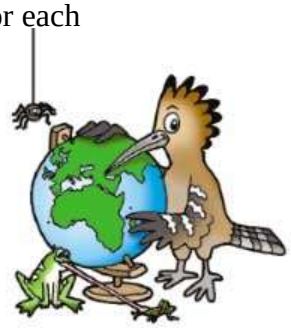
5) Ecosystem Diversity

Overview

Students will learn how animal and plant adaptations create a **niche** for each species. These adaptations are used by scientists to identify and categorize organisms. **Biodiversity** is a measure of how many different species live in a habitat. The greater the biodiversity, the more stable the ecosystem. When a new species enters an ecosystem, it may take over the niches of other native species. These **alien invasive** species can reduce biodiversity and threaten the stability of an ecosystem.



Learning Objectives

After completing this activity, students will be able to understand and explain…

- how scientists use an organism's characteristics to **classify** it;
- how plants and animals fit into **food chains** and more complex **food webs**; and
- what happens when a link in the **food chain is broken**, such as by the loss of a species or the invasion of an alien species that takes over someone else's niche.

Procedure

The table below lists the activities and documents in this unit and gives a brief description of the main ideas and the setting for each activity. There are multiple activities for many learning phases of the unit. Teachers may choose to use one or more activities from any one phase.

Phase	Activity	Main Concept	Setting	Page
Engage	**STUDENT INTRODUCTION TO ECOSYSTEM DIVERSITY**	Gives students an overview of the unit goals and main concepts.	N/A	5-3
	5.1 CLASSIFIED INFORMATION	A collection of Web-based activities to teach classification	Computer Lab/Classroom, Small Group	5-4
	5.2 LET'S TAKE A DIP *(optional student sheets included)*	A Computer Model of Macroinvertebrate Sampling in a Creek.	Computer Lab/ Classroom, Small Group	5-5
Explore	**5.3 EAT LIKE A BIRD**	Models Animal Adaptations	Indoors, Individual/ Whole Class	5-15
	5.4 ANIMAL ADAPTATIONS FIELD STUDY *(optional students sheets included)*	How Adaptations Help A Species Find Its Niche	Indoors/ Outdoors, Small Group	5-21
	5.5 OH DEER!	Role play to model habitat components and predator/prey relationships	Outdoors, Whole Class	5-35

Continued on next page

Procedure (continued)

Phase	Activity	Main Concept	Setting	Page
Explore	**5.6 MACROINVERTEBRATE FIELD STUDY** *(optional student sheets included)*	Students Investigate Adaptations of Macroinvertebrates and Stream Health.	Outdoors, Whole Class	5-43
Explain	**5.7 FRANKENFISH** *(optional student sheets included)*	Students design fish and explain how adaptations fit habitat.	Indoors, Small Group	5-53
Elaborate	**ISSUE INVESTIGATION FRAMEWORK**	Steps to creating a student action project	Indoor & Outdoor	*Unit 6*
Evaluate	**5.8 ECOSYSTEM FOOD WEB MURAL**	Students construct a Food Web Mural to demonstrate understanding of adaptations and Energy Cycle connection in a wetland environment.	Indoor, Whole Class	5-68

Continued on next page

Student Introduction to Ecosystem Diversity Unit

How can a robin, a squirrel, and a bee all live happily in the same little area of your backyard?

Even though they may live close together, each animal has its own home and food. This is called the animal's "**niche**" (pronounced neesh).

- A robin nests in a tree or bush, and eats insects, worms and berries. Earthworms are a favorite food of robins.
- A squirrel nests higher in the tree and on a stronger branch. Squirrels eat nuts, berries and insects, but not earthworms.
- Bees also may nest in a tree. They will build a nest in a hollow, or hanging down from a branch. Bees eat nectar they collect from flowers and turn it into honey for their young.

Robins, squirrels and bees can live in the same tree and not compete for food or space. Each animal has its own niche. The special features of each animal are called **adaptations.**

Many different plants and animals may live In a habitat.
"Bio" means life. "Diversity" means differences.
BIODIVERSITY is a way to count how many different plants and animals live in a habitat.

In this unit, you will learn:

- how scientists **classify** plants and animals by looking at their adaptations;
- how plants and animals form **food chains;**
- how food chains form **food webs**; and
- what happens when a link in the **food chain is broken.**

5.1 Classified Information: Fishing for a Name & Creature Feature

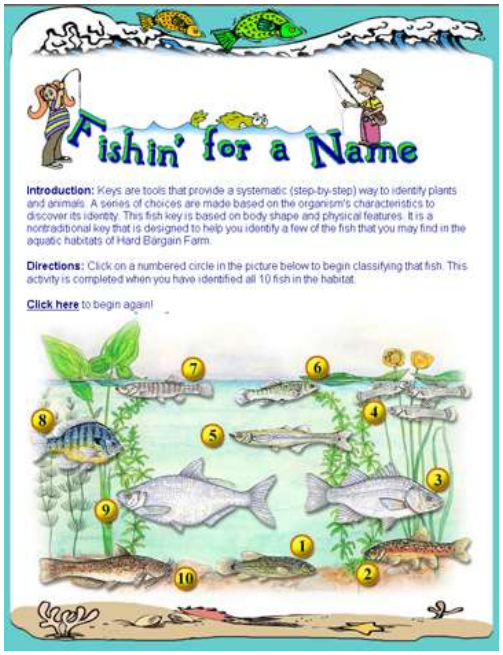
Web-based Activities to Teach Scientific Identification & Classification

Overview

Classified Information is a collection of lessons that introduces students to classification and identification skills. ***Creature Feature*** introduces the basics of classification by having students sort imaginary creatures, while ***Fishin' for a Name*** requires them to apply their skills to identify species of fish.

Sample Website Images

The images below show sample Web pages from this activity.



5.2 Let's Take a Dip

Virtual Macroinvertebrate Population Sampling

Overview

Students will virtually "dip" nets in four different aquatic habitats, collect data, and draw conclusions. This serves as preliminary research by familiarizing students with scientific sampling protocol and organisms they may encounter when they are conducting the ***Macroinvertebrate Field Study***, pg. 5-43 .

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	Pre-Field Study: 45 minutes Post-Field Study: 45 minutes
Key Concepts/Terms	Diversity, Population, Frequency, Habitat, Classification
Prerequisites	Understanding of the Energy Cycle: Food Chains/Food Webs
Setting	Computer Lab/Classroom with Computer Access, Individual/Student pairs

Learning Objectives

After completing this activity, students will be able to…

- Explain how to sample the macroinvertebrate population of a body of water; and
- Compare typical species inhabiting creek, swamp, marsh, and river habitats.

Materials Required

The following materials are required to complete this activity:

<u>For each student/pair</u>

- ***Habitat Populations Frequency Table***, pg. 10
- ***Student Sheets – Data Analysis Questions,*** pg. 11
- Access to a PC with Internet capability

<u>For the class</u>

- Enlarged poster/transparency of the ***Habitat Populations Frequency Table***

Note: Lesson, resources, and activity are available at: www.fergusonfoundation.org.

Continued on next page

Background Information

For further information, refer to ***Student Sheets: What Macroinvertebrates Can Tell You About Stream Health***, pg.5-48.

Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td rowspan="4">Engage</td><td>1</td><td>"Today we are going to collect data on the number and types of organisms found in four different aquatic habitats. Scientists conduct this type of research to learn about the health of the environment and look for patterns of relationships in the habitat."</td></tr>
<tr><td>2</td><td>Give each student/pair a copy of the Habitat Populations Frequency Table, pg.10.

This table allows the students to easily keep track of the data they collect.</td></tr>
<tr><td>3</td><td>Discuss the meaning of the words habitat, population, and frequency.

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td>Habitat</td><td>A place that has the minimum required amounts of food, water, shelter and space for a particular species.</td></tr>
<tr><td>Population</td><td>The total number of individuals of one species occupying a particular area.</td></tr>
<tr><td>Frequency</td><td>The ratio of the number of times an event occurs in a series of trials to the total number of trials in the experiment. For example, a banded killifish was caught in four out of ten dips in the marsh.</td></tr>
</table>
</td></tr>
<tr><td>4</td><td>Review the classifications for the organisms (amphibian, fish, mollusk, reptile, crustacean, insect, plant, etc).</td></tr>
</table>

Continued on next page

Procedure (continued)

Phase	Step	Action
Engage	5	Model data collection on your poster/transparency. Each dip should be recorded as one tally mark, regardless of how many organisms are pictured on the screen. ***Note:*** Advise them to click carefully, one at a time, and to record their data as they go.
Explore	6	Write the Website address on the board: www.fergusonfoundation.org Have students access the Website using the school's Internet browser.
	7	When the HBF Webpage appears on the screen, students will go to the "***Kids' Zone***", then to the "***Let's Take a Dip***" activity.
	8	Instruct them to read the information and directions on the screen, then to proceed at their own pace following those instructions. **Reminders to students**: • start in the creek first, • click carefully, • record data after each dip (click), • dip and record 10 times in the creek, then repeat in the next habitat, • read the information about each critter caught, • write the classification for each creature in the column on the data sheet. ***Note:*** This provides an excellent opportunity for them to read to follow instructions and read to acquire information. Students should work independently as much as possible.
	9	If they didn't catch a particular creature, they can go to the online "*Critter List,"* to read about it.

Continued on next page

Procedure (continued)

Phase	Step	Action
Explain	10	Have students think about what conclusions they can make using only their data, and complete the ***Data Analysis Questions***, providing supporting evidence that helps justify their answers.
	11	Combine data from the class using a large poster version of the frequency table or a transparency and overhead projector.
	12	Draw conclusions as a group about the organisms and habitats using the ***Data Analysis Questions*** as a guide. **Do the group conclusions differ from their individual conclusions?** *They should be somewhat different. Encourage students to explain how.* **Are conclusions based on more collected data more accurate than those based on less data?** *Yes, conclusions are more accurate when based on more data. A larger sample size will give you a more accurate representation of the entire whole than just taking a small sample.*
Elaborate	13	Conduct a field study on a stream, creek, marsh, and/or river. Compare your actual sampling results with the virtual results from this activity. See ***Macroinvertebrate Field Study***, pg. 5-43.
Evaluate	14	Use the ***Tally Sheets*** and the ***Data Analysis Sheets*** to evaluate student performance and understanding.

Continued on next page

Sample Website Images

The pictures shown below are samples of pages from this Web-based activity.

Habitat Population Frequency Table

Tally and classify the organisms caught in each of the four habitats: creek, swamp, marsh, and river. Classify the organisms as AMPHIBIAN, CRUSTACEAN, FISH, INSECT, MOLLUSK, PLANT, or OTHER.

		HABITAT TYPE			
NAME OF ORGANISM	**CLASSIFICATION**	**CREEK**	**SWAMP**	**MARSH**	**RIVER**
American Toad					
Arrow Arum					
Backswimmer					
Blacknose Dace					
Bluegill					
Caddisfly Larva					
Cranefly Larva					
Crayfish					
Dragonfly Nymph					
Eastern Mudminnow					
Freshwater Mussel					
Green Frog					
Hydrilla					
Isopod					
Mosquitofish					
Mud					
Mummichog Minnow					
Pill Clam					
Scud					
Silverside Minnow					
Snail					
Southern Leopard Frog					
Tadpole					
Water Boatman					
Water Strider					
Whirligig Beetle					
OTHER.					

Student Sheet – Let's Take a Dip: Data Analysis

1. Where did you catch the **most animals**?

2. Where did you catch the **most different kinds** of animals?

3. Check the habitat where you caught the **most** of **each type** of animal:

Animal Type	Habitat			
	CREEK	**SWAMP**	**MARSH**	**RIVER**
Amphibians				
Crustaceans				
Mollusks				
Reptiles				
Plants				
Insects				
Fish				

4. Make bar graphs to display the data you collected for **two habitats**.

Habitat 1. _____

Number of Animals

Animal Name

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____

Species of Animal

Continued on next page

Habitat 2. _____

Number of Animals										
Animal Name	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Species of Animal

5. How do your two graphs compare?

6. What are some reasons that might explain the differences you observed between the two habitats?

7. Compare your graphs with those of other students in your class. Do they look the same?

8. Which method is best to find a true picture of the animals that live in each habitat?

    a. ____ Use your data because you did a good job collecting animals
    b. ____ Use another student's data because she usually gets things right
    c. ____ Combine the data from all the students because the more samples you use, the greater the accuracy of your results.

