Bridging the Watershed

An Outreach Program of the Alice Ferguson Foundation
in Partnership with the National Park Service and Area Schools

Herring Highway

A Study of a New Fish Passage for River Herring

A Curriculum Module Written for Rock Creek National Park

Student Booklet

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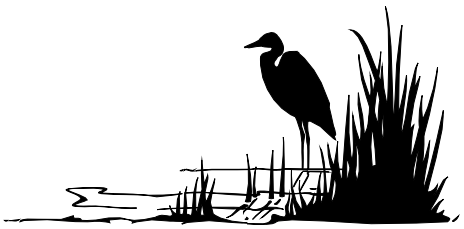

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BRIDGING the WATERSHED PROGRAM MANAGER
Jeanne Troy, Alice Ferguson Foundation

CURRICULUM COORDINATOR and EDITOR
Nancy Smaroff, Alice Ferguson Foundation

CURRICULUM WRITERS
Tammy Shupard, Alice Ferguson Foundation Educator
Matt Curtis, Alice Ferguson Foundation Educator
Rebecca Scott, Alice Ferguson Foundation Educator

CONTRIBUTIONS TO CURRICULUM DEVELOPMENT
Maggie Zadorozny, Rock Creek National Park
Martin Tillett, Prince George's County Public Schools
Gail Webber, Education Consultant
Bill Prudden, Education Consultant

EDITOR and WEB DESIGNER
Laura Gillespie, Alice Ferguson Foundation

PILOT-TEST TEACHERS
Makarand Bidwai, Teacher
Frederick Douglass High School
Prince George's County Public Schools, Maryland

Cynthia Hasty, Teacher
Gwynn Park High School
Prince George's County Public Schools, Maryland

Juliet Thompson, Teacher
Northwestern High School
Prince George's County Public Schools, Maryland

Alice Ferguson Foundation
2001 Bryan Point Road
Accokeek, Maryland 20607
Phone: 301-292-8757
Fax: 301-292-8201
www.bridgingthewatershed.org

Herring Highway

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FISH FACTS: How much do you already know about fish?

This is NOT a TEST. This activity is called a pre-conceptions survey. On your worksheet, you will find the 22 questions listed below and a space for your answers along with a space for the correct answer if you didn't get right. This activity is not graded. It's a fun way to find out what you already know - and don't know - about the topic you are going to study.

1. Which group of vertebrates has the most species?
2. What branch of zoology is the study of fish?
3. Is the plural of fish fish?
4. Do fish breathe air?
5. Do fish sleep?
6. How can you tell the age of a fish?
7. How long do fish live?
8. How do fish swim?
9. What fish are the fastest swimmers, and how fast can they swim?
10. Which fish swims the slowest?
11. Can fish swim backwards?
12. Do fish chew their food?
13. Can fish distinguish color?
14. Why do fish sometimes have a strong odor?
15. Do all fish produce offspring by laying eggs?
16. Is there much salt in fish?
17. Do fish travel very far?
18. How much electricity can an electric eel discharge?
19. Sometimes fish swim in groups and at times are called schools of fish. A group of jellyfish is called a smack. What is a group of herring called?
20. What is a herring?
21. What is a herringbone pattern, and what does it have to do with fish?
22. What does the phrase "red herring" mean?

Introduction to Herring Highway

Herring Populations Changed Over Time

Historically, river herring (blueback herring and alewife species) packed streams in such large numbers that settlers called them "glut" fish.

"In the spring of the year, herrings come up in such abundance into their brooks and fords that it is almost impossible to ride through without treading on them," wrote early Chesapeake historian Robert Beverly in 1705. Herring were so thick, he wrote, that "*even the freshest of rivers…stink of fish*."

River Herring

River herring once supported important commercial fisheries along the Atlantic coast, but that has changed in recent years:

- Commercial landings of Atlantic coast river herring reached historic highs in the late 1950s at around 75,000,000 pounds per year.
- Current totals are less than 2,000,000 pounds per year.

