FLOW Unit 3: Fish Overview

This series of five lessons from Fisheries Learning on the Web (FLOW) begins by introducing students to important distinguishing characteristics of Great Lakes fish. Building upon this knowledge, students use a simple key to identify several common fish families. Lessons then explore the concept of biodiversity and the importance of maintaining healthy fish habitat. The final lesson highlights a variety of people who have chosen scientific careers studying or teaching about the oceans and Great Lakes.

Lesson 1: Fish of the Great Lakes

Introduces students to some of the distinguishing characteristics of Great Lakes fish and how these traits help fish survive in their environment.

Lesson 2: Fins, Tails and Scales: Identifying Great Lakes Fishes

Leads students through the process of using a dichotomous key to organize and identify 8 common fish families.

Lesson 3: Preserving Biodiversity

Discusses the ecological importance of protecting species variety.

Lesson 4: Fish Habitat

Highlights the important connection between Great Lakes fish biodiversity and the need to protect and maintain healthy fish habitat.

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.

About Lesson Materials

See **Lesson Downloads** at the end of this unit for all lesson materials, including cards, game boards, fact sheets and additional materials.

Feedback

If you have not already sent us your feedback, please consider doing so by completing a *FLOW Feedback Form*, and sending it to:
Michigan Sea Grant, 440 Church St., Dana Bldg., Suite 4044, Ann Arbor, MI, 48109-1041.

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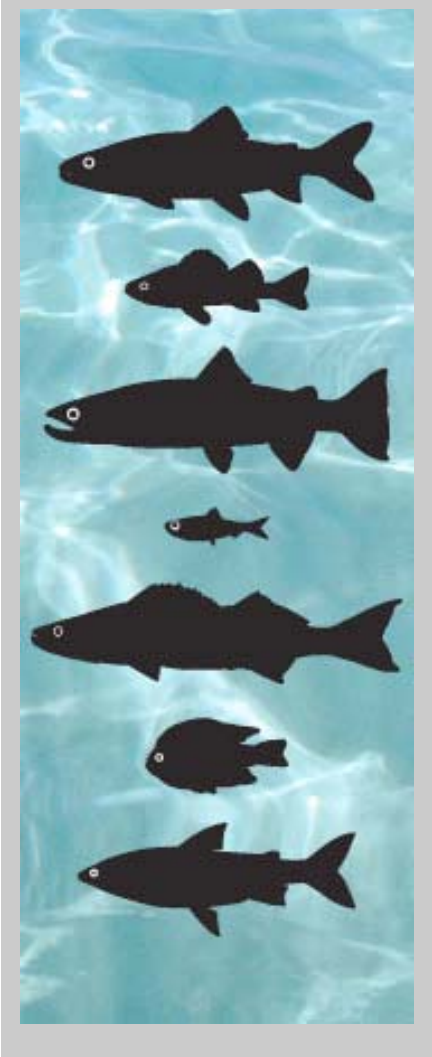
Lesson 1: Fish of the Great Lakes



Activity: Working with a set of Great Lakes fish cards, students identify distinguishing characteristics of fish and organize the collection based on similarities and differences, as well as into an interconnected food web.

Grade level: 4-8
Subjects: Science, social studies
Setting: Classroom
Duration: 30-60 minutes
Key Terms: Adipose fin, Barbels, Caudal fin, Dorsal fin, Pectoral fin, Snout

Objectives

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

- Observe important distinguishing characteristics of Great Lakes fish.
- Describe how these characteristics help fish survive in their environment.
- Organize 10 Great Lakes fish (cards) based on similarities and differences.
- Develop a hypothetical food web involving this representative subset of Great Lakes fish.

Summary

The Great Lakes and other lakes and rivers of the region are home to an impressive variety of fish. Among the species are coldwater fishes like lake trout and lake whitefish, and ancient species such as sturgeon and gar. Students may be most familiar with warm-water fishes like sunfish and bass. Each major family of fishes has traits that set it apart from others, called distinguishing characteristics. These characteristics help fish survive in their environment. By observing and comparing distinguishing characteristics, students begin to understand how fish, like other animals, can be organized and classified into meaningful groups, and how these groups are interrelated via the aquatic food web.

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Background

The Great Lakes region is home to more than 160 species of fish. All have some characteristics in common, such as gills, scales, and bony skeletons. Some characteristics that differentiate fish include head shape, fin type and location, as well as average adult size. These traits also provide clues as to where certain fish typically live and what they eat. Scientists, fishery managers, and anglers use these and many other parts of a fish's anatomy to correctly identify existing fish species and classify newly discovered fish.

Some distinguishing characteristics of fish include the following:

- **Dorsal fin:** Large fin(s) on a fish's back that vary in shape and size, and may be in one or two parts. Some fish have spiny dorsal fins that help protect against predators. Others, like sunfish and bass, have two-part, connected dorsal fins that are part spiny and part soft. The dorsal fin stabilizes fish against rolling and assists with sudden turning.
- **Barbels:** These "whiskers" near the mouth are used by bottom-feeding fish to sense food.
- **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, tend to use their tails for quick darting action to capture prey.
- **Adipose fin:** When present, the adipose fin is located between the dorsal fin and caudal fin. It's much smaller than either of these two fins, and its purpose is unclear. Note that some fish, such as lake sturgeon. have a large dorsal fin near their tail. The large size of this fin helps distinguish it from an adipose fin.
- **Snout:** Front part of a fish that includes the mouth. The size and shape of the mouth provide clues as to what a fish eats. In general, a downward oriented mouth often indicates a bottom feeder, whereas an upward oriented mouth indicates that the fish finds its food within the water column. Other fish such as invasive sea lamprey have a round, suction disk mouth for attaching to other fish and feeding on body fluids.
- **Pectoral fin:** Side fins mainly used for direction or "steering."

Note that color is not an effective distinguishing characteristic because it can change depending on physical or environmental conditions. However, color patterns, such as spots or vertical bars, may be useful.

As learned in lesson 1.2, fish occupy various niches in the aquatic food web. Chinook salmon, lake trout, and northern pike are examples of top predators that feed primarily on other fish. Medium-sized fish such as bluegill and bass eat a variety of food including small fish, crayfish, frogs, snails and macroinvertebrates. Other fish are bottom feeders, eating plankton and macroinvertebrates.

