

Reducing the impacts of shipping and underwater noise on biodiversity



Session Chair: William Halliday

Presenters:

- 1) William Halliday, 2) Camilla Anita Spansvoll, 3) Donna Hauser,
- 4) Melissa Nacke

Schedule

13:30 – William Halliday, WCS Canada

13:45 – Camilla Anita Spansvoll, Norwegian Coastal Admin

14:00 – Donna Hauser, U Washington and U Alaska Fairbanks

14:15 – Melissa Nacke, WWF Canada

14:30 – Open question period and panel discussion

The state of underwater noise throughout the Arctic marine environment: a review

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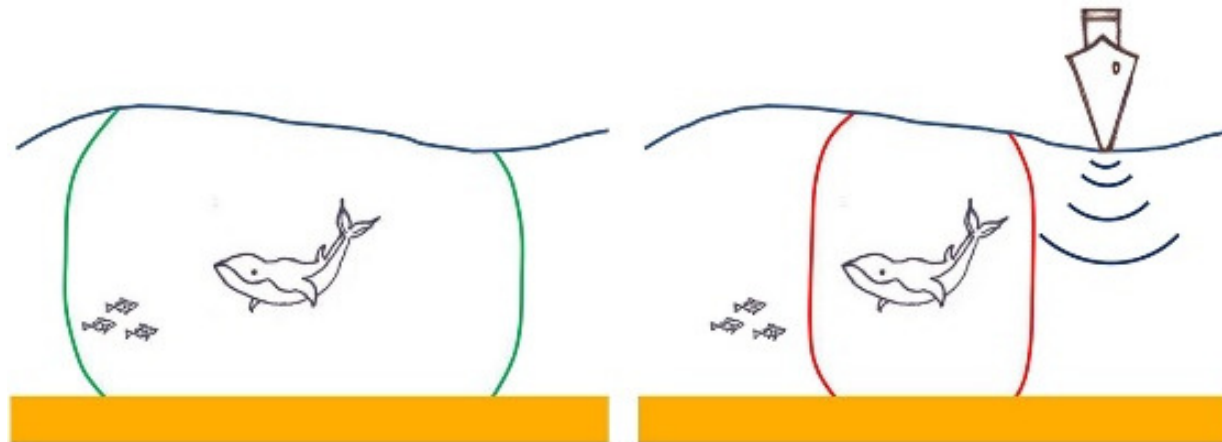
Acknowledgements

- Co-authors: Stephen Insley and Matthew Pine
- This presentation is based on a report that my co-authors and I wrote for Fisheries and Oceans Canada, which was then submitted to PAME
- Funding for the report provided by Fisheries and Oceans Canada
- Literature provided by MANY groups involved in PAME
- Reviews of the report by multiple people in Fisheries and Oceans Canada, Transport Canada, World Wildlife Fund, and Wildlife Conservation Society
- Disclaimer: this presentation is based on my interpretation of the findings from the report, and is not necessarily endorsed by Fisheries and Oceans Canada or by PAME.

Why is sound important to marine animals?

- The ocean is dark, so marine animals rely much less on sight than terrestrial animals
- Sound travels much faster underwater than in air, allowing for greater use in sensing the environment
 - (e.g. blue whale calls propagating across Atlantic, bowhead whale songs heard > 100 km away)
- Sound produced for communication and echolocation, but also incidentally

Underwater Noise



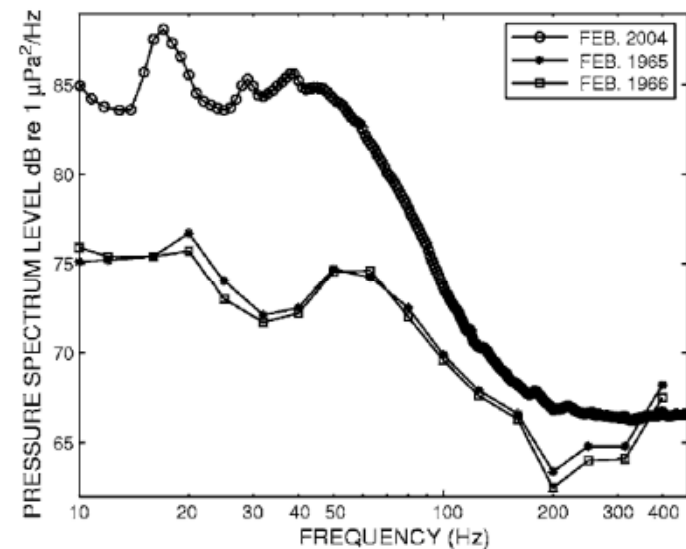
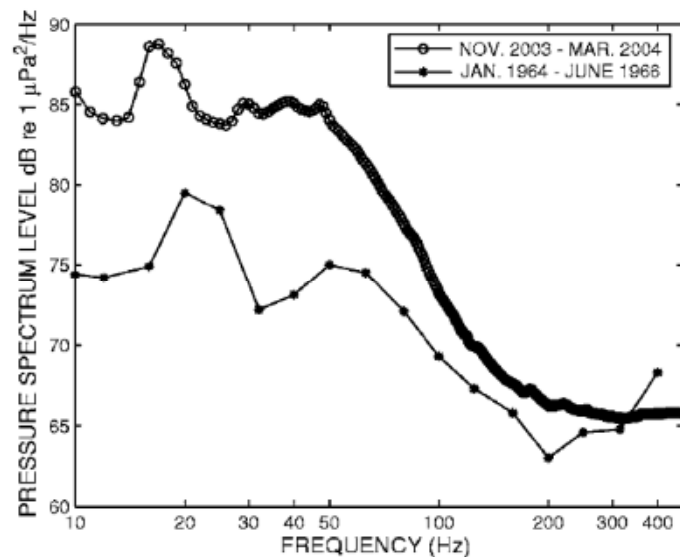
Pine et al 2018 Marine Pollution Bulletin 135: 290-302

