



# **Fish For The Future** *A Hatchery Experience*

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**AN ACTIVITY GUIDE FOR  
NEW HAMPSHIRE HATCHERIES**



New Hampshire Fish and Game Department  
*K-12 Activity Guide and Supplemental Curriculum Materials*

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# Prepare for a Hatchery Visit

## How to Use These Materials

The information and activities within this book are designed to be used prior to, during, and following a hatchery visit by a class or group. They will help enhance an understanding of New Hampshire Fish and Game hatchery management, fish species and their habitats, and the value of healthy watersheds. They incorporate Science, Math, History, Art, English, and many other disciplines in a hands-on and classical classroom approach that can be integrated into school curricula. This book can be useful to all teachers, camp instructors, and home-schools in any school or non-school setting. The activities are supported with information and are adaptable to primary and secondary levels.

An Objectives, Method, Background, Materials, and Procedure section is included with each activity. Student assessment is up to you. The appendices contain helpful information for some of the activities, including a fish species list and glossary.

## Learning Objectives

Students will be able to:

- Understand the life cycle of the trout species in the hatcheries; brook trout, rainbow trout and brown trout
- Understand why the NH Fish and Game Department has hatcheries
- Understand how the NH Fish and Game Department hatcheries are managed

## What Can You See?

**OBJECTIVES:** Students will be able to describe two ways to improve their observational skills.

**METHOD:** Students will study the random placement of objects in an area and verbally express what they observe.

**BACKGROUND:** This is an activity to assist in demonstrating that observing does not mean just examining the immediate area. It will take an observation of the entire area to identify what the entire picture/answer has to say.

**MATERIALS:** Six or seven pencils, area large enough for all students to stand in a semi-circle around the instructor.

### PROCEDURE:

1. Ask the students to form a half circle around the front of you. Tell them that you are going to test their observational skills.
2. Place the pencils in some random pattern on the floor in front of you. Ask the students what number the pattern represents. Before the students are answering, place your hand(s) down (not too obvious) so that the number of fingers showing is the number you are looking for. Repeat this several times with the pencils in different patterns.
3. If a student observes what is going on, don't allow them to tell others, but call on them every once in awhile to see if they are still being observant.
4. At the end of the exercise allow a student to explain what they observed and how they did it.
5. Discuss what is needed to be observant and why we should look at the whole picture not just what is being portrayed to our quick view.

# Evaluation Sheet

Name: \_\_\_\_\_

Grade: \_\_\_\_\_

Group: \_\_\_\_\_

Date of Visit: \_\_\_\_\_

Address: \_\_\_\_\_

Hatchery Visited: \_\_\_\_\_

\_\_\_\_\_

Instructor: \_\_\_\_\_

Please comment on the quality of the materials and services you received by circling the appropriate number:

	Not Used	Poor	Fair	Good	Excellent
1. Pre-visit activities	1	2	3	4	5
2. Post-visit activities	1	2	3	4	5
3. Quality of your program	1	2	3	4	5
4. Appropriateness to the age level	1	2	3	4	5

5. Which activity was the most valuable for preparing students?

6. How might we improve our pre and post-visit educational packet?

7. Was your program facilitator knowledgeable and provide you with enough age specific information?

8. Would you recommend this program to others?

9. How might we improve our programs at the hatcheries?

10. Additional Comments:

**Return To:**

Watershed Education Specialist, Public Affairs

New Hampshire Fish and Game Dept.

11 Hazen Drive, Concord, NH 03301

# The Mission of the New Hampshire Fish and Game Department

As guardians of the state's fish, wildlife and marine resources, the New Hampshire Fish and Game Department works in partnership with the public, agencies, organizations and volunteers to:

- Conserve, manage and protect these resources and their habitats;
- Inform and educate the public about these resources and their habitats;
- Provide the public with opportunities to use and appreciate these resources.

In support of its mission, the New Hampshire Fish and Game Department:

- Sets and enforces hunting and fishing regulations
- Initiates and supports habitat enhancement projects
- Initiates and supports wildlife research projects
- Provides public information and education opportunities
- Organizes search and rescue operations
- Raises fish in hatcheries for stocking of public waters



# NH Fish and Game Department Hatcheries

## Why Does the NH Fish and Game Department Have Hatcheries?

Warm water fish species in New Hampshire successfully produce enough young fish that survive to sustain the species naturally and to offer good recreational opportunities for the public. The cold water species such as Eastern brook trout (EBT), rainbow trout (RT), brown trout (BT) and landlocked salmon (LLS) have insufficient natural habitat capacity and need a little help to sustain their numbers. The hatcheries are in place to maintain, increase, or restore these populations.

The fish culturists substitute hatchery capacity for the lack of natural spawning habitat to complete the life stages of the fish. For trout and salmon, the hatchery provides habitat for spawning, egg incubation and fry up to fingerling size (one to three years and older). Then fish get stocked in the water body to survive from there.

## Who, What, Where, Why, and How of the Fish Hatchery?

### Obtaining the Eggs:

The hatcheries obtain the eggs for rainbow trout from the US Fish and Wildlife Service hatcheries, collected from free-swimming wild species and/or Brood Stock fish that are 3-4 years old. New Hampton Hatchery is currently home to our brown trout brood stock along with a strain of brook trout. Berlin Hatchery also manages a separate strain of brook trout to supply the northern hatcheries with eggs and fingerlings. Commercial eggs are subject to strict Fish Health inspections by a certified fish health professional prior to importation. The eggs are disinfected upon receipt to prevent the introduction of a variety of fish disease causing pathogens.

Fish culturists use crowders, dividers and seines to gather the fish in one area of the pools. The stripping process begins by netting out and placing the fish into containers. Males and females are separated. Males usually have a Kype, a large bump on their bottom jaw, which makes identification easy. When females are ripe, the eggs are stripped by hand (about 800 eggs per pound of body weight). This is done by applying slight pressure to the female stomach region and sliding the hand back towards the caudal tail. The eggs are released through the vent and collected into bowls. They are then fertilized by the male's Milt (sperm), collected by the same process. The same process is used in the wild after the fish have been netted from the waterbody.





## Caring for the Eggs

After the eggs have been fertilized, water is added to “harden” the eggs. At the hatchery the eggs are measured for size and amount. The size of the eggs is determined by counting the number of eggs that lie linearly in a 12 inch trough (Von Bayer method). Once the size is determined, egg numbers are estimated by measuring the volume in a graduated cylinder.

Once they are rinsed clean, they are placed into incubators consisting of trays typically stacked eight high. A constant supply of water provides oxygen to the eggs until they hatch and the yolk sac has been mostly utilized. During this time, temperature is monitored closely to ensure the correct hatch out time, which varies depending on the species, and viability of the eggs.

After approximately “six weeks” the eggs become “eyed”. The embryo has eyes and is more stable allowing Fish Culturists to remove any of the non-fertilized eggs. These are easily recognizable by their opaque color. These must be removed by hand or machine before fungus can grow on them.

## Alevin/Sac-fry

When the eggs hatch, the small fish are called alevin or sac-fry. Alevin still have their yolk sac attached to their body, which provides nutrients for about 24 weeks, depending on water temperature. After the yolk sac is absorbed, they are fed commercial food as often as eight times a day.



## Fry and Fingerlings

At this stage the fish are free swimming and are kept in indoor raceways of the hatchery. They are continually monitored for growth and health, food size and amount as they grow. Fish, which show any signs of bacteria and parasites, are treated or removed.



## Fingerlings

Once they are large enough (3-4inches), they are moved to the outside raceways. Temperature is monitored closely in the summer. Warm water is essential for maximal growth of the fish, but may lower the oxygen level in the water. Testing is done periodically for oxygen, parasites and bacteria by the Fish Culturists. Predation by birds (great blue herons & kingfishers) and mammals (otters and mink) can cause a loss in numbers of the hatchery-raised fish. For this reason the pools should be covered with fencing and netting. The pools need to be manually cleaned by scrubbing the sides and bottoms to remove the fish waste and algae, and then vacuumed. The fish waste can be spread on agricultural fields for disposal. This process protects water quality by preventing the fish waste from going into the local watershed and causing eutrophication from added the nutrients.

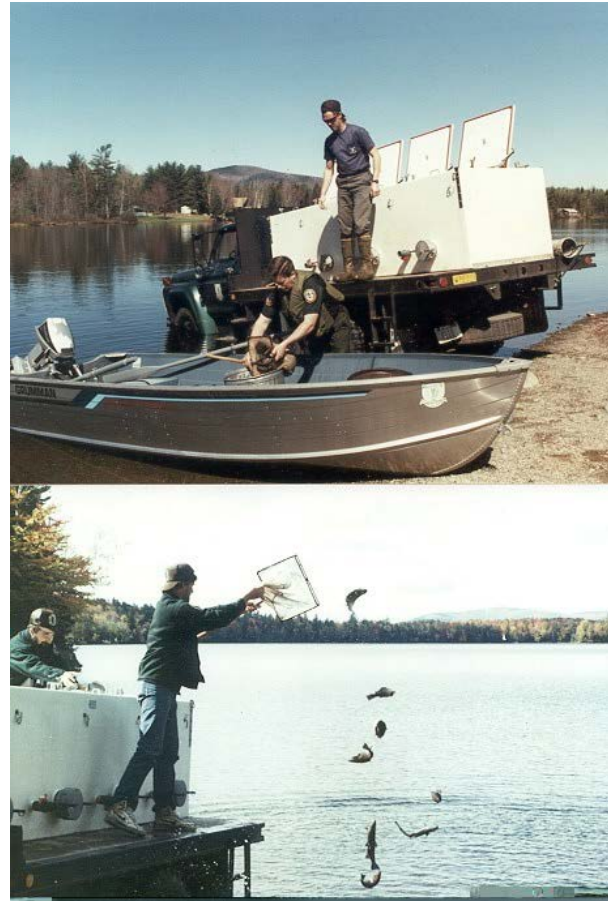


## Where Do They Go From Here?

Fish and Game Department Fisheries Biologists determine the location and numbers of fish to be stocked. Stocking decisions are based on catch records, habitat, water quality, demand, and public access and fish availability.

A large percentage of the fish raised at the hatcheries are considered production fish and are released (stocked) into various ponds, lakes, rivers and streams. This process combines the work of the various hatchery personnel (Hatchery Supervisors, Fish Culturists, and Volunteers) in coordination with Conservation Officers.

First, the fish are seined or crowded up from the pools. This is done by dropping a seine (large net with floats on the top and a lead line on the bottom) in at one end of the pool and dragging it to the other side, corralling the fish into a smaller area. Next they will be netted, counted and lifted into the stock truck. These trucks are equipped with a large water tank, compressed oxygen and water circulation pumps to maintain adequate oxygen levels to the fish during the move. Once the tanks are filled they are driven to the stocking sites and the fish are released either by hand held nets or straight from the tank. A smaller percentage of fish are held for up to three years and will be labeled brood stock. These fish will pass on their genetics to future generation of hatchery-raised fish.



## Which Hatchery Do I Want to Visit?

New Hampshire's Fish and Game fish hatcheries are a great place to learn about how fish are hatched and reared. These facilities raise more than a million trout each year! Hatcheries are open year round, from 8 a.m. to 4 p.m. Outdoor fish viewing is available throughout the year. Guided hatchery tours are available by reservation. Twin Mountain and Warren hatcheries have more extensive educational exhibits; these wildlife centers are typically open seasonally by appointment. You'll enjoy meeting our dedicated, hardworking hatchery staff, who not only understand the technical challenges of raising fish... they also love to fish themselves!

### **Berlin Fish Hatchery**

Off Route 110, Kilkenny Valley,  
White Mountain National Forest  
York Pond Road, Berlin, N.H. 03570  
603-449-3412

### **Twin Mountain Fish Hatchery and Wildlife Center**

1450 Route 3 North  
Whitefield, N.H. 03598  
Telephone: 603-846-5429

### **Warren Fish Hatchery and Wildlife Center**

23 Fish Hatchery Road/Old Route 25  
Warren, N.H. 03279  
Telephone: 603-764-8593

### **New Hampton Fish Hatchery**

Route 132, New Hampton 03256  
603-744-3709

### **Powder Mill Fish Hatchery**

288 Merrymeeting Road, New Durham 03855  
603-859-2041

### **Milford Fish Hatchery**

386 North River Road, Milford 03055  
603-673-1416

## Hatcheries Past and Present

The **Berlin Hatchery** was established by the U.S. Fish and Wildlife Service in 1921. The New Hampshire Fish and Game Department took over operations in 1982. Seven hundred thousand brook trout are hatched here yearly. Although rainbow and brown trout are hatched at other hatcheries, they are shipped to Berlin to be raised until they are 2 years old.

Exhibit area, open May-October, includes a mural of ponds and a stream area, interactive activities about fisheries management, and a history of the Berlin Hatchery. The N.H. Fish and Game's Barry Conservation Camp is located at the hatchery site. This camp is co-sponsored with the University of New Hampshire Cooperative Extension and offers summer sessions for children.

The **Twin Mountain Hatchery** dates back to President Franklin D. Roosevelt's New Deal of the 1930s. The Hatchery was initiated as a Works Progress Administration project in 1934. The Twin Mountain Hatchery provides facilities for egg incubation and rearing. You will find brook and rainbow trout in the raceways and a show pool where you can feed trophy sized brook, brown, and rainbow trout. The Wildlife Center teaches about New Hampshire's wildlife through hands-on exhibits and a 27 foot tank system that allows a view of fish up close.

In 1915, the State of New Hampshire purchased the Walt Smith Farm, and created the **Warren Fish Hatchery**. The site was constructed in 1918, making Warren the oldest state hatchery still in operation. For over 60 years, this hatchery raised a variety of trout and at its peak, it produced nearly half-a-million fish annually. The trout species kept at Warren are brook, brown and rainbow trout. Since the early 1990's Warren Hatchery has been where Atlantic salmon fry have been hatched as part of the Merrimack River Atlantic Salmon Restoration Program. The Warren Hatchery also contains the Wildlife Center. This education center allows the guest to observe New Hampshire's wildlife and the life cycle of the Atlantic salmon.

