

## The Scene

Something is wrong with the Sparkling River. What was once a clear, clean, diverse body of water has become a sluggish, murky eyesore. The residents who moved into the new development along the river are angry that their beautiful riverfront homes are now worth less than when they bought them. Anglers are upset with declining water quality in what used to be an excellent trout stream.

The city has asked you, a fish biologist and expert on **degraded** ecosystems, to come and speak to the angry residents and anglers about what has gone wrong with the river and offer suggestions on how to fix the problems. What do you think could be wrong? What types of surveys would you need to conduct in order to find the culprits? How could the local residents solve the problems you discover?

### SECTION B

## People Knowledge

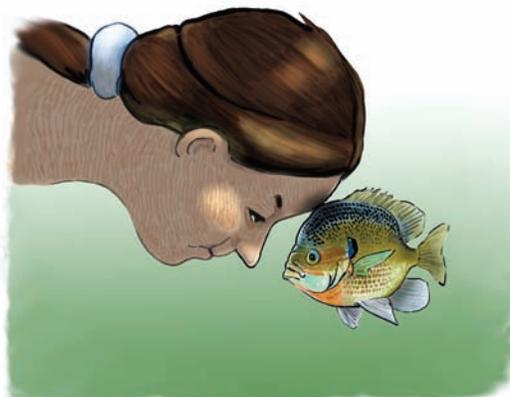
Ecosystems are not perfectly stable machines. Trophic pyramids can crash, dissolved oxygen levels can plummet, temperatures can swing, and shelter can disappear. Sometimes the changing dynamics of an ecosystem are natural fluctuations or disruptions: A volcanic eruption that clouds the sky around the globe can slow photosynthesis and disrupt the trophic pyramid. A long winter that keeps ice on for an extra month can deplete oxygen in a frozen lake. A flood can wash out gravel on the bottom of a stream.

At other times, disruptions to an ecosystem result from human decisions and actions. To be an educated angler, you should be able to recognize some of the actions humans take that can affect fish populations and some steps you can take to improve fishing conditions. In this section, we will discuss some human choices that are changing the environment and several management efforts beneficial to both people and fish.

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## Head to Head

What sorts of decisions do humans make that can affect fish? Sometimes actions that humans take create obvious problems for fish. When a wetland is filled in or a septic tank overflows into a river, the effects on fish populations are immediate and visible. Often, however, we are unaware of the impacts our choices have on aquatic environments. In this section, we'll discuss some environmental **stressors** that affect fish.



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### To the Point

Water that comes out of our taps at home—the water that we drink and shower in—has been filtered and cleaned. That's not the case for fish. Fish have to swim in whatever water comes their way, even if it is polluted. Water pollution can come from two types of sources: **point** and **nonpoint**. A point source of pollution is a particular, identifiable source of pollution that dumps pollutants directly into a water source. A pulp and paper mill, for example, that discharges **effluent** (waste material) into a nearby stream is a point source and is, therefore, regulated by the Clean Water Act. Many of these sources have been cleaned up over the years. Nonpoint source pollution is much harder to regulate, because it comes from many places across a landscape.

#### Point source

a particular, identifiable source of pollution that dumps pollutants directly into a water source

#### Nonpoint source

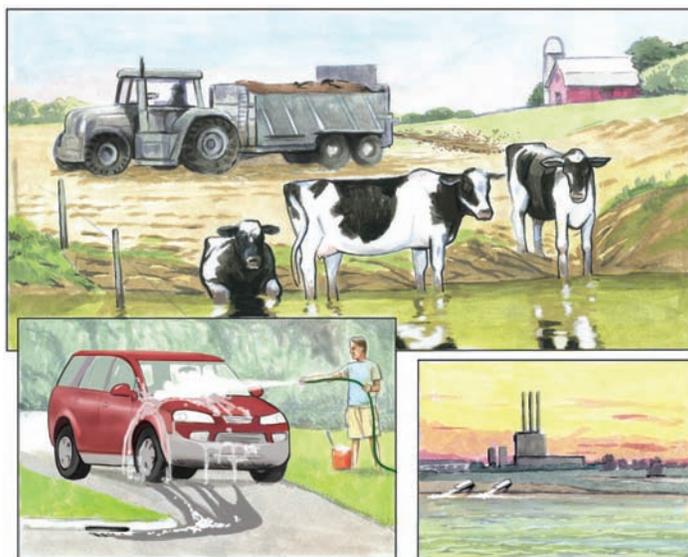
pollution that comes from many places across a landscape

#### Effluent

waste material

### Runoff

Nonpoint source pollution can come from many places. The oil that drips out from under a car, the salt used to make roads safe in winter, and the dog deposit Spot left on your lawn can all become aquatic pollutants. Rain and snowmelt will carry these items into your local stream or down into the groundwater where they contaminate the water. This polluted **runoff** is the leading cause of water quality problems in Wisconsin and in the United States.



