Lesson Title: Bioaccumulation and Pesticides: Organism Interaction

Time: 40 minutes

Materials:
Two readings: one on the honeybee decline, the other on DDT and peregrine falcons. You will also need handouts on organism relationships and pictures of relationships and a handout on bioaccumulation and biomagnification.

Send two readings home to students to read the night before class.

1. About the honeybee decline (send both articles, or pick one)
   http://money.cnn.com/2007/03/29/news/honeybees/

   http://articles.latimes.com/2007/apr/26/science/sci-bees26

2. DDT and peregrine falcons
   http://www.scienceclarified.com/Co-Di/DDT-dichlorodiphenyltrichloroethane.html

Objective:
Students should be able to define relationships between organisms (especially mutualism), understand the problems with pesticides, and define bioaccumulation and biomagnification.

Standards:
S7.A.3.1.1 Describe a system (e.g., ecosystem, circulatory system, agricultural system) as a group of related parts with specific roles that work together to achieve an observed result.
Standard - 3.1.7.C2
Explain why the extinction of a species may occur when the environment changes.
Explain that mutations can alter a gene and are the original source of new variations in a population.

Background:

Bees and flowers have existed together a very long time on earth, and have special structures that enable them to work so well as a team.

Flowers need bees for pollination. To ensure that pollination occurs flowers have special colors and smells to attract bees. When bees visit a flower they collect pollen. This helps transfer pollen between flowers, helping to fertilize the plants. When this happens, the plants are able to produce seeds and grow new plants, increasing the plants population.

Bees need flowers for pollen. Bees use pollen as a food source. By finding the best sources of pollen, bees can collect as much as they can carry to help supply the hive with food. Some bees also store enough pollen to get the hive through the winter when there is little or no pollen available. ***Bees and flowers have a mutualistic relationship****, meaning both benefit from the relationship.*

Opening: Remind students (or even ask for a summary of readings) that they read information about the decline of two species: the honeybees and peregrine falcons. Do a brief summary of

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each article, making note that both situations have components where humans have put some sort of chemical into the environment (pesticides in both articles) and that is a major reason that is linked to both declines.

Activity 1: (~ 15 minutes) Bees, relationships, and pesticides

- **Hand out** pictures that represent the five relationships: parasitism, mutualism, commensalism, competition, and predation.
- **Briefly go through relationships.** Then have students work in groups to brainstorm examples of each relationship.
- **Bring students back together as a group.** Review the relationships and the examples they came up with.
- **Ask** students what relationships are destroyed when farmers use pesticides and herbicides.
    - **Explain** that farmers often use pesticides to prevent parasitic relationships between pests and their plants (Pesticides kill unwanted organisms that damage crops).
    - **Explain** that herbicides are often used to prevent competition between plants they want to grow and weeds. (Herbicides kill weeds that would compete for water and nutrients)
- **Explain** unintended consequences of using pesticides.
    - For example, pesticides are a direct linked cause of the honeybee decline. We need bees to pollinate our crops so we get higher crop yield, unfortunately we are also unintentionally killing the bees through our use of pesticides.
    - Also, bring up the Peregrine Falcon example. Pesticides also go up the food chain and could even have unintended consequences for higher-order organisms (such as us)!

Activity 2: (~ 15 minutes) →Modeling Bioaccumulation and Biomagnification

- Give students small, clear Dixie cups. Divide class into a large group of “producers,” a smaller group of “primary consumers,” an even smaller group of “secondary consumers,” and you take the role of the “tertiary consumer.”
    - **Draw** an energy pyramid on the board with 4 levels.
    - Have students envision that the producers are plants in a garden, the primary consumers are honeybees, the secondary consumers are small birds (such as flycatchers), and the tertiary consumer is a peregrine falcon.
    - Put a bead or marble in each of the “producer” cups. The bead represents pesticide put on the plants. On the bottom trophic level of the energy pyramid on the board, write a “1” for each of the beads in the producer cups.
    - Have the “primary consumers” “eat” the “producers” by taking the bead from the “producer” cups. Have the “producers” sit down.
    - **Ask** how many beads each “primary consumer” has. Write the number of beads in each “primary consumer” cup above the “1’s” from the producer. Here you are representing a second trophic level.
    - Have the “secondary consumers” “eat” the “primary consumers” by taking the bead from the “secondary consumer” cups. Have the “secondary consumers” sit down.

