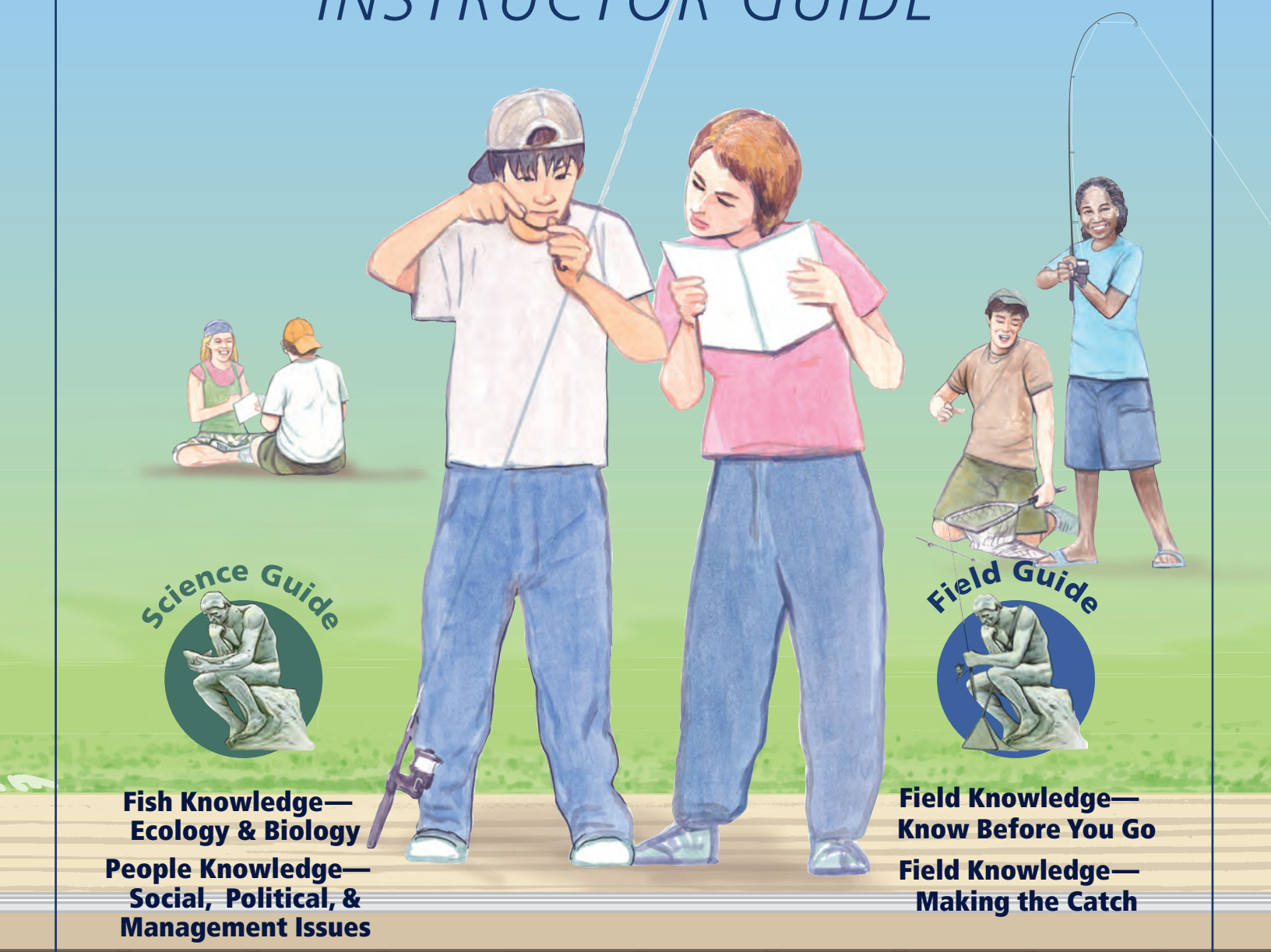
Hook, Line, & Thinker

INSTRUCTOR GUIDE



Fish Knowledge—Ecology & Biology

People Knowledge—Social, Political, & Management Issues

Field Knowledge—Know Before You Go

Field Knowledge—Making the Catch

SPORT FISH RESTORATION

WISCONSIN DEPT. OF NATURAL RESOURCES

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
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Hook, Line, & Thinker: Instructor Guide
Publication Number FH-921-2009

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Special thanks to the many angler education instructors who have helped to guide our program efforts over the years and have taken the time to introduce youth to Wisconsin's fishery.

With all due respect to 19th Century French sculptor, Auguste T. Rodin, we are using playful renditions of his masterpiece, *The Thinker* to lead us through these guides. The Philadelphia Museum of Art houses the original sculpture and notes on their Website that "Rodin was faithful to nature in his work." We hope these words and your experiences outdoors will inspire you to do the same in your work and play.

Hook, Line, & Thinker

Science Guide

INSTRUCTOR GUIDE

Fish Knowledge—Ecology & Biology

People Knowledge—Social, Political, & Management Issues

SPORT FISH RESTORATION

WISCONSIN DEPT. OF NATURAL RESOURCES

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Select a fish that lives in Wisconsin that you would like to learn more about. Use this worksheet to profile the fish as you work through the different sections of this booklet. If each of your classmates selects a different fish, your classroom will know how to catch just about anything!

PLEASE SEE APPENDIX A
Profile of a Swimmer: Wisconsin's Game Fish

Profile of a Swimmer

Common Name(s): Black bullhead

Scientific Name: *Ameiurus melas*

INSTRUCTORS: Underlined content is not provided in student manual.

SENSE	FEATURE AND DESCRIPTION	IMPORTANCE TO FISH (HIGH, MEDIUM, LOW)
Sight	Small eyes, relies on other senses	low
Smell	Nares (nostrils)	high
Hearing	Inner ear receives amplified sounds via swim bladder acting as sound chamber	high
Taste	Taste buds on whiskers and skin	high
Touch	Whisker-like feelers on barbels	high

Identifying Characteristics: Their whiskers are black like those of the brown bullhead, but yellow bullheads have white ones. They have smooth spines on their dorsal and pectoral fins. Their lateral lines are very thin.

Natural Food: They are scavengers and will eat almost anything dead, animal or plant.

Habitat Description: They are demersal (bottom-dwelling) and can live in murky water with low oxygen content. They are widely distributed throughout Wisconsin in shallow bays and along shorelines.

Niche (role): They feed on the bottom and are active at night.

Spawning habits and habitat: The female digs a saucer-shaped nest with her fins under plants, logs, or overhanging banks. Both parents tend the nest of eggs until spawning is completed. As the eggs hatch, the male continues to protect the fry by herding them in a tight little ball until they are about one inch long.

Environmental stressors: Bullheads can do well in polluted waters, because they don't need much oxygen. They can become problems for game fish if there are too many of them stirring up sediments on the bottom.

Tackle and Bait: _____ Bag Limit: None

Is there a health advisory for this fish? if so, where? Yes. There is an advisory in Cedar Creek, the Fox River, the Manitowoc River, the Twin River.

Any restoration or stocking efforts for this fish? No

Good to eat or simple recipes? When taken from clean water, bullheads are good to eat. Fried bullhead recipe: Roll in flour with salt and pepper, fry in hot oil in a skillet until golden. Drain on a paper towel.

Other interesting facts about this species (list 5): Their black backs camouflage them from predators flying above and their white bellies camouflage them from predators swimming below. They do not have scales. They can easily overpopulate an area and become stunted. They sometimes burrow in mud for the winter. The world record black bullhead was eight pounds.

Sources: Various DNR publications

Hook, Line, & Thinker: Science Guide

STUDENT GUIDE PAGES

SECTION B

People Knowledge

Social, Political, & Management Issues

Hook, Line, & Thinker: Field Guide

STUDENT GUIDE PAGES

SECTION A

Field Knowledge—Know Before You Go

Welcome, Teachers & Volunteers!

You are holding a curriculum and activity guide that will help you make educated anglers and responsible water users out of your students. **The Hook, Line, & Thinker** program is designed for upper middle school and high school students. While the guide for teachers contains all activities, there are two separate booklets for students.

The first, **Hook, Line, & Thinker: Science Guide**, is aimed primarily at life sciences students; the second, **Hook, Line, & Thinker: Field Guide**, at physical education students or those in after-school programs, summer camps, or other places that have the ability to provide an angling field trip. We encourage instructors to work together to give their students the full Hook, Line, & Thinker experience.

The **Hook, Line, & Thinker: Science Guide** uses water and fish as focal points for teaching broader life science concepts. The student booklet is organized into two main sections: **Fish Knowledge** and **People Knowledge**.

In **Fish Knowledge**, activities and text are focused on the science of fishing: fish biology and aquatic ecology. Students build on what they learned in that section as they explore the impact people can have on fisheries, outlined in **People Knowledge**. **People Knowledge** looks at problems that humans have caused for fisheries and the various ways that managers and policy makers can try to solve these problems using science as a management tool. This section could also be used in social studies classrooms. In the final activities, students think about their own relationships to fish and our aquatic resources.

The **Hook, Line, & Thinker: Field Guide**, on the other hand, walks students through the steps of a successful fishing excursion. It is divided into two primary sections: **Field Knowledge—Know Before You Go** and **Field Knowledge—Making the Catch**.

In **Know Before You Go**, students consider safety, ethics, and regulations and practice their tackle, knot, and casting skills in a controlled setting. **Making the Catch** has field day activities, including reeling in a fish.

Although the activities in these booklets may be used independently of one another, they build upon each other when used consecutively. If used independently, students may need to refer to earlier activities or the glossary in the back of their booklets to find information.

If doing a section in its entirety, consider opening with the **Scenario**. The scenario is designed to get students thinking about the material that will be covered in the following text and to give you a sense of students' current knowledge. At the end of each section is a **Vocabulary Review and Section Assessment**. The review allows students to practice new vocabulary, while the assessment returns to the opening scenario and suggests a concluding project. Service-learning project ideas are listed under **Extensions**.

Additional resources are included in the Appendix. If you have downloaded this booklet, please see the separate Appendix download for additional materials. Sources and a materials list as well as correlations to the Wisconsin State Academic Standards, Project Wet, Project WILD, and Water Action Volunteers are listed in the back of the book.

Standards are listed with the most basic presentation of the activity in mind. Additional standards may be addressed through extensions and deeper investigations of issues related to the activities.

This guide is not detailed enough to make students expert anglers, but it does set them on a path toward discovering some basic principles about aquatic environments and their connections to them as anglers, as fellow water-dependent beings, and as citizens with the ability to think and choose how they act.

We offer our deepest thanks to you for providing your students with a chance to learn more about Wisconsin's fisheries and the aquatic resources that sustain them. Because of you, fewer students will leave their youth unaware of this great beauty and bounty that surrounds them in Wisconsin.

Enjoy your angling adventure!

If you have downloaded this booklet, please see the appendix that follows for additional materials.

Welcome, Anglers!

You are holding a guidebook that will help you to better understand our aquatic resources. This booklet is organized into two main sections: **Section A, Fish Knowledge** and **Section B, People Knowledge**. In Fish Knowledge, you will focus on science: fish biology and aquatic ecology. You will build on what you learned in that section as you explore the impact that people can have on fisheries, outlined in People Knowledge. This section looks at problems that humans have caused fisheries, and it addresses the various ways that management can try to solve these problems using science as a tool. In the final activity, Great Conservationists, you will consider your own relationship to fish and our aquatic resources.

We'll be using short scenarios at the beginning of each section to guide our investigations. As you read these scenarios, think about how fish ecology, management decisions, and personal choices all play roles in the problems described and in their possible solutions.

This booklet can be paired with *Hook, Line, & Thinker: Field Guide,* a booklet that focuses on the technical skills of angling. Even when done together these booklets are not detailed enough to make you an expert angler: that can take a lifetime. These booklets will, however, set you on a path towards discovering some basic principles about aquatic environments and your connection to them as an angler, as a fellow water-dependent being, and as a citizen with the ability to think and choose how you act.

Be sure to thank your teacher and community members for offering you this chance to learn more about Wisconsin's fisheries and the aquatic resources that sustain them.

INSTRUCTORS: This is the student guide table of contents and page numbers. Student page numbers are noted throughout as:

Student Science Guide 1 Student Field Guide 1

STUDENT GUIDE PAGES

SECTION A

Fish Knowledge
Ecology & Biology

SECTION B

People Knowledge
Social, Political, & Management Issues

Grass pickerel

Student Science Guide 1

The Scene

A local fishing group wants the Wisconsin Department of Natural Resources to put walleye and yellow perch in Linnie Lake, near Muskego. As a fish biologist, you are responsible for deciding whether or not to stock walleye and/or yellow perch in the lake. What sort of data do you need to collect in order to determine whether or not to stock the fish?

INSTRUCTORS: Answers found in Section Assessment on page 35.

SECTION A

Fish Knowledge

A lake is a lake is a lake, or is it? For those of us who live and breathe on land, it is difficult to comprehend how different each body of water is. But fish can tell the difference! Each species of fish requires certain conditions to survive. To be an informed angler, you need to know these conditions and be able to match the environment to the fish. In this section, you will learn how to recognize different species of fish and how to identify different components of fish habitat.

One Fish, Two Fish, Panfish, Catfish

In this chapter, two lesson plans focus on fish adaptations and taxonomic classifications.

What Makes a Fish a Fish?

OBJECTIVES: Students will be able to:

- explain that natural selection leads to adaptations that suit a particular environment
- describe the anatomical position and function of fish fins and organs

METHOD: Students fill in an anatomical drawing of a fish and practice using anatomical terms in sentences.

MATERIALS:

1) ➲ **See Appendix B** for Fish Anatomy Transparency, Salmonid Dissection Guide, and Speaking Anatomically.

2) ➲ **See Appendix C** for Fish Images*

3) Overhead projector

*Alternatively, order Fish Wildcards on cardstock from the DNR or download and print them from **dnr.wi.gov/fish/kidsparents/documents/MatchYourCatch.pdf**. Fish field guides and the fish identification Website, **wiscfish.org/fishid** are other good resources for this activity.

SETTING: Indoors

DURATION: One to two 45-minute session(s)

VOCABULARY: Poikilotherms, chordate, adaptation, niche, lateral line, barbel, extirpated, dorsal, physiology, thermoregulate, swim bladder

STANDARDS:
Science: F 8.6, 12.5.
Environmental Education: B 8.2, 12.5.

BACKGROUND: There are more than 25 families of fish in Wisconsin, each adapted to a specific habitat. These adaptations are the result of millions of years of natural selection. Some of the most evident adaptations fish have are their coloration, marking patterns, shape, and fins. Fish skin and scales have developed colors and patterns that help to conceal or confuse predators and prey. In some fish, like darters, coloration attracts mates. Bullheads and many other species of fish are counter-shaded (dark across the back and light on the belly) to help them stay hidden from above and from below. Knowing the specific markings typical of different species of fish is useful in learning about their niches in an ecosystem and in assisting with identification.

Shape is also an important species and niche identification tool. The torpedo shape of inland trout assists them in swimming against currents. But not all fish could function with a trout shape. Some fish are long, skinny and almost oval in cross-section, like the northern pike, a shape which permits quick bursts of speed and agility in underwater "forests" of aquatic vegetation.

Still others look like they were stepped on (dorsoventrally flattened) or were caught in a sliding door (laterally compressed). The dorsoventrally flattened catfish can eat off the bottom while being concealed from predators. The laterally compressed bluegill is hard for predators to swallow and moves smoothly in and out of weedy growth.

Fins can also be used to identify a species and a niche. Fins are described in detail in the student section and can be used to practice anatomical terms. The internal organs of a fish are also useful in understanding the ecological niche of the species and the adaptations it has made to survive in its environment. Internal organs generally aren't used by the average angler in identification, but are used by scientists to classify fish.

OPENING: Divide the class into teams of three students each. Distribute to each group several Wildcards (with the back covered) or cut-out copies from a field guide. Have the students read the opening paragraphs of **What Makes a Fish a Fish**. Based on what they can see on the fish images they hold, what can they learn about the ecological niche of their fish? What body parts are they using to determine the niche?

After allowing five to 10 minutes of small group discussions, open the discussion to the entire class. If desired, make a chart on the

board of the different body shapes, mouth shapes, coloration patterns, and fin locations on the board. Use the fish identification Website to talk through some of the different adaptations of fish and how they may have developed. What role did evolution play in these adaptations?

MAIN ACTIVITY: Have students read the **What Makes a Fish a Fish** section in their booklets and then work as a class to begin labeling the anatomical drawing of the generic fish.

Use an overhead projector to show body parts and their locations. Lead a discussion of the functions of various fish parts, making sure to include all of the body parts listed below. Have students practice using anatomical terms to describe the location of each part. The use of anatomical terms will be helpful in the **Which Fish is This** lesson that follows. Evolution and adaptations can again be a part of the discussion—gills, the operculum, the lateral line, and the swim bladder are all important adaptations for life underwater.

External

Scales/Skin/Scutes: protect a fish from disease and injury

Lateral lines: sensory lines running the length of the body, pinpoint vibrations

Opercula: bony protective coverings over the gills

Dorsal fin: fin(s) on the back of the fish, aids in balance and maneuverability

Pectoral fins: on the sides of the fish, provide aim and positioning

Pelvic fins: on the underside of the fish, provide stability and balance

Caudal (tail) fin: the fish's propeller, provides locomotion

Anal fins: on the underside of the fish, provide stability and balance

Adipose fin: on the back of the fish, function unclear

Internal

Brain: controls muscle function, processes information

Gills: absorb oxygen from water

Esophagus: short and expandable, connects the mouth to the stomach

Heart: two chambers, an atrium and a ventricle, moves blood through the fish

Liver: filters toxins, stores vitamins, breaks down fat

Stomach: usually in a "u" or "v" shape, secretes acids to break down foods

Pyloric Caecum: not found in all fish, assists with nutrient absorption

Intestine: longer in herbivorous fish, shorter in carnivorous, absorbs nutrients

Vent: expels waste

Kidneys: produce red blood cells

Swim Bladder: a gas-filled chamber, maintains buoyancy and amplifies sound

Gonads: reproductive organs, produce sperm or eggs

Bladder: holds urine

CLOSING: Ask students how knowing some of the anatomy and physiology of fish could help them become better anglers or fish biologists. Have them fill out the **Educated Angler** section at the end of the lesson either in class or as a take home project. Students can begin filling out the **Profile of a Swimmer** on the inside cover of their booklets.

ASSESSMENT QUESTION: List five adaptations most fish have and describe how each one helps suit fish for life underwater.

ANSWERS: *Scales for protection, fins for locomotion or stability, gills for breathing, swim bladder for flotation/buoyancy, operculum for gill protection, lateral line to pinpoint movement.*

EXTENSIONS:

In Depth: Dissect fish in class. ⊙ See **Appendix B** for Salmonid Dissection Guide and Speaking Aantomically, a more in-depth look at fish anatomy.

Art: Have students do a scientific drawing of a fish and label its parts.

⊙ *If you have downloaded this booklet, please see the appendix that follows for additional materials.*

1

One Fish, Two Fish, Panfish, Catfish

Largemouth bass

The fishing group in the scenario requested that both yellow perch and walleye be stocked in Linnie Lake. These are two different species of fish, but how would you tell them apart? In the following section, you will learn what makes an animal a member of the fish family and how to label and identify different species of fish.

What Makes a Fish a Fish?

If you had to describe a fish to someone who had never seen one, what would you say? What makes one species of fish like another species of fish, but different from all other kinds of animals? Scientists struggle with how to appropriately define "fish." All fish are cold-blooded, or **poikilotherms** (animals whose body temperature is that of the environment), but so are reptiles and amphibians. All fish are **chordates** (animals with primitive or well-developed backbones) but so are you. All fish breathe using gills, but so do salamanders. Most fish spend all of their lives underwater, but longnose gar and other species of fish can breathe air. Most fish have scales and fins, but some saltwater eels (which are fish) have neither. Dr. Tim Berra of Ohio State University defines a fish this way, "…poikilothermic, aquatic chordate with appendages (when present) developed as fins, whose chief respiratory organs are gills and whose body is usually covered with scales." Sound confusing?

Poikilotherms
Animals whose body temperature is that of the environment

Chordates
Animals with primitive or well-developed backbones

Fish are hard to define because they have been on earth for so long that they have had time to develop many specialized adaptations. Fish fossils have been found dating back more than 400 million years. Worldwide there are about 21,000 species of fish each adapted through **natural selection** to a particular niche (role) in an aquatic ecosystem. For example, the northern pike's torpedo-shaped body and sharp teeth make it an effective predator. Its markings enable it to hide in the weeds unnoticed while it waits in ambush for its next meal to pass by. Bluegills also rely on coloration for protection instead of predation. The bullhead's keen sense of smell and sensitive barbels (whiskers) compensate for poor vision in the murky water it often inhabits and the **lateral line** senses vibrations as it does in all fish. The more you learn about fish and their habitat, the better angler you'll become.

Natural selection
A process by which only those creatures and plants well adapted to their environment survive

Speaking Anatomically: Scales, Skins and Scutes

Scales are modified skin cells that protect a fish's body from disease and injury. Fish hatch with all the scales they will ever have. They may grow replacement scales, but not additional ones. As fish grow, the scales just get bigger and lay down a growth ring each year. With a microscope, you can count the rings on a scale to determine a fish's age, just like you'd count the rings on the cross-section of a tree trunk. It's a good idea to sample several scales from one fish and go with the highest ring count to ensure that you are not relying on the count from a newer, replacement scale.

Some fish do not have scales at all. Catfish and bullheads have very tough skin and sturgeon have bony plates called scutes for protection.

PLEASE SEE APPENDIX B
What Makes a Fish a Fish? Speaking Anatomically

Diversity Below the Surface

As of 2006, about 156 species of fish lived in Wisconsin waters; 15 of those were non-native, including five non-native game fish stocked by the Department of Natural Resources. Six other fish species are known to have been **extirpated** from Wisconsin since European settlement. Another 12 non-native species have been observed but have not yet become established.

Source: John Lyons, Wisconsin DNR Fisheries Research Biologist

Extirpated
Eliminated from an area

Northern pike

Brook Trout

Mucus

A slimy coating helps protect fish from disease, fungi, parasites, and the grasp of would-be predators. Mucus reduces friction, allowing fish to swim 60% faster than they could without it. When you catch a fish, wet your hands before handling to minimize disturbance of this protective coating.

Gills

Fish breathe every time they take a gulp of water. Water enters a fish's mouth and passes over and out through the gills, where oxygen (the "O" in H_2O) is extracted from water. Carbon dioxide is released from the fish's blood in exchange for oxygen. As a fish swims in moving water, the flow of water through the gills and exchange of gases occur without aid. Injury to the gills is often fatal, so handle fish with care.

Swim Bladder

Swim bladder
An air-tight sac in most fish.

Fish have a **swim bladder**, or gas bladder, that makes it possible for them to remain suspended in water. The bladder is an air-tight sac in most fish; some fish can add or release gas to adjust their depth in the water.

Skeleton

Most fish have a bony skeleton. However, some fish, like lamprey and sturgeon, have skeletons made of cartilage, rather than bone.

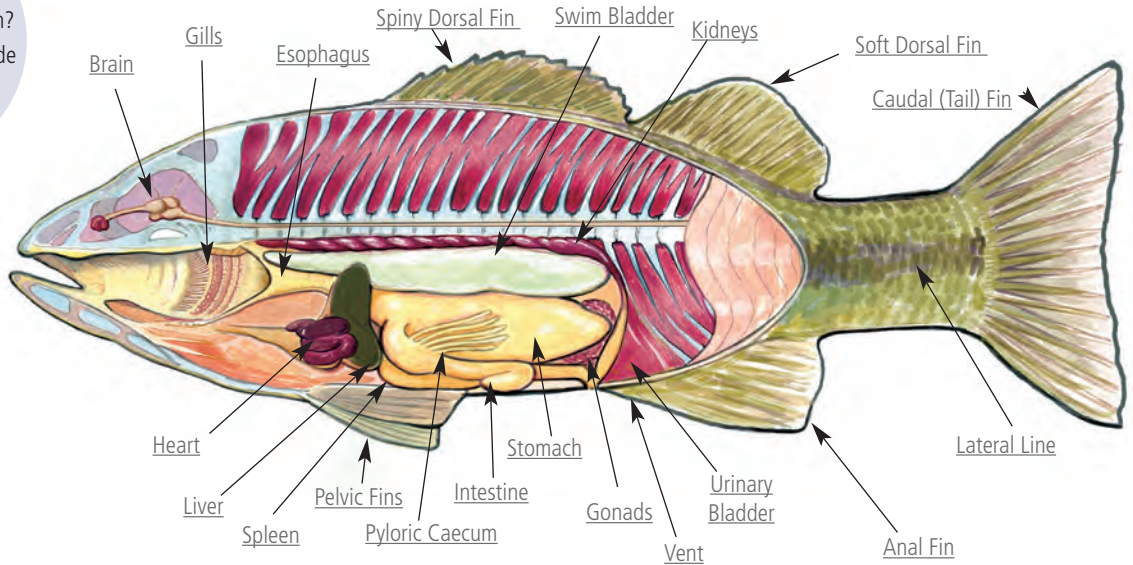
Coloration

Fish come in a variety of colors and patterns that attract mates or conceal fish from predators or prey, depending on their place in the food chain. Almost every species is counter-shaded, dark across the back and light on the belly to help them stay hidden from above and from below.

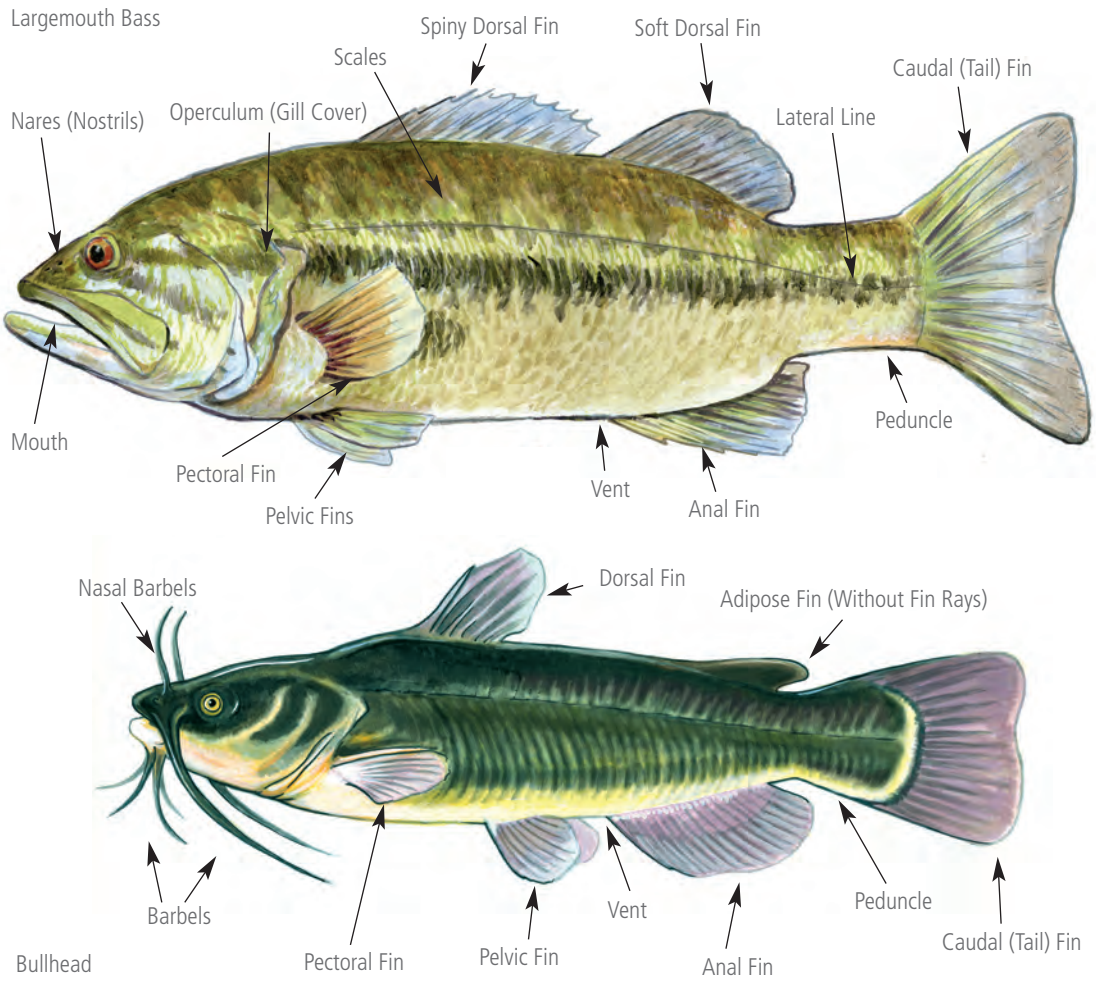
Fin-Tastic

Fins are membranes supported by hard, bony spines or soft rays. They provide balance and make it possible for a fish to maneuver through tight spaces and stay upright in water. There are six types of fins, but not all fish have all types. Different species of fish have developed different sizes of fins depending on the fish's niche in the ecosystem. Knowing the size, shape, and location of different species' fins will help you later with identification. What can you know about a fish by its fins?

PLEASE SEE APPENDIX B
What Makes a Fish a Fish?
Salmonid Dissection Guide
Fish Anatomy Transparency



Use the fish image to label fish fins and anatomy as you discuss it in class.



INSTRUCTORS: Underlined content is not provided in student manual.

FIN	FUNCTION	NOTE
Dorsal	Balance and Maneuverability	Some dorsal fins are spiny-rayed and others are soft-rayed. Fish may have one, two, or three dorsal fins that can be a combination of spiny and soft rays. Fins may or may not be connected to each other.
Pectoral	Aim and Positioning	Pectoral fins help the fish aim itself, hover in one place, and dive.
Pelvic	Stability and Balance	Pelvic fins work with the dorsal and anal fins to provide balance.
Caudal or Tail	Locomotion (the propeller)	Species of fish with forked tails are fast swimmers. Those with broad, flat tails are able to turn and start swimming quickly.
Anal	Stability and Balance	Anal fins work best with dorsal and pelvic fins to provide balance.
Adipose	Unclear	The purpose of the small, fatty adipose fin is unclear. It is found on catfish, bullheads, trout,and salmon.

Marked for Research

Fin clipping is a method of marking fish for research. Biologists clip different combinations of fins to identify groups of fish. A specific clipping pattern indicates when and where a fish was stocked. When fish are recaptured, researchers refer to the fin clip records to chart survival and growth rates. The adipose-only fin clip is reserved by the Great Lakes Fishery Commission to be used throughout the Great Lakes on salmonids that are carrying a coded wire tag.

Wall-eyed

The term "walleye" is similar to an old Norse word meaning "a light beam in the eye." Walleye do indeed seem to be shooting light out of their eyes. They have reflective pigments on their retinas that allow them to see in very low light conditions, like at dawn or dusk. For this same reason, walleye avoid bright light. Remember this when seeking them out! Does anatomy play a role in other fish species' common names?

Physiology
The study of how an organism functions

Thermoregulate
Maintain a constant body temperature

INSTRUCTORS: Underlined content is not provided in student manual.

Fish-iology

Physiology (the study of how an organism functions) can also be important to an angler. As we learned earlier, fish are poikilotherms. Fish are not able to **thermoregulate** (maintain a constant body temperature) like mammals. Instead, a fish's body temperature nearly matches the temperature of its environment. How does knowing this help you to be a better angler?

Fish will live in comfortable temperatures. You probably won't find fish in really hot or really cold water, unless the fish is adapted to those extremes.

Educated Angler

Use the space below to list five facts you have learned about fish anatomy or physiology and how each could help you catch a fish.

1. _____

2. _____

3. _____

4. _____

5. _____

Which Fish Is This?

OBJECTIVES: Students will be able to:

- explain how biologists classify organisms into taxonomic groups
- identify fish using a key

METHOD: Students will use morphological characteristics to group unlabeled fish from the order Perciformes into families and present their groupings to the class. Students will check their work using a fish identification Website and dichotomous key.

MATERIALS:

1) Fish Wildcards or images of fish from a fish field guide or in Appendix C, to make fish cards (see details below).

2) Fish identification Website **wiscfish.org/fishid**

See Appendix C for **Which Fish is This?** Fish Images and A Key to Common Wisconsin Fish, a dichotomous key to fish. (Laminate the key for outdoor activities.)

PREPARATION: Assemble fish card packs using images of two to five species (except goby) from each of the four Perciformes families found in Wisconsin (Centrarchidae, Moronidae, Percidae, and Gobiidae). (The Esocidae cards are part of the opening, not the main activity.) Each group will have a different assortment of fish. Make sure that none of the images is labeled. Make one pack for every two to three students.

Centrarchidae (Sunfish)

Bluegill *(Lepomis macrochirus)*

Pumpkinfish *(L. gibbosus)*

Green Sunfish *(L. cyanellus)*

White Crappie *(Pomoxis annulari)*

Black Crappie *(P. nigromaculatus)*

Rock Bass *(Ambloplites rupestris)*

Largemouth Bass *(Micropterus salmoides)*

Gobiidae (Gobies)

Round Goby *(Neogobius melanostomus)*

Percidae (Perch)

Iowa Darter *(Etheostoma exile)*

Walleye *(Stizostedion vitreum)*

Sauger *(S. canadense)*

Ruffe *(Gymnocephalus cernuus)*

Yellow Perch *(Perca flavescens)*

Moronidae (Temp. Bass)

White Bass *(Morone chrysops)*

Striped Bass *(M. saxatilis)*

Yellow Bass *(M. mississippiensis)*

White Perch *(M. americana)*

*The underlined species are exotic.

SETTING: Indoors

DURATION: Two to three 45-minute sessions

VOCABULARY: Bag limits, morphology, taxonomic groups, dichotomous key

STANDARDS:
Science: F 8.5, 12.5, 12.6.
Environmental Education: B 8.2, 8.4, 8.8.

BACKGROUND: Charles Darwin and Alfred Wallace both used taxonomic groups to formulate their ideas about evolution and natural selection. By placing organisms in groups based on morphology, these biologists could see shared traits that were inherited from earlier generations. Today, taxonomic groups are established into domains, kingdoms, phyla, classes, orders, families, genera, and species.

Bony fish are in the class Osteichthyes, which contains more than 30 different orders. The order Perciformes (ray-finned fish) is the largest of these orders and can be divided into 156 different families. Within these families are thousands of salt- and freshwater species. Wisconsin hosts four families of Perciformes: Centrarchidae (sunfish), Moronidae (temperate bass), Percidae (perch), and the non-native Gobiidae (goby).

Technology is rapidly improving our understanding of the family trees of species around the world. Scientists are continually dividing and subdividing taxonomic groups as they learn

more about the molecular and cellular structure of organisms and as DNA evidence reveals connections that are difficult to see with the naked eye or even a microscope. Still, the most basic system of identifying an organism—looking at its morphology—is an important tool in all biological studies.

OPENING: Have students read **Which Fish Is This?** in its entirety. Introduce the concept of dichotomous keys with A Taxonomic Grouping of Esocidae. UsePowerPoint or handouts to show images of the musky, northern pike, and grass pickerel. (**See Appendix C**). Review the anatomical parts and terms from the previous lesson by comparing these species, which are all from the same family (Esocidae).

Have students look at body and mouth shape; the number, placement, and shape of fins; placement of the eye; and markings. What do they have in common? How are they different? Have students key out the species using the diagram in their booklets.

MAIN ACTIVITY: Divide students into groups of two or three. Distribute the packs of unlabeled fish images from Appendix C. Give the students 10 to 20 minutes to sort the fish into four families, using their classification skills and knowledge of anatomy. Have them take notes in their booklets about why they are dividing species into the categories they have chosen. If there is time, have them speculate about which of the families are more closely related and what traits a common ancestor might have shared with them. At the end of the small group sessions, have students present their results to the rest of the class.

Next, or in a subsequent class, have students identify their fish to determine if they have appropriately grouped them. Field guides, the dichotomous key, or the Wisconsin fish identification Website are possible tools for identifying fish that require students to practice using morphological characteristics. If students incorrectly grouped species, discuss why these species were confusing.

CLOSING: Ask students why anglers should be able to identify fish and what supplies they would need to take on a fishing trip to identify their catch. Students could continue working on their fish profiles.

ASSESSMENT QUESTION: How do dichotomous keys work?

ANSWERS: *Using visual cues, identify a species by working from broad differences to specific distinctions.*

EXTENSIONS:

In Depth: Have students create family trees (Family Ties) for other orders of fish.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

Which Fish Is This?

What did you catch? What does it matter, anyway? A trout doesn't care if you call it a trout, a carp, or a muskellunge, but conservation wardens do and so should you.

Many fish are subject to **bag limits** (the number of fish you may catch in a day), while others are superior in flavor, and still others can be unhealthy if eaten too frequently. Legal requirements, taste preferences, and health issues are a few important reasons to learn to identify what kind of fish you've caught. The problem is, anglers, conservation wardens, and scientists may all place different labels on the same fish.

Surely That's a GamePanMinnow-Fish

The easiest way to identify a fish is to place it in a category based on its purpose.

Anglers group fish by taste and how challenging they are to catch. To an angler, a panfish is generally a fish that is edible, fits in a frying pan, and is legal to keep. A game fish is generally any fish that is caught for sport. But, as you can imagine, definitions as broad as these can include many different fish and might mean something slightly different to each person. Ask around: is a walleye a panfish, a game fish, both, or neither?

To avoid confusion, Wisconsin conservation wardens use the following specific description of fish categories.

By Wisconsin law, **game fish** are defined as all varieties of fish except rough fish and minnows.

Rough fish include: dace, suckers, carp, goldfish, redhorse, freshwater drum, burbot, bowfin, gar, buffalo, lamprey, alewife, gizzard shad, smelt, mooneye, and carpsuckers.

Minnows include: suckers, mud minnow, madtom, stonecat, killifish, stickleback, trout perch, darter, sculpin, and all species of the minnow family (except goldfish and carp).

Wisconsin law is simplifying the identification process by calling *all* panfish game fish. This makes it easier to regulate the catch of the most popular species of fish. You might have noticed that the last sentence of the definition above hints of yet another way of identifying fish: by family.

For legal purposes, goldfish and carp are not considered minnows, but scientifically they are. Biologists identify fish by their **morphology** (structure) rather than by their purpose. Scientists use morphology to classify organisms into **taxonomic groups** (groups of closely related organisms) to build family trees and trace the evolutionary history of everything from plants to bugs to fish.

Once a scientist has built a family tree, she can use it to make a **dichotomous** (die-kot-o-mus) **key** (an identification tool). Keys begin with broad differences and work toward specific distinctions.

By scientific identification, no two fish of different structure will have the same name. A brook trout (Salvelinus frontalis) is in a separate taxonomic group from a smallmouth bass (Micropterus dolomieu). Of course anglers and conservation wardens also use this scientific system of identification, but not usually the scientific name.

Bag limits
The number of fish you may catch in a day

Morphology
Structure

Taxonomic groups
Groups of closely related organisms

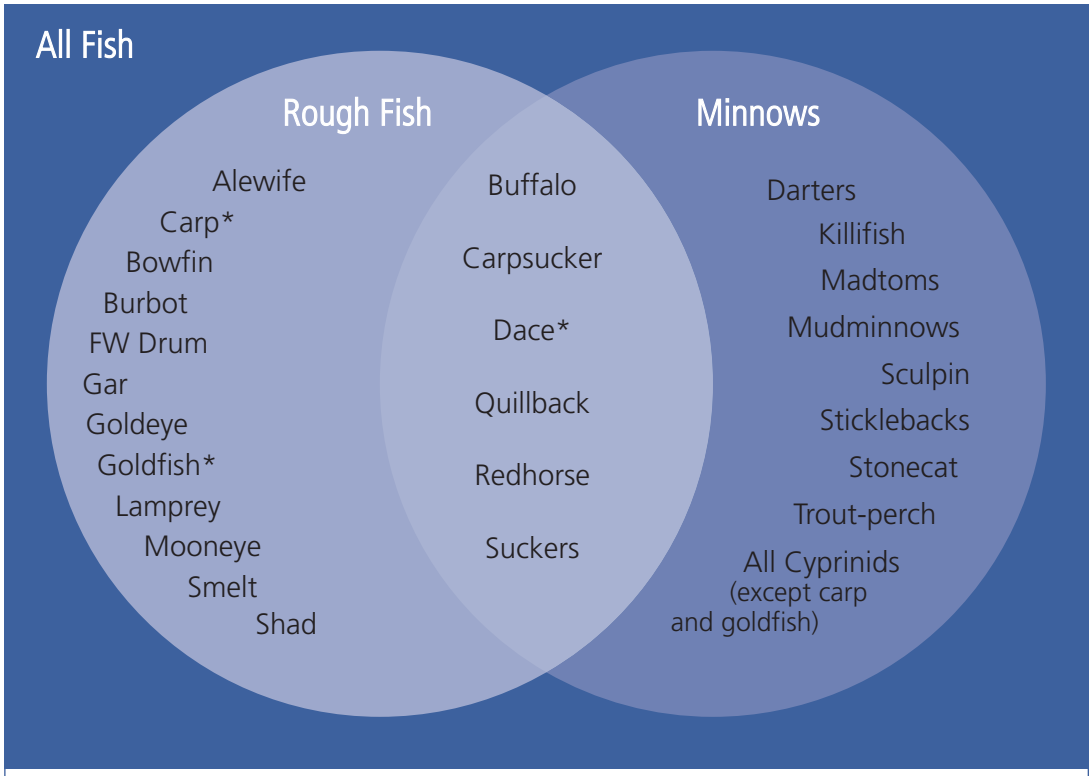
Dichotomous key
An identification tool

PLEASE SEE APPENDIX C
Which Fish is This? A Key to Common Wisconsin Fish

That's Rough

> The term "rough fish" seems to imply that these species have little or no value, but enlightened anglers, biologists, and chefs know better. Rough fish often inhabit a rough neighborhood, the murky bottom, but that doesn't mean they don't taste good. Take a chance and try one sometime!

