	Industry
Voluntary Exclusion Zone	Reporting	Vessel Automatic Identification System	General Public
Vessel Re-Routing	Speed Reduction		

Our recommendations:

- MPA management plans require multiple tools for managing vessels in or near the MPA or other important areas for marine mammals.
- In the Arctic, ice cover and remoteness will affect the implementation and enforcement of any of these tools. However, the governance of MPAs by Inuvialuit communities and co-management institutions can be used to implement and enforce regulations on domestic vessels and drive changes in vessel behaviour through various tools.
- Our research suggests the largest buffer possible (given vessels can be audible when more than 100 km away) together with slowdown schemes would be most effective in AN MPA and TN MPA. These tools will most likely be taken up if they are voluntary, but require monitoring.
- Our research suggests vessel management is best targeted at larger vessels that travel farther from shore and at greater speeds than vessels like tugs that resupply communities. We show that large slow down areas may be more feasible management tools.

Why is this research relevant to the Inuvialuit people?

- Marine mammals such as bowhead whales, beluga whales, bearded seals and ringed seals live in the region and use sound to communicate, find food, mates, and avoid predators. They are also a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Any increase in marine vessel traffic has implications not only for the conservation of marine mammals, but all the Inuvialuit communities that depend on these mammals for nutrition, cultural, and spiritual values.
- The Inuvialuit are actively engaged in management planning for the two MPAs and the AN MPA plan is still in progress. Both consider the impact of vessel activities in the future. This review provides a preliminary overview of tools that the Inuvialuit can consider and suggests two voluntary tools as well as monitoring approaches that may be useful tools to start with in reducing vessel impacts to marine mammals.

How was the community involved?

No community involvement as this was an examination of practices in other jurisdictions.

Where can I get more information about this project?

- Stephen Insley and William Halliday are scientists with Wildlife Conservation Society (WCS) Canada (wcscanada.org). You can reach them at sinsley@wcs.org and whalliday@wcs.org.
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    - www.arcticnoise.ca

Pine MK, Hannay DE, Insley SJ, Halliday WD, Juanes J (2018) Assessing vessel slowdown for reducing auditory masking for marine mammals and fish of the western Canadian Arctic. Marine Pollution Bulletin 135: 290-302.

What is the research about?

- Underwater noise from vessels can cause hearing damage, stress, habitat avoidance, shifts in migration routes and behavioural changes in marine mammals and fishes.
- One of main impacts of underwater noise from vessels is acoustic masking. Acoustic masking is when noise "drowns out" an animal's ability to hear, reducing its detection of sounds and vocalizations used for critical life processes.
- Because vessel noise can travel underwater over large distances (more than 100 km), vessel noise can potentially mask hearing and vocalisations of marine animals over large areas.
- Scientific methods for assessing acoustic masking usually require detailed information on the hearing capabilities of marine animals, which is not available for most Arctic marine animals.
- We wanted to examine vessel slowdown as a tool to reduce vessel noise and, consequently, masking. Vessel slowdown also reduces the risk of ship strikes with marine mammals.

What we did:

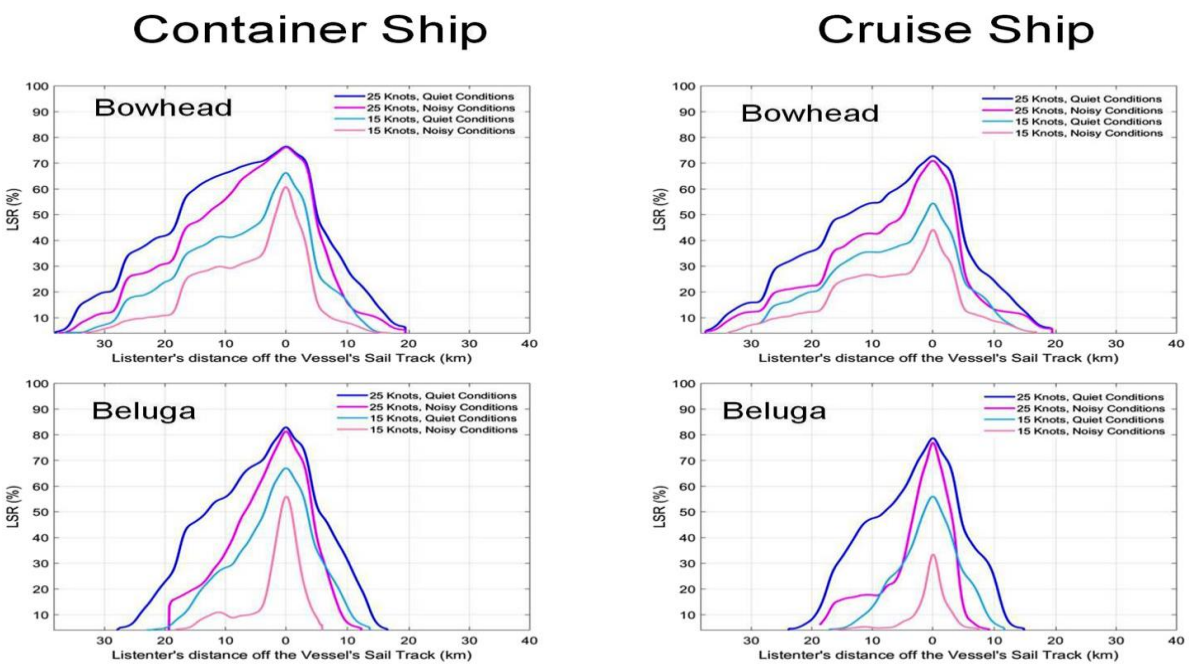
- We applied a method called the "listening space" to model acoustic masking caused by vessel traffic for marine mammals and fish in the Inuvialuit Settlement Region.
- This method assesses how sound travels through the water from a noisy ship, and compares this information to the basic hearing capabilities of the animal of interest.
- We simulated listening space reductions at four sites: north of the Mackenzie Delta, near Ulukhaktok, through the centre of the Prince of Wales Strait, and in Viscount Melville Sound.
- We assessed masking from both container and cruise ships traveling at 25 knots (normal) and 15 knots (reduced speed) on bowhead whales, belugas, ringed and bearded seals, and Arctic cod, and assessed how the slower speed might reduce masking.

What we found:

- Vessels traveling 15 knots caused less acoustic masking than vessels traveling at 25 knots.
- Seals were susceptible to greater masking impacts at greater distances from the vessels than whales. Fish were the least susceptible to masking. Differences were due to species-specific hearing sensitivities.
- The extent of masking also varied between the different sites, depending on the depth contours and position of the vessel as well as natural sound conditions such as wind and wave action.

Key Result:

In the figure on page 15, we show the listening space reduction (LSR, or degree of masking) that either a container ship (left) or cruise ship (right) would cause for bowhead whales when traveling 25 knots (dark blue and purple lines) or 15 knots (light blue and orange lines) under windy (purple and orange lines) or calm (dark and light blue lines) conditions. The horizontal axis shows how far away the vessel is from the bowhead whale, with greatest impact when the vessel is close. Generally, LSR is greater when vessels travel fast and LSR is greater under calm conditions. Container ships are generally noisier than cruise ships, so LSR is generally greater.



Our recommendations:

- Masking assessments can inform species-specific guidelines such as determining the distances away from a vessel when masking occurs or the impact of vessel speed on the zone of masking around a vessel in order to set shipping corridor boundaries and speed restrictions.
- Masking assessments can inform specific vessel management tools such as slow down schemes within new and existing management plans for MPAs (e.g., AN MPA, TN MPA), near marine mammal concentration areas, and other sensitive areas in the ISR where shipping routes may be difficult to move given geographical and navigational issues.
- We show that even with slow down regimes, relief in masking will vary by species and vessel as well as external conditions so monitoring is important.

Why is this research relevant to the Inuvialuit people?

- Marine mammals such as bowhead whales, beluga whales, bearded seals and ringed seals live in the region and use sound to communicate, find food, mates, and avoid predators. They are also a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Any increase in marine vessel traffic has implications not only for the conservation of marine mammals, but all the Inuvialuit communities that depend on these mammals for nutrition, cultural, and spiritual values.
- It is important to understand how different mitigation approaches, such as slow down regimes, can reduce the impacts of acoustic masking that could cause marine mammals to leave the area or affect their populations.

How was the community involved?

- Data for this paper came from work conducted out of Sachs Harbour. We are grateful to the Sachs Harbour Hunters and Trappers Committee, Wayne Gully, Betty Haogak, Terrence Lennie, Joe Kudak, and Jeff Kuptana.

Where can I get more information about this project?