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Materials and Preparation

Assemble the *Set of 10 Great Lakes fish cards* and the *generic fish graphic* for each group of students. If possible, laminate cards for multiple uses. Note: The fish cards document also includes the generic fish graphic with distinguishing characteristics of fish.

Downloads (Materials)

See **Downloads** at the end of this unit for the following materials:

Set of 10 Great Lakes fish cards with *generic fish graphic*

Procedure

1. Discuss the importance of observing distinguishing characteristics of living things in order to classify and identify them.
2. Hold up several of the fish cards. Ask the students: What do you notice? Do some fish have more than one fin on their backs? Do some have "whiskers"? Are there different tail shapes? How would you describe the differences?
3. Hold up the illustration of the generic fish. Explain that this is not a real fish, but rather a composite showing a variety of traits previously discussed. Introduce students to the actual names of the fins and other distinguishing characteristics. Make sure students know where the different fins are located on the fish. Point out that some fish have a single dorsal fin on their backs, while others have a "two part" dorsal fin that may be connected or separate. Explain that the shape of caudal (tail) fin can tell us something about the swimming ability of the fish. Point out that "barbel" is the scientific term for "whiskers," and that the purpose of the barbel is to feel along the bottom for food.
4. Following discussion, arrange the students into small groups, each with a set of fish cards and the generic fish illustration. Ask them to organize the fish based on similarities and differences, such as shape of dorsal fin(s), tail shape, presence or absence of adipose fin, barbels, etc. They may want to organize them two or three different ways. Briefly discuss the results. Which characteristics did students use to separate the fish?
5. Next, have the students arrange the fish cards into a food web, assuming that these fish were the only fish in the Great Lakes. They can use any distinguishing characteristics to justify their food webs. Have them diagram their hypothetical food webs on a separate sheet of paper. One way to do this is to have students tape the laminated fish cards to the page and draw arrows to show who eats whom.
6. After all of the groups have finished, have them present their food web diagrams to the rest of the class, explaining why they assigned certain fish to certain food web niches. Which distinguishing characteristics informed their decisions? Likely, different groups will have different webs. This is acceptable. There is no "right" answer to this exercise. In reality, many more fish and other animals are part of the Great Lakes

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food web. However, this is a valuable exercise that prompts students to think about forms and functions of fish anatomy.

7. In the next lesson, students will use a simple key to identify the fish on the cards, based on distinguishing characteristics.

Source
Developed by Anna Switzer and Joyce Daniels, Michigan Sea Grant

Assessment

This assessment chart was designed for teachers to create their own assessment. The recommended points show the relative difficulty of student performance. In creating assessments, the total point value will depend on the number and type of performances selected.

Learning Objective	Student Performance	Recmnd # Points
Observe important distinguishing characteristics of Great Lakes fish	**Explain** what 'distinguishing characteristic' means	2 each
	Name possible body parts that could be distinguishing for fish	1 each
Describe how these characteristics help fish survive in their environment.	**Describe** how certain fish body parts help them survive.	2 each
Organize the collection of Great Lakes fish cards based on similarities and differences	**Differentiate** between two or more example fish based on a certain characteristic.	1 each
Develop a hypothetical food web involving these fish.	**Defend** their hypothetical food web based on what they have learned about distinguishing characteristics	3 each per logical defense

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Standards

State of Michigan

Science			Social Studies	
Elementary		Middle	Elementary	Middle
I.1.6 II.1.2 II.1.4 III.2.1	III.2.2 III.4.2 III.5.1	I.1.5 I.1.6 II.1.3 III.5.1		

National

NSES		AAAS	
Elementary	Middle	Elementary	Middle
A1.2 C1.2 C1.3	C1.1 C3.4 C4.2	5A.1 5A.2	5A.2 5A.3 5A.5
NAAEE		**NCSS**	
Elementary	Middle	Elementary	Middle
1-C 1-E 2.2-A	1-C 1-E 2.2-A	n/a	n/a

Notes:
NSES = National Science Education Standards
AAAS = American Association for the Advancement of Science (Benchmarks)
NAAEE = North American Association of Environmental Education (Guidelines for Excellence)
NCSS = National Council for the Social Studies (Standards)

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FISH FAMILY CARDS

Unit 3, Lesson 1

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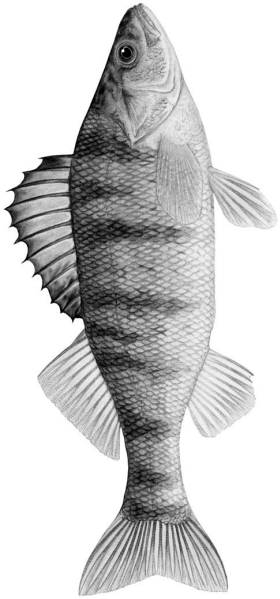
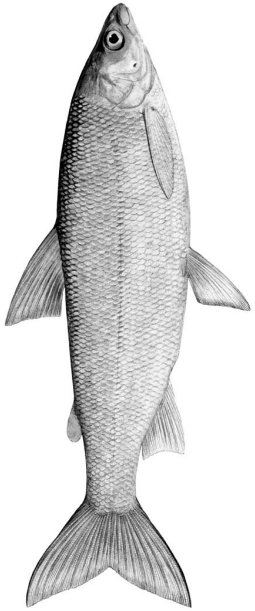


Illustration: E. Damstra



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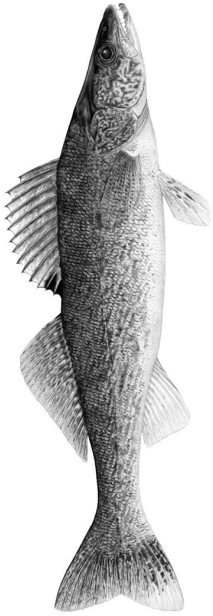

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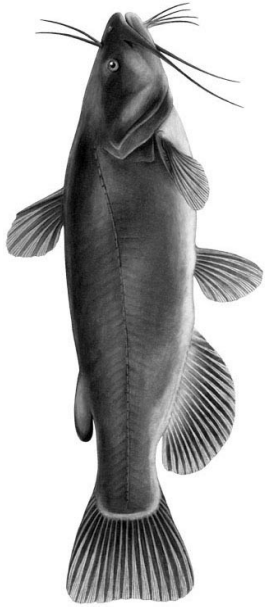

