# Vessel Traffic Trends in the Arctic and Overlap with Important Marine Mammal Areas

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# Rationale

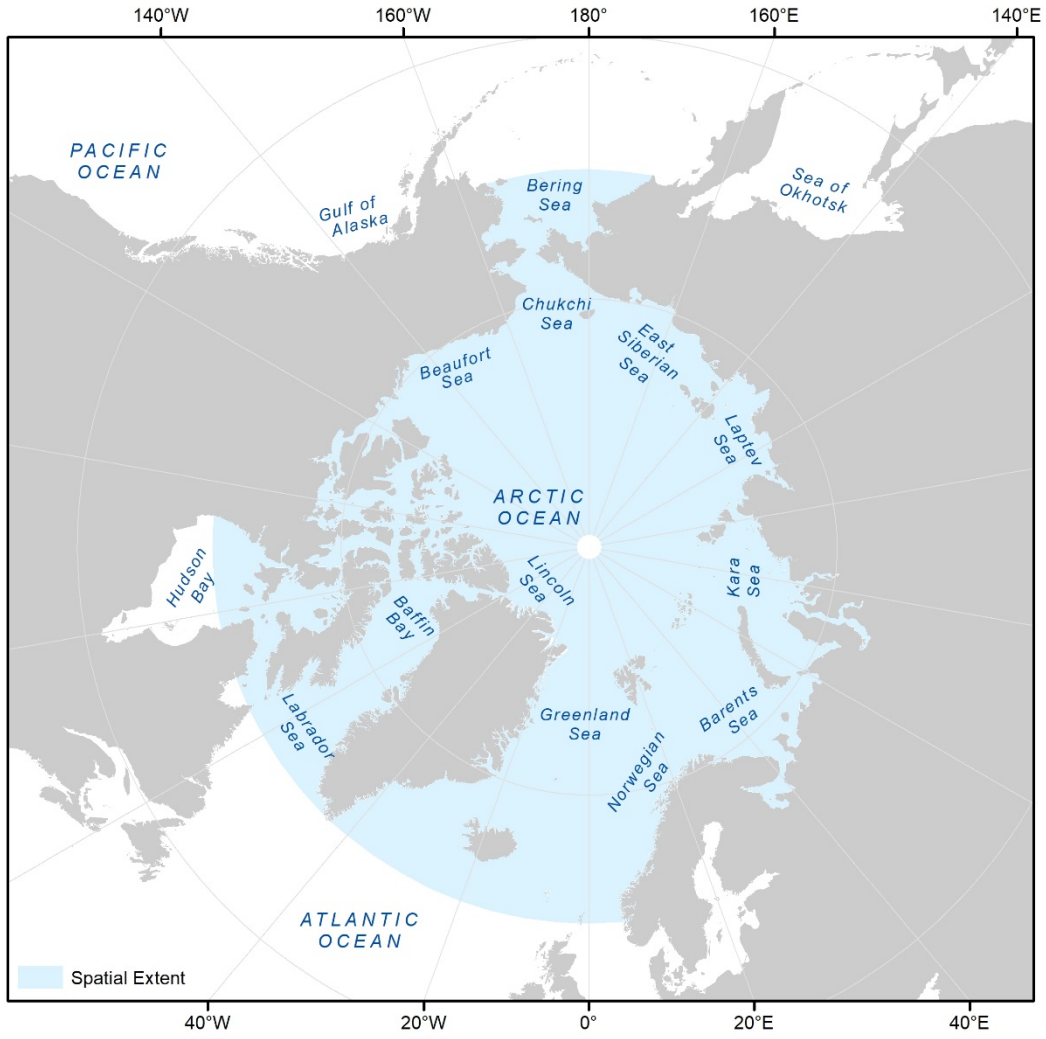
- Vessel traffic is increasing in the Arctic, which will likely lead to increased underwater noise and its associated impacts on marine life
- PAME's underwater noise workplan: one goal is to map underwater noise from ships in the Arctic
- But the Arctic is large, and detailed modeling of the entire Arctic would be time consuming
- PAME could focus modeling efforts on a subset of the Arctic, perhaps the areas with the most vessel traffic overlapping with marine mammals

# Project Goal

- This project used the ASTD to examine ship traffic throughout the Arctic in September, and look at ship traffic in different marine mammal populations.

