Classroom Activities

Salmon in the Classroom
MICHIGAN

DEPARTMENT OF NATURAL RESOURCES
DNR
MICHIGAN

The Salmon in the Classroom program is administered by the Michigan Department of Natural Resources

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Chapter 1: Chinook Salmon Lifecycle & Migration

Chapter 2: Fish Identification and Anatomy

Chapter 3: All About Our Waters

Chapter 4: Cross-Curricular Activities

Chapter 5: Aquatic Invasive Species

Appendices

2019 Edition

The Great Swim

Adapted from Flying WILD's Great Migration

Grade Levels
3-12

Objectives
Students will reenact the life of a non-native salmon in Michigan, and live through the happy days and perils of a little salmon's journey.

Best Taught
Any time. Release day activity.

Materials
- Great Swim half sheet game cards
- Masking tape
- 5 dice
- Circle stickers
- 6 inch pieces of string
- White board or large paper

Background
Review the lifecycle of Chinook salmon with your students. How did non-native Chinook get to Michigan? Why are they not considered an invasive species? How does the DNR support the Chinook Salmon population? What ecological niche do they take on?

Vocabulary

-alewife	-phragmites
-buttoned up	-plankton
-Eurasian watermilfoil	-predacious
-Fisheries Biologist	-quagga mussels
-fry	-rusty crayfish
-hatchery	-spawn
-sea lamprey	-tagged
-natal stream	-zebra mussels

High School Extensions
To simulate research by Fisheries Biologists, have your students run "replicates", each student completes the simulation 3 times and records their data. Using the full classroom data for all 3 replicates, have students chart trends they are seeing in the data.

Procedure

1. Print out station cards and cut in half
2. Using the masking tape, mount them around the room or schoolyard. (At least 5 feet apart.)
3. Stations 3, place two dice in a jar with a lid. (Symbol on station cards corresponds to dice sites)
4. Stations 11, 13, 15 - place 1 die each in a jar with lid
5. Stations 6 and 9, place circle stickers
6. Station 15, place strings
7. Create a chart on your white board that looks like the example below

Caught	Died	Tagged	Spawned

Activity

1. Students can start on either stations 1, 2, 3.
2. Students should read and follow the directions on each station card to complete the simulation
3. Students should then record their results on the chart. They can, and usually will, mark and X in more than one column
4. Upon completion, talk with the class about the results. Who was killed or harmed by an invasive?
5. Repeat the game as many times as possible to start seeing new data trends in successive "year classes"

Leading Questions

- How many salmon were negatively impacted by an invasive species?
- What percentage of fish spawn successfully?
- Multiply each successful pair of spawning fish by 5,000 eggs. How many fertilized eggs were introduced by the Great Lakes system for your seasons?
- Multiply each successful spawning fish by 147.7 lbs of food (amount needed to grow to adulthood.) How much food was used from the ecosystem?
- Multiply the number of successfully caught fish by the average catch weight of 15 lbs. Compare the mass of fish caught, to the mass of fish food needed to raise those fish.

Station 1

Watch our fry! You narrowly escape a predacious diving beetle. Crawl ahead 5 feet.
Then move to Station 7.

Station 2

Good news! Plankton is plentiful and your little fry self is growing well. Make a fishy face 10 times and move ahead 6 stations.

Station 3

Good news! You are a salmon raised in a classroom by students. Roll the dice and enjoy an easy swim ahead that many stations.

Station 4

Lucky you! You were raised in a hatchery and have a much better shot at life. Skip over to Station 6 Lucky you!

Station 5

Watch out for that invasive phragmites! You’re tangled in the roots and lose your way. Act confused and go back 3 stations

Station 6

Before you leave the hatchery you need to be tagged! Place a sticker on your snout then move ahead 5 stations.

Station 7

Way to go! Your little fry self has buttoned up and you are learning to eat plankton.
Swim over 6 Stations.

Station 8

You made it to the big lake! But, you can't find plankton to eat because the invasive quagga and zebra mussels ate it all! Rest and count to 40, then sneak ahead 3

Station 9

Fisheries Biologists catch you for research. They tag you with a coded wire tag and let you go. Put a sticker on your face and swim ahead 3 stations.

Station 10

An invasive sea lamprey latches on to your side and makes you weak. Crawl ahead 2 spaces.

Station 9

Fisheries Biologists catch you for research. They tag you with a coded wire tag and let you go. Put a sticker on your face and swim ahead 3 stations.

Station 10

An invasive sea lamprey latches on to your side and makes you weak. Crawl ahead 2 spaces.

Station 11

Bad news! An invasive rusty cray-fish nipped your tail as you rested near the gravel. Roll the die and move ahead that many stations.

Station 12

A gull snatches you up for his dinner. Die dramatically and stand with your teacher.

Station 13

You find the perfect habitat out in the big lake. Swim around in 4 circles while you eat invasive alewives happily. Roll the die and swim ahead that many stations.

Station 14

As you swim through some quiet water at the mouth of the river where you were born, you get tangled up in a mat of invasive Eurasian watermilfoil and get way too warm. Die dramatically and go stand with your teacher.

Station 15

A fisher catches you and takes a selfie. He throws you back to catch another day. Tie a string on your wrist and roll the die. Move ahead that many stations.

Station 16

You have matured and start making your way back to your natal stream to spawn. Swim ahead 2 stations.

Station 17

An eagle snags you out of the river for its dinner. Die dramatically and go stand with your teacher.

Station 18

Fishers are lined up in the river to catch you! Flop on the line dramatically until she puts you in her cooler. Go stand with your teacher.

Station 19

You reach the end point of your natal stream, spawn successfully and then die naturally. Be happy that your babies will be the next generation of fish in the big lake! Go stand with your teacher.

Station 20

You spawn in your natal stream and then hang out for awhile since you are tired. A fisher catches you and makes you her dinner. You have completed your lifecycle with a purpose. Go stand with your teacher.

Why Fish Go To School

Grade Levels
9-12

Objectives
Introduce students to methods used by biologists to manage Michigan's fisheries through mathematical probability models. Students will learn how to establish appropriate stocking numbers of fish in an ecosystem by assessing the balance of predators and prey by determining the level of hatchery reared fish versus naturally reproduced fish.

Background
Stocking hatchery-reared fish is one of the tools commonly used by fisheries managers. In order for fish stocking to be done properly, a fisheries biologist must consider the balance between predators and prey.

A key piece of information needed for this is to know how many naturally reproduced salmon are recruited to the lakes from tributary streams each year. This would be a much easier question to answer if we could tell a hatchery fish from a naturally produced fish just by looking.

One way to accomplish this is to remove a fin from every hatchery fish before it is stocked (fin clipping). But fin clipping is very time consuming and very costly. Currently, the only cost-effective way to mark all hatchery fish is to feed them fish food that is laced with the antibiotic oxytetracycline (OTC). The OTC is incorporated into the boney material of the fish. When thin sections of bone are viewed under a fluorescent light (black light), the OTC mark shows up as a brightly fluorescent ring. The tissue of choice for evaluating OTC marks is a thin section of vertebra.

Fishery managers can collect samples from fish carcasses at fish cleaning stations or from the weirs operated by the DNR and evaluate them back in the lab. The simple ratio of marked versus unmarked fish is used to describe what portion of the population is from hatchery stock and what proportion is from natural reproduction.

Activity

The amount of OTC-laced feed the fish require is based on the total biomass of fish being fed. In order to ensure a good, readable mark, a nine-day feeding regimen is followed.

The fish are fed at the rate of 2% of their body weight daily for four days. Following a one-day break where they receive no feed, the fish are fed for four more days at 2% of their body weight per day.

Every kilogram of feed eaten results in one kilogram of weight being added to the raceway biomass.

Assuming that on the first day of the treatment you have a raceway that contains 200,000 Chinook salmon fingerlings that average 225 fish per kilogram, answer the following questions:

- What is the total biomass (weight of all of the fish) in your raceway on the first day of the treatment?
  - Answer: 200,000 divided by 225 equals 888.9 kilograms.
- How much feed do the fish get on each day of the treatment, assuming that the fish are not fed on the day in between the two four-day feeding periods?
  - Put your answers into the chart on the next page.
- What is the number of fish per kilogram on the last day of the treatment?
  - Answer: 195.9 fish per kilogram.

Food Allotment Data Sheet

Starting Number	Starting Number of fish per kilogram	
Day	**Biomass**	**Feed Amount**
1		
2		
3		
4		
5		**No Feeding**
6		
7		
8		
9		

Answer Key

Starting Number	Starting Number of fish per kilogram	
Day	**Biomass**	**Feed Amount**
1	**888.9**	**17.8**
2	**906.7**	**18.1**
3	**924.8**	**18.5**
4	**943.3**	**18.9**
5	**962.2**	**No Feeding**
6	**962.2**	**19.2**
7	**981.4**	**19.6**
8	**1001.0**	**20.0**
9	**1021.1**	**90.4**

How Many Fish Does it Take?

Grade Levels

6-8

Objectives

Calculate how many fish we will have for planting based on loss rates at each stage of development

Background

Your classroom received 300 freshly fertilized eggs, called "green" eggs, from the weir in early October. These eggs generally take about 60 days to hatch in water that is 48 degrees F.

About halfway through egg development, the eyes on the embryos become visible. At this point, they are called "eyed" eggs.

Once they hatch, they are considered "sac fry." The word "sac" refers to the yolk sac from which the fry get all of their nutrition during the first 30 days after hatching.

After the yolk sac is gone, the fish are "buttoned up" and are called "swim-up fry." At this stage they begin actively feeding.

At each stage of development, a number of fish (or eggs) fail and drop out of the population. Perhaps they were never fertilized so they don't reach the eyed egg stage, or maybe they were physically damaged after eye up and never hatched. Some may have a genetic trait, such as improperly developed mouth parts, which will not allow them to start feeding once the yolk sac is used up. Whatever their reason for dropping out of the population, a hatchery biologist must plan for these losses when he or she is figuring out how many eggs are needed for a desired fish plant.

Activity

Answer the following questions, keeping in mind that the class started with 200 green eggs.

- If you had an 85% eye-up rate (85% of your green eggs developed into eyed eggs), how many eyed eggs do you have?
  - Answer: 170
- If 95% of the eggs that eyed up eventually hatched, how many sac fry do you have left?
  - Answer: 161
- Assuming 93% of your sac fry successfully started feeding, how many healthy, feeding fry would you have?
  - Answer: 149
- During the rest of fish rearing, you lose only another 2%. What is the final number of fish you have to plant?
  - Answer: 146
- Now, assume you are a hatchery biologist working with much larger numbers. Let's assume you started with 600,000 green eggs. Answer the same questions as above.
  - Answer: 510,000
  - Answer: 484,500
  - Answer: 450,585
  - Answer: 441,573
- To plan your egg needs as a biologist, however, you need to be able to work through this math problem in reverse order. In other words, if you wanted to end up with 500,000 Chinook smolts for stocking in a Lake Michigan tributary, how many green eggs would you need to start with, assuming the loss rates in questions 1-4 above?
  - Answer: Based on the calculations below, you would request 680,000 green eggs.
  - 500,000 ÷ .98 = 510,204 healthy feeding fry
  - 510,204 ÷ .93 = 548,606 hatched sac fry
  - 548,606 ÷ .95 = 577,480 eyed eggs
  - 577,480 ÷ .85 = 679,388 green eggs

Salmon Scents

Adapted from Aquatic WILD

Grade Levels
3-6

Objectives
Students will learn the migratory path and the life cycle of the Chinook salmon by experiencing the olfactory sense used to navigate to their natal stream where they will spawn.

Best Taught
Any time.

Materials
- 100 yards of string
- Scissors
- 50, 1 – 3 ounce Solo cups with lids
- 50 cotton balls
- 5 distinctly different scents (such as peppermint, cinnamon, clove, vanilla and orange)
- Masking tape or clothesline, at least 50’ in length
- River figures 1 and 2

Background
Students will take part in the life cycle of Chinook salmon by tracing their migratory route using their sense of smell. Chinook salmon lay their eggs in clean, cold, swiftly moving streams with a gravel substrate. The male uses his tail to create a depression in the sediment in which the female deposits her eggs. These eggs hatch and continue to develop throughout the winter months. In the spring, now 3 – 4 inches in length and called smolts, they will begin their journey out of their natal stream, intersecting larger and larger rivers before they finally reach the big waters of the Great Lakes.

Not all that begin this journey will survive. Many will perish along the way as a result of predation, poor water quality and other hazards. A majority of the salmon will forage and grow for three years before returning to their natal river, where they will spawn and die. The life cycle then begins again with the newly laid eggs.

Procedure

1. In good weather use a level, outdoor space such as a playground, soccer field or other open area. Use the gym, or large indoor area, in poor weather.
2. Lay one piece of masking tape or clothesline, approximately 50’ in length on ground in-line. This represents the Lake Michigan shoreline.
3. Cut four lengths of string 10 – 12’ long each. These will represent main rivers that flow into Lake Michigan. Beginning at the coastline, lay one of these strings perpendicular to the coast. Lay a second string (river) at least 5 feet from the first in the same fashion. Follow with the last two the same way.
4. Cut an additional 20-25 pieces of string between 2 – 5’ in length. These represent larger tributaries which flow into the main rivers. Randomly, and creatively as you like, lay these smaller pieces anywhere along the four main rivers. They may be between 2-5 feet apart. You may also add more tributaries to these tributaries to create a busy watershed (Figure1).
5. Choose one scent. Pour over cotton ball, place in cup and make sure lid is securely fastened. Place this scent where river #1 meets the Lake Michigan shoreline. Using the same scent, repeat procedure but place this cup somewhere at the end of your main river along a tributary. Students should be able to find this cup. Take all other scents (following the same procedure with the cotton balls and cups) and place them at other intersections of tributaries and the main river.
6. Move on to your second River and repeat same procedure. Be sure a new scent is used at the mouth of the river and at an ending point.
7. The rest of the tributaries should be mixed with other scents. Repeat for last two rivers again being sure that the origin and ending point are the same scent with others used in between (figure 2).

Note: If you create a complex river system with several main tributaries, you may need to use the main scent in between mouth and source of river.

Activity

1. Split your class into four groups and assign them to stand at the four rivers that intersect the shoreline. They are salmon reaching the beginning of a long journey home to their natal stream.

2. Each team should take a smell of the cotton ball at the river mouth. This same scent will help them find their natal stream just like real salmon.

3. They need to follow the river and when they come to an intersecting tributary, they must smell the stream (cotton ball placed there) to determine if it is the right path. The goal is to discover their natal stream by finding the same scent (cotton ball) along the way.

Discussion

Review the journey of a salmon. Can they compare it to another journey they have made where they had to remember their way back? Remind them that Pacific salmon, in their native habitat, may travel up to 900 miles to reach their spawning grounds. Can they imagine driving with their parents from Michigan to Disney World and returning only using their sense of smell. Every exit on I-75 between Michigan and Orlando could represent a tributary intersecting the main river (I-75). Yet, millions of salmon make this journey each year, a true wonder of nature.

Extension

The more times you run this activity, you will find creative ways to make it more educational and fun for your students.

Have students research some of the Pacific salmon that live along migratory routes in Alaska, Washington, Oregon, California and Idaho. They can draw a map of the route and report out to the class the information they have gathered.

