

## Shouting Whales

### Lesson A: Human Sounds in the Ocean

<p><b>Unit Questions</b> 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?</p> <p><b>Lesson Question</b> What sounds do people make in the ocean and why?</p>	<p><b>Suggested Prior Lesson</b> Lesson F: A Whale's Perspective</p> <p><b>Suggested Subsequent Lesson</b> Lesson B: Properties of Sound</p>
<p><b>Grade Level</b> 6-8</p>	<p><b>Time Required</b> Approximately two sessions</p>

#### Abstract

This lesson explores noise in the ocean, with a special focus on human-made sounds. The lesson is divided into three sections, each focusing on a different intrusive sound. The lesson includes experiments, discussions, and sound clips that can be used collectively or independently. This lesson can be used as an introduction to noise in the ocean or can be used as a supporting lesson for understanding noise impact on whales. This lesson is intended to inspire an awareness of noise and its potential impacts in the ocean.

#### Prior Knowledge/ Background for Students

Students would benefit from a basic awareness of how humans meet some needs through using the ocean. For example, students should identify that many cities get goods shipped through global shipping lanes. Students will also benefit from examining animals that explore their environment through senses other than sight.

<p><b>Objectives</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Explore how humans create noise in an aquatic environment.</li> <li><input type="checkbox"/> Create a definition of noise pollution and begin to formulate ideas and thoughts around the impact of a disrupted soundscape.</li> <li><input type="checkbox"/> Explore how anthropogenic noise in the marine environment is potentially impacting animals that depend on sound for survival.</li> <li><input type="checkbox"/> Explore how researchers draw conclusions using audio data.</li> </ul>	<p><b>Materials</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> pen/paper for students</li> <li><input type="checkbox"/> four cans or jars</li> <li><input type="checkbox"/> spoons</li> <li><input type="checkbox"/> shoebox</li> <li><input type="checkbox"/> several objects</li> <li><input type="checkbox"/> straw or chopstick</li> <li><input type="checkbox"/> tennis balls or other bouncy throwing balls</li> </ul>	<p><b>Suggested Links and Downloads</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> <i>Bubble Effect on Seismic Air Guns</i> <a href="http://youtu.be/WpbIB3xToZ4">http://youtu.be/WpbIB3xToZ4</a></li> <li><input type="checkbox"/> <i>Seismic Airgun Surveys</i> <a href="http://ocr.org/portfolio/seismic-airgun-surveys/">http://ocr.org/portfolio/seismic-airgun-surveys/</a></li> <li><input type="checkbox"/> <i>Seismic Survey Blast and Dolphin Chatter.mov</i></li> <li><input type="checkbox"/> <i>Sonar Ping 1.mov</i></li> <li><input type="checkbox"/> <i>Sonar Ping 2.mov</i></li> <li><input type="checkbox"/> <i>Scientists "See" Ocean Floor via Sonar</i> <a href="http://youtu.be/-fAAxEIFeLU">http://youtu.be/-fAAxEIFeLU</a></li> <li><input type="checkbox"/> <i>Navy Sonar Blasts Whales (USS Shoup)</i> <a href="http://www.youtube.com/watch?v=Lcd5EU15y_4">http://www.youtube.com/watch?v=Lcd5EU15y_4</a></li> <li><input type="checkbox"/> <i>ACOUSTICS: Whales, Decibels, and Logarithms</i> <a href="http://www.youtube.com/watch?v=Yq6NRkr2LqA">http://www.youtube.com/watch?v=Yq6NRkr2LqA</a></li> <li><input type="checkbox"/> <i>Small Boat.mov</i></li> <li><input type="checkbox"/> <i>Mechanical Noise and Dolphins.mov</i></li> </ul>
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**The “Hook” (Suggested Introduction)**

- Before the task, ask a few students to set the alarms on their phones or watches. The idea is to have a few interrupting noises continue through the session during the task. Instruct the students not to answer the alarm, simply to let it ring.
- A few minutes before the alarms begin to go off, engage the students in a small thinking and/or writing task. The idea is to engage them in an activity, and then distract them with interruptive sounds. For example, you may want to ask them to:
  - Design an activity that can be performed at/by their school that will help raise awareness about the importance of protecting our ocean.
  - Discuss whether or not a nation’s responsibility for ocean health is tied to the economic stability of the nation. For example, should wealthier nations be more responsible than poorer nations for the health of the oceans since they have the means to pay for cleanup efforts?
  - Discuss the importance of charismatic apex predators in the ocean. For example, Orca whales have little economic value outside of tourism. Are they “worth” conservation efforts when the same amount of resources could be used to protect species with more economic benefit?
- Soon after the interruption, ask the students to reflect on the activity. Guide the discussion with questions that focus on how the noise impacted their performance and concentration during the activity.
- Ask and explore the questions: “How does the noise in your soundscape affect your life? How would you define your soundscape?” Have the students come up with their “best” definition of soundscape. Depending on your students, you may wish to explore this with:
  - Think/Pair/Share
  - Round table discussions (small groups)
  - Fishbowl discussions
  - King’s chair

These activities are described fully under “Exploration Activities” in *A Teacher’s Guide to Shouting Whales*.