9. You know that killifish are predators of amphipods. Make a prediction of what would happen if the killifish population suddenly doubled.

10. What if instead the amphipods suddenly disappeared? What would happen to the killifish?

Teacher Answer Key for

Student Sheet – Let's Take a Dip: Data Analysis

6. What are some reasons that might explain the differences you observed between the two habitats?

Animals have favorite places to live: they are adapted to prefer certain habitats. Some animals cannot live in another habitat, or are present in much smaller numbers.

7. Compare your graphs with those of other students in your class. Do they look the same?

Graphs will vary because net dips are random, and will catch different assortments of animals.

8. Which method is best to find a true picture of the animals that live in each habitat?

    a. ____ Use your data because you did a good job collecting animals
    b. ____ Use another student's data because she usually gets things right
    c. _X_ Combine the data from all the students because the more samples you use, the greater the accuracy of your results.

9. You know that killifish are predators of amphipods. Make a prediction of what would happen if the killifish population suddenly doubled.

The killifish would eat a lot more amphipods. Eventually they would eat so many that the killifish would no longer have enough amphipods to eat. Then they would either eat some other animal, or die of starvation.

10. What if instead the amphipods suddenly disappeared? What would happen to the killifish?

They would lose their food supply. The killifish would have to migrate to another area, find another kind of food, or die of starvation.

Continued on next page

5.3 Eat Like a Bird

Modeling Animal Adaptations

Overview

Students will model how adaptations affect what an animal is able to eat, and hypothesize the potential effects of dramatic habitat change on an animal's ability to survive.

Lesson Planner

Use the table below for lesson planning purposes.

Grade Level(s)	3rd – 6th
Time Required	30-40 minutes
Key Concepts/Terms	Adaptation, Niche, Habitat
Prerequisites	None
Setting	Indoors/Outdoors, Whole Class

Learning Objectives

After completing this activity, students will be able to…

- Correlate an organism's adaptations with its food preferences; and
- Explain how an adaptation may affect an animal's survival in the event of habitat change.

Materials Required

The following materials are required for this activity:

- Masking Tape
- Wrapped Candy (i.e., Starburst™, Now & Later™, etc.)
- Unwrapped Small Candy (M&M's™)
- Unwrapped Stick Candy/Pretzels
- 8 Paper Plates

Note: As with any activity involving food, it is important not to use anything to which students in your group are allergic.

Continued on next page

Background Information

Adaptations

Adaptation is an evolutionary process through which organisms become better suited to their environment over **MANY GENERATIONS**. A characteristic that causes an individual to live successfully is passed on to its offspring. As these offspring are also well suited to the environment, they have a greater likelihood to survive and pass the trait on to future generations. Over time, a larger portion of the population has this trait.

Example of an adaptation:

Hummingbirds drink nectar, a sweet substance produced by flowers to attract pollinators. Hummingbirds that had longer, more slender beaks were able to reach deeper into the flowers and get more food. These individuals were more likely to live and reproduce successfully and pass on the trait of long slender beaks to their offspring.

Note: This topic is an area of frequent misconception with students. It is important that they understand that adaptation **does not mean** adjustment by **one individual organism** to a habitat, but is a **gradual change in the population** over time (many generations) because some individuals are better suited to survive, and those individuals are the ones that reproduce and pass along the traits that enable success to their offspring.

Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td>Engage</td><td>1</td><td>Say: “Name the first thing you think of when I say each of the following animals.”

The table below lists some animals you might choose, and common student responses:

<table>
<tr><td>Animal</td><td>Adaptation</td></tr>
<tr><td>Giraffe</td><td>Long Neck</td></tr>
<tr><td>Porcupine</td><td>Spines/Quills</td></tr>
<tr><td>Turtle</td><td>Hard Shell</td></tr>
<tr><td>Snake</td><td>No Legs</td></tr>
</table>
</td></tr>
</table>

Continued on next page

Procedure (continued)

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td>Engage</td><td>2</td><td>“The characteristics you have just named are adaptations. An adaptation is a characteristic that an organism inherits from its parents that helps it fit into its habitat and survive. What advantage would the adaptations we have just discussed give to each organism?”

The table below lists some animals you might choose, and common student responses:

<table>
<tr><td>Animal Adaptation</td><td>Advantage</td></tr>
<tr><td>Giraffe’s Long Neck</td><td>Allows the giraffe to reach food that is located higher than most other animals can reach.</td></tr>
<tr><td>Porcupine Quills</td><td>Defense from predators</td></tr>
<tr><td>Turtle Shell</td><td>Defense from predators</td></tr>
<tr><td>Snake’s Body Shape</td><td>Allows easy and very silent movement for sneaking up on prey, etc.</td></tr>
</table>
</td></tr>
<tr><td>Explore</td><td>3</td><td>Divide students evenly into four groups.</td></tr>
</table>

Continued on next page

Procedure (continued)

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td rowspan="4">Explore</td><td>4</td><td>“Each group is going to have a certain “adaptation,” and we are going to see how successful an animal with that adaptation is in accomplishing a certain task.”

Assign the tasks to the groups as follows:
<table>
<tr><th>Group #</th><th>Adaptation</th></tr>
<tr><td>1</td><td>All students have full use of their hands/fingers</td></tr>
<tr><td>2</td><td>Tape down students’ thumbs to the rest of their hands.</td></tr>
<tr><td>3</td><td>Tape students’ thumbs, index and middle fingers together. They have use of their ring and pinky fingers.</td></tr>
<tr><td>4</td><td>Hands must be behind their backs.</td></tr>
</table></td></tr>
<tr><td>5</td><td>“You are foraging for food in your habitat. You are successful if you transfer a piece of food from one plate to another without dropping it. The wrapped food must be opened and transferred without the wrapper. You will have 5 minutes to complete your foraging.</td></tr>
<tr><td>6</td><td>“We need to come up with a hypothesis about which groups will finish first and last. Who do we think will finish first? Last? Why do you think so?”

Record hypotheses and supporting reasoning.</td></tr>
<tr><td>7</td><td>Give each group 2 plates, one with an assortment of food types and one that is empty.

“When I say, “GO,” you each need to begin foraging. GO.”</td></tr>
</table>

Continued on next page

Procedure (continued)

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td>Explore</td><td>8</td><td>Record results: the type and quantity of each food item successfully “foraged.” Do not count any that have spilled/fallen outside the plates.</td></tr>
<tr><td rowspan="2">Explain</td><td>9</td><td>Lead students to analyze the data by asking the following questions:

• How does this compare with our hypotheses?

• Did everyone in the group forage in the same way?

• Which foods were impossible for your group to forage? Why?

• If the food represented by the small candies disappeared from your habitat, how would it affect your group?

• What if it was either of the other two food types that disappeared?

• Do any of the groups represent an animal that has a special “niche” – a food source that no other animals have?

• For which food was there the most competition?</td></tr>
<tr><td>10</td><td>“What animals could represent each group?”

The table below lists common student responses:

<table>
<tr><td>Group #</td><td>Animal Represented</td></tr>
<tr><td>1</td><td>Raccoon, Monkey (opposable thumbs)</td></tr>
<tr><td>2</td><td>Mouse, Dog, Cat</td></tr>
<tr><td>3</td><td>Crab, Lobster</td></tr>
<tr><td>4</td><td>Snake, Fish</td></tr>
</table>
</td></tr>
</table>

Continued on next page

Procedure (continued)

Phase	Step	Action
Explain	11	**"What would be the ideal type of food for the animal that represents your group?** *Student answers should reflect a food type that fits with their animal's method of getting it – digging, grasping and tearing, swallowing whole, etc.*
	12	**"What would happen if the habitat in which your animal lives experienced a natural or man-made disaster that eliminated its preferred food?"**
Elaborate	13	Choose a habitat and ask students to research animals that live there to determine each animal's niche. For example, in a forest squirrels eat acorns, raccoons eat insects and crayfish; and deer eat leaves. All three animals live near each other, but usually don't compete for food since they are in different niches.

Vocabulary

Understanding of the following terms is useful in this activity.

Term	Definition
Adaptation	A genetically determined characteristic that enhances the ability of an organism to cope with its environment; an evolutionary process by which organisms are better suited to their environments
Forage	To search for food
Habitat	A place that supplies all an animal needs to survive: food, water, shelter, and space in a suitable arrangement
Niche	The role an animal plays in its environment including where it lives, what it eats, and what it does; its "profession"

5.4 Animal Adaptations Field Study

How Adaptations Help a Species Find its Niche

Overview

Students will study fish to discover how animals are adapted to survive in their environment. They will recognize these adaptations as characteristics used by scientists to classify fish.

Lesson Planner

Use the table below for lesson planning purposes.

Grade Levels	Grades 4-6
Time Required	45 minutes
Key Concepts/Terms	Adaptation, Niche, Food Webs, Biodiversity
Prerequisites	***Classified Information*** (pg.5-4)
Setting	Indoors/Outdoors, Small Groups

Learning Objectives

After completing this activity, students will be able to…

- Recognize and describe adaptations of fish anatomy;
- Interpret how adaptations can help fish survive in their habitats;
- Identify and classify fish based upon their adaptive characteristics; and
- Understand the concept of **niche**: each species' role in the environment.

Materials Required

The following materials are required to complete this activity.

- ***Student Sheets – Read a Fish***, pg. 5-28.
- Field Guides or Reference Books to identify fish species
- A variety of fish to study (one per group). Fish can be:
  - live fish from school aquaria or a nearby stream;
  - preserved fish, or specimens purchased in a market; or
  - pictures of fish

Continued on next page

Background Information

Adaptations

Adaptations increase the likelihood of survival of a species by helping an organism become better suited to its role (or niche) within a habitat.

Fish adaptations include:

- Coloration, such as camouflage;
- Body shape, fin structure, scales;
- Mouth shape and position, teeth and jaws; and
- Movement and behavior.

Habitat

A habitat is a place that provides:

- Food,
- Water,
- Shelter, and
- Space

Niche

A niche is an organism's role in its habitat. It includes food preferences, requirements for shelter, special behaviors, and the timing of its activities (nocturnal/diurnal).

There are numerous ways plants and animals are adapted to their habitat. This variety of adaptations creates a unique niche for each species. However, as habitats change, not all species remain successful. Sometimes, very specialized adaptations are more vulnerable to changes in habitat, making an organism less likely to survive the change.

Continued on next page

Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td rowspan="3">Engage</td><td>1</td><td>***Note:*** If students have completed ***Eat Like a Bird***, pg. 5-15, skip this *Engagement*, and continue on to the *Exploration* phase.

“Name the first thing you think of when I say each of the following animals.”

List student responses on the board.

The table below lists some animals and common student responses:

<table>
<tr><td>Animal</td><td>Adaptation</td></tr>
<tr><td>Giraffe</td><td>Long Neck</td></tr>
<tr><td>Zebra</td><td>Stripes</td></tr>
<tr><td>Owl</td><td>Large Eyes</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>“The characteristics you have just named are adaptations. An adaptation is a characteristic that an organism inherits from its parents that helps it fit into its habitat and survive.”</td></tr>
<tr><td>3</td><td>“What are the values of the adaptations we’ve just listed? What do they do for the animals?”

The table below lists the adaptations from step one, along with student answers.
<table>
<tr><td>Adaptation</td><td>Value</td></tr>
<tr><td>Long Neck (Giraffe)</td><td>Allows the giraffe to reach food that is high above the ground, as well as allowing it to see a great distance.</td></tr>
<tr><td>Stripes (Zebra)</td><td>Stripes provide camouflage in blowing grasses.</td></tr>
<tr><td>Large Eyes (Owl)</td><td>The large eyes enable the owl to see very well in the dark, which is important for finding prey.</td></tr>
</table>
</td></tr>
<tr><td>Explore</td><td>4</td><td>Divide students into small groups to study fish.</td></tr>
</table>

Continued on next page

Procedure (continued)

Phase	Step	Action
Explore	5	Using ***Internal and External Fish Anatomy*** diagrams, pgs. 26 & 27, ask students to draw their fish, labeling the body parts and functions.
	6	Using ***Student Sheets – Read a Fish***, pg. 5-28, have students assess their fish for behavior and lifestyle characteristics.
Explain	7	Ask students to: • choose one body part of their fish and explain how this adaptation helps the fish survive in its habitat; • describe their fish's niche; and • identify the fish species using field guides/reference books.
Elaborate	8	With students, create a class drawing that shows the unique niche of each fish species. Include details of the habitats and food chains, and how each species is interrelated to the whole.
Evaluate	9	Performance Assessment: Conduct the activity ***Frankenfish***, pg.5-53.

