Surface Water Pollution

Essential Standard 2.4

Evaluate how humans use water.

Learning Objective 2.4.2

Evaluate human influences on water quality in North Carolina's river basins, wetlands, and tidal environments.

I Can Statements

At the end of this lesson, you should be able to say, with confidence:

- I can distinguish between point source and non-point source pollution
- I can identify several types of non-point source pollution and the effects they have on the environment and human health
- I can explain what bioaccumulation and biomagnification means and distinguish between the two

Sources of Water Pollution

Water pollution is often classified according to its source and how it enters a body of water.

Pollution that enters at one point, generally through a pipe from a factory, is called point source pollution.

Pollution that enters through surface runoff is called non-point source pollution.

Point Source Pollution

Point source pollution enters the stream from site, such as a factory, and usually enters through a pipe.

The Clean Water Act ensures that this type of pollution is monitored and since its enactment in 1972, our rivers and streams have far less of this type of pollution.

But due to politics, illegal activity, and accidents, point source pollution can still occur.

Point Source Pollution

When warm water enters a stream or lake, it raises the temperature of the stream or lake.

Higher temperatures in water result in lower levels of dissolved oxygen and can result in lower amounts of aquatic wildlife.

Many industries and thermoelectric power plants release warm water into streams and lakes.

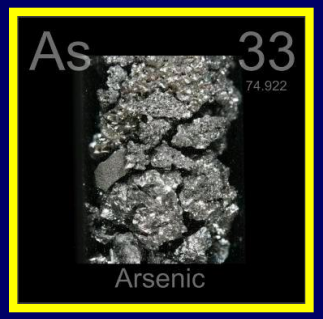
Point Source Pollution

Heavy metals or oils from mining, oils spills, or coal ash accidents, may enter through runoff and not a pipe, but they're still considered a point source because they come from one source that is easily identified.

Mining

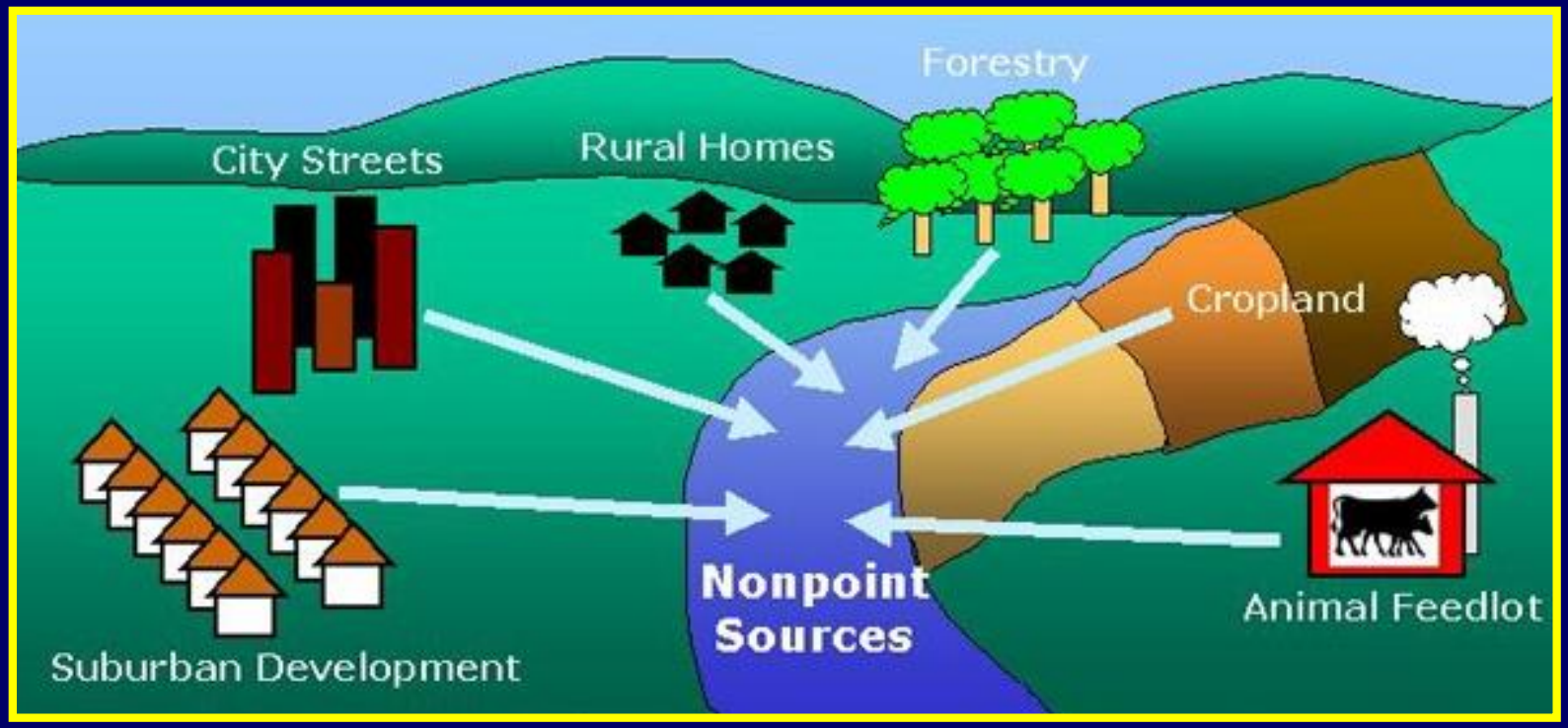
Oil

Coal Ash



Non-Point Source Pollution

Non-point source pollution accumulates from a number of sources and generally enters surface water through surface runoff, although it may also collect and enter through a drain pipe.



