



EMA of BC
Environmental Managers Association
of British Columbia



Underwater Acoustics Webinar Educational Session

May 19, 2021

global **environmental** and **advisory** solutions



Presentation overview

Sound Principles

- Sound definition
- Sound frequency
- Sound wavelength
- Sound speed
- Sound refraction
- Sound in air
- Sound underwater
- Waveform
- Spectrum
- Spectrogram

Underwater Noise

- Noise definition
- Ambient
- Environmental
- Biological
- Anthropogenic
- Masking
- Noise impact

Noise Regulations

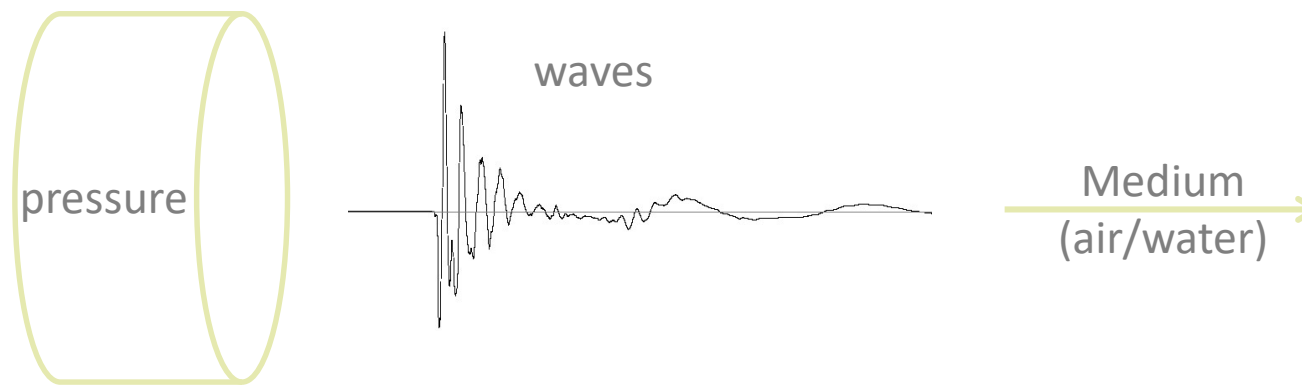
- Marine Mammals
- Fish
- Regulations
- National
- Regional
- Local

Case Studies

- SLR Consulting
- Hatfield Group

Sound definition

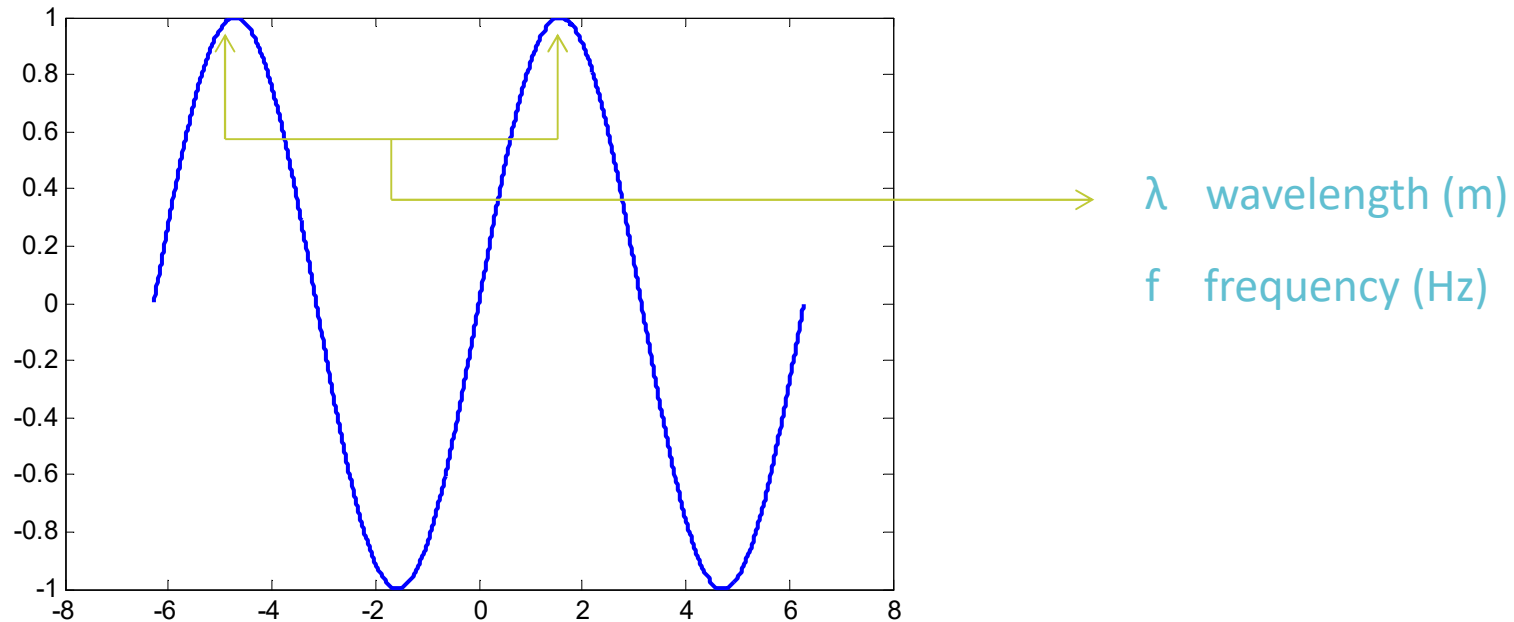
Sound, in **physics**, is any phenomenon that involves the propagation in the form of elastic waves (whether audible or not).



In **underwater acoustics** the word sound describes all the pressure waves that are generated in a water medium.

Sound frequency & wavelength

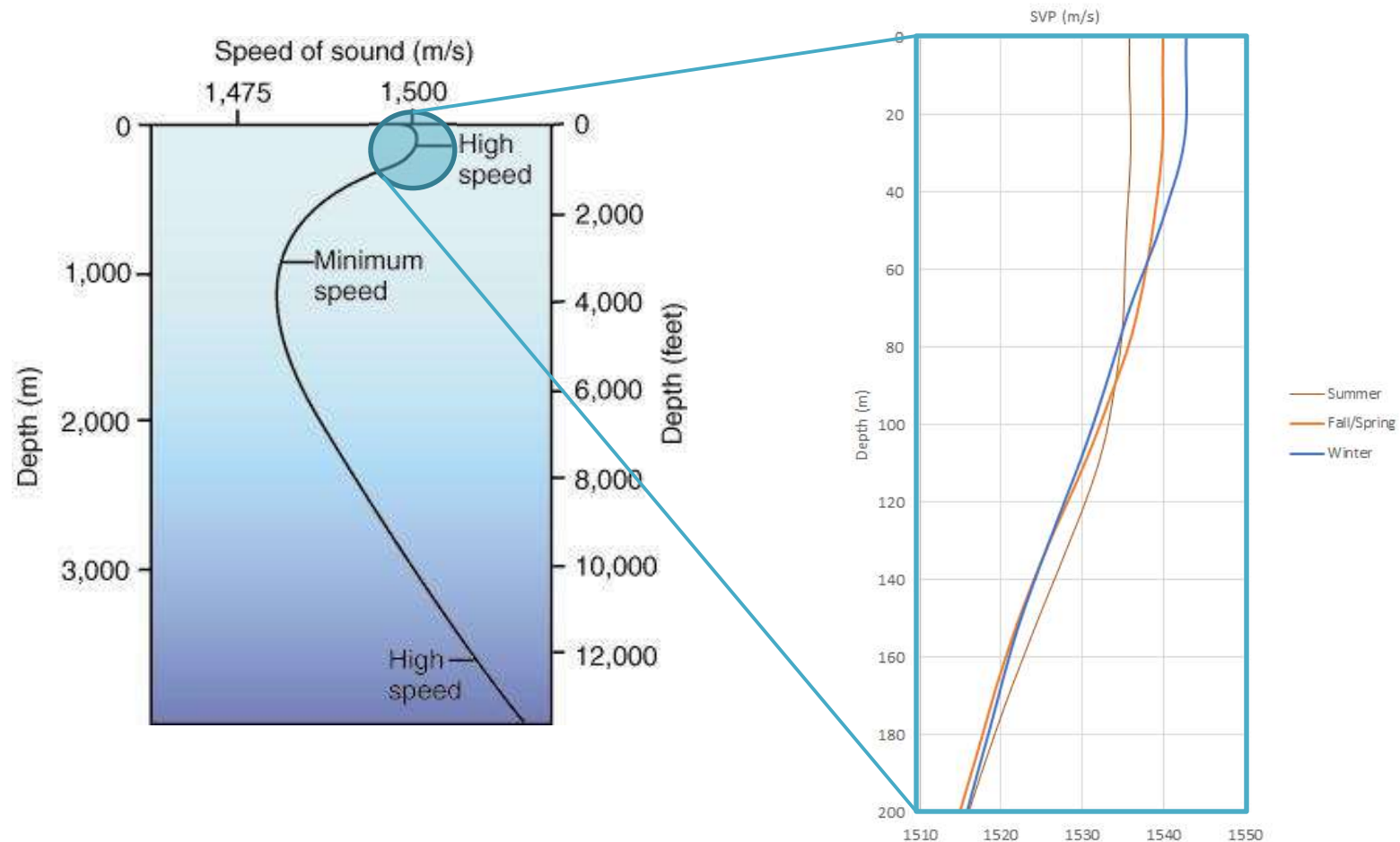
Sound propagates away from a source as a wave