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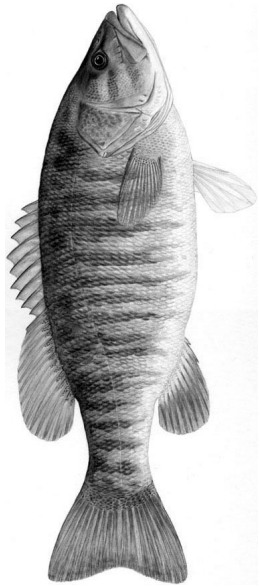

Illustration: E. Damstra

FISH FAMILY CARDS

Unit 3, Lesson 1

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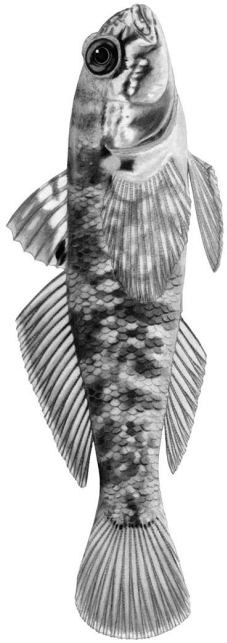


Illustration: E. Damstra

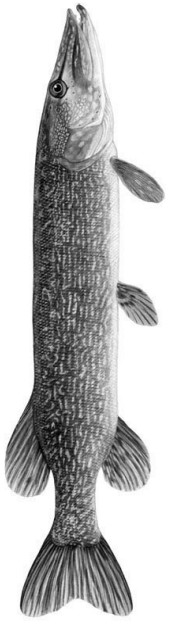


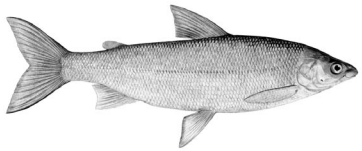
Illustration: E. Damstra

FISH FAMILY ID CARD GUIDE FOR TEACHERS

Chinook salmon

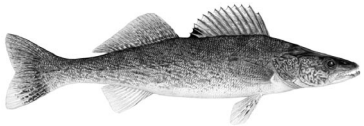
Yellow perch

Sea lamprey



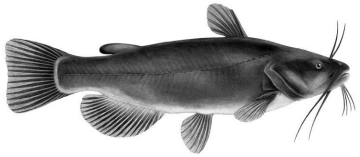
Lake whitefish

Lake sturgeon

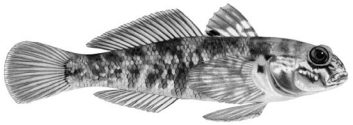


Walleye

Smallmouth bass



Black bullhead



Round goby

Northern pike

Illustrations: E. Damstra

Note: Fish size not to scale

GENERIC FISH GRAPHIC: CHARACTERISTICS OF FISH

Unit 3, Lesson 1

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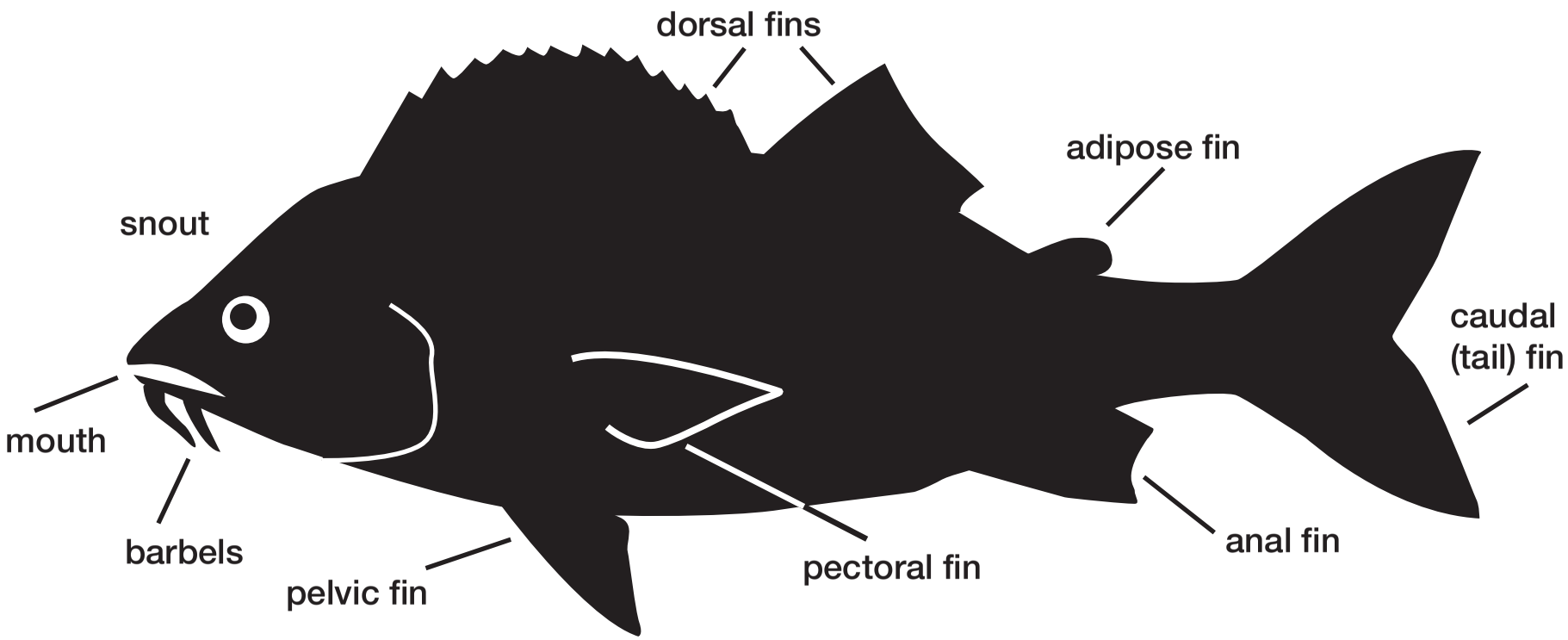
This generic fish illustration shows a variety of distinguishing characteristics. Scientists use these and many other traits to correctly classify and identify fish.



Lesson 2: Fins, Tails and Scales: Identifying Great Lakes Fish

Photos: D. Brenner

Activity: Students use a simple classification system (dichotomous key) to identify 8 common Great Lakes fish families based on distinguishing characteristics.

