# A comparative study of sound production in two marine environments monitored by the NEPTUNE Canada undersea observatory network

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## ABSTRACT

The NEPTUNE Canada network, part of the Ocean Networks Canada (ONC) Observatory is the world's first regional-scale cabled ocean observatory network and is located in the Pacific Ocean, off the west coast of Vancouver Island, British Columbia. The network extends from the rocky coast to the deep abyss across the Juan de Fuca plate and it gathers live data from a rich constellation of instruments deployed in a broad spectrum of undersea environments. Data are transmitted via high-speed fibre optic communications from the seafloor to an innovative data archival system at the University of Victoria. Hydrophones were deployed at two NEPTUNE Canada node sites to support research on sound production in the marine environment. These hydrophones are located in Barkley Canyon, on the continental slope (1000 m) and in Folger Passage on the outer coast of Vancouver Island (100 m). Ambient sounds were recorded simultaneously at both sites over the course of one year (2010-2011). Our main objectives were to characterise and compare the soundscape at these locations, and to examine temporal (daily, seasonal) variations in the soundscape. A critical first step in characterizing the soundscape is to develop a library of known and unknown anthropogenic and biogenic (fish, whales, and invertebrates) sounds that contribute to the soundscape. The ultimate goal is to develop the capacity for observatories like the Neptune Observatory to be used to study the response of deep-sea ecosystems to short-term and long-term environmental change.

## INTRODUCTION

Two classes of sounds in the ocean; **anthropogenic** and **natural**.

Sources of **anthropogenic** noise are more pervasive and more powerful and it is increasing both oceanic background sound levels and peak intensity levels.

Ambient noise in the ocean has increased over the past 50 yrs at both low frequencies (<1000 Hz) and mid-frequencies (1-20 KHz). Created both **purposefully** (e.g., airgun arrays, sonar, acoustic deterrent devices, minesweeping equip., Doppler current profiler) and **unintentionally** (e.g., shipping, operational oil & gas platforms, wind farms, dredging.)

**Natural** underwater sounds in the ocean include wind and rain (ubiquitous), storm (e.g. lightning), earthquake, breaking gravity (surf) waves and wave-wave Interactions and biological sounds from **marine mammals, fish,** crustaceans and other invertebrates and other biota.

Globally, more than 50 families and an estimated 1200 species of fish produce biological sounds for different purpose (spawning, mating, communication, behavioural display etc.).

**Fish sounds remain largely undocumented and unstudied, particularly in the deep ocean.**

## OBJECTIVES

The primary objective of this ongoing study is to characterise the soundscape in two main areas of the NEPTUNE observatory:

- Barkley Canyon (Depth: 982 m, Lat: 48.3166 , Long: -126.0503)

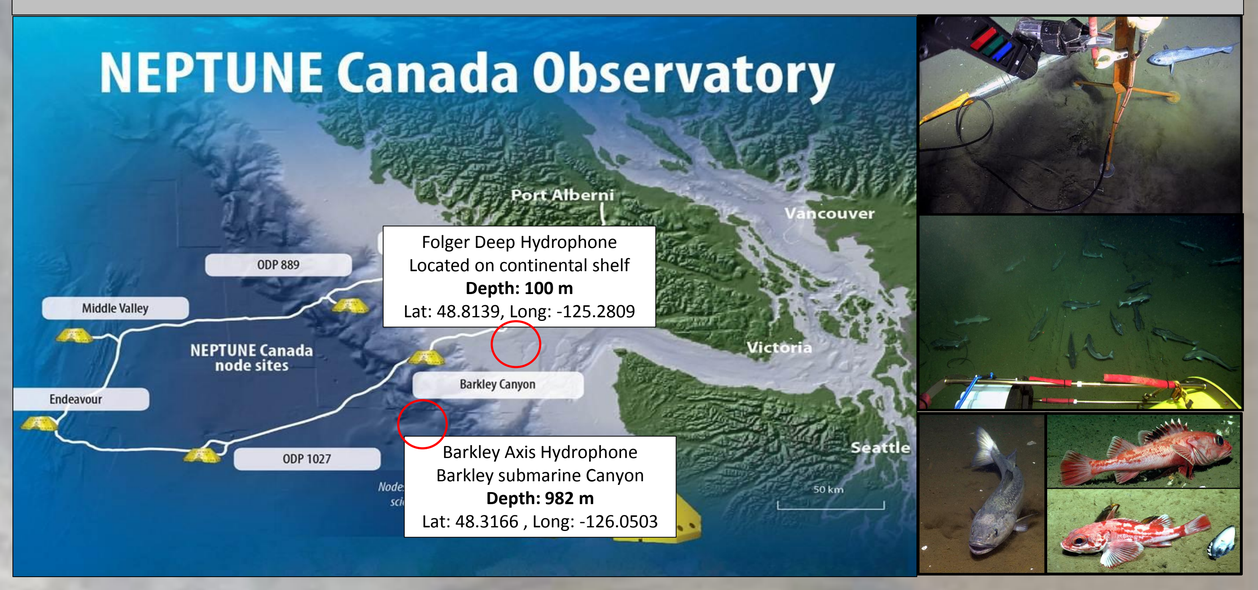
- Folger Passage (Depth: 100 m, Lat: 48.8139, Long: -125.2809)

