



What is a soundscape?

How should soundscapes be quantified and characterized?



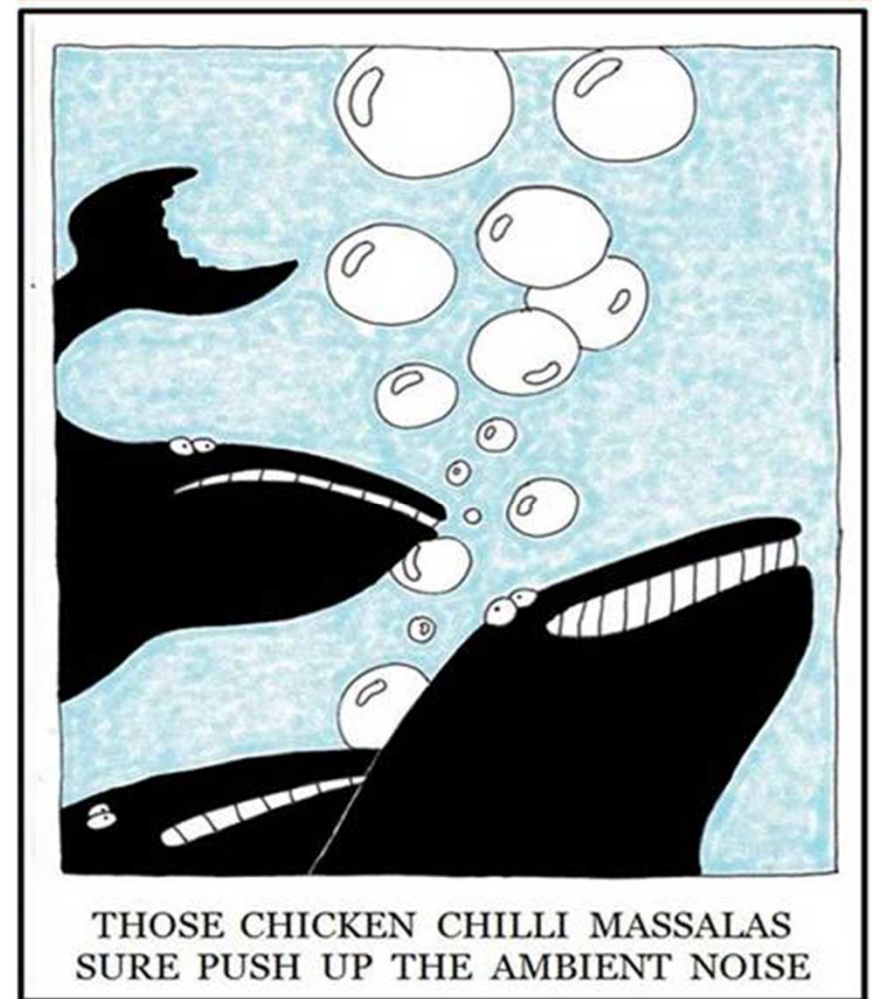
Christine Erbe
JASCO Applied Sciences
Australia, Canada, USA, UK

Overview

1. The Marine Soundscape

- a) Ambient (physical) Sounds
- b) Biological Sounds
- c) Anthropogenic Sounds

2. Quantification & Characterisation



Soundscape:

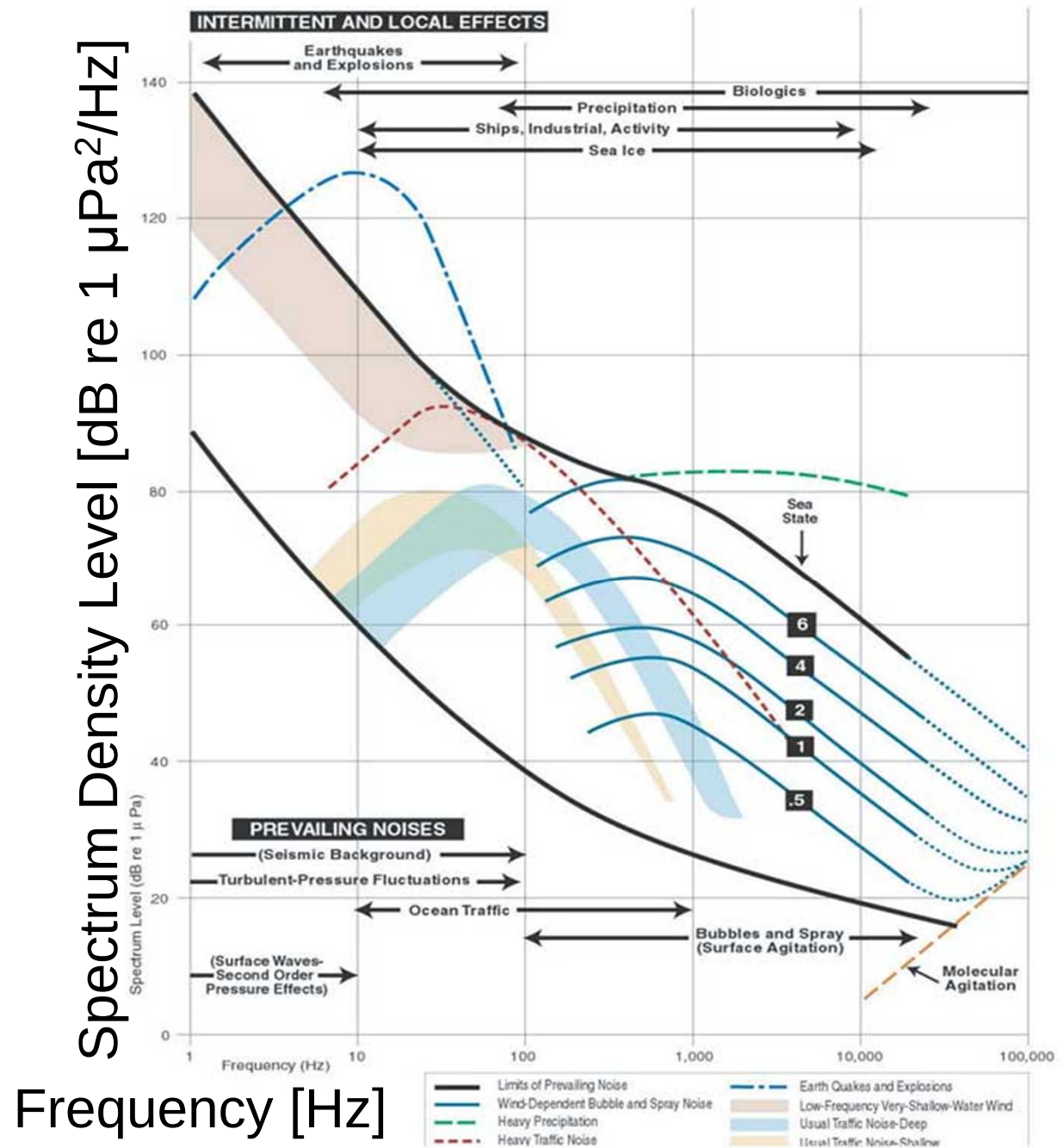
- an acoustic environment consisting of natural sounds (including animal vocalizations and the sounds of weather) and anthropogenic sounds

Acoustic Ecology:

- the study of the relationship—mediated through sound—between organisms and their environment

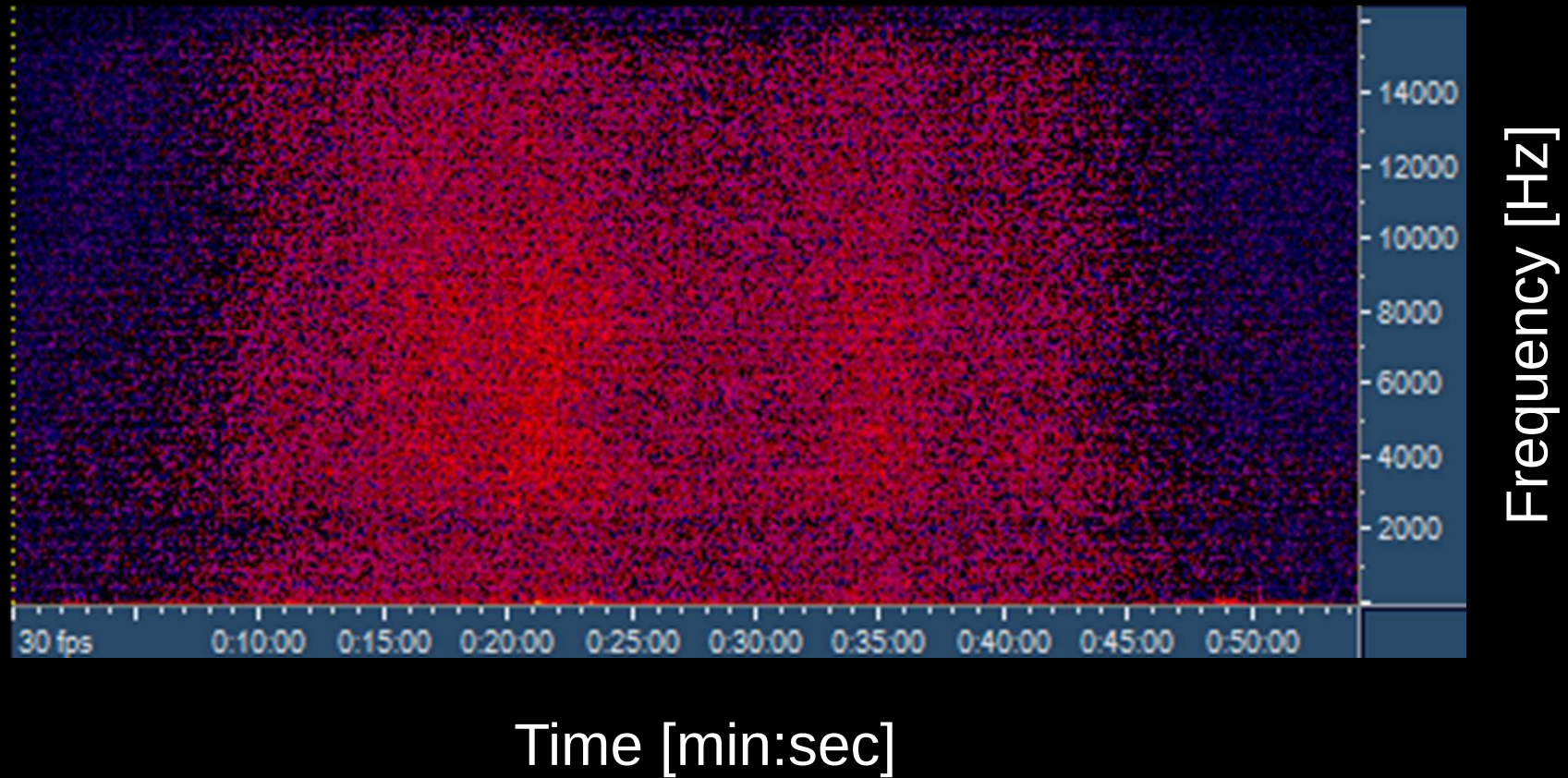
Natural Ambient Sound

[Wenz 1962, JASA 34(12): 1936-1956]