# Spatial Extent

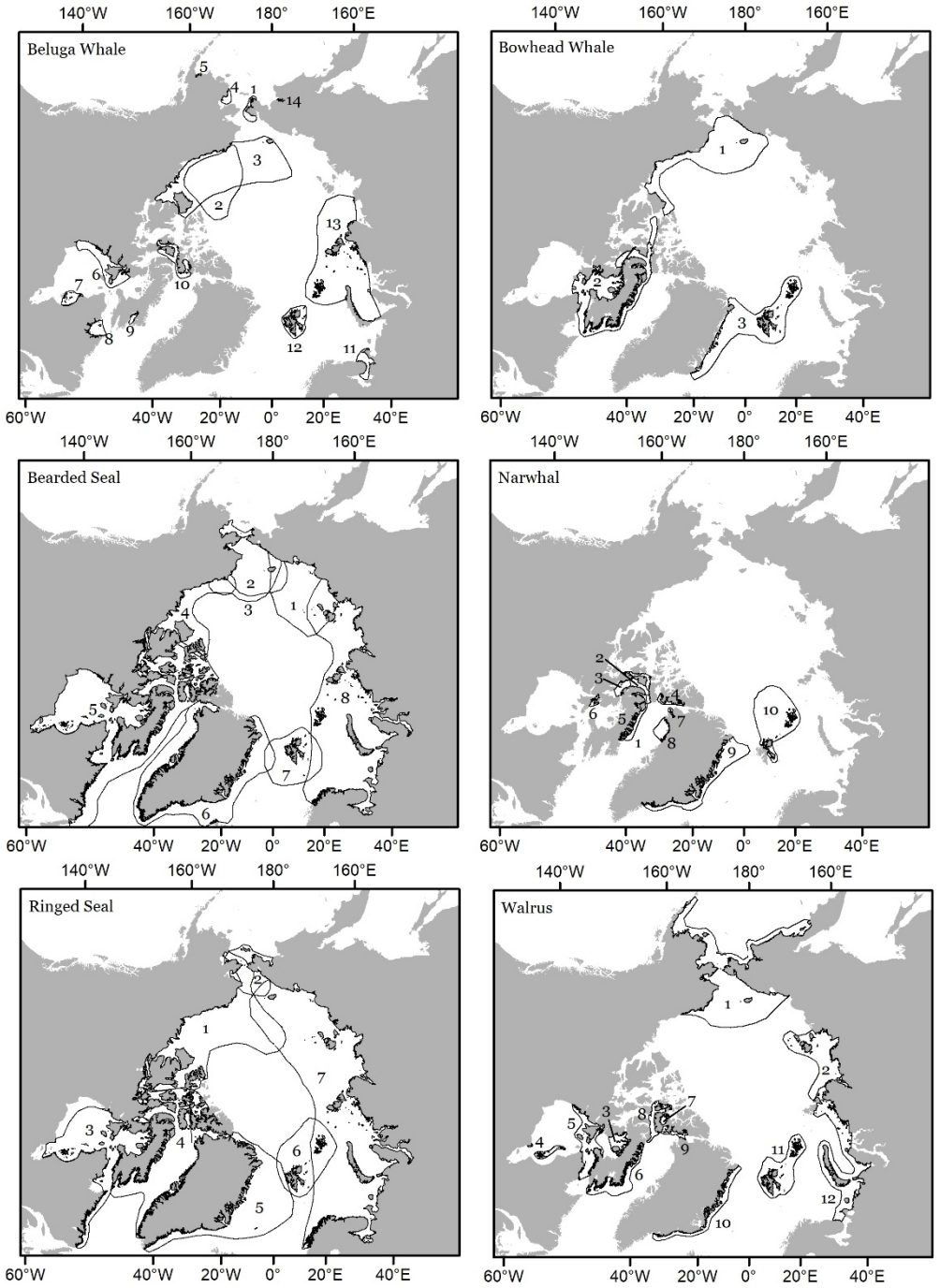
Focused on 60°N, excluding the Baltic Sea and a couple of sites in the Bering Sea and Sea of Ohkotsk