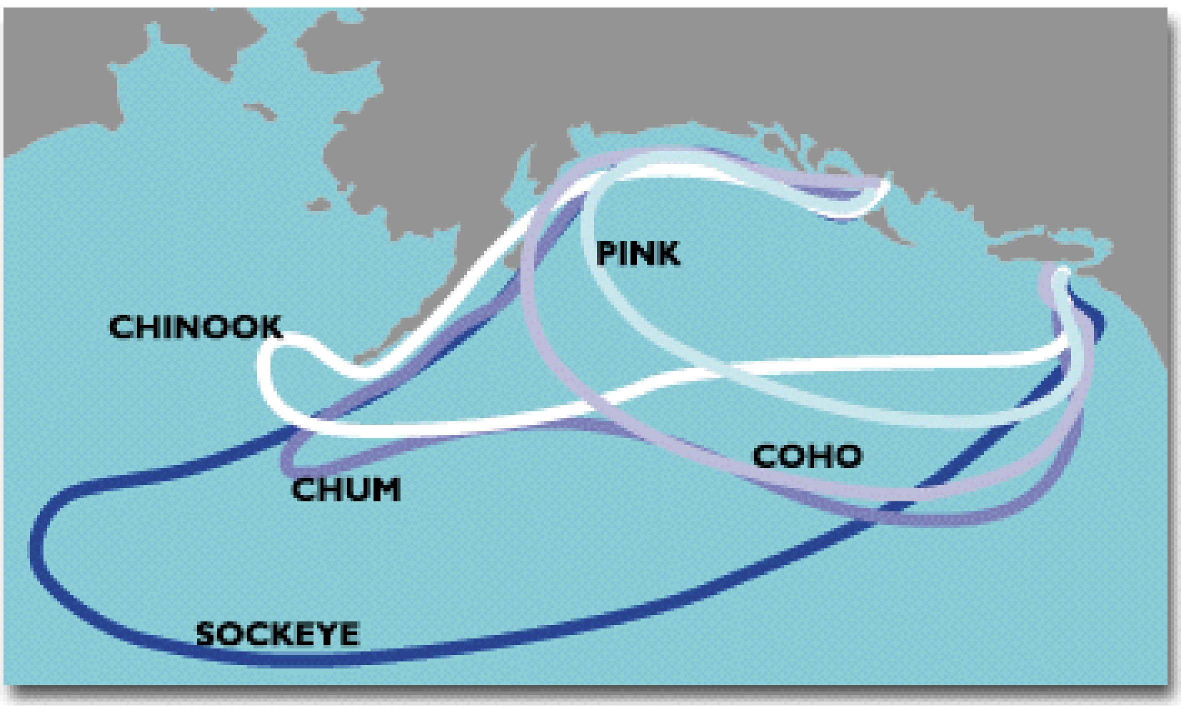


Figure 1

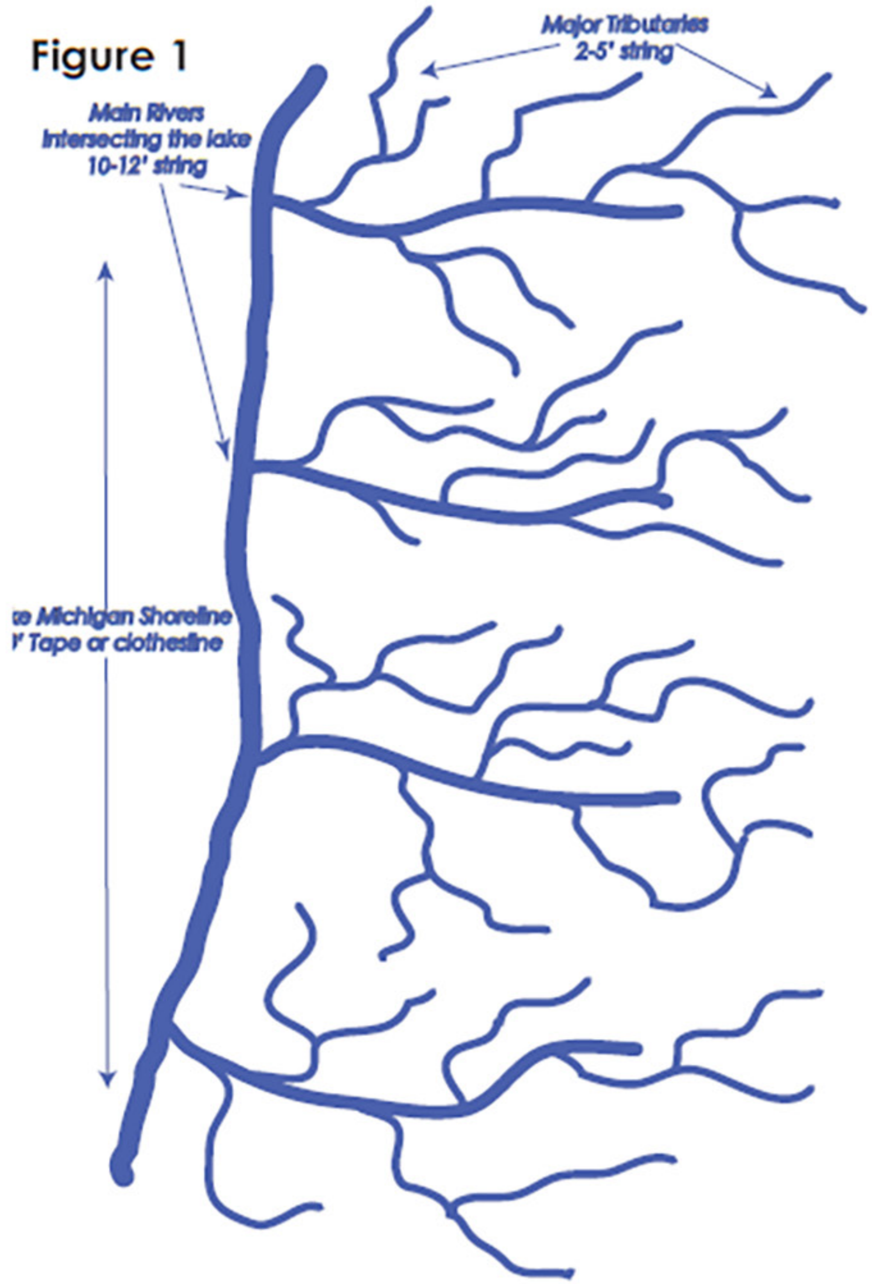
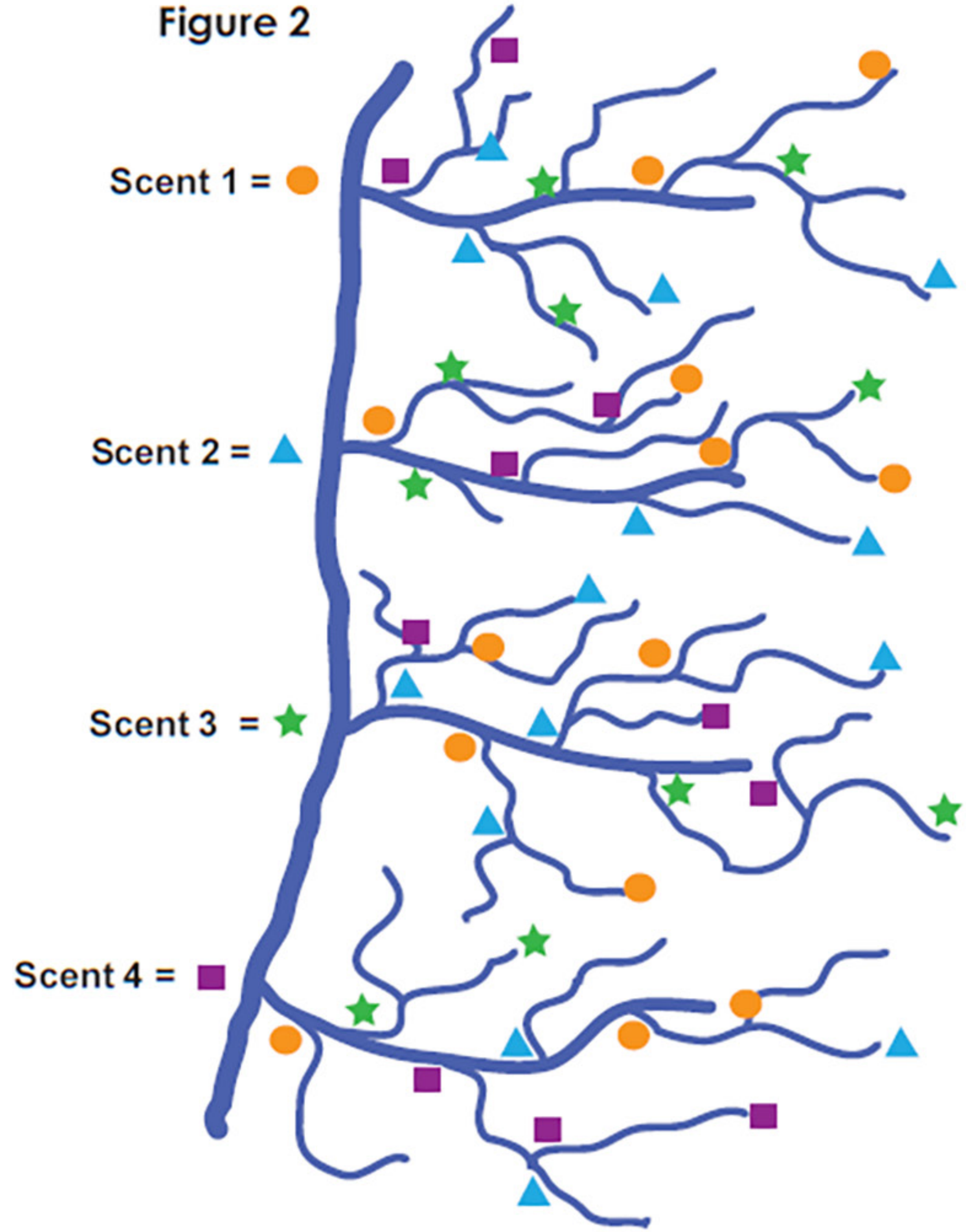


Figure 2



Migration Fixation

Grade Levels
3-6

Objectives
To enhance understanding of salmon behavior, life cycles, diseases associated with salmonids and fish culture vocabulary. The objective of the game is to be the first team (Chinooks or cohos) to reach the Great Lakes.

Best Taught
In spring, closer to date of fish release; also can be used to reinforce principles of salmon migration.

Materials
- 20 salmon cards
- Great Lakes basin map
- 20, 8.5 x 11 sheets of paper
- Two large, colored cotton T-shirts (one red, one blue)
- One large cardboard box, with one to six black dots drawn on each side, representing a die
- Space to move around: gymnasium, etc.

Background
This game reinforces students' learning and the physiology and behaviors of the salmon the students are raising in the classroom. Common fish culture terminology is introduced.

Activity

1. The object of the simulation is to have the team's student token reach the end of the board – the Great Lakes!
2. Tape 8.5 x 11 pieces of paper down in a curvy line, mimicking a stream. Place the Great Lakes basin map or Michigan highway map at the finish after the last sheet. This is your game board. The Michigan map may work better at the end to prevent tearing the basin map or place the last stop (basin map) on a wall.
3. Place 20 'salmon cards' upside down, one per sheet.
4. Divide the class into two teams; one will be the Chinooks, the other will be the cohos.
5. Each team chooses a 'token' piece-- a student who will wear a colored T-shirt, red for the Chinooks team, blue for the Cohos.
6. Roll the die (cardboard box) to decide which team goes first. Each team member (except the token) then takes a turn rolling the die; whoever rolls physically moves the 'token' (student) the number of spaces on the roll (roll a 4, move 4 spaces, etc.)
7. Each space has a 'salmon card' turned face down so it cannot be read before the 'token' reaches it. When the 'token' lands on a space, select another team member to read the card and follow the instruction on the card. The team whose 'token' reaches the Great Lakes first wins

The following pages are copy me pages. Copy and cut on the dotted line.

You contracted Furunculosis, move to a hatchery for a furogen dip. TAKE 2 STEPS FORWARD.	**LUCKY SALMON CARD. Save this card if you get Bacterial Kidney Disease (BKD).**
Ate a pound of black fly larvae, and got a stomach ache. STAY PUT AND MISS ONE TURN. Other team gets to roll die twice.	**You won the Master Angler Award! MOVE AHEAD 1 SPOT.**
Avoid predation by a muskel-lunge (muskie). MOVE AHEAD 2 TURNS.	**Imprinted on a smelly polluted river. TAKE A TRIP BACK TO THE SPACE WHERE YOU CAME FROM ON YOUR LAST TURN.**
Caught and released by an angler. STAY PUT UNTIL NEXT TURN.	**Inflated your air bladder. MOVE A HEAD 5 SPOTS.**

Bacterial Kidney Disease (BKD) discovered in your river. Have a LUCKY SALMON CARD? Return card to deck and MOVE AHEAD 3 SPOTS.	**Snagged in the fin by a poacher. MOVE AHEAD 3 SPOTS.**
Field Technicians clipped your adipose fin! MOVE BACK TO START.	**Electroshocked out of a stream. MOVE BACK 4 SPOTS.**
Electroshocked out of a stream. MOVE BACK 4 SPOTS.	**Successfully made a redd! MOVE AHEAD 2 SPOTS.**
Name all the life cycles of a salmon successfully and MOVE AHEAD 5 SPOTS.	**You eyed-up! MOVE AHEAD 2 SPOTS.**

You got bit in the tail by a kype! MOVE BACK 3 SPOTS.	**Fish Stocking Unit needs more oxygen! MOVE AHEAD ONE SPOT.**
Research Biologists conduct a Status and Trends Survey. MOVE BACK TO START.	**Your yolk sack has buttoned up. MOVE AHEAD ONE SPOT.**

Salmon Survival

Grade Levels
4-12

Objectives
Students will learn factors affecting salmon survival in the wild.

Best Taught
Any time during the school year.

Materials
- One set of "Survival" cards and one set of "Non-Survival" cards.
- Helpful Tip: Color each station's cards the same color to keep the correct number of each at the individual stations.
- 3 – 4 different scents in individual containers (i.e. cumin, chili powder, oregano, etc.).

Note: Students should not be able to see the content of containers. Cover up container

Background
An average Chinook salmon female will lay an average of 4,000 – 5,000 eggs. Of these eggs, only a very small percentage will survive to adulthood and return to their natal river to spawn. Salmon face a myriad of obstacles in the wild that they must overcome in order to survive. These factors can change from year to year, season to season and from one body of water to the next. Both human and natural dangers exist including but not limited to; overfishing, disease, dams, predation, non-native species, genetic deformity and pollution.

Courtesy of Bill Hodges, Holt High School and adapted for this curriculum by Shana Ramsey, DNR

Activity

1. Set up five salmon life cycle stations in the following order; egg, fry, fingerling, smolt and adult.
2. Each station should have 10 playing cards.
3. Each station will have a different allotment of survival and non-survival cards.
   - Egg: 7 survival cards, 3 non –survival cards
   - Fry: 6 survival cards, 4 non-survival cards
   - Fingerling: 5 survival cards, 5 non-survival cards
   - Smolt: 4 survival cards, 6 non-survival cards
   - Adult: 3 survival cards, 7 non-survival cards
4. Starting at the egg stage, one at a time, each student draws a card from the pile.
5. Depending on what they draw (survival card or non-survival card) they will either;
   A) Proceed to the next life stage or
   B) Return to the end of the line to draw again.
6. If a student survives to adulthood, their next challenge is to find their natal stream.
7. Surviving students then proceed to smell their natal stream scent.
8. Next, students will proceed to a station that contains a variety of (3 or4) scents, including the natal stream scent.
9. Each scent has a number on the bottom of the container. Students will try to determine which one matches the winning scent.
10. Students will then relay that number (in a whisper) to the teacher to find out if they survived to spawn!

You were raised at a fish hatchery and provided with everything you needed to survive! Proceed to the next stage of your life cycle

You were raised at a fish hatchery and provided with everything you needed to survive! Proceed to the next stage of your life cycle

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You were raised at a fish hatchery and provided with everything you needed to survive! Proceed to the next stage of your life cycle

Lucky you ~ conditions were perfect and you survived, congratulations! Proceed to the next stage of your life cycle	**Lucky you ~ conditions were perfect and you survived, congratulations! Proceed to the next stage of your life cycle**
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Lucky you ~ conditions were perfect and you survived, congratulations! Proceed to the next stage of your life cycle	**Lucky you ~ conditions were perfect and you survived, congratulations! Proceed to the next stage of your life cycle**
Congratulations, you’ve reached adulthood	**Congratulations, you’ve reached adulthood**
Congratulations, you’ve reached adulthood	**Congratulations, you’ve reached adulthood**

Egg	Egg	Egg
Egg	Egg	Egg
Egg	Eyed Egg	Eyed Egg
Eyed Egg	Eyed Egg	Eyed Egg
Eyed Egg	Eyed Egg	Eyed Egg
Eyed Egg	Eyed Egg	Fry
Fry	Fry	Fry
Fry	Fry	Fry

Fry	Fry	Fry
Parr	Parr	Parr
Parr	Parr	Parr
Parr	Smolt	Smolt
Smolt	Smolt	Smolt
Smolt	Smolt	Smolt
Smolt	Smolt	Adult
Adult	Adult	Adult

Adult	**Adult**	**Adult**
Adult	**Adult**	**Adult**
Parr	**Parr**	**Parr**
Egg	**Egg**	**Egg**
1	**2**	**3**
4	**Natal Stream**	

You were eaten by a hungry largemouth bass. Return to start.	**A new disease was introduced into your lake or river, you didn't survive Return to start.**
An oil spill fouled up the river or lake where you live. You didn't survive Return to start. didn't survive	**Non-native Round Gobies ate you for lunch Return to start.**
You're genetically deformed and didn't survive Return to start.	**Bad alewife survival, you don't have anything to eat and didn't survive Return to start.**
Anglers aren't following fishing regulations and are overfishing Return to start.	**A dam was installed and blocks route Return to start.**

Water temperature rises from factory waste and it's too hot for a cold water fish like you to survive	**You were eaten by a hungry largemouth bass. Return to start.**
Poor fertilization Return to start. Return to start	**A dam was installed and blocks route Return to start.**
Water temperature rises from factory waste and it's too hot for a cold water fish like you to survive Return to start.	

Salmon Life Cycle Mini Unit

Grade Levels
Prek - 3

Salmon Lifecycle Mini Unit created and designed by Tanja Tlusty

Used in the SIC Guide with permission.

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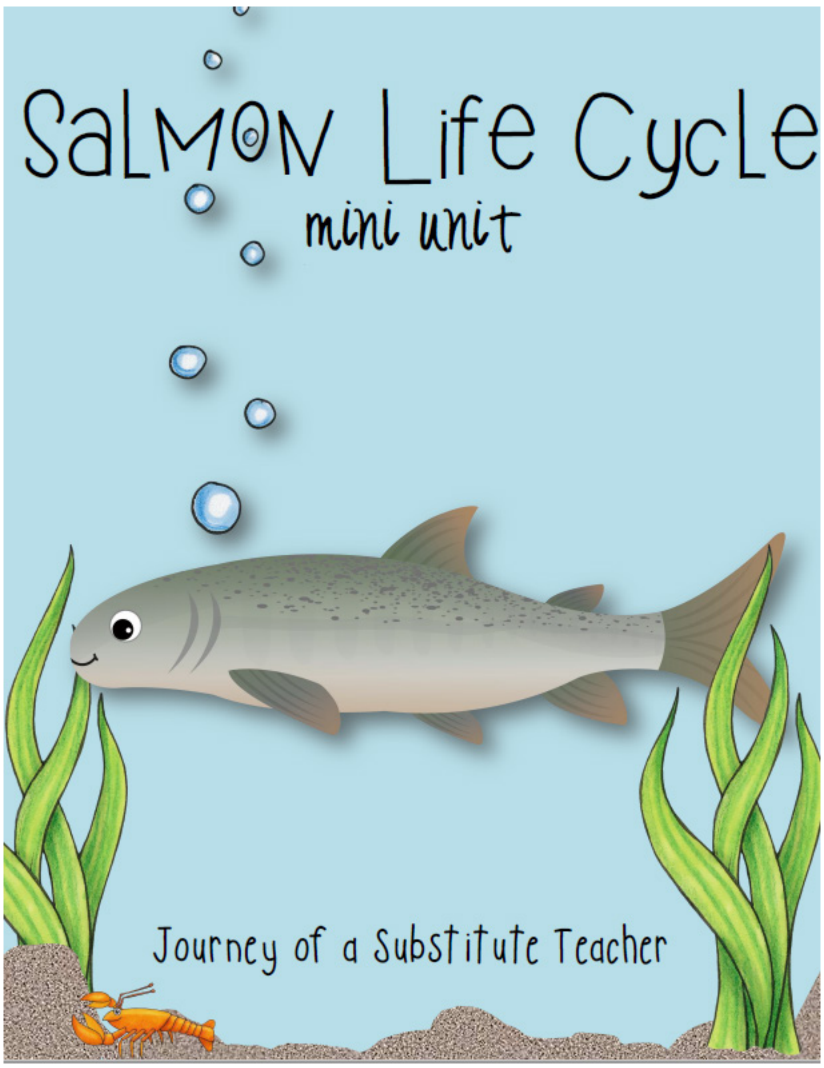
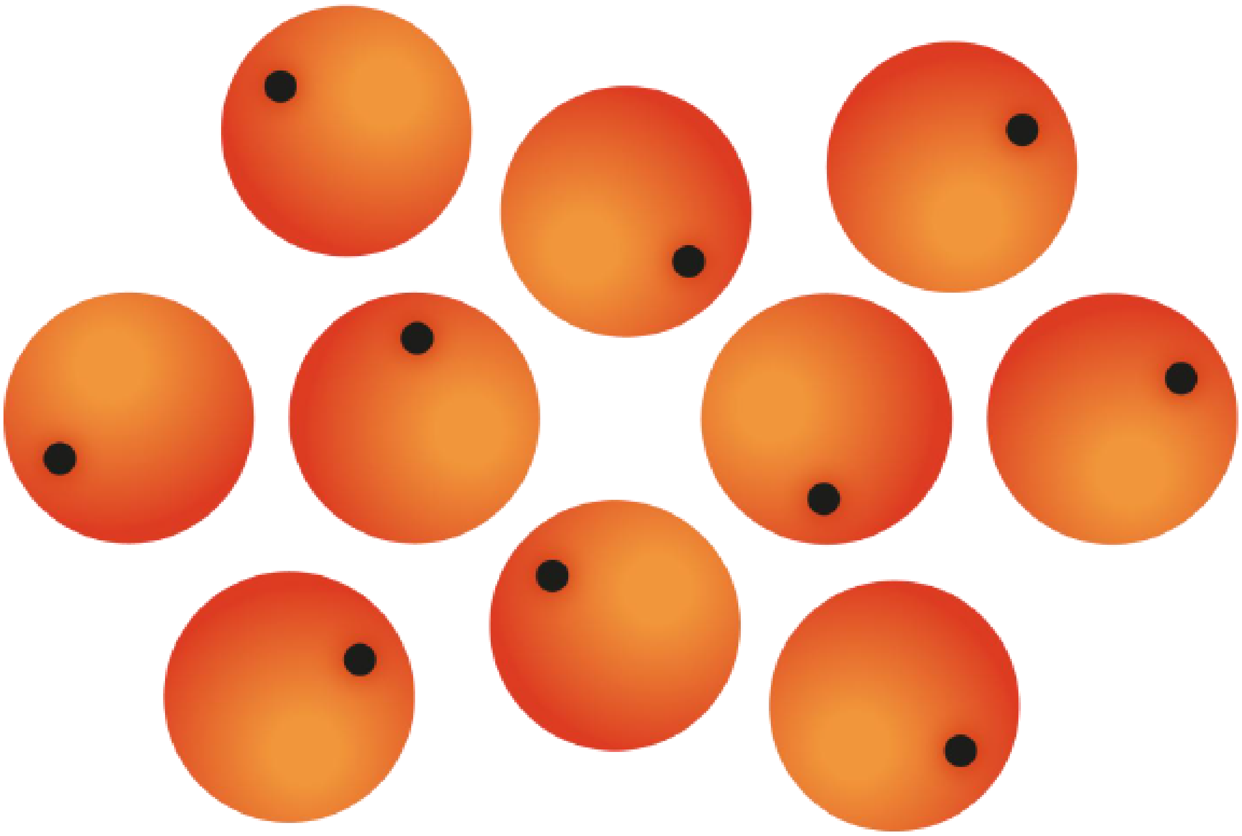
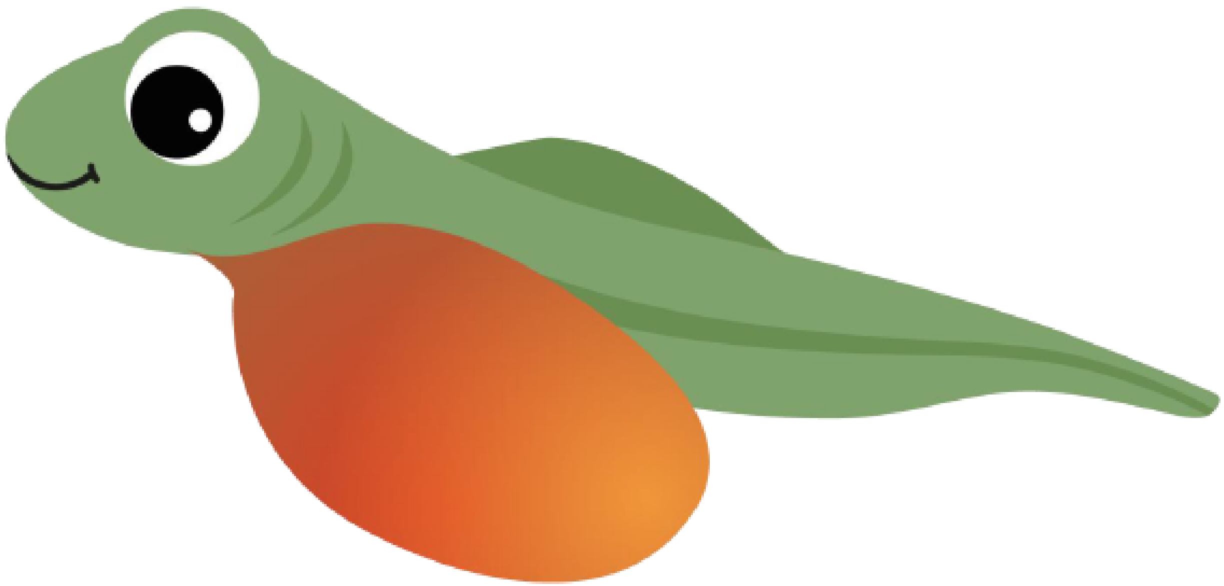