Underwater Noise

- Acoustic masking
 - loud noises can block out important sounds
- Behavioural disturbance
 - Reduced foraging, avoidance
- Temporary or permanent threshold shifts
 - Cues must be louder for animal to hear them
- Injury
 - Barotrauma and internal bleeding
- Death
 - Internal bleeding and lethal changes in behaviour

Global Trends in Underwater Noise

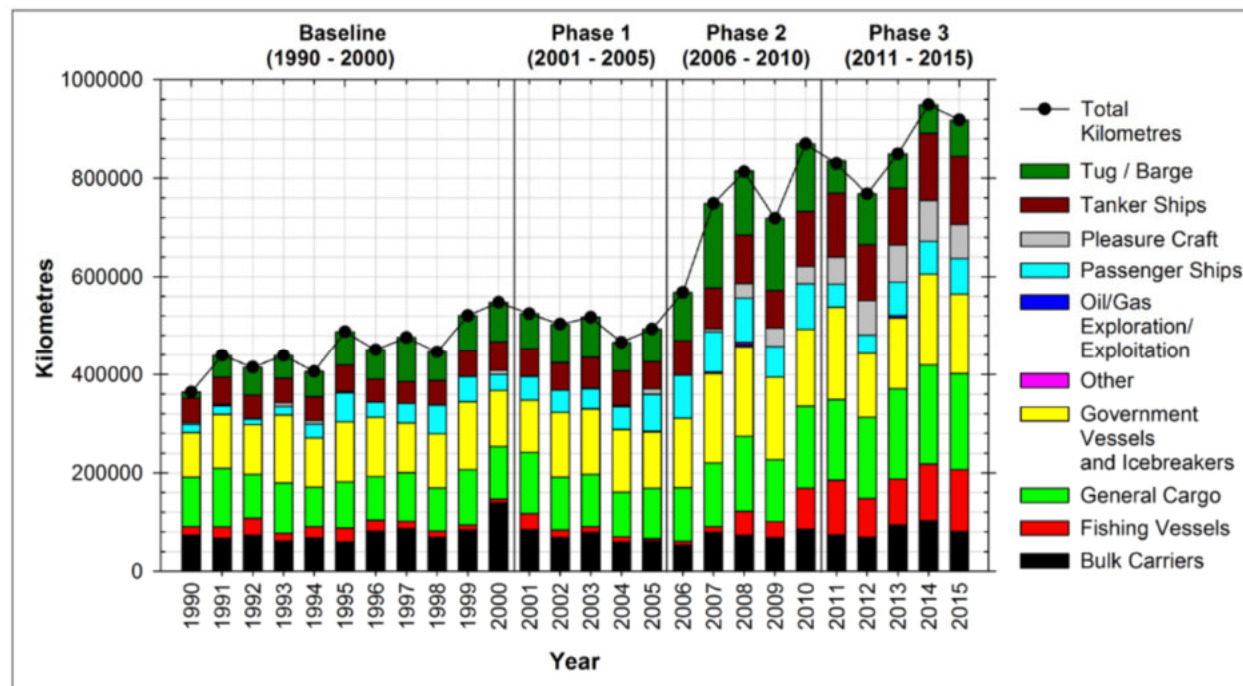
- Underwater noise is a global issue, and noise levels have been increasing globally.
 - Effectively doubling every decade since 1960 in the Pacific.



McDonald et al 2006 Journal of the Acoustical Society of America 120: 711-718

The Arctic

- Why should the impacts of underwater noise be different in the Arctic?
 - Less anthropogenic activity historically
 - Animals may be used to very quiet ambient levels
 - Animals may be more prone to being impacted by noisy activities