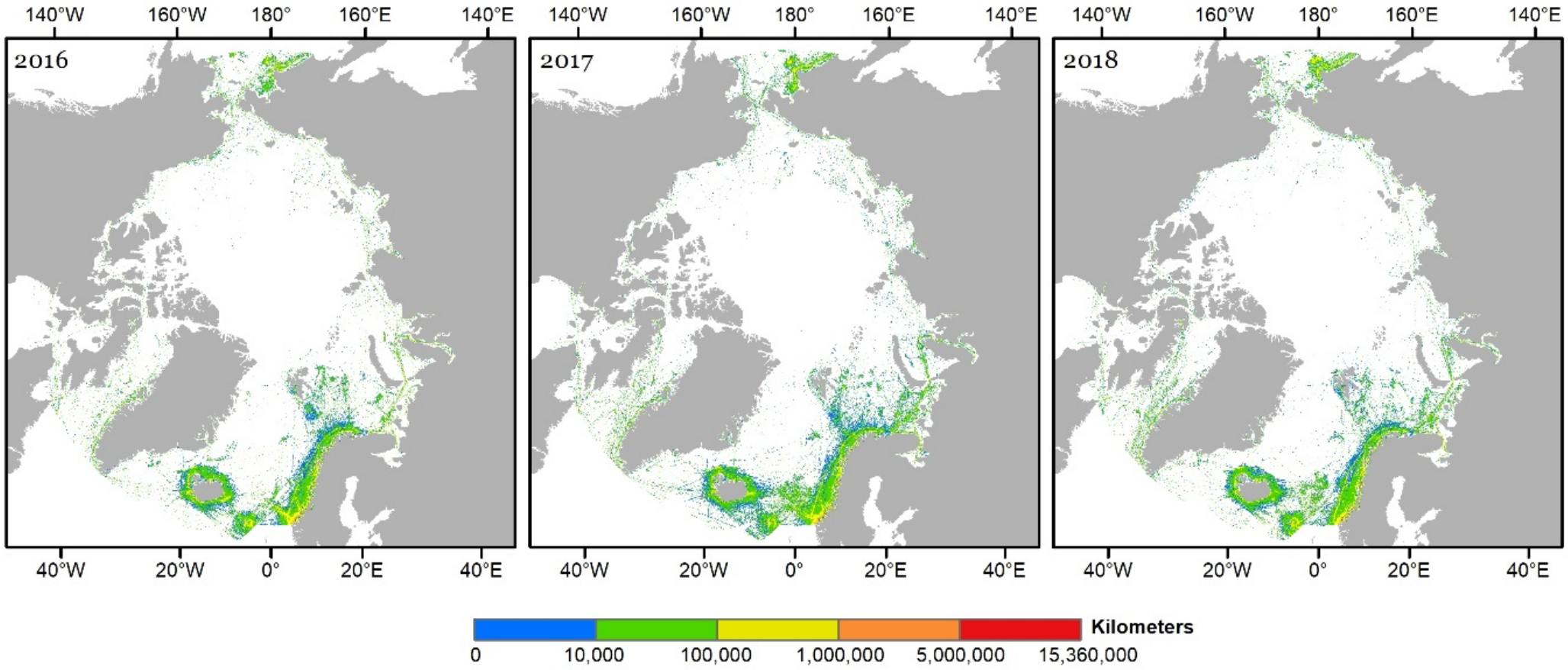
# September Marine Mammal Areas

Marine mammal data from Hauser et al. (2018) PNAS

- Estimated the September range for each population of Arctic marine mammals.
- We focused on 3 cetacean species (beluga, narwhal, bowhead) and 3 pinniped species (ringed seals, bearded seals, walrus), for a total of 51 populations



