**SUMMARY**

Students learn about food chains and food webs in the context of their local community. After discussing the different aspects of a food web, students model the food web of a Highland Park ravine and learn how the food web changes following a disruption.

**OBJECTIVES**

Students are able to:
1. Explain how energy and matter move through a food web;
2. Describe how a change in one section of a food web affects the rest of the web; and
3. Identify examples of producers, consumers, and decomposers in a ravine ecosystem.

**BACKGROUND**

Energy and matter naturally cycle through the **biotic** (living) and **abiotic** (non-living) parts of every ecosystem; this cycle is called a **food web**. Food webs can be divided into simple individual **food chains**, like the chain below. This example demonstrates four different feeding levels, also known as **trophic levels**, in the food chain.

```
DAMSELY
FROG
SNAKE
HAWK
```

Laminate Food Web cards for future reuse.
In nature, many food chains fit together to create a complex food web. **Producers** (plants) use the energy and nutrients from sunlight and soil to create their own food. **Primary consumers** (also called herbivores) eat these plants (or particles of organic matter or detritus).

**Secondary consumers** (carnivores – flesh eaters) eat the primary consumers, or other secondary consumers. Some secondary consumers are omnivores, so they eat both producers and consumers. **Decomposers** break down dead plant and animal matter.

The chart above illustrates a simple food web. Food webs are important because plants and animals cannot create (or destroy) extra energy. They can only change energy from one form to another.

Every ecosystem has its own unique set of producers, primary consumers, secondary consumers, and decomposers. Below is a list of energy sources, organisms and groups of organisms that may inhabit ravines in Highland Park.

Using this list and the procedure below, students will create a food web exclusive to this ecosystem.

**PREPARATION**

There are two sets of Food Web Cards for this lesson. **Set A** includes the basic categories of a food web. **Set B** includes organisms that have been observed in the ravine ecosystems.

Select a set to print for this activity. Be sure to print cards double-sided.

Print enough cards so that each student receives one. If you print duplicate cards, be sure there is only one sunlight card per group.

Punch holes in the top left and right corners of the cards. Weave a piece of yarn through the holes in each card to make a necklace.

**Note:** Illustrations on food web cards are not to scale.

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Producers</th>
<th>Primary Consumers (herbivores)</th>
<th>Secondary Consumers (omnivores and carnivores)</th>
<th>Decomposers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunlight</td>
<td>Leaf litter</td>
<td>Zooplankton (scuds, daphnia, copepods)</td>
<td>Water strider, Dragonfly, Water strider, Rainbow trout, Lake chub, Longnose dace, White sucker, Mosquito, Great blue heron</td>
<td></td>
</tr>
<tr>
<td>Organic matter</td>
<td>Phytoplankton</td>
<td>Bloodworm/Midge Mayfly Riffle beetle</td>
<td>Broadwing damselfly, Rainbow trout, Lake chub, Longnose dace, White sucker, Mosquito, Great blue heron</td>
<td></td>
</tr>
<tr>
<td>(suspended in water)</td>
<td>Algae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blue-green algae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(cyanobacteria)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**PROCEDURE**

**INTRODUCTION**

1. Ask students:
   - What do they know about food chains? [who eats who, energy transfer from one organism to another]
   - What are the levels of a food chain called? [trophic levels]
   - What do we call an animal that eats another animal? [predator]
   - What do we call an animal that is eaten? [prey]
   - How does a plant get its food? [they create their own food through photosynthesis]

2. As a class, define the following science words, and ask students for examples of these:
   - **Producer**: an organism that creates its own food
   - **Consumer**: an organism that eats other living things
   - **Carnivore**: an organism that eats animals (secondary consumer)
   - **Omnivore**: an organism that eats both plants and animals (secondary consumer)
   - **Herbivore**: an organism that eats only plants/ producers (primary consumer)
   - **Decomposer**: an organism that eats dead things and breaks them down into nutrients

3. Introduce the idea of a food web, where each living organism links to several food chains. Explain that while food chains may appear simple, in nature the transfer of energy between organisms is more complicated. Each plant or animal eats or is eaten by several others.

4. Define **food web**: many food chains linked together.

5. Give each student a Food Web Card. After they receive a card, they “become” that organism or ecosystem component. They may be biotic or abiotic.

6. Sit or stand in a circle (or multiple circles based on groups if using Set A).

7. Instruct students to hold their cards facing outward and visible to the group. Hand the ball of yarn to the students with the Sunlight Card.

8. Direct students to hold onto the yarn with one hand and toss the ball of yarn to whomever they think is the next step of the food web. For example, the student with the sunlight card should pass the yarn to a producer, showing the transfer of energy between them. If the group disagrees with their selection then the person should try again. Students should not toss the ball of yarn to the same person every time.
9. After five minutes, ask student to count how many other organisms they are connected to (i.e., their food web connections). Some students may not receive the ball of yarn.

10. Ask a student to roll up the yarn, hand it to the student with The Sun, and start again. After a couple minutes, remove a primary consumer from the food web by asking him or her to step out of the circle. Before they step out have them tug on their part of the yarn. Anyone else who feels the tug should step out as well.

11. Explain that this is an exaggerated model of the ripple effect of changes made to an ecosystem. Changes in the food web could be caused by numerous factors, including changes in weather or climate, disease, pollution, overharvesting by people, and introduction of exotic species.

12. Repeat Step 9.

13. The person with the Decomposer Card should wrap up the yarn. The class can return inside.

DISCUSSION

14. Have a representative from each group explain the yarn’s journey through their food web.

15. Consider the following questions as a class:
   - How did the web differ after one person stepped out of the group? Was the food web more or less complicated?
   - Is it healthier to have a complicated or a simple food web? [Complicated food webs are stronger]
   - If using Set B of the Food Web Cards, ask students if they thought their food webs included every species in their ecosystem? [No, because land plants and animals, as well as species that live only in Lake Michigan, are not included]
   - What are some of the limitations of this model?
   - How might matter or energy leave the ravine ecosystem?

PRESENTING FOOD WEBS

Students create a short skit or multimedia presentation that reenacts an aquatic food web. The story should include producers, primary consumers (herbivores), secondary consumers (carnivores and omnivores), and decomposers.

Students should include a situation where their food web goes out of balance. Encourage students to be creative and have fun with this activity!

VOCABULARY QUIZ

Quiz students on the meaning and spelling of vocabulary words.

EXENSIONS

TROPHIC PYRAMIDS (Grades 6-8)

Explore an alternative visualization of a food web: the trophic pyramid.

After the definitions are written, encourage students to draw examples on each card. Students should label the drawings and list the plants and animals that eat or are eaten by this organism.
TERRESTRIAL FOOD WEBS

Encourage students to create a terrestrial food web which occurs on land. Compare the similarities and differences between the aquatic and terrestrial food webs.

To learn more, visit:

**Food Chain Game** (4th and 5th grade)
www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm

**Food Web** (6-8th grade) – when all arrows are clicked into place the activity is completed.
http://teacher.scholastic.com/activities/explorer/ecosystems/be_an_explorer/map/foodweb_play.htm

RESOURCES

**Fisheries Learning on the Web** (FLOW): Food Web
This set of five lesson plans explores food chains and food webs of a freshwater ecosystem, and the impacts of invasive species on these food webs. www.miseagrant.umich.edu/flow/unit1.html


**Diana, J. S. 1995. Biology and ecology of fishes. BIOLOGICAL SCIENCES PRESS, CARMEL, IN(USA).**

Diet and predation information was gathered from the following sources: (accessed April, 2013)
- Water strider life history: https://insects.tamu.edu/fieldguide/aimg41.html
- Dragonfly life history: https://insects.tamu.edu/fieldguide/aimg5.html
- Broad-winged damselfly life history: https://insects.tamu.edu/fieldguide/aimg7.html
- Rainbow trout life history: http://animaldiversity.ummz.umich.edu/accounts/Oncorhynchus_mykiss/
- Longnose dace life history: http://animaldiversity.ummz.umich.edu/accounts/Rhinichthys_cataractae/
- Great blue heron life history: http://animaldiversity.ummz.umich.edu/accounts/Ardea_herodias/
- Midge life history: http://animaldiversity.ummz.umich.edu/accounts/Chironomidae/
- Mayfly life history: https://insects.tamu.edu/fieldguide/aimg3.html
- Riffle beetle: http://animaldiversity.ummz.umich.edu/accounts/Elmidae/
- Mosquito: https://insects.tamu.edu/fieldguide/bimg220.html