1. Marine Soundscape > a. Natural Ambient Sound

Rain



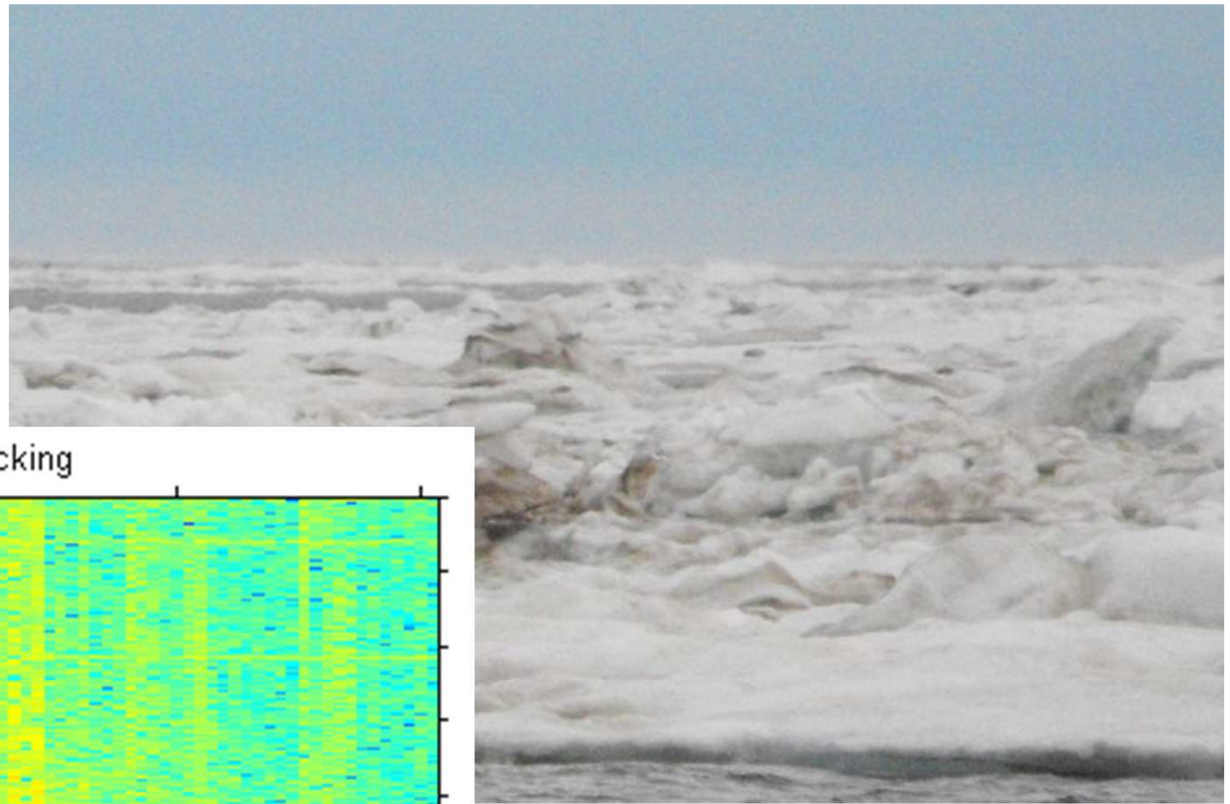
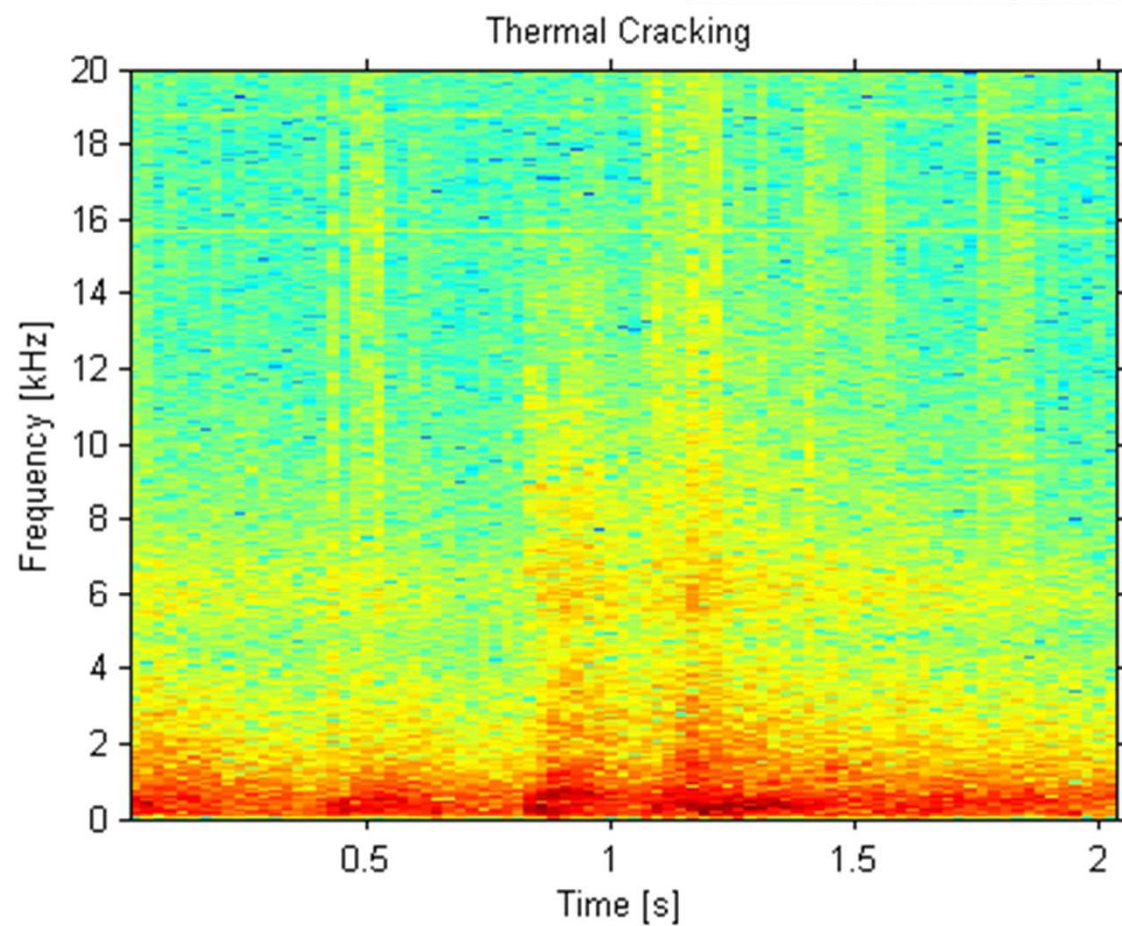
1. Marine Soundscape > a. Natural Ambient Sound

Ice Noise

- Due to deformation, fracturing, breaking & collision of ice sheets & floes, caused by wind, currents, waves, melting & freezing, internal & surface stresses
- Broadband: Hz – 10s of kHz
- Quietest during stable or warming conditions with low winds
- Loudest during periods of rapid cooling or strong winds

Correlate noise spectrum with environmental parameters
[Greene & Buck 1979; Oard 1987; Yang et al. 1987; Wen et al. 1989, 1990; Xie & Farmer 1991, 1992; Feller 1994; Greening & Zakarauskas 1994; Uscinski & Wadhams 1999; Stein et al. 2000 etc.]

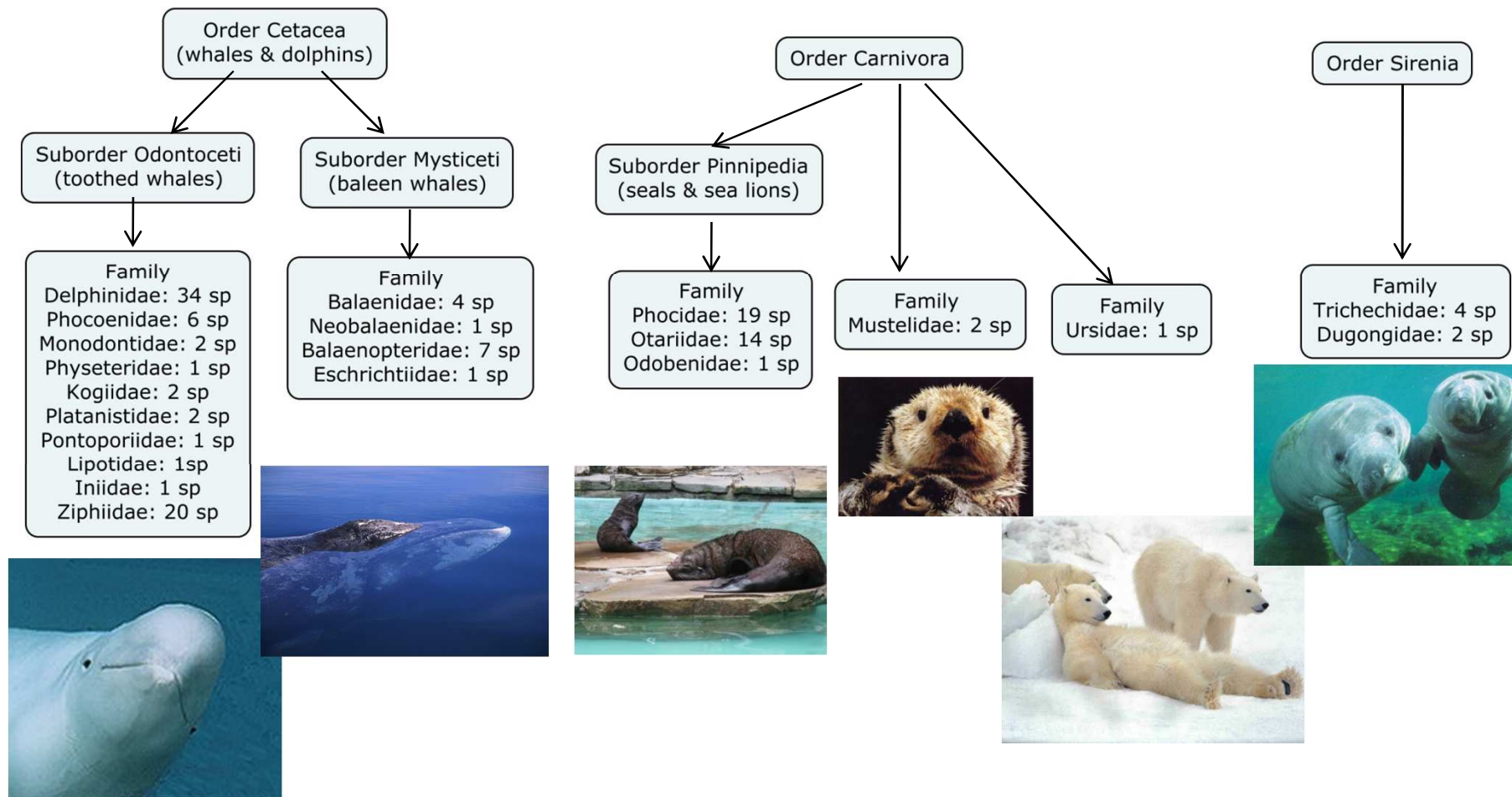




1. Marine Soundscape > a. Natural Ambient Sound

1b. Biological Sounds

- Marine Mammals



Ocean water conducts light very poorly but sound very well.

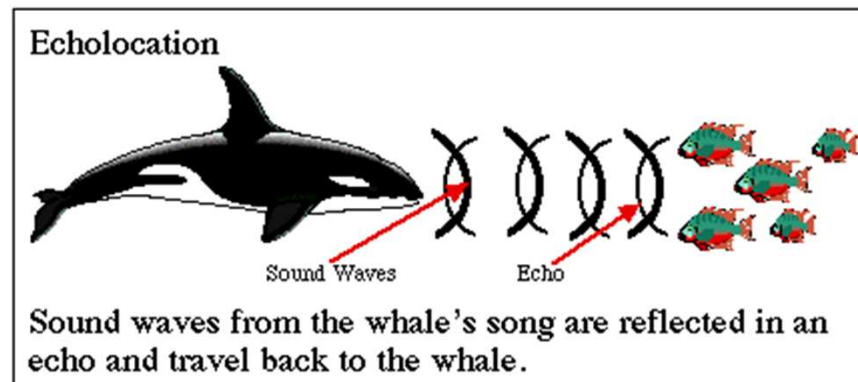
⇒ Marine mammals rely primarily on their acoustic sense for