Contents

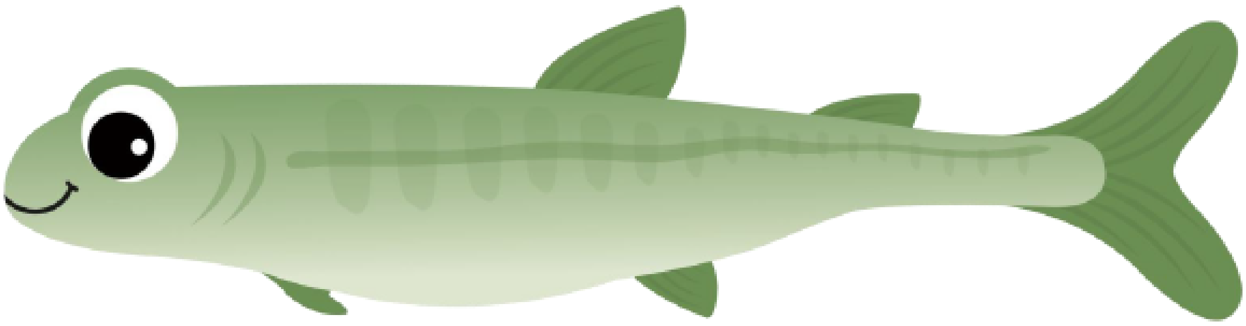
Egg



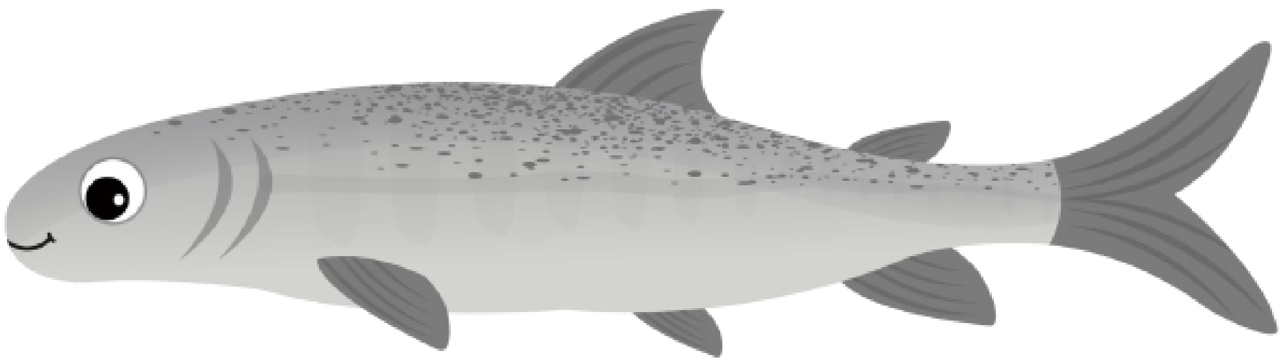
Alevin



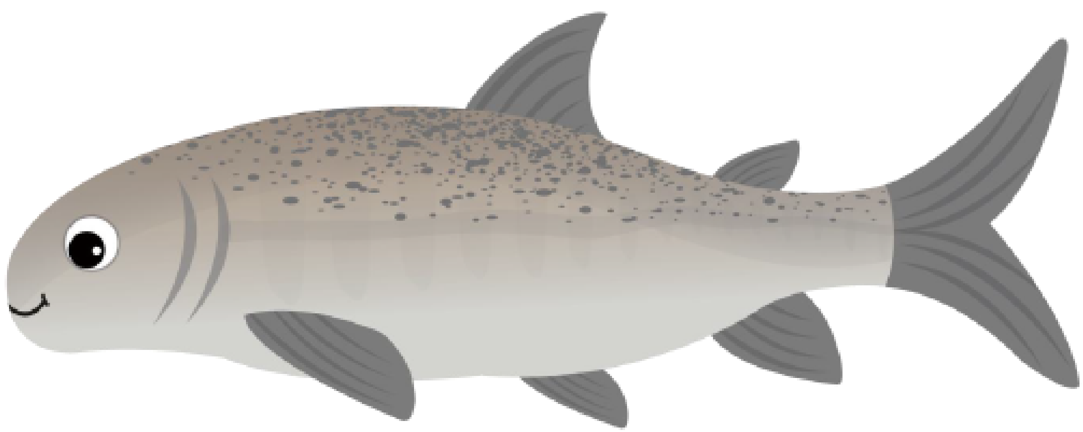
Fry



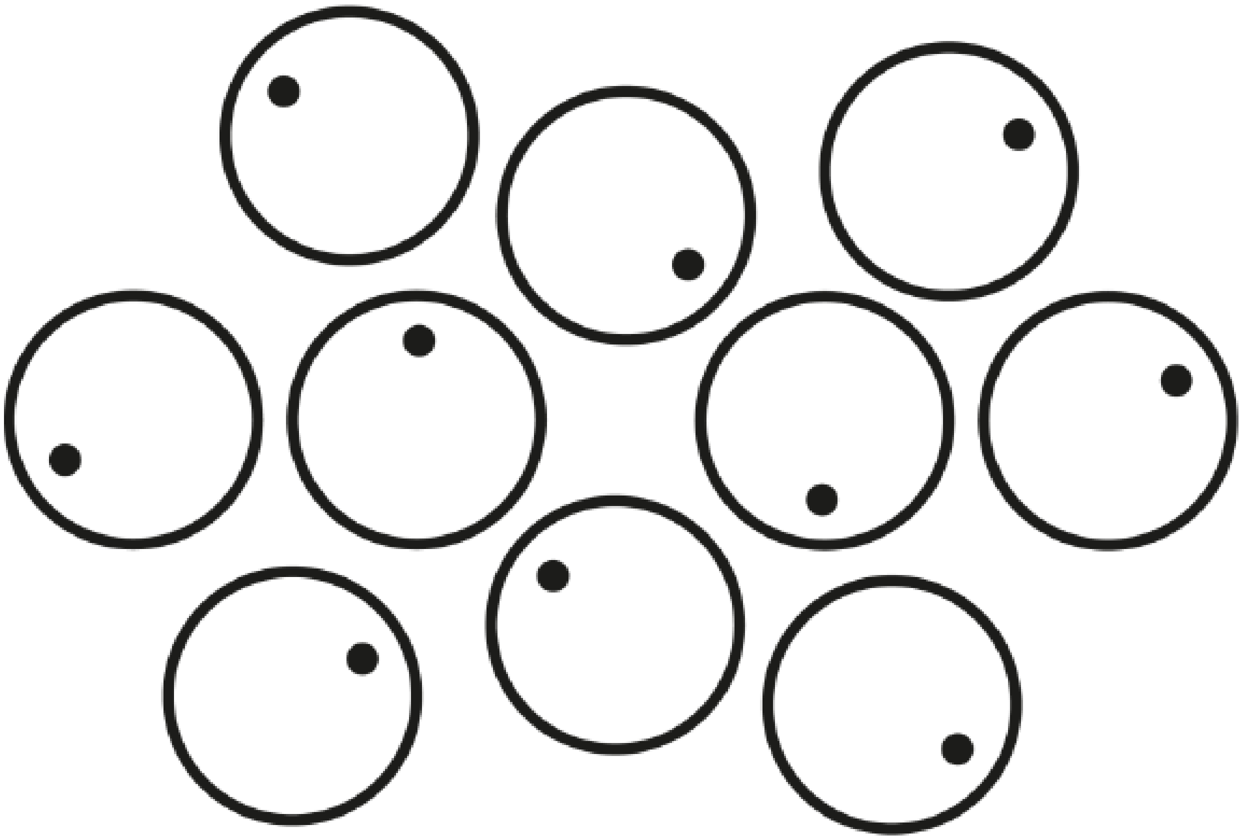
Parr



Smolt

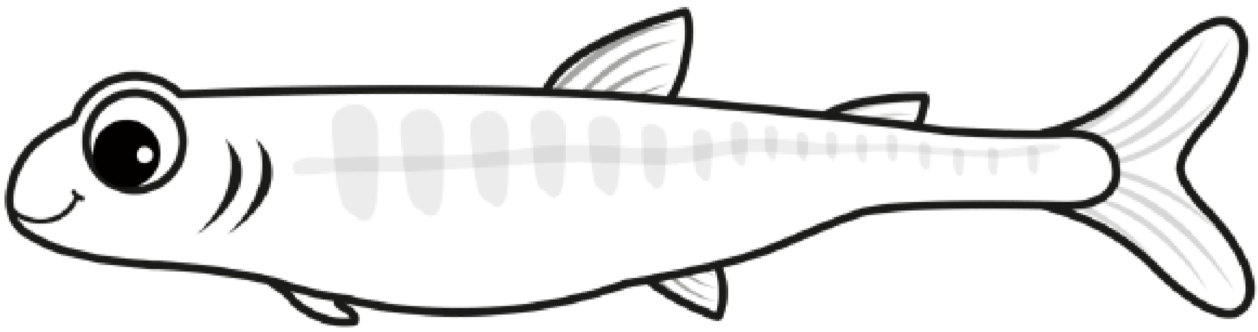


Egg

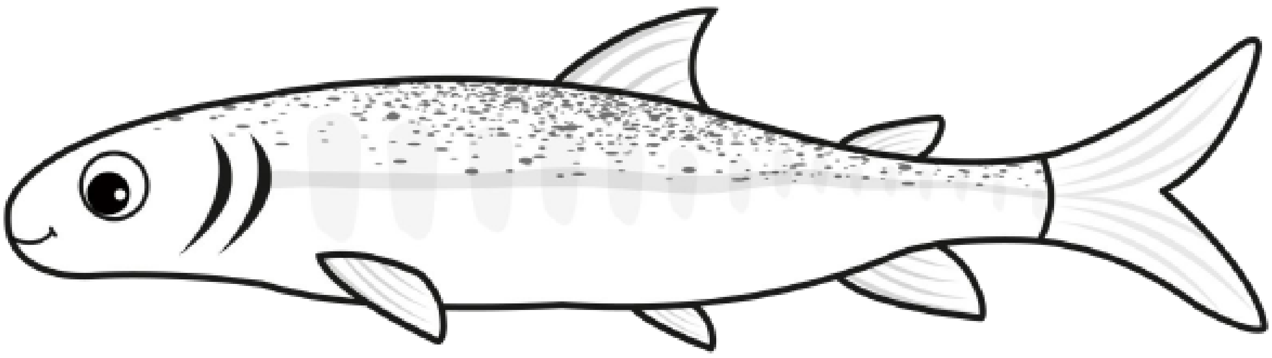


Alevin

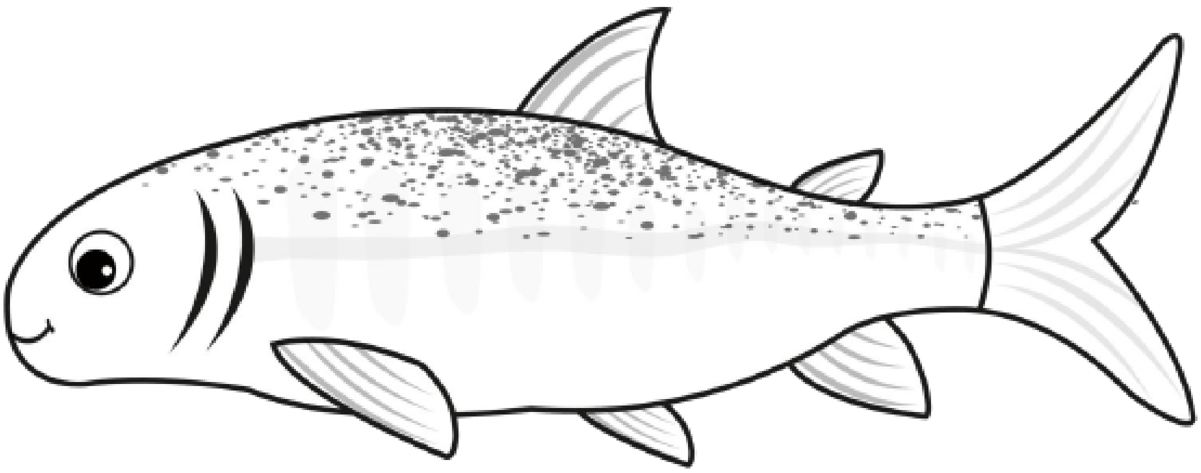
Fry



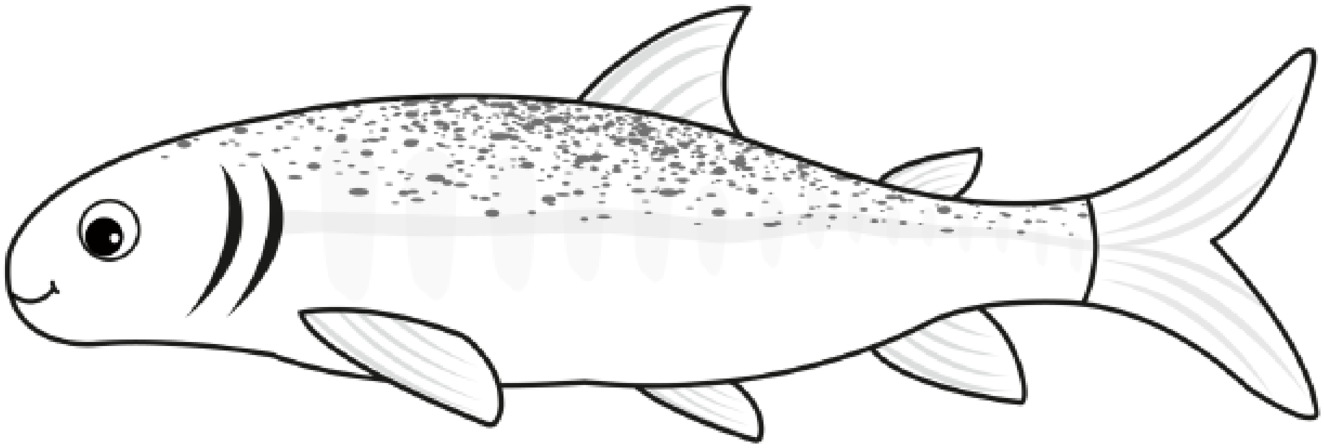
Parr



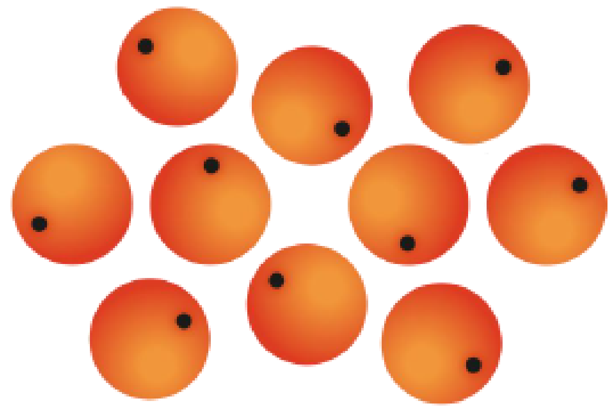
Smolt



Adult Salmon



Egg



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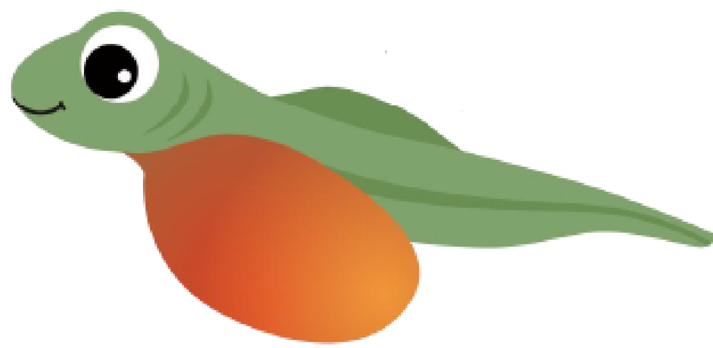
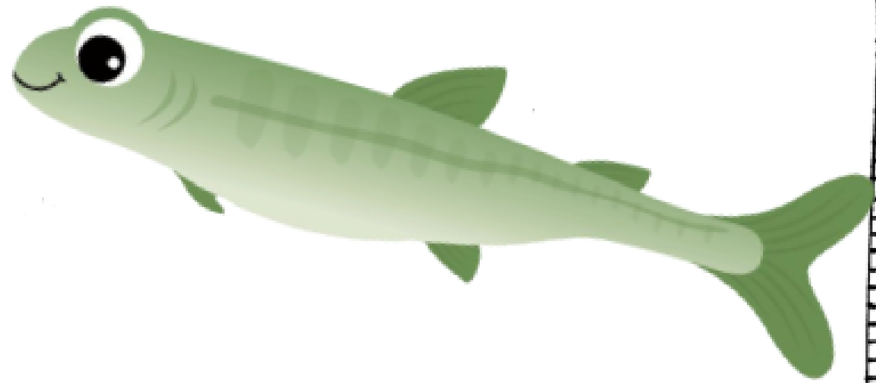
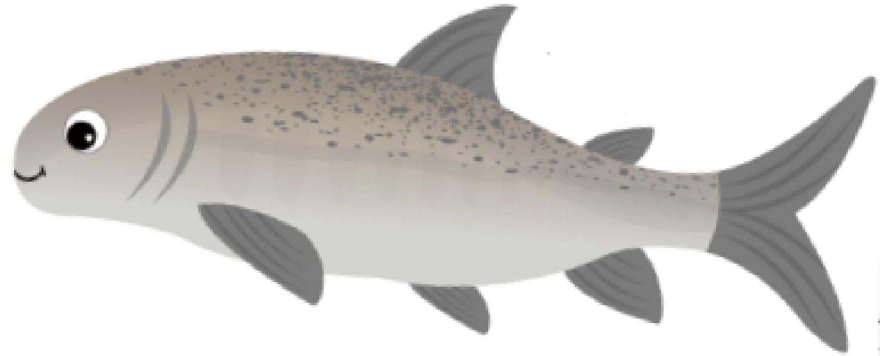


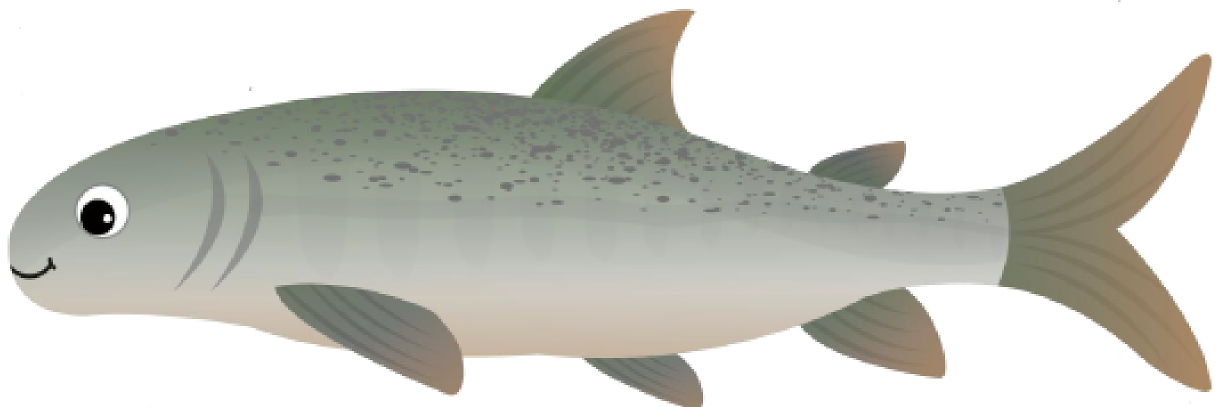
Fry



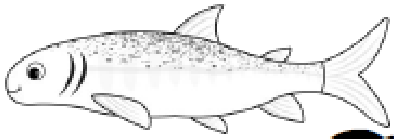
Parr

Smolt 

Adult Salmon



Salmon Life Cycle



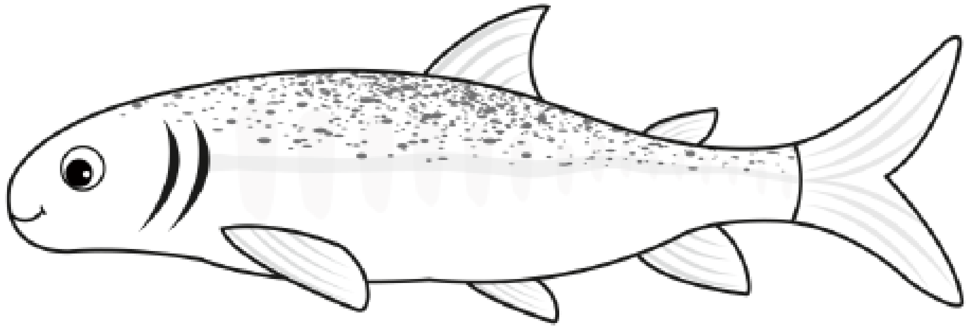
Name:

Salmon

I know	I want to know	I learned

Name:

Salmon



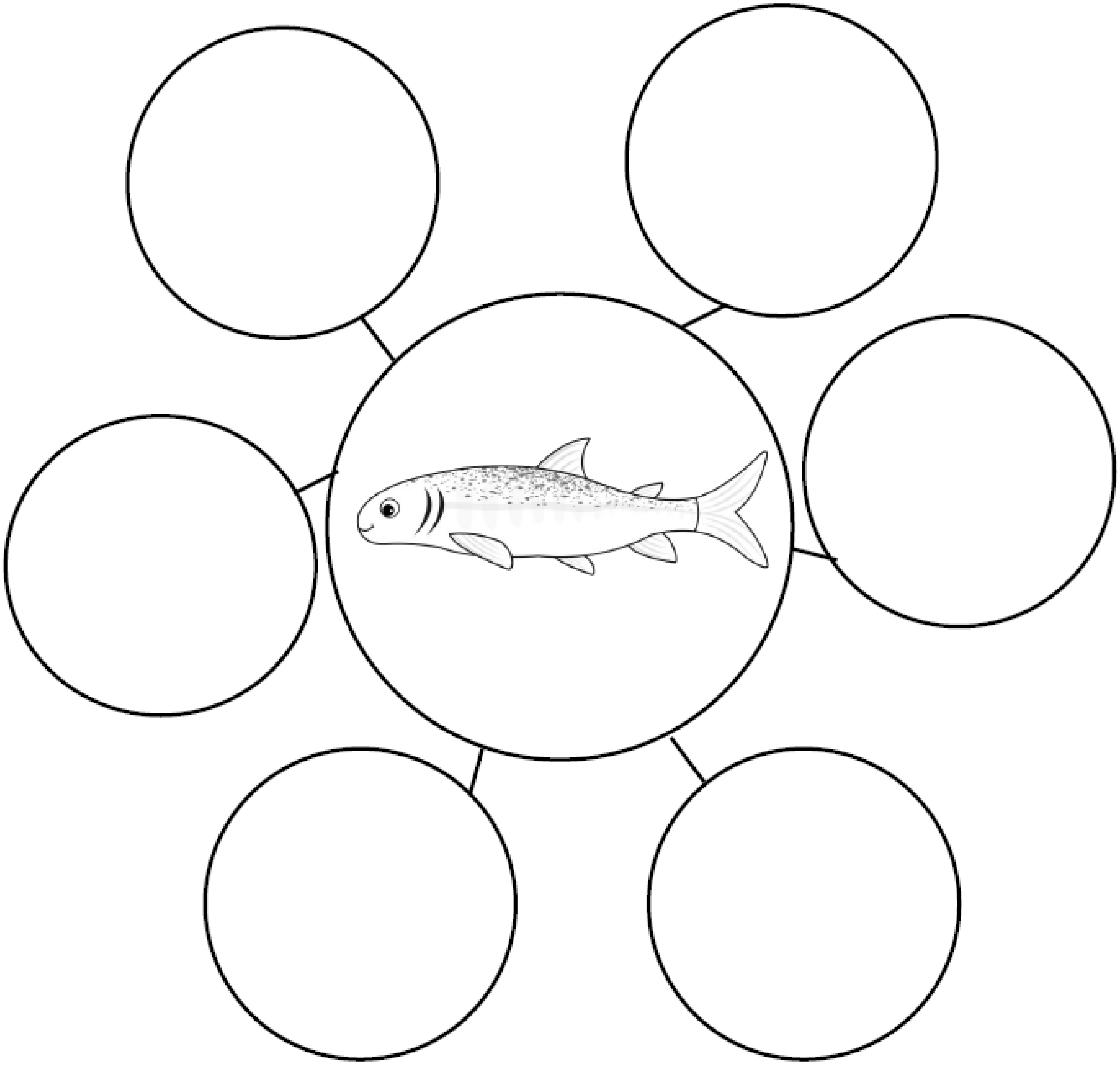
Can

Have

Are

Name:

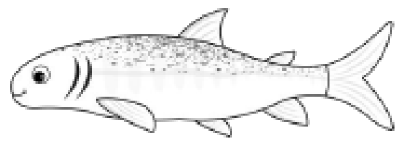
Salmon



Name:________________________

Read and Answer

Read the information and answer the questions.



Salmon

Salmon are found in rivers, lakes, and the ocean. They are silver with a spotted back and fins. Salmon return to where they were hatched, continue the cycle, then die.

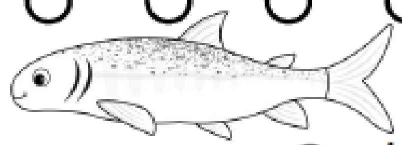
Salmon are born in fresh water, go to salt water, then end back in fresh water at the end of their lives. Some travel thousands of miles to lay their eggs.

Salmon are carnivores. That means they eat meat. Salmon eat fish, squid, and crustaceans. There are several types of salmon, like Chinook and Sockeye.

1. Do salmon live in fresh water or salt water?

2. What do salmon eat?

3. What is one type of salmon?



Name:

Salmon Questions

Are there any salmon near you?

Have you ever seen a salmon before? What did it look like?

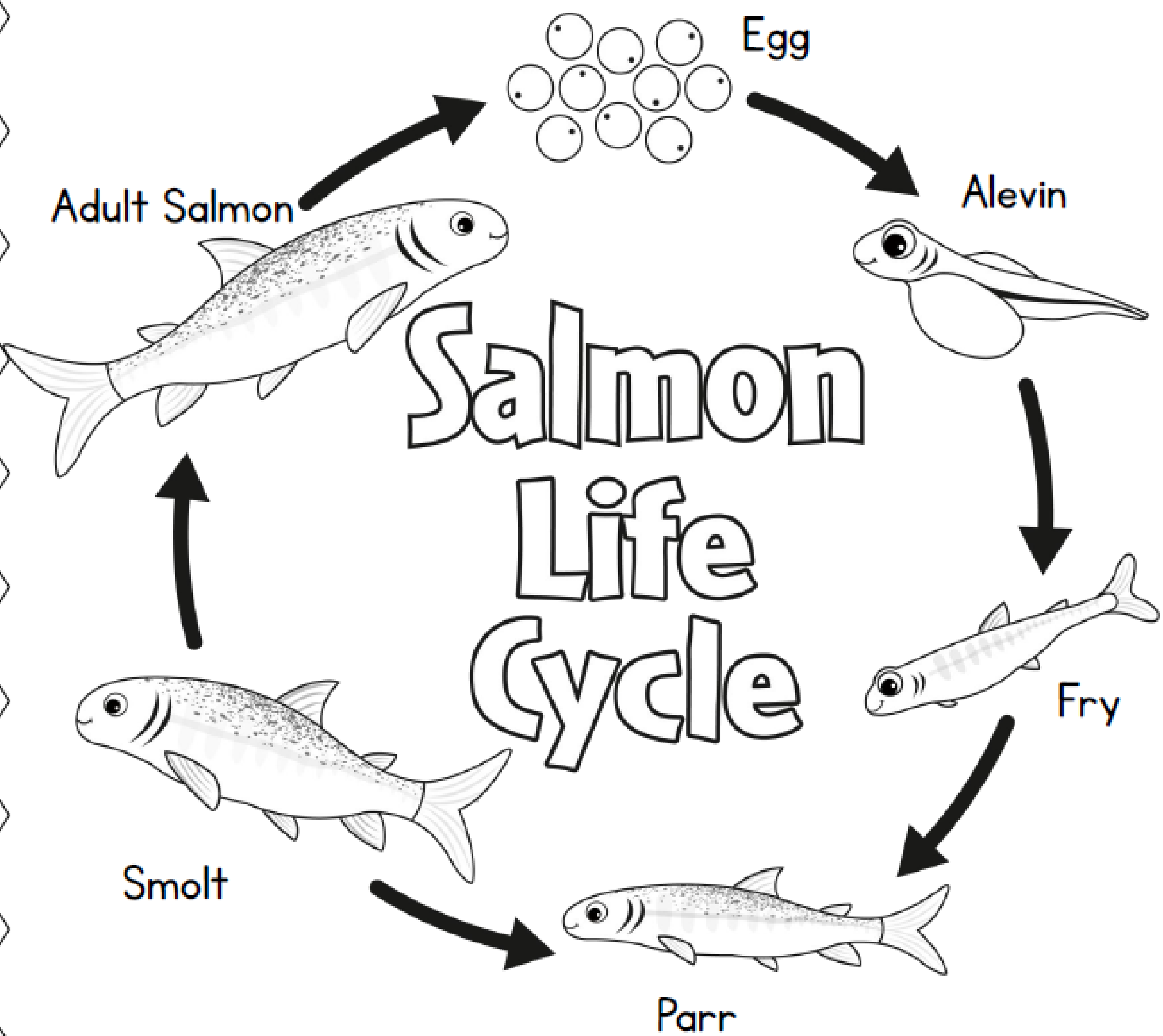
Name three things you know about salmon:

Would you ever try to fish or eat salmon? Why or why not?

Name:

Salmon Life Cycle

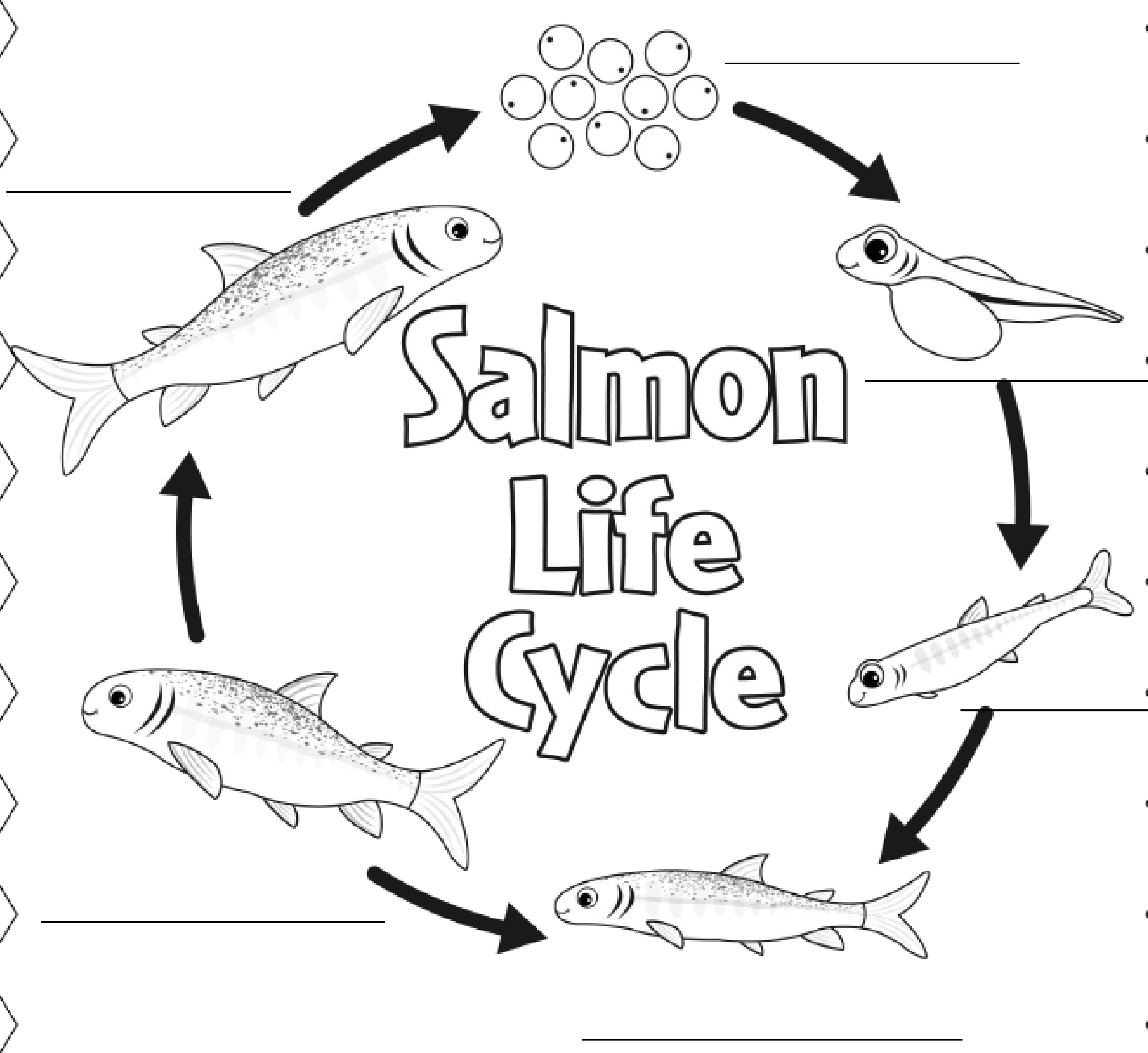
Color in the salmon life cycle.



Name:

Salmon Life Cycle

Label and color in the salmon life cycle.



Name:

Salmon Life Cycle

What is the first part of the salmon life cycle?

What is the second stage of the salmon life cycle?

What are the next two stages in the salmon life cycle?

What is the fifth stage of the salmon's life cycle?

What is the final stage in the salmon life cycle?

Name:

Draw a Salmon Life Cycle

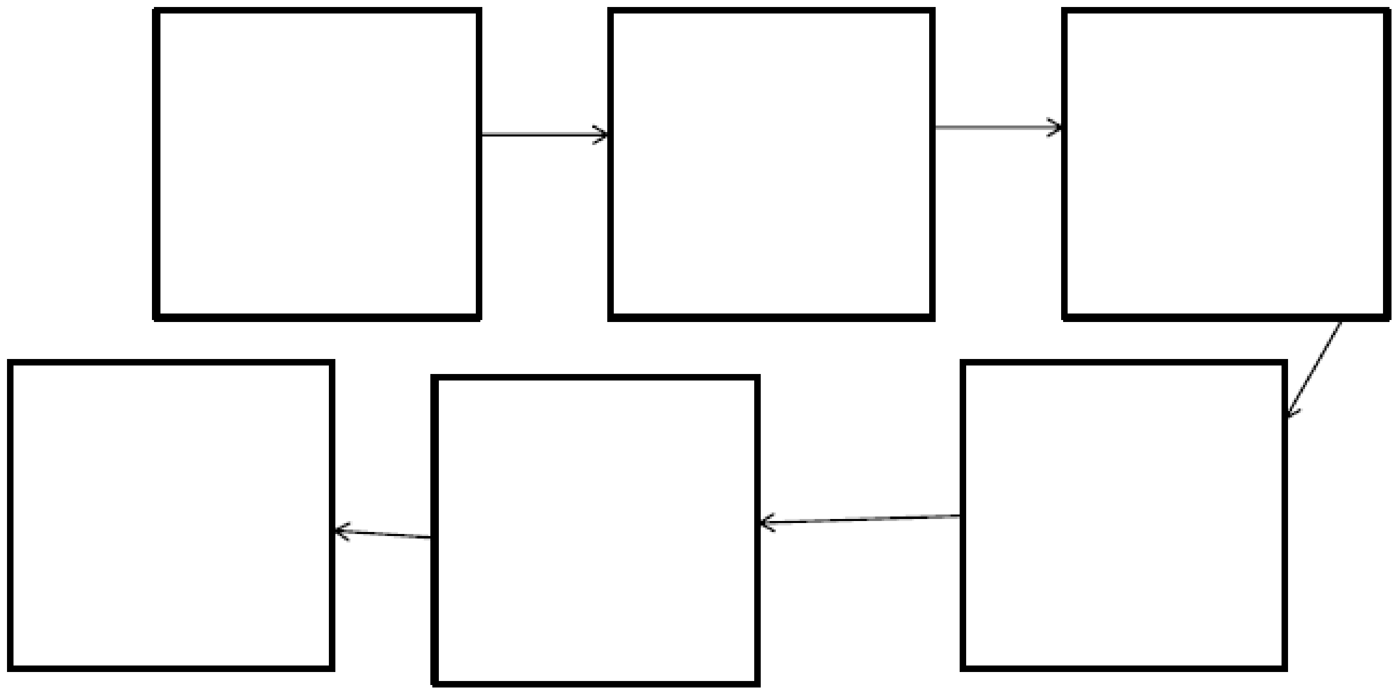
Draw the salmon's life cycle.

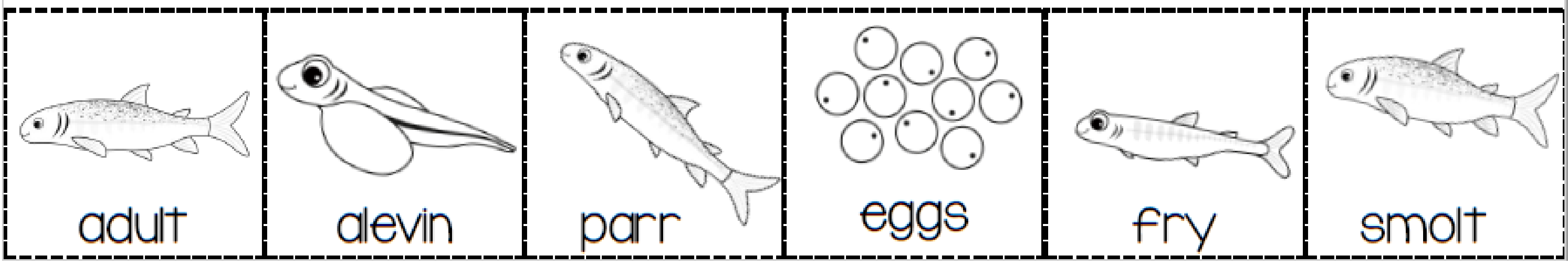
Finished early? Write on the back about salmon.

Life Cycle Sequence

Name:

Cut and paste the salmon life cycle in the correct sequence.

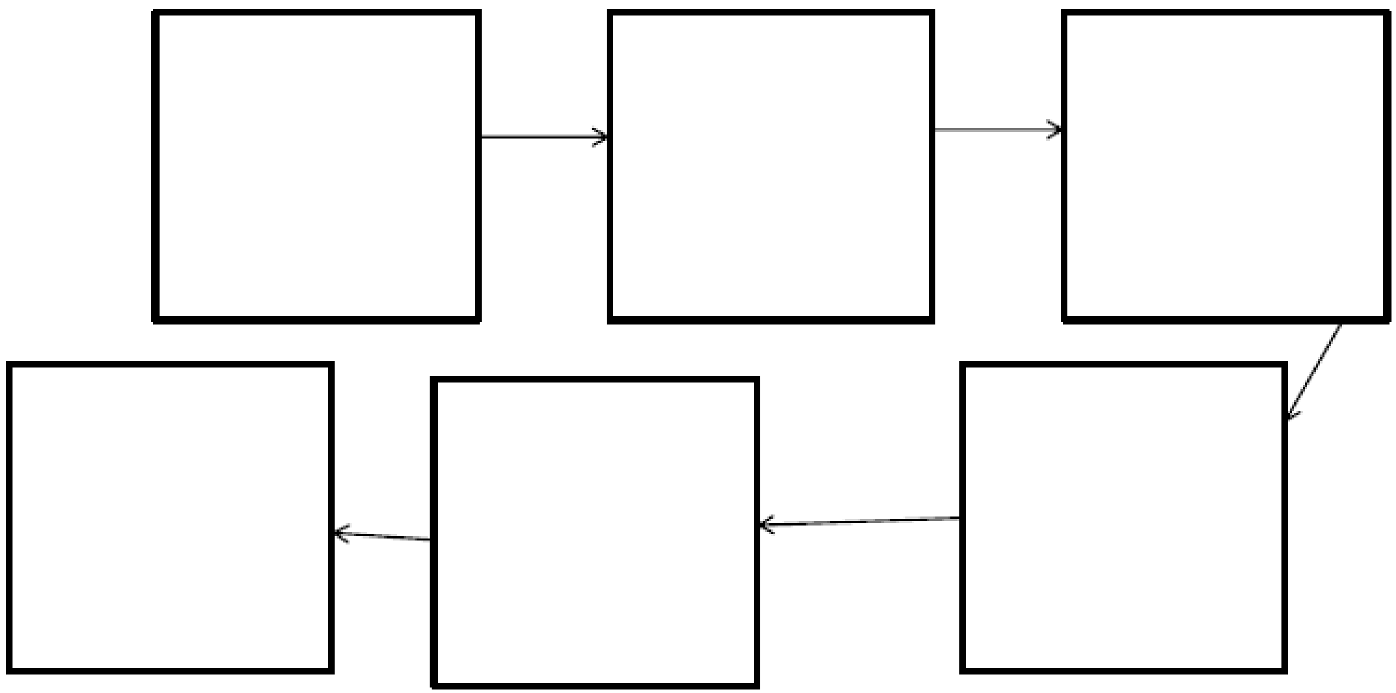


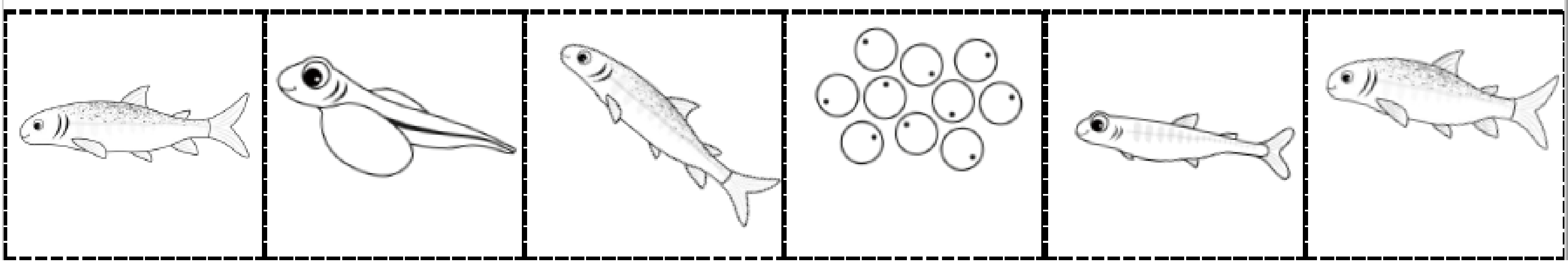


Life Cycle Sequence

Name:

Cut and paste the salmon life cycle in the correct sequence.





