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COMMENTARY
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Key Points:

- Han et al. (2021) published a study in Geophysical Research Letters on underwater sound levels in the East Siberian Sea
- I place this study in the context of broader effort to establish baselines of underwater sound levels in the Arctic
- I call on researchers to continue filling geographic gaps in studies of underwater sound levels, particularly in the Russian Arctic

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Underwater Sound Levels in the Arctic: Filling Knowledge Gaps

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Abstract Climate change is projected to cause the Arctic soundscape to become noisier due to sea ice loss and increased anthropogenic activity. Many studies on underwater sound levels have been conducted in the western North American Arctic and Fram Strait, but the rest of the Arctic is full of geographic gaps. Han et al. (2021, https://doi.org/10.1029/2021gl093097) published a study in Geophysical Research Letters on underwater sound levels in the East Siberian Sea, providing the first estimates of seasonal trends and the natural and anthropogenic drivers of underwater sound levels in this region. This is an excellent first step in filling geographic gaps in the Russian Arctic, and I call on other researchers to continue to fill these geographic gaps throughout the Arctic so that we can set a baseline and study changes to underwater sound levels being caused directly and indirectly by climate change.

Plain Language Summary The Arctic marine environment can be one of the quietest on Earth, particularly under solid sea ice. Climate change is causing sea ice to melt at an alarming rate and is also allowing increased human shipping activity. Both sea ice loss and increased shipping activity will likely lead to a noisier environment underwater in the Arctic. Many studies have examined how loud the underwater environment is in the Arctic of western North America and between East Greenland and Svalbard, but there are many areas throughout the Arctic with no studies. Han et al. (2021, https://doi.org/10.1029/2021gl093097) just published the first study on the loudness of the underwater environment in the East Siberian Sea. This study fills an important gap in our knowledge, and I call on other researchers to continue expanding studies into areas of the Arctic where we have no data on underwater sound levels. More studies will help us track the changes in underwater sound levels being caused by climate change.

The Arctic Ocean and surrounding seas have a globally unique soundscape, that is, driven in large part by sea ice (PAME, 2019). Solid, land-fast sea ice creates an incredibly quiet environment with very low sound levels (Insley et al., 2017; PAME, 2019), yet when sea ice is more dynamic, sea ice can create variable sound levels that can dominate the soundscape (Halliday, Barclay, et al., 2021; Kinda et al., 2015; PAME, 2019). Sea ice also limits anthropogenic activity, and therefore underwater noise from those activities (Halliday, Pine, et al., 2021; PAME, 2019). However, the Arctic environment is shifting rapidly due to climate change, which is causing a general reduction in sea ice (Meredith et al., 2019; Stroeve et al., 2007), and is also allowing for increased anthropogenic activity (Pizzolato et al., 2016; Smith & Stephenson, 2013). The Arctic is projected to become noisier due to both increased noise from anthropogenic activity, but also due to reduced sea ice and a longer open water season (PAME, 2019). A recent report by the Arctic Council's Protection of the Marine Environment working group highlighted significant geographic gaps in studies on underwater sound levels in the Arctic (PAME, 2019) (Figure 1). Our understanding of the Arctic soundscape has been drawn from geographically limited studies in the western North American Arctic and in the marginal ice zone of Fram Strait. Large regions of the Arctic, including the entire Russian coastline, but also some portions of the North American and European Arctic, were completely devoid of studies on underwater sounds levels or on anthropogenic underwater noise. The review by PAME (2019) therefore served as a call for research to fill these geographic gaps, allowing for a more complete understanding of underwater sound levels in the Arctic before more drastic sea ice loss is caused by climate change. Sagen et al. (2020) also made a similar call to researchers and funders to build an Arctic Ocean Observing System, which would include the collection of passive acoustic data.