Runoff, atmospheric deposition and erosion can all affect water quality.

### Watershed Moment

When rain falls on your roof, where does it go? Down the gutters, off the pavement, into the ground...and then where? The rain that falls on your house will eventually make its way into a large waterbody, like Lake Michigan, the Mississippi, or Lake Superior. On its way, it will travel through a network of streams, rivers and, perhaps, some wetlands and lakes. Each waterbody your water passes through is affected by the decisions you, and those who share your watershed, make. What's your watershed, and who shares it with you?

## Erosion

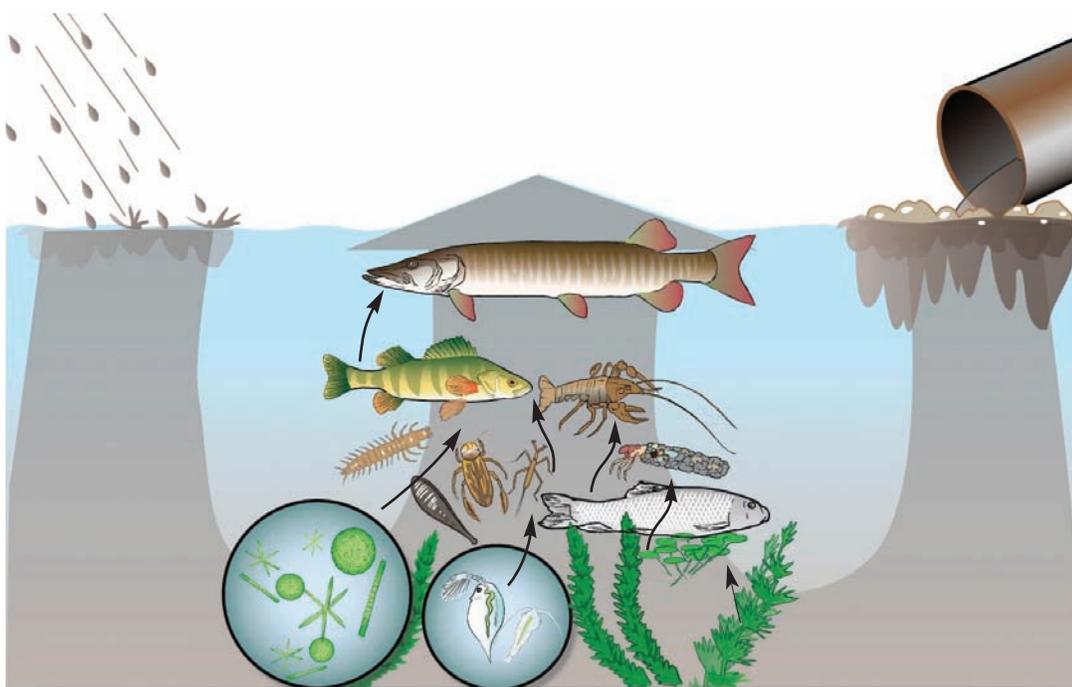
Wind, water, and ice movement are natural processes that cause soil erosion, but certain activities can accelerate it. A cow walking into a stream will kick up soil along the bank. A construction worker digging a hole for a new foundation breaks up soil and piles it up. Both actions allow loose soil to more easily wash away in a rainstorm or with melting snow.

Eroded soil that enters the water can bury fish habitat and smother fish eggs. Eroded soil as a nonpoint source pollutant can be a major cause of fish kills and loss of fish habitat.

## Atmospheric Deposition

When we burn coal for electricity, when a volcano explodes, and when a waste incinerator operates, the smoke and steam that are emitted carry chemicals with them up into the atmosphere. These chemicals can travel long distances in air currents—crossing city, state, and national borders—and will eventually fall to the ground with rain droplets or snow in a process called **atmospheric deposition**.

Atmospheric deposition is another form of nonpoint source pollution that affects the fish in Wisconsin.



### Neurotoxin

A poison that affects the brain and nervous system

Contaminants move up the food chain.

