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MASS BALANCE: ADDING IT ALL UP

Pollutants enter the Great Lakes and other aquatic ecosystems from the air, land, and water. Scientists seek to understand how pollutants are cycled within aquatic systems and their foodwebs, and to determine effects of pollutants on living organisms. Solving this puzzle involves collecting a variety of environmental samples, and using mathematical models to analyze the relationships among the sample sites.

The amount of pollutant that enters a lake equals the amount of that pollutant leaving, remaining in, or breaking down in the lake. This mass balance of sources and fates of pollutants is a valuable tool. It enables resource managers to design cost-effective strategies to minimize risks to human and ecosystem health. The Mid-Continent Ecology Division is using a mass balance approach to study two pollutants of concern in Lake Michigan: mercury and atrazine.

Atrazine

Atrazine was selected for study in Lake Michigan because of its high use in the watershed, presence in the lake, and suspected potential toxicity. Atrazine is an herbicide used to control broadleaf weeds in corn and other crops nationwide. It accounts for 26% of the total herbicide applied within the Lake Michigan watershed. Atrazine enters the lake primarily through runoff and precipitation. Little is known about this pesticide's fate once in the lake, but it is thought to be harmful to aquatic organisms.

Though atrazine degrades rapidly on land, it can remain in water for years. The amount of atrazine in the water increases during times of greater agricultural use and rainfall. Both small and large plants in the lake (phytoplankton and macrophytes) are vulnerable to herbicides. However, bottom-dwelling invertebrates, zooplankton, and fish may be affected by the changes in their food supply or shelter through harmful to plant communities. Atrazine also raised concerns as a potential human carcinogen and endocrine disruptor.

Mercury

Mercury was selected for study in Lake Michigan because of its persistence in the environment, known toxicity, and bioaccumulative properties. Environmental mercury results from both natural and anthropogenic (human-caused) events. Mercury occurs naturally as an element in some minerals, and often occurs in coal and ore deposits. Anthropogenic activities contribute an estimated 11,000 tons of mercury to the air, water, and soil each year. Sources include fuel combustion, mining and manufacturing activities, and agricultural and municipal wastes. Mercury is used in batteries, thermometers, switches, fluorescent lamps, and commercial chemicals.

A strong neurotoxin, mercury contributes to many serious human and animal health problems worldwide. As methyl mercury, it is of particular concern because of its ability to bioaccumulate. Methyl mercury harms organisms as its concentration in tissue increases and interferes with cellular processes.

People around Lake Michigan are developing a Lakewide Management Plan (LaMP) to define and reduce the amount of mercury and other priority pollutants in the lake. The LaMP involves government agencies (federal, state, local, and tribal), academia, industry, and environmental groups working together to form concise strategies to confront pollution issues in the Lake Michigan basin. Atrazine is listed in the LaMP as an "emerging pollutant" with the potential to harm the lake. Completing a mass balance model for both mercury and atrazine will provide a tool for use in the LaMP process.

Study of these chemicals is part of a larger effort of the Lake Michigan Mass Balance Project that focuses on four specific pollutants: PCBs, trans-nonachlor, atrazine, and mercury. These pollutants were chosen from a list of chemicals of concern in Lake Michigan to represent a broad range of pollutants from a variety of sources. Most are persistent in the environment, and many bioaccumulate in living tissue. Thus, they pose a threat to the lake's precious wetlands, wildlife, and fisheries.

Contact: Russell Kreis (734) 692-7615

National Health and Environmental Effects Research Laboratory
Mid-Continent Ecology Division
6201 Congdon Blvd.
Duluth, MN 55804
Environmental Education and Scientific Outreach