STANDARDS

**SCIENCE (NGSS)**
- 4-LS1-1, 5-PS3-1, 5-LS1-1, 5-LS2-1, 5-ESS2-1, MS-LS1-4, MS-LS1-5, MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-ESS2-1

**ENGLISH LANGUAGE ARTS (CCSS)**
- CCRA.W.3, RST.6-8.4, WHST.6-8.2d
Sunlight

Organic Matter

Producer

Primary Consumer

Secondary Consumer

Decomposer
### A Ravine’s Web of Life

**FOOD WEB CARDS: SET A (Back)**

<table>
<thead>
<tr>
<th>Entity</th>
<th>Energy and Matter Source(s)</th>
<th>Energy and Matter Flow(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organic Matter</strong></td>
<td>- Decomposers</td>
<td>- Producers</td>
</tr>
<tr>
<td><strong>Sunlight</strong></td>
<td>- Self-produced</td>
<td>- Producers</td>
</tr>
<tr>
<td><strong>Primary Consumer</strong></td>
<td>- Producers</td>
<td>- Secondary consumers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Sunlight, Organic matter</td>
</tr>
<tr>
<td><strong>Producer</strong></td>
<td>- Self-produced</td>
<td>- Primary consumers, Secondary consumers, Decomposers</td>
</tr>
<tr>
<td><strong>Decomposer</strong></td>
<td>- Producers, Primary consumers, Secondary consumers</td>
<td>- Organic matter</td>
</tr>
<tr>
<td><strong>Secondary Consumer</strong></td>
<td>- Producers, Primary consumers</td>
<td>- Decomposers, Other secondary consumers</td>
</tr>
</tbody>
</table>
A Ravine’s Web of Life
FOOD WEB CARDS: SET B (Front)

Sunlight
Energy Source

Organic Matter
Energy Source

Algae and Phytoplankton
Producer

Leaf Litter
Producer

Zooplankton
(Scuds, Daphnia, Copepods)
Primary Consumer

Bloodworm
(Larva)
Primary Consumer

Midge
(Adult)
### Food Web Cards: Set B (Back)

<table>
<thead>
<tr>
<th><strong>Organic Matter</strong></th>
<th><strong>Sunlight</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>I get my energy and matter from:</td>
<td>My energy and matter flows to:</td>
</tr>
<tr>
<td>- Dead plants and animals</td>
<td>- Zooplankton</td>
</tr>
<tr>
<td></td>
<td>- Bloodworms</td>
</tr>
<tr>
<td></td>
<td>- Mayfly nymphs</td>
</tr>
<tr>
<td></td>
<td>- Riffle beetles</td>
</tr>
<tr>
<td></td>
<td>- Mosquito larvae</td>
</tr>
<tr>
<td></td>
<td>- White suckers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Leaf Litter</strong></th>
<th><strong>Algae and Phytoplankton</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>I get my energy and matter from:</td>
<td>My energy and matter flows to:</td>
</tr>
<tr>
<td>- Producers</td>
<td>- Sunlight (and nutrients)</td>
</tr>
<tr>
<td></td>
<td>- Zooplankton</td>
</tr>
<tr>
<td></td>
<td>- Mayfly nymph</td>
</tr>
<tr>
<td></td>
<td>- Riffle beetle</td>
</tr>
<tr>
<td></td>
<td>- Rainbow trout</td>
</tr>
<tr>
<td></td>
<td>- Longnose dace</td>
</tr>
<tr>
<td></td>
<td>- White sucker</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Bloodworm</strong></th>
<th><strong>Zooplankton</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>I get my energy and matter from eating:</td>
<td>My energy and matter flows to:</td>
</tr>
<tr>
<td>- Leaf litter</td>
<td>- Rainbow trout</td>
</tr>
<tr>
<td>- Organic matter</td>
<td>- Lake chub</td>
</tr>
<tr>
<td></td>
<td>- White sucker</td>
</tr>
<tr>
<td></td>
<td>- Phytoplankton</td>
</tr>
<tr>
<td></td>
<td>- Leaf litter</td>
</tr>
<tr>
<td></td>
<td>- Organic matter</td>
</tr>
</tbody>
</table>

**Organic Matter**: I get my energy and matter from: Dead plants and animals
My energy and matter flows to:
- Zooplankton
- Bloodworms
- Mayfly nymphs
- Riffle beetles
- Mosquito larvae
- White suckers

**Sunlight**: I get my energy and matter from:
- Self-produced
My energy and matter flows to:
- Plants
- Phytoplankton
- Algae

**Leaf Litter**: I get my energy and matter from:
- Producers
My energy and matter flows to:
- Secondary consumers
- Decomposers

**Algae and Phytoplankton**: I get my energy and matter from:
- Sunlight (and nutrients)
My energy and matter flows to:
- Zooplankton
- Mayfly nymph
- Riffle beetle
- Rainbow trout
- Longnose dace
- White sucker
- Mosquito larvae

**Bloodworm**: I get my energy and matter from eating:
- Leaf litter
- Organic matter
My energy and matter flows to:
- Mayfly nymph
- Water strider
- Dragonfly nymph
- Broad-winged damselfly
- Rainbow trout
- Lake chub
- Longnose dace
- White sucker

**Zooplankton**: I get my energy and matter from eating:
- Phytoplankton
- Leaf litter
- Organic matter
My energy and matter flows to:
- Rainbow trout
- Lake chub
- White sucker
A Ravine’s Web of Life
FOOD WEB CARDS: SET B (Front)

Mayfly (Nymph)
Primary Consumer

Riffle Beetle (Larva)
Primary Consumer

Mosquito (Larva)
Secondary Consumer

Water Strider
Secondary Consumer

Dragonfly (Nymph)
Secondary Consumer

Broad-winged Damselfly (Nymph)
Secondary Consumer
A Ravine’s Web of Life
FOOD WEB CARDS: SET B (Back)

**Riffle Beetle Larva**
I get my energy and matter from eating:
- Leaf litter
- Organic matter
- Algae

My energy and matter flows to:
- Small Fish (like Longnose dace or Lake chub)

**Mayfly Nymph**
I get my energy and matter from eating:
- Algae
- Organic matter

My energy and matter flows to:
- Water strider
- Dragonfly nymph
- Broad-winged Damselfly nymph
- Lake chub
- Rainbow trout

**Water Strider**
I get my energy and matter from eating:
- Insects (which may include Midge, Mosquito, Mayfly, Dragonfly, and Broad-winged damselfly)

My energy and matter flows to:
- Rainbow trout
- Lake chub

**Mosquito Larva**
I get my energy and matter from eating:
- Bacteria
- Organic matter
- Phytoplankton

My energy and matter flows to:
- Water strider
- Dragonfly
- Broad-winged Damselfly
- Mosquito
- Lake chub
- Rainbow trout

**Broad-winged Damselfly Nymph**
I get my energy and matter from eating:
- Mosquitoes
- Midges
- Other aquatic insects (which may include Mayfly nymphs)

My energy and matter flows to:
- Rainbow trout
- Lake chub
- White sucker
- Great Blue Heron

**Dragonfly Nymph**
I get my energy and matter from eating:
- Mosquitoes
- Midges
- Other aquatic insects (which may include Mayfly nymphs)

My energy and matter flows to:
- Rainbow trout
- Lake chub
- White sucker
- Great Blue Heron
A Ravine’s Web of Life

FOOD WEB CARDS: SET B (Front)

- Rainbow Trout
  Secondary Consumer

- Lake Chub
  Secondary Consumer

- Longnose Dace
  Secondary Consumer

- White Sucker
  Secondary Consumer

- Great Blue Heron
  Secondary Consumer

- Bacteria
  Decomposer
### A Ravine’s Web of Life

**LESSON MATERIALS**  
**FOOD WEB CARDS: SET B (Back)**

<table>
<thead>
<tr>
<th>Species</th>
<th>I get my energy and matter from eating:</th>
<th>My energy and matter flows to:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lake Chub</strong></td>
<td>- Zooplankton</td>
<td>- Rainbow trout</td>
</tr>
<tr>
<td></td>
<td>- Aquatic insects (may include Mayfly nymph, Dragonfly, Midge, Damsel fly)</td>
<td>- Longnose dace (consumes eggs)</td>
</tr>
<tr>
<td></td>
<td>- Smaller fish (may include Longnose dace)</td>
<td></td>
</tr>
</tbody>
</table>

