

Lesson D: Visual Representations of Sound

Unit Questions

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 Question

What does hydrophone data look like?
 How can visual representations of sound help our interpretation of hydrophone recordings and further our research?

Suggested Prior Lesson

Lesson C: Using Hydrophones for Research

Suggested Subsequent Lesson

Lesson E: Role of a Researcher

Grade Level

6-8

Time Required

One session

Abstract

In this lesson, students will look at data collected from hydrophones and compare between waveform presentation of data and spectrogram presentation of data. Students will differentiate between the two forms and discuss the value and limitation of each. Also, students will compare what they learn by ear with what they can learn by eye. Throughout the lesson, the students will hear various aquatic sounds collected from hydrophones on the Ocean Networks Canada network.

Prior Knowledge/ Background for Students

It is helpful for students to understand how sounds propagate through materials and how instruments and human ears detect them. Students will also benefit from an exposure to key sound terminology such as frequency, amplitude, harmony, and pitch.

Objectives

- ☐ Explore how we talk about sound in order to understand it (including terminology, science, and graphical representation).
- ☐ Explore the difference between a waveform and spectrogram as a way of analyzing sound.
- ☐ Discern situations when waveform would be of better use and when spectrogram would be of better use to analyze sound.

Materials

None

Suggested Links and Downloads

- ☐ *Biggs Killer Whale.mov*
- ☐ *K Pod.mov*
- ☐ *Humpback and Dolphins Waveform.mov*
- ☐ *Humpback and Dolphins Spectrogram.mov*
- ☐ *Earthquake and Sealion.mov*
- ☐ *Earthquake and Sealion (accelerated).mov*
- ☐ *Humpback and Sperm Whale Waveform.mov*
- ☐ *Humpback and Sperm Whale Spectrogram.mov*
- ☐ *Humpback Whale Harmony.mov*
- ☐ *Annotated Spectrogram 1.png*
- ☐ *Annotated Spectrogram 2.png*
- ☐ *Sei Whale.mov*
- ☐ *Lesson D Interviews.mp4*
- ☐ *Lesson D Show What You Know Rubrics.docx*

The “Hook” (Suggested Introduction)

- Play the audio clip *Biggs Killer Whale.mov* without showing the visuals, and ask students to draw a picture of what they think the sound looks like. Remind students that this is an exercise to get them thinking about sound, not a test, so they should draw it as best they can without worrying about what it might mean.
- Have the students discuss their drawings.
 - Which drawings do they think are the most successful at representing the sound?
 Tell them they will be asked to draw another sound.
 - What will they change about their first drawing to give more information?
 - What elements would they consider successful in a sketch of a sound? To ask in another way, what will their drawing need to reflect the elements of sound such as pitch, frequency, and intensity (loudness)?
- Play the audio clip, *K Pod.mov*, and ask them to draw this sound with as many scientific elements as they can.
- Discuss: Conceptually, can a picture of the sound help us better understand what is happening in a sound recording?

Activity Outline

In the activities described below, “Hearing and Seeing Sound 3” and “Hearing and Seeing Sound 4” may be omitted if time does not permit and/or if students understand the concepts presented and do not need further examples.

Activity	Resources	Teaching Points
Hearing Sound 1	<i>Humpback and Dolphins Waveform.mov</i>	Play the audio clip without the visuals and ask the students to try and explain how many animals they think are in the clip. What evidence do they point to in their decision? Hint: The students will not be able to tell the number of individuals in the clip, but they may be able to hear different species.
Seeing Sound 1: Waveform	<i>Humpback and Dolphins Waveform.mov</i>	<p>Play the video showing the waveform of the sound and ask the students to discuss what they see. For example: Do the visuals make it easier to notice when the different animals start signalling (making noise)?</p> <p>Explain to the students that this clip shows the energy of the sound over time. It does not show the pitch or frequency.</p> <p>Knowing that it shows energy over time, what conclusions can be drawn about the clip?</p>
Seeing Sound 1: Spectrogram (video and discussion)	<i>Humpback and Dolphins Spectrogram.mov</i>	<p>Play the video showing the spectrogram and have the students discuss how this is different from the previous clip. The sounds are the same but the image will have changed.</p> <p>Discuss with students:</p> <ul style="list-style-type: none"> □ This representation shows the frequency and pitch over time. In this clip, called a spectrogram, we can see the frequency of the sounds being made.