**Activity Outline**

Start the body of the lesson by having a quick brainstorm. You can do this as a mind map, think/pair/share, or call out session with your students. Preface discussion with: Noise pollution is interruptive noise in an environment. What kinds of noise might be occurring in the marine environment that could cause noise pollution?

Explain that students will often hear the word “anthropogenic” used to describe interruptive noises. This word means “human caused”. In this lesson, students will explore anthropogenic noises in the marine environment, commonly called noise pollution. The students may be able to name some of the causes of noise pollution, and the remainder of the lesson explores three major impacts of noise pollution in detail.

**(PART ONE) SEISMIC AIR-GUN SURVEY**

Activity	Resources	Teaching Points
Acoustic Experiment: Where’s the Oil?	four cans or jars spoons	See “Activity Details” at the end of this lesson plan for complete description of this activity.  Ask the students to determine, using any tapping method, where the oil is in the cans.
Bubble Effect	Play this clip (no audio): <i>Bubble Effect on Seismic Air Guns</i> <a href="http://youtu.be/WpbIB3xToZ4">http://youtu.be/WpbIB3xToZ4</a> .	Discuss/ brainstorm answers to the following questions: <ul style="list-style-type: none"> <li><input type="checkbox"/> What has occurred in this video?</li> <li><input type="checkbox"/> Why does this occur?</li> <li><input type="checkbox"/> How might it impact an animal?</li> </ul>
Air Gun Surveys	Click on the weblink below and locate the following two video clips: <i>Seismic Airgun Surveys</i> <a href="http://ocr.org/portfolio/seismic-airgun-surveys/">http://ocr.org/portfolio/seismic-airgun-surveys/</a> <ul style="list-style-type: none"> <li><input type="checkbox"/> <i>Airgun and Echosounders</i></li> <li><input type="checkbox"/> <i>Source, NOAA Pacific Marine Environmental Laboratory VENTS Program</i></li> </ul> Local example: <i>Seismic Survey Blast and Dolphin Chatter.mov</i> (May use as audio only, or show the visual as well.)	Discuss the first video, <i>Air-gun and Echosounders</i> . WARNING, THIS VIDEO IS VERY LOUD. Some questions: <ul style="list-style-type: none"> <li><input type="checkbox"/> How would this impact an animal over the long term?</li> <li><input type="checkbox"/> Is there an acceptable amount of exposure for an animal?</li> <li><input type="checkbox"/> At what distance would you consider this safe?</li> </ul> Discuss the second video, <i>Source, NOAA Pacific Marine Environmental Laboratory VENTS Program</i> . Explain to the students that the videos and clips are examples of Seismic air-gun surveying. The second clip give an understanding of how often the blasts occur, but does not accurately represent the volume, as heard in the first clip.  Key features of air-gun surveys: <ul style="list-style-type: none"> <li><input type="checkbox"/> Seismic air guns are used to find oil deposits in the Earth’s crust.</li> <li><input type="checkbox"/> A blast of air is fired towards the sea floor and computers monitor the return echoes to determine what materials are in the substrate.</li> <li><input type="checkbox"/> The noise of an air gun is incredibly loud, and continues for weeks on end in 15-20 second intervals.</li> <li><input type="checkbox"/> Ships must make several passes in one area, often scaring marine life away and out of</li> </ul>

valuable habitat for extended periods.  
 Local example:  
 Play the clip, *Seismic Survey Blast and Dolphin Chatter.mov*. Although only one short clip, this is an example of a seismic survey blast that occurred off the coast of BC. Although we cannot be sure how close the dolphins were to the sound, it is very likely they were aware of it.

OPTIONAL:  
 Air gun inquiry

Encourage students to explore their own question about air gun surveys. Some examples to explore:

- How has air gun testing impacted marine mammals in the Gulf of Mexico?
- What efforts are in place to stop or drastically reduce air gun testing, and are these reasons well-founded?
- Are there other ways of exploring the sea floor to find oil deposits?