**Rainbow Trout**

- My energy and matter flows to:
  - Algae
  - Zooplankton
  - Insect larvae (may include Midge, Mayfly nymphs, Dragonfly nymphs, Damsel fly nymphs, Riffle beetle, Mosquito larvae, and Water strider)
  - White sucker eggs
  - Smaller fish (may include Longnose dace and Lake chub)

**White Sucker**

- I get my energy and matter from eating:
  - Organic matter
  - Algae
  - Phytoplankton
  - Zooplankton
  - Aquatic insects (may include Midge, Mosquito, Dragonfly nymph, and Damselfly nymph)

- My energy and matter flows to:
  - Great Blue Heron (consumes juveniles)
  - Rainbow trout (consumes eggs)

**Longnose Dace**

- My energy and matter flows to:
  - Rainbow trout
  - Lake chub

**Bacteria**

- I get my energy and matter from:
  - All dead plants and animals

- My energy and matter flows to:
  - Organic matter

**Great Blue Heron**

- My energy and matter flows to:
  - Gulls (consume eggs)
SUMMARY
As a class, students create a habitat model and explore the concept of carrying capacity as it relates to the number of habitat components available in an ecosystem.

OBJECTIVES
Students are able to:
1. Create a habitat model that reflects changes over time;
2. Construct an argument that changes to a species’ habitat affects the population of that species; and
3. Create a species of fish that would camouflage in a local stream.

BACKGROUND
This activity models a habitat, an organism’s home where it can find the four essential components for survival: food, water, shelter, and space (or territory). Every habitat has a carrying capacity, which is the balance between the availability of habitat components and the number of organisms that habitat can support. Carry capacity determines the maximum population (number of organisms of the same species) that a habitat can support.
In addition to the accessibility of food, water, shelter and space, there are limiting factors that prevent a population from exceeding carrying capacity. Disease, predator and prey relationships, variable weather (e.g., early freezing, heavy snows, flooding, drought), pollution, and habitat destruction are among these factors. When there are many of these limiting factors in a habitat the population can be threatened, endangered, and even eliminated.

Key points for this activity:
- Wildlife need quality habitat in order to survive and succeed.
- Populations will grow unless there are limiting factors.
- Even with limiting factors, fluctuations occur.

Wildlife populations continuously change in response to limiting factors and the availability components.

The above information and procedure steps three through eleven of this lesson were adapted from “Oh Deer!,” a popular lesson from the curriculum guide Project Wild. To view the lesson plan for “Oh Deer!” visit: www.projectwild.org/documents/ohdeer.pdf.

**PREPARATION**

For “Go Fish,” find a flat space at least 20’x40,’ either indoors or outdoors. To minimize risk of injury, use a gymnasium or a grassy area outside. Clearly mark two parallel lines about 40 feet apart and large enough for the whole class to stand on.

**PROCEDURE**

INVESTIGATE: WHAT IS A HABITAT?

1. Ask students: What is a habitat? [Natural environment in which an organism lives]
   Brainstorm the major parts of a habitat with students. [food, water, shelter, space]

2. Compare habitats of different animals. What are the habitat needs for humans? Do all animals have the same habitat needs? What about animals that live under water? [some aquatic animals need fast-moving water, other need calm, slow water]

GO FISH! 🐟🐟🐟

3. Explain to students that in this game they will create a model of a fish habitat. It represents any fish that lives in the Great Lakes or another freshwater system.

4. All students should line up on one of the lines while the instructor explains the game. Students number off in fives. All the ones stand between the two lines, while everyone else remains on the line. Ones are the fish, and the rest of the students are fish habitat components. Twos are food, threes are water, fours are shelter, and fives are space.

5. Explain that in each round, habitat components will run from one line to the other. The fish will try to tag one person, depending on what they are looking for.

6. Students will use hand signals to communicate what habitat component they represent or need. Explain the hand signals:
   - Food: rub stomach
   - Water: hold hands in cup shape
   - Shelter: make triangle over head with arms
   - Space: stretch arms straight out
   - Fish: make a fishy face

7. The first round begins with fish turning away from the other students and picking their choice of signs. When the instructor says “Go Fish!” the fish turn around and try to catch one of their matching components before they reach the other line.

8. If a fish catches what they need, they “multiply” – the person they tag becomes a fish as well. If a fish does not catch what they need, they go “belly up” and join the other habitat components.
9. Select a student or a group of students to graph each round’s the fish population changes. X axis should read “Year,” and Y axis should read “Number of fish.” Plot the number of fish before each round.

10. Play 10-15 rounds, each representing one year, and ask students to observe how the fish population changes.

11. To simulate predation from other animals including humans, remove several habitat components from the game for 3-4 rounds, or until the fish population drops noticeably.

DISCUSSION & ASSESSMENT

12. At the end of the activity, ask students what happened to the population of fish as the years went on. Did it change, or did it remain constant? Refer to the chart to help students visualize these changes.

13. Introduce the idea of carrying capacity, where a habitat can only support a certain number of species, because of limiting factors.

14. Discuss the following questions:
   • What factors limited the population of fish?
   • How and why did these factors limit the number of fish in the habitat?
   • How is this model realistic and unrealistic?
   • What are some other limiting factors in a habitat?
   • Think about the factors humans can help control. If we wanted to increase a habitat’s carrying capacity for a certain species, what actions might we take?

EXTENSIONS

STEALTHY FISH

Ask students what characteristics freshwater stream fish have that allow them to hide more easily. Are they colorful? [not really]

Visit the www.pdhp.org/hpravines and show students pictures of the ravines.

Provide students with water colors, colored pencils, or markers, and ask them to color the fish in a way that they would easily camouflage in the Highland Park ravine streams.

Explain that some fish (such as Rainbow trout) can change colors depending on the coloring of their habitat and the clarity of the water. Also, trout change as they grow and enter new life stages. Young trout (parr) have distinct dark marks on their sides.

RESEARCH PROJECT

Study the habitat requirements of a local plant or animal species. How does that animal or plant obtain food, water, shelter and space? How do humans impact this species’ ability to meet these needs? Write a one page paper in response to these questions.

RESOURCES

NATIONAL GEOGRAPHIC’S GEOGRAPHY ACTION: HABITAT HOME SWEET HOME

This page offers a variety of lesson plans related to habitats around the world, as well as the relationship between humans and natural habitats. www.nationalgeographic.com/geography-action/habitats.html

SOURCES


STANDARDS

SCIENCE (NGSS)

4-LS1-1, 4-LS1-2, 5-LS2-1, MS-LS1-4, MS-LS1-5, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-ESS2-1

ENGLISH LANGUAGE ARTS (CCSS)

RST.6-8.4, WHST.6-8.2d
Go Fish: Stealthy Fish

NAME:

DIRECTIONS
Using the images provided by your instructor, color or paint this fish with colors that would help it camouflage in its habitat.
TIME: 35-40 minutes

GRADES: 4-8

LOCATION: Indoors or outdoors

KEYWORDS: Operculum, lateral line, dorsal fin, adipose fin, tail fin (caudal fin), anal fin, vent, pelvic fin, scales, pectoral fin, terminal mouth, ventral mouth, adaptation

MATERIALS: “Fish Fins” and/or “Fish Adaptations” student pages

SUMMARY
In this activity students learn about the external structures of two freshwater fish found in the Great Lakes, and which are known to use the ravines of Highland Park at certain times of the year. Students learn about the function of these structures along with their similarities and differences from the human body.

OBJECTIVES
Students are able to:
1. Identify similarities and differences between human anatomy and fish anatomy;
2. Identify structural adaptations of fish that function to support their survival, growth, behavior, and reproduction; and
3. Describe the functions of these structures.

BACKGROUND
This activity compares the anatomy of two fish found in Lake Michigan – the White sucker (Catostomus commersonii) and the Rainbow trout (Oncorhynchus mykiss). White suckers are in the Catostomidae family and Rainbow trout are in the Salmonidae family.
For background on fish anatomy, please see the “Fins Table” and Adaptations Table later in this lesson which explain the functions of the structures discussed in this lesson.