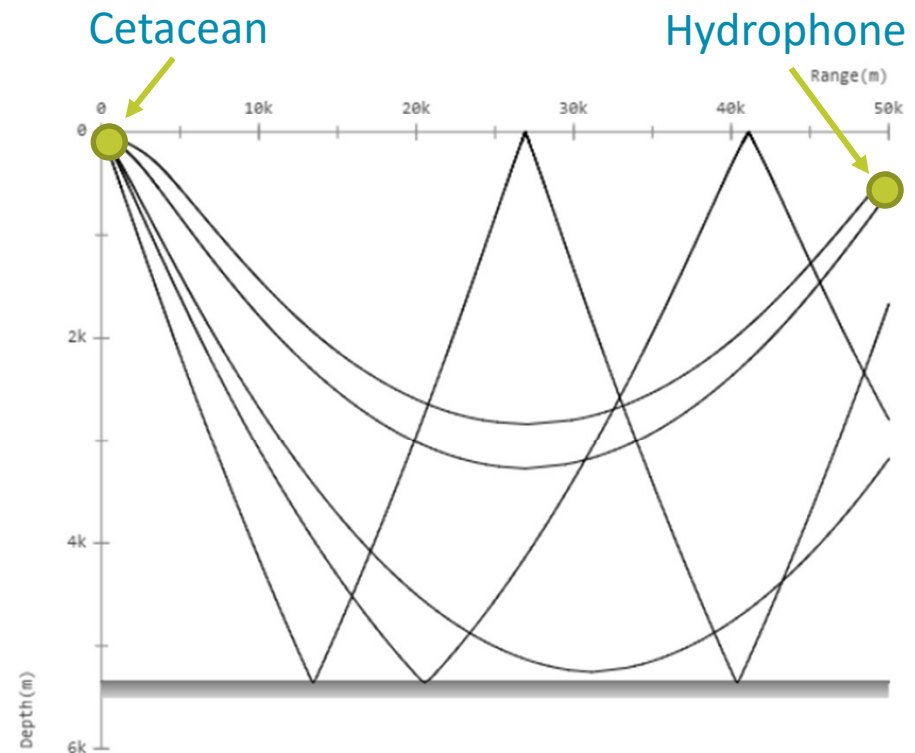
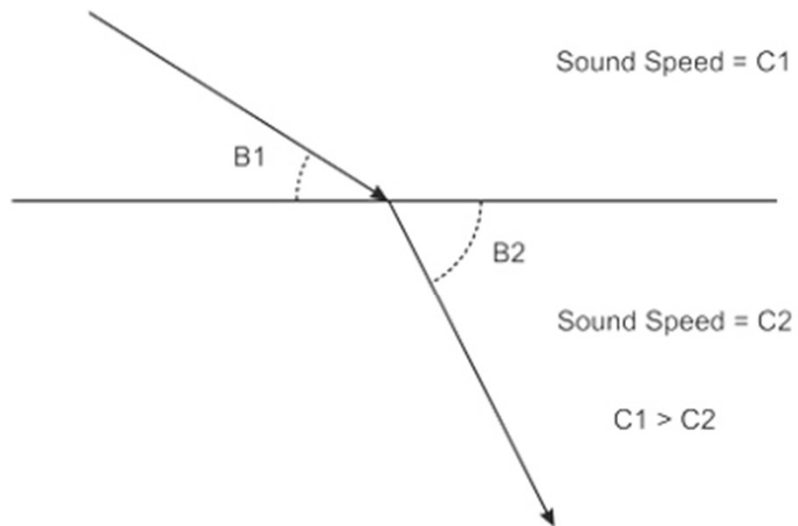
Wavelength is the spatial distance between two successive peaks in a propagating wave

Sound Frequency is the number of waves that pass through a fixed point per second.