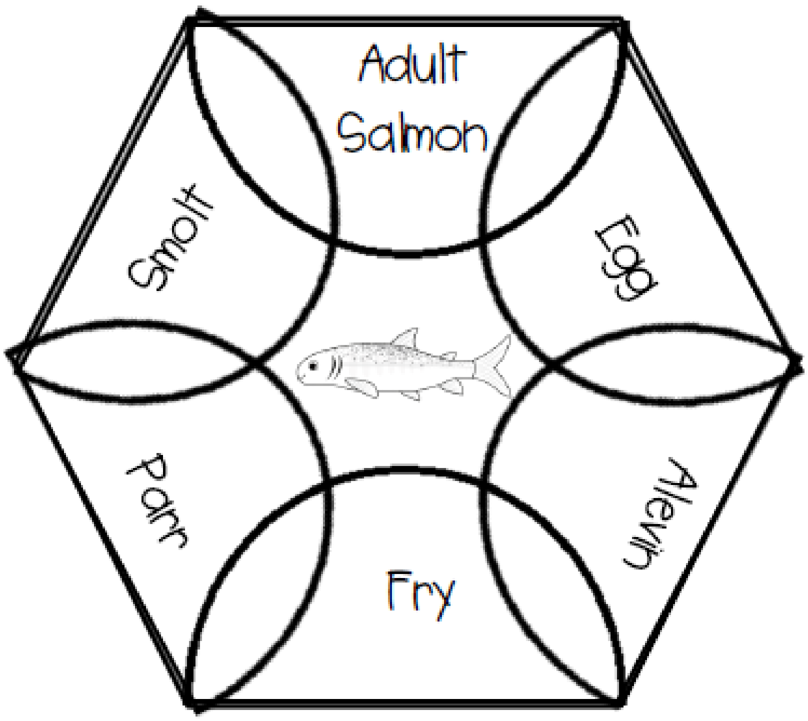
Salmon Tab Book

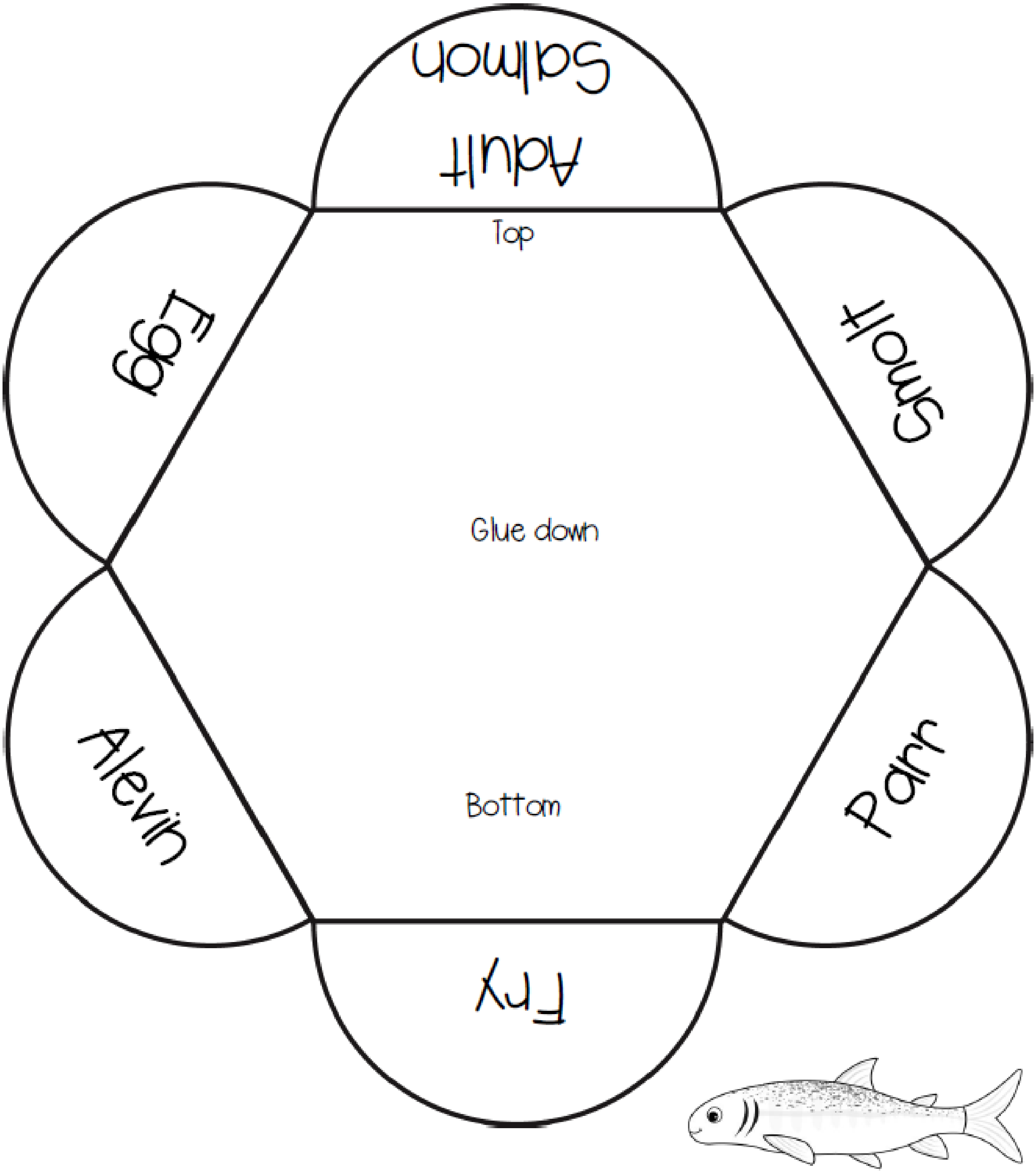
- Students glue the strip where it says salmon facts.
- They cut on the other page to make 4 strips to lift and they write underneath the strips.

Salmon Facts	
	What Salmon Eat
	Where Salmon Live
	What Salmon Look Like
	Interesting Facts

Salmon Life Cycle Shape Book

- Students glue the back of the flower shape into their journal/notebook.
- Under the flap, they write or draw about the salmon life cycle stage.





Salmon for middle

Credits

I've used products by these people/companies in my unit:

Graphics by Kate H.

http://www.teacherspayteachers.com/Store/Zip-a-dee-doo-dah-Designs

thank You!

Thank you for purchasing my product!
Comments, questions, or concerns?
Please e-mail me at
ttlusty07@yahoo.com

Feel free to stop by my blog:
Journey of a Substitute Teacher

Salmon Timeline Shuffle

Grade Levels
3-12

Objectives
Students will 1) work with their classmates to create a visual timeline of the salmon lifecycle; 2) properly label each piece of the timeline; 3) create the appropriate habitat for each section of the timeline

Best Taught
Beginning of the school year, with review at the end of the year.

Materials
- Activity cards
- 4ft piece of large paper
- coloring utensils
- tape/glue
- craft supplies (chenille stems, beads, foam, construction paper, etc)

Background
After the introduction of salmon to Michigan waters, breeding populations began in their natal streams. Following their lifecycle from spawn to adult can help students understand the factors contributing to the salmon population growth or decline. See next page for lifecycle overview.

Vocabulary
- Green egg
- Eyed egg
- Sac Fry
- Swim-up fry
- Parr
- Smolt
- Stream bed
- Spawning
- Open water

Procedure:
Option 1 - Elementary

1. Students cut out activity cards, randomly draw one, and then color their lifestage.
2. On a large labeled timeline, students work together to properly secure their cards in the correct order.
3. As a class, students discuss the factors that could affect the outcome for each stage.

Option 2 - Middle School

1. Students use randomly drawn activity cards as a guide to create 3D models of each salmon lifestage.
2. On a large blank paper,students work together to affix their models to the paper in a timeline.
3. Students then color/create a habitat for each stage.
4. Using the vocabulary activity cards, students work together to label each lifestage and habitat.

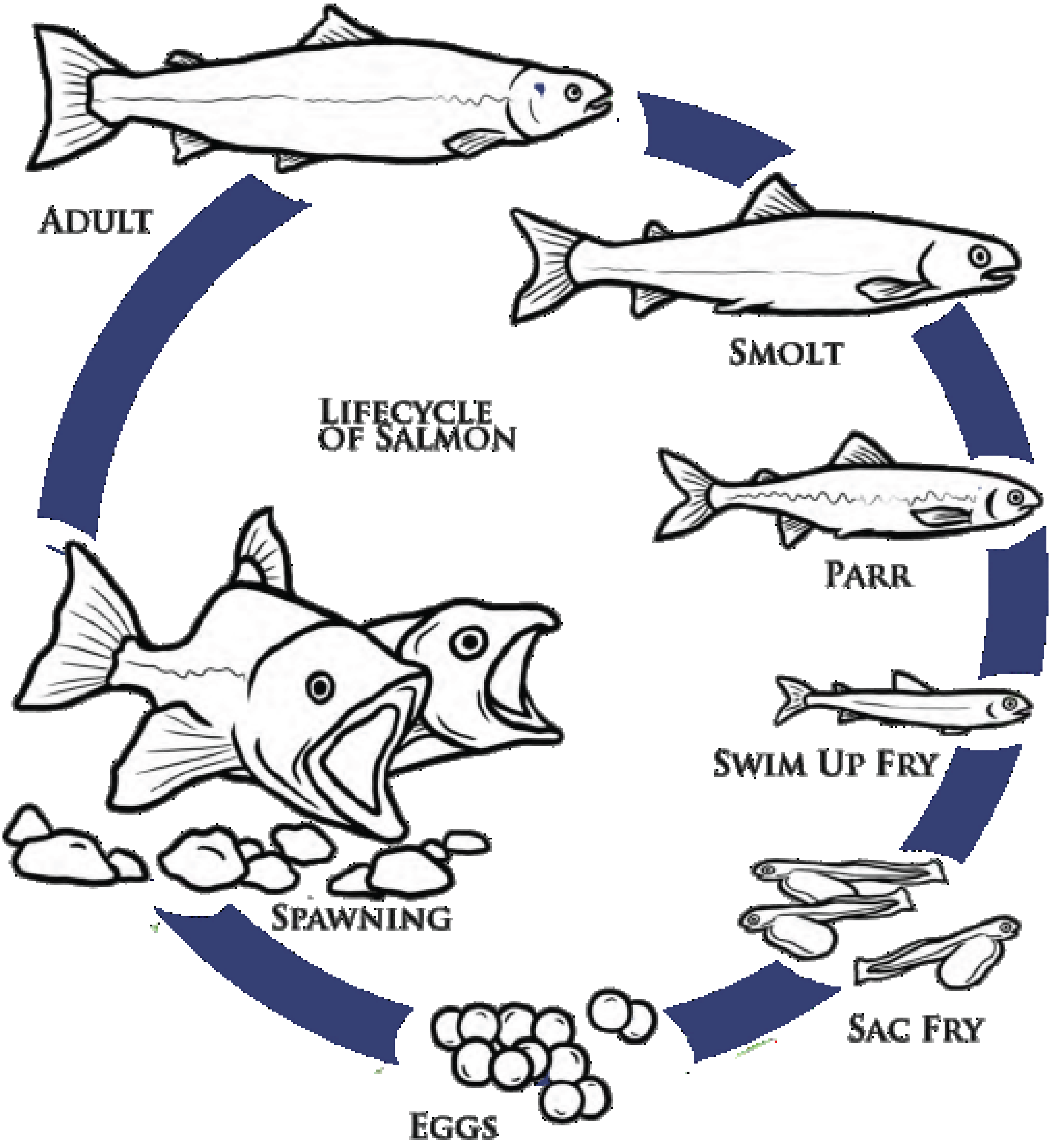
Option 3 - High School

1. Students use their previous knowledge to create 3D models of the Michigan salmon lifecycle.
2. On a large paper,students create habitats for each lifestage and then affix their models in the appropriate spot.
3. Students then label their timeline. *Bonus—add in predators, or abiotic limiting factors.
4. Students then use the internet to research salmon stocking versus wild breeding populations for Michigan and discuss as a class.

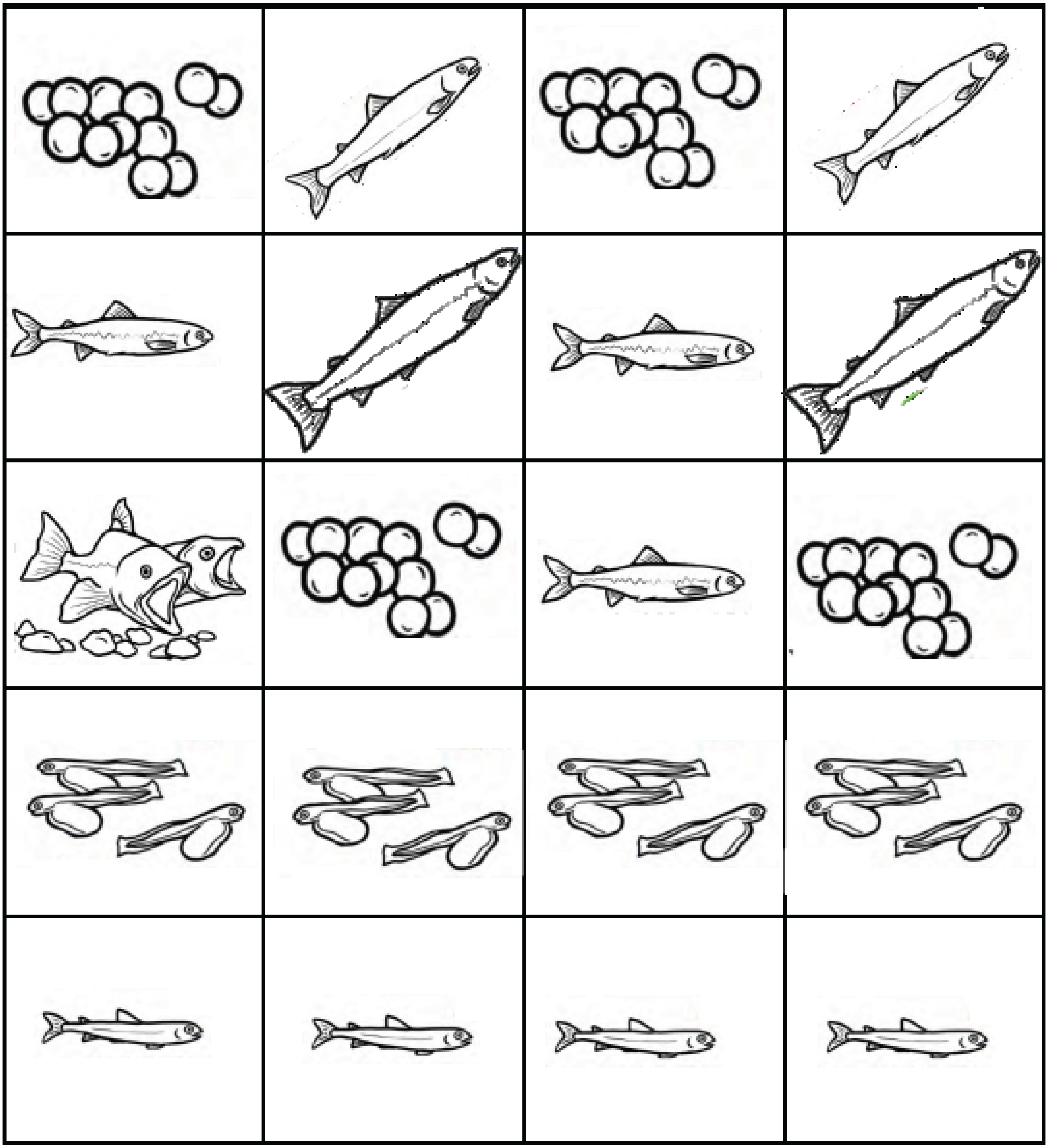
Evaluation

For a measurable assessment tool, utilize the “Salmon Timeline Shuffle” portfolio page activity.

Salmon Timeline Shuffle - Activity Key



Salmon Timeline Shuffle - Activity Cards

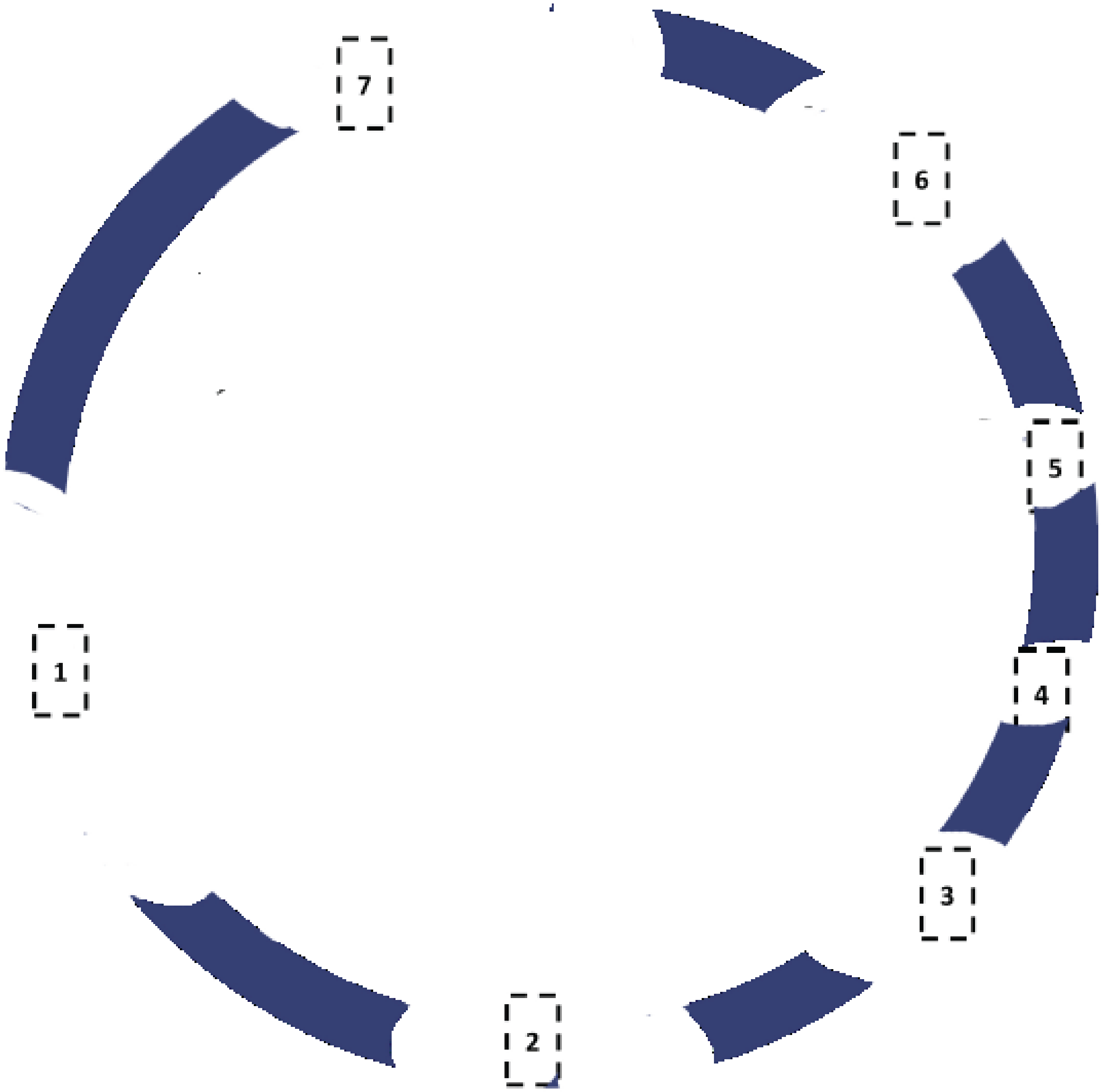


Salmon Timeline Shuffle - Activity Cards

Salmon Life Cycle	Spawning	Eggs	Sac Fry
Swim Up Fry	Parr	Smolt	Adult
River Bottom	Natal Stream	Open Water	Cool, clean, moving water

Salmon Timeline Shuffle - Assessment

Directions: Using the pieces on the next page, create a timeline of the lifestages of salmon

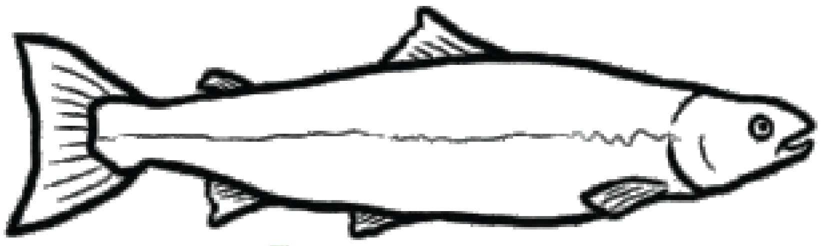


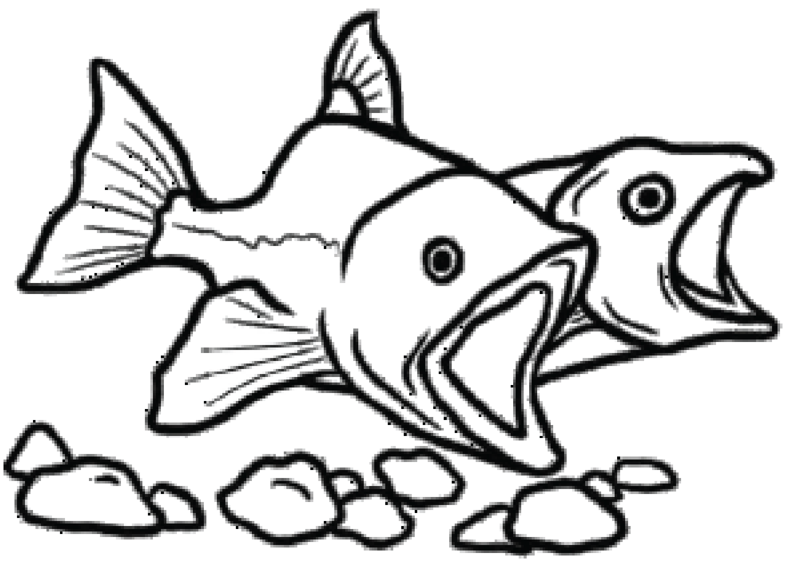
Salmon Timeline Shuffle - Assessment

Directions: Cut out pieces and use on the previous page to create a labeled salmon lifecycle.