Causes of Herring Population Decreases

Population collapses were blamed on:

- foreign fishing fleets—before fishing restrictions were imposed in the 1970s
- loss of essential spawning and nursery habitat because of water pollution
- construction of dams and other blockages to fish migrations

Why Should You Care?

Today, most commercially-caught herring are ground up for fishmeal, pet food, or used as bait, so why should you care?

It Will Help Restore the Potomac River & Chesapeake Bay Watersheds

Allowing river herring to return to their native spawning (releasing eggs and sperm for reproduction) grounds is one of the pieces that will promote the restoration of the Potomac River and greater Chesapeake Bay. Whenever any species is reduced or eliminated, the entire food web suffers. It's a bit like knocking down the first in a line of dominoes, and **people are part of that line**. Humans constantly alter environments to benefit human needs, often at the expense of other species. We can repair environments to benefit the species previously harmed by our actions. Some mistakes can be corrected.

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Why Should You Care? (*continued*)

River herring are planktivores (i.e., plankton-feeders) and eat primarily zooplankton, though they may eat:

- fish eggs
- crustacean eggs
- insects and insect eggs
- small fish

In turn, almost everything likes to eat them, from other fish to reptiles, amphibians, mammals, and birds. These herring species are considered an important forage base for large, near-shore predators such as striped bass. Humans enjoy eating herring pickled and salted.

Research has shown that the large numbers of river herring that once glutted headwater streams were an important source of nutrients in those areas. This provided other ecological benefits as well. One study, for instance, found that the deaths of migrating alewife reduced sedimentation rates in lakes by furnishing nitrogen and phosphorus, which stimulated the growth of organisms that devoured leaf litter.

Herring Migration & Imprinting

River herring spend most of their lives in the salt water of the Atlantic Ocean. Adults return every year to spawn in the streams where they were born. Spawning is releasing eggs and sperm into the water to create new eggs and the next generation of river herring.

Herring "imprint" on the rivers where they were born, which means that as adults they have a drive to return to those places to spawn. This is thought to happen because various stimuli in the environment "program" the fish to return there as adults. Every stream has different characteristics in its water due to the types of rocks and soils and other factors that affect water quality, so the adult fish can "recognize" their correct stream.

What Will You Do in This Module?

You will have the opportunity to:

- learn about river herring, their characteristics, and migration patterns
- study the problems river herring encounter to maintain their species in this watershed and the methods designed to correct the problems
- learn basic fish identification
- conduct a field study at Rock Creek Park in which you will collect data about the kinds and numbers of fish present in Rock Creek
- engage in an activity that will address the perils migrating fish have in their journey from spawning grounds to the Atlantic Ocean and back again

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Lesson 1. What's the Dam Problem?

Objectives

- To design and draw a fish ladder that will overcome a set of obstacles (things that stop them from moving upstream) for migrating fish
- To compare your fish ladder to the one at Peirce Mill dam and analyze why your design will or won't work

So, What's the Dam Problem?

River herring migrate from the Atlantic Ocean and up Rock Creek to spawn. Peirce Mill dam (see picture on the cover of this module) in Rock Creek makes it impossible for fish to swim any farther upstream from that point.

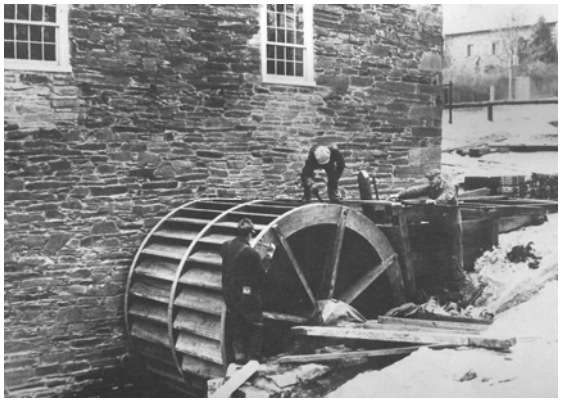
River herring need three things in order to complete this necessary journey upstream:

- no high barriers (they cannot jump like salmon can)
- resting pools along their pathway
- attractive water flow (not too fast or too slow)

Question to Think About: Peirce Mill Dam prevents fish from meeting which one of these three needs?