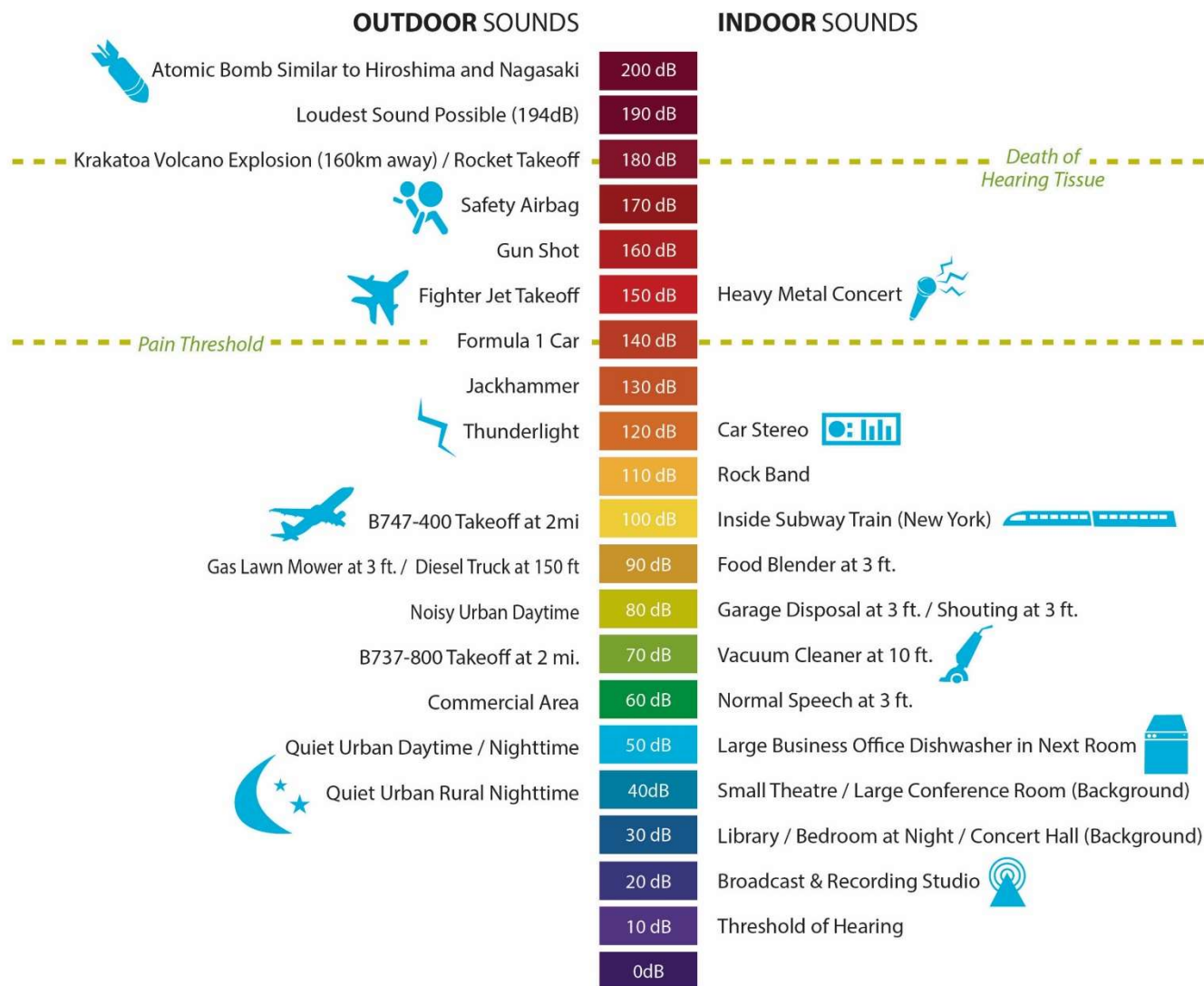
Sound speed

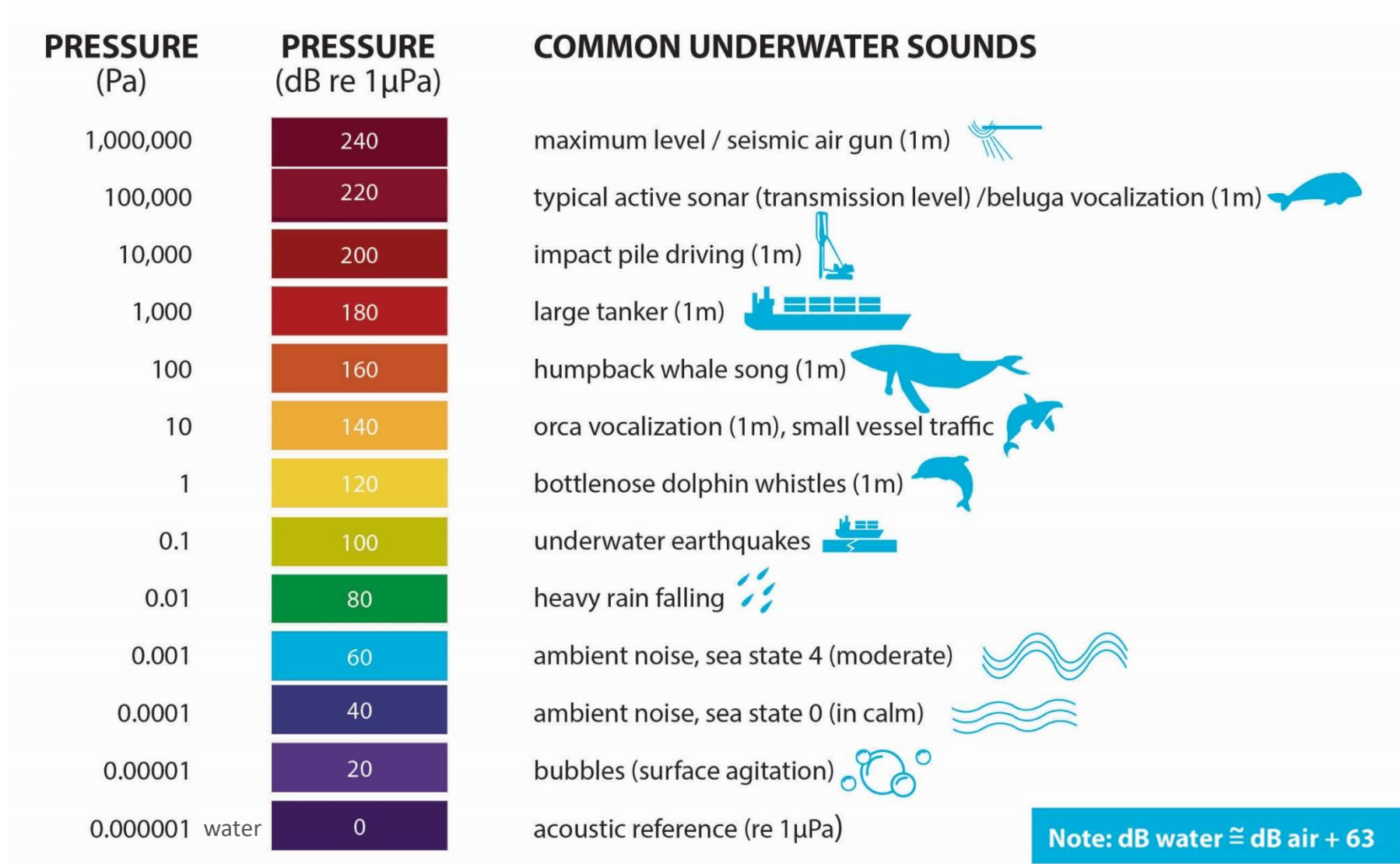


Sound refraction

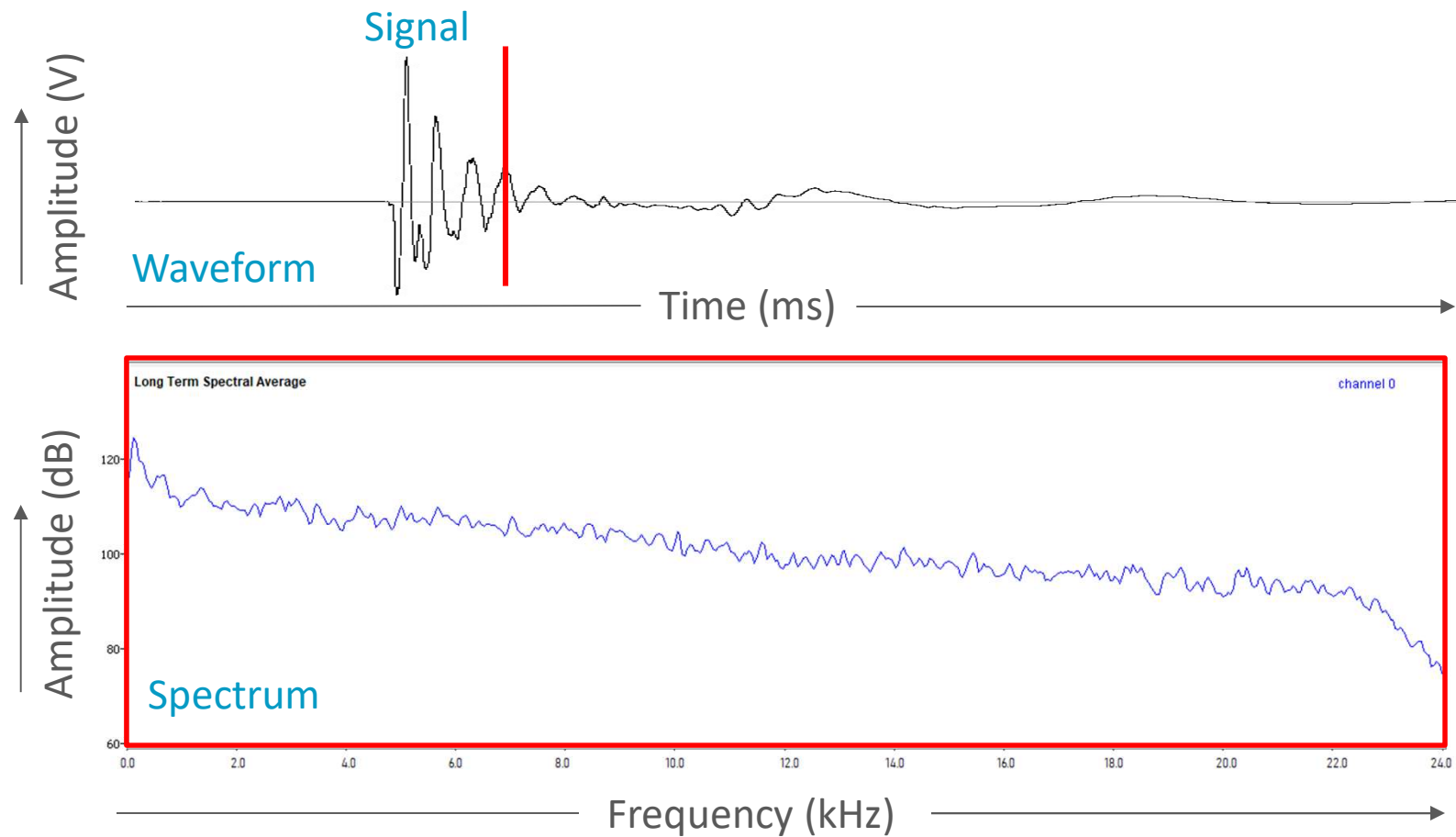


COMPARATIVE NOISE LEVELS

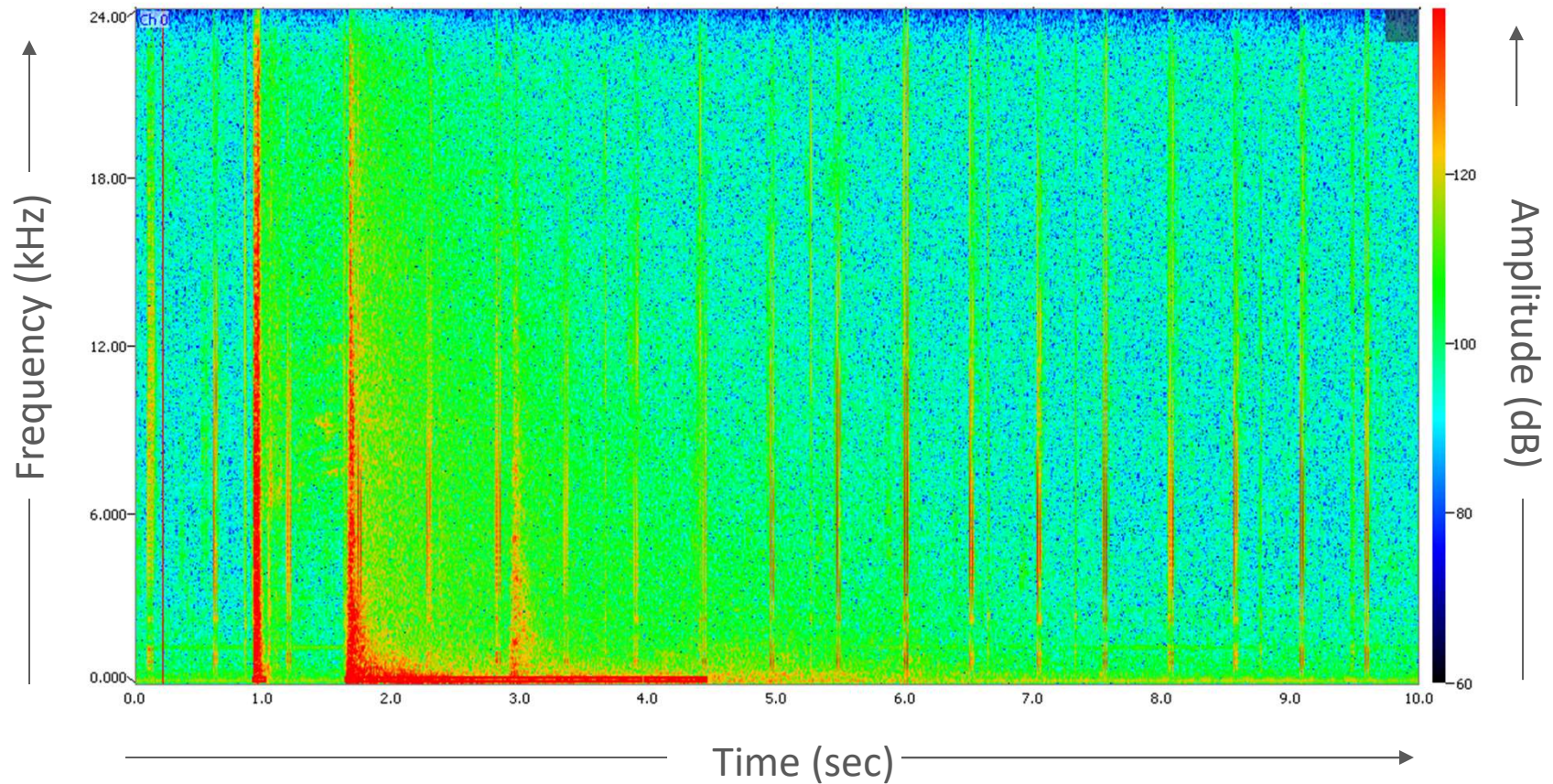




Waveform vs. Spectrum



Spectrogram

