Understanding the marine soundscape off Vancouver Island: An exploration of passive acoustic data from the NEPTUNE Canada ocean Observing system

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NEPTUNE Canada
Transforming Ocean Science

Fish produce sounds?

- So far >700 vocal species worldwide

How do fish make sound?

- Stridulation – rubbing or scrapping together of fins, bones, or teeth
- Air passage – little understood internal movement of air, or escape of air through mouth, gills, or anus
- Drumming – special muscles pushing/pulling on the internal air/ swim bladder (called sonic muscles)

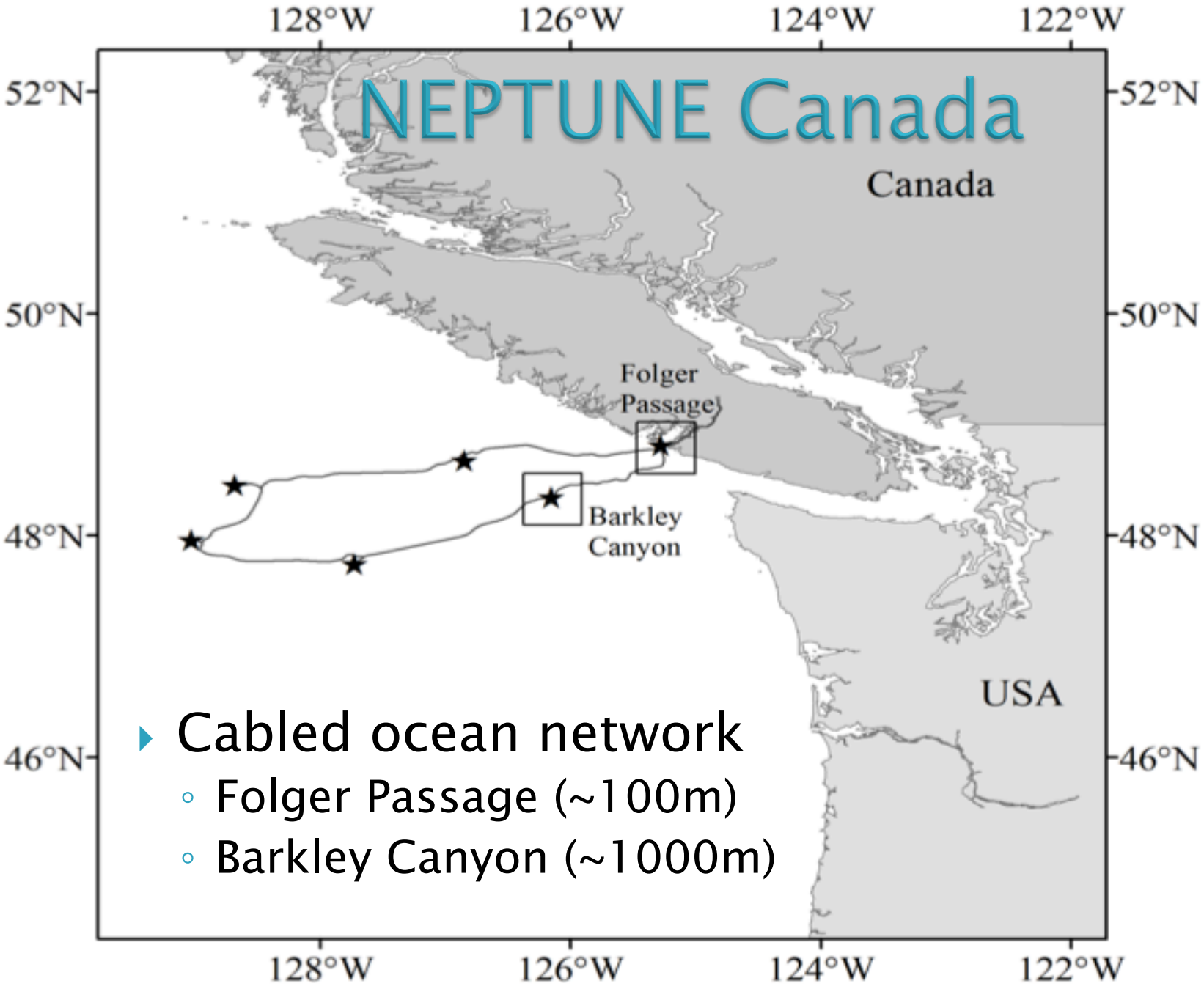
Why/when are fish vocal?

- Spawning and courtship behaviour
- Aggression and territorial behaviour
- Distress
- Predator/prey behaviour?

