**The Basics of Biomagnification**

Environmental concerns have been around for a long time and humans can be one of the biggest threats to the environment because we can quickly impact an otherwise healthy ecosystem. Besides habitat loss, one of the biggest environmental concerns in the past century is the mis-use of pesticides. Pesticides are any substances used to control unwanted or harmful living organisms, such as insects, fungi, plants, or bacteria. Most pesticides are sprayed on crops and other plants to protect them from the destruction caused by insects. Pesticides are used every day by millions of people throughout the world. In addition to their agricultural use, pesticides are often sprayed around homes, lawns, parks, gardens, golf courses, and other places where unwanted pests occur. Unfortunately, the same substances that destroy pests may also harm plants and other living organisms.

**Bioaccumulation** occurs when harmful substances or toxins build-up in the body tissues of organisms. Many of these toxic substances are pesticides or other environmental contaminants. When pesticides are applied to kill or control pests, they make their way into waterways and soil, slowly traveling through the food chain when insects, fish and small mammals consume them, this concentration within the food chain is referred to as **biological magnification**. Some pesticides do not decompose and retain their potency for a long time, lasting decades or longer in the environment. As a predator eats more and more contaminated prey items the concentration of the toxins builds in the animal’s tissues. Scientists often measure the amount of pesticides found in the environment in ppm or parts per million. When toxins enter the environment only trace amounts are detected, or parts per trillion, but by the time the pesticides reach large predators they can be detected up to 20 ppm. Research shows levels above 4 ppm can be toxic to Osprey and other large predators. This process of increased concentration has occurred in several bird of prey species, including the Peregrine Falcon, Osprey and Bald Eagle.

Biomagnification within the food chain usually does not kill an animal directly, but may cause numerous long-term effects. Consequently harming raptors and other large predators. This is especially true if the animal has consumed large quantities of pesticides over a long period of time, as large predators typically outlive smaller ones and consume larger amounts of food over their lifetime.

Because of their vulnerability to environmental contaminants, raptors are recognized as barometers of the health of the environment. When the environment can no longer support raptor populations, the health of the environment itself is in jeopardy. One of the biggest threats to the survival of birds of prey during the late 1950s until the early 1970s was the reproductive failure that resulted from pesticide build-up in the body tissue of birds of prey. Consequently altering the bird’s ability to absorb calcium. In other words, when the eggshell formed there was not enough calcium for it to develop properly. Then, when the eggs were incubated they were not strong enough to withstand the bird’s weight and break, or ultimately fail to hatch because of a significant decrease in the number and size of pores within the eggshell. Birds of prey were hard hit as predators at the top of the food chain, because they consume many prey items over a long period of time. It is important to note the biggest problems with pesticides arise from their mis-use. Properly used pesticides can be very beneficial for controlling mosquito-borne illnesses and destruction caused by pests on crops or other plants.

**The Destruction of DDT**

One of the most well-known and widespread pesticides is DDT. Prevalent in agriculture after WWII, it is an inexpensive and broad-spectrum pesticide that has been used to protect people from mosquito-borne illnesses, such as yellow-fever and malaria. Because of the mis-use of DDT, this pesticide caused the populations of many species of birds of prey to drop drastically during the 1950s and 1960s. Concerns about DDT came to light after the publication of Rachel Carson’s book Silent Spring. The wide-spread use of DDT was banned in the United States in 1972. Unfortunately, the mis-use of DDT still occurs today in many countries throughout the world.

**Our National Symbol at Risk**

There were a few factors leading to the decline of Bald Eagles. First of all, they are large predators, living 25 years or more. Together with their inability to reproduce until five years of age, and their preference to consume a diet of mostly fish, the eagle population was particularly devastated by the use of DDT during the 1950s - 1970s. Listed as an **endangered species** in 1967, the Bald Eagle was at an all-time low with only 417 breeding pairs recorded in the lower 48 states and was at risk for becoming extirpated within the lower 48 states. Many people believed each eagle they saw would be their last. However, due mostly to the ban on DDT, a successful breeding program, reintroduction efforts, and increased protection through the Endangered Species Act, the Bald Eagle population began to climb steadily. Its recovery is a remarkable journey made in a relatively short amount of time. Today, 40 years after DDT was banned, there are more than 10,000 nesting pairs of Bald Eagles in the lower 48 states and an estimated 20,000 pairs residing in Alaska. The species was removed from the Endangered Species List in 2007, though it is still protected through legislation such as the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