**Technology Connections:**
- Download Trout Unlimited’s “Introduction to Trout for Smartboards”: www.troutinthe教室room.org/teachers/library/smartboard-presentation
- Use the below web pages to compare life histories of these two fish:
  - Rainbow trout: www.biokids.umich.edu/critters/Oncorhynchus_mykiss/
  - White sucker: www.dnr.state.mn.us/fish/whitesucker.html

### FINS TABLE

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Human Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1T, 1S</td>
<td>Dorsal fin</td>
<td>“Dorsal” means the backside of an organism. In humans, the backbone is in the dorsal region. Individual organs also have dorsal areas (e.g., the back of the brain is referred to as the brain’s dorsal region).</td>
</tr>
<tr>
<td>2T</td>
<td>Adipose fin (AD-uh-pohs)</td>
<td>Adipose cells in humans are the cells that store body fat.</td>
</tr>
<tr>
<td></td>
<td>Rainbow trout only, not White sucker</td>
<td></td>
</tr>
<tr>
<td>3T, 2S</td>
<td>Tail fin, or caudal fin (KAWD-I)</td>
<td>Tail and caudal both refer to the posterior end of a body. Humans have a tailbone (called coccyx) located at the base of the spinal column.</td>
</tr>
<tr>
<td>4T, 3S</td>
<td>Anal fin</td>
<td>Anal fin is located behind the vent, which is an opening where waste is expelled. In many animals, including humans, this opening is called the anus.</td>
</tr>
<tr>
<td>5T, 4S</td>
<td>Pelvic fins (2)</td>
<td>Pelvic fins are related to the human pelvis structure. Legs are connected to the pelvis and are thought to have evolved from pelvic fins.</td>
</tr>
<tr>
<td>6T, 5S</td>
<td>Pectoral fins (2) (PEK-ter-uhl)</td>
<td>Humans have pectoral muscles, which are located in the chest region. Arms are thought to have evolved from pectoral fins of a species that lived in water over 300 million years ago.</td>
</tr>
<tr>
<td>#</td>
<td>Name</td>
<td>What does it do?</td>
</tr>
<tr>
<td>----</td>
<td>-------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1T</td>
<td>Operculum (oh-PUR-kya-lum)</td>
<td>This is the gill cover, which protects gills from damage.</td>
</tr>
<tr>
<td>2T</td>
<td>Lateral line *Rainbow trout image only*</td>
<td>This line of special scales with pore-like openings is a sensory organ that detects disturbances (pressure and sound) in the water. It helps fish identify movement of predators and prey.</td>
</tr>
<tr>
<td>2S</td>
<td>Scales *Sucker image only*</td>
<td>Scales provide protection for the fish. Rainbow trout have very small scales compared to the White sucker.</td>
</tr>
<tr>
<td>3T</td>
<td>Dorsal fin</td>
<td>Provides stability and some maneuverability. Prevent the fish from rolling over. Some fish have two dorsal fins (example is the Yellow perch, another fish found in the Great Lakes).</td>
</tr>
<tr>
<td>4T</td>
<td>Adipose fin (AD-uh-pohs) *Rainbow trout only, not White sucker*</td>
<td>We don’t know! But some fish species like the Rainbow trout have this fin, while others like the White sucker do not. This fin is fleshy and has no rays or spines. Thus, this fin is often clipped by scientists at fish hatcheries to mark the fish so they know which fish are born in a hatchery and which are born in nature.</td>
</tr>
<tr>
<td>5T</td>
<td>Tail fin, or caudal fin *(KAWD-l)*</td>
<td>Provides propulsion through the water. Rainbow trout and White suckers both have forked tail fins, so they can swim faster than fish with rounded tail fins.</td>
</tr>
<tr>
<td>6T</td>
<td>Anal fin</td>
<td>Helps keep the fish stable in the water. Also used by female Rainbow trout to clear away sand or silt to build a nest.</td>
</tr>
<tr>
<td>7T</td>
<td>Vent</td>
<td>Solid and liquid waste disposal</td>
</tr>
<tr>
<td>8T</td>
<td>Pelvic fins(2)</td>
<td>Provides stability, helps fish swim upwards or downwards through the water column. These fins are in pairs.</td>
</tr>
<tr>
<td>9T</td>
<td>Pectoral fins (2) *(PEK-ter-uhl)*</td>
<td>Provides stability, helps fish turning directions, helps fish swim slowly. These fins are in pairs.</td>
</tr>
<tr>
<td>10T</td>
<td>Terminal mouth *Rainbow trout only, not White sucker*</td>
<td>Enables fish to feed on other fish that are swimming near them. This would be harder to do with a mouth pointing up or down.</td>
</tr>
<tr>
<td>9S</td>
<td>Ventral mouth *White sucker only, not Rainbow trout*</td>
<td>This downward pointing mouth is common on bottom feeders like the White sucker. The White sucker will use its ventral mouth to eat insects, algae, plankton, and other organisms at the bottom of a stream. Note that some fish have superior mouths, where the mouth opens closer to the top of the head. Fish with these types of mouths eat insects or other organisms at the surface of the water.</td>
</tr>
</tbody>
</table>

*Spiny fins provide protection*: Fins on both fish are supported by soft rays, which are very flexible. Other fish like bass and bluegill have spines in their fins. These spiny fins are not flexible, but are very sharp, and protect the fish. Picking up a fish with spiny fins is difficult because their spines can poke you.
ANATOMY WORKSHEETS

4. Using a projector, fill in the worksheet as a class, discussing the functions of each structure. Stop to pronounce difficult words together, and encourage students to ask questions (see “Fins Table”).

Part 1: Fins Worksheet

5. Students write each term for both fish. For each fin, ask students why they think scientists gave it the name they did. Instructor should emphasize the connection between fins and human parts.

Part 2: Adaptation Worksheet

6. Students should label the structures for both fish. For each structure, ask students to guess the function. Emphasize that they are all adaptations that the species has evolved in order to survive in its habitat. Students should also take notes about the function of each structure discussed.

DISCUSSION

7. Consider the following:
   • How are the White sucker and Rainbow trout different in appearance?
   • What are the reasons this might this be? Use life history factsheets to compare (see background).
   • How are they the same?

ASSESSMENT

Review students pages for completion.

EXTENSIONS

TROUT IN THE CLASSROOM ACTIVITIES

Explore Internal Anatomy
    To expose students to internal anatomy of fish, consider the following lesson plan: www.troutintheclassroom.org/teachers/library/trout-guts-collage

Paper Bag Fish Models
    Using what students have learned about fish anatomy, create models of a fish using paper bags. Trout in the Classroom’s website provides directions for building these models: www.troutintheclassroom.org/teachers/library/paper-bag-trout

RESEARCH “LIVING FOSSILS”

The coelacanth (SEEL-uh-canth) is a fish that scientists describe as a “Living Fossil” because the species has been around for about 400 million years. Visit this website for more information: http://animals.nationalgeographic.com/animals/fish/coelacanth/. To see a preserved coelacanth, visit The Field Museum of Natural History, in Chicago.

The lungfish is another fossil fish, with separate species found on several continents throughout the world. To see Australian lungfish, visit The Shedd Aquarium, in Chicago. To learn about the lungfish visit this website: www.shedd aquarium.org/australianlungfish.html.

Note the similarities and difference between the Rainbow trout and these living fossils. Do they look similar? Do they act similar? Why do you think this is? Also, which species is more in danger of extinction?

RESOURCES

TEXAS PARKS AND WILDLIFE FISH SCHOOL
    This user-friendly website provides information on fish anatomy. Users can also learn how fish swim, breathe, see, smell, taste, sense, hear, and reproduce.
    www.tpwd.state.tx.us/kids/wild_things/fish/fishparts.phtml

FISHERIES LEARNING ON THE WEB (FLOW) LESSON
    Fins, Tails and Scales - Identifying Great Lakes Fish
    This activity, designed for grades 4-8, teaches students how to identify the families of fish species based on their external features.
FISH-SPECIFIC RESOURCES

Rainbow trout information: www.biokids.umich.edu/critters/Oncorhynchus_mkykiss/

White sucker information: www.dnr.state.mn.us/fish/whitesucker.html

SOURCES


STANDARDS

SCIENCE (NGSS)
4-LS1-1, 4-LS1-2, MS-LS1-2, MS-LS1-3, MS-LS1-4, MS-LS1-8, MS-LS4-1, MS-LS4-2

ENGLISH LANGUAGE ARTS (CCSS)
RST.6-8.4, WHST.6-8.2d
FINS PAGE

1. Dorsal fin
2. Adipose fin
3. Tail fin, or caudal fin
4. Anal fin
5. Pelvic fins
6. Pectoral fins

Rainbow trout

1. Dorsal fin
2. Tail fin, or caudal fin
3. Anal fin
4. Pelvic fins
5. Pectoral fins

White sucker

ADAPTATIONS PAGE

1. Operculum
2. Lateral line
3. Dorsal fin
4. Adipose fin
5. Tail fin, or caudal fin
6. Anal fin
7. Vent
8. Pelvic fins
9. Pectoral fins
10. Terminal mouth

Rainbow trout

1. Operculum
2. Scales
3. Dorsal fin
4. Tail fin, or caudal fin
5. Anal fin
6. Vent
7. Pelvic fins
8. Pectoral fins
9. Ventral mouth

White sucker
From Head to Tail:
Fish Fins

NAME: ____________________

DIRECTIONS
Label each fish’s fins by completing the blank.