Advantages of passive acoustics

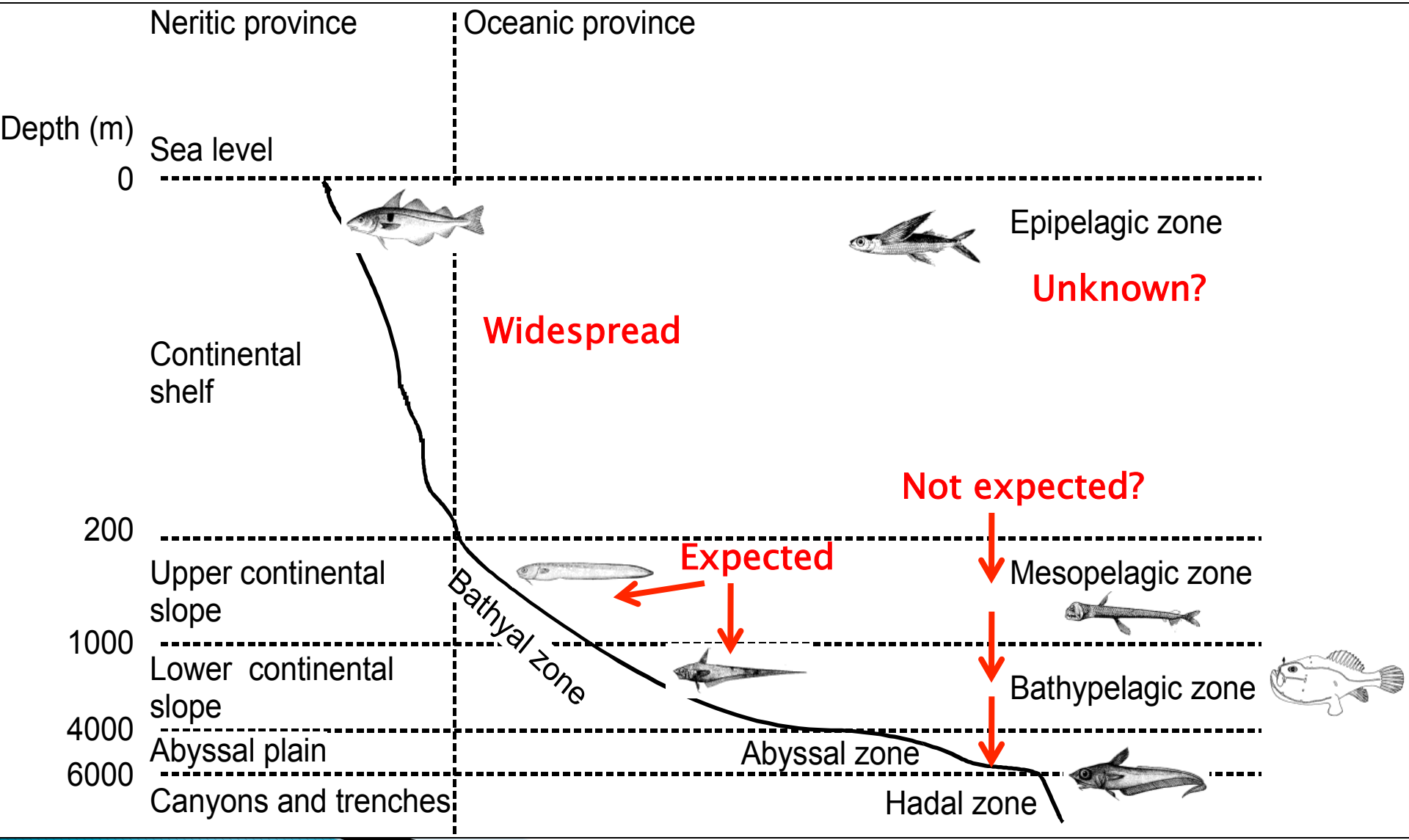
- Non-invasive
- Non-visual (light not needed)
- Continuous remote monitoring
- Provides detailed behavioral information

AULS (Autonomous underwater listening stations)



- Cabled ocean network
  - Folger Passage (~100m)
  - Barkley Canyon (~1000m)

Fish sounds in the deep sea?