Game Fish, Rough Fish, Minnows



By state law all fish are "game" fish if not "rough" fish or "minnows." Game fish may not be harvested unless an open season is specified in Administrative Code.

* Taxonomically, carp and goldfish are in the minnow family. Legally, however, they are classified as "rough" fish, but not as "minnows" in Wisconsin. Although dace are also members of the minnow family, legally, they are classified as both a minnow and a rough fish. All members of the sucker family are considered rough fish for legal purposes; they are in the same *order* as minnows. Other fish legally referred to as "minnows," are in several different taxonomic families.

What's That?

What would you expect to see if your friend said, "Hey I just caught an Animalia Chordata Actinopterygii Perciformes Centrarchidae Lepomis gibbosus!"

Your friend caught a pumpkinseed.

A Taxonomic Grouping of Esocidae

Identify this fish using the key below.

1. a. Body lacks large bony plates. . . . . Go to #2

   b. Body has large bony plates . . . . . **Lake Sturgeon** (not in Esocidae family)

2. a. Dorsal fin is short, much less than half the body length . . . . . Go to #3

   b. Dorsal fin is nearly half the body length or longer . . . . . **Bowfin** (not in Esocidae family)

3. a. Teeth are visible and sharp . . . . . Go to #4

   b. Mouth is fleshy, teeth are not visible and sucker-like **White Sucker** (not in Esocidae family)

4. a. Tips of tail fin are rounded . . . . . Go to #5

   b. Tips of tail fin are pointed . . . . . **Muskellunge** (Esocidae family)

5. a. Cheek and gill cover are fully scaled . . . . . **Grass Pickerel** (Esocidae family)

   b. Cheek and only upper half of gill cover are scaled . . . . **Northern Pike** (Esocidae family)

PLEASE SEE APPENDIX C

What Fish is This? Fish Images

INSTRUCTORS: Underlined content is not provided in student manual.

Family Ties

Construct your own taxonomic groups of fish.

Survivor

In this chapter, three lesson plans review the bare necessities of life for fish.

Fish Food

OBJECTIVES: Students will be able to:

- describe the dynamics of a simple food chain with three trophic levels
- explain that energy is lost as it travels up a food chain
- identify three classes of lakes, their relative nutrient abundance, and their ability to support life

METHOD: Students will complete a set of math problems in You do the Math in their booklets to show how energy is lost in a food chain. Students will play a population dynamics game and answer questions about their results.

MATERIALS:

1) One to three stopwatches* for each group of four students

2) One pair of scissors for each group unless you pre-cut the game pieces with a paper cutter prior to class—recommended.

* It may be easier for students to keep track of the different production rates if you expand the group size to six and assign a timekeeper with stopwatch for each trophic level.

See Appendix D for Steady State? Game materials: Nutrient page (six copies per group on white paper), algae page (six copies per group on green paper), shiner page (six copies per group on yellow paper), bass page (six copies per group on purple paper).

SETTING: Indoors

DURATION: One to two 45-minute sessions, depending on whether math work and answers to game questions are done in class or at home. If having the students answer the game questions at home, make sure they have written their results down before they leave the classroom.

VOCABULARY: Ecosystem, ecology, trophic, primary producer, consumer, biomass, oligotrophic, limiting factor, mesotrophic, eutrophic, eutrophication, "Rule of 10" or "Ten Percent Law"

STANDARDS:
Science: F 8.8, 12.9, 12.10.
Environmental Education: B 8.1, 8.4, 8.8, 8.10, 12.1, 12.2, 12.3, 12.4, 12.6.

BACKGROUND: Ecosystems are intricate communities of interdependent plants and animals. Abiotic (non-living) elements provide support to the biotic (living) elements and include things like water, rocks, climate, and oxygen. Disturbance or limits to any part of an ecosystem creates ripple effects on other parts.

The interconnectivity of ecosystems is often demonstrated by using food chains. In a food chain, the organisms at each trophic level depend on an abundance of organisms at the trophic level beneath them. The population of a particular organism, however, is not determined solely by an abundance of food. The rates at which an organism grows, feeds, and reproduces are also important in understanding populations. In the activity used in this lesson, growth, feeding, and reproduction rates are all rolled into one "production rate" to simplify the game.

If this were a true population dynamics model, like models used by fisheries managers to understand how ecosystems function, students would consider the separate rates independently. More complex models would more accurately show how food choices and varying rates of consumption, growth, and reproduction at different life stages interact and affect other species in a food chain.

Limiting factors are also important in understanding food chains as they prevent the growth of an organism or population. The production rate of green algae, for example, is limited by the amount of nutrients in a body of water. If that limiting factor is removed (e.g. by dumping fertilizers into a lake, thereby providing an abundance of nutrients), the algae population would boom until another limiting factor controlled it (in this case, perhaps, lack of oxygen). An ecosystem in a steady (not stagnant) state is one in which each trophic level is producing at a slower rate than the level beneath it, resulting in a food pyramid.

Ecosystems always fluctuate to some degree, however, making the perfect "steady state ecosystem" more of an ideal than a reality.

OPENING: Have students read the **Fish Food** section in their booklets. Make sure that students understand the roles of primary producers, grazers, and predators in an ecosystem. If a demonstration would be helpful, use piled blocks or books to represent a trophic pyramid for the class. Discuss how ecosystems are controlled by the production rate at each level of the pyramid, which has its foundation in nutrients and sunlight. If something limits the abundance of nutrients or sunlight in an ecosystem, all levels of the pyramid are limited. Each trophic level in a pyramid depends on the level beneath it. Have students complete the math problem or use it as a take-home exercise.

MAIN ACTIVITY: Divide students into groups of four to six and pass the supplies to each group. Within each group, assign one person to each trophic level (algae, shiners, bass) and give one person the stopwatch to keep time or assign a timekeeper for each trophic level. Have students cut the colored copies into pieces, unless you've pre-cut them. Let them know that each square represents an abundance of organisms. For example, each yellow card represents enough shiners to keep one smallmouth bass alive. Have the students lay the six nutrient pages (game board) in front of them and read the rules of the game either from their booklets or go over them as a class. All students will do Round One. Assign a different Round Two (2A, 2B, or 2C) to each group. Depending on the size of the class you may have more than one group assigned to some of the rounds. (If there is time, they can all do all four rounds).

Each round will last exactly five minutes. Students will use the chart on their worksheets to determine the start time and production rates of their organisms. When the stopwatch begins, students will lay their cards on top of the organism they consume at the appropriate rate. For example, in Round One the time keeper will call out five second intervals. Algae will lay down one green card on top of the nutrient squares at a rate of one every five seconds. The shiner will begin after 10 seconds and will lay a yellow card on top of a green card at the rate of one every 10 seconds. The smallmouth bass will begin at 20 seconds and lay a purple card on a yellow card at a rate of one every 30 seconds. This will continue for a total of five minutes, but may require a practice round.

Going extinct: Each organism may only lay its cards on top of the organism it would consume. A purple card may not go on top of a green card, nor can a purple go on top of a purple. In Rounds Two A, Two B, and Two C, populations will crash because of lack of food. If all the cards in a trophic level have been covered up, they have all been eaten. They cannot reproduce or feed. That trophic level has been extirpated. If a trophic level cannot feed (lay down any more cards) because there are no more of its prey cards left uncovered, then that trophic level has crashed. Students will need to record the time that crashes happen and how many cards were left uncovered at the time of the crash. If other trophic levels can continue beyond the crash, let them do so until they, too, crash.

At the end of five minutes, students should record the number of cards left uncovered (still alive and feeding) at each trophic level and/or when the level crashed.

Have one student from each group write their results in a table on the board for their classmates to see. Students should record the results from each group in the table in their individual booklets. They will answer questions in their booklets using the results from all four rounds, not just the rounds they played.

CLOSING: Students can work individually or as a group to answer the questions in their booklets. Encourage students to use their new vocabulary in their answers.

ASSESSMENT QUESTIONS: What is the difference between an oligotrophic and a eutrophic lake? How does this difference affect the trophic structure of the lake? Give an example of a possible limiting factor in each type of lake.

ANSWERS: *The difference between the types of lakes is the amount of nutrients in each. Oligotrophic lakes are low in nutrients, infertile,*

and deep and clear. There are fewer primary producers in oligotrophic lakes, which limits the diversity of organisms that can survive. The limiting factors in oligotrophic lakes are soil and nutrients. Eutrophic lakes are high in nutrients, very fertile, shallow, warmer, and have an abundance of primary producers. The predominant limiting factor in eutrophic lakes is oxygen.

EXTENSIONS:

Field: Head to a local stream or lake and conduct a survey of the various trophic levels you can find. How many different species of plants can students find and what is their relative abundance compared to the number of macroinvertebrates, small fish, or large fish you discover? Macroinvertebrate identification kits can be obtained on loan from Water Education Resource Centers across Wisconsin.

Art: Weave your own aquatic food web showing the connections between different trophic levels, air, land, and water.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

Notes

2

Survivor

Yellow perch and walleye, like all organisms, are adapted to certain habitats. Before stocking fish, a biologist needs to know the food, water, shelter, and space requirements of the species. If a waterbody does not have the components of habitat a fish needs, stocking it would be a waste of time and money. What would be the right habitat for a walleye? Is it the same as for a yellow perch? In this section you will learn what fish need in order to survive. We'll review some ecological principles, look at how the nature of water affects fish, and explore the different aquatic habitat types in Wisconsin.

INSTRUCTORS:
Underlined content is not provided in student manual.

Walleye

Fish Food

What fish eat and who they are eaten by plays a major role in the functioning of an aquatic ecosystem. There are predator and prey fish, just as there are predator and prey mammals. The wolf and the coyote are land versions of the salmon and the northern pike, while darters and shiners are the rabbits and mice. Having a healthy aquatic ecosystem means having the right balance of predators and prey in a body of water.

Walleye are generally found in large rivers and lakes, although they can be found in smaller lakes as well. They are found in all types of lakes, from oligotrophic to eutrophic. The same for yellow perch? Yes, in fact the yellow perch and walleye have an intricate predator-prey relationship where walleye feed on yellow perch, which feed on walleye fry.

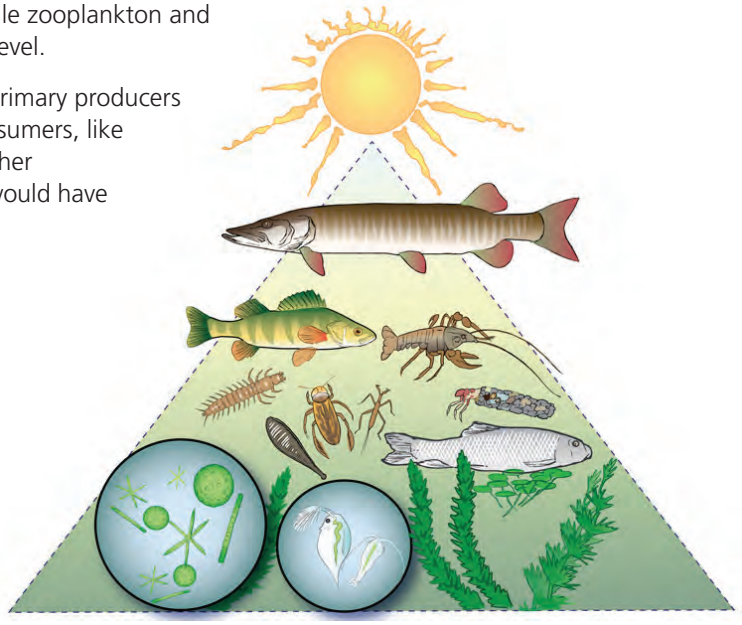
More than a Chain

If you think of the food web as a pyramid, the base of the pyramid would contain many small—even microscopic—plants and animals, while the top would include fewer, larger animals. Thousands of microscopic plants and animals are required to support a few predator fish. Musky and bass are at a high trophic level (feeding position) in the pyramid, while zooplankton and other microscopic organisms are at a low trophic level.

The lowest level on the pyramid is composed of primary producers (those who make their own food, like algae). Consumers, like the bass, feed on the primary producers and on other consumers. Can you think of any organisms that would have a higher trophic level than the musky or bass?

Losing Energy

Within any food web, there is a transfer of energy. When a trout eats a worm, some of the energy stored in that worm is transferred to the trout. Not all of the energy used at each level of the food web, however, is recoverable. As you move up the levels in the pyramid, there is less energy available at each higher level than at the level below.

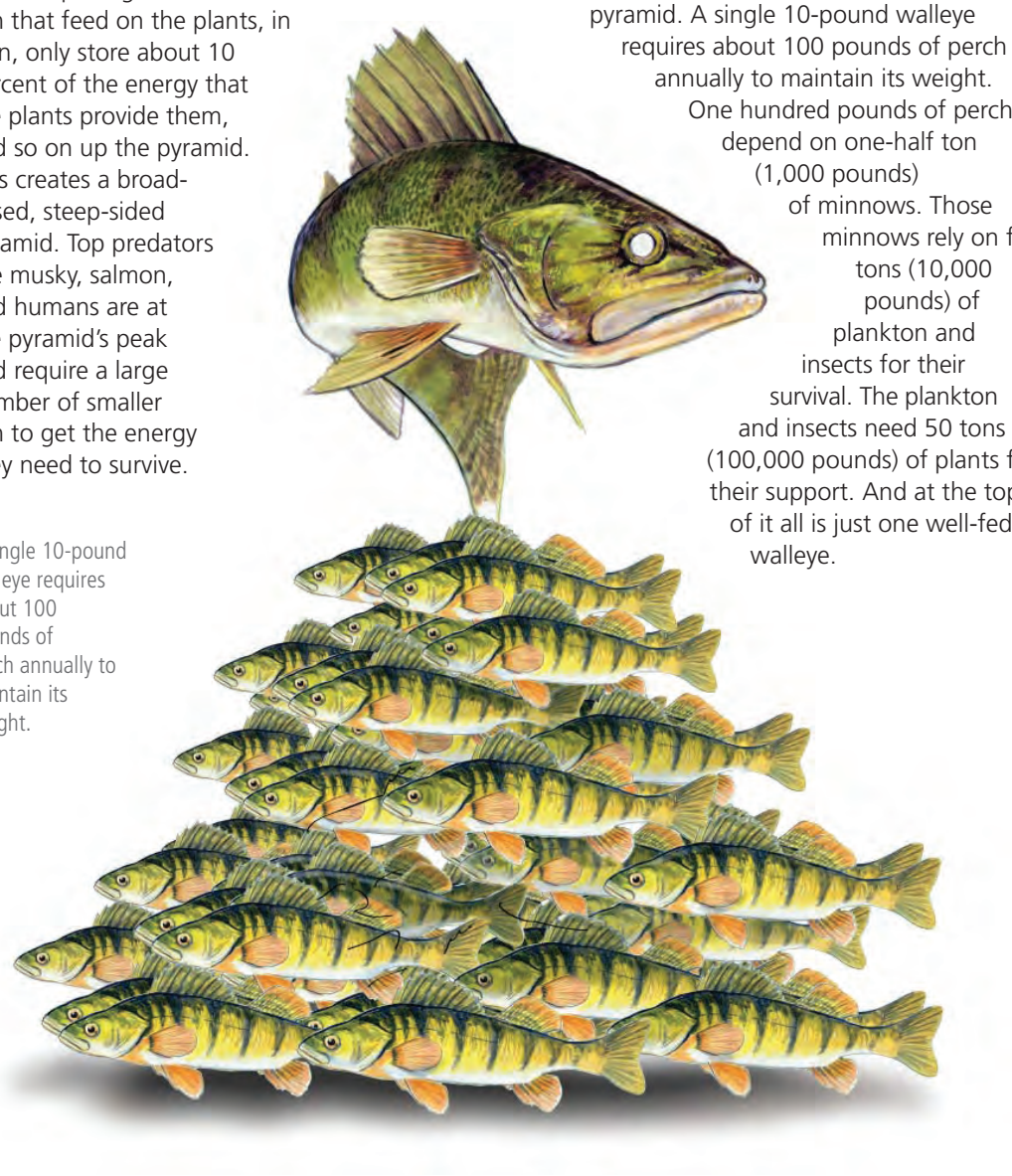


Energy Pyramid: Thousands of microscopic plants and animals are required to support a few predator fish.

Ecology

From Latin meaning "household" or Greek meaning, "house". When we study ecology, we are studying the relationships between organisms and their environments (homes).

Scientists often refer to this transfer and loss of energy as the "Rule of 10" or the "Ten Percent Law." The primary producers at the very bottom of the pyramid can only store about 10 percent of the radiant energy from the sun as sugars or carbohydrates in their tissues. The microscopic organisms and small fish that feed on the plants, in turn, only store about 10 percent of the energy that the plants provide them, and so on up the pyramid. This creates a broad-based, steep-sided pyramid. Top predators like musky, salmon, and humans are at the pyramid's peak and require a large number of smaller fish to get the energy they need to survive.



A single 10-pound walleye requires about 100 pounds of perch annually to maintain its weight.

Feed Me!

Walleye, for example, require a large amount of space in order to find enough prey to survive. There are fewer walleye in any lake or river compared to smaller fish, simply because a walleye is near the top of the trophic pyramid. A single 10-pound walleye requires about 100 pounds of perch annually to maintain its weight. One hundred pounds of perch depend on one-half ton (1,000 pounds) of minnows. Those minnows rely on five tons (10,000 pounds) of plankton and insects for their survival. The plankton and insects need 50 tons (100,000 pounds) of plants for their support. And at the top of it all is just one well-fed walleye.

You do the Math…

1. What is the total weight of biomass (living plants and animals) required to sustain that 10-pound walleye for a year? Show and label your work.

100+1000+10,000+100,000=111,100 lbs of food

2. If 7,300 solar units are equal to the amount of energy required to sustain a pound of plants, how many solar units does it take to sustain a 10-pound walleye?

100,000 lbs of plants x 7,300 solar units = 730,000,000 solar units

INSTRUCTORS: Underlined content is not provided in student manual.

3. What factors influence the amount of energy a fish requires to maintain its weight or grow? In other words, what could cause that 10-pound walleye to starve?

If any of the trophic levels below the walleye crash, the walleye will not survive. If there are not enough nutrients to support the plants, or if pollution blocks sunlight from getting to the plants, the walleye will crash. If the plankton and insects are damaged, the walleye will crash. If the perch are over-fished, the walleye will crash.

Oligotrophic lakes are usually formed by glacial scouring and have little soil on their bottoms.

Most of the lakes in the southern and central counties of Wisconsin are mesotrophic. These lakes were formed by glacial deposits and tend to be well-vegetated and fertile.

Eutrophic lakes are shallow, very fertile, and loaded with nutrients.

Illustrations by Chris Whalen, Courtesy of University of Wisconsin-Extension Lakes Program

This Lake's Got Class...

Lakes are classified into three trophic categories based on the amount of nutrients found in them and on water clarity.

Oligotrophic lakes have few nutrients and are generally found in the far north of Wisconsin. Lake Superior is a great example of an oligotrophic lake. These lakes were formed by glacial scouring which stripped away the soil. Lack of soil and other nutrients limited the growth of vegetation which allowed clear-water conditions to persist over the ages. Oligotrophic lakes tend to be deep with a high oxygen content that supports prized game fish like lake trout, perch and walleye.

Mesotrophic lakes have a medium amount of nutrients. Most of the lakes in the southern and central counties of Wisconsin are mesotrophic. These lakes were formed by glacial deposits and tend to be well-vegetated and fertile. Mesotrophic lakes are not as deep as oligotrophic lakes, but have a rich assortment of game fish like musky, northern pike, and bass.

Eutrophic lakes are low in oxygen, very fertile, and loaded with nutrients. They are typically shallow and found throughout Wisconsin where older lakes have filled in due to erosion or other factors. Eutrophic lakes will eventually become bogs or marshes. Younger eutrophic lakes host panfish and bass, but catfish, carp, and bullheads begin to dominate as the lake ages. Eutrophication is a natural aging process, but human activities can accelerate it by adding nutrients through erosion, polluted runoff, and leaky septic systems.

Steady State?

Use the worksheet below to fill in your population dynamics results as you participate in a simulated food chain with different limiting factors. Your teacher will provide you with a nutrient game board and cards representing algae, shiners, and smallmouth bass. At the end of a round, record the time that each population crashed and the number of uncovered cards of each color.

PLEASE SEE APPENDIX D
Steady State? Game Handouts

1. Each Round lasts exactly five minutes.
2. The Start Time is the time at which a trophic level begins growing (begin laying down cards).
3. The Production Rate is the time interval between laying cards down. It represents the combination of the feeding, growing, and reproducing rates for that trophic level. For example in Round 1, green algae lay down one card at the beginning (t=0) and lay down one card every 5 seconds for the entire 5 minutes. Shiners start after 10 seconds (t=10), and lay down one card every 10 seconds. Bass start after 20 seconds (t=20) and lay down one card every 30 seconds.
4. You may only place your cards on top of the species you consume. If there are no more cards for you to put yours on top of, your species dies of starvation.
5. At the end of five minutes, record the number of cards remaining uncovered (still alive and feeding) and/or when the trophic level crashed.

		ROUND 1		ROUND 2A		ROUND 2B		ROUND 2C	
TROPHIC LEVEL	CARD COLOR	START TIME	PRODUCTION RATE	START TIME	PRODUCTION RATE	START TIME	PRODUCTION RATE	START TIME	PRODUCTION RATE
Green Algae	Green	0	5	0	5	0	5	0	2
Common Shiner	Yellow	10	10	20	3	10	15	10	5
Small-mouth Bass	Purple	20	30	25	20	20	10	20	10

INSTRUCTORS: Underlined content is not provided in student manual.

		ROUND 1		ROUND 2A		ROUND 2B		ROUND 2C	
TROPHIC LEVEL	CARD COLOR	CRASH TIME	NUMBER OF CARDS	CRASH TIME	NUMBER OF CARDS	CRASH TIME	NUMBER OF CARDS	CRASH TIME	NUMBER OF CARDS
Green Algae	Green	X	31	0:44	0	X	60	2:23	45
Common Shiner	Yellow	X	20	0:45	8	0:20	0	X	30
Small-mouth Bass	Purple	X	10	3:05	9	0:30	1	X	29

The results in this table provide answers that you should expect. Students will probably get close to, but not exactly, these answers, depending on how well they followed the rules.

1. Which round of the game does each of these phrases describe?

Primary Producers are the limiting factor: Round 2A

Predators are the limiting factor: Round 2B

Nutrients are the limiting factor: Round 2C

Steady State: Round 1

INSTRUCTORS: Underlined content is not provided in student manual.

2. Which of the rounds describes what can commonly happen in an oligotrophic lake? How would you change the model to reflect a eutrophic lake?

Round 2c is limited by nutrients. Nutrients are a limiting factor in oligotrophic lakes. To make a eutrophic lake, you could copy more nutrient pages so that the algae would never run out of a nutrient supply. (other answers possible)

3. What would happen in Round 1 if the round continued for another five minutes? Why?

If this round continued, the algae would crash first because they would run out of nutrients. The production rate of each level is slower than the one below it, so the shiner and bass wouldn't crash before the algae.

4. Why did all the trophic levels crash in Round 2A?

Shiners were eating faster than algae were growing, so the shiners ran out of food. After the shiners ran out of food, they died, so the bass ran out of food. The bass survived longer, because their production rate was so much slower than the other levels.

5. Name two ways a steady state could be restored for Round 2A:

If the algae rate were increased (e.g. maybe one card every 2 or 3 seconds) or if the shiner rate were decreased (e.g. maybe one card every 6 or 7 seconds) there would be a steady state until the algae ran out of nutrients.

6. What limits the growth of algae in Round 2C? Predict what would happen to the shiners and the smallmouth bass if this game were to run another five minutes.

The growth of algae in Round 2c is limited by nutrients. If the game continued, the shiners and bass would starve to death.

7. If you were planning to stock fish in a lake, what could you learn from these rounds?

You need to have enough biomass to support the fish you want to stock. Before you can put bass in a lake, you need to make sure there is an abundance of primary producers and grazers.

8. What are some of the assumptions and limitations of this food chain model?

It is assumed that feeding rate, reproduction rate, and growth rate are all one rate. In real life all of these rates are different. An animal might eat a lot, but reproduce slowly. In real life, an organism like the shiner doesn't just depend on algae to survive, so if algae disappeared, the animal could probably find another food source in order to survive. (other answers possible)

Water of Life

OBJECTIVES: Students will be able to:

- explain the process of stratification in lakes
- describe how lake stratification affects fish
- make predictions about the effects of climate change on fish distribution

METHOD: Students will watch a demonstration of summer lake stratification, showing the epilimnion, thermocline (metalimnion), and hypolimnion. Students will discuss oxygen and temperature changes in lakes during other seasons. Students will answer questions about the demonstration and work in partners to design an experiment.

MATERIALS:

1) Distilled water
2) Salt
3) Three 400 ml glass beakers or pint-sized canning jars
4) 25 x 200 mL tube with screw cap (ideal) or a large, clear container with limited surface area for a demonstration container
5) Large syringe
6) Drinking straw
7) Blue, yellow, and red food coloring
8) Microwave, hot plate or stove
9) Ice or refrigerator

ALTERNATE DEMONSTRATION MATERIALS LIST

1) Salad or olive oil
2) Vinegar
3) Grape juice concentrate
4) Honey
5) Herbs
6) Pint-sized canning jar

PREPARATION: Make the dense "cold" hypolimnion by supersaturating 250 ml (approximately I cup) of water with salt. Add at least 50 ml (1/4 cup) of salt until the water will hold no more. Aid this process by heating the water so it will hold more salt. Pour off the saltwater into a separate container and chill. Once the salt solution is cold, make the thermocline by mixing a portion of it with distilled or tap water in a 1/3 to 2/3 proportion.

Dye it yellow and heat. Dye the remainder of the cold salt solution blue. The epilimnion consists of pure, distilled water. Dye it red and heat it up, too. Now you are ready to do the demonstration in the main activity.

An alternative preparation would involve pouring equal proportions of honey, vinegar dyed with a tablespoon of grape juice concentrate, and oil; sprinkle in herbs to represent phytoplankton. Use quality ingredients and save to enjoy on a salad with your fish fry later in the unit.

SETTING: Indoors

DURATION: One 45-minute period

VOCABULARY: Dissolved oxygen, stratified, distribution, epilimnion, hypolimnion, thermocline, winterkill

STANDARDS: Science: E 12.2. Environmental Education: A 8.4, 8.5, 12.3; B 8.1, 8.2, 8.4, 12.1, 12.2, 12.3, 12.4, 12.6.

BACKGROUND: The layers of warm and cool water in a lake change with the seasons as the water heats and cools, causing the epilimnion, thermocline, and hypolimnion to change in size and width. Stratification occurs in summer when the sun warms the top layers of water and the epilimnion grows to its maximum thickness. Under the heat of the strong summer sun, the warmer, less dense, water "floats" on the denser, cooler water below. Wind and wave action are not strong enough to overcome these different densities of water. Warm water and oxygen circulate freely in the surface layer, but the cold, denser water in the hypolimnion does not mix with the water above it. Oxygen content is slowly reduced in the hypolimnion, and fish are forced to more favorable conditions nearer the surface.

In fall, surface waters cool. The epilimnion shrinks as cooling water sinks to the bottom, carrying oxygen with it. As the different layers get close to the same temperature and density, wind and waves provide mixing action and the water temperatures become fairly uniform from the top to the bottom of the lake. The epilimnion becomes a very narrow band in fall and fish can more easily circulate between shallow and deep waters.

In winter, ice prevents wind from mixing lake water. The coldest water remains just below the ice at between 32°F (0°C) and 39°F (4°C) while the rest of the lake is 39°F (4°C) or warmer. Thick snow cover prevents sunlight from penetrating the ice and halts photosynthesis, which is necessary for the production of oxygen. Decaying plants consume oxygen and can help set the stage for anoxic (absence of oxygen) conditions. Winterkills (massive die-offs of fish) occur under anoxic conditions. Shallow, heavily-vegetated, snow-blanketed lakes are particularly susceptible to high winterkills. In Wisconsin, deeper lakes that are frozen over and snow-covered usually have enough oxygen for aquatic life to survive the winter.

As the ice melts in the spring, wind and waves mix the water. Lakes once again become uniform in temperature and the process of stratification starts over.

Increasing water temperature due to climate change concerns fish biologists. Many species of freshwater fish, like trout and salmon, require high concentrations of oxygen and cool water to survive. As the climate warms, the epilimnion increases in thickness, making it more difficult for fish to find cool water without swimming deep into lakes. In the deep water, however, fish can suffocate. Anglers, too, may have difficulty catching fish that have gone deep in search of cold waters.

OPENING: Ask students to read the **Water of Life** section. Have them answer the Prime Real Estate questions in a discussion.

MAIN ACTIVITY: Demonstrate summer lake stratification. Begin by pouring the dense blue "hypolimnion" saltwater into the demonstration container. On top of the hypolimnion, **carefully** add the yellow "thermocline" using a syringe. Finally, add the red "epilimnion." You should end up with a blue band of water on the bottom, a yellow middle band, and a red surface band. Ask students which season they think this lake represents. Explain the different seasons and how the demonstration would look different in winter (epilimnion would be thin, blue and frozen), and in spring and fall (water would be mixed, with no bands of color).

To demonstrate wind mixing, blow across the surface of the water using a straw. Mixing may occur in the epilimnion, but the layers should not mix, showing that once a lake is stratified, wind and wave action do not usually cause mixing between the epilimnion and hypolimnion. Ask students where they think fish would be in this demonstration. In early summer, the fish should be well distributed, but as oxygen is depleted from deeper waters, fish will move up to shallower, warmer waters.

A simpler project that requires no advanced preparation is to fill a mason jar with hot tap water and add a few drops of red food coloring to it. Take another mason jar with the same size mouth, fill it with cold tap water, and dye it blue. Hold a 3 x 5 index card over the warm jar and flip it upside down. Place it on top of the cold jar and slowly remove the card. Watch what happens, then repeat the experiment by putting the cold water on top. This version demonstrates water density more than lake stratification.

CLOSING: Have students work in partners to answer the final questions in Coming Up for Air. Alternatively, assign the questions as a take-home project and allow students to use the Internet to find answers.

ASSESSMENT QUESTIONS: Name three factors that affect dissolved oxygen levels in waterbodies. Do these factors increase or decrease the amount of oxygen available to fish?

ANSWERS: Increase: rain, moving water, waves, wind, photosynthesis, colder water. Decrease: warmer water, decomposition, dry weather, respiration, pollution.

EXTENSIONS:

Field: Take your students on a field trip to a local waterbody. Measure the dissolved oxygen and temperature at various depths or in different locations.

In Depth: Direct students to these Websites for more information on how climate change may affect Wisconsin fisheries: Wisconsin Initiative on Climate Change Impacts, **wicci.wisc.edu** and Paradise Lost, **cbe.wisc.edu/K12/paradiselost**.

See Appendix E for a PowerPoint Presentation: Responses of Wisconsin's Coolwater and Warmwater Fishes to Climate Change

See Appendix E for the Field Trip Record Sheet options.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

Water of Life

All organisms require water to live. Humans need it to quench thirst, carry boats, and grow food. Fish, of course, rely on clean water simply to breathe and function. Knowing what sort of water conditions a fish requires will help you find the best fishing holes for the species you seek to catch.

"Breathing" Water

Each water molecule is composed of two atoms of hydrogen and one of oxygen. As long as those molecules are bound together, the oxygen molecule is not available to the fish. Fish get the oxygen they need to "breathe" from microscopic bubbles of dissolved oxygen.

Dissolved oxygen comes primarily from air mixed into the water through wind and wave action. In a stream, moving water tumbling over rocks picks up oxygen from the air and carries it along. Plants and algae also contribute oxygen to the underwater world through photosynthesis during daylight hours.

While plants add oxygen to the water during the day, respiration by and decomposition of dead plants and animals remove it.

Polluted runoff also reduces the dissolved oxygen content of a waterbody by adding nutrients that use up oxygen.

Biological Thermostats

Dissolved oxygen content is also tied to water temperature and other factors. Cold water can hold more oxygen than warm water. As weather or thermal pollution warm the water, dissolved oxygen levels drop and fish must work harder to breathe. Thick snow cover on frozen lakes blocks photosynthesis, necessary for the production of oxygen and can lead to "winterkill" conditions. Dissolved oxygen concentrations in a certain stream may be higher in early morning or in mid-winter than they are in the mid-afternoon or summer.

Dry weather can decrease the amount of water in a stream, causing it to move slower and, therefore, pick up less oxygen. Rain, on the other hand, can mix with oxygen on its way down to earth, bringing the oxygen with it when it lands in a body of water.

Most fish require a dissolved oxygen concentration of seven to nine milligrams per liter (mg/l) . Cold-loving trout prefer higher levels of seven mg/l, while bass are adapted to five mg/l. The majority of fish cannot survive at levels below three mg/l. Can you think of some fish that, based on their habitat, might be tolerant of lower levels of oxygen?

Catfish, bullhead, and carp all inhabit low oxygen lake bottoms.

PLEASE SEE APPENDIX E
Water of Life: Lake Monitoring Field Record Sheet

INSTRUCTORS: Underlined content is not provided in student manual.

Prime Real Estate

Which of the following environments would most likely have good trout habitat based on dissolved oxygen? Which of these could host a catfish?

1. A fast-moving, unpolluted stream — trout
2. A small pond with lots of vegetation — catfish
3. A large slow-moving, muddy river — catfish
4. Lake Michigan — both! but in different areas
5. Lake Superior — trout

Temperature Tolerances of Common Fish

FISH SPECIES	PREFERRED TEMPERATURE °F										
	40	45	50	55	60	65	70	75	80	85	90
Catfish										XX	??
Bullhead								XX	XX	XX	
Sunfish							XX	XX	XX		
Largemouth Bass						XX	XX	XX			
Muskellunge					XX	XX	XX	XX			
Chinook Salmon		XX	XX	XX							
Lake Trout	XX	XX	XX								

Comfort Zones

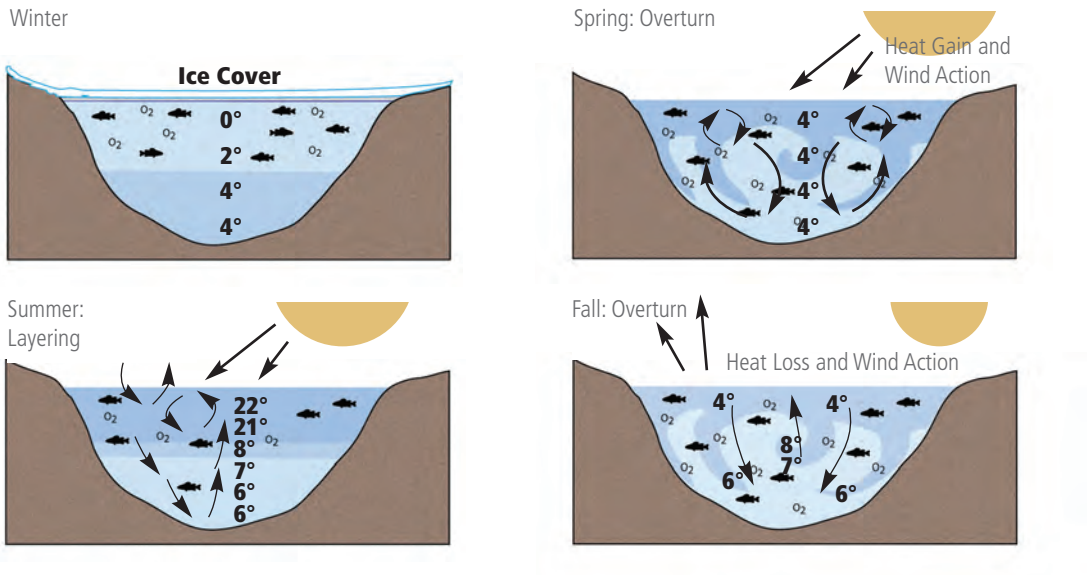
Water temperature is perhaps the single most important factor in determining where fish will be and how they will behave. Each species has its own comfort and tolerance level. Fish tend to seek the most comfortable environment, assuming that there is sufficient oxygen, and will migrate from shallow to deep water to find their optimal temperatures.

Like Oil and Vinegar

What sensations do you feel when you dive into a lake during summer? The cool, deep water is often a shock compared to the warmer surface water. Warm and cool water becomes **stratified** (layered) just like the layers of vinegar and oil in a bottle of salad dressing. This is because different temperatures of water have different densities. Warm water is less dense than cold water. The heat of the summer sun warms the **epilimnion** (surface water) until it becomes so warm and light that it cannot mix with the heavier, colder **thermocline** and **hypolimnion** below. The thermocline (also called the **metalimnion** for "middle layer") marks a rapid change in temperature with a small change in depth.

When surface water cools in fall, it sinks until it reaches its maximum density at 4°C (39°F), just above the freezing point. As it continues to cool, it gets lighter and freezes on the surface, indicating that the ice fishing season is just around the corner. If water did not behave this way, lakes would freeze from the bottom up, killing everything in them. Anglers know that as water temperatures shift throughout the seasons, dissolved oxygen, nutrients, and fish distribution shift as well.

INSTRUCTORS: Underlined content is not provided in student manual.



By late fall, overturn is complete and temperature is a uniform 4°C* throughout.

*C=Celsius

Coming Up for Air

Watch the demonstration of the layers in a summer lake and then answer the following questions:

1) Where does most of the heating occur in a lake? At the surface (epilimnion)

2) What is the effect of wind on a summer lake? Water in the epilimnion is mixed and oxygenated, but the layers stay intact until seasonal temperature changes aid mixing.

3) How does layering affect fish living in the lake? Fish distribution is dependent on temperature and dissolved oxygen content which changes with the weather, from day to day and season to season. In late summer, the epilimnion may hold more oxygen, but be too warm for some species seeking the proper balance.

4) Given all that you have learned about temperature and oxygen, what could climate change mean for aquatic species? For anglers? Climate change may increase stream temperatures and make it difficult for coldwater species, like trout, to get the oxygen they need. Coolwater species, like bass, may expand their ranges to the north. Climate change could lead to a disruption of aquatic food chains.

5) Design a 10-year experiment that would allow you to determine the layering in your own local lake and whether or not it is changing as a result of climate change. What type of equipment would you need? Where would you take measurements and when? How would you know if you were getting a good sample of the lake? Dissolved oxygen (DO) meter and thermometer. Boat. Where would you take measurements and when? At least once a month, sampling every 10 feet or less, from several different locations on the lake. How would you know if you were getting a good sample of the lake? Check many locations on a lake and take an average. Test your temperatures against fish you catch in that depth.

INSTRUCTORS: Underlined content is not provided in student manual.

Home Sweet Home

OBJECTIVES: Students will be able to:

- describe at least three different aquatic habitat types (lake, wetland, river) found in Wisconsin and four different habitat zones in a lake (littoral, limnetic, benthic, wetland)
- detail the different phases in a fish's life cycle
- explain one species' spawning habitat in detail
- present their independent research

METHOD: Students will create a "travel brochure" for a particular species' spawning habitat. The travel brochure will include a detailed description of the environment, a description of the amenities that the fish species requires for spawning, and graphics from the Internet or another source. The students will present their brochures to the class.

MATERIALS:

1) A variety of travel brochures

2) Research materials (books and/or Internet access)

3) Computers

SETTING: Indoors

DURATION: Three to four 45-minute periods

VOCABULARY: Spawn, littoral, limnetic, benthic, terrestrial, tributary, dynamic, headwaters, mouth, wetlands, marsh, substrate, redd, fry, fingerling, profundal

STANDARDS:
Science: F 8.7, 8.8, 12.7, 12.11.
Environmental Education: B 8.6, 8.8, 12.2, 12.4.

BACKGROUND: Each species of fish is adapted to the environment in which it lives. As a result, fish life cycles and habitat requirements are highly variable between species. However, most fish progress through the following generalized life cycle: egg, sac fry (larval fish), fry, fingerling (juvenile), adult, and spawning.

Fish eggs are easily destroyed by sedimentation or flooding, predators, or changes in water temperature or dissolved oxygen content. Spawning fish have developed a variety of strategies to protect their eggs from the most predictable harm: predators. To fool predators, fish may disguise eggs as substrate or attach them under the leaves of submerged plants. Some fish, like male largemouth bass, actively guard eggs.