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Halliday WD, Têtu P-L, Dawson J, Insley SJ, Hilliard RC (2018) Tourist vessel traffic in important whale areas in the western Canadian Arctic: risks and possible management solutions. Marine Policy 97: 72-81.

What is the research about?

- Tourist vessels, especially pleasure craft, are one of the fastest growing sectors of vessel traffic within the Arctic. However, they are problematic in terms of marine mammal conservation.
- Currently, these vessels have far fewer regulations governing them compared to large commercial vessels.
- Also, tourists tend to actively seek out marine mammals, posing a greater risk to marine mammal populations through harassment and strikes.
- Finally, pleasure vessels are not required to carry Automatic Identification System (AIS) transponders, making their movements and impacts difficult to monitor.

What we did:

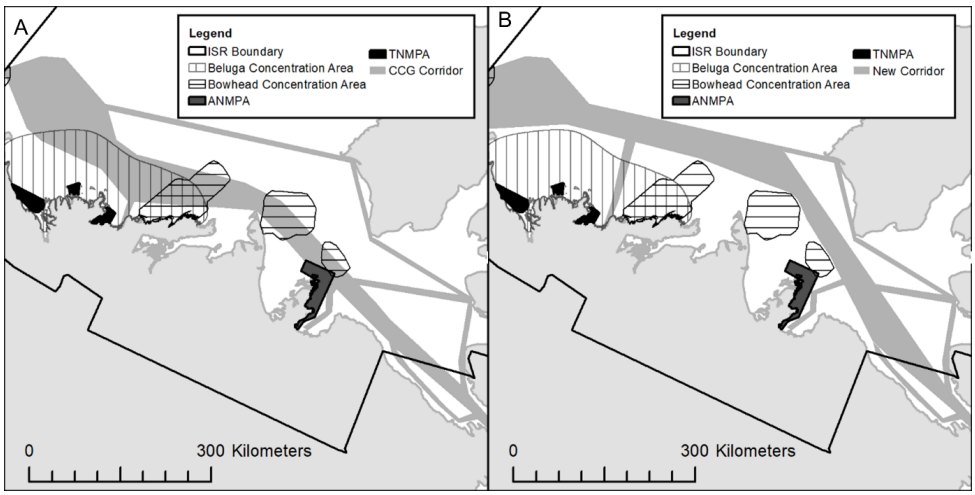
- We assessed the extent to which tourist vessels (both pleasure craft and passenger vessels) traveled within important areas for bowhead whales and belugas within the ISR between 1990 and 2015.
- We also assessed the speed at which those vessels traveled, and their overlap with the vessel corridor and marine protected areas (MPAs).
- We investigated different management tools that could be used to reduce the impact of tourist vessels on whales in this region.

What we found:

- Passenger vessels had a constant, but low presence within the region throughout the study period, whereas pleasure craft showed a dramatic increase in the past 10 years
- All tourist vessels had a large overlap with both bowhead and beluga areas, especially in the last 10 years for pleasure craft
- Passenger vessels typically travel much faster than pleasure craft and may therefore have a higher risk of colliding with whales
- Restricting tourist vessels to a vessel corridor could reduce risk to whales in important whale areas because the vessels would be restricted to just one part of the area – the travel corridor through the whale areas
- A revised corridor that travels farther to the north through the centre of the Amundsen Gulf could avoid whale areas and marine protected areas and greatly reduce the risk to whales posed by vessels
- For vessels unable to travel far from shore, a speed restriction should be put in place to reduce acoustic impacts and lower the risk of ship strikes, along with specific rules about interacting with whales

Key Result:

This figure shows the location of the original and current Canadian Coast Guard corridor (A) and the new proposed corridor (B) that avoids whale concentration areas.



Our recommendations:

- Include spatial and speed restrictions for tourist vessels in existing (e.g., TN MPA) and emerging protected area (e.g., AN MPA) management plans.
- Careful monitoring of pleasure craft, many of which do not carry Automatic Identification System transponders. This could be done by requiring all vessels to carry AIS, requiring vessels to check in with communities, a community observation network, and/or increasing enforcement vessels on the water.
- Outreach and education to tourist vessels (e.g., WWF Canada's Mariner's Guide[5]), especially pleasure craft owners.

Why is this research relevant to the Inuvialuit people?