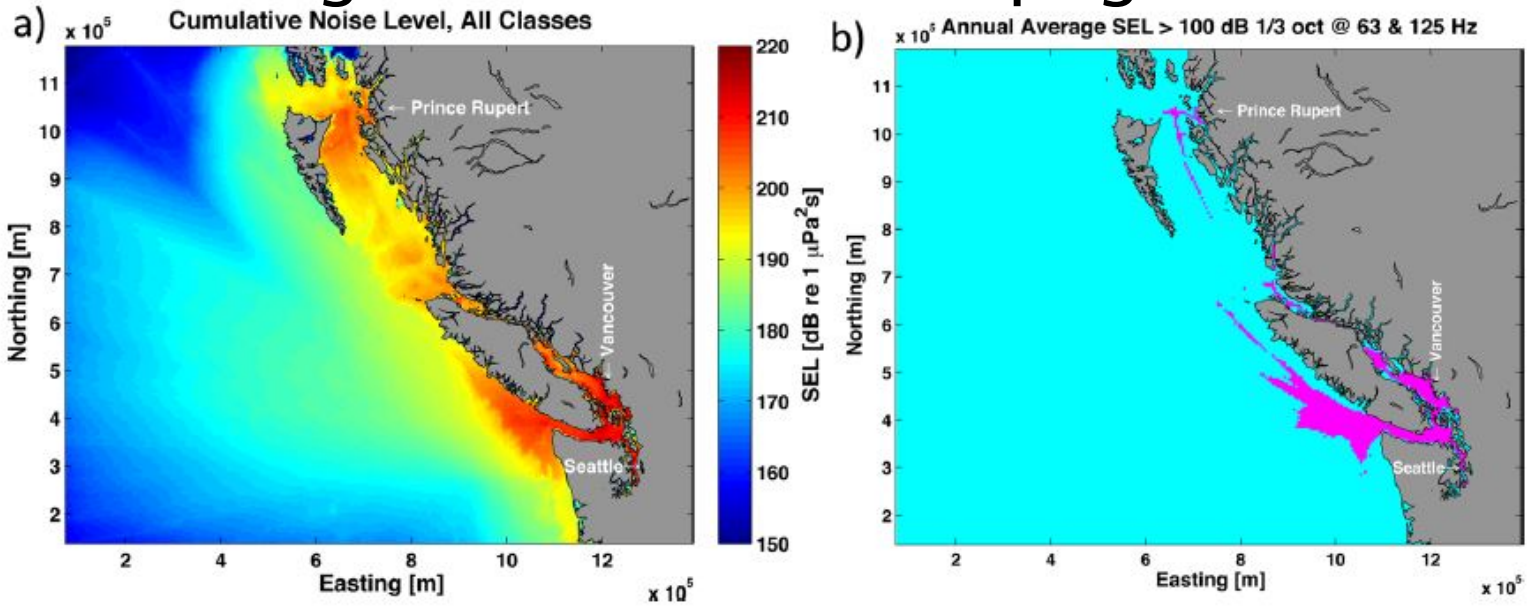


Marshall 1954

WCVI Bioacoustic Background

- Little documented on fish sound production in northern Pacific, especially deep-sea fish
  - In comparison to tropical and Atlantic waters

- Increasing concern of anthropogenic noise



Erbe et al. 2012

Effects of noise?

