FLOW

FISHERIES LEARNING ON THE WEB

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FLOW Unit 3: Fish Overview

This series of five lessons introduces students to the number and variety of Great Lakes fish. Students use a simple key, based on distinguishing characteristics, to identify several common fish families. Lessons then explain the importance of healthy fish habitat, illustrate the significant stages in a fish's life cycle, and describe techniques for tracking and monitoring Great Lakes fish populations. The final lesson highlights a variety of people who have chosen scientific careers studying or teaching about the oceans and Great Lakes. This unit was updated in 2007.

Lesson 1: Fins, Tails and Scales: Identifying Great Lakes Fishes

Introduces students to distinguishing characteristics of Great Lakes fish. Part II: Leads students through the process of using a dichotomous key to organize and identify 10 common fish families.

Lesson 2: Fish Habitat

Discusses common habitats where fish can meet their basic needs for survival. Highlights the need to protect and maintain healthy fish habitat.

Lesson 3: Fish Life Cycle

Explains the life cycle of fish and contrasts the reproductive strategies of several species.

Lesson 4: Fish Populations

Discusses techniques used by scientists to monitor the size and movement of Great Lakes fish populations.

Lesson 5: Great Lakes, Great Careers

A lively group activity introduces students to a variety of people who have chosen scientific careers related to the oceans and Great Lakes.

Supplemental Materials

Note: Some lesson materials (cards, games, charts and other graphics) may be at the very end of this unit, rather than compiled with each lesson.

> See the lesson section *materials and procedures* and the *Supplemental Materials* section at the end of this document.

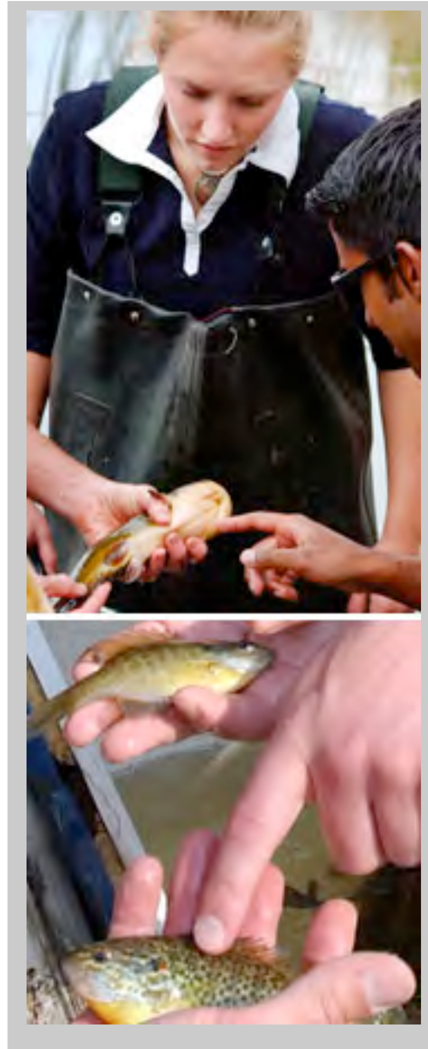
Lesson Assessment, State of Michigan Grade Level Content Expectations (GLCE) and National Benchmarks:

> See separate document, FLOW_Assessment_GLCE.pdf

Lesson 1: Fins, Tails and Scales: Identifying Great Lakes Fish

Updated: November 2007

Activity: Working with a set of Great Lakes fish cards, students identify distinguishing characteristics of fish and use a dichotomous key to identify 10 common fish families.



Grade level: 4-8
Subjects: Science, social studies
Setting: Classroom
Duration: 30-60 minutes
Key Terms: Adipose fin, Anal fin, Barbels, Caudal fin, Dichotomous key, Dorsal fin, Family, Genus, Ichthyologist, Pectoral fin, Pelvic fins, Species, Snout, Superior, Terminal, Ventral

Objectives

After participating in this activity, students will be able to:

- Describe the physical characteristics (traits) of fish that help them survive in their environment.
- Name several distinguishing characteristics of Great Lakes fish.
- Describe how these characteristics help fish survive in their environment.
- Organize Great Lakes fish (cards) based on similarities and differences.
- Use a dichotomous key to identify 10 Great Lakes fish families.

Summary

Each family of fishes in the Great Lakes region has physical traits that set it apart from others, called distinguishing characteristics. These characteristics help fish survive in their environment. By observing and comparing these features, students learn that fish, like other living organisms, can be organized and classified into meaningful groups for identification and further study.

Background

The Great Lakes region is home to an impressive variety of fish, numbering more than 160 separate species. A species consists of individuals that share the same gene pool. These species belong to 28 major fish families. A family is a taxonomic group that includes similar species.

Students may be most familiar with fish in the sunfish and bass family, cold-water species in the salmon and trout family, or some of the 62 species that make up the minnow family. Ancient fish such as lake sturgeon and longnose gar also inhabit waters of the

Great Lakes region and possess unique attributes that have allowed them to survive for millions of years.

With the exception of some primitive species, most fish have common characteristics that include gills, scales, fins, and bony skeletons. Some characteristics that differentiate fish include head shape and mouth orientation, fin type and location, and average adult size. Color markings, such as vertical stripes or fin spots, may also help differentiate fish when used in combination with other factors including geographic range.

Distinguishing characteristics can provide clues about where a species typically lives and what it eats. For example, fish in the sturgeon and sucker families have downward-oriented mouths (sometimes called ventral) that enable them to find food along a lake or stream bottom. Other traits such as fin shape and location can provide clues about whether a fish is generally a fast swimmer or a slow swimmer. See: *Fish Characteristics Fact Sheet*.

Dichotomous Keys

To correctly identify fish and classify newly discovered species, fisheries scientists use a dichotomous key based on distinguishing characteristics. A dichotomous key is a classification tool used to sort, organize and identify a collection of objects or living organisms.

A dichotomous key is made up of a series of questions with two choices. Each choice leads to another question. The key can appear in narrative form (as numbered questions), graphically (resembling a flow chart), or a combination of graphics and narrative. By making choices and progressing logically through the key, users follow a path that ends with the correct identification of the organism.

Dichotomous keys vary in their degree of specificity. In this lesson, a simplified key has been created that distinguishes 10 Great Lakes fish families. By using their knowledge of distinguishing characteristics, students use illustrations of fish to work through the key and make identifications. See: *Dichotomous key, Great Lakes fish families.*

Materials and Preparation

- Great Lakes fish family cards and generic fish graphic
- Dichotomous key: Great Lakes fish families
- Fish Characteristics fact sheet

Note: See FLOW fish cards, fact sheets and other materials at the end of this lesson (supplemental materials).

Procedure: Part 1

1. Discuss the importance of observing distinguishing characteristics of living organisms in order to classify and identify them.
2. Hold up the generic fish illustration. Explain that this is not a real fish, but rather a composite showing a variety of physical traits. Point out the location and names of the various fins and other special features such as barbels (a scientific term for the

"whiskers" used by bottom-feeding fish to sense food), and adipose fin (a fleshy fin located behind the dorsal fin).

3. Arrange the students in small working groups. Provide each group with the generic fish illustration, and a set of fish family cards. Explain that the species on the 12 cards belong to 10 Great Lakes fish families.
4. Ask the groups to sort the fish cards based on any set of physical characteristics they choose or for which they have some prior knowledge. (This is an important step in drawing out students' previous knowledge and creates motivation for students to learn more.)
5. Discuss the results. Ask students: How did you sort the fish? What features did you look at? Was it easy or hard? As the discussion progresses, ask students: Did anyone sort by tail shape, by presence of a barbel, by mouth shape, or fin rays? This way, the discussion becomes informative to students about what features scientists consider important, and informative to the teacher with regard to gauging students' current knowledge.
6. Explain that in Part II, students will use a dichotomous key to sort and identify fish based on the characteristics that ichthyologists, fish scientists, view as important.

Part 2

1. Divide the class into small groups. Explain the need to use classification systems to organize living organisms. Introduce the concept of a dichotomous key. Emphasize that this system uses a set of logical steps based on distinguishing characteristics and results in the correct classification or identification of an organism.
2. Pass out a set of fish family cards and a dichotomous key to each group. (The *Fish Characteristics* fact sheet may be helpful for reference.) Remind students that the species on the 12 cards belong to 10 Great Lakes fish families. Explain that each group will use the dichotomous key to identify the correct families. (Families include Trout and Salmon, Pike, Sturgeon, Lamprey, Sunfish and Bass, Perch, Sucker, Goby (invasive), Catfish, and Freshwater Cod.)
3. Using the set of fish family cards, have students begin by selecting one fish and "keying it out" by answering the questions and following the arrows as indicated on the key. For each fish, they should identify the correct fish family. As they identify each illustration, have them write the name of the family on a post-it note and label each card.
4. Review the results. Hold up the enlarged fish illustrations (labeled Teacher Master) and tell about each species, pointing out distinguishing characteristics and family. Did everyone correctly identify all fish families? Was it difficult to distinguish some of the characteristics? How else might some of the characteristics be described? Remind students that these variations, or adaptations, help fish survive in their environment.
5. Explain that one limitation of a dichotomous key is that all fish of a given family or species do not look exactly alike (as with humans). There will always be individual differences. Fisheries scientists often use many additional physical characteristics, such as scale counts, fin location, and body depth, in combination with factors such as geographic distribution to correctly identify fish.

Extension

The process of using a dichotomous key is valuable in many disciplines. Have students create their own dichotomous keys using a group of commonly found objects, such as pasta, buttons, dried beans, or fruit.

1. Explain that the goal is to sort a large set of items into smaller sets based on distinguishing characteristics, until the items can no longer be sorted.
2. Divide the participants into smaller groups of four to five people, and provide each group with a collection of items to sort. Have them develop a key by forming questions about the objects. An example might be: Is the object textured or smooth? Is the shape curved or straight? Let students work for a few minutes and then stop them to make sure they are using terms everyone will understand.
3. Once the groups have finished sorting the items, ask them to switch their items and keys with another group. Other groups should be able to use the key to sort the items in the same way. Once all the groups have completed this, ask one group to share and demonstrate their key.

Source

FLOW Development Team and Anna Switzer.

Acknowledgements

Anna Switzer, Ph.D. candidate in science education, University of Michigan School of Education; and Gerald Smith, Professor Emeritus of Geological Sciences and Professor Emeritus of Ecology and Evolutionary Biology, University of Michigan College of Literature Science and Arts.

Assessment & Standards

See separate document: **FLOW_Assessment_GLCE.pdf**

FLOW Feedback

Please take 10 minutes to provide us with your feedback.

Go to: http://www.miseagrant.umich.edu/flow/flow-feedback.html

Supplemental Materials: FLOW Unit 3, Fish

Lesson 1 - Fins, Tails and Scales: Identifying Great Lakes Fishes Documents:

- Fish Characteristics Fact Sheet
- Great Lakes Fish Family Cards and Generic Fish Graphic
- Dichotomous key: Great Lakes fish families
- *Fins, Tails and Scales*, poster with full-color illustrations, MICHU-06-702

DISTINGUISHING CHARACTERISTICS OF FISH

Distinguishing characteristics combined with information on geographic range, help scientists, anglers and amateur naturalists observe and identify fish. Some fish characteristics that can be easily compared include structure and location of dorsal fin(s), mouth position and shape of snout, tail shape, and presence or absence of unusual traits such as barbels (whiskers). Other traits used to identify fish include structure and location of pectoral fins, pelvic fins and anal fin, body depth, standard length, and scale counts.


Anal fin


Adipose fin

Adipose fin: Small, fleshy fin located between the dorsal fin and caudal fin. Unlike other fins, the adipose fin does not have rays or spines. Its purpose is unclear.

Anal fin: Fin located on a fish's underside behind pelvic fins.