### Persistent organic pollutants

Contaminants which do not break down in the environment

### Bioaccumulation

The build-up of substances such as pesticides or other toxins in an organism

## What's in Your Water... Ends Up in Your Fish

Atmospheric deposition and runoff are responsible for two contaminants of particular concern for anglers in Wisconsin: mercury and PCBs, respectively. Both are highly toxic and have properties that allow them to remain in our environment for long periods of time.

Once mercury is in the water, bacteria convert it into methylmercury, which is a powerful **neurotoxin** (a poison that affects the brain and nervous system).

Polychlorinated biphenyls (PCBs) were used in industrial applications like paint and hydraulic equipment until they were banned in 1976 because of their toxicity. They are **persistent organic pollutants** (contaminants which do not break down in the environment) and continue to leak out of contaminated sediments, hazardous waste sites, and old products.

When small fish eat bacteria or plankton that have been exposed to methylmercury, for example, that mercury begins to accumulate in the fish's body. **Bioaccumulation** (the build-up of substances such as pesticides or other toxins

in an organism) can have serious implications for fish and angler health.

Toxins aren't the only way that runoff and atmospheric deposition affect fish. When chemical fertilizers and manure, both of which contain phosphorus, are applied to lawns and fields at rates the land cannot absorb, excess phosphorus runs off into waterbodies. Too much phosphorus in the water causes algal blooms that can make water look like pea soup. Not only does a pea soup lake look and smell bad, it can also kill fish and wildlife. When a mat of algae covers the water, it blocks sunlight needed by other aquatic plants and as it decays uses oxygen needed by fish. Massive algal blooms

can also produce toxins that sicken wildlife and, occasionally, pets and humans.

Perhaps the most prevalent runoff contaminant is sediment. The sand, dirt, and gravel from construction sites, roadways, backyard gardens, or farm fields become contaminants when they enter the wrong places in the wrong quantities. Sediment in water can alter stream flow, cover important spawning habitat, or make the water murky. Murky water has lower levels of dissolved oxygen and increased water temperatures which both affect fish populations. Murky water also prevents sunlight from reaching submerged plants which stunts their growth.

## Fish Consumption Advisory

Certain lakes and rivers have special mercury or PCB advisories. Go to the DNR Website at [dnr.wi.gov/fish/consumption](http://dnr.wi.gov/fish/consumption) to investigate which ones. By observing the recommendations in the DNR's "Choose Wisely" fish consumption guide you can enjoy fish as a regular part of your healthy diet.

## Making a Difference

Here are a few steps that you can take to reduce your own contribution to nonpoint source pollution:

- Take unwanted household chemicals and medications to hazardous waste collection centers. Do not pour them down the drain or onto the ground.
- Use low-phosphate or phosphate-free soaps and detergents, non-toxic cleaning supplies, and water-based products.
- Clean up after your pets.
- Reduce the amount of chemicals your car releases into the air by driving only when necessary and keeping your car tuned up. Clean up spilled auto fluids and never dump oil or antifreeze into your household trash.
- Support farm practices such as rotational grazing or fencing off streams. These actions will reduce the amount of streambank erosion caused by cattle and the amount of manure that runs off directly into the water.

## Prescription for Trouble

Leftover medicine can present problems for aquatic wildlife when it is flushed down the toilet. Sewage treatment plants do not have the ability to remove drugs from the water, so fish end up "taking" leftover prescriptions. To solve this problem, some communities schedule special collection days for citizens to do a "clean sweep" of their medicine chests. This helps to reduce the amount of medication entering the food chain.

## Shared Interests

People love living along the shorelines of lakes and rivers. So do fish. The water's edge is a highly diverse environment where people and aquatic species come into contact and often conflict. Fish and humans share an interest in the shoreline, but humans don't always consider fish needs when making shoreline decisions.

Smaller buildings, less pavement, and more natural landscaping like the home on the left protect water quality and shoreline habitat.



## On Land

Lakes in Wisconsin today have nine times the number of homes on them as they did in the 1960s. In Vilas County, over half of the new homes built are on lakes. People seek out places with views of water when selecting their vacation cabins or, increasingly, their permanent homes. And why not? It's appealing to have fishing and swimming access right out your front door.