Non-Point Source Pollution

Because non-point doesn't originate from just one source and is accumulative, it is not as easily monitored and is the current leading cause of surface water pollution.

Also, since non-point pollution generally enters as surface runoff, anything that is on the ground and can be dissolved or picked up and carried by the water, will contribute to surface water pollution.

Impervious Surfaces

Since non-point pollution generally enters as surface runoff, anything that increases surface runoff will increase surface water pollution.

Areas with a lot of impervious surfaces will have increased surface runoff resulting in increased surface water pollution and increased flooding.

Thermal Pollution

Rain storms are more frequent in the hot, summer months.

When rain falls on impervious surfaces, especially black top roads and parking lots, the water becomes warmer.

When the warm rain water flows into a stream or lake, it lowers the dissolved levels since warm water can hold less dissolved oxygen.

Litter

Litter is often the most visible form of surface water pollution.

Some people think litter in a stream or lake was dumped directly into the stream or lake.

But most of the litter was originally on land and washed into the stream or lake through surface runoff.

Excess Sediment

Excess sediments is the most common form of surface water pollution and increases the turbidity of surface water.

Excess sediments lower the dissolved oxygen levels by blocking photosynthesis and raising the temperature.

Excess sediments also clog gills, smother eggs, and cover habitat for aquatic organisms.

Sources of Excess Sediment

The same practices that increased erosion also increase sediment pollution.

Clear Cutting

Poor Construction Practices

Poor Farming Practices

Nitrates and Phosphates

Nitrates and phosphates are essential for plant growth. However, high concentrations of both in surface water can lead to eutrophication and result in algal blooms.

As the algae dies, it is decomposed by aerobic bacteria which results in lower dissolved oxygen levels.

Source of Nitrates and Phosphates

Nitrates and phosphates usually enter surface water in surface runoff after fertilizers have been applied to crops, lawns, or golf courses.

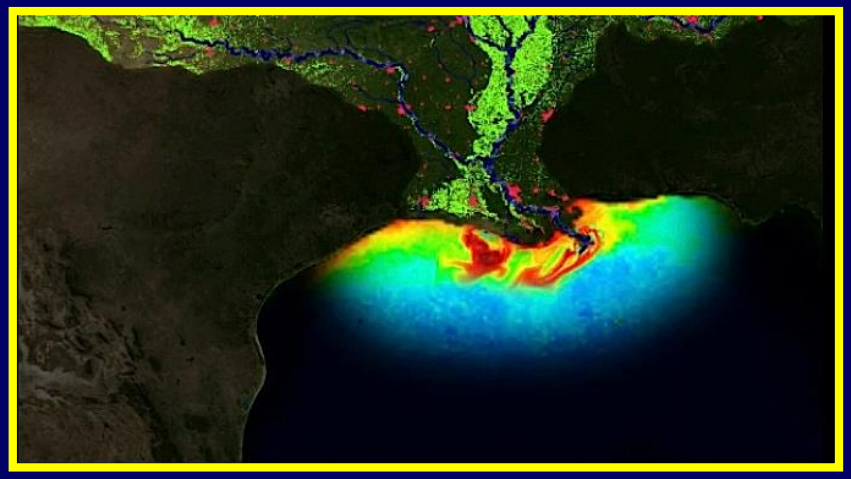
Source of Nitrates and Phosphates

Nitrates and phosphates can also enter surface water through farm animal waste and human waste at overflow outlet or when waste treatment plants fail such as during a hurricane.

Overflow outlets let waste water out when there is too much, rather than having pipes burst.

Dead Zones

Surface water with levels of dissolved oxygen that are too low to support aquatic life and called dead zones.



Each summer a dead zone forms in the Gulf of Mexico, near the mouth of the Mississippi River.

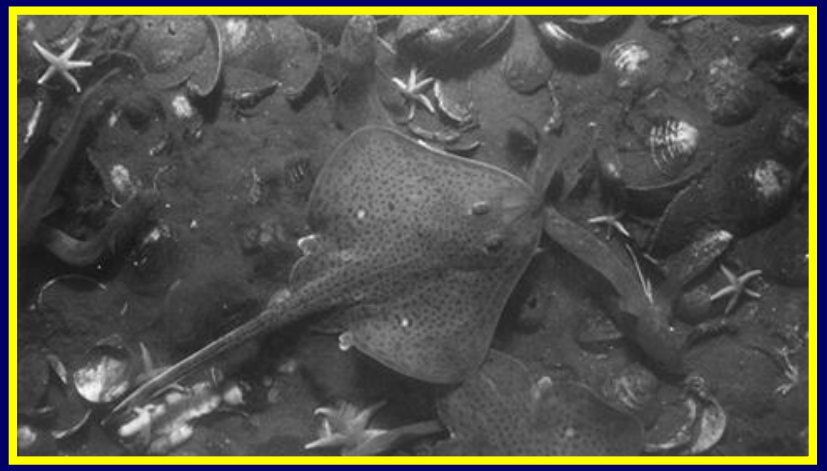
The Mississippi River drains water from over 3 million kilometers of land, along with tons of nitrates and phosphates.