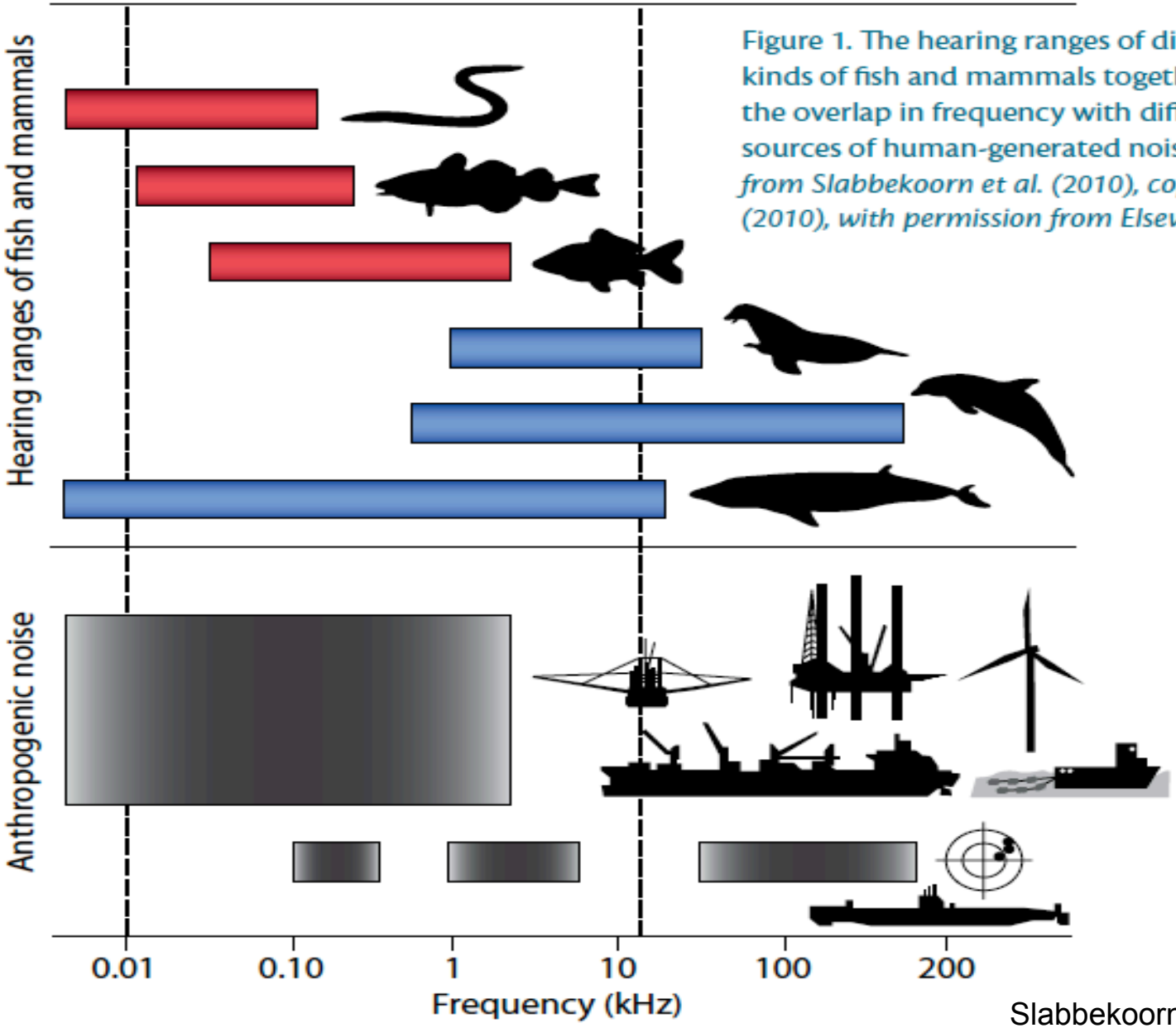


Figure 1. The hearing ranges of different kinds of fish and mammals together with the overlap in frequency with different sources of human-generated noise. *Modified from Slabbekoorn et al. (2010), copyright (2010), with permission from Elsevier*

Slabbekoorn et al. 2010

Objectives

- Using NEPTUNE's passive acoustic data
  - Identify fish sound production
  - Quantify ambient noise, anthropogenic noise, self-generated noise over time
  - Improve our understanding of the potential for anthropogenic noise to impact biological communication in the NE Pacific

NEPTUNE's Passive Acoustic Data

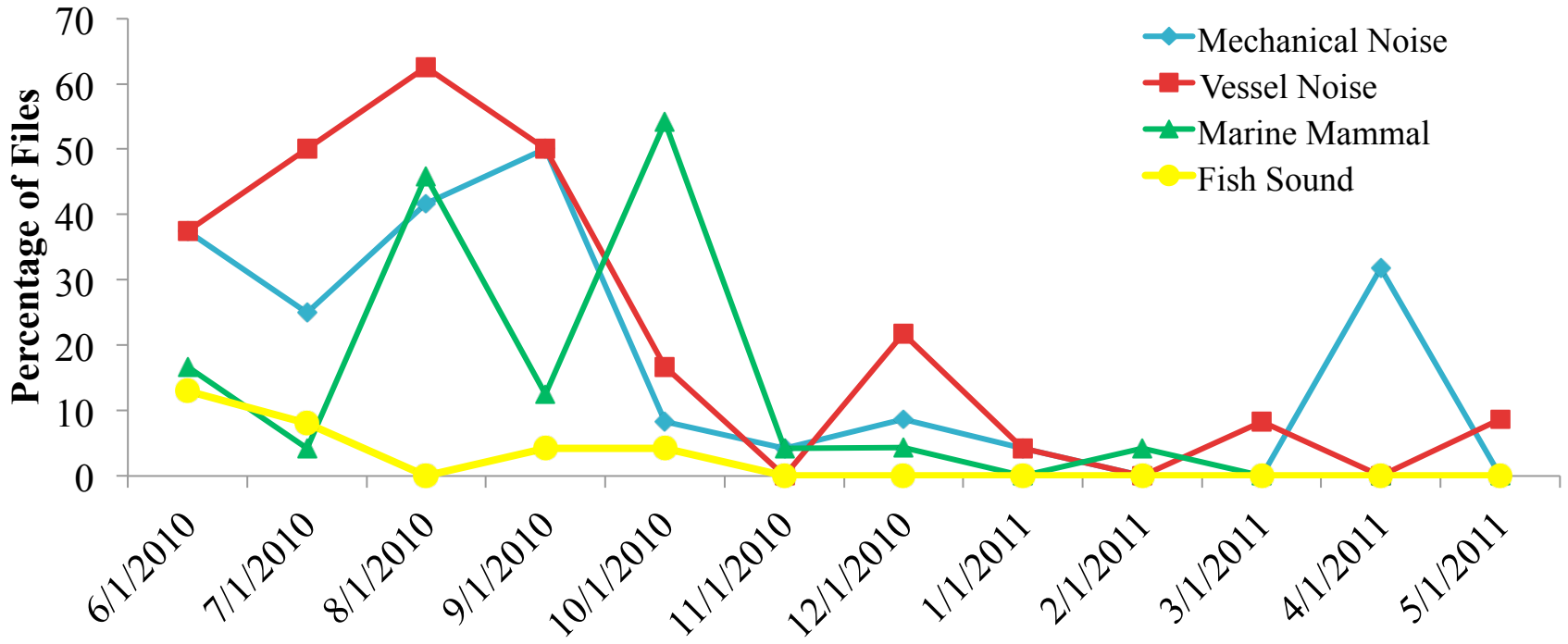
- Sample rate 96,000 Hz
- Continuous sampling
  - Files are 5 minutes in duration
- Deployed August 28, 2009 ~ July 19, 2011
  - **June 2010 – May 2011**
  - **90,000+ files, 4+ TB**

