Ohio River Resource Manual

PA Denny River Education Center

Foundation for Ohio River Education

http://oef.orsanco.org

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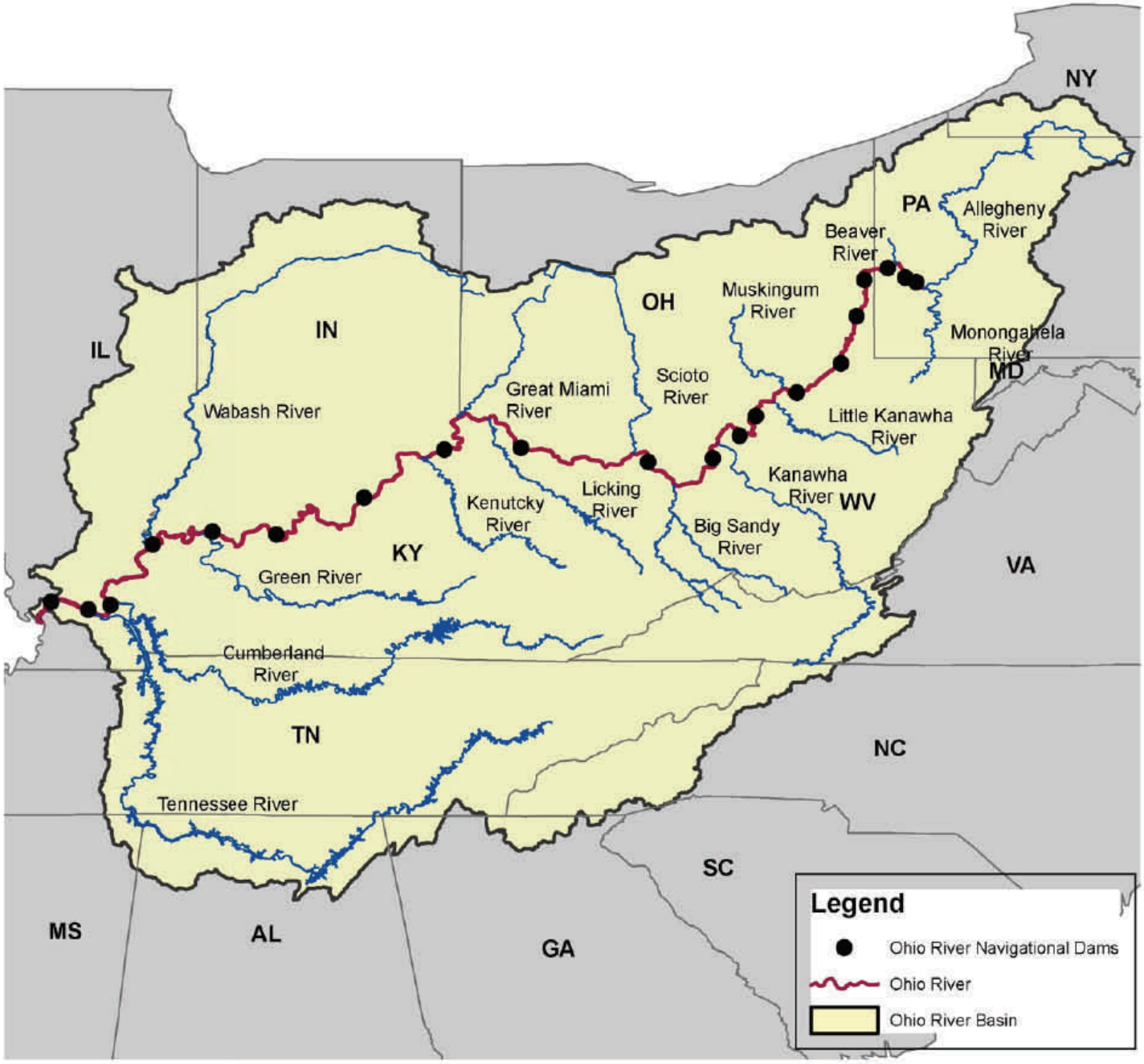
FOUNDATION for OHIO RIVER EDUCATION

The Ohio River and its Watershed

A **watershed,** or **drainage basin** is the total area of land that drains into a particular body of water. The boundaries of a watershed can usually be determined from mountains, hills, or other features of the land that direct the flow of surface water and ground water into a river, lake, stream, or wetland. The area of higher topography that separates one drainage basin from another is called a **drainage divide.** Multiple smaller watersheds can comprise larger watersheds. For instance, the Ohio River watershed is comprised of many smaller watersheds for each of the **tributaries** that flow into it. As a result, water from nine states forms the drainage basin for the Ohio River. The Ohio River is 981 miles long, and is formed by the **confluence** of the Allegheny and Monongahela Rivers in Pittsburgh, PA. It empties into the Mississippi River in Cairo, IL, thus making it part of the larger Mississippi River Watershed.



The Ohio River: Then and Now

The Ohio River that is seen today resulted from systems of glaciers that advanced through Ohio, Indiana, and Northern Kentucky over a million years ago. These glaciers ultimately buried an ancient river system, known as the Teays. As the glaciers retreated, they created new headwaters for the Ohio River in Western Pennsylvania, and carved the channel for the Ohio River to flow toward Illinois. Among the first human inhabitants to depend on the river were the Mound Building Paleo-Indians. Other Native American tribes, such as the Delaware, Wyandot, Shawnee, Miami, Cherokee, Chickasaw, and Iroquois followed. The Iroquois called the river "OYO", meaning "great river", while Frenchmen Rene Robert Cavelier Sieur de La Salle, the first European to see the river in 1669, referred to it as "la belle riviere," meaning the beautiful river. After LaSalle's discovery, the Ohio River was home to many settlements, where it evolved into a primary transportation route during the westward expansion of the early United States. In the 1800's the Ohio River played an important role in the Civil War, separating free states from slave states, and fostering 23 escape routes that were part of the Underground Railroad.

Did You Know?

Around the 1930's, it was said that pollution loads into the Ohio River from Cincinnati equaled a discharge of one dead horse every two minutes.

The river was also used in the 1800's as a shipping route for coal and agricultural goods destined for major cities on its mainstem, and along the Mississippi River. At the time, the river was so shallow in places that it could be crossed with horse and buggy. Thus, goods could only be shipped during high water in the spring and the fall. In response to this problem, the Army Corps of Engineers began a series of projects on the Ohio River that removed sandbars and other obstructions to navigation. This removal process was followed by the construction of locks and dams that slowed and pooled the water to a minimum depth of nine feet, providing navigation on the river year-round. However, these dams, which relied on wooden wickets being raised and lowered from the river bottom, quickly became dangerous to operate as barges began carrying bigger loads. Therefore, in the 1950's, Corps began replacing wicket dams with modern concrete structures that provided quicker and more efficient navigation along the river. Today, there are 18 of these "high lift" dams and two wicket dams on the Ohio River.

