



Underwater Acoustic Sound Monitoring

Middle School Scientists Curriculum

Investigation 3: On the Trail of a Whale

Overview:

Students will learn that humpback whales make different vocalizations. They will also discover how scientists can use technology to track whales by listening to their vocalizations. Students will engage in a role play activity that simulates the use of hydrophones. They will learn how researchers use sound to identify and locate individual whales by becoming whale trackers (hydrophones) and whales. Using their sense of sound while blindfolded, the whale trackers will use triangulation to pinpoint and identify individual whales. The playing area will be outlined using longitude and latitude lines along migratory routes from Alaska to Hawaii (not to scale). Students will actively collect data and record their results on the Whale Vocalizations Table.

For this activity, you will need a large area, such as a playground, field, or large gymnasium. If possible create a large outline of the Pacific Ocean using tape, rope, or cone markers. Use string, tape, or rope to designate longitude and latitude lines. The easiest way to mark the space would be to use cones and put longitude/latitude flags in the cones. The minimum space should be 5 feet for every 20 degrees of latitude.

Background Information:

Studying whales can be challenging. Whales are often in remote oceans where there are few boats. Whales spend most of their life underwater out of sight of people. Scientists had to find a different way to track whales.

Whales are very noisy and vocal animals. They sing songs, make audible blows, and communicate vocally during feeding and mating. Like people, whales also have different accents and voices. Some vocalize at a

Class Time Required	1 class period (50 minutes)
Materials Needed	<ul style="list-style-type: none"> • Student journals, pencils, clipboards • Internet access • Whale Migration Routes (1 per student) • Whale Vocalizations Table (1 per student) • Humpback Whale Photo Gallery (1 per group) • Whale Tracker Data Sheet (1 per group) • Large indoor or outdoor space • Yarn, rope, cones, or tape to outline activity area
Teacher Preparation	1 hour to read background information, investigation, copy data sheets, download vocalizations, and create floor grid.
Prior Student Knowledge	Basic understanding of sound. Familiarity with x-y coordinates, using longitude and latitude
Vocabulary	frequency, sound receiver, sound source, time of arrival difference, triangulation,
National Content Standards	<ul style="list-style-type: none"> • NS.5-8.1 Science as Inquiry • NS.5-8.5 Science and Technology • NS.5-8.7 History and Nature of Science

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higher or lower pitch, or sing faster or slower. Whale calls even have regional differences: humpback whales in the Southern Hemisphere sing a little differently than humpback whales in the Northern Hemisphere. Scientists can track whales by the unique noises they make.

Each whale, like anything that makes noise, is a **sound source**. Hydrophones can record the noise of the whales underwater. Using hydrophones, scientists can determine where whales are, how many there are, where they are going, diving depth, and more. However, scientists need accurate **sound receivers**. For humans, our ears are sound receivers. They are what we use to hear. Not only can ears hear, but they can also determine direction. Since our ears are on two different sides of our head, they hear things at slightly different rates. If the sound source is on the right side of a person, the person's right ear will hear the noise slightly before the left ear. This is called the **time of arrival difference** and allows us to determine which direction a sound is coming from. Sometimes a sound source may be the same distance from each ear and it is hard to determine where the sound comes from. If we had three ears, it would be easier, but no one has three ears. However, we can have three (or more!) hydrophones recording the same whale. Underwater listening stations in the North Atlantic and North Pacific can do this. Using a process called **triangulation**, scientists use the time of arrival difference between several sound receivers (hydrophones) to determine where a whale vocalized.

Focus Questions:

How do scientists record and analyze underwater sounds?

What can scientists learn about whales by listening to their sounds in the sea?

How can this information help scientists in their efforts to protect whales and other marine animals?

Engagement:

(15 minutes)

1. During this activity, students will listen to a variety of humpback whale vocalizations from the clips provided. Give students copies of the [Humpback Whale Photo Gallery](#) and [Whale Vocalizations Table](#). The images can help the students visualize humpback whales in their marine environment as you play the clips.
2. Play each audio clip. Have the students listen carefully to the different humpback whale sounds. Allow the students some time to write down descriptions of the sound on the Whale Vocalizations Table. They may use terms like grunt, groan, song, click, moan, etc. Discuss and record why they think the whale is making that noise.

