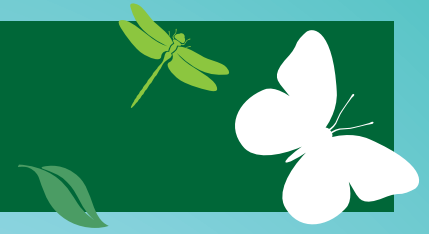


Danger from Afar:

Non-point Source Pollution and the Lake Superior Basin



Summary:

Students play a game to learn about non-point source pollution in Lake Superior.

Grade Level:

3-8

Time:

1-3 class periods

Subjects:

Physical science (chemistry and physics), math, biology, geography, history, social studies and language arts

Learning Objectives:

Students will be able to:

- Explain the meaning of non-point source pollution and a toxic hot spot
- Demonstrate understanding of the relationship between human and wildlife populations and toxic pollution
- Discuss ways in which non-point source pollution may be identified and prevented

Materials:

- Wall map of North America showing the Great Lakes
- A length of string tied in a loop to represent the borders of Lake Superior
- 25-30 plastic disks with "DANGER!!" written on top
- 50-100 plastic disks (poker chips) to represent a water drop

Background

Many rivers and lakes across the country are threatened by non-point source pollution. Non-point source pollution is pollution that enters water from a source that cannot be traced to any single site of discharge. Point source pollution, on the other hand, enters a water source directly from a specific, identifiable location, such as from a ship dumping waste or a factory waste pipe. Non-point source pollution is more difficult to manage than point source pollution. To minimize non-point pollution one can identify those activities relatively near a water source that may be responsible, such as industrial plants and large farms or residential areas that use fertilizers. Identifying non-point source pollution can be an expensive and often frustrating approach, yet it is necessary as part of a comprehensive management plan to improve water quality.

Runoff occurs when rainwater or snowmelt flow overland into nearby waterways. This water becomes polluted as it accumulates toxic chemicals and other wastes produced by vehicles, fertilizers and industries. Many of these pollutants then enter the waterway and are absorbed by plants, insects, mollusks, and fish. Some pollutants accumulate in the fatty tissues of fish, posing a risk to people that eat them. As the concentration of toxic pollutants in water rises, it causes increasingly negative effects on wildlife and humans - causing genetic mutations, illness, and even death. In the Lake Superior basin, unhealthy levels of mercury have been found in fish such as salmon, lake trout and walleye. Humans ingesting even a small amount of mercury can suffer serious health problems. In adults mercury can cause losses in sensory and cognitive ability and developmental delays and birth defects in infants.

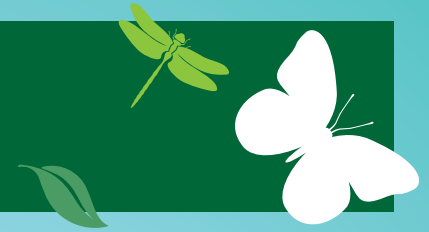
Around Lake Superior there are many areas known to have high concentrations of toxic pollutants. These toxic hotspots, include areas of extensive agricultural fields, major industrial areas, grazing lands, and large road and building construction sites. As the population of people around Lake Superior continues to grow, the number and size of these toxic hotspots also grows, resulting in higher pollution levels in the Lake.

Procedure

1. On a board or flip chart, brainstorm with students a list of possible pollution sources. Encourage students to brainstorm about everyday activities such as running the dishwasher (detergents in the dishwashing liquid) and driving a car (exhaust emissions are a source of air pollution). Once a list has been generated tell students that most of the pollution created by these activities ends up in a water body such as a river or a lake. *Can you think of the connections that lead to water? How might each of these*



Danger from Afar (continued)



pollution products find its way to the nearest or largest water body? Write down some of these connections next to the pollution list.

2. The Lake Superior basin is one example of a place that has been polluted by human activities. Have the students identify Lake Superior and the other Great Lakes on a map of North America and then identify the main urban areas surrounding the lakes. Encourage students to think about the relationship between population numbers and pollution. One way to describe such a relationship is to draw a graph with population numbers on the x-axis and the amount of pollution on the y-axis. Ask students to predict what the graph will look like. Emphasize that the population affecting any given area may not live right next to it, but the needs of that population (industries, logging, mining, housing development) still affect the area.
3. Place the map on the floor or stretch out a string to approximate the shape of the Lake. Have the students stand around the Lake.
4. Place all the water drop disks into the Lake. These disks represent the amount of water in the Lake.
5. Divide the class up into two groups: those representing population and those representing toxic hot spots. Tell the students that each water drop disk represents the water consumption of 100,000 people. The ratio of people to toxic hot spots is five to one. In other words, 500,000 people are responsible for one toxic hot spot in the Lake, so your two groups should have roughly that ratio. See chart below:

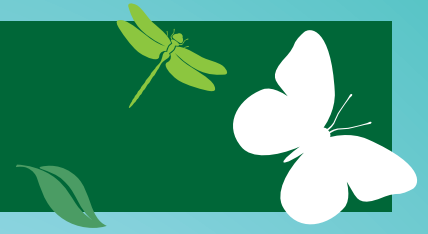
Total students	Population disks	Hot spots
12-16	10-14	2
17-22	14-19	3
23-28	19-24	4
29-34	24-29	5
35+	29+	6

Each toxic hot spot disk represents an activity that creates non-point source pollution in the Lake, from activities like the ones students thought up in Step 1. Some major sources of non-point source pollution are:

- *Agricultural fields and grazing lands:* Runoff carries fertilizers, pesticides, chemicals and nutrients such as nitrates and phosphates in high quantities into water bodies, where they are harmful to aquatic life.
- *Logging:* In the absence of soil protection, logging leads to increases in erosion. This affects the cloudiness or turbidity of the water because of suspended particulate matter. The soil particles can effectively smother aquatic life that needs clean, flowing water, and reduce water flow, which decreases dissolved oxygen.
- *Road and building construction:* With poor erosion controls, soil and construction wastes enter waterways harming wildlife and lowering water quality.
- *Roads and parking lots:* By paving over natural land, the amount of runoff during a rainfall or flooding



Danger from Afar ***(continued)***



event is greatly increased; toxic chemicals, oils and paints used in cars can poison and kill insects, amphibians and fish.

- *Lawns and golf courses:* The heavy use of fertilizers and pesticides in maintaining landscaped areas increases the likelihood that they will eventually find their way into a river or lake (leads to algae blooms, lowers oxygen in the water).
- *Smokestacks and car exhaust:* Power plants, incinerators, automobiles and other industries that release air emissions can cause fallout of pollutants like toxic mercury and even cyanide into water bodies.
- *Dams and levees:* Altering the natural flow of a river by building channels, canals and dams impair the natural ecology of a river or lake.

6. Each student representing a toxic hot spot corresponds with a major source of non-point pollution described above or that they brainstormed. Read off some of the pollution sources listed above and the ones students brainstormed. Have each student pick which source he/she wants to represent.

7. Begin the activity with two students, one representing population and the other a toxic hot spot. Each student representing the human population will take out one water drop disk at a time, representing the consumption of water by that population.

8. After five students have removed five water disks, representing the consumption of water by 500,000 people, a student representing a hot spot will put a disk in the lake. Slowly increase the number of “population” students and have students describe what they see happening and the relationship between population numbers and pollution in the lake. The more people living around the lake, the greater the concentration of pollution. What is the effect of this pollution on people and on wildlife who depend on Lake Superior?

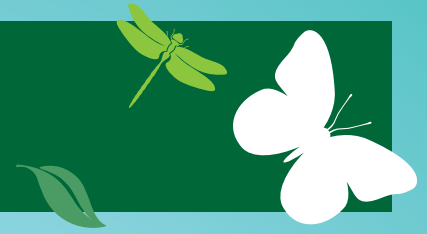
9. Hand out the Lake Superior student fact sheet and give students time to read over it, or have advanced students conduct their own research on the effects of various pollutants on humans and wildlife in the Lake Superior region. What do they discover? Why should we worry about the level of pollutants in the lake?

10. Have students identify the primary local drinking water source and find out how many people depend on it and what kind of wildlife uses it. Have students research major local sources of pollution (visit the website of the Environmental Protection Agency www.epa.gov for assistance). Repeat the game for this local water source.

11. As a class, make a list of all the ways your school community contributes to nonpoint source pollution (driving to school, use of roads, parking lots, etc.). How can they reduce these effects to contribute towards reducing water pollution overall? How can a schoolyard habitat help? (Note: Reducing population growth may be one option students come up with, but encourage them to think of creative ways a growing or steady population can reduce its creation of non-point source pollution.)



Danger from Afar ***(continued)***



Modifications for Older Students (Grades 7-8)

Instead of telling your students what the various non-point sources are, have them research on their own to identify these sources.