# September Vessel Traffic Trends, 2016-2018

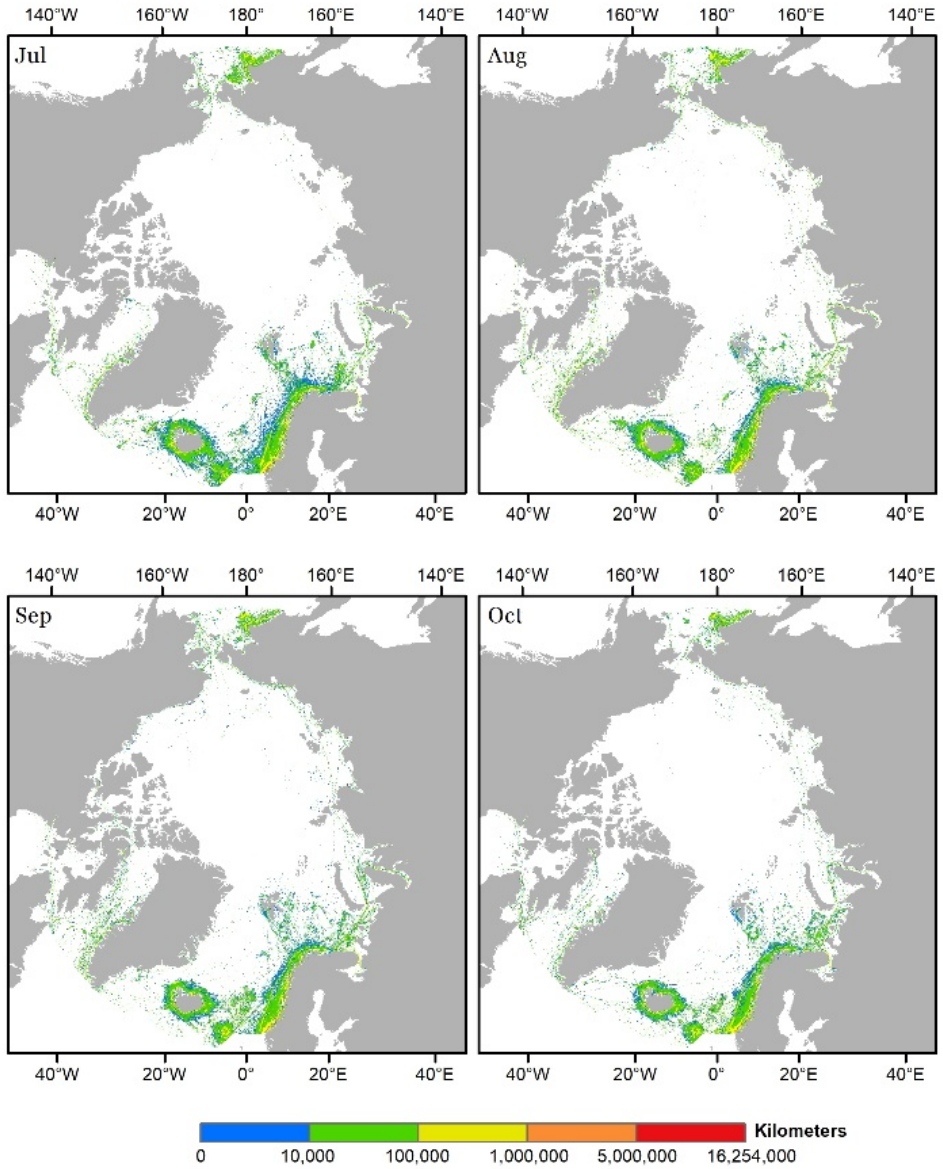


# September Vessel Traffic Trends, 2016-2018

| Sea | 2016 | 2017 | 2018 | 2016-2018 Average |
|---|---|---|---|---|
| Norwegian Sea | 260 | 282 | 260 | 267 |
| Bering Sea | 110 | 133 | 129 | 124 |
| North Atlantic | 101 | 92 | 95 | 96 |
| Barents Sea | 49 | 47 | 44 | 47 |
| Baffin Bay-Davis Strait | 30 | 34 | 38 | 34 |
| Chukchi Sea | 29 | 21 | 17 | 22 |
| Greenland Sea | 23 | 21 | 19 | 21 |
| Kara Sea | 24 | 18 | 17 | 20 |
| East Siberian Sea | 15 | 14 | 12 | 14 |
| Hudson Bay-Foxe Basin | 13 | 13 | 14 | 13 |
| Laptev Sea | 14 | 13 | 11 | 13 |
| Beaufort Sea | 7 | 4 | 3 | 5 |
| Canadian Arctic Archipelago | 5 | 4 | 4 | 4 |
| Arctic Ocean | 1 | 0 | 0 | 0 |

Area-corrected total distance traveled within each Arctic sea.