- Social interaction
- Communication
- Navigation
- Foraging



Odontocete Sounds

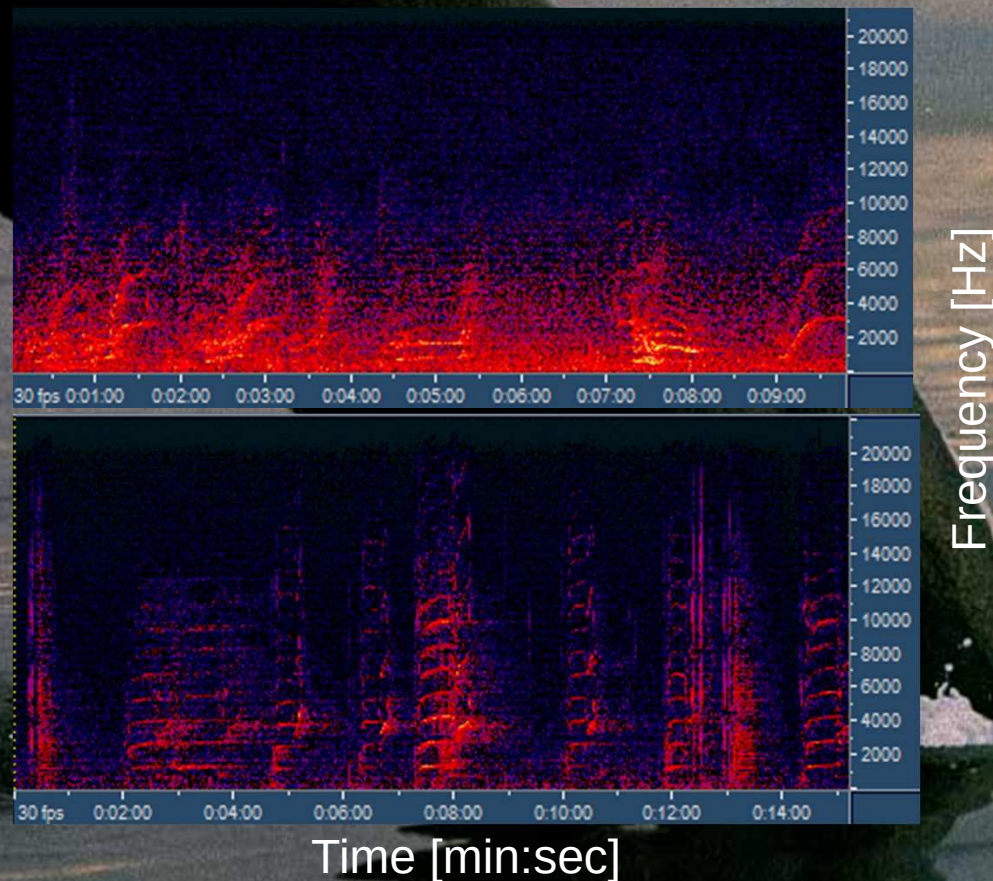
- generated within the nasal system, not the larynx
- can be classified into 3 categories: *tonal whistles*, *burst-pulse sounds* and *echolocation clicks*
- echolocation used for navigation & foraging



<http://staff.more.net/denise/whales/lesson1.htm>

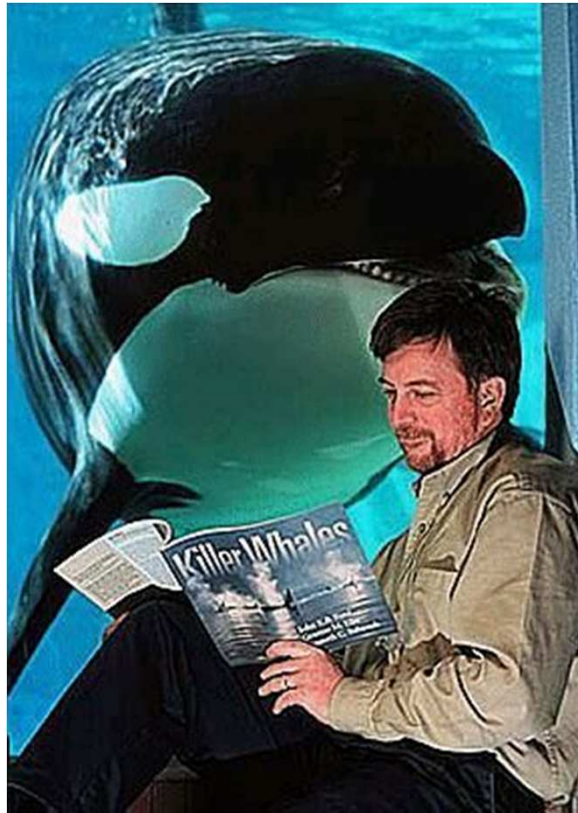
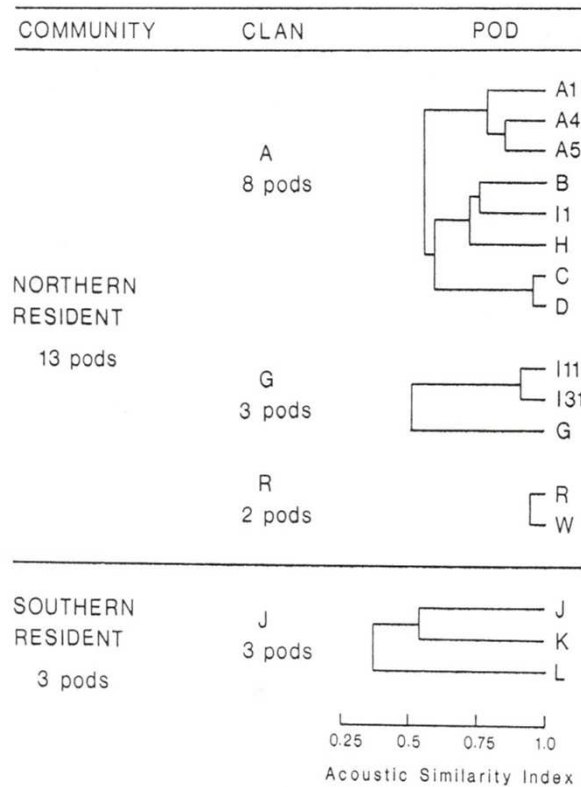
- ∃ geographic differences in call characteristics of the same species
- *Dialects* (sound differences between populations sharing the same geographic region) have been identified for killer whales and sperm whales.

Killer Whales

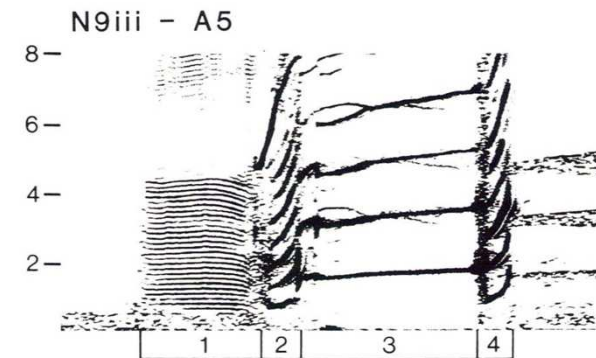
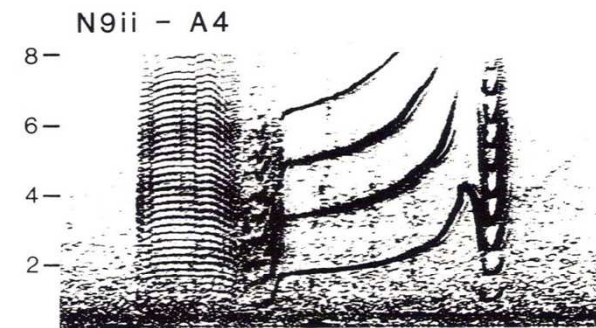
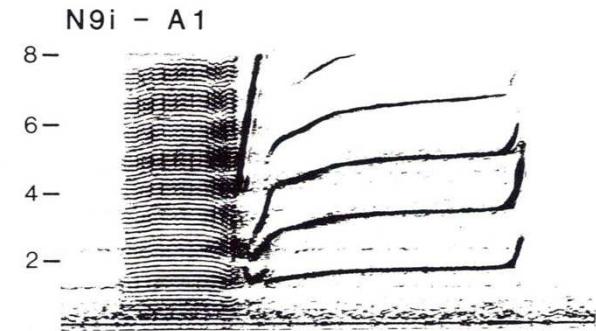


1. Marine Soundscape > b. Biological Sounds

Ford 1991, Can J
Zool 69: 1454-
1483



FREQUENCY (kHz)



TIME 0 500 ms

FIG. 5. Spectrograms of variants of call N9, recorded from clan A pods A1, A4, and A5. Note the variations in the structure of parts 3 and 4.

1. Marine Soundscape > b. Biological Sounds

Welcome to the Salish Sea hydrophone network

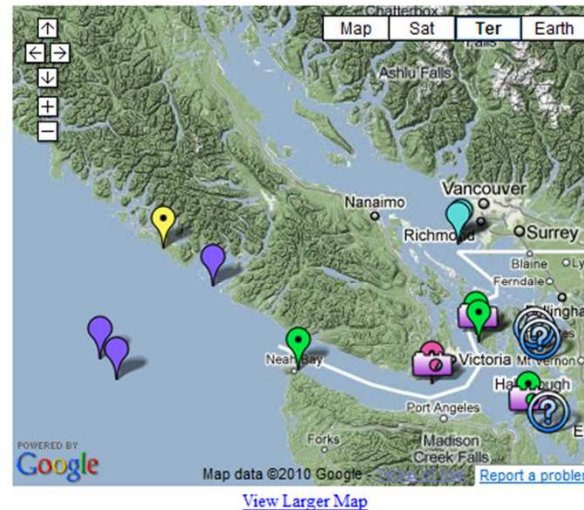
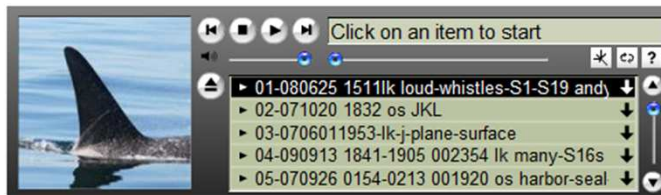
<http://orcasound.net/>

A growing coalition of scientists, educators, and citizens are working together to expand a regional hydrophone network in the Salish Sea. This site is part of the [SeaSound Project of The Whale Museum](#) and is an experiment in sharing real-time underwater sound. The goals are to monitor the critical habitat of endangered southern resident killer whales to detect orca sounds and measure ambient noise levels.

Listen live via the links in the table or in the pop-up description you get by clicking the green markers on the map. For some hydrophones you can also watch live video from nearby (by clicking on the camera icons). The other icons show other hydrophones in the region that have not yet been networked.

2010 listening challenge: Help notify researchers when orcas are in the Salish Sea. If you hear killer whales please [email detection@orcasound.net](mailto:detection@orcasound.net) or [log your observations](#) in a collaborative Google spreadsheet. Use the [Salish Sea sound tutor](#) to learn to tell which pod is present based on the calls they use most often. Use [web cams and other real-time sensors around the Salish Sea](#) to figure out what else you might be hearing.

If you don't hear anything interesting live, you can hear archived sounds in the "greatest hits" player below, or via the sound archive links in the table.