Once they hatch, sac fry live off of their yolk sacs for the first stage of their lives. These yolk sacs are eventually absorbed by the fish, at which point the fish become fry. Fry develop through several more stages over the first few months of their lives. During the fry stages, young fish are tempting food items for many adult fish. Some adult fish, like the male smallmouth bass, remain near larval fish to protect them from hungry predators. Young fish use vegetation, submerged structures, and undercut banks as protection from underwater and surface predators. As fish mature into fingerlings (juvenile stage), they are still challenged by predators, but also face competition for habitat. Shelter is critically important to fish at this stage in their lives. Most fish do not survive their youth.

Fish are considered adults once they are able to reproduce. In some species, this happens within a year (goby); for others it can take decades (lake sturgeon). Fish often select different habitats in their adulthood than they had as youth. As adults, fish are less susceptible to predators and can move more freely through various habitats. They are still, however, constrained by food, temperature, shelter, and dissolved oxygen parameters.

When it is time for fish to spawn, they often relocate to the appropriate spawning environment. Some fish spawn every year, others every few years, and still others only once in a lifetime. To spawn, females release their eggs into the water and males release milt (sperm). After spawning, some fish, like salmon, die. Others return to their adult habitats, or stay near the eggs to protect them from predators.

OPENING: Have students read **Home Sweet Home**. When they are finished, open a discussion about the life cycle of a fish. Have students make some predictions: Where are fish likely to lay their eggs? What challenges might a young fish face? How might the fish overcome those challenges? What sort of differences might exist between a young fish's habitat and an adult fish of that same species?

Tell students that the rest of the activity will be focused on only one habitat selection for fish: the spawning habitat.

MAIN ACTIVITY: Have students look over the travel brochures and make points about how the brochure is organized. What sorts of information are on a brochure? How does the company or location market itself? Have the students notice features of the brochure that are appealing to them or parts that do not make them want to travel to the advertised destination. Tell students that they will be making travel brochures to entice the species of fish they are profiling to a Spa(wning) Resort. The travel brochure will have all the components that fish need for spawning, presented in an attractive manner.

Students will conduct research on their species' needs using books, the Internet, fish *Wildcards*, or other sources, and then will create the brochures on computers using graphics or drawing their own by hand. Allow at least one full class period for creating the travel brochures.

CLOSING: Once students have completed their brochures, have them take turns presenting their Spa(wning) Resort to the rest of the class. Encourage students to ask each other questions. When all students have presented, discuss similarities and differences in habitat choices between species. Encourage students to think about how adaptation and natural selection have figured into spawning habitat choices.

ASSESSMENT QUESTION: Name the five zones of a lake, one characteristic of each, and a species of fish that resides in each.

ANSWERS:
Littoral: shallow, warmer, spawning area, light; northern pike, young fish, sunfish

Limnetic: darker, colder, deeper; coldwater fish (salmon, trout, whitefish)

Profundal: deep, dark lake zone below the limnetic zone

Benthic: low oxygen, murky; scavengers (catfish, bullhead)

Wetland: dynamic, shallow, fertile, spawning area, weedy protection, acts as a filter and a sponge; northern pike, young fish

EXTENSIONS:

Art: Have students work in groups to construct a spawning habitat for a species of fish using natural materials collected near the classroom.

Field: Investigate a local waterbody for spawning habitat. Record the substrate, types of vegetation, and water temperature. What species could spawn in this waterbody? ⊙ **See Appendix F** for the Field Trip Record Sheet options.

Service Learning: Team up with a local fishing or conservation club to help with spawning habitat restoration projects.

⊙ *If you have downloaded this booklet, please see the appendix that follows for additional materials.*

Home Sweet Home

Why do certain fish live deep in lakes, while others can be found in shallow streams, and still others dart in and out of a reedy marsh? Think back to the past two lessons in this section. Fish need to live in waterbodies that can supply enough energy (a small pond cannot support 10-pound walleye) and that will meet their temperature and dissolved oxygen requirements. But fish have more needs than just food and water; they also need places to hide—either to surprise prey or take cover from predators—and places to **spawn** (lay their eggs). A great diversity of aquatic habitats makes for a great diversity of fish species. Woody cover (like fallen logs), aquatic vegetation, rock piles, and overhanging riverbanks are all components of different ideal fish habitats.

Spawn
Lay eggs

Go with the Flow: Rivers and Streams

Rivers and streams provide fish with **dynamic** habitat. Streams dramatically change in depth and flow with the weather, the seasons, and the climate. A flood, for example, can quickly destroy spawning habitat by washing out bottom material. Floods can also make new spawning habitat instantly by felling a log, creating a shady deep pool. Streams are also different from one section to the next—the temperature and current that you find at the **headwaters** of a stream will be different from the temperature and current at the **mouth** of that same stream, and will vary considerably along the stream's entire length from rapids to riffles to pools. Fish travel into, out of, and within stream systems to find the conditions perfect for their food, protection, or spawning needs. As with other habitat types, rivers and streams will warm as our climate changes, which may make them uninhabitable to temperature-sensitive species like trout.

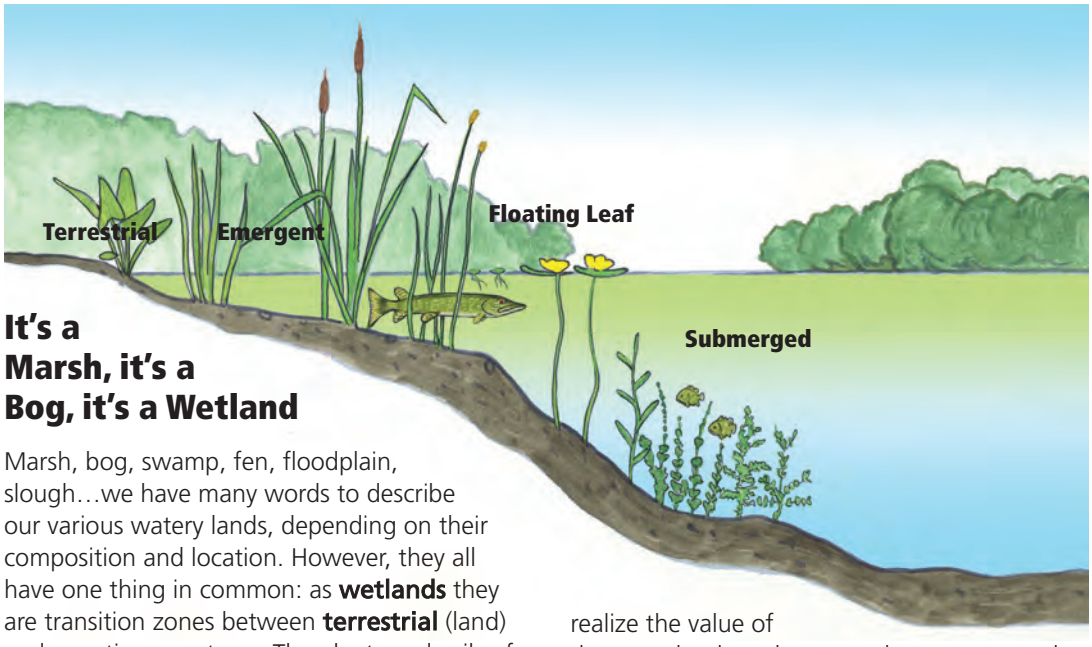
Fish travel into, out of, and within stream systems to find the perfect conditions for their food, protection, or spawning needs.

Wanted

> Large, oligotrophic lake with plenty of minnows and other small fish. Cold depths required. Silty bottom preferred. Access to littoral zone a must. Call or email. - A. Sauger

Math Quiz

Wisconsin once had 10 million acres of wetlands and now has only 5.3 million acres. What percent of Wisconsin's wetlands have been lost? Wisconsin was once 28% wetland. What is it today?



A diversity of native aquatic plants are vital to fish habitat and are rooted in the littoral zone of a lake.

It's a Marsh, it's a Bog, it's a Wetland

Marsh, bog, swamp, fen, floodplain, slough…we have many words to describe our various watery lands, depending on their composition and location. However, they all have one thing in common: as **wetlands** they are transition zones between **terrestrial** (land) and aquatic ecosystems. The plants and soils of a wetland are generally saturated with water for at least one season during the year. Like streams, wetlands are very dynamic and change with the weather. During dry spells water might not even soak a wetland's soil. However, during rainy periods wetlands are quick to fill and the water may be over your head. Some fish spend their entire lives in wetlands, while others come only to feed or spawn. Marshes, which are usually wet year-round and filled with shelter-providing grasses, tend to be the most hospitable wetlands for fish. Bogs are typically too acidic for fish.

Wetlands provide important functions available nowhere else on earth. Beyond providing habitat for fish, they are also wildlife nurseries for birds, amphibians, reptiles, and insects. Wetlands also act as great sponges, sopping up floodwaters and filtering out contaminants before they reach groundwater and surface waters. Wetlands keep the effects of erosion in check by holding back silt and preventing it from clogging spawning beds in rivers and streams. Wetlands used to cover 10 million acres or 28% of Wisconsin. Today roughly 5.3 million acres remain. Long after the damage was done, many people came to realize the value of these wetlands and now work to protect and restore them.

In the Zone: Inland Lakes

Lakes have distinct habitat zones that vary in nutrients, oxygen content, temperature and cover. Fish inhabit lake zones when and where the conditions match their needs. The most commonly recognized habitat zones in a lake are the **littoral** (shallow), **limnetic** (open water), **profundal** (deep water), **benthic** (bottom), and **wetland**. The littoral zone extends from the shoreline out as far as emergent, floating, and submerged rooted plants can grow, which is generally about 15 feet, depending on water clarity and lake depth. It is an important zone for females to spawn and for young fish to hide because of the protection underwater plants and fallen trees offer. The limnetic zone (sometimes called the pelagic zone, particularly in ocean environments) begins where water is too deep for rooted plants to get established, but an abundance of sunshine photosynthesizes phytoplankton (microscopic floating plants).

Large, cold-loving fish can be found in the limnetic zone, feeding on free-swimming

Littoral
shallow

Limnetic
open water

Profundal
deep water

Benthic
bottom

Wetland
land-water transition area

Watery Wisconsin

Trace the history of our abundant aquatic resources and you'll be led back about 15,000 years to the ice age. Mountains of glacial ice channeled out many of Wisconsin's 44,000 miles of rivers and streams. Footprints of the glaciers became the Great Lakes as well as most of the 15,081 inland lakes that are splashed across the state.

Many of Wisconsin's wetlands were created where chunks of ice left depressions. The southwest part of Wisconsin, known as the "driftless area," was not glaciated during the last glacial period. Streams in this region have been at work for thousands of years, cutting deep valleys into the soft layers of limestone and sandstone deposited by ancient inland seas. There are few natural lakes and wetlands in this area.

zooplankton like crustaceans and rotifers. The deep, dark profundal zone lies below the limnetic zone and oxygen levels start to drop. The benthic zone is a very low-oxygen environment where decomposers and scavengers roam.

Wetland habitats associated with lakes are marshy transition areas from the water to upland areas. It is common for the littoral zone to also be called a "wetland" in lakes.

Fingerlings
Young fish

Substrate
Bottom material

Superior Habitat: Great Lakes

Wisconsin's eastern and northern borders are nestled against two of the largest freshwater lakes in the world, Lake Michigan and Lake Superior. The extreme depths and cold temperatures of the Great Lakes provide habitat for many of Wisconsin's big game fish. Near-shore rocky reefs attract chinook salmon, coho salmon, and brown trout, while rainbow trout (or "steelhead") live near the surface in open water, often many miles from shore. Lake trout require the coldest waters and generally live in 50 to 200 feet of water, depending on the season. Extensive wetlands and **tributaries** along Lake Superior provide spawning habitat for brown trout, steelhead, chinook and coho, while northern pike head to Chequamegon Bay at spawning time.

Nursery Needs

Wetlands and littoral zones are host to many aquatic plants that serve as protection for fish eggs, **fry** (newly hatched fish), and **fingerlings** (young fish). This makes them a popular site for spawning—but plenty of fish go elsewhere to raise their young. Protection is one consideration for parent fish, but **substrate** (bottom material) is another. Many fish create **redds** (nests) out of a certain bottom material. If that material is not available, the fish will go elsewhere. Other fish deposit their eggs directly on the bottom of a lake or river, while still other fish have eggs that float or that attach to vegetation. Some fish, like salmon, return to the site where they were spawned when it is time to lay their own eggs. Temperature, dissolved oxygen, and food availability are also important indicators of where a fish will spawn.

Follow Your Nose

When salmon are very young, they "imprint" on the stream in which they are stocked or hatched. In spring, the young salmon migrate to the Great Lakes. At spawning time, the salmon are drawn by their strong sense of smell back to their "home" stream.

Spa(wning) Resort

Research the spawning habitat requirements for a fish in order to determine the ideal habitat for the fish's needs. Then design a travel brochure using images and text to lure the fish to your Spa (wning) Resort. As you develop your travel brochure, keep the following questions in mind:

1) What temperature and dissolved oxygen content do the eggs and fingerlings of the species require?

2) What types of protection do the eggs need? Do they need to be camouflaged or placed under a structure? Do the parent fish create a redd?

3) Who will prey on the eggs or fry? What can the fish parent do to prevent this? What other threats might the eggs and fry encounter?

4) What will the fingerlings eat when they hatch? Is it available nearby?

5) How far will the fingerlings have to travel to reach the area where they live in maturity?

NAME

FISH KNOWLEDGE

Section A
Vocabulary Review

Fill in the blank using the words below.

This review is not found in the student guidebook and may be used as a test. Copies may be made for students.

1. Because a fish's body temperature nearly matches that of its environment, it is called a _____.
2. The lowest level on a _____ pyramid is composed of those who make their own food, or the _____.
3. Layers of warm and cool water are _____ in water-bodies just like the layers of vinegar and olive oil in salad dressing.
4. The weight of all living plants and animals in an ecosystem is its _____.
5. The _____ marks an area of rapid temperature change in a lake.
6. A fish nest is called a _____.
7. The _____ layer of a lake is where most of the heating occurs.
8. Each fish's adaptations help suit the fish to its particular _____ in an ecosystem.
9. Scientists use morphology to classify organisms into _____ groups to build family trees and trace evolutionary history.
10. _____ are wetlands that are usually wet year-round and are hospitable to fish.

Word Choices

stratified	taxonomic	marshes	biomass	redd
consumers	dorsal	niche	bayous	primary producers
ventral	poikilotherm	trophic	epilimnion	thermocline

FISH KNOWLEDGE

Section A Assessment

Return to the scenario given at the beginning of **FISH KNOWLEDGE** to apply the concepts covered in this section in a discussion: "A local fishing group wants the Wisconsin Department of Natural Resources to put walleye and yellow perch in Linnie Lake, near Muskego. As a fish biologist, you are responsible for deciding whether or not to stock walleye and/or yellow perch in the lake. What sort of data do you need to collect in order to determine whether or not to **stock** the fish?"

Students should realize that a fish biologist would need to know the following:

- what the trophic structure of the lake is
- whether there would be enough biomass to support the introduced fish at all stages of its life cycle
- what the average temperatures and dissolved oxygen content of the lake are
- whether the dissolved oxygen and temperatures match the needs of the fish at all stages of its life cycle
- whether the substrate, plants, and shelter found in the lake would be adequate to provide the protection the fish needs both to hide from predators or prey and to camouflage eggs.

Beyond this there would be economic considerations that are discussed briefly in the next section under **Taking Stock**.

Section Assessment Activity

Divide students into groups of two and have each pair design an aquarium or display for a selected species of fish. Please note that a permit from the local DNR fisheries biologist is required to keep game fish in the classroom.

Having a classroom aquarium requires careful consideration because most likely, you will not be permitted to return the fish to the water due to disease concerns, and you will have to euthanize them. This holds true for all organisms you study in your classroom, including those you may have purchased from a biological supply house. You may want to opt for a "virtual" aquarium if you are not prepared for long-term maintenance. Also, sending organisms home with students is a gamble as to where they will end up.

Instruct students to consider all of the factors the fish will need to survive and what types of information aquarium visitors should learn about the fish. Displays should include:

- images and descriptions of the fish's native habitat
- how to identify the fish and any unique adaptations the fish has to its environment
- the trophic level, sources, and biomass of food the fish will need
- the appropriate temperature and dissolved oxygen levels for the fish
- the shelter and substrate this species of fish prefers.

Students should note whether they are including spawning habitat in the design or not.

FISH KNOWLEDGE

Vocabulary Review

Answer Key

1. poikilotherm
2. trophic/primary producers
3. stratified
4. biomass
5. thermocline
6. redd
7. epilimnion
8. niche
9. taxonomic
10. marshes

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?

INSTRUCTORS: Answers found in Section Assessment on page 81.

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.

Head To Head

In this chapter, three lesson plans outline some common threats that compromise the health of a fishery.

To The Point

OBJECTIVES: Students will be able to:

- describe at least five sources of contaminated runoff
- detail at least five impacts that contaminated runoff has on aquatic ecosystems
- discuss at least five actions that can be taken to reduce or eliminate contaminated runoff

METHOD: Students will plan an information program to alert the public to specific nonpoint source pollution problems and solutions for their watershed.

MATERIALS:

1) Overheads or PowerPoint slides made from a topographic map and/or watershed map of your area
2) Information about your local watershed
3) Internet and computer access or copies of Main Activity handouts listed below

You can find topographic maps through the Wisconsin Geological and Natural History Survey: **uwex.edu/wgnhs.htm**
Find your watershed through the Environmental Protection Agency's watershed Website: **cfpub.epa.gov/surf/locate/index.cfm**
Locate information on Wisconsin watersheds and river basins through the DNR's Website at: **dnr.wi.gov/org/gmu**

SETTING: Indoors or outdoors

DURATION: Three to four 45-minute sessions, plus time for research

VOCABULARY: Stressors, watershed, point source pollution, nonpoint source pollution, effluent, runoff, atmospheric deposition, neurotoxin, persistent organic pollutants, bioaccumulation.

STANDARDS:
Science: A 8.8, 12.1, 12.5; F 8.9, 8.10, 12.8.
Environmental Education: A 8.3, 8.4, 8.5, 8.6, 12.5; B 8.5, 8.8, 8.10, 8.15, 8.17, 8.18, 8.19, 8.21, 12.5, 12.17, 12.18; D 8.1, 8.5, 8.6, 12.1, 12.5.
Language Arts: C 8.1, 12.1; F 8.1, 12.1.
Social Studies: A 8.1, 8.11, 12.4, 12.11, 12.12.

BACKGROUND: In 1972, Congress passed the Clean Water Act to help protect and restore U.S. lakes, streams, and rivers so they would be clean enough for fishing, swimming, and other recreational uses. Point sources (factories and wastewater treatment plants) were required to obtain permits limiting the amount of pollution they could release, track their waste discharges, and report on their efforts to reduce pollution.

The Act had widesweeping results. For example, fish began to live in parts of the Wisconsin River again, and citizens began to notice improved water quality in other rivers flowing through their communities. But the law did not address nonpoint source pollution, which occurs when rain and melting snow wash contaminants off urban and rural land. Nonpoint source pollutants include fertilizers and pest control chemicals; oil, grease, and toxic fluids from roads, driveways, and parking lots; sediments from poorly-managed construction sites; and bacteria and nutrients from livestock, pet wastes, and faulty septic tanks, to name a few.

This type of water pollution continues to pose a major threat to aquatic ecosystems around the world, including Wisconsin. Cleaning it up requires a high degree of cooperation among federal, state, and local governments and citizens. Fortunately, many effective projects are under way —look for some in your community!

OPENING: Have students read **To the Point** in their booklets. Ask if anyone knows the name of your local watershed. Show a map of your local watershed, perhaps combined with a topographic map, to show the boundaries of the watershed and the path that water follows from students' lawns to the nearest waterbody and where it travels from that point on. Emphasize that any substance that falls on the ground in the watershed will enter local waterbodies. Many seemingly small things, like pet waste, combine to create large pollution problems, like eutrophication. Anything that is "in the wrong place at the wrong time in the wrong quantity" becomes a pollutant. Ask students to think about pollutants that might come from their own daily activities or pollution-creating activities that they see happening in their watershed.

MAIN ACTIVITY: Tell students that their assignment is to develop a plan to provide information about the causes, results, and prevention of nonpoint source pollution for various public audiences. Discuss the idea of

"target audiences" and who they might be in your local area. Students should realize that because there are so many potential sources of contaminated runoff, there are also many different groups of people who could use specific information about their contributions to nonpoint source pollution. Brainstorm different groups of people that might benefit from nonpoint source pollution education and where students might access these groups. Possibilities include local crop farmers, dairy farmers, homeowners, urban residents, or construction workers.

Assign one target audience to each group of three to four students. Students will research nonpoint source pollutants that could originate with their audience, how those pollutants affect aquatic ecosystems, and potential ways to reduce these pollutants. Students will develop a plan to communicate this information. The plan will include a poster or brochure and an event where this information could be presented. Students should also consider props or tools that could help them present the information to their audiences, like watershed models or maps.

The following Websites have helpful information for understanding nonpoint source pollution problems and solutions. If students have access to the Internet, you can point them in the direction of these Websites. If students do not have access to the Internet, you may want to make copies from these Websites to help students conduct research.

Planning With Power: A land use planning Website with many informational handouts about the sources and effects of nonpoint source pollution (managed by Purdue University). **planningwithpower.org/pubs.htm**

Environmental Protection Agency: Information about sources of contaminated runoff can be found at **epa.gov/owow/nps/categories.html** and Success Stories about nonpoint source pollution restoration projects can be found at **epa.gov/owow/nps/Success319/**

National Oceanic and Atmospheric Administration: NOAA's Ocean Science Education pages have a helpful kit of educational materials about nonpoint source pollution: **oceanservice.noaa.gov/education/kits/pollution/welcome.html**

CLOSING: Have students present their planned information program to the class. Allow each group to add to a list of problems various contaminants cause in aquatic environments. Have a parallel list with suggestions for preventing contaminated runoff.

ASSESSMENT QUESTION: What is the difference between point and nonpoint source pollution? Name five nonpoint source pollutants and five ways of addressing these sources.

ANSWERS: *Point source pollution: an identifiable source that dumps directly into a waterbody. Nonpoint source pollution: pollution that comes from many places across a landscape.*

Possible pollutants: soil, oil, fertilizer, manure, dog waste. Possible ways to address them: control erosion with native plants, keep your car in good condition and dispose of used oil properly, apply fertilizer only in the places and amounts needed, capture manure, collect dog waste and throw it in the trash.

EXTENSIONS:

Service Learning: Have students present their posters at an actual public meeting or to another classroom.

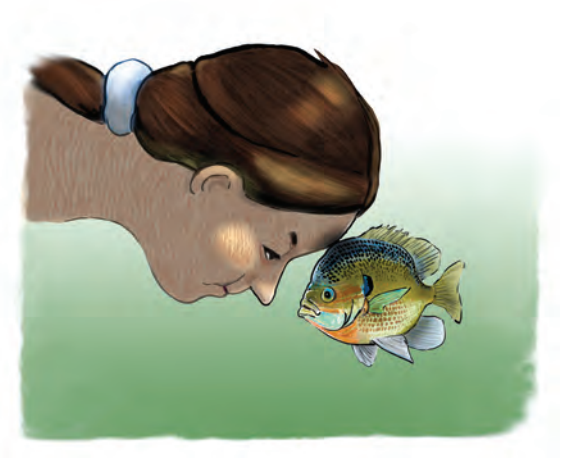
In Depth: Invite guest speakers to describe local environmental issues and encourage students to attend public hearings

If you have downloaded this booklet, please see the appendix that follows for additional materials.

3

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.



In this section, we'll discuss some environmental stressors that affect fish.

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.

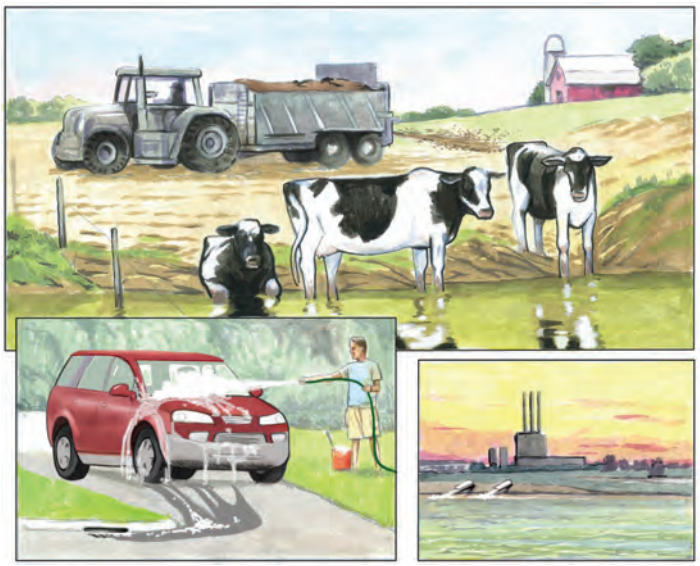
Point source
a particular, identifiable source of pollution that dumps pollutants directly into a water source

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 depostition 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?

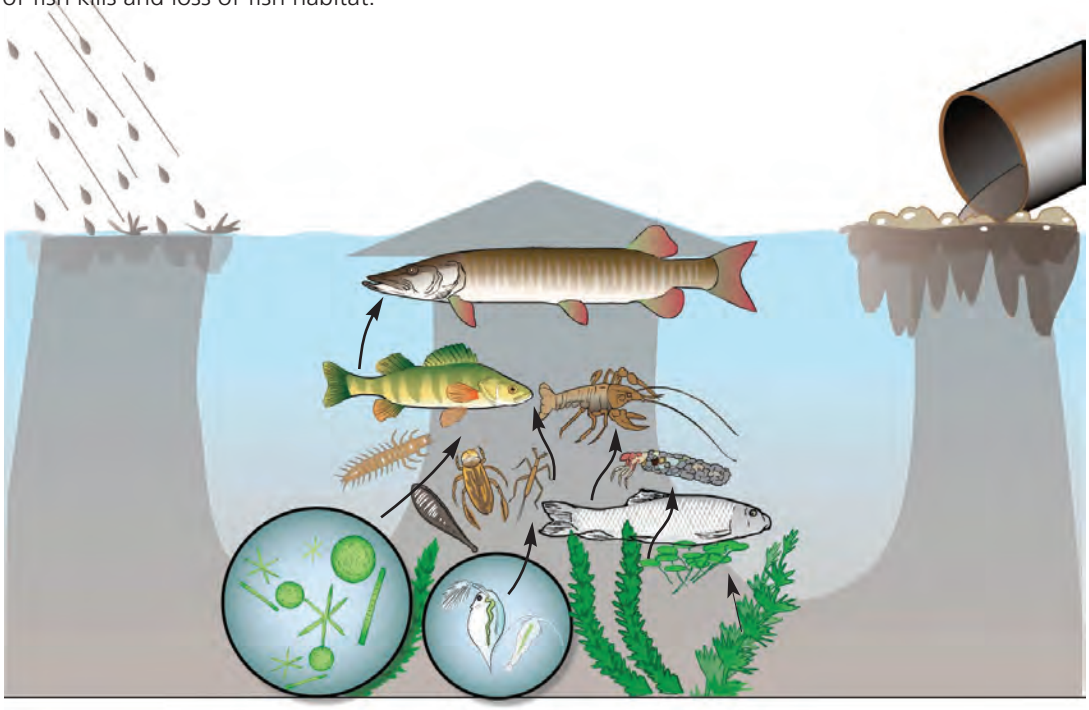
Erosion

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.



Contaminants move up the food chain.

Neurotoxin
A poison that affects the brain and nervous system

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** 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

OBJECTIVES: Students will be able to:

- describe at least three human actions that occur on waterfront property and how those actions may protect, enhance, or degrade aquatic environments
- deduce that compromise between different user groups is challenging
- describe how the Public Trust Doctrine protects their interests as anglers.

METHOD: Students will read a scenario and take on the roles of characters in the story. Students will develop a land use proposal, using material from previous lessons, and argue the merits of their proposal. Students will attempt to compromise on a decision.

MATERIALS:

1) Butcher paper, poster board, or a flip chart for students to display the details of their proposal
2) Markers
3) Optional: a zoning map of your community

SETTING: Indoors or outdoors

DURATION: Two 45-minute sessions

VOCABULARY: Ecotone, land use, land cover, zoning, sustainability

STANDARDS:
Science: F 8.8, 8.9, 8.10, 12.8; H 8.2, 12.1, 12.2.
Environmental Education: B 8.5, 8.10, 8.15, 8.17, 8.18, 12.5, 12.9, 12.12, 12.16,12.19; D 8.1, 8.8, 12.1, 12.4.
Social Studies: A 12.11, 12.12.

BACKGROUND: Zoning decisions are often controversial matters, particularly in desirable locations. One way of compromising between residential or business needs and aquatic wildlife is to create a buffer. Many cities, counties, and villages in Wisconsin are adopting shoreland-wetland zoning ordinances that require new shoreline development proposals to include a vegetated buffer between homes and the water. By leaving trees, shrubs, and woody debris in place, waterfront property owners protect their shoreline from erosion, help support clean water and a healthy fishery, and sustain the natural beauty of the landscape. But this is not a perfect solution. Most people don't want to swim around a mess of fallen logs and weedy plants. Motorboats often have difficulty propelling through submerged plants and can become tangled. Even a buffer can't completely prevent erosion and runoff from groomed lawns and construction projects in progress. The best solution, from an aquatic organism's perspective, would be to have no shoreline development at all. This conflicts with the common human desire for a waterfront home. Humans have yet to come up with a perfect solution or compromise but the Public Trust Doctrine is often called upon to settle disputes.

OPENING: Have students read **Shared Interests** and Water—Good for the Constitution in their booklets up to the Salmo Scenario. Ask: What is meant by the title **Shared Interests**? *Both fish and humans share an interest in the littoral zone.* Have students consider how waterfront property is used in your community. Can they describe any relationships between what they know about fish habitat and the ways that humans are using waterfront property in your community? If you have a zoning map of your town, display it for students to consider.

MAIN ACTIVITY: Have students read through the Salmo Scenario, then divide them into the following groups: sustainable growth organization, angler club, vacation home realtors, logging company, and Icthy, Inc. Give the students the rest of the class period to come up with their group's position on Icthy and their proposal for how the land should be used. You may choose to have the students consider ways in which their proposal may protect, enhance, or impair aquatic habitat. Have students use the drawing of Salmo as a way of presenting their ideas. Outside research is possible, but not necessary.

In the following class period, give students five minutes to present their proposal to the other groups. Have the other stakeholders in the room hold their questions until all groups have presented. Once the presentations are over, allow students to question each other, in character, about the different plans. Allow them to offer each other compromises and encourage them to come up with a plan that all

can agree on. If a compromise can't be reached by the end of class, have the students vote on a plan. Remind them that democracy is challenging!

CLOSING: Ask students if they know of any similar real-life land use scenarios. Who were the stakeholders in the decisions surrounding that conflict? How do those situations affect water quality and fisheries? How were they resolved? Who speaks for the environment when decisions are being made? If students cannot come up with any real-life scenarios, have them consider what effects their Salmo decision would have had on the environment.

ASSESSMENT QUESTION: Describe the difference between land use and land cover using examples. What is the relationship between the two concepts?

ANSWERS: *Land cover includes the forests, asphalt, water, or other visible features found on a landscape. Land use encompasses the cultural and economic activities that take place on a landscape, such as agriculture or a subdivision. There is a strong relationship between the two terms. When land use changes, land cover often does as well, and vice versa.*

EXTENSION:

Field: Have the students conduct a survey of the development along a local waterway.

Photos could be used in lieu of the field component if field trips are limited. ⊙ See Appendix G for Shoreline Development Field Record Sheet.

Post-field activities: Simulate the function of shoreland buffers with a paint tray watershed model, adapted from *Water Action Volunteer materials* available on-line at watermonitoring.uwex.edu/pdf/level1/Pubsurbanrunoffmodel.pdf.

⊙ *If you have downloaded this booklet, please see the appendix that follows for additional materials.*

Shared Interests

On the ground, shoreline development survey. See Field Trip Data sheet in Appendix G for what a scientist might look for on the shoreline.

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.

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.

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

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/PublicPrivateII_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**.

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:

- **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.

A Salmo Scenario...Imagine If

Each group has a reason for not wanting Icthy to gain control of the entire lakefront property. Each also has reason to believe that their own proposed uses of the land would serve the community better, while still protecting the landscape and enticing Icthy.

Think back to what you have learned about fish habitat, water pollution, and the aquatic-forest ecotone, as well as your organization's goals, to determine the reasoning behind your group's opposition to the sale. Develop a proposal for an alternate solution to getting Icthy to come to Salmo while also including your own interests. Be sure to anticipate the arguments Icthy will use against you in advocating for ownership of the entire lake. Is compromise possible?

Aquatic Exotics

OBJECTIVES: Students will be able to:

- relate the differences between native, exotic, and invasive species
- provide three examples showing why invasive species are problematic
- explain why it is easier to prevent introduction of exotic species than to remove them once they are established

METHOD: Students will research Invasive Aquatic Species and briefly report on five different species. They will also read an article describing Sea Lamprey Control Measures and answer questions about the article.

MATERIALS: ➊ See Appendix H for a PowerPoint Presentation: Invasive Species Images.

SETTING: Indoors or outdoors

DURATION: One 45-minute class period – or a possible take-home assignment.

VOCABULARY: Exotic species, invasive species, native species, assessment

STANDARDS:
Science: A 8.6, 12.4; C 8.4, 8.11, 12.4, 12.7; F 8.8, 8.9, 8.10, 12.7, 12.8.
Environmental Education: A 8.4, 8.5, 12.3; B 8.5, 8.8, 8.15, 8.18, 12.3, 12.4, 12.5, 12.8; C 12.4; D 8.1, 8.5, 12.1.
Social Studies: A 8.11, 12.11.

BACKGROUND: The vast majority of the exotic species in the Great Lakes have been unintentionally introduced. Some exotic species have swum in through connecting waterways, like the Welland Canal. The Welland is part of a network of canals extending from the Atlantic Ocean and the St. Lawrence Seaway into the Great Lakes. People dug these canals to allow for shipping between the Atlantic Ocean and the Great Lakes. At the same time, they unintentionally opened a corridor for exotic species to swim from the ocean all the way up into Lake Superior. The parasitic sea lamprey is one that took the opportunity to do so. It naturally spawns in freshwater.

Ships coming into the Great Lakes also bring surprise visitors in their ballast water. A foreign ship that is not filled to capacity with a product will fill its ballast tanks with water before it leaves its home port. The weight of the water in the tanks gives the ship more stability when crossing the Atlantic Ocean. When the ship arrives in the Great Lakes and is filled with wheat, corn, coal, or another product, it dumps its ballast water—and any live organisms it picked up at home—into the Great Lakes. Once in one of the Great Lakes, these exotic species can swim from lake to lake or up streams to inland waters. The zebra mussel likely arrived this way.

While many exotic species have arrived unintentionally, some are brought on purpose. Since European settlement began, generations of immigrants have brought along plants and animals from their native lands for food and for familiar touches in their new homes and yards. Purple loosestrife is one example of an exotic plant that was intentionally planted as an ornamental. It was also carried along in soil that was used as ballast on ships.

All three of the species listed above have rapidly reproduced and spread to areas far removed from their original introduction. They are considered exotic invasive species. Exotic invasive species have had an enormous economic impact on the Great Lakes region. A recent study by University of Notre Dame researchers found that invasive species introduced through ocean vessels, in ballast water and attached to hulls, cost the Great Lakes region over $200 million dollars a year. These costs are the result of lost commercial and sport fishing revenue, lost wildlife watching revenue, and increased operating costs for Great Lakes water users. Currently the United States and Canada have regulations requiring ocean ships to flush their ballast tanks with saltwater before leaving the ocean, but this regulation is not eliminating the introduction of new species. Strengthening ballast regulations is a hot topic of discussion between various states and Canada.

This lesson uses the sea lamprey as a representative invasive species because of its well-known and dramatic impact on commercial fisheries and the long term and still unsuccessful efforts to eliminate it.* The sea lamprey is an excellent reminder of why it makes economic sense to prevent the introduction of exotic species, rather than to try to eliminate them once they are established.

*The sea lamprey contributed to the near-annihilation of the Great Lakes commercial fishery in the 1950s.

OPENING: Have students read **Aquatic Exotics** up to the questions about sea lamprey. Discuss exotics as a class: How do they get here? How do exotics, natives, and invasives differ? Why are invasive species a problem? What are some of the more problematic invasive aquatic species for Wisconsin?

MAIN ACTIVITY: Ask students to read the article on Sea Lamprey Control Methods independently. They can answer the questions either in class or as a take-home assignment.

CLOSING: New exotic species are entering the Great Lakes every year. Have students read the **Newsflash! Asian Carp Approaching Wisconsin** paragraph. The current location of the carp is ever-changing. Students can use the Internet and search for "silver carp" or "Asian carp" to see if they can discover its most recent location. In December 2008, silver carp were caught near La Crosse, marking their arrival in Wisconsin. One year later, biologists confirmed that Asian carp had entered the Chicago Sanitary and Ship Canal and the multi-state, multi-agency Asian Carp Rapid Response Workgroup was deployed to halt the Asian carp's advance toward Lake Michigan.

ASSESSMENT QUESTIONS: What is the difference between an exotic species, an exotic invasive species, and a native species? Give an example of each type.

ANSWERS: *An exotic species is from another place, but is not necessarily seen as a problem (examples: coho salmon, rainbow trout). An exotic invasive species is from another place and is causing problems for native species (examples: sea lamprey, Eurasian watermilfoil, spiny waterflea). A native species is one that has existed in the local ecosystem for a very long time (many examples possible).*

EXTENSIONS:

In Depth: Have each student investigate a different invasive species and describe the best control measures based on his or her evaluation of scientific studies.

Service Learning: The UW Sea Grant has an "Attack Pack" designed to allow high school students to teach elementary students about aquatic nuisance species. Check the UW Sea Grant's Website for details: **seagrant.wisc.edu**

Contact the DNR to find out about invasive species eradication field days or projects to involve your students: **dnr.wi.gov/invasives/publications/class**

If you have downloaded this booklet, please see the appendix that follows for additional materials.

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"?

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

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?

PLEASE SEE APPENDIX H
PowerPoint: Aquatic Exotics

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.

INSTRUCTORS: Underlined content is not provided in student manual.

Don't Dump Your Science Projects!

It's great to study living organisms in the classroom, but please do not dump any of them into Wisconsin waters, public or private. Doing so without a permit is illegal and can spread disease, invasive species, and/or undesirable genetic strains.

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?

INSTRUCTORS: Underlined content is not provided in student manual.

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?

1. Eurasian water milfoil (grows rapidly, shades natives; chemical controls attempted)

2. Purple loosestrife (grows rapidly, outcompetes natives for space; biological and chemical controls attempted)

3. Zebra mussel (clogs water intake pipes; chlorine, filters, and scraping used to control)

4. Eurasian ruffe (outcompete walleye and perch; chemical controls attempted)

5. Rusty crayfish (outcompete native crayfish; no control beyond prevention)

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?

Larvae are counted after being electro-shocked. Parasitic-phase are counted by charter and commercial fishermen and reported to the government. Spawning-phase are counted by scientists using mechanical traps. Students may pick any of the three, as long as they support their choice. Most will choose the larval or spawning-phase, because individuals are concentrated in a small area. Parasitic-phase depends on what fishermen catch and what they decide to report.

INSTRUCTORS: Underlined content is not provided in student manual.

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?

Fishermen could be convinced to help, because reducing lamprey populations is in their best interest. They should be asked to record the number of lamprey they catch, the number of lamprey scars on fish, and the times and locations where the lamprey were caught.

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

TFM is remarkably effective because it is selective for sea lamprey, is applied at their most vulnerable stage (larval), does not bioaccumulate in the environment, and breaks down in a matter of days. Invertebrates that are affected by TFM are able to recover in the long interval between TFM applications.

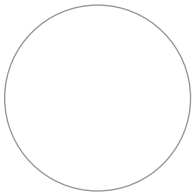
4) Describe at least three advantages or benefits of using sea lamprey barriers when compared to the use of TFM.

Benefits are reduced lampricide costs, reduced application costs, more efficient sea lamprey control, increased opportunities for population assessment and male-sterilization collection, and longer duration (one barrier works for years).

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.

Students should demonstrate their understanding that sterilized males are in their spawning phase and no longer harming fish. By releasing them, scientists are assuring that at least some of the eggs produced that year will not be fertilized.

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.



Students may choose any answer, as long as they support it. Students may choose lampricide because it is so successful, barriers because they involve one investment as opposed to many, or male sterilization because of its potential to rapidly reduce larval lamprey. Students should give some thought to a combination. The actual breakdown of the money given to control measures in 2008 was 80% to TFM ($10.9 million), 12% to barriers

INSTRUCTORS: Underlined content is not provided in student manual.

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

Theoretically, with enough money and manpower, it seems possible. However, it is unlikely as there will always be some small number that escape barriers, spawn in unusual areas, or show resistance to lampricides. Our track record for wiping out invasives is not good.

