Board of Pilotage Commissioners – Tug Escort Rulemaking Underwater Noise Deep Dive

November 7, 2024

DEPARTMENT OF ECOLOGY
State of Washington

Acoustic Modeling of Vessel Underwater Radiated Noise (URN)

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JASCO APPLIED SCIENCES

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Outline

- Rulemaking and EIS Overview (ECY/BPC)
- Fundamentals of underwater acoustics
- Study objectives
- Vessel data and maps
- Computer model details and inputs
- Summary of the results

Ground Rules

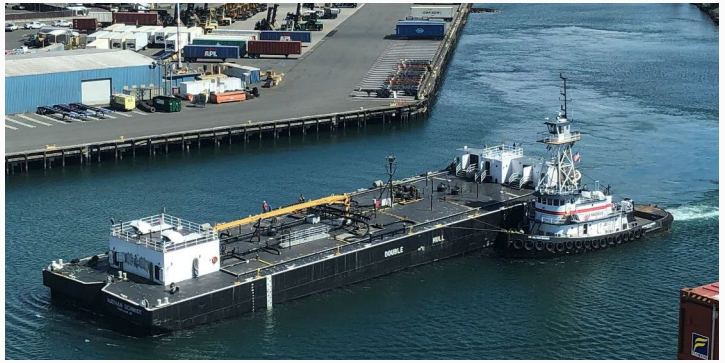
- **Respectful Dialogue:** Speak courteously, focus on ideas, not individuals.
- **One Voice at a Time:** Allow everyone to finish before responding.
- **Share Your Perspective:** Represent your own expertise, views, and knowledge.
- **Agree to Disagree:** Acknowledge different opinions respectfully.
- **Focus on Solutions:** Aim for constructive outcomes and actionable steps.
- **Respect Time Limits and Agenda:** Aim to keep comments on topic and concise. Allow space for everyone to contribute.

Rulemaking Overview (ESHB 1578)

- **Vessel Types:** The BPC, in consultation with Ecology, must adopt tug escorts rules for the following vessels:
  - Small (5,000 – 40,000 dwt) oil tankers
  - ATBs, and towed barges greater than 5,000 dwt designed to transport oil in bulk internal to the hull

Tanker

ATB



Tank Barge

Reminder: Current Proposed Alternatives

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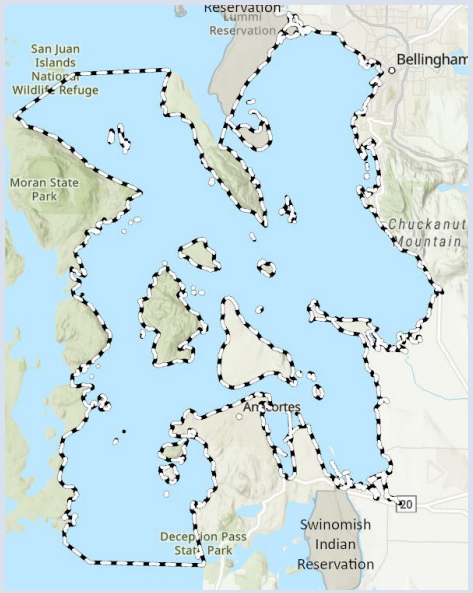
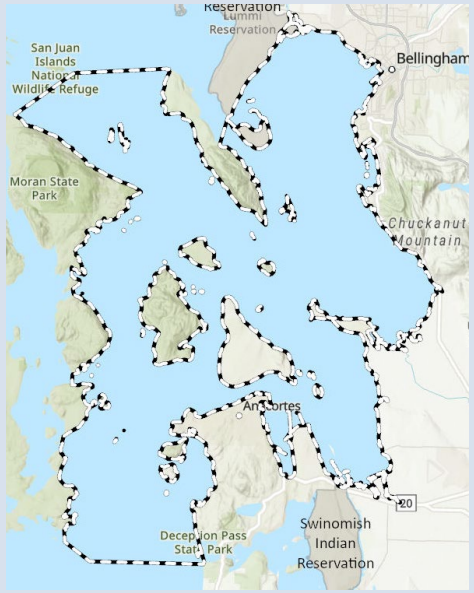
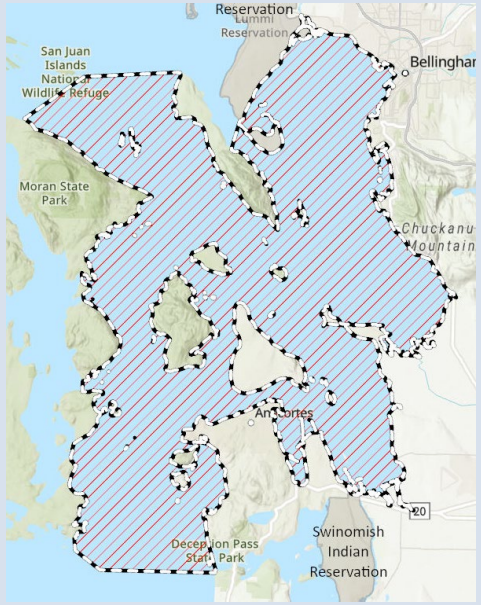
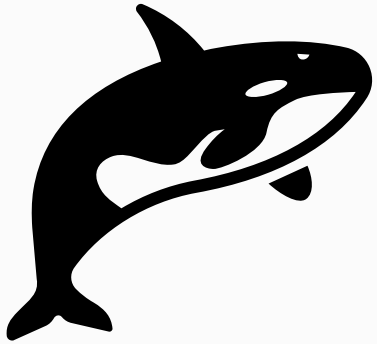
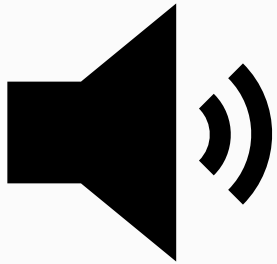
	No Action	Addition of FOR Only	Expansion	Removal
Geography	No change from 2020 	No change from 2020 	Keep 2020 + expand to SoG/SoG S. 	Remove reqs. w/in 2020 boundary 
Functional and Operational Requirements (FOR)?	No change from 2020.	ADD pre-escort conference, minimum horsepower, propulsion specifications	ADD pre-escort conference, minimum horsepower, propulsion specifications	No requirements for small vessels/ATBs/ barges. Requirements remain unchanged for large vessels

Reminder: Priority Elements

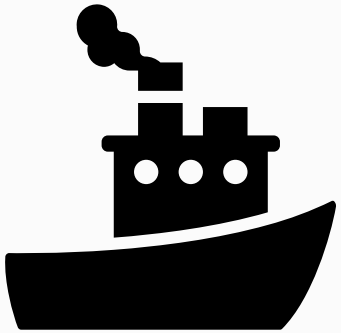


Plants and Animals

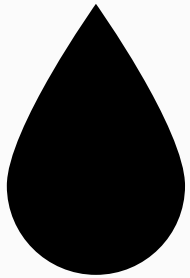


Underwater Noise (Noise)

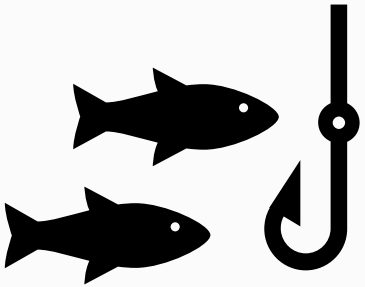
Air Quality



Vessel Traffic



Oil Pollution



Tribal Resources

Fundamentals of Underwater Acoustics

JASCO Applied Sciences

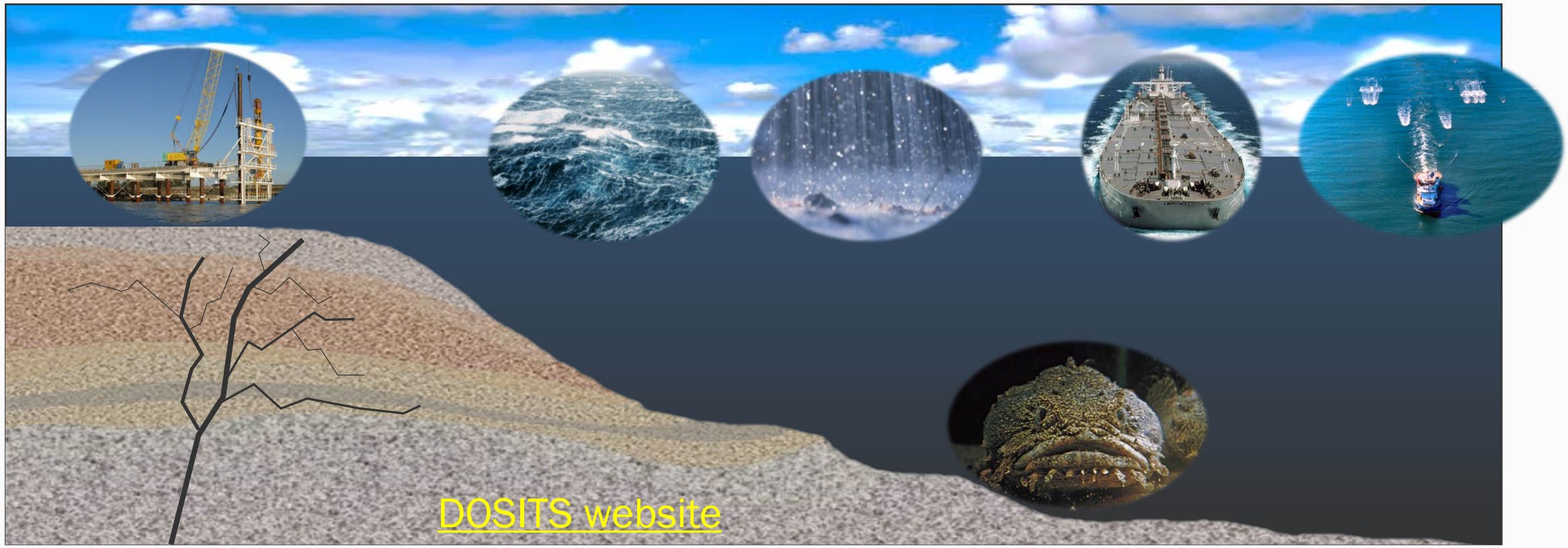
Sound in the Ocean

Natural ambient sound is always present in the ocean...

- Wind & waves
- Precipitation
- Seismic activity (earthquakes)
- Animals (mammals, fish, invertebrates)

Manmade sources also contribute to ocean noise...

- Motorized vessels
- Marine construction
- Geophysical surveys

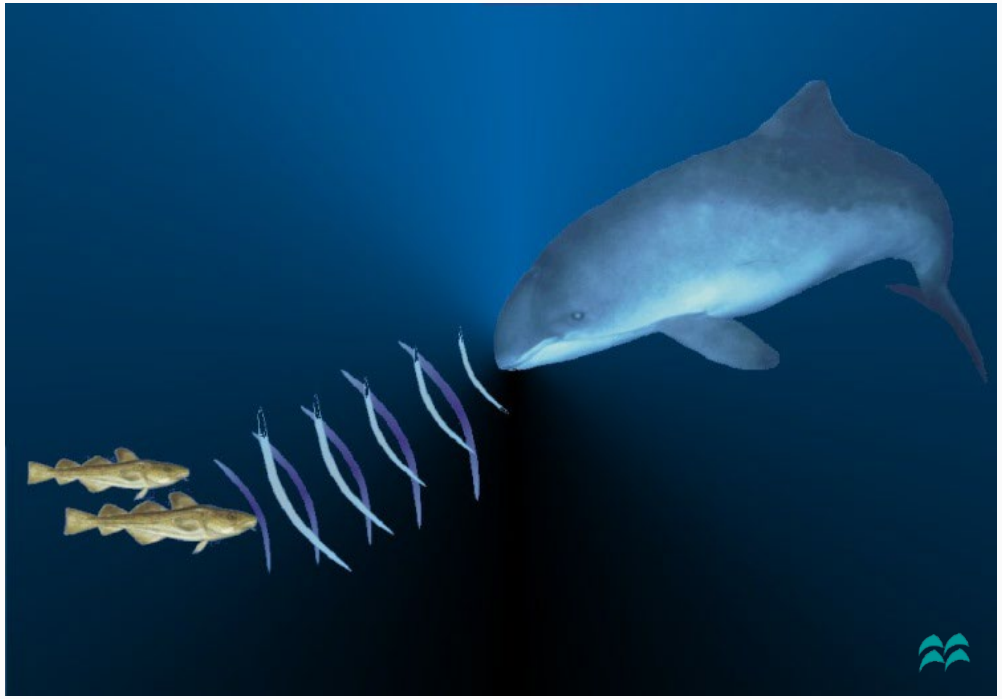


Importance of Sound to Marine Life

- Under water, sound travels far greater distances than light
  - *sound is more efficient for transferring information*

- Marine organisms use sound for critical life functions:
  - Orientation
  - Predator avoidance
  - Obstacle avoidance
  - Communication
  - Localising food

- Audibility of sound is limited by background noise (masking) and hearing sensitivity



Southern Resident Killer Whales

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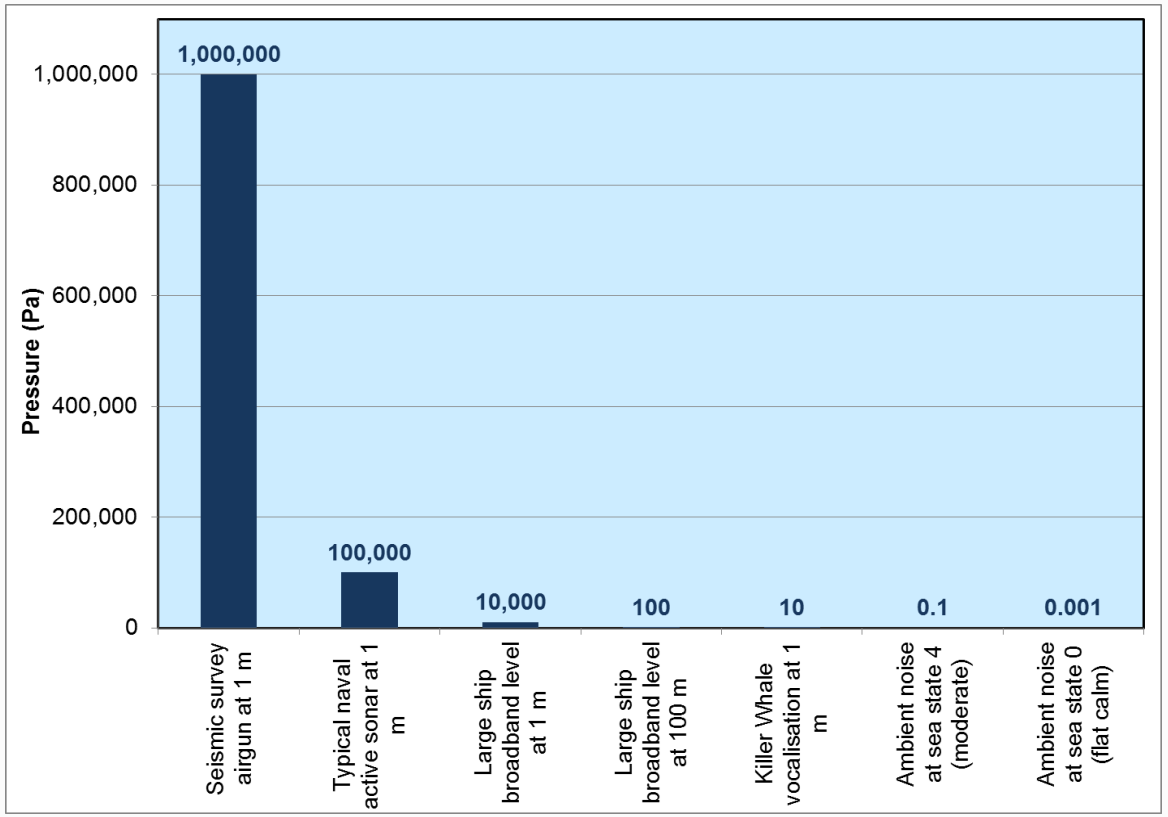
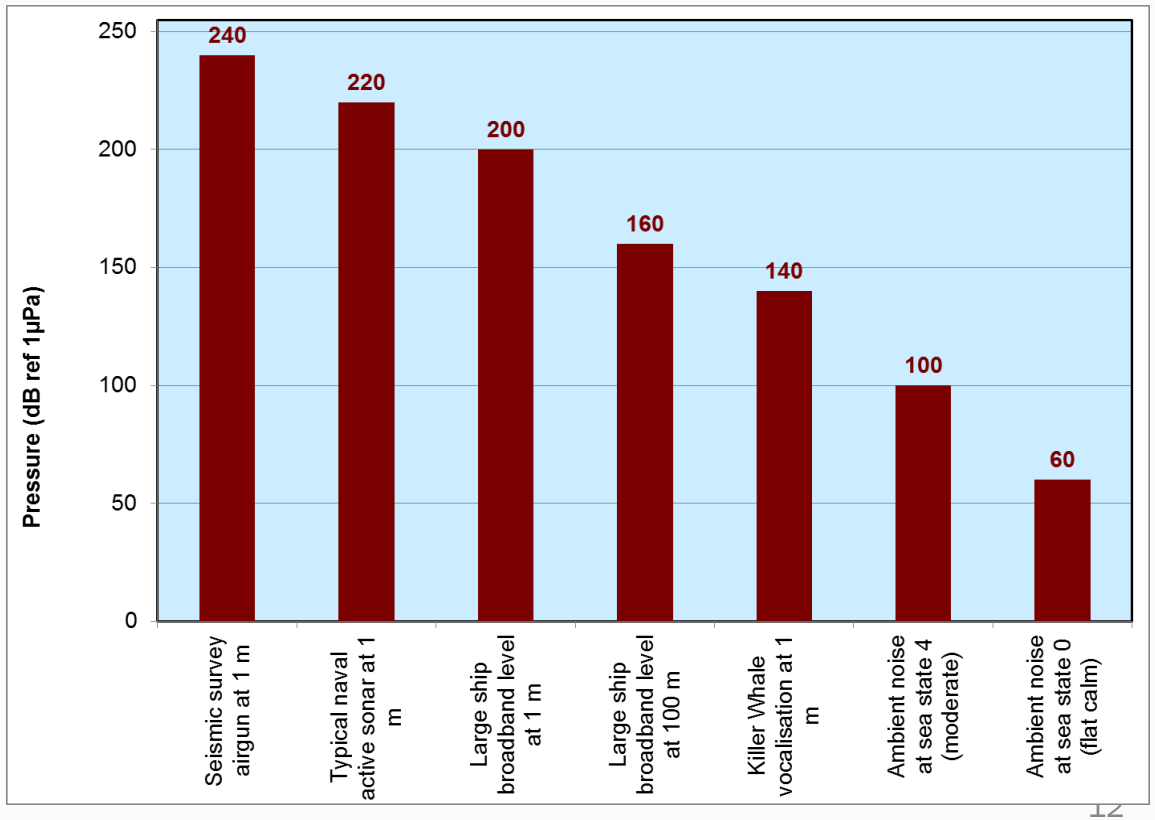
Decibels