Gulf of Mexico Dead Zone

The zone varies in size from about 5,000 to 7,000 square miles.

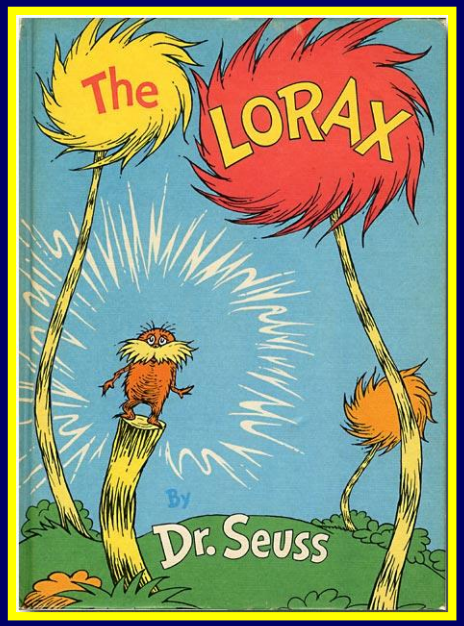
Dissolved oxygen levels often reach as low as 2 ppm.

Fish and other mobile aquatic organisms can migrate to better water, but less mobile aquatic organisms die.



Dead Zones

In the 1960's, Lake Erie was declared "dead" due to excessive algae growth and the resulting decreased levels of dissolved oxygen.



The demise of Lake Erie even made it into the Dr. Seuss book, *The Lorax*.

"I hear things are just as bad up in Lake Erie"

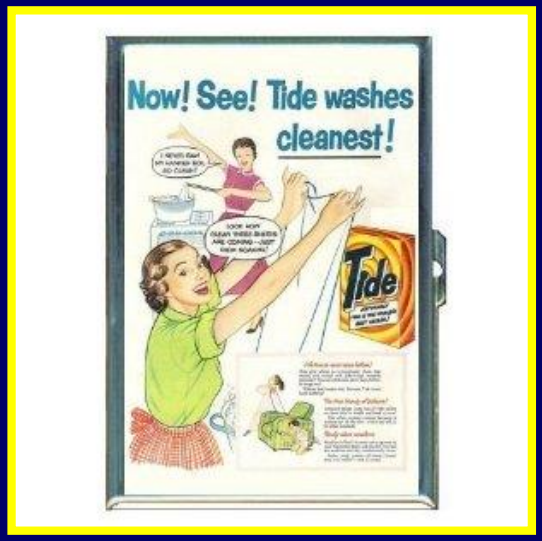
Lake Erie - Dead Zone

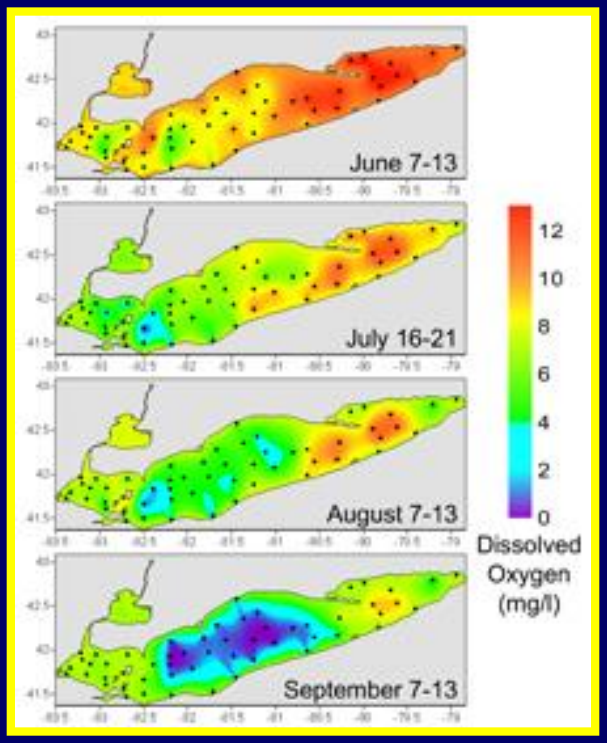
Lake Erie is the shallowest and warmest of the Great Lakes and shares a border with Canada and the US.

The land area around Lake Erie is also heavily developed with agriculture, urban areas, industries, and sewage treatment plants.

Lake Erie - Phosphates

For decades, pollution filled Lake Erie with more nutrients, especially phosphates from detergent, than the lake could handle.