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?

Let students know: Sport fishing brings over $7 billion dollars to the Great Lakes region, and commercial fishing is worth millions more.

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?

We need to study invasive species to determine the extent of their effect on the natural ecosystem and to learn their life histories well enough to develop effective control measures. Students may come up with other answers as well.

Help students to recognize and explain that it is much easier to prevent than to eliminate.

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

Highlight the fact that decades of research have gone into creating controls that are specific to lamprey and will not affect other species. The lampricide and specific barriers and sterilization chemicals used on lamprey would likely not be effective on other species. However, the ideas behind each of the controls—a special chemical, a physical barrier, a sterilization process—could give inspiration to other projects, like the carp barrier on the Illinois River.

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

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**

Buddy System

In this chapter, four lesson plans illustrate various ways people work together to solve environmental problems.

Restoration Nation

OBJECTIVES: Students will be able to:

- describe three different stream restoration techniques
- explain three different steps taken in a stream restoration project
- relate that preventing stream degradation is easier than trying to re-create a complex ecosystem

METHOD: Students will work in small teams to develop a restoration plan for Gilbert Creek using questions for direction. They will present their results to the class.

MATERIALS: Optional: This lesson provides a great opportunity to have a classroom visit from a guest speaker who is familiar with local restoration efforts.

SETTING: Indoors or outdoors

DURATION: One or two 45-minute sessions

VOCABULARY: Restore, stakeholders, fragmented

STANDARDS:
Science: B 8.6; C 8.4, 8.11, 12.1; F 8.9, 8.10, 12.8; G 8.5; H 8.2, 12.1, 12.3, 12.4, 12.7.
Environmental Education: B 8.5, 8.10, 8.15, 8.17, 8.18, 8.22, 8.23, 12.3, 12.5, 12.6, 12.8, 12.12, 12.19; D 8.1, 8.5, 8.8, 12.1, 12.7.
Social Studies: A 8.11, 12.11, 12.12.

BACKGROUND: Land management has been, and continues to be, a learning experience for humans. Ecosystem restoration, or the repair of ecosystems, is now a multi-billion-dollar industry in the United States. Generally, the goals of restoration on a waterbody are to improve water quality, enhance aquatic habitat, and reduce erosion. In streams, restorationists often have the added goal of trying to improve fish passage so that spawning is possible. Managers have to be very cautious in trying to restore a natural system—if they don't understand and work with the natural system, they could end up creating new challenges. Consultation with a variety of experts is important, as is monitoring and testing to make sure that the stream is responding as intended. If done well, ecological restoration can have dramatic and inspiring effects.

In Wisconsin, many aquatic restoration efforts are focused on making streams habitable by trout. Trout require cold water, plenty of oxygen, sheltered places to hide and rest, and abundant supplies of insects and forage fish. Trout streams must offer gravel beds for spawning and water swift enough to sweep silt off developing eggs. If a few of these necessities are missing, the trout go missing as well.

Not all Wisconsin streams are capable of supporting trout; some never were. However, some trout streams were and continue to be impaired by beaver dams, human-made dams, grazing cattle, highway construction, runoff pollution, flooding, soil erosion, and other sources. Gilbert Creek, the focus of this activity, was affected by soil erosion.

Streams are not the only waterbodies affected by land use decisions. Lakes and wetlands can also change as a result of land management decisions and, as a result, present their own restoration challenges. A lake's often-large watershed can cover more area and involve more stakeholders than a small stream's. Large watersheds may even cross state or country borders, making cooperation between different political organizations an important part of large waterbody restoration.

Perhaps the most challenging waterbodies that Wisconsin is trying to restore are lakes Michigan and Superior. These Great Lakes are examples of an extreme in ecosystem restoration. The watersheds for these lakes cross many state borders and Lake Superior's crosses our international border with Canada. Maintaining a fishery, reducing pollution, and regulating how Great Lakes water is used involves cooperation between many different governments. The International Joint Commission, a group of Canadian and American citizens, uses science to make restoration and management recommendations to all Great Lakes governments. The Great Lakes Compact is an agreement among Great

Lakes states on how the Great Lakes should be managed and maintained.

OPENING: Ask students to read **Restoration Nation** up to the Gilbert Creek Case Study. Have students define "restoration" and provide some examples as to why it is necessary. Encourage students to think back to Chapter 3 to come up with reasons why soil erosion or highway construction would affect fish habitat, particularly trout habitat.

MAIN ACTIVITY: Divide students into groups of three and have them read through the Gilbert Creek Case Study together. Give them time to answer the questions asked in their booklets and to develop a restoration plan for the creek. This may take the remainder of the class period, especially if they are being thoughtful. You may need to assist them in synthesizing their knowledge of trout needs and restoration possibilities.

Once the students have had time to develop their plan, have them share the plans with each other. Keep a running tally on the chalkboard or white board of the stakeholders students identify, their project goals, constraints, some measures they took, and some of their monitoring ideas.

Read students the events that actually took place in Gilbert Creek: The DNR, Trout Unlimited (a nonprofit group that does stream restoration), and Dunn County Fish and Game Club volunteers came together with the goal of improving trout habitat to make a sustainable fishery. Project managers spoke to local school groups, university classes, farmers, and other local citizens to broaden interest in trout habitat. During the summers of 2003, 2004, and 2005, every Tuesday night became a volunteer work party along the creek. The volunteers put LUNKERS structures in place to stabilize the streambanks and used logs and boulders to make pools. Volunteers removed over two miles of invasive trees and reseeded the land with native grasses. Gilbert Creek is now a much more attractive trout habitat: temperatures have dropped and macroinvertebrates have increased in numbers and diversity. There is less erosion and a more stable channel.

The threat of erosion from farmland and new construction projects remains a concern at Gilbert Creek. The health and stability of the hills around Gilbert Creek are just as important as the land immediately surrounding the stream. Trout Unlimited, the DNR, and others are keeping a close eye on the stream to see if new projects are needed.

CLOSING: Have students think about why restoring a lake or a large river would be more difficult than restoring a stream. Who would be the stakeholders in a restoration of Lake Michigan or Lake Superior? If you have invited a restoration ecologist, fisheries biologist, or other local expert in to talk about the mix of science and society, this would be an excellent time to have him or her describe a local restoration project.

ASSESSMENT QUESTION: Name three habitat problems a fisheries biologist may find in a degraded trout stream and one way of addressing each problem.

ANSWERS: *Lack of shelter: sink LUNKERS and logs. Lack of sunlight: plant native shrubs and vegetation, remove non-native trees. Bank erosion: plant vegetation, grade bank, remove livestock, put stabilization structures in place. Water too warm or slow: create log jams, narrow stream with gravel.*

EXTENSIONS:

In Depth: Have students read articles about and evaluate a local restoration project.

Field: Visit a local stream that has been restored and one that has not needed restoration. Can students find differences between the two? Can they see evidence of any of the restoration techniques described in their booklets?

Service Learning: Team up with a local fishing or conservation club to help with stream habitat restoration projects.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

4

Buddy System

Making sure that there is a healthy and sustained fishery for all to enjoy requires resource managers. Managing waterbodies for fish means creating, maintaining, and improving environments favorable to all stages of a fish's life cycle. We all play a role in managing Wisconsin's fisheries, because we all live in watersheds that support fish. Keeping fish in mind when making decisions about when and where we apply fertilizer, how we dispose of hazardous waste, or where we place cattle fences makes us all fish managers. The primary agency for managing fish in Wisconsin is the Department of Natural Resources (DNR). The DNR manages habitat improvement projects; studies, protects and restores fish populations; monitors fish health; staffs hatcheries; stocks fish; and enforces fishing regulations on Wisconsin waters, all of which are public.

Musky

Restoration Nation

The Wisconsin DNR Bureau of Fisheries Management protects, maintains, and improves fish habitat. One of the jobs fisheries staff have is to partner with other DNR bureaus and concerned groups, like angler clubs, to improve fish habitat through restoring our streams, lakes, and wetlands.

Make sure students understand that ALL NAVIGABLE WATERS in Wisconsin are constitutionally protected as PUBLIC property. As long as the waterway is navigable for one period during the year, even if it is in flood, it is considered public property and they may enjoy it!

The Route to Trout: Stream Restoration

Early 20th century farming practices harmed local watersheds in western Wisconsin's Driftless Area, where clean, cold creeks wind through valleys flanked by steep hills. When farmers removed trees and native grasses to plant crops, loose soil flowed downhill, depositing as much as 12 to 15 feet of soil in some creeks over the years. Water quality worsened, stream temperatures increased, and flooding became more frequent and severe.

Gilbert Creek Case Study

One hundred years after farming began in the Driftless Area, a local stream, Gilbert Creek (located twelve miles west of Menomonie), remained choked with silt. Its water was murky and warm, and invasive tree species lined its banks rather than the deep-rooted prairie grasses that once anchored soil in place.

In 2002, brook trout laid eggs in the North Branch of Gilbert Creek, but fish survey crews did not find any newly-hatched trout in 2003. The eggs were likely smothered by silt or killed by high water temperatures. If fishing were to continue in Gilbert Creek, something had to be done. Work with your team to develop a plan to restore trout habitat to Gilbert Creek, using the following questions for direction.

1) Who are the **stakeholders** in the Gilbert Creek restoration, and what do they want?

Students should consider at least some of the following: the property owners along the creek, the local angler club, individual anglers, local government, community businesses, recreationists, environmental advocacy groups, and perhaps others. Most would probably want to improve the creek's fish habitat and restore it to a healthier condition. Businesses and governments would both benefit from an increase in anglers and other recreationists to the area. Landowners and environmental advocacy groups may be concerned about how the team will go about doing the restoration. Will they cause property or ecosystem damage during the process?

INSTRUCTORS:
Underlined content is not provided in student manual.

2) Considering the needs of the stakeholders, what are your goals for the project?

The actual goal was to improve trout habitat for a sustainable fishery.

3) What are the constraints?

Government permits might be needed. Even though your goal is a good one, these permits might take years to obtain. Resistant stakeholders might not allow you to cut down invasive species on their property. You may not be able to find adequate funding, time, volunteers, or leaders. Ask students how they might overcome these constraints.

4) Using the stream improvement techniques on the next page and your own inspiration, decide some of the measures you will take to restore the stream.

Read the case resolution to see what actually took place. There are many possible ways to restore a stream. Teams should mention consulting with local experts like hydrologists, aquatic ecologists, fish biologists, engineers, or botanists to make sure they are taking reasonable steps.

5) How will you know if the steps you have taken succeeded in meeting your goals? What might you continue to monitor after your project is done?

Success will be proven when trout naturally reproduce in a stream. It would be wise to continue to monitor temperature, dissolved oxygen, and turbidity to make sure the project is working and to identify new hazards before they harm the stream.

INSTRUCTORS: Underlined content is not provided in student manual.

No matter what actions your restoration team takes, it is important that your team understands both the habitat needs of a fish during all phases of its life and the root causes of the habitat loss. If your team restores a stream, but does not address the cause of the erosion, for example, the stream will just need to be restored again later.

Lessons Learned

Wisconsin has over 2,700 trout streams with some natural reproduction. The DNR wants to improve and sustain these populations, believing the thrill and challenge wild trout offer will always be valued by anglers.

Protecting natural spawning areas is today's biggest challenge for Wisconsin habitat improvement. The ultimate goal of habitat improvement is a completely self-sufficient stream with large populations of wild trout maintaining themselves.

Perhaps the best lesson to learn from all of our restoration work is that it is much easier to prevent habitat loss by making thoughtful land use decisions than it is to restore degraded habitats. We have also learned that it is better to use natural structures and processes to restore streams, lakes, and rivers than it is to install artificial habitat structures. We may never be able to recreate the full complexity of a natural system after it has been altered.

Stream Improvement Techniques

When seeking to improve a trout stream, fishery biologists focus on making habitat meet the needs of the trout. Areas for them to address might include the following: lack of shelter (cover) or living space for fish, lack of sunlight due to overgrowth of vegetation, siltation due to erosion of streambanks, water that is too warm because a stream is too shallow. Fishery experts have developed many solutions to such concerns.

PROBLEM	TECHNIQUE
Bank Erosion	Plant vegetation on bank and buffer. Exclude or modify livestock grazing. Put stabilizing structures in place. Re-grade the slope of the bank.
Lack of Sunlight	Plant native shrubs and grasses. Remove non-native trees and plants.
Over-widened/ Shallow Streams	Use log jams to deepen pools. Use gravel to narrow a stream channel.
No Shelter	Place materials like wood and boulders. Install LUNKERS.

Installing a LUNKERS.

LUNKERS!

Little Underwater Neighborhood Keepers Encompassing Rheotactic Salmonids are crib-like wooden structures that imitate an undercut bank. LUNKERS provide shelter for fish while stabilizing the streambank. They were developed in Wisconsin by DNR trout stream biologist David Vetrano and work well for restoring fish habitat in Midwestern streams.

Taking Stock

OBJECTIVES: Students will be able to:

- describe two ways in which a fish population increases and three ways in which a fish population decreases
- provide three reasons why managing fisheries is a controversial and challenging job that is influenced by economic, environmental, and social factors
- relate that managing fisheries is necessary for a sustained harvest
- recognize the limitations of a fisheries model

METHOD: Students will study and take part in a model of the factors affecting fishery populations in Lake Michigan, a resource held in common by all citizens. Through a game they will investigate how decisions by commercial fishermen, recreational anglers, fisheries biologists, and lawmakers influence and are influenced by economics and by the abundance and scarcity of fish.

MATERIALS: For each group of six students:

1) Two open-top containers (large bowls, shoeboxes, or Tupperware®)
2) 1-lb bag of dried pinto or small kidney beans—you'll measure out and divide 500 ml (2 cups)
3) One graduated cylinder (250 ml or larger)
4) Four measuring spoon sets
5) Four cups
6) One piece of paper rolled into a cone or a large funnel

See Appendix I for Balancing Act Game materials: Fishery Factor Cards, Balancing Act Roles with data charts, and Balancing Act Student Instructions.

SETTING: Indoors

DURATION: Two or three 45-minute periods

VOCABULARY: Hatchery, harvest, regulations, moratorium, Tragedy of the Commons

STANDARDS:
Science: A 8.6, 8.7, 12.3, 12.5; B 8.6; F 8.8, 8.10, 12.7, 12.8; G 8.2, 8.7.
Environmental Education: A 8.4, 8.5, 12.3, 12.4; B 8.10, 8.15, 8.16, 8.17, 8.22, 8.23, 12.2, 12.9, 12.10, 12.11, 12.12, 12.19; D 8.1, 12.1.
Social Studies: A 8.11, 12.4.

BACKGROUND: On average, Wisconsin state fish hatcheries raise 3,500,000 walleye, 5,280,000 trout, 1,830,000 salmon, 140,000 muskellunge, 350,000 largemouth bass, and 50,000 northern pike every year. Yet, stocking occurs in less than 10% of Wisconsin's lakes and streams. Most Wisconsin waters support excellent fish populations without the aid of stocking, so management focuses more on habitat protection, regulation, and restoration. Still, stocking is vital to the survival of certain species of fish in Wisconsin, like salmon and certain trout, and is an important way of increasing fishing opportunities.

Stocking decisions, like decisions on fishing regulations, are almost always a contentious topic for citizens, scientists, commercial fishermen, lawmakers, and recreational anglers alike. These groups all want the same thing—sustainable populations of commercial and recreational fish species, yet they have different ideas about how this should be accomplished. The balance between environmental supply and social demand is not an easy one to obtain. The balance is even more challenging to achieve when events like floods, more efficient commercial harvesting gear, or loss of habitat reduce supply but not demand. The tough choices arising from these various factors are at the heart of current fisheries management.

OPENING: Have students read the **Taking Stock** section of the booklet. Have students answer the questions in their booklets about the Bottle Model. Discuss their answers as a group. Let them know that the rest of the activity will be based on this model.

MAIN ACTIVITY: Explain to students that they are going to play a game, Balancing Act, the goal of which is to maintain a fishery that is stable enough to keep everyone in business for at least 10 rounds. Pass the materials to groups of six to eight students. Make sure that each student gets a role card. Each group should have one lawmaker, one fisheries scientist, at least three commercial fishermen, and at least one angler. Clarify roles if students are confused.

The "fisheries biologist" will place 400 ml of beans in one of the containers and label it "lake." The beans in this container represent the stock of beanfish in the lake. The rest of the beans go in the second container, labeled

"extra." To make the harvest more realistic, each group's lake should be covered so that the harvesters cannot tell how many fish are in the lake.

The game is played in 10 rounds, with each round representing a year. In each round, the commercial fishermen and recreational anglers harvest from the lake, abiding by current harvesting laws. For the first round, commercial fishermen are allowed to scoop three tablespoons of beans into their cup. The recreational anglers, who each represent 25 people, are allowed to take two tablespoons. These harvesting levels will change in subsequent rounds.

At the end of the round, harvesters count their catch and the fish biologist calculates the amount of beanfish reproduction for that round and adds the appropriate quantity of beans to the lake. (For every one ml remaining in the lake, the stock reproduces one ml). All students except the lawmaker record their actions for this round on their record sheets. Each bean harvested is worth $100 in the first round. Once recorded, the harvests are emptied into the "extra" bin.

After the first round, the effects of supply and demand enter the game. If fewer than 150 beans are caught commercially, then the price per fish rises to $110. If more than 210 beans are caught commercially, the price per fish falls to $90. Knowing this, all harvesters and the fish biologist make verbal recommendations to the lawmaker as to the type and extent of regulations they feel should be in place in the upcoming year. The lawmaker records everyone's recommendations on the lawmaker's record sheet. Based on the recommendations, lawmakers make laws that must be followed by all of the harvesters in the next round.

The round ends with the lawmaker drawing a Fishery Factor card that introduces additional and unexpected occurrences. If the instructions on the card conflict with the lawmaker's decision, the instructions on the card override the lawmaker's decision. Otherwise, both card instructions and laws apply. Repeat for 10 rounds.

Special reminders: Students must keep their roles in mind when making recommendations, and commercial fishermen must make $6,000 each round to stay in business. Broken beans do not count toward the total—they are under legal harvest size. Any beans that fall off the spoon during harvesting go back into the lake and do not count. To make sure the harvesters are recording their catch accurately, fish biologists may count any person's harvest at any time. Anyone who has counted half beans or has more beans than he or she recorded is fined $1,000. If anglers have trouble calculating the percentage of anglers who caught more than one beanfish, offer them this formula: Percentage of anglers who caught more than one fish = (# of beanfish caught - 25) x 4.

CLOSING: After 10 rounds, have the students answer the follow-up questions for **Balancing Act** in their booklets.

ASSESSMENT QUESTIONS: How are introduction stocking and rehabilitation stocking different? Provide an example of when and why each might be used. What are the ways in which a lake may be depleted of fish?

ANSWERS: *Introduction stocking puts a species of fish in a waterbody that had never held that species before. Example: putting bass in a new pond or putting muskellunge in southern Wisconsin lakes. Rehabilitation stocking follows an event such as overfishing or winterkill to bring a species back into a waterbody after it has disappeared. Example: stocking lake sturgeon in many of Wisconsin's rivers and lakes. Depletion (refer to Bottle Model): harvest pressure, natural mortality, habitat loss or competition with invasives, poor water quality.*

EXTENSIONS:

In Depth: Have students graph the data they collect to investigate the following question: Does looking at harvest data really tell you how a species is doing?

Students can further explore the Tragedy of the Commons as it relates to sustainable fish harvests online, in "The Fish Game," **sustainabilityed.org/games**.

Field: Have your class visit one of Wisconsin's state fish hatcheries. Look for locations and visitation hours on the DNR's Website.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

Taking Stock

In the first scenario of this booklet, you were asked to think about what factors might determine whether or not to stock walleye and yellow perch in Linnie Lake. These decisions are actually a part of the job description of DNR fisheries biologists who manage this resource for the common good (more about that later.) The DNR uses science to determine what goes into (stocking quotas) and comes out of (bag limits) Wisconsin's lakes.

Fish Nurseries

Hatchery
a place where eggs are hatched

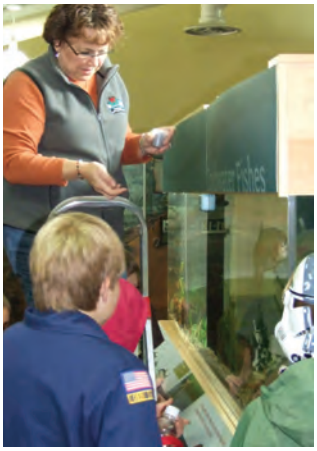
Nature provides the best fish **hatchery** (a place where eggs are hatched) and stocking program. In a healthy aquatic ecosystem, all of the elements are in place for a productive fishery: the eggs hatch on their own and fish grow to normal adult sizes in healthy numbers. Not all of our lakes and streams, however, have healthy fisheries. In some instances, we need to supplement and enhance fisheries through artificial hatcheries and wild releases (stocking programs) in order to provide anglers with fish to catch or to reintroduce species after a habitat has been restored. Wisconsin has been stocking hatchery-raised fish since the late 1800s. Today, anglers help fund state-operated hatcheries through license sales, trout and salmon stamps, and taxes on fishing tackle, boats and boat fuel.

Many egg collection facilities, hatcheries, and fish rearing stations are open to the public for tours during certain times of the year. Check the Website for information on locations, hours and visitation policies, **dnr.wi.gov/fish/hatchery/hatcheries**.

Who pays? You do!

Anglers fund a large share of the fisheries habitat work the DNR does through the Sport Fish Restoration (SFR) fund. This fund is generated by a 10% federal tax collected on fishing gear, tackle, baits, motors, and motor boat fuel. The tax money is divided among states for education programs, fisheries habitat work, stocking, and fishing access development. Each state's share of funding is based in part on how much water a state has and how many licenses are sold. Wisconsin is near the top in both categories! Anglers also support fisheries programs through the purchase of licenses and stamps, which you'll learn more about later.

Wisconsin Fish Hatcheries



Wild Rose State Fish Hatchery opened an education center in 2008 as part of a three-phase renovation project.

When stocking a waterbody, a biologist has to consider more than just the physiology and habitat requirements of a species of fish. Ecological balance, cost, and angler needs are also important considerations. Biologists stock a waterbody for one or a combination of the following reasons:

1. **Rehabilitation stocking.** Rehabilitation stocking is a top priority for biologists. In this type of stocking, biologists reintroduce a species of fish that used to exist in a waterbody, but that was extirpated or became too scarce to effectively reproduce. This method of stocking usually follows a catastrophic natural event like a winterkill, disease, or dam failure. It can also follow human-caused events like overfishing or chemical spills. The species is re-introduced to the waterbody with the goal that it will soon become a self-sustaining population again. The DNR is currently using rehabilitation stocking to return lake sturgeon to many rivers and lakes in Wisconsin.
2. **Research and Evaluation stocking.** In this type of high-priority stocking, biologists experiment with putting different species or sizes of fish in a waterbody to determine the most cost-effective or most successful way to manage the lake. For example, biologists are experimenting with stocking small walleye fingerlings (young fish) instead of large walleye fingerlings to see which size is more likely to survive.
3. **Recreation stocking.** Recreation stocking either creates or maintains a fishing opportunity that did not previously exist. A wide array and volume of fish are stocked in urban waters, for example, to provide local residents with the opportunity to fish. If these waters were not stocked, limits on the number of fish caught would have to be lower. Coho and Chinook salmon are stocked in the Great Lakes partly to provide a recreational fishery.
4. **Remediation stocking.** Sometimes an event extirpates or severely lowers a fish population, such as the loss of spawning habitat or the invasion of an exotic species. If the event that caused the problem cannot be readily fixed, the DNR will use remediation stocking to maintain a species of fish that is ecologically or recreationally valuable. For example, the draining of wetlands has greatly reduced northern pike spawning habitat in some areas of Wisconsin. The northern pike are necessary to maintain a predator/prey balance in many inland lakes. Even if the drained wetlands will not be restored, the DNR will continue to stock northern pike as a last resort to maintain a fishery. The stocking of once-abundant lake trout along the offshore reefs of Lake Michigan is also an example of remediation stocking.

Photo: Alisa Santiesteban, July 2009.

Wisconsin DNR Fisheries technician Tom Burzynski stocks young lake sturgeon into the Milwaukee River, a tributary of Lake Michigan, below the Thiensville Dam. The sturgeon were raised at a streamside rearing facility, located at Riveredge Nature Center in Newburg, Wisc. Learn more about this exciting rehabilitation project and take a tour of the facility on the DNR's Website: **dnr.wi.gov/fish/lakemich/LakeSturgeon**.

5. **Introduction stocking.** When a fish is placed in a newly created waterbody, like a small pond or reservoir, or when a species is put in a waterbody it has not previously inhabited, the DNR has conducted an introduction stocking. The DNR generally discourages introductions unless done on a new pond or reservoir where the species could soon develop a self-sustaining population. Stocking of muskellunge into southern Wisconsin lakes to expand musky range could be considered introduction stocking, because it is unlikely muskies occurred in these lakes prior to European settlement.

Managing the Commons

Moratorium
a period of time when a certain activity is not allowed

Fish, like air and water, are resources held in common by all citizens. In other words, no one person owns them, but all share them. The "tragedy of the commons, "a phrase coined by Garrett Hardin in 1968, refers to unsustainable rates of use or abuse of a resource held in common. Fisheries biologists attempt to manage the commons by considering how many fish anglers and commercial fishermen should be allowed to harvest (keep) from Wisconsin's waters to ensure a fair, equitable and sustainable distribution of the resource.

Sustainable Harvest Rates

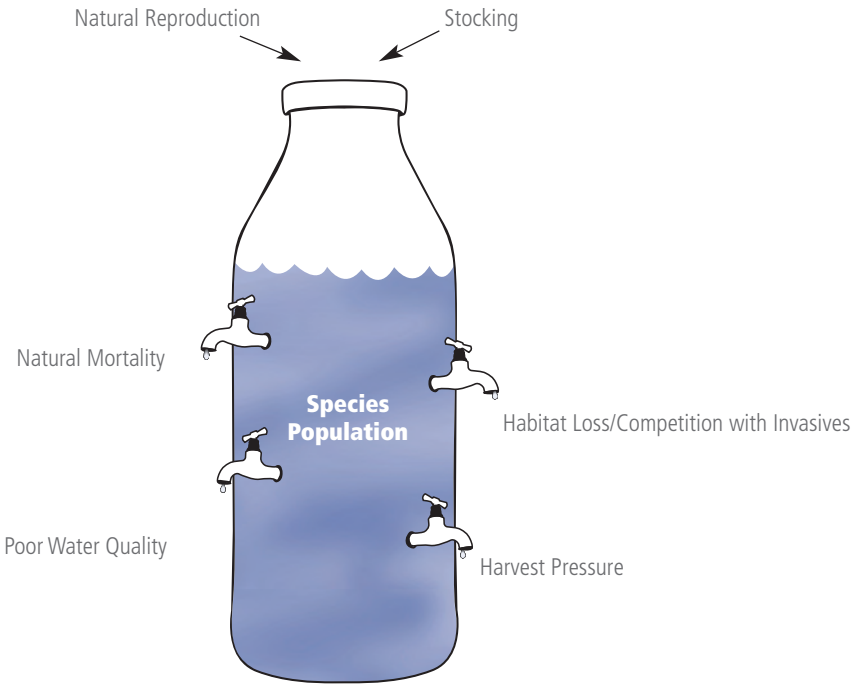
Imagine if every single angler and commercial fishermen were able to harvest as many fish as they wanted, regardless of species. Overfishing, especially on smaller lakes and with popular fish, could rapidly eliminate certain fish populations. Historically, many species of fish suffered because of overharvest. To sustain our diverse fish populations, and the ecosystems they are a part of, the DNR makes. Although some lakes, regions, and fish have special **regulations**, in general the DNR defines how many fish of a certain species you may catch in one day from all waters as the "total daily bag limit."

Occasionally fisheries managers may recommend a **moratorium** (a period of time when a certain activity is not allowed) on fishing for a certain species of fish in a certain lake to allow its population to grow. Whether fish managers are restoring streams, putting fish in the water, or regulating how you take them out, they have a fascinating job that mixes science and policy to help create a sustainable fishery.

The Dam Problem

Dams have had an enormous effect on stream habitats; about 3,700 were built in Wisconsin to grind flour, saw lumber, and power other early Wisconsin industries. Dams **fragmented** (divided) fish communities and blocked fish movement essential for reproduction during spawning time. Paddlefish, sturgeon, and other river species that swim upstream to spawn declined in population, partly as a result of dam construction. Dams also created stagnant millponds that became clogged with algae. To remedy some of these problems, Wisconsin has been leading the nation in dam removal. As of 2008, about 100 dams have been removed. Dam removal projects are major community efforts the DNR supports. Once a community removes a dam, it is rewarded with a return of cool sparkling waters and native catchable fish.

Bottle Model



Look at the Bottle Model diagram above. This model represents the interaction among ways in which species are removed from and added back to Lake Michigan.

1) Explain what you think the model illustrates about the factors that bring fish into the lake and that take fish out of the lake.

Students should recognize that there are only a few supplies of fish and many demands.

2) Describe an event that could make one faucet flow faster, and name the affected faucet.

An example could be a heat wave which depletes the oxygen in the lake and increases natural mortality. Many other answers are possible.

INSTRUCTORS: Underlined content is not provided in student manual.

3) If the event you described above did happen, what would happen to the population level in the bottle? Would the population be able to return to its original level after the event? How?

The population would drop. It might recover if temperatures returned to normal and other pressures were reduced until the fish had time to recover.

Balancing Act

Your teacher will provide you with instructions to play a game that illustrates the way that people, fish populations, and laws interact and influence each other. In the game, you will represent some of the people—lawmaker, scientist, anglers, and commercial fishermen—who influence and are affected by fisheries regulations. You can play a similar on-line version, The Fish Game, by the Cloud Institute, that demonstrates how individual actions affect a resource held in common, **sustainabilityed.org/games/**.

After you have played 10 rounds of Balancing Act, answer the following questions.

PLEASE SEE APPENDIX I
Taking Stock: Balancing Act Student Materials

1) Summarize the results of the game. What trends did you see in the beanfish population over time?

Depends on the group

2) Of the factors that increase and reduce species in the water, which can we control? Look back at the Bottle Model and record here the factors that people can control. Under each factor, provide an example of an action that you, or others, do or could do to decrease the flow of the faucet.

Humans can control harvest pressure and, to some extent, habitat loss/invasive competition and water quality.

Natural mortality is uncontrollable. Students should come up with many creative answers for how they can make a

difference in the flow of the faucets.

3) What would happen to the fishery if commercial fishermen or anglers "cheated" on their fish counts when fisheries scientists weren't watching?

Cheating could lead to destruction of the fishery if enough people consistently under-reported their catch.

INSTRUCTORS: Underlined content is not provided in student manual.

4) Describe three events, actions, or decisions in the game that most influenced the health of your fishery.

Depends on the group.

5) List and explain three things that you would do differently if you were to play Balancing Act again. How do you believe these actions would affect the outcome of the game?

Depends on the group.

6) Because this was a game, or a model of a real-life process, there were many things that were not quite realistic. Even so, this game should have given you a good sense of the challenges, cooperation, and compromise involved in fisheries management. What other factors might influence populations and catches in real life that this model does not account for?

Climate and climate change, weather patterns, exotic species, more.

7) This game deals with a very real issue: the role of laws in fisheries management. Think about how laws or regulations affected the commercial fishermen and anglers in your game. How did the regulations affect the fish population? Write a persuasive paragraph to a classmate explaining whether or not you think we need laws, such as those you saw in the game, to manage fisheries. Use examples and evidence from the Bottle Model, the game, and any other knowledge you have to support your perspective.

Students should recognize that laws were necessary in regulating the actions of multiple user groups.

INSTRUCTORS: Underlined content is not provided in student manual.

Making Decisions

OBJECTIVES: Students will be able to:

- identify controversial issues involving Wisconsin's aquatic ecosystems
- describe how natural resources decisions are made in Wisconsin
- detail how they can be involved in natural resources decision making

METHOD: Students will brainstorm ideas together about natural resources controversies or Hot Topics. Students will work in pairs to craft a resolution on how they would like to see a natural resources policy changed. Students will present their resolutions to each other, and, if the class finds a resolution compelling, introduce that resolution at the annual spring hearing.

MATERIALS: Internet access during class, and/or Internet accessibility after class for students to do research.

➲ See Appendix J for Sample Resolutions for each pair of students.

SETTING: Indoors

DURATION: Two 45-minute sessions if research and writing done outside of class

VOCABULARY: Natural Resources Board, Conservation Congress

STANDARDS:
Science: C 8.1, 8.2; F 8.10; G 8.5, 12.1, 12.5; H 8.1, 8.2, 12.1, 12.2, 12.4, 12.5, 12.7.
Environmental Education: A 8.1, 8.4, 8.5, 12.1, 12.3, 12.4, 12.5; C 8.1, 8.3, 8.4, 12.2, 12.3; D 8.1, 8.4, 8.7, 8.8, 12.1, 12.3, 12.4, 12.7, 12.9.
Social Studies: C 8.3, 8.7, 8.8, 12.8, 12.9, 12.10.
Language Arts: F 8.1, 12.1.

BACKGROUND: State statutes define the Wisconsin Conservation Congress as the Natural Resources Board's (NRB) official citizen advisory body on all natural resource issues of local and statewide significance. Wisconsin citizens elect delegates to serve on the Conservation Congress and help the NRB and DNR effectively manage the state's natural resources for current and future generations. The Congress meets with local citizens to hear their opinions about Wisconsin natural resource management, consults with local and statewide organizations, and works with organizations, educators and citizens to increase outdoor opportunities for all. The Congress further participates in the science and politics of decision making by considering all reasonable resolutions submitted to it and recommending to the NRB support or opposition to rule changes on natural resources management.

Citizens resolutions can be found under the Spring Hearings page of the Conservation Congress Web page (**dnr.wi.us/org/nrboard/congress**). Some of the issues and suggestions are often controversial and involve a mix of science and compromise to solve.

OPENING: Have students suggest aquatic resource management issues that are currently in the local news. Begin keeping a class list of potential topics for resolutions.

MAIN ACTIVITY: Direct students to How to Write a Resolution and Hot Topics in their booklet. ➲ Hand out the Sample Resolutions from Appendix J. Divide the students into pairs and have each pair select a topic on which to write a resolution. Let students know the resolution will be a combination of the information they find on the issue and their own views on how current policy should change. This should not be merely a report, but an attempt to persuade the Conservation Congress that the author's position is the correct one. In devising their resolutions, students should keep both science and politics in mind.

Students should be given time in class to decide on their issue and begin outlining possible places to get information on their topics. Most of the research will be done outside of class.

CLOSING: Students will give short presentations about their resolutions that include the reason for the needed policy change. If a pair has written a compelling resolution, encourage them to introduce it to the Conservation Congress at the annual spring hearing in April. If the resolution is accepted in the county where the students introduced the resolution, students can track it as it moves through the approval process.

ASSESSMENT QUESTIONS: What is the function of the Natural Resources Board? How is this different than the function of the Conservation Congress? How do people become members of each?

ANSWERS: *The Natural Resources Board makes policy decisions for the DNR. It is composed of members appointed by the governor. In the Conservation Congress, citizens propose and vote on rule changes they would like to see happen. Their recommendations are brought to the Natural Resources Board and the DNR. Anyone over 18 can be a member of the Conservation Congress.*

EXTENSIONS:

Service Learning: Encourage students to attend the county's Conservation Congress hearing in April and introduce resolutions.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

Making Decisions

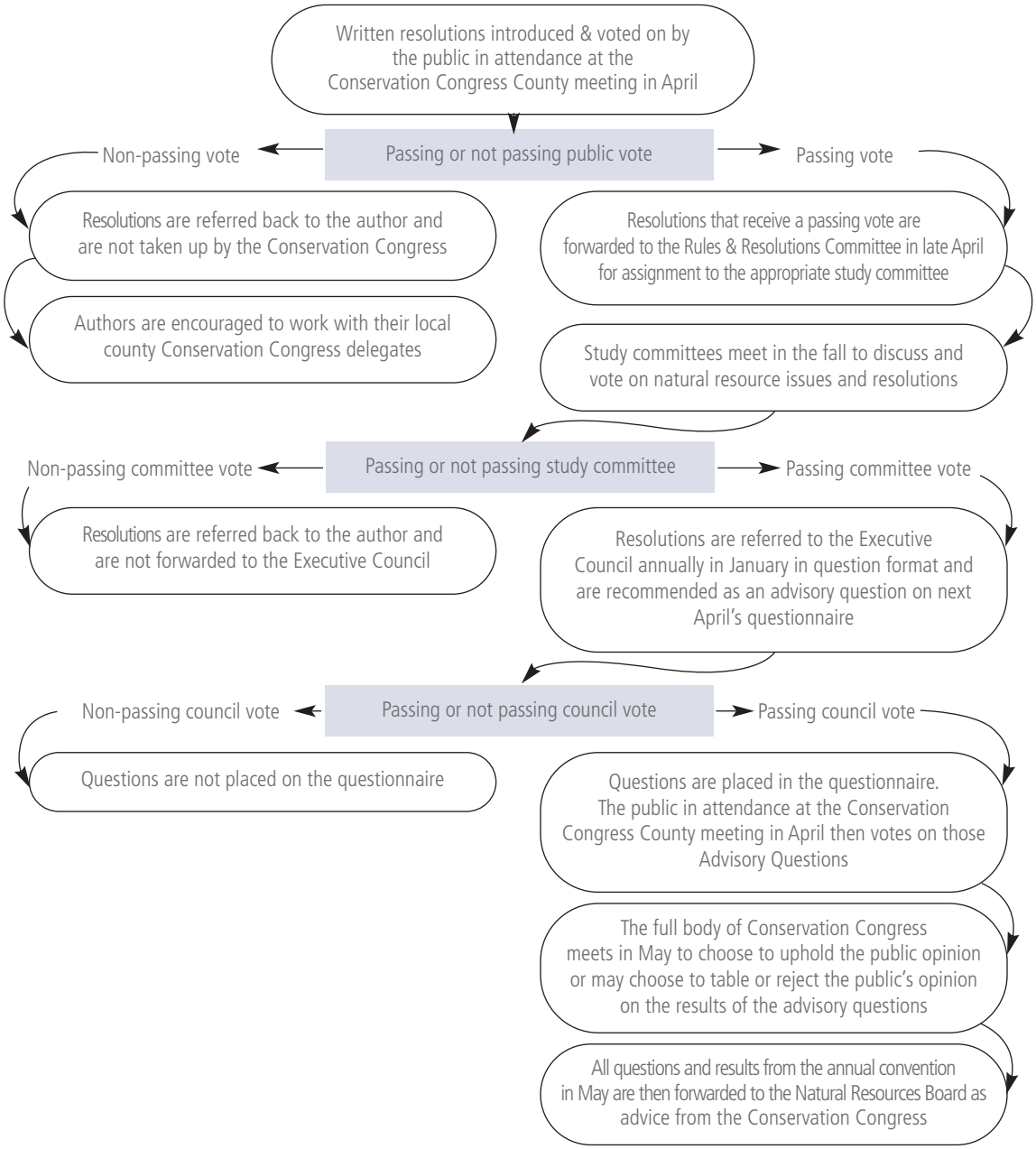
Who is responsible for making sure that our fisheries stay healthy? We all are—through our daily actions and the power of our vote. We choose the legislators who create laws that affect natural resources. But who actually determines, for example, whether a bottled water business can be built at the headwaters of a trout stream? That would be the **Natural Resources Board** (NRB) based on input from DNR staff and citizens. The NRB makes policy decisions for the Department of Natural Resources. The governor appoints the board's seven members, whom the state Senate must approve. After hearing from scientists and citizens, the NRB members make environmental and natural resource decisions, within the confines of law.

Policy Process

The **Wisconsin Conservation Congress**, an independent citizen advisory body defined in state statutes, advises the NRB on natural resource issues. Wisconsin citizens elect delegates to serve on the Conservation Congress. You must be 18 years old to be a delegate or to vote for a delegate to the Congress, but people of any age may propose and vote on rule changes. Hearings where these proposals are brought to a vote occur the second Monday in April in every Wisconsin county every year. If you feel strongly about a natural resource issue, use Wisconsin's citizen input opportunities to help the NRB make a decision to present to legislators!

PLEASE SEE APPENDIX J
Making Decisions: Sample Resolutions

The Conservation Congress Resolution Process



How to Write a Resolution

Each year the Conservation Congress accepts written resolutions from the public in each county regarding natural resource issues of statewide concern. The public introduces these resolutions during the Conservation Congress county meeting held annually in conjunction with the DNR Spring Fish and Wildlife Rules Hearings in April.

1. Resolution Content

In order for a resolution to be accepted for further consideration by the Conservation Congress and for public vote at the annual Conservation Congress county meeting, all resolutions introduced must meet the following requirements:

1. The concern must be of statewide impact.
2. The concern must be practical, achievable and reasonable.
3. The resolution must have a clear title.
4. The resolution must clearly define the concern.
5. Current state statutes and laws must be considered, with reasonable cause for change being presented.
6. The resolution must clearly suggest a solution to the concern and a description of further action desired.

