Lesson 7: Biomagnification

ESTIMATED TIME: Three 1 hour class periods

MATERIALS:

For the teacher

Biomagnification Transparency
12 circles cut with a hole punch (small confetti)
Overhead projector

Per group

Chart paper
Markers
Pen
Pencil
Biomagnification worksheet

DESCRIPTION OF THE ACTIVITY:

In this lesson students will learn about chemicals that are critical pollutants in the Saginaw Bay Watershed, how they move through a food chain, and how they adversely affect life.

LESSON FOCUS QUESTIONS:

What are some critical pollutants in the Saginaw Bay Watershed?
How do the levels of toxic chemicals get altered as they move through the food chain?
How do the critical toxic chemicals adversely affect life?

PROCEDURE:

- Begin the lesson by having students share what they have learned so far about pollutants in our watershed ecosystem.
- Explain to them that they will be studying how toxic substances can get concentrated in a food chain through a process called biomagnification.
- Perform the following demonstration to explain the process of biomagnification.
    - Show students the biomagnification transparency and explain that it represents a food chain. They should note that there are fewer and fewer organisms as you move up the food chain, but the organisms are larger and each needs to eat more food as you go up the chain.
    - Place one circle of paper (from a hole punch) on each strand of algae in the diagram and tell students that this represents toxic pollutants such as PCB's absorbed by the algae.
    - Explain that as the algae are eaten by small organisms such as the daphnia in the second trophic level the pollutants travel up into them. Move the circles up the

arrows into the daphnia to represent them eating the algae and the pollutant also moving into the daphia.

- Ask the students, "How does the concentration of pollutants in the daphnia compare to the concentration in the algae?" You want to make sure they bring up the idea that the amount of pollutant in each daphnia is double that in the algae. Also ask them to explain how it happened (daphnia consume many algae and therefore their level of contamination is greater).
- You may want to cover the algae section of the transparency at this point to avoid them distracting students from monitoring only the pollutants.
- Explain to students that many daphnia are in turn eaten by small fish such as minnows and baby fish such as perch and that the pollutants get transferred to them as well. Move the pollutants up into the perch as you did with the daphnia and repeat the style of questions asked before:
    - "How does the concentration of pollutants in the perch compare to the concentration in the daphnia?" Again you want to make sure they bring up the idea that the amount of pollutant is increasing as you move up the food chain. Again, ask them to explain how it happened.
- Repeat the process of moving the paper circles (pollutants) up into the trout and finally the human again asking the same questions about how the concentration of pollutants changes.
- Pose the following question to students:
    - "If a concentration of 4 pollutants or more can cause birth defects in organisms, and a concentration of 10 or more can cause cancer and potential death, which organisms in the food chain could have offspring with birth defects and which could even die from the levels of contamination?
    - Explain that this is very similar to how the process works in nature.
- Explain to students that they will now investigate some of the pollutants that bioaccumulate in the Great Lakes and further investigate which are problems in our watershed.
- Assign students to small groups of 2 to 4 students.
- Pass out the Bioaccumulation packets.
- Allow 2-3 class periods to complete the activity.

GOING DEEPER

Have the students create a graph reflecting the increasing magnification of PCBs from the figure. Write two conclusions that can be drawn from the graph.

Have the students compile a comprehensive list of chemicals used in and around the Great Lakes Basin. Classify them according to the nature of the problem they cause (if any) and identify the source of each one.

GREAT LAKES LIBRARY

Great Lakes Water Quality Board, 1985, Report: Guidance on Characterization of Toxic Substances Problems in Areas of Concern in the Great Lakes Basin, October, Windsor, ONT, 179 p.

Great Lakes Water Quality Board, 1987, Report: Guidance on Characterization of Toxic Substances Problems in Areas of Concern in the Great Lakes Basin, March, Windsor, ONT, 179 p.
Great Lakes Water Quality Board, 1987, 1987 Report on Great Lakes Water Quality, November, Windsor, ONT, 236 p.