- Marine mammals such as bowhead whales, beluga whales, bearded seals and ringed seals live in the region and use sound to communicate, find food, mates, and avoid predators. They are also a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Any increase in marine vessel traffic has implications not only for the conservation of marine mammals, but all the Inuvialuit communities that depend on these mammals for nutrition, cultural, and spiritual values.
- It is important to understand the impacts of tourist vessels and design appropriate mitigation for MPAs and other areas of importance. The combination of scientific research could be complementary to Inuvialuit long-term observations and experiences of marine mammal behaviour to co-create "rules" and educational materials for tourist vessels.

How was the community involved?

Not involved in this study.

Where can I get more information about this project?

- William Halliday and Stephen Insley are scientists with Wildlife Conservation Society (WCS) Canada (wcscanada.org). You can reach them at sinsley@wcs.org and whalliday@wcs.org.
- Other information:
  - http://data.nwtresearch.com/Scientific/16330
  - www.arcticnoise.ca

5 http://assets.wwf.ca/downloads/Marine-Mammals-2018may.pdf

Protection of the Arctic Marine Environment (PAME) (2019) Underwater noise in the Arctic: a state of knowledge report. PAME Secretariat, Akureyri[6]. Authored by William D. Halliday, Matthew K. Pine, and Stephen J. Insley.

What is the research about?

- Underwater noise is an important issue globally, and underwater noise from human activities causes a variety of negative impacts on marine life.
- Underwater noise has been increasing in temperate areas due to increased ship traffic, but no study has examined long-term trends in underwater noise across the Arctic.
- The Arctic is a unique acoustic environment due to the presence of sea ice and lower levels of human activity, so underwater noise may have different impacts on Arctic marine life.

What we did:

- We conducted a literature review of background ambient sound levels in the Arctic, sources of anthropogenic (human-caused) underwater noise, and the impacts of underwater noise on Arctic marine animals.

What we found:

- The Arctic has lower ambient sound levels than non-polar areas due to the presence of sea ice and decreased anthropogenic activity.
- When anthropogenic activity is present in the Arctic, it can be heard from very far away due to these low ambient sound levels.
- The majority of anthropogenic underwater noise in the Arctic is due to oil-and-gas exploration and extraction activities and ship traffic.
- Underwater noise may increase in the Arctic in the future as levels of ship traffic are projected to increase.
- Arctic marine mammals may be more sensitive to underwater noise than non-Arctic marine mammals. For example, beluga whales and narwhal react to noise sources that are nearly 50 km away.
- Arctic seals may be more tolerant to underwater noise than Arctic whales, but only a handful of studies have examined Arctic seals, often only incidentally.
- Only two studies examined the impact of ships (and indirectly, noise) on Arctic fish, and both found that the fish changed their movement behaviour in response to ships.
- No studies have examined the impact of underwater noise on Arctic marine invertebrates.
- There were many knowledge gaps, including entire geographic areas where we couldn't find any studies (Russian Arctic; much of the European Arctic), and many species with no information about how they react to underwater noise (walrus, bearded seals, most fish, all marine invertebrates).

Our recommendations:

- Fill knowledge gaps, either by making data/reports available or conducting new research.
- Use the precautionary approach in the Arctic before underwater noise increases as shipping increases.

6 https://oaarchive.arctic-council.org/bitstream/handle/11374/2394/Underwater%20noise%20report.pdf?sequence=1&isAllowed=y

Why is this research relevant to the Inuvialuit people?

- Marine mammals such as bowhead whales, beluga whales, bearded seals and ringed seals live in the region and use sound to communicate, find food, mates, and avoid predators. They are also a critical part of Inuvialuit food sovereignty and have been managed by Indigenous communities for millennia.
- Any increase in underwater noise has implications not only for the conservation of marine mammals, but all the Inuvialuit communities that depend on these mammals for nutrition, cultural, and spiritual values.
- It is important to understand the impacts of underwater noise and design appropriate mitigation for MPAs and other areas of importance. The combination of scientific research could be complementary to Inuvialuit long-term observations and experiences of marine mammal behaviour to co-create "rules" and educational materials for tourist vessels.

How was the community involved?

Not involved directly in this study. Data from research conducted out of Sachs Harbour were included in this literature review.

Where can I get more information about this project?

- William Halliday, Matt Pine, and Stephen Insley are scientists with Wildlife Conservation Society (WCS) Canada (wcscanada.org). You can reach them at sinsley@wcs.org and whalliday@wcs.org.
- Other information:
    - www.arcticnoise.ca

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