NOTE: If the resolution defines an unresolved concern at the local county level, or district level within your Congress district, please make sure to indicate whether or not you have already spoken with local department staff and your local county congress delegates.

2. Resolution Format

- Resolutions must total 250 words or less and be typed or legibly hand-written on one side of an 8 ½ x 11 sheet of white paper. No attachments or additional sheets will be accepted for the same resolution.
- The author's name, mailing address, county, telephone number and signature are required at the bottom of the resolution.
- Only the individual author or designated representative may present the resolution within the county. The author or designated representative must be present at the time the resolution is introduced.
- No one may introduce more than two resolutions during the Congress portion of the Spring Hearings.
- Written resolutions not meeting the above criteria and/or verbal resolutions will not be accepted.
- Provide the Congress County Chair with TWO COPIES of the resolution for submission at the beginning of the evening, one to be part of the official record and the other to be posted for public viewing.
- Individuals attending the meeting may vote on the resolution being introduced within the county.

3. Sample Resolution

Title: Spring Dinosaur Hunting Season

The Problem: Dinosaurs are a threat to agriculture across the state, especially in April and May, because they make deep footprints in newly planted farm fields, damaging the emerging crops. The problem is aggravated in southern Wisconsin, because dinosaurs are migrating across the state line to avoid hunting pressure in Illinois. There is already an overpopulation of dinosaurs in Wisconsin. At present, state law does not permit dinosaur hunting at any time during the year. We feel that Wisconsin law should be consistent with Illinois, which permits dinosaur hunting in the spring. Wisconsin farmers are suffering significant crop damage because of dinosaur incursions.

BE IT RESOLVED, that the Conservation Congress at its annual meeting held in Buffalo County on April 16, 2007 recommends that the Conservation Congress work with the Department to take action to correct this situation by introducing rule change allowing a spring dinosaur hunting season.

Name of Author: Fred Flintstone
Name of Organization (optional): Private Citizen
Address: W12345 State Road 3
City, State, Zip Code: Bedrock, Wisconsin 54231
Name of the County Introducing In: Buffalo
Telephone Number (including area code): 123-456-0789

4. DNR Rules Process

A lengthy internal process begins at this point that includes an environmental analysis, legal review, public hearings, a public comment period, review by the Natural Resources Board, and finally, action by the Legislature where it is made law or rejected.

Hot Topics

Resource policy is rarely developed or changed without controversy. Wisconsin citizens often feel strongly about how natural resources should be managed. Every year the Conservation Congress hears debates about several hot topics. In the past, citizens have debated manure management, large livestock operation site approval, and, as mentioned above, bottling spring water near the headwaters of a trout stream. Check out the Conservation Congress on the DNR's Website to discover some of this year's topics. Citizen resolutions, Advisory Committees' notes, and the annual Spring Hearing Questionnaire describe the topics.

Choose a hot topic, research it, and develop a resolution on it that could be introduced to the Conservation Congress in the spring. Use the outline on the next page to guide the process. Keep the following questions in mind: Who are the stakeholders? What role should science have in determining policy? Who and what will be affected by this resolution?

As you work through your resolution, consider this quote from the Wisconsin Conservation Congress publication, *Democracy in Wildlife Regulations*, "In the final analysis, no matter what the commission or the department believes to be in the best interest of the state, if the citizenry is not in accord, any program set up would eventually be doomed to failure. The birds, animals and fish belong to the people of the state." Do you agree or disagree with this quote? How does your opinion of this quote relate to your resolution?

Great Conservationists

OBJECTIVES: Students will be able to:

- articulate their personal conservation values and beliefs
- articulate a connection between fishing and conservation

METHOD: Students will write a reflective one-page paper on a conservation quotation.

MATERIALS: None

SETTING: Outdoors (preferably)

DURATION: One 45-minute period

VOCABULARY: Stewardship

STANDARDS:
Environmental Education: C 8.1, 12.2; D 8.5, 8.7, 12.6; E 8.1, 12.1.
Language Arts: B 8.1, 12.1.

BACKGROUND: Enjoying and appreciating fishing could be a student's first step toward a lifetime of interest and involvement in conserving fisheries, aquatic environments, and other natural resources. **Great Conservationists** encourages students to reflect on the issues in this booklet, on their feelings about the natural world, and on their future involvement with aquatic resources.

OPENING: Have students read through **Great Conservationists**. Ask students to choose a quotation from the booklet or allow them the option of choosing their own conservation quotation without the use of the booklet.

MAIN ACTIVITY: Have students write a one-page response to the quotation they have chosen. This can be done during class time or at home, along with the Cheap Date exercise.

CLOSING: Allow students time to discuss their conservation values and beliefs. Have students determine an angler's cost to fish and compare it to other leisure activities. Discuss as a class whether or not students will continue to fish and/or care about the health of our fisheries.

ASSESSMENT QUESTION: Provide two examples of where you have seen stewardship in action.

ANSWERS: *Answers will be personal but should reflect the student's understanding of the word "stewardship."*

EXTENSIONS:

In Depth: Have students reflect on the life and beliefs of a renowned conservationist in a research paper or poster. Here is a short list to provide to your students, if they need prompting, of individuals who made impressive contributions to conservation. Feel free to add to this list.

- Warren Knowles
- Gaylord Nelson
- Theodore Roosevelt
- Margaret Murie
- Frances Hamerstrom
- Jimmy Carter
- Izaak Walton
- Sylvia Earle
- Aldo Leopold
- John Muir
- C.D. "Buzz" Besadny
- Rachel Carson
- Ansel Adams
- Sigurd Olson

Service Learning: Have students work with a community group or elementary school to plan a fishing outing for younger children. Ask them to plan an experience that is both safe and enjoyable for the children. Remember, students 16 and over need a fishing license.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

Notes

Forward Thinking

At the start of Iroquois council meetings council members would invoke this declaration: "In every deliberation we must consider the impact on the seventh generation." When making a decision, a representative spoke for the needs of those who would follow 150 years, or seven generations, from that moment. How can we learn from this idea?

Great Conservationists

Fishing is an amazing way to enjoy the outdoors, learn about the natural world, spend time with family and friends, explore the state, and catch fabulous food. But maintaining a healthy fishery requires our attention and care. The future of fishing in this state rests in the hands of those who regularly use it. If you think fishing is a valuable and important pastime, it's up to you to make your voice heard and your opinions matter.

Through the ages individuals have made decisions and developed personal ethics that are helpful in guiding our own decisions today. Great thinkers since ancient times have heard a call for stewardship of the earth and all of its inhabitants. Native Americans and leaders of religious movements continue to reflect on the spiritual aspects of water resources and fish and recognize that the health of the water is linked to humankind's existence. Modern leaders from around the world have stepped on the path of environmental activism, bringing awareness of natural resources to a society increasingly unaware of them, yet just as dependent on them.

Through the Eyes of Another

Research the environmental views of an artist, or a scientific, civic, or spiritual leader. What were his or her contributions to the environment? What evidence did you find to support these contributions (art, books, speeches, projects, public service)? What struggles or challenges did he or she encounter in protecting natural resources? Did his or her commitment to the environment erode or strengthen over time? In what way? Explain his or her beliefs about what responsibility people have to protect the environment.

Wise Elders

Each of the following leaders had different viewpoints about why and how we should care for the earth. As a caretaker of the earth yourself, you can learn from their experiences. Choose one of the quotes below to reflect on in a one-page response. Do you agree or disagree with the quote? Why? If you disagree with the quote, do you know of another quote that better matches your feelings about conservation? If you agree with the quote, what can you do in your own life to support it?

1) *"We abuse the land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."* - Aldo Leopold, Wisconsin ecologist, wildlife biologist, angler, and hunter.

2) *"The human race is challenged more than ever before to demonstrate our mastery—not over nature but of ourselves."* - Rachel Carson, marine biologist and nature writer.

3) *"We all have to take responsibility for the direction we are going. In our schools we are focusing on numbers and letters but we need, from the earliest times, to get across the concept that we are connected to nature and that we are trying to find a space to sustain ourselves."* - Sylvia Earle, marine biologist, National Geographic Explorer-in-Residence and *Time Magazine*'s first Hero for the Planet.

4) "*The most important environmental issue is one that is rarely mentioned, and that is the lack of a conservation ethic in our culture."* - Gaylord Nelson, Governor and State Senator of Wisconsin and founder of Earth Day.

5) *"The conservation of natural resources is the fundamental problem. Unless we solve that problem, it will avail us little to solve all others."* - Teddy Roosevelt, U.S. President, Nobel Prize winner, conservationist, and rancher.

The Wealth of Nature

> "The economy is a wholly-owned subsidiary of the environment, not the other way around." Gaylord Nelson

Swimming Upstream

You too can be a great conservationist! There are direct and indirect paths to helping protect our natural resources. Some people choose to dedicate their lives to natural resources in careers at conservation organizations like the DNR.

The future of fishing in this state rests in the hands of those who regularly use it.

If you are planning a career in natural resources, check the DNR Website for a sampling of jobs in the field. If you see one that looks great, interview someone in that job to find out what skills you should be getting while still in school.

You can also check university Websites to see what types of courses they offer for people interested in our natural resources.

You don't need a career in conservation to be a conservationist. No matter what career you choose, artists, economists, cashiers, mathematicians, and flight attendants, to name a few, can all advocate and volunteer on behalf of our natural resources. There are many ways to stay involved with and learn more about Wisconsin's fish and waters. Here are a few suggestions:

- Take a friend fishing. One of the best ways to gain support for the resource is to introduce others to it.
- If you like trout fishing, or are interested in starting, contact Trout Unlimited to see if they have a chapter near you. You could help with a restoration effort or meet others who want to help trout.
- Start a fishing club at your school or join one in your community.
- Speak up! Write letters to your representatives and senators about your resource concerns and vote as soon as you are eligible.
- Get outside. Being an active observer is the first step to working for the changes you would like to see.

It's not always easy to improve our natural resources, but neither is it to swim upstream and plenty of fish do it every year. Keep your eyes on the water and your mind open. Even if you don't continue fishing, you will continue to live in a world where water resources and aquatic wildlife will play a role in the health and stability of our planet. Don't lose touch with the water in your world!

Cheap Date

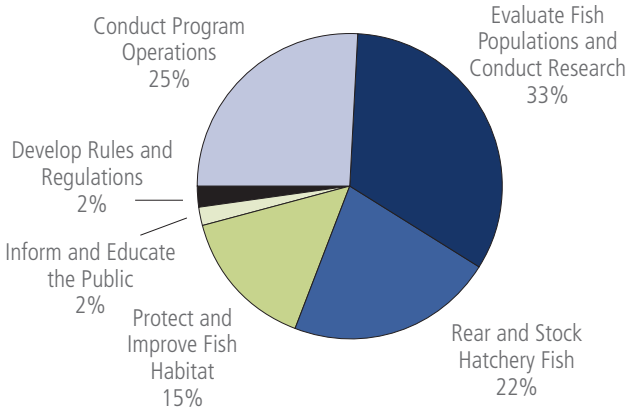
Take your date or a pal fishing! After a small annual investment, you can fish 365 days a year with whomever you want. Many Wisconsin communities are situated on or near fishable waters. Pack a picnic, call a friend or two, hop on your bike, and head for the water's edge.

Compare the cost of a day of fishing to other leisure activities.
Consider total costs of participation and how often you can use your investment. Here are some examples:

ACTIVITY	MINIMUM REQUIREMENTS	COST	ONE-TIME USE OR OPPORTUNITY	MULTIPLE USES OR OPPORTUNITIES
Fishing	License & Stamps Rod Reel Bait Tackle Other:			
Prom	Ticket Clothes Dinner Flowers Special Transportation Other:			
A night out Several options: movie, food, gasoline. List what you would do.				
A night at home Several options: games, music, snacks. List what you would do.				

Where does your license money go?

Money collected through the Sport Fish Restoration Fund and fish license fees funds the fisheries program at the Department of Natural Resources. Within the fisheries program, the money gets divided into many different projects, illustrated in the pie chart below:



All that for less than the cost of one night on the town!

Data from 2006 DNR Fishing Report

A love of fishing has inspired generations of anglers to pay close attention to natural resources. Invite a friend to join you in enjoying the beauty and excitement that fishing offers. Maybe he or she will become a *great conservationist*.

NAME

PEOPLE KNOWLEDGE

Section B
Vocabulary Review

This review is not found in the student guidebook and may be used as a test. Copies may be made for students.

Fill in the blank using the words below.

1. A _____ is where fish eggs are taken to provide suitable habitat for hatching.

2. The process by which contaminants fall to the ground in rain or snow after traveling long distances in air currents is called _____.

3. _____ can be accelerated by human activity and damage fish spawning habitat when loose soil is carried into a waterbody.

4. PCBs are called _____ because they do not break down in the environment.

5. When communities consider the long-term environmental and cultural effects of their land use decisions, they are designing for _____.

6. _____ is the build-up of substances, such as pesticides or other toxins, in an organism.

7. An action or agent that negatively affects an organism is called a _____.

8. The process by which fish habitat is deliberately improved by land managers and concerned citizens is called _____.

9. Dams can _____ fish habitat and communities by blocking fish movement between the above dam and below dam areas.

10. Water (rain and snowmelt) that flows over land into a water body is called _____.

Word Choices

sustainability	persistent organic pollutants	erosion
fragment	weathering	bioaccumulation
hatchery	atmospheric deposition	restoration
runoff	enduring chemicals	stressor

PEOPLE KNOWLEDGE

Section B Section Assessment

Return to the scenario given at the beginning of **PEOPLE KNOWLEDGE** to apply the concepts covered in this section in a discussion: "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 locals solve the problems you discover?"

Students should realize that erosion (due to the removal of shoreline vegetation) and runoff pollution could be major factors in the changes observed in the river. Students should recognize that the habitat demands of trout are very particular and differ from those of a catfish, and that the change in fish populations indicates a change in the river's temperature and dissolved oxygen content. Students should consider using a shoreline survey to find where erosion is likely occurring and a water quality survey to determine temperature and dissolved oxygen content. Local residents could work to stabilize riverbanks with vegetation.

Section Assessment Activity

Divide students into teams of two or three. Have each team research one or more local water quality or aquatic habitat concerns relating to nonpoint source pollution, exotic species, or shoreline development. Each team should write newspaper articles describing the problem, its biological or ecological roots, and management decisions that are affecting the issue either positively or negatively. Each article should end with a short description of what the reader can do about the concern. Once all articles are turned in and edited, a newspaper could be created and distributed to other classes.

PEOPLE KNOWLEDGE

Vocabulary Review

Answer Key

1. hatchery
2. atmospheric deposition
3. Erosion
4. persistent organic pollutants
5. sustainability
6. Bioaccumulation
7. stressor
8. restoration
9. fragment
10. runoff

Glossary

Adaptation
a physical, chemical, or behavioral change made by a species or an individual organism which improves its relationship to its environment

Assessment
the action of determining the amount or value of something

Atmospheric deposition
nonpoint source pollution that travels through the air and is deposited on land and water

Bag limit
the number of fish of a certain species from a certain body of water that an angler can keep on a single day

Barbels
slender, whisker-like taste receptors found on certain fish, such as catfish, bullheads, and sturgeon; used to find food

Benthic Zone
the bottom of a lake

Bioaccumulation
the build-up of substances, such as pesticides or other toxins, in an organism

Biomass
the total mass of live plants and animals in a given area

Chordate
animal that belongs to the phylum Chordata (has a notochord for at least part of its life cycle)

Conservation Congress
the citizen group that suggests regulation changes to the Natural Resources Board

Consumer
an organism that cannot produce its own food and must eat other organisms to survive

Degraded
lowered to a less desirable or less diverse level

Dichotomous key
a system of classification used to identify organisms by moving from broad differences to specific distinctions

Dissolved oxygen
molecules of oxygen mixed into water

Distal
located away from the central point or origin

Distribution
the range, or geographic locations, of an organism

Dorsal
located on the back of an animal

Dynamic
continually changing

Ecology
the study of the interrelationship between environments and organisms

Ecotone
a transition area between two different ecological communities

Ecosystem
closed communities of interdependent plants, animals, and non-living factors

Effluent
waste material released into the environment

Emergent
near-shore plants rooted in shallow water with most vegetative growth above water

Epilimnion
the top layer of lake water, often warmest in the summer and frozen in winter

Erosion
the process of soil and other natural materials being worn away

Eutrophic
characterized by having a high level of nutrients; often used to describe a lake or pond with low oxygen and thick plant growth

Eutrophication
the process of adding nutrients to a waterbody

Exotic species
species that live in environments where they are not native

Extirpate
a species that has disappeared from part of its native environment, but is not extinct

Fingerling
a young fish

Floating leaf
plants rooted in the lake bottom; their leaves and flowers float on the water surface

Fragmentation
the process of dividing landscapes or watersheds into parcels that are isolated

Fry
newly-hatched fish

Harvest
to gather, catch, hunt, or kill for human use, sport, or recreation

Hatchery
a place where eggs are hatched, either human-made or natural

Headwaters
the origin, or beginning, of a stream or river

Hypolimnion
The bottom layer of lake or pond water

Inferior
located nearer the lower extremity of a body

Invasive species
an exotic species that tends to spread, causing environmental or economic harm

Land cover
the visible features on a landscape

Land use
the cultural and economic activities that take place on a landscape

Lateral
located on or near the side of the body

Lateral line
a canal along the side of a fish containing pores with sensory organs that detect vibrations

Limiting factor
a factor in the environment that limits the growth, abundance, or distribution of organisms in an ecosystem

Limnetic zone
the open-water zone away from shore where light is abundant

Littoral zone
the shallow area of a lake or pond where plants are able to grow

Marsh
a wetland that is rich in plant life, especially grasses and cattails; excellent fish spawning habitat

Medial
located near the middle (mid-line) of the body

Mesotrophic
characterized by having a moderate amount of nutrients

Moratorium
the suspension of an activity for a period of time

Morphology
the shape or structure of an organism

Mouth
the end of a stream or river, where it empties into another waterbody

Native species
a species that lives in its natural environment

Natural Resources Board
a group of citizens selected by the governor which makes policy decisions for the Wisconsin DNR

Natural selection
the process that results in the survival and reproductive success of individuals or groups best adapted to their environment

Neurotoxin
a poison which affects the brain or nervous system

Niche
the specific role an organism or a population plays within an ecosystem

Nonpoint source pollution
contamination that comes from many sources across a landscape; often carried into waterbodies by runoff

Notochord
a flexible, primitive backbone that provides support in chordate embryos. As vertebrates (the highest class of chordates) develop, the notochord is replaced by spinal vertebrae.

Oligotrophic
characterized by having few nutrients

Persistent organic pollutant
a contaminant that does not break down easily or quickly in the environment

Physiology
the study of the functions of living organisms

Phytoplankton
microscopic floating plants

Poikilotherm
an organism that cannot regulate its own body temperature; the temperature of the organism matches that of the surrounding environment

Point source pollution
a particular, identifiable source of contamination

Primary producer
an organism which creates its own food through photosynthesis

Profundal
deep dark lake zone below the limnetic zone

Proximal
located near the center of the body

Public Trust Doctrine
a body of common law that protects navigable waters for the common good

Redd
the nest or spawning ground of a fish

Regulation
a rule dealing with details or procedures

Restore
to repair damage (in this case, to an ecosystem)

Rheotactic
orienting upstream

Rule of 10
a law of nature that says that approximately 10 percent of available energy passes from one trophic level to the next and the rest is lost as heat

Runoff
precipitation not absorbed by the soil; often carries nonpoint source pollution with it into a waterbody

Spawn
to produce and deposit eggs (generally refers to fish, amphibians, and mollusks)

Stakeholder
a person who has an interest in a decision, but is not responsible for making that decision; for example, a private landholder may be a stakeholder in a decision the county makes about the stream running through her property

Stewardship
the careful and responsible management of something

Stock
the act of putting quantities of fish in a lake, stream, or other waterbody for recreational or scientific purposes

Stratify
to become layered; lakes are stratified by temperature

Stressor
an action or agent that puts stress on an organism

Submerged
rooted plants that grow entirely underwater, although some leaves may float above water. They grow from near shore to the deepest part of the littoral zone.

Substrate
the layer of material, such as clay or gravel, found on the bottom of a waterbody

Superior
located higher on a body, nearer the upper extremity

Sustainable practices
the use and management of a resource that meets the needs of the present generation without compromising the ability of future generations to meet their own needs

Swim bladder
the swim bladder (also gas bladder or air bladder) is an internal gas-filled organ allows a fish to control its buoyancy and depth in the water.

Taxonomic groups
a group of closely related plants or animals

Terrestrial
land-based, not aquatic; as in a terrestrial organism or habitat

Thermocline
a layer of water in a lake in which the temperature change is most abrupt; found below the epilimnion

Thermoregulate
to maintain a constant body temperature; humans thermoregulate, fish do not

Tragedy of the Commons
unsustainable rates of use or abuse of a resource held in common

Tributary
a stream or river that flows into a larger stream or waterbody

Trophic level
feeding position in the food pyramid; primary producers are the lowest trophic level

Ventral
located opposite the back, on the front or belly

Vertebrates
animals with backbones

Watershed
a region or area that all drains to the same body of water

Wetland
an area that is a transition between an aquatic and a terrestrial environment; saturated for at least one period of time each year

Zoning
division of a city (or other region) into sections reserved for certain purposes (homes or businesses)

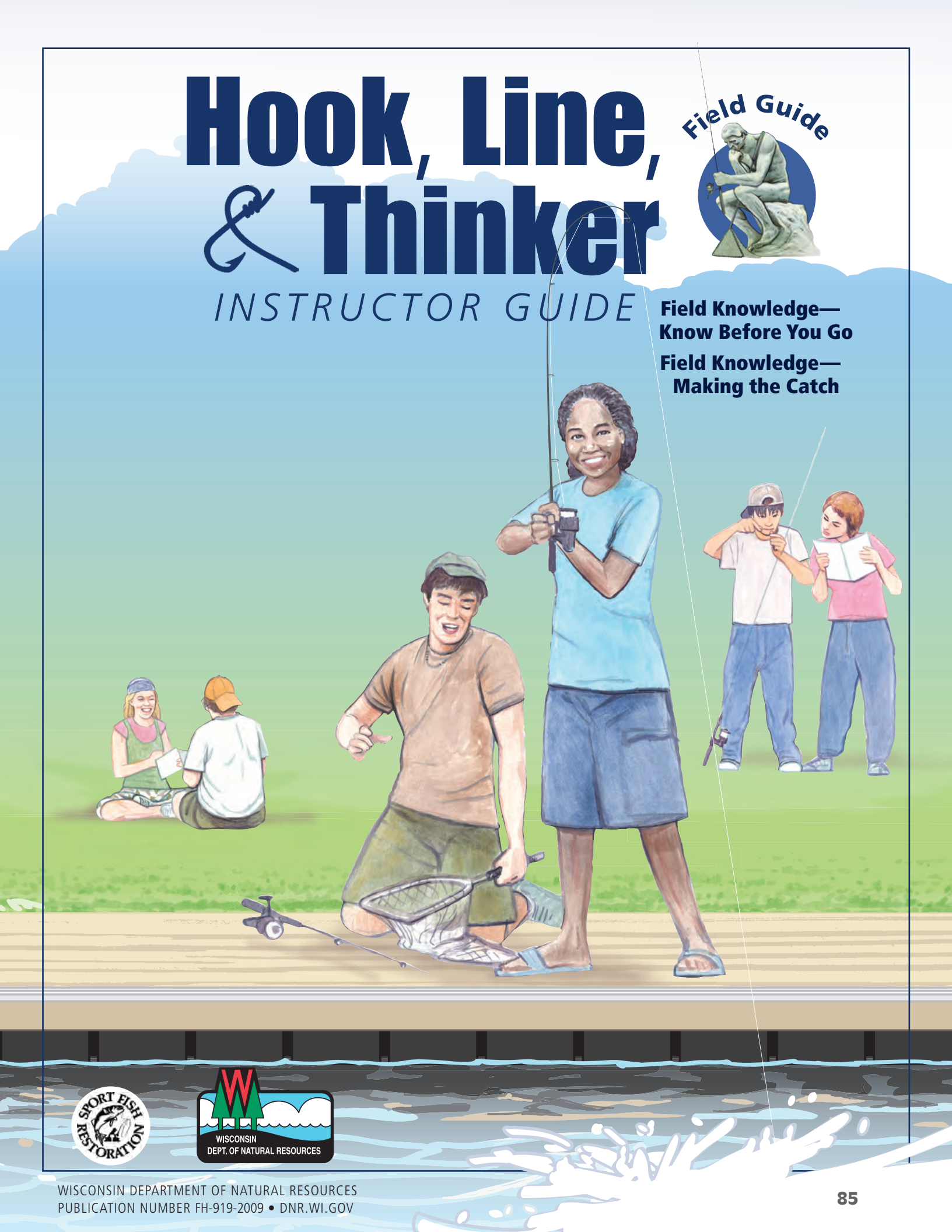
Hook, Line, & Thinker

Field Guide

INSTRUCTOR GUIDE

Field Knowledge—Know Before You Go

Field Knowledge—Making the Catch



SPORT FISH RESTORATION

WISCONSIN DEPT. OF NATURAL RESOURCES

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
PUBLICATION NUMBER FH-919-2009 • DNR.WI.GOV

Select a fish that lives in Wisconsin that you would like to learn more about. Use this worksheet to profile the fish as you work through the different sections of this booklet. If each of your classmates selects a different fish, your classroom will know how to catch just about anything!

PLEASE SEE APPENDIX A
Profile of a Swimmer: Wisconsin's Game Fish

Profile of a Swimmer

Common Name(s): Black bullhead

Scientific Name: *Ameiurus melas*

INSTRUCTORS: Underlined content is not provided in student manual.

SENSE	FEATURE AND DESCRIPTION	IMPORTANCE TO FISH (HIGH, MEDIUM, LOW)
Sight	Small eyes, relies on other senses	low
Smell	Nares (nostrils)	high
Hearing	Inner ear receives amplified sounds via swim bladder acting as sound chamber	high
Taste	Taste buds on whiskers and skin	high
Touch	Whisker-like feelers on barbels	high

Identifying Characteristics: Their whiskers are black like those of the brown bullhead, but yellow bullheads have white ones. They have smooth spines on their dorsal and pectoral fins. Their lateral lines are very thin.

Natural Food: They are scavengers and will eat almost anything dead, animal or plant.

Habitat Description: They are demersal (bottom-dwelling) and can live in murky water with low oxygen content. They are widely distributed throughout Wisconsin in shallow bays and along shorelines.

Niche (role): They feed on the bottom and are active at night.

Spawning habits and habitat: The female digs a saucer-shaped nest with her fins under plants, logs, or overhanging banks. Both parents tend the nest of eggs until spawning is completed. As the eggs hatch, the male continues to protect the fry by herding them in a tight little ball until they are about one inch long.

Environmental stressors: Bullheads can do well in polluted waters, because they don't need much oxygen. They can become problems for game fish if there are too many of them stirring up sediments on the bottom.

Tackle and Bait: _____ Bag Limit: None

Is there a health advisory for this fish? if so, where? Yes. There is an advisory in Cedar Creek, the Fox River, the Manitowoc River, the Twin River.

Any restoration or stocking efforts for this fish? No

Good to eat or simple recipes? When taken from clean water, bullheads are good to eat. Fried bullhead recipe: Roll in flour with salt and pepper, fry in hot oil in a skillet until golden. Drain on a paper towel.

Other interesting facts about this species (list 5): Their black backs camouflage them from predators flying above and their white bellies camouflage them from predators swimming below. They do not have scales. They can easily overpopulate an area and become stunted. They sometimes burrow in mud for the winter. The world record black bullhead was eight pounds.

Sources: Various DNR publications

Welcome, Anglers!

You are holding a guidebook that will provide you with **Field Knowledge** to take you through the various steps of fishing. This booklet is organized into two main sections: **Section A**, **Field Knowledge—Know Before You Go** and **Section B**, **Field Knowledge—Making the Catch**.

In Section A, Know Before You Go, you will learn about:

- fishing equipment
- techniques
- regulations
- safety considerations

You will build on what you learn in this section when you go outside for an actual fishing trip. Section B, Making the Catch guides you through:

- reading the water
- catching a fish
- deciding whether or not to keep your fish
- cleaning your catch
- cooking your catch

This booklet can be paired with the *Hook, Line, & Thinker: Science Guide* that focuses on the biology, ecology, and management of fish in Wisconsin. Even when done together, however, these booklets are not detailed enough to make you an expert angler. Fishing is a life-long adventure and the more you fish, the more you'll learn.

Be sure to thank your teacher and community members for offering you this chance to get outside and test the waters. We wish you the best in making an exciting catch and hope you will enjoy angling for many years to come!

In this booklet:

The Scene

You and your friends are out fishing on Devil's Lake. You've each caught and kept your limit of one northern pike for the day, but the weather is perfect and you're all enjoying yourselves so much that you decide to keep fishing for a few more hours. If you catch any more fish, you'll release them. You sit back to watch the hikers on the ridge, when suddenly your bobber sinks and your line goes taut. You pick up your rod and struggle to reel in what turns out to be the largest northern pike you've ever seen! It's much bigger than the fish you caught several hours ago and would feed many more mouths. What would you do? Would you keep it or release it? Why? If you release it, how will you go about making it a safe release for the fish?

INSTRUCTORS: Answers found in Section Assessment on page 128.

SECTION A

Field Knowledge—Know Before You Go

Knowing when to keep a fish and when to release it is an important part of being a responsible angler. In this booklet you will learn about the gear, techniques, and skills necessary for fishing, but most importantly you will learn some guidelines on how to be an ethical and responsible angler. It will be up to you to put these ethics into action!

Fishing is an excellent way to connect with the water world around you while relaxing with friends and family. But first you need to select your tackle, practice your casting, and make sure you have a handle on water safety and fishing regulations.

SECTION A

Field Knowledge—Know Before You Go

Tackling Tackle

OBJECTIVES: Students will be able to:

- recognize various pieces of tackle and match them to their functions
- describe several lures and the fish that might be attracted to these lures
- assemble a tackle box to catch a certain species of fish

METHOD: Divided into two teams, students will compete in a game similar to Twenty Questions to identify mystery tackle. Students will work in pairs to create an appropriate tackle box for a certain species of fish.

MATERIALS:

1) Rods and reels

2) Hooks

3) Bobbers

4) Sinkers

5) Lures

6) Baits

Optional: a clear tank filled with water and fishing line

See Appendix K for Tackle Cue Cards; print on sturdy paper

*Tackle is available for loan through the Tackle Loaner Program. See the DNR's Website for details: **dnr.state.wi.us/fish/kidsparents/loanerequipment**

SETTING: Indoors or outdoors

DURATION: One or two 45-minute periods

VOCABULARY: Tackle, rod, reel, guides, cast, spinning gear, baitcasting gear, spincasting gear, fly-fishing gear, line, hook, bobber, sinker, snap, swivel, bait, lure, plug, spoon, spinner, spinnerbait, jig, plastic tail, pork rind, marabou, fly, popper.

STANDARDS:
Physical Education: C 8.1, 8.3, 12.2, 12.4.
Science: G.8.3, 8.7

BACKGROUND: To be effective anglers, students need to understand the function of each piece of tackle and how that tackle is adapted to catch a particular species of fish.

OPENING: Allow students to familiarize themselves with the tackle. The tackle could be displayed on a table with labels or you could explain each piece of tackle and pass it around to students so they have the opportunity to closely examine it. Discuss the strengths and weaknesses of spincasting versus baitcasting, etc., and allow students who have fishing experience to share their opinions. If time and space allow, demonstrate how various lures move through the water by attaching each to a two-foot piece of line and dragging them through a tank of water at fast and slow speeds. Allow students to use their booklets to take notes on the tackle. This activity may take an entire class period.

MAIN ACTIVITY: Divide the students into two teams that will compete to guess mystery tackle. Decide whether or not they may use their booklets to help them in the game. Start by picking an angler from one team to describe a piece of mystery tackle. The angler is given a cue card describing the uses and characteristics of a piece of tackle. The opposite team will ask the first yes or no question about the mystery item. They may ask, for instance, "Does it float?" or "Is it used to catch trout?" Then the angler's team has an opportunity to either ask another question or to guess what the item is. An accurate guess will earn one point. An inaccurate guess will earn two points. Encourage teams to keep a record of the "yes" answers on paper to help them make informed guesses. At the end of the game, the team with the low score wins. Display the cue cards with their appropriate tackle at the end of the game for students to review.

CLOSING: Divide students into pairs and assign each pair a fish. Again, decide whether or not they may use their booklets during this task. Students will make a list of the gear they would

include in their tackle box if they were to go fishing for their assigned fish. They will turn their list in at the end of class for review. Keep these lists handy for the next lesson.

ASSESSMENT QUESTION: Name and describe three types of lures.

ANSWERS: *Plugs, spoons, spinners, spinnerbaits, jigs, flies, poppers, etc. are all described in* **Tackling Tackle**.

EXTENSIONS*:*

Art: Have students design and create their own fishing lures.

Service Learning: Have students work with a community after-school program or nearby elementary school to teach tackle-craft to younger children or start a school club to share their knowledge with their own peers.

See Appendix K for Tackle Craft instructions, transparencies, and games.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

1 Tackling Tackle

Newcomers to fishing are often overwhelmed when they step into a bait shop and face a wide variety of gear and gadgets. Anglers have a language all their own when it comes to tackle (gear), but fishing club members, bait shopkeepers, and probably some of your classmates are happy to translate. Where could you go for tackle advice in your community? Here are the basics to help you start a conversation and make the best selection for your fishing goals.

Fishing clubs, parents and friends who fish, tackle shops.

All you really need to fish is a soda can, a piece of fishing line, a hook and some bait.

Hook, Line, and Sinker

All you really need to fish is a soda can, a piece of fishing line, a hook and some bait. If you wrap the line around the can about 50 times and thrust the can forward while letting the line release, you have a very inexpensive form of fishing tackle. Most people, however, find that a rod and reel help them better meet their fishing goals.

PLEASE SEE APPENDIX K
Tackling Tackle: Tackle Transparencies, Tackle Cue Cards, and Tackle Craft

Most rods (poles) are made of graphite, fiberglass, composites, or bamboo.

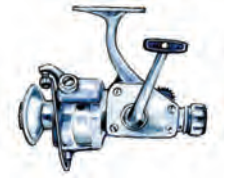
Rods and Reels

Rods and reels are two separate pieces of equipment, but they are almost always sold and used together. Most **rods** (poles) are made of graphite, fiberglass, composites, or bamboo. In general, the more high-tech the rod material, the more expensive the rod will be. Most rods have **guides** (loops) along their length to thread fishing line through. Rods can be as short as four feet or as long as 16 feet, but most are about six feet in length. In general, the longer the rod, the further you can cast. However, a shorter rod allows for greater accuracy.

Baitcasting reel

Reels are used to **cast** (send out) and retrieve fishing line. The reel attaches to the base of the rod. Many people, however, start fishing on the no-reel cane pole, the simplicity of which allows new anglers to focus on fish, rather than on gadgets.

The type of rod and reel you choose depends on the type of casting you will be doing.



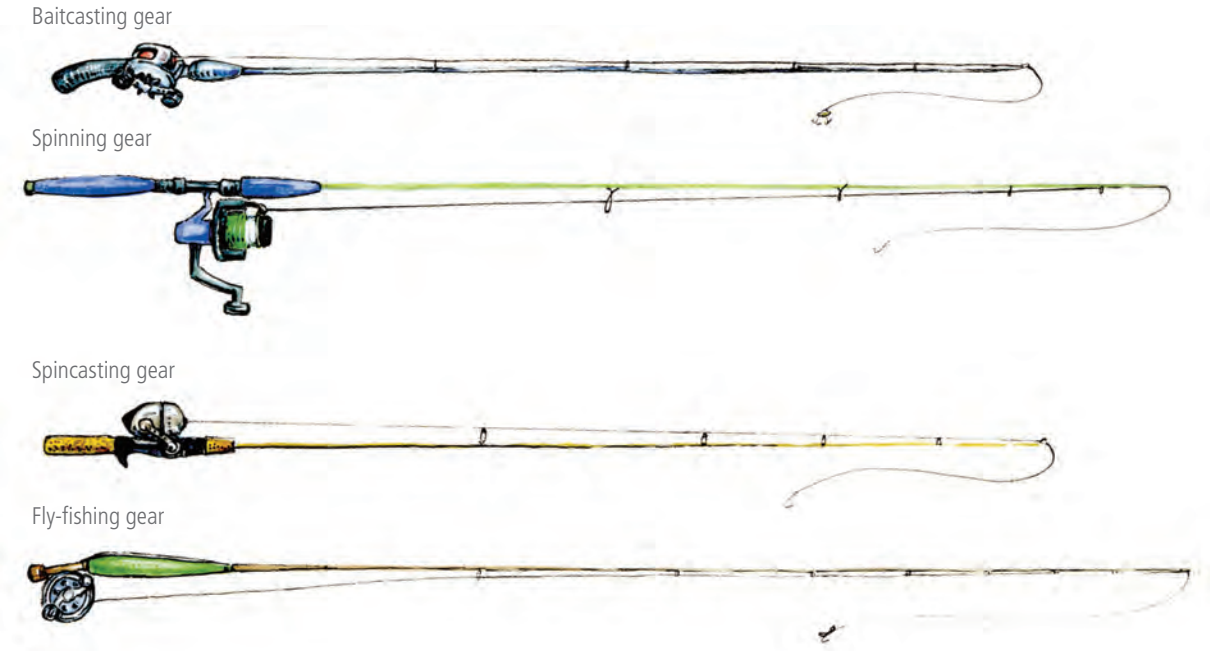
Spinning reel

Reels are used to cast (send out) and retrieve fishing line. The reel attaches to the base of the rod.

Spinning gear is designed for long, backlash-free casts and is effective with relatively light weights.

Baitcasting gear (also called "levelwind") is designed for precision casting and can be used with heavier weights and heavier line. Beware of the backlash though; baitcasting gear can leave your line in tangles.

Spincasting gear is similar to spinning gear, but has a button on the reel that makes it one of the simplest reels to use.



Rods and reels are two separate pieces of equipment, but they are almost aways sold and used together.

Fly-fishing tackle is very different from the others listed above. The reel is designed to store line, not to cast and retrieve, and the rod is long and limber. The angler does the casting, rather than the gear; it takes some skill and a lot of practice to become a successful fly angler.

Lines

Line comes in a variety of sizes and strengths.

Fishing line winds around the reel up through the guides on the rod and is tied off with a hook on the end. Line comes in a variety of sizes and strengths. There are four basic types: monofilament (meaning "one line"), braided, high-performance polyethylene, and fly line. The type you choose depends on your rod and reel, the fish you plan to catch and the bait you will be using. The higher the "pound test" on the line, the stronger it is. A 10-pound test line should break when a fish pulls back with 10 pounds of force or more. Lines are actually under-rated to allow for knots, the weakest point on your line. For optimal castability, look for limp, 8-pound test line.

There are four basic types of fishing line: (top left) braided, (top right) monofilament, (bottom left) fly line, and (bottom right) high-performance polyethylene.

Hooks

There are many fish hook styles and sizes, and you will want to try to match the hook size to the size of your intended catch's mouth. Hook sizes work the opposite of what one might logically expect. The larger the number, the smaller the hook. So a no. 24, used for fly-fishing, is tiny and much smaller than a no. 2. It might seem, then, that there would be no hook larger than a no. 1. There are, but sizes larger than a no. 1 add a "/0." So the next size up is a 1/0, then 2/0, 3/0 (pronounced "three-oh" or "three-ought") and so on. At this end of the scale, the larger the number the larger the hook, so a 12/0 is larger than a 2/0.

The larger the number, the smaller the hook. So a no. 24, used for fly-fishing, is tiny and much smaller than a no. 2.

Buy Local!

Take a guess: how many large tackle manufacturers are based in Wisconsin?

If you guessed over 30, you're correct. With a little pre-shopping research, you could boost Wisconsin's manufacturing industry by assuring that your rod, reel, spoons, spinners, plugs, tackle box, artificial baits, and lure components were all produced in the state. In the 2006–2007 fishing season, anglers spent $2.75 billion dollars on their hobby here in Wisconsin. What better way to help the economy than to go fishing?

Bobbers

Also known as "floats," bobbers have two jobs: to hold your bait at the right level in the water and to help you detect bites. Bobbers are Styrofoam® or hollow plastic and are attached to the line. When a bobber dips down, you might have a fish (or maybe a stump!)

Also known as "floats," bobbers have two jobs: to hold your bait at the right level in the water and to help you detect fish bites.

Sinkers

Sinkers are weights to help get your bait and hook under the water. There are many different sinker shapes and weights. Choose one that meets your needs—but avoid ones with lead. Lead poisons wildlife. Many anglers have turned to non-lead alternatives. Tin and bismuth sinkers are lighter, so you need more of them to sink your bait.

Sinkers are weights to help get your bait and hook under the water.

Snaps and Swivels

Snaps are used to connect a hook or lure to the line, and swivels are used to prevent the line from twisting. The number one mistake beginning anglers make is to add too many snaps and swivels. Try starting without snaps and swivels and only add what you need.