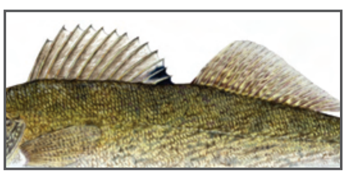
Barbels: These "whiskers" near the mouth are used by bottom-feeding fish to sense food.

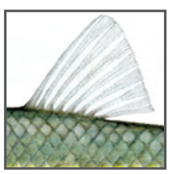

Rounded


Forked, symmetrical

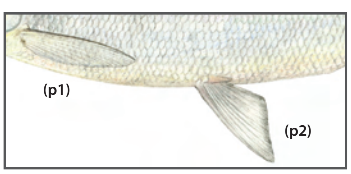

Asymmetrical

Caudal fin: The caudal fin (tail fin) is used for propulsion. It varies in shape and this affects a fish's speed and buoyancy. Fish with forked caudal fins, such as lake trout, are generally fast swimmers. Fish with rounder caudal fins, such as round goby, are slower.


Split dorsal fin


Single dorsal fin

Dorsal fin: Large fin on a fish's back that varies in shape, size and position. Some fish have single, soft-rayed dorsal fins. Others, like sunfish and bass, have split dorsal fins that are part spiny and part soft. The dorsal fin stabilizes fish against rolling and assists with maneuverability.



Pectoral fin (p1), Pelvic fin (p2)

Pectoral fin: Side fins mainly used for direction or "steering," and sometimes for slow swimming.

Pelvic fin: Paired fins located on the belly or under pectoral fins.


Terminal


Ventral


Superior

Mouth: The size and position of the mouth indicates what a fish eats. A ventral, or downward-oriented mouth, indicates a fish that feeds on insects and snails along the lake or stream bottom.* A forward or upward-directed mouth indicates a fish that feeds within the water column.

**Lampreys are an exception. Some lampreys are parasites and feed on other fish.*

FISH FAMILY CARDS

Unit 3, Lesson 1

Illustration: E. Damstra

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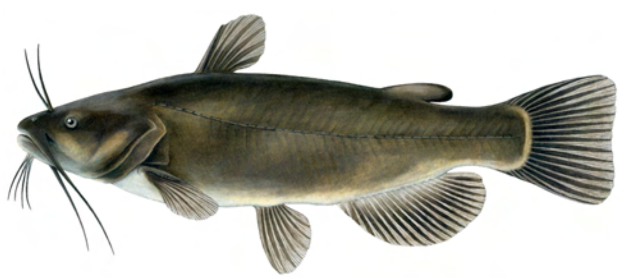

Illustration: E. Damstra

FISH FAMILY CARDS

Unit 3, Lesson 1

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Illustration: E. Damstra

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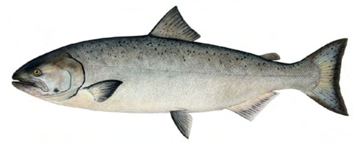
Photo: Ted Lawrence

FISH FAMILY ID CARD GUIDE FOR TEACHERS



Chinook salmon

Round goby

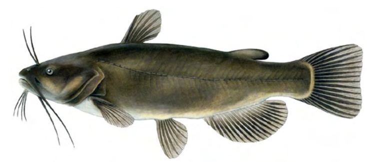
Burbot

Pike

Lake sturgeon

Walleye

Smallmouth bass

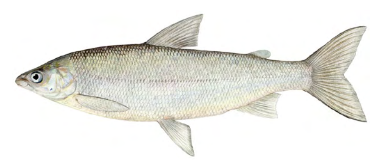


Black bullhead

Yellow perch

Longnose Sucker

Sea lamprey



Lake whitefish

Illustrations: E. Damstra

Note: Fish size not to scale

Generic Fish Graphic: Characteristics of Fish

Unit 3, Lesson 1

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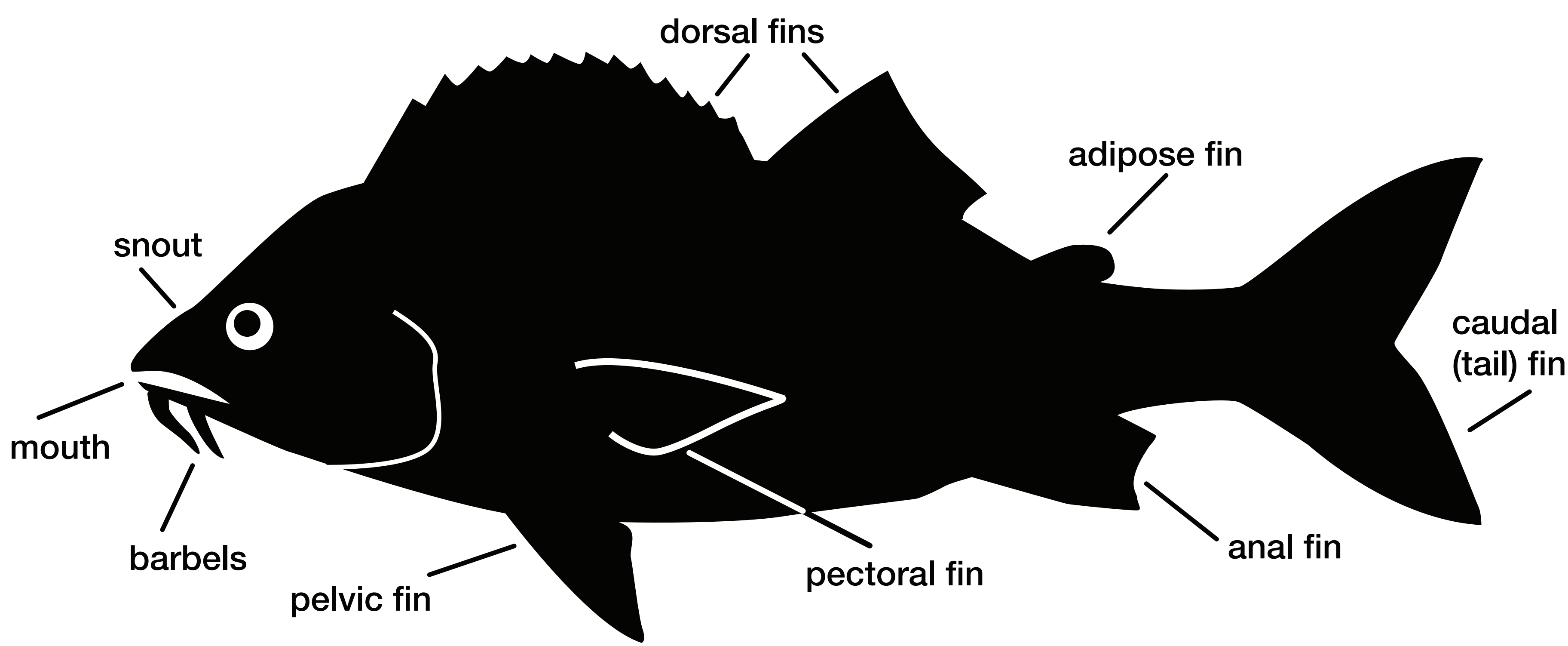
This graphic is a composite illustration that shows a variety of distinguishing characteristics. Scientists use these and many other characteristics to correctly classify and identify fish.



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Salmon and Trout Family, Salmonidae

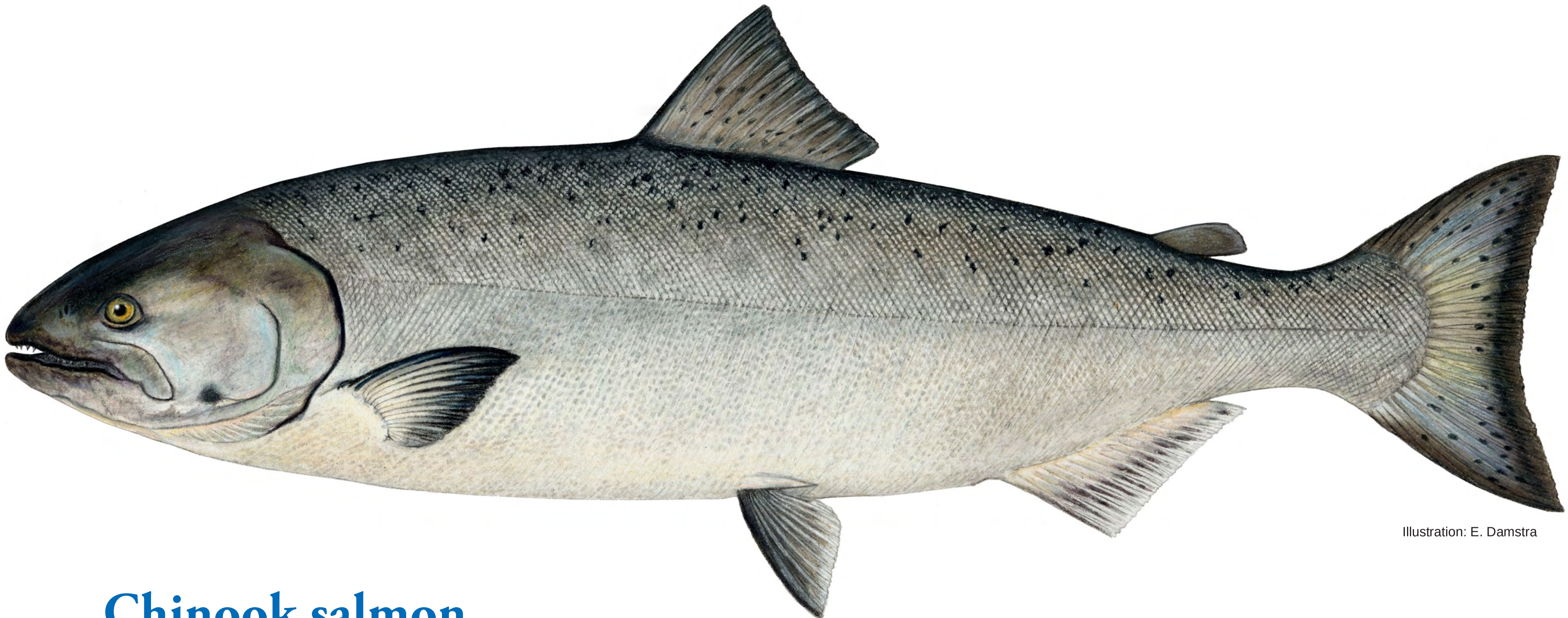

Illustration: E. Damstra

Chinook salmon

Oncorhynchus tshawytscha

- Native to Pacific Ocean from southern California to Alaska.
- Introduced to Great Lakes in 1967.
- Habitat: Deep open waters of the Great Lakes. Spawns in tributaries in autumn.

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Perch Family, Percidae

Illustration: E. Damstra

Yellow perch

Perca flavescens

- Important food and sport fish throughout southern part of Great Lakes region.
- Split dorsal fin. Body has distinct vertical bands.
- Habitat: Variety of locations; quiet ponds, streams with little current; large and small lakes including the Great Lakes.

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Lamprey Family, Petromyzontidae

Illustration: E. Damstra

Sea lamprey

Petromyzon marinus

- Primitive, parasitic fish native to the Atlantic Ocean.
- Eel-like body shape. Round mouth. Mottled coloring.
- Habitat: Large population in northern Lake Huron and St. Marys River. Larval stage spent in silty stream bottoms.

