Underwater Acoustic Sound Monitoring

Middle School Scientist Curriculum

Investigation 1: The World of Underwater Sound

Overview

Students begin this investigation by watching the seven minute video, *Underwater Acoustic Monitoring*. In this video, researcher Chris Gabriele interacts with local students to answer questions about underwater acoustic monitoring in Glacier Bay. Students discuss their reactions to the video and then listen to sound clips of ocean animals and human-made sounds. This will familiarize them with sounds commonly heard in the ocean. This investigation demonstrates how humans and marine mammals rely on sound for communication and survival.

Class Time Required	1 Class Period (50 minutes)
Materials Needed • Student journals • Video and Vocabulary Worksheet (1 per student) • Internet access • Stick notes (10 per group or student) • Marine Mammal Photo Gallery (1 per student) • 2 safe locations where student can conduct a 1-2 minutes listening activity	
Teacher Preparation	20 minutes to read background information, investigation, preview video
Prior Student Knowledge	Basic understanding of sound and marine mammals
New Vocabulary	acoustics, ambient noise, anthropogenic, decibel, frequency, hydrophone, infrasonic, pitch, ultrasonic
National Content Standards • NS.5-8.1 Science as Inquiry • NS.5-8.3 Life Science • NS.5-8.7 History and Nature of Science	

Background Information

Sound travels in waves. Waves are rhythmic disturbances that carry energy through space, like water ripples traveling across a pond's surface. Sound waves can travel through different solids, liquids, and gases. The study of sound is called **acoustics** and researchers in Glacier Bay conduct underwater acoustic monitoring.

The ocean is full of sound, some natural and some **anthropogenic** (human-made). Most anthropogenic sound comes from boat traffic, especially large shipping freighters. Other human noise contributors come from industrial activities such as drilling, mining and military observations using **sonar**. In Glacier Bay, most boat noise is produced by small recreational boats, cruise ships, and tour boats. Other natural sounds you can hear underwater include, surf, rain, wind, underwater earthquakes, glaciers calving, fish, crustaceans, marine mammals, and more! These underwater sounds are heard and recorded by a **hydrophone**. Many marine animals, especially mammals, rely on sound to communicate, navigate, find food, and interact with their environment. By studying underwater sound and analyzing data, scientists are trying to understand how ambient noise, or background noise, may impact or alter the behavior of marine mammals and other ocean animals.

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Your ears allow you to hear sounds because they are caused by the vibration of objects. For example, your voice is produced by the vibrations of your vocal chords. The energy produced by these vibrations is carried to your friend's ears by sound waves. Loud sounds have more energy than soft sounds. The volume (or loudness) of a sound is measured in **decibels (dB).** The rustling of leaves measures about 15 dB while a jet plane taking off measures about 150 dB.

Wave **frequency** determines the **pitch** of a sound. Pitch is defined as the highness or lowness of a sound. The pitch you hear depends on the sound waves' frequency, how quickly the sound waves complete a wave. The higher the frequency, the higher the pitch, and the lower the frequency, the lower the pitch. Pitch or frequency is measured in cycles per second, or Hertz (Hz). For example, most people can hear frequencies from between 20 Hz to 20,000 Hz. Sound frequencies over 20,000 Hz are called **ultrasonic** waves and are out of our range of hearing. A dog whistle frequency is optimized to produce sounds above 20,000 Hz, which is inaudible to the human ear.

High frequency sounds do not travel very far in water because their wavelengths are short and the energy gets rapidly absorbed by water. Low frequency sound waves travel farther in water because of their longer wavelengths. Humpback whales produce sounds that are within the range of human hearing. Their songs can travel 20-30 kilometers or more. A blue whale produces **infrasonic** sound, which is well below our range of hearing. These low frequency waves can travel thousands of kilometers in water.

Focus Questions

What is underwater acoustic monitoring? What sounds can you hear underwater? Why is underwater acoustic monitoring important? How is sound important to marine mammal survival?

Engagement (15 minutes)

Pass out the Video and Vocabulary worksheet to each student and give them a few minutes to answer the questions prior to watching the video. Show students the video *Underwater Acoustic Monitoring*. As they are watching, the students should write down the researcher's answers to the questions. The video highlights current research in Glacier Bay National Park as researcher Chris Gabriele interacts with local middle school students. The interaction is question and answer format, allowing time to stop and start the video to solicit answers from students. In conclusion, review what the students already knew about sound and what they learned about sound and how scientists study underwater sound. Do they think noise sounds differently on land than under water? Invite children to close their eyes and listen. What sounds do they hear? How do they hear it? Remind them that sound is made when something vibrates. It pushes molecules in a medium (solid, liquid, or gas) to create waves. The waves travel to our ears, and vibrate our eardrums, which helps us hear.

Have students place their hands on the sides of their throats and hum, sing, or talk. Can they feel the vibrations? If possible, pluck a guitar string or rubber band to show them how sound vibrates.

Ask students if they ever threw a rock into a large pond. Upon hitting the surface, small waves move from the rock along the surface of the pond. Explain that this transfer of energy is how sound travels in all mediums whether a gas (air), liquid (water), or a solid. Optional: Can use dominoes to show how molecules transfer energy.