Snaps are used to connect a hook or lure to the line, and swivels are used to prevent the line from twisting.

Luring Them In

The method you choose to entice a fish to bite depends entirely on what species of fish you want to catch. Your attention-grabbing item could be live bait or an artificial lure. Both serve the same purpose of luring in the fish either by offering something to eat or something to attack.

Bait

Worms, grasshoppers, live minnows, and dough balls are common baits you can slip onto your fishing hook. Not all baits are legal at all times so check the regulations before you drop your line in the water.

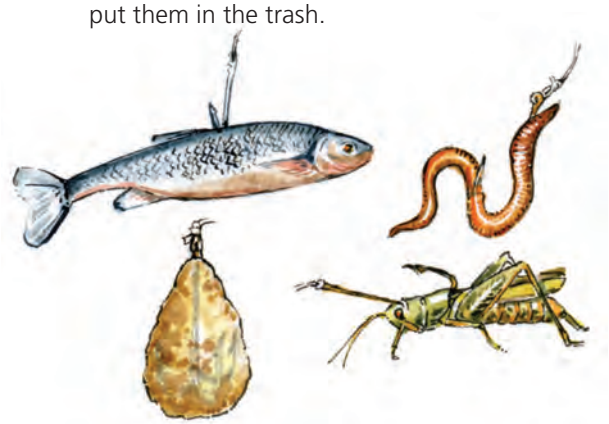
Obtaining bait is easy, but what to do with it after a day of fishing requires some thought.

Transferring bait from one waterbody to another is prohibited due to concerns about spreading invasive species and viral hemorrhagic septicemia (VHS).

Lead poisons wildlife. Many anglers have turned to non-lead sinkers.

In order to prevent the spread of VHS, it is illegal to harvest wild minnows, both commercially and for personal use, from all known and suspected VHS waters. It is also illegal to possess or use minnow harvesting gear on any of the VHS waters. A current listing of these waters is posted on the DNR's Website.

Worms are another matter. All common bait worms are non-native and often become invasive. They can change the species composition of the forest by devouring the leaves that would normally decompose slowly and provide important soil nutrients for tree seedlings, wildflowers and ferns. So, just like you wouldn't dump your leftover minnows in the water, don't dump your worms in the woods; put them in the trash.



Live minnows, worms, dough balls, and grasshoppers are all forms of bait that you slip onto a hook when fishing.

Lures

Lures are designed to resemble natural fish food, grab a fish's curiosity, or just make a fish mad enough to bite. Lures come in a variety of shapes, sizes, and colors. They're fun to look at and to make.

A **plug** is a casting lure, usually made of wood or plastic. It is designed to imitate a small fish or other aquatic animal moving on the water or below the surface. The actions of the angler make plugs dip, dive, rattle and thrash like live prey. The faster you retrieve a wooden plug, the deeper it will "swim."

Plug

A **spoon** is a curved, tapered slab of metal designed to wobble or flutter upon retrieval. As it is retrieved, the spoon will catch light and flash, attracting a fish's curiosity. Spoons may be fished at virtually any depth.

This well-proven spoon for northern pike is most effective when fished slowly, just off the bottom.

A **spinner** is a wire shaft with a treble hook at the bottom and a blade that spins (revolves) when pulled through the water. A variation of this is the spinnerbait, a weighted lure with one or two spinning blades set over the hook. It spins around a shaft that looks like a safety pin. Spinners also attract fish by catching and reflecting sunlight.

Spinners attract fish by catching and reflecting sunlight.

The most common freshwater **jig** is called a leadhead, which is a piece of lead molded onto a hook. It is baited with a plastic tail, pork rind, or marabou (described below).

Anglers allow the jig to sink, then quickly jerk it up, then allow it to sink again. This action is called jigging. Jigs may also be trolled or reeled in at a steady or irregular rate at any depth or speed. Consider choosing a non-lead jig to protect birds and other wildlife.

The most common freshwater jig is called a leadhead, which is a piece of lead molded onto a hook.

How Many Hooks are Legal?

The regulations state that you can fish with only three hooks, baits, or lures. What does that mean for lures with treble hooks? A treble hook has three points and some lures have three treble hooks or nine points, but still are counted as one bait or lure. So, you can fish with three lures that have treble hooks. You'll learn more about regulations later.

Plastic tails, **pork rind**, and **marabou** are generally fished behind a jig or a weight. Plastic tails come in a tremendous array of shapes, colors, sizes, and even flavors! They imitate worms, eels, frogs, or salamanders. Many have curly-cue ends that wiggle upon retrieval.

Very thin, colored, cured strips of pork skin are appropriately called pork rind. Pork rind has amazingly lifelike action in the water and, although more expensive than plastic, is tougher and can't be pulled off a hook.

Marabou is a type of feather that takes on lifelike movements in the water.

Plastic tails

Pork rind attached to a spoon

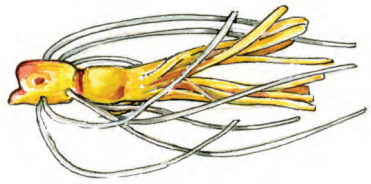
The marabou lure imitates the mayfly nymph, a favorite food of trout.

Fish will bite on **flies** that imitate what they would encounter in nature, so anglers need to "match the hatch" or choose flies to match the insects that are currently on the water.

Wet flies are used below the surface while **dry flies** float on the surface.

The dry fly (left) is a Traun-wing caddis; it mimics the veining of a caddis fly's wing. The wet fly (right) imitates the woolly bear caterpillar.

Poppers are bug-like flies that, because of their shape, pop when pulled along the surface.



Popper

A few other fishing essentials are listed below. What else would you add to this list?

Line clipper

Pliers

Life jacket or personal flotation device (pfd)

First aid kit

Sunglasses

Sunscreen

Drinking water

Don't Catch Birds!

A major cause of wildlife entrapment is fishing line that has been cut loose and left as litter by anglers.

Good fishing ethics include proper disposal of old line when you re-spool your reel with new line. Patronize local bait shops that will recycle old line.

Know Your Fish

Your choice of equipment, bait, and technique when fishing all depend on the fish you are hoping to catch. Here is an easy chart that you can use to help you make the right choices.

FISH SPECIES	PREFERRED HABITAT	EQUIPMENT CHOICE	BAIT	PRINCIPLE FOOD	TECHNIQUE
Bluegill Pumpkinseed	shallow, fertile, warm waters often around weeds	light tackle: poppers, flies, bait	worms	insects	jiggle bait, depth is key
Crappie	open water, or near logs/weed beds; in cooler water in summer	bait casting rod with light line	minnows or small jigs or spinners	insects, fish	early morning is best
Largemouth Bass	warm water with cover such as lily pads and weed beds	medium bait casting or spinning rod	weedless artificial worms, minnows	fish, crayfish	casting into cover is best
Smallmouth Bass	rocky substrate, deep and cool water in summer	medium spin casting or bait casting, fly rod on occasion	hellgrammite, crayfish, dragonfly larvae	fish, crayfish, insects	quiet casting near old logs or rocks, deep holes
Perch	cool open water	light casting or spinning	minnows, worms	insects, fish	find a school, jig bait in the school
Walleye, Sauger	shallow at night, deep during day	medium casting	leeches, night crawlers, minnows, small plugs	insects, fish	trolling or casting in known habitats
Salmon	open water of Great Lakes	heavy trolling with downriggers, heavy casting in fall	plugs and spoons when using down-riggers on open water; spawn bags of fish eggs and streamer flies on tributaries	insects, fish	trolling in open water around epilimnion
Brook Trout	head of streams, small pools	fly rod or light casting in streams	flies, worms, minnows, small spinners	insects, fish	quietly using flies in pools
Brown Trout	deep pools or rocky ledges of streams	fly rod or light casting	flies, worms, minnows, small spinners	small minnows, crayfish, fish eggs, insects	May to June using dry flies
Rainbow Trout	cold, clear stream	fly rod or light bait casting	flies, worms, minnows, small spinners	minnows, insects	fly-fishing at night is best
Catfish, Bullheads	shallows at night	medium casting	stinkbait	fish, mollusks, insects	use their sense of smell against them
Northern Pike	weed beds	heavy casting or spinning	rapalas, bait fish	fish	casting in weed beds
Muskellunge	weed beds and old logs	heavy casting or spinning	live suckers or large plugs, spoons, and bucktails	fish	10,000 casts

Notes

Got Skills?

OBJECTIVES: Students will be able to:

- tie basic fishing knots
- assemble terminal tackle for certain fish
- demonstrate basic casting techniques

METHOD: Students will tie knots using ropes and then advance to fishing line. Students will work in teams to assemble terminal tackle. Students will practice casting.

MATERIALS:

1) Rope for each student to practice tying knots
2) Eye bolts or shower curtain rings for practice "hooks"
3) Hooks in various sizes
4) Fishing line
5) A variety of rods, reels, and lures
6) Tires, hoops, or Backyard Bass™ to use as casting targets

See Appendix L for **Get Rigged** Information Sheet

SETTING: Outdoors or in a large indoor space (for example, a gym)

DURATION: Two to four 45-minute periods

VOCABULARY: Arbor knot, Improved Clinch knot, Palomar knot, Clinch knot, Blood knot, Nail knot, Uni knot, terminal tackle.

STANDARDS:
Physical Education: B 8.1, 8.3, 12.1, 12.2; C 8.1, 8.3, 12.2, 12.4, F.8.2, 12.6.

BACKGROUND: Knot-tying, terminal tackle assembly, and casting are all vital components of angling. Give your students time to become confident in each of these areas before moving on.

OPENING: Have the students read through **Got Skills** in their booklets. Divide the room or field into three stations: one for knot-tying, another for terminal tackle assembly, and the last for casting. The third station should have at least four targets for the four different casting methods. Show students the three areas and take time to demonstrate a knot, a terminal tackle set-up, and a casting method.

MAIN ACTIVITY: Divide the class into two or three groups (two groups if doing casting on a separate day) and assign each group a station. If you have students who are experienced anglers, make sure they are divided up among the groups as assistants.

In the knot group, have students practice knots using rope and eye bolts or shower curtain rings before moving to hooks and fishing line. Let students know that you will be coming by to check on their progress and that you hope they will learn at least three knots by the end of the class. In the terminal tackle group, have the students divide into two teams. Each team will assemble several different rigs, based on the three different target species: a bluegill, a bullhead, and a walleye. Use the handout provided in Appendix L to inform students about tackle for the species. The teams will check each other's work. In the casting group, students will practice several different styles of casting using tackle and targets. Allow students at least 20 minutes at each station so they can begin to feel comfortable with the skills.

CLOSING: Once all teams have done all stations, have them complete a skills relay race. The race could consist of only one of the activities or a combination of all three.

ASSESSMENT QUESTION: Name four things you should consider when selecting your terminal tackle.

ANSWERS: *What type of fish you are seeking, where this fish lives, what the fish eats, and what method of casting works well for the fish.*

EXTENSIONS:

Service Learning: Have students work with a community after-school program or nearby elementary school or start a school club to share their knowledge with their own peers.

In Depth: Have students test the strength of their knots using the Knot-testing Experiment and basic physics principles in fly casting. Additional Math and Science Standards are addressed in these activities.

See Appendix L for Knot-testing Experiment Worksheet.

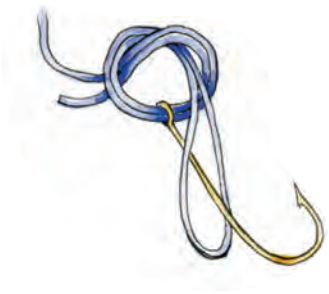
See Appendix L for *Joining Physics and Physical Education through Fly Casting*.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

2

Got Skills?

Fishing is a set of skills that can be quickly learned but will improve over a lifetime of experiences. To head out fishing you need to know how to tie knots, assemble tackle, and cast your line.



Palomar Knot

Knot—As Easy As It Looks

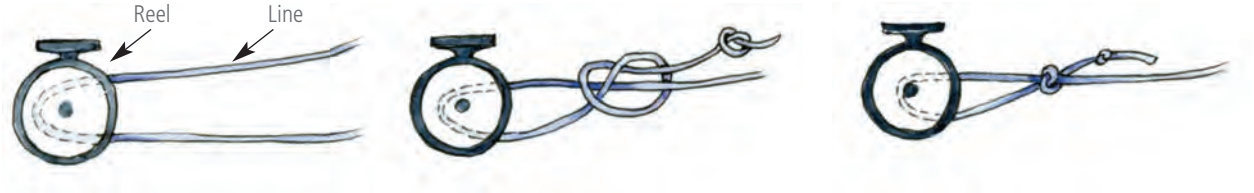
Before you can catch a fish, your hook or lure needs to be attached to your line with a knot. Every angler has a favorite knot, and all knots have certain purposes and advantages or work best on certain types of line. Review the knot diagrams in this section and tie knots using practice materials such as rope and a shower curtain ring. Once you've mastered a knot or two using practice materials, move to fishing hooks and fishing line.

Regardless of how well you tie your knot, the knot is always the weakest point on a line—the part most likely to break when a fish fights back. A great knot still only retains about 90% of the line's test strength. For this reason, test strength on lines is almost always under-estimated. A 10-pound line may actually test at 11 to 16 pounds of pull, but it is rated down to account for your knot.

PLEASE SEE APPENDIX L
Got Skills: Get Rigged
Knot -testing Experiment Worksheet

Tying Line to Reel

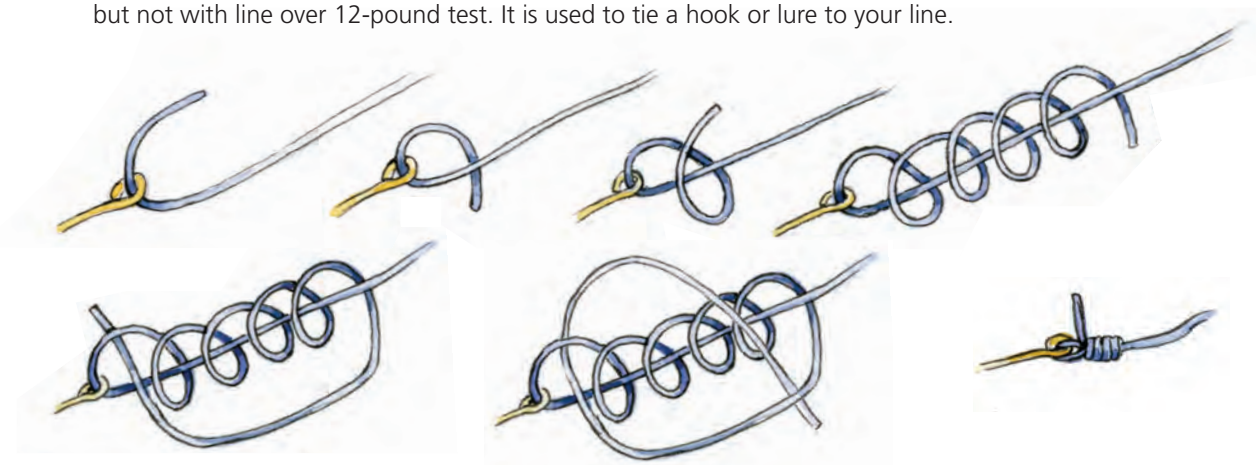
The **Arbor knot** is simple, easily learned, and effective. It is used most often to tie line onto a fishing reel, but is also used when setting up spinning reels.



Arbor Knot

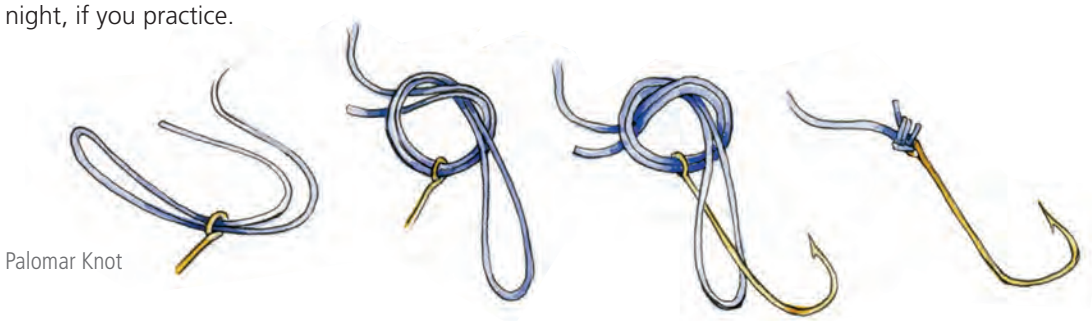
Tying Line to Hook or Lure

The **Improved Clinch Knot** is an angler's old standby. It works well on smaller line, but not with line over 12-pound test. It is used to tie a hook or lure to your line.



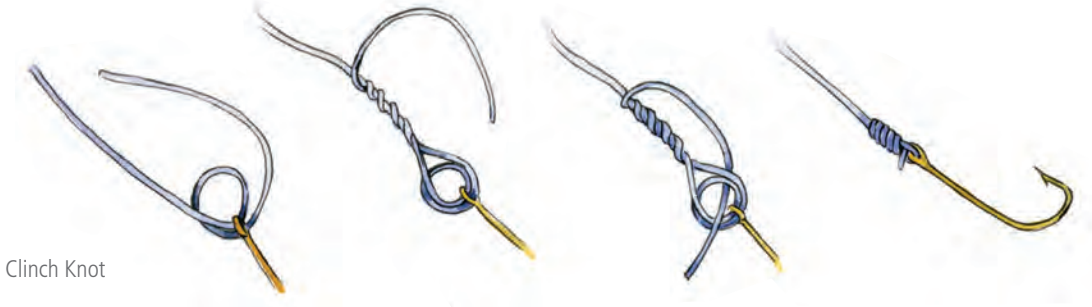
Improved Clinch Knot

The **Palomar Knot** is a strong and reliable way of tying a hook to a line. It can be tied in the dark of night, if you practice.



Palomar Knot

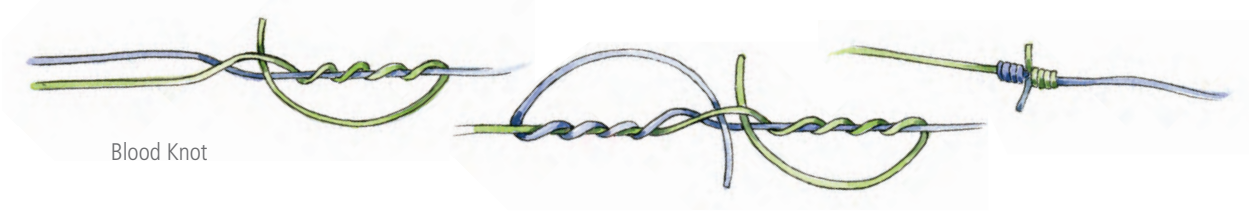
The **Clinch Knot** is for use with monofilament lines. It can attach hooks, swivels, and lures to monofilament in a way that resists slippage and failure.



Clinch Knot

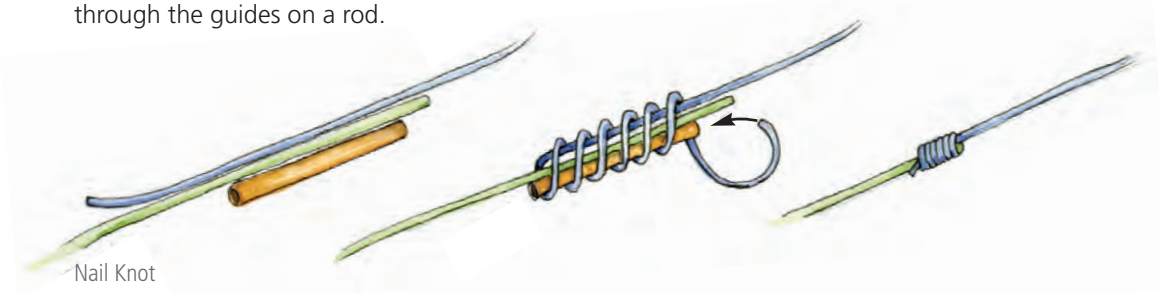
Tying Line to Line

The **Blood Knot** can tie lines of similar size together in a simple and effective manner.



Blood Knot

The **Nail Knot** ties lines of different diameter together. The Nail is smooth and will easily pass through the guides on a rod.



Nail Knot

Multi-Purpose

The **Uni Knot** can be used for most knot purposes and can be tied in the dark. It is not as strong as some of the other knots, but it is very versatile.

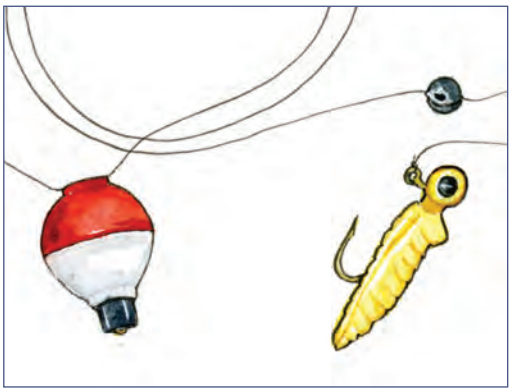
Uni Knot

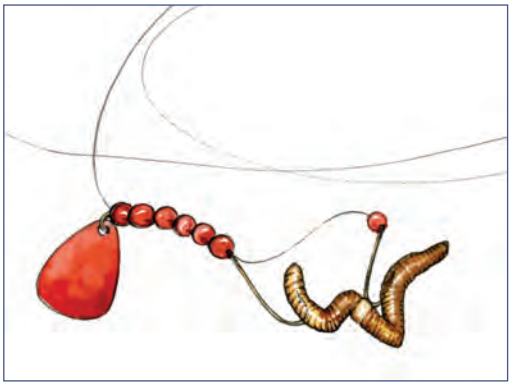
Get Rigged

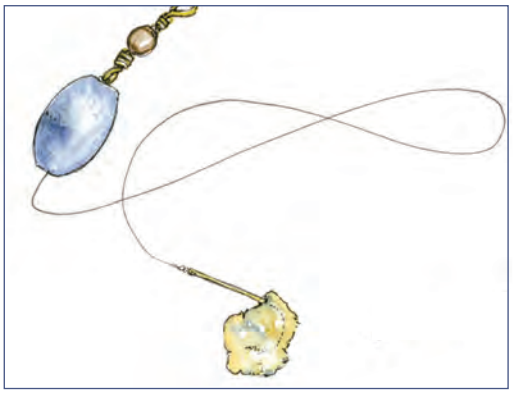
The combination of tackle used at the end of your fishing line is called terminal tackle. The type you use will correspond to the type of fish you want to catch.

What combination of tackle would you rig up for use on a bluegill? How about a walleye? A catfish? Consider where you will find your fish, what it likes to eat, and what method of casting will work best for the fish. As you go through this activity, take notes on the tackle your classmates used:

Terminal Tackle Set-ups

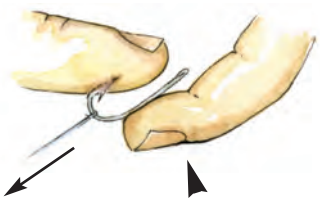






Top: light terminal tackle for bluegill: bobber, split-shot, and artificial bait.
Middle: medium set-up for walleye: spinner, beads, worm harness.
Bottom: heavy terminal tackle set-up for bullheads and catfish: sinker, artificial natural-scented bait.

Finger Bait



Watch your fingers when baiting a hook! One of the most common fishing accidents is getting stuck with a fish hook. If this happens to you and just the point of a fish hook is stuck, pull it out! If the hook goes into your skin past the barb, however, the wisest thing to do is to have a doctor remove it. If that's not possible, have your trusted fishing buddy loop a string around the shank of the hook, push down on the eye, and pull the string straight out. Flush the wound with hydrogen peroxide and make sure your tetanus shot is up to date!

Bait live minnows through the mouth or dorsal fin.

Cast Away

Being able to cast well enough to accurately place the bait increases your chances of catching fish. Casting games help to develop your casting ability and improve your skill. The more you practice, the more control you have over your fishing success.

Before you cast ALWAYS look around you to make sure no one is nearby. Look behind you for trees and bushes and overhead for power lines. Make sure your line isn't wrapped around the tip of the rod. Lines can quickly become tangled messes!

Similar steps apply to a **spincasting** reel (above), which has a pushbutton mechanism to free the line. In this case you do not need to grasp the line when casting, only when reeling.

For **baitcasting**, (below) hold your thumb over the line as it feeds off the reel to prevent snarling the line as it pays out.

A **spinning reel** has a bail that you must flip to free the line. To cast:

1. Grasp the line under your index finger, hold it against the rod, and flip the bail.

2. Point the rod in the direction you want the bait to go and bend at the elbow for an overhand cast, or extend your arm for a side arm cast.

3. Smoothly throw forward and let your finger off the line to release it.

4. **Reel It In!** Apply tension by holding the line between your thumb and first finger to take up the slack. This helps the line wind snuggly around the spool minimizing tangles.

Student Field Guide 12

Golden Rules

OBJECTIVES: Students will be able to:

- navigate the regulation handbook
- identify species of fish using a key

METHOD: Students will answer questions in their booklet. Students will work in small groups to determine whether or not they may keep their paper "catches."

MATERIALS:

1) Slips of paper with dates, waterbodies, and fish images
2) Current copies of the Wisconsin DNR Fishing Regulations
3) Three boxes or bowls

See Appendix M for A Key to Common Wisconsin Fish, Fish Identification Cheat Sheet, Fish Images, and Game Fish, Rough Fish, Minnows. (Laminate the key for outdoor activities.)

PREPARATION: For a class of 20, copy at least 35 images of fish and write different lengths on each one. Use images from Appendix M or from DNR publication FH-500, *Wisconsin Fishing*, or use the fish Wildcards with the information covered. Place the fish in one box or bowl. Write random dates on 14 slips of paper and place them in another bowl. Write 14 different Wisconsin waterbodies and their counties on slips of paper and put them in the final bowl.

SETTING: Indoors or outdoors

DURATION: One or two 45-minute periods

VOCABULARY: Total daily bag limits, coloration, creel clerk, possession limit

STANDARDS:
Physical Education: F 8.2, 8.4, 12.1.
Environmental Education: B.12.13, D 8.5, 12.4, 12.6, 12.7, 12.9.

BACKGROUND: Being able to navigate the regulations handbook is a fishing skill that is just as important as knowing how to cast a line or tie a knot. As part of this lesson, students will be asked to identify the fish they "catch." If fish identification is not a skill the students currently have, you may want to refer to the **Which Fish is This?** lesson in the *Hook, Line, & Thinker: Science Guide* for instruction ideas.

OPENING: Have students read **Golden Rules** through the **Species Specific** section. Ask them to work with a partner to answer the **General Regulations** questions or discuss the questions as a class. Students should understand that the restrictions are not arbitrary, rather they are made to protect the health and safety of fish and anglers.

MAIN ACTIVITY: Place students in groups of about three. Have each group draw two slips of paper from the waterbodies bowl, two slips from the dates bowl and six fish from the fish bowl. Each group will also need a regulations handbook and a Fish Identification Cheat Sheet or key.

Students will record their first body of water and their first date on their **Catch and Keep** log in their booklets. The first three fish they caught will be from this date and location. Students will identify the fish, using the cheat sheet in Appendix M if necessary, and decide whether or not it is legal to keep the fish by using the regulations handbook. Students should record whether or not they kept the fish and, if not keeping the fish, give a reason why with a supporting page number from the regulations. The second date and location will be used for fish numbers four, five, and six.

CLOSING: Have students do the **Bag Limit Scavenger Hunt** on their own, or assign it as a take home exercise.

ASSESSMENT QUESTION: What are two reasons for Wisconsin to have fishing licenses?

ANSWERS: *License sales help fund fisheries management work including habitat restoration and stocking. They also provide for tracking the number of anglers and offer a broad general measure of fishing pressure.*

Which game fish are not covered by the general fishing license alone? *Trout and salmon have special stamps.*

EXTENSIONS:

Regulations Quiz Bowl. Divide the group into two or three teams. Place a bell on a table in the front of the room and have one person from each team come up to the table. Ask the

contestants questions from the regulations; the first person to ring the bell gets to answer. Correct answers earn two points, incorrect answers lose one. Devise enough questions from the regulations for several rounds so everyone gets a chance to play. Be sure to include questions pertinent to the area students are likely to fish.

In Depth: Have students complete the Cheap Date activity to discover how fishing can be inexpensive, compared with other recreational activities.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

3 Golden Rules

Actually, we might call them "Golden Regulations." In the 2007–2008 fishing season, over one million people spent 21 million days casting their lines into Wisconsin waters. That's a lot of time and a lot of anglers. Imagine if all these anglers were able to keep as many fish as they wanted, regardless of species. Overfishing, especially on smaller lakes and with popular fish, could eliminate certain fish populations. Historically, many species of fish suffered because of overharvest. To sustain our diverse fishery and aquatic ecosystems, anglers observe regulations. An important one you'll learn about in these pages is the requirement for anglers to have a fishing license.

Largemouth bass

General Regulations

To help keep fisheries healthy, the DNR has an overlying set of regulations that all Wisconsin anglers must follow. DNR conservation wardens enforce these regulations. It is the responsibility of every angler to know them before going fishing. Each of the restrictions has a sensible explanation and reason behind it. See if you can figure out why the DNR has the following five regulations:

1) It is illegal to fish in any waters of the state without a Wisconsin fishing license.

2) It is illegal to possess a fish that is within a protected size range ("slot" limit) or below the minimum length limit for the waterbody being fished.

3) It is illegal to release unused bait into Wisconsin lakes, ponds, rivers, or streams.

4) It is illegal to fish for a species during a closed season for that species even if you release the fish you catch.

5) It is illegal to leave any fish line unattended. When fishing in open water, anglers must remain within 100 yards of their lines.

Species Specifics

Beyond the general rules that all anglers must follow, specific rules apply to each species of game fish and body of water in Wisconsin. These rules can change from year to year based on fish populations and the health of different bodies of water. It is important to always have a copy of the current DNR fishing regulations with you so that you can refer back to them when you catch a fish. Many fish are regulated by **total daily bag limits** (the number you can keep in a day from all Wisconsin waters). For this reason, you need to be able to identify each species of fish you catch. Knowing that you can only keep one northern pike on your local lake isn't helpful if you don't know when you've caught a northern pike!

There are three important things to consider when identifying your fish:

- The overall size and shape of the fish:
  Is it round like a bluegill? Long like a musky?
- The size, shape, and position of the fins:
  Is the dorsal fin ray-shaped, like on a pumpkinseed? Is it pointed like a whitefish?
- The pattern of markings: Is it spotted like a brown trout? Striped like a perch?

Practice identifying the fish you are most likely to catch on your fishing trip and quiz yourself regularly.

INSTRUCTORS:
Underlined content is not provided in student manual.

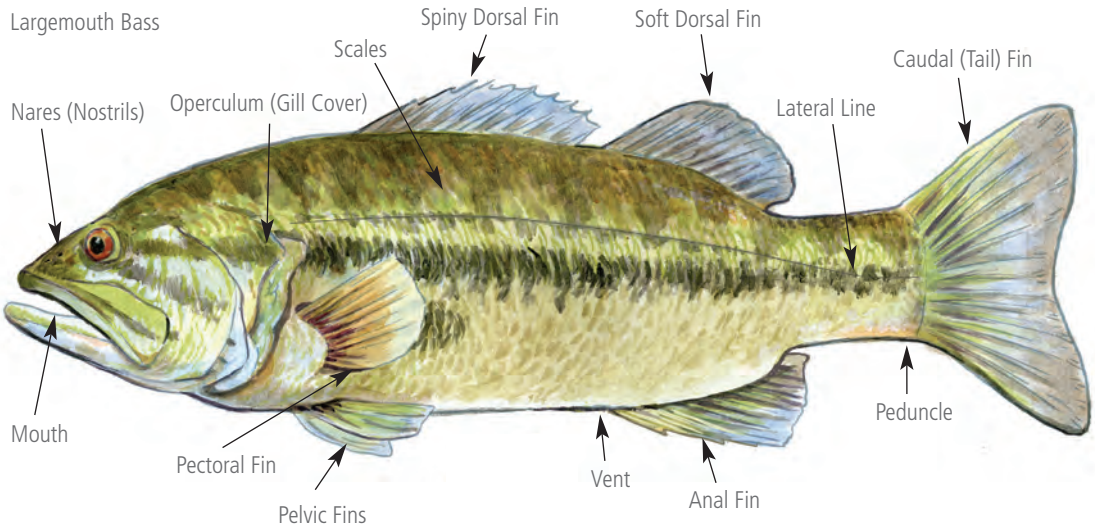
1) The fishing license is vital to funding fisheries projects such as habitat restoration or improvement, stocking, education, hatchery operations, fish population estimates, and access development.

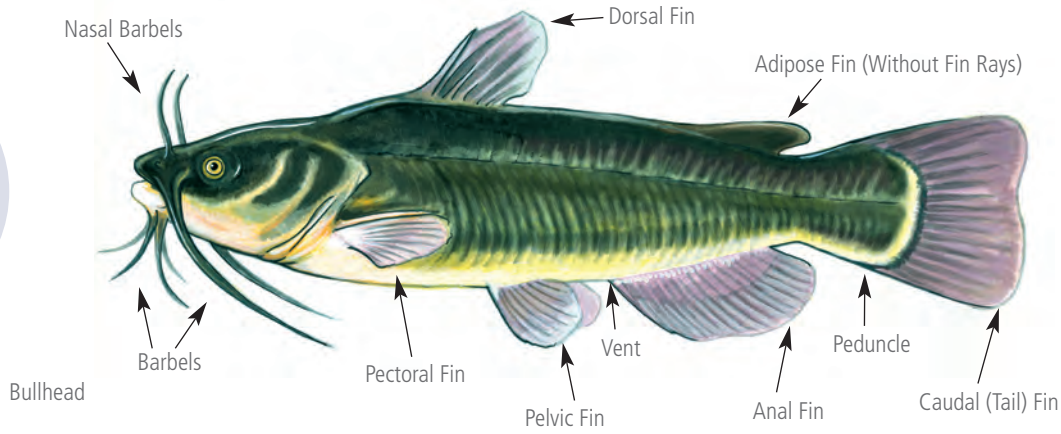
2) By setting slot limits, the DNR tries to keep a healthy breeding population of fish in a waterbody. Fish below legal limits are often immature and have not yet bred.

3) To prevent the introduction of new species or diseases, unused bait should not be released. The bait may be of a species not currently present in the water being fished, or it may harbor a disease that has not yet been introduced to the waterbody. By taking your bait with you, you protect the integrity of the waterbody. This is especially important with the threat of viral hemorrhagic septicemia (VHS).

4) Even catch and release can kill a fish, especially if not done properly. This rule protects fish from being overharvested.

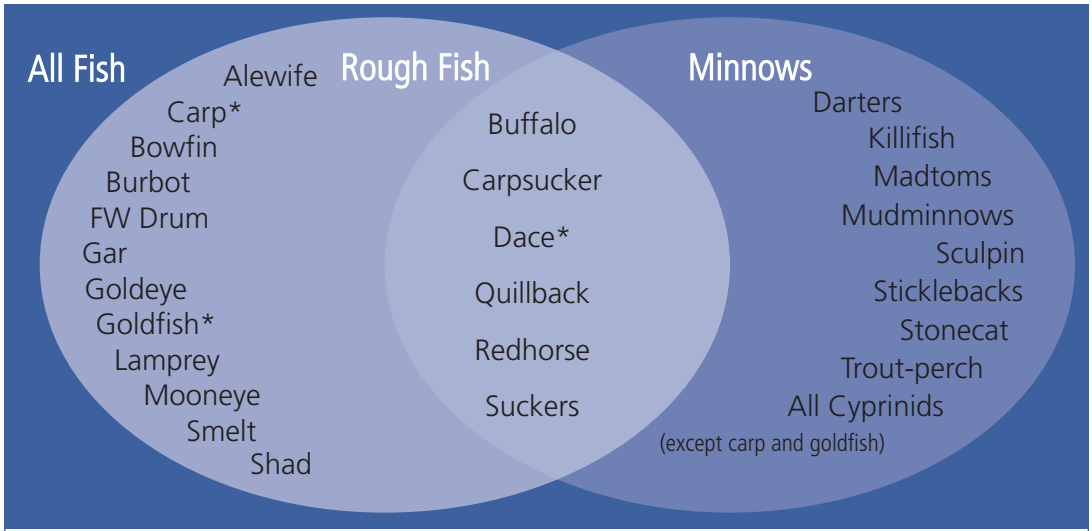
5) Unattended fishing lines are a hazard to waders, swimmers, water skiers and other recreational water users, as well as wildlife.





PLEASE SEE APPENDIX M
Golden Rules:A Key to Common Wisconsin Fish
Fish Identification Cheat Sheet
Fish Images
Game Fish, Rough Fish, Minnows

Game Fish, Rough Fish, Minnows



By state law all fish are "game" fish if not "rough" fish or "minnows." Game fish may not be harvested unless an open season is specified in Administrative Code.

* Taxonomically, carp and goldfish are in the minnow family. Legally, however, they are classified as "rough" fish, but not as "minnows" in Wisconsin. Although dace are also members of the minnow family, legally, they are classified as both a minnow and a rough fish. All members of the sucker family are considered rough fish for legal purposes; they are in the same *order* as minnows. Other fish legally referred to as "minnows," are in several different taxonomic families.

Catch and Keep?

Use this chart as the basis for a fishing journal. Record your paper "catch" and whether or not you could keep your fish:

	SPECIES	LENGTH	DATE	LOCATION	BAG LIMIT	LEGAL?	WILL KEEP?
1	Bluegill	7"	2/14	Wilson Lake, Iron County	25	Yes	Yes
2							
3							
4							
5							
6							

INSTRUCTORS: Underlined content is not provided in student manual.

Bag Limit Scavenger Hunt!

Use the regulation book or go online (**dnr.wi.gov/fish/regulations/dailybag.htm**) to find out:

1) What is the total daily bag limit on largemouth and smallmouth bass during summer months?

5 in total

2) What is the total daily bag limit on muskellunge?

1

3) What is the daily bag limit for panfish on Sawdust Lake in Bayfield County?

10 in total

4) What's the difference between "daily bag limit" and "possession limit"? ?

The daily bag limit is the maximum number that you can keep in one day. The possession limit is the maximum number of a species that you can control or transport at any time. It is twice the daily bag limit and includes fish you may have in your car, cabin, or home.

5) Why can't you keep a slender madtom?

It is an endangered species.

6) Suppose that you go to a lake that has a bag limit of three for walleye and you catch three walleye. Later that day you want to go to another lake that also has a three-fish bag limit on walleye. What do you do?

You must either have a shore lunch of your first catch or take it home before fishing on the second lake. It is illegal to transport live fish away from the water. You may not possess (e.g. have in your freezer, etc.) the first three walleye you caught when fishing the second lake. Also, you may only keep a total of two more walleye for the day, even if you eat some of your catch because walleye has a total daily bag limit of five.

7) If you have questions about the fishing regulations, who do you call in your area?

Varies by region. The last page of the regulations handbook has regional phone numbers so you can contact your local conservation warden.

What about Trout and Salmon?

Regulations for trout and salmon that inhabit the Great Lakes and their tributaries are listed separately in the back of the general hook and line fishing regulations booklet. More detailed regulations for inland trout are outlined in a separate booklet. Specific size and bag limits for trout are color-coded to a stream map of Wisconsin and vary from one stream to the next. It's important to be able to read a map and figure out where you are when you go trout fishing! You also need a trout or salmon stamp if you intend to fish for those species, in addition to a fishing license.

License Loop

You don't need special training or certification to fish, but you do need a license to wet a line when you reach driving age. Anglers age 16 and 17 pay less for a license, while fishing is free for those age 15 and under. Your license fees come back to you in the form of more fish to catch through habitat restoration or improvement, stocking, and hatchery operations. License fees fund education programs and places to fish along waterways.

The funding also enables fisheries biologists to conduct fish population surveys, and creel clerks to interview anglers, record their success rates and estimate fishing pressure. These assessments help set bag limits. In 1977, Wisconsin introduced an inland trout stamp followed by a Great Lakes trout and salmon stamp in 1982. Stamp sales fund salmon production and projects to restore or improve trout and salmon habitat.

Notes

Safety First!

OBJECTIVES: Students will be able to:

- relate some of the hazards they face when involved in a water sport
- describe several steps they can take to be safe anglers
- develop a personal set of fishing ethics.

METHOD: Students will independently reflect on safety issues related to angling. Students will develop and act out skits demonstrating appropriate and inappropriate fishing behavior.

MATERIALS:

1) Several personal flotation devices (PFDs)

2) Rods and reels

3) Paddles

4) Other supplies that could be used in skits

SETTING: Indoors or outdoors

DURATION: One or two 45-minute class periods

VOCABULARY: PFD, ethical

STANDARDS:
Physical Education: d.12.6, F 8.2, 8.3, 8.4, 8.6, 12.1, 12.5, 12.6.