### Ecotones

Transition areas where two habitat types meet

### Land cover

The forests, highways, water, parking lots, rocks and other visible features on a landscape

### Land use

The cultural and economic activities that take place on the landscape

## In the Ecotone

**Ecotones** (transition areas where two habitat types meet) contain greater species diversity than either habitat type alone. The aquatic ecotone of the forest contains an abundance of fish species. It is a patchwork of many micro-habitats, each offering a unique set of niches for a variety of organisms.

The near-shore habitat includes woody cover, bank cover and aquatic plants. Tangles of drooping bank plants, fallen logs, and underwater vegetation are habitat for a rich aquatic insect community. Small fish gather to feed on the insects and hide from predators. Zooplankton feed on tiny underwater plants and are consumed by small fish and young predators. Large fish gather to feed on their prey. The vegetated banks of the lake are important, too: plants hold the soil in place, preventing erosion that could clog spawning habitats. They also provide shelter for a lake's many shoreline species, like frogs and birds.

## Conflict in the Clearing

When humans build their waterfront homes, they change the ecosystem. People value their

views and want to make sure they can see the water from their homes. Often people also want a sandy beach and a swimming and boating area free of aquatic plants. When waterfront property owners clear their lands of trees, shrubs, fallen logs, and aquatic vegetation, the effects are felt by the animals living nearby. Eighty percent of the plants and animals on Wisconsin's endangered and threatened species list spend all or part of their life cycle within the littoral zone. Clearly, the aquatic ecotone is under pressure from shoreline development.

## Land Use for the Future

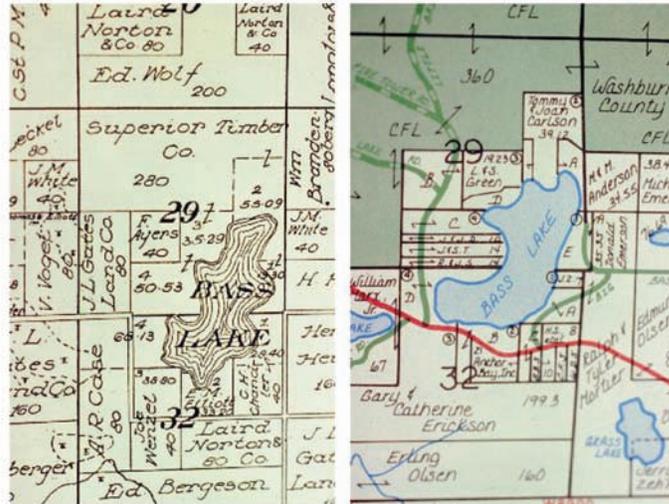
Satellite images and air photos help scientists and land use planners monitor changes in land use and land cover over time. Historic plat maps are telling, too as they show ownership and reflect changes when land is sold and subdivided. The **land cover** of a region (the forests, highways, water, parking lots, rocks and other visible features on a landscape) often changes as **land use** (the cultural and economic activities that take place on the landscape) changes.

For example, when an agricultural field is converted into a subdivision, the change in land use results in new land cover. But such visible

changes are helpful only on a limited scale. A satellite would not be able to see the removal of woody debris and aquatic plants from a lake, a change in land cover that makes a huge difference to a fish. What sort of monitoring method would help scientists understand local, small-scale changes?

Land use decisions at the local level are often regulated by **zoning laws**. City and county governments decide which types of activities (residential, commercial, agricultural, industrial) can take place on a parcel of land. These decisions are based on input from citizens and from environmental assessments. Some cities are moving toward zoning for **sustainability**. These communities are considering the long-term environmental and cultural effects of their land use decisions. They are working to identify ways in which they can enjoy economic growth while

preserving the environment and a sense of place. They are designing compact, walk-able communities of mixed land uses that preserve public space in important habitat areas, like along waterfronts.



Historic plat maps can give clues to how changes in land ownership affect land use, water quality, and fish habitat. Left: Bass Lake area, Washburn County, 1915. Right: Bass Lake area, Washburn Co. 1996.

**Zoning laws**  
City and county government regulations concerning which types of activities (residential, commercial, agricultural, industrial) can take place on a parcel of land

## Water—Good for the Constitution

The Northwest Ordinance of 1787 is the basis for the Public Trust Doctrine guaranteeing all citizens access to all the navigable waters of the state. It was embedded into the Wisconsin State Constitution of 1848 and states:

*“The navigable waters leading into the Mississippi and St. Lawrence, and the carrying places between the same, shall be common highways, and forever free....”*

Where can you fish in Wisconsin? Anywhere you can legally gain access to the water! All navigable water (water you can float a canoe, skiff, or kayak down during any time of the year on a recurring basis) is held in trust (protected) by the State of Wisconsin for all Wisconsin citizens, including anglers.