Grade level: 4-8
Subjects: Science, social studies
Setting: Classroom
Duration: 30-60 minutes
Key Terms: Dichotomous key, Family, Ichthyologist, Species

Objectives

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

- Use a **dichotomous key** to identify 10 Great Lakes fish representing 8 common families.
- List distinguishing characteristics of some of the families.
- Name several common Great Lakes fish.

Summary

Scientists use classification systems to organize living organisms into groups based on similarities, distinguishing characteristics and other attributes or behaviors. Incorporating the traits described in Lesson 3.1, this lesson introduces students to a simple dichotomous key that can be used to identify some common families of Great Lakes fish.

Background

Many **species** of Great Lakes fish look similar in size, shape and color. It can sometimes be difficult to tell them apart. However, each species belongs to a larger **family** that shares similar characteristics. There are 28 fish families in the Great Lakes. To organize and identify the main families, **ichthyologists** (fish scientists) use a dichotomous key

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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 starting at one common point and progressing through the key, making choices based on distinguishing characteristics, the user is led through a path that ends with a correct identification of the object or organism.

A dichotomous key can be complex (incorporating all families and species of a particular animal) or simple. In this lesson, a simplified key has been created that distinguishes 8 Great Lakes fish families. By using their knowledge of distinguishing characteristics, students use illustrations of fish to work through the key and make identifications.

Materials and Preparation

- Download: Set of 10 *Great Lakes Fish cards*
- Download: Dichotomous key to 8 common Great Lakes fish families. Note: This key will print out as 2 pages that will need to be taped together.
- Download: Generic fish illustration
- Post-it notes

Downloads (Materials)

See **Downloads** at the end of this unit for the following materials:
Set of 10 *Great Lakes fish cards*, *generic fish illustration*, and *dichotomous key*.

Procedure

1. Divide the class into small groups. Explain the need to use classification systems to organize living organisms. Describe a dichotomous key, emphasizing that this type of key uses a series of questions based on distinguishing characteristics. For example, a key to identify fish might ask: Does the fish have barbels (whiskers)? or Is the dorsal fin spiny?
2. Explain that each group will use a dichotomous key to identify 8-10 of the fish pictured on the Great Lakes fish cards. The cards represent 8 common families: Trout and Salmon, Pike, Sturgeon, Lamprey, Sunfish and Bass, Perch, Goby (invasive), and Catfish. Note that there are 10 fish cards. Yellow perch and walleye both belong to the Perch family. Chinook salmon (an introduced species) and lake whitefish both belong to the Trout and Salmon family.
3. Pass out the generic fish diagram and remind students of some of the distinguishing characteristics of fish covered in the previous lesson (Lesson 3.1).

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4. Using the set of 10 Great Lakes fish 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. Note that there are Bonus Questions on the key that ask students to identify 4 fish at the species level.
5. Discuss the results. Did everyone correctly identify all fish? Was it difficult to distinguish some of the characteristics, such as a rounded or forked tail? How else might some of the characteristics be described? 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. Still, the process of using a dichotomous key is valuable in many disciplines. Also, by learning to observe important fish characteristics, students will be more competent in identifying common Great Lakes fish families—a useful skill whether they enjoy fishing or simply want to know what lives in their local lake or river.

Adaptations

1. Have students create their own dichotomous keys using a group of commonly found objects, such as pasta, buttons, dried beans, or fruit.
2. 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.
3. 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.
4. 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

Developed by Anna Switzer and Joyce Daniels, Michigan Sea Grant.

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Assessment

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Learning Objective	Student Performance	Recmnd # Points
Observe important distinguishing characteristics of Great Lakes fish	Explain what 'distinguishing characteristic' means	2 each
	Name possible body parts that could be distinguishing for fish	1 each
Describe how these characteristics help fish survive in their environment.	Describe how certain fish body parts help them survive.	2 each
Organize the collection of Great Lakes fish cards based on similarities and differences	Differentiate between two or more example fish based on a certain characteristic.	1 each
Develop a hypothetical food web involving these fish.	Defend their hypothetical food web based on what they have learned about distinguishing characteristics	3 each per logical defense

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Standards

State of Michigan

Science				Social Studies	
Elementary		Middle		Elementary	Middle
I.1.1 I.1.2 I.1.5 I.1.6 II.1.2	II.1.4 III.2.1 III.2.2 IV.1.1	I.1.1 I.1.2 I.1.5	I.1.6 II.1.3 III.2.1	n/a	n/a

National

NSES		AAAS	
Elementary	Middle	Elementary	Middle
A1.2 B1.1	A1.1 C5.1	5A.1 5F.1 12D.1	5A.2 12D.1 12D.2

NAAEE				NCSS	
Elementary		Middle		Elementary	Middle
1-A 1-C 1-E	1-F 2.2-A	1-A 1-C 1-E	1-F 2.2-A	n/a	n/a

Notes:
NSES = National Science Education Standards
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NCSS = National Council for the Social Studies (Standards)