Adult **Swim Up Fry** **Parr** **Spawning**

Sac Fry **Smolt** **Eggs**





Fish Finder

Grade Levels
3-12

Objectives
Students will learn how to identify different fish of the Great Lakes and how to use a dichotomous key. Students also will learn about the physical characteristics of fish and how they help fish adapt to their environment. Students will learn about different physical characteristics of the Great Lakes.

Best Taught
September/October; great foundation for other lessons

Materials
- Fish of Michigan Field Guide
- Michigan fish species illustrations
- External anatomy of a fish diagram
- Fish finder data sheet
- Dichotomous Key data sheet
- Dichotomous key
- Clipboards

Background
Approximately 150 species of fish live in the Great Lakes. More than 3,500 species of plants and animals live in the Great Lakes

Activity

1. Prior to program, set up 8 numbered fish identification stations using the color drawings of fish, one per table (laminating suggested).
2. Each station should have a copy of the External Anatomy of a Fish.
3. Break students into groups of 3-4.
4. Each group should receive the following: clipboard, data sheet and dichotomous key
5. Give instructions on how to use a dichotomous key. Explain that each question on the key has only 1 correct answer. Following the directions after each answer will lead down a path to the next question until a fish is identified, much like a "Choose Your Own Adventure Story."
6. Each group will start at a different station.
7. Each station should last approximately five minutes and then students will rotate to another station.
8. After students have gone through all 8 of the stations, tally results on a chalkboard or dry erase board, (i.e., at station number one, group 1 identified the fish as a Chinook salmon), in chart form.
9. Discuss the physical characteristics they used to determine what kind of fish they identified.
10. How could they tell the difference between a northern pike and a muskellunge? Or between a steelhead trout and a Chinook salmon? How can you tell if fish are in the same family?

Sources
www.wiscfish.org/fishID/frames.aspx
www.great-lakes.net

Dichotomous Key to Common Fish of Michigan

1, Does the fish have an adipose fin?

A. Adipose fin present
  - Go to 2

B. Adipose fin not present
  - Got to 3

2. Salmonidae family:

A. Fish has spotted tail and white mouth; commonly has a pinkish colored streak on its sides
  - STEELHEAD TROUT

B. Large black spots over tail and upper portion of its body; black mouth and gums; is commonly silver in color
  - CHINOOK “KING” SALMON

3. What does the dorsal fin look like?

A. Dorsal fin’s spiny and soft-rayed portions are connected as one fin
  - Go to 4

B. Dorsal fin sits far back on the fish’s body (very close to its tail)
  - Go to 5

C. Dorsal fin is divided into separate spiny and soft-rayed portions
  - WALLEYE

4. What body shape does the fish have?

A. Fish’s body is longer than it is deep
  - Go to 6

B. Fish’s body is deeper than it is long
  - BLUEGILL

5. What special features does the fish have?

A. Dark bards or spots on a light background
  - MUSKELLUNGE

B. Bean shaped yellowish spots on green background
  - NORTHERN PIKE

6.How big is the upper jaw?

A. The upper jaw extends past the eye.
  - LARGE MOUTH BASS

B. The upper jaw does not extend past the eye
  - SMALLMOUTH BASS

Dichotomous Key Data Sheet

STEP 1: What kind of fish is it? Using the key provided, determine which fish species each drawing represents. *Example:* Chinook salmon and steelhead trout are both members of the Salmonidae family and look very similar. How can you tell the difference? Chinook salmon have a black mouth and gums; steelhead trout have a white mouth. Record the fish species and family.

STEP 2: List the characteristics that led to your identification of the fish.

Fish Species (Chinook salmon, Largemouth bass, etc.)	**Fish Family** (Salmonidae, Centrachidae, etc.)	**How did you know what kind of fish it was?**

Dichotomous Key Data Sheet

Groups	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

Scales and Tails

Grade Levels
4-12

Objectives
Students will learn to identify key anatomical and physiological elements of salmon, including external features, internal organs and describe how various organs and appendages function.

Best Taught
Anytime during the school year

Materials
- One whole fish per 2 students (available by contacting your nearest bait shop, local supermarket, Asian market, or aquaculture facility.
- Several fish scales (also available buy purchasing a fish at a local fish market.)
- Images of 3 fish mouth shapes, images of 2 scale types, parts of a fish head, parts of a fish external, parts of a fish internal (templates provided in curriculum) images of various fish body shape to use for comparisons.
- Microscope
- 1 pair of sharp scissors per 2 students
- Newspaper to cover tables
- Sink for washing hands and tools
- Internal Fish Parts copy me page
- External Fish Parts copy me page
- A tree cookie
- Fish Scales and Tails Poster

Activity 1: Anatomical Identification
Discuss each of the following anatomical features of the fish and have students decide which feature applies to the fish in front of them:
- Body shape: Disc shaped, tapering,fusiform, rectangular, oval, eel-like.
- Do shapes of fish have impact on various behaviors, speed of travel,habitat, feeding, predation, etc.?
- Color and patterns on fish: Ocelli, saddle, stripes, bands, lines.
- Discuss fins - adipose fin-evolution?
- Shapes of tail: rounded, pointed, lunate, forked, truncated, emarginate,heterocercal.
- Mouth shapes: terminal, superior, inferior
- What is the mucus layer for?

Activity 2: Dissection
1. Dissection: cut from vent to isthmus (anus to under bottom lip). The instructor may have to assist with first cut
2. Cut a ‘window’ to see into fish. Make an incision (a half-moon shape) from the vent up the side of the fish, to the pectoral fin.
3. ID each organ, check for color, texture, one by one, discussing the function of each organ.
4. Cut open stomach see what the fish had been eating.

Conclusion
Ask students for questions! Discuss the function of internal organs and external features:

Eyes - As in humans, fish eyes serve a variety of purposes - to seek out food, to avoid predators and other dangers, and, perhaps even to navigate in the ocean. Fish do not have eyelids. They are constantly bathed in water and do not need tears.

Nostrils - Salmonids have a well developed sense of smell and use this ability to seek out their natal streams for spawning. In some cases this sense is also helpful in avoiding predators. Fish breathe through their gills, not their nostrils.

Gills - Fish gills are composed of two basic parts, the gill covers and the gill filaments. The gill covers protect delicate filaments and together with the mouth force water containing oxygen over the gills. The gills are probably one of the most important organs of the body of the fish. They are delicate but very effective breathing mechanisms. Gills are far more efficient than human lungs, because they extract 80% of the oxygen dissolved in water, while human lungs only extract 25% of the oxygen in the air. Gills are thin walled structures, filled with blood vessels. Their structure is arranged so that they are constantly bathed in water. The fish takes in the water through its mouth. The oxygen dissolved in the water is absorbed through the thin gill membranes into the fish's blood. Carbon dioxide is simultaneously released from the blood into the water across the same membranes.

Mouth - Fish use their mouth to catch and hold food of various types, but their food is not chewed before swallowing. In addition, the mouth is a very important part of the breathing process. Water is constantly taken in through the mouth and forced out over the gills.

Lateral Line - Fish do not have ears, as such. In part, low frequency sounds are detected in the water through a system of small holes along each side of a fish called the lateral line, which is connected to a delicate system of nerves. They also react to medium frequencies suggesting they detect these as well (this is not well understood at this time).

Fins - Salmonids have two sets of paired fins (pelvic and pectoral) and four single fins (dorsal, caudal, anal, and adipose). Except for the adipose and caudal fin, all the others are basically used to balance the fish in the water. The adipose is a small, fleshy fin which serves no known purpose and is clipped in some hatchery fish. The most important fin is the caudal. It acts like a rudder, and combined with the very strong body muscles the fish, is their only means of propulsion. The caudal fin is also used by female salmonids to dig the redds in which they deposit their eggs

Scales - The bodies of salmonids are protected by scales which grow in regular concentric patterns and can be used to determine the age and life history of the fish. Over the scales is a layer of mucus (slime) which further protects the fish from disease organisms and helps it slide through the water more easily.

Swim Bladder - A membranous sac filled with gas, situated in the body cavity of fish, ventral to the vertebral column, used to control buoyancy.

Esophagus - The gullet, or esophagus, carries food from the mouth to the stomach.

Gall Bladder - The gall bladder is a sac in which bile is stored.

Heart - A hollow, muscular organ, the heart circulates blood through the body.

Intestine - The intestine is found in the lower part of the alimentary canal extending from the pyloric end of the stomach to the anus.

Kidney - Pair of organs, remove waste from the blood and produce urine.

Liver - A digestive, storage and excretory organ.

Opercule –fish gill plate. (Available from many online science learning stores.)

Otoliths – fish inner ear bones which rest on a bed of sensory hairs, that send messages to the brain about the orientation of the fish. (Available from many online science learning stores.)

Ovaries - The female reproductive organs which produce eggs.

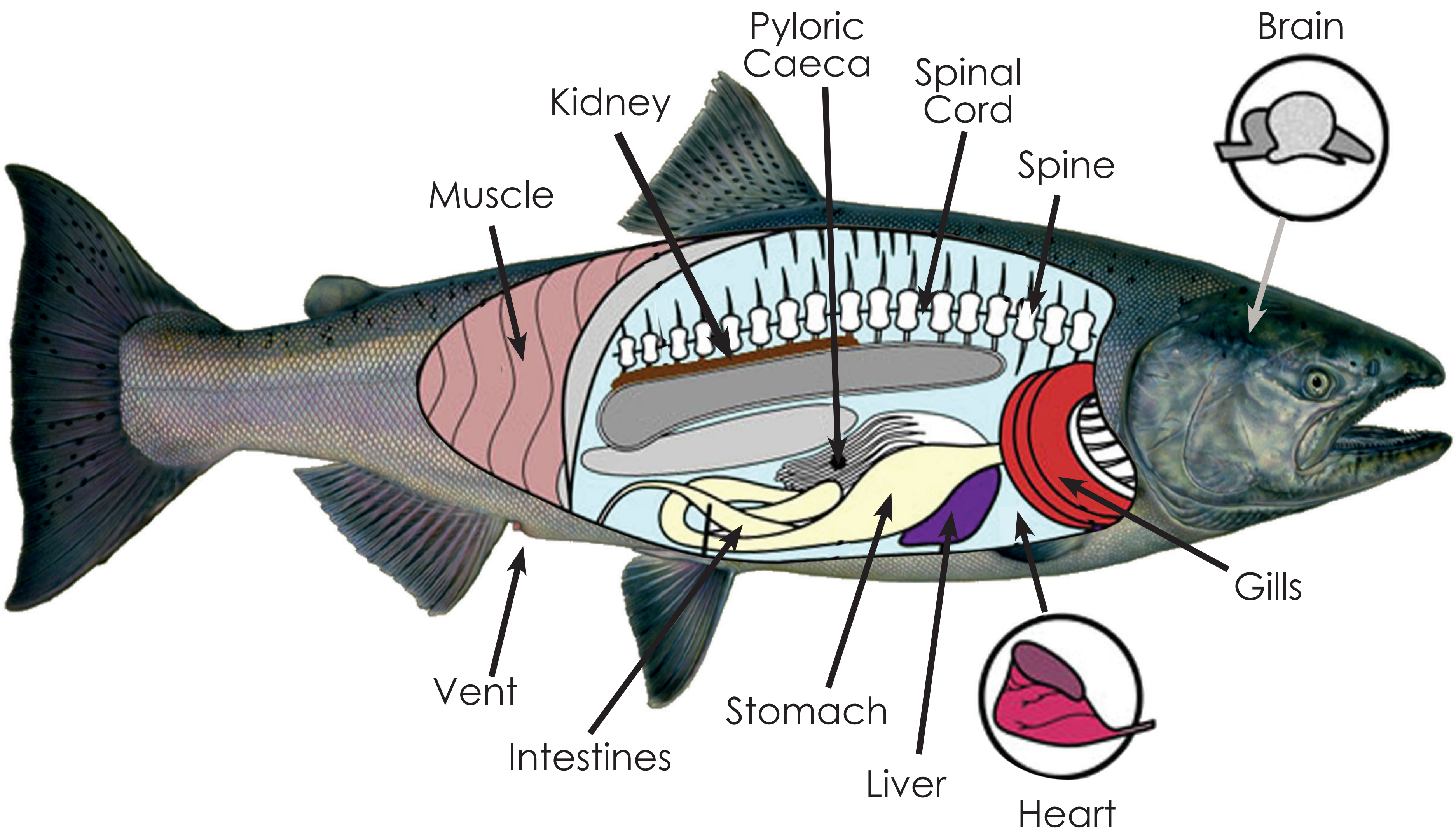
Pyloric Caeca - An appendage in the form of a blind sac, connected with the alimentary canal, in which digestion takes place.

Spleen - The organ in which white blood cells are produced and red blood cells are destroyed, in vertebrates.

Stomach - A sac-like digestive organ receiving food from the esophagus and opening into the intestine. Testis - The male reproductive organ in which milt is produced.

Vent - The external opening of the alimentary canal. Urine, feces, eggs and milt exit here.

Internal Anatomy - Chinook



External Anatomy - Chinook

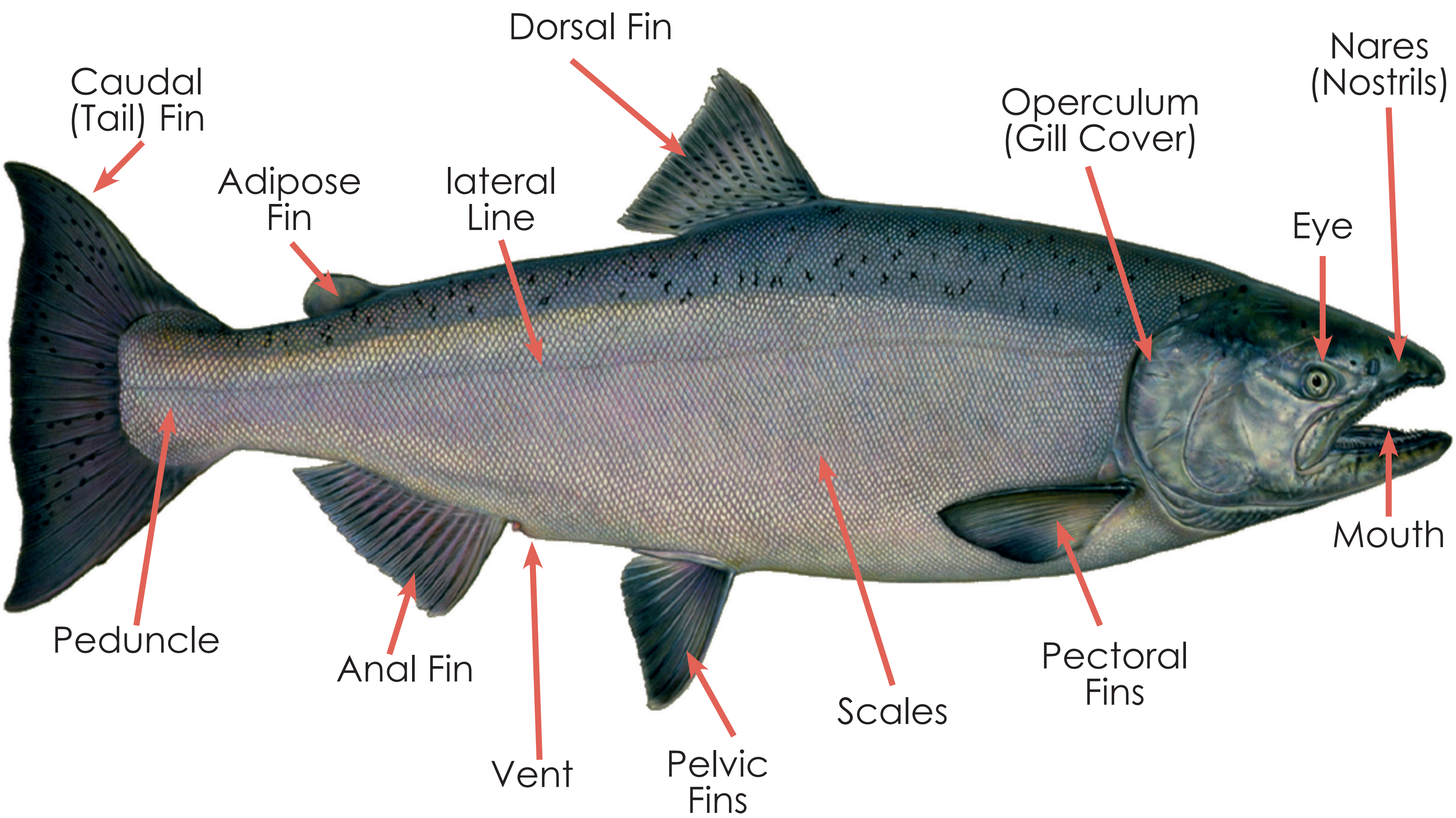


Illustration by
Joseph R. Tomelleri ©

Pin the Parts on the Salmon

Grade Levels
3-7

Objectives
Students will be able to identify the different parts of a fish and their function.

Best Taught
September/October; good background information.

Materials
- Pin the Parts on the Salmon Handout
- Silhouette and pieces for each student
- Scissors
- Glue or tape

Background

Dorsal fin:
The dorsal fin is located on the back or upper portion of a fish and can be spiny, soft or both. Salmon have a soft dorsal fin. The dorsal fin is used as a stabilizer while fish are swimming. The dorsal fin also is used for precise movement and provides the fish with the ability to make minor adjustmentswith ease. If a fish has a spiny dorsal fin, it is used for protection from predators.

Adipose and Anal fins:
These fins provide stability to fish while swimming. The adipose fin is present in only a few families of fish; one is the salmonid family. Although no conclusive evidence is available on the true purpose of the adipose fin, it is used much like other fins. These fins are just in front of the tail fin on the top (dorsal) and bottom (ventral) surface of the fish.

Background Continued:

Pectoral and Pelvic fins:
Pectoral fins typically are larger than pelvic fins and usually are located behind the gills on either side of the fish. These fins help fish to stabilize and prevent the fish from rolling as it moves through the water. They also assist fish in steering, and up and down motion. The paired pelvic fins are located ventrally below the pelvic fins toward the tail. An easy way to remember where each of these fins is located on the fish is to think of where our pectoral muscles and pelvic bone are located. Pectoral muscles are located in our upper chest area and are closest to our heads. Pectoral fins are located just behind the gills and also are close to the head of a fish. Our pelvis is located at the top of our legs. Do fish have legs? Fish have a caudal fin or tail. The pelvic fins are located closest to the tail of a fish.

Caudal fin/tail:
How do we get from one place to another? We have legs and feet. Fish have a caudal fin that acts as their major source of propulsion to move around. The caudal fin, or tail, is like the motor or propeller on a boat. It provides their main power for movement. Most fish can not swim backwards.

Gills:
How do humans breathe? We use our nose or mouth to breath in oxygen. Do fish breathe the same way? How do they get oxygen? Respiration occurs in a fish's gills. Blood flows through the gills and takes the oxygen from the water for the fish to breathe. Fish gills are covered by the operculum.

Lateral line:
How do humans hear? Do fish have ears? How do fish hear? On fish the lateral line acts like a sensory organ. Water moving against the fish causes vibrations which funnel information to the fish's brain. This process is very similar to how the inner ear collects and interprets sound waves. The lateral line is like a sonar system. It helps fish detect prey and helps them to determine where objects are so they can swim in total darkness.