### Keep your Feet Wet!

As a wading angler, if you keep your feet in navigable waters, you have the right to be there, regardless if it is a stream or a lake! You may exit the water to portage around an obstruction, water too shallow to boat, or water too deep to

wade, but by the shortest route possible. Still, be considerate of riparian landowners when choosing your fishing hole and exercising your water rights.

### A Mark of Distinction

The state holds title to all lakebeds; however riparians own the streambeds to the center of the stream. The ordinary high water mark (OHWM) is the point on the bank or shore where the water leaves a distinct mark and establishes the boundary between a public lakebed and private lands. During low water, exposed lakebeds while still part of the public trust are not open to the public. The DNR’s Website describes the OHWM in detail: [dnr.wi.gov/waterways/factsheets/PublicPrivate\\_OHWM\\_Brochure.pdf](http://dnr.wi.gov/waterways/factsheets/PublicPrivate_OHWM_Brochure.pdf).

Water rights have been challenged in the courts through the years, building a body of common law that defines your rights as an angler. Watch the video, *Champions of the Public Trust*, available on the DNR’s Website to learn more about this important linkage to our history: [dnr.wi.gov/org/water/wm/dsfm/shore/doctrine](http://dnr.wi.gov/org/water/wm/dsfm/shore/doctrine).

## A Salmo Scenario...Imagine If

Imagine the city of Salmo, in northern Wisconsin. Salmo is a former logging town of 10,000 with an attractive downtown district surrounded by compact neighborhoods and, further out, wooded lots with residences on them.

Salmo has been selected as a possible site for the new headquarters for Icthy, Inc., a rod and reel manufacturer. Icthy would like to relocate to Salmo because of its proximity to Truffa Lake—a known walleye hotspot.

Truffa Lake is a moderately oligotrophic lake, known for its clarity, cool temperatures, and diversity of fish. It is only 10 miles from town.

Three quarters of the lakeshore is surrounded by forest, with a narrow band of coarse sand between the trees and the water. The last quarter is a low-lying wetland that eventually rises to meet the forest.

Icthy is hoping to build its headquarters along the shore of Truffa Lake so that customers can test Icthy's products right out the back door. It is important to Icthy that their building be as close to the lake as possible, and they want a large dock attached to the building's back door to make it easy for customers to test their products.

The company's president, Molly Rose Fish, imagines marketing the headquarters as a business center, a shopping place, and a fishing destination. Ms. Fish dreams that one day she will be able to attach a vacation resort to the headquarters.

Many people in the town of Salmo are excited about the possibility of Icthy moving in. Ever since a nearby paper plant closed, Salmo has been struggling to attract new people to the region. Ms. Fish has promised to bring 85 jobs to the region and hopes to provide even more in the future.

In return for Icthy's selection of Salmo, the county is considering re-zoning the lakefront as "commercial" and giving Icthy a great deal on the entire property surrounding Truffa Lake. This land is currently being leased from the county by a lumber company, which has yet to cut near the lake.

The logging lease will come up for renewal in a few months, and the county is holding a meeting to determine what should be done with the land. Four local groups have arrived at the meeting to discuss their concerns about the possible sale to Icthy. Even though these groups understand the importance of attracting Icthy to Salmo, their organization goals conflict with Icthy's business plan. The groups are:



Forest



Coarse Sand



Edge of town



Marsh

- **Sustaining Salmo**, a sustainable growth organization. Sustaining Salmo promotes the development of downtown businesses where residents can easily walk or bus to work. The group discourages shoreline development, believing that waterfront property should be used for recreation and conservation.
- **Salmo Spinners**, an angling club. Salmo Spinners works to preserve and restore fish habitat and angling accessibility.
- **Lakeland**, a vacation home real estate group. Lakeland sells vacation homes to people seeking cabins in remote, unspoiled landscapes. Most of their sales are on waterfront property.
- **Truffa Lumber**, the logging company. Truffa Lumber seeks to responsibly and selectively log county land. The company prefers to work on land that is not visible to the public, because people often complain about logging practices.



### **Invasive species**

Exotic species that often rapidly out-compete **native species**, species that live in their natural environments

## **Aquatic Exotics**

When you hear of an “exotic vacation,” what do you think of? Perhaps a tropical island or maybe a trip to the Himalayas? Regardless of where you go on your imaginary exotic vacation, it will be, by definition, far away from your life here in Wisconsin. So what makes a certain plant or fish or mussel that you can find in your local stream “exotic”?