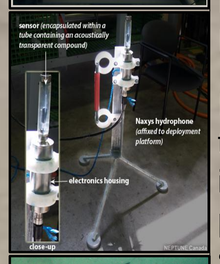
**TWO MAIN QUESTIONS:**

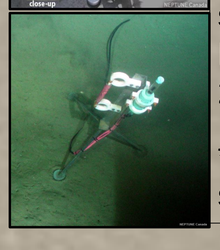
1) Do fish or fish-like sounds occur near the observatory, and what are the diel and seasonal patterns in their occurrence?

2) What are the major components of the soundscape and how do they differ between sites through diel and seasonal periods?

## STUDY AREA



## METHODOLOGY

Passive acoustic data were collected using a NAXYS omnidirectional hydrophone with a frequency response of 10 Hz to 65 kHz.

Acoustic data were available from June 2010 to May 2011.
Folger Passage => 590 days of recordings => 155 760 files (8.7 Tb!)
Barkley Canyon => 585 days => 154 440 files (8.6 Tb!)

For our preliminary survey we chose a subset of the data with strong temporal overlap between the sites. Due to the large amount of data our initial sampling design consisted of manual* examination of one 24 hour period each month at each site. One file/hour was examined for each 24 h subsample. A total of 576 sound files were processed using RavenPro Interactive Sound Analysis Software (The Cornell Lab of Ornithology, 2011).

*Note autodetection were not applicable during this initial survey because sound source characteristics were not yet known.

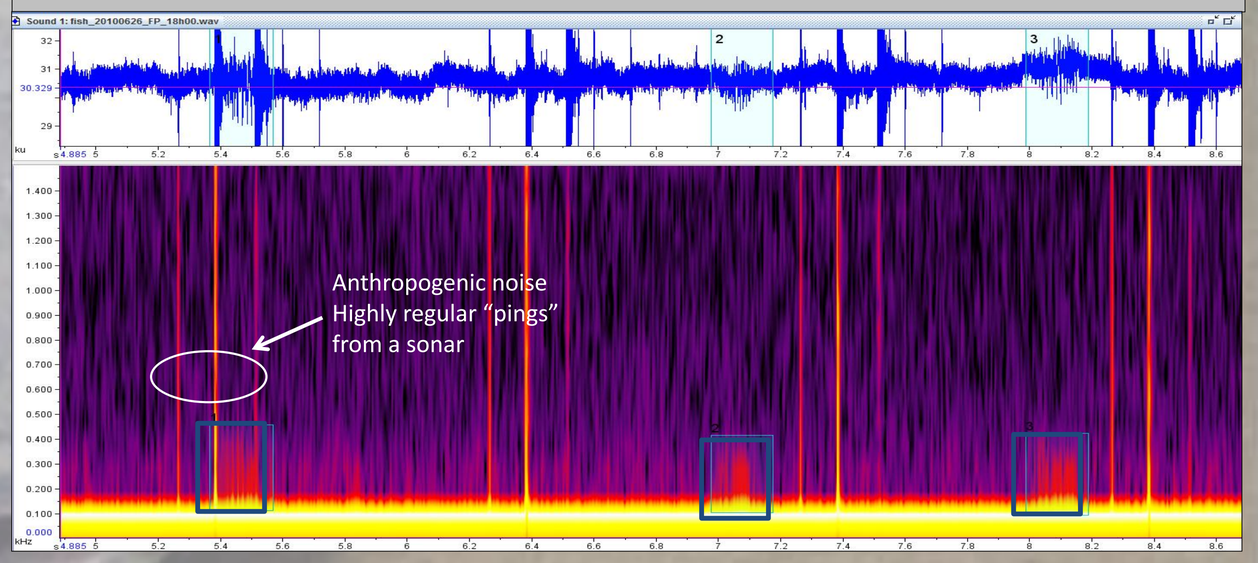
### Results – Barkley Canyon (983 meters)

Main sources of **anthropogenic** sounds identified were from shipping, working vessels, sonars & Network cable instruments (e.g. video-camera). As for natural sounds, we found earth quakes (Jun-Jul 2010), Pacific white-sided dolphins (Aug-Sep 2010), Humpback whales (Oct-Nov 2010), Baleen whales (Nov-Dec 2010) and potential fish sounds.