- Sound levels are expressed in decibels (dB)

- It is the logarithm of the ratio between the pressure and a reference pressure multiplied by 20

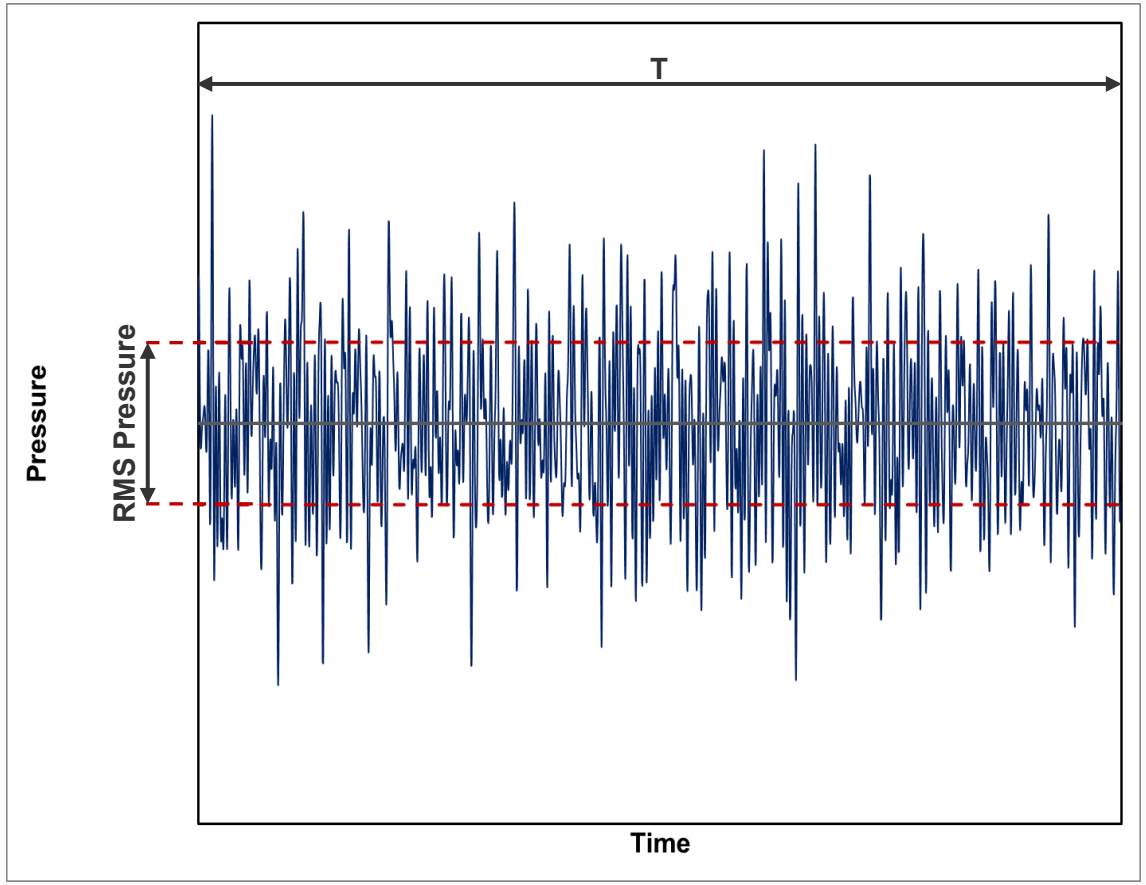




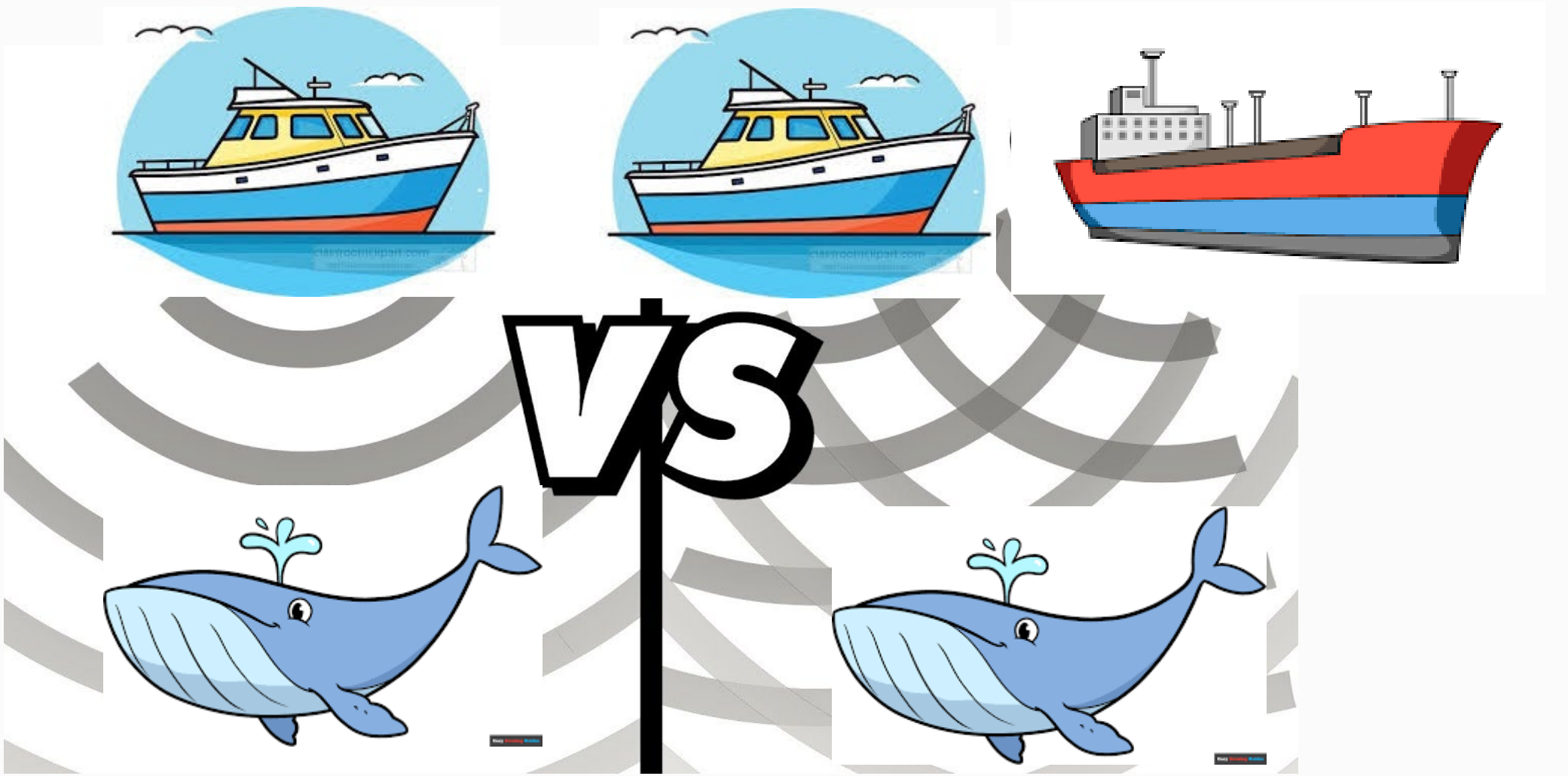
Commonly used metrics for continuous sound

Sound Pressure Level (SPL, L_p)

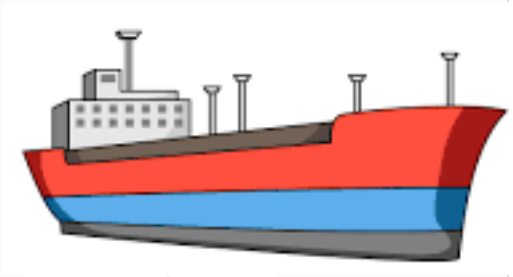
Units: dB re 1 µPa

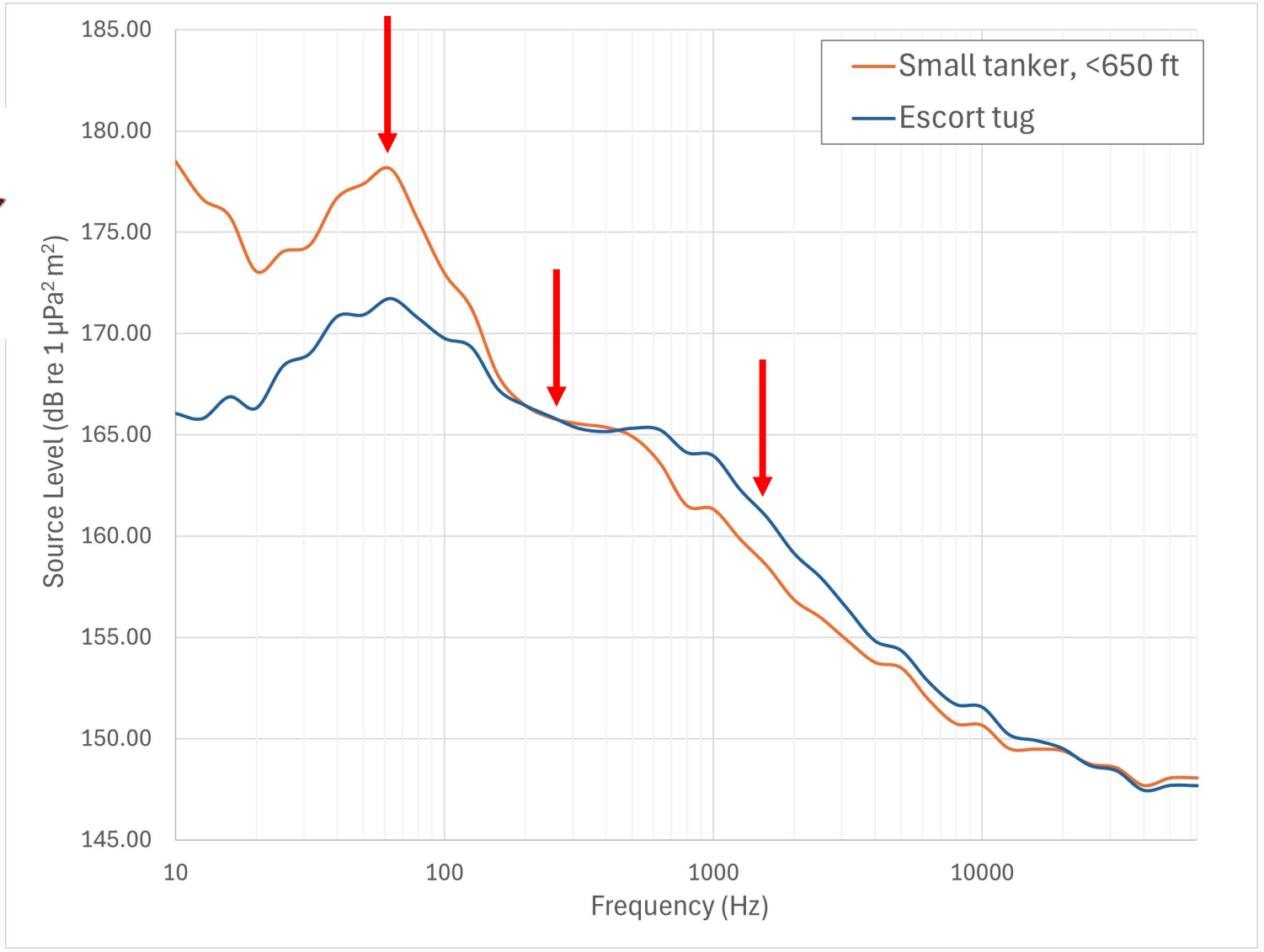


1, 2, and combined sources



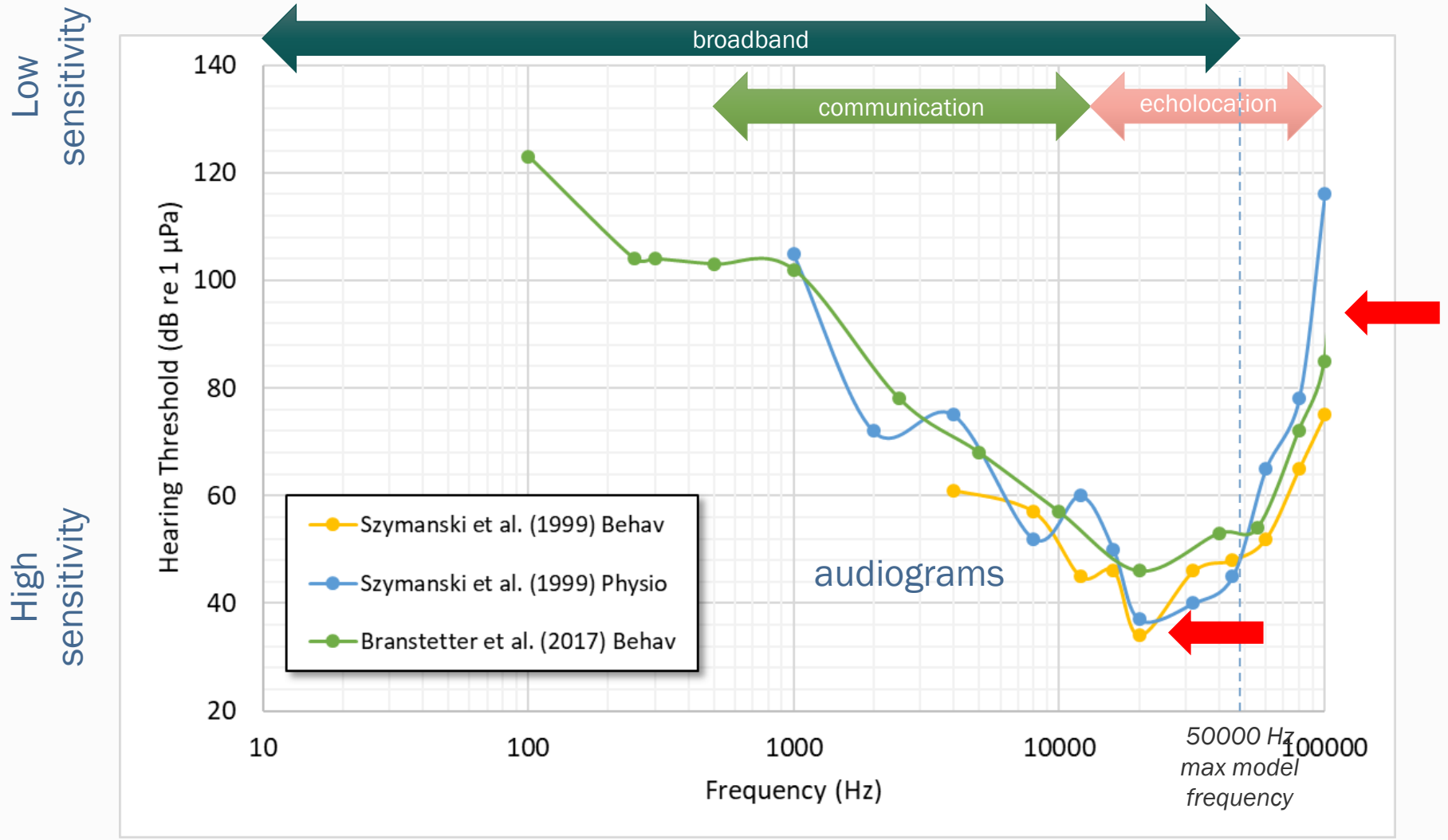
Vessel source levels (SLs)