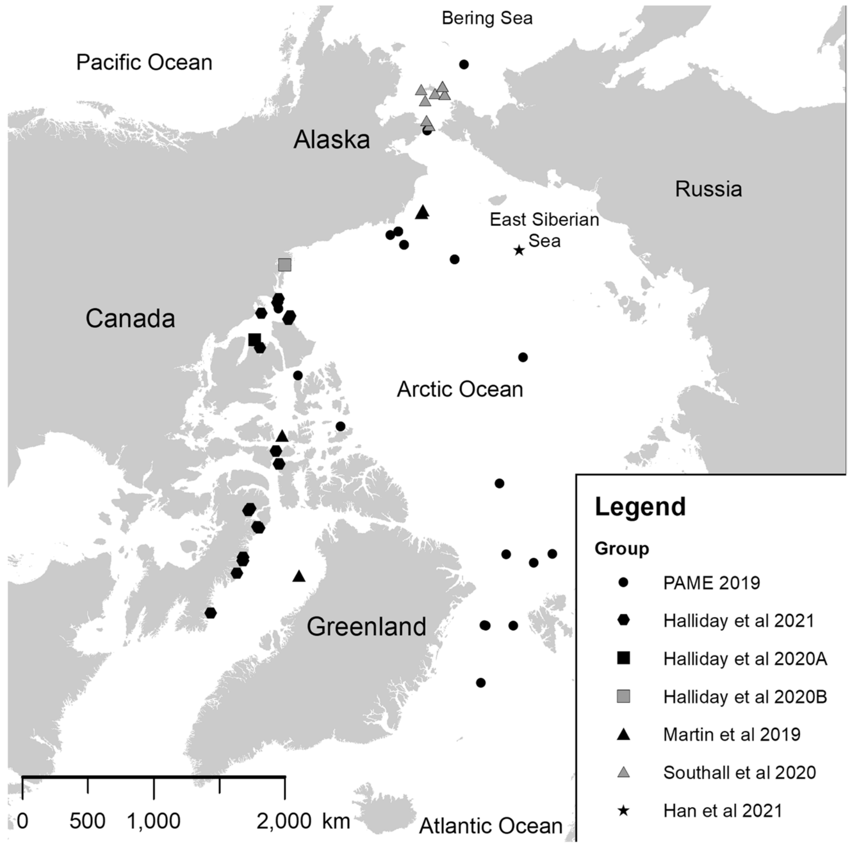

Figure 1. Map showing all studies peer-reviewed, published studies on underwater sound levels in the Arctic from PAME (2019), and additional studies since the PAME review, including Halliday, Barclay, et al. (2021), Halliday, Pine, et al. (2020), Halliday, Scharffenberg, et al. (2020), Han et al. (2021), Martin et al. (2019), and Southall et al. (2020). Studies are only included if they presented data on underwater sound levels. Basemap from Natural Earth.

Since the publication of the review by PAME (2019), six peer-reviewed studies that I am aware of have come out filling some of these geographic gaps (Figure 1). For example, our research group just completed an analysis of underwater sound levels in the Canadian Arctic, filling a large gap in the eastern Canadian Arctic (Halliday, Barclay, et al., 2021). Similarly, this latest paper by Han et al. (2021) in Geophysical Research Letters fills an important geographic gap along the Russian coastline, and is the first study of underwater sound levels that I am aware of in this under-studied region of the Arctic. Although this study only has a single year of data from one monitoring location, it is a first step toward understanding underwater sound levels in the Russian Arctic.

Han et al. (2021) collected one year of passive acoustic data from August 2017 to August 2018 in the East Siberian Sea (74°37′N, 174°56′E), roughly 600 km north of the Russian coastline. This site only experienced open water for a very short time during parts of September and October 2017, so from this perspective, it represents a very unique full-year data set; most other Arctic recording locations from previous studies typically have open water throughout most of August and September (Kwok et al., 2009; Meredith et al., 2019). Throughout the entire year-long data set, underwater sound levels were negatively correlated with sea ice concentration, such that sound levels were lowest when sea ice concentration was high. Only a single ship came near this site during the deployment, and this was the ship that deployed the oceanographic mooring that the acoustic recorder was attached to. Seismic airgun signals were recorded in 68% of September and 26% of October, which was the only major source of anthropogenic noise recorded in the entire data set. These airgun pulses raised ambient sound levels significantly when they were present. None of these results on their own are unexpected: for example, Roth et al. (2012) found similar effects of seismic airgun signals in the Chukchi Sea, and Halliday, Barclay et al. (2021) and Halliday, Pine et al. (2021) broadly found the same effect of sea ice concentration on underwater sound levels across the Canadian Arctic. However, the novel aspect of this study by Han et al. (2021) is the recording location and the paucity of studies in this region. They provide good quantitative measurements of monthly power spectral density and sound pressure levels that can be used for comparisons in future studies, effectively helping to establish a baseline of underwater sound levels in this under-studied region of the Arctic.

This study is a good first step at establishing a baseline of underwater sound levels in the Russian Arctic, but represents a single year of data from a single location. Despite the large amount of ship traffic traveling the Northern Sea Route, the study was too far north to capture the noise from those ships. Future work on collecting passive acoustic data throughout the Russian Arctic should target locations with varying levels of ship traffic to thoroughly quantify the contributions of underwater noise from ship traffic. Many parts of the Russian Arctic, particularly along the coastline, will have very different ice conditions compared to this study that was far offshore, and will therefore have very different natural sound levels. Targeting locations at different points along the major shipping route, areas nearshore and offshore, and sites closer to populated areas, will provide the best estimates of the range of underwater sound levels throughout this region. I, therefore, call on acousticians to continue to fill these and other geographic gaps in the Arctic. In some cases, acoustic data are collected for use in studies on marine mammals or studies of acoustic propagation, but are not analyzed for underwater sound levels. For example, Burov et al. (2014) collected passive acoustic data in the Barents Sea and studied sound propagation in the data, but did not present information on underwater sound levels. I implore researchers to quantify underwater sound levels in their passive acoustic data.

Data Availability Statement

No data was used in this commentary.

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