With excess phosphates, algae began growing exponentially and then dying, and decomposing in Lake Erie, creating anoxic (low oxygen) waters at the bottom of the lake.

Lake Erie - International

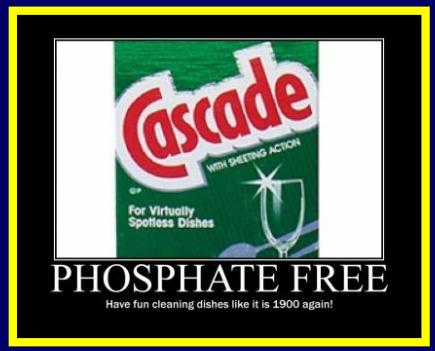
Due to the lack of oxygen, fish and other aquatic organisms began dying, creating a stench that surrounded the lake.

Environment Canada | Environnement Canada

EPA

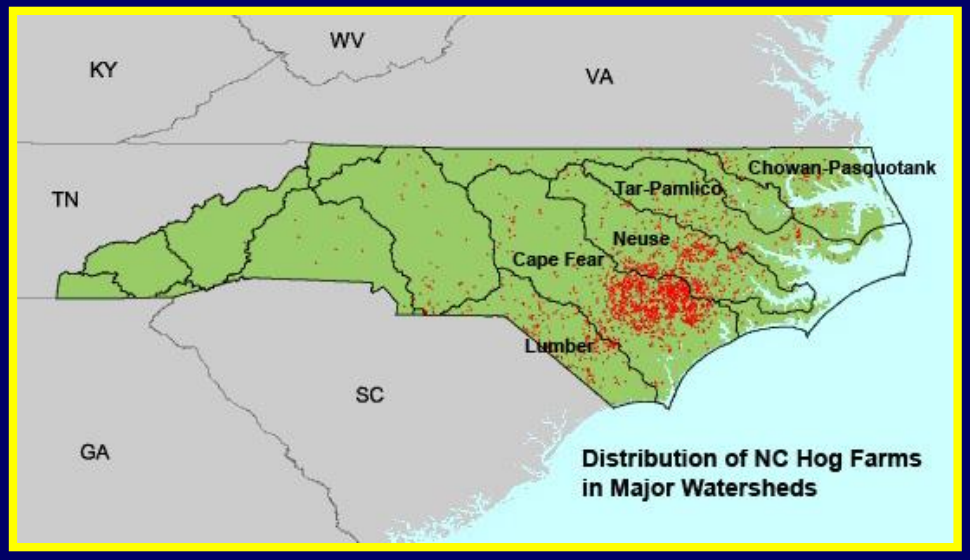
In response to public concerns, an international joint commission was formed between the United States and Canada in 1972.

An agreement was made to reduce the amount of phosphorus into Lake Erie by putting controls on sewage treatment and agricultural methods. In 1977, the use of phosphates in detergent was banned.



North Carolina – Hog Farms

In the 1990's, North Carolina's hog population rose from 2 million to over 10 million, making it the 2nd largest hog farming state.



Many of the farms were built on floodplains near the eastern part of the state.

North Carolina – Hog Farms

The manure and urine from pigs were usually washed out of the barns and into open, unlined lagoons.

The wastes are then sprayed on crops as fertilizer.

The total amount of hog waste in North Carolina in 1997 reached 20 million tons.

X 20

North Carolina – Hog Farms

In the 1990's, North Carolina was hit by a series of hurricanes that flooded the hog farms.

250 million gallons of liquid pig wastes were washed into creeks, rivers, and wetlands.

Massive fish kills began to occur regularly in North Carolina's rivers.

North Carolina – Pfiesteria

In the late 1980's and early 1990's, two scientists at NC State discovered a toxic animal-like algae (dinoflagellate), called *Pfiesteria piscicida* in North Carolina's estuaries.

Pfiesteria piscidida has a very elaborate life cycle and can go through many stages and alters its feeding habits accordingly.

Most of the time it will feed on photosynthetic algae, retain their chloroplasts in small vacuoles, thus allowing the pfisteria to photosynthesize.

North Carolina – Pfiesteria

Pfiesteria piscicida thrive in brackish, estuarine waters, overloaded with nitrates and phosphates that help create algal blooms, their main food source.

When schools of menhaden and other fish come along, the *Pfiesteria piscicida* are stimulated into a toxic live cycle stage.

North Carolina – Pfiesteria

In their toxic life cycle stage, *Pfiesteria piscicida* release a neurotoxin into the water that lowers the immune response in the fish, making them more susceptible to attack.

Most of the fish die within minutes of exposure to the toxin.

Scallops, oysters, and blue crabs also die when exposed to the toxin.

Pfiesteria piscicida

North Carolina – Pfiesteria

The toxin can also act as an aerosol in the air and has adverse affects on human neurological systems.

Both fisherman and scientists studying pfieseria have experienced blurred vision, acute respiratory difficulty, nausea, and severe memory loss.