The growth of cities, along with navigation and industrial activities in the late 19th and early 20th centuries, took a heavy toll on water quality in the Ohio River. At that time, people worried little about what happened to the wastewater coming from industries and homes. In fact, less than one percent of industrial and human wastewater was treated before 1948, causing the river to literally resemble and open sewer. Today, due to the work of governments, environmental agencies, and citizens, most **point source** discharges into the Ohio River are regulated by permits and pollution control requirements. Water must now be treated to remove or reduce contaminants, resulting in dramatic improvements in water quality over the last 35 years.

Ohio River Facts

- The average depth of the Ohio River is approximately 24 feet.
- The widest point of the river is about one mile at Smithland Lock and Dam, near the mouth of Kentucky's Cumberland River.
- The Ohio River Basin covers 203,940 miles and his home to more than 25 million people (approximately 10% of the US population).
- The Ohio River is habitat for approximately 130 warm water fish species and 50 mussel species.
- Manufacturing facilities, terminals, and docks in the Ohio River Basin ship and receive about 280 million tons of commerce on the Ohio River each year. Coal and other energy products make up approximately 70 percent of river commerce traveling by barge.
- Power generating plants on the Ohio River produce more than five percent of the nation's electricity.

Where Does Pollution in the Ohio River Come From Now?

Today, roughly 80% of pollution in the Ohio River comes from **non-point** sources, rather than a specific pipe or discharge. Non-point pollution is directly linked to what we do on land, such as mining, farming, forestry, construction, and everyday urban activities. Non-point pollutants can be washed into rivers directly through rainwater or snowmelt, or carried into storm sewers that empty into the river and its tributaries. Non-point pollutants can also be deposited directly from the atmosphere through rainfall.

Non-point pollution is often exacerbated removing the **riparian area**, which is the vegetation surrounding a body of water. Roots from trees and vegetation keep soil from washing into lakes, streams, and rivers. They also enable the soil to absorb and filter pollutants that are washed in from other parts of the watershed. When they are removed, polluted runoff finds a quicker route into the water.

Non-point Pollution Sources

Urban Runoff

Urban and suburban areas contain large expanses of concrete and other surfaces that water cannot easily penetrate. These surfaces allow water to run quickly into the Ohio River and its tributaries, either directly, or through storm sewers. Common pollutants carried in runoff include salts, automotive fluids, animal and yard waste, lawn chemicals, litter and sediment.

Resource Extraction

Like a many of our nations waterways, the river is significantly affected by the extraction of natural resources, such as gas, coal and oil, from its watershed. Rain and snowmelt mix with certain elements in mine wastes to form acidic runoff containing metals, which can kill aquatic life. Surface runoff from strip-mined areas and inactive mines can also pollute.

Photo courtesy of Hoosier Riverwatch.

Agriculture

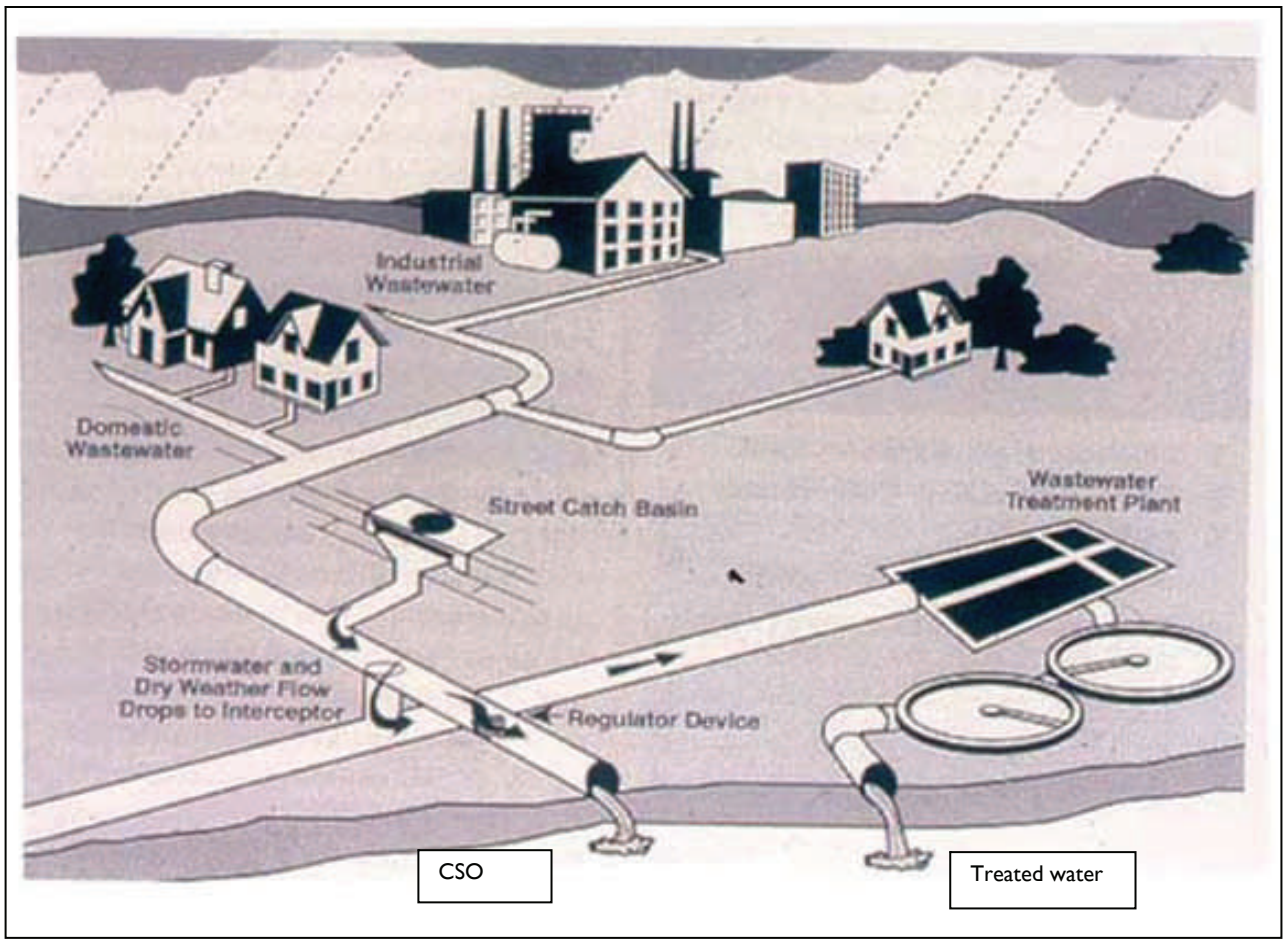
Close to 50% of land in the Ohio River Valley is used for agriculture, livestock, and crop production. Pollution in the form of fertilizers, pesticides, and eroded soil can result from these practices, along with animal wastes that can cause elevated bacterial levels in the water.