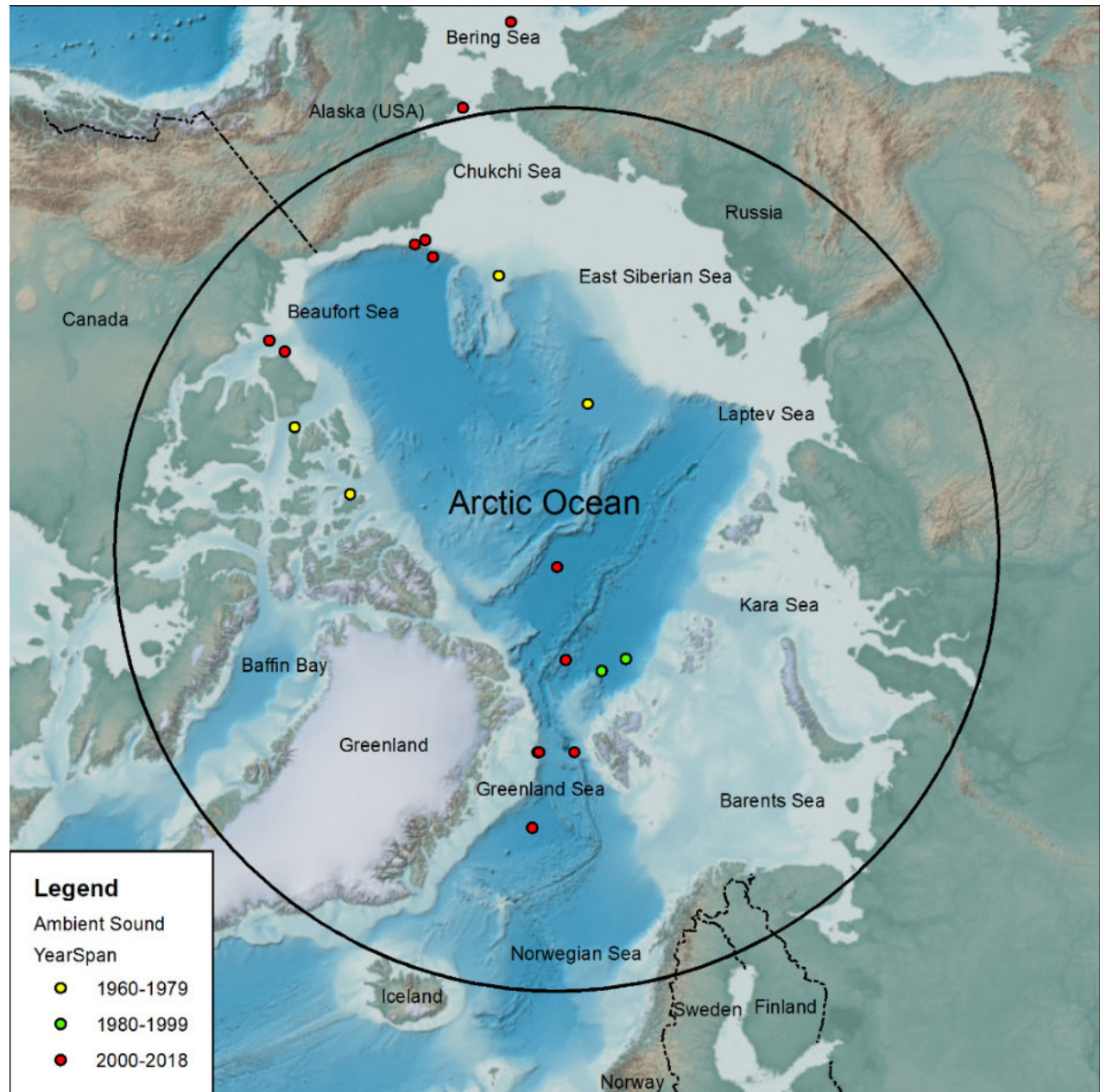


Dawson et al 2018
Arctic 71: 15-26

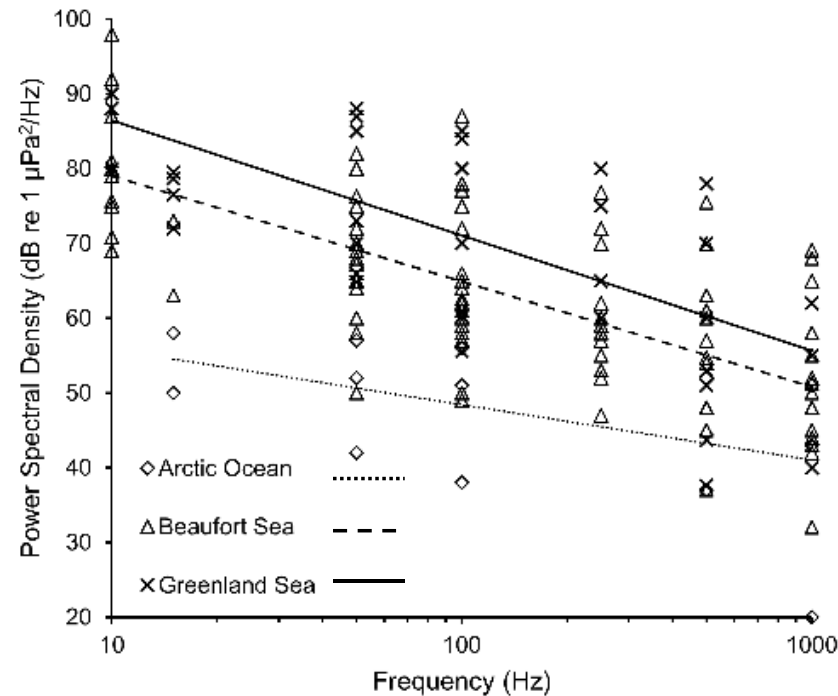
Scope

- Arctic defined as north of the Arctic Circle, adjacent seas if relevant to Arctic animals
- Literature found through scholarly search engines and provided by PAME members
- Text in English