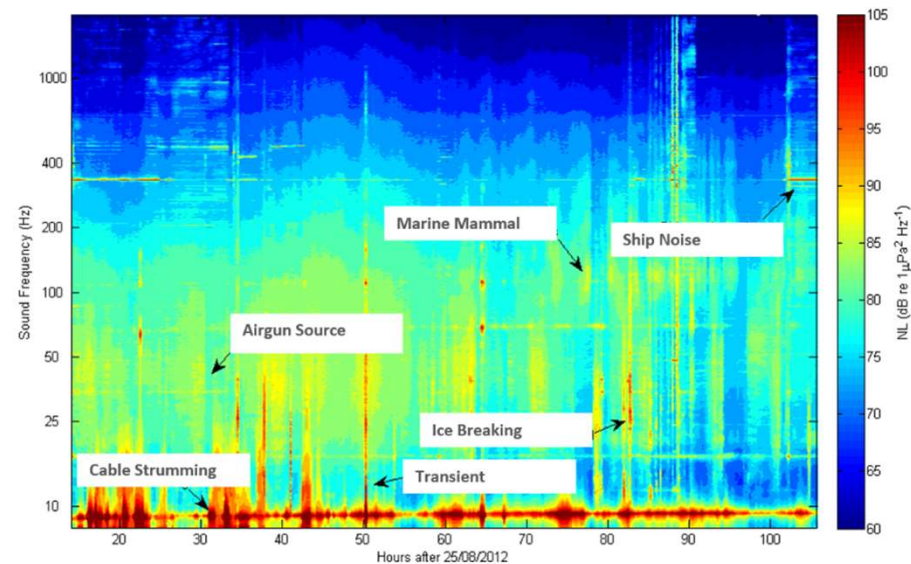


Noise definition

Noise is unwanted sound judged to be unpleasant, loud or disruptive to hearing.

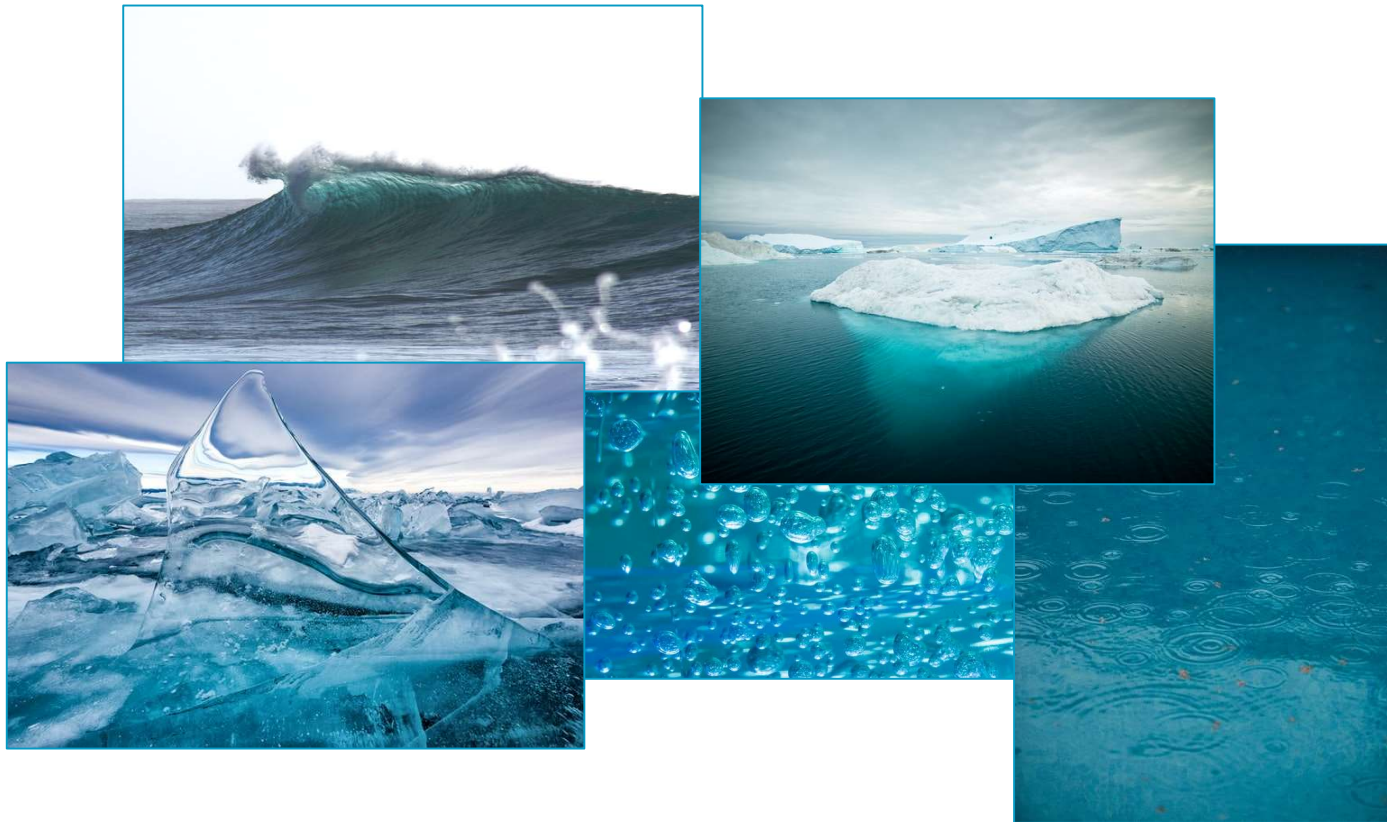


source: photograph curator



Acoustic noise is any sound in the acoustic domain, either deliberate or unintended.