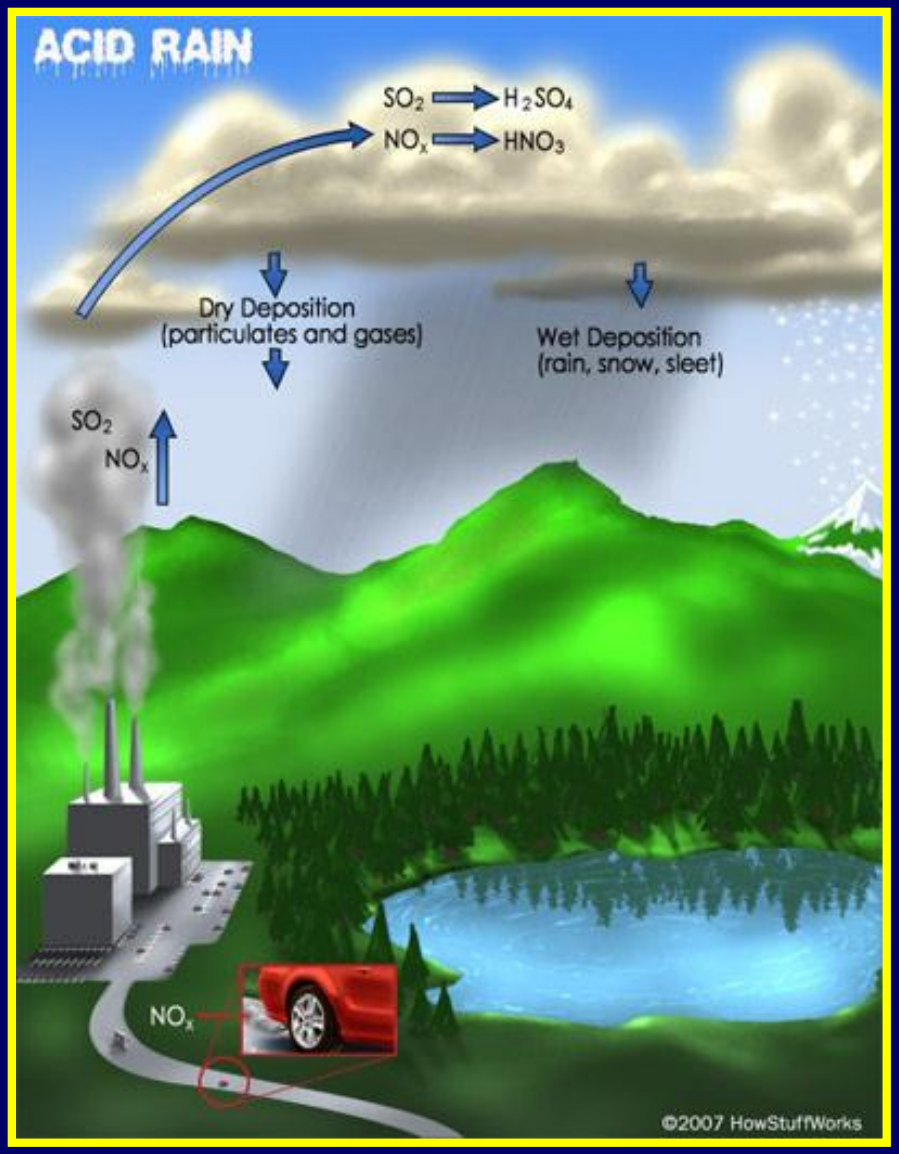
If you see a fish kill, like the one pictured above, do not go near it, leave the area and report it to authorities.

Bacteria and Viruses

Disease causing bacteria and viruses can also be a cause for concern in surface water from animal wastes and human sewage.

Often during hurricanes, the tanks at waste water treatment plants flood, causing untreated sewage to flow into surface water.