BACKGROUND: Even though angling is a fun and relaxing way to spend time, it is important for students to remember that the water deserves their respect. Drowning, boating accidents (often alcohol-related), falls overboard, and hypothermia are all potential angling hazards that can be avoided with care and consideration. Students should not be nervous about going fishing, but neither should they ignore the hazards. They should also keep in mind public opinion of fishing can be tarnished by the actions of a few and act accordingly.

OPENING: Have students read the **Gearing Up** and **An Ethical Note** sections and independently answer the questions posed under **Gearing Up**.

MAIN ACTIVITY: Divide students into groups of three and give them10 minutes to come up with a one- to two-minute skit in which an angler does something unsafe or unethical. If this is done during one class period, have half the students present skits on safety and the other half on ethics. Students may decide to resolve the issue in their skit, or the class can discuss potential solutions to the problem as a group after the skit is over. Students will present the skit to their classmates.

CLOSING: Have students share personal experiences related to near-misses or a lack of outdoor ethics they may have witnessed.

ASSESSMENT QUESTIONS: Explain the three steps you could take to assist a struggling swimmer. What should you never do when assisting a struggling swimmer?

ANSWERS: *Do: Reach from the shore with an object like an oar or a branch and pull the person in, throw an object like a PFD attached to a rope and pull the person in, row a boat or other safe alternative out to the person and help him get in or hold on.*

Don't: Swim out to the person unless trained.

EXTENSIONS:

In Depth: Have students assemble a safety kit for the upcoming trip.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

4

Safety First!

Ethics are a close second. Fishing can be relaxing and sociable, a quiet personal escape, or an exciting group adventure. Regardless of your goals for your fishing trip, safety and outdoor ethics should always be a consideration when you pack your gear.

Gearing Up

Think about the environment you will be in while you are fishing. What are three dangers you might face?

1) Possibilities include: storm, high waves, boat trouble, boat collision, hitting a rock, falling overboard, slipping in a stream, getting tugged by a current, hypothermia, heatstroke, dehydration

2)

3)

Think about the types of gear that you could bring that would help you to avoid these dangers or allow you to address them if they happen. Make a list below.

1) Possibilities include: weather radio, repair kit, marine radio, maps, GPS, PFD, layers of clothing, wool hat, sun hat, water bottle, floating ring.

2)

3)

INSTRUCTORS:
Underlined content is not provided in student manual.

INSTRUCTORS: Underlined content is not provided in student manual.

SOS

Drowning kills nearly 3,000 Americans of all ages every year. It is the second leading cause of accidental death for people ages five to 44. Even great swimmers can drown when something unexpected happens—like a boat overturning in cold water. If you need to assist a struggling swimmer, follow these steps:

REACH: Extend a branch, paddle, fishing pole or other item towards the person to pull him or her to safety.

THROW: If the person cannot be reached, throw him or her a buoy, a PFD, or another floating item attached to a rope and pull the person in.

ROW: Use a rescue boat to go to the person. Help him or her get into the boat or hold on.

NEVER swim out to the person unless you are trained in lifesaving methods.

Before You Go

When getting ready to take a fishing trip, it is always a good idea to check the weather. High winds, hot temperatures, or cold rain could all change the location you choose to fish and the gear that you will take. You might have to postpone your trip until another day. No matter when and where you end up going, you should always tell someone where you are planning to fish and when you will return. Even if you are just walking down the road to the local creek with a friend, tell a family member or leave a note. It is always better to be safe than sorry.

At the Waterfront

If you're going to be fishing from shore or wading in the water, it's a good idea to take a look around before you start fishing. Check with a walking stick to see how stable the banks are, how even or uneven the stream bottom or lakebed is, and whether there are any hazards on the bank or in the water. If you are going to be in the water, wear a **lifejacket or personal flotation device** (PFD)—especially if you plan to wear waders. If you fall, waders can fill with water and make it hard for you to swim. If you are staying on shore, a PFD is still a good idea. You never know when it could come in handy.

If you are going fishing in a boat, be careful not to overload it. Weather can change quickly on the water. A boat that seemed appropriately loaded in calm water may not be suitable for waves. Pack as if the weather were going to get bad, even if storms are not in the forecast. Make sure that there is a PFD for every person onboard the boat (it's the law), and set an example by wearing yours. If you are under 16, you MUST have either an adult onboard with you or a boating certificate.

Back at Home

When you return from a fishing trip, always take a moment to think through any near-misses you may have had or any actions others were taking that seemed unsafe. What could be done differently to avoid the danger? Anglers can always learn from themselves and from the actions of others, no matter how experienced they are.

INSTRUCTORS: Underlined content is not provided in student manual.

An Ethical Note

Anglers are always faced with choices. Which bait? Where to fish? When to quit for the day? Sometimes, choices made are based on fishing regulations while others are guided by a set of personal ethics, or what you do when no one is watching. Public perception and support of angling depends a lot on the behavior of anglers. When stream banks and shorelines are littered with worm containers and fishing line, an accusing finger is pointed at all anglers. To help cultivate or maintain the image of anglers as conservationists, we have to clean up after a few thoughtless individuals and set a good example for novices.

As a group, brainstorm a list of ethical and unethical fishing behaviors. In small teams, use the list to role-play different scenarios in skits. Some examples are listed below to get you started; there can be more than one choice for each situation. Consider landowner-angler interactions and note any legal or ethical violations as well as positive behaviors. When the skits are over, discuss your observations.

1. You come upon an angler fishing a pool in a nice stretch of stream. You:
   a. backtrack around the angler and find a different spot a respectable distance away.
   b. wade in to claim a good spot for yourself.
   c. wait for the angler to finish.
2. You've been wading a stream and decide it's time for lunch. You:
   a. clamber up the bank near a private home for a picnic. (trespassing)
   b. find a big, comfortable log hanging over the water to take a rest.
   c. hop up on the nearest pier. (trespassing)
3. You and a friend have been fishing for a time near clusters of other anglers and it's time to quit for the day. You
   a. crank up some music.
   b. reel in and go for a quiet dip.
   c. look around for old fishing line or other trash you may have dropped.
4. As you and your friend are fishing, a pair of loons swims within 100 feet of you. Your friend starts throwing rocks at the birds. You
   a. start practicing your loon call.
   b. remind your friend that there are laws against harassing wildlife.
   c. try to prove that you're a better aim.
5. You're hungry for fish and decide that you're going to keep a couple to eat if luck is with you today. You catch a legal-sized fish and put it on the stringer. A few casts later, you catch an even bigger one of the same species. Keeping it would put you over the daily bag limit. You:
   a. release it immediately.
   b. give away the smaller one and keep the big one. (illegal)
   c. switch it for the one on your stringer. (illegal)

Leaving trash, bringing loud music, communicating by shouting, destroying the vegetation on the streambank, horseplaying in the water, scaring fish, and more.

Here are some questions to ask when confronted with a decision:

- Is it legal?
- Would it be good if everybody did it?
- Would you want to be on the receiving end of the action?
- Would it make you proud?

Here are a few simple guidelines to help you fulfill your **ethical** responsibility to the outdoors:

- Leave the environment as you found it. Pack out anything you brought with you on your fishing trip and take it home with you. Do not leave trash or discarded fishing line behind.
- Be courteous to others in the outdoors. Avoid crowding other anglers and keep your voice down! Sound carries very well over water, so speak softly.
- Take advantage of opportunities to help improve our out-of-doors. Community groups occasionally have clean up or maintenance trips to improve the quality of our public lands and waters.
- Be aware of public-private boundaries and ask private landowners for access to the water before venturing onto their land. Check the DNR Website to learn about your water rights as an angler, through the Public Trust Doctrine under the state constitution, **dnr.wi.gov/org/water/wm/dsfm/shore/doctrine**.

SECTION B

Field Knowledge—Making the Catch

It's finally time to go in for the catch! How will you know where to fish, how to get the fish out of the water, and what to do with it once you've caught it? Read on! Remember: It is up to you to be respectful and to be safe. No one else will make decisions for you.

SECTION B

Field Knowledge—Making the Catch

Reading the Water

OBJECTIVES: Students will be able to:

- explain why fish are not evenly distributed throughout a waterbody
- describe the habitat preferences of at least one species of fish

METHOD: Students will profile a fish and share their research with others. Students will use a lake map to discuss possible fish locations.

MATERIALS:

1) Local lake chart showing underwater topography or a whiteboard

2) Fish reference books or Internet access

See Appendix A for a list of Wisconsin's Game Fish to use in Profile of a Swimmer.

SETTING: Indoors

DURATION: Two 45-minute class periods

VOCABULARY: Navigable, riparian

STANDARDS:
Physical Education: D 8.3, 12.1, 12.2; F 8.2, 12.1. Science: C.8.1, 8.2, 12.4.

BACKGROUND: Like humans, fish have preferred habitats. An angler fishing in shallow, warm water, for example, is much more likely to catch a bullhead than a salmon. An angler's chance of success is increased by knowing the habitat and temperature preferences of her target fish and matching them to the underwater topography of the lake. For more information on fish habitat, refer to Chapter 2 in *Hook, Line, & Thinker: Science Guide*.

OPENING: Have students read **Reading the Water**. Assign a different game fish to each student in the class. Give the students in-class or at-home time to research the fish and fill in Profile of a Swimmer on the inside cover of the booklet.

MAIN ACTIVITY: If possible, get a map of the location where you will be fishing or draw a basic outline of the lake or river on the board. Have students take turns sharing information on their profiled fish and marking the most likely location of the fish on the map. Discuss how to adjust tackle to accommodate different underwater hazards. For example, use weedless lures around weeds, slipfloats and split-shot or leadless alternative to fish along drop-offs or in deep water. When all presentations are complete, put all student profiles into a binder to take as a reference guide on the fishing trip.

CLOSING: Review with students what they need to do to prepare for their upcoming fishing trip and have them read the next two lessons, **Fish Out of Water** and **Cooking, Cleaning and Companions** before heading out.

ASSESSMENT QUESTION: Name three places you are most likely to find a diversity of fish when fishing in a stream, two places to look for fish in a lake, and one species you are likely to find in cold, deep, open water.

ANSWERS: *Stream: out of the current, deep pools, undercut banks, behind logs or rocks. Lake: weed beds, rocky points, under culverts. Open water species: salmon, lake trout.*

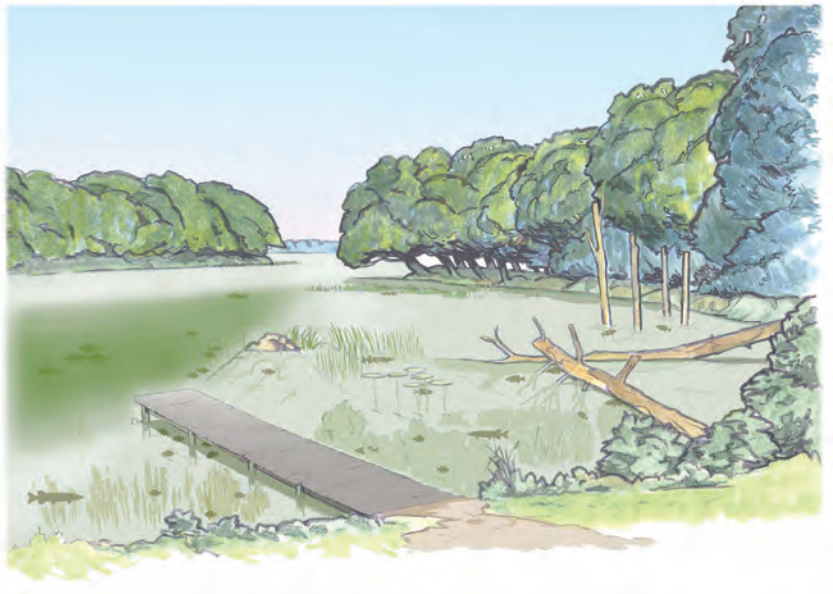
EXTENSION:

In Depth: Invite a fishing guide in to describe how he or she "reads the water."

If you have downloaded this booklet, please see the appendix that follows for additional materials.

5 Reading the Water

You can read a book and you can read your friend like a book, but can you read the water? Perhaps you have a favorite place that you know very well. It's a place that you feel comfortable in—you know where it is busy, where it is quiet, where to get snacks, and where you can find your friends. Like humans, fish have favorite spots where they regularly spend time. Knowing a fish's habits and being observant about water conditions can help you find your target in the water.



Knowing a fish's habits and being observant about water conditions can help you find your target in the water.

Productive Water?

Informed anglers know that predator fish (most game species) need prey. When you first approach a waterway, take a look around. Can you see enough aquatic plants, the right assortment of insects, and minnows or other small fish to support your desired catch? If you overturn rocks on the shore of a lake and spot crayfish, you can be almost certain that there are bass in the lake. If you peer into the shallows and find tadpoles, however, there are likely few bass, since they would have eaten the tadpoles if they were around. Keep an eye out for the food sources of the fish you hope to catch. Chances are, if you can find the food, you can find the fish.

How fish find food is also important. Those that ambush their prey will usually be close to some type of cover or will use their natural camouflage to help them blend into their habitat. Know your fish's favorite haunts, like weeds for the muskellunge, and where fish will blend in with their surroundings.

Water that is stinky, stagnant, blanketed in algae, visibly polluted, empty of small fish, or shows other signs of being unlivable will probably not be the best place to cast your line. Be observant! The more you fish, the more you will learn.

PLEASE SEE APPENDIX A
Profile of a Swimmer: Wisconsin's Game Fish

Wisconsin Waters—Keep Your Feet Wet

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. 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.

INSTRUCTORS: Underlined content is not provided in student manual.

See underwater using radar or another imaging technique to actually mark the location of a fish.

Yoo-Hoo, Fish?

Knowing how and where to find fish is a valuable skill that helps you connect to the world around you. But if you want a little backup to help you find the big one, there are all kinds of electronic gadgets, like fish finders, to help you do so. What can a fish finder do that you can't?

Fever or Chills?

As long as a waterbody has sufficient oxygen, water temperature is the most important factor in determining where a fish will be. Even within a body of water, a slight temperature variation can affect the location of fish. Know what temperatures your fish species likes and seek out spots that meet the fish's requirements.

Look for areas that are a degree or two warmer in cool weather, such as a shallow bay in early summer, or a degree or two cooler in warm weather, such as a shaded bank. Fish are extremely sensitive and react to even the smallest of differences in temperature.

FISH SPECIES	PREFERRED TEMPERATURE °F										
	40	45	50	55	60	65	70	75	80	85	90
Catfish										XX	??
Bullhead								XX	XX	XX	
Sunfish							XX	XX	XX		
Largemouth Bass						XX	XX	XX			
Muskellunge					XX	XX	XX	XX			
Chinook Salmon		XX	XX	XX							
Lake Trout	XX	XX	XX								

Moon Sense

During the new moon it is very dark at night. Fish do not feed as much in the darkness, which leaves them hungrier during the day. Take advantage of it! During a full moon, some fish will feed all night. Perhaps a night fishing trip is in order?

Stay Current

In general, fish position themselves so that they don't have to constantly battle a stream or river current. This is particularly true for trout and salmon. Deep pools are important holding areas for game fish, as are undercut banks. Undercut banks provide depth, calm water, shade, and occasionally back currents that deliver food right to a fish's mouth. Look for logs, rocks, sandbars, and other natural and artificial structures that break the current. Where there is shelter, there are fish.

Lakes and ponds don't have currents, but there are still predictable places to look for fish. Most Wisconsin lakes are moderately to very fertile. They are shallow and warm enough in summer to host aquatic vegetation and plankton. Most fish caught in lakes and ponds are found around structures or cover. In weed beds, near rocky points, and under culverts are all good places to look for fish. Open water is only suitable habitat for a few species of fish. Can you name one?

Lake Trout, Salmon

Notes

Fish Out of Water

OBJECTIVES: Students will be able to:

- describe the procedures involved in hooking and landing a fish
- relate the proper way to release a fish
- explain how to prevent the spread of viral hemorrhagic septicemia (VHS)

METHOD: Students will go fishing on a field trip.

MATERIALS:

1) Tackle
2) PFDs
3) Bait
4) Fishing licenses
5) First aid kit
6) Other equipment necessary for a field trip

See Appendix N for Fishing Journal (also found on back page of student booklet).

SETTING: Outdoors

DURATION: One half to one full day field trip (combine this lesson with the next lesson, **Cooking, Cleaning, and Companions**)

VOCABULARY: Stringer, CPR, VHS

STANDARDS:

Physical Education: B 8.3, 12.1; C 8.1, 12.2; D 8.1, 8.2, 8.3, 12.1, 12.2, 12.3; F 8.2, 8.3, 8.4, 8.6, 12.1, 12.5, 12.6. **Environmental Education**: D.8.5. **Science**: C.8.6, F.8.10, 12.7, 12.8.

BACKGROUND: Choose a location for your fishing trip that will accommodate your entire group without impacting the surrounding environment. Make sure all students who are 16 or older have a fishing license. Assemble fishing gear, PFDs, and chaperones to meet your group's needs. The Wisconsin Tackle Loaner Program is a great resource for outfitting your class for the day. Check the DNR's Website for more information.

OPENING: Assist students in selecting the bait, lure, and other terminal tackle necessary for the fish they are hoping to catch. Check to make sure they have selected an appropriate fish for the fishing location.

MAIN ACTIVITY:

The Fishing Trip. At the location, encourage students to discuss where they think fish are most likely to be found. In other words, "read the water" as a group. Have students overturn rocks, examine banks, and observe the current to learn more about fish habitat. The less experienced anglers may want to warm up or review casting techniques on dry land using casting plugs before they head for the water.

For students who choose not to fish, select an alternative activity such as sketching the location of the fishing trip, noting aspects of the location that make it quality fish habitat and any habitat degradations or restorations that are evident.

CLOSING: Have students record their trip in a fishing journal using the back page of their booklets. If students would like more journal pages, extra journal blanks can be found in Appendix N. Discuss as a class the factors that helped students to be successful and have students evaluate what they will do differently the next time they fish.

ASSESSMENT QUESTIONS:

1. Describe what happens to fish with VHS, how they get VHS, and three ways an angler or boater could help prevent the spread of VHS.

   ANSWERS: *VHS causes fish to bleed to death. It is caused by a fish consuming another with the disease, or by fish swimming in water infected with the virus. To prevent the spread of VHS, don't move live fish, only purchase minnows from licensed dealers, report sick fish, drain water from your boat and bait wells before moving to a new lake, and put unused bait in the trash.*

2. What are three steps you should take when releasing a fish?

   ANSWERS: *Don't play the fish, use a landing net, leave fish in the water or wet hands before touching the fish, keep fish horizontal, don't remove swallowed hooks, do it quickly (in 10 to 15 seconds).*

If you have downloaded this booklet, please see the appendix that follows for additional materials.

6 Fish Out of Water

Once you've selected your fishing spot, set up your gear, and cast your line, you're ready to land a fish. Follow these steps to get the fish out of water:

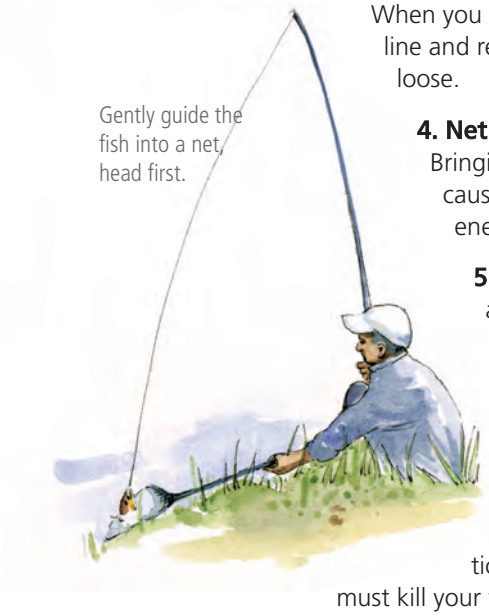
1. Stay Calm!

2. Set the Hook You want the hook to be secure in the fish's mouth before you reel the fish in. To set the hook, give the line a quick jerk. How hard you pull on the line to set the hook depends on the fish species. Be gentle with soft-mouth fish like crappie, but jerk hard to set the hook in the bony mouths of musky and northern pike. Frequently the fish will set the hook themselves as they engulf your bait and try to swim away.

Frequently the fish will set the hook themselves as they engulf your bait and try to swim away.

3. Reel It In Keep your rod tip up. An upright rod acts like a spring to keep the line from breaking, yet keeps tension on the hook so it does not slip out. Be careful to keep the line from rubbing on the boat, dock, and rocks and keep it clear of the boat's motor. Tension weakens the line and may cause it to break. If your fish jumps up out of the water, release the line or the fish may dislodge the hook as it shakes its head. Many experienced anglers recommend bowing to the fish as it jumps. When you bow, you will automatically give the fish more line and reduce the chances of the fish pulling the hook loose.

An upright rod acts like a spring to keep the line from breaking, yet keeps tension on the hook so it does not slip out.



Gently guide the fish into a net, head first.

4. Net It Gently guide the fish into a net, head first. Bringing a net up behind a fish might spook it and cause it to swim away in a frightened burst of energy.

5. Store or Release If the fish is of a legal size and species and you have not exceeded your daily bag limit, you have to decide whether you want to keep or release it. If you are releasing a fish, do so immediately by following the instructions below. If the fish is legal and you decide to keep it, try to keep it alive until you can put it on ice. A wire basket or **stringer** will keep the fish alive all day. If that is impractical, quickly kill the fish and put it on ice. You must kill your fish (remove it from water) BEFORE you leave your fishing spot to prevent the spread of **viral hemorrhagic septicemia** (VHS).

When releasing a fish, handle it in the net; don't bring it out of the water.

6. Record Your Catch One of the best ways to learn how to fish is to learn from yourself. Keep a fishing journal to track your fishing success. Note where you caught the fish, what the weather conditions and water temperature were, and what type of tackle you used. For ideas see the back page of this booklet. If you are careful in your record keeping, you will soon have a book of knowledge on how to catch fish.

Keep a fishing journal to track your fishing success.

Play Nice

> Do not "play" the fish any longer than absolutely necessary, especially if you are planning to release it. As the fish fights, it builds up lactic acids in its muscles. This can ultimately kill the fish even though it was still alive when you released it.

Catch and Release

What if you want to catch a fish, but do not want to keep it? Catch and release is a very popular form of fishing in Wisconsin. In fact, even though approximately 88 million fish were caught in the 2007 season, only 33 million were kept! Catch and release is a conservation practice that allows people the pleasure of fishing, but if done effectively, doesn't lower the fish population of a lake. Catch and release is a necessary skill to learn so that you can follow regulations when you catch a fish under the legal size or within a restricted size range.

Different Strokes for Different Folks

People have a variety of opinions about catch and release. On one extreme are people who always practice catch and release, and on the other extreme are people who never practice catch and release. The people on these extremes may have very strong opinions about why you should or should not catch and release a fish. One argument for releasing is that it lets people enjoy fishing, but does not deplete the fish population in the lake. One argument against releasing is that if catch and release is not done with great care, the released fish may die soon after being put back in the water. In that case, you have depleted the fish population without getting a tasty meal.

Most anglers have opinions between the extremes. In other words, they only release certain species of fish, or only release on certain fishing trips. What would be reasons for releasing some of the time? Before heading out on your own fishing trip, consider your own catch and release philosophy.

CPR For Fish

If you decide to catch and release, **Consider Proper Release** (CPR) to help fish survive after you have put them back in the water. Fish can be traumatized, weakened, or injured during the catching and releasing process. By following the CPR steps, you can help fish survive.

- Don't play the fish to exhaustion. Use a landing net to bring the fish under control and be as quick as possible.
- Handle the fish in the net; don't bring it out of the water.
- If you must take the fish out of water, wet your hands first, turn the fish belly-up, and keep the fish horizontal while removing the hook.
- Don't remove swallowed hooks, just clip the fishing line. If legal, consider keeping fish with swallowed hooks, as they are unlikely to survive.
- Don't keep a fish out of water for more than 10 to 15 seconds.

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.

- 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.

Cooking, Cleaning, and Companions

OBJECTIVES: Students will be able to:

- describe two different methods of preparing a fish
- explain at least one benefit to eating fish as a regular part of a diet
- make an informed choice when considering fishing as an affordable leisure activity

METHOD: Students will prepare and cook the fish caught on their field trip.

MATERIALS:

1) Fillet knives

2) Spoons or fish scalers

3) Plastic bags, newspaper or other waste wrappings

4) Several copies of the DNR's Choose Wisely guide

5) First-aid kit

*If using the recipe below gather ingredients, cookware, aluminum foil, and paper towels.

SETTING: Outdoors or in a large indoor kitchen

DURATION: Conduct as part of the fishing field trip or one 45-minute period.

VOCABULARY: Fillet

STANDARDS:
Physical Education: D 8.1, 8.2, 8.3; F 8.3, 8.6, 12.1, 12.5, 12.6. Environmental Education: D.8.3, 8.5. Science: A.12.5, B.8.6.

BACKGROUND: Encouraging students to prepare and cook their fish is an excellent way to entice students into another fishing adventure.

OPENING: Demonstrate the proper methods for cleaning and for filleting a fish.

MAIN ACTIVITY: Students will be preparing and cooking fish. Divide the students into groups so that each student has a fish to work with. Discuss the method most appropriate for preparing each fish as a group. Remind students to work with the knife blade pointed away from their hands. Some students may not want to be involved in cleaning the fish, but should at least read through the steps in their booklet and be familiar with the differences between cleaning and filleting. As students prepare their fish, encourage them to look at and record the contents of the fish's stomach.

Once all fish are properly prepared, students can use the recipe provided to bake or fry the catch. Assign some students to recipe preparation, some to the dipping of the fish, and some to the cooking. Serve the fish as finger-food on squares of paper towel unless cooking enough for a meal.

CLOSING: Encourage students to gather fish recipes from home and have a recipe exchange in a future class.

ASSESSMENT QUESTION: Describe three ways that you can continue to learn about fish and help to protect them after this course is over.

ANSWERS: *Take a friend fishing, help with restoration projects, write letters, get outside, don't transport bait or live fish and other VHS prevention tips, leave no trash at fishing sites, other possibilities*

EXTENSION:

In Depth: Have students research the health benefits of eating self-caught fish.

Service Learning: Have students work with a community group or elementary school to plan a fishing outing for younger children. Ask them to plan an experience that is both safe and enjoyable for the children. Remember, students 16 and over need a fishing license.

MUSIC:
For Your Indoor Dining Pleasure

Food preparation should be a pleasant experience and can be made more so with music. Water and fish have inspired musicians through the ages. Here is a short list of selections that could enhance your fish fry; many more can be found with a quick Google search of "fishing songs" or "clean water songs."

Swimming to the Other Side by Pat Humphries

Clean Water by Malvina Reynolds

Fishing Blues by Taj Mahal

Take Me to the River by Al Green (and immortalized by Big Mouth Billy Bass)

Blue Boat Home by Peter Mayer

Trollin' on the River by Alvin Rhodes (parody of Creedence Clearwater Revival's *Proud Mary*).

Bon Appétit!

If you have downloaded this booklet, please see the appendix that follows for additional materials.

7 Cooking, Cleaning, and Companions

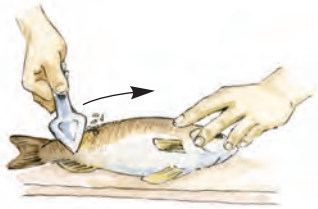
Cooking and eating a fish you caught is one of life's simple pleasures. First, however, you have to prepare it. Preparing a fish provides an opportunity to learn more about fish anatomy and fish diets. After preparing, you're ready to cook and eat the fish. Fish are low in fat and calories and are a good source of protein.

Staying Sharp

Cleaning is the technique used to prepare fish without removing bones. **Filleting** leaves the fish boneless, and occasionally skinless, and is generally used for larger fish. The most important step in preparing any fish is choosing a sharp knife of the correct size and shape. Most fillet knives have thin, slightly flexible blades five to eight inches long. A dull knife can be more dangerous than a sharp knife because you have to work harder to make the proper cuts. Make sure your knife is sharp, and hold it away from your fingers and body as you prepare your fish. Work patiently and attentively.

Cleaning Steps

- Use a spoon or fish scaler to remove scales.



Remove the scales.

- Without cutting through bones or internal organs, cut around the head, behind the pectoral fins, and down to the anus.
- Break the backbone by bending the head downward and twisting. Remove the head and internal organs.
- Check local rules, but generally you can dispose of wrapped waste in a trash bin or bury it deep in your garden. Fish waste does not belong in compost bins.

Remove the internal organs.

Fish Fillet

- Cut along the dorsal fin from head to tail and along the anal fin from anus to tail.
- Just behind the gill cover make a vertical cut through the flesh down to the bone. This cut extends from the back to the stomach. Deepen the cut made along the dorsal fin working from head to tail. Hold the knife nearly parallel to the row of bones extending upward from the spine to the back. This cut should extend downward only as far as the backbone.
- Repeat this procedure on the stomach side. Cut first from behind the gills to the anus, then along the anal fin cut you made earlier. These cuts should be just below the surface of the belly skin to avoid rupturing internal organs. As you cut up toward the backbone your fillet will come free.

Cut along the dorsal fin from head to tail.

Just behind the gill cover, make a vertical cut.

Hold the knife nearly parallel to the row of bones extending upward from the spine to the back.

Tummy Talk

Check out your fish's stomach! Examining a fish's last meal will help you become a better angler. Knowing what the fish was eating can help you better match your next lure to this species' diet.

Hold the fish down with one hand just in front of the tail fin.

For catfish, remove the skin by cutting around the head and pulling the skin off with pliers.

- Do not cut the fillet from the tail. Flip the fillet so that it is lying skin-side down. Hold the fish down with one hand just in front of the tail fin. Beginning at the tail carefully skin the fillet, working away from your hand. Work slowly and patiently; cutting too deeply will result in cutting through the skin and not cutting deeply enough will result in lost meat.
- Check local rules, but generally you can dispose of wrapped waste in a trash bin or bury it in your garden.

A note about catfish and bullheads: skin removal is accomplished by cutting around the head and pulling the skin off with pliers.

Flaky, Not Fishy

Fish are a tasty, healthy way to add a lot of muscle-building protein to your diet without adding fat. Many cookbooks have recipes specific to different species of fish, but fish can be prepared quite simply as well. Regardless of how much time you take with your fish preparation, fish should be flaky in texture and shouldn't taste fishy. The muscle layers of a properly cooked fish should separate effortlessly (flake) and the flesh will turn from translucent to white. Fish can easily be overcooked, making them taste dry. Fish can also be undercooked, which could transfer fish parasites to humans. And no fish tastes good if it was left too long in the sun after being caught, so remember to ice your fish and keep it cool! Give your own cooking skills a try by following the recipe below:

The Famous Triple Dip Fish Fry

- 1 pound fish fillets
- 1 cup flour
- ¼ teaspoon ground pepper
- ¼ teaspoon paprika
- ¼ teaspoon salt
- 1 egg
- 1/8 cup water
- 1–1½ cups bread or cracker crumbs
- cooking oil

1) Pat fish dry with paper towels and set aside.

2) In a shallow dish, mix flour, pepper, paprika, and salt.

3) In another shallow dish beat egg together with water to make an egg wash.

4) In a third shallow dish, place the crushed crumbs of your choice.

5) Pick up a fillet and dip it in the first bowl until coated with flour. Next dip the fillet in the egg wash, then transfer it to the third dish and pat the crumbs evenly over the entire fish. Do this for each fillet, separating them by aluminum foil on a plate.

TO FRY Heat ¼ inch of cooking oil in a heavy skillet. When a pinch of flour sizzles in the pan, it's hot enough for the fish. Cook a few fillets at a time until the fish are brown and crispy.

TO BAKE Coat a pan with cooking oil and place it in the oven. Heat oven to 450°F. Place fillets on the heated pan and cook about 6-7 minutes on each side, until crispy.

Cut It Out!

Even though eating fish is healthy, you should be aware that certain lakes and rivers have special advisories about PCBs and mercury. PCBs and mercury are toxins that are found in high concentrations in the fish of some lakes. Check the DNR Website at **dnr.wi.gov/fish/consumption** to investigate which ones have advisories.

You can safely enjoy fish from Wisconsin waters as a regular part of a healthy diet. Just observe these recommendations in the DNR's *Choose Wisely* fish consumption guide: cut the fat off of your fish; eat younger, smaller fish; and eat a wide variety of fish.

Swimming Upstream

Fishing is an amazing way to spend time outdoors, learn about the natural world, enjoy time with family and friends, explore the state, and catch fabulous food. But maintaining a healthy fishery requires our attention and care. If you see something that concerns you while out on the water—litter, erosion, a thick mat of algae—do something about it! The future of fishing in this state rests in the hands of those who regularly use it. If you think fishing is a valuable and important pastime, it's up to you to make your voice heard and your opinions matter.

There are direct and indirect paths to helping protect our natural resources. Some people choose to dedicate their lives to natural resources in careers at conservation organizations like the DNR. If you are planning a career in natural resources, check the DNR Website for a sampling of jobs in the field. If you see one that looks great, interview someone in that job to find out what sort of skills you should be getting while still in school. You can also check university Websites to see what types of courses they offer for people interested in our natural resources.

You don't need a career in conservation to be a conservationist. No matter what career you choose, artists, economists, cashiers, mathematicians, and flight attendants, to name a few, can all advocate and volunteer on behalf of natural resources. There are many ways to stay involved with and learn more about Wisconsin's fish and waters. Here are a few suggestions:

- Take a friend fishing. One of the best ways to gain support for the resource is to introduce others to it.
- If you like trout fishing, or are interested in starting, contact Trout Unlimited to see if they have a chapter near you. You could help with a restoration effort, or meet others who want to help trout.
- Start a fishing club at your school or join one in your community.
- Speak up! Write letters to your representatives and senators about your resource concerns and vote as soon as you are eligible!
- Get outside. Being an active observer is the first step to working for the changes you would like to see.

It's not always easy to improve our natural resources, but neither is it to swim upstream and plenty of fish do it every year. Keep your eyes on the water and your mind open. Even if you don't continue fishing, you will continue to live in a world where water resources and aquatic wildlife will play a role in the health and stability of our planet. Don't lose touch with the water in your world!

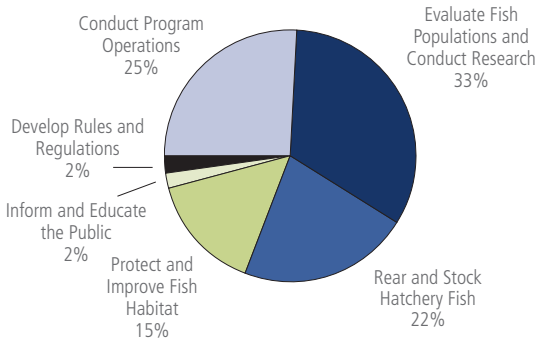
Cheap Date

Take your date or a pal fishing! After a small annual investment, you can fish 365 days a year with whomever you want. Many Wisconsin communities are situated on or near fishable waters. Pack a picnic, call a friend or two, hop on your bike, and head for the water's edge.

A love of fishing has inspired generations of anglers to pay close attention to natural resources. Invite a friend to join you in enjoying the beauty and excitement that fishing offers.

Where does your license money go?

Money collected through the Sport Fish Restoration Fund and fish license fees funds the fisheries program at the Department of Natural Resources. Within the fisheries program, the money gets divided into many different projects, illustrated in the pie chart below:



All that for less than the cost of one night on the town! *Data from 2006 DNR Fishing Report*

Compare the cost of a day of fishing to other leisure activities. Consider total costs of participation and how often you can use your investment. Here are some examples:

ACTIVITY	MINIMUM REQUIREMENTS	COST	ONE-TIME USE OR OPPORTUNITY	MULTIPLE USES OR OPPORTUNITIES
Fishing	License & Stamps Rod Reel Bait Tackle Other:			
Prom	Ticket Clothes Dinner Flowers Special Transportation Other:			
A night out Several options: movie, food, gasoline. List what you would do.				
A night at home Several options: games, music, snacks. List what you would do.				

Student Field Guide 28

NAME

FIELD KNOWLEDGE

Know Before You Go/Making the Catch

Sections A & B
Vocabulary Review

Fill in the blank using the words below.

This review is not found in the student guidebook and may be used as a test. Copies may be made for students.

1. The _____ knot is an angler's old standby and works well to tie a smaller line to a hook or lure.
2. Treating others as you would like to be treated is an example of _____ behavior.
3. With _____ gear, the reel is designed to store line (not to cast or retrieve) and the rod is long and limber.
4. _____ is a method used to clean fish that leaves them boneless.
5. Water you can float a canoe down during at least one day of the year is considered _____ by the State of Wisconsin.
6. People who own homes next to a natural body of water are considered _____ landowners.
7. A _____ is a type of feather lure that takes on lifelike movement in the water.
8. Many species of fish are regulated by " _____," which define the number of a species you may catch in one day.
9. CPR for fish stands for _____, a series of actions an angler can take to improve a fish's chance of surviving release.
10. The combination of tackle used on the end of a fishing line is called _____ tackle.

Word Choices

marabou	filleting	riparian	universal
terminal	fly-fishing	ethical	consider proper release
careful piscivore release	improved clinch	total daily bag limits	navigable

FIELD KNOWLEDGE

Sections A & B Section Assessment

Return to the scenario given at the beginning of FIELD KNOWLEDGE to apply the concepts covered in this section in a discussion: "You and your friends are out fishing on Devil's Lake. You've each kept your limit of one northern pike for the day, but the weather is perfect and you're all enjoying yourselves so much that you decide to keep fishing for a few more hours. If you catch any more fish, you'll release them. You sit back to watch the hikers on the ridge, when suddenly your bobber sinks and your line goes taut. You pick up your rod and struggle to reel in what turns out to be the largest northern pike you've ever seen! It's much bigger than the fish you caught several hours ago and would feed many more mouths. What would you do? Would you keep it or release it? Why? If you release it, how will you go about making it a safe release for the fish?"

Students should understand that once you decide to keep a fish, it is ILLEGAL to later release that fish in favor of another. In this scenario, the students should release the second fish immediately using the Consider Proper Release procedures. The Statewide Fishing Restrictions in the DNR fishing regulations clearly states that it is illegal to "sort fish." Any fish that a person takes into his or her possession which they do not immediately release is considered part of their daily bag limit. If students do not provide the correct answer when this scenario is discussed, make sure you spend time processing the correct answer as a class.

Field Knowledge Assessment Activity

If students are asked to keep a fishing journal, it could be an appropriate comprehensive assessment technique. Another option is to have the students work in teams of two to expand their fish profiles from **Profile of a Swimmer** into large, visually compelling posters. Each pair should develop two posters that are both explanatory and attractive. Posters should include information on how to identify the fish, where to find the fish (both in the state and within a waterbody), what tackle and bait are most appropriate for catching the fish, regulations affecting the fish, land use decisions that can or are affecting the fish, and a quote about the fish, fishing, or conservation, as appropriate.

FIELD KNOWLEDGE

Vocabulary Review

Answer Key

1. Improved Clinch
2. ethical
3. flycasting
4. Filleting
5. navigable
6. riparian
7. marabou
8. total daily bag limits
9. Consider Proper Release
10. terminal

Glossary

Arbor knot
a knot used to tie fishing line to a reel

Bait
live or dead animal material used to attract fish to a hook

Baitcasting
a rod and reel combination designed for larger baits

Barbels
slender, whisker-like taste receptors found on certain fish, such as catfish, bullheads, and sturgeon; used to find food

Blood Knot
a knot used to tie two fishing lines of similar width together

Bobber
a float used to keep terminal tackle at the desired depth in the water

Cast
the action of sending fishing line out over the water

Clinch Knot
a knot used to tie a fishing hook to a fishing line

Consider Proper Release (CPR)
the steps to follow when releasing a caught fish

Creel clerk
DNR fisheries staff who gathers information from anglers such as catch rates and the size and number of fish harvested on a particular lake. The number of boats and weather data are also recorded to help determine fishing pressure.

Downrigger
a special type of fishing tackle that gets lures down into deeper water (e.g. Great Lakes)

Ethical
good, respectable, acceptable

Fillet
a cutting technique used to remove the bones from fish

Fly
an artificial lure designed to imitate an insect

Fly-fishing Gear
a rod and reel combination consisting of a long, flexible rod and a simple reel that holds the line but does not assist the angler in casting

Guides
the loops found along a fishing rod that hold the fishing line in place

Hellgrammite
the aquatic nymph stage of a dragonfly; used for fish bait

Hook
the tackle used to attach a fish to fishing line, usually used with bait

Improved Clinch Knot
a knot used to tie a fishing hook to fishing line

Jig
a type of lure; a hook with a colorful weight attached to the top of the hook

Lateral line
a canal along the side of a fish containing pores with sensory organs that detect vibrations

Line
a thin, strong, often clear, cord used to attach a fishing hook to a reel

Lure
a combination of colorful artificial bait and hook, attached to a fishing line, to attract fish

Marabou
a type of feather that looks lifelike underwater and is attached to a lure to attract fish

Nail Knot
a knot used to tie fishing lines of different diameters together

Navigable
water being deep enough and wide enough to allow a boat to pass

PFD
a personal flotation device, or lifejacket, used to hold a person's head above water

Palomar Knot
a knot used to tie a fishing hook to a fishing line

Plastic Tail
a piece of plastic used to imitate worms, salamanders, eels, or frogs; usually tied below a jig or weight to attract fish

Plug
a lure designed to imitate a small fish or other aquatic animal

Popper
an artificial bug-like fly that pops as it is pulled along the water's surface

Pork Rind
a colored, cured strip of pork skin that is attached to a jig to attract fish

Possession Limit
the maximum number of a species that you can control, transport, etc., at any time; includes fish you have at home or in a vehicle. It is twice the daily bag limit.