Atmospheric Deposition

Airborne pollutants, such as mercury and nitrogen, are deposited into water bodies by snow and rain, or by dust, gases, and gravity. Sources of these pollutants include burning fossil fuels, waste incineration, and industry.

Combined Sewer Overflows

Combined sewer systems, found in many older cities, are designed to collect and carry wastewater from homes and businesses, as well as storm water from rain and snowmelt. Because our cities and suburbs continue developing at a rapid rate, storm water runoff from impervious surfaces can often overload these antiquated sewer systems when it rains. When this happens, combined sewer systems discharge untreated waste, containing bacteria and other pollutants, into the river. This is a problem for the Ohio River because 52 cities along its banks have combined sewer systems. Large urban areas such as Pittsburgh and Cincinnati have significant numbers of CSO's that make boating and swimming unsafe on the Ohio River during and after heavy rain. The federal government is forcing many cities along the Ohio River, and along other US rivers, to begin addressing the problem of combined sewer overflows. Because the sewer systems in many of these cities are antiquated, fixing the problem may entail replacing sewer systems entirely.



Can I Swim in the Ohio River?

Millions of people use the Ohio River for fishing, boating, water skiing, and swimming. While many enjoy the benefits of this wonderful natural resource, recreational users should be aware of potential health hazards and after heavy rains. One threat to human health is the presence of fecal coliform and E. coli bacteria from human or animal feces. These bacteria may not be harmful themselves; however, they indicate the presence of other pathogens that can cause gastrointestinal illness, sore throats, and ear and eye infections. Although limits for bacteria have been established in the Ohio River, they can often be exceeded during heavy rains. Bacteria are generally higher at and downstream of large cities after heavy rainfalls due to CSO's, so avoid the water during these times. Other safety concerns include swift currents, floating debris, and commercial barge traffic. Boaters and swimmers should avoid areas near dams, which are restricted due to strong currents and the concentration of boat and barge traffic.

How is Water Quality in the Ohio River Protected?

The Ohio River flows through six states, while water from nine states drains into its watersheds. Have you ever wondered who holds the responsibility of protecting the river from pollution? That responsibility falls on the shoulders of both the states that border the river, the federal government, and interstate agencies.

The Ohio River Valley Water Sanitation Commission (ORSANCO)

In 1948, when the river resembled an open sewer, a group of states that bordered the river began working together to control discharges that went into the river. They formed a Commission that is still in existence today, called the Ohio River Valley Water Sanitation Commission (ORSANCO). ORSANCO is made of up three representatives from each of eight states that either border the river or make up its drainage basin. The representatives are appointed by the governors of each state and by the President of the United States. One of the first outcomes of the ORSANCO compact was the treatment and regulation of industrial and municipal (sewage) discharges. Among ORSANCO programs are water quality monitoring and assessment; spill detection and notification; pollution control standards for discharges into the Ohio River; and public information programs.

A Global Perspective

-More than one billion people in developing countries have unsafe drinking water.

-Waterborne disease accounts for nearly 80% of all illnesses in developing countries.

-6.8 billion gallons of water are flushed down American toilets each day.

-By 2052, 2/3 of the world's population will have water shortages.

The Clean Water Act

In 1972, roughly 25 years after the ORSANCO Compact, the federal government enacted the Clean Water Act at a time when 60% of the nation's waters were considered unsafe for fishing and swimming. Since the Clean Water Act was enacted, the number of waters unsafe for fishing and swimming has decreased from 60% to 40%. The federal government charges each state in the United States with enacting the Clean Water Act for all the rivers, lakes, and streams within its borders through a Water Quality Standards Program. In the case of an interstate waterway, such as the Ohio River, each state works with ORSANCO to regulate pollution discharges that will affect the Ohio River.

The Clean Water Act Fact Sheet

- The Clean Water Act was passed when 60% of waterways in the US were not "fishable or swimmable". Today, because of the Clean Water Act, the number of waterways that are not fishable or swimmable has decreased to 40%.

- Only three years before the passage of the Clean Water Act, the Cuyahoga River in Cleveland was so polluted that it caught fire. It is believed that sparks from a passing train ignited oil and other pollutants in the water.

- The goal of the Clean Water Act was to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The interim goals of the Clean Water Act were to achieve "fishable and swimmable" waters by 1983, and eliminate all discharges of pollutants into navigable waters by 1985.

- According to USEPA, "fishable and swimmable" meant that a level of water quality should be achieved "for the protection and propagation of fish, shellfish, and wildlife, and to provide for recreation in and on the water."

- The Clean Water Act was passed by the federal government; however, each state is responsible for enacting it through a Water Quality Standards Program (WQS).

- The Water Quality Standards program acts as a road map for achieving the goals of the Clean Water Act by doing three specific things: designating uses of each water body in the state, establishing numeric, biological, and narrative criteria to protect those uses, and protecting levels of good water quality in waters that already meet their designated uses.

- Possible designated uses of waters in your state include, primary contact recreation (swimming), secondary contact recreation (boating and wading), municipal water source (water to be treated for drinking water), and aquatic habitat.

- If a business, industry, or other entity wants to discharge into a waterway, it has to obtain a permit from the state. The permit should limit pollution amounts according to the water quality criteria established for the designated use of the waterway. For example, a waste water treatment plant would not be allowed to discharge more than 130 colonies of *E. Coli* (a fecal coliform bacteria) per 100 milliliters of water into a stream designated for primary contact recreation.

- If a waterway is assessed and doesn't meet the water quality criteria established to protect its designated use, it is considered impaired.

- Each state is responsible for identifying and writing clean up plans for impaired waters.

- State and interstate agencies are notify the public on water quality decisions, including permits or changes in water quality standards. It is your responsibility to make sure the Clean Water Act is enacted properly by submitting your written or oral comments on water quality decisions. Information about water quality decisions in your state can be found on your state agency's website.

Kentucky: http://www.water.ky.gov/

Ohio: www.epa.state.oh.us

Indiana: www.in.gov/idem

Measuring Water Quality in the Ohio River

Types of Pollution:

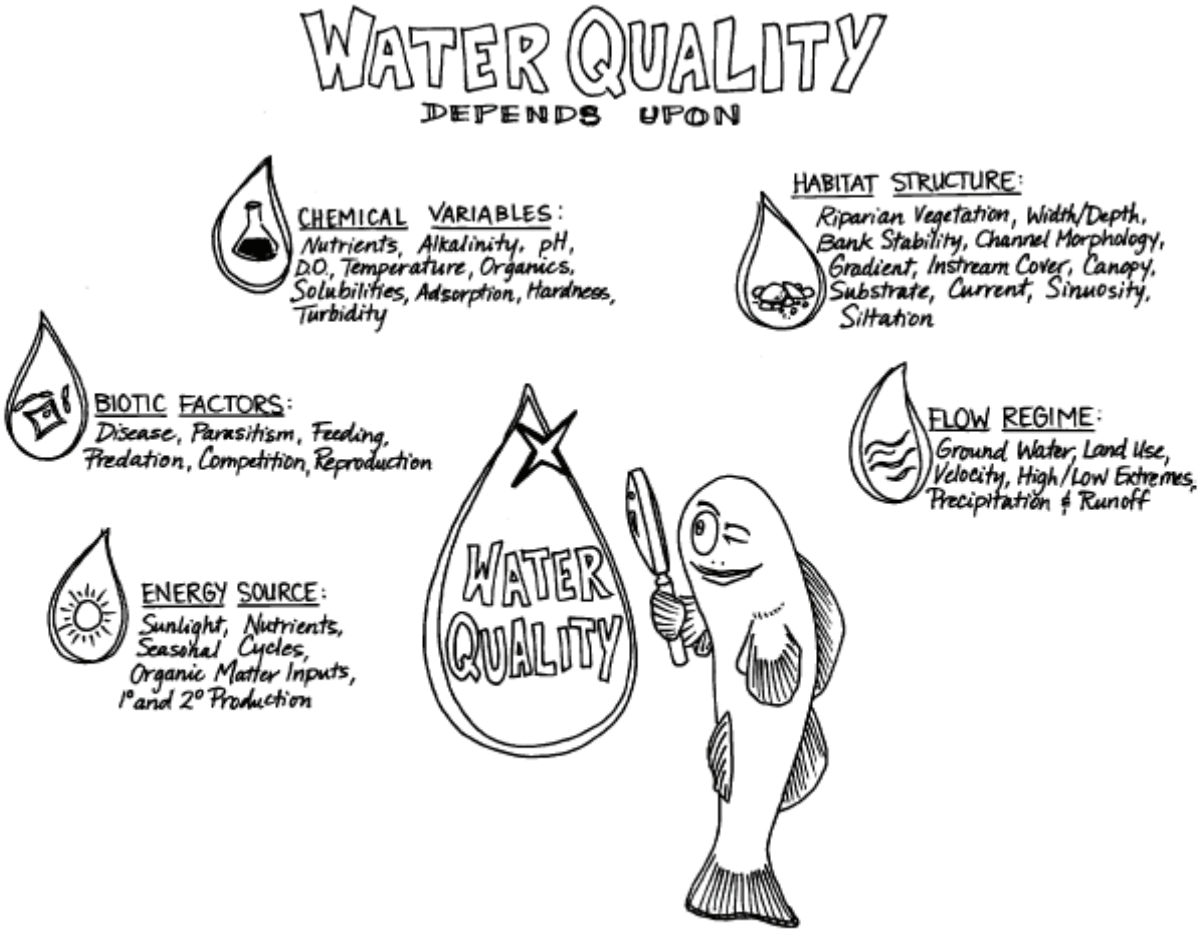
Organic– decomposition of once-living material (human and animal waste, algae)

Inorganic- suspended and dissolved materials (sand, silt, minerals)

Toxic- heavy metals and lethal organic compounds (iron, mercury, PCBs)

Thermal- water heated by urban runoff or industry (streets, nuclear power)

Biological- introduction of non-native species (zebra mussels)



www.HoosierRiverwatch.com

Information on this page courtesy of Hoosier Riverwatch.

Parameter	Pollution Problem	Possible Causes
Water Temperature Change	-Aquatic organisms have narrow optimal temperature ranges -Oxygen is not as soluble in warm water as it is in colder water, low DO levels can stress organisms -Warmer temperatures can increase toxicity of some pollutants, and can increase solubility of solid pollutants	-Shade or loss of shade -Release of water from standing water (temperature increases) -Wastewater discharges (temperature increases)
pH	-Aquatic organisms sensitive to low or high pH -Affects reproductive portion of growth cycle -Can affect toxicity of elements or other substances in water	-Algal blooms -Industrial processes release acids and bases
Dissolved Oxygen	-Low levels of dissolved oxygen can be harmful to aquatic organisms that require dissolved oxygen for respiration -Levels are affected by temperature, salinity, and atmospheric pressure	-Rapid decomposition of organics (dead algae, manure, shoreline vegetation, sewage) by microbes consumes oxygen -Nitrification of ammonia in fertilizers by aquatic microbes -Stagnation , lack of turbulence or movement in a waterway -Respiration of aquatic plants and algae can cause low levels of dissolved oxygen over different periods of a day
Turbidity	-Many fish need clear water to spot prey -Sediments can smother fish eggs and aquatic insects -Decreases light penetration, which is needed for photosynthesis	-Sediment from erosion -Road building, construction, agriculture, logging, anything that removes vegetation and causes sediment to be washed into a waterway
E. coli	-Associated with fecal matter of warm blooded animals -Presence of large amounts can indicate presence of pathogens such as typhoid, cholera, Hepatitis A -Ingestion of bacteria found with *E.coli* could lead to gastrointestinal distress and eye, nose and throat infections	-Raw sewage from Combined Sewer Overflows during heavy rains -Feces from animals utilizing streams for wading, drinking and cooling -Raw sewage from malfunctioning sanitary sewage systems -Illegal straight pipes -Illegal sewage pump-outs from boats and watercraft
Nitrite	-High levels in the body oxidize hemoglobin in the blood, causing oxygen to be improperly transported through the body.	-Sewage and fertilizer -Intermediate product in Nitrification
Nitrate	-Can cause excessive algal growth	-Over-fertilized fields -Runoff from agriculture, lawns, golf courses
Ammonia Nitrogen	-Depletes water of oxygen through nitrification -Toxic to fish, causing them to become lethargic and to not eat	-Biological decay of plant and animal matter -Raw sewage, industrial effluents, fertilizers
Orthophosphate	-Can support rapid algal growth rates (algal decomposition uses oxygen and produces odors and toxins)	-Sewage and fertilizer (agricultural runoff) -Enriched groundwater, suspended sediments -Runoff from parking lots
Total Phosphate	-Can support rapid algal growth rates (algal decomposition can consume oxygen and produces odors and toxins)	-Detergents and fertilizer (agricultural runoff) -Enriched groundwater -Suspended sediments -Runoff from parking lots

General Guide for Water Quality Ranges

Dissolved Oxygen (% Saturation)

91 to 110	Excellent
71 to 90, >110	Good
51 to 70	Fair
<50	Poor

***E. Coli* (colonies per 100 mL)**

< 50	Excellent
51 to 200	Good
201 to 1000	Fair
>1000	Poor

pH (pH units)

6.5 to 7.5	Excellent
6.0 to 6.4, 7.6 to 8.0	Good
5.5 to 5.9, 8.1 to 8.5	Fair
<5.5, >8.6	Poor

Biochemical Oxygen Demand (mg/L)

< 2	Excellent
2.0 to 4.0	Good
4.1 to 10	Fair
>10	Poor

Water Temperature Change (°C)