Acid Rain

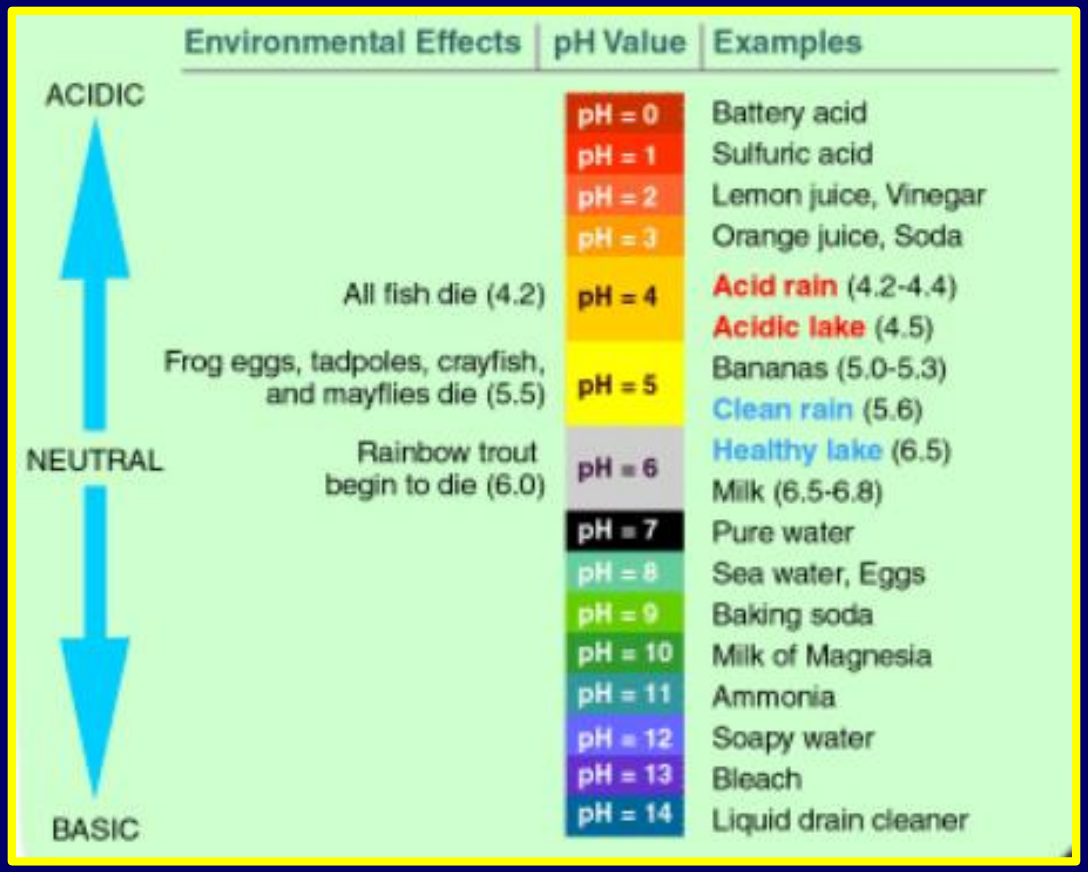


Acid rain can enter as a nonpoint source pollution when exhaust from coal burning plants and cars mix with rain to form nitric acid and sulfuric acids that decrease the pH of streams and lakes.

While usually called acid rain, it can also occur with snow or sleet, so some call it acid precipitation.

Acid Rain

While all fish species die if the pH goes below 4.2, fish and other aquatic organisms have various tolerance levels to changes in pH above 4.2.



Mercury

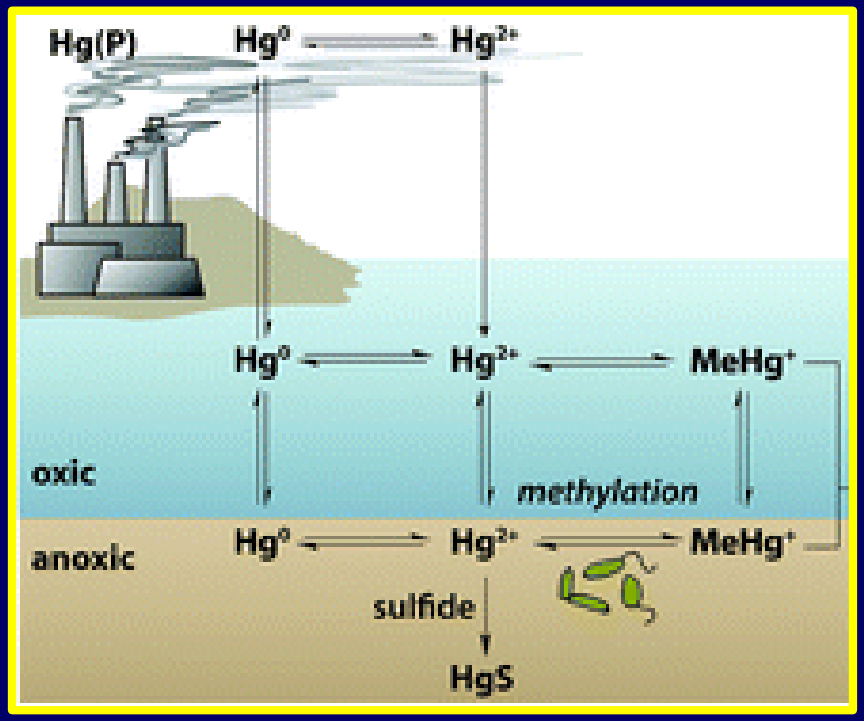
Mercury is the only metal element that is a liquid at room temperature.

Mercury is naturally found in the mineral, cinnabar. (86% mercury)

Mercury is released through volcanic activity and weathering of rocks.

