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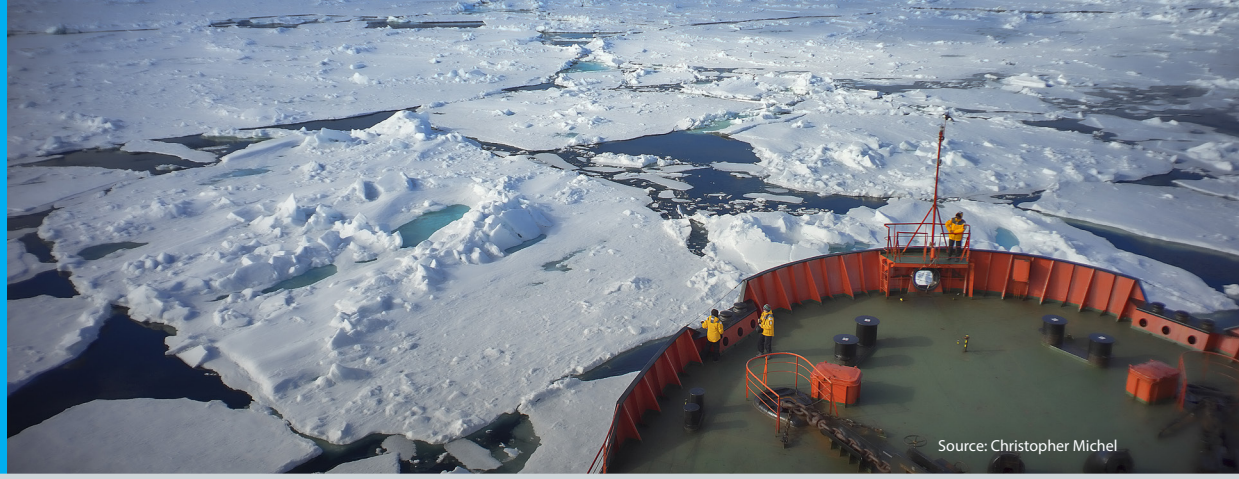
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White Noise: Preventing Acoustic Pollution in the Arctic

Overview

1. Anthropogenic underwater noise is a threat to cetaceans worldwide.
2. For the Arctic, there is still time to implement mitigation and protective measures before industrial activity in the region increases further.
3. EIA urges nations to support the Resolution on Underwater Noise IWC 67/05.

Underwater environments are not silent places, but the natural soundscape most marine species rely on to communicate or find prey is being increasingly dominated by industrial activity. Since the 1960s the number of commercial shipping vessels has doubled, adding to the levels of low frequency noise as these vessels carry the world's goods from port to port.[1] This industrial noise has both acute and chronic impacts which affect every part of the ecosystem from masking blue whale calls to the outright killing of tiny zooplankton.

For Arctic species such as bowhead whales, beluga whales, and narwhals, increasing noise raises the risk of interference with vital behaviors including communications, foraging, mating and calving. In extreme cases, noise physically harms whales and the prey they rely on. Increasing underwater noise compounds the other threats faced by these species, including chemical pollution, the potential impact of an oil spill from drilling or ships, the introduction of invasive species, entanglement in fishing nets, ship strikes, and the overarching impact of climate change.

As the Arctic grows louder underwater, the impact on its iconic cetacean species will only continue to grow. The solutions for many underwater noise problems are already known and awaiting a little more investment and incentives to receive wider adoption. Even as more research is conducted, precautionary action is urgently needed to mitigate these potential threats.

The International Whaling Commission (IWC) has long acknowledged the significance of underwater noise to cetaceans. Since 1999, underwater noise pollution has been a standing item on the agenda of the IWC Scientific Committee. In 2008 the IWC Scientific Committee endorsed a "reduction in the contributions of shipping to ambient noise energy in the 10-300 Hz band by 3 dB in 10 years and by 10 dB in 30 years relative to current levels".[2] Ten years later mitigation and preventative measures have yet to be widely adopted. As more development shifts to the Arctic, we have an unprecedented opportunity to put in place precautionary protective measures to prevent harmful increases in noise in this fragile region.