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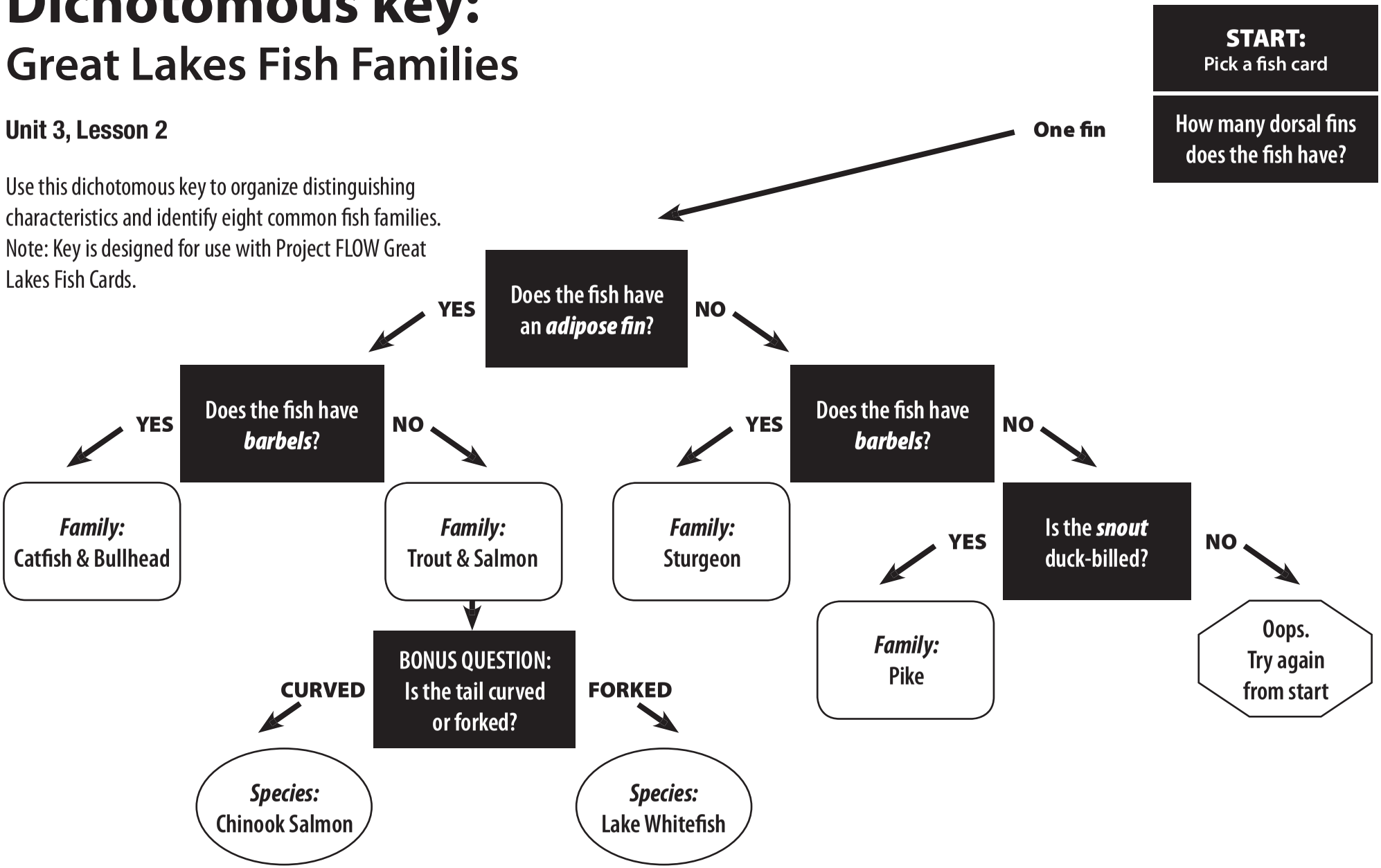
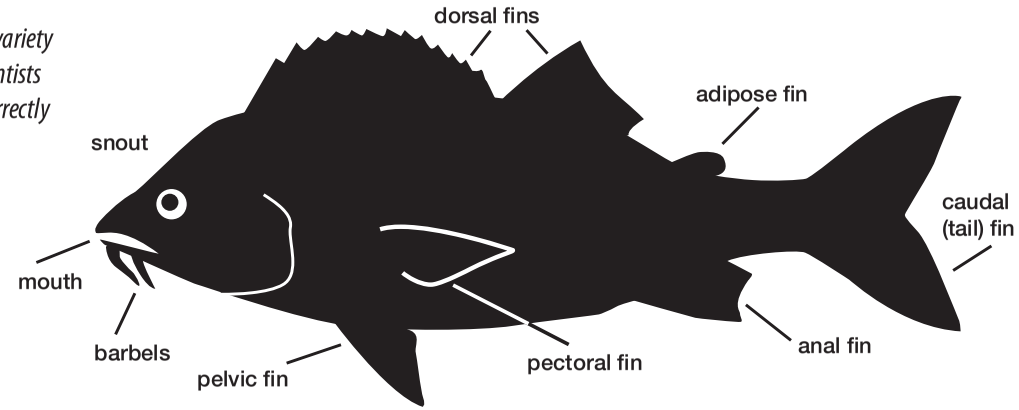
Dichotomous key:
Great Lakes Fish Families

Unit 3, Lesson 2

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



This generic fish illustration shows a variety of distinguishing characteristics. Scientists use these and many other traits to correctly classify and identify fish.



Two fins

Is one *dorsal fin* spiny and one smooth?

- **YES** → **Are the two fins well connected?**
  - **YES** → ***Family:*** Sunfish & Bass
  - **NO** → **Is the *caudal (tail) fin* rounded or forked?**
    - **FORKED** → ***Family:*** Perch → **BONUS QUESTION: Does the fish have vertical stripes?**
      - **YES** → ***Species:*** Yellow Perch
      - **NO** → ***Species:*** Walleye
    - **ROUNDED** → ***Family:*** Goby
- **NO** → **Does the fish have a round *mouth***
  - **YES** → ***Family:*** Lamprey
  - **NO** → Oops. Try again from start

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Lesson 3: Preserving Biodiversity

Activity: Following class discussion, students create an educational poster or booklet highlighting the importance of biodiversity.

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

Photos 1-3: D. Brenner, Photo 4: T. Marsee

Objectives

Following this lesson, students will be able to:

- Explain what is meant by **biodiversity** and why it's important.
- Describe some of the benefits of having a diverse population of plants and animals.
- Describe some of the major threats to Great Lakes biodiversity.

Background

Life on earth depends on the interaction of many different plants and animals. Each has unique abilities, some of which include absorbing carbon dioxide and producing oxygen, filtering water, and producing food and medicines. This variety also enriches our own lives with natural beauty and mystery. In biodiversity, bio means life, and diversity means variety. In essence, biodiversity means "variety of life," or the number and variety of all living things on earth. We can think about biodiversity in several ways:

- Variety of genes
- Variety of species (and populations)
- Variety of ecosystems

Unfortunately, this variety is rapidly declining. According to the *Biodiversity Project*, as many as 500 plant and animal species have disappeared forever since people first arrived in North America. Some loss has always occurred over time, but species loss has accelerated with increasing human influence and activity. Some of the major threats to

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biodiversity are habitat loss, introduced species, pollution, population growth, and over-consumption.

