

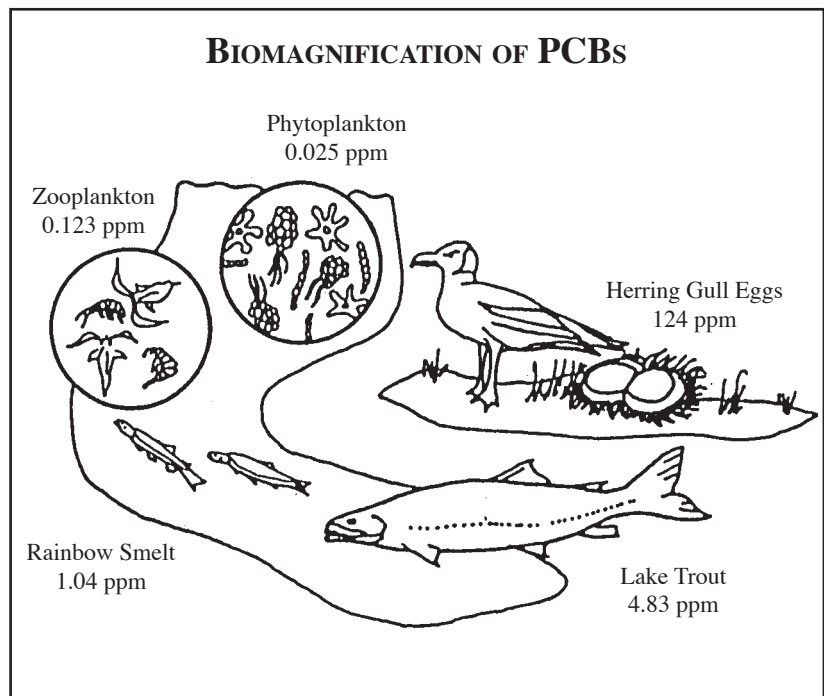
Where Do All the Toxins Go? (Internal View)

An unfortunate byproduct of the high standard of living enjoyed by developed nations is a heavy reliance on chemicals. Chemicals are used in agriculture and industry and are unintentional byproducts of many human activities. Many of the chemicals that we have become so dependent on are entering our Great Lakes as toxic fallout from the air.

In what ways do chemicals present a problem in the Great Lakes ecosystem? Not very often do we hear about massive kills from chemicals. The effects are much more subtle. Many chemicals enter the food chain at the lower end and accumulate and magnify within organisms throughout the chain. Those carnivores at the top of the food chain, including humans, have the highest levels of these toxins in their bodies. One of the foods that is popular with humans is fish — fatty fish such as trout and salmon accumulate the most toxins through the food chain, and larger fish are the most dangerous. People are warned not to eat fish that exceed a certain length (such as brown trout over 18 inches in Lake Ontario) and to restrict consumption of smaller fish of these species.

The characteristics of a chemical that determine whether or not it will be an environmental hazard are: its toxicity, its persistence, and its affinity for water. Chemicals that have no affinity for water tend to have an affinity for lipids (fats). They combine with the fatty substances in an organism's body, and if persistent, will remain with the organism until it dies or is consumed.

PCBs (polychlorinated biphenyls) are a class of toxic chemicals that appear in many Great Lakes fish. They were frequently used as coolants, especially around electric transformers, because they conduct heat but not electricity. All production of PCBs was stopped in 1976 after it was discovered how toxic they were. However, they do not break down in nature, and many products containing them are still around. As old transformers and other such equipment are discarded, PCBs may leak into the air or water. PCBs then enter the marine food chain and collect in the fatty tissues of fish. PCBs cause carnivores such as cormorants, and scavengers such as gulls, to develop reproductive problems or deformities.



The Great Lakes. An Environmental Atlas and Resource Book. Produced by Environment Canada and U.S. Environmental Protection Agency (1987 and 1995)

In this activity, iodine is used as an example of a fat-soluble compound. The iodine atoms associate themselves with oil (fat) molecules and cause a color change. In the lake environment, chemicals such as DDT and PCBs are fat soluble. They tend to be extracted from the lake water and concentrated in fatty substances in plants and animals. Carnivores, such as fish, eat other organisms that contain the toxins and accumulate the substances in their bodies. High concentrations of these chemicals are found in the belly fat and under the skin of fatty fish such as lake trout, salmon, and chub.

Source

This activity was originated by Michigan Sea Grant in its curriculum activity, "A fish fat phenomenon" (*Great Lakes Fishing in Transition*)

Materials

- Iodine crystals (8 per demonstration)
- Screw-top vial (about 75 ml)
- 20 ml water
- 20 ml vegetable oil
- Ohio Sea Grant Fact Sheet 007: *PCBs: Their history and our health.* (optional)

Earth Systems Understandings

This activity focuses on ESU 2 (stewardship), 3 (science processes), 4 (interactions) and 7 (careers).