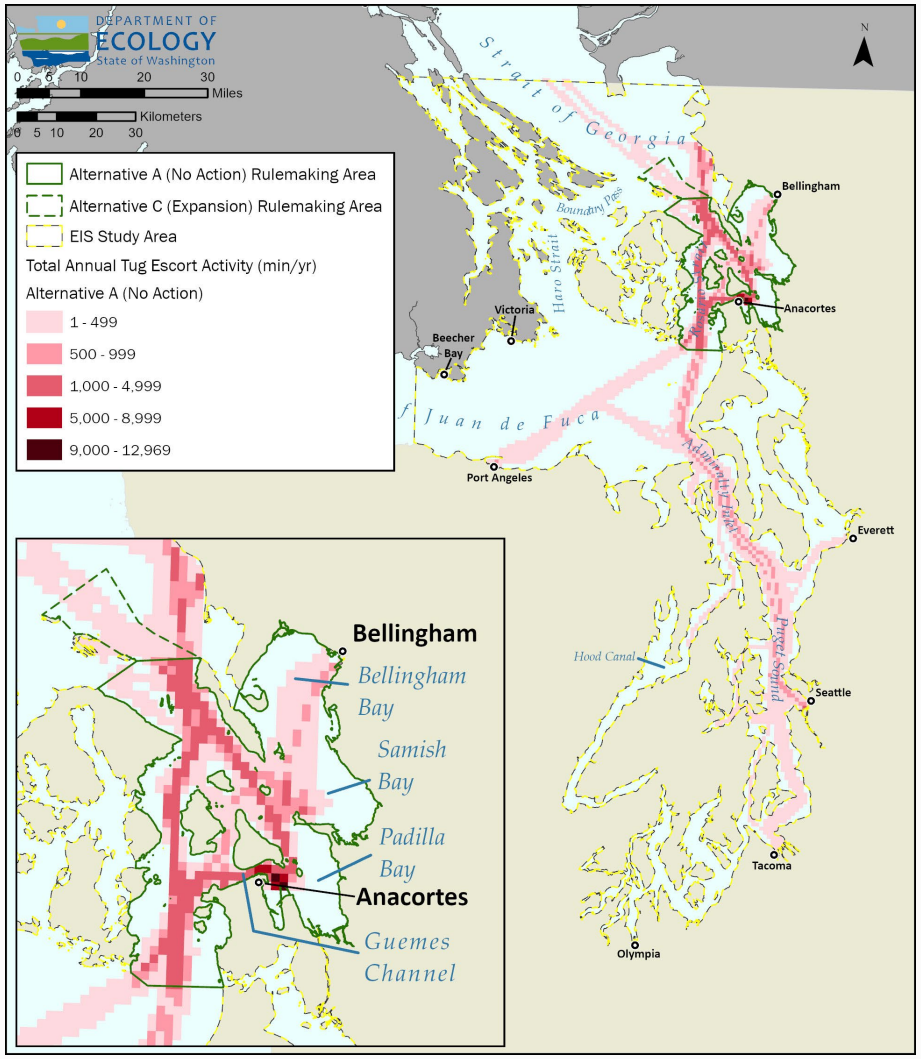
Multiple sources in close proximity

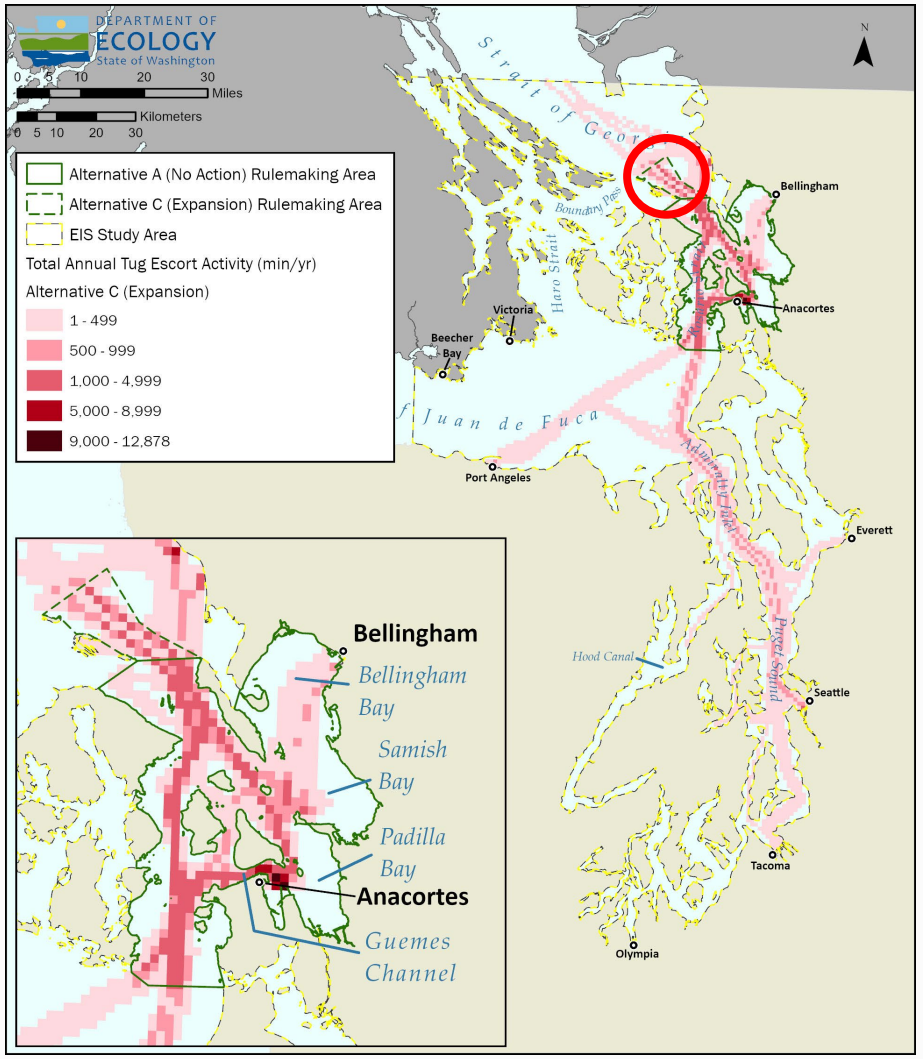
Killer Whale Hearing and Masking Bands



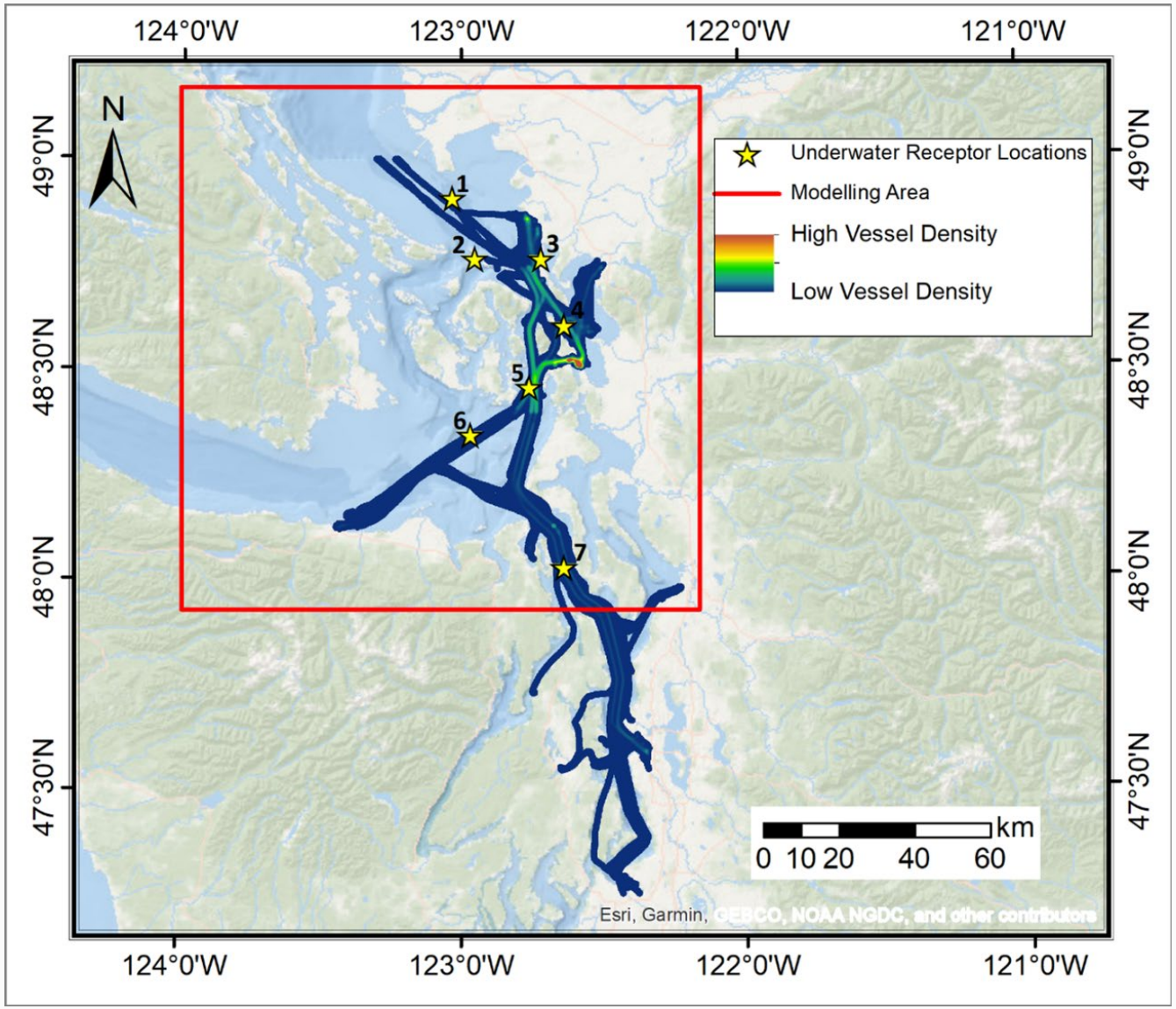
Underwater noise modeling for the Tug Escort EIS (Methods)

“Alternatives” modeled

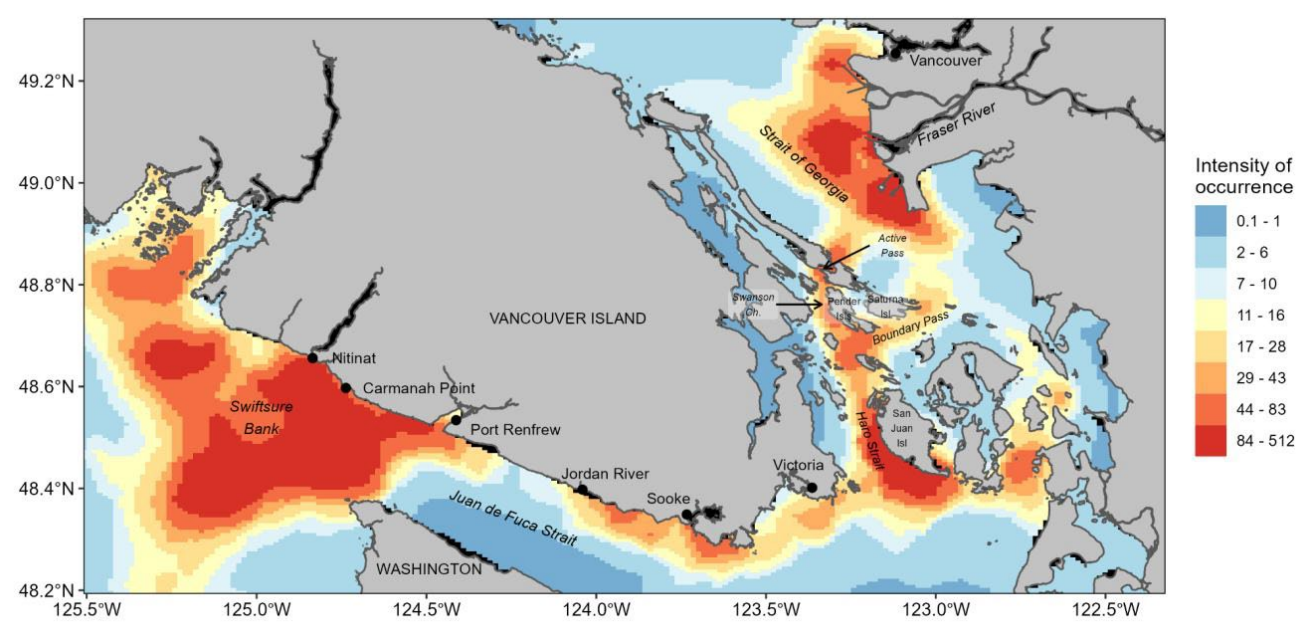




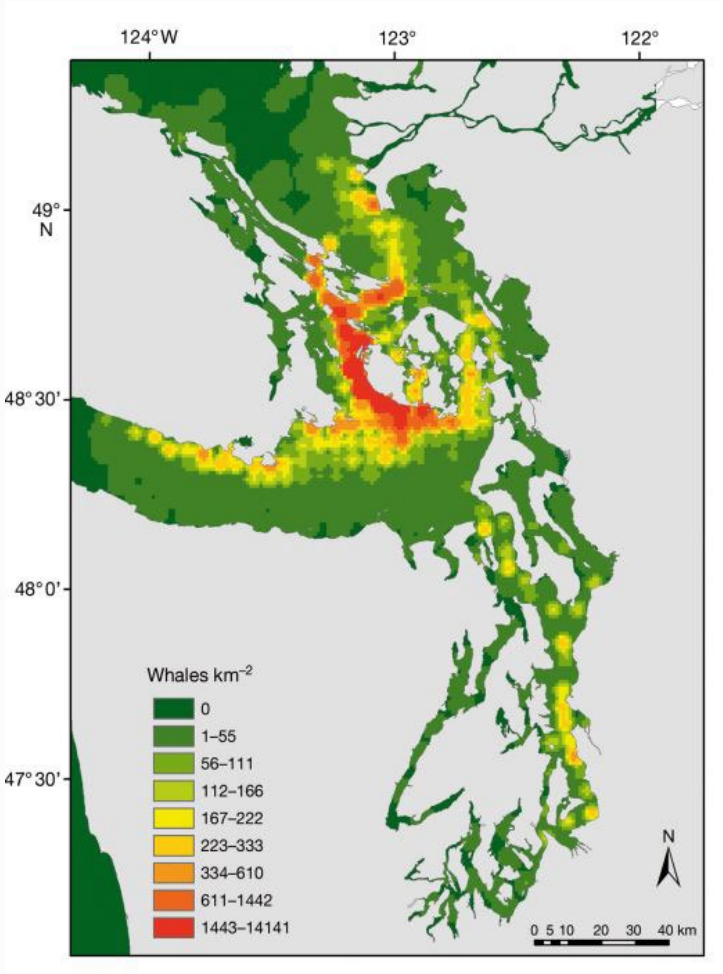
Key acoustic receiver locations



SRKW presence

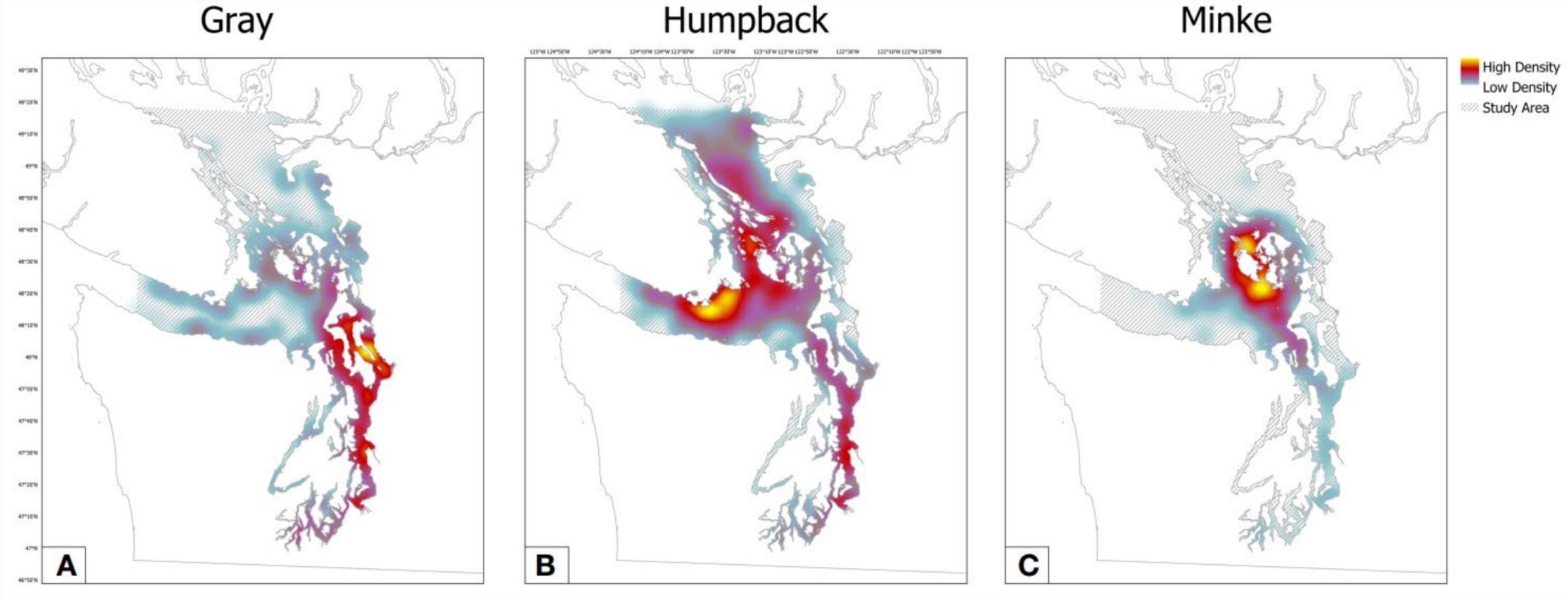


Thornton, S. J., et al. (2022). Southern Resident Killer Whale (*Orcinus orca) summer distribution and habitat use in the southern Salish Sea and the Swiftsure Bank area (2009 to 2020), DFO Canada Science Advisory Secretariat Research Document 2022/037: 56.*



Olson, J. K., et al. (2018). Sightings of southern resident killer whales in the Salish Sea 1976-2014: the importance of a long-term opportunistic dataset, *Endangered Species Research, 56: 105-118.*

