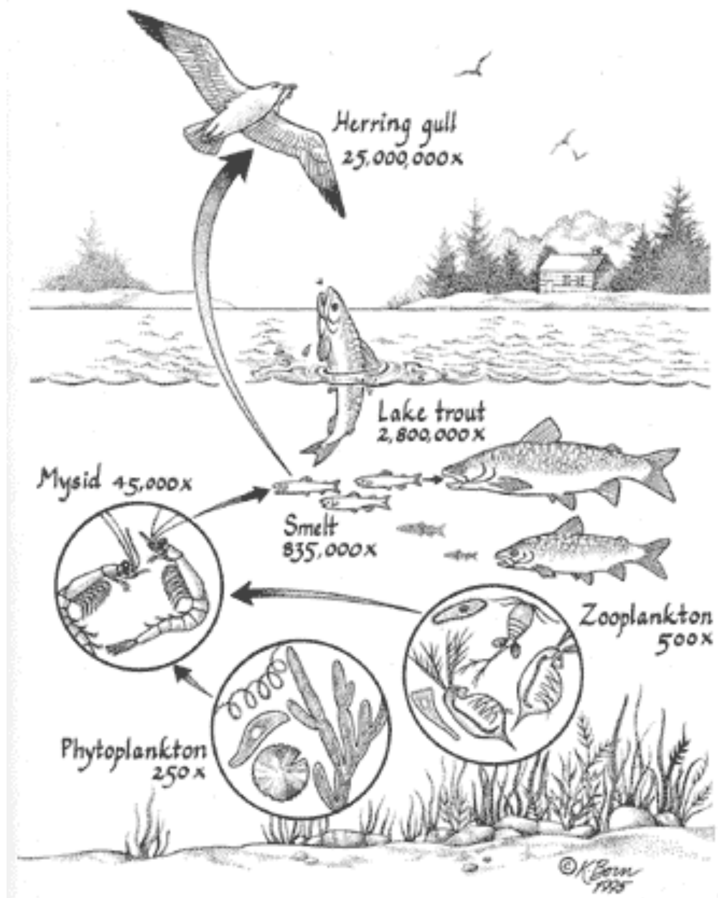
Biodegradable and Non-Biodegradable Substances

Substances that are broken down naturally in the environment are called **biodegradable**. Examples of biodegradable substances include sewage, food scraps, and dead organisms.

Non-biodegradable substances are either broken down very slowly or not broken down at all by natural means. Once these pollutants enter an ecosystem, they will remain there forever. Examples of non-biodegradable substances include DDT (a pesticide), mercury, glass, and certain types of plastic.

A pollutant becomes a **toxin** when it adversely affects living organisms. DDT and mercury are toxins.

Bioaccumulation



When plants take in the water, they may also absorb small amounts of non-biodegradable substances.

Because these substances can't be broken down, they are stored inside the plants. The pollutants begin to accumulate inside the producers, in a process called bioaccumulation.

Bioaccumulation is the buildup of a substance (such as a pesticide) in an organism.

When an animal eats the plants, they too begin to store the pollutants in their body. Because many producers must be eaten to keep one animal alive, the amount of pollutant inside the animal is much higher than it was in the plant.

At each trophic level, the amount of toxin inside the organisms increases. This is known as **biomagnification**.

Eventually, the levels of pollutants becomes high enough that the animal's health may be affected. They may be poisoned and die, or weakened and more susceptible to disease or predators.

DDT

One well known example of bioaccumulation is that of the pesticide DDT. Starting in the 1940s, this chemical was sprayed on crops to control insects. In the 1950s and 1960s, the number of birds of prey, such as falcons, hawks, and eagles, began to decline rapidly.

When wheat was sprayed with DDT to kill the insects that fed on it, some insects did not die. The DDT was passed from the wheat to the insects. It continued to move up the food chain and to increase in concentration. By the time it had reached the top of the food chain (birds of prey), the levels of DDT had become toxic, killing the birds.

By the 1970s, the use of DDT had been restricted in Canada. Unfortunately, DDT is not biodegradable and has continued to persist in the environment. It is still found in the tissues of higher-level consumers today.