### **From Another Land**

**Exotic** plants and animals are species that humans have helped move from a far-away native environment, where these species would naturally live, to a new environment. This happens frequently in the Great Lakes. Since the 1800s more than 100 exotic species have been documented in the Great Lakes bordering Wisconsin. There are many potential pathways for non-native or aquatic exotic species to enter a new waterbody. Can you think of one way they could get here?



There are many potential pathways for non-native or aquatic exotic species to enter a new waterbody.

### **Competing for Space**

Have you heard of people worrying about exotic species? If so, why do you think people are concerned? Why do resource managers count, discuss, and try to control exotic species? Not all exotics are of concern. In fact, some exotic species are still regularly introduced to our lakes and rivers on purpose. Chinook salmon and coho salmon are native to the Pacific Ocean, but the Wisconsin Department

of Natural Resources began stocking them in the 1960s to devour an invasive exotic, the alewife, which washed up on Lake Michigan beaches. As an added bonus, they were fun to catch and a new sport fishery was born in Wisconsin. Salmon, brown trout, and rainbow trout are reared at state fish hatcheries and stocked. They are not among the exotics that are considered invasive.

**Invasive species** are exotic species that often rapidly out-compete **native species** (species that live in their natural environments) for food, prey on native species, and/or take over a native species’ niche. These are the exotic species that resource managers and others are concerned about. Many invasive species arrive in the United States without their natural predators, so there is nothing to keep their growth in check.

The spiny water flea, for example, is a tiny crustacean with a sharp, barbed tail. It competes with young perch and other small fish for zooplankton. The spiny water flea arrived in the Great Lakes, and now many inland lakes, without predators and faces little predation from native fish because of its sharp tail. It eats without being eaten, so its population is booming, harming native species.

Resource managers are especially concerned about predator invasive species because these predators can rapidly change an ecosystem when they begin consuming native species. Because native species did not evolve with the exotic predators, they have little natural defense against them.

The sea lamprey, for example, can kill up to 40 pounds of fish in its lifetime—often focusing its efforts on the popular lake trout. The lake trout has no defense against lamprey and was nearly eliminated from the Great Lakes in the 1950s, in part because of lamprey. The diminished population of lake trout, once the Great Lakes’ top predator, has had significant effects throughout the ecosystem.

The impact of each exotic species varies, and resource managers cannot work on all of them. Instead, they focus their efforts on the most aggressive and the most controllable species in Wisconsin.



## Help is on the way: Chapter NR 40

An administrative rule, Chapter NR 40, was approved by the state legislature in 2009 to establish an invasive species control program. Check the DNR Website to see the full text of this historic document.

### Take Action!

Boaters and anglers play an important role in preventing the spread of invasive species in Wisconsin waters.

- INSPECT boat, trailers and equipment and REMOVE plants, animals, and mud.
- DRAIN water from your boat, motor, bilge, live wells, and bait containers.
- DON'T MOVE live fish away from a waterbody. Dispatch your catch and put it on ice.

- DISPOSE of unwanted bait in the trash. Use leftover minnows only under certain conditions outlined on the DNR's Website.
- RINSE boat and equipment with hot or high pressure water OR dry for at least five days

Wisconsin laws prohibit launching a boat or placing a trailer in the water if it has aquatic plants or mussels attached to it. Unauthorized introduction of fish, crayfish, or plants into the wild is illegal—even if you didn't mean to do it! Escaped or dumped exotic pets can also upset the balance of natural systems. Take care and don't be a part of the exotic invasion.

## Very Horrible and Scary

Viral hemorrhagic septicemia (VHS) is an invasive disease that causes fish to bleed to death. It caused large fish kills in the lower Great Lakes in 2005-2006 and was detected in lakes Michigan and Winnebago in May, 2007. VHS spreads easily when a healthy fish eats an infected fish or when fish swim in water carrying the virus. Infected bait (often minnows) is a primary source of the disease. Anglers can make a big difference in preventing VHS from moving into new lakes. In addition to the precautions all boaters must take, anglers are also required to do the following:

- Do not move live fish or fish eggs away from any water.
- Only purchase minnows from a licensed Wisconsin bait dealer. You can use these minnows again on the same water or other waters if no lake or river water or other fish were added to the minnow container.
- You may not harvest minnows from VHS waters. However, suckers can be taken, but may not be transported away while alive. Check the DNR Website for the list of VHS waters.
- Do not use dead fish for bait unless they have been preserved by methods other than refrigeration or freezing.
- Report sick fish to the DNR.