Photo: Ted Lawrence

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Whitefish Subfamily, Coregoninae

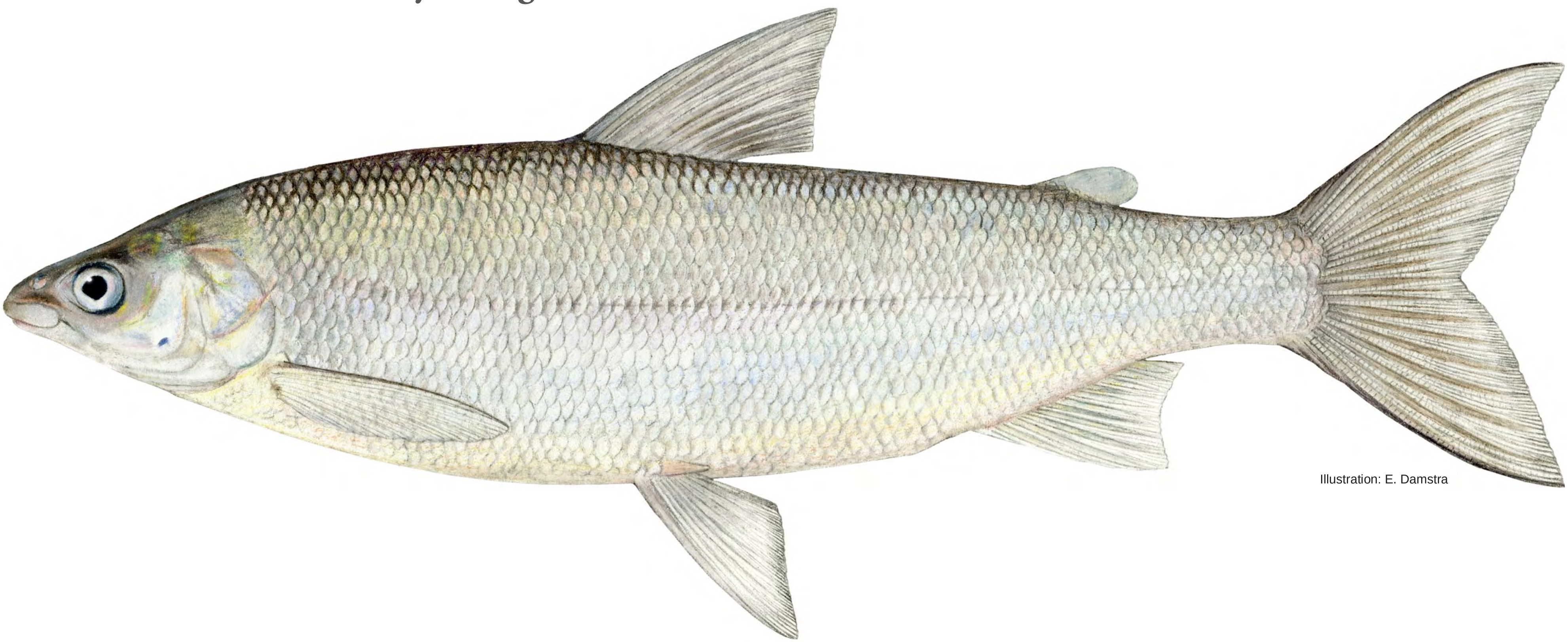

Illustration: E. Damstra

Lake whitefish

Coregonus clupeaformis

- Most valuable commercially caught fish in Great Lakes.
- Long, deep-bodied fish related to salmon and trout.
- Habitat: Deep, open waters of the Great Lakes; cold, deep inland lakes.

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Sturgeon Family, Acipenseridae

Illustration: E. Damstra

Lake sturgeon

Acipenser fulvescens

- Primitive, long-lived fish native to Great Lakes.
- Asymmetric, shark-like tail.
- Habitat: Nearshore waters at depths of 15 to 30 feet.

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Perch Family, Percidae


Illustration: E. Damstra

Walleye

Sander vitreus

- Popular sport fish in the Great Lakes.
- Slender body with pointed snout. Split dorsal fin.
- Habitat: Moderately fertile lakes with primarily sandy basins.

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Sunfish and Bass Family, Centrarchidae

Illustration: E. Damstra

Smallmouth bass

Micropterus dolomieu

- Popular sport fish in Canadian and U.S. waters.
- Narrow, oval-shaped body. Split dorsal fin with short fin spines in front.
- Habitat: Clear, gravel-bottom runs in flowing rivers; shallow rocky areas of lakes.

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North American Catfish Family, Ictaluridae

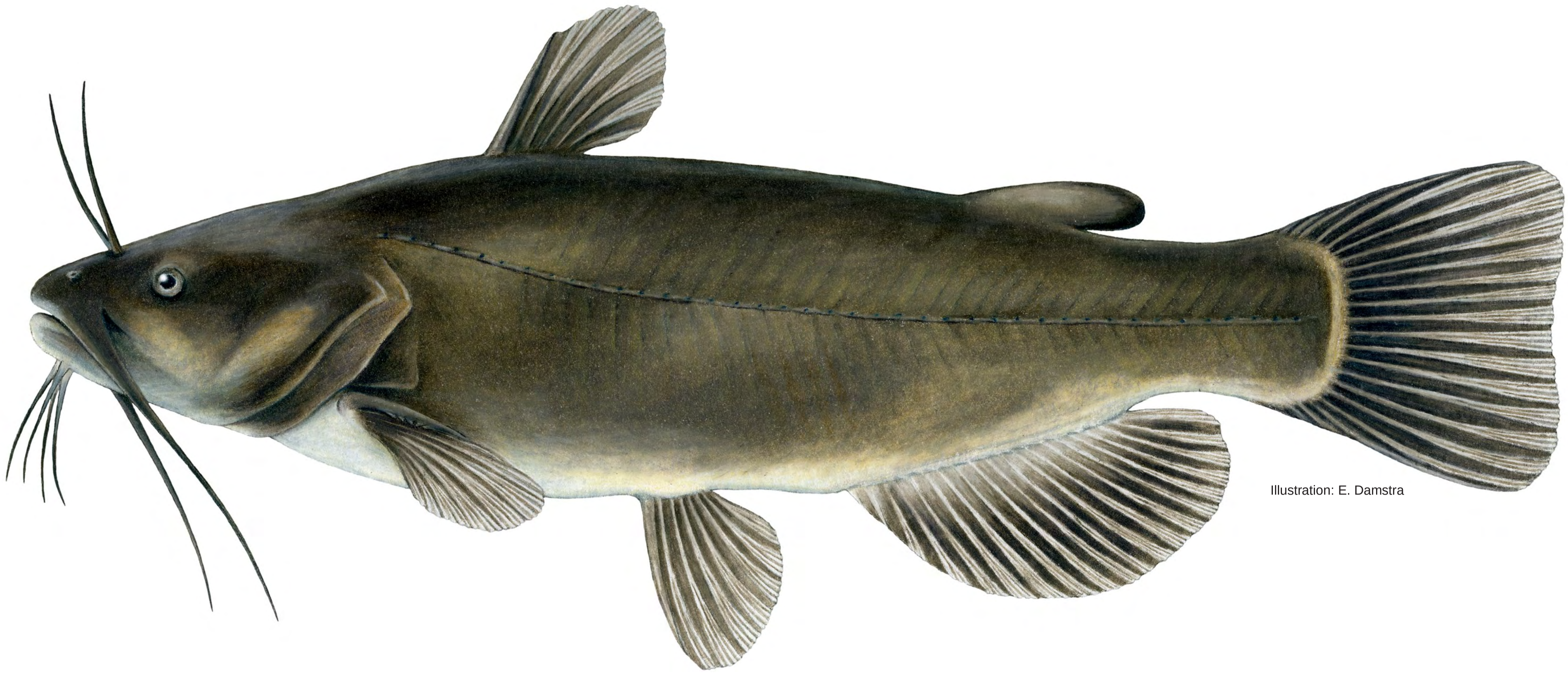

Illustration: E. Damstra

Black bullhead

Ameiurus melas

- Scaleless, bottom-dwelling fish.
- Long barbels (whiskers) around mouth.
- Habitat: Deep pools in small to large rivers; lakes.

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Goby Family, Gobiidae

Illustration: E. Damstra

Round goby

Neogobius melanostomus

- Invasive, bottom-dwelling fish.
- Mottled coloring with frog-like raised eyes.
- Habitat: Nearshore areas of the Great Lakes and tributaries.

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Pike Family, Esocidae

Illustration: E. Damstra

Northern pike

Esox lucius

- Fast-swimming predator that feeds on other fish and animals.
- Long, slender body with duck-billed snout.
- Habitat: Cool to moderately warm, weedy lakes, ponds and sluggish rivers.

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Sucker Family, Catostomidae

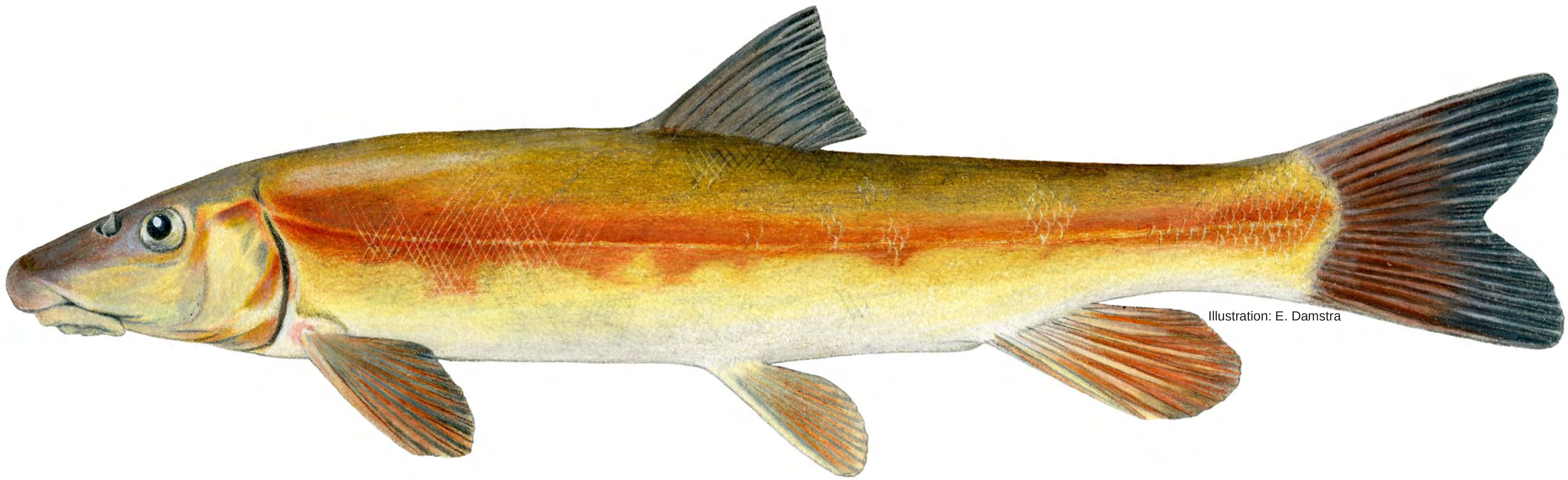

Illustration: E. Damstra

Eastern Longnose Sucker

Catostomus catostomus

- One of many bottom-dwelling species in the sucker family.
- Ventral mouth used to locate food in bottom sediment.
- Habitat: Deep, cold lakes. Spawns in streams and rivers.