Methylmercury

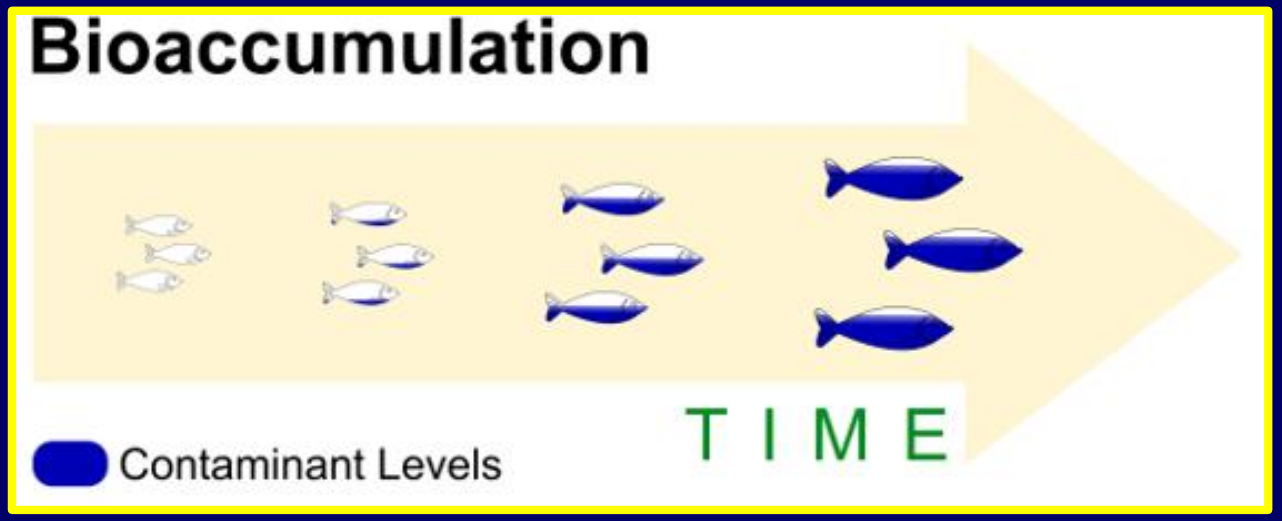
The most common way for mercury to enter the environment from human activity is through coal burning plants and industrial waste disposal.



Once mercury is released to the environment, it can be converted to a biologically toxic form of methylmercury (MeHg) by microorganisms found in soil and in the aquatic environment.

Bioaccumulation

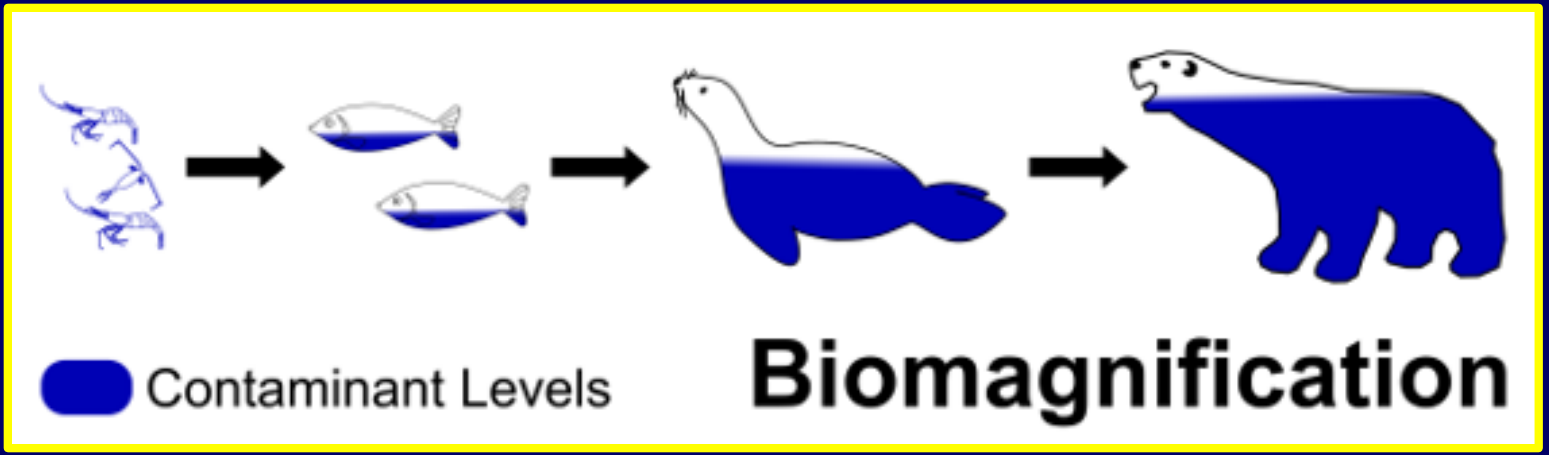
Once consumed, methylmercury doesn't break down, it just keeps accumulation with more and more consumption.



When a contaminate accumulates over time within an organism, increasing in concentration, it is called bioaccumulation.