VHS does not harm humans, but it is deadly for fish. Do your part to keep the fishery healthy and check the DNR Website for updates.

## News Flash! Asian Carp Approaching Wisconsin!

While resource managers are trying to control the exotic invasive species currently in Wisconsin, others are working their way into our lakes. One of the greatest threats to Wisconsin and the Great Lakes is the Asian carp.

These enormous fish, which can weigh up to 100 pounds, were brought to the United States intentionally by catfish farmers who used them to clean algae out of their ponds. In the 1990s, many rivers near the Mississippi River flooded,

connecting the catfish ponds to river systems. Asian carp made their way into the Mississippi River and from there began swimming up the Illinois River toward Chicago and Lake Michigan.

If the carp make it into the Great Lakes, they could significantly change the ecosystem. Asian carp are big eaters and rapid reproducers. They will compete with Great Lakes game fish for food and could end up a dominant species in the Lakes. Managers are trying to stop their advances. Do a quick Internet search: Where is the Asian carp now?

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## Invasive Aquatic Species

List five aquatic invasive species that live in Wisconsin. What's the impact of each? How are we trying to control them?

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3. \_\_\_\_\_

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## Sea Lamprey Control Methods Survey

Read the article on the next pages to answer the following questions:

- 1) How do scientists count sea lamprey in their different life stages? Of the three assessment methods described—larval, parasitic-phase, and spawning-phase—which of these do you think provides the most accurate data about the sea lamprey population? Why do you think so?

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- 2) Suppose you are a scientist trying to assess parasitic adult sea lamprey using the help of local commercial and sport fishermen. What kinds of information would you want the fishermen to record for you? Why would it be worth their time to help you?

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- 3) How effective has TFM been at controlling lamprey without hurting other species? Why? State at least three reasons.

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- 4) Describe at least three advantages or benefits of using sea lamprey barriers when compared to the use of TFM.

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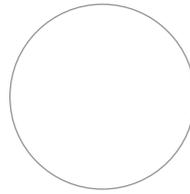
- 5) According to the fact sheet, about 25,000 male sea lamprey are caught each year in traps. If you had the choice between destroying these lamprey or sterilizing and then releasing them, which would you choose? State a reason to support your answer.

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6) If you were managing the Great Lakes fishery, which method of sea lamprey control would you devote the most time and money to—lampricides, sterile males, or barriers? Why? Make a pie graph showing how you would divide your funds.



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7) Do you think it will ever be possible to eliminate all the sea lamprey in the Great Lakes? Why or why not?

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8) In 2008 the Great Lakes Fishery Commission spent over \$18 million dollars on sea lamprey management. Do you think this is a worthwhile investment? Why or why not?

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9) Why is it important for scientists to study other invasive species? Why is it important for us to try to prevent the introduction and spread of new invasive species?

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10) Could any of the methods used for sea lamprey control be used on other invasive species? Why or why not?

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## Sea Lamprey Control Methods

### A Summary of Great Lakes Fishery Commission Reports

Sea lamprey are eel-like jawless fish native to the Atlantic Ocean. They entered the Great Lakes system in the 1800s through a series of manmade locks and shipping canals. Sea lamprey were first observed in Lake Ontario in the 1830s. They were discovered in Lake Michigan in 1936 and in Lake Superior in 1938. By the late 1940s, sea lamprey populations had exploded in all of the Great Lakes, causing severe damage to lake trout, salmon, rainbow trout, whitefish, chub, burbot, walleye, and catfish populations. Because Great Lakes fish did not evolve with sea lamprey, the fish do not have defense mechanisms against the aggressive predacious behavior of lamprey. Sea lamprey have no native predators in the Great Lakes.

### Lamprey Life Cycle

Sea lamprey begin their lives in tributary streams of the Great Lakes, where they hatch from eggs laid in gravel nests. Once hatched, wormlike larvae are swept downstream until they burrow into sand and silt substrates. The larvae feed on algae and bottom debris for four to six years, until they are six inches long. Once large enough, the larvae transform into their parasitic phase and migrate downstream to the open waters of the Great Lakes. There they attach to large fish with their sucking mouths, rasp through skin and scales, and feed on a fish's bodily fluids. This action often kills the fish. A lamprey can kill 40 or more pounds of fish in its lifetime. After 12 to 20 months of feeding on fish, the lamprey enter their spawning phase and migrate upstream to lay eggs and die.