The **New Hampton Hatchery** was established in 1920 by the New Hampshire Fish and Game Department. Five hundred thousand brook trout and 200,000 brown trout are hatched here yearly. Both species are raised until they are yearling and two-year-old size before being stocked. New Hampton Hatchery also manages brood lines of brook and brown trout that are used to provide eggs and fingerlings to other hatcheries. New Hampton also raises fingerling trout that are utilized in our remote ponds and stocked via helicopter.

The site of the **Powder Mill Hatchery** was used around 1857 as a mill that produced sporting and blasting powder, therefore giving this site its name. The hatchery was opened in 1946 after the powder mill closed down. Landlocked Atlantic salmon are hatched and raised here to a size of 6 to 7 inches. Brook, rainbow, and brown trout fingerlings are transferred here and are raised for a year. Powder Mill is New Hampshire's largest production facility and utilizes Merrymeeting Lake as its water source.

The **Milford Hatchery** was established in 1973 by the New Hampshire Fish and Game Department with aid from the National Oceanic Atmospheric Administration's National Marine Fisheries monies. Milford originally raised only anadromous fish, but due to changes in fisheries management the facility began to raise trout in 1982. Approximately one million fish (rainbow, brown and brook trout) are produced yearly at this hatchery.

Exhibits explain hatchery operation, importance of riparian areas and fisheries management.

# What is Trout in the Classroom? (TIC)

Trout in the Classroom is a national environmental education program in which students in grades K-12:

- raise trout from eggs to fry.
- monitor tank water quality.
- engage in stream habitat study.
- learn about fish hatcheries and fish culture.
- begin to foster a conservation ethic.
- grow to understand ecosystems.

TIC is a unique way to teach the relevance of watersheds. Trout are indicator species; their abundance directly reflects the quality of the water in which they live. In the TIC program, students grow to care about their trout and then the habitat in which trout live. As the program progresses, students learn to see connections between the trout, water resources, the environment, and themselves. For more information about the TIC program in NH, contact Judy Tumosa: [judy.l.tumosa@wildlife.nh.gov](mailto:judy.l.tumosa@wildlife.nh.gov).

## TIC partners:

The Watershed Education Specialist at NH Fish & Game (NHF&G) provides oversight and resources to support the state TIC programs. NH F&G keeps track of teachers, schools, and other organizations that participate and provides eggs and permits for release into local streams. NHF&G also provides training and environmental education resources, and helps to connect teachers with New Hampshire Trout Unlimited (NHTU), local chapters of Trout Unlimited (TU), and other organizations that support TIC.

The NHF&G Fish Hatcheries provide the trout eggs and technical assistance to the schools to help them successfully raise the trout eggs. They also, by appointment, can provide hatchery tours. The fisheries division and biologists provide the permits to raise the trout eggs, advice about acceptable stocking sites, and information about habitat needs of the trout.

New Hampshire Trout Unlimited and its associated Chapters are important partners in the state TIC program. The state TU Council, TU chapters, and other partners can sponsor one or more schools by providing funding, equipment, technical support, classroom guest speakers, and guidance during fieldwork. Members of TU can help classes by sharing their expertise in conservation, stream restoration, fly-tying, trout biology, invertebrate identification, and outdoor sports activities.

The Eastern Brook Trout Joint Venture (EBTJV) is a recognized Fish Habitat Partnership operating under the National Fish Habitat Action Plan. The EBTJV coordinates efforts that build private and public partnerships to improve brook trout habitat. The long-term goals of the EBTJV are to implement a comprehensive conservation strategy to improve aquatic habitat, raise public awareness, and prioritize the use of federal, state and local funds for brook trout conservation. TIC assists in this public awareness with the students and with the public.

## Hatchery Safety

PLEASE, in order to prevent the spread of fish disease in the hatchery:

1. Fish should not be fed anything other than their controlled diet.
2. Do not throw, kick or put anything into the water (hands, stones, etc.)
3. Stay out of restricted areas.
4. Fishing equipment is not allowed in the hatchery
5. Children must be supervised.

For your safety, please stay off concrete tanks. Your cooperation is important to the fish, hatchery personnel and future hatchery visitors. Thank you, Enjoy your visit!

# Hatchery Bingo

**OBJECTIVES:** Students will be able to: Describe the basic function of a hatchery and become familiar with the hatchery surroundings.

**METHOD:** Students will use the fill-in-the-blank bingo sheet to familiarize themselves with the hatchery and functions.

**BACKGROUND:** Review the information provided in the Hatcheries Past and Present portion of this book and the information on the specific hatchery you will be visiting to obtain a background on the Hatchery System.

**MATERIALS:** Photocopies of the Hatchery Bingo

## PROCEDURE:

1. Use this Bingo as an activity/note taking device to allow the students to independently familiarize themselves with the hatchery and its functions.



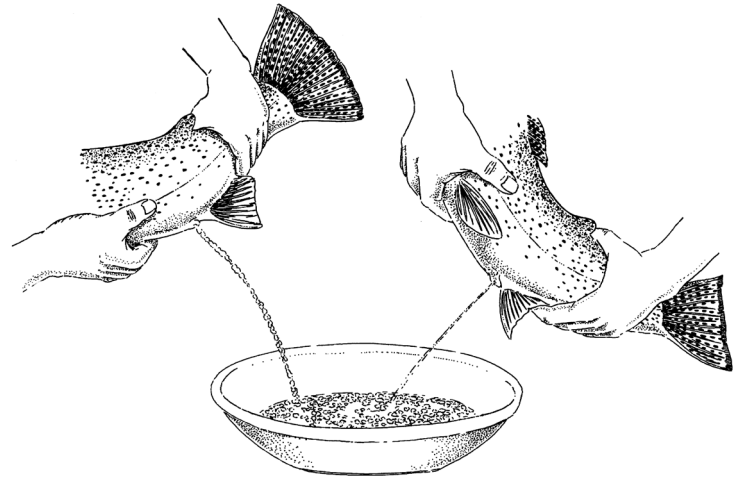
# Hatchery Bingo

Where do the fish go from here?	Name a plant/tree at the hatchery.	Color of a fish.	What is a Fish Culturist?	Name a fish disease.
When does a fish breed?	What is the life cycle of a trout?	Name of Hatchery.  When was it established?	What is Brood Stock?	What do fish breathe?
How does the hatchery get its water?	Where do the fish go in the winter?	<b>Free Space</b>	Name a Scientific Name of a fish.	What is the water temperature?
Name a type of fish.	Name a natural sound.  What is it?	Number of fish on site.	Number of different species on site.	What is dissolved oxygen?
Name a type of fish.	What does anadromous mean?	Number of fish on site.	Name a fish predator.	Name a Scientific Name of a fish.

# Hatchery Bingo

<p>Name a type of fish.</p>	<p>Name a natural sound. What is it?</p>	<p>Name a plant/tree at the hatchery.</p>	<p>Name of Hatchery.</p>
<p>Find an animal track.  Draw it</p>	<p>Find a sign of a bird.  Draw it</p>	<p>Name a fish predator at the hatchery.</p>	<p>Name a type of fish.</p>
<p>How many fish are at the hatchery?</p>	<p>Where do the fish go in the winter?</p>	<p>Where do the fish go from here?</p>	<p>How many pools of fish are there?</p>
<p>What is a raceway?</p>	<p>Color of a fish</p>	<p>What do fish eat?</p>	<p>Name a type of fish.</p>

# Introduction To Fish



## Portrait of a Fish

**OBJECTIVES:** Students will be able to:

- 1) Name the basic parts of a generalized fish: 2) Describe the function of the parts.

**METHOD:** Students will use the Generalized Fish to fill in the blank sheet and the Find a Fish Word Search to familiarize themselves with the fish parts and functions.

**BACKGROUND:** Picture of Generalized Fish with labeled parts: Dorsal fin, Caudal Fin(tail fin), Anal Fin, Pelvic Fin, Mouth, Pectoral Fin, Gills, Dorsum (back), Venter (belly), Eyes, Coloring(spots/stripes), Scales

**GILLS** - Fish use gills instead of lungs to breathe. The gills remove oxygen from the water. Water flows into the mouth of the fish and over the gills, exiting finally through the gill slits.

**FINS** - A fishes' fins are important for movement through the water, aim, and balance. The caudal fin (tail fin) is used for forward momentum through the water. The pectoral fins "aim" the fish and act as brakes. The dorsal, pelvic, and anal fins help to balance and position the fish.

**COLOR** - Most fish have a special color adaptation. Similar to why a soldier wears camouflage, a fish can use its colors to hide or move undetected. Notice how a catfish is typically dark colored, then look at its muddy/dark habitat where it lives. If the catfish was orange or any other light color it would easily be seen, and probably eaten by a predator.

**MUCUS and SCALES** - Why does a fish feel slimy? Mucus is a protective coat on some fish. It helps to protect the fish from diseases, fungi and parasites. Scales are another way to help protect the fish body from injury. Scales come in many sizes, shapes, and textures. Biologist can tell the age of a fish by studying the rings formed on a scale. This is very similar, to reading the rings on a cross-section of a tree to tell its age. Note: It is important that you do not touch the fish during your visit, except under the direction of the hatchery staff. Even gentle hands can remove this protective layer, putting the fish at risk of infection.

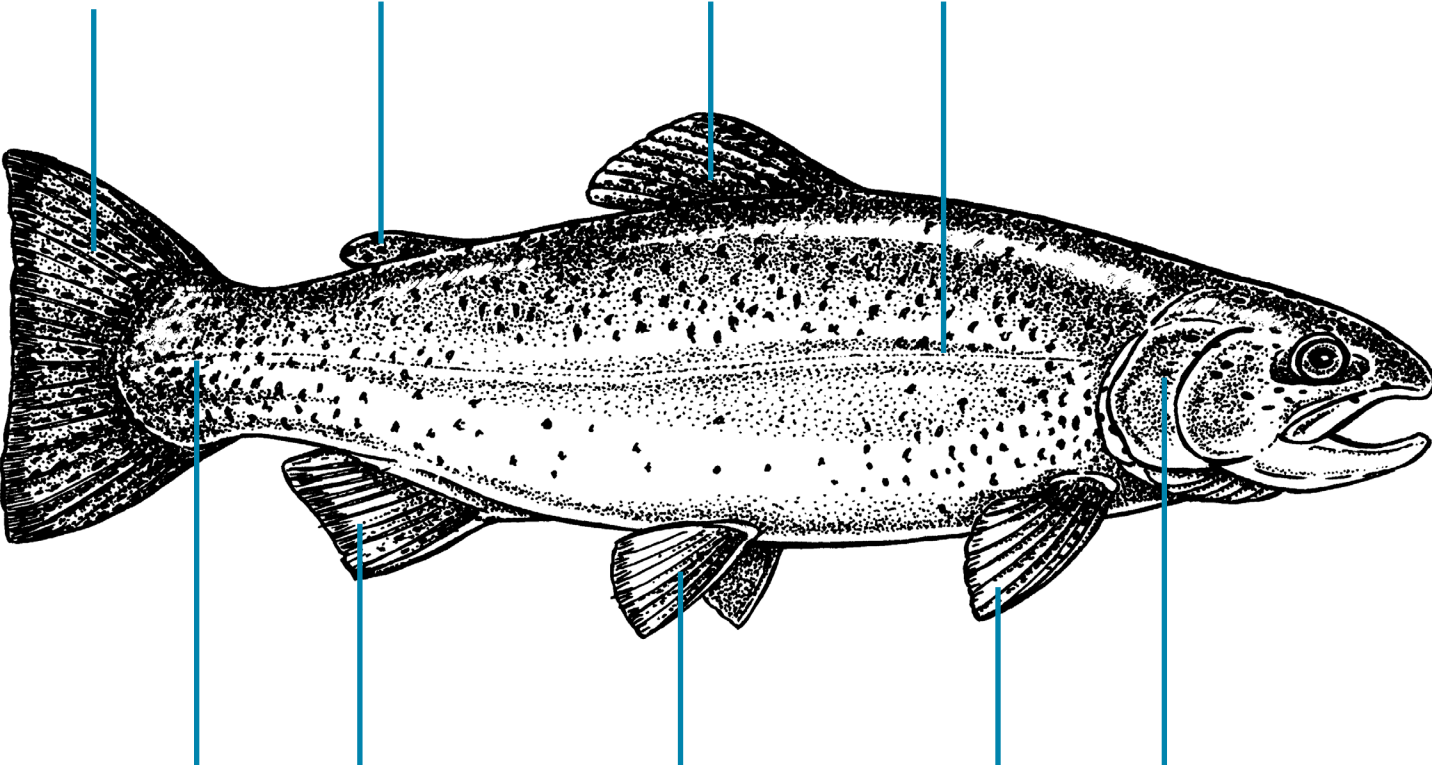
**EYES and EYESIGHT** - Fish have very good eyesight. They can see above, below and ahead of them at any time. Their eyes also can move independently from each other, meaning one eye can look up while the other can be looking forward.