Other marine mammal presence



Olson, J. K., et al. (2024). Utilizing long-term opportunistic sightings records to document spatio-temporal shifts in mysticete presence and use in the Central Salish Sea*, Front. Conserv. Sci. 5:1401838.*

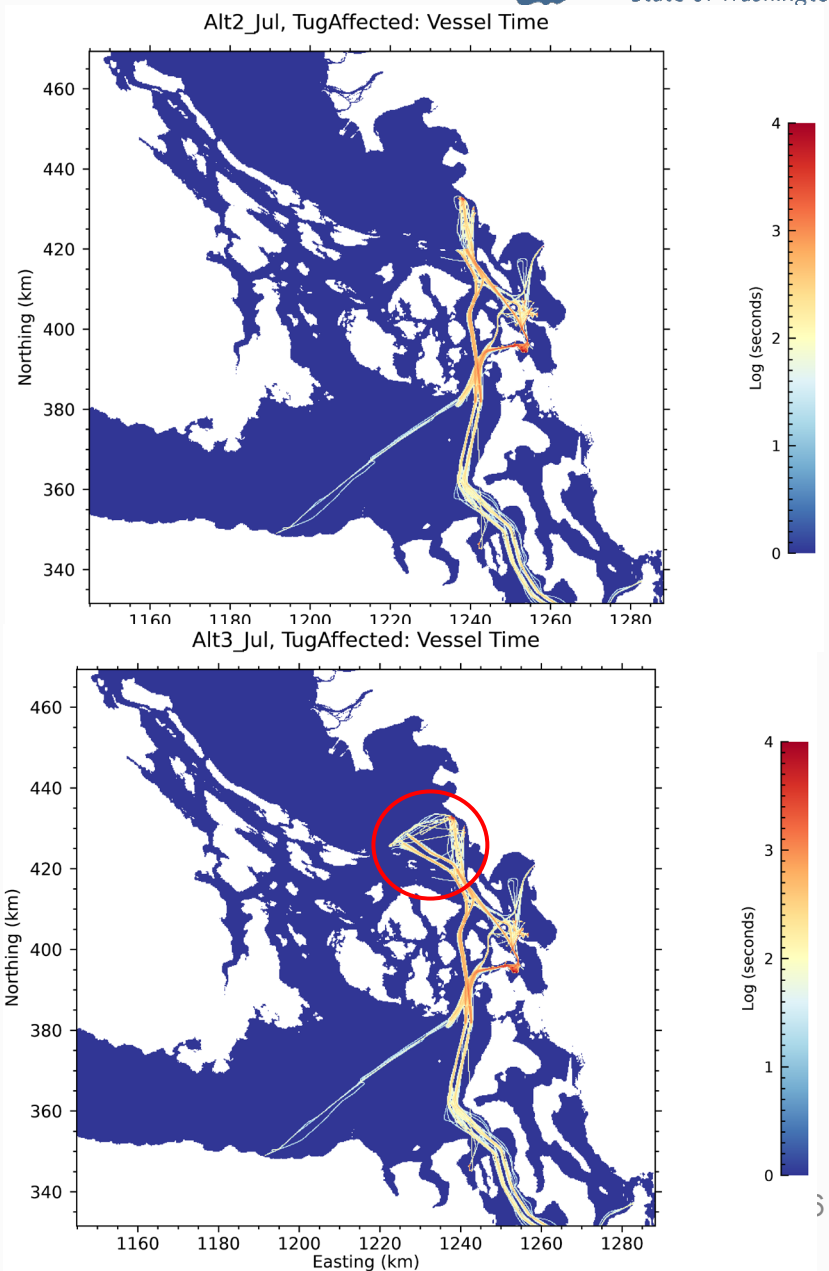
Objectives of the underwater noise assessment

- What are the existing underwater sound levels at selected key receptor locations (i.e., biologically significant areas)?
- How do existing escort tug operations contribute to these existing conditions?
- How does the proposed expansion of the tug escort requirements affect the underwater sound levels at selected key receptor locations?
- What are the changes in noise levels at selected key receptor locations due to the removal of the tug escort requirements?
- **Assess areas of impact**: where and how often are acoustic thresholds exceeded i.e., National Marine Fisheries Service (NMFS) behavioral disturbance threshold (120 dB broadband SPL). Also examined changes in Southern Resident killer whale (SRKW) communication and echolocation frequency bands.

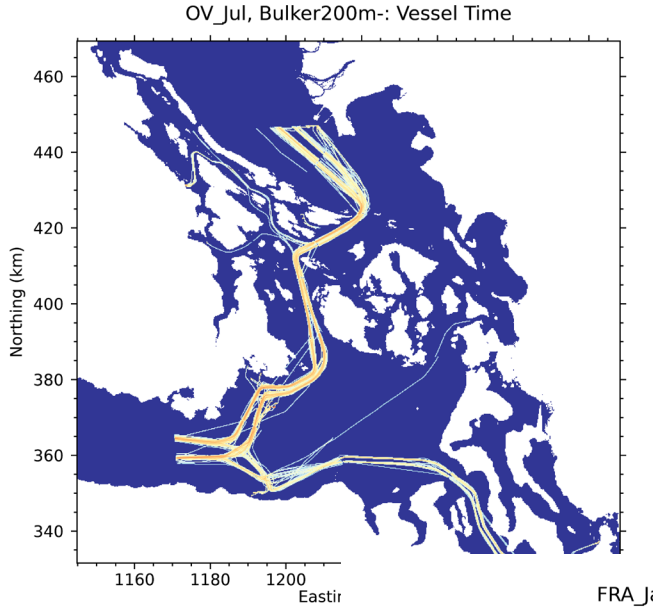
Marine vessel activity

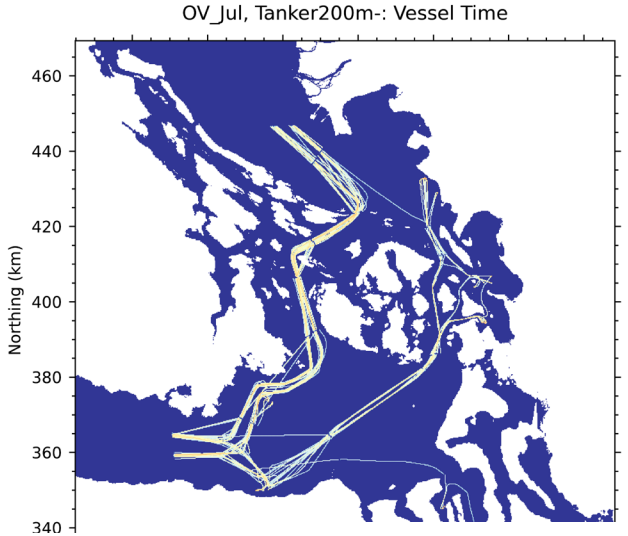
Vessel Tracking Data

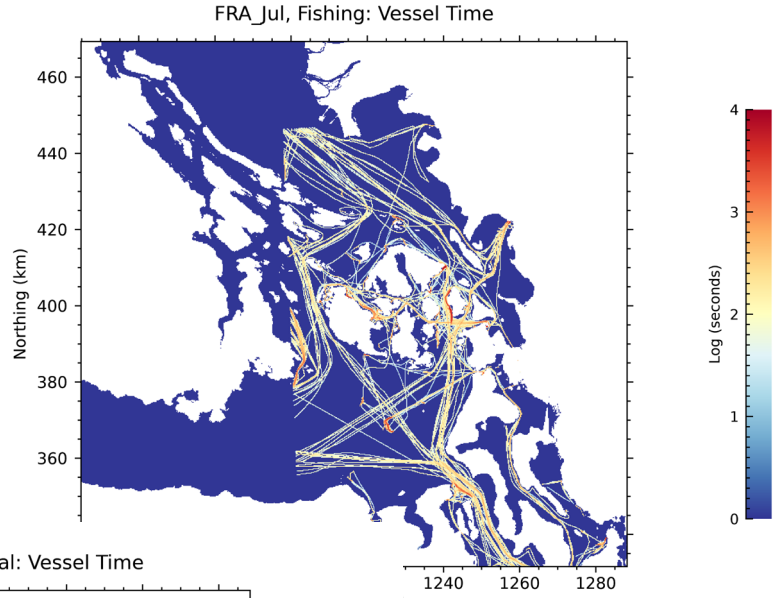
- AIS = Automatic Identification System
  - Carried by most large commercial vessels
  - Many smaller vessels also carry AIS (but not to the same degree -> scaled in model)
- Simulated traffic data provided by Ecology
- January and July selected to represent normal vessel traffic in winter & summer seasons
  - Vessels appearing in data set assigned to one of 15 different vessel categories

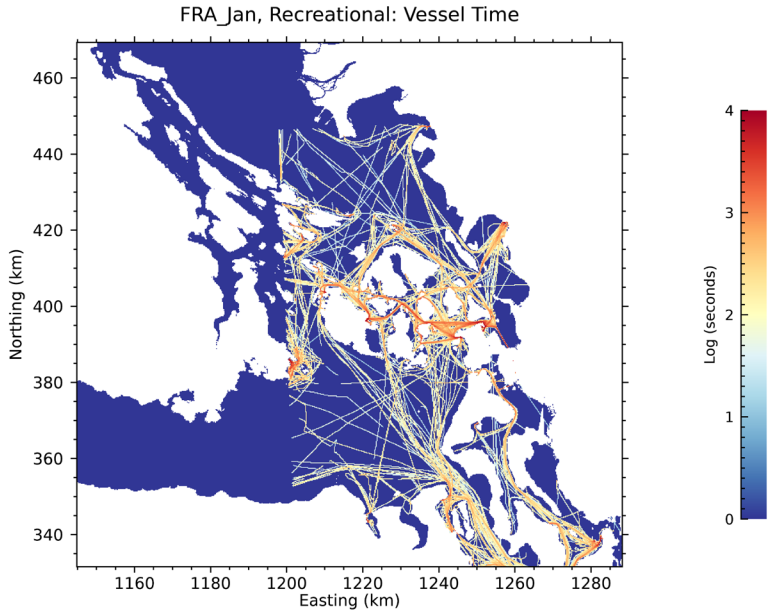


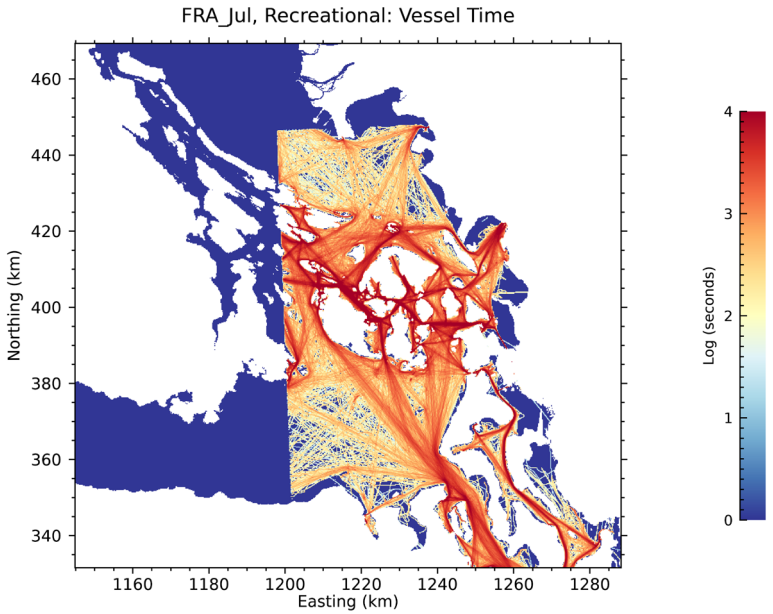
Vessel Tracking Data





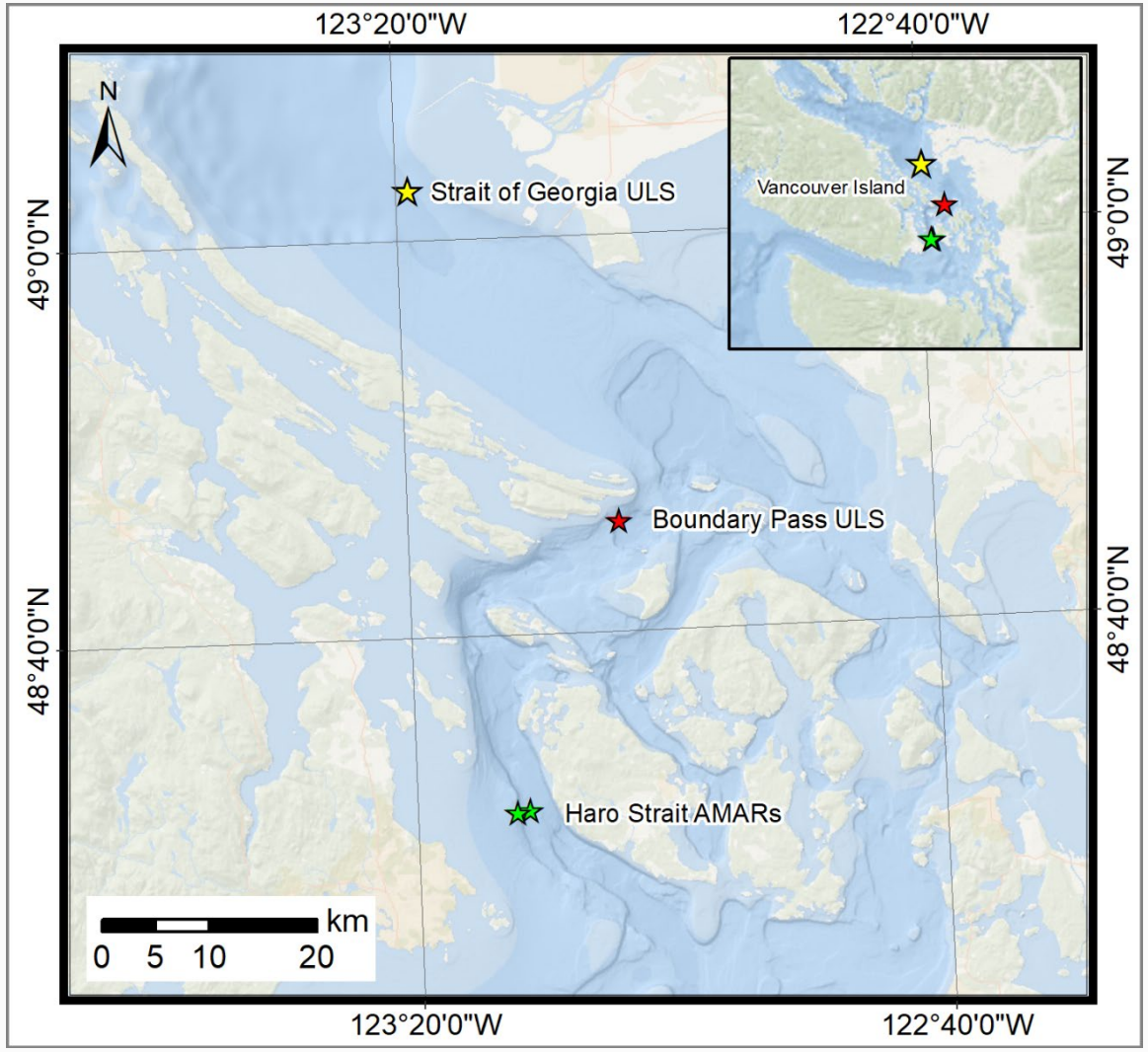


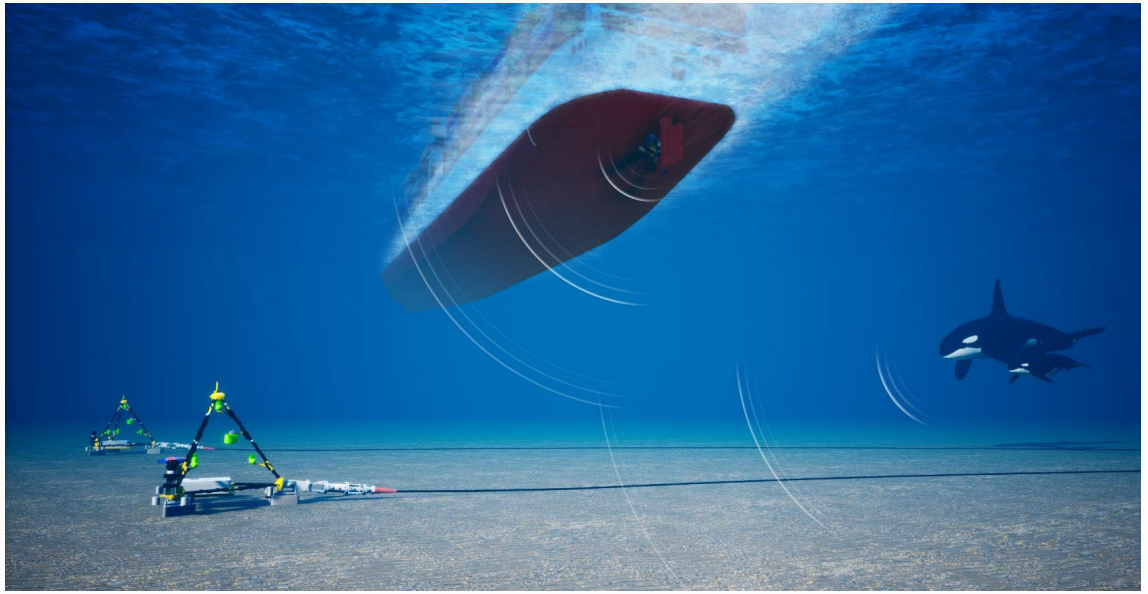




Vessel noise emissions

Vessel Noise Emissions Data

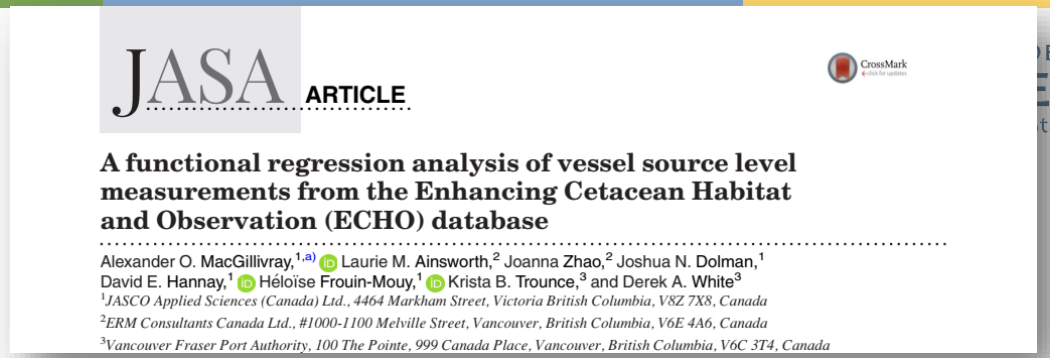




- Underwater radiated noise (URN) data primarily originate from JASCO underwater listening stations in local area
- Stations designed to collect URN data for ships of opportunity transiting int'l shipping lanes
- ECHO database collects approximately 62,000 noise measurements for nearly 10,000 unique ships
- Additional URN data shared by ECHO Program:
  - Ro-ro ferries
  - Anchored cargo vessels