0 to 2	Excellent
2.2 to 5	Good
5.1 to 9.9	Fair
>10	Poor

Total Phosphate

< .10	Excellent
.11 to .16	Good
.17 to .58	Fair
.59 to 2.99	Poor
>3.0	Very Poor

Nitrate (NO_3) (mg/L)

< 1.32	Excellent
1.76 to 3.52	Good
3.96 to 8.36	Fair
> 8.8	Poor

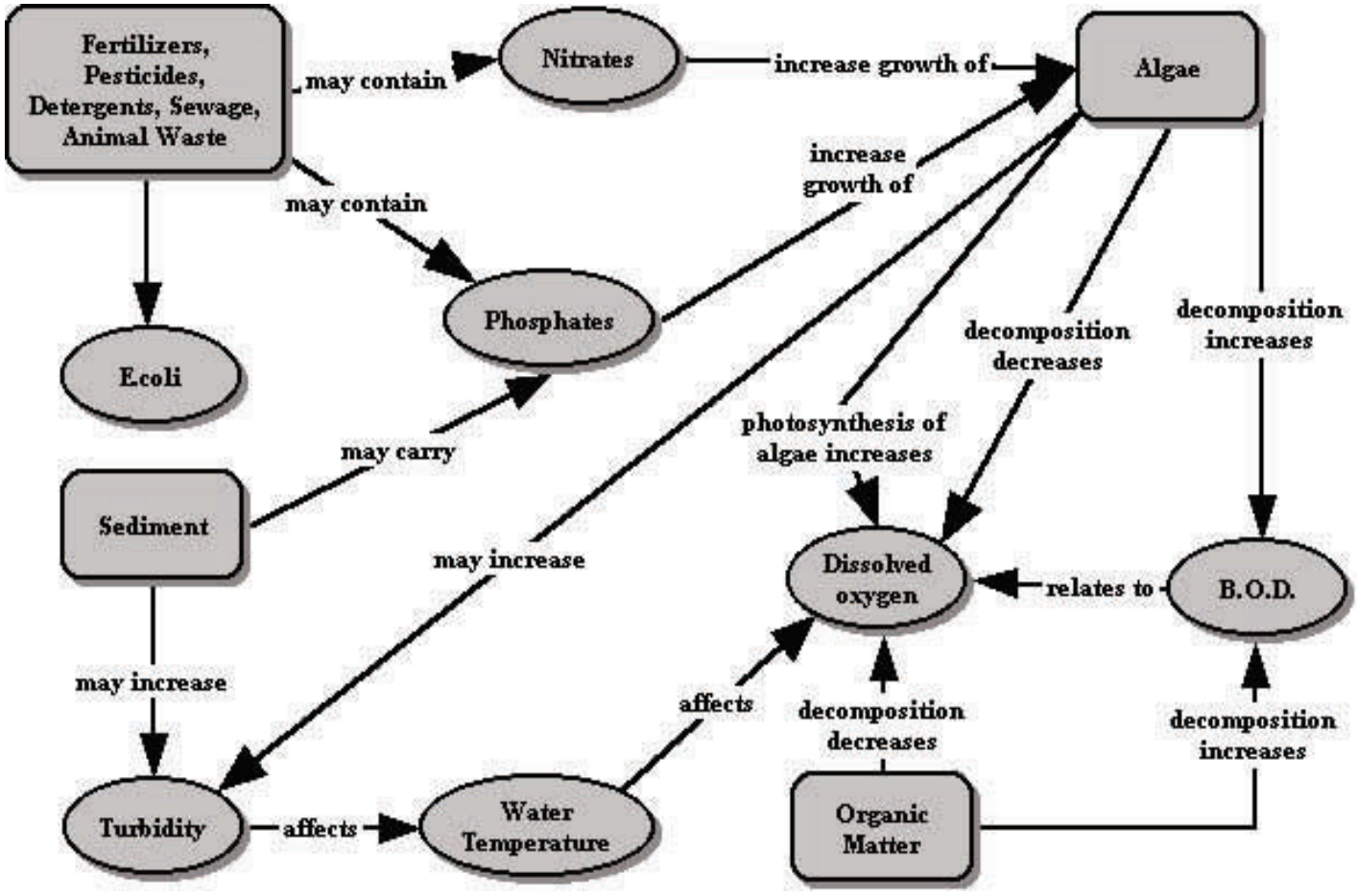
Turbidity (JTU, NTU)

1 to 10	Excellent
10.1 to 40	Good
40.1 to 150	Fair
> 150	Poor

Total Solids (mg/L)

< 100	Excellent
100 to 250	Good
251 to 400	Fair
>400	Poor

Photo courtesy of Hoosier Riverwatch.



Biological Monitoring

Macroinvertebrates

The water quality of the streams in your own backyard can be assessed using macroinvertebrates . Macroinvertebrates are those animals that lack a backbone (invertebrate), are large enough to be seen with the naked eye (macro), and live at least part of their lives in or on the bottom (benthos) of a body of water. Macroinvertebrates can include mussels, snails, worms and insect larvae.

Macroinvertebrates live in the sand and mud, and on rocks, logs, sticks and vegetation in water bodies. Flowing water provides material on which the organisms feed. Rocks, logs, and plants provide nooks and crannies for the organisms to hide and a place for them to attach. There are thousands of different macroinvertebrate species in the Ohio River Valley, each with its own unique requirements for survival. Many require high levels of oxygen and can't tolerate toxic pollutants. However, some can tolerate very low oxygen levels or high toxicity and are known as pollution-tolerant species.