**What’s the Alternative?**

Environmental awareness, knowledge and education are the first steps towards environmental protection. Before taking action, one must learn what consequences and possible effects may occur to the environment or future generations. Some actions may not have an immediate impact on the environment, but may arise years or decades later, as in the case of DDT. As with all chemicals and pest-control measures, it is important to assess each on an individual basis then determine what benefits or detriments they pose. Many scientists now use broad-cast spraying of pests as a last resort because of the knowledge gained from the DDT era. We now know that many insects and pests are actually beneficial to our environment and help pollinate or play an important role in the food chain. Always consider alternative options to controlling pests in an undesirable location, rather than immediately destroying them. Next time you see an unwanted pest in your home or school, try to find out why it’s there or how it got there and then take action to correct the problem.

**Women in Conservation**

**Rosalie Edge**

Often referred to as the first “true woman conservationist in North America,” Rosalie Edge made a difference in the conservation movement in the early part of the 20th century, years before other woman were taking a stance on the environment. Rosalie Edge began the Emergency Conservation Committee and founded Hawk Mountain Sanctuary. She also helped establish Kings Canyon and Olympic National Parks and expand Yosemite and Sequoia National Parks. Read the brief biography (or portions of it) on Rosalie Edge “A Most Determined Lady” written by Peter Edge to learn more about this remarkable woman and her journey in the conservation movement.

**Rachel Carson**

Her name is synonymous with the environment and conservation and with good reason. Rachel Carson, a biologist from Pennsylvania became famous for researching pesticide misuse and writing *Silent Spring*. This book detailed the dangers occurring from the mis-use of pesticides and other environmental contaminants. Rachel Carson began researching and documenting what was causing many species of plants and animals to become sick and die and relied on Hawk Mountain Sanctuary’s count data to help make her case. Rachel Carson used annual Bald Eagle migration counts to provide evidence that the numbers of immature eagles were declining steadily during the 1950s.

Increasing awareness about raptors and their role in nature is important. Knowledge leads to action. Public involvement makes a difference. Rosalie Edge realized something had to be done about the shooting at Hawk Mountain and took action to set aside the area as a sanctuary and Rachel Carson spent many years researching a highly controversial subject that she was passionate about.

Whether by joining and supporting a conservation organization, writing a senator or congressman, or taking direct personal action in a special situation, every individual can help in the effort to conserve raptors and other wildlife.

**Science 10: Ecosystems**

**Bioaccumulation and Biomagnification Worksheet**

**Introduction:**

Imagine a pond near a farmer’s field that is infested with harmful insects. The farmer sprays the field with DDT. Wind blows some of the pesticide onto the marsh plants. Each plant receives 1 unit of DDT. The DDT stays in the cells of the plant (bioaccumulation).

The following food chain represents the flow of energy in this pond ecosystem.



**Investigation:**

1. Suppose that a minnow eats 100 marsh plants in one year. How much DDT builds up in the body of the minnow? Write that number below the minnow in the food chain.
2. A perch eats 50 minnows in one year. How much DDT accumulates in its body? Write that number below the perch in the food chain.
3. The red-tailed hawk consumes 20 perch in one year. What amount of the pesticide builds up in this consumer? Write the number underneath the red-tailed hawk in the food chain.
4. Fill in the pyramid to represent the **number of organisms** and the **amount of energy** in each trophic level of the food chain.
5. Fill in the pyramid to represent the **units of DDT** in each trophic level of the food chain. Keep the marsh plants at the bottom of the pyramid.

**Analysis:**

1. How does the DDT originally enter the food chain?
2. (a) Which organism had the most DDT in their bodies?

(b) At what trophic level would you expect to find these organisms?

1. What is the relationship between the trophic level and the amount of DDT found in the body of these organisms?

1. Define Bioaccumulation.
2. Define Biomagnification.
3. Give an example of how an animal that lives many kilometres away from a region, which has been sprayed with DDT, could have DDT in their bodies.
4. What year did the United States ban the use of DDT?