These same threats have affected biodiversity in the Great Lakes. In the mid 1800s as the region's human population grew rapidly, a number of factors combined to impact some native fish species beyond recovery. Blue pike is one example of a fish that succumbed to a combination of factors including over-fishing, pollution and habitat loss. Today, populations of lake sturgeon and lake trout are examples of fish that have declined to such an extent that restoration projects have been launched to enhance habitat and aid recovery.

For some species, however, recovery strategies have not been identified. One example is *Diporeia*, a shrimp-like organism that lives in bottom sediments and provides food for many species of Great Lakes fish. In recent years, it has declined in all the lakes except Lake Superior. While the causes are complex, scientists believe invasive zebra mussels are a contributing factor. They filter massive amounts of plankton from the water column, reducing food for native species.

This type of disruption of the aquatic food web has potentially long term impacts. As biodiversity declines, the aquatic ecosystem becomes increasingly vulnerable to disturbances. Some strategies to address the loss of biodiversity are to prevent the introduction and spread of invasive species, reduce pollution, and protect habitat. (See lessons 2.5 and 3.4)

Also see:

- American Museum of Natural History: http://www.amnh.org
- Biodiversity Project: http://www.biodiversityproject.org
- Michigan Natural Features Inventory: http://web4.msue.msu.edu/mnfi

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Number of Fish Species Found in the Great Lakes Basin*

Basin (Lake/River)	*No. of Species*
Erie:	129
Ontario:	119
Huron:	117
Michigan:	136
Superior:	83
Lake Nipigon:	39
St. Lawrence River:	105
Total 5 lakes and tributaries:	172
Total basin:	179

*Source: Coon 1999 in Taylor and Ferreri 1999 *Includes tributaries*

Materials and Preparation

- Construction paper
- Markers
- Poster board
- Magazines
- Internet or reference materials for additional research (optional)

Procedure

1. Discuss the concept of biodiversity and what it means. Ask students why it might be important to have a diversity of living plants and animals. Answers might include: natural beauty, food, medicine, oxygen, clean water, etc.
2. Explain to the students that they'll be creating an educational poster or booklet—incorporating pictures from magazines, original artwork, or narrative—describing what biodiversity means to them. Some examples might include:
   - Bugs and Bogs: Show the variety of life—cattails, frogs, turtles, insects and fish—in a nearby pond or river, or use species from around the world.
   - Time for Lunch: Highlight the variety of food people enjoy, including vegetables, grains, fish, spices, etc. Prompt students to consider where it all comes from (different plants and animals around the world).
   - In the Garden: Cultivating a diversity of native plants also supports biodiversity by providing food and habitat for native species. Along lakes and rivers, plants help maintain water quality by filtering nutrients and sediments.
   - Get Involved: Describe a stewardship activity to clean up parks, collect recyclables, or use environmentally friendly household products. Each of these activities contributes to a high quality natural environment that supports biodiversity.

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3. After students have completed their posters and booklets, ask for volunteers to present them to the class, explaining what illustrations and/or photos they used and why they chose them.

Adaptations

- *A Fishy Tale:* Have students conduct supplemental research and tell the story of a native Great Lakes fish species that has been significantly affected over time. When did the species live? Is it still living? What factors have affected the population? Use words and pictures to tell the story. Examples include: lake trout, lake sturgeon, walleye, yellow perch, grayling, and blue pike.
- *For older students:* Construct a poster or short narrative that focuses on some of the threats to biodiversity. Examples of threats include invasive species, pollution, and loss of habitat (often due to unplanned urban development). Students might focus their project on preventing the spread of invasive species, or protecting water quality by reducing pollution, especially runoff from things like lawn fertilizers and household chemicals.

Source

Developed by Elizabeth LaPorte, Anna Switzer and Joyce Daniels, Michigan Sea Grant.

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Assessment

This assessment chart was designed for teachers to create their own assessment. The recommended points show the relative difficulty of student performance. In creating assessments, the total point value will depend on the number and type of performances selected.

Learning Objective	Student Performance	Recmnd # Points
Explain what is meant by biodiversity and why it's important	**Express** biodiversity as a two-part word and define each part	3 total
	Name the three levels of biodiversity that are important	1 each
	Explain why having a biologically diverse planet is important	3 pts.
Describe some of the benefits of having a diverse population of plants and animals	**Give reasons** to support the idea that within one ecosystem, having many plants and animals is beneficial to that ecosystem	3 pts. per valid reason
Describe some of the major threats to Great Lakes biodiversity	**List** the three main threats to GL biodiversity	1 each
	List the three main threats to GL biodiversity	1 each
	Choose one of the threats to biodiversity and explain how that threat could be reduced.	3 pts.

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Standards

State of Michigan

Science			Social Studies	
Elementary		Middle	Elementary	Middle
I.1.2 I.1.5 II.1.2	II.1.4 III.5.2 III.5.5	I.1.5 II.1.3 III.5.1	II.2.1 II.4.5 IV.1.3	II.2.4 II.5.3 V.1.2 V.1.3

National

NSES		AAAS	
Elementary	Middle	Elementary	Middle
C3.2	C4.1 C4-4	n/a	n/a
NAAEE		**NCSS**	
Elementary	Middle	Elementary	Middle
1.A 1.C 2.4.E 3.A 3.2.B	1.A 2.4.E 3.A 3.2.B	III.k IX.d	III.k IX.d

Notes:
NSES = National Science Education Standards
AAAS = American Association for the Advancement of Science (Benchmarks)
NAAEE = North American Association of Environmental Education (Guidelines for Excellence)
NCSS = National Council for the Social Studies (Standards)

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Lesson 4: Fish Habitat

Photo 1: D. Brenner, Photo 2: E. LaPorte

Activity: Students listen to an online interview with a fisheries researcher who studies Great Lakes fish and their habitats. Students will use a KWL chart to review what they know, what they want to know, and what they've learned.

Grade level: 4-8
Subjects: Science, social studies
Setting: Classroom
Duration:
Key terms: Habitat, Restoration

Objectives

Following this lesson, students will be able to:

- Identify some of the features that contribute to healthy fish **habitat**.
- List several fish species and the types of habitat they require.
- Describe some of the factors that impact fish habitat and affect fish populations.

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 fish habitat and some of the changes that have taken place over time, including pollution, invasive species, and urban development.

Background

Like people, fish must meet certain basic needs for survival, as described in lesson 1.4. Food, water and shelter are among the most important requirements:

- **Food:** Fish must be able to find enough to eat at various life stages, whether they feed on microorganisms, small fish or larger prey.