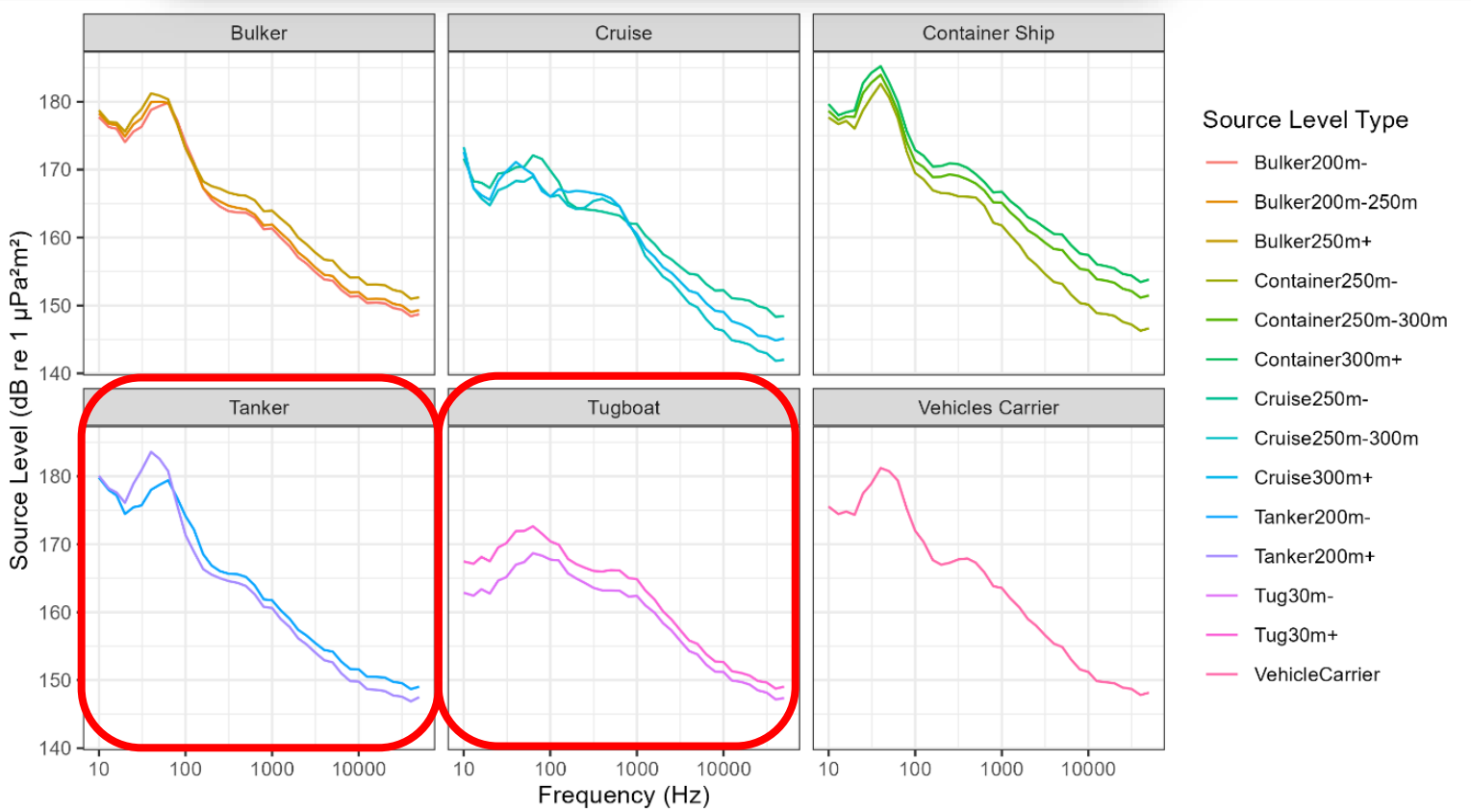
Source Level Curves

- Source level = noise emissions by frequency band
- ECHO database and other sources used to define representative source level curves for 31 vessel subcategories
- Source levels are scaled according to vessel length and speed trends derived from ECHO database (MacGillivray et al. 2022)
- Vessel source levels assigned to AIS tracks in frequency bands from 10 Hz to 50,000 Hz


JASA ARTICLE

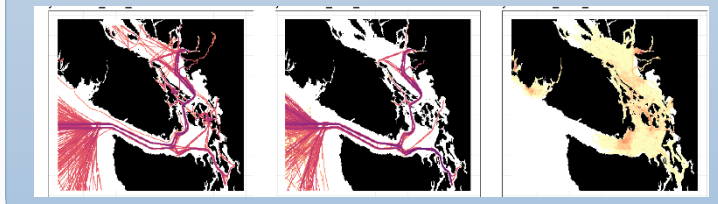
A functional regression analysis of vessel source level measurements from the Enhancing Cetacean Habitat and Observation (ECHO) database

Alexander O. MacGillivray,[1,a] Laurie M. Ainsworth,[2] Joanna Zhao,[2] Joshua N. Dolman,[1] David E. Hannay,[1] Héloïse Frouin-Mouy,[1] Krista B. Trounce,[3] and Derek A. White[3]
[1]JASCO Applied Sciences (Canada) Ltd., 4464 Markham Street, Victoria British Columbia, V8Z 7X8, Canada
[2]ERM Consultants Canada Ltd., #1000-1100 Melville Street, Vancouver, British Columbia, V6E 4A6, Canada
[3]Vancouver Fraser Port Authority, 100 The Pointe, 999 Canada Place, Vancouver, British Columbia, V6C 3T4, Canada