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Freshwater Cod, Gadidae

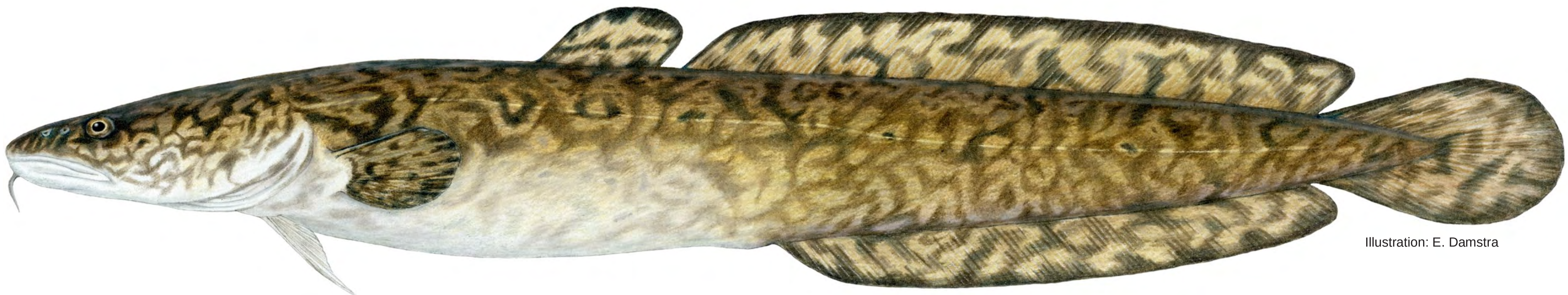


Illustration: E. Damstra

Burbot

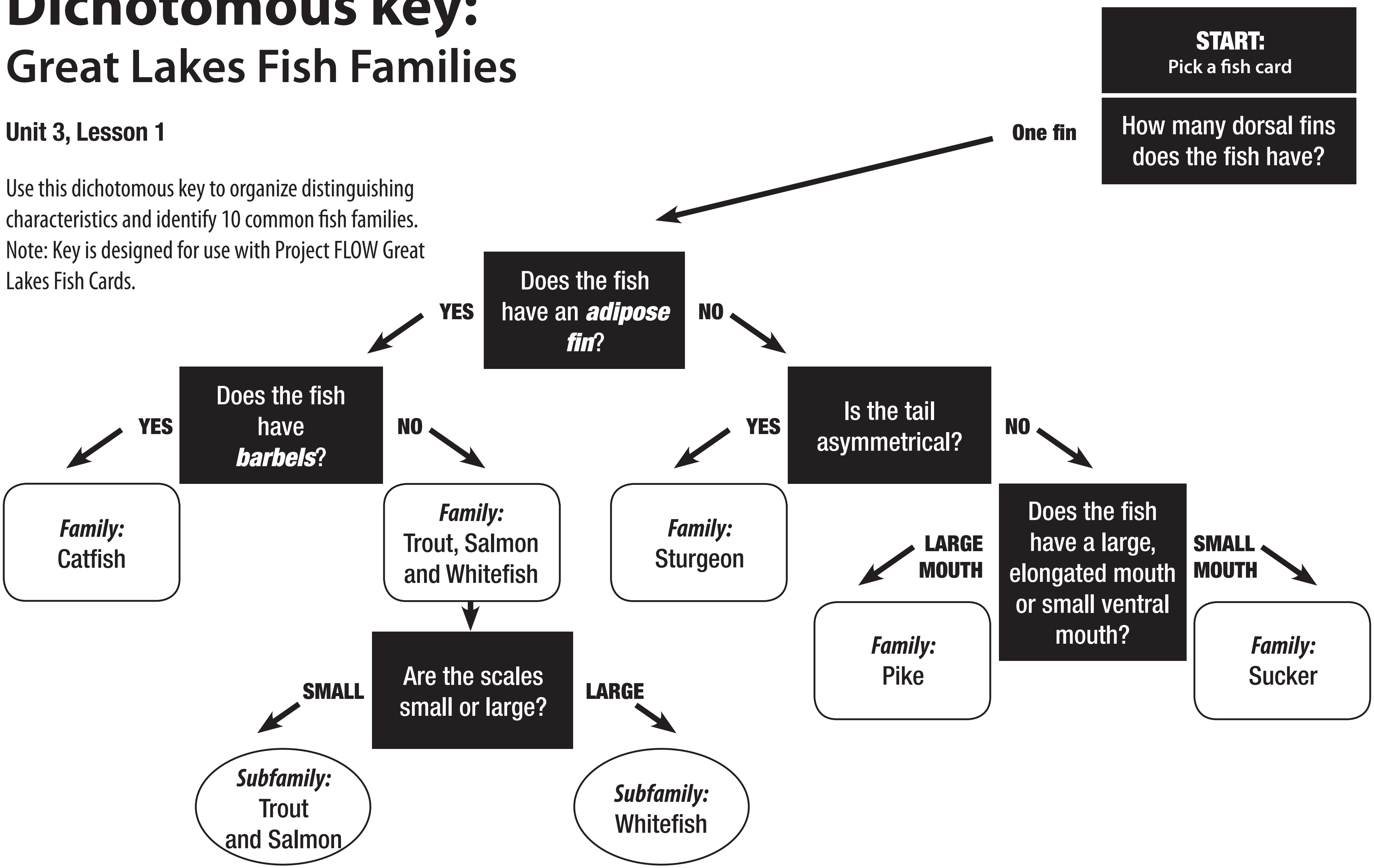
Lota lota

- Native top predator in deep waters of the Great Lakes.
- Two dorsal fins; first is small, second is long.
- Habitat: Medium to large streams and cold, deep lakes.

Dichotomous key:
Great Lakes Fish Families

Unit 3, Lesson 1

Use this dichotomous key to organize distinguishing characteristics and identify 10 common fish families. Note: Key is designed for use with Project FLOW Great Lakes Fish Cards.



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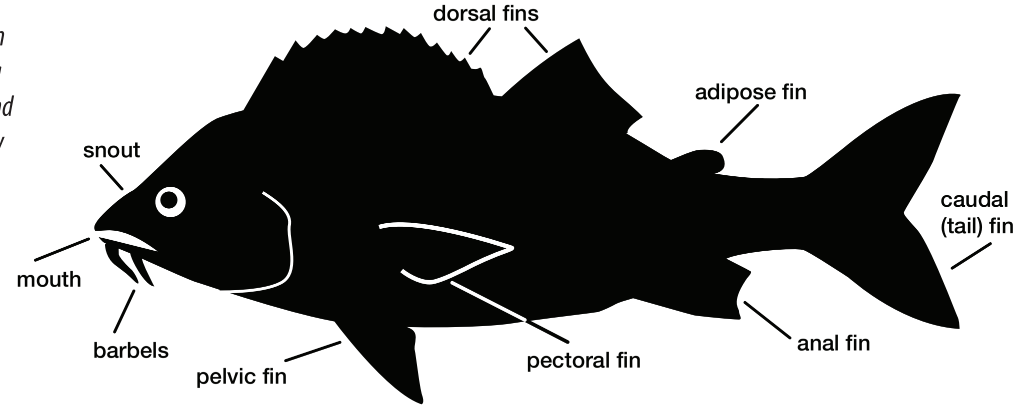

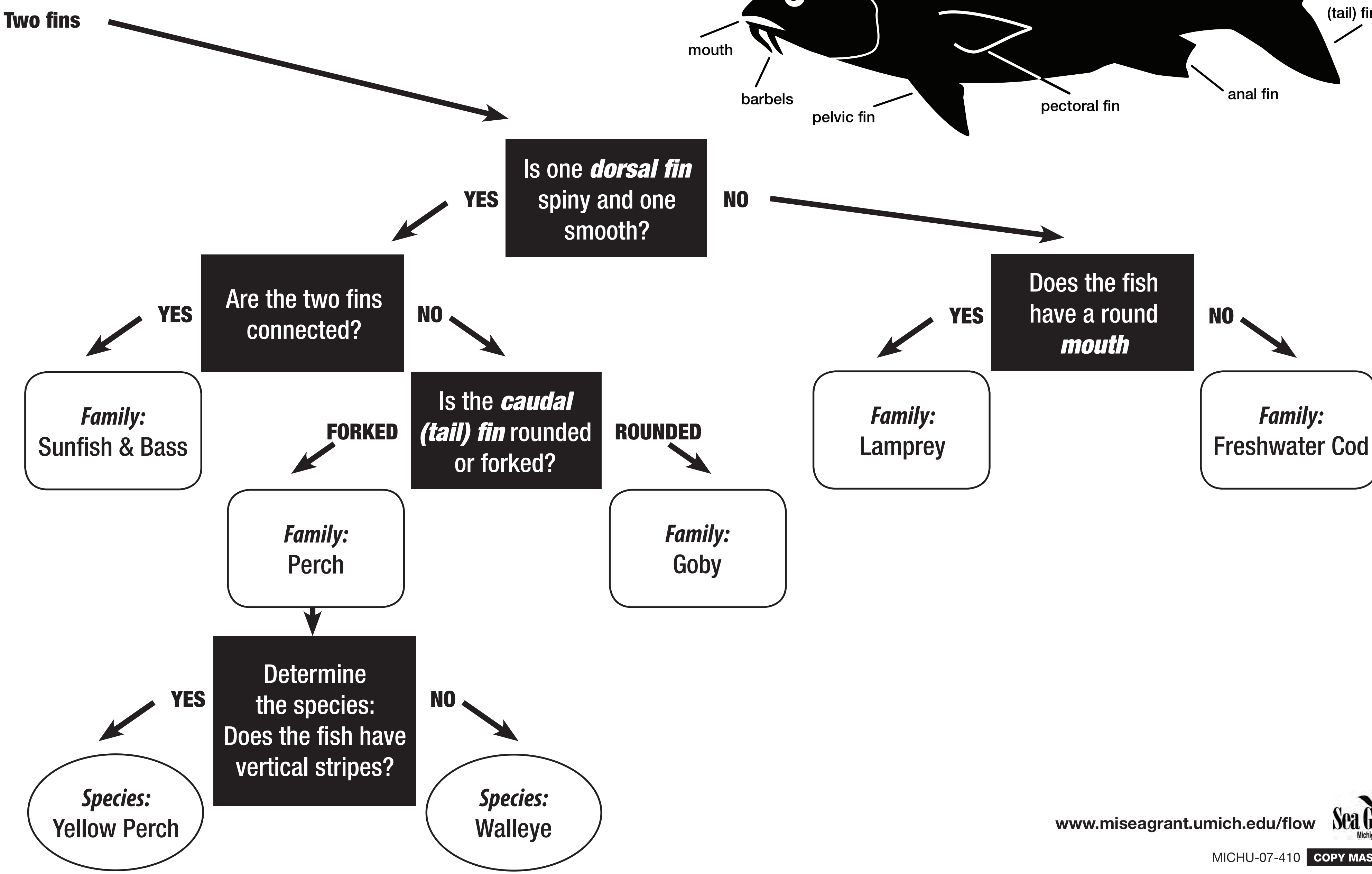

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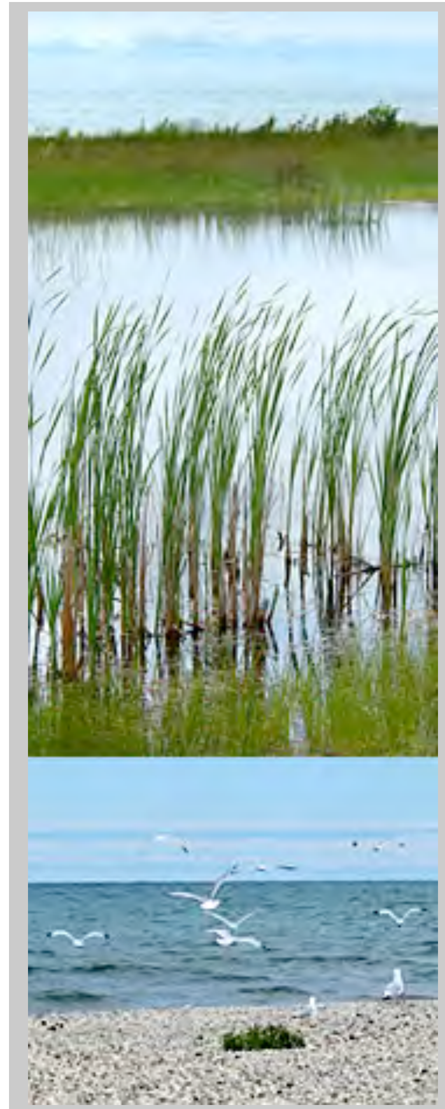
Lesson 2: Fish Habitat



Activity: Observe, collect environmental data and describe an aquatic site near school using a field notebook.