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- **Water:** Water composition can vary greatly from one location to another. Variables include water temperature, depth, speed of water flow, amount of oxygen, and degree of clarity.
- **Shelter:** At various stages in their lives, fish need a place to hide from predators and to reproduce. Some fish can be found on rocky lake or river bottoms, while others prefer weedy shorelines. Many fish need special habitat conditions to spawn such as coastal wetlands, sheltered bays, or rivers and streams.

Many factors have impacted or altered fish habitat and affected native fish populations. Some examples include:

- **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.
- **Coastal Development:** Increasing development in coastal areas threatens fish habitat, especially for species that depend on coastal wetlands for critical life stages. Dams and other obstacles can prevent some fish from migrating upstream to reach spawning habitat.
- **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:
    a. **Lake Trout:** Management agencies maintain a lake trout stocking program and work to control the invasive sea lamprey, which preys heavily on lake trout and other native fish.
    b. **Lake Sturgeon:** Several groups teamed up to construct new spawning reefs for lake sturgeon in the Detroit River to increase population of this primitive species.
    c. **Walleye:** The Fisheries Division of the Michigan Department of Natural Resources has developed a walleye recovery for Saginaw Bay to increase population to historic levels.
    d. **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

- Classroom computer with Internet access.
- *K-W-L chart* (one per student). Download or have students create their own.

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Downloads (Materials)

See **Downloads** at the end of this unit for the following materials:
K-W-L chart and *transcript of audio interview*.

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.) How might these characteristics vary? (Water can be clear, turbid, cold, warm, fast moving, etc.) What types of activities harm fish habitat? (Pollution, invasive species, destruction of wetlands, urban development, etc.)
2. Ask the students about their own fishing experiences. Have they or their parents ever caught a fish? What was the habitat like? (Answers might include: sunfish caught in a pond or inland lake; brook trout caught in clear, fast-moving river; salmon caught on open waters of the Great Lakes; yellow perch caught in a coastal wetland; largemouth bass caught in a weedy area of an inland lake.)
3. Download or have students create simple KWL charts. In the first chart column, instruct students to write 5 facts about fish habitat that they **Know** already.
4. In the second chart column, instruct students to write 5 questions about fish habitat that they **Want** to know.
5. Tell the students they're now going to hear a Great Lakes fisheries scientist talk about his research related to fish and their habitats. While listening to the audio clip (or reading the printed transcript), instruct students to write 5 facts that they've **Learned** about fish habitat, in the third chart column. To play the audio clip, access the Project FLOW Web site on the classroom computer. Note: Windows Media Player must be installed. The software is free.
6. Discuss the results. What new information did students learn about fish habitat? How many different responses were there? What was the most interesting aspect of the scientist's work related to fish and their habitats?

Source

Developed by Anna Switzer and Joyce Daniels, Michigan Sea Grant.

K-W-L Teaching Technique

K = KNOW already W = WANT to know L = LEARNED

This is a technique used to engage students in the learning cycle. First, it gives students a forum to express what they already know on a topic as well as what they would like to know before that topic is addressed in class. After the topic has been explored, students can express what they've learned. Using the K-W-L technique, teachers and students can easily see what is accomplished in class. It can be used on smaller scales, such as here at the topic level, or larger scales, with an entire curriculum or subject of study.

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Assessment

This assessment chart was designed for teachers to create their own assessment. The recommended points show the relative difficulty of student performance. In creating assessments, the total point value depends on the number and type of performances selected.

Learning Objective	Student Performance	Recmnd # Points
Identify some of the variables that comprise Great Lakes fish habitats	**Name** some of the general characteristics that might influence the suitability of a habitat (e.g. temperature, food source, etc.)	1 each
	For each general characteristic **explain** its significance to providing good habitat	2 each
List several fish species and the types of habitat they require	**Name** some of the fish species that were discussed in the interviews	1 each
	Explain for each fish, the specific characteristics it requires in its habitat (e.g. cold water, plant growth, etc.)	2 each
	Compare and **contrast** the habitat requirements for the different fish discussed in the interviews	3 pts.
Describe some of the factors that have changed fish habitat	**Describe** how some fish habitat characteristics have been altered over time	2 each
	Explain the positive and negative aspects of these changes	3 pts.

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Standards

State of Michigan

Science			Social Studies	
Elementary		Middle	Elementary	Middle
II.1.4 II.1.5 III.2.4	III.4.2 III.5.3 III.5.5	II.1.3 II.1.5 II.5.6	II.2.1 II.2.3 II.4.5	II.2.4

National

NSES				AAAS	
Elementary		Middle		Elementary	Middle
C1.1 C3.2 C3.4 E1.4	F4.1 F4.2 G1.3 G1.4	A1.4 C4.1 C4.4 E1.2	E1.3 F5.5 G1.1 G2.1	1B.1 1C.3 5D.1 5D.4	1B.1 1C.1 1C.4 3A.2 5D.1

NAAEE		NCSS	
Elementary	Middle	Elementary	Middle
2.2-A 2.2-C	2.2-A	III.h III.i VIII.b IX.d	III.i IX.d

Notes:
NSES = National Science Education Standards
AAAS = American Association for the Advancement of Science (Benchmarks)
NAAEE = North American Association of Environmental Education (Guidelines for Excellence)
NCSS = National Council for the Social Studies (Standards)

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K-W-L (KNOW, WANT TO KNOW, LEARNED SHEET)

Unit 3, Lesson 4

www.miseagrant.umich.edu/flow

K KNOW ALREADY	W WANT TO KNOW	L LEARNED
		Researcher: Fish studied: Cool fact: Habtitat: Threats to habitat: What's Being Done (ie, restoration):

WRITTEN TRANSCRIPT OF ED RUTHERFORD AUDIO INTERVIEW

Fish (Unit 3, Lesson 4)

Name and title:

My name's Ed Rutherford. I'm a research scientist at the University of Michigan. I work with the Michigan Department of Natural Resources, Fisheries Division here at the Institute for Fisheries Research.

What fish do you study?

I study a lot of fishes that use the rivers entering the Great Lakes for spawning and growing up and then migrate out to the Great Lakes to spend their adult lives.

