**Science Unit:** ***Animals, Matter, and Mankind in the Environment***

**Lesson # 2:** ***Water, Whales and Sound***

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| Summary | Students learn about **sound** and use a modified **game of "telephone"** to explore how sound differs when travelling through air and water. They also conduct a **movement activity** to simulate how **boat noise** can affect **killer whale** foraging and communication. |
| School Year: | 2013/2014 |
| Developed for: | Renfrew Elementary School, Vancouver School District |
| Developed by: | Sheila Thornton (scientist); Jessica Wersta-Duncan and Lucia Bildstein (teachers) |
| Grade level: | Presented to grade K/1/2; appropriate for grades K-4 with age appropriate modifications |
| Duration of lesson: | 1 hour and 20 minutes |
| Notes: | This lesson requires students to move around in an open space and involves shouting and loud noises; therefore, a gym or school ground is recommended. |

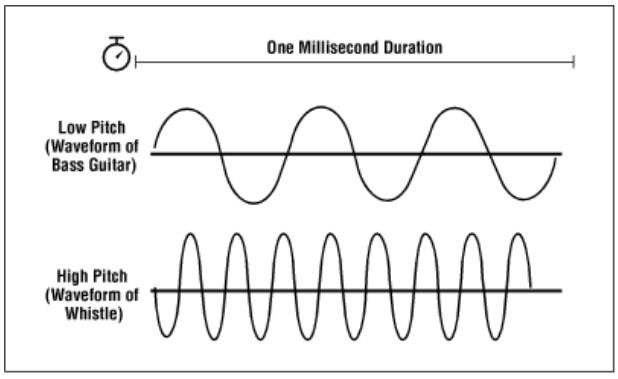
## Objectives

### Students will be able to:

1. Understand how sound moves through air and water
2. Learn the words that are used to describe sound waves (amplitude and frequency)
3. Discover how different animals hear and make sounds
4. Explore how the environment can affect how animals communicate through sound

## Background Information

Sound is a form of energy that travels in invisible waves. Vibrations transmit energy through matter (air, water, solids), moving molecules in the form of waves. When a vibration travels through the air and into the ear canal, it vibrates the eardrum and we recognize it as *sound.* Just as the vibration of vocal chords creates our voice through sound waves, vibrations are produced when a dog barks, or when a cat purrs. Some animals produce vibrations through non-vocal means to communicate (echolocation in a dolphin; crickets rubbing their legs together; tail slaps of a beaver or whale).




These sound waves may be small or large in **amplitude**, which results in quiet or loud sounds. They may also be high or low **frequency**, which relates to the pitch (long, low frequency waves are "deeper", low-pitched sounds; short, higher frequency waves are perceived as higher-pitch sounds).

When the molecules in the environment are moving from many sounds, it becomes difficult to separate out the signals and figure out which ones are coming from which source.

### Vocabulary

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| Vibration | A rapid back-and-forth movement |
| Frequency | The number of wavelengths per second – relates to the pitch of a sound |
| Amplitude | A measure of the height of a sound wave – relates to loudness of a sound |
| Communication | The act of transferring information from one place to another |
| Echolocation | Navigation using sound waves |
| Foraging | The act of finding food |
| Impacts | Negative consequences of actions – not always on purpose |

### Materials

- Skipping rope or length of cord
- Whistle
- Laminated cards with images of Chinook, killer khales, pleasure craft, container ships, oil carriers

## In the Classroom

### Introductory Discussion

**1. Give a brief introduction to sound.**

- Review or introduce the concept of “matter”.
- What is sound and how does it travel? How does matter affect sound travel?
- How far do you think sound travels? Close your eyes and report on what you can hear.
- What factors do you think will make sound travel further? Will high sounds travel further than low sounds?
- Use a skipping rope to demonstrate sound waves and introduce the terms “frequency” and “amplitude”.

**2. Sound moving through matter**

- Remind students of the difference between gases and liquids.
- Ask students to demonstrate the difference between sound moving through water and air using a modified “telephone” activity:
  - Have the students form two lines of equal numbers of children – one standing immediately behind each other to represent liquids, the second standing approximately arm’s length from the person in front of them to represent gas.
  - Teachers simultaneously whisper a sentence to the child in the front of each line and ask them to whisper it to the person behind them (e.g., “Killer whales have big dorsal fins”).
  - Measure how long it takes the sentence to reach the end of the line (should be faster in the children standing closer together, demonstrating more rapid transmission of sound in water).
  - Sentence moving through “water” is usually faster, and more accurate transmission of the sound than the sentence moving through “air” (whispering from arm’s length often leads to loss of accuracy).
  - Switch lines (gas becomes liquid, liquid becomes gas) and repeat with a new sentence.