		<ul style="list-style-type: none"> □ Can they guess how many animals are in the clip knowing that one makes a high sound and one makes a very low sound? □ Researchers use spectrograms to look for signals in sound data.
Hearing Sound 2	<i>Earthquake and Sealion.mov</i>	<p>Play the audio once and let students listen to it. Discuss with students:</p> <ul style="list-style-type: none"> □ What are the squeaks at the beginning of the clip? □ What do our ears notice in this clip? □ What do they expect the spectrogram to look like?
Seeing Sound 2: Spectrogram	<i>Earthquake and Sealion.mov</i>	<p>Play the clip again, showing the students the spectrogram of the sound. Does anything surprise them?</p> <p>Explain that even though we can't always hear the sounds on the hydrophone, we can use the visual information to find other things, in this case an earthquake.</p>
Hearing and Seeing Sound 2: Spectrogram	<i>Earthquake and Sealion (accelerated).mov</i>	<p>Play accelerated version of the clip.</p> <p>Explain that this clip has been accelerated to allow us to hear the additional parts of the clip that are outside our hearing range. We can now hear the earthquake that we couldn't hear in the previous clip. Things we could already hear become accelerated as well (i.e. seal sounds are higher and "squeakier").</p>
Hearing and Seeing Sound 3	<i>Humpback and Sperm Whale Waveform.mov</i>	<p>Play the audio clip without visuals . Ask: What do we hear?</p>
	<i>Humpback and Sperm Whale Spectrogram.mov</i>	<p>Show students the waveform and spectrogram. Discuss.</p>
Hearing and Seeing Sound 4	<i>Humpback Whale Harmony.mov</i>	<p>Play the audio clip without visuals and ask the students to brainstorm what this clip might look like.</p> <p>Show the students the visual so they can see all the different harmonies.</p>
Snapshot from a Researcher	<i>Annotated Spectrogram 1.png</i> <i>Annotated Spectrogram 2.png</i>	<p>These images show a few examples of key features that researchers look for in whale calls. In both examples, the researcher has indicated known calls, and marked unknowns with '?'. </p> <p>Explain to students that researchers can't identify everything they hear. Marking unknown calls and then investigating further helps them to build their knowledge and make new discoveries.</p>

Discuss with students:

- ☐ How can visualizing the sound help researchers see if a call is known or unknown?

Optional:
What
Frequencies
Can We Hear?

Look online for a
“What Can You Hear?” app
and/or “Hear Like a Teenager”
app

Have the students test their hearing using the apps.
Discuss:

- ☐ Are some frequencies easier to hear than others?
- ☐ Is everyone’s hearing the same?
- ☐ Optional connection: What does noise pollution do to us?

Optional:
Hearing and
Seeing Sound
6

Sei Whale.mov

Have the students listen to the clip: What do they hear?

In this clip, researchers think they are hearing Sei whales, animals that have been hunted to extinction in BC waters. Although the animals have not been sighted, researchers think these sounds match known Sei whale calls.

Discuss with students:

- ☐ Do you think this is enough information to say that the animals are now in the area?
- ☐ What further evidence would be needed?
- ☐ How does seeing sound help us know more about the deep-sea environment?

Researcher Interviews

Lesson D Interviews.mp4

Researchers interviewed:

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

Questions asked:

- ☐ How do scientists understand and interpret the data from hydrophones?
- ☐ How is the information collected from a hydrophone represented?

Suggested Summary

Discuss with students:

- ☐ How does visualizing the sound (through either form) help us gain better insight to the use of sound in the ocean?
- ☐ Looking at whale calls, how would a waveform help us determine the amount of energy a whale is using in a call?
- ☐ How would spectrogram help us understand the differences in calls used by the whales?
- ☐ How can spectrogram help us understand the number of animals present? How might it help us determine differences among individuals?
- ☐ Could the spectrogram help us categorize different calls and vocalizations?

Show What You Know

Make a Written Piece

Explore: Once we have spectrograms, is it necessary to have the sound as well? Is it possible to analyze what is happening with just the images alone? Why, or why not?

Make a Media Presentation

Create a visual comparison of waveform, spectrograph data, and audio data. What are the key features of each that help researchers understand what they are hearing?

Take on a Role

As a marine biologist, how does spectrograph and waveform data inform your practice and enhance your understanding of noise in the ocean?

Assessment Options

- ☐ Overall lesson assessment questions
 - Can the students accurately indicate where low and high frequency sounds appear on a spectrograph?
 - Can the students articulate the difference between waveform and spectrograph, as well as expressing an opinion on the value of either?
 - Can the students answer questions such as: Why is it important to see sound as well as hear it?
 - Can the students explain how different sounds are identified in a spectrograph?
 - Can the students identify why sounds have many lines in the spectrogram display?
- ☐ Show what you know
 - See: *Lesson D Show What You Know Rubrics.docx*