The fish I work on is Chinook salmon, and this fish is not native to the Great Lakes. It was introduced to the Great Lakes in the 1960s, and it's important for a number of reasons. One is that it's the basis for the sport fishery in the Great Lakes. So it grows to a big size, people love to catch it, and in the process they spend lots of money trying to catch it, so it supports Michigan's economy.

The other reason it's really important is an ecological reason. The Chinook salmon was introduced to eat and control another non-native species, the alewife, which got into the Great Lakes in the 1940s and out-competed the native fishes for food. The Michigan Department of Natural Resources in the 1960s brought the salmon in to try and eat and knock down the alewife to low levels, so that the other fishes would be able to survive. And that actually worked. It was a real-life experiment that worked.

Chinook salmon now are at the top of the food chain in the open waters of the Great Lakes, so they serve both an important ecological role and also an important economic role.

What kind of habitat do Chinook salmon need?

They need good quality habitat in both the rivers and Great Lakes themselves. In the rivers, they need cold, clean water with lots of oxygen in it that is flowing pretty fast. They like to spawn in shallow areas that have gravel and cobble on the bottom. They also need sides of rivers. After they first hatch out of their nest, they migrate to the side of the river to feed, so they need wood in the stream to use as shelter—so big logs or brush that has fallen down is really important to help young fish survive.

And then, later as they grow up and start to move out toward the Great Lakes, they need cold, clean water in the Great Lakes and plenty of food to be able to grow.

What are some of the threats to Chinook habitat?

There are a couple of things that are really serious threats. One is construction of dams or dam operations. That's a threat because dams can constrict the amount of habitat that they [Chinook] have available to them. And then dams tend to heat up water, which makes it too hot for salmon to live in when they're young. Because the water heats up, the oxygen content drops. And then some operators hold the water back and release it a couple of times during the day to make it more efficient to run their turbines. But that has the effect of eroding the substrate and the sediment that's in the river, which then gets the silt and sand off the river banks and ends up covering salmon nests and suffocating them and ruining their habitat.

Another big problem or threat to their habitat is invasive species that come in and out-compete some of the native species and change the food web. So an example would be zebra mussels, which have gotten into the rivers where salmon first hatch out and grow up. And zebra mussels have changed the source of food for the salmon, and we found that some of their growth and survival has gone down since zebra mussels have entered the rivers.

How does your research address these problems?

What I'm doing is trying to figure out, first of all, how the fish use their habitat. What are their critical habitat needs? Where in these rivers do they first spawn, hatch out and grow up?

And then I work with hydrologists and land planners to understand how development affects the amount of sand and silt that goes into the rivers, and also affects the water quality. I'm working with modelers to try and make plans for a whole watershed in terms of what's the best… If you wanted to protect the habitat for fish like salmon or sturgeon, what's the best option for developing the watershed, or for building homes or having farms?

Similarly, I'm studying the food webs out in the Great Lakes to see how invasive species have changed the food webs and how that might have affected survival and growth of salmon.

COPY MASTER

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

Photo 2: D. Jude, Photos 3, 4: D. Brenner

Objectives

Following this lesson, students will be able to:

- Name at least 5 careers in marine and aquatic science, including both the oceans and Great Lakes.
- Identify several recent contributions 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

"As a child, I became fascinated with the ocean while visiting the New Jersey shore with my family," says marine ecologist Deborah McArdle. 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!

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McArdle is one of more than 50 people profiled on web pages created by WHOI and NH Sea Grant programs (see: www.marinecareers.net) 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: www.marinecareers.net. 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.

1. Extension Educator
   http://www.miseagrant.umich.edu/about/staff/stewart.html
2. Aquatic Ecologist and Artist
   http://www.miseagrant.umich.edu/pubs/up/oct04/art1.html
3. Business Owner
   http://www.msfishcompany.com/our_story.shtml
4. Marine Policy 1
   http://www.miseagrant.umich.edu/pubs/up/win02/cimo.html
5. Marine Policy 2
   http://www.miseagrant.umich.edu/pubs/up/spring99/knauss.html

Procedure

1. Begin by introducing the topic of marine and aquatic science careers. Point out that for each of the prior lessons in Project 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

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for each student to figure out whose name is on his or her own back, 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.

Source
Developed by Anna Switzer and Joyce Daniels, Michigan Sea Grant

Extension

If students have Internet access, have them spend 15 minutes reviewing a variety of the profiles on www.marinecareers.net 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.

For Additional Career Information: www.marinecareers.net

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Assessment

This assessment chart was designed for teachers to create their own assessment. The recommended points show the relative difficulty of student performance. In creating assessments, the total point value will depend on the number and type of performances selected.

Learning Objective	Student Performance	Recmnd # Points
Name at least five careers in marine and aquatic science, including both the oceans and the Great Lakes	Name two or three careers which are specific to the oceans	1 each
	Name two or three careers which are specific to the Great Lakes region	1 each
Identify several contributions people have made in marine and aquatic science fields	Describe the position of one or more marine/aquatic scientists and explain the benefits to the world (physical, animal, or human) of that position	3 each
Describe a marine or Great Lakes science career that interests them	Describe the career that most interests you of the ones that were explored in class or on the web.	2 each
	Explain what aspects of that career seem interesting.	2 pts.
	Explain how science (which aspect/ discipline) plays a role in that career.	2 pts.

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Standards

State of Michigan

Science		Social Studies	
Elementary	Middle	Elementary	Middle
II.1.3 II.1.5	II.1.3 II.1.5	n/a	n/a

National

NSES				AAAS	
Elementary		Middle		Elementary	Middle
E1.3 E1.4 E1.5	F5.1 G1.2 G1.4	E1.2 E1.3 F5.2 F5.4	F5.5 G1.1 G1.2 G3.1	1C.1 1C.3	1C.1 1C.3

NAAEE		NCSS	
Elementary	Middle	Elementary	Middle
n/a	n/a	VIII.b	n/a

Notes:
NSES = National Science Education Standards
AAAS = American Association for the Advancement of Science (Benchmarks)
NAAEE = North American Association of Environmental Education (Guidelines for Excellence)
NCSS = National Council for the Social Studies (Standards)

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Fish Glossary / Key Terms

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

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: Divided or dividing into two parts.

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

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

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

Ichthyologist: Scientist who studies fish.

Key: (Biol) A systematic classification of the significant characteristics of the members of a group of organisms to facilitate identification and comparison.

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.

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

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