Passive Acoustic Data Analysis

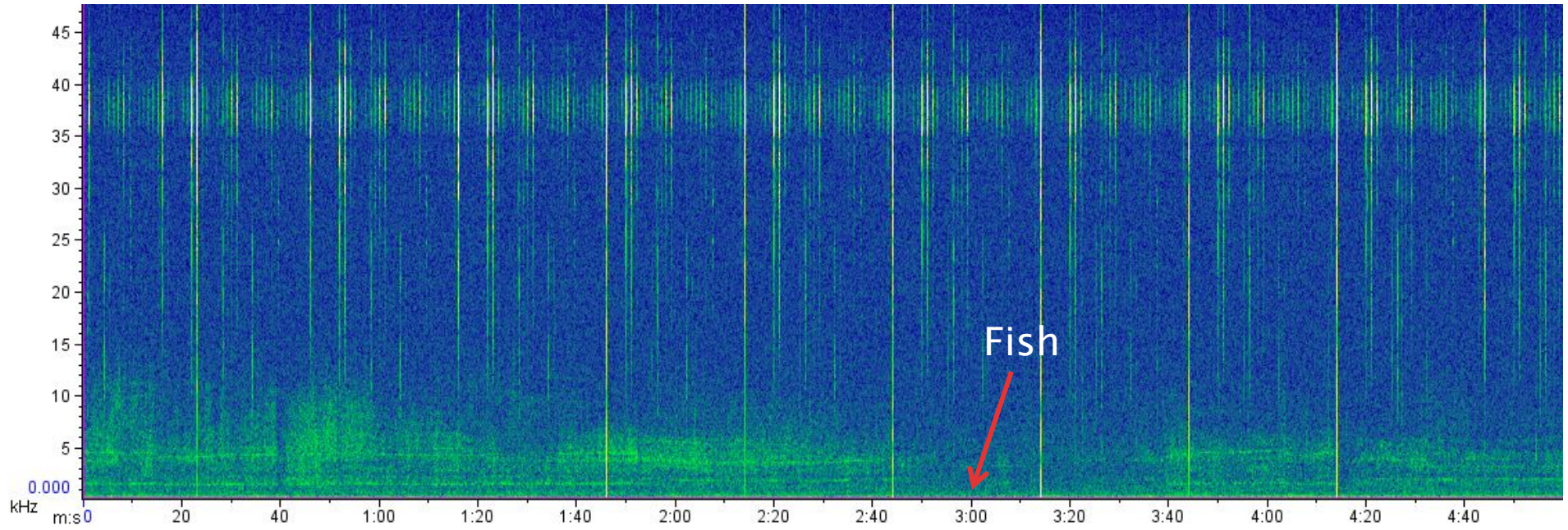
- **Manual Analysis**
  - Examined one file per hour for one day in every month between June 2010 and May 2011
- **Automated Analysis**
  - Calculated the overall RMS values for two files every hour, every day between June 2010 and May 2011
  - Create a 100 Hz bandwidth composite spectrogram and examined amplitude within varying bandwidths