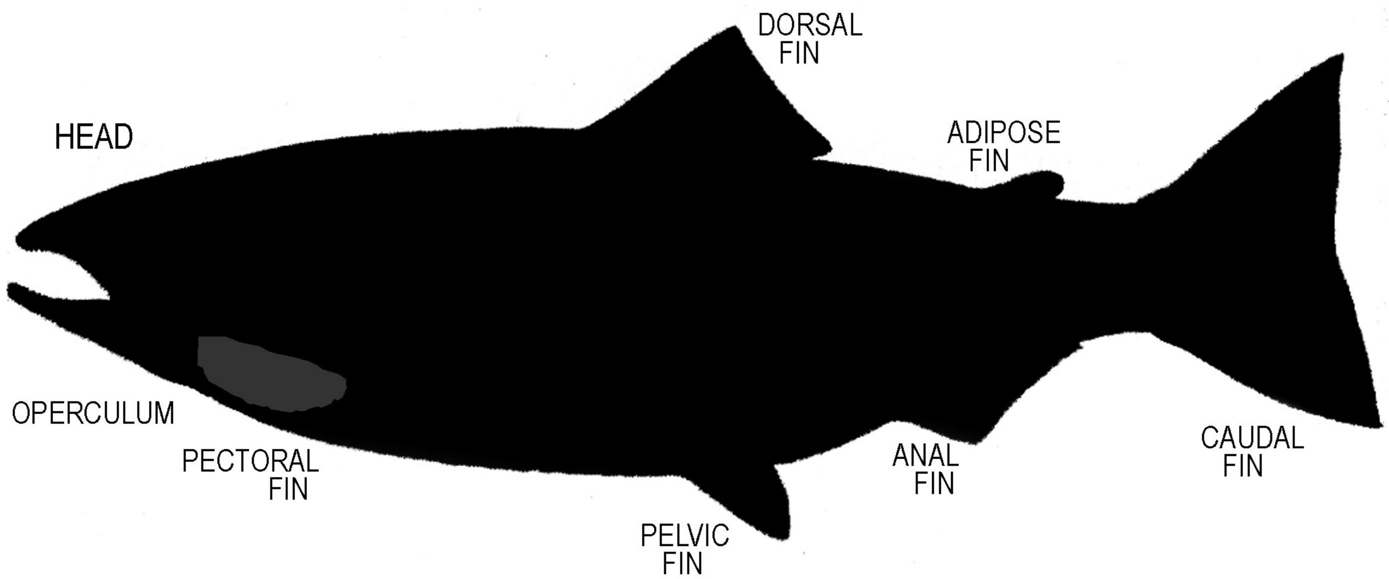
Scales:
What purpose does skin serve for humans? What would happen to your skin if you went swimming for a long period of time? Would it start to wrinkle or "prune?" Where do fish live? Do fish have skin? What protects their skin? Fish have scales to support their body and protect their skin. Scales also protect them from predators.

Example:
Largemouth bass have lightly colored scales on their underside and darker colored scales on their upper portion. The lighter scales help to camouflage the fish from predators swimming below them because when a predator is looking up at a largemouth bass, the lighter colored scales blend with the light coming into the water. The darker scales help to camouflage fish from predators swimming above them because when the predator looks down, the scales blend with the darker and deeper depths of the water.

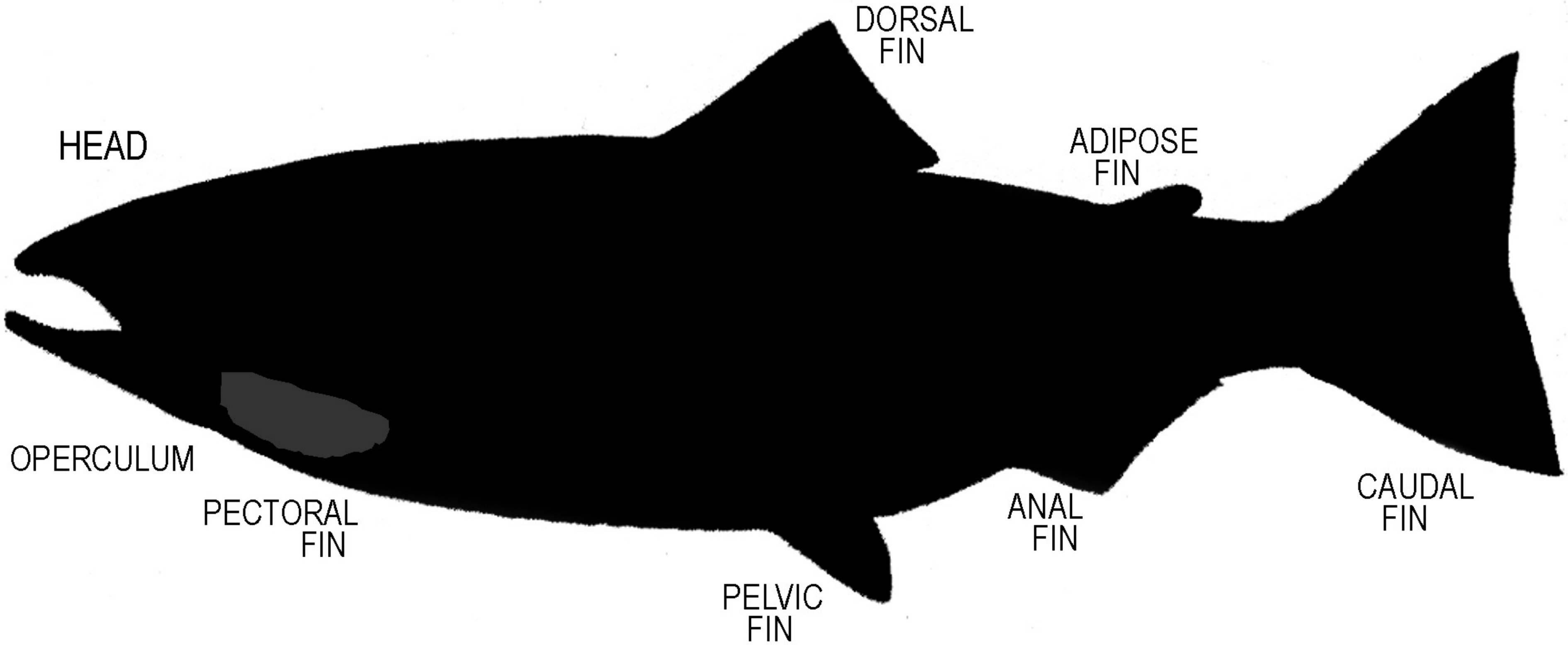
Eyes:
If we want to see under water, what can we put over our eyes to help us? Goggles. Fish have a thick lens or thick layer that covers their eyes, which allows them to see very clearly in the water. Fish do not have eyelids and can not blink.

Activity

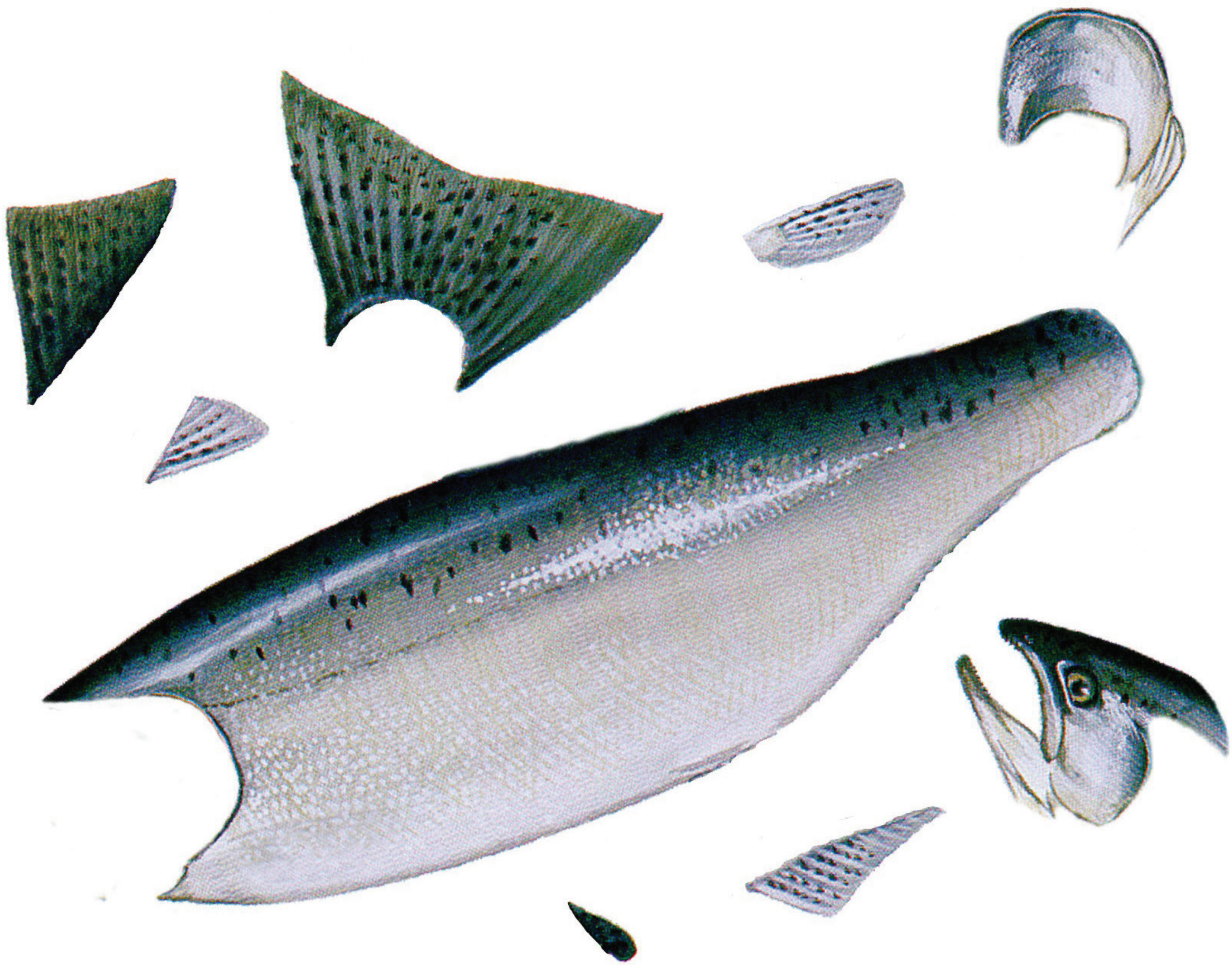
1. Using the background information, discuss each part and its function.
2. Hand out 1 copy of both Pin the Parts on the Salmon handouts.
3. Ask each student to cut out the pieces from the handout and place them in the correct place on the silhouette.
4. After each student has had a chance to assemble their salmon call on one to show the class the final salmon put together correctly.
5. Leave a few minutes for discussion.



Pin the Parts on the Salmon



Pin the Parts on the Salmon



Fashion a Michigan Fish

Grade Levels
3-6

Objectives
Students will classify fish according to body shape and coloration. Students will describe adaptations of fish to their environments, describe how adaptations can help fish survive in their habitats, and interpret the importance of adaptation in animals by designing a fish adapted for various aquatic habitats.

Best Taught
Any time during the school year.

Materials
- Fashion a Fish Adaptation Cards - teacher can prepare in advance or students can design and cut out
- Crayons and/or markers
- Clay
- Chenille stems
- Construction or plain paper
- Glue
- Glitter
- Various decorative art supplies

Background
Aquatic animals are the products of countless adaptations over long periods of time. Those adaptations, for the most part, are features that increase the animal's likelihood of surviving in their habitat. Some animals have adapted to such a narrow range of habitat conditions that they are extremely vulnerable to change (e.g. giant pandas only eat bamboo). These species are usually more susceptible to extinction than other animals (e.g. racoons eat anything). Some adaptations help animals attract mates, hide from predators, protect their young and more. Those best adapted will survive.

In this activity, the students design a fish. Because of the variety of conditions within each habitat, many different fish can live together and flourish. Some common adaptations of fish are listed in the following chart.

Activity 1: Find a Fish
1. Assign students to find a picture or make a drawing of a species of animal that has a special adaptation. (For example, owls have large eyes to let in light at night and to see very far. Snowshoe hares turn white in winter to blend with snow.)
2. Conduct a class discussion on the value of different kinds of adaptations to animals. Ask about human adaptations.
3. Collect the students' pictures or drawings and categorize them into the adaptation groups listed in the chart: Body shape, coloration/camouflage, fin type, mouth/feeding and reproduction type.

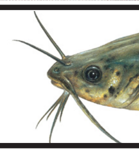
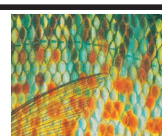
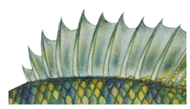
Activity 2: Build a Fish
1. Divide the Fashion a Fish Adaptation Cards into 6 groups of five cards each. Each group of cards should have one card for: mouth, body shape, coloration, fin type and reproduction type.
2. Split class into 6 groups, and hand one set of Adaptation cards to each group.
3. Ask the students in each group to Fashion a Fish using all five adaptations listed on the cards their group received. They should individually create a fish, name the fish, and draw the habitat for that fish with the art supplies available. Give different supplies to each table to stress differences.
4. Each group should present their fish, one at a time to the rest of the class. After the last person in each group is done presenting their fish, the whole group should hold up their fish/habitat at once. Ask the class to look for the similarities and differences that appear even within the same adaptation type. Repeat until all groups have presented.

Extension:
Students can research to find an actual fish with one or more of the adaptations their personally designed fish had.

This activity was adapted to Michigan species from the Aquatic WILD curriculum guide.

Adaptation	Advantage	Examples
Body Shape		
Torpedo shaped	Fast moving	Pike, salmon
Flat-bellied	Bottom feeder	Bullhead, sucker
Vertically compressed	Feeds above or below	Bluegill, sunfish
Horizontally compressed	Bottom dweller	Sculpin
Tubular	Streamlined for movement	Sea lamprey
Hump backed	Stable in fast-moving water	Drum
Fin Type		
Adipose fin and truncate caudal fin	Caudal (tail) fin for movement in currents	Salmon, trout
Heterocercal tail	Horizontal stability, and good speed	Sturgeon
Forked caudal fin	Lunate (forked) fins are for swift swimming	Alewife
Long dorsal fin, rounded caudal	Slower swimming with good stability	Bowfin
Fins shifted posterior	Gliding through the water and agility	Muskie, pike
Combination spiny and soft rays	Protection from predators, stability	Sunfish, bluegill
Coloration		
Mottled/spotted	Can hide in rocks/bottom	Trout, crappie
Iridescence	Reflects light, disruptive	Pupkinseed
Horizontal stripes	Can hide in vegetation	White bass
Vertical stripes	Can hide in vegetation	Perch
Dark upperside/light belly	Difficult to see from above and below	Bullhead, catfish
Muted solid color	Blend in with bottom	Lake sturgeon
Mouth/Feeding		
Toothed mouth	Punctures and holds prey	Muskie, salmon
Large flexible jaw	Surrounds entire prey	Bass
Sucking disc	Attaches to prey's body	Sea lamprey
Duckbill jaw	Grasps prey	Pike, muskie
Elongated upper jaw	Feeds on prey below	Sturgeon
Barbels and wide mouth	Senses food on bottom	Catfish
Reproduction		
Eggs on bottom	Hidden from predators	Salmon, trout
Eggs in nest	Protected by parents	Bluegill
Eggs on deep reefs	Hidden from predators	Lake Trout
Eggs in vegetation	Restricts movement and predators	Perch, pike
Free-floating eggs	Dispersed in high numbers	Drum
Live birth	Skips vulnerable egg stage	Mosquito fish

Vocabulary Review

Adipose fin	Small rayless fin with no known purpose	
Barbels	Whisker-like sensory organ near mouth	
Caudal	Tail fin	
Dorsal	Back side, or fin on back	
Heterocercal	Upper lobe of tail larger than lower lobe	
Iridescence	Rainbow like color that refracts light	
Mottled	Marked with spots or smears of color	
Posterior	Near the end	
Reefs	A bar of rock/sand on the lake bottom	
Soft ray	Softer flexible band in a fin	
Spiny ray	Stiff, pointed band in a fin	
Truncate	Straight edged	

Fish illustrations provided by Joseph R. Tomelleri

Fish Adaptation Cards

BODY SHAPE

Torpedo Shaped
(Pike, salmon)

Fish illustrations provided by Joseph R. Tomelleri ©

BODY SHAPE

Flat-Bellied
(Bullhead)

Fish illustrations provided by Joseph R. Tomelleri ©

BODY SHAPE

Tall Bodied
(Bluegill)

Fish illustrations provided by Joseph R. Tomelleri ©

BODY SHAPE

Wide Bodied
(Sculpin)

BODY SHAPE

Tubular
(Invasive Sea Lamprey)

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BODY SHAPE

Hump Backed
(Freshwater Drum)

Fish Adaptation Cards

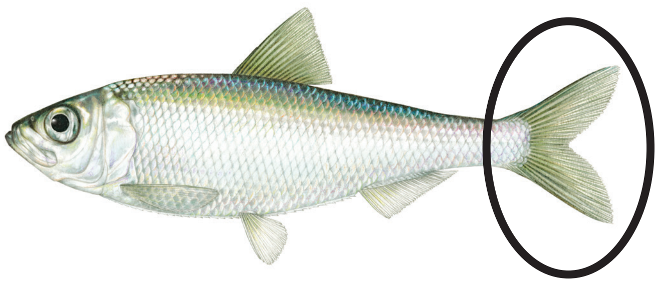
FIN TYPES

Adipose Fin and Truncate Tail
(Salmon)

FIN TYPES

Heterocercal Tail
(Lake Sturgeon)

FIN TYPES



Forked Tail
(*Invasive* Alewife)

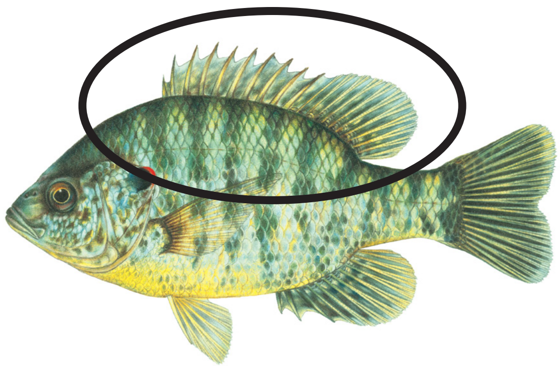
FIN TYPES

Long Dorsal Fin, Rounded Tail
(Bowfin)

FIN TYPES

Dorsal Fin Shifted Posterior
(Muskellunge)

FIN TYPES



Combination Spiny and Soft Rays
(Sunfish)

Fish Adaptation Cards

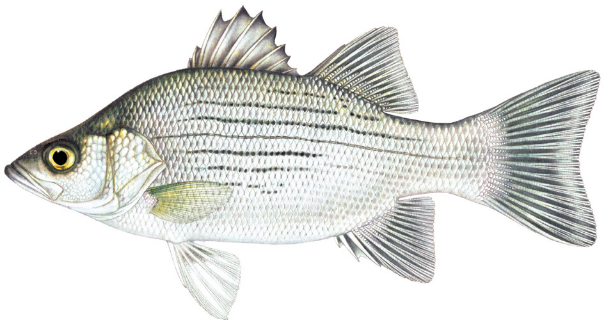
COLORATION

Mottled/Spotted
(Crappie/Trout)
Fish illustrations provided by Joseph R. Tomelleri ©

COLORATION

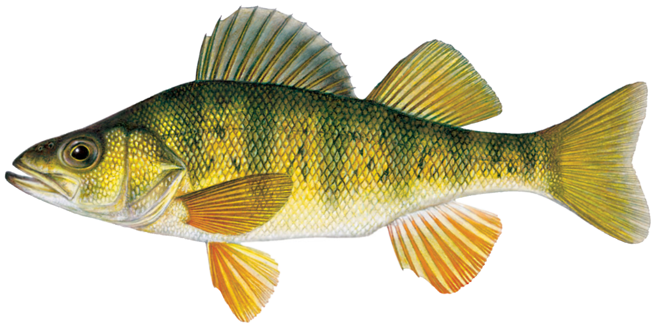
Iridescence
(Pumpkinseed)
Fish illustrations provided by Joseph R. Tomelleri ©

COLORATION



Horizontal Stripes
(White Bass)
Fish illustrations provided by Joseph R. Tomelleri ©

COLORATION



Vertical Stripes
(Yellow Perch/Muskellunge)
Fish illustrations provided by Joseph R. Tomelleri ©

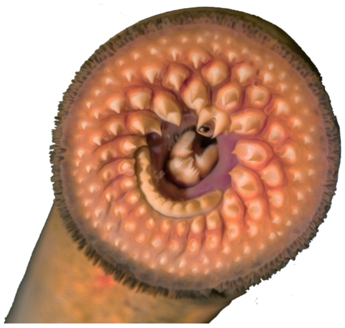
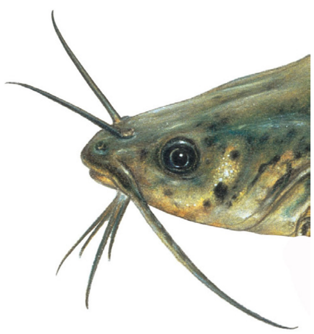
COLORATION

Dark Upperside/Light Belly
(Catfish)
Fish illustrations provided by Joseph R. Tomelleri ©

COLORATION

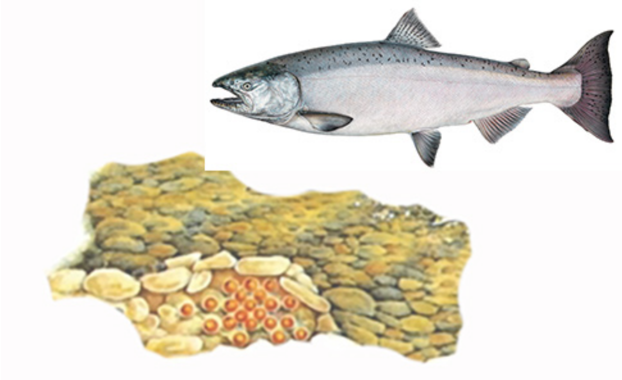
Muted Solid Color
(Lake Sturgeon)
Fish illustrations provided by Joseph R. Tomelleri ©