Continued on next page

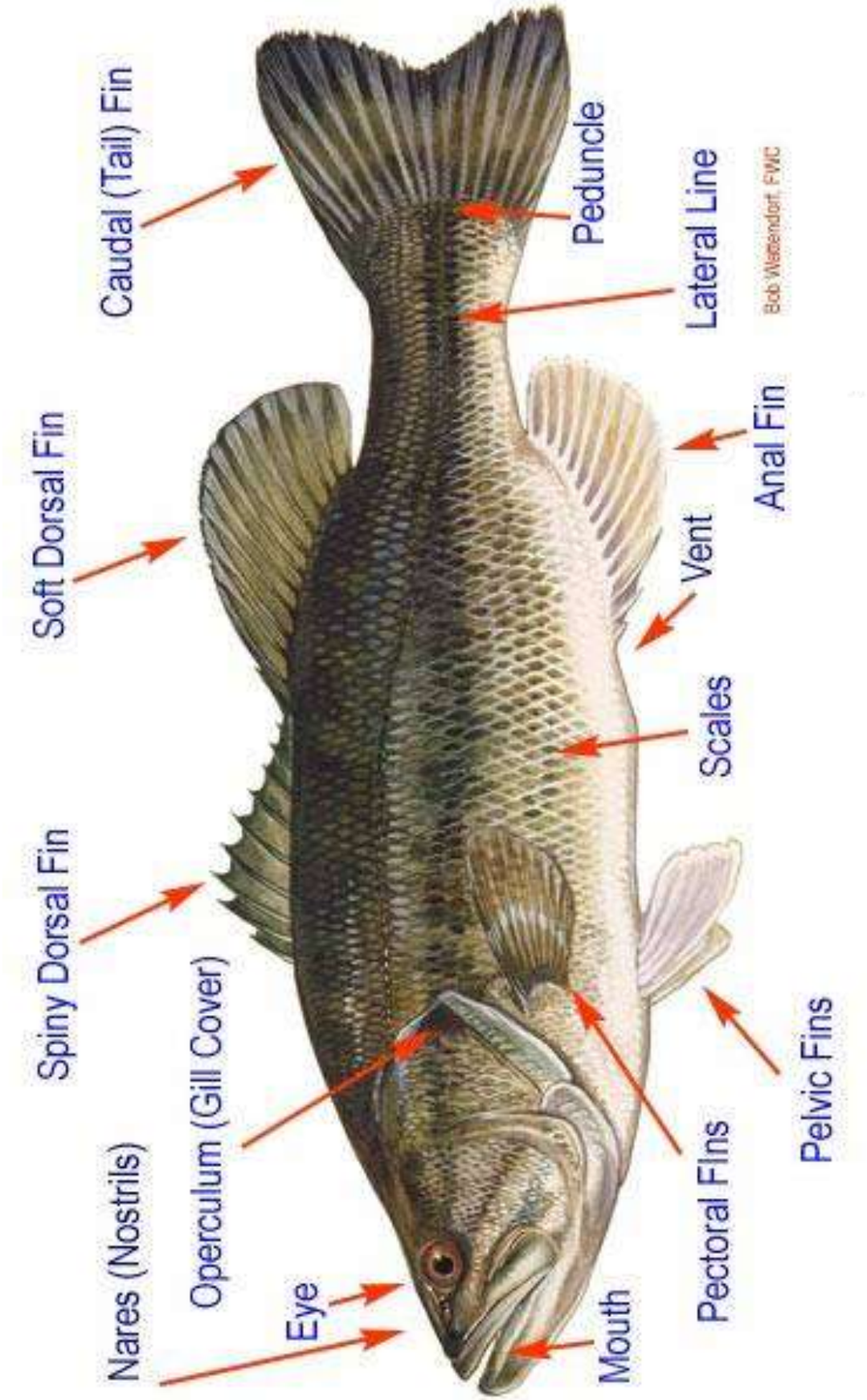
Vocabulary

Understanding of the following terms is useful in this activity.

Term	Definition
Adaptation	A characteristic that enhances the ability of an organism to cope with its environment
Anal Fin	Fin closest to the caudal fin (tail) on the underside of a fish; used for stability in the water; prevents rolling to one side or another
Barbel	Whisker-like structure around the mouth of a fish used to feel and taste
Camouflage	Colors, shapes or structures that enable an animal to blend in and hide in its surroundings
Carnivore	An organism that eats only other animals
Caudal Fin	A fish's tail fin; used to move the fish around
Dorsal Fin	Fin(s) on the back of a fish; used to help turn and maintain alignment in the water
Habitat	A place that supplies all an animal needs to survive: food, water, shelter, and space in a suitable arrangement
Herbivore	An organism that eats only plants
Omnivore	An organism that eats both plants and animals
Operculum	The hard, flap-like covering that protects the gills of fish (gill cover)
Opportunistic Feeder	An organism that eats whatever is available
Pectoral Fins	The pair of fins on the sides of a fish's body, located near the front; used to help the fish turn
Pelvic Fins	The pair of fins on the underside of a fish's body, located mid to rear; used to help the fish steer and stop movement
Pharyngeal	Having to do with the cavity at the back of the mouth, leading to the stomach
Predator	An animal that catches other animals for eating
Prey	An animal that is eaten by another animal
Ventral	The underside or belly of an animal

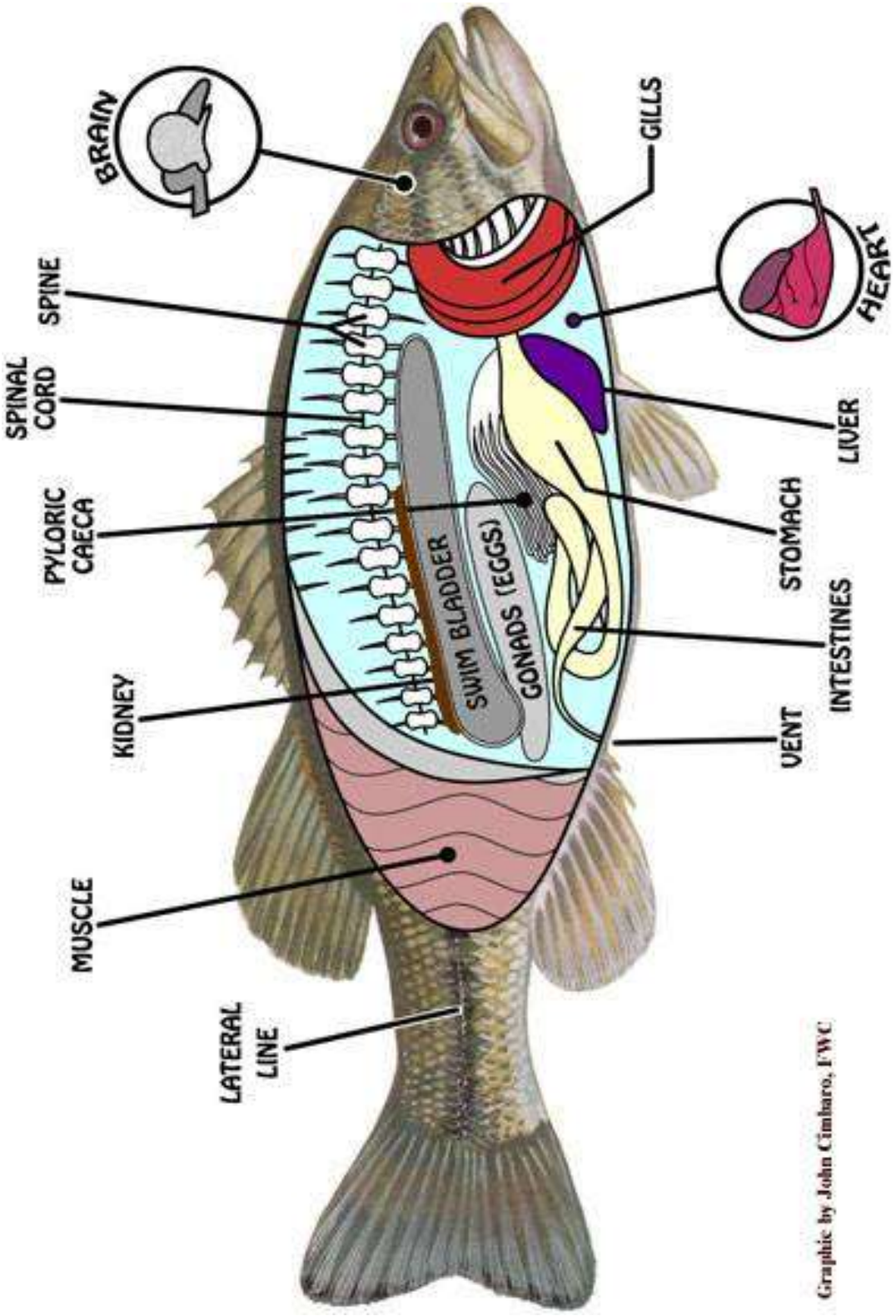
External Anatomy

Diagram from Florida Fish & Wildlife Conservation Commission



Internal Anatomy

Internal Anatomy Diagram from Florida Fish & Wildlife Conservation Commission



Look at your fish, and compare it to these features. Check which ones fit your fish.

Shape of Body
(tells where a fish may live)

- ▫ body tapered at the ends

- ▫ round and thin

- ▫ flat or wide-bottomed

- ▫ long and slender

Shape of Tail
(tells how a fish swims)

- ▫ rounded = swims in weedy beds

- ▫ forked = speed and long distance

Position of Mouth
(tells where a fish feeds)

- ▫ mouth faces upward = surface feeder

- ▫ mouth faces downward = bottom feeder

- ▫ mouth opens forward = picks food off objects

Shape of Mouth
(tells what a fish eats)

- ▫ horizontal oval = scavenger

- ▫ vertical oval = predator

- ▫ round = picks food off objects or eats plankton

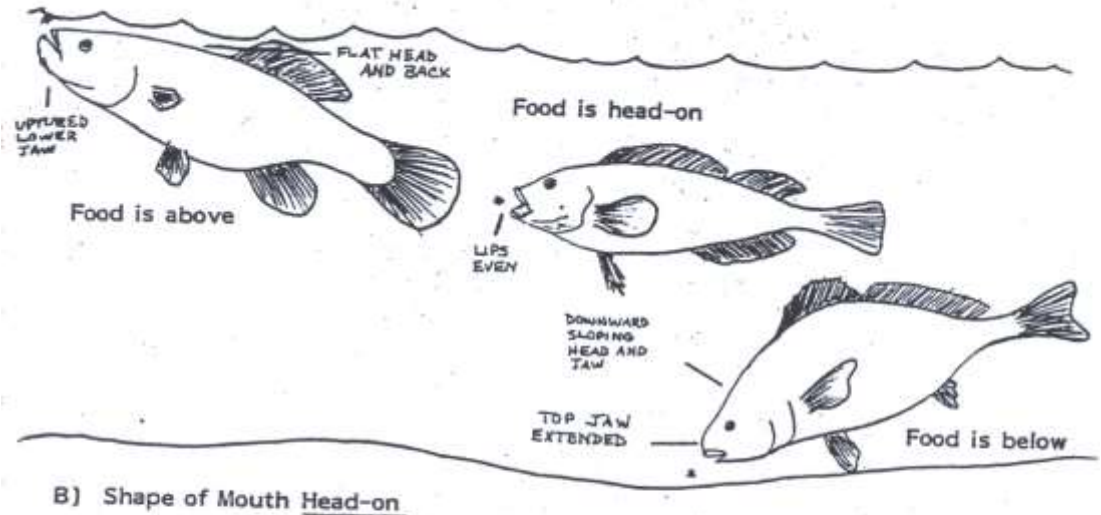
Teeth
(tells how a fish eats its food)

- ▫ sharp, cutting teeth = rips at prey
- ▫ many tiny teeth = grasps and gulps
- ▫ no teeth = strains water for plankton or sucks up food

Continued on next page

Here's how to interpret your fish's adaptations:

A) Position of fish relative to its food



B) Shape of Mouth Head-on

Horizontal Oval	Vertical Oval	Round
Scavengers, bottom bottom dwellers shellfish eaters	Predators – fisheaters or for filtering plankton	Selective plankton eaters or for picking sessile organisms

C) Teeth

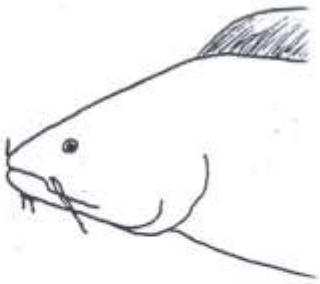
Predators often have small sharp teeth for seizing prey – which is usually swallowed whole.