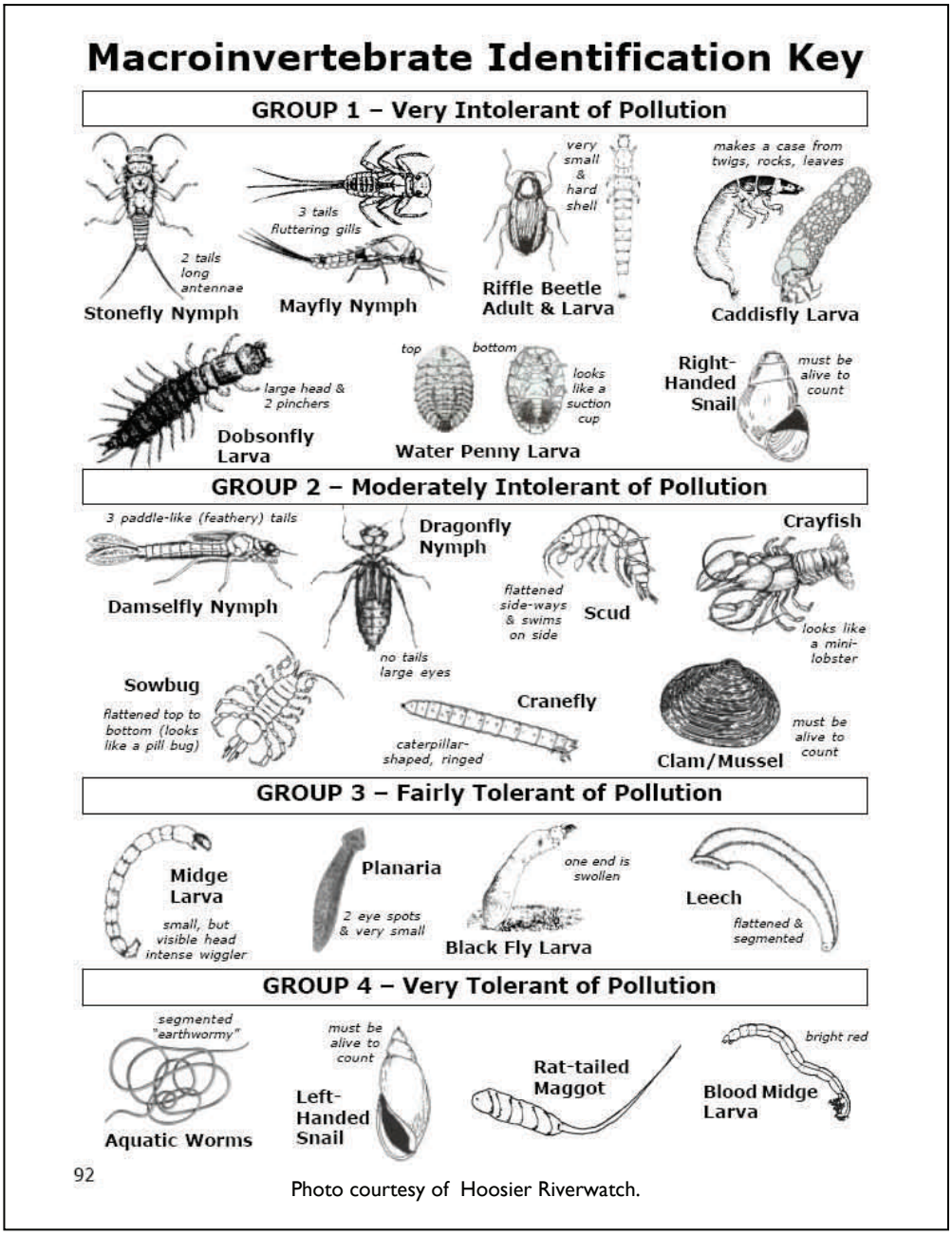


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Photo courtesy of Hoosier Riverwatch.

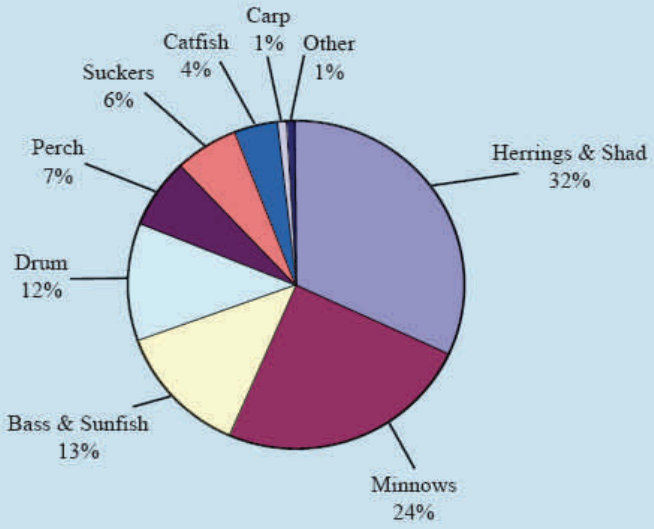
Macroinvertebrates are relatively immobile. They cannot escape from changes in water quality, so if pollution occurs, macroinvertebrates are affected. Therefore, you can determine the how healthy a river, lake, or stream is by looking at the variety of organisms present. In general, the greater the diversity of organisms the better the water quality!

Fishing for Water Quality

In the 1900s, miners took canaries into the coal mines to serve as early indicators of toxic gases. The canaries were particularly sensitive to toxic gases such as carbon monoxide and therefore could alert the miners to low levels of these gases, giving them enough time to leave the area safely. Biologists recognize that other organisms also can serve as environmental indicators, or bioindicators. They act as early warning systems, indicating disturbances to habitat or the presence of toxins in the environment before humans can feel or see the effects. Fish act as "canaries" for the Ohio River. They are practical for biological monitoring because, unlike other organisms such as turtles, frogs, and some macroinvertebrates, they live in the water all of their lives and feel the effects of water quality changes throughout their life cycles. In addition, fish species differ in their tolerance to amounts and types of pollution, are easy to collect, live for several years, and are easy to identify in the field. They provide an accurate assessment of stream health because most species stay in the same area during the summer sampling season, recover rapidly following disturbance, have large ranges lessening the effects of small-scale habitat changes, and vary in their sensitivity to water quality changes. Public interest in fish as a recreational resource further increases their utility as an indicator of the river's health.

Fish of the Ohio River

Currently, 126 species of fish have been collected by ORSANCO from the Ohio River. Members of the herring family such as gizzard shad and skipjack herring are the most commonly encountered species in the Ohio River. They are followed by minnows, freshwater drum, and catfish such as the channel, flathead, and blue catfish. Bass species collected in the river include smallmouth, largemouth, and spotted bass. The perch family is represented by sauger, walleye, and darters. The diversity of fish found in the Ohio River suggests that pollution levels are not nearly the issue they have been in the past.



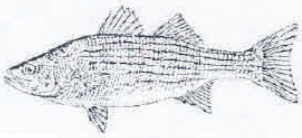
Can I Eat Fish from the Ohio River?

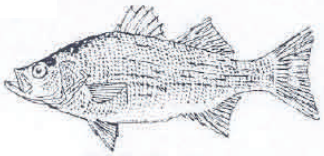
Some toxins can bioaccumulate in the tissues of fish, and increase in concentration as they travel up the food chain. Bioaccumulative toxins include metals, pesticides, and polychlorinated biphenyls (PCB's), industrial compounds that were banned in 1977 but do not break down easily in the environment. Another bioaccumulative compound is mercury, which is emitted into the air primarily by coal-fired power plants and incinerators. When rainwater carries mercury into rivers, lakes and streams, it is converted by bacteria into a form that is more easily taken up by aquatic organisms. Because mercury and other compounds accumulate human tissues, they can be harmful to people who eat certain types of fish in significant amounts. Fish consumption advisories are issued for each state across the country and generally recommend against eating bottom-feeding fish such as carp and channel catfish. They also recommend that pregnant women, women of child-bearing age, and children limit their intake of certain **piscivorus** fish, since mercury increases in concentration as it travels up the food chain. You can find fish consumption advisories for your state at:

Kentucky: http://www.water.ky.gov/ Ohio: www.epa.state.oh.us Indiana: www.in.gov/idem

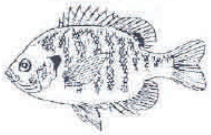
Fish Commonly Found in the Ohio River*

*Fish on this list represent only a small sample of the 130 species that have been found in the Ohio River.