Humpback Whale Vocalizations

[Whale Song](#)

[Feeding Call](#)

[Contact Call \(moo\)](#)

[Bubble net and Vocals](#)

[Wheeze-blows](#)

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Investigation: (30 minutes)

(adapted from *On the Trail of a Whale, Discovery of Sounds in the Sea and Searching for Sounds in the Seas*, Sea Grant Alaska)

Before you begin, make copies of the [Whale Tracker Data Sheet](#) for each group. Tell students that today they will have a chance to become whale trackers (hydrophones), whales, and researchers (data recorders). They will be using their sense of sound to identify and locate different humpback whales.

1. Mark out an open area with longitude and latitude lines. Every five feet should represent 20 degrees of longitude and latitude. Show students copies of the Pacific Ocean map and identify Alaska, North America, and Hawaii. While standing in the activity area, have them identify longitude and latitude lines by locating a given coordinate. Call out two coordinates and ask for a volunteer to stand on that coordinate. After students become familiar with navigating the map, designate five students to be whale trackers (hydrophones), five students to be humpback whales, and one student to be a researcher (recorder).
2. Students representing whales will each make a different, unique noise. Each student could make a different animal noise, say their name, sing a song, or (for an extra challenge) imitate a whale noise.
3. The whale trackers will listen to all five noisy humpbacks, but they will be trying to identify a specific whale. Blindfold each tracker or have them close their eyes.
4. The whales, each with their unique vocalization, will wander around the playing area making their noise. The teacher will choose a noise for whale trackers to listen for. They will try to track that whale. For example, if the teacher says track the whale making the feeding call, the trackers must filter out all other sounds and point in the direction of the whale making the feeding call.
5. When the whale trackers think they hear the given vocalization, they point in the direction of the whale. When three trackers are all pointing at the correct whale, the game stops and the researcher records the longitude and latitude of that whale on the Whale Data Sheet.
6. Repeat this activity for each whale vocalization, having students change jobs as needed.
7. After the activity is completed, the Whale Trackers should plot the detected locations of their whales on the Humpback Whale Migratory Routes page.

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Explanation:

(10 minutes)

Using technology, scientists can gather underwater sound data to help make informed decisions regarding current and future management policies. Use the following questions to help students reflect on the activity. What difficulties might scientists have using this method of gathering data? What can scientists learn by tracking whales?

Extension:

Have students compare their coordinates with actual humpback whale migration routes. Are they close? Discuss why these points are accurate/inaccurate to actual whale migrations.

References/Resources:

Sea Grant Alaska, Alaska Seas and Rivers Curriculum

<http://seagrant.uaf.edu/marine-ed/curriculum/grade-6/investigation-4.html?task=view>

Glacier Bay National Park and Preserve, Acoustic Monitoring Program

<http://www.nps.gov/glba/naturescience/acoustics.htm>

<http://www.dosits.org/> - This website will introduce you the science and uses of “Sound in the Sea.”

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.
- Communicate scientific procedures and explanations.

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.

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NS.5-8.5 Science and Technology

Abilities of Technological Design (5-8):

- Implement and propose a design. Students should organize materials and other resources, plan their work, make good use of group collaboration where appropriate, choose suitable tools and techniques, and work with appropriate measurement methods to ensure adequate accuracy.

Understandings about Science and Technology (5-8):

- Scientific inquiry and technological design have similarities and differences. Scientists propose explanations for questions about the natural world, and engineers propose solutions relating to human problems, needs, and aspirations. Technological solutions are temporary, technologies exist within nature and so they cannot contravene physical or biological principles; technological solutions have side effects; and technologies cost, carry risks, and provide benefits.
- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique.

NS.5-8.7 History and Nature of Science

Nature of Science (5-8):

- Scientists formulate and test their explanations of nature using observations, 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.