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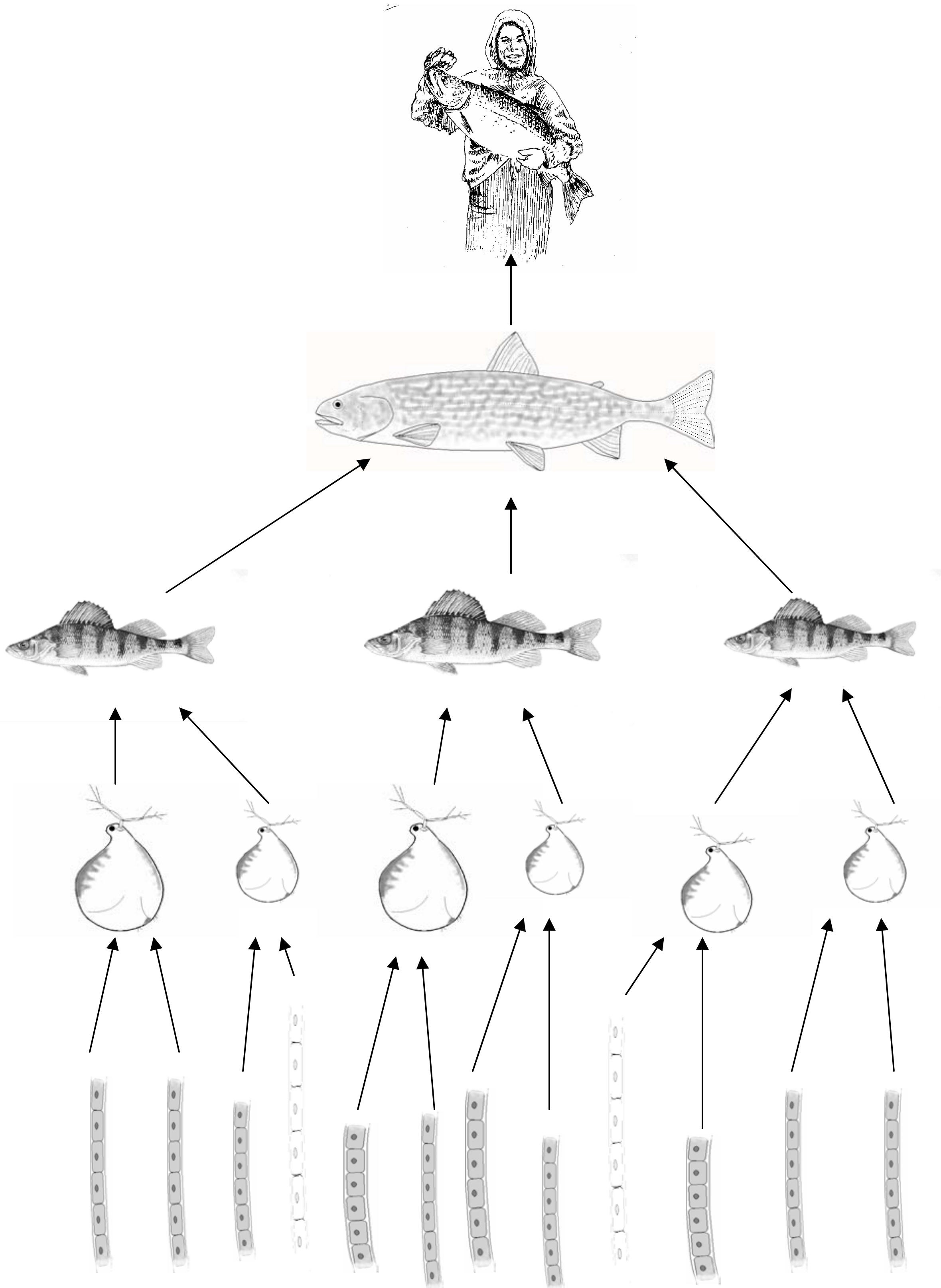
Phone: 312-939-0838.

Biomagnification

(transparency)



Biomagnification

BACKGROUND:

Toxic chemicals are released into our ecosystem from a variety of industrial, commercial , and residential activities. The Ontario Water Resources Commission reported that Hamilton Harbor (on the Canadian side of Lake Ontario) receives nearly 220 tons of chemicals per day. Toxic substances can be quickly distributed throughout the lakes by active mixing of lake water and the stirring up of lake sediments. Many of these human made chemicals and metals can be acutely poisonous in very small amounts. Many trace contaminants have the potential risk of causing cancer, birth defects, and genetic mutations from long-term exposure.

Humans are exposed to toxic chemicals when they eat contaminated fish. In 1987, the Wisconsin Department of Health and Social Services analyzed the amount of PCBs, DDE, and mercury in the blood of nearly 200 anglers in ten counties bordering the Great Lakes. On the average, these families consumed three times the national average of fish per year. Almost half showed the presence of DDE and more than two-thirds contained PCBs.