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Investigation (30 minutes)

1. Students will learn to hone their sense of hearing. Divide the students into groups of 3-4 students. Take the class or groups to two different locations where they will be exposed to different sounds varying in volume. Have them sit quietly for 2-3 minutes in each location. Mixing indoor and outdoor locations is ideal. Ask them to write a description of the sounds they hear at each location in their journals.
2. After students complete the listening activity, ask each group to share their results and write down at least 10 different sounds on individual sticky notes - one sound per sticky note. Allow five minutes for this.
3. While the students are completing this task, draw four columns on the board: Loud/Low Pitched, Loud/ High Pitched, Soft/Low Pitched, Soft/High Pitched. Ask each group to share their results and place their notes in the appropriate columns on the board. Discuss the various sounds students heard. Ask the students to associate feelings with the sounds they heard. Did some sounds make them feel happy, excited, annoyed, or afraid?
4. Play the five marine mammal audio clips for the class. Each clip is just one of many different vocalizations each mammal may make. If possible, keep the names or pictures associated with the clips a secret. These may be shown after the listening activity. This should be solely an auditory experience. Remind the students that they are ALL mammals. After each clip, ask students to write the name of the animal they think is making the sound, keeping the clips in order #1-5. You can also make a list on the board as a class. Have them describe the sound. Is it high pitched or low pitched? It is loud or soft? Can they make the sound? Why do you think that animal is making that sound? What do you think the animal is trying to say?

Marine Mammal Audio Clips

#1 Fin Whale	https://dosits.org/galleries/audio-gallery/marine-mammals/baleen-whales/fin-whale/
#2 Humpback Whale	https://dosits.org/galleries/audio-gallery/marine-mammals/baleen-whales/humpback-whale/
#3 Harbor Porpoise	https://dosits.org/galleries/audio-gallery/marine-mammals/toothed-whales/harbor-porpoise/
#4 Killer Whale	https://dosits.org/galleries/audio-gallery/marine-mammals/toothed-whales/killer-whale-orca/
#5 Harbor Seal	https://dosits.org/galleries/audio-gallery/marine-mammals/pinnipeds/harbor-seal/

5. After all the clips are played and students have had time to discuss, pass out the Marine Mammal Photo Gallery Sheet. Play the clips again and have them write the audio clip number (1-5) in the box beside the animal they think is making that sound. Discuss results.
6. Have them write a brief compare/contrast commentary in their journals on human versus marine animal sounds. How and why do we make sound? How and why do they think marine mammals make sound? How is sound important to the survival of marine mammals?

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Explanation (10 minutes)

After students listen to the sounds clips, they should have an understanding that animals rely on sound for communication. In addition to communication, have them discuss other ways marine mammals use sound for survival (locating and consuming prey, attracting a mate, avoid predators, navigation, interact with their environment).

Extension

"Try Listening For Yourself" activity. This link provides three audio clips of humpback whale vocalizations that will allow students to compare pitch and frequency. The site also provides in depth information on humpback whale song. Students can also link to this site and conduct this activity at home.

https://journeynorth.org/tm/hwhale/SingingHumpback.html

"Soundscape Constructor" activity. This link will allow students to construct their own soundscape by choosing their favorite sounds.

https://www.exploratorium.edu/listen/activities/soundscapes/deploy/SoundscapeConstructor.swf

Play additional sound clips of natural or human-made sounds heard in the ocean. Choose five clips from the list below that reflect a variety of sounds. Draw five columns on the board and write each sound at the top of each column. As you play the clips, have students write down what emotions they associate with each sound on sticky notes. When the listening activity is complete, have them place their sticky notes in the appropriate columns. Discuss the emotions they associated with the various sounds. In their journals, have students reflect on how this noise might affect marine mammals.

Ambient Noise	**Vessel Noise**
Heavy Rain	Cruise Ship
Light Winds	Small Diesel Engine
Light Rain	State Ferry
Snowfall	Outboard Engine (60 hp) at 20 knots
	Outboard Engine (60 hp) at 10 knots

References/Resources

Official Glacier Bay National Park website

https://www.nps.gov/glba/learn/nature/acoustics.htm

Discovery of Sound in the Sea Audio Gallery

https://dosits.org/galleries/audio-gallery/

This website will introduce you the science and uses of "Sound in the Sea."

https://dosits.org/

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.
- Develop descriptions, explanations, predictions, and models using evidence. Think critically and logically to make the relationships between evidence and explanations.

Understanding about Scientific Inquiry (5-8)

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models
- Current scientific knowledge and understanding guide scientific investigations. Different scientific domains employ different methods, core theories, and standards to advance scientific knowledge and understanding.
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanation until displaced by better scientific ones. When such displacement occurs, science advances.

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.

NS.5-8.7 History and Nature of Science

Science as a Human Endeavor (5-8)

- Women and men of various social and ethnic backgrounds – and with diverse interests, talents, qualities, and motivations – engage in the activities of science, engineering, and related fields.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry.

Nature of Science (5-8)

- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.