Why is Peirce Mill Dam in Rock Creek?

In the early 1800s, a number of mills were built along Rock Creek. The power of flowing water was used to turn water-wheels to provide energy for grinding grain and bone, sawing lumber, and processing other raw materials. There were eventually nineteen creek side mills, eight of them powered by water, transforming the area into a thriving agricultural and industrial complex. Most of the mills are long gone, but you can still see Peirce Mill, built in 1820, in Rock Creek.



Mill Wheel at Peirce Mill

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Why Not Just Remove the Dam?

Well, why not blow up the dam? Peirce Mill dam is a historic structure and a beloved icon of Rock Creek National Park. The sole survivor of the milling era, Peirce Mill is preserved and protected today by the National Park Service and is listed on the National Register of Historic Places. The park's mission is to preserve and protect the plants, animals, structures, and the landscape. The scenery is vital to the look and feel of the park that has been a public area since 1890.

Every Problem Has a Solution

As a solution to this problem, a fish ladder was constructed at Peirce Mill dam in 2006. This was only a part of a huge project to remove multiple barriers to fish migration in Rock Creek funded by the Woodrow Wilson Bridge construction project. As part of large projects such as this one, which cause environmental harm, there are laws requiring that the organizations or companies involved "make up" for the damage they cause by paying for the creation, restoration or preservation of another area of equal or greater ecological importance. This is called "**compensatory mitigation**."

Aerial View of the Woodrow Wilson Bridge between Maryland and Virginia

Legislators from Maryland, Virginia, and the District of Columbia determined years ago that a new Woodrow Wilson Bridge was needed because of the age of the existing bridge, traffic congestion and safety issues.

One of the necessary parts of planning the construction of a new bridge is evaluating the impact that construction will have on the environment, deciding how the damage can be avoided, and considering whether any alternatives are possible.

Impacts: Building a new Woodrow Wilson Bridge would require sinking massive supports into the river bottom, a process requiring dredging 340,000 cubic yards of sediments up from the bottom. Not only would disruption of the river bottom and suspension of sometimes toxic sediments damage the aquatic environment, but sediment disposal would disrupt nearby wetland ecosystems.

Alternatives to Avoid Damages: After considering possible alternatives, it was decided that no feasible alternative would damage the environment less, and a new bridge was necessary.

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Every Problem Has a Solution *(continued)*

Results: As part of the compensatory mitigation plan, the following changes to fish migration blockages have occurred:

- Three abandoned sewer lines which blocked the fish migration were removed.
- Two concrete fords (paved areas for carriages and cars to cross a river or stream) have been removed.
- At the historic Milkhouse Ford, contractors lowered the ford, which increased the depth and flow of water over the ford, making fish passage possible. This one cannot be removed because of its historic value.

Milkhouse Ford (c.1989)

- At active sewer lines, boulder step-pools were created to establish grade control and the appropriate backwater condition that allows fish to swim over the pipes.
- A Denil fish ladder was constructed at Peirce Mill Dam to allow fish to bypass the dam, which they cannot jump over.

Task 1
Design a Way for Fish to Get Past the Dam

Before we proceed with information about the fishway that was built at Peirce Mill Dam, let's see if you might have a solution to the dam problem. There is generally more than one solution to a problem.

Your task is to create a method for fish to get above the dam without blowing it up. On page 4 you will find the space to draw your solution to the obstacle the dam has created for the fish. Draw the waterway, the dam, your design for fish passage, and label all parts. Don't forget to show the direction of flow of water. Keep in mind that the fish—river herring in this case— can't jump over this obstacle; they need resting places, and they need an adequate flow of water.

On page 3 of your worksheet booklet you will find the rubric that will provide you with specific items that will be used to evaluate your design. Remember that your design will be evaluated on creative, not artistic, ability.