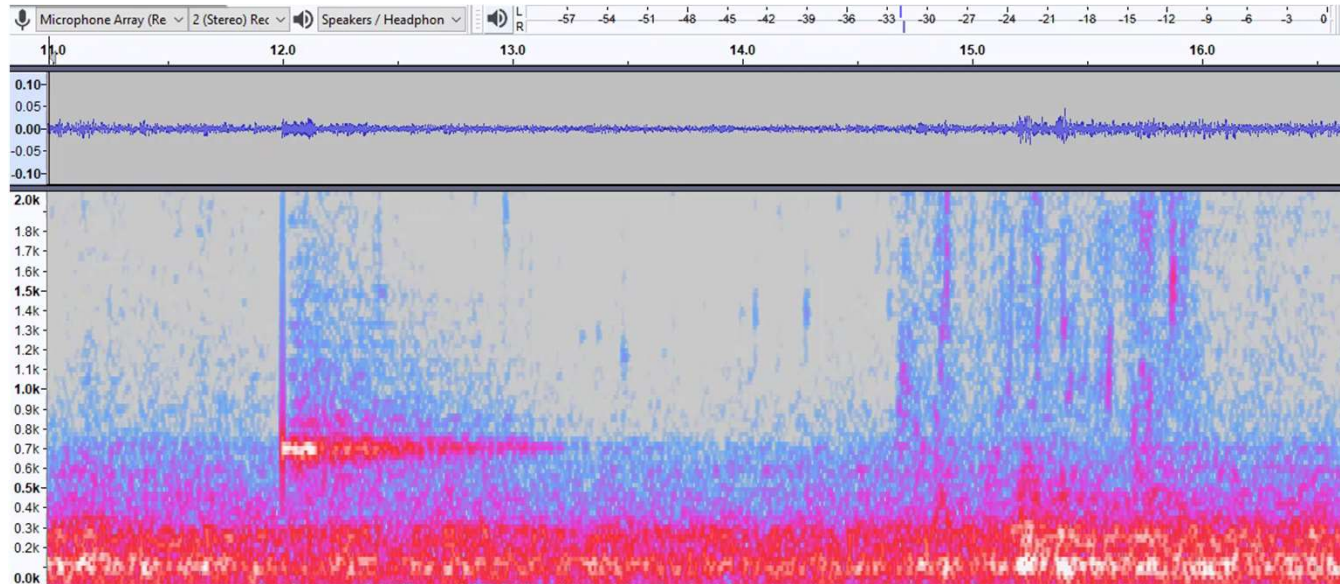
Environmental noise



source: www.unsplash.com

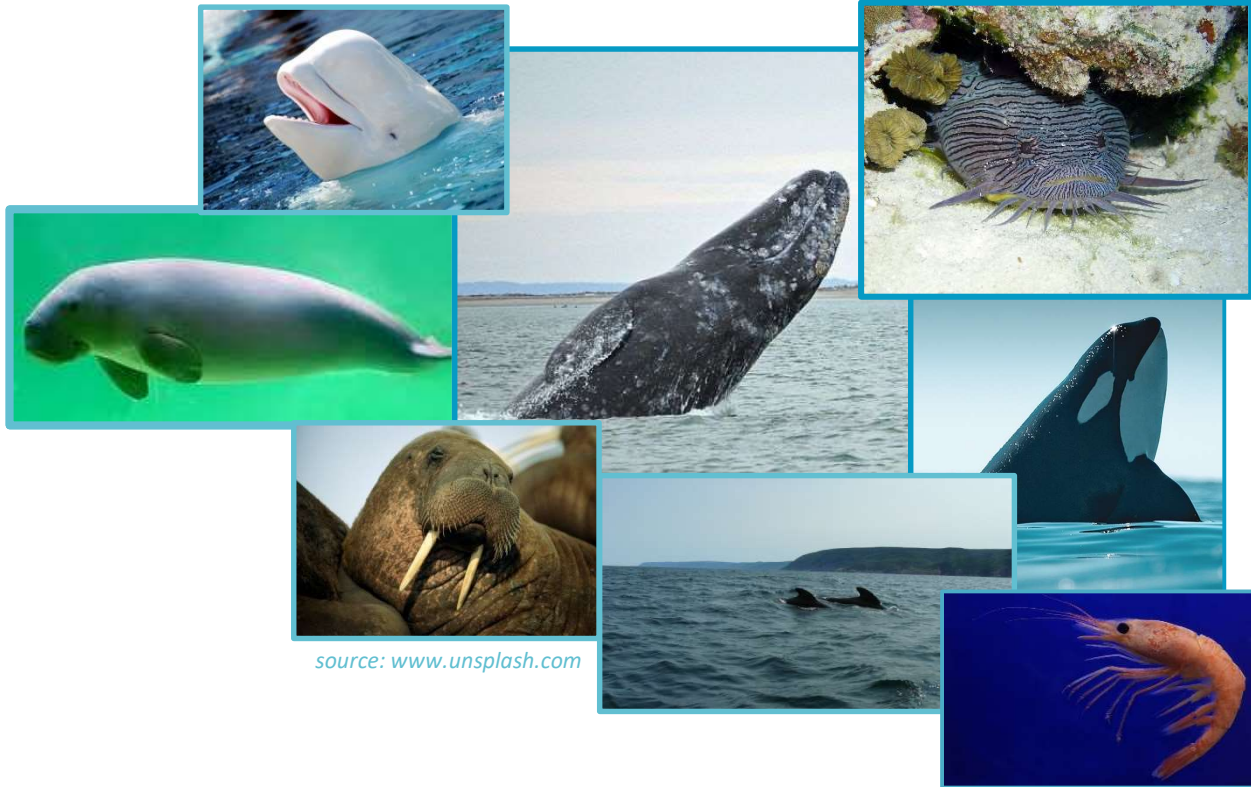
Ambient noise

Usually defined as the background sound, ambient noise in the 200 Hz to 50 kHz frequency range is primarily associated with bubbles due to breaking waves.



sound source: freesound.org/406623/ public domain

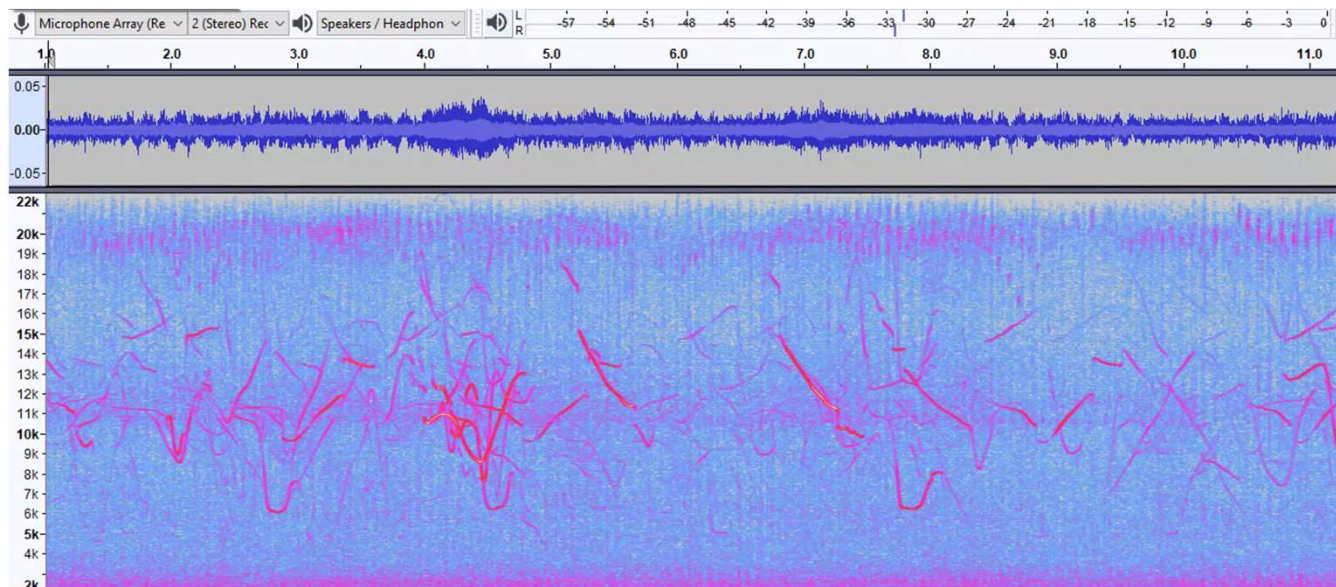
Biological noise



source: www.unsplash.com

Clicks, Moans and Whistles

Whales have an acoustic modality, using moans and complex songs for communication, or whistles and clicks for echolocation to find food and navigate.



