

Sounds of the Deep

Subject: Science

Grade Level: 4th – 6th Grade

Rationale or Purpose: This activity introduces the concept of echolocation in whales and their use of vocalizations to locate prey or other objects.

Materials:

- At least 1 computer with Internet access attached to a set of speakers
- Copies of data sheet at end of this lesson (one for every student)

Lesson Duration: 45 minutes

Source of Lesson: *Hot Science – Cool Talks* CD-ROM # 45: “The History and Future of Whales”

TEKS Objectives:

4th Grade Science

(2A) plan and implement descriptive investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology

(2B) collect information by observing and measuring

(2C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence

(2D) communicate valid conclusions

(3A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information

(3B) draw inferences based on information related to promotional materials for products and services

(3D) evaluate the impact of research on scientific thought, society, and the environment

(3E) connect Grade 4 science concepts with the history of science and contributions of scientists

(8B) compare adaptive characteristics of various species

5th Grade Science

(2A) plan and implement descriptive and simple experimental investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology

(2B) collect information by observing and measuring

(2C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence

(2D) communicate valid conclusions

(3A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information

(3B) draw inferences based on information related to promotional materials for products and services

(3D) evaluate the impact of research on scientific thought, society, and the environment

(3E) connect Grade 5 science concepts with the history of science and contributions of scientists

(7A) classify matter based on its physical properties including magnetism, physical state, and the ability to conduct or insulate heat, electricity, and sound

(8D) verify that vibrating an object can produce sound

6th Grade Science

(2A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting and using equipment and technology

(2B) collect data by observing and measuring

(2C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence

- (2D) communicate valid conclusions
- (3A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information
- (3B) draw inferences based on data related to promotional materials for products and services
- (3D) evaluate the impact of research on scientific thought, society, and the environment
- (3E) connect Grade 6 science concepts with the history of science and contributions of scientists

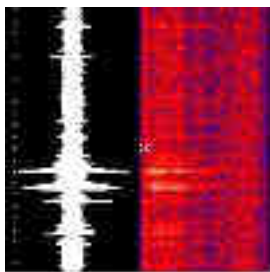
Background Information:

Vocalizations like clicks and songs are used not only for communication, but also for bouncing the sound waves off prey or other objects to locate them in ocean waters. This bouncing of sound from a source, to an object, and back to the source is called **echolocation**. Examples of mammals that use this cool method of prey location are whales, dolphins, and bats.

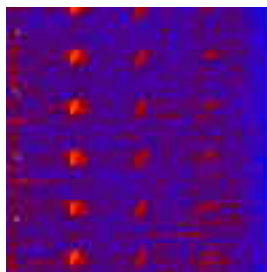
Sound is a vibration or wave of air or water molecules caused by the motion of an object. Each molecule moves back and forth only a very small distance, but it pushes molecules next to it causing them to vibrate. This wave of vibration is made up of areas where the molecules are pushed close together next to areas where they are farther apart (known as compressed and rarified areas). These compressions and rarefactions (but not the molecules) move outward, away from the source of the sound. These vibrations can bounce off of objects. Whales can determine the length of time it takes for their sound to hit an object and bounce back to them. As they approach a prey, like a school of Atlantic Cod, their sound bounces back faster, thus they know they are approaching their prey.

Sound wave units are described in terms of frequencies which are measured in cycles per second or Hertz (Hz). The higher the frequency, the higher the pitch will be. Conversely, the lower the Hz, the lower the pitch. Humans have an average hearing range of 20Hz to 20,000Hz. Blue whales can emit very low sounds; so low that humans cannot hear some of the song! Scientists can record blue whale song, but in order for humans to hear the song, the scientists must speed up the recordings so we can detect it.

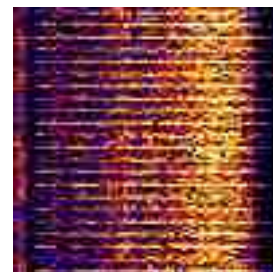
The bottom of this page shows examples of **spectrograms** (visual representations of sound in terms of time versus frequency) from the National Oceanic and Atmospheric Administration (NOAA)'s acoustic monitoring program.



Seismic waves



Blue Whale



Human air guns

Engage:

1. At the start of this lesson, play Blue Whale song clips (www.pmel.noaa.gov/vents/acoustics/sounds_whales.html)
2. Ask the students what animal they think is making this sound.
3. Ask the students how they think whales are able to emit these sounds. Do they open their mouth and shout it? Do they hum songs through their blow hole?
4. Ask the students why they think whales make these sounds. Are they attracting a mate? Are they looking for food?
5. Show students a short video clip of whale songs from *The Secret Lives of Whales* (www.stanford.edu/group/Palumbi/microdocs.html#secret).
6. **Demonstration of Echolocation:** Conspire with 2 students ahead of time in preparing for this front-of-class demonstration. One student will be blindfolded and will snap once to locate its “prey.” The other student will walk around him/her and make one snapping sound in response to the blindfolded “predator.” The blindfolded student will try to “locate” its prey by moving slowly toward the predator until they get close enough to reach their prey.

Procedure:

Using NOAA’s whale sound collection (www.pmel.noaa.gov/vents/acoustics/sounds_whales.html), have students write in their journals based on scientific inquiry about these particular songs. You may wish to use the data table located at the end of this lesson to guide the student’s thinking about whale song analysis.

Ideas for Data Collection and Analysis:

- You may want your students to keep a journal, recording their predictions, diagram of the sound wave demonstrations, etc.
- Concept mapping of the how echolocation can be applied to another mammal: the bat
- Encourage questions and connections

Sources:

National Geographic’s “Xpeditions”:

www.nationalgeographic.com/xpeditions/lessons/08/g68/ccwhalesounds.html

National Oceanic and Atmospheric Administration’s Vents Program in Acoustic Monitoring:

www.pmel.noaa.gov/vents/acoustics/sounds_whales.html

Name: _____

Whale Song Analysis Chart

Directions: Listen to each whale song as your teacher plays them. Write down characteristics about each one.

Type of Whale	Characteristics
Blue Whale - Northeast Pacific Ocean	
Blue Whale - West Pacific Ocean	
Blue Whale - South Pacific Ocean	
Blue Whale - Atlantic Ocean	
Fin Whale - Atlantic Ocean	
Fin Whale - Pacific Ocean	
Humpback Whale - Alaska	
Minke Whale - Atlantic	

Mystery Whale - Do you think it may be a Blue, Fin, Humpback, or Minke Whale based on characteristics you described earlier about each species' song?	

- 1) Why do you think Blue Whales sound different in different oceans?

- 2) Why do you think whales make songs?

- 3) Why do scientists study whale songs? Why would this information be useful in studying whales?

- 4) Why do you think different whale species (like the Fin vs. the Blue) have different calls?

- 5) What changes have occurred in the oceans that affect how far whales can hear other whales?