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Fish Ladders

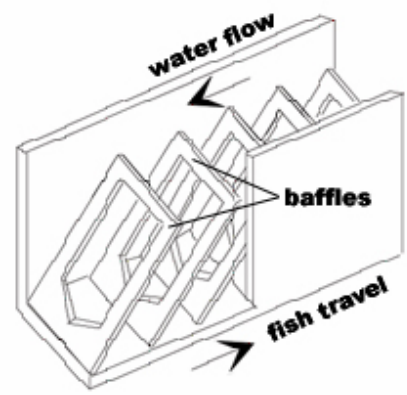
Since each situation is different, engineers consider many factors when designing a fishway for a certain obstacle. Some of the factors are the:

- height of the obstacle
- number and kinds of fish that will use the ladder
- speed and depth of the water
- pattern of currents in that part of the river

There are four basic types of fishways: pool-weir, vertical slot, steep pass, and Denil. This section focuses on the **DENIL fish ladder**. For further information on the other three types of fish ladders, a search on the World Wide Web will provide lots of resources.

Denil Fish Ladders

The original design for a Denil fish ladder was developed in 1909 by a Belgian scientist, G. Denil. A Denil fish ladder is made by fitting a series of slanted slats (or "baffles"), with a hole cut in each one, into a rectangular channel of the fishway. The fishway is angled up to allow the fish to swim to the higher reaches of the stream, above the dam. The baffles are slanted toward the flow of water to reduce the current through the ladder, especially right in the middle. Fish swim through the baffles until they reach the top of the ladder where it joins the waterway above the dam.



Denil Fish Ladder Diagram

Denil fish ladders can be built with different sized baffles and openings to suit even rivers with fast-moving currents and accommodate many kinds of fish. Resting pools can be included in the design if the length of the blockage makes this necessary.

The picture to the left, the fish ladder at Peirce Mill Dam, taken before the fish ladder was operational, shows the view looking down from the top. Fish will swim upwards through the baffles to the stream above the dam.

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Task 2
Analyzing Fish Ladders

Look below at the pictures of the Denil fish ladder at Peirce Mill Dam. Compare the design of this fish ladder to the one you created, and **answer the following questions on page 5 of your worksheet.**

- How does your design compare to the Denil fish ladder design?
- Explain why you think your design would work for fish.

1. At the lower end of the channel, fish feel the flow of water and swim into the fish ladder.

2. Close-up view of the path to entrance to the fish ladder

3. Opening to the fish ladder

4. The long narrow wall to the right of the person standing above the dam is the fish ladder containing the baffles that allow the fish to climb and rest to get above the dam.

5. Opening at the end of the fish ladder where fish re-enter Rock Creek above the dam at Peirce Mill. The bars keep debris from washing into the fish ladder during flooding. The cover of the fish ladder will be removed during migration to allow for natural light conditions, encouraging fish to swim through the ladder.

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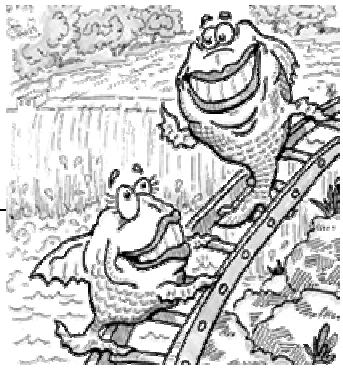
Lesson 2. The Little Fishes That Could



Objective

To create a "foldable" that includes the life cycle stages of the river herring in the Chesapeake Bay watershed

Migrating Fish

Most species of fish are either freshwater (e.g., lakes, streams, rivers, ponds) or saltwater (e.g., seas, salt lakes, oceans) fish, completing their entire life cycle in one type of water. They may migrate to different locations within their range, but they are so adapted to either fresh or salt water that they cannot survive in the other type.

There are other fish that migrate between salt water and fresh water, living most of their lives in one, and periodically migrating through brackish water to get to the other. Fish that migrate between fresh and salt water are called "**diadromous**," and there are three types:

- **AMPHIDROMOUS** fish move between fresh and salt water during some part of their life cycle for a purpose OTHER THAN breeding. Examples include fish that follow seasonal changes in water temperature or food sources (e.g., sheepshead minnow).