Arctic Ambient Sound Levels

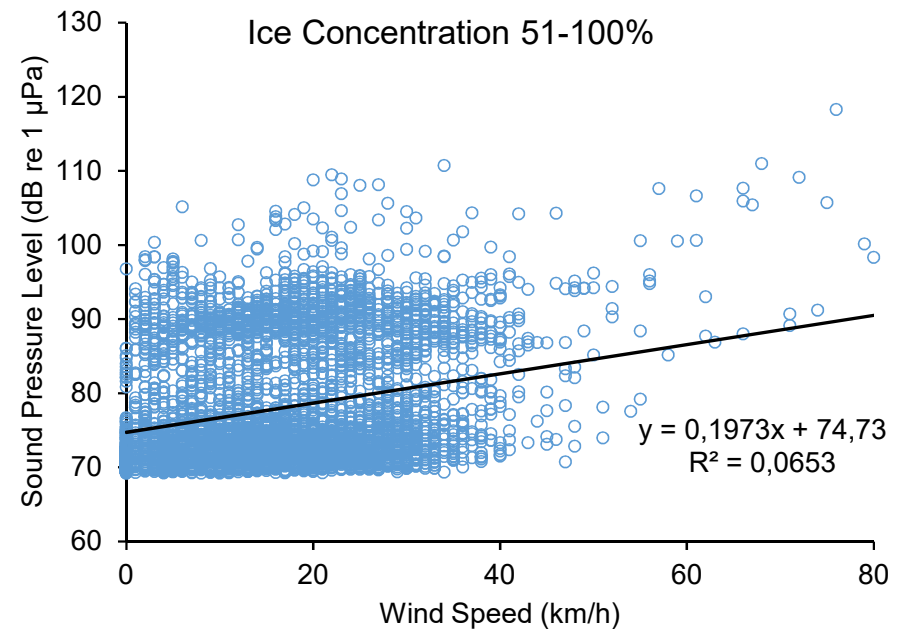
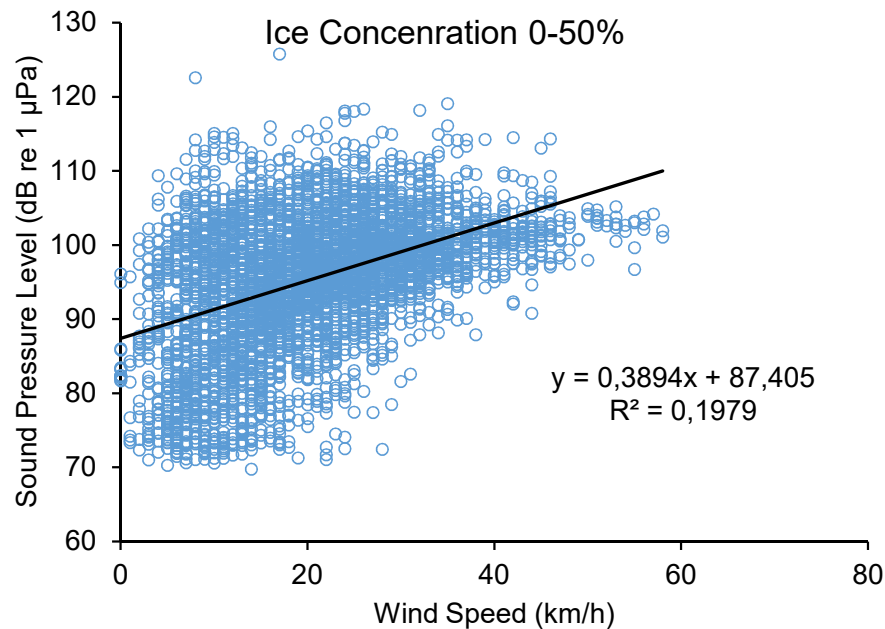


Arctic Ambient Sound Levels



Ambient levels are typically lower under solid ice, highest in breaking ice and in open water with windy conditions. Levels in the Greenland Sea (Fram Strait) were higher than in the Beaufort Sea, levels in the middle of the Arctic Ocean were very quiet.

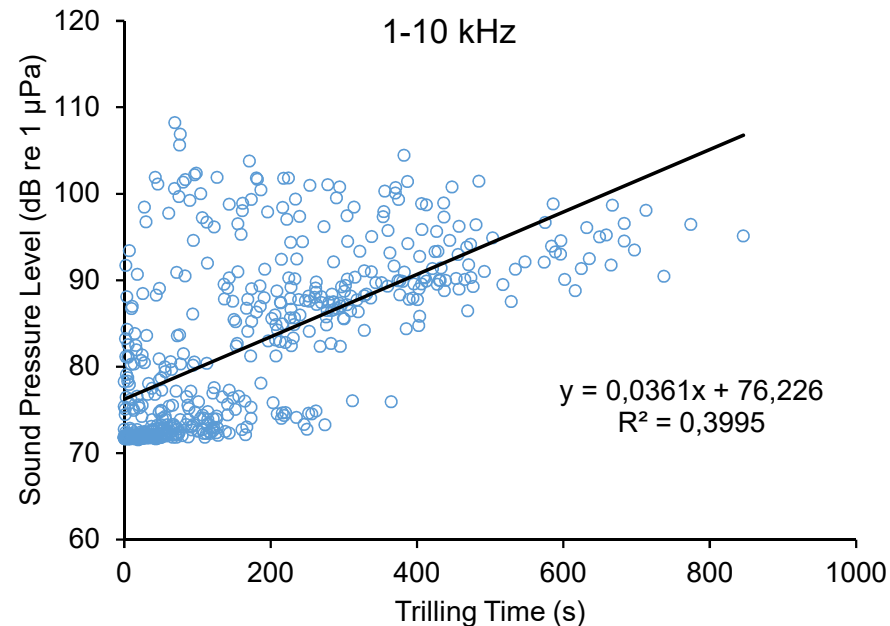
Drivers of Sound Levels – Environmental Forcing



Sound pressure levels tend to increase as wind speed increases, but this effect is stronger when ice concentration is low. Levels are generally lower when ice concentration is high.