RAINBOW TROUT

1. ___________________

2. ___________________

3. ___________________

4. ___________________

5. ___________________

6. ___________________

WHITE SUCKER

1. ___________________

2. ___________________

3. ___________________

4. ___________________

5. ___________________
From Head to Tail:
Fish Adaptations

NAME: __________________________

DIRECTIONS

Label each fish’s adaptations by completing the blank.

RAINBOW TROUT

1. ___________________ 4. ___________________
2. ___________________ 5. ___________________
3. ___________________ 6. ___________________
4. ___________________ 7. ___________________
5. ___________________ 8. ___________________
6. ___________________ 9. ___________________
7. ___________________ 10. ___________________

WHITE SUCKER

1. ___________________ 4. ___________________
2. ___________________ 5. ___________________
3. ___________________ 6. ___________________
4. ___________________ 7. ___________________
5. ___________________ 8. ___________________
**TIME**: 60-90 minutes at the ravine and 15-30 minutes indoors

**GRADES**: 6-8

**LOCATION**: Ravine (in fall or spring) and indoors

**SAFETY**: When exploring the ravine, step very carefully. Rocks may be unstable to stand on.

**KEYWORDS**: Ecosystem, biotic, abiotic, habitat, turbidity, transparent, translucent, opaque, dissolved oxygen, pH, salinity, nearshore ecosystem, stream pools, riffles, substrate, indicator

**MATERIALS**:
- All water quality testing materials
- Four flags
- Stuffed animal trout
- Trout visual aid
- Clipboards
- Student sheets

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**SUMMARY**

In this guided field trip to a ravine stream, students evaluate the habitat quality of the ecosystem. Visiting students are broken up into three groups to test the availability of food, healthy water, shelter, and physical habitat for Rainbow trout.

**OBJECTIVES**

Students are able to:
1. Provide and interpret empirical evidence about the health of a habitat for a specific species;
2. Consider actions that would increase or decrease the health of that habitat; and
3. Demonstrate the ability to describe the difference between an ecosystem and a habitat.

**BACKGROUND and PREPARATION**

**Teachers**: Before visiting the ravine, review proper field trip behavior with students. Divide students into three groups for the field trip and show them the habitat components worksheet they will complete on-site.
If necessary, introduce the concept of a **habitat** [the environment in which an animal lives and a place where a species has everything it needs to survive], and the four major habitat components, (1) food, (2) water, (3) shelter, and (4) space. Note that a habitat can be any size and vary by species. Habitat needs also change as individuals of a species grow and experience different parts of their life cycle.

The Rainbow trout is a good example—a native of the Pacific Ocean, it was introduced to the Great Lakes for recreational fishing in the late 1800s. In Lake Michigan, Rainbows (sometimes called Steelhead) spend most of their time in deep cold waters, but when they mature, they move into adjacent (tributary) streams to spawn in gravel found on the streambeds. When conditions are right, young Rainbow trout may stay a year or two in these sheltered streams until they grow big enough to go out to the lake. Here in the ravines, young Rainbows have been observed at the mouths of the streams in early summer coming to fill up on aquatic insects that are plentiful during that time. The Park District of Highland Park has released some Rainbow trout that have stayed over summer in the ravine stream, but conditions are hard as the streams get very dry in the hot months. That is why they have created pools and shelters to try to make it better for them and other fish using the stream.

Another large fish, the White sucker, which is native to the Great Lakes, uses tributary streams in the same way. However the White sucker is more tolerant of degraded conditions such as **turbidity** (suspended sediments in the water) and warmer temperatures. Here in the ravines, the White suckers come to the streams in April to spawn. Their eggs hatch and baby fish (fry) can be seen swimming the the streams. By July, they are usually gone, pushed out to the lake by summer storms.

On the field trip, students will observe the Rainbow trout’s habitat components in a stream. Students will also have an opportunity to study habitat in a Great Lake.

**Facilitators:** Before students arrive, plant the four flags along the ravine (at 50 foot intervals) to mark study sites.

**PROCEDURE**

**INTRODUCTION**

1. Educators welcome students to the ravine ecosystem. Explain to students that they will be exploring this restored ravine ecosystem and decide how well it can serve as a habitat for *Oncorhynchus mykiss*, or the Rainbow trout [hold up picture of trout].

2. Ice breaker: Play “Pass the Trout” using the stuffed animal trout. Explain that there is no talking until you receive the Rainbow trout.
trout. When a student has the trout, they should say their name and something about themselves (facilitator decides the topic).

3. Ask students if they can explain what an ecosystem is. [a place where living and non-living things interact] Scientists call the living things biotic, and the non-living abiotic. Ask students to look around and brainstorm biotic and abiotic components that they observe in the ravine ecosystem.

4. Explain that one of the biotic parts of this ravine ecosystem is the fish, which is the focus of this field trip. One of the reasons we are focusing on fish is because some of the fish found in this ravine ecosystem, such as the Longnose dace, are rarely found in any other area in our state.

The Rainbow trout is another species of interest because it is particular about the quality of the water it lives in. Its presence is an indicator of relatively cool and clean water. If conditions are right, Rainbow trout will use streams adjacent to Lake Michigan to spawn or to find food to grow.

White suckers use the streams in the same way but they are more tolerant of conditions such as warmer temperatures and turbidity (suspended bits of soil which make the water cloudy). They have been successful in hatching eggs in the ravine streams. So far, Rainbow trout have not been seen doing this.

There are some important little fish (commonly called minnows) that live mostly in the nearshore waters of the Lake. These fish may come up the streams to lay eggs, seek shelter or find food. Lake chub and Longnose dace have both been spotted in the ravine streams. These fish vary in their tolerances for water quality.

5. Before splitting into groups to start filling out the “Ravine Habitats” student page, ask students to define habitat. [A place where an organism has everything it needs to survive.] Ask them to name the four habitat components that all species need to survive? [food, water, shelter, space] Ask if all species have the same habitat needs. [No – example: A penguin must live in a very different habitat from a zebra. A clownfish lives in a different habitat than a bass]

6. Break into three rotating groups. Explain the three stations and who will lead students through each station. Based on time constraints, spend between 10-20 minutes at each station.

STATIONS

Station 1: Water (2-3 instructors)
- Remind students to walk VERY cautiously on the rocks. Also, equipment is expensive. It should be handled with great care.
- Conduct water quality tests at one of the study sites to determine the habitat suitability of water. Students should complete results for turbidity, temperature, dissolved oxygen (DO), pH, and salinity.
  - **Note on turbidity**: For younger audiences, identifying whether the water is turbid, translucent, or transparent is sufficient. 6-8th graders should record numerical turbidity data.
  - **Note on salinity**: Explain that 1000 mg/L over a whole week is lethal to Rainbow trout. Ask students, what might cause salinity, or the amount of salt, to increase in the stream?
- If time remains, show students other tests as well (flow rate, conductivity).
- Explain how all of these tests help us to determine whether or not Rainbow trout can tolerate this ecosystem.
Station 2: Food, Shelter, and Space at Beach (1-2 instructors)

• Instructor should explain that the fish come up the stream against the current after rainstorms. Also, discuss the importance of nearshore and coastal habitats in the Great Lakes, where many small fish and several larger fish, like yellow perch, go to find food. Also, this is an area of Lake Michigan where humans can have the most impact.

• Point out areas of shelter and places where the fish can swim into the ravines (mouth or outfall of stream).