Herbivors (who eat vascular plants) and shellfish eaters may have massive mouths with stout grinding teeth farther back in the jaw.

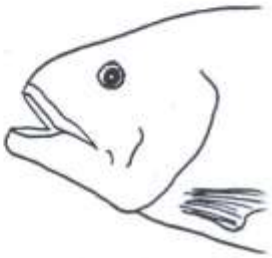
Filter feeding plankton eaters have large delicate mouths with hairs on the inner cheeks called gill rakers. The gill rakers sieve food from the water.

Continued on next page

III EYES



Small - Nocturnal, bottom, and cave dwelling fish. May have barbels which have glands to taste and smell. Usually slow swimmers.



Medium - Top feeders.

Large - Fish which live on the edge of darkness. Also associated with fast swimmers.

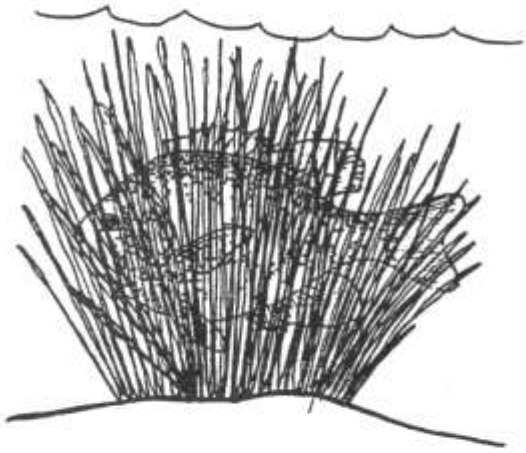
IV BEHAVIOR

• Constantly swimming in circles	High energy consumption, many plankton eaters, long distance swimmers
• Tries to hide	Territorial fish, many bottom dwellers
• Still	Low energy consumption can stand poor D.O. conditions for long periods

Continued on next page

A) Fish may rely on

1) outrunning enemies
2) out-maneuvering them, or
3) hiding in crevaces or sediments.



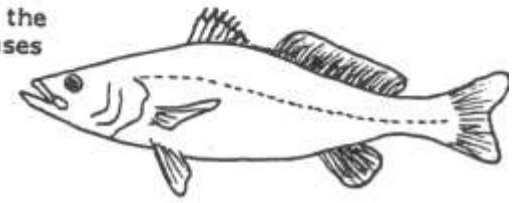
B) Camouflage

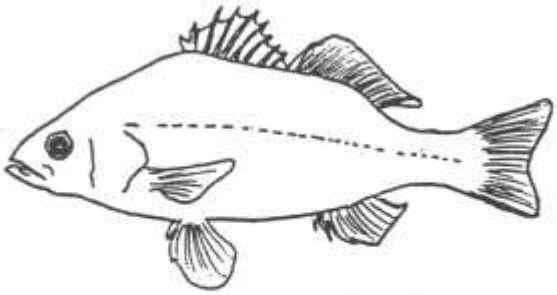
1) markings
2) colors
3) shapes

help fish blend with their surroundings.

C) Lateral Line

Some fish have this line, between the gill covers and the tail, which senses vibrations (movements) in the water.





D) Spines

When locked in place increase the size of a fish. Hard, clear spines can be in combination with softer flexible rays in any of the fins on your fish.

Spines

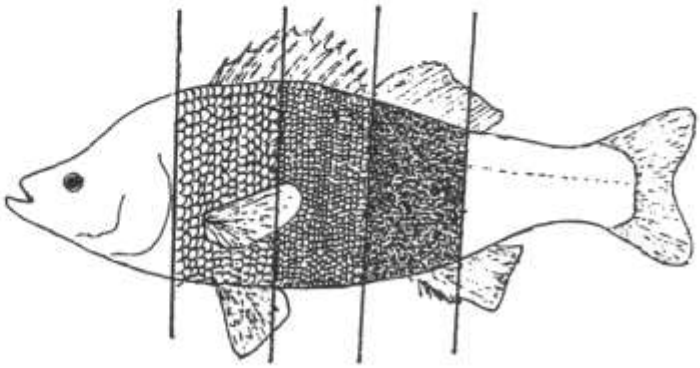
Rays

Continued on next page

(Defenses Continued)

E) Scales –

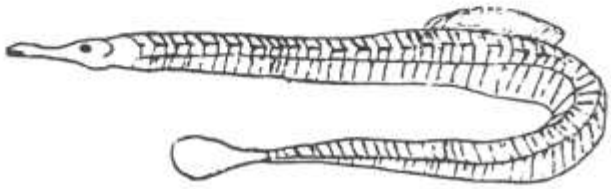
Protect fish, but also add weight and friction (speed loss). Faster constantly swimming fish usually have smaller scales. Scale is estimated relative to body size.



No scales – Rough skin – scales replaced by tiny erect spines, giving skin the feel of sand paper.

Smooth skin – fish is protected by an extra thick layer of slime. and extremely tough skin. These fish may have habits like backing in and out of holes.

Plates – In some species large bony plates protect the fish which is often an extremely slow swimmer.



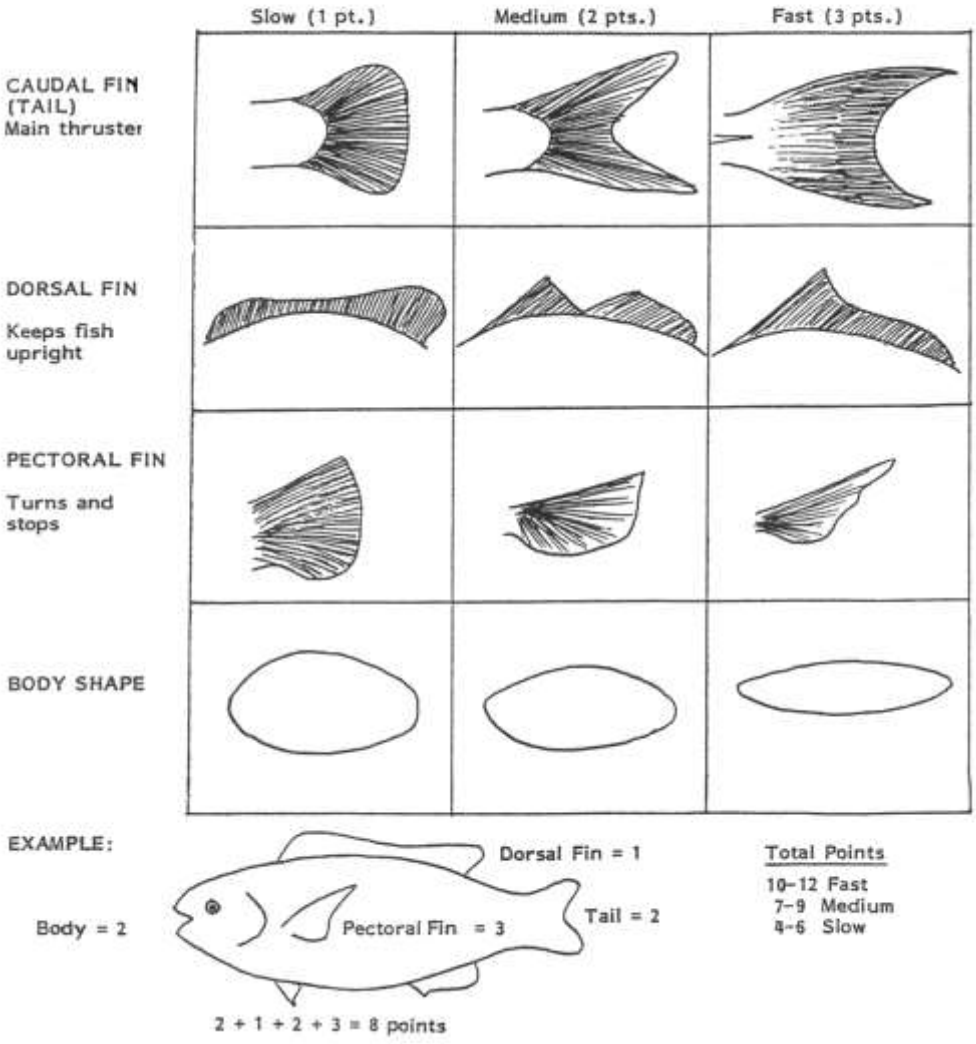
Continued on next page

Compute the speed of your fish:

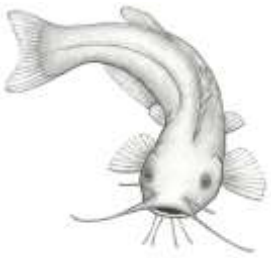
A GUIDE TO UNDERSTANDING FISH HABITS BY FORM/FUNCTION AND BEHAVIOR

I SPEED The shape of a fish's body and fins determines its speed and maneuverability. Use the chart below to rate your fish's swimming equipment.

The more streamlined shapes have the highest top speed and are most suited for fish that swim constantly. The slower shapes are more suited to short bursts of speed, sharp turns and quick stops.



Continued on next page



Using all the information you have gathered about your fish:

1. What would be a good name for your fish?
2. Where does your fish live – near the top of the water? The bottom? In open water? Under cover? Explain how you know.

3. What does your fish like to eat?
4. What kind of defenses does your fish have? Explain your answer.

5. Does your fish migrate, or does it live here all year?

5.5 Oh Deer!*

A Role-Playing Game to Model Wildlife Population Cycles

* Reprinted, with permission, from Project WILD

Overview

Students will participate in a fun, interactive game that simulates population dynamics of a deer population, focusing on habitat requirements and predator/prey interactions.

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	30-45 minutes
Key Concepts/Terms	Habitat, Limiting Factors, Predator, Prey, Population, Energy Cycle
Prerequisites	Predator/Prey Concept
Setting	Outdoors (or Large Indoor Space), Whole Class

Learning Objectives

After completing this activity, students will be able to…

- Identify and describe the four components of habitat: food, water, shelter and space;
- Define and give examples of limiting factors;
- Recognize and explain some possible causes for natural cyclic fluctuations of populations; and
- Explain predator/prey relationships and their effects on population.

Materials Required

The following materials are required to complete this activity.

- Large open area
- Chalkboard/whiteboard/flip chart
- Chalk/Markers

Background Information

Animals have four requirements for survival in a habitat:

- Food
- Water
- Shelter
- Space

Continued on next page

Background Information (continued)

These factors are not generally available in limitless quantity, which limits the survival and reproductive rate of the animal in question. These are then considered **limiting factors**.

There are other limiting factors that control population size, including:

- Disease
- Predator/Prey Relationships
- Weather Conditions
- Accidents
- Environmental Pollution

Populations go through natural cycles depending on the limiting factors present in the habitat. This activity will allow students to understand population dynamics and limiting factors in relation to a hypothetical deer population.

Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

Phase	Step	Action
Engage	1	Ask students to list a few essential things that they need to survive. Emphasize that this is for survival, not comfort.
	2	Relate their list to the four basic things animals need in any habitat: • Food, • Water, • Shelter, and • Space
	3	Mark two parallel lines on the ground or floor from 10-20 yards apart. Have students count off in fours. Have all the one's go to one line, and all the two's, three's and four's go together to the other line, facing the one's.

Continued on next page

Procedure, (continued)

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td rowspan="4">Explore</td><td>4</td><td>All of the one's become "deer."

Ask students to remind you of the essential components of habitat. As students say each of the four components, demonstrate the motion that represents it, as explained in the table below. During any round, the deer can choose to look for any one of the four components, but they cannot change what they are looking for in the middle of a round.