Sound pressure levels in these figures is measured in the 50 – 1000 Hz bandwidth. Data measured at Sachs Harbour, Canada.

Drivers of Sound Levels – Animal Sounds

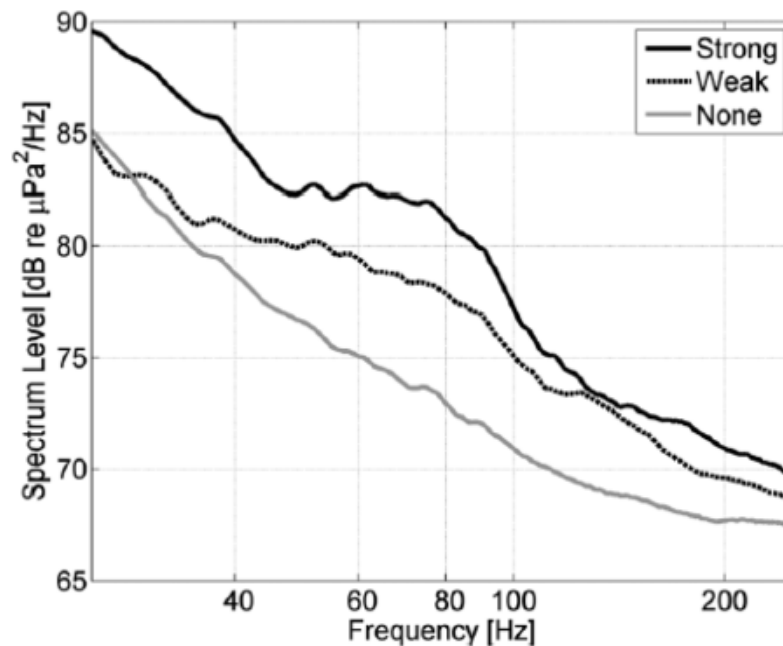


Marine mammal vocalizations can add a lot of energy to ambient levels. Here, bearded seal trills cause large increases to ambient levels in two separate frequency bands.

Other marine animals, including fish, can also contribute to sound levels, although they have not been documented in the Arctic yet.

Drivers of Sound Levels – Anthropogenic Activity

- Ambient levels driven up by seismic surveys and boat noise.
- Other activities, like operation and drilling at oil and gas platforms, can also drive up levels.