- **CATADROMOUS** fish hatch in salt water, move to fresh water to mature, and return to the sea to breed (e.g., American eel).

- **ANADROMOUS** fish hatch in fresh water, move to salt water to mature, and return to fresh water rivers and streams to breed (e.g., salmon, alewife, shad, blueback herring).

In this lesson, you will learn about two species of **anadromous** fish: blueback herring and alewife. These species together are called river herring. River herring spend most of their lives in the salt water of the Atlantic Ocean. Adults return once every year to spawn (releasing eggs and sperm into the water to reproduce) in the streams where they were born.

These two species of fish have not been able to return to their native spawning grounds in Rock Creek for over 200 hundred years, and scientists hope the Denil fish ladder at Peirce Mill dam will allow them to do so.

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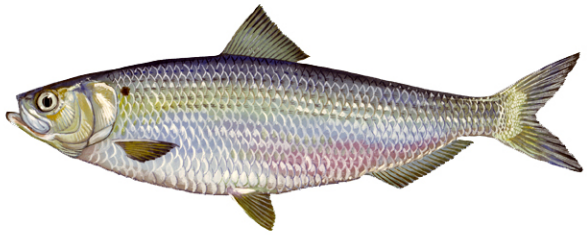
Comparing River Herring

The following graphic provides you with some basic characteristics of the two fish and a drawing of what they look like. Many times both are grouped together and referred to as "river herring." As you can see from the drawing and characteristics, they look very similar.

River Herring	
Blueback Herring (*Alosa aestivalis*)	**Alewife** (*Alosa pseudoharengus*)
	
Back Color	
blue-green	gray-green
Eye Width	
equal distance between the front of the eye and the tip of the snout	greater distance between the front of the eye and the tip of the snout
Body Shape	
slightly more slender and elongated than alewife	slightly deeper than the blueback
Dorsal Area (top of the fish) Color	
deep bluish-green	Bronze
Migration Range	
Nova Scotia to northern Florida	Newfoundland to South Carolina
Spawning Period	
March through May	February through April
Length	
about 38 centimeters	about 27 centimeters

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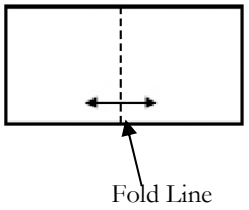
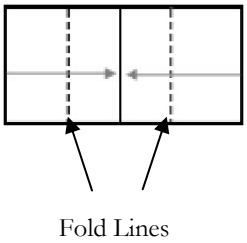
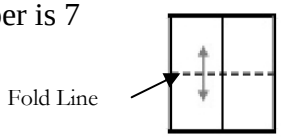
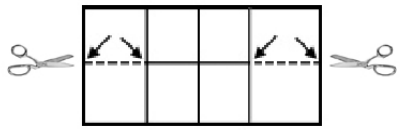
Task 3
Create a Foldable

The following information will provide you with much information about the lives of river herring, their migration, and the stages of their life cycle. **To show your understanding of the material, you will create a foldable.** "Foldables" are clever and interesting ways to learn new information.

You will be given a separate, legal-sized piece of paper with a map drawn on it to complete this activity. Follow the steps below to make a blank foldable. Dotted lines are the fold or cut lines.

Step	Action
1	Turn one sheet of white, legal-size (8 ½ x 14 inches) paper so that the longest side is running from right to left (as in the picture to the right). The map should be face-down on the table so that you can't see it. Fold the paper in half, from side to side, like a book. The map will now show on the outside along the fold line. 
2	Open the folded paper, lay it flat, and fold each of the ends **IN** towards the center fold. Each end should meet at the center fold. Crease the folds. You now have a paper with an opening between your two flaps that runs from top to bottom. They look like cabinet doors with a map on the front that meet in the middle of your paper. 
4	Keeping the paper folded as in step 2, fold again, in half, from top to bottom, so that the flaps are hidden inside and the folded paper is 7 x 4 ¼ inches. 
5	Open the folded paper so that it is completely flat on your table, and using a pair of scissors, cut each flap at the fold (see dotted cut lines on the diagram to the right). You should now have four flaps and the inside sheet should have four quadrants created by two folds. 
6	Each quadrant should be 3 x 4 ¼ inches. **You have constructed your foldable!**