<table>
<tr><td>Habitat Component</td><td>When students need this, they…</td></tr>
<tr><td>Food</td><td>put their hands over their stomach</td></tr>
<tr><td>Water</td><td>put their hands over their mouth</td></tr>
<tr><td>Shelter</td><td>put their hands together over their heads</td></tr>
<tr><td>Space</td><td>hold their arms out to the side (like an airplane or bird)</td></tr>
</table>
</td></tr>
<tr><td>5</td><td>The two's, three's and four's are the habitat components. Each student chooses at the beginning of each round which component he/she will be. They make the same motions to signal their choice as the deer.</td></tr>
<tr><td>6</td><td>The activity starts with all players lined up on their respective lines, with their backs to the students on the other line.</td></tr>
<tr><td>7</td><td>The teacher begins the first round by:

a. asking all of the students to make their sign: The deer should choose what they are looking for this round, and the habitat components should choose which of the four they are representing.
b. giving a few moments for students to arrange themselves.
c. explaining that everyone should turn to face the other line on the count of three, continuing to hold their signs clearly.
d. when students are ready, counting, "One…Two…Three."</td></tr>
</table>

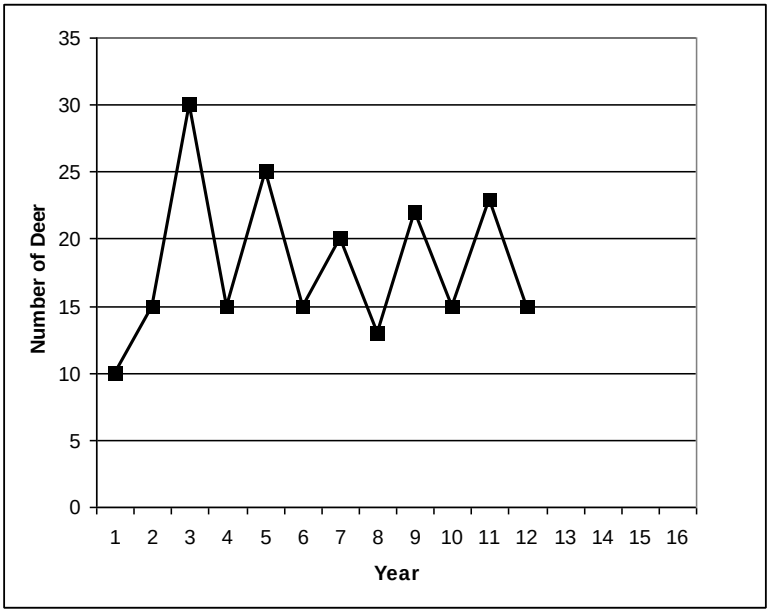
Continued on next page

Procedure (continued)

Phase	Step	Action
Explore	8	When the deer see the habitat component they need (matching their own symbol), they… a. Run to it while still holding the sign of what it is looking for, and then b. Take their "habitat component" back with them to the deer side of the playing space. This represents that the deer has successfully met its needs, and reproduced. Any deer that fails to meet its needs dies and becomes part of the habitat, returning to the other line.
	9	***Notes:*** • Students who represent habitat components may confer and make group decisions (i.e. none represent water), if they like. The teacher may also instruct these students to do this quietly to represent a drought, etc. • If you have a problem with students switching their signs mid-way through a round, you can use colored paper or tokens to represent habitat components, instead of hand signals. • If more than one deer reaches a habitat component, the student who gets there first survives. • Habitat components stay in their place until a deer needs them. If no deer needs them during a round, they remain on the line for the next round, but they can change which component they represent in that next round.
	10	The facilitator should record, on the board/flipchart, the size of the deer population at the start of the activity, and at the end of each subsequent round. Play should continue for about 15 rounds.
Explain	11	At the end of 15 rounds, gather students together to discuss the activity, and analyze the data regarding population size. Encourage them to talk about what they observed regarding the changes in population size and what caused these changes.

Continued on next page

Procedure, (continued)

Phase	Step	Action
Explain	12	Use the data you recorded to create a large graph, with the start of each new round being the start of a new year. Students should see that their "deer" population fluctuated over time, based on the limiting factors in the habitat. This is a natural process in which wildlife populations peak, decline, and rebuild continually, as long as there are enough individuals in the population to reproduce successfully. If there are not enough individuals to reproduce, you will have extinction, where there are no deer left. A sample graph is provided below: 
	13	Discuss the following points with students: • What do animals need to survive? • What are some "limiting factors" that affect their survival? • Are wildlife populations always the same or do they tend to fluctuate? Is this a natural cycle?

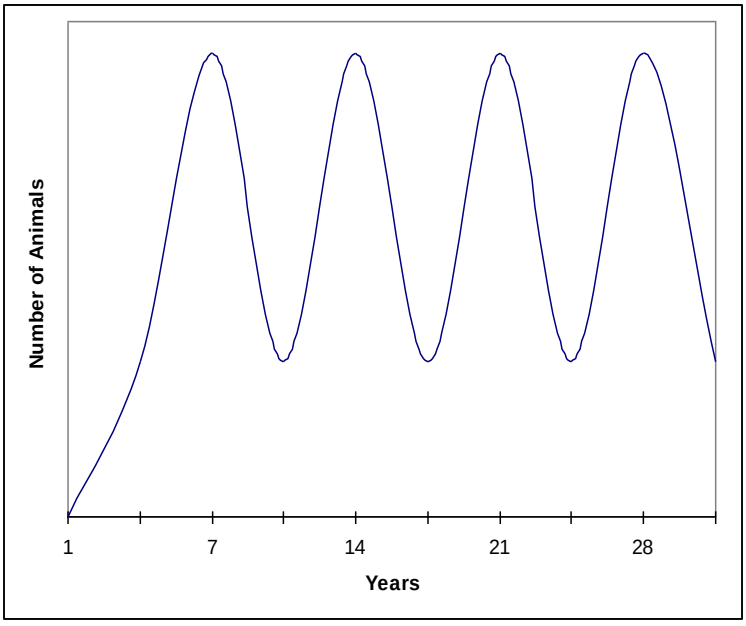
Continued on next page

Procedure (continued)

Phase	Step	Action
Elaborate	14	After the students have played several rounds of "Oh Deer!", introduce a predator such as a mountain lion or wolf into the simulation. Predator Rules: • The predator starts in a designated "predator den" area off to the side. • The predator has to skip or hop, which reduces the possibility of violent collisions between the deer and predator. Tell students that this replicates the "stealth" of the predator hunting. • The predators can only tag deer when they are going towards the habitat components and are between the two lines. • Once a deer is tagged, the predator escorts the deer back to the predator den, which represents the time it takes for the predator to eat. • "Eaten" deer become a predator, symbolizing predator reproduction. • If a predator fails to tag anyone, they die and join the habitat line. ***Note:*** The teacher should keep track of the predator population size during each round, as well as the deer population size, and include both on the graph as overlapping lines.
	15	Instead of drawing the graph as a class, have students create their own graphs. Provide them with data regarding year and population size(s).

Continued on next page

Procedure (continued)

Phase	Step	Action
Elaborate	16	Hudson Bay Trapper Data Read the description below and complete the accompanying graph and discussion. **There are a hundred years or more of records of the Hudson Bay trappers' activities. In those records are some interesting data. These data tell how many pelts were shipped from America to Europe each year, particularly snowshoe hare and lynx pelts. Researchers have found that snowshoe hare populations seemed to peak every seven to nine years, then decline, repeatedly.** **It has also been discovered that lynx populations do the same thing – except that they do it a year behind the hare populations.** Use the graph of the snowshoe hare population below, and graph the lynx population data on the same graph. Snowshoe Hare Pelt Graph 

Continued on next page

Procedure (continued)

Phase	Step	Action
Elaborate	17	Discussion Questions for Hudson Bay trapper data • **Which animal is the predator?** *Lynx* • **Which animal is the prey?** *Hare* • **Are predators controlling the prey population, or are the prey controlling the predator population?** *The number of prey animals available determines the number of predators that can live in an area, though we have traditionally been taught to "know" that predators control the prey.* • **Is this example like the deer activity we just played? How?**
Evaluate	18	• Have students name the four essential components of habitat. • Have students define and give examples of limiting factors.
	19	Aquatic Extension Conduct the activity along the same lines; just substitute an aquatic species of wildlife. You can either eliminate the need for water (they live in it), or specify that they need clean, unpolluted water. Examples of aquatic wildlife are: salmon, frog, crayfish.

References

Project WILD, Aquatic, 1992. Western Regional Environmental Education Council.

5.6 Macroinvertebrate Field Study

Investigating Macroinvertebrates to Assess Stream Health

Overview

Students will investigate living organisms in a local stream to learn how they are adapted to this environment and how they can be indicators of the stream's overall health.

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	2 hours
Key Concepts/Terms	Adaptations, Stream Health, Habitat, Energy Cycle
Prerequisites	***Classified Information, Let's Take a Dip***
Setting	Indoors and Outdoors, Small Group

Learning Objectives

After completing this activity, students will be able to…

- Be able to collect and identify organisms commonly found in freshwater streams and describe their special adaptations to the aquatic environment; and
- Assess the health of a stream by comparing the organisms' sensitivity to pollutants.

Materials Required

The following materials are required to complete this activity:

- Kick Seines and/or D-Ring Aquatic Dip Nets
- Containers for Organism Collection and Observation
- Plastic Forceps and Small Paint Brushes for Handling Organisms
- Hand Lens or Magiscope™
- Macroinvertebrate Identification Guide
- Data Sheets
- Student Journals & Pencils

Background Information

Macroinvertebrates (animals without a backbone that are large enough to see without a microscope) are used to assess stream health because they vary in sensitivity, tend to stay in one location, and are relatively long-lived. By sampling the macroinvertebrates living in an aquatic habitat, we can estimate the relative health of a stream as well as monitor it for changes in water quality over time.

Continued on next page

Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

Phase	Step	Action
Engage	1	Complete the Web-based activity, ***Let's Take a Dip***, pg.5. The activity itself is found at www.fergusonfoundation.org. During this activity, students will become familiar with population sampling techniques and the types of organisms and habitat present locally. This activity serves to provide preliminary research for students prior to the field study.
	2	Have students read and discuss ***Student Background Information: What Macroinvertebrates Can Tell You About Stream Health***, pg. 5-48.
Explore	3	Choose a study site. Be sure you have permission from the landowner to use your chosen site before conducting the field study.
	4	<u>At the Field Study Site</u> Have students hypothesize about the quality of the creek based on first impressions. They can do this on a scale from 0 to 10, with 1 being very poor and 10 being excellent, or just make a general observation such as excellent, fair, or poor.
	5	<u>Preliminary Observations</u> Have students make observations in their **journals**, before anyone disturbs the water. Use the list below for journaling guidelines: • Time of day, date, season and recent weather • Width, depth and current patterns of the stream. • Condition of the stream bank – plant cover? erosion? • Condition of the stream bottom – sandy? pebbly? silty? • Tree canopy cover and shade/sunlight patterns on the water • Signs of life in the stream • Color and odor of the water Alternatively, use the ***Student Sheet: Looking at Habitat to Assess Stream Health***, pg. 5-50.

Continued on next page

Procedure (continued)

Phase	Step	Action
Explore	6	Macroinvertebrate Sampling • Stress **safety**: point out deep pools or steep banks. • Remind students that we are trying not to harm living things. • **Caution** students to step in the water as little as possible, so that they do not chase away the organisms they hope to catch. This is also very stressful to the organisms living in the creek. The fewer disturbances, the better. • **Collect clear water BEFORE netting anything**. This way you have a safe place to store organisms while studying them and you can actually SEE them, which will be difficult if they are in silty water. • **Demonstrate** how to use the nets.
	7	• **Assign** each student group a specific sampling area, and • **Allow** them two sampling trials, so as not to overuse the stream. Try to be consistent in technique so that sampling is more scientific than it would be with a more random sampling technique.
	8	Have students gently place all organisms in the collection bucket/trays as they catch them. ***Note:*** Remind students that these organisms cannot breathe out of the water. They need to be transported relatively quickly.
Explain	9	Use forceps and paintbrushes to handle organisms as gently as possible. Use the Macroinvertebrate ID guide to identify the organisms you have found after you have completed the sampling as a class. Record the number and species of each organism on the ***Student Sheet: Macroinvertebrates as Stream Health Indicators***, pg. 5-52.
	10	After tallying all the organisms… • determine their relative sensitivity to pollution; and • discuss special adaptations noticed as you examine each type of organism, and how it fits the habitat.