• Remind students to wait to complete their assessment of the habitat components until they have finished ALL stations.

• If time remains, introduce the game “Go Fish”. Instructions can be found in the earlier lesson plan titled “Go Fish.”

Station 3: Food, Shelter, and Space in Ravine (1-2 instructors)

• Guide students on a hike upstream, stopping at each of the four study sites to look for sources of food (look under rocks for invertebrates) and shelter.

• Instructor should point out the stream pools, riffles, cover, and substrate and explain their functions.

• This is a good location for students to create their sketches for question #4.

WRAP-UP

7. Ask students about the preliminary results of their assessment. Does this ecosystem have the habitat components to support a population of rainbow trout? What other tests or observations could we conduct? Do you think results might change if we were here during another season? How would they be different and why?

8. How do human actions affect this ecosystem? [1) physical destruction of habitat, 2) decreasing the water quality, and oxygen availability, and 3) introducing invasive species] Explain what the Park District of Highland Park is doing to prevent these human impacts to this ecosystem and other natural areas in Highland Park.

9. If field trip was 60 minutes, take 15-30 minutes in class to ensure that all students have recorded data from the site visit.

ASSESSMENT

1. Check student page for completion and accuracy.

2. Discuss the below questions, and have students write their own answers independently or in groups:

• What is the difference between an ecosystem and a habitat?

• Which of the habitat components are biotic factors?

• What of the habitat components are abiotic factors?

• How do human actions affect this ecosystem?

SOURCES


STANDARDS

SCIENCE (NGSS)

5-LS2-1, 5-ESS2-1, MS-LS1-5, MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-LS2-5, MS-ESS3-3

ENGLISH LANGUAGE ARTS (CCSS)

CCRA.W.2, CCRA.W.4, RH.6-8.7, RST.6-8.3, RST.6-8.4, WHST.6-8.1, WHST.6-8.2, WHST.6-8.2a, WHST.6-8.2b, WHST.6-8.2d, WHST.6-8.4, WHST.6-8.7

MATHEMATICS (CCSS)

4.MD.A.1, 4.MD.A.2, 5.MD.A.1, 6.EE.C.9, 7.EE.B.3, 6.SP.B.5, 6.NS.B.3, 6.NS.C.5
NAME: _______________________

**DIRECTIONS**

In your groups, complete this table to determine how well this ravine stream ecosystem could support a population of Rainbow trout. Add up your numbers in the assessment column to calculate your habitat assessment score.

<table>
<thead>
<tr>
<th>HABITAT COMPONENT</th>
<th>WHAT TO LOOK FOR</th>
<th>ASSESSMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FOOD</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insect larvae, macroinvertebrates</td>
<td>How many of the four sites have food present? (Circle your answer)</td>
<td>0 1 2 3 4</td>
</tr>
<tr>
<td>What do you see?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WATER</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circle your answer: Turbidity: Transparent Yes or No</td>
<td>How many “yeses”?</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td>Temperature: 12-18°C Yes or No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DO: ≥5mg/L Yes or No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH: 6-8.5 Yes or No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salinity: &lt;1,000 mg/L Yes or No</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SHELTER</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overhanging rocks and tree roots Shade from trees</td>
<td>How much of the four sites have shelter present?</td>
<td>0 1 2 3 4</td>
</tr>
<tr>
<td>What do you see?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SPACE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pools, riffles, water level/flow</td>
<td>How many of the four sites have physical habitat for the rainbow trout?</td>
<td>0 1 2 3 4</td>
</tr>
<tr>
<td>What do you see?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Trout-O-Meter**

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Habitat Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-7</td>
<td>Unhealthy habitat</td>
</tr>
<tr>
<td>8-10</td>
<td>Moderately healthy habitat</td>
</tr>
<tr>
<td>11-17</td>
<td>Healthy habitat</td>
</tr>
</tbody>
</table>

My trout habitat assessment score: _____
1. Based on your assessment could this stream ecosystem provide healthy habitat for Rainbow trout? How might we help to make this stream healthier?
_______________________________________________________________________________
_______________________________________________________________________________

2. What other aspects of this ecosystem do you think could harm or support a population of Rainbow trout?
_______________________________________________________________________________
_______________________________________________________________________________

3. Do you think results would be different during another season? How would results differ?
_______________________________________________________________________________
_______________________________________________________________________________

4. In the box below, sketch a habitat component you observed today.

Aquatic Life in Streams and Nearshore

To Invade or Not to Invade

**TIME:** 40-60 minutes  
**GRADES:** 6-8  
**LOCATION:** Indoors  
**KEYWORDS:** Species, native species, non-native species, invasive species, naturalized species, terrestrial, ballast water  

**MATERIALS:**  
Print enough of the following printouts for each pair of students:  
- Fish Stories  
- To Invade or Not to Invade (Directions, Gameboard, Ecosystem situation cards)

**SUMMARY**  
In this lesson students learn about the idea of invasive species. They compare characteristics of three Great Lakes fish and then play a board game modeling terrestrial invasive species in an Illinois forest.

**OBJECTIVES**  
Students are able to:  
1. Differentiate between native species and non-native or exotic species and identify whether or not a species is invasive;  
2. Identify characteristics that make a species invasive;  
3. Explore the social, ecological, and economic impacts of invasive species; and  
4. Identify and critique solutions to control the spread of invasive species.

**BACKGROUND**  
Since the late 19th century, humans have introduced approximately 180 **non-native species** to the Great Lakes region. About 10% of these are categorized as invasive species because of the harmful impacts they can have on their new ecosystems or on human activity.
Invasive species can impact new areas by:
• outcompeting native species for resources (food, habitat, spawning areas);
• changing the characteristics of natural areas;
• spreading diseases and parasites;
• damaging human equipment and infrastructure; and
• consuming native species.

ACCIDENTAL INTRODUCTIONS
One of the more recent invasive species in Lake Michigan is the Round goby, a bottom dwelling fish. In Illinois, the Round goby was first observed in the Grand Calumet River in 1993 and was then found in Lake Michigan near Chicago two years later. The goby outcompetes native species by spawning multiple times each year (about six times depending on temperatures) from April to September. Additionally, its advanced sensory system allows it to feed in the dark at nighttime, when other bottom dwelling fish like sculpins and darters are unable to locate food.

Round gobies are thought to have drastically reduced numbers of native Mottled sculpins through competition for food and breeding habitat. Round goby also eat the eggs of some native fish species. The Round goby is one example of a long history of accidental non-native species introductions in the Great Lakes that caused permanent changes to the ecosystem.

VOCABULARY
Species: a group of organisms with common attributes and the ability to reproduce fertile offspring together.
Native species: a species that lives in a region or place without intervention from people.
Non-native species: a species (not in captivity) introduced by humans to a place outside of its historical native range.
Invasive species: a species that can be native or non-native to an ecosystem, and whose introduction can cause harm to the environment, native species, the economy, or human health. They usually have no natural predators in their new environment and reproduce rapidly.
Naturalized species: a non-native species that brings minimal negative impacts to a new ecosystem

PREPARATION
Print “Fish Stories from Lake Michigan” student pages. Read and print directions for the invasive species modeling game. Become familiar with the invasive species information resources listed for student use. Prepare game materials by cutting out the Ecosystem Situation Cards.

PROCEDURE
INTRODUCTION:  🤔🤔🤔
COMPARING THE IMPACTS OF SPECIES
1. Introduce the concept of an invasive species and review habitats and food webs. Students should have a foundational understanding of these concepts before participating in this exercise.

2. Introduce vocabulary terms: native species, non-native species, invasive species, and naturalized species (see “Vocabulary” box above).

3. Explore the differences and brainstorm examples of each of the above with students.

EXPLORATION: IS IT INVASIVE?
4. Instructor hands out “Fish Stories from Lake Michigan” student pages. Students work in pairs to read about each of the three species (White sucker, Rainbow trout, Round goby) and complete reading comprehension questions.
RECALL: RECAP FISH STORIES
5. After everyone has read “Fish Stories,” ask students:
   • Which of the three species are invasive? [Round goby]
   • Where did this species come from? [ballast water from ships]
   • Why is it invasive? [It outcompetes other species of fish by being aggressive and feeding at night; it can also consume zebra mussels, unlike many native fish, taking advantage of an additional food resource.]