**MATERIALS:** Generalized Fish, Find a Fish Word Search, Art Supplies, Pencils

## PROCEDURE:

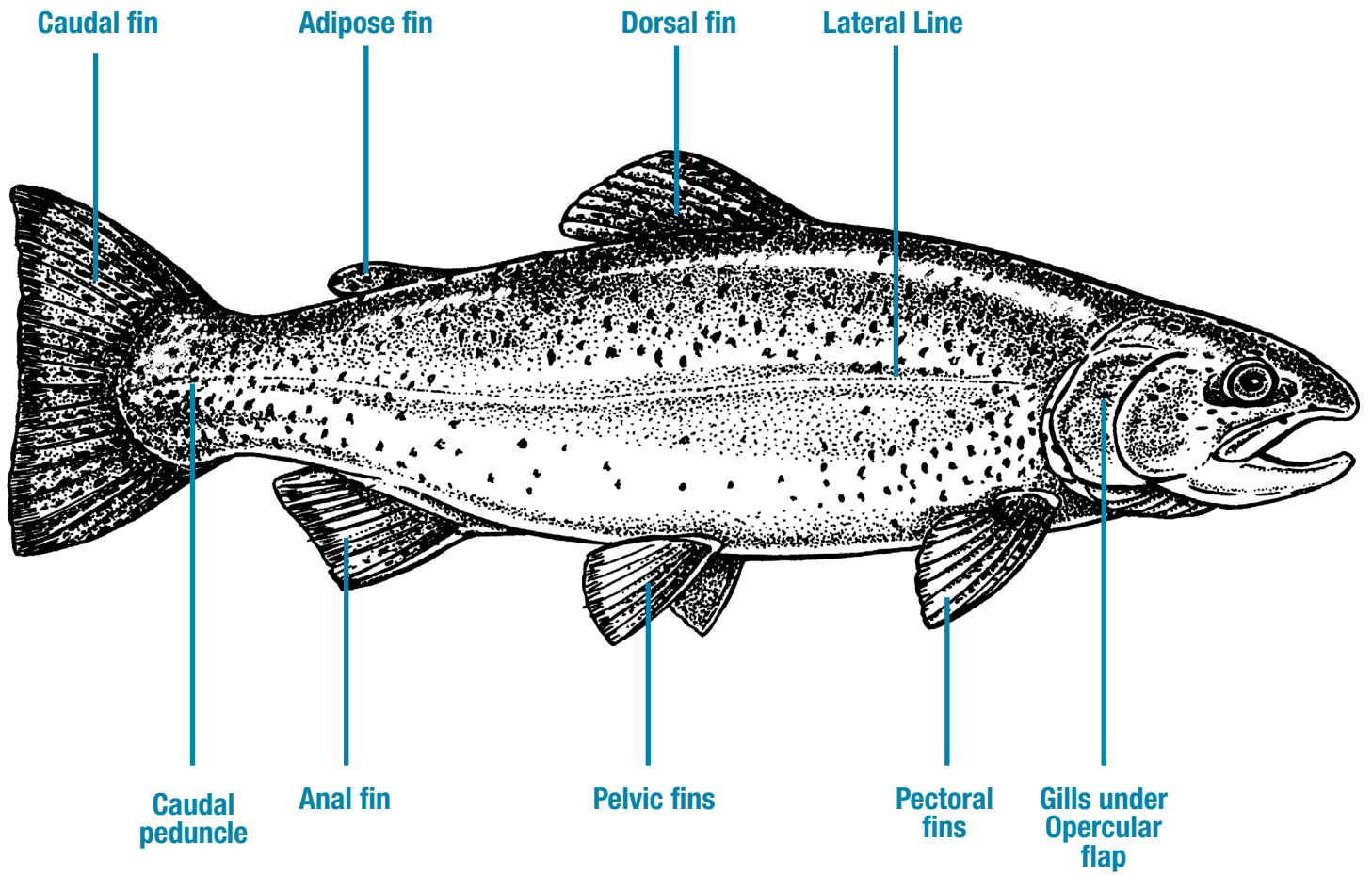
1. Ask the students to close their eyes and imagine a fish. Have them picture the environment where their fish lives. Allow them to draw their view of the fish.
2. Discuss the parts of the generalized fish. Ask the students about what they think each part is used for. Fill in the generalized fish handout.
3. Allow the students time to complete the Find a Fish Word Search. This is used to reinforce the terms and functions of the parts of a fish.

# Generalized Fish





# Generalized Fish



# Find A Fish Word Puzzle

D	E	T	E	Y	E	S	S	X	G
R	T	Y	H	U	I	L	A	S	K
F	I	N	G	I	G	I	L	L	S
L	L	O	S	T	F	R	O	U	A
S	A	F	T	H	I	S	U	S	L
C	O	L	R	S	S	A	T	W	M
A	I	O	I	V	H	B	R	M	O
L	V	S	P	O	T	S	O	O	N
E	Y	E	E	D	A	O	U	V	L
S	A	F	S	U	N	S	T	A	K

Fin

Fish

Stripes

Scales

Spots

Trout

Gills

Eyes

Salmon

# Find A Fish Word Puzzle

D	E	T	E	Y	E	S	S	X	G
R	T	Y	H	U	I	L	A	S	K
F	I	N	G	I	G	I	L	L	S
L	L	O	S	T	F	R	O	U	A
S	A	F	T	H	I	S	U	S	L
C	O	L	R	S	S	A	T	W	M
A	I	O	I	V	H	B	R	M	O
L	V	S	P	O	T	S	O	O	N
E	Y	E	E	D	A	O	U	V	L
S	A	F	S	U	N	S	T	A	K

Fin

Scales

Gills

Fish

Spots

Eyes

Stripes

Trout

Salmon

# Find A Fish Word Puzzle

D	O	R	S	A	L	F	I	N	N	I	F	L	A	D	U	A	C	F	I
D	O	R	A	F	H	U	R	P	Q	W	E	R	E	T	N	E	V	O	J
A	Z	D	C	C	A	M	G	E	E	D	G	E	E	T	A	U	I	N	K
R	Y	I	A	W	A	F	G	L	H	I	Y	R	W	Q	N	E	P	N	O
A	D	F	M	M	O	F	S	V	A	O	P	P	F	S	E	R	E	C	S
K	L	M	O	U	T	H	B	I	S	D	T	C	W	E	O	G	C	V	A
A	S	H	U	J	T	Y	U	C	O	P	S	O	X	Y	P	J	T	B	F
E	V	E	F	W	E	B	O	F	U	I	O	L	U	E	H	I	O	U	D
D	P	A	L	S	H	J	I	I	S	S	P	O	T	S	G	M	R	G	G
S	S	D	A	C	A	U	D	N	I	H	B	R	M	I	D	L	A	G	I
G	S	L	G	K	B	N	Y	R	N	E	E	I	O	H	S	D	L	S	L
H	T	L	E	C	O	L	O	Y	N	L	G	N	C	G	E	S	F	W	L
U	R	P	H	I	S	H	I	F	I	S	H	G	V	F	F	A	I	A	S
R	I	I	S	A	G	O	O	D	N	P	O	D	B	S	G	Z	N	U	F
N	P	B	A	N	D	X	M	R	I	D	O	O	J	D	Y	V	A	I	H
B	E	A	H	I	D	U	V	X	F	A	D	L	D	D	M	Y	A	O	F
Z	S	T	H	E	C	E	N	A	N	A	L	F	I	N	L	T	T	P	I
A	E	N	D	U	A	S	U	W	Y	V	F	A	S	B	Q	L	Q	R	N
V	M	U	S	R	O	D	R	E	H	E	U	C	T	B	A	S	Y	S	D
G	J	K	L	O	R	E	E	S	A	I	N	S	S	C	A	L	E	S	S

Dorsal Fin

Caudal Fin

Anal Fin

Pelvic Fin

Mouth

Pectoral Fin

Gills

Dorsum

Venter

Eyes

Coloring

Spots

Stripes

Scales

Mucus

Camouflage

Fish



# Find A Fish Word Puzzle

D	O	R	S	A	L	F	I	N	N	I	F	L	A	D	U	A	C	F	I
D	O	R	A	F	H	U	R	P	Q	W	E	R	E	T	N	E	V	O	J
A	Z	D	C	C	A	M	G	E	E	D	G	E	E	T	A	U	I	N	K
R	Y	I	A	W	A	F	G	L	H	I	Y	R	W	Q	N	E	P	N	O
A	D	F	M	M	O	F	S	V	A	O	P	P	F	S	E	R	E	C	S
K	L	M	O	U	T	H	B	I	S	D	T	C	W	E	O	G	C	V	A
A	S	H	U	J	T	Y	U	C	O	P	S	O	X	Y	P	J	T	B	F
E	V	E	F	W	E	B	O	F	U	I	O	L	U	E	H	I	O	U	D
D	P	A	L	S	H	J	I	I	S	S	P	O	T	S	G	M	R	G	G
S	S	D	A	C	A	U	D	N	I	H	B	R	M	I	D	L	A	G	I
G	S	L	G	K	B	N	Y	R	N	E	E	I	O	H	S	D	L	S	L
H	T	L	E	C	O	L	O	Y	N	L	G	N	C	G	E	S	F	W	L
U	R	P	H	I	S	H	I	F	I	S	H	G	V	F	F	A	I	A	S
R	I	I	S	A	G	O	O	D	N	P	O	D	B	S	G	Z	N	U	F
N	P	B	A	N	D	X	M	R	I	D	O	O	J	D	Y	V	A	I	H
B	E	A	H	I	D	U	V	X	F	A	D	L	D	D	M	Y	A	O	F
Z	S	T	H	E	C	E	N	A	N	A	L	F	I	N	L	T	T	P	I
A	E	N	D	U	A	S	U	W	Y	V	F	A	S	B	Q	L	Q	R	N
V	M	U	S	R	O	D	R	E	H	E	U	C	T	B	A	S	Y	S	D
G	J	K	L	O	R	E	E	S	A	I	N	S	S	C	A	L	E	S	S

Dorsal Fin

Caudal Fin

Anal Fin

Pelvic Fin

Mouth

Pectoral Fin

Gills

Dorsum

Venter

Eyes

Coloring

Spots

Stripes

Scales

Mucus

Camouflage

Fish

**OBJECTIVES:** For younger students, students will be able to classify fish according to body shape and coloration.

For older students, students will be able to:

1. describe adaptations of fish to their environments;
2. describe how adaptations can help fish survive in their habitat; and
3. interpret the importance of adaptations in animals.

**METHOD:** Students design a variety of fish adapted for various aquatic habitats.

**BACKGROUND:** Aquatic animals are the product of countless adaptations over long periods of time. These adaptations, for the most part, are features that increase the animal's likelihood of surviving in their habitat.

When a habitat changes, either slowly or catastrophically, the species of animals with adaptations that allow them many options are the ones most likely to survive. Some species have adapted to such a narrow range of habitat conditions that they are extremely vulnerable to change. They are over-specialized and are usually more susceptible than other animals to death or extinction.

In this activity, the students design a kind of fish. They choose the adaptations that their fish will have. Each choice they make would actually take countless years to develop. As these adaptations become part of the fish's design, the fish becomes better suited to the habitat in which it lives. Because of the variety of conditions within each habitat, many different fish can live together and flourish. Some adaptations of fish are shown in the table that follows. The major purpose of this activity is for students to investigate the concept of adaptation in fish.

**MATERIALS:** Five cards for each adaptation from the masters provided: mouth, body shape, coloration, reproduction; art materials: paper (NOTE: Body shape and coloration are the only cards needed for younger students.)

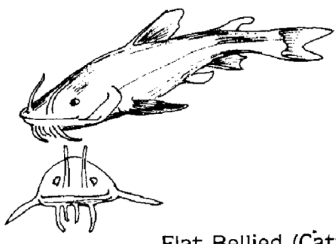
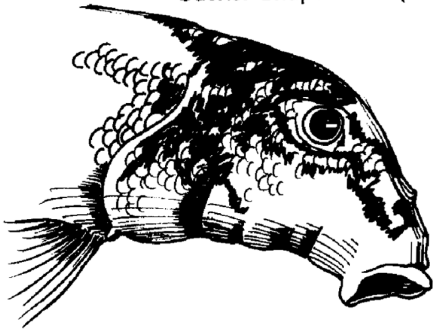
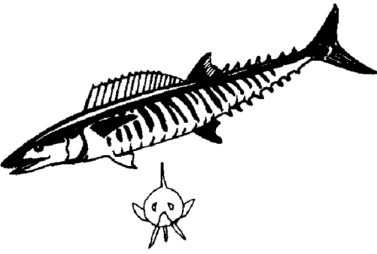
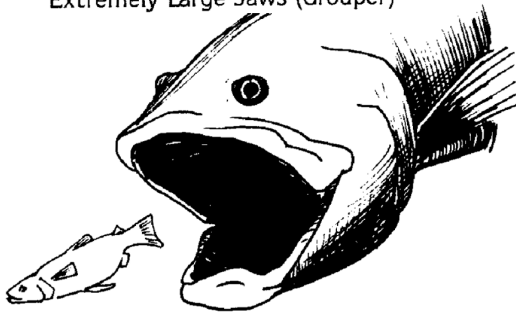
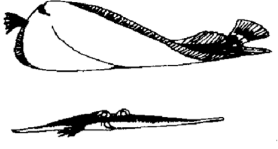
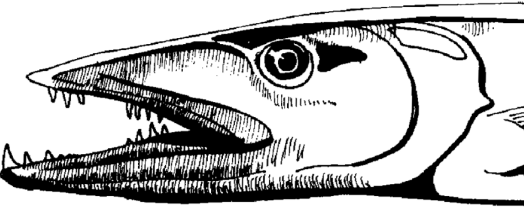
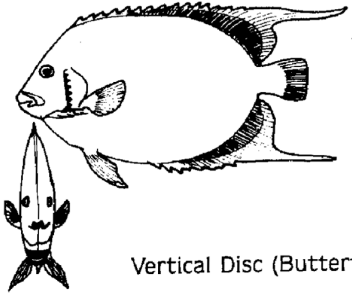
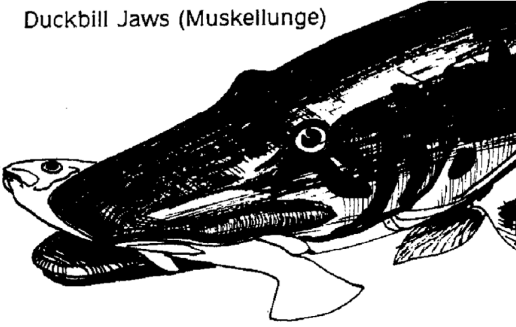
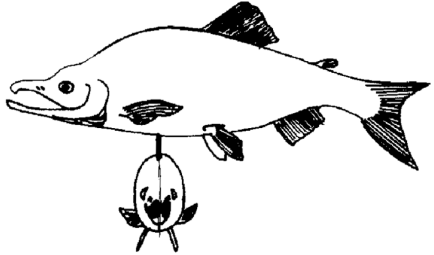
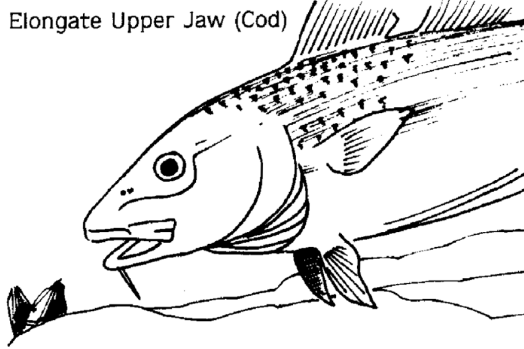
## **PROCEDURE:**