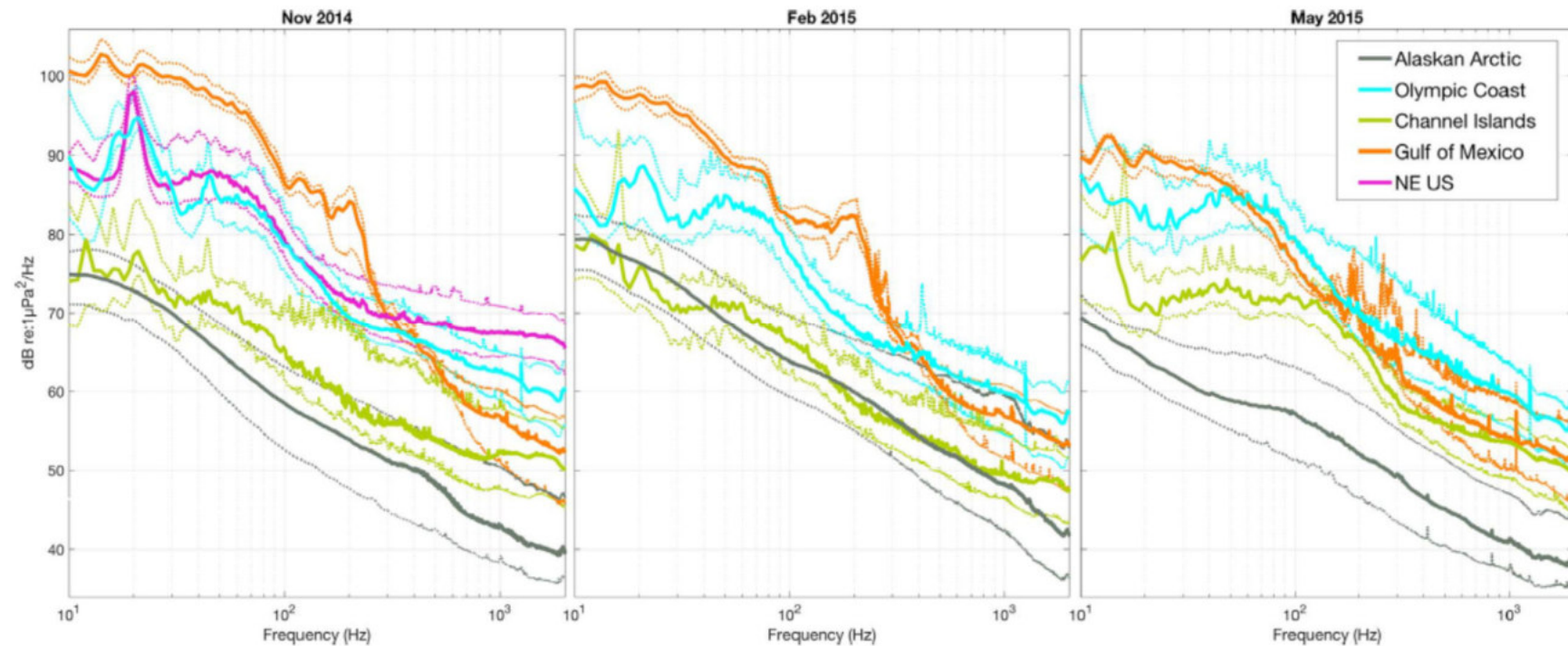


Roth et al 2012

Comparison of power spectral densities when:

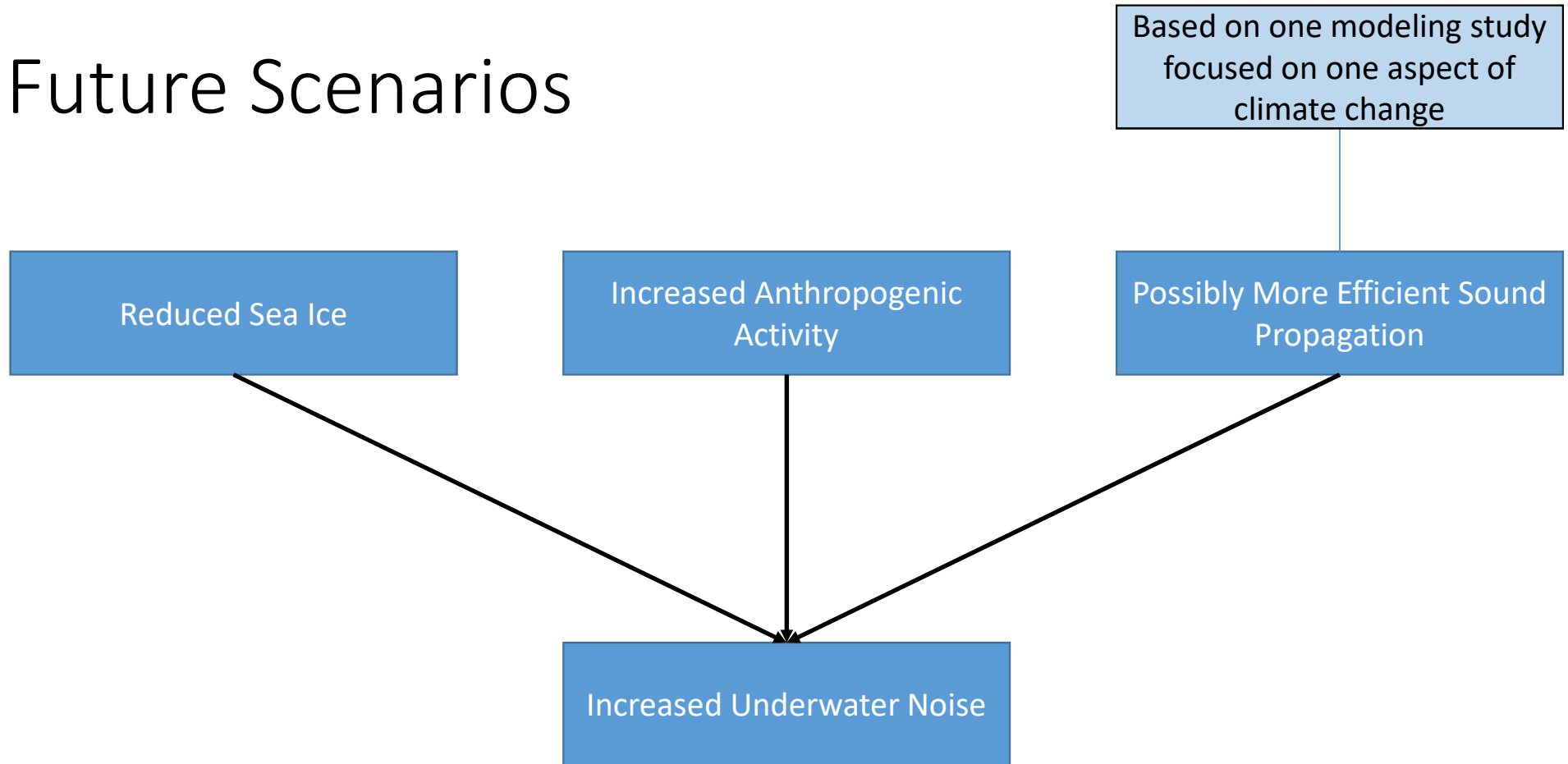
- no signals from seismic surveys
- weak signals from seismic surveys
- strong signals from seismic surveys