Answers

- a. The sugar dissolves.
- b. The butter would not dissolve; it would stay in lumps.
- c. Solubility refers to the ability of one substance to become evenly distributed in another substance.
- d. Some of the iodine dissolves — some does not. The water turns light brown.
- e. Iodine was extracted into the oil because iodine is more soluble in fat than in water. Since there is no more iodine in the water, the water clears up. The oil layer turns pink, indicating the presence of iodine.
- f. Oil
- g. The oil represents fat; water represents other bodily fluids (lood, saliva, sweat.).
- h. PCBs accumulate in the fat.
- i. They can't be washed out because the fats won't dissolve in these fluids.
- j. To prepare fish safely, clean all the fat off before cooking, and broil the fish on a rack so that it doesn't cook in its own juices. Note that this method would not remove poison metals such as mercury, because they accumulate in muscle tissue.

OBJECTIVES

When students have completed this activity, they will be able to demonstrate how chemicals accumulate in fish fat, the biopathways of the toxins in the fish's body, and ways to prepare fish to avoid consuming the toxins.

PROCEDURE

1. Introduce the concept of solubility to the students.
Ask the following questions:
 - a. What happens to a teaspoon of sugar when you put it into a glass of water?
 - b. What would happen to a pat of butter if you mixed it into a glass of water?
 - c. What is meant by *solubility* ?
2. As a demonstration, put the iodine crystals in the vial with 20 ml of water. Tighten the lid, and allow the students to pass the vial around and shake it.
 - d. What happened to the iodine when it was mixed with the water?
3. Open the vial and pour in 20 ml of vegetable oil.
Replace the lid, and pass the vial around for more shaking.
 - e. What happened when the oil is added? Why?
 - f. In which substance is iodine more soluble, water or oil?
 - g. What type of bodily substance in an animal does the oil represent? The water?
 - h. Where do PCBs accumulate in fish and other animals?
 - i. Why can't the PCBs be "washed out" by blood or urine?
 - j. If you want to consume fish, but are not sure if it contains PCBs, how would you prepare it to be safe?

4. Distribute the fact sheet on preparing your catch (#007). If possible, have a student who is an experienced angler demonstrate proper fish cleaning. Other students should note where fat is found in the fish's body.
5. Gravid fish (full of eggs) carry most of their toxin load in the eggs. Discuss the implications of this for
 - a. Using fish eggs as bait,
 - b. Fish that feed on fish eggs, and
 - c. The safest time to catch female fish.
6. The use of chemicals has become part of the lifestyle of people living near the Great Lakes.
 - d. If all the toxic chemicals were eliminated from the environment, would everyone be pleased? Which professions would suffer without the chemicals? Which professions are impacted now by the presence of toxic chemicals?

EXTENSIONS

1. Investigate the existing and proposed cooperative regulations between the United States and Canada regarding protection of the Great Lakes environment. Do you feel that they are sufficient, or can they be strengthened?
2. Suppose a state or province decided to regulate commercial fishing so that consumers would receive fish with less chance of contamination. Use the activities titled "Which fish can we eat?" and "How should the public health be protected?" to role play the issues that would have to be addressed to strengthen environmental regulations.

Answers

- a. Fish eggs used as bait do not have time to be digested. Therefore, they would be relatively harmless to the fish and the angler.
- b. Fish that eat fish eggs regularly are exposed to a large amount of toxins. The more they eat, the more they bioaccumulate.
- c. The safest time to catch female fish would be when they have just spawned and rid themselves of the toxic load. However, fish flesh sometimes becomes less desirable for food at such a time (it may be softer and have a darker color). If the fish were caught before spawning, while still gravid, the problem might be eliminated. People do not usually eat fish eggs (except for caviar). Fishing at this time could seriously reduce the next year's population of fish.
- d. Accept student brainstormed answers and discuss them. Americans depend on toxic chemicals for a variety of things; for instance, the fuel we use to power our vehicles (gasoline) is toxic. Toxic chemicals are components of most paints, plastics, batteries, roofing materials, and pesticides used in farming. They are also used in developing film, dry cleaning, producing paper, making many medical supplies (X-ray film), purifying water for public use, caring for lawns, and a large variety of other things.

Teacher's Note

A recent public health advisory chart that indicates which fish are considered dangerous to eat is located in the activity "Which fish can we eat?" Local information is available wherever fishing licenses are sold.