



DDT and the Food Chain

Time Needed – 40 minutes

Ages – 9th to 12th

Season - Any

Materials – poker chips, paper bags, life cards, cones

Outline

- I. Introduction – 5 minutes
- II. You Are What You Eat – 25 minutes
- III. Rachel Carson and DDT – 10 minutes

Overview of Lesson: Students will be able to explain the effects of DDT in the aquatic food chain based on the concepts of bioaccumulation.

Minnesota Science Standards

9.4.4.1.1 Describe the social, economic, and ecological risks and benefits of biotechnology in agriculture and medicine. *For example:* Selective breeding, genetic engineering, and antibiotic development and use.

9.4.2.2.2 Explain how matter and energy is transformed and transferred among organisms in an ecosystem, and how energy is dissipated as heat into the environment.

Background Information

Bald eagles historically ranged across the contiguous United States, Canada and Alaska. After Europeans settlement in North America, eagles were sometimes hunted for food, and later because eagles were a perceived threat to livestock and competition for wild game. In 1940 Congress passed the Bald and Golden Eagle Protection Act, making it illegal to disturb or kill eagles.

In the 1950's the insecticide DDT (dichlorodiphenyltrichloroethane) was introduced and was used widely to combat a broad spectrum of insect pests, including mosquitos. DDT is a powerful chemical that also has serious environmental effects, and its chemical by-products persisted in aquatic environments long after the initial application.

In 1962, in her book *Silent Spring*, biologist Rachel Carson detailed the impacts on wildlife and birds of the indiscriminate spraying of DDT. DDT interferes with the calcium processing of birds and results in deformed eggshells. Since bald eagles are at the top of the aquatic food chain and feed primarily on fish, they received concentrated doses of the chemical. When the female eagle laid a thin, deformed eggshell, she crushed it under her own weight when incubating the egg. Since bald eagles pairs breed only once per year, with many bald eagle pairs not reproducing successfully, the bald eagle population declined steeply throughout the 1960's and 1970's.

In 1972, DDT was banned in the United States and the bald eagle was of the first species on the newly established Endangered Species List. Habitat conservation and reintroduction efforts helped ensure the successful recovery of the bald eagle, and in 2007 and they were removed from the Endangered Species List.

For many years, the United States Fish and Wildlife Service (USFWS) conducted annual surveys of the bald eagle population. This lesson uses data from the annual surveys and will allow students to explore the changes in the population over time.

Two data sets are presented. The first is the survey of number of nesting pairs in the lower 48 states. The second data set the number of nesting pairs of bald eagles in the Upper Mississippi River Wildlife and Fish Refuge (Refuge). The Refuge is located in four states: Minnesota, Wisconsin, Iowa and Illinois along the Mississippi River. In total, this refuge covers over 240,000 acres and extends 261 river miles from north to south from the confluence of the Chippewa River with the Mississippi River near Wabasha, MN to Rock Island, Illinois.

Vocabulary

- I. **Predator** – an animal or bird that hunts and feeds on other living organisms
- II. **Prey** – an organism that is hunted by predator, food source for predators
- III. **Bioaccumulation** - an increase in the concentration of a chemical in a biological organism over time
- IV. **DDT** – dichlorodiphenyltrichloroethane was widely used insecticide in the mid-1900s

Prior to Teaching

Get all supplies set-up for You Are What You Eat activity. Print out enough life cards for each student to have one. This includes setting up the field boundaries with cones and counting poker chips.