Grade level: 4-8
Subjects: Science, social studies
Setting: Classroom, aquatic site near school
Duration: Three 50-minute classes
Key terms: Habitat, restoration

Objectives

Following this lesson, students will be able to:

- Name three basic requirements for fish survival.
- Name several Great Lakes fish species and their habitat.
- Explain two ways human activities impact Great Lakes fish habitat and affect the survival of fish and other organisms.
- Make purposeful observations of a nearby aquatic area using illustrations, photographs and narratives.
- Describe scientific questions about habitat and human impact based on observations.
- Use observations to predict which Great Lakes fish might favor that particular habitat.

Summary

A healthy environment supports a variety of native species. This is especially true for Great Lakes fish. Different species of fish require specific habitats, and loss or alteration of fish habitat can lead to population declines. This lesson explains some of the characteristics of healthy fish habitat and guides students in making their own field observations and scientific predictions.

Background

Like other living creatures, fish must meet certain basic needs for survival. Water, food and shelter are among the most important requirements:

- Water: Fish not only live in water, but they get oxygen from water. They breathe by taking water into their mouths and forcing it out through gill passages.
- Food: Fish must be able to find enough to eat at various life stages, whether they feed on microorganisms, small fish or larger prey.
- Shelter: Fish need a place to hide from predators and to reproduce. Some fish find shelter among submerged aquatic plants and shoreline vegetation, while others hide among rocks, soft sediments, or blend into clear, open waters.

Where can fish meet these needs? Fish are adapted to living in a variety of habitats. Some examples include the following:

- Rivers
- Streams
- Inland lakes
- Great Lakes
- Coastal wetlands

These habitats can vary greatly in water quality, turbidity, speed of water flow, amount of vegetation, water temperature, and water composition. Fish are particularly sensitive to water temperature and oxygen content, which play a major role in determining which species can survive in a given water body. See *Aquatic Habitat Data Worksheet* for examples of 14 common fish species and their preferred habitats.

Human Impacts on Fish Habitat

Over the last century, many factors have altered water quality and fish habitat and subsequently affected native fish populations. Some examples include:

- Coastal Development: Increasing development in coastal areas threatens the function and diversity of coastal wetlands. These areas are critical during the early life stages of many fish species. Removal of shoreline vegetation and trees from riverbanks can decrease shade and increase water temperature. Lack of vegetation also increases erosion and sedimentation, which alters spawning areas. Dams and other obstacles can prevent fish from migrating upstream to reach critical spawning habitat.
- Invasive Species: Invasive species compete with native fish for food and habitat. Round goby and Eurasian ruffe are examples of fish that have displaced native species in some locations. Invasive species can also change habitat. By filtering microorganisms, zebra mussels reduce food for native species and increase water clarity, which stimulates growth of aquatic plants.
- Pollution: Industrial pollutants, urban and agricultural runoff, and sewage overflows are some of the sources of pollutants that continue to impair Great Lakes water quality and impact fish habitat.

Habitat Restoration

People around the Great Lakes region are working to restore fish habitat for a number of native fish populations. Some examples include:

- Lake Sturgeon: Several groups teamed up to construct spawning reefs for lake sturgeon in the Detroit River to increase population of this threatened species.
- Walleye: The Fisheries Division of the Michigan Department of Natural Resources is implementing a walleye recovery plan for Saginaw Bay to enhance walleye populations and production in Saginaw Bay
- Coaster Brook Trout: Researchers in the Upper Peninsula and Canada are tagging and monitoring this fish to learn more about its unique habitat requirements.

Materials and Preparation

- Aquatic Habitat Data Worksheet
- Water thermometer
- Secchi disk: for measuring water clarity (optional)

Note: See Aquatic Habitat Data Worksheet and other materials at the end of this lesson (supplemental materials).

Procedure

1. Begin with a group discussion on fish habitat. Ask students: What do fish need in order to survive? (Basic needs include food, water and shelter.)
2. Ask students to name some different types of aquatic habitats where fish can meet their needs. Answers might include lakes, ponds, rivers, and small streams. How might these habitats vary? (Water might be warm, cold, fast moving, sluggish, turbid, clear, etc.) Explain that flowing water contains more oxygen than still water. Fish are very sensitive to the amount of dissolved oxygen available.
3. Using the Aquatic Habitat Data Worksheet download, discuss examples of common Great Lakes fish and their preferred habitats. Ask if students are familiar with these fish. Do they know of other examples?
4. Introduce the concept of indicator species. Explain that the presence of some organisms such as mayflies, stoneflies, and caddisflies indicates good water quality, an important part of healthy fish habitat. Note also that the number and type of aquatic plants (which form the base of the aquatic food web) can indicate health of a stream, river, pond or lake.
5. Next, ask if students are familiar with an aquatic habitat near their home or school. Ask them to describe its main characteristics.
6. Explain to students that they'll be visiting a nearby aquatic area (river, pond, marsh, drainage ditch, etc.) to examine the habitat, record their observations (field data), and make predictions about what fish might live there.
7. Create groups of three to four students. Distribute field notebook pages. Help students select roles:
   - Note taker: records observations
   - Observer(s): relays information to note taker
   - Illustrator/photographer: sketches or photographs key characteristics of the aquatic habitat.
   - Data analyst: creates simple table or graph using data collected.
8. Have the groups visit a nearby aquatic site, taking the field observation worksheet with them. Each student completes his or her task within the group, recording and/or illustrating characteristics of the aquatic habitat. Encourage students to record as much detailed data as they can. For example, if applicable, estimate the number of aquatic plants, or the number of different aquatic organisms. Numerical data can be used later to create a simple table or graph.

9. Return to the classroom and have groups complete their field data worksheets. Remind them to use the examples of common fish and their habitat to make a prediction about what fish species might favor that particular habitat. Write the prediction on the field notebook page.

10. Have the groups share their field notebooks and observations with the class. Did any groups see fish or other living organisms? Remind students that the presence of some organisms can be used as water quality indicators.

11. If no aquatic organisms were seen, what do students predict might live there based on the physical characteristics of the site? Emphasize how much we can learn about a particular habitat by making careful observations.

12. Finally, discuss any factors that may be impacting or altering the habitat, such as proximity to roads or buildings (which might increase runoff), and what steps could be taken to lessen or mitigate these impacts. Examples might include creation of grassy buffer zones to filter urban runoff, shoreline restoration projects that replace concrete banks with natural materials and native plants (soft engineering), or working with local watershed groups to post informational signs to prevent the spread of aquatic invasive species.

Extension

- Invite a local fisheries scientist or watershed expert to speak to the class about what is known about the particular habitat visited by the students. For larger rivers and water bodies, scientific assessments can often be found online that document major fish species and historic range. Compare the results with the student predictions.
  See: MDNR Fish Atlas.
- For older students: Use three-dimensional modeling software to create a virtual habitat that includes environmental threats. Discuss possible mitigations.

Source

FLOW Development Team

Acknowledgements

Jim Diana, Professor of Natural Resources, School of Natural Resources and Environment and Associate Research Scientist, Center for Great Lakes & Aquatic Sciences, University of Michigan College of Literature Science and Arts; and graduate students from Professor Diana's 2007 course, Biology and Ecology of Fishes.

Assessment & Standards

See separate document: **FLOW_Assessment_GLCE.pdf**

FLOW Feedback

Please take 10 minutes to provide us with your feedback.

Go to: http://www.miseagrant.umich.edu/flow/flow-feedback.html

Supplemental Materials: FLOW Unit 3, Fish

Lesson 2 - Fish Habitat Document:

- Aquatic Habitat Data Worksheet

Aquatic Habitat Data Worksheet

Date: ______________________ Study location: ______________________

Field observation team: ______________________ Weather: ______________________

Water Temperature: ______________________

Habitat type: ☐ Ditch ☐ Stream ☐ River ☐ Pond ☐ Wetland ☐ Lake

Description: ____

____

Soil: ☐ Sandy ☐ Rocky ☐ Clay ☐ Silt ☐ Sediment

Description: ____

____

Shoreline Vegetation: ☐ None ☐ Moderate growth ☐ Dense plant growth ☐ Wooded

Description: ____

____

Aquatic vegetation: ☐ None ☐ algae ☐ floating plants (ie, lilypads) ☐ submerged plants
☐ rooted plants (ie cattails)

Description: ____

____

Water clarity: ☐ Clear ☐ Somewhat clear ☐ Cloudy (turbid)

Description: ____

____

Water movement: ☐ Still ☐ Slow moving ☐ Gently flowing ☐ Fast moving

Description: ____

____

Water depth (if known) ______________________ Vertebrates: ______________________

Living organisms ______________________ Macroinvertebrates: ______________________

Description: ____

____

____

____

____

____

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Aquatic Habitat Data Worksheet

Observation Illustration and Summary

Use the space below to draw or photograph significant details of the aquatic habitat at this site. Write a short summary of the habitat based on field observations, notes, and illustrations. Be sure to record any other characteristics of this particular aquatic habitat. Additional factors might include fallen logs or other objects in the water, proximity of water to buildings or roads, whether the shoreline is altered in any way by humans (e.g. mowing, etc)

Based on the habitat illustration and summary above, make a predication about which species of freshwater fish might live in this type of habitat and why. Refer to habitat cards for examples.

Habitat prediction: ______________________________

____

____

____

____

____

____

____

____

____

____

FISH HABITAT

Unit 3, Lesson 2

More than 160 species of fish thrive in the Great Lakes region. All species tolerate cold, near freezing water temperatures for several months every year. However, during warmer months, fish can be grouped by water temperature preference. Listed here are some common fish species and their habitat.

WARMWATER FISH

(higher than 75 degrees)

Black bullhead

Ameiurus melas

Habitat: Ponds, sloughs, and sluggish parts of creeks and rivers; in shallow and often silty water.

Bluegill

Lepomis macrochirus

Habitat: Vegetated lakes and slow-moving streams. Prefers weedy areas with lily pads and other aquatic vegetation.

Common carp

Cyprinus carpio

Habitat: Primarily warm rivers and inland lakes. Tolerant of silty and turbid environments. Bottom-feeder.

Largemouth bass

Micropterus salmoides

Habitat: Warm, weedy, or brushy lakes and ponds, bayous, backwaters, and quiet streams.

COOLWATER FISH

(higher than 65 degrees but less than 75)

Northern pike

Esox lucius

Habitat: Cool to moderately warm, weedy lakes, ponds and sluggish rivers.

Pumpkinseed

Lepomis gibbosus

Habitat: Cool, weedy ponds, small lakes and slow-moving streams.

Smallmouth bass

Micropterus dolomieu

Habitat: Clear, gravel-bottom runs in flowing rivers; shallow rocky areas of lakes.

Walleye

Sander vitreus

Habitat: Cold, clear waters of lakes and streams. Prefers sand, gravel or rock bottom. Seldom found in mud-bottomed waters.

Yellow perch

Perca flavescens

Habitat: Thrives in a variety of locations, including quiet ponds, streams with little current, and large and small lakes. Also found in the Great Lakes.

COLDWATER FISH

(less than 70 degrees)

Brook trout

Salvelinus fontinalis

Habitat: Cold, clear lakes and streams.

Chinook salmon

Oncorhynchus tshawytscha

Habitat: Deep open waters of the Great Lakes. Spawns in tributaries in autumn.

Deepwater sculpin

Myoxocephalus thompsonii

Habitat: Cold, bottom waters of the Great Lakes.

Emerald shiner

Notropis atherinoides

Habitat: Pelagic (open water) species found in large lakes and rivers.

Lake whitefish

Coregonus clupeaformis

Habitat: Cold, deep waters of the Great Lakes; cold, deep inland lakes.

Sources:
Fishes of the Great Lakes Region
Michigan Fishes (Michigan State University and Michigan Dept. of Natural Resources)
Reviewers: Gerald R. Smith; Solomon David

Lesson 3: Fish Life Cycle

Activity: Diagram fish life cycle.

Grade level: 4-8
Subjects: Science, social studies
Setting: Classroom
Duration: 50 minutes
Key Terms: Fry, life cycle, life history, spawn, yolk sac

Objectives

After participating in this activity, students will be able to:

- Name stages of the fish life cycle
- Diagram progression from egg, larval fish, fry, juvenile, adult
- Describe two general animal reproductive strategies
- Contrast the reproductive strategies of at least two Great Lakes fish

Summary

Like all animals, fish need to survive and grow large enough to reproduce. Fish that survive to spawn use a range of strategies to ensure successful reproduction.