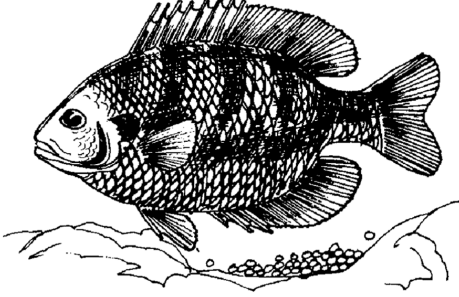
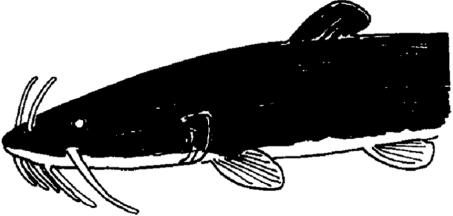
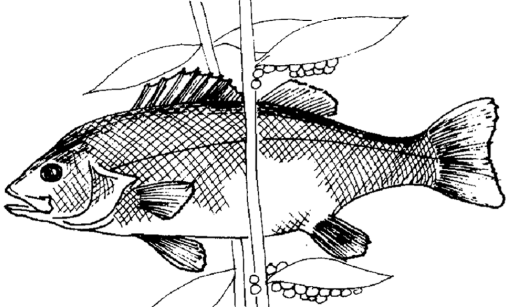
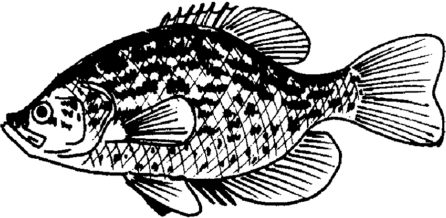
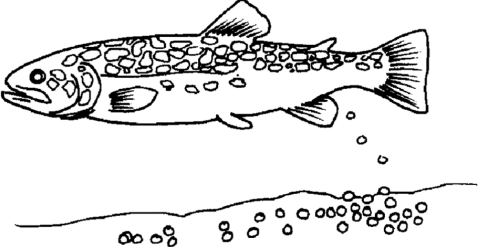
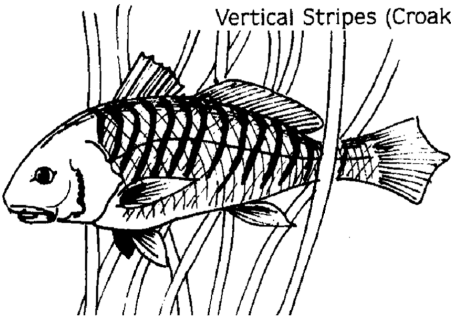
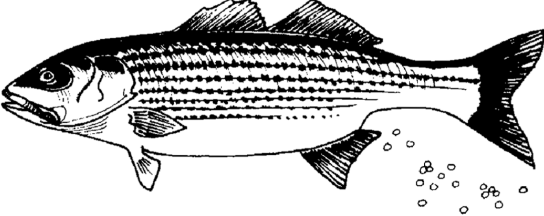
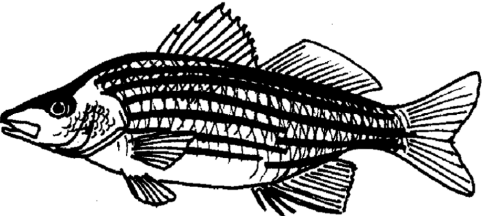
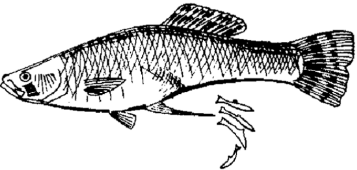
1. Assign students to find a picture or make a drawing of a kind of animal that has a special adaptation - for example, long necks on giraffes for reaching high vegetation to eat, large eyes set into feathered cones in the heads of owls to gather light for night hunting.
2. Conduct a class discussion on the value of different kinds of adaptations to animals. As a part of the discussion, ask the students to identify different kinds of adaptations in humans.
3. Pool all of the students' pictures or drawings of adaptations. Categorize them into the following groups:
  - protective coloration and camouflage
  - body shape/form
  - mouth type/feeding behavior
  - reproduction/behavior
  - other (one or more categories the students establish, in addition to the four above that will be needed for the rest of the activity)
4. Divide the adaptation cards into five groups of four cards each, one each of coloration, mouth type, body shape and reproduction.
5. Pass one complete set of cards to each group of students. There might be five groups, with four to six students in each group.
6. Ask the students to "fashion a fish" from the characteristics of the cards in the set they receive. Each group should: create an art form that represents their fish, name the fish, describe and draw the habitat for their fish
7. Ask each group to report to the rest of the class about the attributes of the fish they have designed, including identifying and describing its adaptations. Ask the students to describe how this kind of fish is adapted for survival.
8. FOR OLDER STUDENTS: Ask the students to make inferences about the importance of adaptations in fish and other animals.

## EXTENSIONS:

1. Take an adaptation card from any category and find real fish with that adaptation! NOTE: A collection of books about fish is useful. Do not be as concerned about reading level as much as profuse illustrations.
2. Look at examples of actual fish. Describe the fish's "lifestyle" and speculate on its habitat by examining its coloration, body shape and mouth.

	ADAPTION	ADVANTAGE	EXAMPLES
Mouth	Sucker shaped mouth	Feeds on very small plants and animals	Sucker, Carp
	Elongate upper jaw	Feeds on prey it looks down on	Spoonbill, Sturgeon
	Elongate lower jaw	Feeds on prey it sees above	Barracuda, Snook
	Duckbill jaw	Grasps prey	Muskellunge, Pike
	Extremely large jaws	Surrounds prey	Bass, Grouper
Body Shape	Torpedo shape	Fast moving	Trout, Salmon, Tuna
	Flat bellied	Bottom feeder	Catfish, Sucker
	Vertical disk	Feeds above or below	Butterfish, Bluegill
	Horizontal disk	Bottom dweller	Flounder, Halibut
	Hump back	Stable in fast moving water	Sockeye salmon, Chub, Razorback
Coloration	Light colored belly	Predators have difficulty seeing it from below	Most minnows, Perch, Tuna, Mackerel
	Dark upper side	Predators have difficulty seeing it from above	Bluegill, Crappie, Barracuda, Flounder
	Vertical stripes	Can hide in vegetation	Muskellunge, Pickerel, Bluegill
	Horizontal stripes	Can hide in vegetation	Yellow and white bass, Snook
	Mottled coloration	Can hide in rocks and on bottom	Trout, Grouper, Rockbass, Hogsucker
Reproduction	Eggs deposited in bottom	Hidden from predators	Trout, Salmon, most minnows
	Eggs deposited in nests	Protected by adults	Bass, Stickleback
	Floating eggs	Dispersed in high numbers	Striped bass
	Eggs attached to vegetation	Stable until hatching	Perch, Northern Pike, Carp
	Live bearers	High survival rate	Guppies

<p>Shape</p>  <p>Flat Bellied (Catfish)</p>	<p>Sucker Shaped Jaw (Sucker)</p> <p>Mouth/Feeding</p> 
<p>Torpedo Shape (Wahoo)</p> <p>Shape</p> 	<p>Extremely Large Jaws (Grouper)</p> <p>Mouth/Feeding</p> 
<p>Horizontal Disc (Halibut)</p> <p>Shape</p> 	<p>Elongate Lower Jaw (Barracuda)</p> <p>Mouth/Feeding</p> 
<p>Vertical Disc (Butterfish)</p> <p>Shape</p> 	<p>Duckbill Jaws (Muskellunge)</p> <p>Mouth/Feeding</p> 
<p>Humpbacked (Sockeye)</p> <p>Shape</p> 	<p>Elongate Upper Jaw (Cod)</p> <p>Mouth/Feeding</p> 

 <p>Light Colored Belly (Albacore)</p>	<p>Coloration</p>	<p>Eggs Deposited in Nests (Blue Gill)</p> 	<p>Reproduction</p>
<p>Dark Upperside (Catfish)</p> 	<p>Coloration</p>	 <p>Eggs Deposited on Vegetation (Yellow Perch)</p>	<p>Reproduction</p>
 <p>Mottled (Crappie)</p>	<p>Coloration</p>	 <p>Eggs Deposited on Bottom (Trout)</p>	<p>Reproduction</p>
<p>Vertical Stripes (Croaker)</p> 	<p>Coloration</p>	<p>Free Floating Eggs (Striped Bass)</p> 	<p>Reproduction</p>
<p>Horizontal Stripes (Yellow Bass)</p> 	<p>Coloration</p>	 <p>Live Birth (Gambusia)</p>	<p>Reproduction</p>

# Fish in Our Libraries?

**OBJECTIVES:** Students will be able to list and describe the different species of fish in New Hampshire waters.

**METHOD:** Students research New Hampshire fish, create a picture, and report their findings to the class.

**BACKGROUND:** See Appendix A for a Species List of Freshwater Fishes of New Hampshire. For older students have them include habitat where the fish are found, diet, description, and possible predators in their reports.

**MATERIALS:** Library resources, Art supplies

## PROCEDURE:

1. Ask/Assign the students to do research on a New Hampshire Fish.
2. Allow them to illustrate the fish or use pictures.
3. Students should then present their findings to the class.

# Fish Word Scramble

**OBJECTIVES:** Students will be able to complete the Fish Word Scramble as a review for the terminology used in fish hatcheries.

**METHOD:** Students independently complete the scrambled word worksheet.

**BACKGROUND:** Previous information from lessons.

**MATERIALS:** Fish Word Scramble

## PROCEDURE:

1. Fill out the Fish Word Scramble



# Fish Word Scramble

1. mosaln

---

2. sligl

---

3. liinnggefr

---

4. aamoosnrdu

---

5. rdoals nfi

---

6. cehhrtya

---

7. ltms0

---

8. cktoinsg

---

9. racwyae

---

10. uaadlc nif

---

11. eaivnl

---

12. poisade inf

---

13. oordb kctos

---

14. tcrolaep fin

---

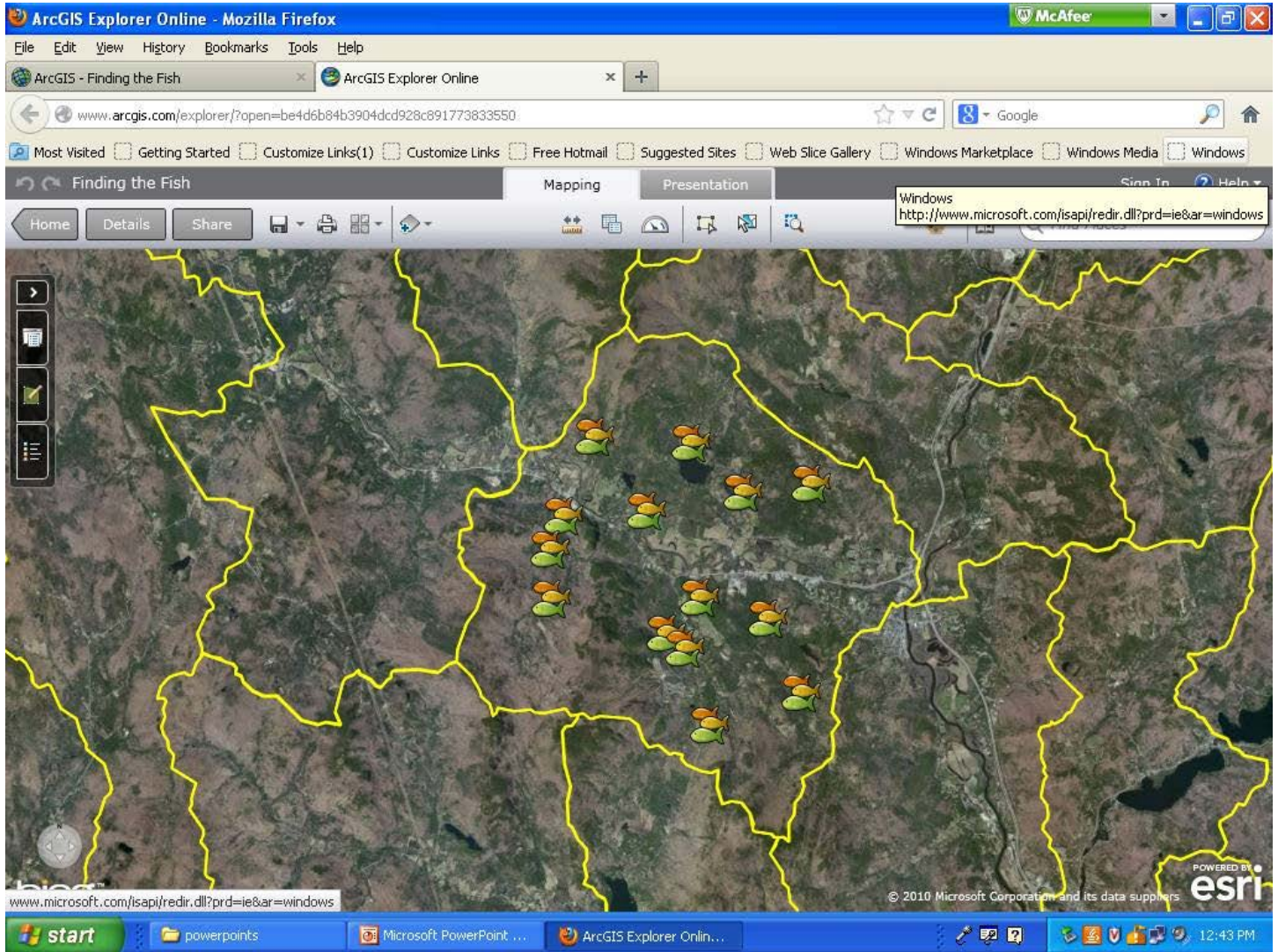
15. imlt

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# Fish Word Scramble

- |                  |              |
|------------------|--------------|
| 1. mosaln        | Salmon       |
| 2. sligl         | gills        |
| 3. liinnggefr    | fingerling   |
| 4. aamoosnrdu    | anadromous   |
| 5. rdoals nfi    | dorsal fin   |
| 6. cehhtrya      | hatchery     |
| 7. ltmsa         | smolt        |
| 8. cktoinsg      | stocking     |
| 9. racwyae       | raceway      |
| 10. uacdlc nif   | caudal fin   |
| 11. eaivnl       | alevin       |
| 12. poisade inf  | adipose fin  |
| 13. oordb kctos  | brood stock  |
| 14. tcrolaep fin | pectoral fin |
| 15. imlt         | milt         |

# Watersheds and Habitats



# Blue Ribbon Niche

*Project Wild Aquatic – Council for Environmental Education*

**OBJECTIVES:** Students will be able to: 1) identify different organisms that live in riparian ecosystems; 2) describe the ecological role of some organisms in riparian habitats; 3) describe some basic characteristics of riparian habitats; and 4) evaluate potential positive and negative effects from changes in riparian habitats.