The Map

On the map, locate each of the following bodies of water:

1. Rock Creek
2. Potomac River
3. Chesapeake Bay
4. Atlantic Ocean

continued on next page

Lesson 2. The Little Fishes That Could *(continued)*

Task 3
Create a Foldable
(continued)

Follow the following five steps to complete your foldable for the life cycle of the river herring.

Step	Action
1	Start in the upper left-hand quadrant and **NUMBER** the outside corner of each flap with a number, 1-4, moving around counterclockwise, so the upper left-hand quadrant is 1, the lower left quadrant is 2, etc.
2	Next, **CUT AND PASTE** the labels, on page 6 of your worksheet, to show the correct bodies of water represented. ▪ Quadrant 1.) Rock Creek ▪ Quadrant 2.) Potomac River ▪ Quadrant 3.) Chesapeake Bay ▪ Quadrant 4.) Atlantic Ocean.
3	**READ** the information in the section called, "River Herring Life Cycle Information," on page 16.
4	Using what you learned about the herring life cycle, **CUT OUT** the pictures of stages of the herring life cycle, on page 6 of your worksheet, and **GLUE** each stage on the outside of the flap that matches where that life stage takes place.
5	Under each flap of your foldable, **WRITE** the important information about each stage of the herring life cycle. For example, information about what happens during the egg stage should be written inside your foldable under the flap that has the egg picture on it. Make certain your notes answer the following questions for each life stage: ▪ When are they are at that location? ▪ How long do they stay at that location? ▪ Why are they at that location for that life stage? ▪ Other information that may be important
	In the end, each section of your foldable should have: • a **picture** of the correct herring life stage on the map on the outside flap • the **location** where the herring are during that life stage on the outside of the flap • **notes** about that stage of the life cycle under that flap

continued on next page

River Herring Life Cycle Information

We call the alewife and blueback herring species "river herring." River herring spend most of their adult lives in the open ocean, returning to the rivers and creeks of their birth only once a year to spawn (release eggs and sperm into the water). During spawning, female adults from both species of river herring produce and release 60,000 – 300,000 eggs into the upstream waters in the creeks or rivers where they were born. For our study, we are going to focus on those herring which spawn in Rock Creek. Immediately after spawning, adults migrate quickly downstream and back to the open ocean.

Spawning is driven by water temperature. Herring start spawning in the spring when water temperatures get above 13-15^{o} C and end when the water temperature gets above 27^{o} C. Therefore, spawning time is different in different streams. Adults will return to the same stream to spawn for 2 – 4 years in a row before they die at around age 8.

Eggs float downstream to larger rivers with the motion of the water. Eggs hatch after 2 -3 days at 22 – 24^{o} C. When the fry (young fish) hatch, they are 2.5-5.0 mm long, and they feed for the first few days by absorbing their yolk sacs. After the first 3-5 days, the fry begin to feed, eating mostly plankton. These larvae can't control their movement, so they drift passively further downstream into "nurseries" which are located in tidal marsh areas. For the fish we are studying, these nurseries are in the marshes along the Potomac River.

The fry are considered juveniles after about a month, at which point they are approximately 2.5 cm long. At this stage, they have most of the characteristics of adults, with developed scales and the typical silvery coloring. Juveniles gradually move downstream into estuary areas throughout the summer in response to the increasing water temperatures. In our area, this estuary is the Chesapeake Bay. They will move downstream so that, by fall, they reach the mouth of the estuary and enter the ocean, where they will remain until they reach adulthood and can reproduce. Many juveniles spend their first winter close to the mouth of the river or among submerged aquatic vegetation beds in the lower Chesapeake Bay. One study estimated that one out of every 80,000 spawned alewife eggs survived to the juvenile stage.