Background

Each fish species has a unique reproductive strategy and favors certain habitats for spawning and for early development of their newly hatched young. Many Great Lakes fish can be found in shallow water during part of their life cycle. Many species use shallow waters of lakes or rivers as spawning habitat either in the spring or fall. Some, such as northern pike, prefer wetlands with aquatic vegetation. Others such as lake whitefish prefer shallow reefs, which provide rich areas for food and rocky structure to protect the eggs and later the fry.

Fish life cycles vary among species. In general, however, fish progress through the following life cycle stages:

- Eggs: Fertilized eggs develop into fish. Most eggs do not survive to maturity even under the best conditions. Threats to eggs include changes in water temperature and oxygen levels, flooding or sedimentation, predators and disease.
- Larval fish: Larval fish live off a yolk sac attached to their bodies. When the yolk sac is fully absorbed the young fish are called fry.
- Fry: Fry are ready to start eating on their own. Fry undergo several more developmental stages, which vary by species, as they mature into adults. Young fish are generally considered fry during their first few months (during their first few months to less than one year in some species).
- Juvenile: The time fish spend developing from fry into reproductively mature adults varies among species. Most fish do not survive to become adults. Threats to survival

include fluctuations in water temperature, changes in oxygen levels, competition for habitat, and predators.

- Adult: When fish are able to reproduce, they are considered adults. The time it takes to reach maturity varies among species and individual fish. Fish with shorter life spans reach maturity faster. For example, female round gobies mature in approximately one year and live for two to three years. Lake sturgeon can live from 80-150 years, but females don't reach maturity until they are approximately 25 years old.
- Spawning: Female fish release eggs into the water (either into the water column or into a nest) and male fish fertilize eggs by releasing milt. Not all eggs are fertilized. Some fish spawn each year (or every one or more years) after reaching maturity, while others spawn only once and then die.

Materials and Preparation

Paper or Electronic Methods:

1. Paper: large, white and colored paper. Matt board or construction paper may also be useful. See materials from Unit 3, Lesson I, with fish cards.
2. Classroom computer with Internet access, and illustration software.

Examples: Inspiration, Adobe illustrator*, Microsoft PowerPoint *Note – example provided was created in Adobe Illustrator. Please send us feedback about which software would be the most useful in your classroom.

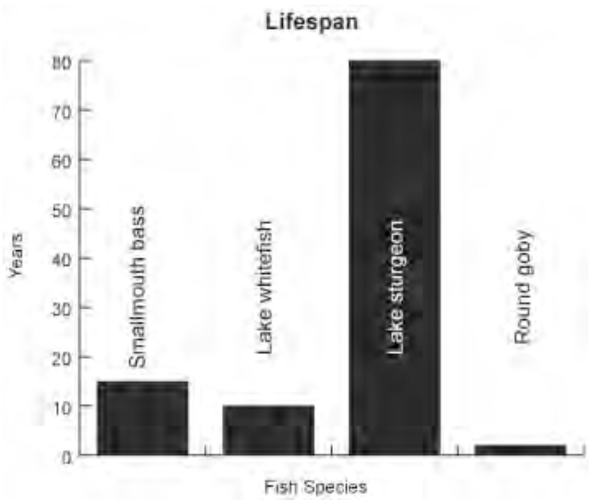
See: *Fish Life Cycle Worksheet* and *Reproductive Strategies* fact sheet.
Note: See Fish Life Cycle Worksheet and other materials at the end of this lesson (supplemental materials).

Procedure

1. Explain how, just like all animals, fish have a basic task — to reproduce. Discuss the basic fish life cycle.
2. Describe the two major reproductive strategies of animals. Contrast fish reproductive strategy with human reproductive strategy.
3. Describe spawning strategies used by Great Lakes fish. See the *Reproductive Strategies fact sheet*.
4. Create student groups and help each group select a Great Lakes fish.
5. Groups use the Internet or visit the library to learn more about the life cycle and preferred spawning habitat of their chosen fish.
6. Groups illustrate the fish's life cycle using software or classroom materials. See the *Fish Life Cycle Worksheet*.

Extension

Students hone charting skills using the data from the Reproductive Strategy Chart (see bottom of *Reproductive Strategy Worksheet*) to create a simple bar chart (electronically using Excel or on paper). The objective for this activity is to encourage students to consider how to present data by creating a chart. An example of a bar chart is below:



Source

FLOW Development Team

Acknowledgements

Jim Diana, Professor of Natural Resources, School of Natural Resources and Environment and Associate Research Scientist, Center for Great Lakes & Aquatic Sciences, University of Michigan College of Literature Science and Arts; and graduate students from Professor Diana's 2007 course, Biology and Ecology of Fishes.

Assessment & Standards

See separate document: **FLOW_Assessment_GLCE.pdf**

FLOW Feedback

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Supplemental Materials: FLOW Unit 3, Fish

Lesson 3 - Fish Life Cycle Documents:

- Fish Life Cycle Worksheet
- Reproductive Strategies fact sheet

Also see documents from Lesson 1:

- Fish Characteristics Fact Sheet
- Great Lakes Fish Family Cards and Generic Fish Graphic
- Dichotomous key: Great Lakes fish families

LIFE CYCLE WORKSHEET

Unit 3, Lesson 3

Sketch or picture of fish

Name of Fish: ______________________________

EGGS

Egg size: ____________

Location: ____________

Incubation time: ________

Comments: ___________

____

LARVAL FISH:

Month of hatch: ________

Habitat: ____________

Diet: ____________

Comments: ___________

____

FRY

Habitat: ____________

Diet: ____________

Comments: ___________

____

____

JUVENILE

Habitat: ____________

Diet: ____________

Comments: ___________

____

____

ADULT

Habitat: ____________

Diet: ____________

Average lifespan: ________

Comments: ___________

____

____

SPAWNING

Age at first spawning: ____________

Frequency of spawning: ____________

Preferred spawning habitat: ____________

Spawning season: ____________

Average number of eggs deposited
(varies by size of female): ____________

Spawning behavior: ____________

Comments: ____________

____

____

REPRODUCTIVE STRATEGIES

In general, animals use one of two basic reproductive strategies. They may produce:

- Limited numbers of offspring, reproduce infrequently, and invest significant nutritional resources and time to ensure a high probability of survival for each offspring (e.g., humans, elephants);
- Massive quantities of offspring, reproduce more frequently, and invest hardly any time or resources in any one offspring (e.g., fish).

EXAMPLE REPRODUCTIVE STRATEGIES OF GREAT LAKES FISH

While Great Lakes fish typically produce eggs in mass quantities, the number of eggs and amount of energy invested into each egg varies by species.

- **Smallmouth bass:** Female smallmouth bass produce eggs in the spring. Males build nests in shallow gravel areas near a rock or log for shelter and guard the fertilized eggs. After smallmouth bass hatch and emerge from the gravel, they form balls up to three feet in diameter containing hundreds of fry. The male continues to guard his offspring as they begin to move apart and wander farther from the nest until the fry are so far apart that guarding is no longer possible.
- **Lake whitefish:** Lake whitefish are open water fish but spawn near shore in the fall. Spawning takes place at night close to the surface and is very active. Male and female fish sometimes leap out of the water during spawning. Eggs fall to the bottom and remain there until hatching in the spring. Winter ice cover may help keep wind from stirring the bottom and covering the eggs with sediment. Removal of natural bedrock such as in the creation of shipping channels is thought to interfere with lake whitefish spawning.
- **Lake sturgeon:** Lake sturgeon have a slow reproductive cycle and spawn only once every four years on average. Fast flowing water is best for sturgeon. Lake sturgeon compete with power companies for habitat because high gradient (steep), fast flowing sections of rivers are also good places to produce hydro-electric power.
- **Round goby:** Female round gobies spawn repeatedly from April to September. Males build nests and guard their eggs and young, but most die soon after spawning. Round gobies are an invasive species that presumably arrived in the ballast water of vessels coming into the Great Lakes. They can tolerate degraded water quality and are able to withstand low oxygen concentrations for several days. They compete with native species for spawning habitat.

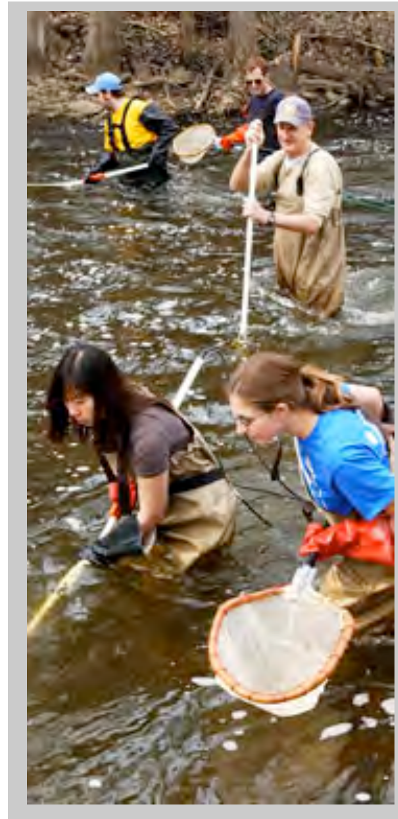
The chart below compares the reproductive strategies of four Great Lakes fish.

Notice the differences in lifespan, age at first spawning, and spawn interval among these fish. Round gobies have a shorter lifespan but reproduce several times per year. Lake sturgeon live longer but reproduce less frequently.

Also notice the differences in egg size and number of eggs produced. Lake whitefish produce a greater number of eggs per pound than lake sturgeon. However, lake sturgeon eggs are much bigger than lake whitefish eggs. In relation to lake whitefish, lake sturgeon tend to invest more energy and time in fewer offspring with the goal to ensure a high probability of survival for each.

	Smallmouth bass	Lake whitefish	Lake sturgeon	Round goby
Lifespan	15 years	10 years	80-150 years (female)	2-3 years (female)
Age at first spawning	5-7 years (female)	2-8 years	24-26 years (female)	1-2 years (female)
Spawn interval	Every year	Every 2-3 years	Every 4-6 years (female)	Many times per year (female)
Egg size	1.2 - 2.5 mm diameter	~2.3 mm in diameter	2.7-3.5 mm diameter	~3 mm in diameter
Number of eggs	~7000 per pound	8000-16000 per pound	4000-6000 per pound	80 - 600 (goby weigh <1 pound)

Lesson 4: Fish Populations



Activity: Students learn how to determine latitude and longitude. They learn about specific technologies used by fisheries scientists by exploring the movement of salmon using digital maps. They learn about GIS and other monitoring technologies.

Grade level: 4-8
Subjects: Science, social studies
Setting: Classroom
Duration: Three 50 min class periods
Key Terms: Ecosystem, GIS, GPS, hydro-acoustics, mark-recapture, latitude, longitude, population, spatial, biodiversity

Objectives

After participating in this activity, students will be able to:

- Explain why researchers study fish populations
- Describe techniques researchers use to monitor fish populations
- Describe the components of a GIS and other monitoring technologies

Summary

Scientists monitor the size, movement, and health of fish populations to better understand ecosystem interactions, manage sport and commercial fisheries, and help ensure biodiversity. Scientists use many different techniques to monitor Great Lakes fish populations.

Background

As discussed in Lesson 3, fish employ various strategies to reproduce and ensure survival of their own species. A group of individual organisms of the same species living in a particular area is called a **population**. Fisheries scientists study the size and movement of Great Lakes fish populations to understand ecosystem interactions. An **ecosystem** is a community of organisms interacting with one another and the physical environment.