6. Ask students if they think the White sucker and Rainbow trout are invasive in the Great Lakes [answers may vary].

7. Explain that while the Rainbow trout was brought into the Great Lakes and its streams by people, the Rainbow trout generally has minimal impact on its ecosystem. The Rainbow trout is an example of a species that has become naturalized, or has adapted to an ecosystem without causing major disruptions. Generally, naturalized species like the Rainbow trout aren’t described as invasive species.

WHAT IS BALLAST WATER?
Ballast water is water held in a ship to increase its stability while floating. Ballast water is pumped into the ballast tank (at the bottom of the ship) from the surrounding the body of water. Ballast water is exchanged as a ship loads or empties cargo. For example, a freighter may fill its tank with ballast water at one port, and then release it in another port. Since that ballast water is used only for balance, most living organisms survive in the ballast tank and may also survive when the ballast water is released.

Demonstrate how ballast water keeps a ship from “keeling over” by taping the bottom of a funnel closed and placing it in a bowl of water. The funnel will tip over or sink unless the bottom of the funnel is partially filled with water.

TO INVADE OR NOT TO INVADE
8. Pass out board game materials to each pair of students, including directions, game board, game pieces, and ecosystem situation cards.

9. Game play should last approximately 15-20 minutes.

10. As students finish they should consider the discussion questions independently.

ASSESSMENT
Check student page for accuracy. Student page answers:
1. The White sucker is native. It has been in the Great Lakes for thousands of years.
2. Rainbow trout and Round gobies are non-native. They were introduced by humans.
3. Round goby is invasive. It disrupts the ecosystem by outcompeting native species and reproducing rapidly.
4. Rainbow trout is naturalized. It has adjusted to living in the Great Lakes region with little impact on the ecosystem.

EXTENSIONS
INVASIVE SPECIES REMOVAL IN YOUR NEIGHBORHOOD
Every community is subject to invaders by land and water. Garlic Mustard, Buckthorn, Japanese Knotweed, and Goutweed are among the invasive plants commonly
Aquatic Life in Streams and Nearshore

FLOW LESSON 3: GREAT LAKES MOST UNWANTED

This lesson, designed for grades 4-8, provides fact cards, pictures, and other resources on many aquatic invasive species in the Great Lakes Region, and their impacts. www.miseagrant.umich.edu/flow/pdf/U1/FLOW-U1-L3-MICHU-08-401.pdf

STANDARDS

SCIENCE (NGSS)
4-ESS3-2, S-LS2-1, MS-LS1-4, MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-4, MS-LS2-5, MS-ESS3-3

ENGLISH LANGUAGE ARTS (CCSS)
CCRA.R.6, CCRA.R.9, CCRA.SL.3, RH.6-8.5, RH.6-8.8, RST.6-8.2, RST.6-8.4, WHST.6-8.2d

SOURCES


Want to work with the experts? The Park District of Highland Park has educated individuals specializing in natural area restoration and the removal of invasive species. If you are interested in setting up a work day for your student group, visit www.pdhp.org/hpravines.

INVASIVE SPECIES OUTREACH PROJECT

Students use what they have learned to create a product to educate the community about invasive species in Highland Park or in the Great Lakes.

found in or near Highland Park. See if any of these plants are growing at or near your school. To identify common woodland invasive species, visit: www.inhs.illinois.edu/research/CAPS/docs/WoodlandWeedsfinal.pdf.
To Invade or Not to Invade:
Fish Stories from Lake Michigan

NAME: ____________________________

DIRECTIONS

Read about three fish found in Lake Michigan and answer the following questions:

RAINBOW TROUT

We first arrived in the Great Lakes in 1876, when humans brought a group of our ancestors from our native streams in the Western United States. We are often categorized in two groups – Rainbow trout (“landlocked”) and Steelhead. If we spend our adult lives in streams, people call us Rainbow trout for our pretty colors. We tend to stay smaller (8 – 22 inches, up to 4 pounds) because we eat mostly insects and sometimes small fish. Others of us, the Steelhead, live in the Great Lakes. We are born in streams, but live our adult lives in the Great Lakes where prey fish are more abundant. As Steelhead, we swim up streams to spawn, or reproduce. Because we eat mostly fish when we live in the Great Lakes, we can grow larger (20 – 36”, average 8-10 pounds, but can grow up to 20 pounds). The Illinois state record for steelhead from Lake Michigan is 31 pounds.

Both Rainbow trout and Steelhead usually spawn during the spring and fall. Fishermen really enjoy catching us, so scientists raise baby trout in a place called a hatchery, and then release us into the wild when we are big enough to find our own food. If hatcheries didn’t do this, we probably wouldn’t be able to sustain a population on our own. These Midwest streams are great, but they’re not quite the same as the streams we are used to out west!

WHITE SUCKER

We are suckers for Lake Michigan. Having lived here for thousands of years, this is our home. We are bottom feeders with a diversified diet, so we will eat almost anything on the bottom of the Lake Michigan, including algae, insect larvae, and crustaceans. Until we are about 8 inches in length, we can be eaten by walleye, bass, burbot, salmon and trout, and northern pike, as well as birds such as the Great Blue Heron. When we are adults, we weigh about two pounds and are 12-16”, which is too large for most fish eating predators. The record White sucker caught in Michigan was 28 inches long and weighed 7 pounds.

In April and May we swim up streams to spawn. After our eggs hatch, baby suckers live in the stream for about one to two months until they are large enough to survive in the near shore habitat of Lake Michigan, which spans about 3/4 of a mile. We are generally more tolerant of a wide range of environmental conditions than other fish in the Great Lakes region.
To Invade or Not to Invade:
Fish Stories from Lake Michigan

ROUND GObY

WE are from the other side of the world. Our ancestors came from Europe, possibly the Black Sea or the Caspian Sea. In Illinois, we were first noticed in the Grand Calumet River in 1993. Scientists think we hitched a ride in the ballast water of a freighter that travelled to the Great Lakes and then dumped its ballast water. We are only about six inches long, but we have made Lake Michigan our home. You might even say we have taken over. Unlike almost all native fish in Lake Michigan, which spawn only once a year, we spawn multiple times between April and September. We will aggressively defend our nests from any intruder and scare native sculpins away from their preferred habitat, which is the same as ours.

A lot of people don’t like us. Because we are so good at reproducing, we outcompete other bottom-dwelling fish for food. Additionally, we can feed at night and sometimes eat eggs of native fish. One of our favorite foods, both here and in our native countries, is the zebra mussel, which filters pollution (mercury, PCBs) out of the water. When a larger fish eats us, it also consumes all the pollution in our systems from dining on zebra mussels. This makes people that eat fish like trout and walleye from Lake Michigan nervous.

WHICH IS WHICH?

1. Which, if any, of these species are native to Lake Michigan? How do you know?
   ____________________________________________________________

2. Which, if any, of these species are non-native to Lake Michigan? How do you know?
   ____________________________________________________________

3. Which, if any, of these species are invasive in Lake Michigan? How do you know?
   ____________________________________________________________

4. Which, if any, of these species are naturalized to life in Lake Michigan? How do you know?
   ____________________________________________________________
To Invade or Not to Invade
Invasive Species Modeling for 4-8th Graders

BACKGROUND
This is a learning game! By playing this game, students create a model that demonstrates the impact of invasive species in a fictitious forest in their community.

SUPPLIES
- Game board
- Dice (one per student group)
- Invasive species game pieces (suggestions include: beans, tokens, paper squares, etc.)
- Native species game pieces (should be different in color or shape from invasive pieces)
- Cut out game cards
- Cut out X-pieces

DIRECTIONS
Object of the game: to have as many pieces on the board at the end of the round

SET UP
- Students should work in groups of two. In each group, one student is an invasive species and one is a native species.
- In this game, a native and a non-native invasive plant species are competing in a Highland Park forest.
- Players take turns putting pieces down. For each turn, a player will roll the die. If they roll an odd number they place one piece on the space of their choice. If they roll an even they place two pieces.
- After each person takes two turns, draw one Ecosystem Situation Card and follow the directions on that card.
- After the board is filled, count your pieces and consider the discussion questions.