Lesson Outline

- V. Introduction – Review with students vocabulary of the food chain including terms like predator and prey.
- VI. You Are What You Eat activity
 - a. Assign each student a role in the food chain – for a class of 30 students, the roles should be 1 bald eagle, 3 fish, 10 insects and 16 corn plants.
 - b. Randomly distribute poker chips in the field where boundaries were set up before class.
 - c. Gather the students at one end of the field. Hand each student a bag to collect their “food” and the appropriate “life card” with directions on how to act during the game.
 - i. Corn – will have a limited amount of time to grow and collect nutrients. They will run around and collect nutrients. Nutrients should be placed in the bag. Once time is over, corn plants should remain still for the remainder of the game.
 - ii. Insects – will be able to fly around and eat the corn plants.
 - iii. Fish – will eat around and consume insects.
 - iv. Bald eagle – fly around and catch fish.
 - d. Students will act out the food web – one trophic level at a time – in a game of tag. Corn run around the field and collect nutrients (pick up poker chips from the ground). Once their time is done, corn plants freeze. Insects are up next – they will run around the game field and tag corn. Then the fish will tag the insects and finally the eagles will catch or tag the fish.

The insects, fish and eagle will all collect their food by tagging the previous animal and taking their food bag. These food chain members may not pick up any remaining poker chips from the ground.

- e. After the bald eagle has hunted, inform the students that the field had actually been treated with a pesticide known as DDT. DDT is toxic to wildlife.
- f. Have the students holding food bags count the total number of chips and the number of purple chips. The purple chips represent DDT. Students should do the math to figure out the percentage of purple chips in their bag.
 - i. Corn is not affected by DDT – it can continue to grow and reproduce normally after being sprayed with DDT.
 - ii. Insects – some insects will not eat plants sprayed with DDT but some will. There are some tough insects though, that even after they consume DDT they will continue to function normally.
 - iii. Fish – at low levels fish that eat insects containing DDT will continue to behave normal.

- iv. Eagle – By time the eagle eats fish, the amount of DDT is a lot higher. DDT doesn't kill the eagle by changes the way calcium forms in the eggshell. This makes the eggs weak and parents would accidently crush the eggs while incubating.

If the eagle has consumed over 30% purple poker chips, the eagle is unable to produce healthy eggs and offspring.

- g. Define bioaccumulation with students.

- VII. Wrap-up: Remind students that it was because of DDT that the bald eagle population declined greatly in the mid-1900s. It was the work of one woman that brought the problem to the attention of the public. Introduce students to this conservation hero using a 10 minute video review of Carson's life. <http://www.cbsnews.com/news/the-legacy-of-silent-spring/>

Extensions

- Have students read part or all of *Silent Spring* by Rachel Carson.
- Have students brainstorm environmental topics today and how human actions are impacting the environment.

Resources

You Are What You Eat http://www.bigelow.org/edhab/tracing_toxins.html

Reading "Rachel Carson and Her Book That Changed the World"
http://amhistory.si.edu/ourstory/pdf/environment/environment_read.pdf

Corn

You have been planted and now need to grow! You only have a limited time to collect nutrients before they are taken by other plants or washed away in the rain. Grab everything that you can to get those needed nutrients. Place the nutrients that you find in your food bag.

Insect #1

You came across a beautiful field of growing corn. You are hungry for some fresh leaves, so you eat **3** corn plants.

Take the food bags of the corn that you ate.

Insect #2

You came across a beautiful field of growing corn. You have just finished munching on some wildflowers in the prairie, so you aren't very hungry. You only eat **1** corn plant.

Take the food bag of the corn that you ate.

Insect #3

You came across a beautiful field of corn. You are hungry enough to eat **2** corn plants.

Take the food bags of the corn that you ate.

Fish #1

You came across a swarm of insects. You were very stealthy in your hunt, and as a result, you were successful at catching **4** of them for your morning meal.

Take the food bags of the insects that you caught.

Fish #2

You came across a swarm of insects but you were only able to catch **2** insects—you are probably going to be hungry again soon!

Take the food bags of the insects that you caught.

Fish #3

You came across a swarm of insects. You are hungry, so you catch **3** insects for a mid-morning snack.

Take the food bags of the insects that you caught.

Bald Eagle

You came across a group of fish feasting on a swarm of insects. You were successful at catching **2** of them for your mid-morning meal.

Take the food bag of the songbirds that you caught.