# 2018 July to October Vessel Traffic Trends



# 2018 July to October Vessel Traffic Trends

| Sea | July | August | September | October |
|---|---|---|---|---|
| **Norwegian Sea** | 262.8 | 257.2 | 259.9 | 197.4 |
| **Bering Sea** | 159.3 | 144.2 | 128.9 | 97.4 |
| **North Atlantic** | 146.2 | 140.7 | 95.2 | 82.4 |
| **Barents Sea** | 44.1 | 44.8 | 44 | 39 |
| **Baffin Bay-Davis Strait** | 26 | 42.4 | 37.6 | 21.9 |
| **Greenland Sea** | 14.6 | 24.4 | 16.8 | 8.3 |
| **Kara Sea** | 22.7 | 23.6 | 19.5 | 15.3 |
| **Chukchi Sea** | 11.6 | 17.2 | 17.4 | 13 |
| **Hudson Bay-Foxe Basin** | 16 | 11.3 | 14.2 | 15.9 |
| **East Siberian Sea** | 2.2 | 11 | 12.4 | 7.2 |
| **Laptev Sea** | 1.7 | 8.8 | 10.8 | 5.7 |
| **Canadian Arctic Archipelago** | 0.2 | 2.6 | 3.1 | 0.1 |
| **Beaufort Sea** | 0 | 2.2 | 3.6 | 0.4 |
| **Arctic Ocean** | 0.1 | 0.2 | 0.1 | 0 |

Area-corrected total distance traveled within each Arctic sea.

# Vessel Traffic in Marine Mammal Areas

| Rank | Cetaceans | | Pinnipeds | |
|---|---|---|---|---|
| | Marine Mammal Area | Value | Marine Mammal Area | Value |
| 1 | Beluga – White Sea | 241 | Walrus – Novaya-Semlya-Barents Seas | 54 |
| 2 | Beluga – Gulf of Anadyr | 122 | Ringed Seal – Bering Sea | 44 |
| 3 | Beluga – Siberian Sea | 85 | Bearded Seal – Barents-White-Kara-Laptev Seas | 41 |
| 4 | Narwhal – Eclipse Sound | 59 | Walrus – SE. Baffin Island | 37 |
| 5 | Beluga - Svalbard | 37 | Walrus – Bering-Chukchi Seas | 35 |
| 6 | Beluga – Bering Sea | 33 | Ringed Seal – White-Barents-Kara-Siberia Seas | 30 |
| 7 | Bowhead – E. Canada-W. Greenland | 24 | Bearded Seal – Svalbard | 26 |
| 8 | Narwhal – Admiralty Inlet | 24 | Walrus – N. Hudson Bay | 25 |
| 9 | Narwhal – Somerset Island | 20 | Ringed Seal – Baffin Bay | 25 |