**(PART TWO) SONAR**

Activity	Resources	Teaching Points
Acoustic Experiment: How Does Sonar Work? <b>and/or</b> Acoustic Experiment: Sonar Demo – Sound Returns	shoebox several objects straw or chopstick  tennis balls or other bouncy throwing balls	See “Activity Details” at the end of this lesson plan for complete description of these activities.  You may choose to do one or both of these activities, depending on the time you have available and the prior knowledge of your students.  For “Acoustic Experiment: How Does Sonar Work?” using the straw or chopstick, students try to determine what object is hidden in their shoebox.  For “Acoustic Experiment: Sonar Demo – Sound Returns” Help a partner get as close to a wall by listening to the echo of the tennis ball. Partners protect each other from injury by intervening as needed.
Sonar Pings: What is That Sound?	<i>Sonar Ping 1.mov</i> <i>Sonar Ping 2.mov</i>	Play the recordings. Discuss and brainstorm: <ul style="list-style-type: none"> <li><input type="checkbox"/> What do the students think the sound is in the video?</li> <li><input type="checkbox"/> How might this sound (identified or not) impact the soundscape?</li> </ul>
Sonar	<i>Scientists “See” Ocean Floor via Sonar</i> <a href="http://youtu.be/-fAAxEIFeLU">http://youtu.be/-fAAxEIFeLU</a>	Key features of sonar: <ul style="list-style-type: none"> <li><input type="checkbox"/> Sonar is used to create a map of the sea floor; it essentially allows ships and large vessels to ‘see’ the sea floor and potential hazards.</li> </ul>

- Sonar works just like echolocation: a loud pulse of sound is sent from the ship and then the returning echoes are monitored and analyzed.
- Sonar pings can be heard for many miles, and repeat every few seconds.

Drawing  
Conclusions  
About Sonar

*Navy Sonar Blasts Whales (USS Shoup)*  
[http://www.youtube.com/watch?v=Lcd5EU15y\\_4](http://www.youtube.com/watch?v=Lcd5EU15y_4)

*ACOUSTICS: Whales, Decibels, and Logarithms*  
<http://www.youtube.com/watch?v=Yq6NRkr2LqA>

Compare the previous video to these two. All three comment on sonar in different ways. Have students draw conclusions about the quality of evidence used in each video and identify what questions remain unanswered by each party.

- What does each video tell us about sonar?
- What are the strengths and weakness of each video?
- How might sonar impact marine life?
- How might we mitigate this impact without jeopardizing the safety of ships? Could sonar be used in a range not audible to whales? How could we determine what tone this is, and how can it be enforced around the world?

OPTIONAL:  
Sonar Inquiry

Encourage students to explore their own question about sonar. Some examples to explore:

- What alternatives are available for sonar? Why is sonar the tool of choice when mapping the sea floor?
- Does sonar need to occur at a specific frequency? Would the impacts of sonar change if the frequency were beyond the audible range of whales? What evidence would researchers need to determine this?

**(PART THREE) SHIPPING NOISE**

Activity	Resources	Teaching Points
Shipping Noise	<i>Small Boat.mov</i> <i>Mechanical Noise and Dolphins.mov</i>	Play clips for students. <ul style="list-style-type: none"> <li><input type="checkbox"/> Discuss with students what they think is happening in the clip.</li> <li><input type="checkbox"/> What conclusions can they draw?</li> </ul>
World Shipping Routes	<i>World Shipping Map (2008).gif</i>	Show image to students. Discuss with students: <ul style="list-style-type: none"> <li><input type="checkbox"/> What does this map show?</li> <li><input type="checkbox"/> Do you think the map accurately represents the amount of shipping that occurs in a year?</li> <li><input type="checkbox"/> Should shipping lanes be as regulated as highways and land roads?</li> </ul>
Minimizing Shipping Noise		Key features of, and questions about, shipping noise: <ul style="list-style-type: none"> <li><input type="checkbox"/> Shipping remains a fast and expensive way to move goods. How might our dependence on</li> </ul>

overseas goods be impacting the marine environment?

- Most ship noise comes from the noise of the propeller and engine. More efficient props and engines have been found to be less noisy, yet they are not mandatory on ships. Why might this be?
- A ship's noise continues for long after the ship has been in the area. How could protected marine areas help create quiet zones for the whales?

## Researcher Interviews

*Lesson A Interviews.mp4*

Researchers interviewed:

- Tom Dakin  
ONC Innovation Centre (Sensors, Instruments, Technology)
- Lance Barrett-Lennard  
Research Scientist, Vancouver Aquarium

Questions asked:

- What is making sound, other than whales, in the ocean?
- How are whales affected by sound?