Persistent chemicals are those chemicals which do not break down readily in the environment. Some persistent chemicals such as DDT and PCB **bioaccumulate** in the organism and become concentrated at levels which are much higher in living cells than in water. Bioaccumulate is repeated at each step of the food chain. The process of increasing concentrated through the food chain is called **biomagnification**. The top preditors at the end of the food chain, such as large trout, salmon and fish-eating gulls may accumulate concentrations of a toxic chemical high enough to result in serious deformities or death. Further biomagnification occurs in birds, other animals, and humans that consume fish.

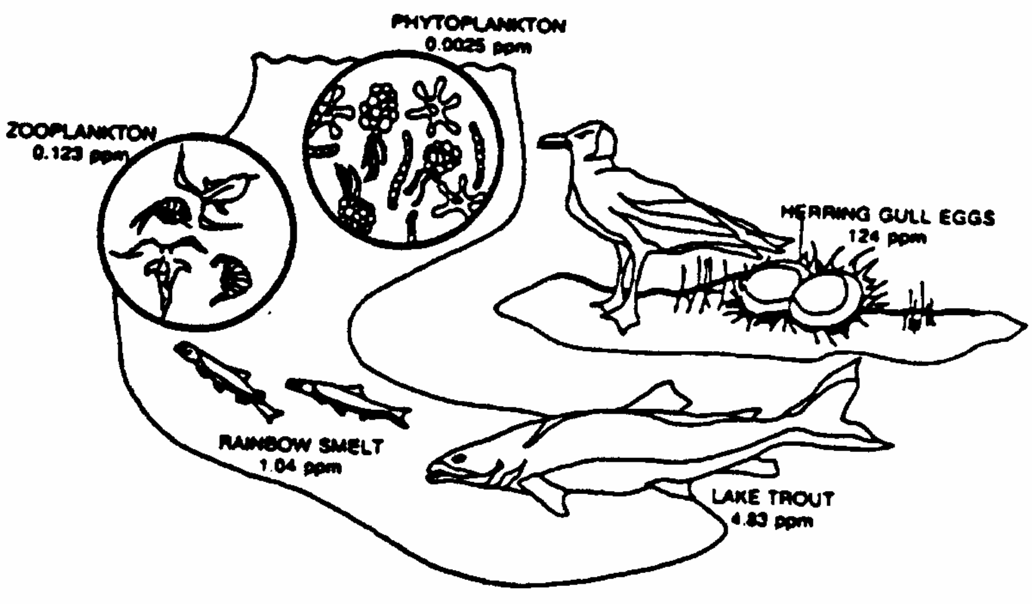
The concentration of some chemicals in the fatty tissue can be a million times higher than the concentration in open water. Because egg yolk is rich in fatty material, eggs of aquatic birds at the top of the food chain often have some of the highest concentrations. As a result, the initial effects of toxic chemicals in a lake appear as dead or malformed chicks. Monitoring and analyzing colonies of gull eggs can serve as an early warning of toxic contamination.

The IJC has identified eleven "**critical pollutants**" which are widespread throughput the Great Lakes. Critical pollutants are substances "capable of producing adverse, often irreversible effects in a wide range of mammalian and aquatic species." These substances have the ability to bioconcentrate and to bioaccumulate in the upper levels of the food chain. These toxic chemicals present potential health risks to humans and animals that consume contaminated levels and reductions in the ecosystem are at unacceptable levels.

Critical Pollutants

Polychlorinated biphenyls (PCBs)	Dioxin (2,3,7,8-TCDD)
Mercury	Toxaphene
Dieldrin	Dibenzofuran (2,3,7,8-TCDF)
DDT and metabolites	Lead
Mirex	Benzo(a)pyrene(BaP)
	Hexachlorobenzene

Figure 1.



QUESTIONS

Use Figure 1 to answer these questions.

1. What organism absorbs PCBs directly form the water?

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2. Explain the process in which the gull eggs become contaminated.

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3. If a human consumed ten lake trout over a period of a year, what would be the maximum amount of PCB contamination consumed in 1 year? 5 years?

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4. How many times greater is the contamination of the gull eggs than the phytoplankton? _______________The lake trout? ____________________

5. How many phytoplankton must be consumed to produce the contamination level of the zooplankton?

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6. Which organisms would result in the highest contamination with consumption of only one item? Explain why.

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7. Illustrate a food chain that includes humans and show how humans can be contaminated by PCBs.