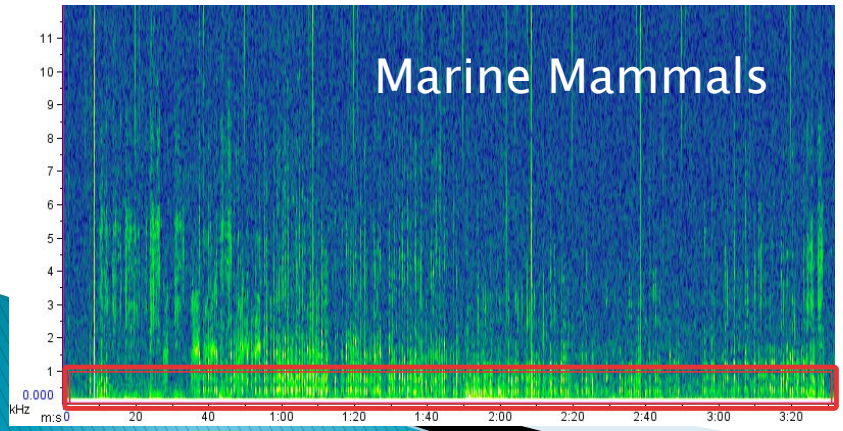
Passive Acoustic Data Results

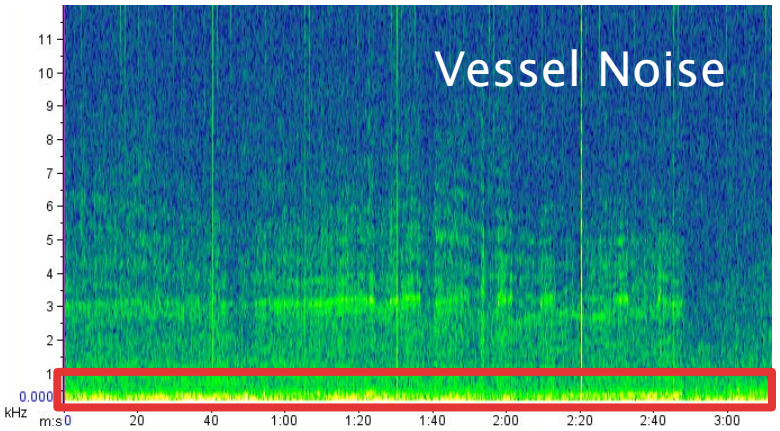
Manual Analysis



Passive Acoustic Data Results

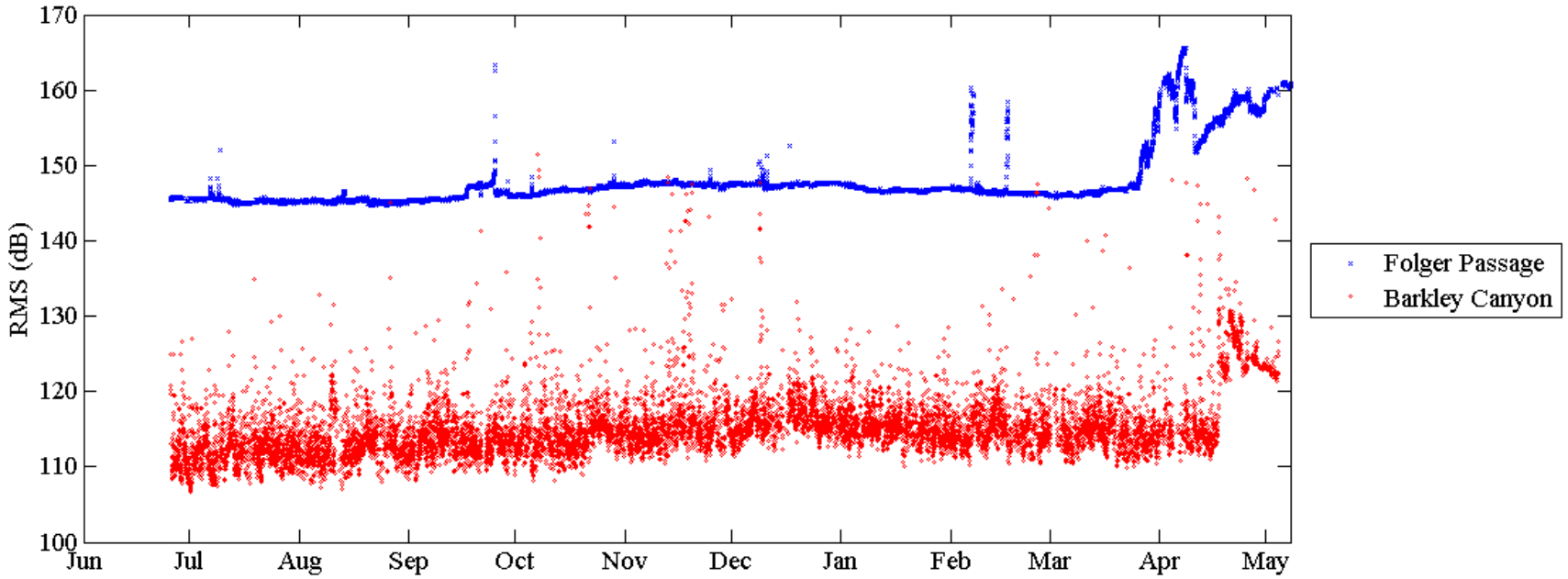