Striped Bass


White Bass


Yellow Bass

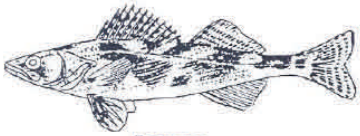

Bluegill


Green Sunfish


Black Crappie


White Crappie


Yellow Perch


Sauger


Walleye


Paddlefish

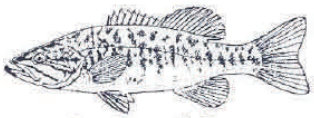

Spotted Gar


Longnose Gar

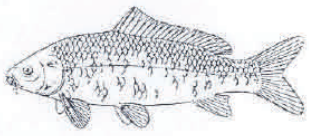

Shortnose Gar


Largemouth Bass

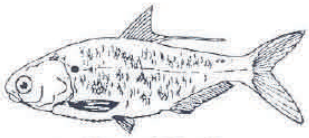

Spotted or Kentucky Bass

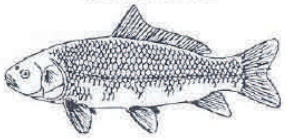

Smallmouth Bass

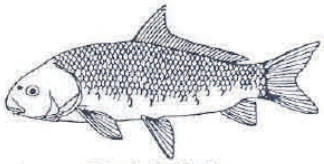

Rock Bass

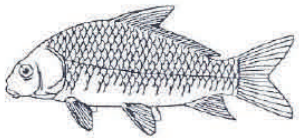

Carp


Freshwater Drum

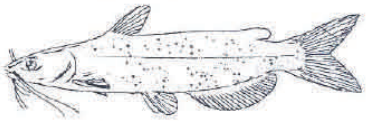

Gizzard Shad

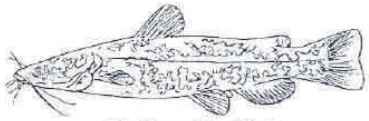

Bigmouth Buffalo

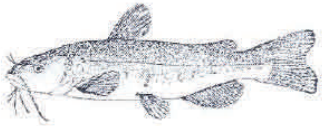

Black Buffalo


Smallmouth Buffalo


Blue Catfish


Channel Catfish


Flathead Catfish


White Catfish

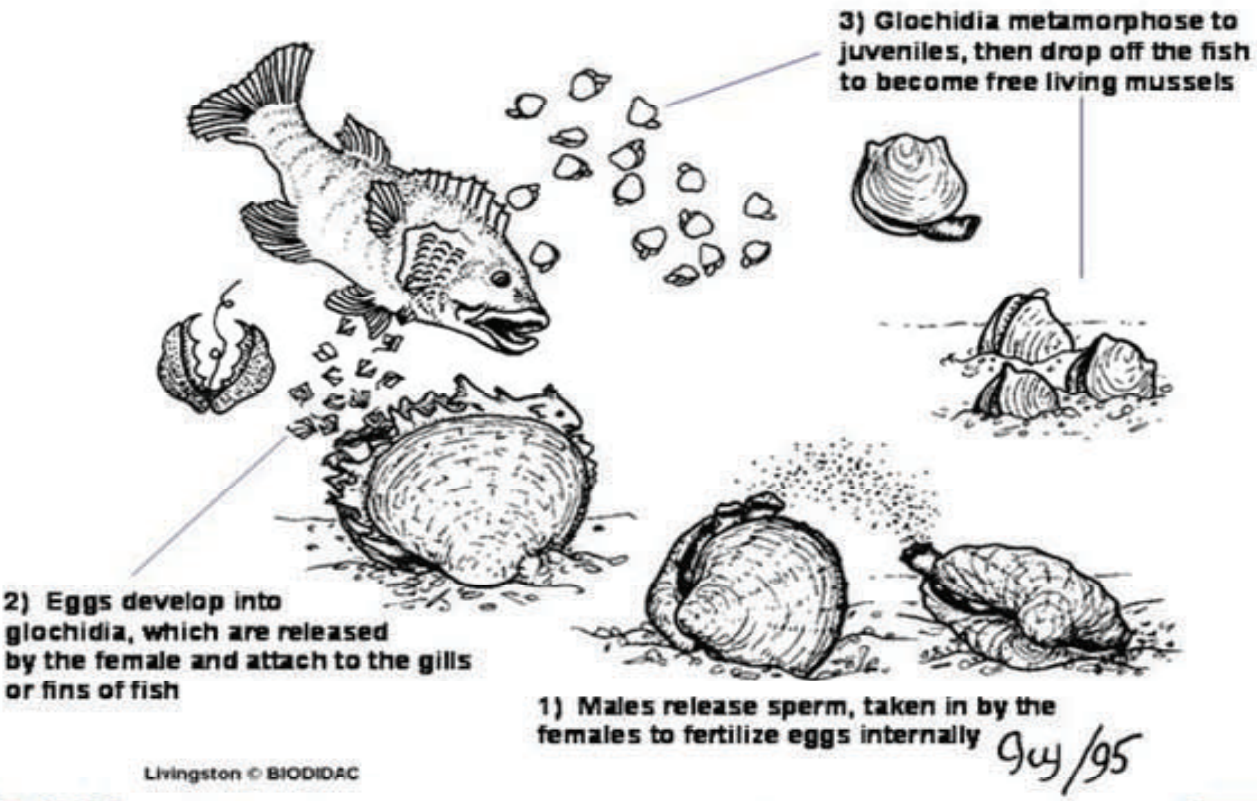
ORSANCO
The Ohio River Valley Water Sanitation Commission
5735 Kellogg Avenue Cincinnati, OH 45228
1-800-359-3977
http://www.orsanco.org