Comparison to Non-Arctic Areas

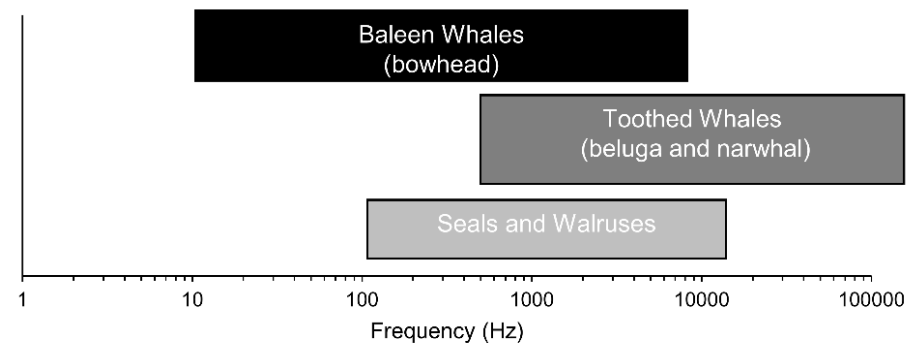
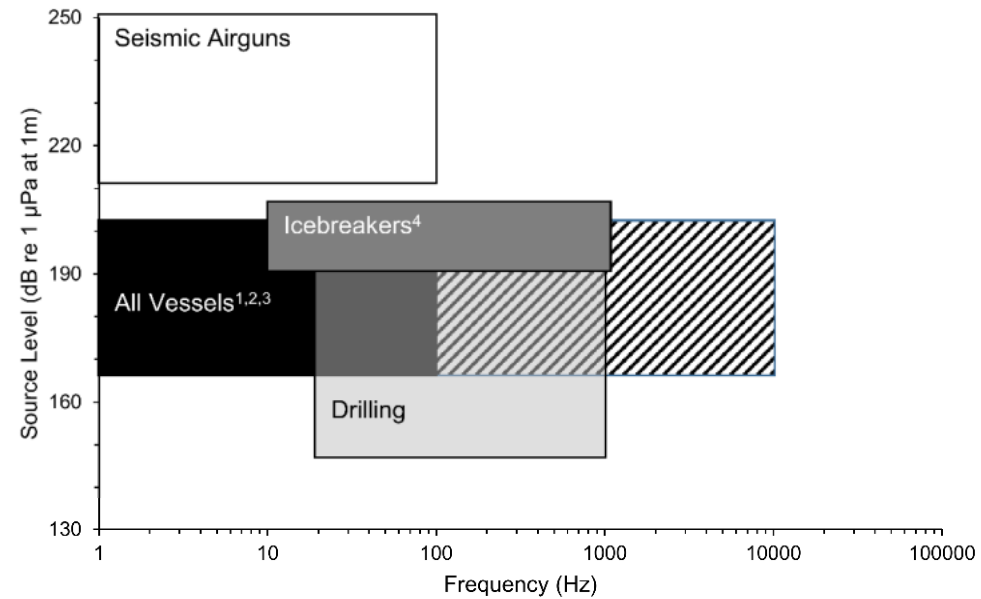


Haver et al 2018 – power spectral densities lower in Alaska Arctic compared to other sites around USA.