### Control Measures

The Great Lakes Fishery Commission and its agents gather information to assess the population dynamics of sea lamprey. The purpose for collecting and analyzing data is to develop the most efficient and effective sea lamprey control program at the lowest cost and with the least possible negative effects on the environment.

### Gathering Information

Larval sea lamprey live in tributary streams and in some offshore areas of the Great Lakes. To estimate the number of larvae that will migrate into the Great Lakes, biologists use a backpack electro-shocker in shallow waters and a deep-water electro-fisher in harder-to-reach waters. The electro-fisher equipment delivers electricity to the water and stimulates (shocks) the larvae out of their burrows to the surface, where they can be counted.

Through a cooperative program, charter boats and commercial fishermen provide government agencies with data on their sightings of parasitic-phase sea lamprey in the open waters of the Great Lakes. To monitor lamprey in their spawning phase, mechanical traps are set in streams to catch the sea lamprey on their spawning migrations. The sex, weight, and length of the trapped sea lamprey are recorded to understand population characteristics. The data collected from all three life phases help scientists determine where and when to apply control measures.

### TFM

During the 1950s, scientists tested almost 6,000 compounds to identify one to which sea lamprey were especially sensitive but other aquatic species were not. Through this research, scientists discovered in 1958 that TFM (3-trifluoromethyl-4-nitrophenol) was remarkably effective at controlling lamprey. Sea lamprey are most

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vulnerable to TFM during their larval phase. For this reason, TFM is applied in streams, not to the open waters of the Great Lakes. A typical treatment takes between 48 and 72 hours to complete, but can take as long as a week. At the levels used, TFM is non-toxic to fish other than lamprey, but it does harm short-lived invertebrates. However, because TFM is applied to a stream in three- to ten-year intervals, populations of these invertebrates can recover between treatments.

TFM does not bioaccumulate in the aquatic environment, and it breaks down in a matter of days. In the Great Lakes, long-term studies have shown no traces of TFM in fish, even in multiply-treated streams in which the fish were caught. Through careful TFM use, the Great Lakes Fishery Commission and its agents have successfully reduced sea lamprey populations in the Great Lakes by 90%.

### Sea Lamprey Barriers

Sea lamprey barriers are non-chemical weapons used to control lamprey as they attempt to migrate up streams to spawn. Barriers are constructed across streams in strategic locations throughout the Great Lakes Basin to prevent sea lamprey from getting to their spawning locations, thus reducing the number of streams that produce lamprey. When properly constructed, barriers prevent lamprey passage while still allowing desirable fish species to pass. In some cases, lamprey may spawn below the barriers, but these short stretches of streams are usually much easier and less expensive to treat with TFM than an entire river system. The benefits of barriers include savings in lampricide chemical and application costs and more efficient sea lamprey control. Types of barriers include:

- low-head barriers that create walls across the stream which trout and salmon can jump, but lamprey cannot;
- adjustable-crest barriers, which pop up only during lamprey migration;
- velocity barriers, which make the stream move too swiftly for a lamprey to swim; and
- electrical barriers, which send a current across the stream and are only used during lamprey migration to deter the fish's passage.

### Sterile-Male Release Technique

A sterile-male release technique has been used successfully around the world to reduce populations of insect pests. In 1991, scientists began a similar program to control sea lamprey populations in the Great Lakes, starting with Lake Superior. Lamprey are trapped in strategic locations, often at sea lamprey barriers, on Great Lakes tributaries and the males are taken to a sterilization facility where they are injected with a chemical that makes them sterile. These males are in their spawning phase and are no longer feeding on fish.

Once the males are fully sterilized, they are released back into Lake Superior tributaries. Why not just destroy these males? Scientists believe that releasing the sterilized males will actually reduce the number of sea lamprey produced in tributaries, because the sterilized males will compete with normal males to mate with females. None of the eggs produced by the mating of a sterile male and normal female will hatch. Without sterilized males competing during the spawning run, all spawning would be done by normal males and all eggs would be fertilized. The goal of the sterile male release technique is to increase the ratio of sterile to normal males. Early results show success so far.

Source: Great Lakes Fishery Commission Sea Lamprey Control Website: [glfc.org/lampcon.php.php](http://glfc.org/lampcon.php.php)