



Underwater Acoustic Sound Monitoring

Middle School Scientists Curriculum

Investigation 2: Echolocation in Action!

Overview:

Students will engage in a listening game that simulates how killer whales use echolocation to find food in Glacier Bay. They will try to determine the location of nine sounds made from various locations around a circle – in front, behind, or to the side of them. The data collectors will record the results and the class will analyze the data. In the final round, students will be introduced to ambient noise to see how it affects the ability of the killer whales to locate their prey.

Background Information:

Marine animals rely on sound to acoustically sense their surroundings, communicate, locate food, and protect themselves underwater. Some predators, like orcas (killer whales) and dolphins, use **echolocation** to find prey. By emitting short pulses of sounds called clicks, these marine mammals listen for echoes to detect prey and navigate around obstacles. Similarly, some fish are able to hear the killer whale clicks and avoid capture! Because these animals live in a relatively dark environment, being able to “see” acoustically is important to their survival. Engineers have mimicked this natural echolocation in **SONAR (SOund Navigation And Ranging)** which works the same way as echolocation in animals.

Some blind people use sonar by listening to the echoes from taps of their canes to help them avoid objects or help them determine how far they are away from a wall.

Sound travels faster and farther underwater than through air. This means that sounds produced by marine animals and humans can travel great distances without much loss to the quality of the sound. These sounds are often reflected by underwater topography making it tricky to communicate using sound underwater. Marine mammals must be able to sort out all the echoes in the water in order to effectively communicate and feed. Whales and dolphin anatomy and sensory systems are adapted to meet this challenge.

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| Class Time Required | 1 class period (50 minutes) |
| Materials Needed | <ul style="list-style-type: none"> • Student journals, pencils, clipboards • Internet access • Echolocation Worksheet (1-2 copies) • Echolocation Bar Graph Worksheet (1-2 copies) • Indoor or outdoor space (at least 12 ft. x 12 ft.) |
| Teacher Preparation | 20 minutes to read background information, investigation |
| Prior Student Knowledge | Basic understanding of echolocation, predator-prey relationships |
| New Vocabulary | echolocation, sonar, sound source |
| National Content Standards | <ul style="list-style-type: none"> • NS.5-8.1 Science as Inquiry • NS.5-8.3 Life Science • NS.5-7.7 History and Nature of Science |

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While humpback whales do not echolocate, they do use sound to communicate and may use sound to navigate and find food. Glacier Bay is currently studying the effects underwater sound may have on the feeding behavior of endangered humpback whales. Research shows that whales may move away from preferred feeding areas when disturbed by boat noise. Repeated disturbances could be detrimental to Alaskan humpbacks, who must feed enough during the summer to sustain themselves through their 3,000 mile roundtrip migration to and from Hawaii. Additionally, increased ambient noise, or background noise, may make it difficult for humpback whales and other animals to communicate, find mates and more.

Focus Questions:

How do marine mammals use sound?

What are the most common human-made sounds heard in the ocean?

How might vessel noise affect the behavior (feeding, diving, respiration, resting) of marine mammals?

Why is studying underwater acoustics important to the survival of marine mammals?



Engagement:

(10 minutes)

Tell students they are going to hone their sense of hearing by using their hands to make “cups.” Teach them how to cup their hands around their ears facing forward, then backward. This will help focus sounds to their ears. Tell them it may be useful during the next investigation. Allow them to experiment with their new “ears” by trying to focus on a sound in the room. You can have a student go to the back of the room and clap.

Ask students to carefully listen to several underwater sounds from the clips provided. All of these sounds were recorded using the hydrophone in Glacier Bay. Listen to all six, so students will have the opportunity to discriminate between human-made, animal, and other natural sounds. As you play each clip, have students try to identify the **sound source** (what is making the sound) and write it in their journals. Ask students to explain experiences they’ve had with sound underwater.

Animal Sounds

[Whale Song](#)

[Glacier Bay Harbor Seal](#)

[Seabirds Calling at Sea Surface](#)

[Seabirds Diving at Sea Surface](#)

Other Natural Sounds

[Heavy Rain](#)

[Light Winds](#)

[Light Rain](#)

[Snowfall](#)

Vessel Noise

[Cruise Ship](#)

[Small Diesel Engine](#)

[State Ferry](#)

[Outboard Engine \(60hp\) at 20 Knots](#)

[Outboard Engine \(60hp\) at 10 Knots](#)

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Investigation:

(adapted from Teach Engineering—Echolocation in Action!, www.teachengineering.org)

(30 minutes)

Before you begin, copy the three activity worksheets.

[3 Echolocation Worksheets \(Round 1,2,3\) \(pdf.\)](#)

[Echolocation Bar Graph Worksheet\(pdf.\)](#)

1. Tell students that they will have a chance to experience echolocation for themselves. If you have a large class, you may want to divide them up into smaller groups of 10-12 students. Try to spread students and/or teams out as much as possible so that each team can focus on their own finger snapping noises without being distracted by other teams. Conducting this activity outside or in a school gym is ideal. Give a brief explanation of how killer whales use echolocation to find food. Then go over the activity. It will be conducted in three rounds.
2. Give each group a blindfold. One person will volunteer to be the killer whale, who will be blindfolded. If a student feels uncomfortable being blindfolded, just have him/her close their eyes. Another student will volunteer to be the data recorder. Give the data recorder three data sheets, one for each round. The data recorder will stand off to the side while the other students in the group form a large circle around the killer whale. Be sure students are spread out and not within arms' reach of each other or the killer whale.