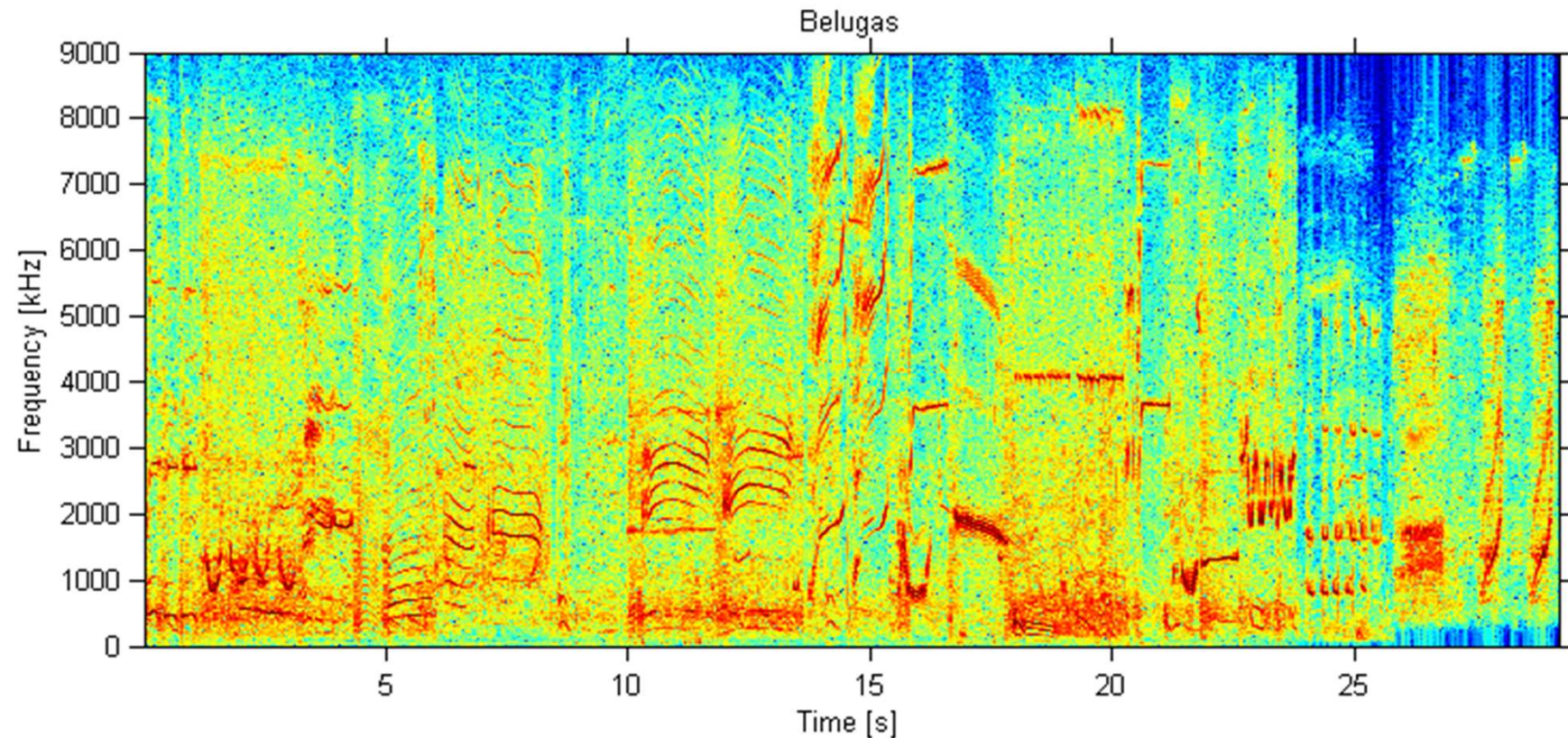


Click on the links in this column to listen to underwater sound from each location. (If the link doesn't work, see the listening guidance below.)	Follow links in this column to explore archived sounds and details about the hydrophone location.
Listen to OrcaSound on San Juan Island Watch live video from ~300m south of the OrcaSound hydrophone (offline July 09) (courtesy of the Center for Whale Research)	Site description and sound archives History and research results
Listen to Lime Kiln State Park on San Juan Island	Site description and sound archives
Listen to Port Townsend Marine Science Center Watch live video from the Port Townsend Towercam (located a few km to the south of the hydrophone; KX-HCM280A Panasonic Network Camera with West-East presets: 8 = Keystone; 3 = Point Hudson; 5 = Marrowstone Point)	Site description and sound archive Port Townsend Marine Science Center Port Townsend Ferry Camera Port Townsend - Keystone Ferry Locator
Listen to the Seattle Aquarium	Site description and sound archive Seattle Aquarium Real-time ferry locations



1. Marine Soundscape > b. Biological Sounds

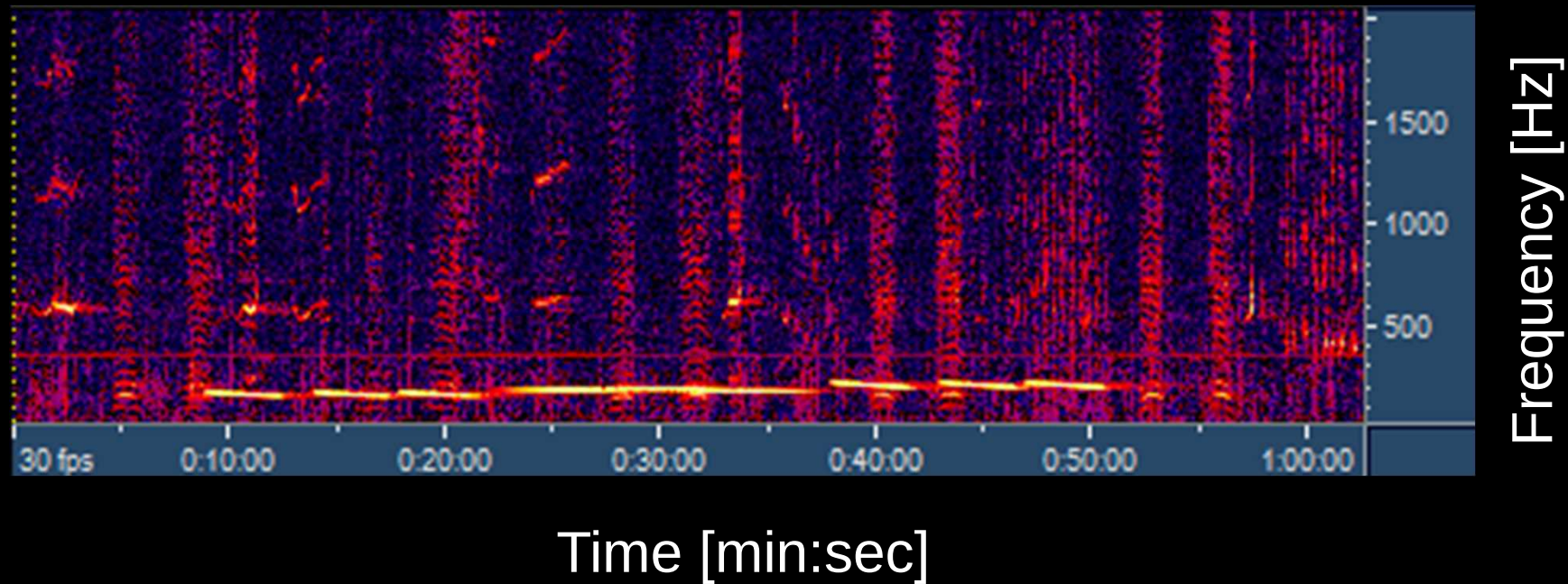
Beluga Whales



1. Marine Soundscape > b. Biological Sounds

Humpback Song & Sonar

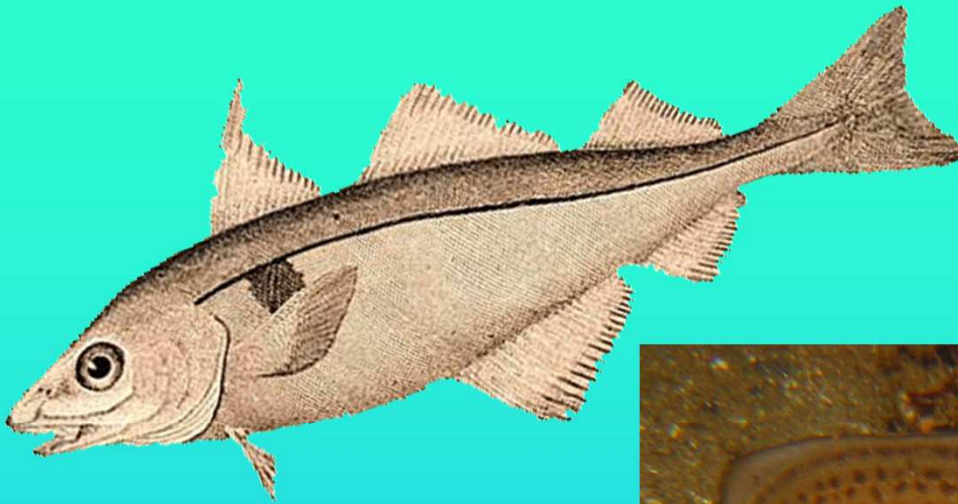
[Patrick Miller]



1. Marine Soundscape > b. Biological Sounds

Fish

Haddock



Cusk-eel



Toadfish



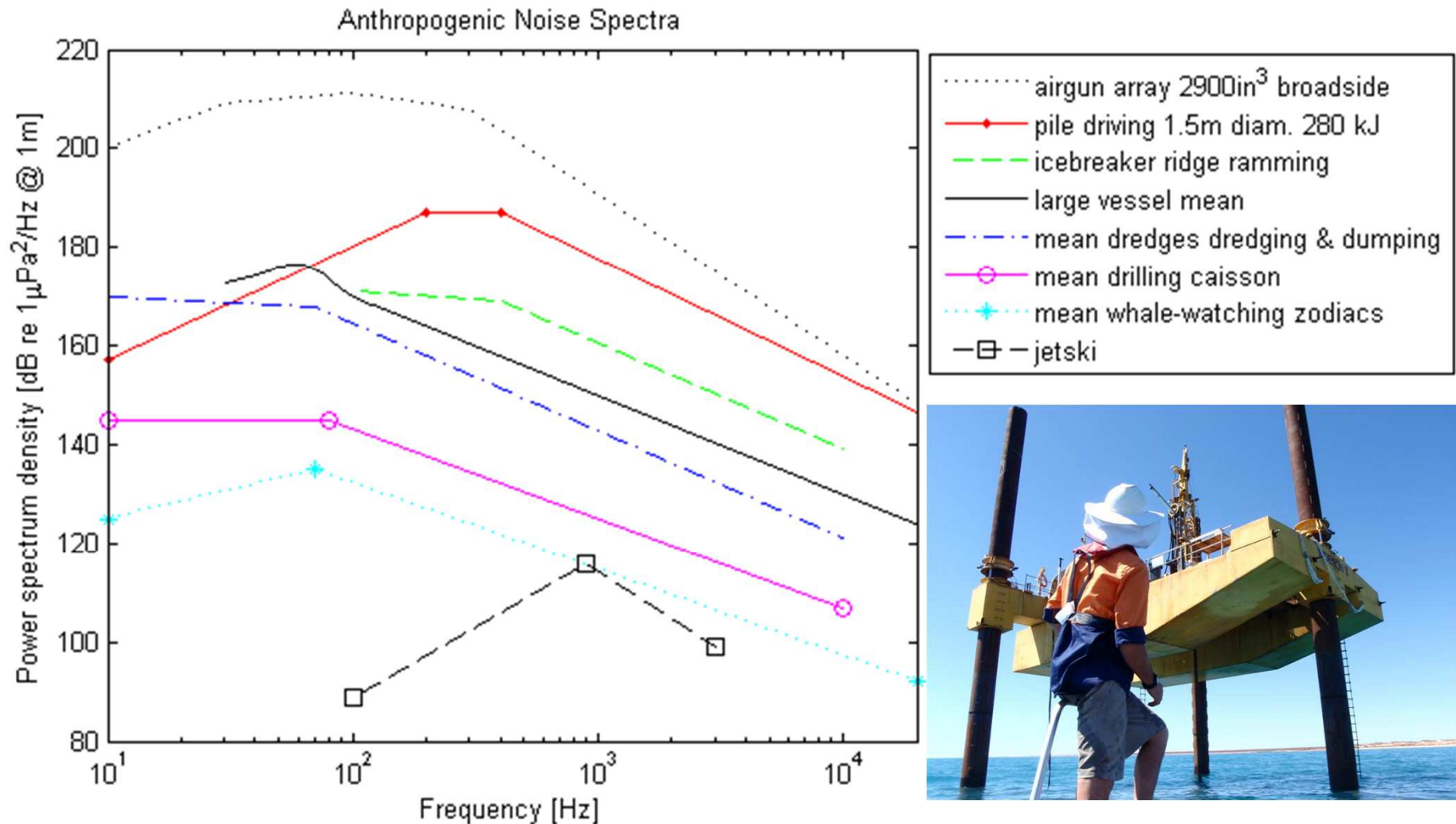
[<http://www.fishecology.org/soniferous/justsounds.htm>]

Tropical Ambient (fish & crustaceans)