Ohio River Mussels: Silent Sentinels of Water Quality

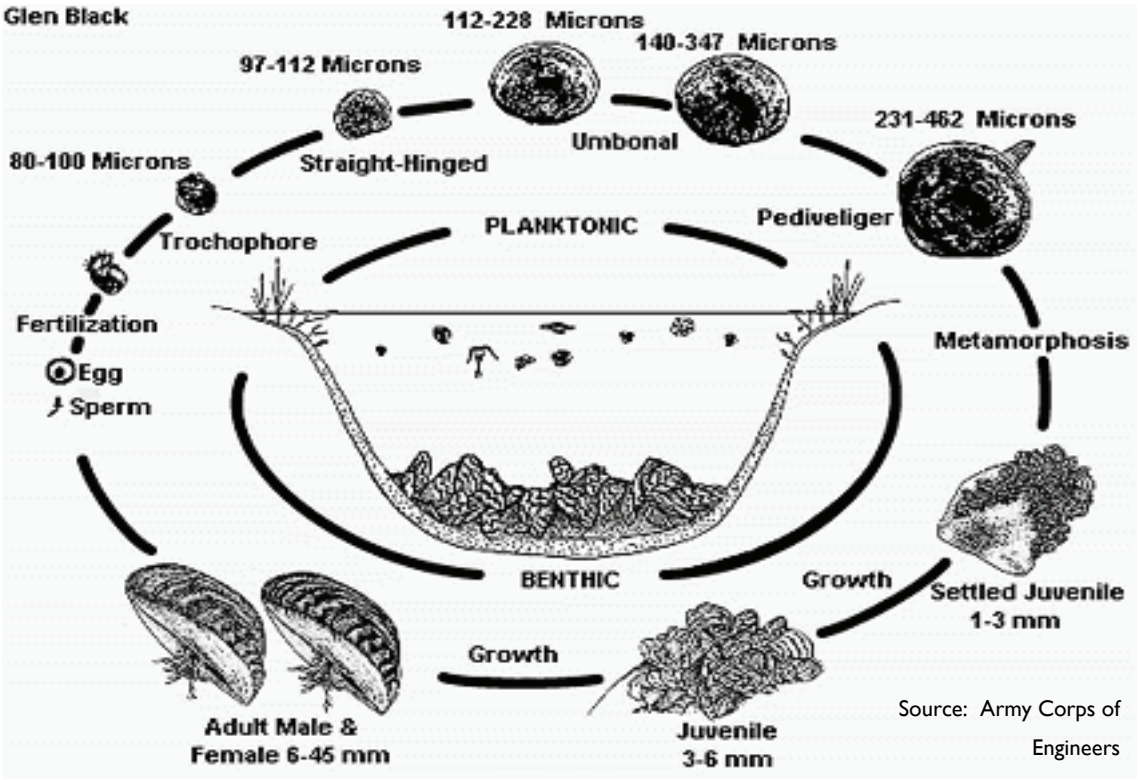
Freshwater mussels in the Ohio River are bivalve mollusks that belong in the family Unionidae. Although some have been found to live over 100 years old, most live between 20 and 30 years. The Ohio River is home to approximately 50 species of mussels. Over 100 years ago, the Ohio River was home to approximately 127 species of mussels, some of which are now extinct. Mussels have been used by humans for centuries as a source of food, and for jewelry and other types of ornamentation. In fact, one of the primary reasons for the decline in mussel populations in the Ohio River was over-harvesting for the button industry. Other factors that have contributed to declines in mussel populations include river channelization and dams, industrial pollution, erosion and siltation, urban runoff, and mining.

Mussels easily take up pollutants in the water because they are filter feeders. They are preyed upon fish and other animals in the river system and some contaminants found in their tissue can magnify as they travel up the food web. For this reason, freshwater mussels are considered indicators of water quality. Because they rely on host fish for reproduction, their populations can drop drastically if water pollution affects fish populations. They are also sensitive to mining, as well as agricultural and urban runoff because excess silt from these processes can literally cause them to smother. Excessive siltation may also stress mussel populations by causing oxygen levels to drop.

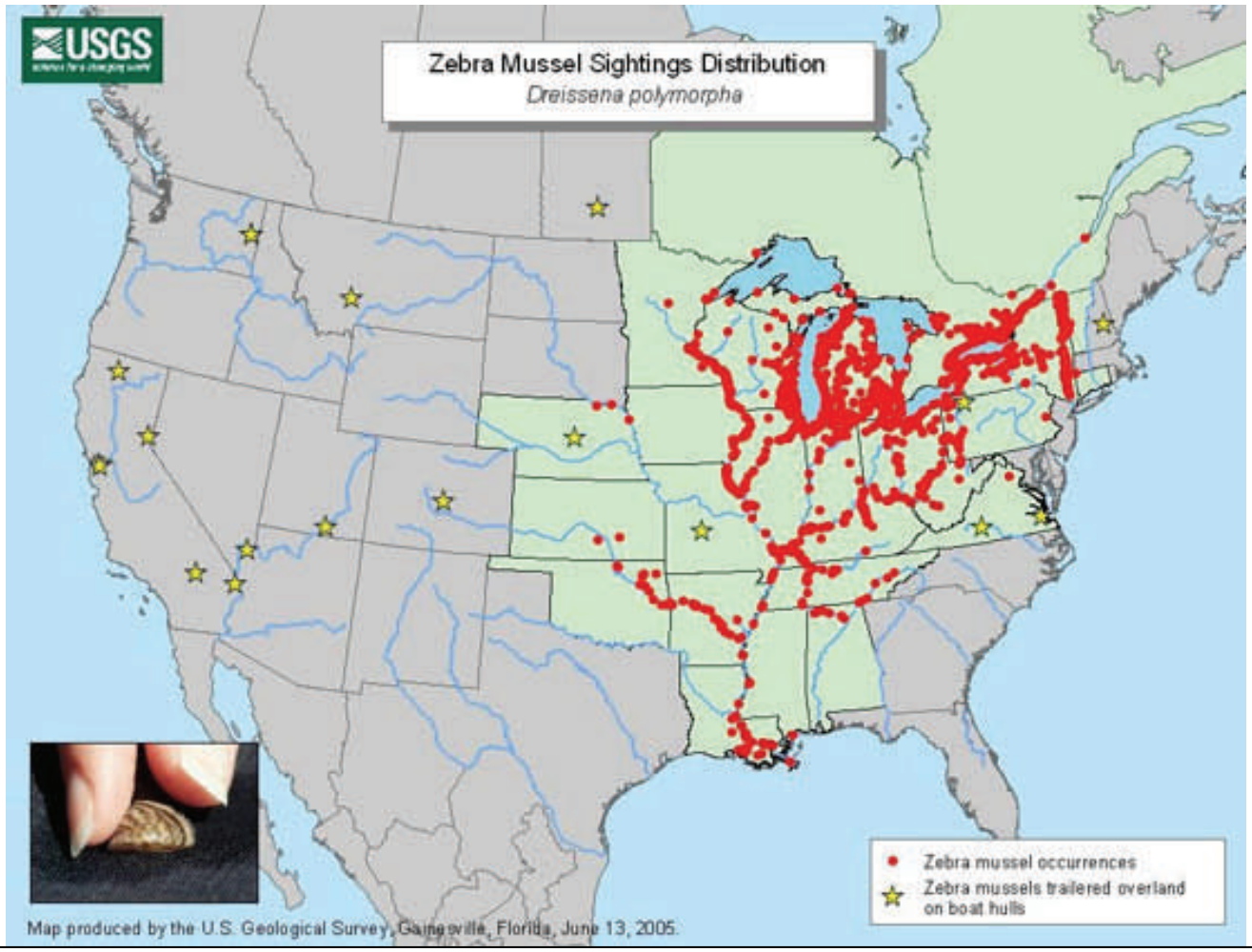
FRESHWATER MUSSEL LIFE CYCLE



ZEBRA MUSSEL LIFE CYCLE



Source: Army Corps of Engineers



Ohio River Navigation