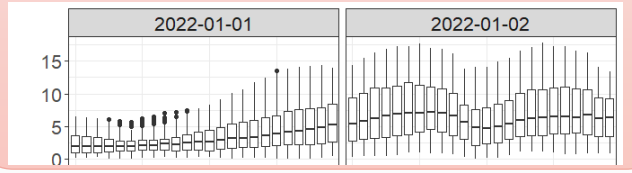


ARTEMIA Soundscape Model

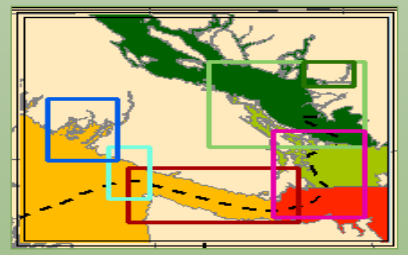
Source density layers



Wind and rain data



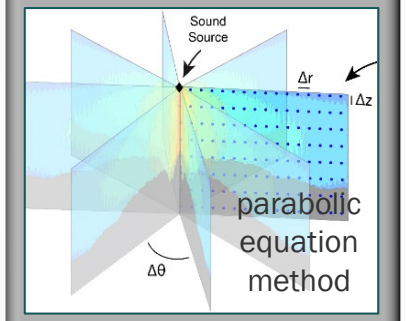
Environmental databases

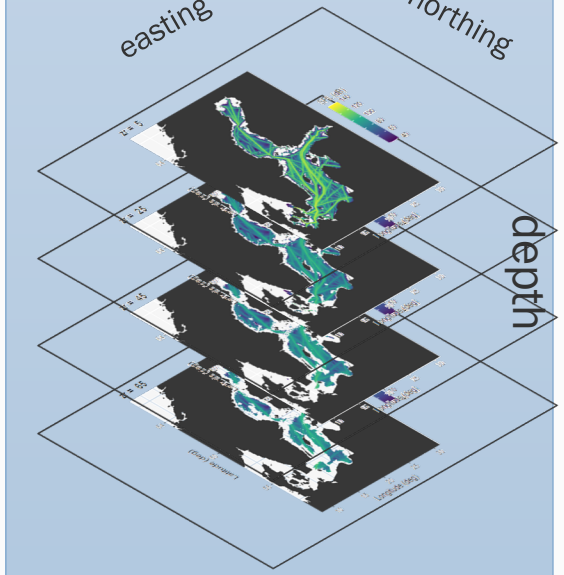


ARTEMIA

Sound Propagation

OpenMP

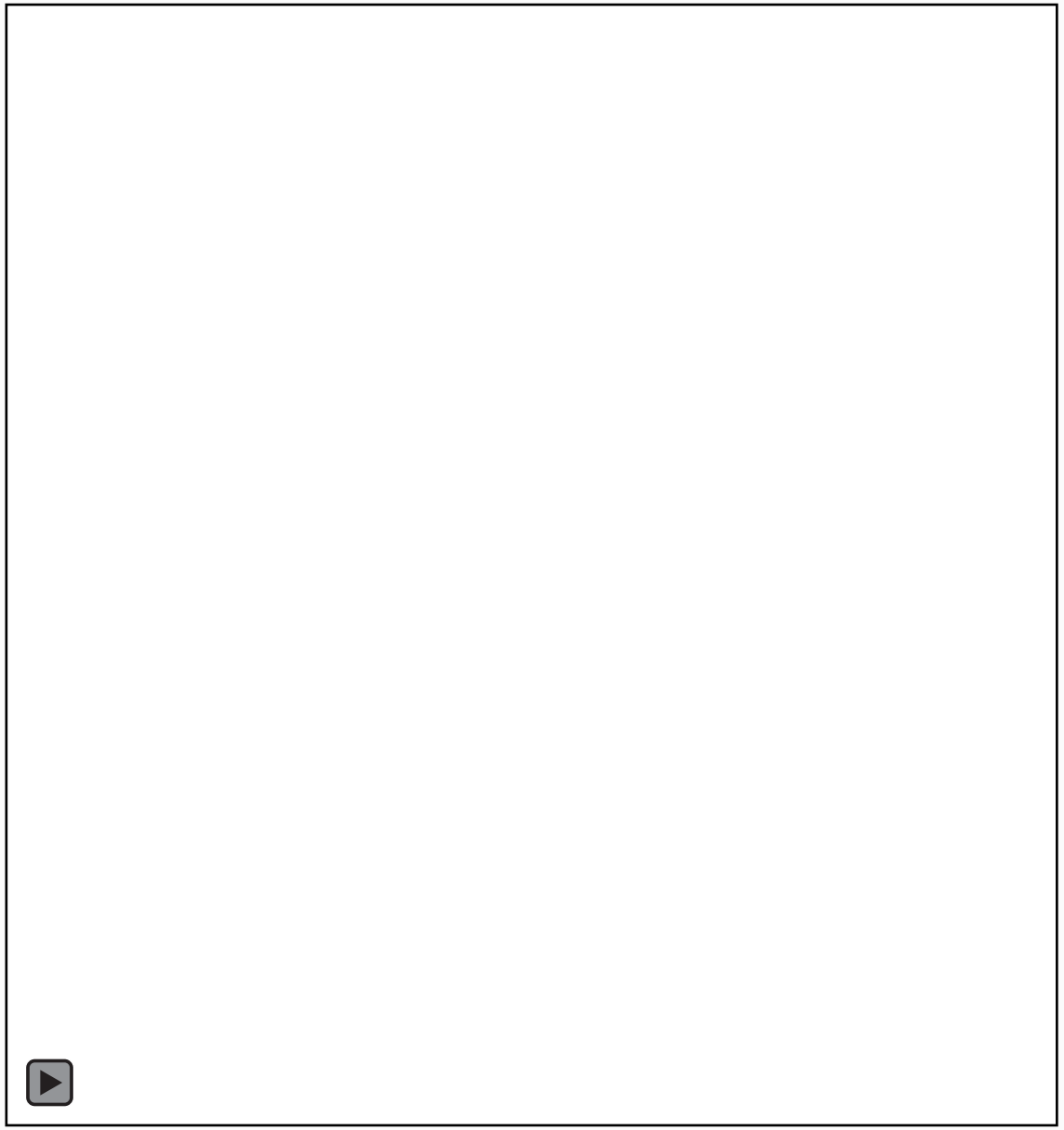




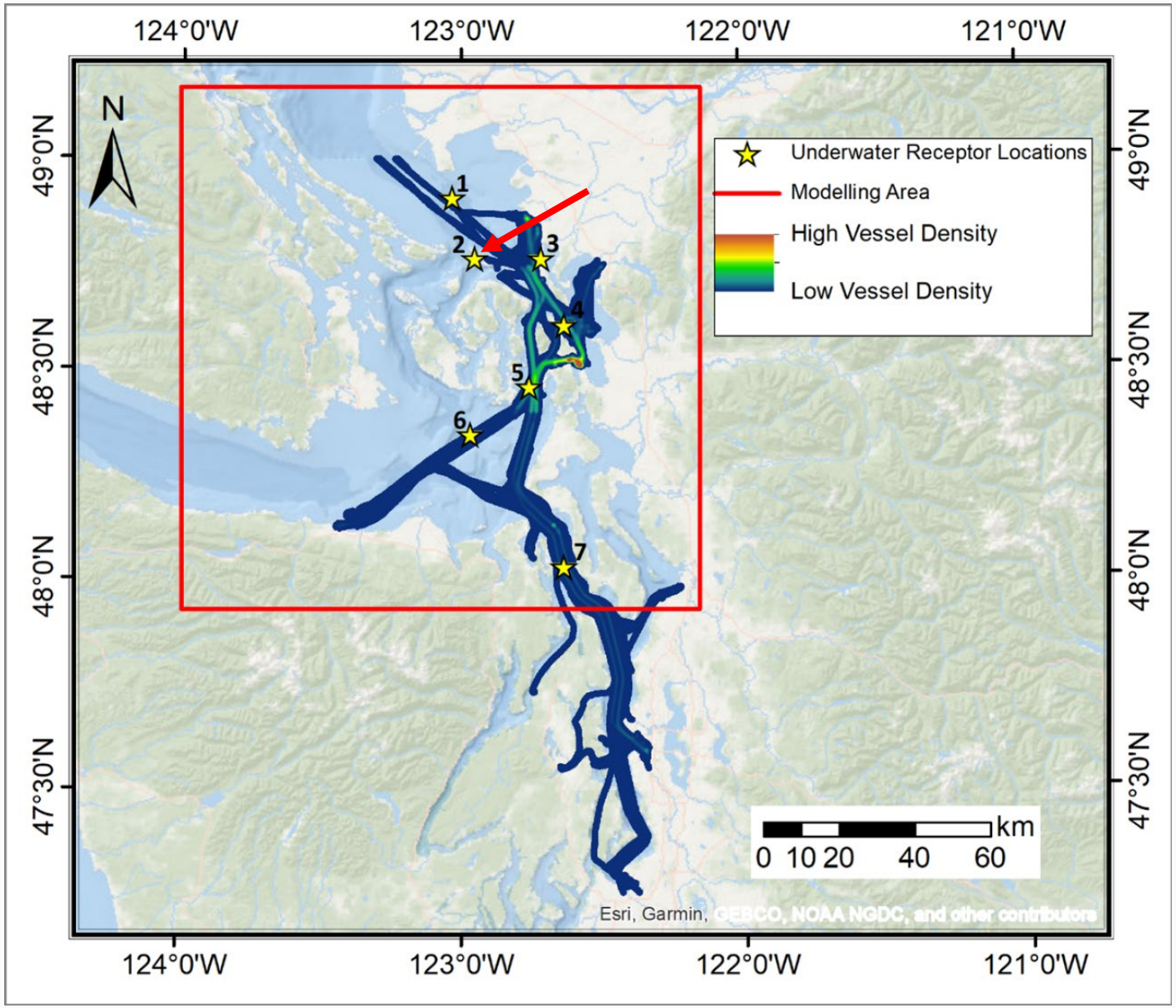
sound map layers

$L_p\ (x, y, z)$

by source type
by frequency band
by month

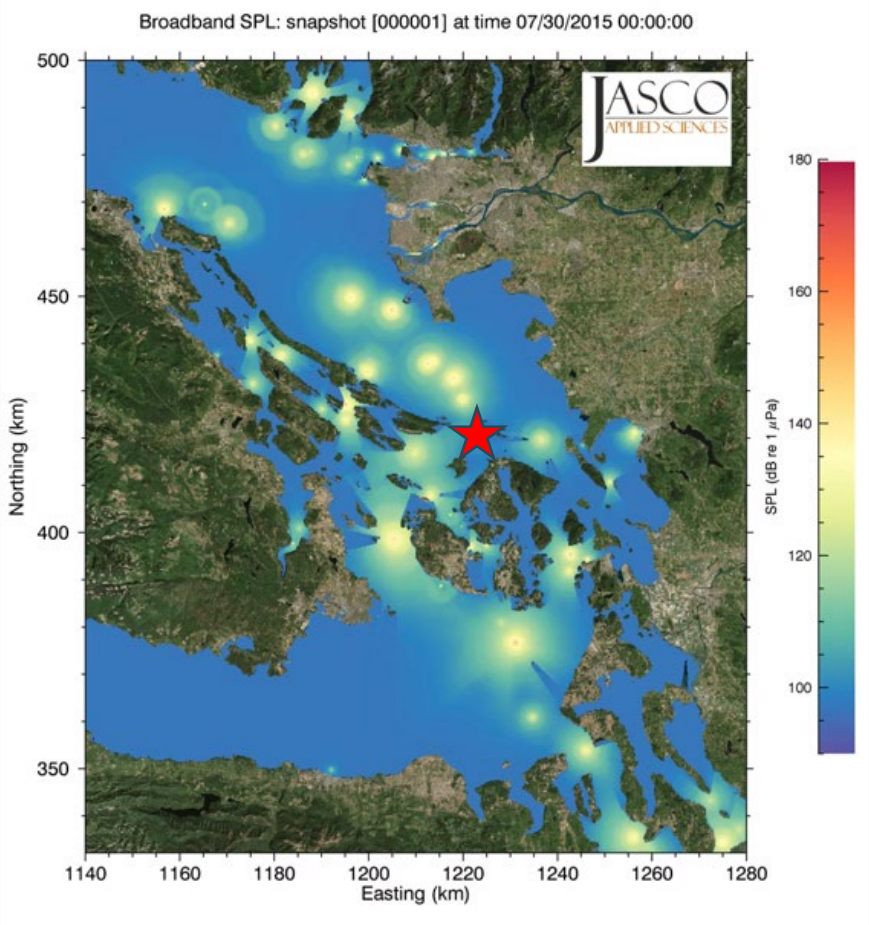


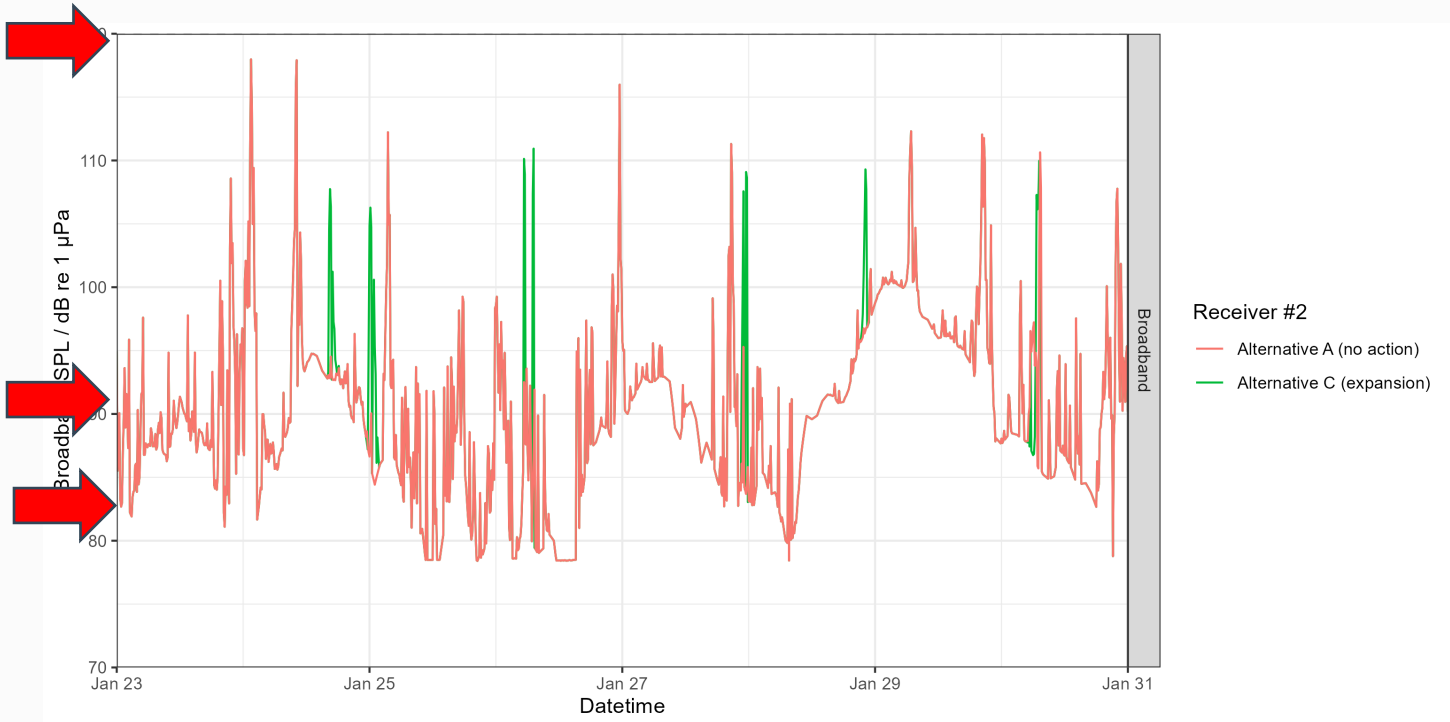
Examine sound levels at key receiver locations

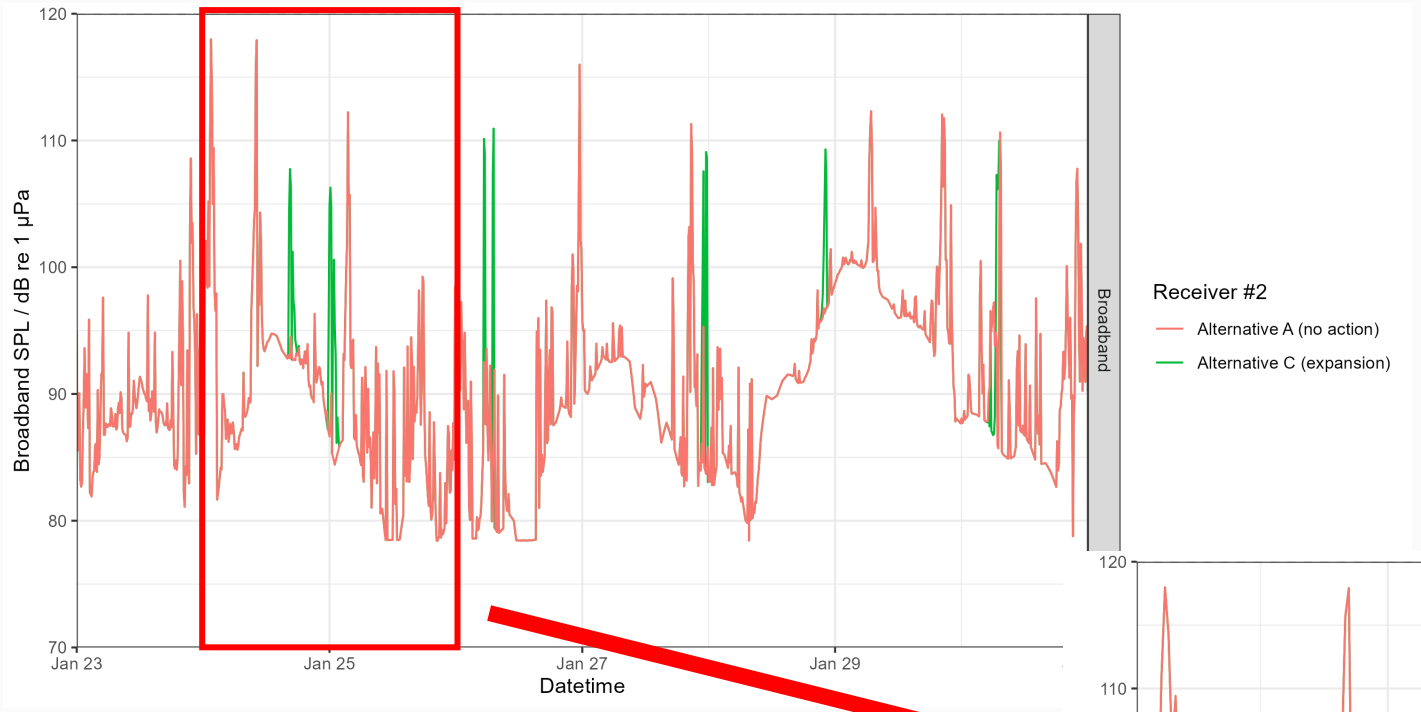


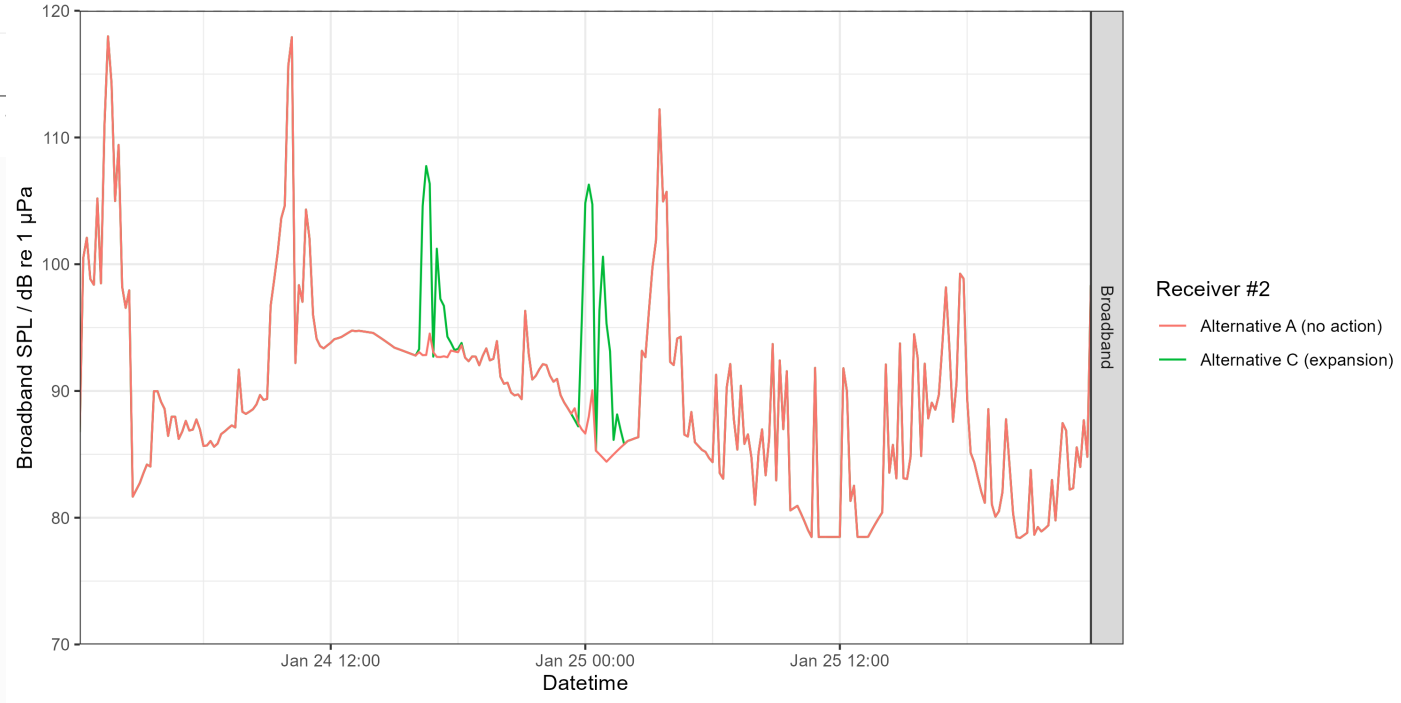
Results Overview

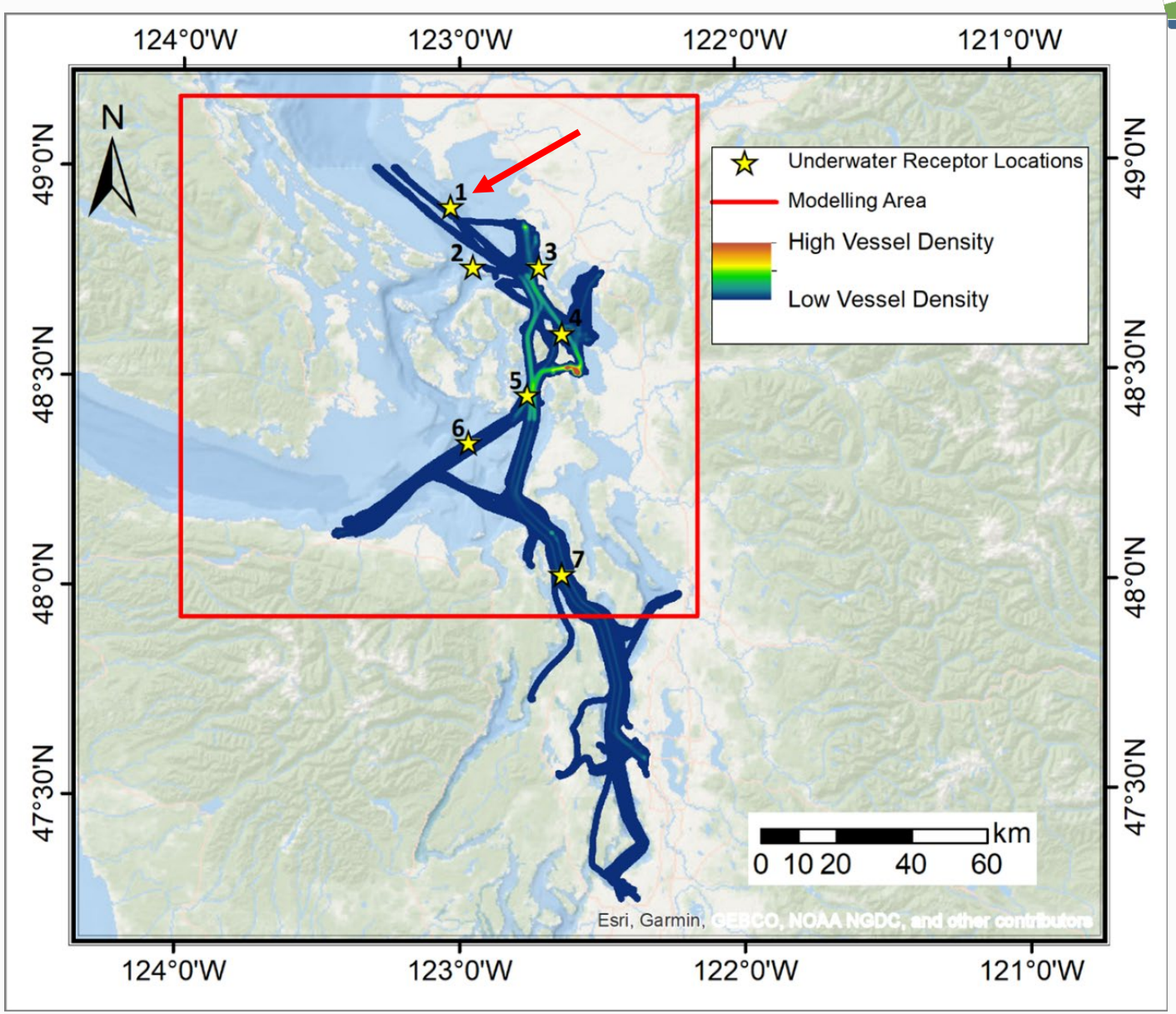
Change in noise levels with time



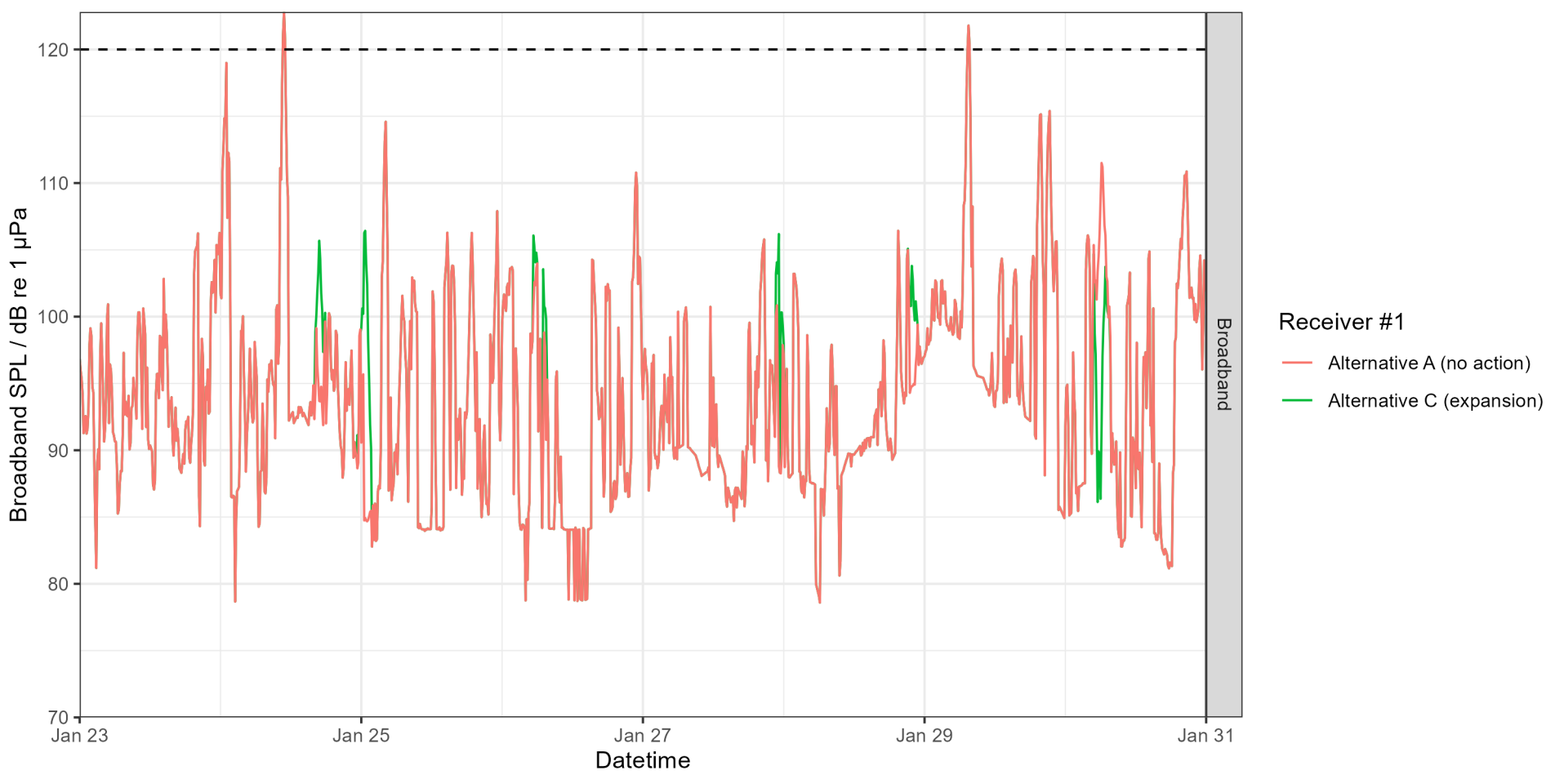



Broadband SPL / dB re 1 µPa
120
110
100
90
80
70
Jan 23
Jan 25
Jan 27
Jan 29
Datetime
Broadband
Receiver #2
Alternative A (no action)
Alternative C (expansion)