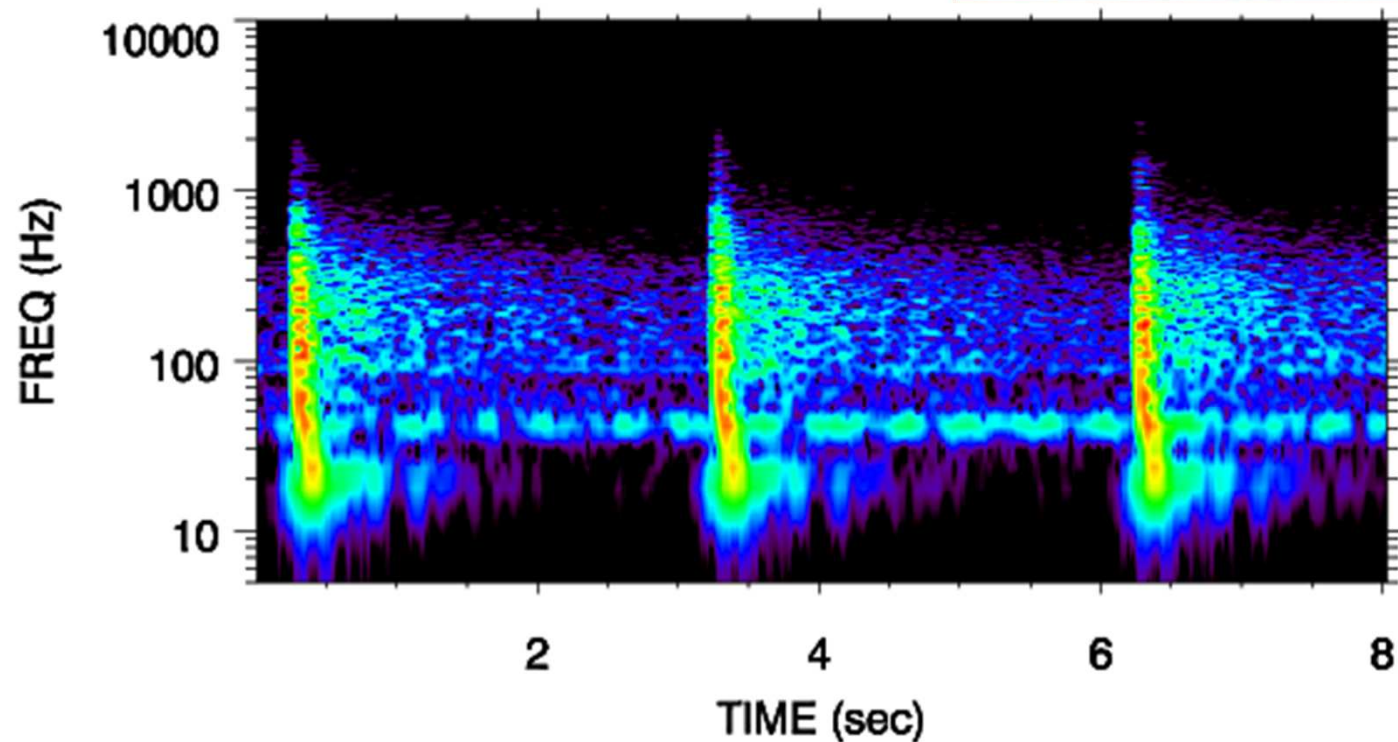
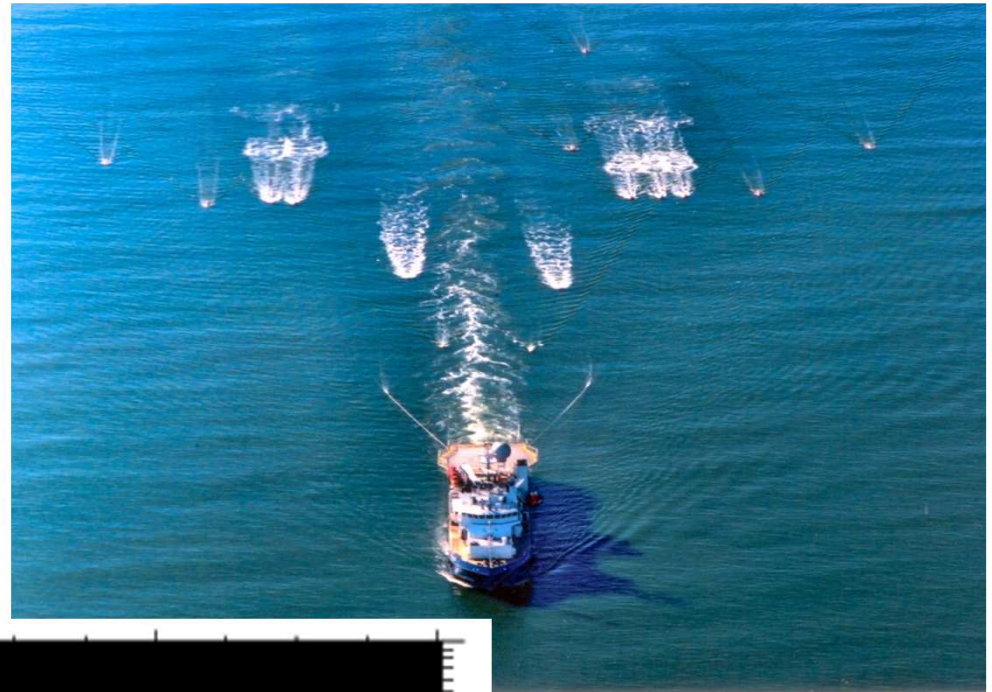
1. Marine Soundscape > b. Biological Sounds

1c. Types and Characteristics of Anthropogenic Noise



1. Marine Soundscape > c. Anthropogenic Sounds

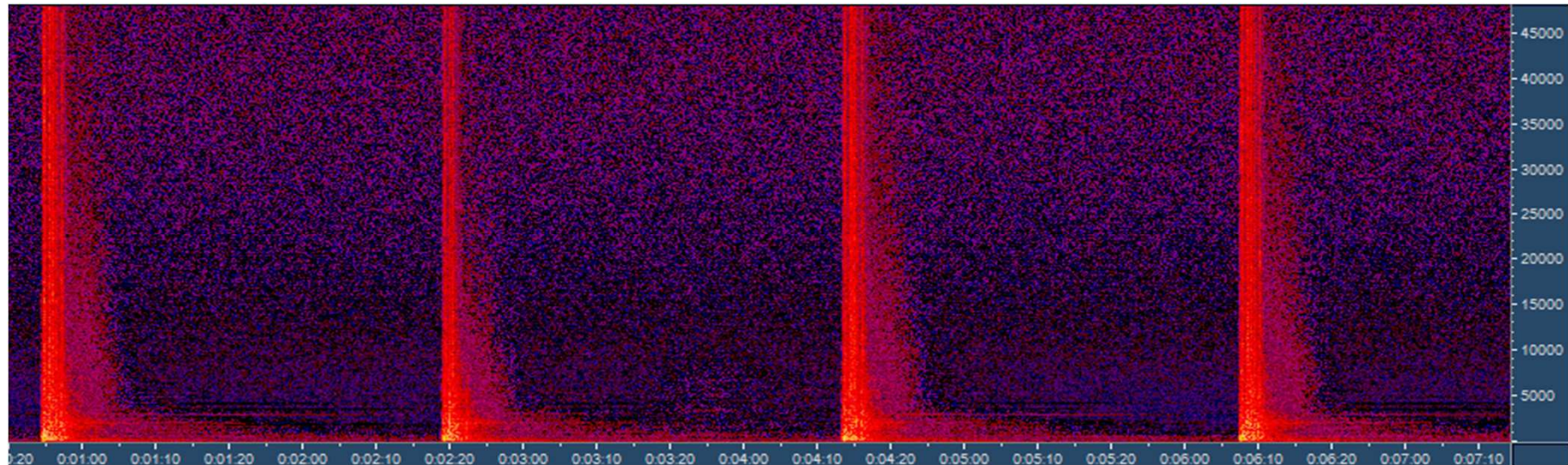
Airguns



1. Marine Soundscape > c. Anthropogenic Sounds

Pile Driving

[Erbe 2009]



1. Marine Soundscape > c. Anthropogenic Sounds

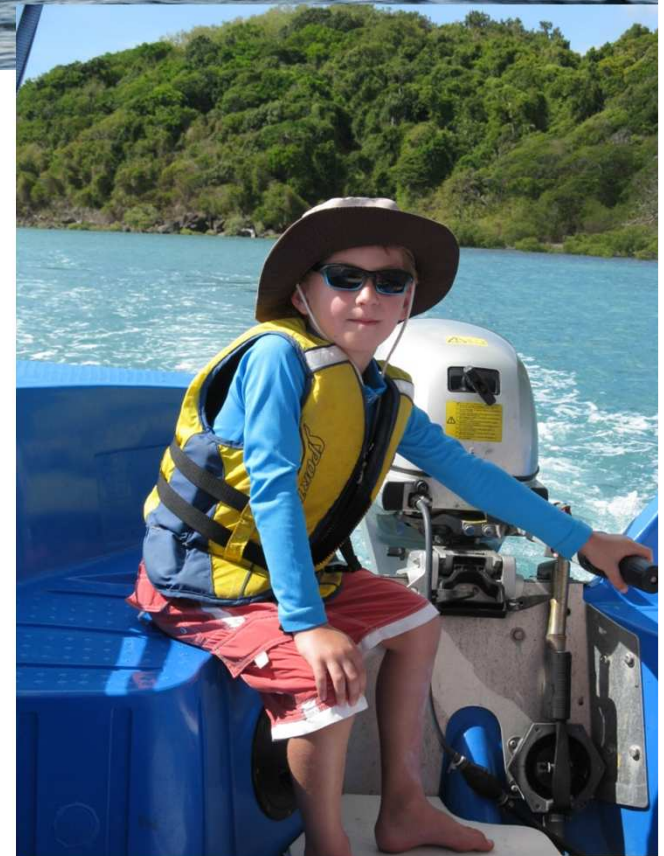
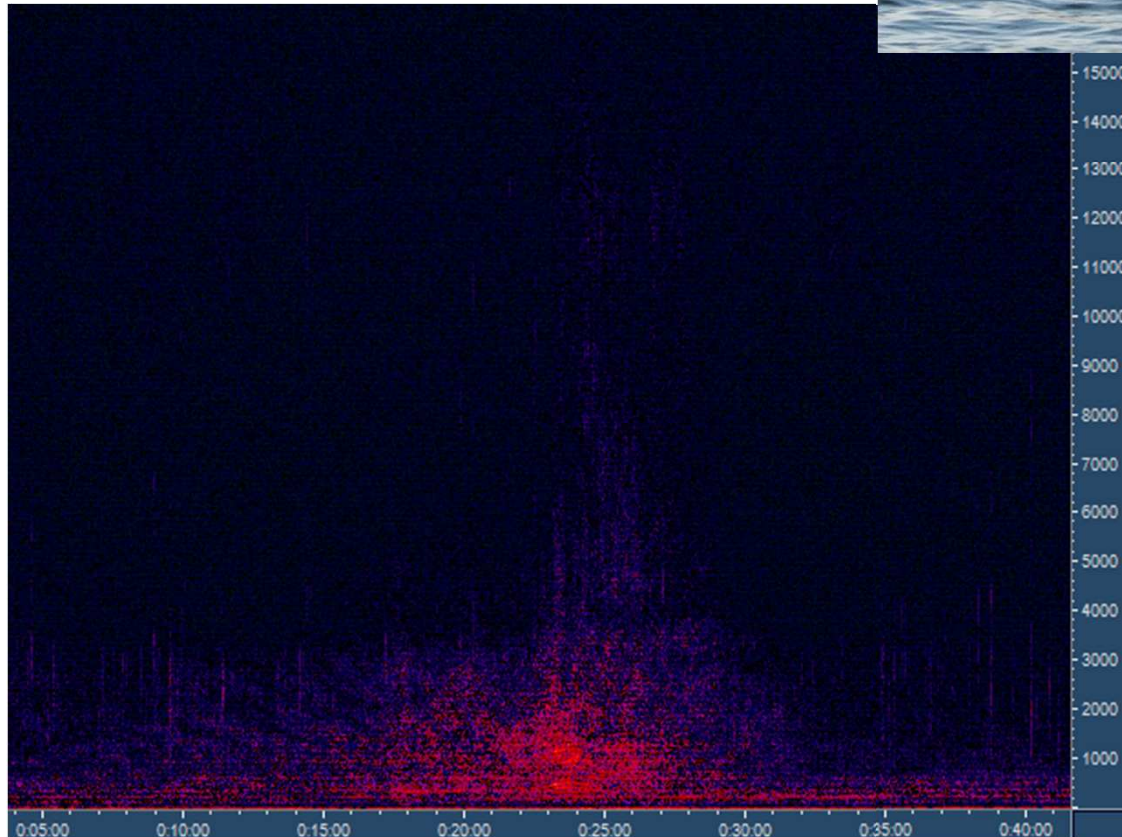
Large Vessels