**METHOD:** Students create a variety of representations of animals that live in riparian habitats.

**BACKGROUND:** Each animal in a community has a role or “occupation” it performs as it lives out its biological life. This role or occupation is called its ecological niche. The niche includes such things as the animal’s preferences for food, shelter, and space. If niche is an animal’s “occupation,” then “habitat” is its address. This activity is designed to focus on riparian niches and habitats.

Riparian habitats are the green ribbons of life found on the edges of water courses. They are important and valuable areas supporting a variety of plant and animal life. Each plant and animal in the riparian ecosystem has an important role, or niche. Some are predators, some prey. Some are producers, some consumers, and some decomposers. Some are herbivores, some carnivores, and some omnivores. The plants and animals in the riparian habitat are interdependent, with each species contributing to the functioning of the overall system.

Traditionally, a riparian zone has been defined as a distinctive plant community living at the edges of flowing water. However, some biologists extend the definition to include standing and even sub-surface water. Riparian zones include the water and the vegetation associated with the water.

Many animals that live here cannot survive without the special conditions that the riparian zone provides. Riparian areas often provide different and more abundant vegetation than surrounding areas; higher percentage of shade; higher humidity; and more diversity in animals and plants. The width of a riparian area depends on the amount of available water, soil types, minerals, water table, geologic structures, and many other factors.

Riparian habitats are both aquatic and terrestrial and are characterized by wide diversity in life forms. For example, frogs are commonly found in areas of calm waters in riparian zones. Frogs are predators, once they mature beyond their algae-eating tadpole stages. They need moisture,

sunlight, and grasses or other vegetative shelter. Their eggs must be deposited in water that is permanent enough to allow a yearlong period to hatch, grow into gilled tadpoles, and finally transform into insect-eating, air-breathing frogs. Both tadpoles and frogs affect other animals’ niches. Fish and wading birds prey on both. Raccoons, foxes, and other animals eat both tadpoles and frogs as well as fish. It is the interrelatedness of all these “occupations” and “addresses” that contributes to the importance, uniqueness and beauty of riparian zones.

Riparian areas are easily affected by natural and human-caused changes. For example, spring flooding and flash floods dramatically affect vegetation and wildlife. Excessive use of riparian areas by humans, livestock, and wildlife can result in destruction of riparian vegetation and destabilization of the stream or riverbanks, causing increased rates of erosion. Development and recreational pressures also threaten this unique habitat. Riparian zones are fragile and can be easily destroyed. Riparian areas are important in many ways. They have aesthetic, ecological, scientific, social, economic, recreational, and intrinsic value. By learning about the unique characteristics of riparian areas, people may have more appreciation for their importance.

**MATERIALS:** A variety of art materials, e.g., paints, clay, paper mache, glue, wire, string, brushes; construction paper; nature magazines for photos (optional); books of references about riparian habitats and wildlife (optional).

## PROCEDURE:

**NOTE:** This activity is designed to involve a visit to an actual stream site. If that is not possible, see the “Variation” for an alternative approach!

1. Select a local stream or standing body of water with which the students may have some familiarity. Tell the students that dozens of different animals and plants live in, around, above, and below that aquatic habitat. Ask the students to generate a list of the animals that they think live in the water and its nearby environment. Consider the water and its bordering ecosystems a riparian area.
2. Assist the students in verifying which of the animals they list actually do live in your region and might live in this riparian area. The list may be obvious, making it possible for you and the students to quickly decide. However, some animals may be in question, and you may want the students to consult references. Also, without additional research, many animals may not be identified which do live in the area.
3. Once the list is verified, have the students each choose an organism. Ask each student to create an art form



representation of his or her animal. They can use drawing, painting, collage, sculpture, magazine images- or any other art form of their choice. Be sure to ask the students to make their work durable enough to be displayed out of doors. Each art form should have a hook, string, or support to allow it to be hung on branches, stuck in the soil, or placed on a solid surface.

4. The students should become familiar with how the organism they have chosen “makes a living.” That is, they should know its “occupation” in the habitat. They should know what animals or plants their organism depends upon and which organisms depend upon their animal. Discuss the concepts of niche and habitat with the students at this point for emphasis. Again, habitat is the animal’s “address.” Niche is the animal’s “occupation” at that address.

OPTIONAL: Add terms such as predator, prey, consumer, producer, decomposer, herbivore, carnivore, omnivore, and food web.

5. The next step is to visit the riparian habitat that was selected in the first procedure. Emphasize personal safety and regard for the habitat. Select a “central gathering place” where everyone can return for discussion. Choose this central place so that any area in which the students place their animals is visible.
6. Ask the students to disperse and place their animals in appropriate settings within the habitat-places in which their animals would live. If possible, the students can be alert as to whether the real living organism is in the environment at this time as well! Remind the students to restrict themselves to a designated area so that all of the art form animals can be seen from the central gathering place. After each animal is placed in its appropriate spot in the habitat, have all the students return to the starting place.
7. Ask each student to go to his or her animal alone to tell about the animal, its characteristics, its habitat, and its niche in three or four sentences. Make sure all of the students can hear and see one another clearly during this process.
8. Once each of the students has done this, gather the students together in the central location and discuss the concepts of niches, habitats, and the interrelatedness of all organisms in any ecosystem. Point out the effects the body of water has on the surrounding area. Emphasize the word riparian in the discussion. Have the students identify and discuss the characteristics of riparian habitats.
9. Now ask the students to consider things that might change this riparian zone so as to affect how suitable the habitat would be for the animals living there. Here are examples of potential changes (good and bad) that could take place in some areas:

- Removing shade-producing trees or shrubs along the bank of a flowing stream.
- Introducing an invasive plant.
- Draining to expand acres under cultivation on nearby farms.
- Clear cutting a slope above a stream producing siltation from increased runoff.
- Straightening or channelization of a stream thereby increasing the speed of flow.
- Disturbing spawning beds by livestock moving through or people wading in streams
- Planting vegetative cover on a previously bare slope above a riparian area.
- Regulating uses of the area that are compacting soil and creating erosion problems.

Identify and describe, if possible, changes that would have negative consequences for one or more kinds of animals.

Identify and describe, if possible, changes that would have positive consequences for one or more kinds of animals.

10. Have one or two students volunteer to demonstrate and evaluate the consequences of a change that would damage the habitat for one or more of the animals. They can use their riparian animal art form to illustrate. They could do this by removing the animal art form that would be immediately affected by the change. For example, severe pollution would affect the aquatic dwellers-fish, frogs, mosquitoes, etc. Ask the students to discuss the possible effect on the remaining animals in the area when one or more animals are removed. Repeat with a different change, e.g., fire, development, damming, stream diversion.
11. OPTIONAL: Invite the students to work in small teams to investigate the area for evidence and observation of actual animal life in this riparian area. List and quantify any species they observe. Ask the students to compare similarities and differences between the diversity of animals they actually find evidence for, and the diversity they represented in their art forms.
12. 12) Ask the students to summarize what they have learned about niche, habitat, and riparian environments. Ask the students to gather their artwork animals from the environment and return to the classroom.

**VARIATION:** There is no substitute for the quality of experience gained from an actual site visit. If, however, a site visit is impossible, these alternatives are suggested:

1. Create a simulated riparian area on the school grounds using chalk, paper cutouts, etc.
2. Limit the scale of a simulated riparian area to the classroom – or even a tabletop!

## **EXTENSION:**

1. Identify some basic niches found in all environments; e.g., producers, consumers, and decomposers. Break down the consumer category into predator and prey groupings. Identify examples of predator and prey animals in local riparian and other aquatic habitats.
2. Investigate what kind of repairs can be done to riparian zones after extensive damage has occurred. Explore the possibility of a riparian restoration team working in your community to reinstate the health of any riparian areas. Consult wildlife and conservation groups for advice.

## **Fish Food Chain** *Adapted from Food Chain Game*

**OBJECTIVES:** Students will be able to describe what an aquatic food chain is and become familiar with some aquatic species that make up a food chain.

**METHOD:** Students simulate an aquatic food chain in an activity that portrays them an actual food chain.

**BACKGROUND:** A food chain is a relationship between many different organisms (trophic levels) and a trace of how energy flows through an environment. Sometimes observing a food chain entirely is hard to do but close inspection of the environment, a single part of a food chain, is usually observable. This food chain starts out as algae (a producer) living in the water near the edge of a stream. A primary consumer such as the mosquito larva living in the water feeds upon the algae. A rainbow trout (secondary consumer) feeds upon the unsuspecting mosquito larva. Finally the tertiary consumer, the Great Blue Heron, a predator of the trout catches and eats the trout.

## **MATERIALS:**

- Site area of about 15 m to 20 m square (adjust with size of group)
- 4 cones or markers for the playing areas corners
- 4-5 liters of popped popcorn signifying the algae
- Sashes (touch football flags) of three different colors cut to about 20 cm x 100 cm
  - 3/5 of the group size is green signifying the mosquito larva
  - 1/5 of the group size is red signifying the trout
  - 1/5 of the group size is blue signifying the Heron
- One plastic baggie for each member of the group signifying the stomach
- Roll of masking tape
- One timer or stopwatch
- Ruler measuring in cm
- Data keeping materials
- Playing members (at least 10 are needed)



## PROCEDURE:

1. Have the students prepare the stomach bags by placing a strip of tape across the bag so the bottom edge of the tape is 4 cm from the bottom of the bag.
2. Designate the playing area with cones at the four corners. Allow the cones to be safe areas such as under a rock or the mud where the mosquito larva and trout can hide or be safe.
3. Spread the popcorn over the area and tell the group this is algae for the mosquito larva to eat.
4. Hand out the pre-taped baggies and a sash to all the mosquitoes. Tell them they must collect the algae (the popcorn) for food and it must be placed in their stomach (baggies).
5. Hand out the pre-taped baggies and a sash to all the trout. Tell them they must capture (grab sash/tag) a mosquito larva for food. They then must transfer all of the larva's stomach into their own.
6. Hand out sashes to the herons and tell them they must capture the trout for their food. Once they have captured the trout they must take the trout's stomach from them.
7. Set the timer for five minutes (the simulated day length) and holler, "Go".
8. After the game has been played for the 5 minutes, holler "Stop" and analyze the game results.

**ANALYSIS:** How many animals survive? For a mosquito larva to survive, the popcorn must fill the stomach to the bottom edge of the tape (4 cm); if not they have starved to death. For a trout to survive they must have filled their stomach to the top edge of the tape; if not they did not find enough food and have starved. The herons must have the equivalent of one frog with sufficient food to survive. If at least one of each kind of animal survives, there is an on going food chain. Record the results to compare with the next rounds with rule changes (EXTENSION). Return the popcorn to the playing field.

**EXTENSION:** The first round of this game usually ends quickly. Replay the game with suggestions that result in a more balanced end result. Change one rule per each replay.

*Suggestions:* Change the numbers of each species.  
Provide the safety zone if not used on the first play.  
Time release the different species so some may feed unmolested.  
Final round, spread out some caramel corn. Don't let the players know that it signifies some form of pollutant (DDT). Examine how this concentrates at higher levels in the ecosystem and trophic levels.  
Set an upper limit for each species survivability of digesting this.

## FOLLOW UP:

- Discuss the roles of each of the species and what happened when the numbers changed for each species.
- What occurs as you move up the trophic levels, both in having to obtain more energy and the possible build up of pollutants in the levels.
- Do herons need plants to survive?
- Describe other food chains.

# Something Fishy in the Year 2050

**OBJECTIVES:** This lesson provides students an opportunity to synthesize what they have learned about the anatomy of fish with their knowledge of aquatic environments and an organism's methods of adapting to survive. The problem can be expanded to include other creatures and environments.

**METHOD:** Given the hypothetically evolved condition of the New Hampshire's waters, students will create a fish of the future, listing different and unusual ways that their fish will adapt to survive. The student will name the fish and create a labeled model of it.