Rapala
a type of fishing lure

Reel
a piece of tackle used to hold fishing line and to assist an angler in casting and retrieving line

Riparian
living or located on the bank of a natural waterbody

Rod
a fishing pole, used to extend the distance an angler can cast

Sinker
a weight used to hold terminal tackle below the surface of the water at the level desired by the angler

Snap
a piece of tackle used to assist the angler in attaching a hook or lure to fishing line

Spincasting Gear
a rod and reel combination with a push-button closed-bail reel; good for beginners

Spinner
a lure that has blades which spin as it is pulled through the water

Spinnerbait
a weighted lure with one or two spinning blades attached to it

Spinning Gear
a rod and reel combination with an open-bail reel designed for long backlash-free casting

Spoon
a lure that wobbles and flutters as it is retrieved

Stink Bait
smelly bait often used to attract catfish

Stringer
a string or wire that anglers hang fish from

Swivel
a piece of tackle used to connect a hook or lure to a fishing line

Tackle
fishing gear

Terminal Tackle
the combination of tackle used at the end of a fishing line, generally consisting of hooks, bait, lures, sinkers, snaps, and swivels

Total Daily Bag Limit
the total number of fish that an angler may keep in one day from all Wisconsin waters

Uni Knot
a versatile knot used in many fishing applications

Viral Hemorrhagic Septicemia (VHS)
an invasive disease that causes fish to bleed to death

Sources

Fish Knowledge

What makes a fish a fish?

Background Information

- Busch Gardens-Sea World, "Anatomy and Physiology of Bony Fish," **seaworld.org/animal-info/info-books/bony-fish/anatomy.htm** Accessed: December 2008.
- Kent Simmons, University of Winnipeg. "Perch Digestive System," **kentsimmons.uwinnipeg.ca/16cm05/16labman05/lb8content** Accessed: December 2008.

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Which fish is this?

Background Information

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Activity

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Fish Food

Background Information

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- Michigan Sea Grant, "Fish Habitat," **misea-grant.umich.edu/flow/unit3.html** Accessed: December 2008.
- Sally Ellingboe, "Weave a Web" extension activity submitted to the Wisconsin Department of Natural Resources Angler Education Program.

Activity

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Water of Life

Background Information

- City of Boulder, Colorado and United States Geological Survey, "General Information on Dissolved Oxygen," **bcn.boulder.co.us/basin/data/COBWQ/info/DO** Accessed: November 2008. **gvsu.edu/videticp/stratification**
- Grand Valley State University, "Seasonal Lake Stratification," **gvsu.edu/videticp/stratification** Accessed: November 2009. **faculty.gvsu.edu/videticp/stratification.htm**
- Water on the Web, **waterontheweb.org** Accessed: November 2008.
- U.S. Geological Survey, "Water Resources of the United States," **water.usgs.gov** Accessed: November 2008.
- WWF-World Wide Fund for Nature, **faculty.gvsu.edu/videticp/stratification.htm** "Hot, Hungry, and Gasping for Air: Climate Change Puts Fish at Risk," **worldwildlife.org/who/media/press/2005/WWFPresitem819.html** Accessed: December 2008.
- Terry Daulton and Dolly Ledin, Paradise Lost? Climate Change in the North Woods Exhibition, University Wisconsin–Center for Biology Education.

- "Understanding Lake Data" by Byron Shaw, Lowell Klessig and Christine Mechenich, University of Wisconsin-Stevens Point. Available on-line at **dnr.state.wi.us/lakes/publications/under/mixing** Accessed: November 2009.

Activity

- Adapted from Inland Seas Education Association, "Lake Stratification," **schoolship.org** Accessed: December 2008. Used by permission.
- Additional ideas by Jenifer Wroblewski, West High, Madison, WI; Ansel Schimpff; and Theresa Stabo.

Home Sweet Home

Background Information

- Michigan Sea Grant, "Fish Habitat," **miseagrant.umich.edu/flow/unit3.html** Accessed: December 2008.
- Michigan Sea Grant, "Fish Life Cycle," **miseagrant.umich.edu/flow/unit3.html** Accessed: December 2008.
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Activity

- Adapted from Keith Wittkopp's "Aquatic Environment Brochure" submitted to the Wisconsin Department of Natural Resources Angler Education Program.

People Knowledge

To the Point

Background Information

- Purdue University, "Planning with Power," **planningwithpower.org/pubs.htm** Accessed: December 2008.

Activity

- Adapted from National Oceanic and Atmospheric Association's (NOAA) National Ocean Service Communication and Education Division, "Where's the Point?" lesson plan, **oceanservice.noaa.gov/education/classroom/lessons/09_coastmanag_point.pdf** Accessed: December 2008. Used by permission.

Shared Interests

Background Information

- National Oceanic and Atmospheric Association National Ocean Service Education, "Get Smart" lesson plan, **oceanservice.noaa.gov/education/classroom/lessons/10_coastal_getsmart.pdf** Accessed: December 2008.
- Carleton College, "Starting Point Teaching Entry Level Geoscience," **serc.carleton.edu/introgeo/roleplaying/whatis.html** Accessed: December 2008.

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Aquatic Exotics

Background Information

- Great Lakes Fishery Commission, **glfc.org** Accessed: December 2008.
- Great Lakes United, **glu.org** Accessed: December 2008.
- Asian Carp Management, **asiancarp.org** Accessed: December 2008.
- National Atlas, "Zebra Mussels," **nationalatlas.gov/articles/biology/a_zm** Accessed: December 2008.
- Minnesota Sea Grant, "Aquatic Invasive Species," **seagrant.umn.edu/ais/index** Accessed: January 2008.

Activity

- Adapted from Inland Seas Education Association, "The Lamprey Are Here. Now What?," **schoolship.org** Accessed: December 2008. Used by permission.
- Sea Lamprey Control cost information updated by Marc Gaden, Great Lakes Fishery Commission, January 2008.

Restoration Nation

Background Information

- Trout Unlimited, **tu.org** Accessed: December 2008.
- Washington Department of Fish and Wildlife, "Stream Habitat Restoration Guidelines,"

wdfw.wa.gov/hab/ahg/shrg Accessed: December 2008.

- Center for Watershed Protection's Stormwater Manager's Resource Center, "Stream Restoration: Bank Restoration Practices," **stormwatercenter.net** Accessed: December 2008.
- United States Fish and Wildlife Service and Montana Water Center, "Wild Fish Habitat Initiative," **wildfish.montana.edu** Accessed: December 2008.

Activity

- Background information for the Case Study from Trout Unlimited, **tu.org** Accessed: December 2008) and from Marty Engel, Wisconsin Department of Natural Resources.
- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Taking Stock

Background Information

- Al Kaas, Wisconsin Department of Natural Resources.
- The Garret Hardin Society, "Tragedy of the Commons," **garretthardinsociety.org/articles/art_tragedy_of_the_commons** Accessed: November 2009

Activity

- Adapted from Habitat Media's "Empty Oceans, Empty Nets" lesson plans. Activity is a freshwater version of "Net Results" lesson plan. **pbs.org/emptyoceans/educators/index.html** Accessed: December 2008. Used with permission.

Making Decisions

Background Information

- Kurt Thiede, Wisconsin Department of Natural Resources.

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.
- Additional ideas from Todd Shucha, "What Would You Do?" activity submitted to the Wisconsin Department of Natural Resources Angler Education Program.

Great Conservationists

Background Information

- Think Exist, **thinkexist.com** Accessed: January 2009.
- Quoteland, **quoteland.com** Accessed: January 2009.
- Brainy Quote, **brainyquote.com** Accessed: January 2009.

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Field Knowledge

Tackling Tackle

Background Information

- South Shore Fishing's Tackle Manufacturers' Directory, **southshorefishing.net/reference/tackle.htm** Accessed: January 2009.
- Fishing Tackle in Wisconsin, **thomasnet.com/wisconsin/fishing_tackle_82491507.html** Accessed: January 2009.
- Take Me Fishing, **takemefishing.org** Accessed: January 2009.
- All About Fishing, **aa-fishing.com** Accessed: January 2009.
- Judy Hunt, fishing chart recommendations submitted to the Wisconsin Department of Natural Resources Angler Education Program.
- Mike Shoys, Vice President, Wisconsin Manufacturers & Commerce

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Got Skills

Background Information

- Grog's Fishing Knot Index, **animatedknots.com/indexfishing.php** Accessed: January 2009.
- Bruce Koellen, "Making Lures Work," activity submitted to the Wisconsin Department of Natural Resources Angler Education Program.

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Golden Rules

Background Information

- Wisconsin Department of Natural Resources, "Guide to Wisconsin Hook and Line Fishing Regulations 2008-2009."

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.
- Elizabeth Rhyner, "Will There Be Fish For Dinner Tonight?" activity submitted to the Wisconsin Department of Natural Resources Angler Education Program.

Safety First

Background Information

- Drowning statistics from Poseidon, **poseidon.fr/us/index.html** Accessed: January 2009.
- California Department of Boating and Waterways, **dbw.ca.gov** Accessed: January 2009.

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Reading the Water

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Fish Out of Water

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Cooking, Cleaning, and Companions

Background Information

- Recipe from "These Are Fish, They Bite Sometimes," Maureen Mecozzi, et al., published by the Wisconsin Natural Resources Magazine, 1990, pg. 13.

Activity

- Adapted and expanded from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Glossaries

Definitions

- Merriam Webster, **merriam-webster.com**
- Biology Online, **biology-online.org**

All lessons are based on background information from Wisconsin Department of Natural Resources, Master Angler Program, Theresa Stabo, et al., Outdoor Empire Publishing, 1991.

Master Materials List

Profile of a Swimmer

- Appendix A: Wisconsin's Game Fish

What Makes a Fish a Fish?

- Fish Wildcards/Fish Field Guide*
- Appendix B: Salmonid Dissection Guide
- Appendix B: Fish Anatomy Transparency
- Appendix B: Speaking Anatomically

Which Fish is This?

- Appendix C: A Key to Common Wisconsin Fish
- Appendix C: Credits for Fish Drawings
- Appendix C: Fish Images
- Fish Wildcards/Fish Field Guide*

Fish Food

(One set for each group of four to six students.)

- Appendix D: Steady State? Game handouts
- Stopwatches
- Scissors (if materials are not precut)

Water of Life

- Appendix E: Field Trip Record sheet
- Distilled water
- Salt
- Three 400 ml glass beakers or pint-sized canning jars
- 25 x 200 mL tube with screw cap
- Large syringe
- Drinking straw
- Blue, yellow, and red food coloring
- A means to repidly heat and cool water

Alternate Demonstration Materials List

- Honey
- Vinegar
- Grape juice concentrate
- Salad or olive oil
- Herbs
- Pint-sized canning jar with lid

Home Sweet Home

- Appendix F: Field Trip Record sheet
- A variety of travel brochures
- Research materials
- Computers

To the Point

- Topographic map of your area*
- Map and information about your local watershed
- Internet access or handouts

Shared Interests

- Appendix G: Field Trip Record sheet
- Butcher paper or poster board
- Markers
- A local zoning map

Aquatic Exotics

- Appendix H: PowerPoint Presentation: Invasive Images

Restoration Nation

- Optional: Guest speaker

Taking Stock

One set for each group of six students.

- Appendix I: Balancing Act Game handouts
- Open top containers
- Dried pinto beans (approximately one pound or 2 cups for each group)
- Graduated cylinders (250 ml or larger)
- Measuring spoon sets
- Cups
- Papers rolled into cones or funnel with large opening

If you have downloaded this booklet, please see the appendix that follows for additional materials.

Great Conservationists

- Pencil

Tackling Tackle

- Appendix K: Tackle Craft Instructions
- Appendix K: Tackle Craft Pictures
- Appendix K: Tackle Cue Cards
- Appendix K: Tackle Transparencies
- A wide sampling of tackle*
- Tackle craft supplies
- A clear tank with water
- Fishing line

Got Skills?

- Appendix L: Knot-testing Experiment
- Appendix L: Getting Rigged
- Rope for practice knots
- Eye bolts or shower curtain rings
- Hooks and fishing line*
- A sampling of tackle*
- Tires/hoops/Backyard Bass®*

Golden Rules

- Appendix M:
  A Key to Common Wisconsin Fish
- Appendix M: Fish images
- Appendix M: Fish Identification Cheat Sheet
- Scraps of paper
- DNR fishing regulations*
- Three boxes or bowls

Safety First

- PFDs
- Rods and reels*
- Paddles
- Other skit supplies

Reading the Water

- Appendix A: Wisconsin's Game Fish
- Lake chart for a local lake
- Fish reference books* or Internet access

Fish Out of Water

- Tackle*
- PFDs
- Fishing licenses
- First Aid kit

Cooking, Cleaning, and Companions

- Fillet knives
- Spoons/fish scalers
- Plastic bags/newspaper
- DNR's Choose Wisely guide*
- First Aid kit
- Recipe supplies

* Materials Notes

- Fish Wildcards available from the DNR.
- *Fish of Wisconsin* by Dave Bosanko is a pocket-sized, inexpensive field guide.
- The Website **wiscfish.org** is an excellent tool for identifying fish and learning morphology.
- Maps of the state can be ordered for a low price from the Wisconsin Geological and Natural History Survey.
- Current Fishing Regulations and the *Choose Wisely* guide can be found on the DNR Website or wherever fish licenses are sold.
- A limited selection of tackle is available for classroom use through the Tackle Loaner program. Go to the DNR Website at **dnr.wi.gov/fish/kidsparents/loanerequipment** for more information.
- Backyard Bass® can be purchased from **ironwoodpacific.com** or borrowed from many DNR tackle loaner sites: **dnr.wi.gov/fish/kidsparents/loanerequipment**.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

Environmental Education

Students will	Hook, Line, & Thinker: Science Guide											Hook, Line, & Thinker: Field Guide						
	What Makes a Fish a Fish	Which Fish is This	Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, & Companions
A.8.1 Identify environmental issue questions that can be investigated using resources and equipment available											X								
A.8.3 Use techniques such as modeling and simulating to organize information gathered in their investigations						X													
A.8.4 Use critical-thinking strategies to interpret and analyze gathered information				X		X		X		X	X								
A.8.5 Use the results of the investigation to develop answers, draw conclusions, and revise their personal understanding						X		X		X	X				X				
A.8.6 Communicate the results of investigations by using a variety of media and logially defend their answers						X													
A.12.1 Identify questions that require skilled investigation to solve current problems cited in literature, media, or observed through personal observations											X								
A.12.3 Evaluate personal investigations and those of others, critiquing procedures, results, and sources of data and suggest improvements to the investigation						X		X		X	X								
A.12.4 State and interpret results of their investigations to groups concerned with the issue										X					X				
A.12.5 Communicate the results of their investigations to groups concerned with the issue						X					X								
B.8.1 Describe the flow of energy in natural and a human-built ecosystem using the laws of thermodynamics			X	X															
B.8.2 Explain how change is a natural process, citing examples of succession, evolution, and extinction	X	X		X															
B.8.4 Map the levels of organization of matter		X	X	X															
B.8.5 Give examples of human impact on various ecosystems						X	X	X	X										

Environmental Education

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B.8.6 Describe major ecosystems of Wisconsin					X														
B.8.8 Explain interactions among organisms or populations of organisms		X	X		X	X		X											
B.8.10 Explain and cite examples of how humans shape the environment			X			X	X		X	X									
B.8.15 Analyze how people impact their environment through resource use						X	X	X	X	X									
B.8.16 Recognize the economic, environmental, and other factors that impact resource availability and explain why certain resources are becoming depleted										X									
B.8.17 Explain how human resource use can impact the environment; e.g. erosion						X	X		X	X									
B.8.18 Identify major air, water, or land pollutants and their sources						X	X	X	X										
B.8.19 Distinguish between point and nonpoint source pollution						X													
B.8.21 Identify and analyze individual, local, regional, national, and global effects of pollution on plant, animal, and human health						X													
B.8.22 Identify careers related to natural resources and environmental concerns									X	X									
B.8.23 Identify governmental and private agencies responsible for environmental protection and resource management									X	X									
B.12.1 Evaluate the relationship of matter and energy and the flow of energy in natural, managed, and built systems			X	X															
B.12.2 Describe the value of ecosystems from a natural and a human perspective			X	X	X					X									
B.12.3 Evaluate the stability and sustainability of ecosystems in response to changes in environmental conditions			X	X				X	X										

Environmental Education

Students will	Hook, Line, & Thinker: Science Guide											Hook, Line, & Thinker: Field Guide						
	What Makes a Fish a Fish	Which Fish is This	Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, & Companions
B.12.4 Analyze the factors that determine the number of organisms that can exist in a given area			X	X	X			X											
B.12.5 Analyze past and current trends in ecosystem degradation and species extinction	X					X	X	X	X										
B.12.6 Predict population response to changes in environmental conditions			X	X					X										
B.12.8 Relate the impact of human activities in ecosystems to the natural process of change, citing examples of succession, evolution, and extinction								X	X										
B.12.9 Evaluate ways in which technology has expanded our ability to alter the environment and its capacity to support humans and other living organisms							X			X									
B.12.10 Identify and evaluate multiple uses of natural resources and how society is influenced by the availability of these resources										X									
B.12.11 Assess how changes in the availability and use of natural resources will affect society and human activities										X									
B.12.12 Evaluate the environmental and societal costs and benefits of allocating resources in various ways and identify management strategies to maintain economic and environmental sustainability							X		X	X									
B.12.13 Analyze how different political and governmental systems manage resource development, distribution a, consumption, and waste disposal.										X					X				
B.12.16 Analyze how natural resource ownership and trade influences relationships in local, national, and global economies.							X	X					X						
B.12.17 Explain the concept of exported/imported pollution; eg watersheds						X													
B.12.18 Analyze cause and effect relationships of pollutants and other environmental changes on human health						X													

Environmental Education

Students will	Hook, Line, & Thinker: Science Guide												Hook, Line, & Thinker: Field Guide						
	What Makes a Fish a Fish	Which Fish is This	Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, & Companions
B.12.19 Illustrate how environmental quality affects the economic well-being of a community								X		X	X								
C.8.1 Define and provide examples of environmental issues, explaining the role of beliefs, attitudes, and values										X	X								
C.8.3 Use questioning and analysis skills to determine beliefs, attitudes, and values held by people involved in an environmental issue											X								
C.8.4 Evaluate the credibility of information, recognizing social, economic, political, environmental, technological, and educational influences											X								
C.12.2 Explain the factors that contribute to the development of individual and societal values											X	X							
C.12.3 Maintain a historical perspective when researching environmental issues; include past, present, and future considerations											X								
C.12.4 Identify strengths and weaknesses of different approaches to investigating an envrionmental issue and identify some of the assumptions of each approach								X											
D.8.1 Identify options for addressing an environmental issue and evaluate the consequences of each option						X	X	X	X	X	X								
D.8.3 List reasons why an individual or group chooses to participate or not in an environmental activity.																			X
D.8.4 Explain the political, legal and budgetary options for resolving local, state, and national environmental issues											X								
D.8.5 Explain how personal actions can impact an environmental issue						X		X	X			X						X	X
D.8.6 Develop a plan for improving or maintaining some part of the local environment and identify their role in accomplishing this plan						X													

Environmental Education

Students will	Hook, Line, & Thinker: Science Guide											Hook, Line, & Thinker: Field Guide						
	What Makes a Fish a Fish	Which Fish is This Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, & Companions
D.8.7 Identify examples of how personal beliefs can influence environmental decisions										X	X							
D.8.8 Give examples of education, economic, and government institutions' influence on an envrionmental issue, and the role of citizens in policy formation						X		X		X								
D.12.1 Identify a variety of approaches to environmental issues, evaluate the consequences of each, and select and defend a position					X	X	X	X	X									
D.12.4 Describe the rights and responsibilities of citizenship in regard to environmental problems and issues						X												
D.12.5 Develop a plan to maintain or improve some part of the local or regional environment, and enlist support for the implementation of that plan					X													
D.12.6 Identify and analyze examples of the impact beliefs and values have on environmental quality											X			X	X			
D.12.7 Analyze political, educational, economic, and governmental influences on envrionmental issues, and the role of citizens in policy formation								X						X				
D.12.8 Use cost-benefit analysis to evaluate proposals to improve environmental quality										X				X				
D.12.9 Describe regulatory and economic approaches to improving the environment and explain the advantages and disadvantages of each										X								

Language Arts and Social Studies

Language Arts Students will	Hook, Line, & Thinker: Science Guide											Hook, Line, & Thinker: Field Guide						
	What Makes a Fish a Fish	Which Fish is This	Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, & Companions
B.8.1 Create or produce writing to communicate with different audiences for a variety of purposes												X							
B.12.1 Create or produce writing to communicate with different audiences for a variety of purposes												X							
C.8.1 Orally communicate information, opinions, and ideas effectively to different audiences for a variety of purposes						X													
C.12.1 Prepare and deliver formal oral presentations appropriate to specific purposes and audiences						X													
F.8.1 Conduct research and inquiry on self-selected or assigned topics, issues, or problems and use an appropriate form to communicate their findings						X					X								
F.12.1 Conduct research and inquiry on self-selected or assigned topics, issues, or problems and use an appropriate form to communicate their findings						X					X								
Social Studies Students will																			
A.8.1 Use a variety of geographic representations, such as political, physical, and topographic maps, a globe, aerial photographs, and satellite images, to gather and compare information about a place						X													
A.8.11 Give examples of the causes and consequences of current global issues, such as the expansion of global markets, the urbanization of the developing world, the consumption of natural resources, and the extinction of species, and suggest possible responses by various individuals, groups, and nations						X		X	X	X									

Language Arts and Social Studies

Social Studies Students will	Hook, Line, & Thinker: Science Guide											Hook, Line, & Thinker: Field Guide						
	What Makes a Fish a Fish	Which Fish is This	Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, & Companions
A.12.4 Analyze the short-term and long-term effects that major changes in population in various parts of the world have had or might have on the environment						X				X									
A.12.11 Describe scientific and technological development in various regions of the world and analyze the ways in which development affects environment and culture						X	X	X	X										
A.12.12 Assess the advantages and disadvantages of selected land use policies in the local community, Wisconsin, the United States, and the world						X	X		X										
C.8.3 Explain how laws are developed, how the purposes of government are established, and how the powers of government are acquired, maintained, justified, and sometimes abused											X								
C.8.7 Locate, organize, and use relevant information to understand an issue of public concern, take a position, and advocate the position in a debate											X								
C.8.8 Identify ways in which advocates participate in public policy debates											X								
C.12.8 Locate, organize, analyze, and use information from various sources to understand an issue of public concern, take a position, and communicate the position											X								
C.12.9 Identify and evaluate the means through which advocates influence public policy											X								
C.12.10 Identify ways people may participate effectively in community affairs and the political process											X								

Physical Education*

Students will	Hook, Line, & Thinker: Science Guide											Hook, Line, & Thinker: Field Guide						
	What Makes a Fish a Fish	Which Fish is This	Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, & Companions
B.8.1 Demonstrate competence in modified versions of movement forms such as performing in a variety of simple folk and square dances														X					
B.8.3 Demonstrate increasing competence in more advanced specialized physical skills														X				X	
B.12.1 Demonstrate competence in an increasing number of more complex versions of different types of movement forms such as outdoor activities														X				X	
B.12.2 Demonstrate competence and work toward advanced proficiency in selected activities such as getting nine out of ten arrows in the target from 40 feet														X					
C.8.1 Understand and apply more advanced movement and game strategies such as explaining and demonstrating strategies involved in tennis doubles													X	X				X	
C.8.3 Identify and apply principles of practice and conditioning to enhance performance such as understanding that conditioning will allow one to play for longer periods of time without fatigue													X	X					
C.12.2 Independently apply advanced, movement-specific information													X	X				X	
C.12.4 Identify and apply characteristics and critical elements of highly skilled performance to develop movement competence or proficiency such as using internal and external information to modify movement during performance													X	X					
D.8.1 Feel satisfaction when engaging in physical activity																		X	X
D.8.2 Recognize the social benefits of participation in physical activity such as the joy of participating with a team and sensing team fulfillment																		X	X
D.8.3 Enjoy learning new activities																	X	X	X

Physical Education*

*Note: Revised Wisconsin's Model Academic Standards for Physical Education are expected in 2010. Standards1, 2, 5, and 6 apply as they were drafted in early 2010.

Students will	Hook, Line, & Thinker: Science Guide												Hook, Line, & Thinker: Field Guide						
	What Makes a Fish a Fish	Which Fish is This	Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, & Companions
D.12.1 Derive pleasure from participating in physical activities in competitive and recreational settings																	X	X	X
D.12.2 Pursue new activities both alone and with others																	X	X	
D.12.3 Recognize the strengths and weaknesses of teammates and provide opportunities for everyone to enjoy success within skill limitations																	X		
F.8.2 Solve problems by analyzing causes and potential solutions															X	X	X	X	
F.8.3 Make choices based on the safety of self and others																X		X	X
F.8.4 Consider the consequences when confronted with a behavior choice															X	X		X	
F.8.6 Work cooperatively with a group to achieve group goals in competitive as well as cooperative settings																X		X	X
F.12.1 Apply rules, procedures, and etiquette in all physical-activity settings															X	X	X	X	X
F.12.5 Take appropriate leadership or supportive roles in activities																X		X	X
F.12.6 Create a safe environment for their own skill practice and group activities																X		X	X
Revised Physical Education Standards for 2010																			
1 Demonstrates competency in motor skills and movement patterns needed to perform a variety of physical activities.														X				X	
2 Demonstrates understanding of movement concepts, principals, strategies, and tactics as they apply to the learning and performance physical activities.														X				X	
5 Exhibits responsible personal and social behavior that respects self and others in physical activity settings.														X	X	X	X	X	X
6 Values physical activity for health, enjoyment, challenge, self-expression, and/or social interaction.																		X	X

Science

Students will	Hook, Line, & Thinker: Science Guide											Hook, Line, & Thinker: Field Guide						
	What Makes a Fish a Fish	Which Fish is This	Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, & Companions
A.8.6 Use models and explanations to predict actions and events in the natural world								X		X									
A.8.7 Design real or thought investigations to test the usefulness and limitations of a model										X									
A.8.8 Use themes of evolution, equilibrium, and energy to predict future events or changes in the natural world						X													
A.12.1 Apply the underlying themes of science to develop defensible visions of the future						X													
A.12.3 Give examples that show how partial systems, models, and explanations are used to give quick and reasonable solutions that are accurate enough for basic needs										X									
A.12.4 Construct arguments that show how conflicting models and explantions of events can start with similar evidence								X											
A.12.5 Show how the ideas and themes of science can be used to make real-life decisions about careers, work places, life styles, and use of resources					X				X										X
B.8.6 Explain the ways in which scientific knowledge is useful and also limited when applied to social issues									X	X									X
C.8.1 Identify questions they can investigate using resources and equipment they have available											X						X		
C.8.2 Identify data and locate sources of information including their own records to answer the questions being investigated											X						X		

Science

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C.8.4 Use inferences to help decide possible results of their investigations, use observations to check their inferences								X	X										
C.8.6 State what they have learned from investigations, relating their inferences to scientific knowledge and to data they have collected.													X					X	
C.8.11 Raise further questions which still need to be answered								X	X										
C.12.1 Ask questions suggested by…observations of phenomena, build hypothesis…design possible investigations…and describe results that might emerge from such investigations									X										
C.12.4 During investigations, choose the best data-collection procedures and materials available								X									X		
C.12.7 Evaluate articles and reports…using criteria related to accuracy, degreee of error, sampling, treatment of data, and other standards of experimental design								X											
E.12.2 Analyze the geochemical and physical cycles of the earth and use them to describe movements of matter				X															
F.8.5 Show how different structures both reproduce and pass on characteristics of their group		X																	
F.8.6 Understand that an organism is regulated both internally and externally	X																		
F.8.7 Understand that an organism's behavior evolves through adaptation to its environment					X														
F.8.8 Show how organisms both depend on and contribute to the balance or imbalance of populations and/or ecosystems, which in turn contribute to the total system of life on the planet			X		X		X	X		X									

Science

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F.8.9 Explain how some of the changes on earth are contributing to changes in the balance of life and affecting the survival and population growth of certain species						X	X	X	X										
F.8.10 Project how current trends in human resource use and population growth will influence the natural environment, and show how current policies affect those trends					X	X	X	X	X	X								X	
F.12.5 Understand the theory of evolution, natural selection, and biological classification	X	X																	
F.12.6 Using concepts of evolution and heredity, account for changes in species and the diversity of species, include the influence of these changes on science		X																	
F.12.7 Investigate how organisms both cooperate and compete in ecosystems					X			X		X								X	
F.12.8 Using science themes, infer changes in ecosystems prompted by the introduction of new species, environmental conditions, chemicals, and air, water, or earth pollution						X	X	X	X	X								X	
F.12.9 Using science themes, investigate energy systems to show how energy is stored in food and how energy is released by digestion and metabolism			X																
F.12.10 Understand the impact of energy on organisms in living systems						X													
F.12.11 Investigate how the complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain an organism					X														

Science

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G.8.2 Explain how current scientific and technological discoveries have an influence on the work people do and how some of these discoveries also lead to new careers										X									
G.8.3 Illustrate the impact that science and technology have had, both good and bad, on careers, systems, society, environment, and quality of life.													X						
G.8.5 Investigate a specific local problem to which there has been a scientific…solution, including proposals for alternative courses of action, the choices that were made…and subsequent community satisfaction									X		X								
G.8.7 Show evidence of how science and technology are interdependent, using some examples drawn from personally conducted investigations										X									
G.12.1 Identify personal interests in science and technology, implications that these interests might have for future education, and decisions to be considered											X								
G.12.5 Choose a specific problem in our society, identify alternative scientific or technological solutions to that problem and argue its merits											X								
H.8.1 Evaluate the scientific evidence used in various media to address a social issue, using criteria of accuracy, logic, bias, relevance of data, and credibility of sources											X								
H.8.2 Present a scientific solution to a problem involving…life and environmental…sciences and participate in a consensus-building discussion to arrive at a group decision							X		X		X								

Science and Math

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H.12.1 Using science themes and knowledge of…life and environmental sciences…analyze the costs, risks, benefits, and consequences of a proposal concerning resource management in the community and determine the potential impact of the proposal…							X		X		X								
H.12.2 Evaluate proposed policy recommendations in science and technology for validity, evidence, reasoning, and implications, both short and long-term							X				X								
H.12.3 Show how policy decisions in science depend on social values, ethics, beliefs, and time-frames as well as considerations of science and technology							X												
H.12.4 Advocate a solution or combination of solutions to a problem in science or technology									X			X							
H.12.5 Investigate how current plans or proposals concerning resource management…will have an impact on the environment, ecology, and quality of life in a community or region											X								
H.12.7 When making decisions, construct a plan that includes the use of current scientific knowledge and scientific reasoning									X		X								

Projects WET and WILD

Projects WET and WILD are national programs that focus on aquatic resources. Materials are distributed at workshops arranged by the Wisconsin Department of Natural Resources. Please see their Web page on the DNR's Website, **dnr.wi.gov/education/pltwildwet**.

		Hook, Line, & Thinker: Science Guide											Hook, Line, & Thinker: Field Guide						
PAGE	ACTIVITY GUIDE	What Makes a Fish a Fish	Which Fish is This	Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, and Companions
Wild Aquatic																				
8	Fishy Who's Who		X			X														
19	Designing a Habitat					X														
21	Where Does Water Run?						X													
24	Water Canaries				X															
39	Wetland Metaphors					X														
43	Hooks and Ladders			X		X														
49	Micro-Odyssey			X																
52	Blue-Ribbon Niche					X		X												
66	Pond Succession					X														
69	Eat and Glow	X																		
75	Edge of Home					X														
85	Net Gain, Net Effect										X			X						
91	Watered Down History						X	X												
110	Water Wings						X													
118	Riparian Retreat					X		X												
121	How Wet Is Our Planet?			X																
124	Facts and Falsehoods											X								
132	Watershed						X													
136	What's in the Air?						X													
140	What's in the Water?						X													
145	Something's Fishy Here						X			X										
151	Alice in Waterland						X													
158	Fishable Waters									X	X			X						
177	Aquatic Roots								X											
180	Where Have All the Salmon Gone?										X			X						
184	To Dam or Not to Dam									X										
188	Aquatic Times											X								
190	Silt: A Dirty Word						X	X												
198	Dragonfly Pond							X												
204	Living Research													X						

Projects WET and WILD

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		What Makes a Fish a Fish	Which Fish is This	Fish Food	Water of Life	Home Sweet Home	To the Point	Shared Interests	Aquatic Exotics	Restoration Nation	Taking Stock	Making Decisions	Great Conservationists	Tackling Tackle	Got Skills	Golden Rules	Safety First	Reading the Water	Fish Out of Water	Cooking, Cleaning, and Companions
Project WILD																				
23	How Many Bears?			X																
28	My Kingdom for a Shelter					X														
36	Oh Deer!			X																
41	Wild Words												X							
44	We're in This Together						X		X			X								
46	Carrying Capacity			X																
61	Habitat Lap Sit					X		X												
64	Who Fits Here?	X																		
66	Which Niche?	X																		
82	Micro-trek Treasure Hunt							X												
96	What's For Dinner?			X																
105	Energy Pipeline			X																
122	Quick Frozen Critters	X																		
128	Adaptation Artistry	X																		
152	Planting Animals								X		X									
166	Ecosystem Facelift									X										
172	Bottleneck Genes	X																		
203	Ethi-Reasoning												X							
216	Pay to Play										X			X						
267	History of Wildlife Management											X								
270	Wild Bill's Fate											X								
272	Know Your Legislation											X								
297	Wildlife Issues									X										
308	Migration Barriers							X												
310	Shrinking Habitat							X												
321	To Zone or Not to Zone							X												
326	Hazardous Links,Possible Solutions						X													
330	World Travelers								X											
341	Riparian Zone							X												
345	Changing the Land							X												

Projects WET and WILD

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364	Philosphical Differences											X								
371	Career Critters									X										
385	Wildwork										X									
387	Checks and Balances										X									
434	Litter We Know						X													
440	Improving Wildlife Habitat									X										
443	Enviro-Ethics														X					
446	Can Do!											X								
Project Wet																				
19	Water Log															X				
25	Adventures in Density				X															
79	Life in the Fast Lane					X														
129	Branching Out						X													
133	Capture, Store, Release					X														
166	Just Passing Through							X												
186	Rainy Day Hike						X													
219	A-Maze-Ing Water						X													
223	Color Me a Watershed						X	X												
232	Common Water							X												
Page	Project WET																			
238	A Drop in the Bucket						X													
267	Sum of the Parts						X													
279	Where Are the Frogs?						X													
316	Humpty Dumpty									X										
322	Macroinvertebrate Mayhem						X													
338	The Pucker Effect						X													
388	Hot Water											X								
397	Perspectives											X								
425	What's Happening?											X								
457	Water Write												X							

Water Action Volunteers

Water Action Volunteers (WAV) is a cooperative program between the University of Wisconsin–Extension and the Wisconsin Department of Natural Resources. All WAV activities can be downloaded from the WAV Website, **watermonitoring.uwex.edu/wav/pubs**.

Hook, Line, & Thinker: Science Guide

Hook, Line, & Thinker: Field Guide

Activity Name	Related Lesson Plan
Stream Walk Outdoors	Home Sweet Home
Watershed in a Box: Indoor Service Project with Younger Students	To the Point Shared Interests
Stream and River Clean Up: Service Project	Restoration Nation Great Conservationists
Erosion in a Bottle	To the Point
Urban Runoff Model	To the Point
Biotic Index Survey: Outdoor "Critter Search"	Fish Food
Storm Drain Stenciling: Service Project	To the Point
Human Watershed	Shared Interests

Fishing Journal

Date & Time **Location** (DETAILED)

_____ _____

_____ _____

Weather Details

AIR TEMPERATURE: _____

WATER TEMPERATURE: _____

SKY:	Clear	Partly Cloudy	_____ % Cover	Overcast
WIND:	Direction _____	Calm	Breezy	Windy
PRECIPITATION:	None	Drizzle	Hard Rain	Snow

Catch

1 SPECIES: _____ SIZE: _____ KEPT?: _____

BAIT: _____ METHOD: _____

LOCATION OF CATCH (CURRENT, WAVES, STRUCTURE): _____

2 SPECIES: _____ SIZE: _____ KEPT?: _____

BAIT: _____ METHOD: _____

LOCATION OF CATCH (CURRENT, WAVES, STRUCTURE): _____

3 SPECIES: _____ SIZE: _____ KEPT?: _____

BAIT: _____ METHOD: _____

LOCATION OF CATCH (CURRENT, WAVES, STRUCTURE): _____

4 SPECIES: _____ SIZE: _____ KEPT?: _____

BAIT: _____ METHOD: _____

LOCATION OF CATCH (CURRENT, WAVES, STRUCTURE): _____

Next Time Bring:

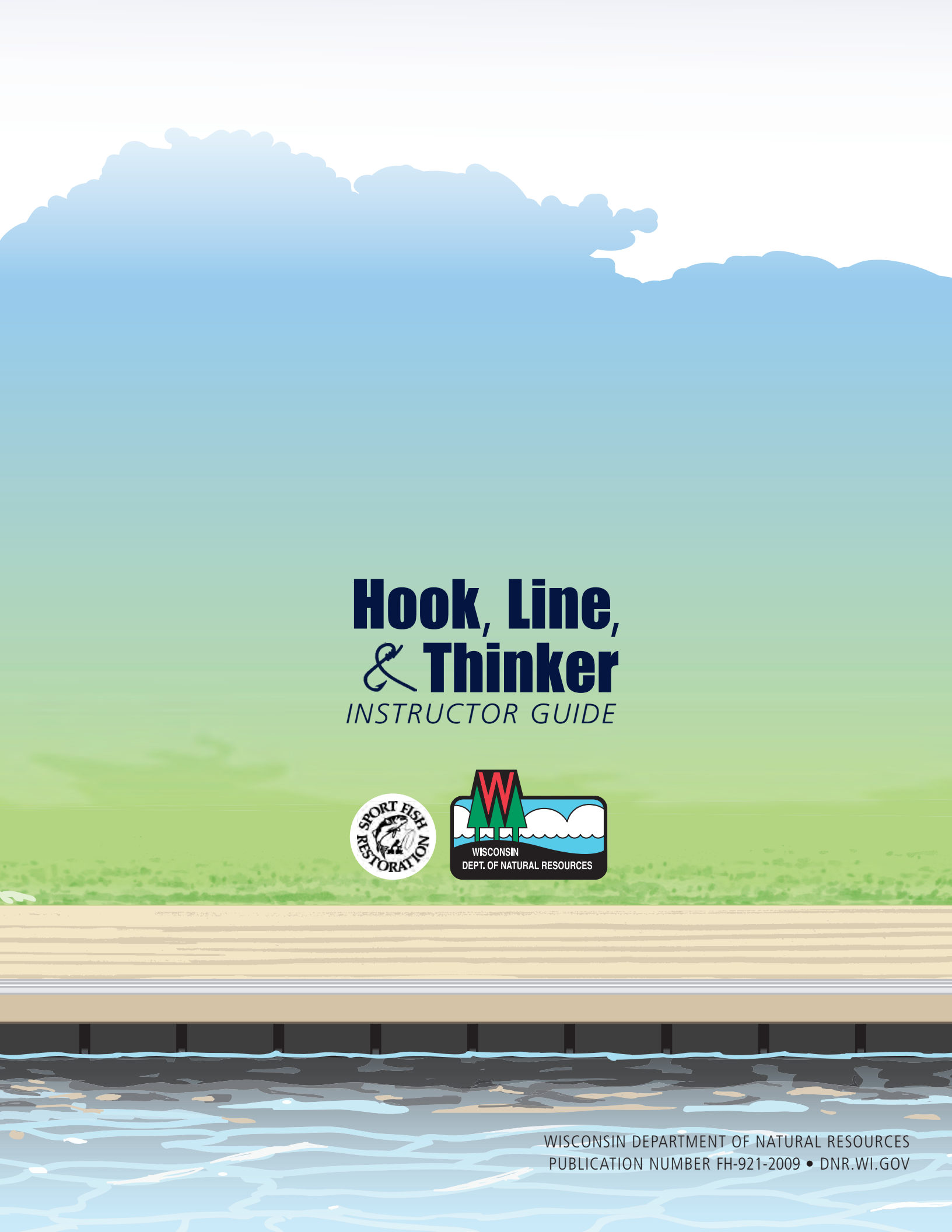
_____

_____

Special Notes: (INSECT HATCH, SPAWNING, ETC)

_____

_____



Hook, Line, & Thinker

INSTRUCTOR GUIDE

SPORT FISH RESTORATION

WISCONSIN DEPT. OF NATURAL RESOURCES

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