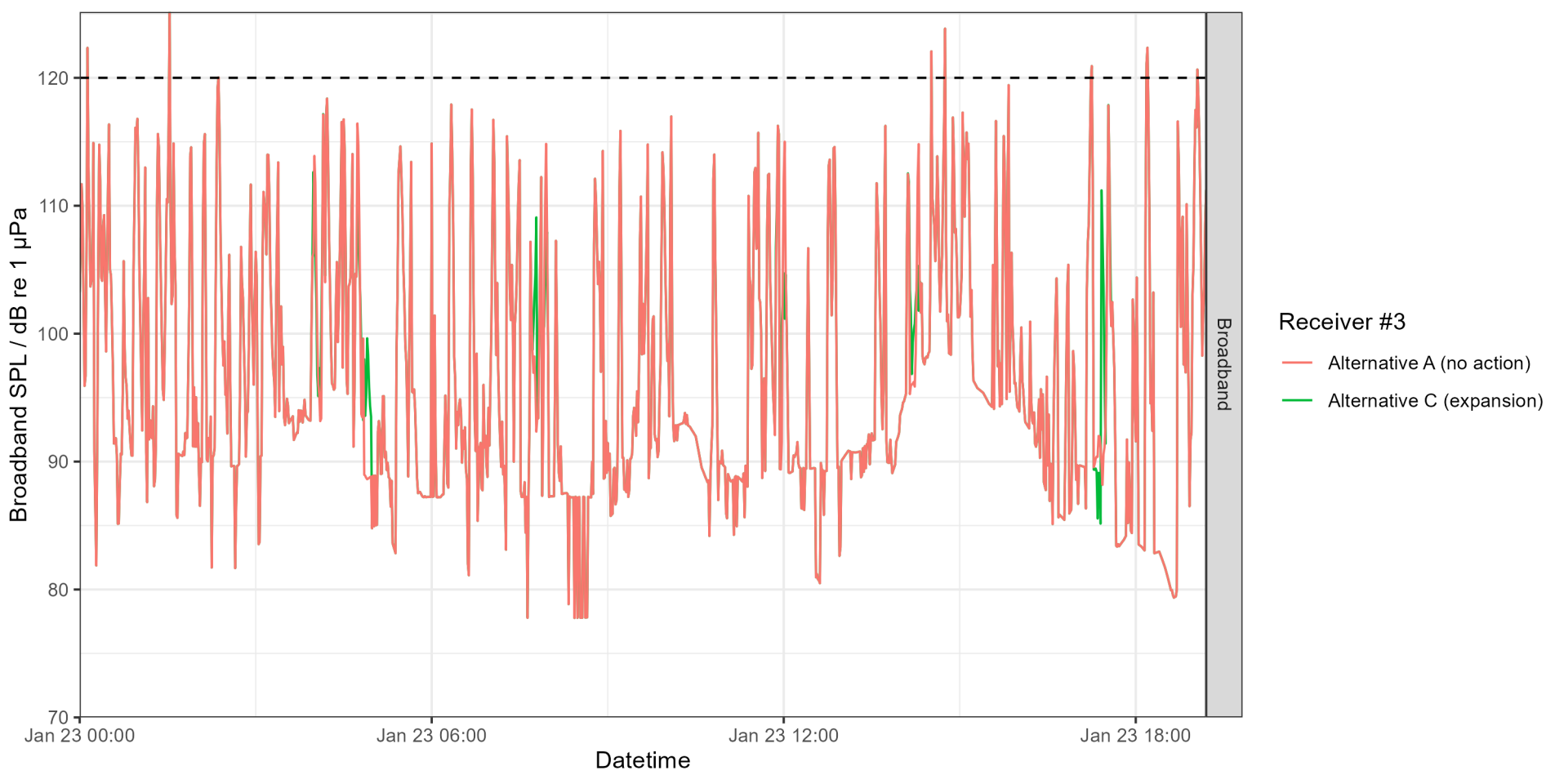

Broadband SPL / dB re 1 µPa
120
110
100
90
80
70
Jan 24 12:00
Jan 25 00:00
Jan 25 12:00
Datetime
Broadband
Receiver #2
Alternative A (no action)
Alternative C (expansion)


124°0'W
123°0'W
122°0'W
121°0'W
49°0'N
48°30'N
48°0'N
47°30'N
N
1
2
3
4
5
6
7
Underwater Receptor Locations
Modelling Area
High Vessel Density
Low Vessel Density
km
0 10 20 40 60
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

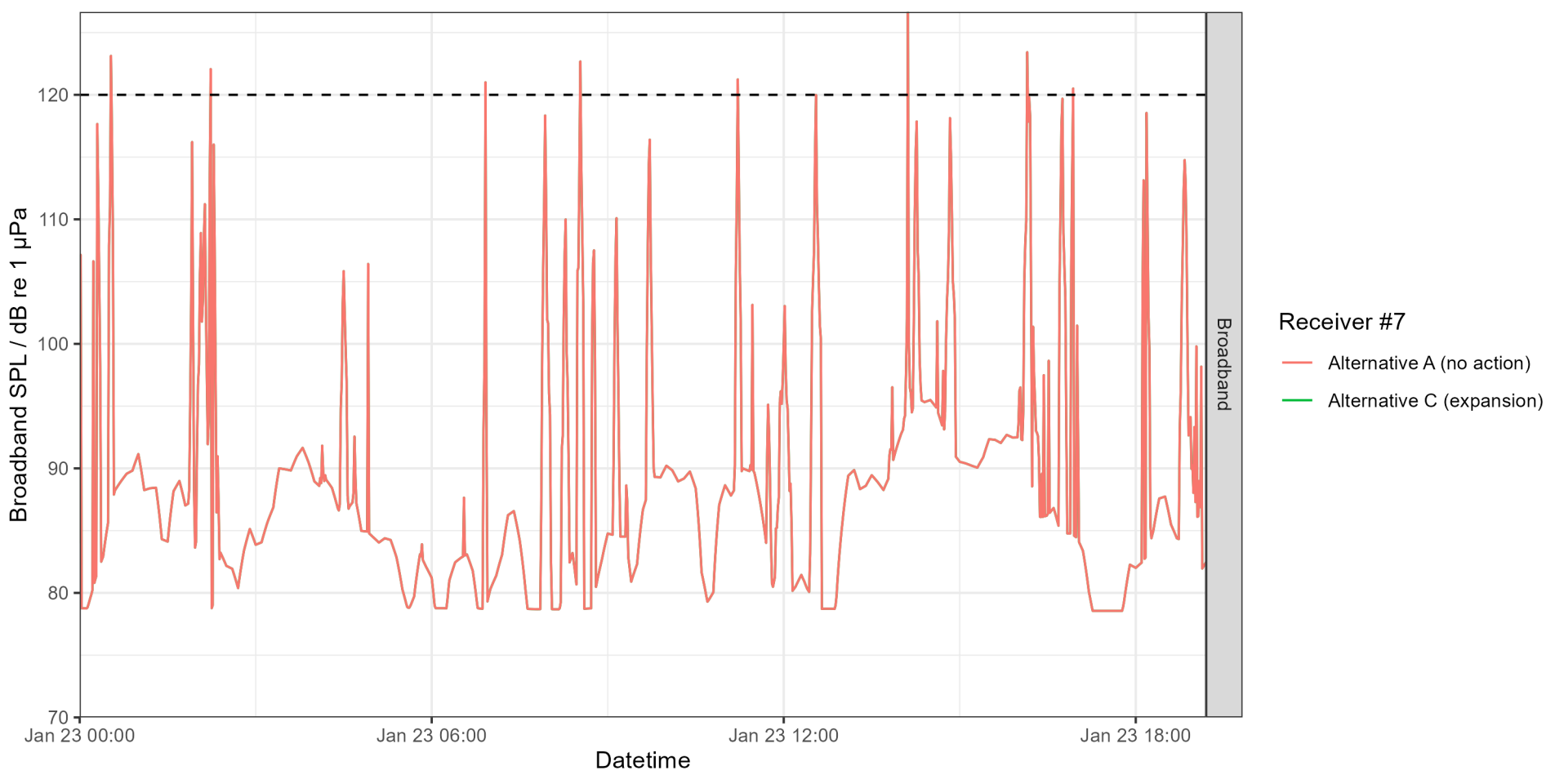
Alt. A (No Action) versus Alt. C (Expansion of tug escort requirement)



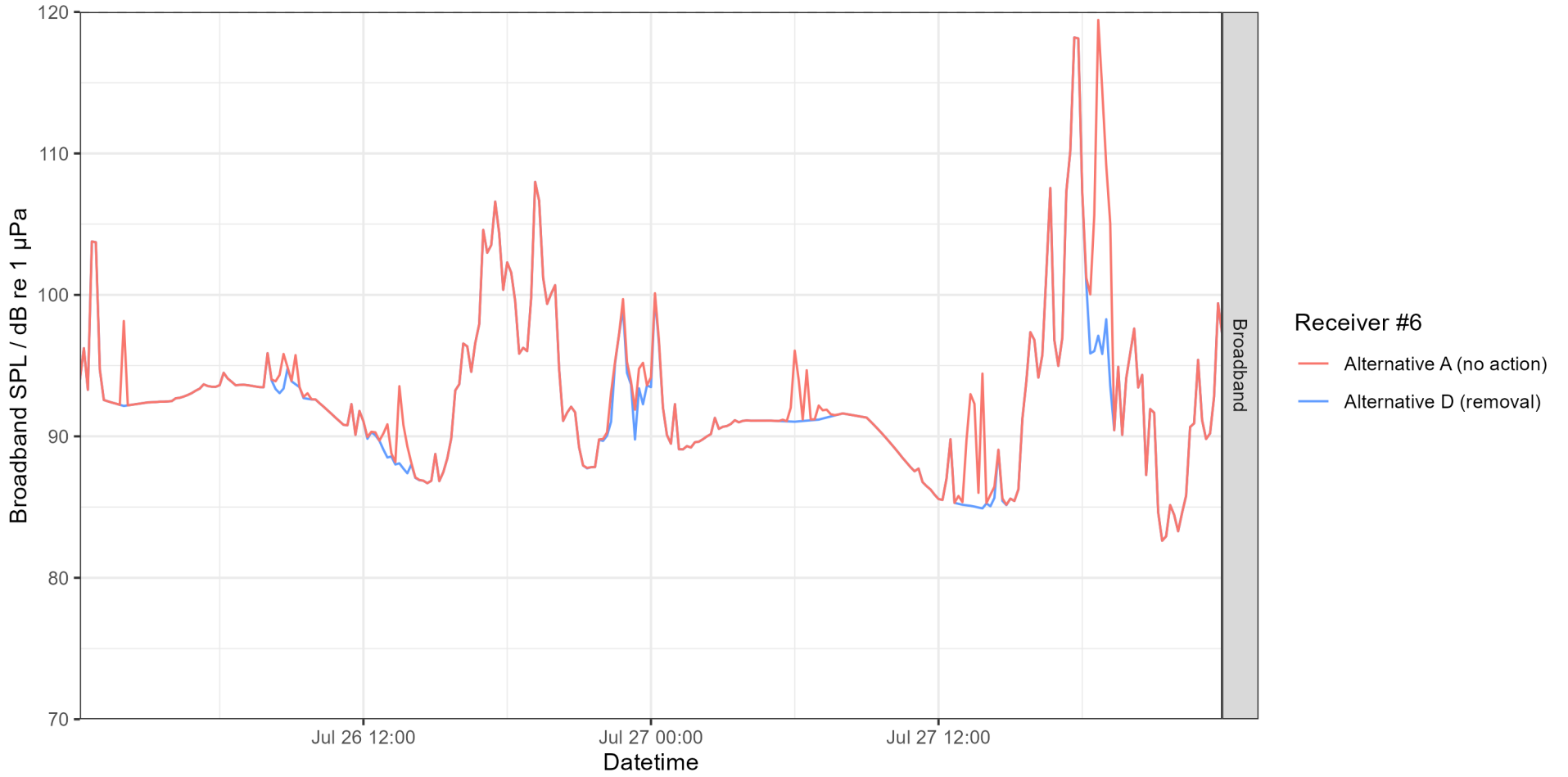
Alt. A (No Action) versus Alt. C (Expansion of tug escort requirement)



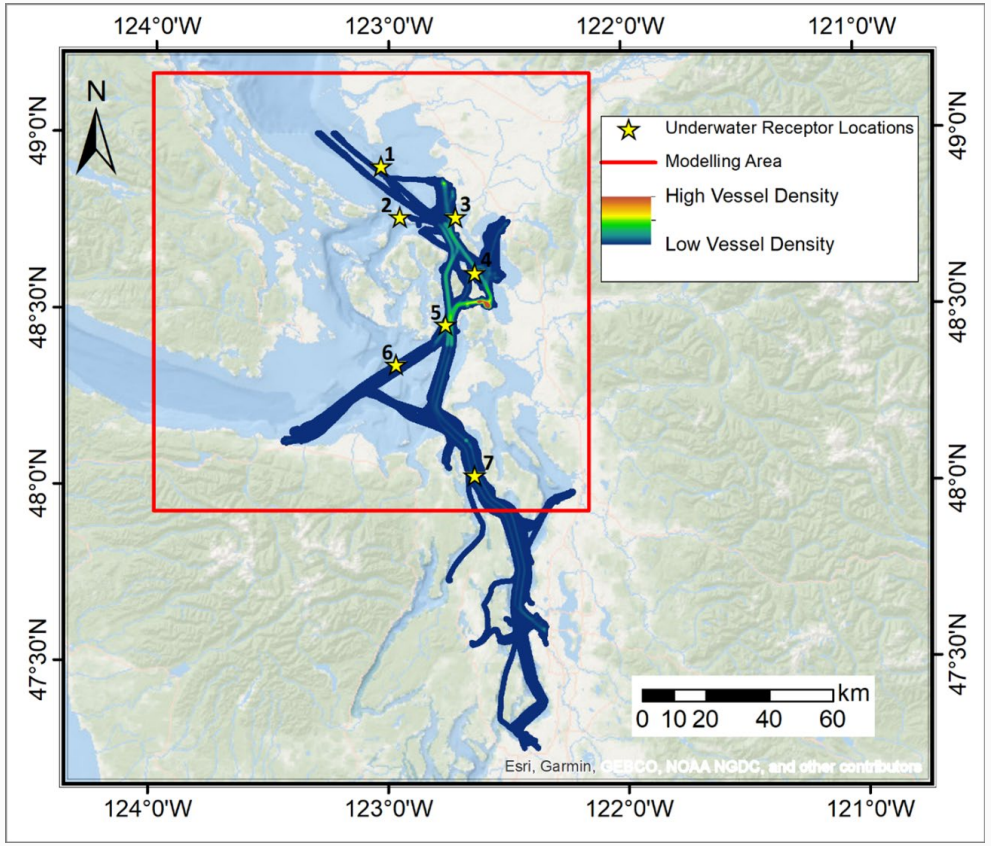
Alt. A (No Action) versus Alt. C (Expansion of tug escort requirement)



Alt. A (No Action) versus Alt. D (Removal of tug escort requirement)