EIA urges the members of the International Whaling Commission to continue to show leadership on this crucial topic and support the Resolution on Anthropogenic Underwater Noise (IWC 67/05), and to identify and implement strategies to reduce, prevent and mitigate underwater noise at the national and international level.

The Acoustic Arctic

Compared to other oceans, the underwater soundscape of the Arctic remains relatively undisturbed. The Arctic ambient environment can still be noisy at times, characterized by sounds of cracking sea ice, as well as wind and waves.[3] In winter, however, sea ice cover creates an acoustic shield over the water column, dampening the sound of wind.[4] The thicker the ice, the stronger the dampening effect. Unfortunately, the Arctic is warming at twice the global rate due to anthropogenic climate change, and as a result the acoustic shield is declining.[5]

In the Arctic's naturally quiet environment, cetaceans have evolved to use sound to communicate with each other and locate prey. The low-frequency songs of bowhead whales travel long distances. This species is highly vocal and its songs are often complex and freeform, leading some researchers to compare the diverse repertoire of bowhead calls to jazz. Among the critically endangered population near Svalbard, 184 different song types were recorded in a three-year period.[6] Beluga whales and narwhals rely more on mid- to high-frequencies to communicate, navigate, and locate prey, often through a wide variety of sounds such as clicks, chirps, and whistles. All three species also migrate between regular winter and summer areas, communicating as they travel under the ice.
As interest in Arctic's hydrocarbon resources grows, and as greater numbers of commercial and tourist vessels navigate Arctic routes, underwater noise will increase, perhaps substantially. The increased industrial activity in the region could threaten belugas, bowheads, narwhals, which evolved in quieter environments and are less habituated to human noise.

The Threat of Underwater Noise

Different frequencies of sound elicit different responses from cetaceans. Some sounds lie outside of their range of hearing entirely. Within their hearing range, there are roughly three zones of impact. At the outermost zone, a sound is merely audible. In the second zone a sound is sufficient to prompt a response, such as to move away from the source of the noise, or to increase the volume of its own calls to compensate. In the third zone, a sound can provoke discomfort, hearing loss, and even physical injury. At these levels the sound is loud enough to cause permanent or temporary threshold shifts (PTS or TTS) to the animal's hearing, and may even be fatal at certain levels.[7]

While most sounds are unlikely to cause fatal injury, they add stress and pressure to Arctic whales by creating chronic background noise, masking their calls, and disrupting their normal feeding and migration behaviors. For narwhals, noise disturbance may prompt a series of hard swimming deep dives, an energy intensive process likened to running long distance while holding one's breath.[8] For some species, notably bowhead and beluga whales, the added pressure from underwater noise may hamper their ability to recover from centuries of commercial exploitation. From a pre-whaling minimum of 50,000 bowheads, whalers reduced global abundance to less than 3,000 by the 1920s.[9] While some populations, like the Bering-Chukchi-Beaufort whales, have demonstrated substantial recovery, others like the Spitsbergen or Okhotsk Sea bowheads have not and only a few hundred whales remain in each area.

Oil and Gas Activities

The Arctic is thought to contain 13 percent of the world's remaining undiscovered oil and as much as 30 percent of its undiscovered natural gas, mostly underwater.[10] At present, the favored method for discovering these resources is the use of seismic airguns to map the seafloor for hydrocarbons. Airgun surveys might utilize as many as 48 airguns. These guns are grouped into arrays and towed behind a vessel, with each airgun emitting loud blasts (235–260 decibels) every 10 to 15 seconds.[11] Airgun surveys may run 24 hours a day, seven days a week, for months on end. In one 16 month study conducted near the equatorial Ascension Island, sound from seismic airguns dominated the soundscape for the entire study period without any seasonal variation.[12]

Airgun noises can affect a large portion of the ocean. In one study in Arctic waters, noises from seismic testing could be detected up to 1,300 kilometers away.[13] Once oil is found, drilling platforms can also contribute to local underwater noise.[14]