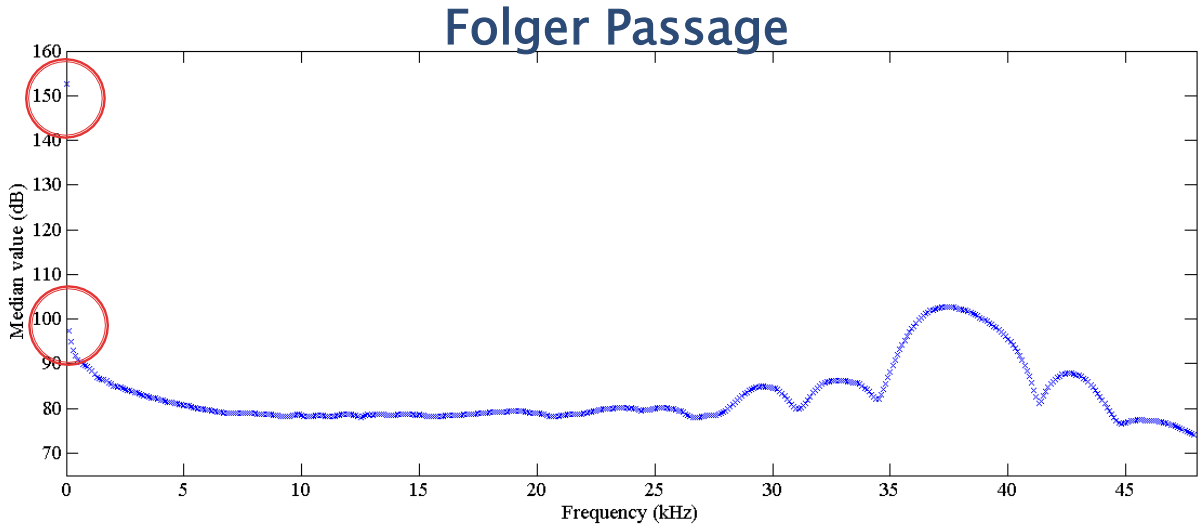
Automated Analysis: Overall RMS values

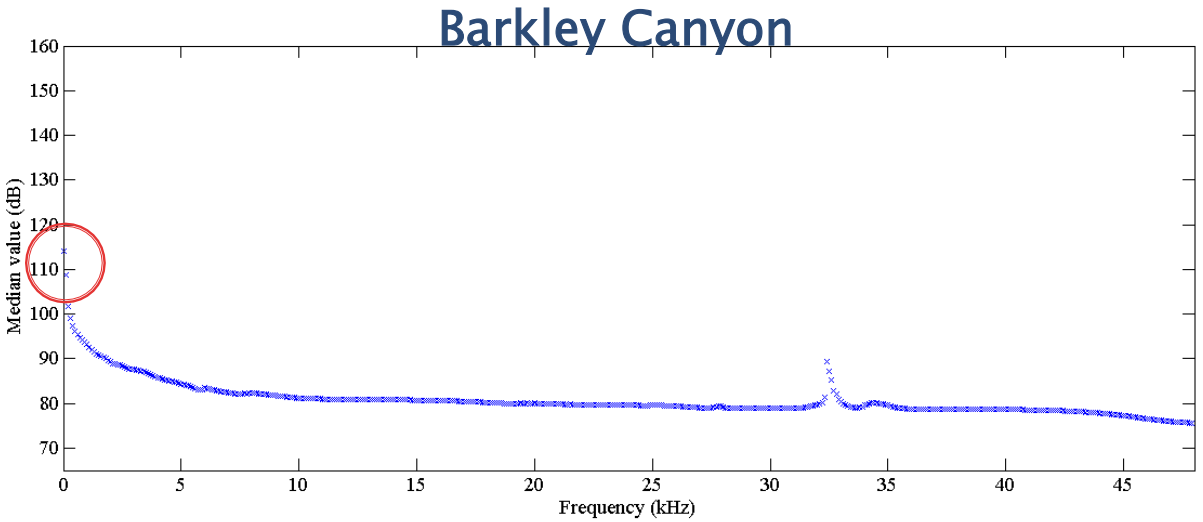
Folger passage consistently higher RMS, but Barkley more variable



