Shouting Whales

Lesson C: Using Hydrophones for Research

Unit Questions	**Suggested Prior Lesson**
How is sound related to marine species survival? What is the relationship between a marine animal's soundscape, sound output, sound reception, and the overall survival and well-being of that animal?	Lesson B: Properties of Sound **Suggested Subsequent Lesson** Lesson D: Visual Representations of Sound
Lesson Question How does a hydrophone collect data? What are examples of hydrophone recordings?	
Grade Level 6-8	**Time Required** One session

Abstract

In this lesson, students explore how hydrophones detect sound in the ocean, and how the data collected from hydrophones can be used to understand what is happening in the ocean. Students will listen to hydrophone data, which will lead them into the following lesson in which they explore how to read hydrophone data.

Prior Knowledge/ Background for Students

Students will benefit from understanding the properties of sound, as well as what sounds may be encountered in an ocean environment. Students may also benefit from understanding how the Ocean Networks Canada network uses hydrophones. You may also need to remind students that sounds are created by vibration, and that all sounds we hear are caused by our brain's interpretation of vibrations. The lesson will focus on how we interpret sounds with our ears, even though we are visual animals.

Objectives	**Materials**	**Suggested Links and Downloads**
☐ Explore how hydrophones collect and convert sound data. ☐ Explore how researchers interpret hydrophone data, and what evidence they use to draw their conclusions. ☐ Explore how researchers draw conclusions about what they hear on hydrophones, by making educated guesses about different sounds.	☐ A coin ☐ An object to grab (something soft, such as a stuffed toy)	☐ *hydrophone 1.jpg* ☐ *hydrophone 2.jpg* ☐ *hydrophone 3.jpg* ☐ *icListen_3500m.jpg* ☐ *Orca Attack.mov* ☐ *Humpback and Dolphins.mov* ☐ *Humpback.mov* ☐ *Blue Whale.mov* ☐ *Snowmobile on Ice.mov*

The "Hook" (Suggested Introduction)

- ☐ Start by introducing the question: How is sound recorded? Your students may already know that sound travels as an energy wave, or that sound is caused by vibration, but how is this energy wave or vibration captured and recorded? We often describe sound as moving like ripples in a pond. How would you capture a ripple so that you could carry it around and show it when you wanted it? Encourage your students to think beyond "I would record it" and think about how they would capture each tone, sound, and harmony.
- ☐ After some discussion, make the question a bit more difficult by asking: How do we record sounds underwater? How do we hear things in the water, instead of just the water itself?
- ☐ Continue to shape thinking: How can hearing a sound be used as scientific data? How does monitoring sound help us locate objects and make hypotheses about the movement or condition of these objects? How might sound help a researcher better understand human/animal interactions and relationships?

- Ask the students if they know what a hydrophone is. Explain that it's an underwater microphone.
- Ask the students if they can describe what a hydrophone looks like. After some time, distribute the different images of the hydrophones (images *hydrophone 1.jpg* and *iclisten_3500.jpg*) and explain to the students that these are examples of hydrophones. Show them *hydrophone 2.jpg* and *hydrophone 3.jpg* and ask the students to consider how a singular hydrophone (*hydrophone 2.jpg*) has advantages and disadvantages over an array of three hydrophones (*hydrophone 3.jpg*) and vice versa.

Activity Outline

This lesson is set up in two parts:

- Part 1: How does a hydrophone work?
- Part 2: Examples of hydrophone recordings

(PART ONE) HOW DOES A HYDROPHONE WORK?

Activity	Resources	Teaching Points
"Human Hydrophone" Game	coin object to grab (something soft, such as a stuffed toy)	See "Activity Details" at the end of this lesson plan for complete description of this activity. This activity can be used to enforce the concept that hydrophones record sounds by detecting a pressure wave and creating an electrical impulse. Discuss with students: - Just like a hydrophone, the students didn't hear anything. Instead, they felt energy. The energy was recorded (the grab). Hydrophones don't "hear" – instead they record the movement of energy in water and a computer translates this energy into vibrations that our ears can hear as sounds. Hydrophones are sensitive enough to pick up and record the tiniest changes as sound energy.
Passive Acoustics	None	Have the students brainstorm: - What is the difference between passive and active acoustics? Active acoustics: when a device creates a sound signal and then waits for the returning sound. An example is sonar. Passive acoustics: when a device simply 'listens' for any sounds that go by. It does not use any sound signals to elicit a response. An example is a hydrophone.
Hearing vs. Seeing	None	Discuss with students: - Knowing that light does not travel very far in the ocean, why it is advantageous to use sound as an observation tool? - Low frequency sounds can travel for hundreds of kilometres under water. What further evidence would you need to know where a sound occurred? Can you know for sure where a sound occurred?