Propeller Cavitation Noise



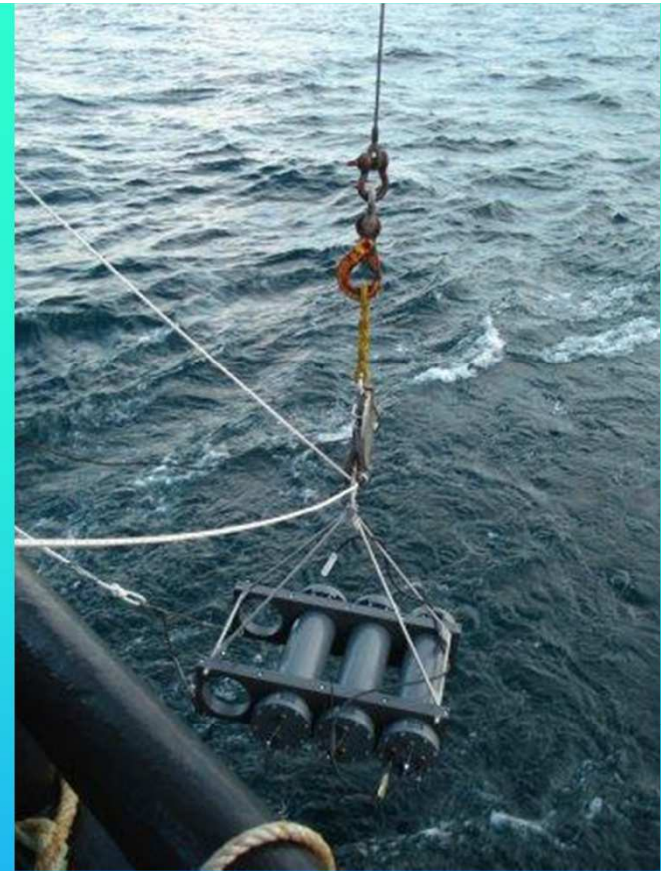
[Erbe & Farmer 1998, 2000]

Pleasure Craft



1. Marine Soundscape > c. Anthropogenic Sounds

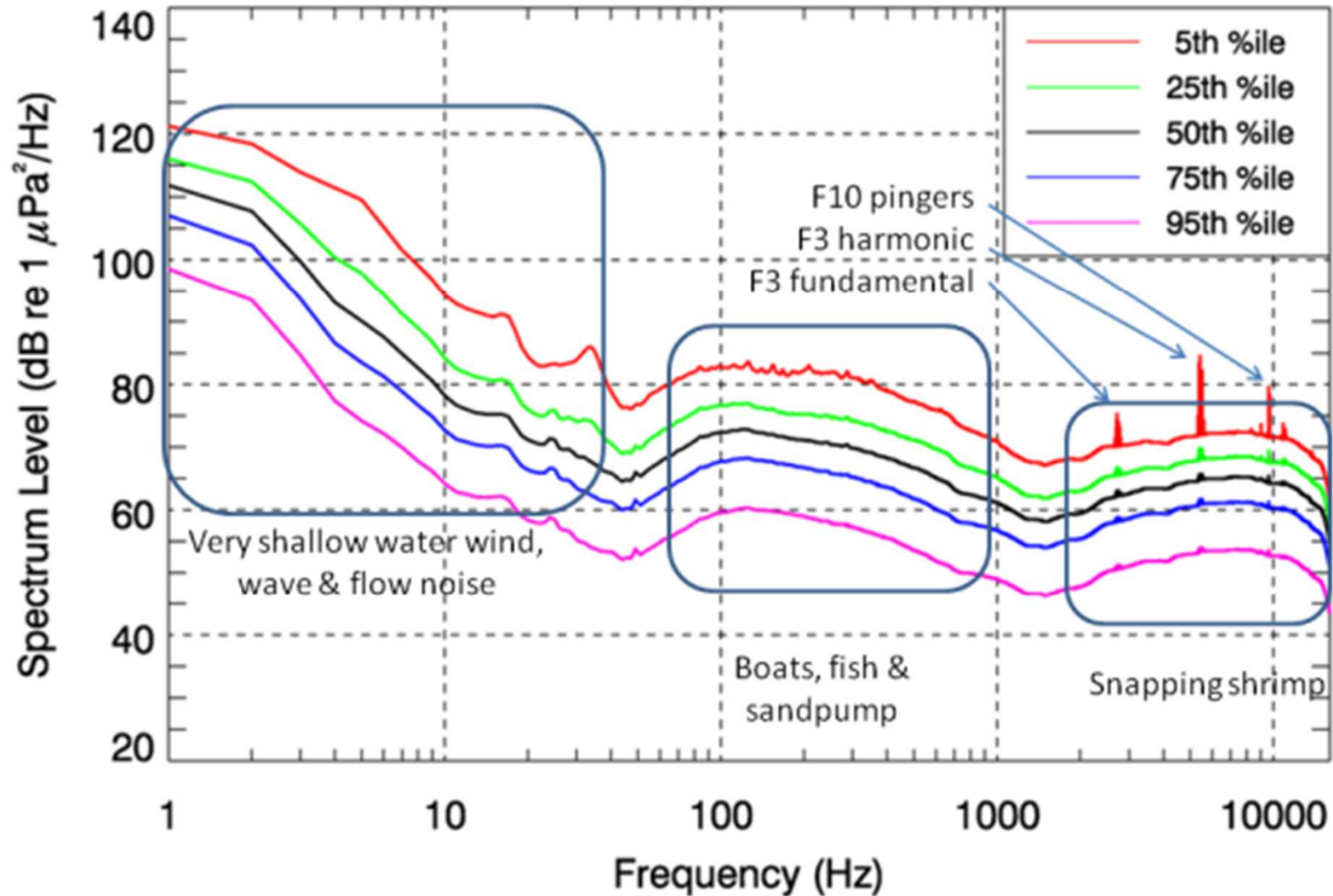
How do we measure soundscapes?



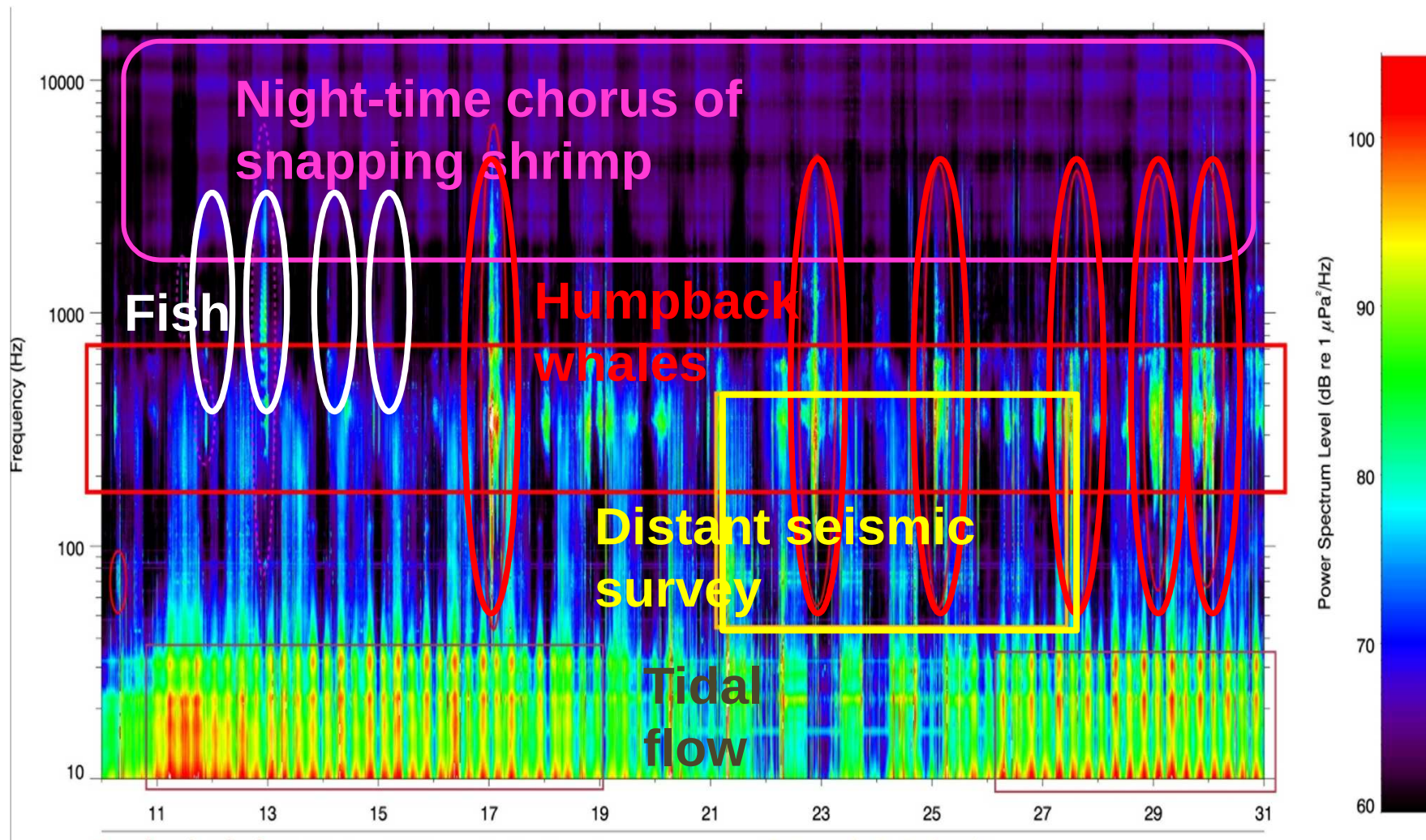
=> after the coffee break...



2. Quantification: Ambient Noise Percentiles



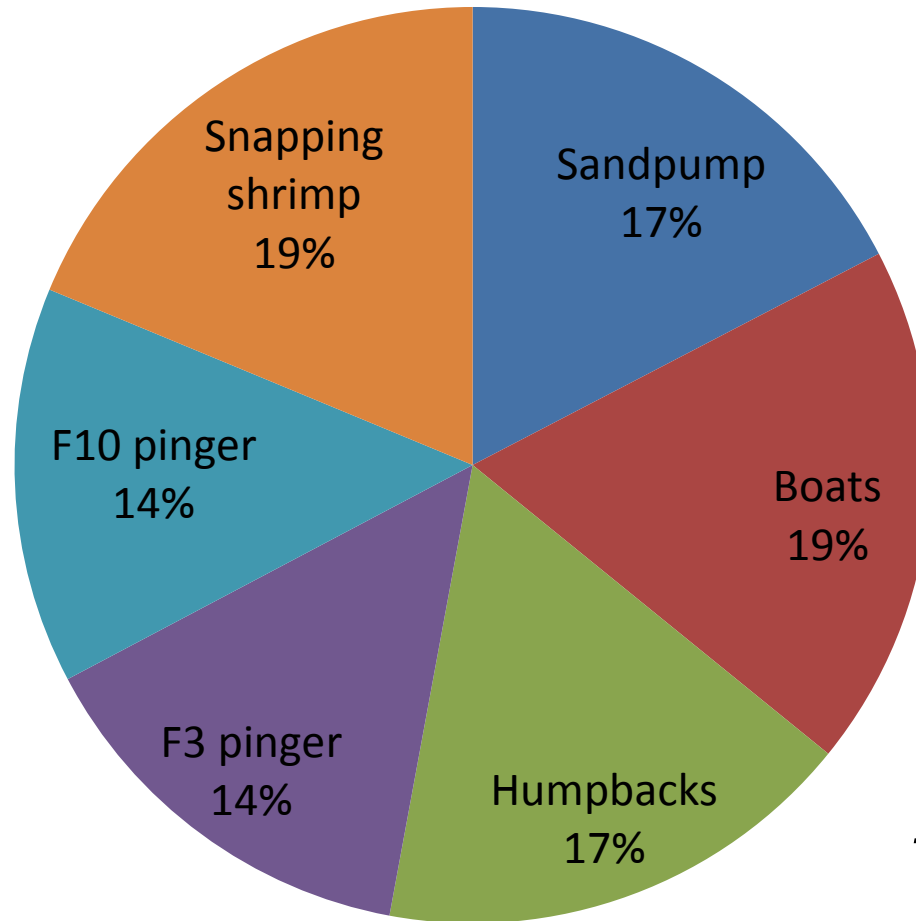
Spectrograms



2. Quantifying the Marine Soundscape

Same data as
in slide 24:

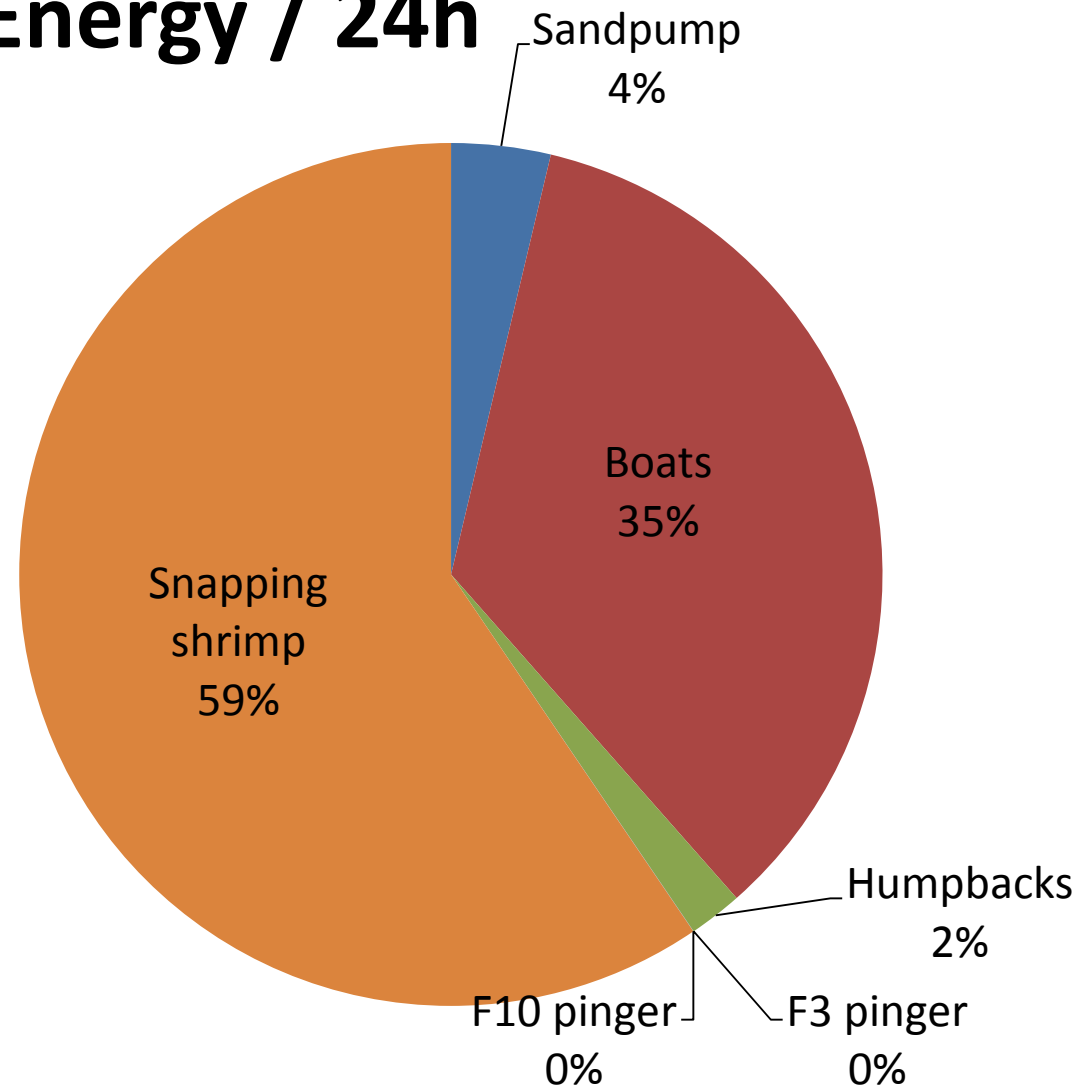
Total Energy [dB] / Day



*The problem
with these pie
charts...*

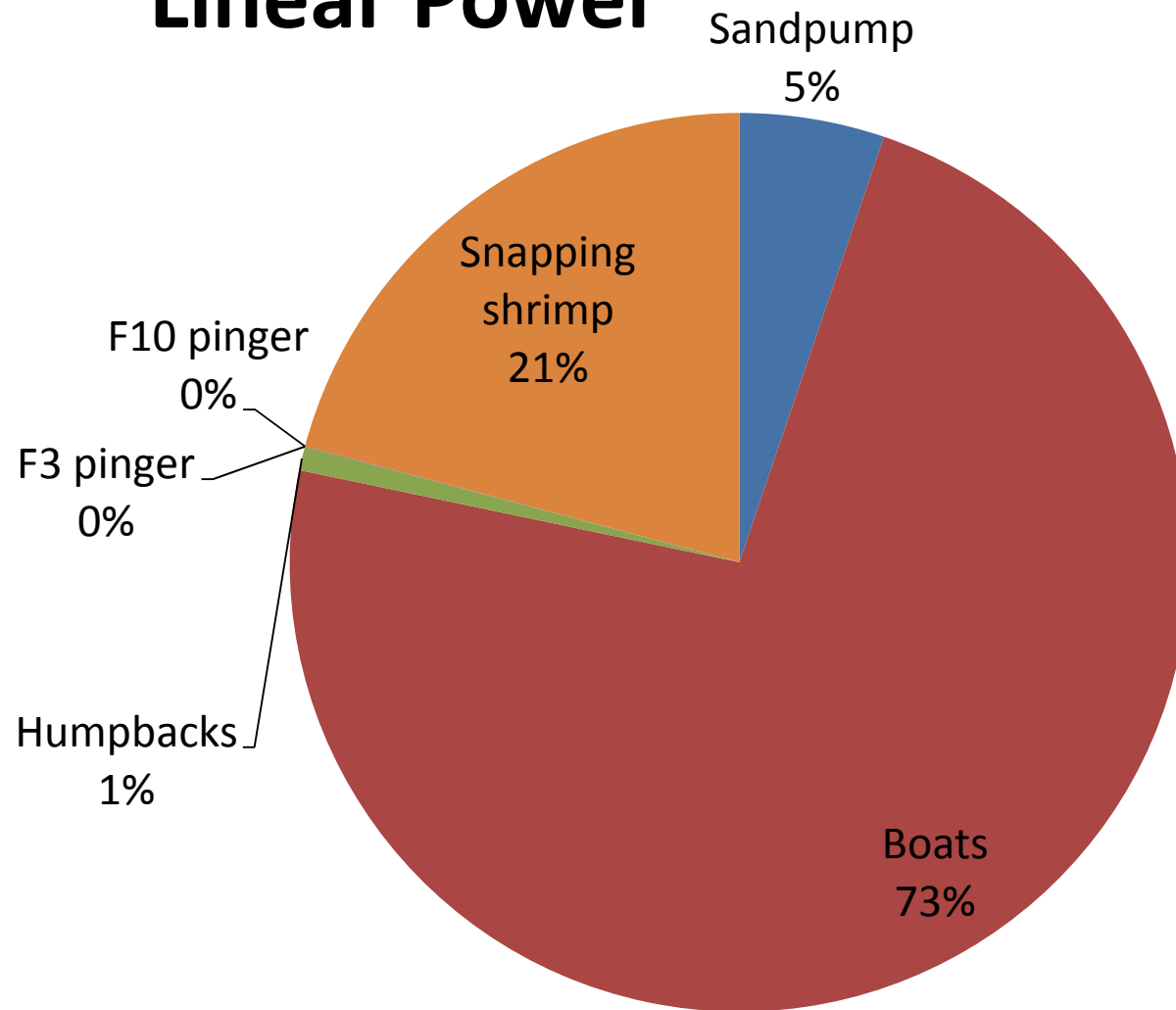
Same data:

Linear Energy / 24h



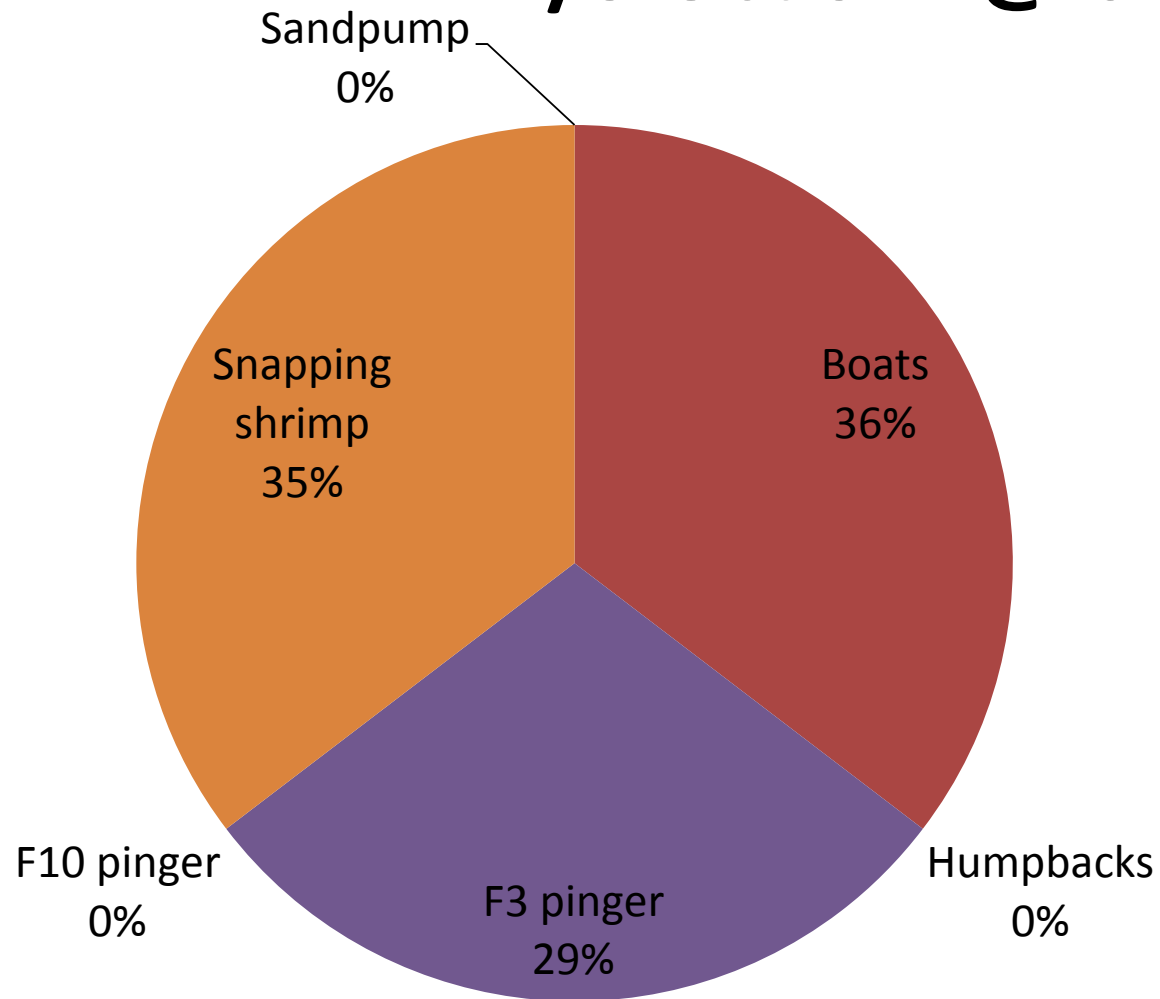
Same data:

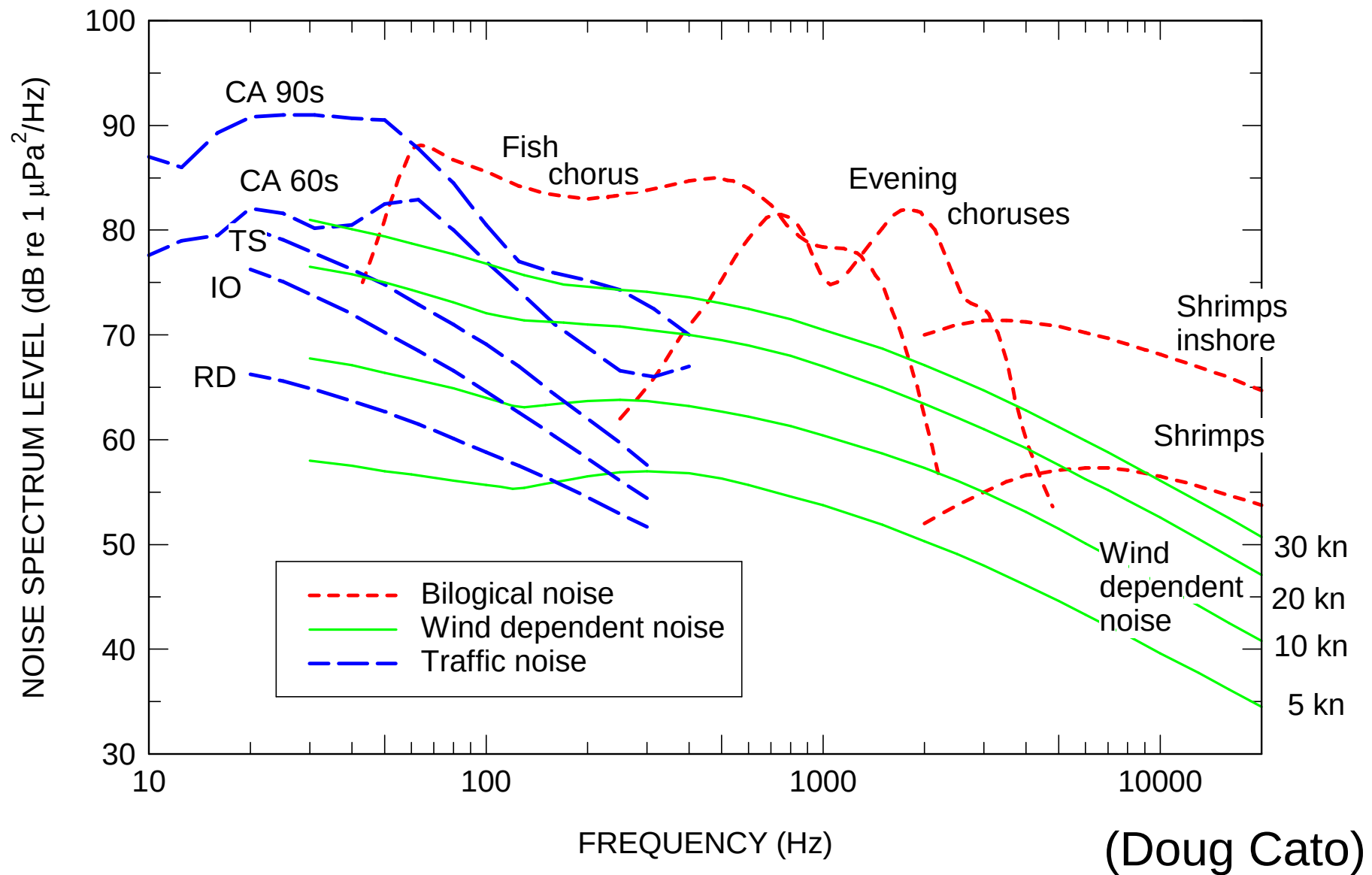
Linear Power



Same data:

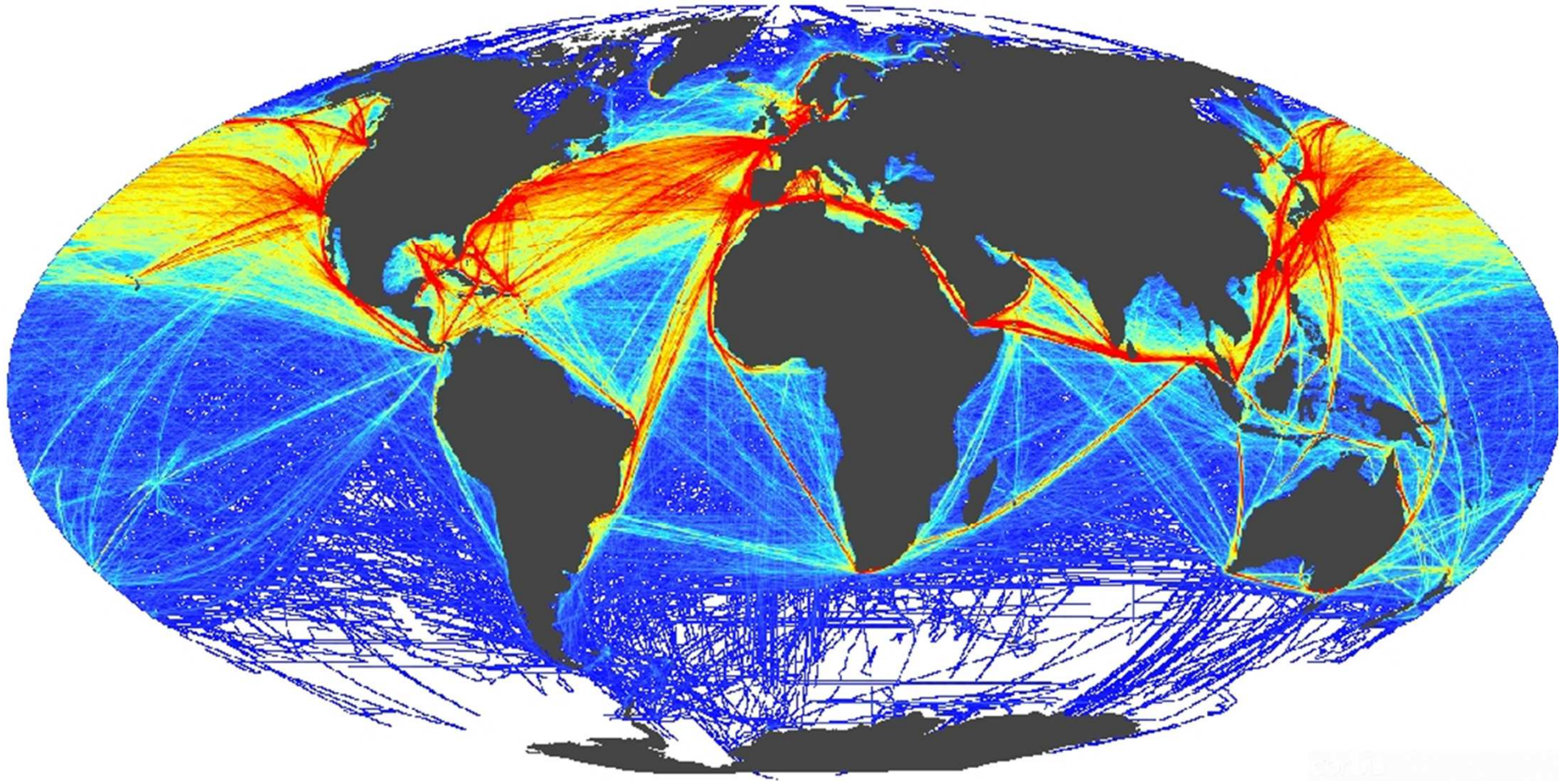
1/3 Oct SPL @ 6kHz





2. Quantifying the Marine Soundscape

- Modelling Soundscapes => later today



- Noise Effects on Animals => tomorrow



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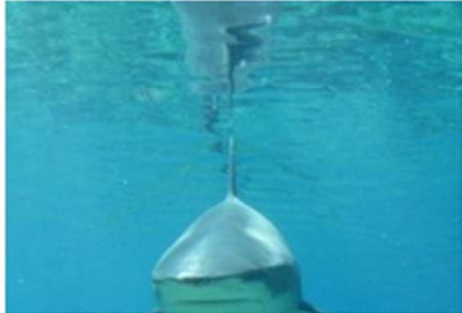
Welcome to the

Aquatic Acoustic Archive

This is a resource library containing searchable references to publications on

- underwater acoustics,
- ambient noise,
- anthropogenic noise,
- sounds made by marine animals.



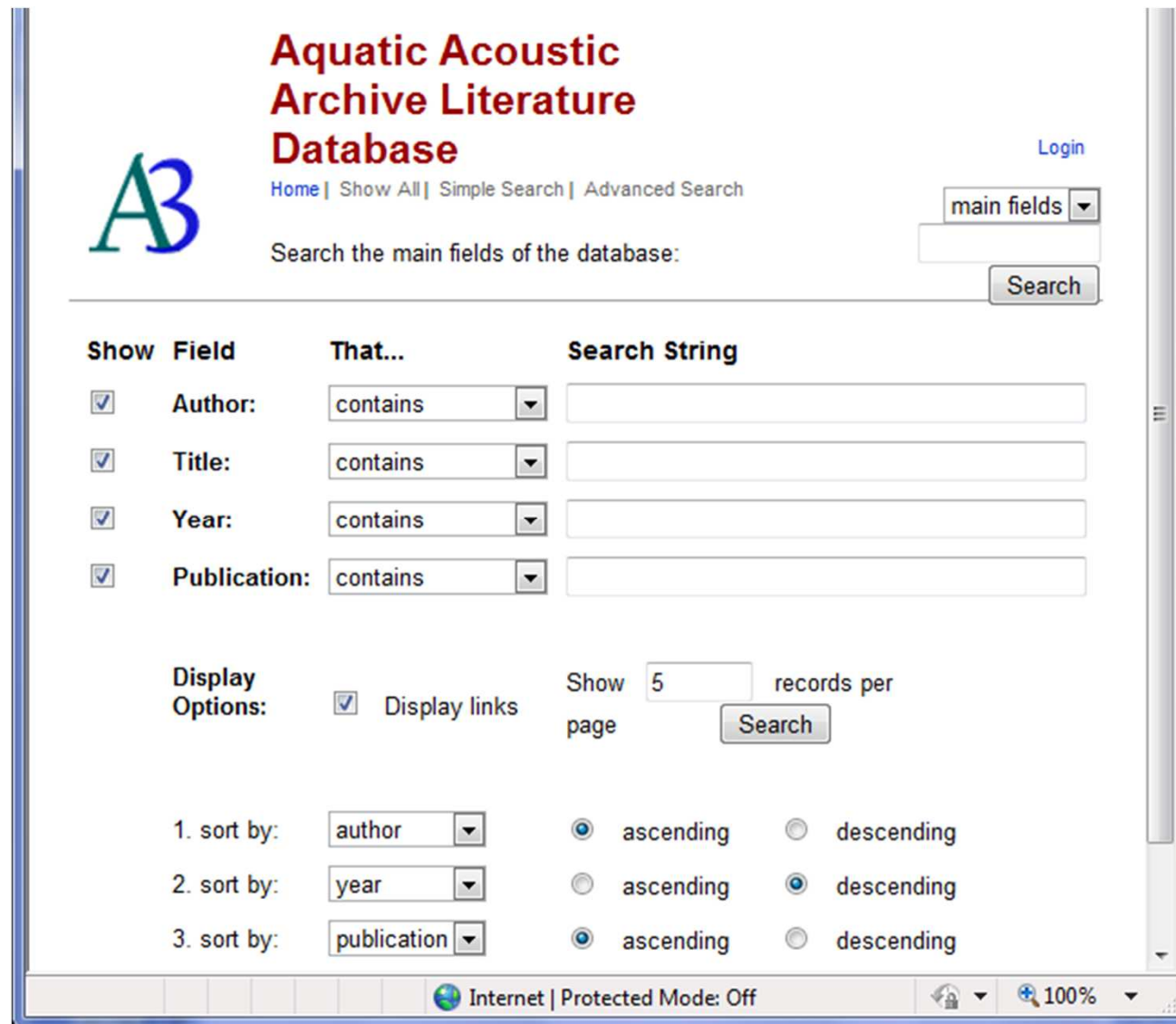


Done

Internet | Protected Mode: Off

100%

http://AquaticAcousticArchive.com



The screenshot shows the web interface of the Aquatic Acoustic Archive Literature Database. At the top, the title "Aquatic Acoustic Archive Literature Database" is displayed in red, with a logo "A3" to the left. Navigation links include "Home", "Show All", "Simple Search", and "Advanced Search". A "Login" link is in the top right. Below the title, there is a search box with a "main fields" dropdown and a "Search" button. The main search area is divided into four sections: "Show", "Field", "That...", and "Search String". Each section has a checkbox and a dropdown menu. Below this, there are "Display Options" including "Display links" and "Show 5 records per page". At the bottom, there are three "sort by" options: "author", "year", and "publication", each with "ascending" and "descending" radio buttons. The browser's status bar at the bottom shows "Internet | Protected Mode: Off" and a zoom level of "100%".

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Search the main fields of the database:

main fields

Show	Field	That...	Search String
☒	Author:	contains	
☒	Title:	contains	
☒	Year:	contains	
☒	Publication:	contains	

Display Options: ☒ Display links

Show 5 records per page

1. sort by: author ☐ ascending ☐ descending

2. sort by: year ☐ ascending ☒ descending

3. sort by: publication ☐ ascending ☐ descending

Internet | Protected Mode: Off 100%



Thank You !