Automated Analysis: median values by bandwidth

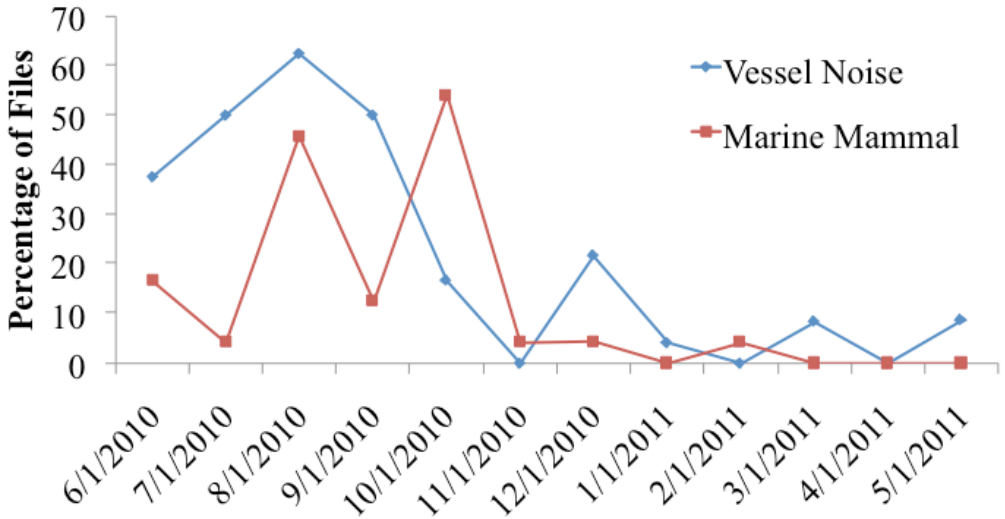
Very high amplitude at low frequency at Folger



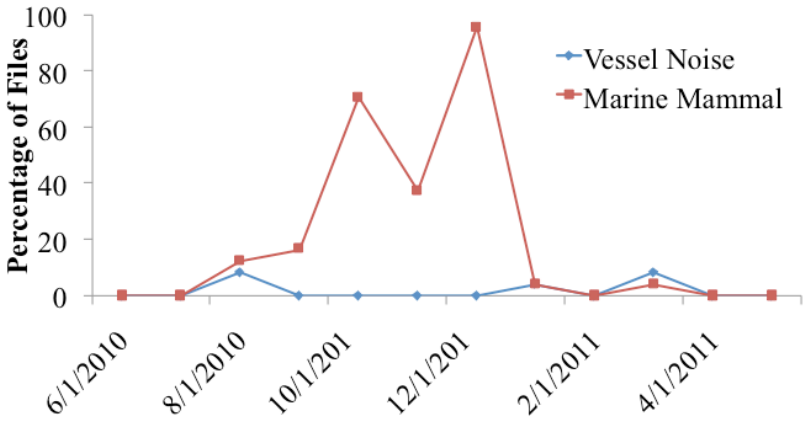


Passive Acoustic Data Results

Folger Passage



Barkley Canyon



Conclusions

- Low (< 2 kHz) frequency sounds do not contribute greatly to the acoustic soundscape
- Very few fish sounds

Conclusions–fish sounds?

- At least 32 fish spp from known sound producing families present in BC at depths >700m
- Most of these rarely observed in videos
- Transition between photic and aphotic layer
- Sound production occurs in pelagic realm rather than on the seafloor
- Use of lights
- Sounds are low amplitude, detection limited
- Location driven by geophysical rather than biological factors
- Effects of self-generated noise

Conclusions

- Broader band and long duration sounds resulting from marine mammals and passing vessels dominate frequencies below 10 kHz
- Monthly variation in amplitude is likely due to marine mammal migration, seasonal shipping patterns, and seasonal wind patterns and storms
- Ocean observatories such as NEPTUNE Canada provide excellent opportunities to conduct long-term acoustic research, but perhaps not ideal for detecting fish sounds