Marine Optics and Acoustics Workshop Outline

Instructors:

1. Dr. David Barclay, Dalhousie University
2. Joe Hood, GeoSpectrum

In the marine optics and acoustics workshop, you will be introduced to the real-world applications for optics and acoustics, and their role in ocean research and ocean technology. You will have a chance to see and use ocean instruments and connect it back to outcomes in your classroom. Activities in this workshop include identifying noises under water, identifying sound frequencies and exploring the concept of refraction and why it is importance to be able to calculate index of refraction.

All of these activities are easily replicable for your class, and require minimal, easy to find, low-cost materials. This is an 80-minute workshop, but can be expanded to a whole module when teaching within the school.

Key Outcomes

- Develop an understanding of how light behaves in water
- Explore optics and acoustics technologies such as hydrophones and spectrograms
- Investigate how sound propagates in water
- Gain insight into how information can be transmitted and captured in water using the science of optics and acoustics

Key vocabulary

Optics, acoustics, sound propagation, refraction, Snell's Law, total internal reflection, hydrophone, spectrogram

Curriculum Integration Document

Topic	**Description of discussion or exploration**	**questions and probes**	**resources**
Intro Activity 1	**What are marine optics and acoustics?** Transmitting and receiving light and sound through marine water. Optics and acoustics allow us to see and hear far into the deep recesses of the ocean, where our human senses are unable to penetrate. Optics and acoustics provide access and observation of this un/under-explored part of our world Optics in the Ocean: Why is the ocean blue? Acoustics in the Ocean:	What are the applications for optics and acoustics in the real world? (ocean floor mapping, fish tagging, sensors, geological surveying, observing marine animals, underwater communication)	Bob Ballard clip -exploring the oceans https://www.ted.com/talks/robert_ballard_on_exploring_the_oceans?language=en
Sound Propagation	**Acoustics: What is sound?** How does sound travel? How does sound propagate in the ocean? **Reflection and refraction of sound**	What advantages are there to the propagation of sound in the oceans? (marine animals can communicate long distances, we can transmit audio information – and listen -long distances through the water, can detect nuclear explosions, track submarines, track marine animal movements or hear distress, can conduct seismic exploration, ocean mapping	https://www.youtube.com/watch?v=1V_mEc9lkMo (listening to dolphins with a hydrophone)

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Refraction of Light	**Optics: What is light?** What happens to light when it enters the water? **Snell's Law – refraction** How to calculate the index of refraction? What is reflection? **Jello investigation:** Guessing the index of refraction of jello using lasers. What is total internal reflection?	Does water behave differently in ocean/fresh water? Warm/cold water? What are the analogous applications of total internal reflection? (fibre optic cable, when the light bounces off a mountain perfectly and blinds you)	Jello Laser pointers
	Sights and sounds of the sea Natural sounds: Listen and view clip to explore how sights and sounds are captured and transmitted. Can you identify the following sounds? (e.g. pod of whales, ferry, dolphins, small boat, etc). Human-made sounds – listening activity	What do you notice about marine sounds? What other sounds might we encounter in the oceans? What potential impact could sound in the ocean have on marine life/on us?	Neptune Website http://www.oceannetworks.ca/ Live-stream from Neptune http://www.oceannetworks.ca/sights-sounds/live-audio/ http://www.oceannetworks.ca/sights-sounds/video http://apps.cwf-fcf.org/whales/?msg=submitted
Bubble Investigation	**Bubble Investigation** Even bubbles make sound – using an eye dropper, squeeze out a bubble. What is the frequency of the sound? Can you match it using a keyboard?	How do we listen in the ocean? (Hydrophone) How can we visualize sound in the ocean? (spectrogram). Compare ocean calls (audio) with spectrograms of the same calls.	Bubble solution Water tank Eye droppers Hydrophone keyboard

Instructor Bios

Dr. David Barclay

Dr. David Barclay is a new faculty member in Dalhousie University's Department of Oceanography and the Canada Research Chair in Ocean Technology system. He was recently a Deep Ocean Exploration Institute post-doctoral scholar at the Woods Hole Oceanographic Institution and an Office of Naval Research postdoctoral fellow in Ocean Acoustics. He has a B.Sc. in physics from McGill University and received a Ph.D. in 2011 from the Scripps Institution of Oceanography at the University of California, San Diego, where he built the instrument 'Deep Sound', an autonomous deep ocean profiler that has made ambient noise recordings at depths of 9 km in the Mariana Trench and at the bottom of the Tonga Trench (8.5 km). His research is focused on modeling and measuring the spatial and temporal properties of ambient noise. Accurate knowledge of ambient noise increases the ability to detect signals from biologic or anthropogenic sources embedded within the ocean's cacophony. Furthermore, the noise can be used to study the natural mechanisms that generate underwater sound and the properties of various oceanographic environments through which sound propagates. This includes the current study of surface noise generated by wind and rain in the deep ocean and continental shelf, surf noise, erosion, and interface waves in near shore regions, sediment generated noise in the Mississippi River, and anthropogenic noise at tidal energy sites. He currently supervises a lab with six graduate students studying various aspects of ambient noise, soundscapes, and underwater acoustic technology, measurements, and modeling.

Joe Hood

Joe Hood, Software Product Manager, is a computer engineer and retired military officer with an M.Sc. in Acoustics and Oceanography. He has 25 years experience hunting submarines and performing R&D to develop advanced sonar systems. He founded Akoostix in 2006, which was acquired by GeoSpectrum in 2014. Joe led the successful CICP (now BCIP) bid for TruView, which has become a coveted processor at the Acoustic Data Analysis Center (ADAC), while the core framework is used for GeoSpectrum's sonar processing.