DEADLY LINKS

OBJECTIVES

Students will: 1) give examples of ways in which pesticides enter food chains; and 2) describe possible consequences of pesticides entering food chains.

METHOD

Students become "hawks," "shrews," and "grasshoppers" in a highly involving physical activity.

BACKGROUND

People have developed pesticides to control organisms. Herbicides are used to control unwanted plants; insecticides to control nuisance insects, etc. Although these pesticides are useful to humans when properly used, they frequently end up going where they are not wanted. Many toxic chemicals have a way of persisting in the environment, and often become concentrated in unexpected and undesirable places—from food and water supplies to wildlife and sometimes people, too.

For example, a pesticide (a chemical—frequently synthesized from inorganic compounds—used to kill something identified as a "pest" under some conditions) called DDT used to be applied regularly to crops as a means of controlling insects that were damaging the plants or trees. Then it was discovered that DDT entered the food chain with damaging results. For example, fish ate insects that were sprayed by the chemical; hawks, eagles and pelicans ate the fish. The poison became concentrated in the birds—sometimes weakening and killing them directly, and over time resulting in side effects such as egg shells so thin that the eggs would not hatch, or were crushed by the parents in the nesting process. The impact on species, including the bald eagle and the brown pelican, has been well documented. Use of DDT has now been prohibited by law in the United States. DDT use is not prohibited worldwide. Resident animal populations in countries that still allow the use of DDT are at particular risk. Also, many species of animals that migrate between countries that permit DDT use and those that prohibit DDT are still at risk of DDT exposure. Even after the application of DDT is stopped, DDT and its by-products can impact the environment for decades.

People use other synthetic chemical pesticides in their homes, yards and gardens. Each targets a different organism. For instance, some kill cockroaches while others kill weeds. If used improperly, these substances can also be toxic to non-targeted animals such as honey bees and fish. Careful handling, application, and storage of these substances are important steps which can help prevent these substances from entering the food chain in the first place.

Damaging fertilizers as well as pesticides are used by many farmers as a part of the agricultural industry. Again, use of such chemicals—particularly the inorganic, synthesized compounds—can have varying side effects. For example, a pesticide may be sprayed or dusted on a crop. The pesticide may settle into the soil, or stay on the crop, until it is washed by rain or irrigation into other water sources like groundwater, lakes, streams, rivers and oceans. Testing the water after this has occurred typically does not show a particularly high concentration of these human-made chemicals—but testing the invertebrates (i.e., crayfish and shellfish) and fin-fish often does! Waterfowl and other species may also be affected—including human beings, if people eat contaminated fish or waterfowl,

Age: Grades 4-9
Subjects: Social Studies, Science, Physical Education
Skills: analysis, classification, comparing similarities and differences, computation, description, discussion, evaluation, generalization, kinesthetic concept development, synthesis
Duration: one 30 to 45-minute period
Group Size: minimum of ten students preferred
Setting: large playing area
Conceptual Framework Reference: I.C., I.C.3., I.C.4., I.D., II.B.2., II.B.3., II.B.4., III.B., III.B.1., III.B.2., IV.A.4., IV.C.3., VI.A., VI.A.2., VI.A.3., VI.A.4., VI.A.5., VI.B., VI.B.1., VI.B.2., VI.B.3., VI.C., VI.C.1., VI.C.6., VI.C.12., VI.C.13., VI.C.14., VI.C.15., VI.C.16., VI.D., VII.A.2., VII.A.4., VII.B., VII.B.1., VII.B.2., VII.B.3., VII.B.4., VII.B.5., VII.B.6., VII.B.7.
Key Vocabulary: pesticide, insecticide, herbicide, food chain, accumulate, toxic, chemicals, trade-offs, organic, inorganic
Appendices: Local Resources, Agencies and Organizations, Outdoors, Simulations

for example. In other words, wildlife and people become the concentrators of the pesticide because the chemicals do not pass out of their bodies but accumulate in their bodies over time.

Public pressure continues to force changes in the application and availability of pesticides. For example, there is now growing interest in integrated pest management. This is an approach to agriculture that considers the entire farm and garden ecosystem. Integrated pest management can include using a pest's predator as well as other biological controls to reduce crop damage. Integrated pest management can also include the selective use of naturally-occurring and synthetic pesticides as well as habitat manipulations. One concern with this approach concerns possible introduction of non-native species.

The major purpose of this activity is for students to recognize the possible consequences of accumulation of some pesticides in the environment.

MATERIALS

white and colored drinking straws, pipe cleaners, poker chips or any other material that students can easily pick up (NOTE: multi-colored, dry dog food works well and poses little environmental threat even if it is not all collected following the activity); 30 pieces per student is recommended in a proportion of two-thirds white to one-third colored pieces; one bag per grasshopper (approximately 18-20)