Continued on next page

Procedure (continued)

Phase	Step	Action
Explain	11	Determine a rating for the stream health using the ***Student Sheet: Analyzing Macroinvertebrate Data to Assess Stream Health***, pg. 5-51.
Elaborate	12	Monitor the site by sampling at different times of the year, or by comparing your data with that taken by others at the same site.
Evaluate	13	Use the ***Student Sheets*** to evaluate student performance.

Continued on next page

Vocabulary

Understanding of the following terms is useful in this activity.

Term	Definition
Adaptation	Characteristics that make an animal fit in a particular situation or habitat
Aquatic	Having to do with water
Bank	The sloping area that edges a stream. A bare bank will allow erosion of soil and sediment into the stream. A bank well covered in vegetation will prevent this runoff, and protect the stream
Biological Indicator	A living thing whose presence or absence tells something about the quality of the environment
Biomonitoring	Assessing the water quality of a pond or stream by sampling the invertebrate animals living there
Canopy	Tree cover over a stream that shades and cools the water. The canopy also allows leaves to fall into the stream, which are the start of the aquatic food chain
Crustacean	One of the groups of invertebrates whose members are characterized by having more than eight legs and a hard shell. Examples of aquatic crustaceans are crayfish and scuds
Dissolved Oxygen	Molecules of oxygen gas that are dissolved in water and are available to animals that breathe with gills
Gill	An organ in insects, fish or amphibians that allows dissolved oxygen from the water to be used by the animal
Habitat	An area that meets the needs of an animal: food, water, shelter, and space
Larva	The immature form of an animal that hatches from an egg. For instance, a caterpillar is the larva of a butterfly, and a tadpole is the larva of a frog
Macroinvertebrate	An animal without a backbone that is large enough to be seen without a microscope
Riffle	A fast-moving part of a shallow stream that creates bubbles and ripples. These areas tend to have more dissolved oxygen
Terrestrial	Living on land

References

Bridging the Watershed, a "National Parks Labs" partnership among Potomac Area Parks and Schools, and the Alice Ferguson Foundation. 2002. "Water Canaries." Charter Printing, Alexandria, VA.

Student Sheets – What Macroinvertebrates Can Tell You about Stream Health

Think About It

Have you ever sat by a pond watching dragonflies flitting about?

Or wondered why there always seem to be more mosquitoes near water?

Or watched spider-shaped insects dancing on the surface of water?

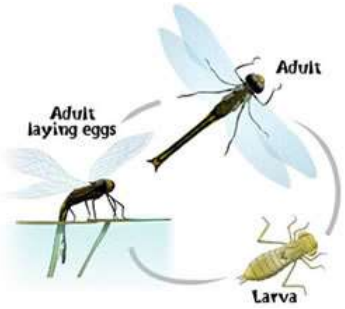
MACROINVERTEBRATES are insects and other creatures that are:

- big enough to see without a microscope (MACRO), and
- don't have a backbone (INVERTEBRATE).

We are interested in aquatic macroinvertebrates (ones that live in the water). Examples of these are dragonfly larvae, crayfish, and clams.

How Insects get from Water to Land

Many insects lay their eggs in water. When they hatch, the young live and grow under water.



When they are ready to become adults, they go through a great body change called **METAMORPHOSIS**.

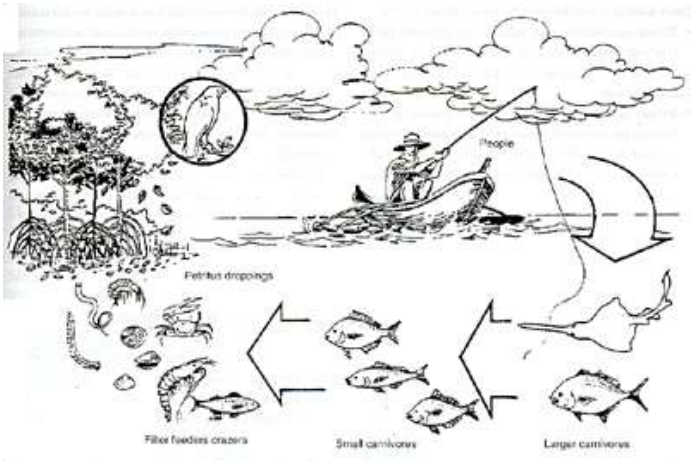
When they become adults, they don't live in the water anymore. They may still stay near water to eat and mate.

Examples of these kinds of insects include: dragonflies, stoneflies, and mosquitoes.

Why Should We Care?

Insects are an important part of **FOOD WEBS.**

Many other animals eat them, so they are needed in our water.



Continued on next page

What Macros Tell Us about the Water They Live In

You can't always see pollution, so you have to find other ways to find out if the water is clean or dirty. The animals living there give you information.

- Some animals need very clean water to live. If you find a lot of these, you have clean water.
- Some can handle a little bit of pollution. If you find these, and not many of the ones that need clean water, then you have fair water.
- Some animals can live in very dirty water. If you only find these, then you have dirty water.

Rating Streams

We rate streams according to the categories listed below:

Excellent: In a very healthy stream, there are many different KINDS of organisms (high biodiversity). If you find these, then you have good to excellent water. Examples of organisms that require good-excellent water are mayflies, stoneflies and case-making caddisflies. You'll probably also find animals from the other categories (fair and poor). These can live in any water.

Fair: A medium healthy site will have animals that can handle a little more pollution. These include crayfish, dragonflies, crane flies, and snails. There won't be as many KINDS of different species. You won't find many mayflies, stoneflies, and caddisflies.

Poor: There won't be many KINDS of organisms (low biodiversity) in poor water. In poor water, you'll find mostly organisms that can handle a lot of pollution. Examples are black fly larvae, worms, midge larvae and possibly leeches. If you find mostly these, you have poor quality water.

Student Sheet: Looking at the Habitat to Assess Stream Health

Overview

Name of the Stream: _____

Date of the Survey: _____

Use the data table below to assess each part of the stream.
Circle the observation that most closely matches your own.

OBSERVATION TABLE				
Observation	**Excellent**	**Good**	**Fair**	**Poor**
Flow	**Bubbles, fast moving, lots of riffles**	**Strong current, some riffles**	**Slow current, few or no riffles**	**Slow or not moving**
Shape of stream	**Lots of S-curves and bends**	**Curves and bends**	**Some bends**	**Completely straight**
Snags (A object sticking out, like a tree root/branch, etc.)	**Lots of snags catching leaves and twigs**	**Several snags**	**Few snags**	**No snags**
Turbidity	**Water very clear**	**Water slightly cloudy**	**Water cloudy**	**Water very cloudy**
Stream Bottom	**Pebbles clearly visible**	**Some fine sediment, but mostly pebbly**	**Few pebbles visible, mostly sediment**	**Bottom covered with soft, fine sediment**
Plant Life in Water	**Some plants growing in the water or on the rocks**	**Few plants, but no algae on the surface**	**Plant life is mostly algae on surface of water**	**Choked or covered with algae**
Shade	**Stream entirely shaded by trees**	**Mostly shade**	**Mostly sun**	**Stream in complete sun**
Stream Bank	**Stream bank completely covered with plants**	**Stream bank mostly covered with plants, but some bare spots**	**Stream bank mostly bare**	**Stream bank completely bare and eroding**
Color and Odor of Water	**Clear water, no smell**	**Mostly clear water, slight smell**	**Colored or cloudy water, noticeable smell**	**Cloudy or colored water, strong smell**

Look at your observations above, and assess the health of this stream (circle one):

EXCELLENT GOOD FAIR POOR

Student Sheet: Analyzing Macroinvertebrate Data to Assess Stream Health

Overview You will use this data sheet to grade the health of the stream by looking at what lives in it.

Look at your ***Student Sheet: Macroinvertebrate Data***. In the first table below, write down the number of different ***SPECIES*** you found in each column. BE CAREFUL – THIS IS NOT THE TOTAL NUMBER OF ANIMALS YOU FOUND.

Analyzing Your Macroinvertebrate Data				
Record your group's data:	**Sensitive**	**Somewhat Sensitive**	**Tolerant**	
Number of different species				
Multiply by	**3**	**2**	**1**	**Total**
Subtotal				

Find your total on the table below. This is your stream's "grade" or rating.

Rating	
Greater than 22	**Excellent**
17 to 22	**Good**
11 to 16	**Fair**
Less than 11	**Poor**

Stream Rating by looking at Macroinvertebrates: _____

Stream Rating by looking at Stream Habitat: _____

Compare these two different grades of the stream.

What might be some reasons that one rating or the other might not be accurate?

Student Data Sheet – Macroinvertebrates as Stream Health Indicators

Clean Stream Pollution Sensitive Organisms	**Partly Polluted Stream** Somewhat Pollution Sensitive Organisms	**Polluted Stream** Pollution Tolerant Organisms
caddisfly larvae ____ 	clams ____ 	aquatic worms ____ 
hellgrammite ____ 	crane fly larvae ____ 	blackfly larvae ____ 
mayfly nymphs ____ 	crayfish ____ 	leeches ____ 
gilled snails ____ 	damselfly nymphs ____ 	midge larvae ____ 
riffle beetle ____ 	dragonfly nymphs ____ 	other snails ____ 
stonefly nymphs ____ 	scud/amphipods ____ 	
water pennies ____ 	sowbugs/isopods ____ 	
	backswimmer ____ 	
	beetle larvae ____ 	
	mosquito larvae ____ 	
	predaceous diving beetle larvae ____ 	
	water boatman ____ 	
	water strider ____ 	
	whirligig beetle ____ 	

28, Hard Bargain Farm Environmental Center

5.7 Frankenfish

Investigating Fish Adaptations

Overview

Students will explore fish adaptations by "designing" fish that are adapted for various habitats.

Lesson Planner

Use the table below for lesson planning purposes.

Grade Level(s)	4^{th} – 6^{th}
Time Required	45 minutes
Key Concepts/Terms	Adaptation, Habitat, Camouflage, Niche, Predator, Prey, Herbivore, Carnivore, Omnivore, Food Chain/Web
Prerequisites	Understanding of Food Webs, the Energy Cycle, Habitats and Adaptations
Setting	Indoors at a desk/table, Individual/Small Group

Learning Objectives

After completing this activity, students will be able to…

- Describe the adaptations of fish to their habitats, and
- Describe how adaptations can help organisms survive in their habitats.

Materials Required

The following materials are required for this activity:

- ***Frankenfish Adaptation Cards*** (see pg. 5-61)
- Art Materials for illustrations
- Paper
- Chalkboard/White Board/Chart Paper

Continued on next page

Background Information

Adaptations
Adaptation is an evolutionary process through which organisms become better suited to their environment over **MANY GENERATIONS**. A characteristic that causes an individual to live successfully is passed on to its offspring. As these offspring are also well suited to the environment, they have a greater likelihood to survive and pass the trait on to future generations. Over time, a larger portion of the population has this trait.

Example of an adaptation:
Hummingbirds drink nectar, a sweet substance produced by flowers to attract pollinators. Hummingbirds that had longer, more slender beaks were able to reach deeper into the flowers and get more food. These individuals were more likely to live and reproduce successfully and pass on the trait of long slender beaks to their offspring.

Note: This topic is an area of frequent misconception with students. It is important that they understand that adaptation **does not me**an adjustment by **one individual organism** to a habitat, but is a **gradual change in the population** over time (many generations) because some individuals are better suited to survive, and those individuals are the ones that reproduce and pass along the traits that enable success to their offspring.

Continued on next page

Procedure

Follow the steps in the table below to conduct the activity.

Phase	Step	Action
Engage	1	Preparation: • Copy the adaptation card masters onto cardstock (they last longer this way). • Cut the adaptation cards apart. • Divide the adaptation cards into 5 groups of 10 cards each, with one card for each adaptation category in each group. So, each of the 5 groups will have one card from each of the following categories: • body shape; • coloration; • position of mouth; • shape of mouth; • teeth; • scales and skin; • fin shape – caudal; • fin shape – dorsal; • fin shape – pectoral; and • eyes. (You will need to make duplicates of some adaptation cards so that there are 5 cards per category – enough for each group. For example, there are only 3 cards with eye sizes, but you need enough for each group to have one, so make duplicates of these.)