If a fish population shows signs of stress, whether due to over-fishing, pollution, or habitat loss, scientists can pursue strategies to mitigate these factors. Some strategies might involve restoring critical fisheries habitat or implementing harvest restrictions. In this way, scientists help maintain Great Lakes **biodiversity**, or the abundance and variety of native species inhabiting the lakes.

Great Lakes fish populations are also closely monitored to meet fisheries management goals and ensure a sustainable fishery. The Great Lakes fishery is comprised of state and tribal commercial fishing operations and recreational fisheries. Accurate evaluation of fish populations helps fisheries managers establish equitable harvest quotas, set stocking levels for hatchery-reared fish, establish length and timing of fishing seasons, and help maintain a healthy predator-prey balance.

Studying fish populations often involves estimating the number of fish in a given population and tracking their movement. Fisheries scientists use different methods to do this. Some of these methods include GIS: Geographic Information System, GPS: Global Positioning System, Hydro-acoustics, and Mark-recapture. To use these methods correctly, scientists must understand basic geographic concepts. Two of these are latitude and longitude. See glossary for definitions.

FLOW Case Study

Using GIS to study coho salmon distribution in Lake Michigan

Two species that are closely monitored are coho and Chinook salmon. These Pacific salmon species were introduced to the Great Lakes in the 1960s to boost the sport fishing industry and to help curb the overabundance of alewife. Alewife, an invasive forage fish, entered the Great Lakes in the 1950s following completion of the Welland Canal.
The majority of coho salmon discussed in this FLOW Case Study were stocked at the State of Michigan Platte River fish hatchery in northwest Michigan. Once in the lake, however, their location and movement is of interest to fisheries scientists, managers and the anglers who harvest them.

The series of GIS maps (available in Downloads) display coho salmon distribution in Lake Michigan. The Lake Michigan coho salmon maps contain (1) coho salmon stocking numbers and locations (where the fish actually entered the water) in 1991; and (2) actual fisheries catch data from charter boat captains in Lake Michigan. Catch rates were calculated as the number of fish caught per hour of fishing, considering the number of anglers on each boat. Catch rates are shown for May – September (averaged from 1992-2001 data). *Catch data as reported to DNR.*

By examining the maps, fisheries scientists see that coho salmon are stocked in Michigan waters of Lake Michigan but appear to move to the southwestern corner of the lake. By looking at the catch data, it becomes clear that many of the fish are being harvested by anglers in other states, including Wisconsin, Illinois, and Indiana. In the fall, the data shows that coho salmon return to their native streams to spawn. In this case, many of the fish returned to the Platte River. It is not well understood why they move to southwestern Lake Michigan. Some possible explanations include the availability of high-quality habitat, a genetic predisposition, and predator-prey relationships.

Source: Institute for Fisheries Research, University of Michigan and Michigan Department of Natural Resources (DNR).

Materials and Preparation

- A world map with lines of latitude and longitude
- See data sheet: *FLOW Case Study* (Print copies for students) *Coho Salmon in Lake Michigan*

Note: See *FLOW Case Study* and other materials at the end of this lesson (supplemental materials).

Procedure

1. Explain that students will learn how to find a specific location using latitude and longitude. Start with the world map and explain the two key terms: latitude and longitude. Latitude measures north and south, and longitude measures east and west. Explain the two points of reference used to determine latitude and longitude: the Equator and the Prime Meridian. The Equator: Located at 0 degrees latitude (north and south of the Equator). Pinpoint the line of the Equator on the world map. The Prime Meridian: Located at 0 degrees longitude (east and west of the Prime Meridian). Look at the world map again and pinpoint the Prime Meridian.
2. Pinpoint the latitude and longitude of the State of Michigan Platte River Hatchery. Provide the street address: 15210 US 31 Highway, Beulah, MI 49617
   - Determine if the hatchery is north or south of the Equator. Determine which two lines of latitude the hatchery is between. Explain how to find the midpoint by splitting the difference between the two lines. Determine if the hatchery is closer to the midpoint or one of the lines, and estimate the degrees latitude. Write the answer in the chart.
   - Determine if the hatchery is east or west of the Prime Meridian. Determine which two lines of longitude the hatchery is in between. Determine the midpoint by splitting the difference between the two lines. Determine if the hatchery is closer to the midpoint or one of the lines, and estimate the degrees longitude. Write the answer in the chart.
3. Use a simple chart, see below, to pinpoint the hatchery and one or two additional locations.

Location Name	Latitude (N/S)	Longitude (E/W)

4. Now, move onto the *FLOW Case Study* examples using GIS to track the movement of coho salmon in Lake Michigan. Explain some of the reasons why scientists study fish populations and track their movement. (Reasons might include gaining knowledge about ecosystem interactions and informing fisheries management.) Discuss some of the methods currently used to monitor fish, such as GIS and mark-recapture.
5. Explain to students that they will review several maps of spatial patterns for a population of fish—coho salmon.
6. Use the FLOW Case Study to briefly review the history of coho salmon, explaining that the majority of coho salmon are stocked at the State of Michigan Platte River Hatchery. Students should know the exact location of this hatchery, as they recorded the latitude and longitude earlier. *(Note: Coho salmon are stocked at 17 locations.)*
7. Hand out the map of coho stocking locations to each group. See the *Coho Salmon in Lake Michigan map* in downloads. Note that the majority of stocked fish enter the lake at the same location near the Platte River. Remind students that scientists learn about

fish populations by mapping their location and movement. Notice how the movement of coho changes. *Note: Because the fish are not tagged, scientists infer movement based on catch data, or Catch Per Unit Effort (CPUE). This is the number of fish caught per hour of fishing.*

8. Compare the six maps: look at the map showing coho salmon during the months of May through September. Ask students: How are the patterns of movement similar or different? Where are the fish moving? Why might the fish be moving to that particular location? What predictions can be made about the habits of the population?
9. Emphasize the amount of information that can be gained, and questions raised, by simply observing the movement patterns of various species of fish, birds and mammals. Relate observations back to fisheries research goals and the value of studying population movement and behavior.

Extension

To learn more about GIS:
Download Google Earth to view layers of data about a river near your school. Adjust the views and note the latitude, longitude and elevation of the area you pinpointed. Turn the layers on and off to view different data.

To view GIS fish stocking data:
Add the URL of the database: www.glfc.org/fishstocking

View maps using ArcReader freeware and map files:
www.esri.com/software/arcgis/arcreader/download.html

Source

FLOW Development Team

Acknowledgements

Christine Geddes, Institute for Fisheries Research, University of Michigan School of Natural Resources and Environment and Michigan Department of Natural Resources; and Martha Wolgamood, Hatchery Manager, Wolf Lake State Fish Hatchery, Michigan Department of Natural Resources.

Assessment & Standards

See separate document: **FLOW_Assessment_GLCE.pdf**

FLOW Feedback

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Supplemental Materials: FLOW Unit 3, Fish

Lesson 4 - Fish Populations Documents:

- FLOW Case Study (print copies for students) and Coho Salmon in Lake Michigan
- The *Life of the Lakes, A Guide to the Great Lakes Fishery*, by Shari Dann and Brandon Schroeder, published by Michigan Sea Grant, MICHU-03-400.

FLOW Case Study
Using GIS to Study Coho Salmon Distribution in Lake Michigan

Two species that are closely monitored are coho and Chinook salmon. These Pacific salmon species were introduced to the Great Lakes in the 1960s to boost the sport fishing industry and to help curb the overabundance of alewife. Alewife, an invasive forage fish, entered the Great Lakes in the 1950s following completion of the Welland Canal.

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Catch data as reported to DNR.

Source: Institute for Fisheries Research (IFR), University of Michigan (UM) and Michigan Department of Natural Resources (DNR).

COHO SALMON IN LAKE MICHIGAN

Unit 3, Lesson 4

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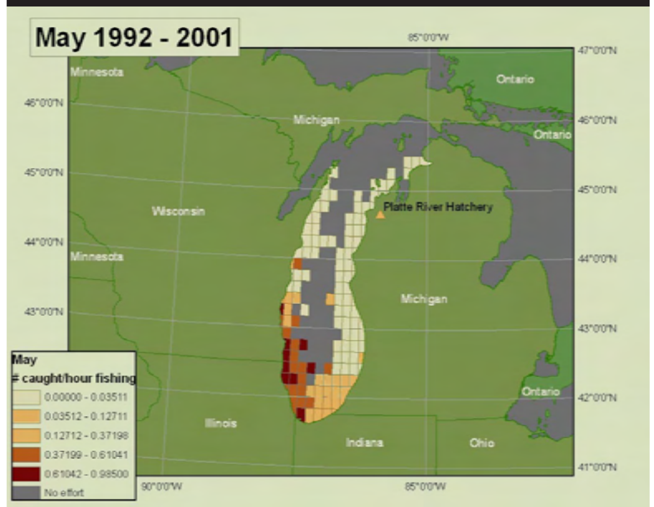

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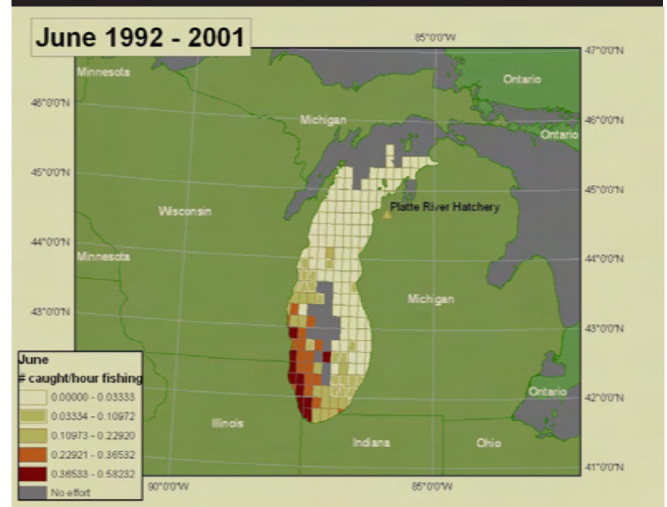

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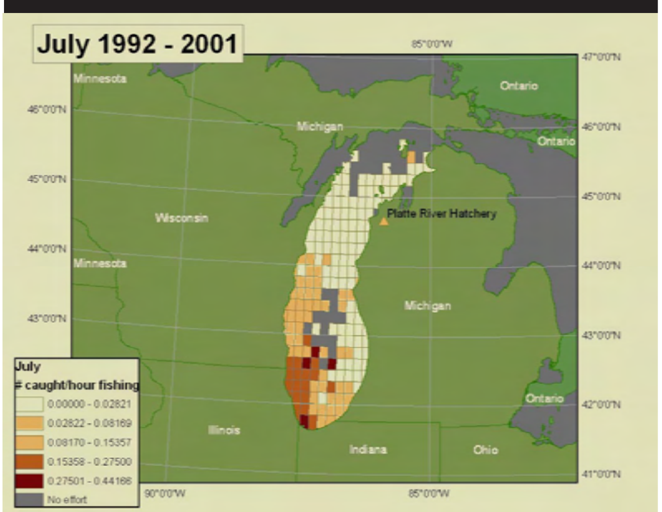

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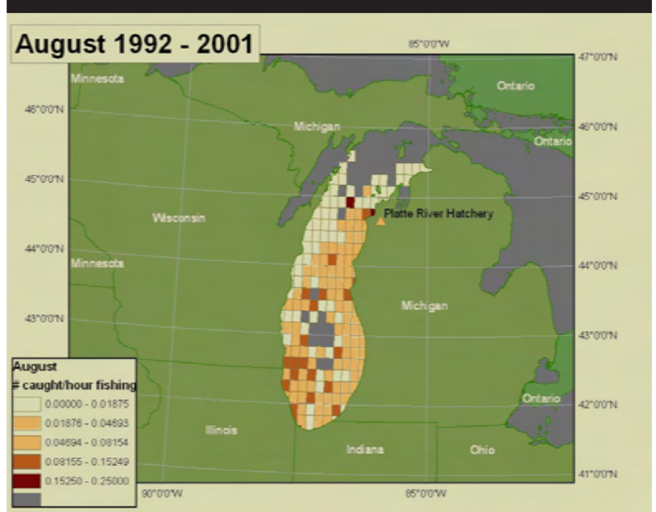