PROCEDURE

1. Tell the students that this is an activity about "food chains." If they are not familiar with the term, spend time in establishing a definition. (Food chain: a sequence or "chain" of living things in a community, based on one member of the community eating the member above it, and so forth; e.g., grasshopper eats plants like corn, shrews eat grasshoppers, hawks eat shrews.)
2. Divide the students into three groups. In a class of 26 students, there would be two "hawks," six "shrews," and 18 "grasshoppers." (Work with approximately three times as many shrews as hawks, and three times as many grasshoppers as shrews.) OPTIONAL: Have grasshoppers, hawks, and shrews labeled so they can be easily identified; e.g., arm ties for grasshoppers, red bandannas for "red-tail hawks," and brown arm ties or caps for shrews.
3. Hand each "grasshopper" a small paper bag or other small container. The container is to represent the "stomach" of whatever animal is holding it.
4. With the students' eyes closed, or otherwise not watching where you place the "food," distribute the white and colored straws (or whatever material you use) around in a large open space. Outside on a playing field if it is not windy or on a gymnasium floor will work; a classroom will also work if chairs and tables or desks can be moved back.
5. Give the students their instructions. The grasshoppers are the first to go looking for food. The hawks and shrews are to sit quietly on the sidelines watching the grasshoppers; after all, the hawks and shrews are predators, and are watching their prey! At a given sig-

nal, the grasshoppers are allowed to enter the area to collect food and place the food in their stomachs (the bags). The grasshoppers have to move quickly to gather food. At the end of 30 seconds, the grasshoppers are to stop collecting food.

6. The shrews are now allowed to hunt the grasshoppers. The hawks are still on the sidelines quietly watching the activity. The amount of time available to the shrews to hunt grasshoppers should take into account the size area in which you are working. In a classroom, 15 seconds may be enough time; on a large playing field, 60 seconds may be better. Each shrew should have time to catch one or more grasshoppers. Any grasshopper tagged or caught by the shrew, must give its bag of food to the shrew and then sit on the sidelines.

7. The next time period (from 15 to 60 seconds, or whatever time you set) is time for the hawks to hunt food. The same rules follow. Any shrews still alive may hunt for grasshoppers; grasshoppers are hunting for the food chips that represent corn or other plants; and the hawks are hunting for the shrews. If a hawk catches a shrew, the hawk gets the food bag and the shrew goes to the sidelines. At the end of the designated time period, ask all the students to come together in a circle, bringing whatever food bags they have with them.

8. Ask the students who are "dead," having been consumed, to identify what animal they are and what animal ate them. (If they are wearing labels, this will be obvious.) Next, ask any animals still alive to empty their food bags out onto the floor or on a piece of paper where they can count the number of food pieces they have. They should count the total number of white food pieces and total number of multi-colored food pieces they have in their food sacks. List any grasshoppers and the total number of white and multi-colored food pieces each has; list the number of shrews left and the number of white and multi-colored pieces each has; and finally list the hawks and the number of white and multi-colored food pieces each has.

9. Inform the students that there is something called a "pesticide" in the environment. This pesticide, DDT, was sprayed onto the crop the grasshoppers were eating in order to prevent a lot of damage by the grasshoppers. If there were substantial crop damage by the grasshoppers, the farmers would have less of their crop to sell, and some people and domestic livestock might have less of that kind of food to eat—or it might cost more to buy it because a smaller quantity was available. DDT been historically proven to accumulate in food chains and can stay in the environment for a long time. In this activity, all of the multi-colored food pieces represent the pesticide. All of the grasshoppers that were not eaten by shrews may now be considered dead, **if they have any multi-colored food pieces in their food supply.** Any shrews for which half or more of their food supply was multi-colored pieces would also be considered dead. The one hawk with the highest number of multi-colored food pieces will not die at this time; however, it has accumulated so much of the pesticide in its body that the egg shells produced by it and its mate during the next nesting season will be so thin that the eggs will not hatch successfully. The other hawks are not visibly affected at this time.

10. Talk with the students about what they just experienced in the activity. Ask them for their observations about how the food chain seems to work, and how toxic substances can enter the food chain, with a variety of results. The students may be able to give examples beyond those of the grasshopper—shrew—hawk food chain affected by the pesticide in this activity.

EXTENSIONS

1. Consider and discuss possible reasons for use of such chemicals. What are some of the trade-offs? What are some of the consequences?

2. Offer and discuss possible alternatives to uses of such chemicals in instances where it seems the negative consequences outweigh the benefits. For example, some farmers are successfully using organic techniques (e.g., sprays of organic, non-toxic substances; crop rotation; companion planting); biological controls (e.g., predatory insects); and genetic approaches (e.g., releasing sterile male insects of the pest species) in efforts to minimize damages to their crops.

3. Find out what research is going on to develop and test effects of pest control efforts—from effects of possibly toxic chemicals to non-toxic alternatives. With what impacts? Trade-offs? Potential?

4. Check newspapers for relevant local, national, or international examples of such issues.

AQUATIC EXTENSIONS

1. See the Aquatic WILD activities, "Deadly Waters" and "Plastic Jellyfish."

2. Show how pesticides can enter an aquatic food chain. Also show how pesticides can enter aquatic environments and end up in the food chains of terrestrial environments (mosquito larvae—fish—birds). Show how pesticides can enter the food chains in terrestrial environments and end up in aquatic environments (grasshoppers—small fish—large fish).

EVALUATION

1. Give examples of ways in which pesticides could enter a food chain.

2. Discuss two possible consequences of pesticides entering the food chain for each of the examples you gave above.

3. A group of ecologists studied the presence of a toxic chemical in a lake. They found the water had one molecule of the chemical for every one billion molecules of water. This is called one part per billion (1 ppb). The algae had one part per million (1 ppm) of the toxic chemical. Small animals, called zooplankton, had 10 ppm. Small fish had 100 ppm. Large fish had 1,000 ppm. How do you explain this increase in this toxic chemical to 1,000 ppm for the large fish? Use a drawing to help support your answer. The ecologists found the chemical was a pesticide which had been sprayed on cropland 100 miles away from the lake. How did so much of it get into the lake?