DISCUSSION QUESTIONS
1. What were the major ways that the invasive was able to succeed?
2. What were the main ways the invasive species was controlled?
3. What are the limitations of this game? How is it different in the real word?
4. How might this game be different if we were talking about aquatic invasive species?
### To Invade or Not to Invade: Invasive Species Modeling: Game Cards (Front)

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bird Consumes Berries From Invasives</td>
<td>They spread seeds around the forest. Place 1 Invasive Piece in an available space in 5 columns of your choice.</td>
</tr>
<tr>
<td>Volunteer Work Day!</td>
<td>Remove 2 Invasive Pieces.</td>
</tr>
<tr>
<td>Bird Consumes Berries From Invasives</td>
<td>They spread seeds around the forest. Place 1 Invasive Piece on an available space in every column.</td>
</tr>
<tr>
<td>Volunteer Planting Day!</td>
<td>Place 3 Native Pieces in any available spaces.</td>
</tr>
<tr>
<td>Fire!</td>
<td>A large controlled burn in rows 9 and 10 destroys half of the Invasive species. Remove half of the Invasive Pieces in rows 9 and 10.</td>
</tr>
<tr>
<td>Drought</td>
<td>Plants struggle to grow.</td>
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<tr>
<td>Each player removes 3 Pieces.</td>
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<tr>
<td>Healthy Growing Season</td>
<td>The temperature and amount of precipitation are just right. Each player places 3 Pieces on the board (Invasive goes first).</td>
</tr>
<tr>
<td>Invasive Species Removal Festival!</td>
<td>Remove 9 Invasive Pieces.</td>
</tr>
<tr>
<td>New Invasive Arrives!</td>
<td>This plant releases a toxin into the soil, so nothing else can grow where it grows. Remove all Pieces from H7, H8, H9, P7, P8, P9, I7, I8 and I9. Replace with Xs. Remove Xs after three turns.</td>
</tr>
<tr>
<td>Forest Steward</td>
<td>A caring individual adopts a small section of the forest. Remove all Invasive Pieces from R1, R2, S1, and S2. For the rest of the game Invasive Pieces may not be placed on these squares.</td>
</tr>
<tr>
<td>New Invader Arrives!</td>
<td>This plant brings a disease that affects the native species. Remove all Native Pieces in N5, A5, V5, N6, A6, V6, N7, A7, and V7. Remove all Invasive Pieces from H7, H8, H9, P7, P8, P9, I7, I8 and I9. Replace with Xs. Remove Xs after three turns.</td>
</tr>
</tbody>
</table>
**To Invade or Not to Invade**

Invasive Species Modeling: Game Cards (Back)

<table>
<thead>
<tr>
<th>ECOSYSTEM SITUATION CARD</th>
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*Cut out X pieces on other side*
To Invade or Not to Invade
Invasive Species Modeling: Game Board

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<th>H</th>
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</tbody>
</table>
TIME: Two to three 45 minute class periods

GRADES: 6-8

LOCATION: Indoors

KEYWORDS: Species, native species, non-native species, invasive species, naturalized species, terrestrial, ballast water

MATERIALS: Resources
    “Invasive Species Report” student page

SUMMARY
In this activity, designed for a middle school grade level, students research, report, and present to their class on an invasive species found in the Great Lakes region.

OBJECTIVES
Students are able to:
1. Research and present information on an invasive species in the Midwest;
2. Explore the social, ecological, and economic impacts of invasive species; and
3. Identify and critique solutions to control the spread of invasive species.

BACKGROUND
Refer to the Background section in the previous lesson, “To Invade or Not to Invade.”

PREPARATION
Gather resources for student research. Consider reserving a library or computer lab for students to complete their research project.
PROCEDURE

INVASIVE SPECIES REPORT RESEARCH

1. Break students into groups of 3-4 for this activity, and provide students with student page. Groups should select one invader to research, and create a 2-3 minute presentation or video for the class with the following information:
   • Common name
   • How was it introduced to this area?
   • What does it eat? Does it have predators?
   • What makes this invader so successful?
   • How does the invader affect the other plants and animals in its community? How might it affect people?
   • How can we keep this invader from spreading?
   • Encourage students to create their own innovative solutions to prevent their species from spreading.
Instructor should ask students to add an element of creativity to their presentations by creating a multimedia presentation (i.e., PowerPoint or Prezi), song, skit, narrative, or video.

2. Student groups (or instructor) determine which invasive species they will research. The side table contains a potential list of species for research.

3. Students should answer the research questions using the resources, and any other information sources they can locate with the instructor’s guidance. For each answer students should document the source.

4. Students should prepare a 3-5 minute presentation for the class answering the research questions about their invasive species. Additionally, each group must turn in written answers to their instructor for assessment.

   PRESENTATIONS & STEWARDSHIP

5. Students should present their findings to the class. Presentations should not exceed five minutes.

6. As a class discuss the implications of these invasive species.

Consider these questions:
• Which of these invaders are the most important for us to be thinking about, and why?
• What are some of the most promising solutions to controlling these invaders?
• Are there any species that we should be working harder to prevent from spreading?
• How can we help teach people about the importance of controlling our invaders?

ASSESSMENT

Collect written invasive species reports. Grade for completion and accuracy with the understanding that many invaders will have incomplete information because of the varying levels of scientific knowledge of a specific species.

Provide students with feedback on their presentations.

<table>
<thead>
<tr>
<th>Terrestrial (Land-dwelling) Invasive Species</th>
<th>Aquatic Invasive Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garlic Mustard</td>
<td>Sea lamprey</td>
</tr>
<tr>
<td>Common Buckthorn</td>
<td>Spiny water flea</td>
</tr>
<tr>
<td>Emerald ash borer</td>
<td>Zebra mussels and quagga mussels</td>
</tr>
<tr>
<td>Japanese beetle</td>
<td>Asian carp (Silver carp, big head carp)</td>
</tr>
<tr>
<td>Teasel</td>
<td>Purple Loosestrife</td>
</tr>
<tr>
<td>Kudzu</td>
<td>Eurasian Milfoil</td>
</tr>
</tbody>
</table>

Use the “Resources” section at the end of this lesson plan to guide students toward useful information.
EXTENSIONS

INVASIVE SPECIES OUTREACH PROJECT

Students use what they have learned to create a product to educate the community about invasive species in Highland Park or in the Great Lakes.

RESOURCES

These government agencies and programs provide access to information on aquatic invasive species:

U.S. Environmental Protection Agency: www.epa.gov/glnde/invasive/

Great Lakes Nonindigenous Species Information System: www.glerl.noaa.gov/res/Programs/glansis/glansis.html

Illinois-Indiana Seagrant: www.iiseagrant.org/nabinvader/Lakes/admin/factsheets.html

Northeastern Illinois Invasive Plants Partnership: http://niipp.net/?page_id=1016


Below are terrestrial invasive species factsheets from the Illinois Natural History Survey:

Grasslands: www.inhs.illinois.edu/research/CAPS/docs/GrasslandWeedsfinal.pdf

Woodlands: www.inhs.illinois.edu/research/CAPS/docs/WoodlandWeedsfinal.pdf

Wetlands: www.inhs.illinois.edu/research/CAPS/docs/WetlandWeedsfinal.pdf

SOURCES


STANDARDS

SCIENCE (NGSS)

4-ESS3-2, MS-LS1-4, MS-LS2-1, MS-LS2-2, MS-LS2-4, MS-LS2-5, MS-ESS3-3

ENGLISH LANGUAGE ARTS (CCSS)

CCRA.R.7, CCRA.W.6, CCRA.W.7, CCRA.W.8, CCRA.W.9, CCRA.SL.1, CCRA.SL.2, CCRA.SL.3, CCRA.SL.4, CCRA.SL.5, RH.6-8.1, RST.6-8.1, RST.6-8.4, WHST.6-8.2d, WHST.6-8.7, WHST.6-8.9

Aquatic Life in Streams and Nearshore Invasive Species Reports
Invasive Species Report

NAME: ____________________________

GROUP MEMBERS: ____________________

1. What is the common name of your invasive species? ______________________________________

2. How was it introduced to this area? ___________________________________________________
   ________________________________________________________________________________

3. What does it eat? ________________________________________________________________
   ________________________________________________________________________________

4. Does it have predators? If so, what are they? _____________________________________________
   ________________________________________________________________________________

5. What makes this invader so successful? ________________________________________________
   ________________________________________________________________________________
   ________________________________________________________________________________

6. How does the invader affect the other plants and animals in its community? How might it affect people?
   ________________________________________________________________________________
   ________________________________________________________________________________

7. How can we keep this invader from spreading? ___________________________________________
   ________________________________________________________________________________
   ________________________________________________________________________________