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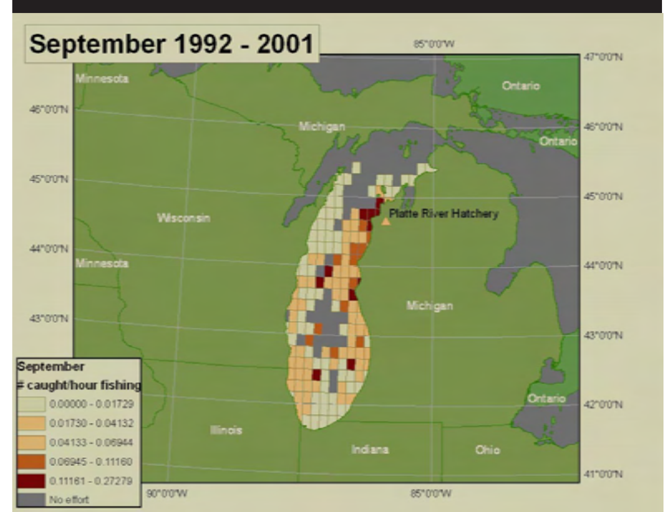
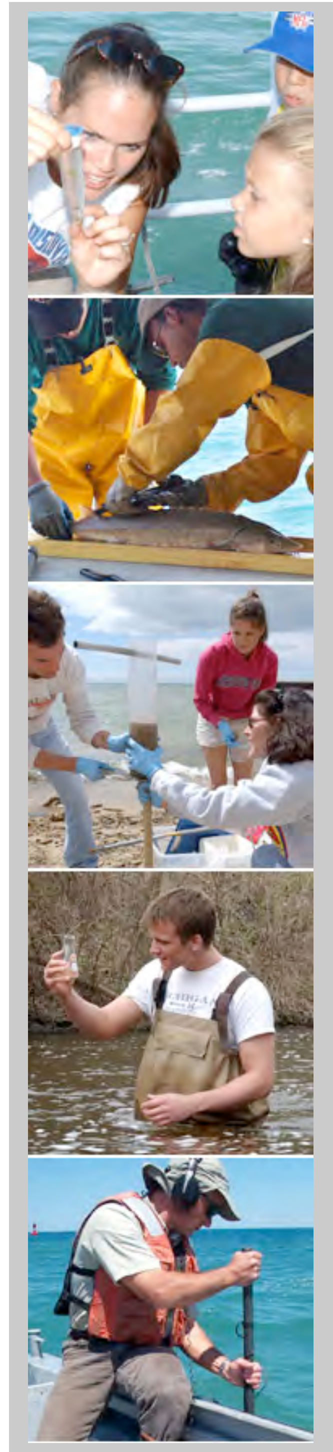


GIS images provided by Institute for Fisheries Research

Lesson 5: Great Lakes, Great Careers



Activity: Students review a selection of career profiles and play a lively classroom game to find out more about marine and aquatic science professionals.

Grade level: 4-8
Subjects: Science, social studies
Setting: Classroom
Duration: 1 hour
Key terms: Career, Profile

Objectives

Following this lesson, students will be able to:

- Name at least five careers in marine and aquatic science, including both the oceans and Great Lakes.
- Identify several recent contributions that people have made in marine and aquatic science fields.
- Describe a marine or Great Lakes science career that interests them.

Summary

A variety of people make their living studying the oceans and Great Lakes or educating others about these valuable natural resources. Yet for many students in the U.S., these careers may seem relatively remote or unattainable, until they learn about the actual people who do them. This activity will help students become familiar with possible and exciting careers.

Background

"I have always loved the water. Since junior high school, I was certain I wanted a career that would involve the ocean," says Ocean Engineer Dianna Bo. For some young people, that's all it takes—an early fascination that leads to a lifelong passion. Others, however, may not realize that related careers even exist, much less that they would enjoy the work!

Bo is one of more than 50 people profiled on web pages created by WHOI and NH Sea Grant programs (see: Marine Careers website) The pages provide an excellent introduction to a wide range of marine career fields and to people working in those fields. The featured men and women tell how they got started in their careers, what they like and dislike, and give advice for young people. Fields covered include marine biology, oceanography, ocean engineering, and related fields such as marine law, education, and economics.

Materials and Preparation

- Select approximately 15 career profiles, available online, see www.whoi.edu/science/marinecareers. It is best to select a wide range of careers and a diversity of men and women.
- Make multiple copies, so that each student has a stapled packet of all 15 profiles.
- Create stickers or labels with the name of each person profiled.
- Note: Many Great Lakes career profiles are currently available online in a variety of formats.

Procedure

1. Begin by introducing the topic of marine and aquatic science careers. Point out that for each of the prior lessons in FLOW, people are employed in related fields—as ecologists, wetland biologists, water quality experts, fisheries researchers, natural resource educators, science writers and a host of others. Ask students if they know of family members or friends who make a living by studying or educating others about the oceans and Great Lakes.
2. Distribute the packet of career profiles to each student. Explain that each of the profiles describes a real person whose career involves the oceans or Great Lakes. Explain that they'll be playing a game using these profiles.
3. Next, place a sticker on the back of each student, identifying a person in one of the profiles. Students are not allowed to see their own stickers. The goal of the game is for each student to figure out whose name is on their backs, by asking other students questions.
4. Start the game. Allow the students to mingle, while carrying the profiles. When two students meet, they should first look at the name on the other person's back and consult the appropriate profile for information. They then ask each other a yes-no question about their own identity. (For example: Am I a fisheries biologist? Am I female?) They are only allowed to ask one question per pairing and then must move on to mingle with others.
5. Once they have gathered enough answers to guess their own identify (the name on their back), they can remove the sticker, sit down, and read about that professional. They then become the "expert" on this person. After everyone is sitting and has had a chance to read about their person, ask each student to "introduce" the person to the class. They can talk about what the profiled professional does in relation to the oceans or Great Lakes, what he or she enjoys most, and what skills or education are needed to do this kind of job, etc.

Extension

If students have Internet access, have them spend 15 minutes reviewing a variety of the profiles online. Ask students if they had to choose a career involving the oceans or Great Lakes, which one most interests them? Students will write a short essay explaining why they like this career, why they would be good at it, what kind of education they would need, and where—if they could choose anywhere in the world—they would like to work.

Source

FLOW Development Team and Anna Switzer.

Assessment & Standards

See separate document: **FLOW_Assessment_GLCE.pdf**

FLOW Feedback

Please take 10 minutes to provide us with your feedback.
Go to: http://www.miseagrant.umich.edu/flow/flow-feedback.html

Supplemental Materials: FLOW Unit 3, Fish

Lesson 5 - Great Lakes, Great Careers Documents:

- *Marine Careers website:* http://www.whoi.edu/science/marinecareers/index.php
- Print: 15 career profiles, multiple copies, diversity of men and women
  Reminder: Stickers or labels with the name of each person profiled.

Fish Glossary / Key Terms

Adipose fin: Small, fleshy fin. When present, the adipose fin is located between a fish's dorsal and caudal fin.

Anal fin: Fin located on a fish's underside behind the pelvic fins.

Barbels: These "whiskers" are used by bottom-feeding fish to sense food.

Biodiversity: The number and variety of all living things.

Career: A chosen profession or occupation.

Caudal fin: Tail fin.

Dichotomous key: Classification "tool" used to sort, organize and identify a collection of objects or living organisms. (Dichotomous: Divided into two parts. Key: (Biol) A systematic classification of the significant characteristics of the members of a group of organisms to facilitate identification and comparison.)

Dorsal fin: Large fin or fins on a fish's back that vary in shape and size and may be connected or separate.

Ecosystem: An ecosystem is a community of organisms interacting with one another and the physical environment.

Family: (Biol) A taxonomic category ranking below an order and above a genus.

Fry: Newly hatched young after the yolk sac has been fully absorbed, and the fish shifts from the bottom to swim freely and search for food.

Genus *(Biol.):* Major subdivision of a family or subfamily in the classification of organisms, usually consisting of more than one species.

Geographic Information System (GIS): A database system with software that can analyze and display data using digitized maps and tables for planning and decision-making. A GIS can assemble, store, manipulate and display geographically referenced data, tying this data to points, lines and areas on a map or in a table. GIS software uses locations (typically recorded in latitude and longitude). Example: Using GIS, fisheries scientists can plot information on a map to study the location and movement of fish and overlay different types of geographical data (rivers, lakes, human populations, roads, etc.). GIS software helps scientists display and manipulate information about an area (e.g., Lake Michigan). Scientists in Michigan use GIS to study coho salmon distribution in Lake Michigan.

Global Positioning System (GPS): A technology that uses the position of satellites to determine locations on Earth. GPS is an essential tool for GIS because it allows for the gathering of data that location-wise is highly accurate. Example: Scientists in Michigan used a Global Positioning System (GPS) to determine the exact location for the construction of fish spawning reefs for lake sturgeon and other fish in the Detroit River.

Habitat: An area that provides life requirements such as appropriate food, water, shelter and space for a particular organism.

Hydro-acoustics: A technique used by scientists that uses transmitted sound to sense fish in the water column. Researchers use hydro-acoustics to study the size of individual fish, fish movement, spatial distribution and swimming speed. Hydro-acoustic equipment is used in either mobile surveys or fixed locations (usually in rivers or at fish passages). Also referred to as fisheries sonar.

Ichthyologist: Scientist who studies fish.

Juvenile: The time fish spend developing from fry to reproductively mature adults.

Larval fish: Stage in a fish's life cycle just after hatching from an egg. Larval fish live off a yolk sac attached to their bodies.

Latitude: Gives the location of a place on Earth in relation to its distance north or south of the Equator. A line of latitude is horizontal, parallel to the Equator, and is also referred to as a *parallel*. Latitude is expressed in degrees ranging from 0 degrees at the Equator to 90 degrees at the poles (90 degrees N or 90 degrees S).

Life cycle: The continuous sequence of changes undergone by an organism from one primary form (such as an egg) to the development of the same form again.

Life history: A continuous, descriptive account of a life cycle of an organism.

Longitude: Describes the location of a place on Earth in relation to its distance east or west of a north-south line called the Prime Meridian, located in Greenwich, England. Longitude is expressed as an angular measurement ranging from 0 degrees at the Prime Meridian to +180 eastward and –180 degrees westward.

Mark-recapture: Method of monitoring fish populations that requires catching fish and marking them in some way, either by attaching a tag or clipping a fin. Once fish are tagged, scientists release them back into their habitat. When these fish are recaptured, either by researchers or fisherman, it is possible, based on satellite data, to determine how far that fish has traveled or, using simple math, estimate the number of fish living in that habitat. Some tags do not remain permanently on fish. These tags are programmed to pop off the fish, float to the surface and transmit data via satellite back to researchers.

Pectoral fins: Side fins mainly used for direction or "steering."

Pelvic fins: Paired fins located on the belly of a fish or under the pectoral fins.

Population: A group of individual organisms of the same species living in a particular area.

Profile: A biographical essay presenting the subject's most noteworthy characteristics and achievements.

Restoration: To return to nearly a former condition or status.

Snout: Front part of a fish that includes the mouth.

Spatial: Pertaining to distribution, distance, direction, areas and other aspects of space on the Earth's surface. Ecologists are interested in the spatial arrangement of features in landscapes. The arrangement of elements is important because it affects ecological processes.

Spawn: To deposit eggs; to produce offspring in large numbers.

Species: A fundamental category of taxonomic classification ranking after a genus and consisting of organisms capable of interbreeding.

Superior: Directed upward.

Terminal: Directed forward.

Ventral: Directed downward.

Yolk sac: a membranous sac attached to an embryo, providing early nourishment in the form of yolk. In many fish the yolk sac is retained for a period after hatching.