River herring females usually reach maturity by age 4-5, whereas males of both species generally mature at an earlier age (ages 3-4). Most adults and sub-adults spend the majority of their lives at sea following a north-south seasonal migration along the Atlantic coast, only returning to rivers to spawn. Bluebacks are found at depths of 27 - 55 meters throughout their offshore range. Little information is available on the life history of sub-adult and adult river herring after they migrate to the sea as juveniles, and before they mature and return to freshwater to spawn.

Lesson 3. Fishin' For a Name

Objective

To draw and name common fish found in Rock Creek using basic fish anatomy characteristics

Scientific Classification

Most people identify fish using a common name, but that gets confusing because more than one fish might have the same common name in different places, or one species might have several common names. Scientists need to know exactly which fish they are identifying, so they use scientific names.

In the eighteenth century, **Carolus Linnaeus** developed a classification system based on the external features of organisms. He used a two-term naming system called **binomial nomenclature**. Each organism is given a two-word Latin name.

- The first word is the **genus** (division in classification between family and species) to which an organism belongs, and this is capitalized.
- The second word represents the **species** (group of organisms that normally interbreed in nature to produce fertile offspring), and it is not capitalized.

In print, both names are written in *italics.* If written by hand, both names should be underlined.

Example: The scientific name for the blueback herring found in the District of Columbia is, *Alosa aestivalis*. As an aside, Linneaeus referred to herring as "*Copiosissimus piscis*"; in other words, the most prolific fish.

How to Identify a Fish

Fish have different characteristics, or things about their bodies, that allow us to tell one species from another. In this activity, you will be learning about these differences and how to identify fish you will be catching during the field study.

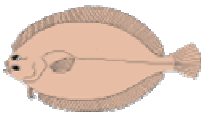
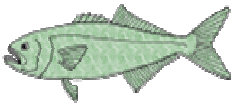
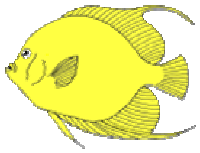
continued on next page

Task 4
Basic Fish Anatomy

This is a guided activity in which you will be shown a PowerPoint presentation that will provide you with the information that will help you learn basic fish identification in preparation for your field study at Rock Creek Park.

Body Shape

The first step to fish identification is to determine the overall body shape of your fish. There are four common body shapes, as shown in the pictures below. On page 7 of your worksheet, **LABEL** each body shape**.**


Tall-bodied, laterally-compressed species like discus and angelfish are adapted to life in slow-moving waters. Slender, torpedo-shaped fish are better adapted to moving waters. Bottom-dwelling fish have flattened bellies and inferior mouths.

Body Parts

- As your teacher goes through the fish anatomy, complete your fish diagram on page 8 of your student worksheet packet. On the diagram,
    - **LABEL** the body part
    - **COLOR** the entire body part

- After you have labeled and color-coded the diagram of the fish, turn to the "Fish Body Part" chart on pages 9 and 10. This table gives an explanation of each part of the fish anatomy. **COLOR** in each box with same color you chose for your diagram.

Example: If you colored the dorsal fin blue, the box on the table that says "dorsal fin" on your diagram would also be blue.

continued on next page

Task 5
ID Your Fish

On pages 9 – 12 of your worksheet packet, you are going to **SKETCH** different fish that you are shown on the PowerPoint presentation.

For each specimen, you will be given **3 MINUTES TO DRAW** it. You will use your drawings to identify these fish later.

Note basic body shape and parts so that your sketches are useful for identification. Do not get too caught up in making a perfectly detailed drawing.

In the box labeled "Characteristics," **NOTE** important features of that fish that would help identify it (i.e., forked caudal fin, barbels present, etc.).

Prepare for Your "Herring Highway" Field Study

Dress Appropriately

- You should wear comfortable clothing that allows you to easily move, hike, bend, and climb. You may have to gather data in a wet and muddy environment, so choose clothes you don't mind getting wet and dirty.
- Dress for the weather. In cool weather, wear layers of clothing to keep warm in the early morning, but that you can remove later in the day or while working. If the forecast calls for possible rain, wear a waterproof jacket, hat, and shoes, and bring a plastic bag for materials.
- Even in warm weather, wear long pants and a long-sleeved shirt for protection from poison ivy.
- Expensive clothes and shoes are not appropriate for work in the outdoors, and wearing these expensive items will make you reluctant to engage in field studies.
- Do not wear skirts, shoes with high heels, or sandals.