Airguns can have a potentially serious effect on all Arctic cetaceans. Although they are less likely to do so when actively feeding, bowhead whales have deflected away from areas of seismic testing at distances of 20 km.[15] Similarly, at distances of 41-45 km, bowheads have been found to react to the airguns, first increasing their call rate to potentially "shout" over the interfering noise, then falling silent altogether when sound levels rise above 160 dB.[16] In 2008 and 2009, seismic tests were conducted in Baffin Bay, which may have caused narwhals to delay migrating from their northern summer habitat to avoid the survey noise. This delay proved deadly. From 2008-2010 over 1,200 narwhals became fatally entrapped in Pond Inlet, Canada, and Smith Sound, Greenland, as the sea ice froze.[17] Neither area had ever been known for entrapments prior to these airgun surveys.

Airguns have damaging, and potentially fatal, impacts on many other marine species, including some which whales consume as prey.[18] For instance, the bowhead's favored prey are zooplankton. In a 2017 study, when exposed to a single airgun, researchers found that abundance of many zooplankton species (like krill) dropped by half or more.[19] A detectable "kill zone" of more than a kilometer would appear behind the airgun. Physical trauma to fish is also well documented in response to seismic testing.[20] After even brief exposure to airgun frequency sounds, some cephalopods such as cuttlefish demonstrate internal damage to their statocysts, an organ responsible for balance and underwater movement; the damage increases with exposure time.[21] Exposure in fish species can burst swim bladders, cause other physical damage, alter behaviors and heighten stress.[22]

Ship Noise

The vessels on which goods, people, and navies traverse the oceans are one of the largest sources of underwater noise globally. As propeller blades on these vessels slice through the water, they generate bubbles that create noise when they burst. Propulsion, machinery, hydraulic flow over the hull, and flexing of the hull also create underwater noise.[23] The level of sound depends on the size, weight, and speed of the vessel, with the largest 10 percent of vessels likely generating the majority of the industry's underwater noise.[24] Unlike airguns, ship noise is not directional and projects out in all directions. The constant presence of commercial shipping makes it the largest contributor to chronic background noise in the oceans, especially near shipping lanes and coastal areas.

Historically, shipping in the Arctic has been limited mostly to community resupply, along with some cruise shipping and other "local" traffic to and from specific destinations. However, with the decline of the Arctic's sea ice cover and thickness, interest in traversing the region has grown. In the Canadian Arctic, declines in sea ice correlate strongly with increases in ship traffic.[25] Interest in the Russian Northern Sea Route (NSR) and Canada's long sought Northwest Passage as commercial shipping routes has increased significantly in recent years with the longer summers as a result of climate change creating longer ice-free windows. The Russian Federation has made increasing shipping along the NSR, with a projected target of 80 million tons by 2024 over just 10.7 million in 2017, a presidential priority.[26] As part of its Belt and Road economic initiative, China has also expressed interest in using the NSR as a "Polar Silk Road".[27] Much of this ship traffic would also have to pass through several migratory bottlenecks, such as the Bering Strait or Lancaster Sound, that all species of Arctic cetaceans utilize for their seasonal migrations. While some measures, like the International Maritime Organization's (IMO) Polar Code, have been implemented, more effort is needed to reduce the impact of increasing vessel traffic on Arctic cetaceans.

After most shipping to the eastern United States was suspended following the September 11 attacks, researchers found that low frequency noise levels in places like the Bay of Fundy decreased sharply.[28] This drop in noise corresponded with a sharp drop of stress hormones in the critically endangered North Atlantic right whale, indicating a close link between the stress and higher levels of underwater noise. Bowhead whales are closely related to right whales, and several populations are just as endangered, thus this crucial link suggests that Arctic bowhead populations could be negatively affected by increases in ship noise.

