Unit 2. Lesson 5. Noise Pollution

Objectives: Upon completion of this unit, students will understand that noise pollution is more than loud noises. They will also learn what causes hearing damage and that animals, as well as humans, are subject to hearing loss.

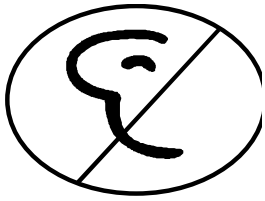
Vocabulary words: litter, pollution, loudness-related hearing loss, blast trauma

What is Noise Pollution?

Litter on the side of the road, junk floating in the water, and smokes spewing into the atmosphere from factory smokestacks are obvious forms of **pollution.** There are other types of pollution that are not as obvious. **Noise pollution** is one form. What is noise pollution? It is defined as sounds, or noises, that are loud, annoying and harmful to the ear. Often, sound pollution is thought to be a sound so intense that it could shatter glass, or crack plaster in rooms or on buildings. That is not so. It can come from sources such as jet airplanes, constant droning of traffic, motorcycles, high-power equipment, or loud music.

How is Noise Pollution Harmful?

Sound energy is transferred through compressions and rarefactions. (Reference lesson 1, if necessary.) If the intensity is very large, it can harm human and animal ears, and do damage to physical structures.



When sound reaches the human ear, it causes structures to vibrate. Intense vibrations can rupture the eardrum, but more often, **loudness-related hearing loss** usually develops over time. When sound enters the ear, it is transferred to the brain as a nerve impulse. Each nerve is composed of tiny nerve fibers, surrounded by special fluid within the ear. When intense sound is transferred (as

compressional waves) through the fluid, the tiny nerve fibers are destroyed, and hearing loss occurs. Sounds in the frequency range of 4,000 to 20,000 Hz cause most of the damage to the nerve fibers.

Noise pollution sometimes requires legal intervention because it can be harmful. The laws have been created because loud sounds can damage the ear, not only in humans, but also in animals.

Hearing Loss in Humans and Marine Mammals

Background noise in the ocean, including the noise of ships and other industrial activity, can interfere with marine mammals' use of sound for hunting, navigating, and communicating. This is called **masking.**

Noise trauma is another impact that results in declined hearing ability in marine mammals. Sudden and long or repeated exposure to high frequency sounds can cause permanent hearing loss. Sudden onset of intense sounds can also induce trauma. One of these sounds would be the sudden revving of a boat engine from idle to full speed. The motor makes a very sharp and distinctive change in sound.

Another injury that marine mammals suffer from is **blast trauma**. This results from a single exposure to a sound that has an explosive shock wave. The shock wave has a compressive wave phase carrying much energy through the water quickly. The pressure rises much higher than normal for a few seconds, and then drops quickly to levels below normal. This is much like the feeling that humans have during the ascent and descent of airplane; although it is much, much faster. So fast, that it causes damage to the ear of marine mammals. The damage may or may not be reparable.

Specifics of Hearing

The ability to hear is at its peak at birth. From there, it decreases with age. This is called degenerative hearing loss, or degeneration. Humans are born with a hearing range of 16-30,000 cycles per second. The measurement of cycles per second is also called **hertz**. A cycle per second refers to the number of times per second that the mallet in the ear touches the eardrum, and transfers information. By the age of twelve, that has declined to approximately 20,000 cycles per second. Grandparents at the age of 50 and older might only hear 4000 cycles per second.

In marine mammals, the ability to hear high frequencies is the first hearing loss to occur. Remember, many marine mammals hear and detect sounds that are much higher and lower than the human ear can detect. Loss of high frequency hearing in marine mammals could result in the animal losing its locating ability, and its ability to detect food or predators.

It is commonly thought that all animals suffer from degenerative hearing loss. The ability to hear is at its peak at birth. From there, it decreases with age. Outside forces act strongly on hearing loss. Some forms of these include:

- Drum punctures (perhaps from pressure).
- Ringing resulting from fever, tumors, and circulation changes.
- Infection (usually middle ear in the Eustachian Tube)
- Bone overgrowth
- Loudness

All of these forms of hearing loss can be applied to marine mammals and humans. Unfortunately, marine mammals have a few more problems to contend with.

- β Underwater shock waves
- ► Underwater explosions (perhaps missile testing, or from mining)

And last but not least:

- Motor boats of all kinds.

Activity 5-1. How Loud is Too Loud?

Use the diagram found in the Student Activity Sheet for this unit to answer the following questions.

How Loud is :

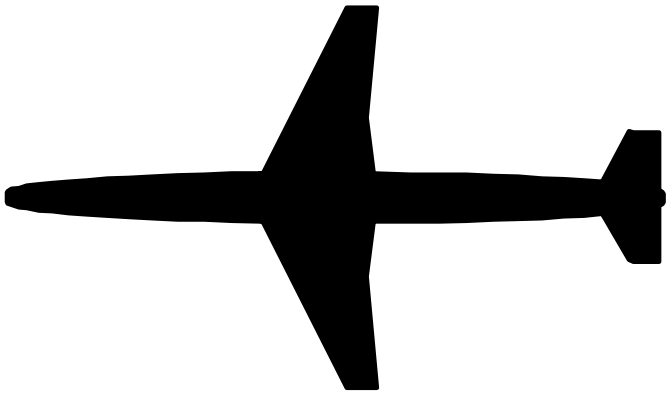
1. Chain Saw _____
2. Breathing _____
3. Just audible sound _____
4. Conversation in a restaurant _____
5. Racetrack _____
6. Airport _____
7. Airstrip with planes taking off _____
8. Raking leaves _____

Now, rearrange the sounds in order of increasing loudness.