**BACKGROUND:** Show slides/pictures of several species of fish. For review, have students verbally identify parts of anatomies and adaptive characteristics. Next say: "The year is 2050. Since the turn of the century, pollution, over fishing and climate change have dramatically altered characteristics of New Hampshire's waters." Ask students, through discussion, to come up with a composite of 10 characteristics that would describe the New Hampshire's waters in 2050. List them for the students to see.

**MATERIALS:** Various art supplies

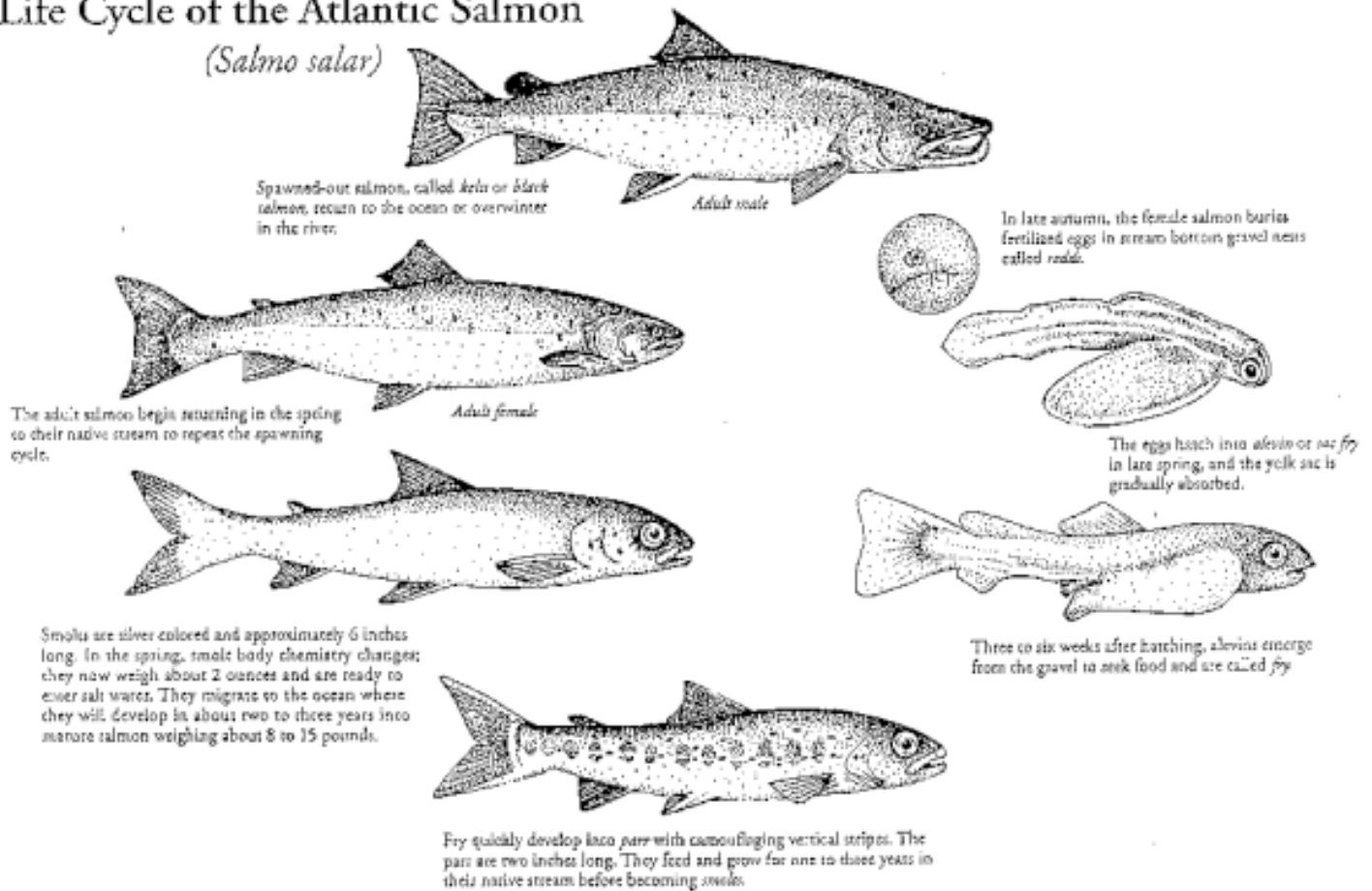
## PROCEDURE:

1. After creating the aquatic descriptors, individually, then as a class, allow students to brainstorm for fifteen minutes about the adaptive characteristics and behaviors needed to survive in 2050. Ideas are then to be categorized.
2. Students will narrow the specific characteristics of their fish's environment.
3. Using the generated adaptive characteristics and behaviors as a resource, students will identify adaptations that will impact characteristics of their fish. They will then collect materials needed to make a model.
4. Students will make a model and name it.
5. Fish models will be labeled, presented and displayed in a synthesized environment. Students might arrange their creations in a food chain or web of the future.

# Atlantic Salmon

## Life Cycle of the Atlantic Salmon

(*Salmo salar*)



## HISTORY OF ATLANTIC SALMON:

Atlantic Salmon, *Salmo salar*, are anadromous fish, meaning they are hatched in fresh water, then migrate to the sea where they spend most of their lives, then migrate back to the freshwater stream of their birth to spawn.

In the fall, a female will deposit 1,500 to 7,000 eggs in a streambed gravel nest called a redd, then the male fertilizes them. The following spring the eggs hatch into small fish (measuring 15mm), called alevins. Their first two weeks are spent hiding in the gravel, receiving nutrients from their yolk sac. Once this sac is used up and they become free swimming, they are called fry. During the summer, they acquire bars and red dots that identify them as parr. In two to four years, they reach a length of 12 to 15 cm. At this stage they are considered smolts. The smolt stage is reached in the spring and they are now ready to migrate to the ocean. Because of predators and encountering various barriers, it is estimated that 90% of the original population do not make it to the ocean. In the ocean they spend the next two to five years growing rapidly to adult size. Finally as adults, Atlantic salmon return to the fresh waters of their birthplace to lay their eggs.

The historical population of the Atlantic salmon during pre-colonial times (200 years ago) was estimated to be between 8,940 to 26,820 adult fish. By the 1850s the Atlantic salmon population met its demise and was completely extirpated.

## **WHY DID THEY DISAPPEAR? (ON THE MERRIMACK RIVER):**

**Dams and Locks - The Industrial Revolution:** During the 1700s, the Merrimack River was a major transportation route for the movement of goods. A series of canals and locks were built so boats could bypass the waterfalls. During the early 1800s the demand for power increased as America entered the Industrial Revolution. Dams were built at the major falls of the Merrimack to harness the river's power, which made the river and surrounding communities the industrial center of the time.

**Over Harvesting -** During the years surrounding 1805, it has been noted each fisherman was harvesting about 20 salmon per day. In 1985, the commercial harvesting of Atlantic salmon in the ocean totaled 825,000 kg.

**Pollution -** The dumping of chemicals (toxins) into the rivers was common practice during the 1700s and early 1800s. There were no regulations at this time, to prevent the rivers from being poisoned.

## **THE FIRST RESTORATION ATTEMPT:**

The Fisheries Commissioners from Massachusetts and New Hampshire pioneered plans to restore the Atlantic salmon population in 1865. They developed plans to obtain and raise the salmon, enacted laws to provide fish passage facilities, and manage the resource once the salmon were restored. The first 70,000 eggs arrived from Canada in 1866. During the next 11 years (1866-1876), 1.3 million salmon fry were released into the Merrimack and its tributaries. An increase in adult Atlantic salmon populations was noticeable. The Livermore Hatchery was important to the restoration effort. Here, adult salmon from the Pemigewasset River could be caught, spawned, and the eggs raised on site.

## **WHY WAS THIS EARLY RESTORATION EFFORT FADED OUT?**

The fish passage facilities were inefficient, not allowing the adult salmon to return to the fresh waters to spawn. Poor water quality due to siltation and chemicals, and heavy illegal harvesting also destroyed the adult population.

## **WHERE ARE THE ATLANTIC SALMON TODAY?**

In 2013 the U.S. Fish and Wildlife Service ended its participation in the Merrimack River Atlantic Salmon Restoration Program. Low annual returns and diminishing budgets led the USFWS to shift priority to salmon restoration efforts in Maine and other projects in the region. Poor survival at sea has been cited as a major limiting factor for salmon recovery throughout the North Atlantic. Until ocean conditions improve, it will be difficult for salmon spawning runs to increase in the northeast. However, dam removals on the Penobscot River have the potential to open up significant spawning habitat for Atlantic salmon, which may help offset poor marine survival. At this point the fate of Atlantic salmon in the northeastern U.S. is uncertain.

Although the goal of establishing a self-sustaining Atlantic salmon population in the Merrimack River watershed has not been achieved, there were many successes along the way in the form of river habitat restoration, improvements in fish passage for other migratory fish species, and cleaner water. The Merrimack River today is a much healthier river than it was 40 years ago, in part, due to the efforts to restore Atlantic salmon.

## Hooks and Ladders *Project Wild Aquatic – Council for Environmental Education*

**OBJECTIVES:** Students will be able to: 1) recognize that some fish migrate as part of their life cycle; 2) identify the stages of the life cycle of one kind of fish; 3) describe limiting factors affecting Atlantic salmon as they complete their life cycle; and 4) generalize that limiting factors affect all populations of animals.

**METHOD:** Students simulate Atlantic salmon and the hazards faced by salmon in an activity portraying the life cycle of these aquatic creatures.

**BACKGROUND:** Many fish live part of their lives in one habitat and then migrate to another habitat. Some make their migratory journeys to mature and reproduce. Atlantic salmon are an example of one of the most spectacular of the migrating species.

Atlantic salmon can spawn more than once in their lifetime, compared to the Pacific Salmon. Within their genetic fiber is an encoded instinct that drives them from the time of hatching along a monumental journey from their freshwater spawning beds downstream into the sea. Once in the sea they spend several years reaching the maturity needed for their single return journey to their original hatching ground to spawn. Salmon must face a myriad of hazards that serve as limiting factors in the completion of their life cycle. Limiting factors are factors that reduce the populations of living organisms. Sometimes the limiting factors are natural and sometimes they result from human intervention with natural systems. The female Atlantic salmon deposits 1,500 to 7,000 eggs in her freshwater spawn. The eggs are deposited in a shallow gravel depression scooped out by the female. Once deposited, the male fertilizes the eggs and then both fish nudge the gravel back over the eggs to offer as much protection as possible.

The eggs, before and after hatching, are susceptible to many limiting factors. Smothering silt can be washed in suddenly from watersheds damaged by a variety of land-use practices and events-including erosion following some road building, logging, and fires. Predators can eat some of the eggs and damage hatching populations. Dropping water levels can isolate salmon offspring in streamside depressions to remain isolated and die.

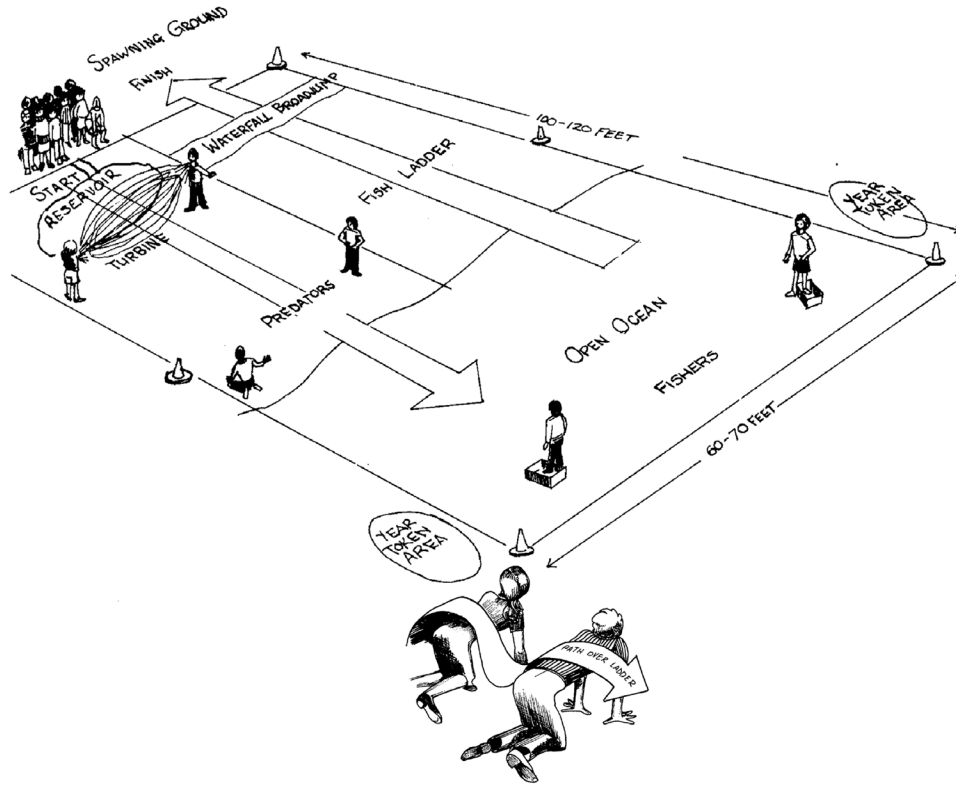
After hatching, the small fish called “alevins” spend their first two weeks hiding in the gravel. Gradually they absorb their yolk sac and become known as “fry.” If they survive the first two weeks, they then begin their journeys. Depending on the species, young salmon may spend several months to as much as a year or more in the river before migrating to the estuary and then to the open ocean. The small ocean-bound salmon, now called “smolts,” are at once confronted by hazards on their downstream journey. Examples are dams, low water in streams, and predatory birds, mammals, and larger fish. Up to 90% of the salmon that hatch never reach the sea.

When in the ocean, the salmon grow rapidly by feeding on the ocean’s rich food supply. Predators such as sharks, and other marine mammals take their toll. In addition, humans fish for salmon commercially and for personal reasons, including food and recreation.