Bring

- **LUNCH –** There will be no place to buy food. **Bring a bag lunch and plenty to drink**, preferably water. Pack your lunch and drinks in a backpack or bag that can be easily carried into and out of the park study site. Keeping in the ecology-minded spirit, make your lunch as trash free as possible. Avoid excessive packaging and reduce, reuse, and recycle. Remember, there is nothing beautiful about trash.
- **WATER** – The hotter the weather, the more you should bring to drink.
- **NOTEBOOK** – A notebook, clipboard, or journal to write in and on (waterproof is best, if possible)
- **PENCIL** – Something to write with (Pencils are best because they work when wet and are cheap to replace if lost.)
- **FISH ID INFORMATION** – Your worksheet with your fish drawings
- **POLARIZED SUNGLASSES** – If you have Polarized glasses, bring them. They will help you see fish in the water.

Park Stewardship

- No collecting of any type is permitted.
- Take only photographs/memories and leave only footprints.

Lesson 4. Swim for Your Life

Objective

To complete an interactive, online game and collect data that illustrate the hazards that anadromous fish encounter in their journey from spawning grounds to ocean and back to spawning grounds

Introduction

Over the course of time, species of anadromous fish that used to be very common have all but disappeared. There are many causes for the decline of these species. Over-harvesting has certainly affected fish populations. However, most fisheries biologists agree that the steady decline in water quality and resulting loss of spawning and wetland habitats during the early and middle part of the last century has had the most dramatic impact. The annual migration, or run, is still significant for the river herring. One can still see people gathering at bridges over creeks and along waterways in the early spring when the fish make their move upstream to begin again this timeless cycle of life.

About the Game

At www.bridgingthewatershed.org, you will find the "Swim for Your Life" interactive game that traces the natural history of the anadromous fish. In the game, these fish begin their lives as developing fish embryos contained within the egg, and then develop into larval fish, living and feeding in marshland nurseries. Later they move into the river and estuary to begin their journey to the ocean. Once in the ocean, they will require three or four years of growth to reach sexual maturity, whereupon they will begin the same migration their parents made, leaving the open ocean and entering coastal estuaries and rivers. Their upstream journey will eventually take them to the watersheds from which they originated. Once there, they will spawn to create a future generation and continuation of the cycle. The task is for two fish to return to their original spawning grounds to breed and continue their species.

Complete Online Game Board →

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How Herring Reproduce

A player begins the game as fertilized river herring eggs left to chance by the adults. Gravid (pregnant) females lay eggs. A male fish accompanies the female to fertilize the eggs. A mature female can lay as many as 300,000 eggs. Typically, the female swims in a very tight circle over the gravel or sand bottom in the water near the bank in a sort of mating ritual. The male is usually on the outside of the circle, swimming next to the female. As the female releases the eggs, the male releases the milt or semen into the water at the same time. At the end of the mating ritual, the male and female depart, and the eggs are left to chance. As the eggs begin to float downstream, they will encounter perils, both natural and man-made.

How to Play the Game

One or two people can play the game. During the game, your school of fish will move through the watershed from the spawning grounds (upper left hand corner/start) to the ocean (upper right hand corner online, lower right hand corner on the board game) and back again. Your school starts out with 100,000 eggs. The fish may encounter perils that will reduce the number of fish. (You can learn more about each peril by clicking your mouse on the name of the peril.).

As you move through the game, **RECORD** information on the datasheet located on pages 16 – 18 of your worksheet booklet. After each turn, record the percent fish destroyed and number of fish remaining in your school. Also decide if the peril is natural or caused by humans, and whether it is unavoidable or preventable.

The goal is to have at least two fish return to the spawning grounds to reproduce again.