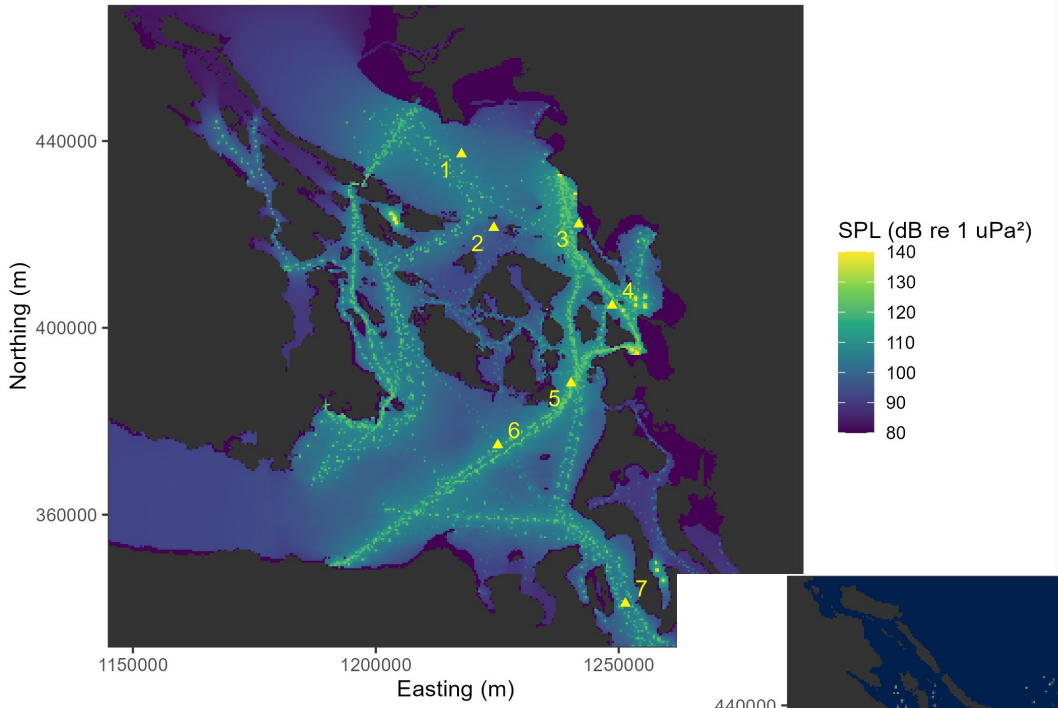
Amount of time spent above disturbance threshold

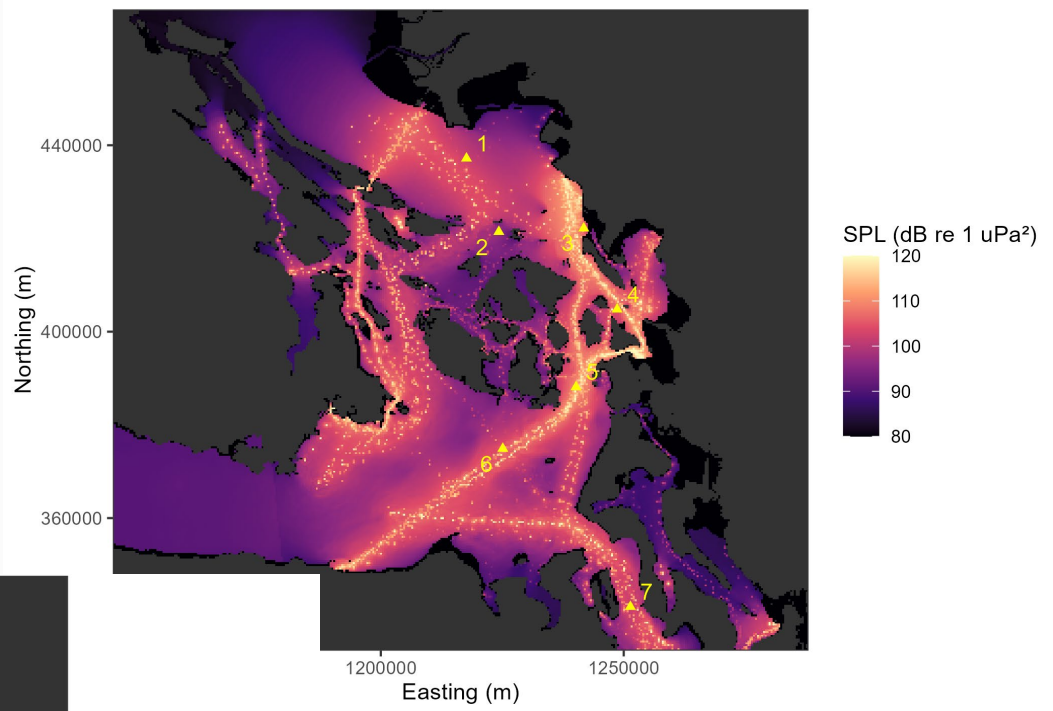


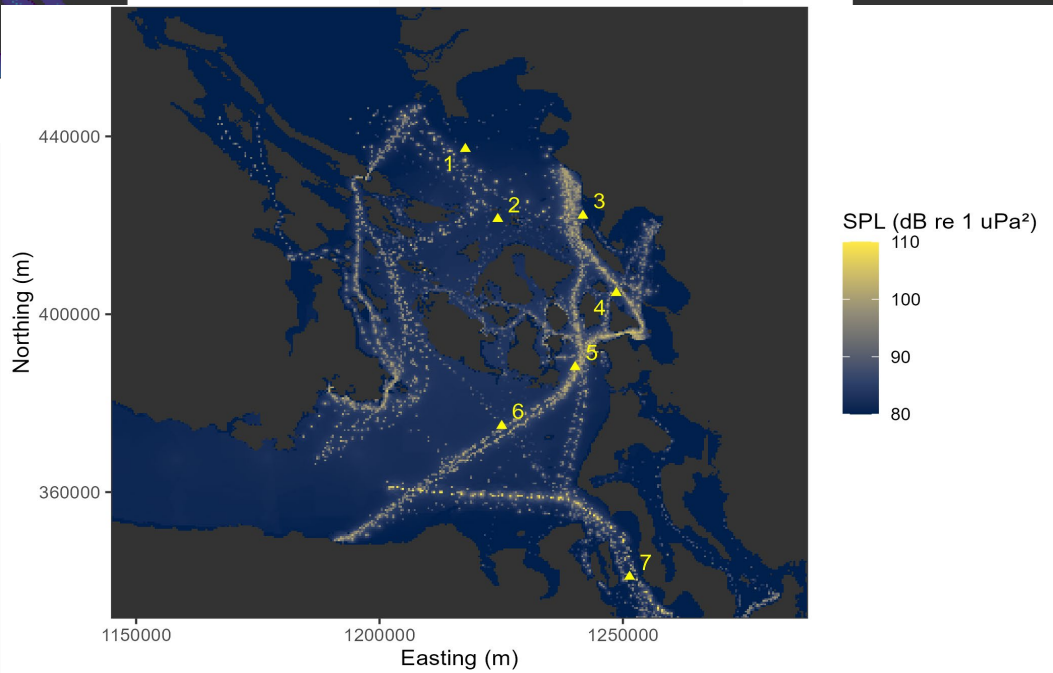
Winter results

Alternative	Duration of noise levels exceeding 120 dB (min/week)						
	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6	Location 7
Alt A (No Action)	60 min	0 min	90 min	70 min	420 min	120 min	80 min
Alt C (Expansion)	60 min	0 min	90 min	70 min	420 min	120 min	80 min
Alt D (Removal)	60 min	0 min	**80 min**	70 min	**270 min**	120 min	80 min

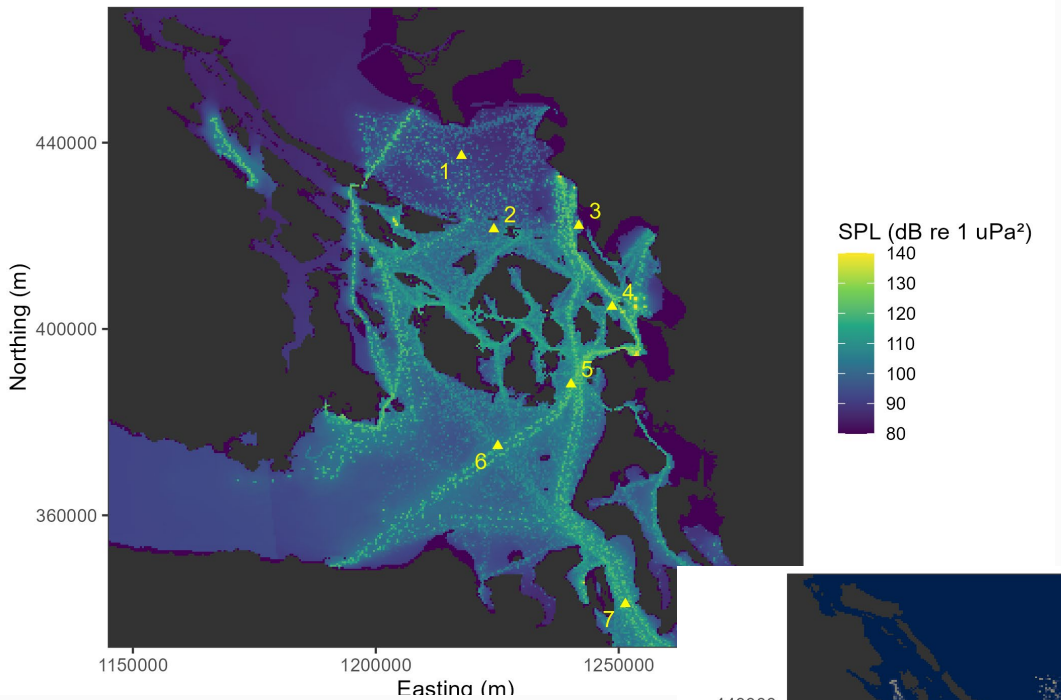
Sound maps – Winter noise levels

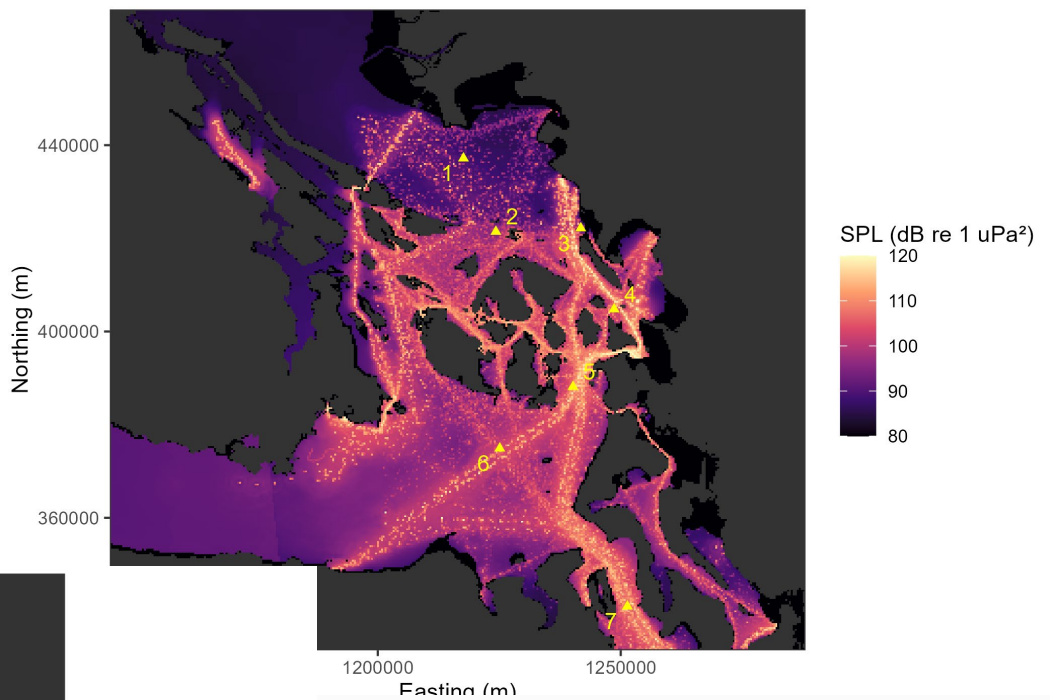


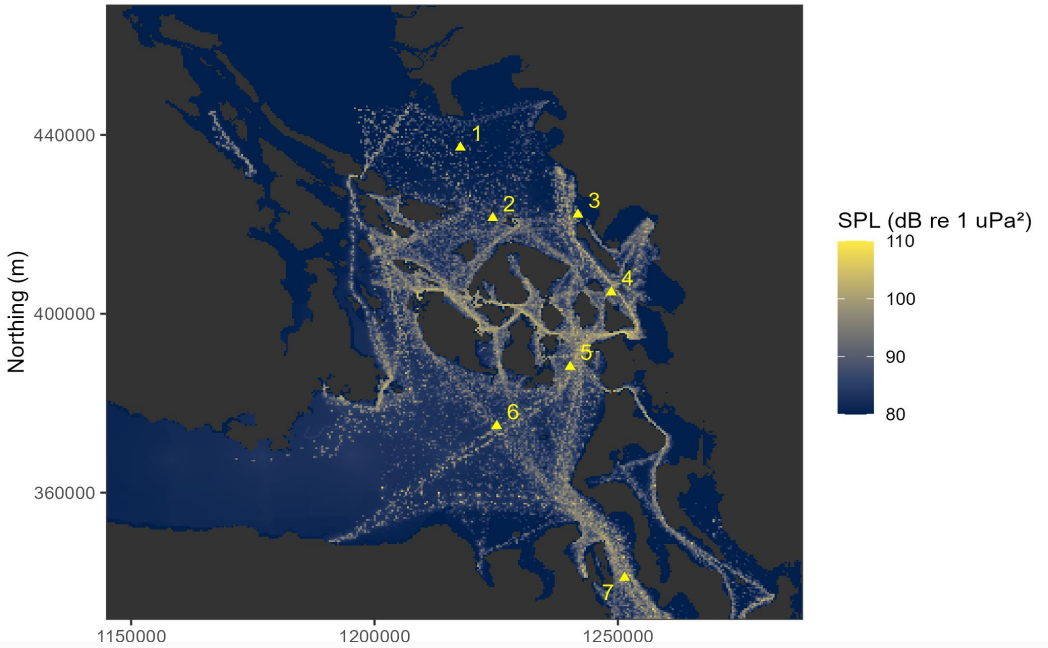




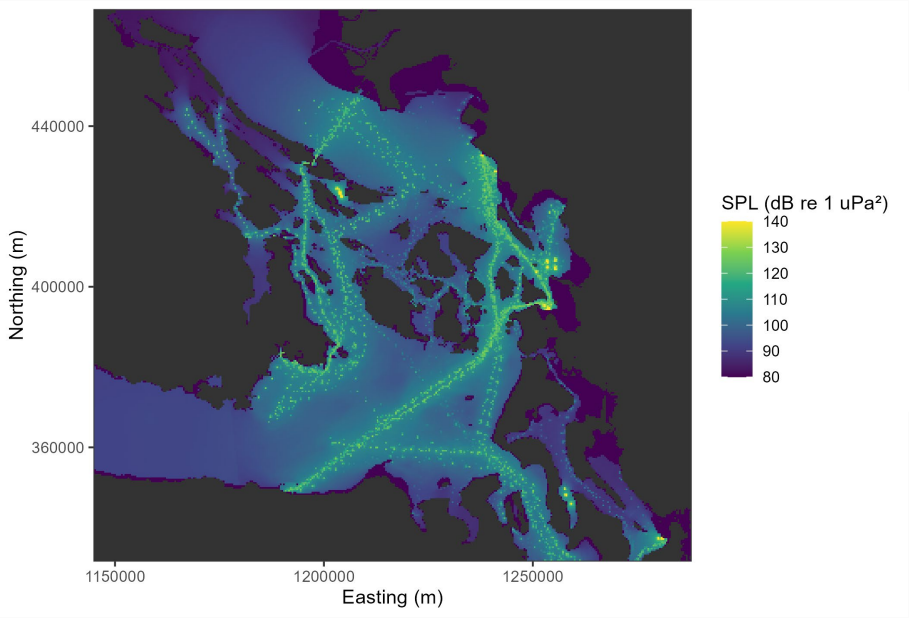
Sound maps – Summer noise levels







Area ensonified above disturbance threshold



Winter results

	Alternative				
	Alt A (No Action)	Alt C (Expansion)	Alt D (Removal)	**Difference A vs C**	**Difference A vs D**
Average area ensonified above disturbance threshold averaged over the week (km^2)	31.3	31.4	29.3	**0.1**	**-2.0**

Objectives of the underwater noise assessment

- What are the existing underwater sound levels at selected key receptor locations (i.e., biologically significant areas)? All receiver locations except one had baseline noise levels reach 120 dB.
- How do existing escort tug operations contribute to these existing conditions? They increase the average noise levels at some locations by a maximum of 2.9 dB broadband SPL.
- How does the proposed expansion of the tug escort requirements affect the underwater sound levels at selected key receptor locations? Minimally – average broadband noise levels increased by a maximum of 0.6 dB, at the closest receiver to the expansion area.
- **Assess areas of impact**: where and how often are acoustic thresholds exceeded i.e., National Marine Fisheries Service (NMFS) behavioral disturbance threshold (120 dB broadband SPL). Every location except #2 near Boundary Pass reached 120 dB SPL under baseline conditions. Only two of those stations had changes in the amount of time over 120 dB due to an alternative (i.e. removal)

Reminder: Upcoming Workshops

- **Workshop #10**
  - **Tribal Governments Only Workshop:** November 13, 2024 (1 PM – 3 PM)
- **Workshop #11**
  - **Stakeholder Workshop:** February 5, 2025 (10 AM – Noon), hybrid meeting at Ecology Northwest Regional Office
  - **Tribal Governments Only Workshop:** February 11, 2025 (10 AM –Noon)

Informal Public Comment Form Open Through 3/14/25:
https://sppr.ecology.commentinput.com/?id=x27tZ4iRfs

Final Questions or Discussion?

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