In two to five years, the Atlantic salmon start the journey that will guide them back to the rivers and streams leading to their own hatching site. The upstream migration from the ocean is also a series of hazards. For example, dams hinder their journey and would block it completely if fish ladders were not installed. Fish ladders are water-filled staircases that allow the migrating fish to swim upstream, around the dam. Humans who fish, eagles, bears, and other predatory mammals also reduce the numbers along the way to the spawning ground. Sometimes landslides and logjams provide unexpected new barriers that the now weighty salmon must overcome. Once back at the spawning ground the life cycle of the Atlantic salmon begins anew.

All possible conditions are not covered by the design of this activity. However, the activity does serve simply and effectively to illustrate three important concepts-life cycle, migration, and limiting factors. The major purpose of this activity is for students to gain an understanding of some of the complex characteristics of the life cycle of one representative aquatic species, the Atlantic salmon.

**MATERIALS:** Large Playing area (100 feet x 50 feet); about 500 feet of rope, string, or six traffic cones for marking boundaries (masking tape may be used if area is indoors); two cardboard boxes: 100 tokens (3 x 5 cards, poker chips, etc.)



## PROCEDURE:

- Begin by asking the students what they know about the life cycle of fish that live in their area. Do any local fish migrate to spawn? If yes, which ones? (Mullet, shad, lake trout, striped bass, suckers, carp, and salmon are examples of fish that migrate to spawn.) In this activity, students will learn about some of the characteristics of one species of fish that migrates as a part of its life cycle—the Atlantic salmon.
- Set up a playing field as shown in the diagram, including spawning grounds, downstream, upstream, and ocean. The area must be about 100 feet by 50 feet. Assign roles to each of the students. Some will be salmon; others will be potential hazards to the salmon. Assign the students roles as follows.
  - Choose two students to be the turbine team. These are the ones who operate the jump rope, which represents the turbines in hydroelectric dams. Later in the simulation, when all the salmon have passed the turbine going downstream, these students move to the upstream side to become the waterfall-broad jump monitors. (See diagram.)
  - Choose two students to be predatory wildlife. At the start of the simulation the predators will be below the turbines where they catch salmon headed downstream. Later in the activity when all the salmon are in the sea, these same two predators will patrol the area above the “broad jump” waterfalls. There they will feed on salmon just before they enter the spawning ground. (See diagram.)
  - Choose two students to be humans in fishing boats catching salmon in the open ocean. These students in the fishing boats must keep one foot in a cardboard box to reduce their speed and maneuverability.
  - All remaining students are salmon.

**NOTE:** These figures are based on a class size of 25 to 30. If the group is larger or smaller, adjust the number of people who are fishing and predatory wild animals accordingly.

- Begin the activity with all of the salmon in the spawning ground. The salmon first move into the reservoir above the dam. They must stay in the reservoir while they count to 30. This pause simulates the disorientation that salmon face because



of a lack of current in the lake to direct them on their journey. During this time the predators may catch the salmon and escort them one at a time, to become part of the fish ladder. The salmon then start their journey downstream. The first major limiting factor that the salmon encounter is turbines at the dam. At most dams, escape weirs guide migrating salmon past turbines. The student salmon cannot go around the jump rope swingers, but they can slip under the swingers' arms if they do not get touched while doing so. A salmon dies if the turbine (jump rope) hits it. The turbine operators may change the speed at which they swing the jump rope. Any salmon that "dies" at any time in this activity must immediately become part of the fish ladder. The student is no longer the fish, but becomes part of the physical structure of the human-made fish ladders now used by migrating salmon to get past barriers such as dams. The students who are the fish ladder kneel on the ground, with one body space between them.

- Once past the turbines, the salmon must pass some predatory wildlife. The predators, who have moved from the reservoir area to the area below the turbine, must catch the salmon with both hands – tagging isn't enough. Dead salmon are escorted by the predator to become part of the fish ladder. Later, the salmon that survive life in the open ocean will pass through the fish ladder to return to the spawning ground. NOTE: Both the predatory wildlife in the downstream area and the people fishing in the open ocean must take dead salmon to the fish ladder site. This action moves the predators and fishing boats off the field regularly, helping to provide a more realistic survival ratio.
- Once in the open ocean, the salmon can be caught by fishing boats. The salmon must move back and forth across the ocean area in order to gather four tokens. Each token represents 1 year of growth. Once each fish has four tokens (4 year's growth), that fish can begin migration upstream. The year tokens can be picked up only one at a time on each crossing. Remember, the salmon must cross the entire open ocean area to get a token. The "4 years" that these trips take make the salmon more vulnerable; thus they are more readily caught by fishing boats. For this simulation, the impact of this limiting factor creates a more realistic survival ratio on the population before the salmon begin the return migration upstream.
- When four of the year tokens have been gathered, the salmon can start upstream. The salmon must walk through the entire pattern of the fish ladder. This enforced trip through the fish ladder gives the students a hint of how restricting and tedious the upstream journey can be. In the fish ladder, predators may not harm the salmon.
- Once through the ladder, the salmon face the broad-jump waterfall. The waterfall represents one of the natural barriers salmon face going upstream. Be sure the jumping distance is challenging but realistic. The two former turbine students will monitor the jump. The salmon must jump the entire breadth of the waterfall to be able to continue. If the salmon fails to make the jump, then it must return to the bottom of the fish ladder and come through again.
- Above the falls, the two predators who started as the predators below the turbines have now become the last set of limiting factors faced by the salmon. They represent bears – one example of predatory wildlife. Again, remember that the predators must catch the salmon with both hands. If they catch a salmon, they must then take the student they caught to become part of the structure of the fish ladder.
- The activity ends when all the salmon are gone before the spawning ground is reached – or when the surviving salmon reach the spawning ground.
- Next engage the students in a discussion. Explore topics such as: the apparent survival or mortality ratio of salmon, the role of barriers; the role of predatory wildlife and the people fishing, where the losses were greatest, where the losses were least, what the consequences would be if all the eggs deposited made the journey successfully, and what seemed realistic about this simulation and what did not.
- Ask the students to summarize what they have learned about the life cycle of salmon, the salmon's migration, and limiting factors that affect salmon. Make sure the students have a clear working definition of limiting factors. Encourage the students to make the generalization that all animals are affected by limiting factors. Ask the students to give examples of limiting factors. They might mention the availability of suitable food, water, shelter and space; disease; weather; predation; and changes in land use and other human activities. REMEMBER: Unlike other salmon species, Atlantic salmon can spawn more than once. Some Atlantic salmon make their complete migratory journey and spawn two or more times. After the activity is finished, ask students to report how many times they successfully completed the migratory cycle. Graph the data. Have the students explain how age influences mortality rates and susceptibility to limiting factors.



# Trout

## Life Cycle of a Trout

**OBJECTIVES:** Students become familiar with the trout life cycle.

**METHOD:** Students will use the trout life cycle handouts and the hatchery visit to examine the life cycle of a trout.

**BACKGROUND:** Trout Life Cycle Handout.

**MATERIALS:** Trout Life Cycle Handout and the Life cycle of a Trout Hatchery Worksheet

**PROCEDURE:**

1. Review the handouts.
2. Visit a hatchery for a hands on approach to see the life cycle.
3. Fill in the Life cycle of a Trout Hatchery Worksheet.

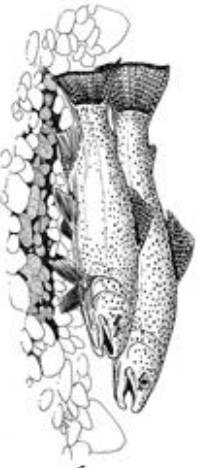
# Cycle...Life...Trout



In the fall, the female makes a depression in the gravel of a stream called a "redd".



Only a few young fish survive to adulthood. Most of the eggs and young fish die from natural causes, such as floods.



The eggs are deposited in the redd, where they develop for 5 months before hatching in the spring.

## NATURAL



Newly hatched fish are called fry. They live on food absorbed from the yolk sac, until they emerge from the gravel.



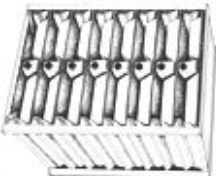
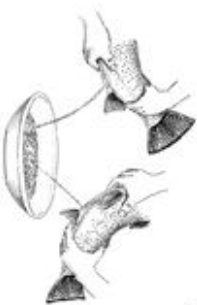
Fingerlings (2 to 3 inches long) feed on tiny aquatic plants and animals.



Hatchery raised trout are stocked in ponds, lakes and streams in the spring, summer and fall.

Eggs are taken from the female and are fertilized with male's sperm.

## HATCHERY REARED



Fertilized eggs are placed in incubators. The 50-degree water flows continuously over the eggs. They hatch in just under 7 weeks.



As yolk sacs are absorbed, the young fish swim up from the bottom of the tanks and begin to feed.



Fish are fed a balanced diet composed of meat products, cereals, and a variety of additives. When the trout are over 3 inches, they are moved from the hatchery building to the outside raceways.

# Life Cycle of Trout Hatchery Worksheet

Draw and label each of the stages of the life cycle of a trout and then answer the following questions.

1. What time of year do trout spawn? \_\_\_\_\_
2. What is the term used to name the fish we get the eggs and milt from? \_\_\_\_\_
3. How many days do the eggs take to hatch? \_\_\_\_\_
4. How many eggs can an incubation tray hold? \_\_\_\_\_
5. How does a biologist calculate the numbers of eggs? \_\_\_\_\_
6. What is a newly hatched trout called? \_\_\_\_\_
7. What is the term for when the trout's eyes form? \_\_\_\_\_
8. What does a biologist monitor the fish for? \_\_\_\_\_
9. When are fingerlings transferred outside? \_\_\_\_\_
10. How old are the fish when they are stocked? \_\_\_\_\_

# Fry Hatch Crossword Puzzle

**OBJECTIVES:** Students will be able to complete the Fry Hatch Crossword Puzzle as a review for the terminology used in fish hatcheries.

**METHOD:** Students independently complete the crossword worksheet.

**BACKGROUND:** Previous information from lessons.

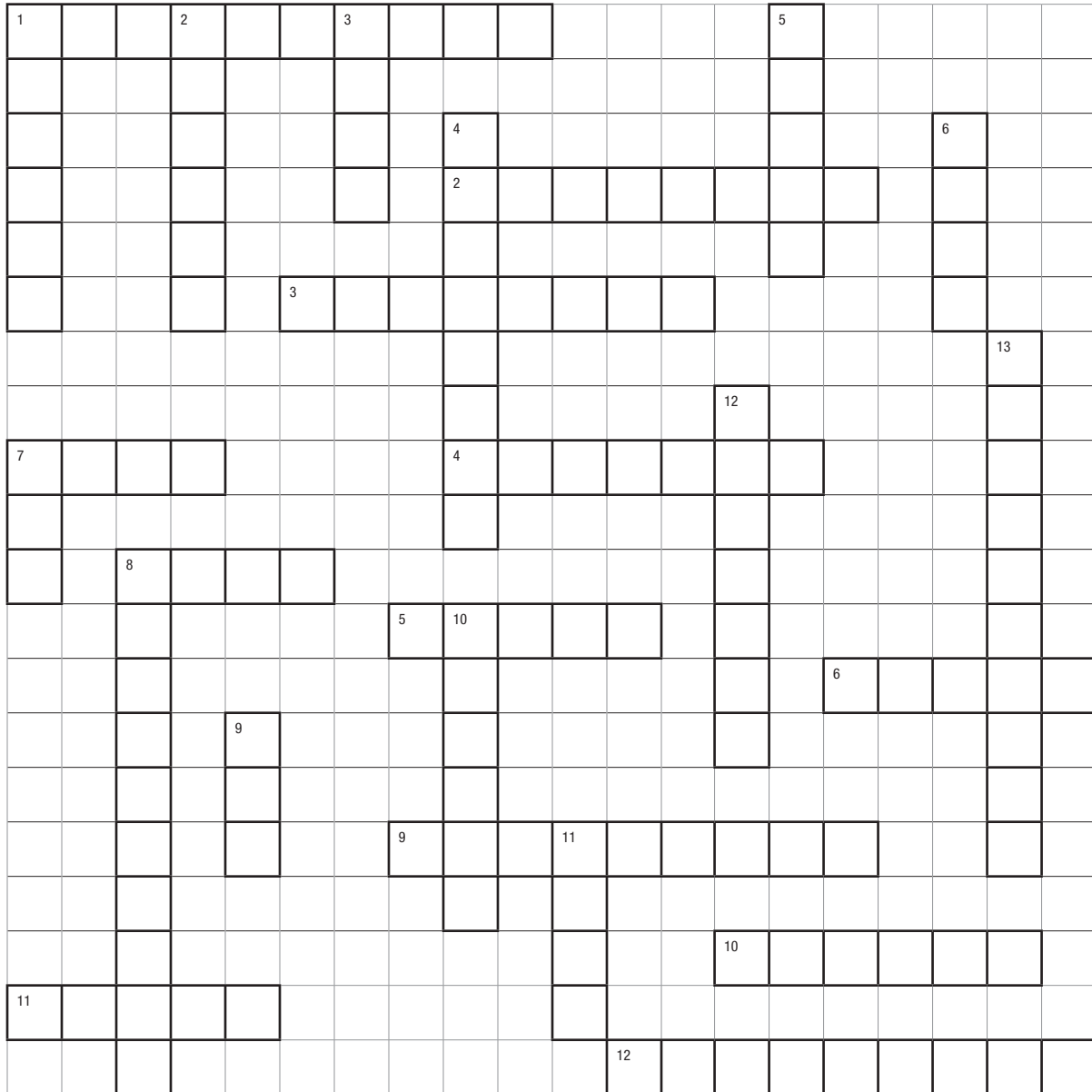
**MATERIALS:** Fry Hatch Crossword Puzzle