**3. Killer whale sounds, foraging and ocean noise**

- The ocean is a noisy place. Even without any sounds made by human activities, there are many sources of sound in the water - for example, rain (think about being inside a tent or in your house when the rain falls); other organisms (you would be VERY surprised to hear how much noise a scallop can make!); wind and waves on the surface of the water.
- Killer whales have evolved or adapted to communicate effectively in the presence of natural noise levels, but when the noise in the environment is increased through events such as shipping, pleasure boats, construction, etc., animals may have trouble communicating.
- In addition to communication, killer whales use sound waves to locate their prey (primarily Chinook Salmon). Using sound waves to forage or hunt for prey is a form of "echolocation".
- The Southern Resident Killer Whales are an endangered group of killer whales, consisting of 3 pods (J-pod, K-pod, and L-pod), that are often seen in the waters off southern Vancouver Island, around Georgia Strait and the San Juan Islands. (In 2014, there were only 80 animals in that population).
- The main shipping channel for ships entering and leaving from ports in the Lower Mainland runs right through the middle of an important feeding area for killer whales. In addition, in the summer months, hundreds of whale watching boats and pleasure craft may surround a pod of whales. When the ocean is noisy, killer whales may have trouble communicating with each other, or may find it difficult to locate prey.
- Encourage discussion on the possible effects of excessive noise in this environment.
- As our demand for goods increases, shipping also increases, as many of the items we purchase are manufactured overseas (electronics, video games, cell phones, cars, toys, plastics, etc). Do you think there is anything YOU could do to reduce the number of ships that are required? (Lead discussion to the concept that reducing/reusing/recycling of goods will reduce demand for overseas goods.)

**Science Activity**

**Activity Title:** Ocean Noise

**Purpose of Activity:** Emphasize the fact that many aquatic animals depend on acoustic signals (both sent and received) in order to undertake daily activities such as navigation and feeding and foraging.

**Observations:** The effects of ocean noise on communication/echolocation and foraging.

**Instructions:**

***Round 1:***

1. Randomly assign students to a group by giving them laminated cards identifying them as a killer whale pod (J pod, K pod or L pod), or as a Chinook salmon.

2. Ask students to spread out around the gym, saying the name on their card (e.g., "J pod" or "Chinook") every 30 seconds. (Students should use a normal speaking voice – no shouting or whispering.) Instruct the "whales" to find the other members of their pods by listening to the other students. Ask Chinook salmon to avoid the whales.

3. Once the whale pods are reunited, ask students to hold hands and work on "foraging" for Chinook. If appropriate for your group, you can dim the lights in the gym and ask students to focus on "seeing" with their ears, rather than their eyes.

4. Hold a brief discussion**:** Have the students sit down for a brief discussion on their experience of "seeing" other pod members and foraging for Chinook, using their sense of hearing rather than sight.

***Round 2*:**

1. Reassign the students to new groups and run the simulation again. This time, add a number of "ships" and "pleasure boats" to the activity. (Adults may want to assist in filling this role.)

2. Instruct students who are pleasure boats to make a constant "pthththth" motorboat sound, and those that are ships to make a long, low, constant sound (a low, drawn-out "boh" sound works well).

**Final Discussion**

- Ask students to see if there is a difference in the time it takes for whale pods to reunite, or if there is a level of difficulty in finding Chinook with the presence of vessels.

- Ask the students to *observe any changes they made in their behaviour* in the presence of vessel noise (most will indicate that they had to call out their names more loudly, or had trouble hearing the other pod members or the Chinook).

- Explain that when whales are subjected to disturbance from vessels, their calls are louder – this is termed the *Lombard effect.* Ask the students if they used the Lombard effect to attempt to overcome the disturbance and if they thought it was an effective strategy.

- Ask the students to *compare the time it took to locate pod members* in the presence or absence of vessel noise.

**References**

**Ocean noise and animal sound production:**
http://www.dosits.org/animals/soundproduction/ (site contains information on sound production, recordings of underwater sounds, such as crabs or scallops, etc)

**Killer whales:**

http://www.whaleresearch.com/ - !about-orcas/c1qa8
http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/killerwhale.htm
http://www2.epa.gov/salish-sea/southern-resident-killer-whales