Continued on next page

Procedure (continued)

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td rowspan="3">Engage</td><td>2</td><td>Note: If students have completed the Eat Like a Bird, pg. 5-15 or Animal Adaptations activity, pg. 5-21), omit this Engagement, and proceed to the Exploration phase of this activity.

Say: “Name the first thing you think of when I say each of the following animals.”

List student responses on the board.

The table below lists some animals and common student responses:

<table>
<tr><td>Animal</td><td>Adaptation</td></tr>
<tr><td>Giraffe</td><td>Long Neck</td></tr>
<tr><td>Zebra</td><td>Stripes</td></tr>
<tr><td>Owl</td><td>Large Eyes</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>“The characteristics you have just named are adaptations. An adaptation is a characteristic or behavior that an organism inherits or learns from its parents that helps it fit into its habitat and survive.”</td></tr>
<tr><td>4</td><td>“What are the values of the adaptations we’ve just listed? What do they do for the animals?”

The table below lists the adaptations from step one, along with student answers.

<table>
<tr><td>Adaptation</td><td>Value</td></tr>
<tr><td>Long Neck (Giraffe)</td><td>Allows the giraffe to reach food that is high above the ground, as well as allowing it to see a great distance.</td></tr>
<tr><td>Stripes (Zebra)</td><td>Stripes provide camouflage in blowing grasses.</td></tr>
<tr><td>Large Eyes (Owl)</td><td>The large eyes enable the owl to see very well in the dark, which is important for finding prey.</td></tr>
</table>
</td></tr>
</table>

Continued on next page

Procedure (continued)

Phase	Step	Action
Explore	5	Divide the class into 5 groups. Give each group a set of cards (10 cards for the group; one randomly drawn from each category).
	6	Each group creates (draws/paints) a fish that incorporates all of the adaptations on their cards. They also need to name their fish, and describe or draw the habitat where it lives.
Explain	7	<u>Presentations</u> Each group will present their fish to the rest of the class. They should identify and explain: • Each of the adaptations; • What their fish is named/Why they chose that name; • How this fish is adapted to its habitat; and • How the fish's adaptations are important to its survival.
Elaborate	8	<u>Discussion Questions</u> • **Are some fish more adaptable to change than others are? What would happen if:** ○ **The stream was flooded, and there were no more shallow hiding places?** ○ **There was a drought and the stream had a lot less water?** ○ **A new species of predator suddenly appeared?** ○ **A new species that competed for this fish's niche suddenly appeared?** ○ **The favorite plant or insect the fish preferred suddenly disappeared?** • **What would happen if all the fish had the same adaptations, and one of the above scenarios occurred?**

Continued on next page

Procedure (continued)

Phase	Step	Action
Elaborate	9	Ask students to research the life history of a specific fish in your area. How are they adapted for where they live and what they eat? How would a sudden change of habitat affect them?
	10	Investigate how some fish got their names. For example, why is a darter called a darter? Explore the scientific names of some common fish.
	11	Write a story about how a fish population (or other animal) might adapt over time to unusual or bizarre conditions or habitats.
Evaluate	12	Performance Evaluation: Frankenfish Drawings/Explanations. Sample evaluation criteria are listed below: • Fish is named based on its appearance/adaptations; • Illustration incorporates all adaptations; • Habitat is drawn/described with adequate detail; • Work is neat and legible, etc.

Continued on next page

Vocabulary

Understanding of the following terms is useful in this activity.

Term	Definition
Adaptation	A characteristic that enhances the ability of an organism to cope with its environment.
Anal Fin	Fin closest to the caudal fin (tail) on the underside of a fish; used for stability in the water; prevents rolling to one side or another
Barbel	Whisker-like structure around the mouth of a fish used to feel and taste
Camouflage	Colors, shapes or structures that enable an animal to blend in and hide in its surroundings
Carnivore	An organism that eats only other animals
Caudal Fin	A fish's tail fin; used to move the fish around
Dorsal Fin	A fin(s) on the back of a fish; used to help turn and maintain alignment in the water.
Habitat	A place that supplies all an animal needs to survive: food, water, shelter, and space in a suitable arrangement
Herbivore	An organism that eats only plants
Omnivore	An organism that eats both plants and animals
Operculum	The hard, flap-like covering that protects the gills of fish (gill cover)
Opportunistic Feeder	An organism that eats whatever is available
Pectoral Fins	The pair of fins on the sides of a fish's body, located near the front; used to help the fish turn
Pelvic Fins	The pair of fins on the underside of a fish's body, located mid to rear; used to help the fish steer and stop movement
Pharyngeal	Having to do with the cavity at the back of the mouth, leading to the stomach
Predator	An animal that catches other animals for eating
Prey	An animal that is eaten by another animal
Ventral	The underside or belly of an animal

Continued on next page

Frankenfish Examples

The pictures below are samples from the Frankenfish activity created by teacher participants from the 2003 Summer Science Institute.

References

The activity was adapted from *Fashion a Fish*, Project Wild: Aquatic, Project Wild National Office, 5430 Grosvenor Lane, Bethesda, MD 20814, 301.493.5447.

Frankenfish Adaptation Cards

How to Use These Cards

Copy the card templates, on the following pages. You will need more than one copy of some of the pages, because you need to have 5 complete sets of cards, and some categories have fewer adaptation options (ex. Shape of the Mouth Category has only 3 versions, so you would need to make more than one copy of this page to get 5 cards).

Body Shape

Adaptation	**Advantage**	**Example**
Torpedo-like (Tapered at Both Ends) Front Side 	fast-moving, streamlined for high-speed or swimming in currents	trout, salmon, tuna, mackerel

Body Shape

Adaptation	**Advantage**	**Example**
flat-bellied Front Side 	feeds off or rests on the bottom	catfish, sturgeon, sucker

Body Shape

Adaptation	**Advantage**	**Example**
flat from side to side (upright in water) Front Side 	moves easily around rocks or weeds	butterfish, bluegill, perch

Body Shape

Adaptation	**Advantage**	**Example**
flat - lying on side on bottom Front Side 	bottom dweller, blends in with the bottom	flounder, halibut, hogchoker

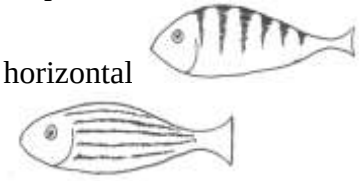
Body Shape

Adaptation	Advantage	Example
long and slender Front Side 	fast-moving in quick bursts, moves easily around rocks	Northern pike, burbot, ling

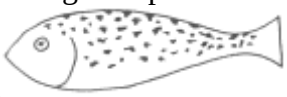
Coloration

Adaptation	Advantage	Example
mostly uniform, no markings	swims in open water	walleye, shad

Coloration

Adaptation	Advantage	Example
stripes - vertical or horizontal 	hides in weeds for protections or to ambush prey	perch, smallmouth bass, striped bass (rockfish)

Coloration

Adaptation	Advantage	Example
mottled - irregular spots of speckles 	hides near rocks, sand, or gravel near bottom	trout, croaker

Coloration

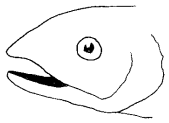
Adaptation	Advantage	Example
counter coloring - dark topside with light underside 	less visible to predators from above or beneath	mackerel, catfish

Continued on next page

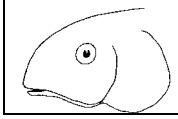
Position of Mouth

Adaptation	Advantage	Example
Pointing upwards 	feeds on prey above or on surface such as small fish or aquatic insects	mosquitofish

Position of Mouth

Adaptation	Advantage	Example
pointing straight ahead 	feeds throughout water, food is in front	butterfish, bluegill, bass

Position of Mouth

Adaptation	Advantage	Example
pointing down 	food found below or on bottom	croaker, mullet, catfish

Position of Mouth

Adaptation	Advantage	Example
under head, sucker-like	vacuums food off the bottom	sucker

Shape of Mouth

Adaptation	Advantage	Example
vertical oval 	predators - fish eaters OR filter feeders - plankton eaters	bluefish, striped bass shad, mackerel

Shape of Mouth

Adaptation	Advantage	Example
round 	selective plankton eaters or picking food attached to rocks	butterfish, spot

Continued on next page

Frankenfish Adaptation Cards, Continued

Shape of Mouth

Adaptation	Advantage	Example
horizontal oval 	scavengers, bottom dwellers, shellfish eaters	catfish, mullet

Teeth

Adaptation	Advantage	Example
sharp, inside lips, pointing in	predators; seize prey and swallow whole	trout, bass, bluegill

Teeth

Adaptation	Advantage	Example
grinding teeth, far back on jaw	herbivores (plant eaters) and shellfish eaters	carp

Teeth

Adaptation	Advantage	Example
gill rakers (comb-like on gill arches)	filter feeders, strain plankton from the water	shad, mackerel

Scales and Skin

Adaptation	Advantage	Example
large	used for protection on slower moving fish, adds weight and friction	carp

Scales and Skin

Adaptation	Advantage	Example
small	faster moving fish or those with other behavior as protection	bluefish, butterfish, mackerel

Continued on next page

Scales and Skin

Adaptation	Advantage	Example
no scales - has rough skin	scales replaced by tiny erect spines	catfish

Scales and Skin

Adaptation	Advantage	Example
no scales - has smooth skin	tough skin protected by extra slime, may have habits such as backing in and out of holes	eel

Scales and Skin

Adaptation	Advantage	Example
large bony plates	protective armor, but extremely slow	gar

Fin Shape - Caudal (tail)

Adaptation	Advantage	Example
crescent or deeply forked 	swims very fast or in fast currents	mackerel, tuna, butterfish

Fin Shape - Caudal (tail)

Adaptation	Advantage	Example
somewhat forked 	swims at medium speeds	trout, croaker

Fin Shape - Caudal (tail)

Adaptation	Advantage	Example
rounded or squared 	swims slowly or short bursts	bullhead, ling

Continued on next page

Fin Shape - Dorsal (back)

Adaptation	Advantage	Example
	fast swimmer	tuna

Fin Shape - Dorsal (back)

Adaptation	Advantage	Example
	medium swimmer	bass, perch, bluegill

Fin Shape - Dorsal (back)

Adaptation	Advantage	Example
	slow swimmer	bowfin

Fin Shape - Pectoral (side)

Adaptation	Advantage	Example
pointed 	fast swimmer	mackerel

Fin Shape - Pectoral (side)

Adaptation	Advantage	Example
slightly rounded 	medium swimmer	croaker

Fin Shape - Pectoral (side)

Adaptation	Advantage	Example
very rounded 	slow swimmer	bowfin

Continued on next page

Eyes

Adaptation	Advantage	Example
Large 	feeds by sight or lives on the edge of darkness; may be associated with fast swimmers	whiting, walleye, alewife

Eyes

Adaptation	Advantage	Example
Medium 	live and feed at the top of the water column	trout, perch

Eyes

Adaptation	Advantage	Example
Small 	nocturnal, bottom, and cave dwelling fish, may have barbels to smell and taste, usually slow swimmers	catfish

5.8 Ecosystem Food Web Mural

Summative Activity for Ecosystem Diversity

Overview

Students will research and present information on organisms found in a specific aquatic habitat, and then assemble their information to create a food web mural.

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	Research: 45 minutes minimum; This can be expanded as desired Presentation: 30-45 minutes
Key Concepts/Terms	Biodiversity, Energy Cycle, Food Webs, Adaptations, Niche
Prerequisites	Understanding of the key concepts, above
Setting	Indoors, Whole Class/Small Group

Learning Objectives

After completing this activity, students will be able to…

- Research and present information regarding an organism's adaptations, life cycle, and niche; and
- Identify connections between an organism and others in the ecosystem, including food web, energy cycle, and predator/prey relationships.

Materials Required

The following materials are required to complete this activity.

- Paper
- Scissors
- Crayons, Marker, Colored Pencils
- Stapler/Glue
- Lined Index Cards
- String
- Resource Materials, Library, or Internet Access
- Blank Habitat Drawn on Poster or Banner Sized Paper

How to Use This Activity

This is the summative activity for this unit, in which students demonstrate understanding of adaptations, biodiversity, the Energy Cycle, Food Webs and the effects of human activities on ecosystem health.

This activity is written using a freshwater marsh as the chosen ecosystem, but it can be adapted to any other habitat chosen.