Mad Hatters – A Bioaccumulation Story

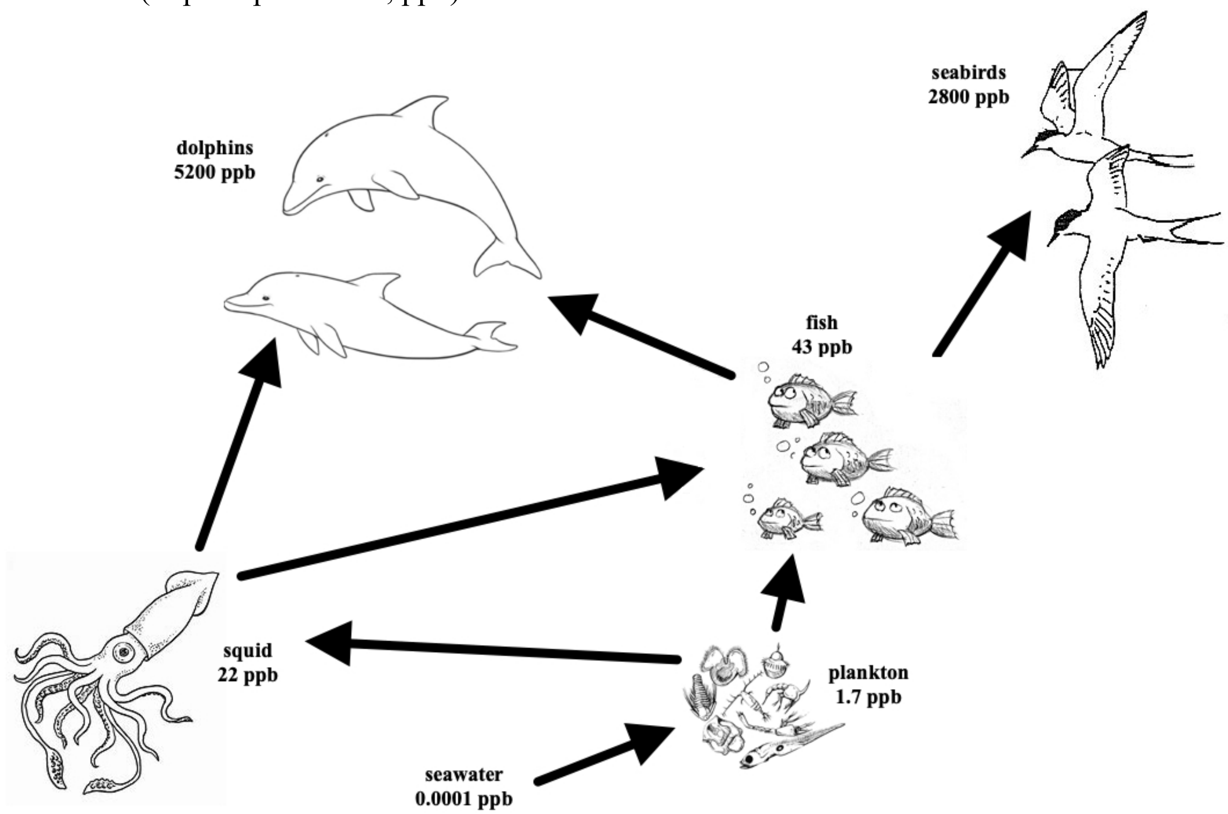
Recall the "Mad Hatter" from Alice in Wonderland. In the 18^{th} and 19^{th} centuries, fashionable men's hats were made in a process that used mercury to convert beaver fur into felt. Exposure to high levels of mercury vapor can result in damage to the human nervous system, including tremors, and mood or personality alterations. Because the hat makers (or hatters) exhibited symptoms of mercury poisoning, they became known as "mad-hatters."

Investigation

In this investigation, you will trace the path of DDT in a north Pacific Ocean food chain.

Procedure

1. Study the food web below.
   - the number below each organisms name indicates the amount of DDT in their bodies (in parts per billion, ppb)



2. Read the DDT Story (see next page).

3. Answer the questions on the last page.

The DDT Story

The risks of using powerful pesticides in ecosystems first became widely known during the 1950s and 1960s, when the toxic effects of the insecticide DDT were recorded. DDT was one of the first and most powerful insecticides developed. During World War II, it was used to control populations of insects (such as body lice, fleas, and mosquitos) that can transmit deadly diseases to people. As a result, the rate of death from malaria, bubonic plague, typhus, and yellow fever fell dramatically. DDT was also used widely on crops to control damage caused by insect pests.

In 1962, biologist and writer Rachel Carson published a book titled Silent Spring, which describes how pesticides had spread through the environment. As a result of her scientific evidence and the demands from an alarmed public, the use of DDT was restricted in Canada after 1969.

About ten years after the first use of DDT, signs of trouble appeared. Dead birds, fish, frogs, and other animals were found in areas that had been heavily sprayed with DDT. The fat in their bodies contained high levels of the insecticide. Harmless or beneficial insects, such as butterflies and honeybees, also started to disappear from areas that had been sprayed.

Tests of soil and water showed that DDT remained in the environment for many years. For example, DDT was still found in soil of some heavily sprayed orchards ten years after the spraying was stopped. DDT was also found in the bodies of many different organisms in areas around the world where the insecticide had never been used. It also began to show up in the tissues of people.

An unexpected outcome of using DDT was its effect on populations of birds of prey. Numbers of hawks, eagles, and ospreys on farmlands across North America and Europe fell sharply during the 1950s and 1960s. Scientists discovered that DDT reduced the ability of these birds to produce normal eggshells. Affected birds laid eggs with thin shells that broke in the nest, so they were unable to produce the usual number of young. The adult birds had accumulated DDT in their bodies from the fish they ate. The amount of DDT had accumulated in the bodies of organisms, moving from producers to primary consumers, to secondary consumers, and so on. This process is called **biomagnification**. Eventually concentrations of DDT became large enough in birds of prey to affect their reproduction.

Unfortunately, DDT continues to be used in some tropical countries because it is such an effective pesticide. It not only affects species that live in these countries, but also species that live elsewhere in the world, including people who consume food products imported from the tropics.

Questions

1. How does DDT enter a food web? ____

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2. In the north Pacific Ocean food web, which organism contains the most DDT? ____________

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3. At what trophic level is the organism from question 2? __________________________________

4. How does the concentration of DDT change as you move to higher trophic levels? _________

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5. How many times greater is the concentration of DDT in fish than in seawater? (Hint: divide the concentration in fish by the concentration in seawater.) ______________________________

6. How many times greater is the concentration of DDT in dolphins than in seawater? ________

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7. Why are animals at the top of the food chain at the most risk from environmental toxins (like DDT)? ____

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8. Use an example to explain how DDT from one area might find its way into the body of an animal living hundreds of kilometers away. ____

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