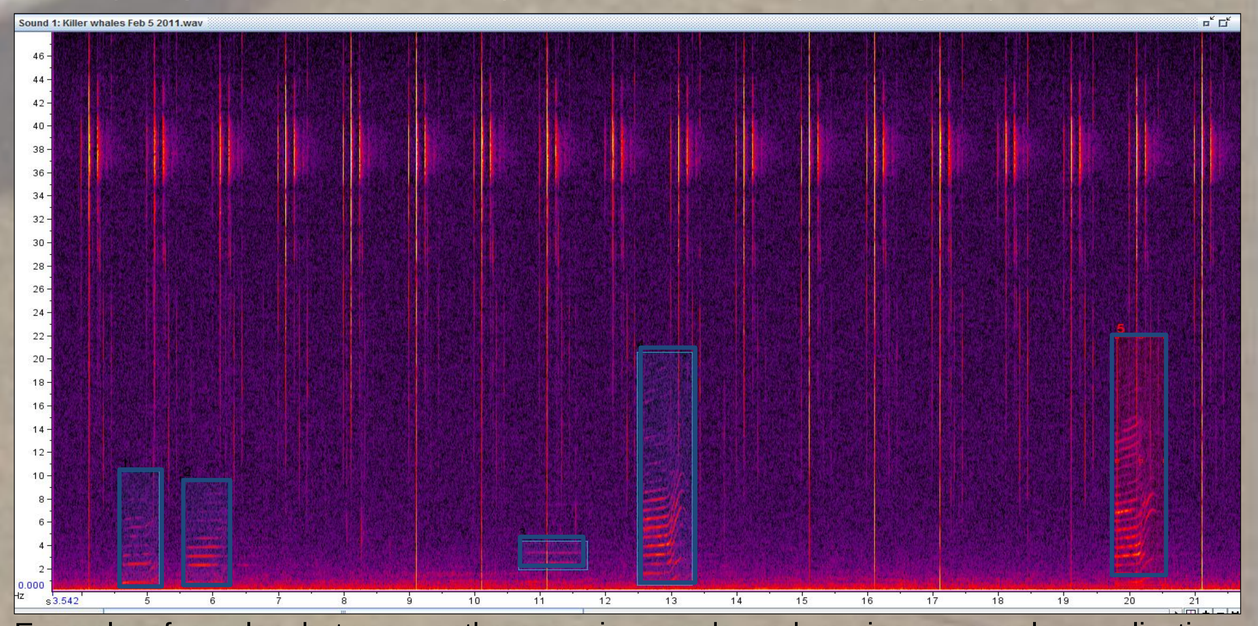
### Results – Folger Passage (100 meters)

Main man-made contributing sources were fishing & working vessels, shipping, sonars, NAVY operations & Network cable instruments. Natural sounds including mainly transient Killer whales (Feb. 2011), Sea lions (Aug-Oct 2010), Humpback whales (Jun 2010) and potential fish sounds (Jun-Dec 2010).

## RESULTS




Sequence of three "knock trains" that are ***fish-like*** drumming sounds that are well within the frequency of known fish sounds (June 26 2010 – 5h00 pm – Folger P.)




Example of overlap between anthropogenic sounds and marine mammals vocalizations (killer whales) (February 02 2011 – 6h02 pm – Folger P.)

## CONCLUSION REMARKS

1) Fish sounds in the deep: We were able to identify a small number of ***fish-like*** sounds, but we need to analyse a greater numbers of file in order to better characterize these sounds, find diel and/or seasonal patterns, and ultimately identify to genus/species level.

2) Use of the observatory for studying the soundscape/deep sea ecosystem: Our preliminary work suggests the Network instruments are impacting the soundscape and other aspects of the ecosystem. They may have more of an observational bias than we think. The instruments are contributing to local noise posing a challenge to record and identify the biological soundscape.

## FUTURE WORKS

Creation of a library of sounds of NEPTUNE Canada, as the one already online for VENUS Canada. Analyze of a great number of sound files and development of basic automatic detection for whales and fish species.

ACKNOWLEDGEMENTS. We thank NEPTUNE Canada & the officers and crew of the CCGS Tully & PICES for an award.