Vessel traffic can mask the calls of belugas and narwhals. In one 2009 study along Saguenay Fjord in the St. Lawrence Estuary, for half of a studied day beluga potential communication range was reduced to less than 30 percent of its expected range, and to less than 15 percent a quarter of the time by vessel traffic. Ambient sound levels occurred just 9.4 percent of the day, typically at night after ferry traffic decreased and operations by whale watchers ceased.[29]

Belugas and narwhals are also especially affected by icebreakers. Icebreakers often accompany vessels traversing the Arctic region, and new shipping vessels like the liquified natural gas tanker

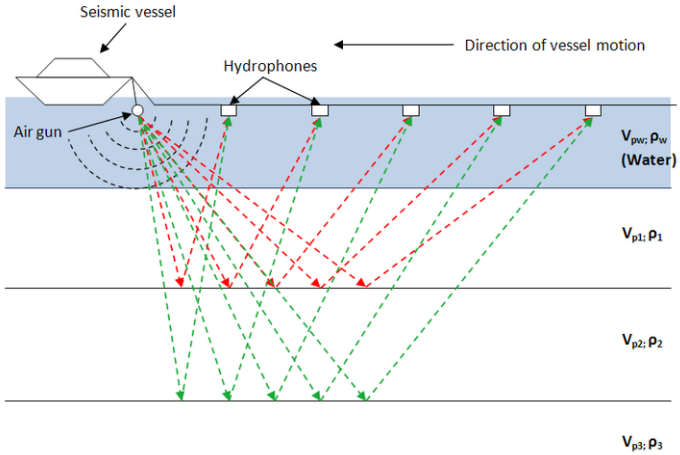

Diagram of a marine towed streamer seismic survey with the raypaths that result from a single shot by an airgun into a streamer containing 5 hydrophones.
--- = raypaths to first reflector; --- = raypaths to second reflector; Source: NOAA

Christophe de Margerie are increasingly designed to function as their own icebreakers.[30] As these vessels carve their path through sea ice, they may emit more noise than any other ship. Even at distances of 50 kilometers, belugas have been observed "fleeing" from icebreaker sounds.[31] While the whales may become somewhat used to vessel noise over time, the noise may disrupt their habitat use and migratory patterns, as well as facilitate access by predators such as killer whales, with potentially serious consequences for entire populations.


Source: Dr. Kristin Laidre/NOAA

SONAR

The Arctic has historically been an area of peaceful international cooperation, but the decline in sea ice has led to increased discussions of national security in the region and potentially more military exercises involving the use of sonar.[32] Sonar (SOund Navigation And Ranging) is an acronym for equipment used to communicate or detect objects like vessels or fish on or under the water. While passive sonar merely listens for sound, active sonar projects a sound wave called a ping, which can often be loud, powerful, and potentially damaging to cetaceans at mid frequencies. Use of naval sonar has been linked to mass strandings of some whale species, especially beaked whales but also minke whales, sperm whales, and multiple species of dolphins.[33] When exposed to these sounds whales responded by swimming away rapidly from the source.[34] In many stranding cases, Cuvier's beaked whales exhibited signs of gas bubble-related lesions and fat embolism, suggesting they had risen so rapidly in response to the sonar that they had suffered from decompression sickness.[35] Non-fatal impacts are also possible. Blue whales, for instance, have been found to cease feeding and move away from simulated active sonar.[36]

Some commercial forms of sonar are also detectable by Arctic cetaceans and may prompt a behavioral response. For instance, beluga whales can detect the pulses produced by some echo sounders, a device used to detect the depth of the seabed or by commercial fishermen to detect and identify fish.[37]

Construction Noise

Increased industrial activity in the Arctic will inevitably require building more infrastructure, including larger harbors, the construction and utilization of which is likely to result in a louder marine environment. For instance, dredging sand, either to build artificial islands for oil and gas drilling or to deepen harbors, can make as much noise as a large cargo ship.[38] Port expansion, and the installation of wind farms and oil and gas drilling platforms, require impact and vibratory pile driving, in which a pile is hammered or vibrated into place. Each impact of a pile drivers creates a loud noise that ripples through the water and also travels along the sea bed.