Biomagnification

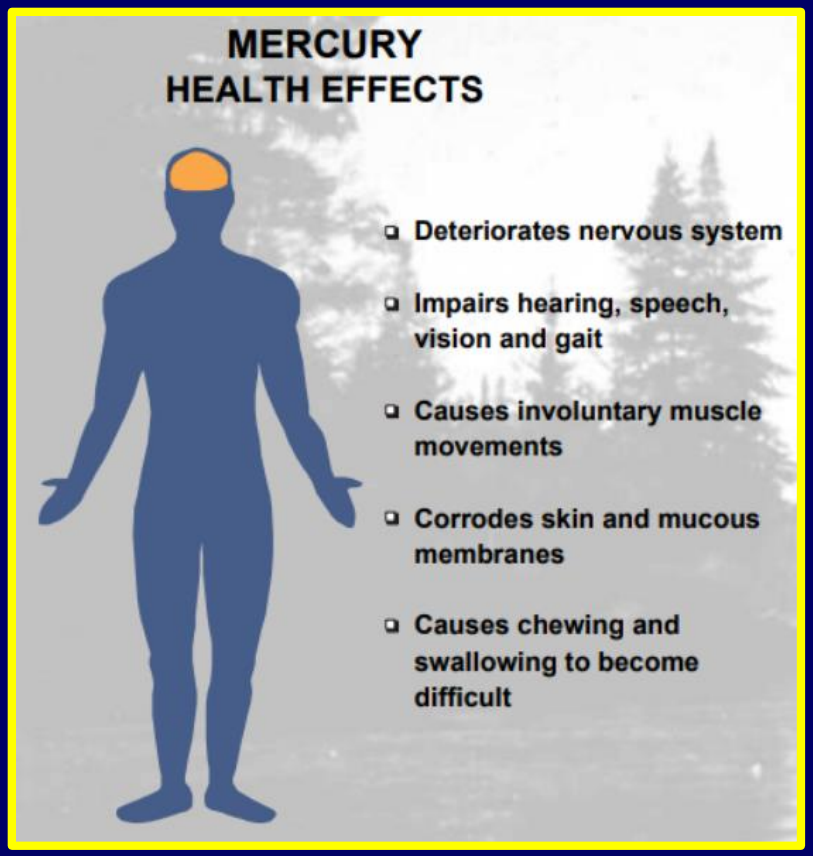
When larger animals consume animals that have bioaccumlated mercury, the dose the larger animals get is higher than it was for the smaller animals.



When a contaminate increases in concentration or dosage, as it moves up the food chain, it is called biomagnification.

Impact on Humans

Since humans are at the top of the food chain, the concentration we get from consuming fish with tends to be very high and will bioaccumulate.

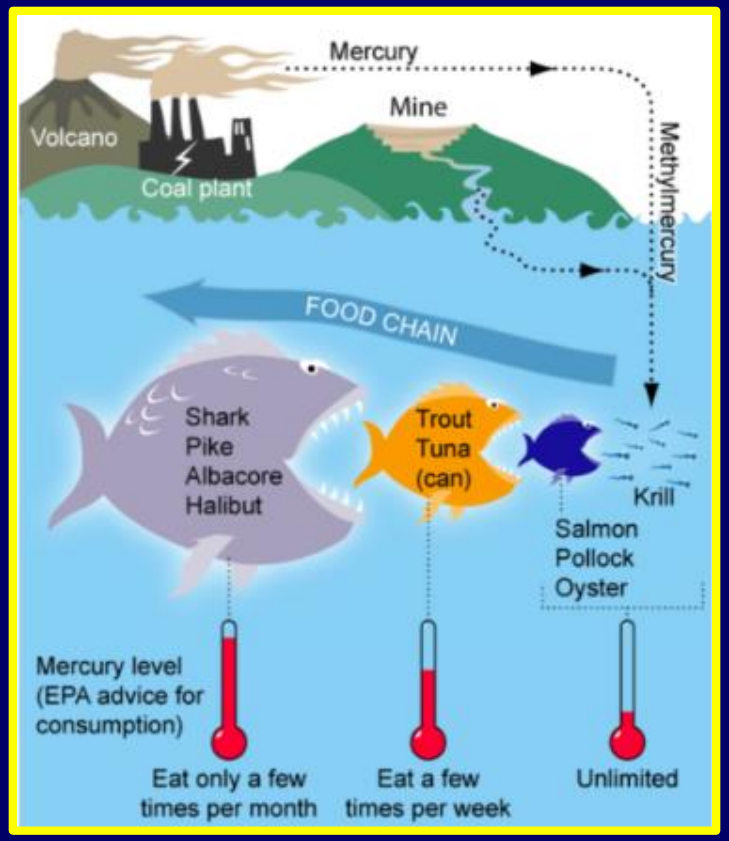


Mercury poisoning can damage the nervous system and even result in death.

Pregnant women need to be extra careful with avoiding mercury because it can result birth defects or death of the baby.

Fish Consumption

Because methylmercury is commonly found in our waters, constant consumption of certain fish, especially by pregnant women, is not recommended.



Click on link for an interactive map that announces fish advisories.

Note that there is a mercury advisory for Baden Lake.

Fish Advisory

Pesticides

Pesticides can enter waterways as a non-point source pollution when crops are irrigated and surface runoff carries the pesticides into streams.

Pesticides can kill benthic macroinvertebrates that live in the stream and are an important part of aquatic food webs.

One pesticide called DDT, was widely used to kill mosquitoes. However, like mercury, DDT was capable of bioaccumulating and biomagnifying up the food chain.

Pesticides

Consumption of DDT by fish eating birds, resulted in weakened egg shells that never hatched.

As a result, the populations of many birds like eagles, osprey, and pelicans began to drop to near extinction levels.

A wildlife biologist, named Rachel Carson, discovered the problem and wrote a book about it called Silent Spring. DDT was later banned in the US.

The End