Estimate and discuss the loudness of the following:

A. Rustling of a newspaper. (Remember average home sounds =40 dB and rustle of leaves = 20 dB)

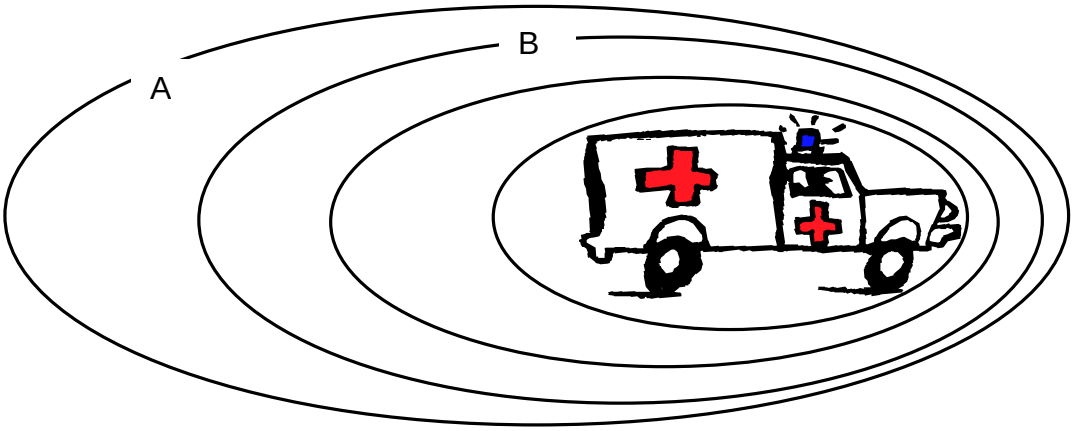
B. Air drill breaking cement (Remember that a Power Mower = 100 dB and a Chain Saw is 115 dB.)



Activity 5-2. Making Sounds.

Sounds can be heard over long and short distances. Why do some sounds get higher as they get closer? Why do sounds like a siren sound louder as they get closer, and not as loud the further you get from them?

This is because of a phenomenon called the Doppler Effect. For example, an ambulance is moving quickly along a road near your



house, blaring its horn. The pitch of the horn sounds higher, as it is coming near, than it would if it were standing still. This is because the crest of waves for expands in larger circles from the spot where it started. By the time crest B left the truck, the truck had moved forward causing crest B to be closer to crest A in front of the truck. The sound that is left behind the ambulance has crests that are further apart, and therefore, the volume of the sound reaches our ears as less.

Materials:

- Rubber stopper
- Tuning fork
- two students

Procedure A:

1. Ask yourself this question, what is the relationship between loudness and the distance between the ear and the source of the sound?
2. Hit the rubber stopper lightly. Listen to the sound.
3. Hit the rubber stopper again, strongly.
4. Observe and listen to the sound.
5. Discuss the difference in sound.

HOW IT WORKS.

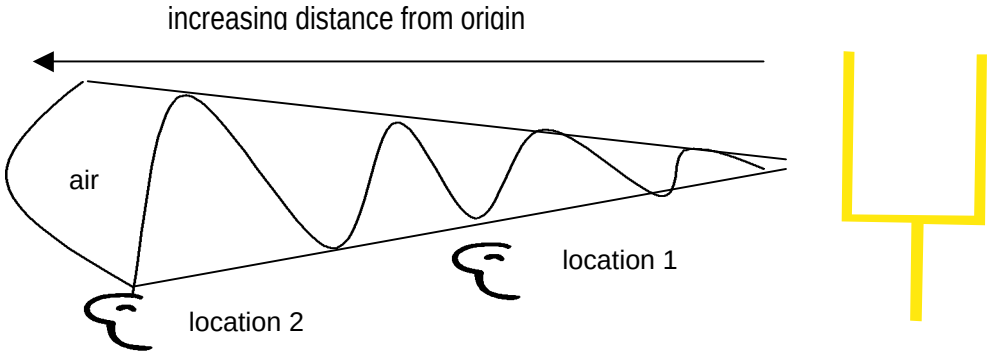
After the tuning fork was hit lightly on the rubber stopper, the amplitude of sound emitted was small. When it was hit on the rubber stopper more strongly, the amplitude increased.

Procedure B. Why does sound decrease in loudness with distance?

1. Have one student stand very close to tuning fork.
2. Hit the fork on the stopper.
3. Have the student move further away and hit the stopper again.
4. Have them describe their 'listening' responses.

HOW IT WORKS.

When the student is close to the tuning fork, the distance the sound must travel is short. When the student moves further away from the experiment, the volume of air that the sound wave must travel through is a greater distance. Thus, there is more air to attenuate the sound, and perhaps the student is intercepting a smaller part of the sound wave. Thus, not receiving it in its entirety, and getting only part of the sound.



Sound travels in all directions. Sound waves spread over volume, not area.

Student Information Sheet 5. How Loud is What You Hear?