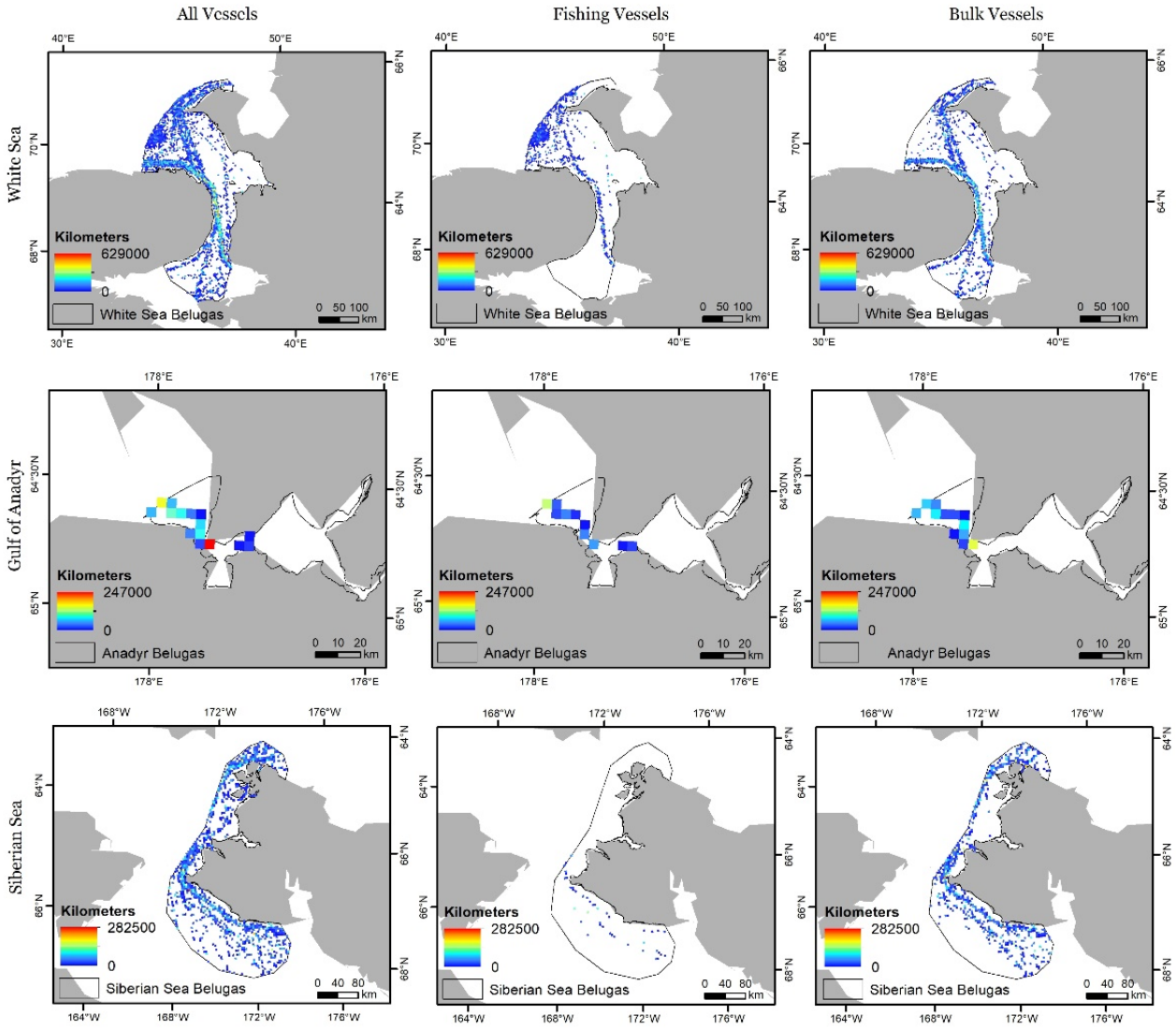
Top ten areas for cetaceans and pinnipeds with the most area-corrected vessel traffic. Top three cetacean areas have much more traffic than all other areas, although 4$^{th}$ cetacean area is also quite high.

NOTE: our list of marine mammal areas with most traffic differs greatly from Hauser et al.'s analysis – important methodological difference.

# Vessel Traffic in Top 3 Marine Mammal Areas

In these top three areas, individual 10 x 10 km cells aren't all that high, but looking at the whole marine mammal area, large amounts of each area are covered by vessel traffic.

Fishing vessels and bulk carriers were the largest contributor to vessel traffic in all of these areas, as well as for most of the other areas.



# Next Steps for PAME

- Decide how to focus the underwater noise mapping (pan-Arctic vs focused on smaller areas)
- I have two suggestions, based on this analysis:
  - Focus on the marine mammal areas with the highest vessel traffic. The top 10 for cetaceans and pinnipeds are listed separately in the report.
  - Focus on the seas with the highest vessel traffic that also overlap with multiple marine mammal areas. My suggestions are Bering Sea, Barents Sea, and Baffin Bay-Davis Strait.
- Of the two options, I prefer focusing on the seas rather than the marine mammal areas. After modeling is done, then overlay the marine mammal areas to examine ship noise in multiple marine mammal areas in each of the three seas.

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