sound source: pamguard.org/public-domain

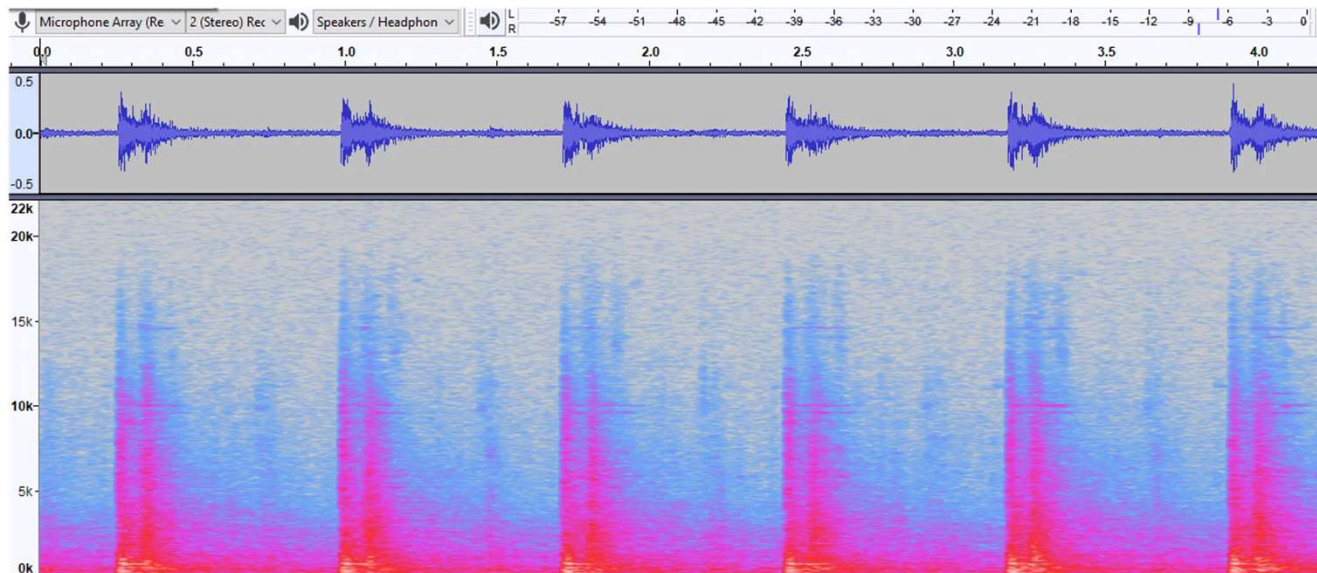
Anthropogenic noise



source: www.unsplash.com

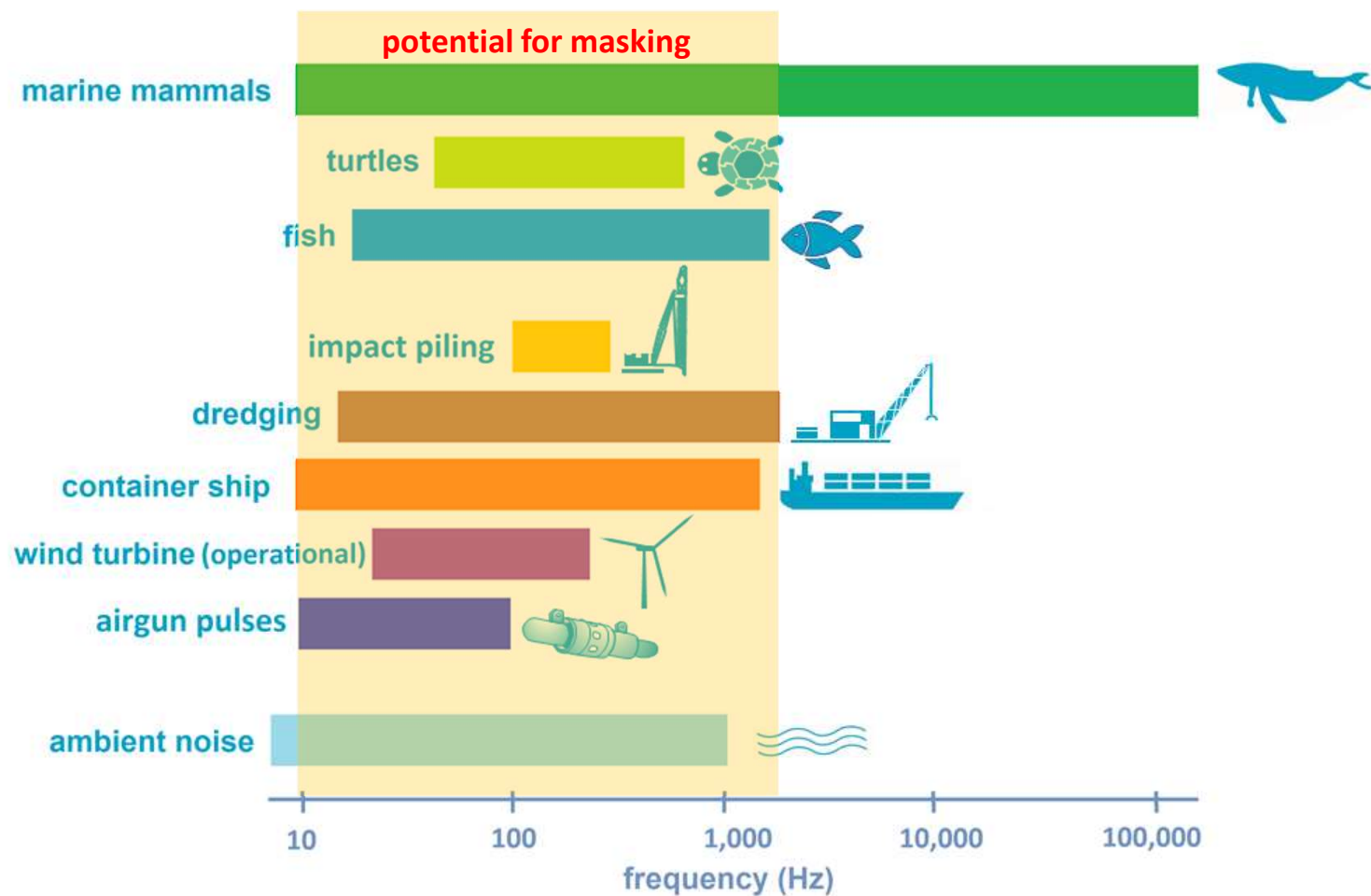
Impulsive Noise

Impulsive sounds are emitted by a point source comprising one or more pulses of short duration and with long gaps between pulses (i.e., blasting, impact pile driving, air guns).