Note: They will conduct this activity several times using natural ambient sounds and human-made ambient noise. The goal of this activity is to have students understand that there are many natural, animal, and human-made sounds in the ocean, but human-made sounds may have an impact on the behavior of marine mammals. In Glacier Bay, researchers are concerned about the impacts vessel traffic noise may have on endangered humpback whales.

3. Have student gently blindfold the killer whale so that she or he is unable to see. The other students form a big circle around the killer whale. The killer whale should stand facing the same direction for the duration of the activity. When the killer whale hears the sound, he/she will say whether the sound came from behind, side, or front. The data recorder will write down the results on the chart.
4. In the first round, students forming the circle should just snap their fingers when instructed by the data recorder. Following the Echolocation Worksheets (Round 1,2,3), the data recorder will point to a student who will then snap their fingers from the indicated location (front, side, behind). The student should snap their fingers, just one time.
5. The killer whale will say where she or he thinks the sound came from using the terms: front, side, behind. The data recorder will record the actual location on [Echolocation Worksheet Round 1](#) and mark if this was right or wrong. The data recorder will follow the data sheet for all nine locations as students in the circle snap while the killer whale tries to determine the location. The game is over when the data sheet is complete.

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6. The second round is the same as the first. If you'd like new students can be chosen to be the killer whale and data recorder. Make sure the data recorder has [Echolocation Worksheet Round 2](#).
7. In the third round the ambient noise of humming will be introduced. The killer whale will continue to try to discern the location of the finger snaps, but the other students will be humming. They can hum the same tune or each choose their own. They are creating ambient noise. Make sure the data recorder is ready with [Echolocation Worksheet Round 3](#). This is a great opportunity to discuss the difficulty in “sorting” sound. How might this influence a killer whales ability to use echolocation to find food? How did this ambient noise make them feel?
8. At the conclusion of Round 3, each group should have three sets of data sheets. Break them into smaller groups so that several students are working together to compile the data. Using the [Echolocation Bar Graph Worksheet](#), have students analyze their data. When all groups have completed their bar graph, have them share their results. If you have time, the class can make one giant bar graph.

Explanation:

(10 minutes)

Talk about the results and discuss why some locations were harder to guess than others. Did anyone use their “cups” to focus sound during the activity? Encourage students to think about why ambient noise made it harder to guess the location of the finger snaps. How might this noise affect marine animals? Why is it important for researchers to study sound in Glacier Bay? How could park managers eliminate or moderate human caused sounds that may disturb wildlife in Glacier Bay?

Extension:

Have students compile their data and make comparisons. Create one large chart or bar graph using computer programs like Excel or Word Charts/Graphs. For a more challenging activity, have students plot actual location of snap versus real location and then find the percent of correct responses.

Have students watch the short four-minute video, *Dean Hudson, acoustic navigator*. Dean is visually impaired and uses sound clues to navigate the city. Have several students wear blindfolds or close their eyes while making sound. They can either clap or snap their fingers. See if they can interpret the echoes to navigate around the room without bumping into objects or a wall. Be sure to give them plenty of space and use some students as monitors to help prevent trips or falls. Here is the link to Dean Hudson's video:

http://www.exploratorium.edu/listen/lg_dean.php

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References/Resources:

www.teachengineering.org—University of Colorado, Teach Engineering – Resources for K-12.

The Cornell Lab of Ornithology, *Effects of Human-Made Sound on the Behavior of Whales*

<http://www.birds.cornell.edu/brp/research/effects-of-human-made-sound-on-the-behavior-of-whales>

Bamfield Marine Sciences Centre Public Education Program

Oceanlink, An Ocean of Sound – An Exploration of Underwater Acoustics

<http://oceanlink.info/oinfo/acoustics/acoustics.html>

Exploratorium, The *Listen* Project.

<http://www.exploratorium.edu/listen/index.php>

National Education Science Standards Addressed: Grades 5-8

NS.5-8.1 Science as Inquiry

Abilities Necessary to do Scientific Inquiry (5-8):

- Identify questions that can be answered through scientific investigations. Students should develop the ability to refine and refocus broad and ill-defined questions.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Understanding about Scientific Inquiry (5-8):

- Current scientific knowledge and understanding guide scientific investigations. Different scientific domains employ different methods, core theories, and standards to advance scientific knowledge and understanding.
- Mathematics is important in all aspects of scientific inquiry.
- Scientific investigations sometimes result in new ideas and phenomena for study; generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All of these results can lead to new investigations.

NS.5-8.3 Life Science

Regulation and Behavior (5-8):

- All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.

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NS.5-8.7 History and Nature of Science

Nature of Science (5-8):

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.
- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theories, and the explanations proposed by other scientists.