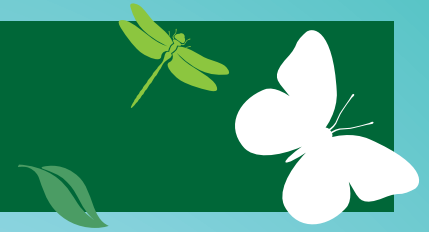
Extensions

- Have students investigate their local watershed. Visit EPA's "Surf your Watershed" website (<http://cfpub.epa.gov/surf/locate/index.cfm>) to identify their local watershed, learn the health status of this watershed, major point-source pollution sources and the vulnerability of the watershed to future pollution issues.
- In addition to water quality issues, the Great Lakes also face water quantity issues, with various states and localities wishing to withdraw water from the lakes for the whole range of human activities. Have students investigate some of these issues and why some people are concerned about water withdrawals from the Great Lakes. Ask students to research Annex 2001, a water resources agreement between the governors of the eight Great Lakes states and the premiers of Ontario and Quebec. *What does it do? Why is it necessary?*

Assessment

- Assign students, or have them choose a source of non-point pollution from the list in Step #5. For each pollution source, ask students to identify the major polluting chemicals and their effects on wildlife and the environment.
- Using a library and online sources have students create a presentation on the effects of non-point pollution on their local water bodies. The presentation should include how the pollutant enters the waterway and its effect on aquatic wildlife and potential threats to humans. They should also include proposed solutions for preventing or minimizing non-point pollution.

Lake Superior Student Fact Sheet



Lake Superior is one of the Earth's greatest treasures. The amount of water in the lake, the beauty of the area and the relative lack of development, all make Lake Superior an amazing resource. However, like almost every other part of the world, Lake Superior is threatened by both pollution and habitat destruction. A healthy Lake Superior is crucial for the people and wildlife in the region.

Major sources of air and water pollution in the Lake Superior area include iron ore mining, pulp and paper mills, oil refineries, steel-making factories, coal-fired power plants. Pollution enters the Lake Superior watershed through the air, rain, snow and water. Eventually, these pollutants end up in the bodies of organisms which use the lake, such as fish, insects, aquatic birds, and others. When people eat them, these pollutants enter their bodies as well.

Mercury

Mercury is a potent neurotoxin, which means it affects the brain and nervous system. Mercury exposure can cause serious nerve and developmental damage to humans ranging from minimal losses of senses or thinking ability and/or delays in developmental stages (e.g. walking, talking), to serious birth defects, tremors, and even death.

People can get mercury poisoning by eating fish contaminated with it. When mercury enters water, it travels up the food chain and eventually into the fish we eat. Mercury accumulates at such high levels in the aquatic food web that fish at the top of the food chain, such as salmon, lake trout, or walleye can have mercury concentration over a million times higher than the water they live in. Since these species are among the fish that people most like to catch and eat, mercury poisoning is a serious public health problem. Fish in more than 50,000 bodies of water in 40 states contain such high levels of mercury that health agencies have warned people against eating them.

Dioxin

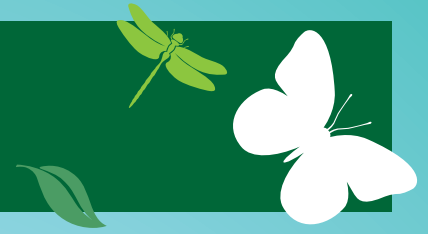
Dioxin was once considered the most toxic chemical ever made because of its ability to cause cancer.

Dioxin is not made intentionally and serves no industrial use. It is made through the process of using chlorine to bleach paper pulp, burning waste that contains plastics, making certain pesticides, and many other industrial processes. Humans are exposed to it by eating meat, fish, and dairy foods. According to the EPA, Americans eat 167 times more dioxin each day than the acceptable daily level of 0.006 picograms per kilogram of body weight.

Dioxin has been shown in laboratory experiments to upset normal development of a fetus and to affect the development of the nervous system, behavior and ability to learn. It also harms the ability of the body to defend itself from diseases. Dioxin is regulated by the EPA as a dangerous pollutant. EPA's limit on the release of dioxin under the Clean Water Act is set at 0.013 parts of dioxin per quadrillion parts of water. Companies that make paper, and produce a lot of dioxin, have made great improvements in reducing their emissions recently, yet as a whole group industry has not met industry guidelines for this chemical.



Lake Superior Student Fact Sheet (continued)



Wildlife

Lake Superior is home to numerous wild creatures: wolves, moose, lynx, loons and trout, to name a few. These creatures are in trouble when their habitat is damaged. Development (especially on shores), poor methods of logging and dams are a few of the threats to Lake Superior's native biodiversity. When homes are built on the shore of Lake Superior, shoreline habitat for amphibians is lost, nesting sites for bald eagles may be disturbed and spawning sites for fish are also lost. The continuing need for timber products (paper, building materials, toilet paper) is felt strongly around Lake Superior, one of the most heavily-forested areas in North America. Poor forestry practices can eliminate habitat and alter native ecosystems, disrupting the natural relationships of plants and animals. Acid rain created from the wastes of industrial processes also affect the water quality of the lake.