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## Suggested Summary

Discuss with the students:

- Can noise be considered a form of pollution? Based on what we know about the sounds we cause in the ocean, does this count as pollution? Why, or why not?
  - Explore: Is volume (amplitude) an important factor in noise pollution? Are quiet yet obtrusive sounds (such as beeping) considered noise pollution? Why or why not?
    - Consider trying this experiment. Have some students set alarms on their phones. After a few minutes have a few people (not all) turn them off. Keep turning off a few devices at a time until only one or two remain. Do the students feel that they could cope with the lesser sound compared to all the phones going off at once?
  - How important is geological exploration to the world economy? Although not currently occurring in BC, offshore oil and gas exploration could bring this testing to the BC coast. Which is more important, economic need or preservation of the aquatic environment? Similarly, shipping is excellent for the economy but hard on the acoustic environment. How can we improve the situation for both parties?
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## Show What You Know

**Make a Written Piece**

Discuss: Should all noise in the ocean be regulated? What will these regulations look like, and how will they be enforced? Which noises are the regulation intended to address, and how will it correct the issue?

**Make a Media Presentation**

Choose one of the causes of anthropogenic sounds in the ocean. Make a visual representation of the sound and explain its possible impact on marine ecosystems. Choose how to represent this information, and explain why you chose it.

**Take on a Role**

Set up a marine environment use council. Have students take on various roles. You may choose to assign these or have the students brainstorm their own (e.g. geological surveyor, ship captain, developer, naval officer, and environmental researcher). Ask the students to create a presentation on why they should be granted rights to work in the area. How will each group accommodate the needs of the others? (So, for example, the researchers cannot exclude the other users, and the other users cannot exist without a reasonable plan to limit their environmental impacts.)

**Assessment Options**

- Overall lesson assessment questions
  - Can the student articulate how human-made sounds are created in the marine environment?
  - Can the student develop hypotheses on why this may be a problem for marine animals, especially whales?
  - Can the student express an opinion on what is noise pollution, and is this supported by information?
  - Was the student participating in the lesson (asking questions, participating in discussion, etc.)?
- Show What You Know
  - See: *Lesson A Show What You Know Rubrics.docx*

**Activity Details****Acoustic Experiment: Where's the Oil?**

What you'll need:

- Several cans or opaque jars (empty soup or pop cans work well)
- Vegetable oil
- Water
- Sand or soil
- Flour
- Spoons
- A stopwatch or timer

What to do:

In this experiment, students explore how sound is used to find oil and gas deposits while exploring how sound impacts animals.

1. Fill each of the cans or jars  $\frac{1}{2}$  to  $\frac{3}{4}$  with one of vegetable oil, water, sand, or flour. Seal the cans with tape so that the students can't see which substances are in the jars (and so they won't spill).

2. Have the students tap the top of the cans with a metal spoon once a second for 30 seconds.
3. Using the sound the taps make, have the students guess which substance is in each can.
4. Explore the question: How can sound surveys help us determine where oil and gas deposits might be in the ocean floor?
5. As a possible extension, have a group of three students try and play “telephone”—whispering instructions from one to another—while a nearby group of students bangs on each of the cans/jars. What kind of impact did the noise have on the game?

### Acoustic Experiment: How does sonar work?

What you'll need:

- A shoebox with a line of holes punched in the lid. The holes should be about one centimetre apart
- Common everyday objects with distinctive profiles such as a shoe or rubber ducky
- A straw or chopstick (something that will fit in the holes in the lid)

What to do:

In this experiment, students explore how sonar is used to detect objects under the water.

1. Place an object in the box.
2. Have the students use the straws or chopsticks to probe the box using the holes in the lid.
3. Ensure the students follow the holes in sequence and record the depth in which the probe enters the box.
4. The data points should create a general profile of the item in the box.
5. Using the data collected from the probe, have the students guess which object is hidden in the box.

### Acoustic Experiment: Sonar Demo – Sound Returns.

What you'll need:

- A tennis ball (one per student)
- A blindfold
- Safety observer/ runner

What to do:

1. Head outside to an area with a large wall—likely outside the school's gym. The object of the activity is to try and get within 1.5 feet of the wall by listening for the sound of the tennis ball hitting the wall.
2. Explain to the students that sonar is used to determine where an object is by sending out a beam of sound and listening for the return echoes of the sound.
3. Have students get into pairs. In their group, assign one person to be blindfolded and one person to be the safety observer/ runner.
4. Have the blindfolded students line up about 10-20 feet from the wall, with a tennis ball.
5. Each blindfolded student throws the ball (underhand, safely) and then decides how many paces forward to take.
6. Their partners will help keep them safe, and collect the ball after they have thrown it.
7. Have each pair run through a few trials, trying to get to as close to the wall as they can.