Continued on next page

Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

Phase	Step	Action
Engage	1	Assign or have each student select a plant or animal from the attached list of marsh organisms (or a list you have created). Explain that they will be researching and presenting their research to the class, as well as combining their work to create a class project. ***Note:*** Make sure your mural has enough producers and decomposers to create a good food web later. If students did not select to research enough of these, add them in to the mural as students are researching.
	2	Distribute the ***Student Sheet -- Ecosystem Food Web Mural***, pg. 5-73, plain paper, and index cards. Review the instructions on the ***Student Sheet*** so that students understand their task.
Explore	3	<u>Research</u> Students research their organism, create an illustration, and compile the information for their presentation.
Explain	4	<u>Presentations</u> Each student gives a brief oral report to the class about their organism and attaches their drawing and index card to the mural IN ITS APPROPRIATE LOCATION.
	5	After all organisms are placed on the mural, ask if students can tell what major organism is missing: HUMAN. Place a picture of a human (that you have completed before the activity) in an appropriate place on the diagram.

Continued on next page

Procedure (continued)

Phase	Step	Action
Explain	6	Making Connections Once students have given presentations and all organisms are placed appropriately on the mural, discuss that the energy in a food web starts with the sun. Using one color of string, start it at the sun and have students choose one PRODUCER from the mural that might start a food web. The student who researched the chosen organism should come up to the mural and, using the string, connect their organism to another in the mural that would be its predator, showing the transfer of energy to that organism. The student who researched the second chosen organism (the one to which the first student connected the string) should return to the mural and make a connection with another organism that is its predator, and so on, until the food chain ends with a decomposer.
	7	A new food chain should be started, again with the sun, but this time use a different colored string. Repeat Step Six for the new string. This should continue until you have many different food chains overlapping and forming a multi-colored web.
Elaborate	8	Have students answer some or all of the questions in Part E of the ***Student Sheets*** to elaborate on the concepts of adaptations, niche, and biodiversity.
Evaluate	9	Use the attached rubric to evaluate student performance.

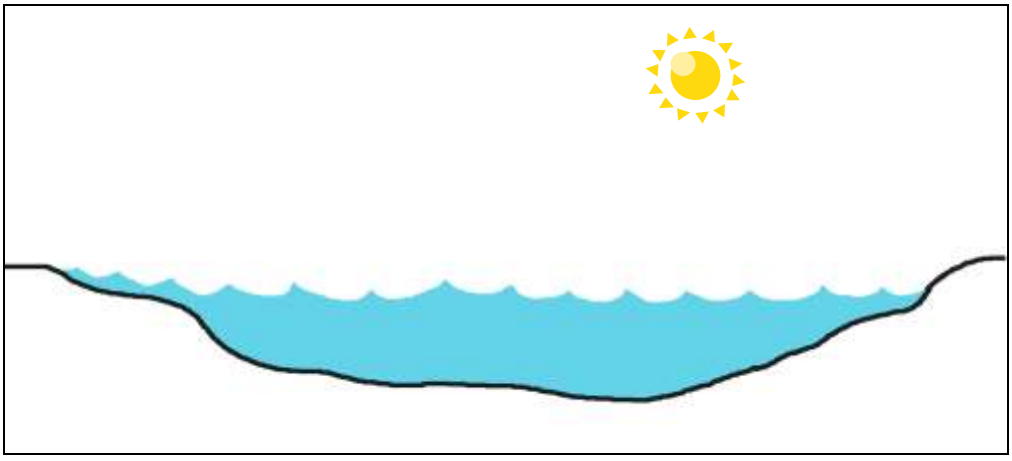
Continued on next page

Fresh Water Marsh Organism List

Be sure to assign a variety of organisms to get a complete web. The list below gives some possible choices.

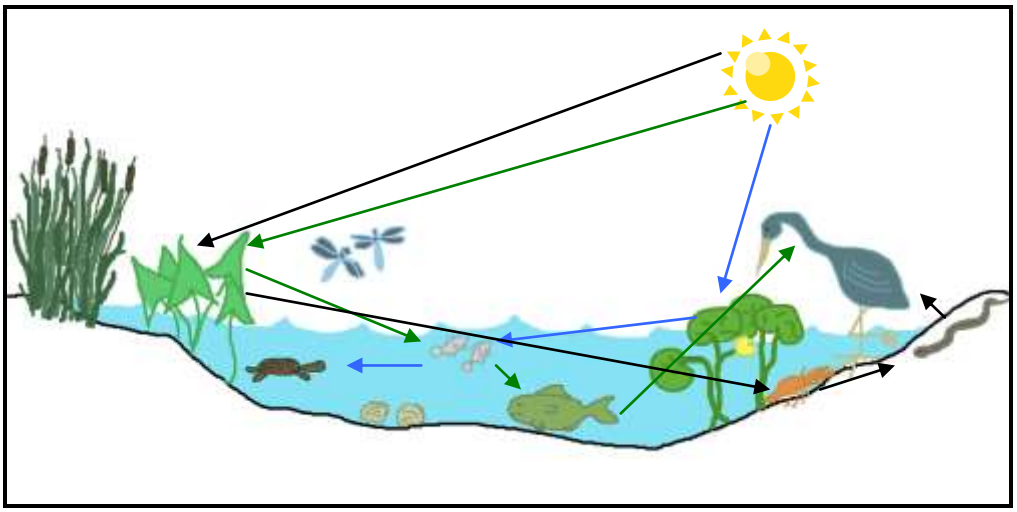
Mosquito & Larvae	White Perch	Belted Kingfisher
Isopod	Mummichog	Osprey
Crayfish	Eastern Mudminnow	Green Frog & Tadpole
Whirligig Beetle	American Eel	Northern Water Snake
Water Strider	Gizzard Shad	Painted Turtle
Dragonfly & Nymph	Inland Silverside	Beaver
Bluegill	Banded Killifish	Raccoon
Catfish	Great Blue Heron	White-Tailed Deer
Mosquitofish	Red-Winged Blackbird	Muskrat
Bald Eagle	Snail	Algae
Mallard	Clam	Eel Grass
Water Boatman	Mussel	Coontail
Damselfly & Nymph	Copepod	Hydrilla
Predaceous Diving Beetle	Scud	Wild Rice
Marsh Mallow (Hibiscus)	Spatterdock Lily	Duckweed
Tearthumb	Pickerelweed	Bacteria
Cattail	Arrow Arum	Leech

Sample Blank Mural



Continued on next page

Sample Completed Mural



Vocabulary

Understanding of the following terms is useful in this activity.

Term	Definition
Biodiversity	the variety, distribution and abundance of living things and ecological processes in an ecosystem
Consumer	an organism that obtains food by eating other organisms (can be a herbivore, carnivore, or omnivore)
Decomposer	An organism that helps to break organic material down physically, chemically and biologically; gets energy by breaking down organic matter into basic nutrients that go back into the soil, recycling the nutrients to be used by a new generation of plants (include insects, worms, bacteria and fungi)
Ecosystem	the system of living organisms, their physical environment, and all their interactions and relationships. Ecosystem can also be used to describe the area where these interactions occur (ex. pond or forest ecosystem)
Food Chain	the sequence of transfers of food energy from one organism to another. Producer – Consumer – Decomposer (hierarchy of "who eats what")
Food Web	complex and interlocking food chains
Habitat	a place that has the minimum required amounts of food, water, shelter and space for a particular species
Predator	an animal that obtains food mainly by killing and consuming other animals
Prey	an animal taken by a predator as food
Producer	any organism (such as a green plant) that produces its own food; many producers are food sources for other organisms

References

This activity was adapted from "Estuary Food Chain Mural," Hands On! Feet Wet! Echo Hill Outdoor School, Blooming Neck Road, Worton, MD 21678

Student Sheet – Ecosystem Food Web Mural

Objectives

You need to show your teacher how much you understand about adaptations, biodiversity, the energy cycle and niches.

You will:

1. Research an organism in a marsh ecosystem.
2. Place your drawing of your organism in a mural of the ecosystem.
3. Tell your class about your organism.
4. Connect your organism to others in a food chain/food web.
5. Explain how your organism connects to others in the food web.

Part A. Research

You are going to learn about a specific organism. The instructions for your drawing an information card are listed below. Both of these will be put up on the mural to teach others about your organism.

Drawing

On the sheet of blank paper, draw a realistic picture of your organism.

Information Card

On your index card, write the following information:

A. **HABITAT** – Where in the ecosystem does it live? (deep or shallow water, trees, edge of the marsh, etc.)

B. **SIZE --** Average size of the adult organism.

C. **FOOD --** What the organism eats (how it obtains energy and nutrients).

D. **PREDATORS --** What eats the organism?

E. **REPRODUCTION:** Location and means of reproduction.

F. **ADAPTATION –** Tell about one adaptation for the organism. Make sure you tell how this adaptation helps it survive in the habitat.

G. **ROLE IN THE FOOD CHAIN:** Is your organism a **producer, consumer or decomposer**? Explain why it is this role.

H. **CLASSIFICATION** of the organism by type (for example, a snake is a **reptile**; coontail is an **aquatic plant**, etc.).

Continued on next page

Part B. Present Your Research

You will tell your classmates about your organism. You need to…

- Show them what your organism looks like;
- Explain the information on your index card; and
- Put your picture of the organism in a CORRECT PLACE on the mural (somewhere it would really be found).

Part C. Making Food Web Connections

You and your classmates will connect all of the organisms on the mural into food chains. These connections show how living things get energy to live.

When your organism is selected, go to the mural and connect it to another organism that eats it. You'll connect them using string. The string shows energy moving from your organism into the one that eats it.

Part D. Your Organism and the Energy Cycle

In the space below, draw a food chain that includes your organism. Make sure you…

- Show how energy is transferred through the food chain, and
- Label producers, consumers, and decomposers.

Continued on next page

Part E. Explain

Answer the following questions.

1. Choose two organisms that live close to one another. Explain how they have different niches and can share the same space.

2. Imagine something happened that caused one of the organisms in the food web to die off. You can choose any organism from the food web. Explain how the loss of the organism would affect others in the food web. Why does greater biodiversity make a healthier ecosystem?

Ecosystem Food Web Mural Scoring Rubric

How You Will Be Graded

Your grade will be based on the criteria in the table below. Next to each criteria are four columns:

- How many points each topic is worth;
- your score of your own work;
- how another student (peer) scores your work; and
- the teacher's score of your work.

	Assessment			
Grading Criteria	**Possible Points**	**Self**	**Peer**	**Teacher**
DIAGRAM is complete and shows clearly what the organism looks like				
HABITAT is correctly explained on information card				
SIZE: Correct size is on information card				
FOOD: Correctly explained what the organism eats/how it gets energy				
PREDATORS: Correctly explained what eats the organism				
REPRODUCTION: Correctly explained how and where the organism reproduces				
CLASSIFICATION: Correctly identified the KIND of organism				
PRESENTATION: Clearly communicated all information to the class				
MURAL PLACEMENT: Put organism drawing in a place that shows where the organism lives in the habitat.				
FOOD CHAIN CONNECTION: Correctly connected the organism to something that eats it in the mural				
PART D: Drew a complete food chain that includes their organism.				
PART E: Correctly Answered Questions in Part E of the Student Sheet				
TOTAL SCORE				

Ecosystem Diversity Teacher Resources

Overview

This section provides teachers with suggested Websites, books, videos and organization contact information regarding Ecosystem Diversity

Books

Websites

Learn some creative ways to integrate the Chesapeake Bay and environ issues into your classroom lessons. Search through the **Bay Backpack**'s books, multimedia, curriculum guides, individual lesson plans and online data sources about the subjects you are teaching in class. www.baybackpack.com/

AFF website—Kids' Zone: *Classified Information, Let's Take a Dip, Go Fish, Plant Identification, Macroinvertebrate ID at* fergusonfoundation.org/hard-bargain-farm/activities-lessons-links/

Project Budburst *is a citizen scientist web site to collect data on the first blooming of common plants. Web site includes many educational resources and project ideas for K-12.* budburst.org

Growing Native *is a year-round volunteer project that collects hardwood seeds and plants trees to help restore and protect rivers and streams in the Potomac River watershed.* www.growingnative.org/

Maryland Department of Natural Resources, *member of the Maryland Children in Nature Coalition has a web site with kid-friendly outdoor activities.* http://dnr2.maryland.gov/cin/Pages/default.aspx

Agencies/ Organizations

Project Wild *is one of the most widely-used conservation and environmental education programs among educators of students in kindergarten through high school.* www.projectwild.org/