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    - **Ask** how many beads each “secondary consumer” has. Write the number of beads in each “secondary consumer” cup above the “#’s” from the secondary consumers. Here you are representing a third trophic level.
    - Finally, collect the beads from the “secondary consumers.” You are the “tertiary consumer.” Write the number of beads you have in the top box of the energy pyramid you have drawn.
- **Ask** students what they just represented while doing this activity.
    - They represented pesticides going up the food chain.
- **Ask** students how exactly the pesticides went up the food chain.
    - **Define** the two factors at work: Biomagnification and bioaccumulation.
        - Bioaccumulation: When a toxin increases in the tissues of an organism over time.
        - Biomagnification: When a toxin travels up the trophic levels in a food chain.
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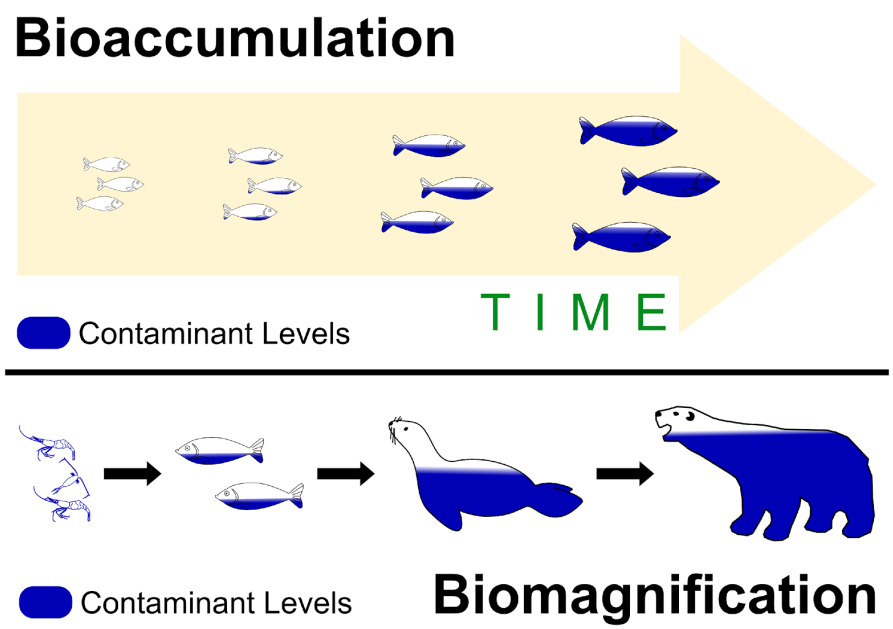

Activity 3 (if time and resources): DDT Demonstration

To demonstrate the extreme effects that DDT had on the immune systems of Peregrine falcons, you can pile rocks on top of a chicken egg (same size as peregrine egg) and show students how much weight that egg can normally sustain. This can be done by creating or obtaining a demo where an egg is placed in a contraption that allows you to pile weight on top of it. The egg should hold anywhere from 80-100 lbs. Explain to students that, with DDT in their systems, peregrine falcons were crushing eggs with their own body weight, which was only a few ounces. This should show student how weak DDT made peregrine egg shells.

Closing: Explain to students that what they just modeled (bioaccumulation and biomagnification) was the reason the peregrine falcons declined in the 1960-70’s. That when

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you put small amounts of something in the environment it's going to have a very large effect on something else and could even hurt us! This is the reason to try to use non-toxic chemicals or even no chemicals at all whenever possible.

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Relationships between organisms:

This is an example of parasitism where the parasite is the mosquito and the host is the human.
Parasitism: A relationship between two organisms where one organism, the parasite, feeds off of the host. ☺ •
Host: The organism the parasite lives on or in.
Parasite: an organism that feeds off of another living organism

This is an example of mutualism. The honeybee is getting food for its hive from the flower, so it is benefiting. The flower is also benefiting because the honeybee is pollinating it.
Mutualism : A relationship that exists between two organisms where both benefit.
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In this example of commensalism, the deer is not affected by the spider web between its antlers. However, the spider is benefiting from having a home and from the deer possibly attracting insects.

Commensalism: A relationship that exists between two organisms where one organism benefits and the other is unchanged. ☺ •

In this example of competition, the hyena and the lioness are competing over the same food sources.

Competition: A relationship between two organisms that use the same resources. ☹ ☹

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In this example, the osprey (bird) is the predator consuming the fish (prey).
Predation: A relationship between two organisms where one organism, the predator, feeds on the other organism, the prey. ☹ ☹
Predator: a consumer that feeds on other consumers.
Prey: The organism that is eaten by the predator.

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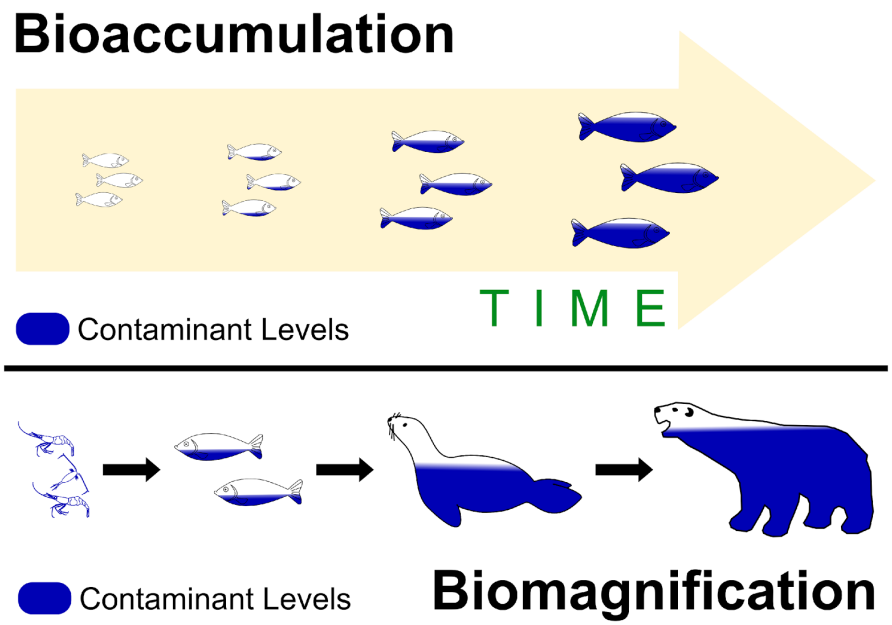

Bioaccumulation: When a toxin increases in the tissues of an organism over time.
Biomagnification: When a toxin travels up the trophic levels in a food chain.

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