Pile driving noises may cause both whales and their prey species to avoid impacted areas causing potentially significant disruptions to feeding, calving and other important activities. During pile driving in Cook Inlet, Alaska, belugas changed behaviors near the area, diving quickly and foraging less.[39] Similarly, a long term study near a Canadian drilling site in the Arctic found that bowheads mostly abandoned the area for the duration.[40] While it was unclear whether the change in habitat was driven by the noise or shifts in zooplankton, the latter could have also been affected by the sounds of construction.

Existing Policy

Most approaches to addressing underwater noise have focused on addressing acute sources of noise pollution through spatial planning. For example, in the United States, under the Marine Mammal Protection Act (MMPA) obtaining an incidental harassment authorization (IHA) is required before using airguns or underwater pile drivers.[41] However, the MMPA does not regulate all potential forms of underwater noise, such as vessel traffic, as harassment.

Addressing cumulative underwater noise impacts will require comprehensive regional, industry-wide, and even global approaches from all stakeholders. For instance, after a series of stakeholder workshops by scientists, shipowners, and engineers the 2008 "Hamburg Protocol", proposed a "reduction in the contributions of shipping to ambient noise energy in the 10-300 Hz band by 3 dB in 10 years and by 10 dB in 30 years relative to current levels", a target endorsed by the IWC Scientific Committee.[42] This attempt at industry wide noise reduction spurred the creation of the IMO's 2014 *Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life*, although it is unclear how many companies have adopted these measures.[43,44]

The U.S. National Oceanic and Atmospheric Administration (NOAA) has also attempted to incorporate underwater noise in management activities across the entire agency with its *Ocean Noise Roadmap*.[45] And the European Union's 2008 Habitats Directive explicitly incorporates underwater noise in its consideration of good environmental status (GES).[46]

Turning Down the Volume

Because the Arctic is still a relatively quiet environment, the international community has a rare opportunity to prevent or mitigate noise impacts before widespread industrialization and significant increases in Arctic shipping occur. Underwater noise is much less persistent than other pollutants, and there are some sources of noise pollution that can be mitigated or reduced in impact, for example:

- In lieu of airguns, alternative technology like marine vibroseis can be used. Marine Vibroseis is an alternative technology which uses vibrations instead of air blasts and produces much less noise within a much narrower field. While marine vibroseis is still a relatively new technology, it has begun to enter industry use due to underwater noise concerns and regulatory pressure.[47]
- Vessels can reduce noise cost-effectively, for example by cleaning their hulls and installing more efficient propellers. Such measures not only cut sound from ships by 6-8 dB at certain frequencies, but can also cut fuel use by 10 percent or more.[48]
- Vessels can also reduce their noise by reducing speed, another measure that can also save fuel, though at the cost of lengthening the vessel's presence in an area.[49]
- The use of bubble curtains or wood block silencers has been shown to be effective in mitigating noise for certain types of marine construction.
- Time-area closures where construction or other types of activities creating noise sources are stopped when vulnerable species are present is also a commonly used mitigation measure.[50]

- Spatial plans, like routing measures, marine protected areas, voyage planning and the creation of dynamic shipping lanes can incorporate underwater noise into to better ensure the protection of marine species, or to move sources of noise away from key habitat.


Source: EIA

Conclusion

Underwater noise is a complex problem, but one that will only increase in urgency as time passes. For the Arctic and its endemic whales there is still time to take precautionary action. With regard to Arctic underwater noise mitigation, EIA makes the following recommendations to nations:

1. Support the Resolution on Anthropogenic Underwater Noise (IWC 67/05), which instructs research into the impacts of underwater noise on cetaceans and evaluating mitigation measures by the Scientific Committee, as well as advice from the Conservation Committee on priority actions to be implemented.

2. Encourage government participation in underwater noise discussions at other forums, including the International Maritime Organization, the United Nations, and within the International Whaling Commission's Scientific Committee.

3. Support cooperation between, and information sharing among, the relevant forum discussed above.

EIA looks forward to working with all stakeholders on this important issue for Arctic cetaceans.

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