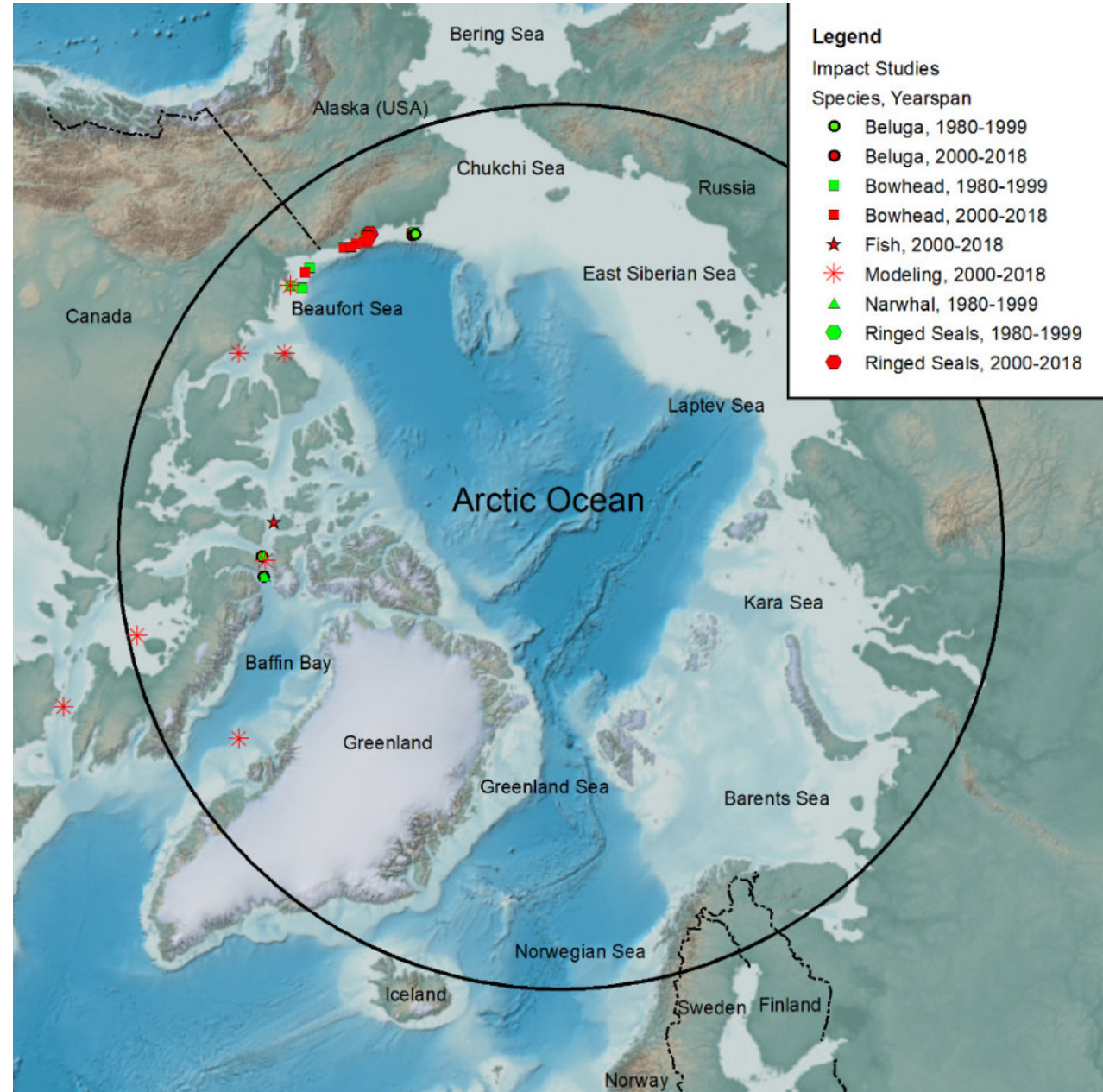
Future Scenarios



Impacts on Arctic Marine Mammals



Impacts on Arctic Marine Mammals



Impacts on Arctic Marine Mammals

Bowhead Whales:

- Changes behaviour:
 - Avoidance
 - changing vocalization rates
 - altered dive cycles
- Response is context-dependent:
 - foraging vs migration



Impacts on Arctic Marine Mammals

Beluga and Narwhal:

- Show strong avoidance behaviour to noise from ships
- Belugas may become acclimated to noise or can become tolerant of it
- Belugas may be more sensitive than bowheads for certain noise sources



© naturepl.com / Sue Flood / WWF-Canon

Impacts on Arctic Marine Mammals

Ringed Seals:

- More tolerant to noise than whales, but still change behaviour when noise is intense



Photo: Kit M. Kovacs / Norwegian Polar Institute

Impacts on Arctic Marine Fish

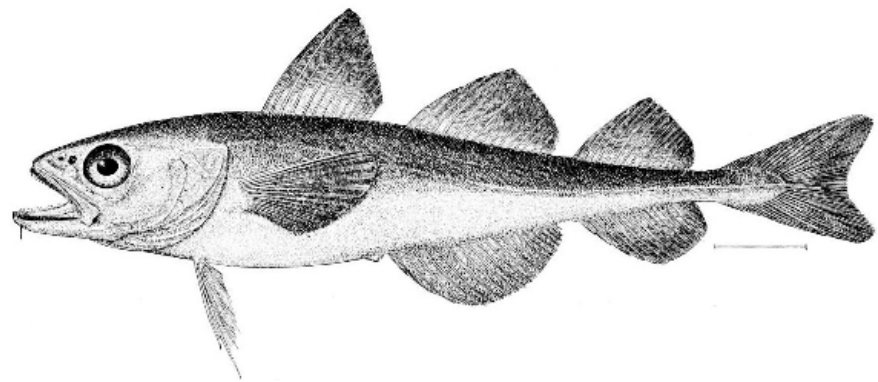


Impacts on Arctic Marine Fish

- Only two studies on marine fish, both at Resolute in the Canadian Arctic, both by the same authors (Ivanova et al).
- Studied Arctic Cod (*Boreogadus saida*) and Shorthorn Sculpin (*Myoxocephalus scorpius*)
- Both species changed their movement patterns and home range size in response to noise from ships

Non-Arctic Studies:

- Auditory masking
- Behavioural changes
- Temporary hearing loss
- Death



Impacts on Arctic Marine Invertebrates

No studies on noise impacts on Arctic marine invertebrates.

What we know from non-Arctic studies:

Underwater noise can have many impacts on invertebrates:

- Hearing loss
- Physiological changes
- Behavioural changes
- Reduced fitness
- Mortality

Knowledge Gaps

- Geography: huge focus on Beaufort and Chukchi Seas, driven by oil and gas exploration/extraction. Noise monitoring in Fram Strait. No data from Russia, northern Europe, much of Canadian Arctic
- Many species have not been studied, especially invertebrates and fish
- No information on chronic/cumulative effects
- Need more information on hearing ability
- Standardization of methods
- Specific measures of anthropogenic noise in the Arctic

Is the Arctic a Special Case for Underwater Noise?

- Unique sound propagation mixed with low ambient levels means greater zones of impact around noisy activities
- Animals may be more sensitive to noise, meaning even wider zones of influence

Next Steps

- **Fill knowledge gaps: speak to me if you have data!**
- Look into mitigation and policy
- Are Arctic-specific measures necessary?
- More monitoring throughout the Arctic is necessary

Thank you!

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