**PROCEDURE:**

1. Fill out the Fry Hatch Crossword Puzzle



# Fry Hatch Crossword Puzzle



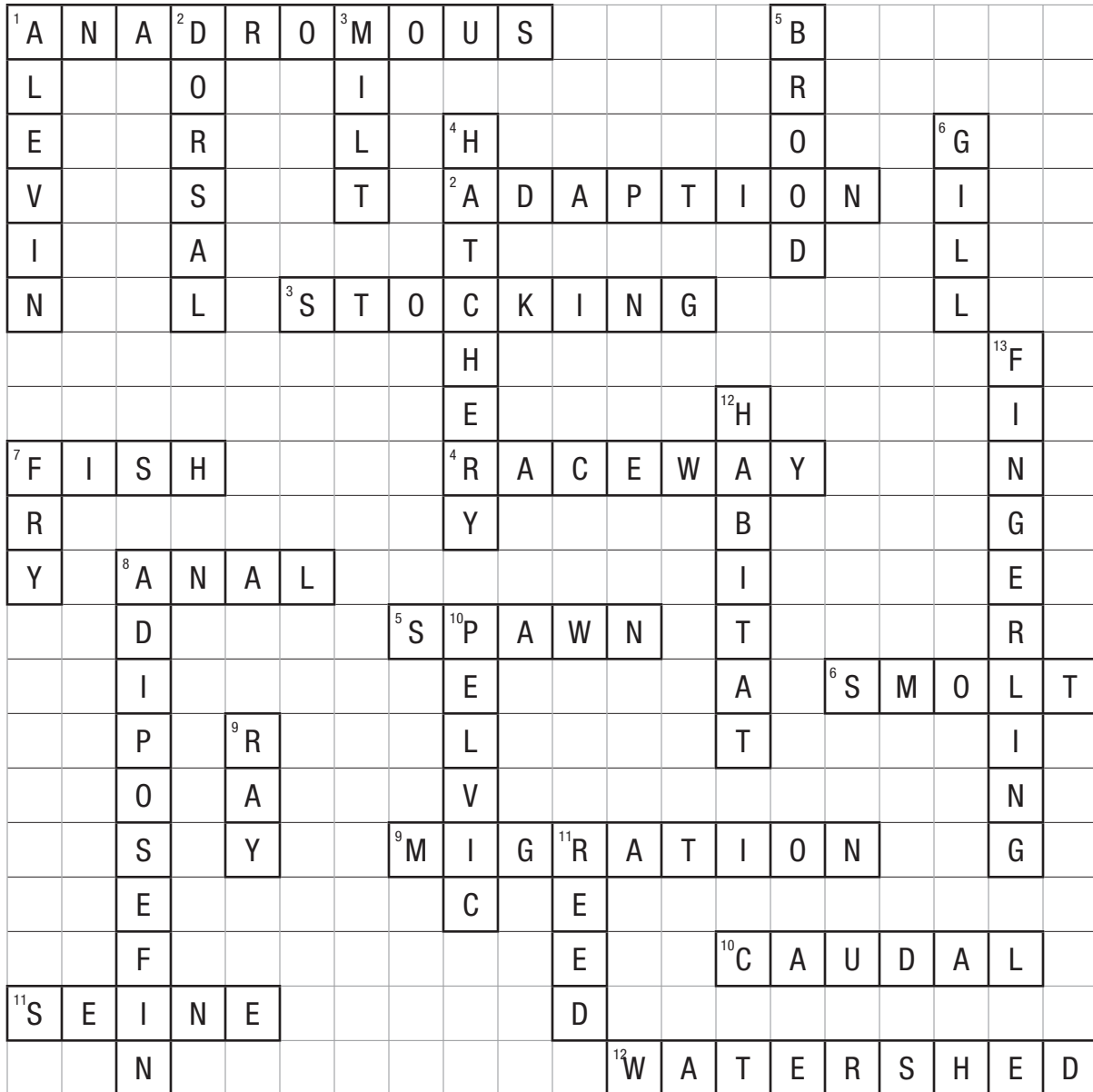
## DOWN

1. A newly hatched fish with its yolk sac attached.
2. \_\_\_\_\_ fin is on the back of a fish
3. Sperm
4. A place where fish are raised.
5. Spawning adult fish at the hatchery.
6. Used in breathing
7. Prior to fingerlings.
8. Rayless fin
9. Supporting structure for fins.
10. Lower fin on either side of fish.
11. Nest for fish.
12. Home
13. One-year-old fish.

## ACROSS

1. Migrating to spawn.
2. Change to the environment.
3. Release fish.
4. Outdoor fish tanks.
5. Act of egg laying and fertilization.
6. A young salmon/trout ready to migrate to the ocean.
7. Trout, Salmon, Bass
8. Unpaired fin.
9. Travel between breeding habitats.
10. Tail fin
11. Used to corral fish.
12. Land area where water collects and flows.

# Fry Hatch Crossword Puzzle



## DOWN

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11. Used to corral fish.
12. Land area where water collects and flows.

# To Sample or Not to Sample? (That is the Question)

## PROCEDURE:

1. Count out 50 beans and weigh them. Now you know the sample weight and number. These numbers can be used to calculate the weight or number of the larger fish populations.
2. The hypothetical stock rate for this activity is 200 fish per acre. The 8-inch diameter pie plate represents the pond you are stocking with you sample fish.
3. Assume that 25 inches squared is equal to 1 acre. How many acres is the pie plate? \_\_\_\_\_  
Use the formula:  $a = \pi r^2$  to determine the area.
4. Determine the weight of your scale population of \_\_\_\_\_ fish by substituting in your three known variables and solving for **X** (the total scale weight).

$$\frac{\text{Sample Number}}{\text{Sample Weight}} = \frac{\text{Total Number}}{X \text{ (Total Weight)}}$$

5. Weigh out the amount of beans from the answer above to represent the sample of fish from your populations that you will be stocking, and place them in the tin.

## DISCUSSION:

1. Do you think that estimating numbers by weight is an accurate measure? Why? Or Why Not?
  
  
  
  
  
  
  
  
  
  
2. Why would this method be ineffective if your population was made up of different aged fish?

# Appendix A.

## Species List of Freshwater Fishes of New Hampshire

### Lamprey Family

- Sea Lamprey, *Petromyzon marinus*
- American Brook Lamprey, *Lethenteron appendix*

### Freshwater Eel Family, Anguillidae

- American Eel, *Anguilla rostrata*

### Herring Family, Clupeidae

- Alewife, *Alosa pseudoharengus*
- Blueback Herring, *Alosa aestivalis*
- American Shad, *Alosa sapidissima*

### Trout Family, Salmonidae

- Atlantic Salmon, *Salmo salar*
- Rainbow Trout, *Oncorhynchus mykiss*
- Brown Trout, *Salmo trutta*
- Brook Trout, *Salvelinus fontinalis*
- Lake Trout, *Salvelinus namaycush*
- Sunapee Trout, *Salvelinus aureolus*
- Round Whitefish, *Prosopium cylindraceum*
- Lake Whitefish, *Coregonus clupeaformis*

### Smelt Family, Osmeridae

- Rainbow Smelt, *Osmerus mordax*

### Pike Family, Esocidae

- Northern Pike, *Esox lucius*
- Chain Pickerel, *Esox niger*
- Redfin Pickerel, *Esox americanus*

### Minnnow Family, Cyprinidae

- Common Carp, *Cyprinus carpio*
- Goldfish, *Carassius auratus*
- Longnose Dace, *Rhinichthys cataractae*
- Blacknose Dace, *Rhinichthys atratulus*
- Lake Chub, *Couesius plumbeus*
- Creek Chub, *Semotilus atromaculatus*
- Fallfish, *Semotilus corporalis*
- Northern Redbelly Dace, *Chrosomus eos*
- Finescale Dace, *Chrosomus neogaeus*
- Golden Shiner, *Notemigonus crysoleucas*
- Fathead Minnow, *Pimephales promelas*
- Common Shiner, *Luxilis cornutus*
- Emerald Shiner, *Notropis atherinoides*
- Bridle Shiner, *Notropis bifrenatus*
- Blacknose Shiner, *Notropis heterolepis*
- Spottail Shiner, *Notropis hudsonius*
- Eastern Silvery Minnow, *Hybognathus regius*

### Sucker Family, Catostomidae

- Eastern Creek Chubsucker, *Erimyzon oblongus*
- Longnose Sucker, *Catostomus catostomus*
- White Sucker, *Catostomus commersoni*

### Freshwater Catfish Family, Ictaluridae

- Channel Catfish, *Ictalurus punctatus*
- Brown Bullhead, *Ameiurus nebulosus*
- Yellow Bullhead, *Ameiurus natalis*
- Margined Madtom, *Noturus insignis*
- Tadpole Madtom, *Noturus gyrinus*

### Codfish Family, Gadidae

- Burbot, *Lota lota*

### Killifish Family, Cyprinodontidae

- Banded Killifish, *Fundulus diaphanus Ictalurus*
- Mummichog, *Fundulus heteroclitus*

### Stickleback Family, Gasterosteidae

- Threespine Stickleback, *Gasterosteus aculeatus*
- Fourspine Stickleback, *Apeltes quadracus*
- Ninespine Stickleback, *Pungitius pungitius*

### Temperate Bass Family, Moronidae

- White Perch, *Morone americana*

### Sunfish Family, Centrarchidae

- Smallmouth Bass, *Micropterus dolomieu*
- Largemouth Bass, *Micropterus salmoides*
- Banded Sunfish, *Enneacanthus obesus*
- Redbreast Sunfish, *Lepomis auritus*
- Pumpkinseed, *Lepomis gibbosus*
- Bluegill, *Lepomis macrochirus*
- Rock Bass, *Ambloplites rupestris*
- Black Crappie, *Pomoxis nigrimaculatus*

### Perch Family, Percidae

- Walleye, *Sander vitreus*
- Yellow Perch, *Perca flavescens*
- Tessellated Darter, *Etheostoma olmstedii*
- Swamp Darter, *Etheostoma fusiforme*

### Sculpin Family, Cottidae

- Slimy Sculpin, *Cottus cognatus*

For a complete list of fish species in New Hampshire: <https://www.wildlife.state.nh.us/fishing/species.html>

# Appendix B.

## Glossary

**Adaptation** – An adjustment or modification of an organism to changes in its environment.

**Adipose fin** – A small fleshy rayless fin on the back between the dorsal and caudal fins.

**Air bladder** – A membranous gas-filled sac in the upper part of the body cavity.

**Alevin** – A newly hatched fish with its yolk sac attached.

**Anadromous** – Ascending rivers from the sea to spawn.

**Anal fin** – The unpaired fin on the underside of the fish just in front of the caudal fin.

**Barbel** – A flesh projection about the mouth.

**Brood stock/fish** – Fish held at the hatchery to produce fertilized eggs. (Both male and female).

**Canine teeth** – Large conical teeth in the front part of the jaws.

**Carnivorous** – Eating flesh.

**Carrying Capacity** – The number of fish that can be supported by a given area.

**Caudal fin** – The tail fin.

**Caudal peduncle** – The slender region of the fish's body between the anal fin and the base of the caudal fin.

**Cycle** – A series of events that happen regularly and repeatedly.

**Dorsal fin** – A fin composed of spines, rays, or both on the back of the fish.

**Ecology** – The study of the relationship of animals and the environment.

**Eyed Egg/eyed up** – A fish egg that has developed dark eyes of the embryo that can be seen through the shell.

**Fertilize** – One sperm unites with one egg to create an embryo with a complete set of genes.

**Fingerling** – A small fish up to one year in age.

**Food Chain** – A series of plants and animals where some are feed upon and in turn are eaten by others.

**Fry** – Recently hatched fish, that have absorbed their yolk sac, but prior to fingerling stage.

**Gills** – Organs of the fish that extract oxygen from the water and return carbon dioxide.

**Gill arch** – The bony support to which the gills and gill rakers are attached.

**Gill Rakers** – The projections along the inner edged of the gill arches.

**Habitat** – The place where an animal lives, including food, water and shelter.

**Hatchery** – A location for raising fish.

**Herbivorous** – Eating of living plant material.

**Kype** – An enlarged, sometimes hooked shaped extension of the lower jaw in sexually mature male salmonoids.

**Larvae** – An immature of development in many different kinds of organisms.

**Lateral band** – A band of color running horizontally along the sides of the fish.

**Lateral Line** – A sensitive line along the side of a fish that senses changes in pressure.

**Limiting Factor** – Factors that reduce the populations of organisms.

**Maxilla** – The bone lying on each side of the upper jaw.

**Migration** – Traveling between seasonal habitats.

**Milt** – A milky fluid that contains sperm.

**Mortality** – Death.

**Niche** – The role an organism plays in the community.

**Omnivorous** – Eating and living on foods of all kinds.

**Opercle** – The large, rearmost bone on each side of the upper jaw.

**Parr Marks** – Vertical lines on a young fish. Used as camouflage.

**Pectoral Fin** – Front steering fins on either side of a fish.

**Pelvic Fin** – Lower fin on either side of a fish.

**Predator** – An animal that eats another animal.

**Prey** – An animal that is eaten by another animal.

**Raceway** – A rectangular pond where water enters one end and leaves the other. Used to hold fish during their development.

**Ray** – The supporting structures for fins.

**Redd** – A nest made by salmonids for their eggs.

**Riparian Zone** – The vegetated area next to a stream/river.

**Salmonid** – Any fish of the salmon/trout families.

**Seine** – A net that is weighted at the bottom, used to corral and catch fish.

**Slime Layer** – A layer of mucus covering fish that protects against fungi, parasites and diseases.

**Smolt** – A young salmon or trout that is silvery in color and is ready to migrate to the ocean.

**Spawn** – The act of egg laying and fertilization by adult fish.

**Stocking** – The process of releasing fish in the wild.

**Vent** – The tube with which the female deposits her eggs.

**Watershed** – The land area where water collects and flows.

**Yolk Sac** – Sack attached to a newly hatched fish containing the food it needs for early growth.