(PART TWO) EXAMPLES OF HYDROPHONE RECORDINGS

Activity	Resources	Teaching Points
What's that Sound? Clip 1	*Orca Attack.mov*	Play audio clip, *Orca Attack.mov,* for students (audio only, no visuals). Have the students try and identify three key moments or sounds in the audio clip. Use one of "Think/Pair/Share", "Mind Map", "Roundtable", or "Fishbowl". Have each group report what they thought were the key moments in the clip. Discuss as a class. Explain that in this video researchers confirm that a pod of orcas is attacking another animal. Exactly which animal remains unknown as researchers cannot see the animal, nor does it make species-specific noise. It could be a large baleen whale, or a seal. We cannot verify the sound with visuals, but it matches similar sounds recorded when orcas have been observed attacking an animal. Discuss with students: • Does this make the data any less meaningful? Why or why not? • What other instances can they think of where sound is used to diagnose behaviour? • Are there human examples when we can hear sounds and make inferences about what is happening?
What's that Sound? Clip 2	*Humpback and Dolphins.mov*	Play audio, *Humpback and Dolphins.mov,* for students. Discuss: • How many animals can they hear in the clip? • What parts of the audio lead them to their conclusion about the number of animals?
What's that Sound? Clip 3	*Humpback.mov*	Play audio, *Humpback.mov,* for students. Discuss: • What do students think this is? • What other animals might it sound like? • How can we use the location of the hydrophone to help us determine what animal this is? • What further information could we use to confirm our guess as to the animal?
What's that Sound? Clip 4	*Blue Whale.mov*	Play audio, *Blue Whale.mov,* for students. Discuss: • What might this sound be? • Tell students it's an animal and ask: What animal do you think of when you hear the sound? • Tell students it's the largest animal in the world and ask: What might it be?

What's that Sound? Clip 5	*Snowmobile on Ice.mov*	Play audio, *Snowmobile on Ice.mov,* for students. Students will likely hear the engine, but have them listen for ticking and crackling at the beginning of the clip. Discuss: • What might be the cause of the ticking and crackling sound? This is ice cracking, and is the biggest clue (other than the location) to the type of vehicle in the clip.

Researcher Interviews

Lesson C Interviews.mp4

Researchers interviewed:

- Tom Dakin
  ONC Innovation Centre (Sensors, Instruments, Technology)
- Amalis Riera
  Researcher, University of Victoria

Questions asked:

- What is a hydrophone?
- Are there different types of hydrophones?
- What are the ranges of low frequency and high frequency hydrophones?
- What have we learned about whales using hydrophones?
- Why do we use hydrophones to identify whales instead of photos or other forms of identification?
- Why do we use hydrophones to study whales?

Suggested Summary

Discuss with students:

- How does sound detection help us understand what might be happening in the ocean?
- Does a hydrophone help us determine the amplitude of sounds in the ocean? Why or why not?
- How does a hydrophone help us determine what kind of animals are in an environment?
- In what ways are we limited by hydrophones?

Show What You Know

Making a Reflective Piece	Make a Media Presentation	Take on a Role
Compare and contrast a hydrophone and a deep sea camera. Why is a hydrophone an important piece of ocean monitoring equipment? What are the advantages over a camera? What are the disadvantages?	Using graphic data, how would you explain how a hydrophone collects data? How would you demonstrate what can be learned from hydrophone data?	As a scientist, how would a hydrophone array help you better understand how whales behave and interact in an environment? You need to make a pitch to a company or group to receive funding to support your research. You must interest and engage the company by explaining what locations you would want to study and what kind of data you would want to collect and why.

Assessment Options

- Overall lesson assessment questions
  - Can the students make an informed decision about where to place a hydrophone?
  - Can the students determine how a hydrophone could help them in scientific whale research?
  - Can the students explain how a hydrophone collects data, and how this data can be used? For example, can they explain why a hydrophone can "hear" an earthquake even though our ears can't?
- Show What You Know
  - See: *Lesson C Show What You Know Rubrics.docx*

Activity Details

Human Hydrophone

This activity can be used to enforce the concept that hydrophones record sounds by detecting a pressure wave and creating an electrical impulse.

What to do:

1. Split the students into two groups.
2. Have students line up in two lines across from one another.
3. Place an object something soft and easy to grab such as a stuffed toy, at the end of the lines.
4. All team members will close their eyes and holds hands with the person on either side of them. (You'll have two lines, a few feet apart, of people holding hands.)
5. Stand near the front of the lines. Tell the students that the first student in each line represents the receiver in the hydrophone. So, there is one receiver per line.
6. The teacher will flip a coin. If the coin lands heads up, the receivers have detected a pressure wave. They will send this wave down their respective lines by squeezing the hand of the person next to them.
7. When the squeeze reaches the last person in line, they can open their eyes and grab the object.
8. The fastest team to send a squeeze down the line and grab the object wins a point and rotates players (i.e. the person grabbing the object comes to the front of the line and becomes the receiver, and everyone else shifts down to make room for the new receiver).
9. If the coin lands tails up but the squeeze signal still gets sent, that's another event (not a sound) and the team does not receive a point, nor do their players rotate.
10. Continue the game until one team has rotated all their players through the receiver position and is declared the winner.

In this activity/game the students are acting like a hydrophone. They feel a pressure wave (the squeeze) and turn it into a signal (the grab). The computer (the teacher) then interprets if this was a sound (a heads on the coin) or a something else (an incorrectly sent squeeze).