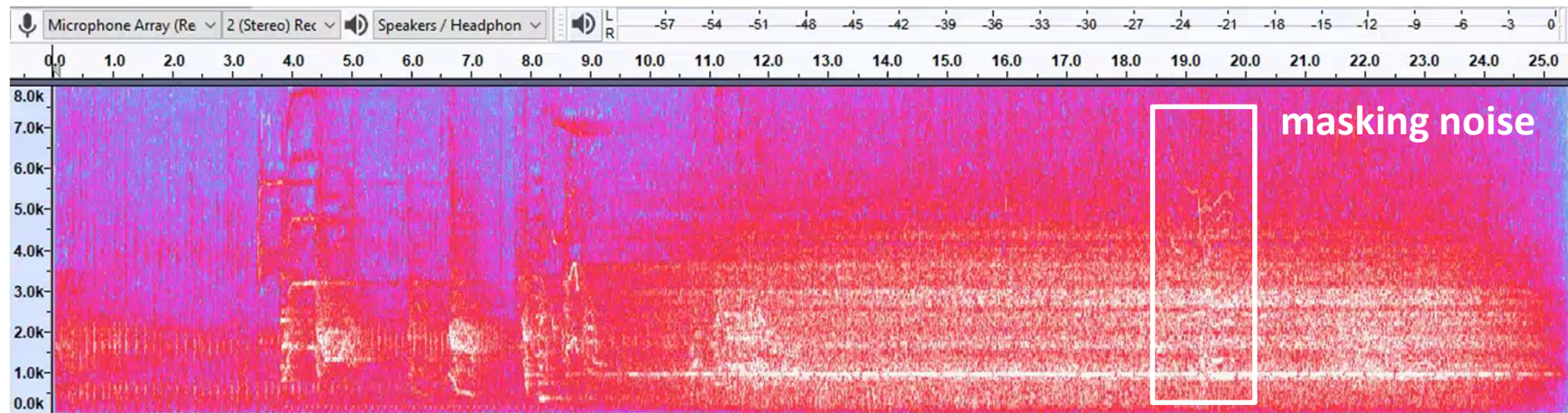


sound source: freesound.org/30547/ licensed under CCBYNC 3.0

Masking noise



NRKW masked by vessel noise



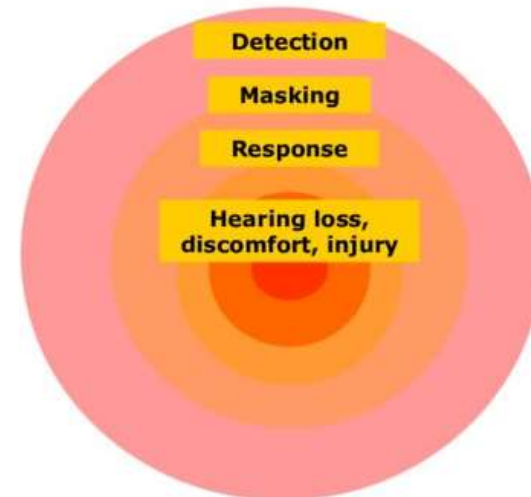
sound source: Hanson Island BC Orcalab



Noise impact

- The effect of noise on the animal depends on the **proximity** of the animal to the noise source and the animals **received level** of the signal
- At very **short ranges**, a sufficiently loud source may cause severe physiological damage and perhaps death.
- At **longer distances**, the sound can still cause behavioral responses that can interfere with important life functions

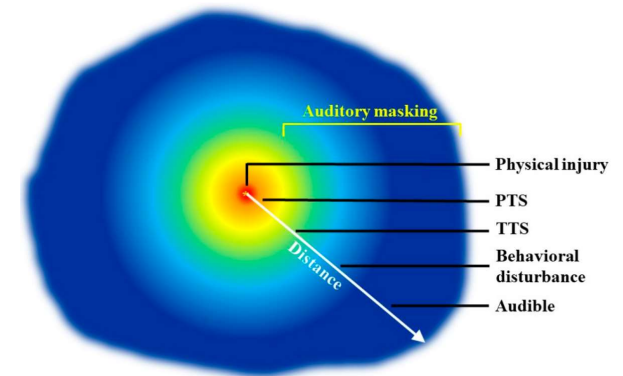
Theoretical zones of noise influence



(Richardson et al. 1995)

Marine Mammal Noise Criteria

- **Permanent Threshold Shift (PTS)**
If a threshold shift never recovers (Level A)
- **Temporary Threshold Shift (TTS)**
It is recoverable over time (Level B)



Guan, S. and Brookens, T., 2021

Harassment Categories

| | | | | | | Non-impulsive | | Impulse | | | |
|-------|-----|-----|-------------|-------------|----------|----------------|----------------|------------------|-----------------------|----------------|-----------------------|
| | | | | | | TTS Threshold | PTS Threshold | TTS Threshold | | PTS Threshold | |
| Group | a | b | f_1 (kHz) | f_2 (kHz) | C (dB) | SEL (Weighted) | SEL (Weighted) | SEL (Unweighted) | Peak SPL (Unweighted) | SEL (Weighted) | Peak SPL (Unweighted) |
| LF | 1 | 2 | 0.20 | 19 | 0.13 | 179 | 199 | 168 | 213 | 183 | 219 |
| MF | 1.6 | 2 | 8.8 | 110 | 1.20 | 178 | 198 | 170 | 224 | 185 | 230 |
| HF | 1.8 | 2 | 12 | 140 | 1.36 | 153 | 173 | 140 | 196 | 155 | 202 |
| SI | 1.8 | 2 | 4.3 | 25 | 2.62 | 186 | 206 | 175 | 220 | 190 | 226 |
| OW | 2 | 2 | 0.94 | 25 | 0.64 | 199 | 219 | 188 | 226 | 203 | 232 |
| PW | 1 | 2 | 1.9 | 30 | 0.75 | 181 | 201 | 170 | 212 | 185 | 218 |

source: NMFS. 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing .

Fish noise criteria

Sturgeon



> 207 dB Peak @ 10m

≥ 186 dB SELcum

Salmon



160 dB RMS

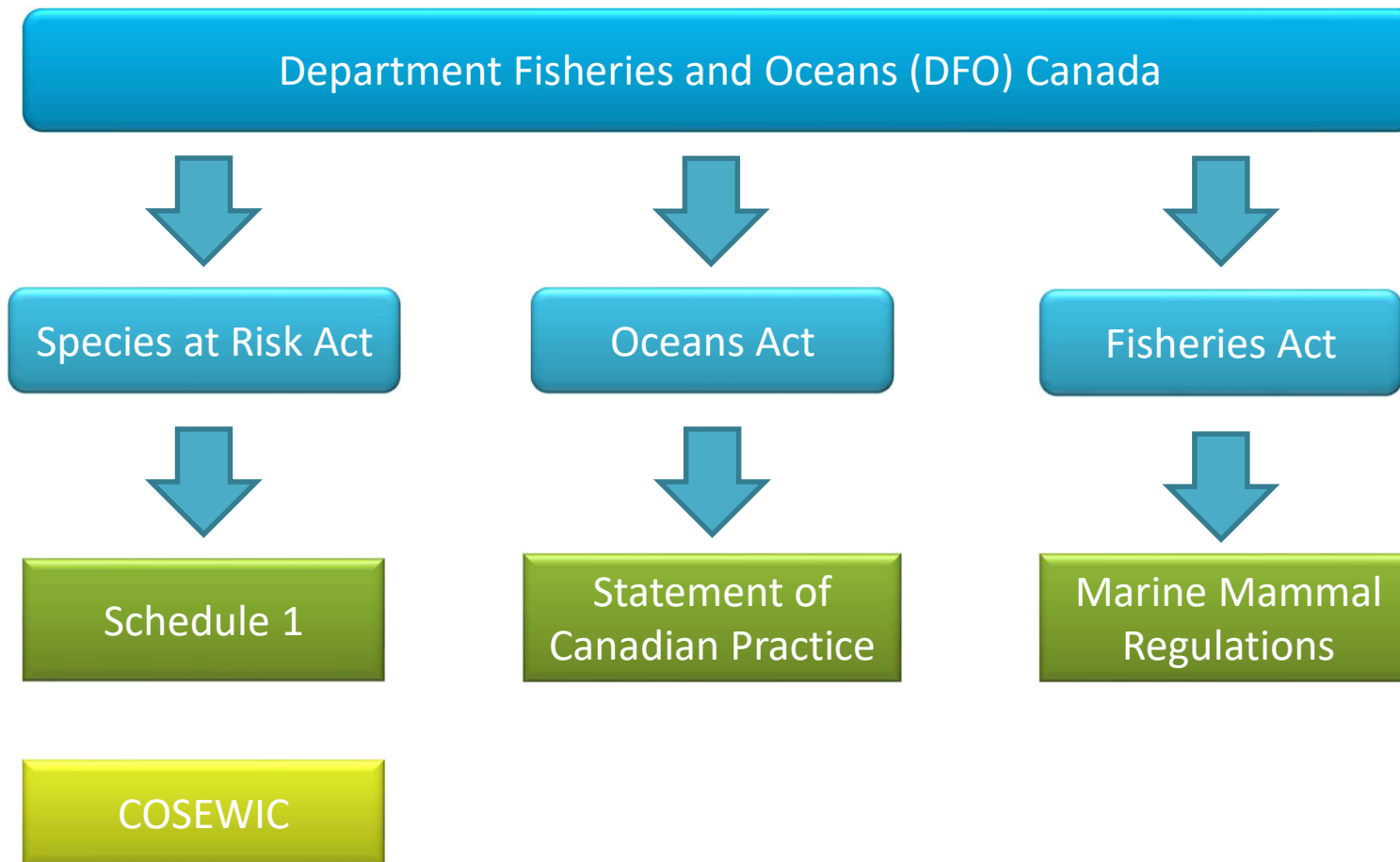
disturbance

injury

behavioral

physiological



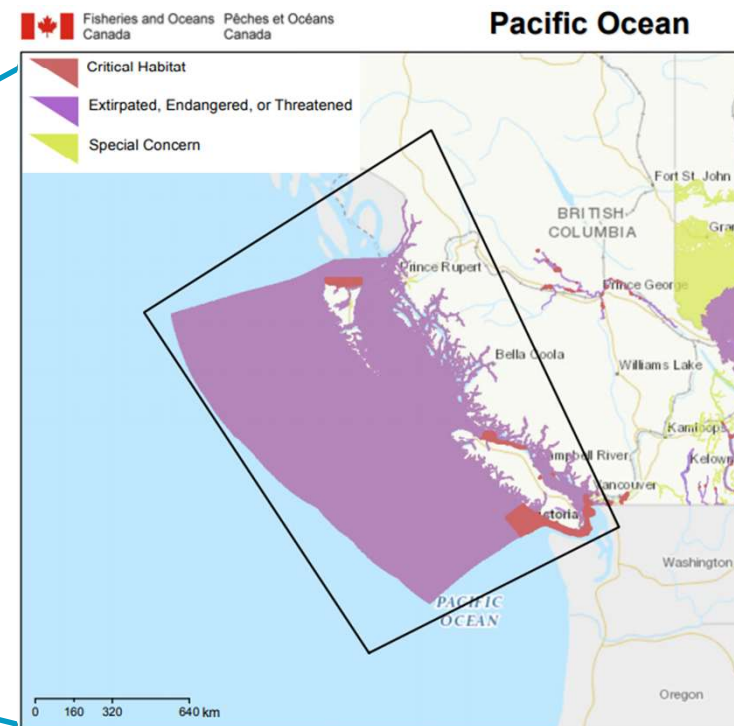
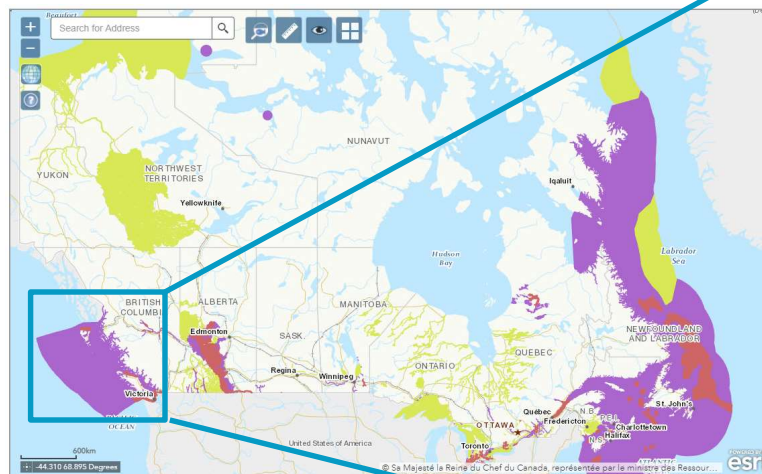


Regional, British Columbia



The aquatic species at risk maps are intended to provide an overview of the distribution of aquatic species at risk and the presence of their critical habitat within Canadian waters.

[Aquatic species at risk map \(dfo-mpo.gc.ca\)](http://dfo-mpo.gc.ca)



Local, Vancouver



- ➔ The Vancouver Fraser Port Authority is mandated to protect the environment, including the lands and waters within its jurisdiction

Map of the Vancouver Fraser Port Authority's jurisdiction



Application
submission

Step 1

Application
review

Step 2

Project permit
conditions

Step 4

Project
decision

Step 3

ECHO Program

➔ Enhancing Cetacean Habitat and Observation (ECHO) Program initiatives:



- **Boundary Pass Underwater Listening Station**

Two observation listening stations, each equipped with 8 hydrophone have been installed 190 m below the shipping lanes of Boundary Pass and located about 50 km south of Vancouver.

- Underwater noise reduction
- Voluntary ship slowdown
- Voluntary inshore lateral displacement

Canada Excavation and Construction

→ Harbour deepening and jetty reconstruction

The Project

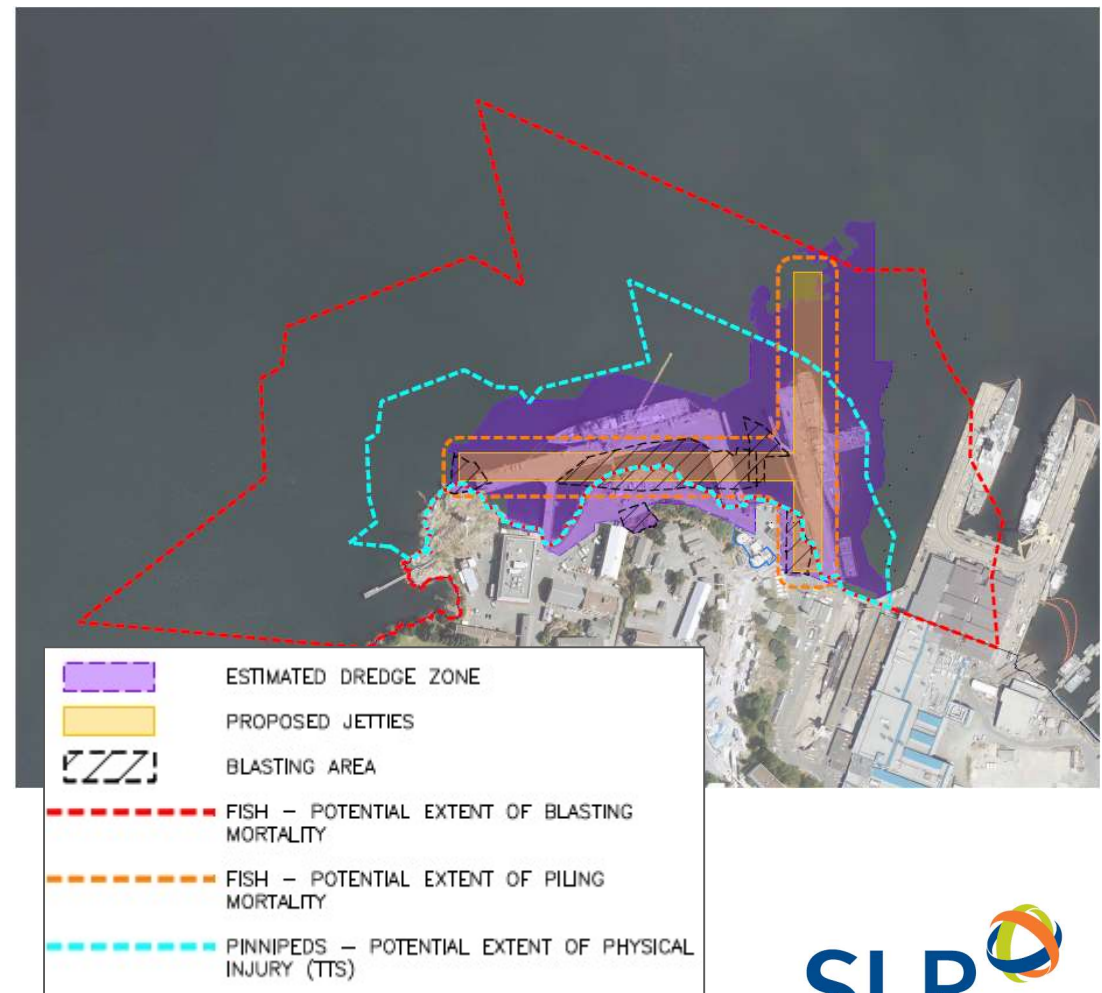
- Demolishing existing infrastructure
- Dredging and blasting to deepen harbour
- Piling and jetty reconstruction

The Guidelines

- Marine Mammal Protection Act prohibits disturbance to marine mammals
- Fisheries Act requires authorization for projects causing the death of fish or any permanent alteration to, or destruction of, fish habitat

Objectives

- Zones of impact (fish mortality, injury to pinnipeds, and behavioural impact area)
- Mitigation measures (reduced charge weights, exclusion zones)



Thank you



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