Fish Adaptation Cards

MOUTH / FEEDING	MOUTH / FEEDING
 **Toothed Mouth** (Salmon/muskie/pike) Fish illustrations provided by Joseph R. Tomelleri ©	 **Large Flexible Jaw** (Bass)
MOUTH / FEEDING	**MOUTH / FEEDING**
 **Sucking Disc** (*Invasive* Sea Lamprey)	 **Duckbill Jaw** (Muskie/pike) Fish illustrations provided by Joseph R. Tomelleri ©
MOUTH / FEEDING	**MOUTH / FEEDING**
 **Elongated Upper Jaw** (Lake Sturgeon) Fish illustrations provided by Joseph R. Tomelleri ©	 **Barbels and Wide Mouth** (Catfish) Fish illustrations provided by Joseph R. Tomelleri ©

Fish Adaptation Cards

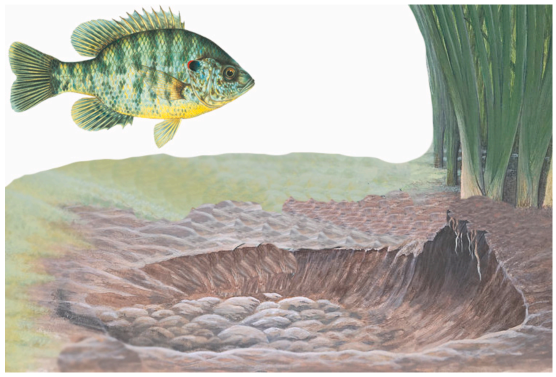
REPRODUCTION



Eggs on Bottom
(Salmon)

Fish illustrations provided by Joseph R. Tomelleri ©

REPRODUCTION



Eggs in Nest
(Bluegill)

Fish illustrations provided by Joseph R. Tomelleri ©

REPRODUCTION

Eggs on Deep Reefs
(Lake Trout)

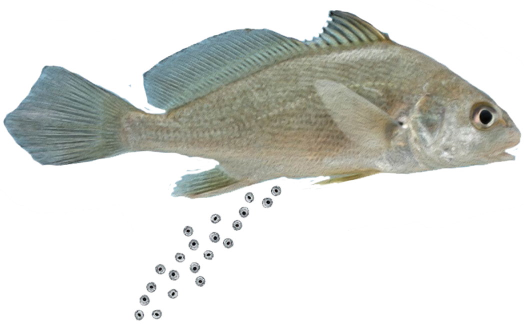
Fish illustrations provided by Joseph R. Tomelleri ©

REPRODUCTION

Eggs in Vegetation
(Perch, Pike)

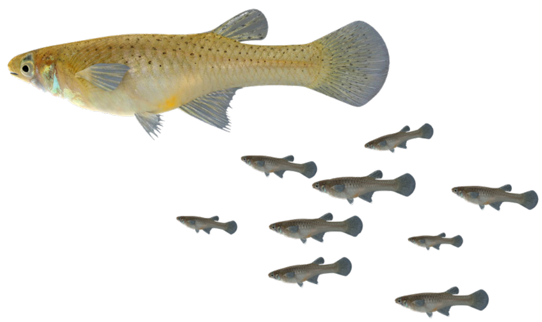
Fish illustrations provided by Joseph R. Tomelleri ©

REPRODUCTION



Free-floating Eggs
(Freshwater Drum)

REPRODUCTION



Live Birth
(*Introduced* Mosquito Fish)

Squid Dissection Lab

Grade Levels
4-12

Objectives
Students will learn basic dissection skills on squid. Squid are a food source for Chinook salmon in their native Pacific Ocean.

Best Taught
Anytime during the school year.

Materials
- Frozen whole squid (not cleaned) found at Asian food markets
- Newspapers
- Scissors
- Magnifying lens
- Forceps
- Bamboo skewers (halved)
- Dissection diagrams
- Vinyl gloves
- Wet wipes (optional)

Calamari Addition
- Buttermilk
- Fish breading mix
- Frying oil
- Electric fry pan
- Tongs
- Marinara

Background
Dissection skills are easier to teach on large animals, with minimal blood. Fresh specimens are also preferable over preserved.

Squid make excellent dissection specimens due to their large invertebrate anatomy, as well as their lack of “blood and guts”. Squid also work well with SIC due to the fact that in the Chinook salmon’s native habitat of the Pacific Ocean, squid would be a food source for the adults.

External Anatomy Observations

1. Have students examine the external anatomy and hypothesize why this mollusk is in the cephalopod (head foots) family.
2. Have students use their bamboo skewer as a probe to separate the arms and count. They will find 8 shorter 8 lined withe suckers.
3. Students will also find 2 long tentacles with suckers just at the end. The sucker ends are called clubs. Tentacles are used to capture prey, while the eight arms old the prey and bring it to their mouth.
4. Use the magnifying lens to observe the suction cups. Each cup is on a short stalk, and has a toothed ring around their edge. The suction cups help the squid hold on to prey.
5. Have students move the arms out of the way to see the mouth at the base of the body. By squeezing the small circle they can see the beak emerge. Once they see the black speck they can carefully squeeze and use their forceps to gently remove the beak. The squid’s beak is in two halves like a parrot’s, and it tears its food into small pieces before it is swallowed.
6. Students will remove the muscular encasing around the beak, called the buccal mass. The buccal mass may have the esophagus still attached which looks like a long tube.
7. Inside the beak, students will see a toothed ribbon like structure called the radula. The radula shreds food into smaller pieces.
8. Have students move their observations to the squid eyes. Students may snip open the cornea (outer layer) and search for the hard part of the eye, the lens.
9. The main “skin” of the body is called a mantle. Unlike other mollusks, squid and octopus do not have an external shell. The surface is covered in chromatophores, small pigment cells, each surrounded by a muscle. When the muscles relax the squid becomes lighter in color. When they contract, they get darker in color.
10. At the posterior end (opposite the arms), you can see two fins attached to the mantle. The fins help the squid to steer, stabilize and propel at low speeds.

11. Students can now flip their squid and look for the funnel. This is a short tube located under the eyes. They can use their probe to show that the funnel exits on the opposite side. The funnel lets the squid use jet propulsion to move. They take water into their mantle and expel it out the funnel with high force. This propels the squid “backwards” using their pointy end and fins to steer.

Dissection of Internal Anatomy

1. Students should place their squid ventral side (funnel side) up. Use the scissors to cut the mantle from funnel to tip. Be careful to lift the mantle up as you cut so that you do not cut the underlying organs. The mantle can now be spread open to reveal the organs.

REPRODUCTIVE ORGANS

2. The most prominent structure visible is the reproductive system. The large gonads can be seen near the fins. Female gonads will have eggs inside the ovaries, with a slightly yellowish color and jelly like structure. Male gonads have sperm which is white in color and has the consistency of milk. Be sure to have students observe both male and female specimens.

DIGESTIVE SYSTEM

3. The esophagus is the small tube attached to the buccal mass that runs through the center of the buccal mass that runs through the center of the squid’s brain and midway down the mantle cavity. Squid must tear their food into small pieces so that is does not get caught on the brain as it passes.
4. Next, look for an attached oval structure, this is the stomach. It is connected to the caecum which increases the surface area for digestion.
5. Waste leaves the caecum through the long tube called the intestine. The intestine ends in the anus which runs along the funnel to release waste.
6. Two strong tendon like muscles are attached to the mantle. These are the funnel retractor muscles, they help create and direct the jet streams through the funnel that the squid uses to move.
7. Now, locate the small olive organ. This is the ink sac. Have students carefully remove the ink sac and set it aside. The ink inside the sac is expelled as a defense mechanism, obscuring the view of the squid from predators. It can also numb the predator’s sense of smell.

RESPIRATORY AND CIRCULATORY SYSTEM

8. The two white feathery structures on either side of the mantle cavity are the gills. Gills extract oxygen from the water that enters the mantle cavity. Then the water is expelled out the funnel for propulsion.
9. Squid have 3 hearts! At the base of each gill you will find a branchial heart. They pump blood from the body to the gills to be oxygenated. They also have a systemic heart that is larger and located between the branchial hearts, and moves blood around the body. The systemic heart is found underneath the kidney, which removes waste from the blood.

NERVOUS SYSTEM

10. Like octopus, squids have highly developed brains, and are considered the most intelligent invertebrates. You can find the brain between the eyes. Students should carefully cut the protective cartilage between the eyes to find the brain.

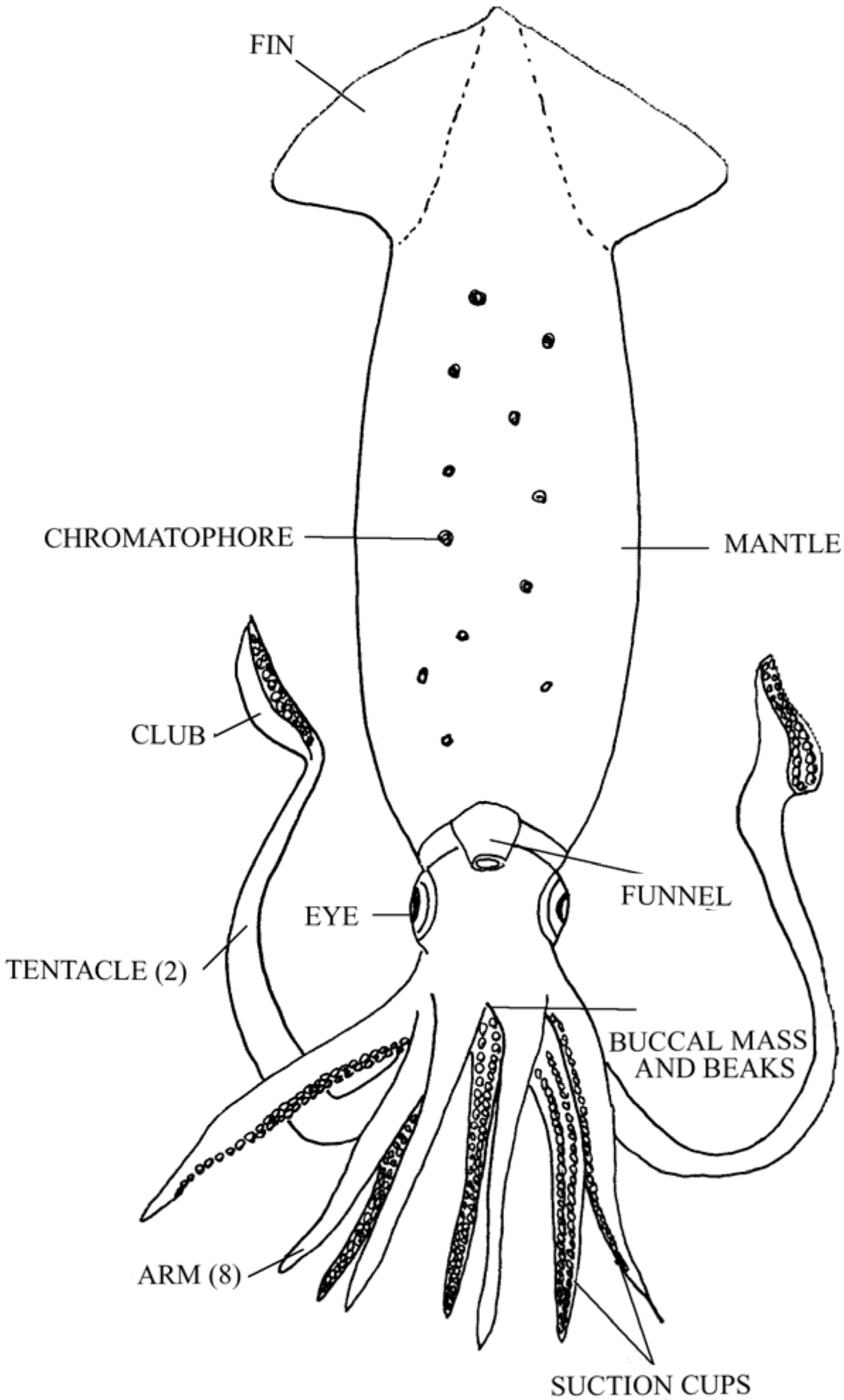
SUPPORT SYSTEM

11. As an invertebrate, squid do not have a skeleton, and, for a mollusk, it is odd they do not have a shell. The squids body is supported by a “shell remnant” called a pen. The pen is embedded in the mantle from the tip along the midline. It can be removed by carefully cutting the membrane alongside it. It looks like a thin piece of plastic, and is made of chitin.
12. Have students pierce their ink sac and use the pen to write their names on a paper.

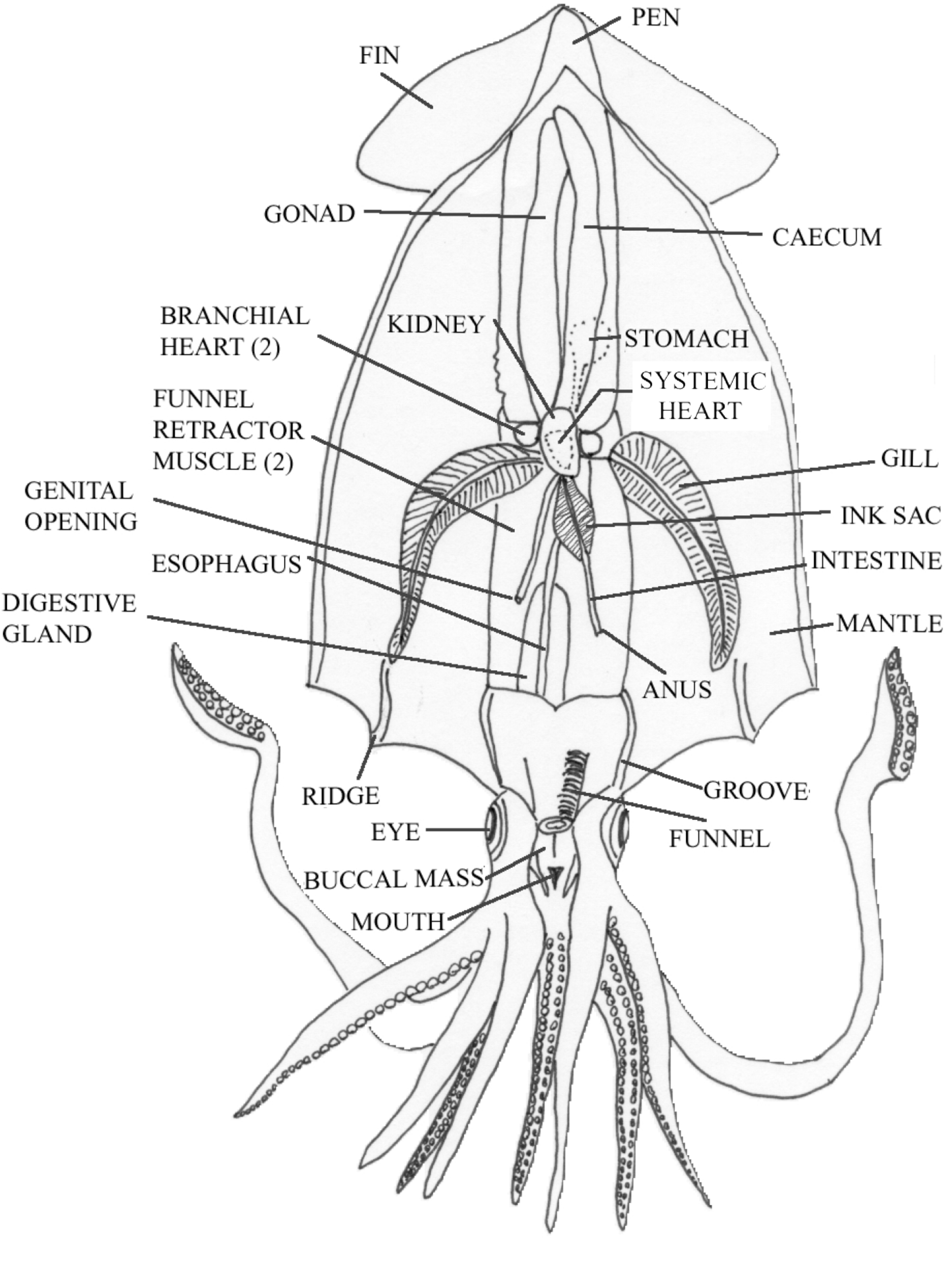
Calamari Addition

1. Now that you have “cleaned” squid - eat them!
2. Strip mantles of any extraneous material.
3. On the outside of the mantle peel the chromatophore layer off.
4. Rinse well and slice into thin strips.
5. Drop into a ziplock of buttermilk to soak.
6. When ready, use tongs to pull out pieces and drop them in breading.
7. Place breaded pieces in a preheated electric fry pan with oil of your choice.
8. Once golden brown, remove with tongs and drain on paper towel.
9. Serve immediately with a side of marinara.

Squid Dissection: External Anatomy



Squid Dissection: External Anatomy



Aquatic Epidemiology Mystery

Grade Levels
9-12

Objectives
Students will learn how the careful research and documentation of fish diseases helps to keep wild and captive fish populations healthy.

Best Taught
Any time of the year.

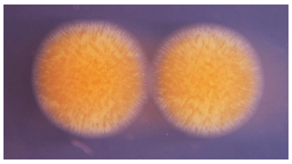
Background
Aquatic epidemiology is the study of disease in fish populations. and the factors that determine its occurance. Clinical and laboratory medicine as well as biostatistics and health economics are all integrated to link this field of science.

Documenting virus and disease occurance in fish populations is very important to fisheries and hatchery biologists. If a wild population is found to have a disease, biologists may choose not to use them. Likewise, if a disease is found in a hatchery, they may have to treat the facility, treat the fish, or cull those fish.

Fish health experts from the Michigan State University Department of Pathology and Diagnostic Investigation aids the Michigan DNR in conducting health assesments of wild fish, fish taken at one of our weirs for spawning purposes and fish raised in our hatcheries.

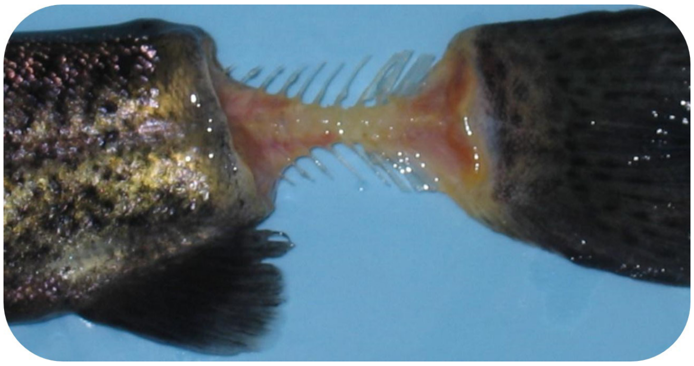
One important disease to monitor is Flavobacteria infections. Flavobacteria is a naturally occuring in soil and freshwater systems. Several species are known to cause disease in freshwater fish. *Flavobacterium psychrophilum* causes the "bacterial cold water disease" is salmonids. Multilocus sequence typing has been conducted in Michigan populations to determine the genetic diversity of *F. psychrophilum* isolates.

Bacterial Coldwater Disease
BCWD is a bacterial disease of salmonids (salmon/trout, etc). Caused by the bacterium *Flavobacterium psychophilum* found in freshwater systems. Usually found in water temperatures below 15°C. Asymptomatic carrier fish and contaminated water provide reservoirs for the disease.



Transmission is mainly through horizontal transfer, but vertical transmission can also occur. Transmission is primarily through fish to fish contact, especially fins and gills, and from adult female, to egg, to fry. Many of the instances in Michigan are thought to be from adult to fry through infected eggs. But, flavobacteria are naturally occuring in water and soil and can be transferred that way as well.

Fish infected with the pathogen suffer from tissue erosion, jaw ulcers, inflammation and behavior issues. Fish appear darl, torn, frayed or missing. Stress and damage to the skin are the two common ways the disease takes hold.



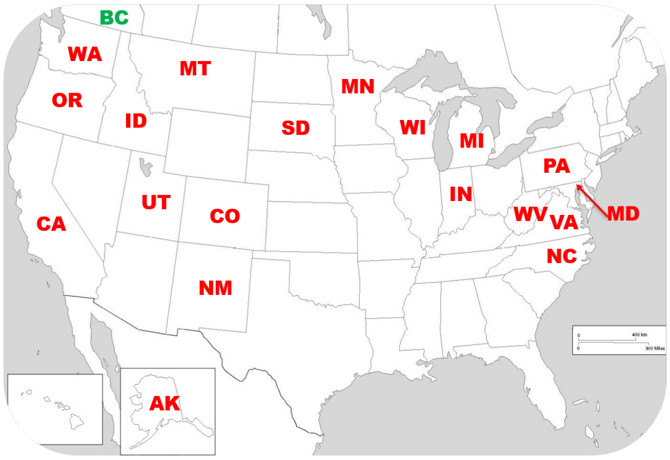
The disease is treated by removing infected fish, treating the water with UV light and antibiotic treatment of fish, as well as disenfection of eggs.

Fish are tested by the lab at MIchigan State University upon request, and also during egg takes, either at a weir from wild stock, or in the hatcheries from broodstock. These efforts help to monitor potential infections that could spread hatchery wide.

Pictures, charts and content proofing courtesy Dr. T.P. Loch, MSU-AAHL.

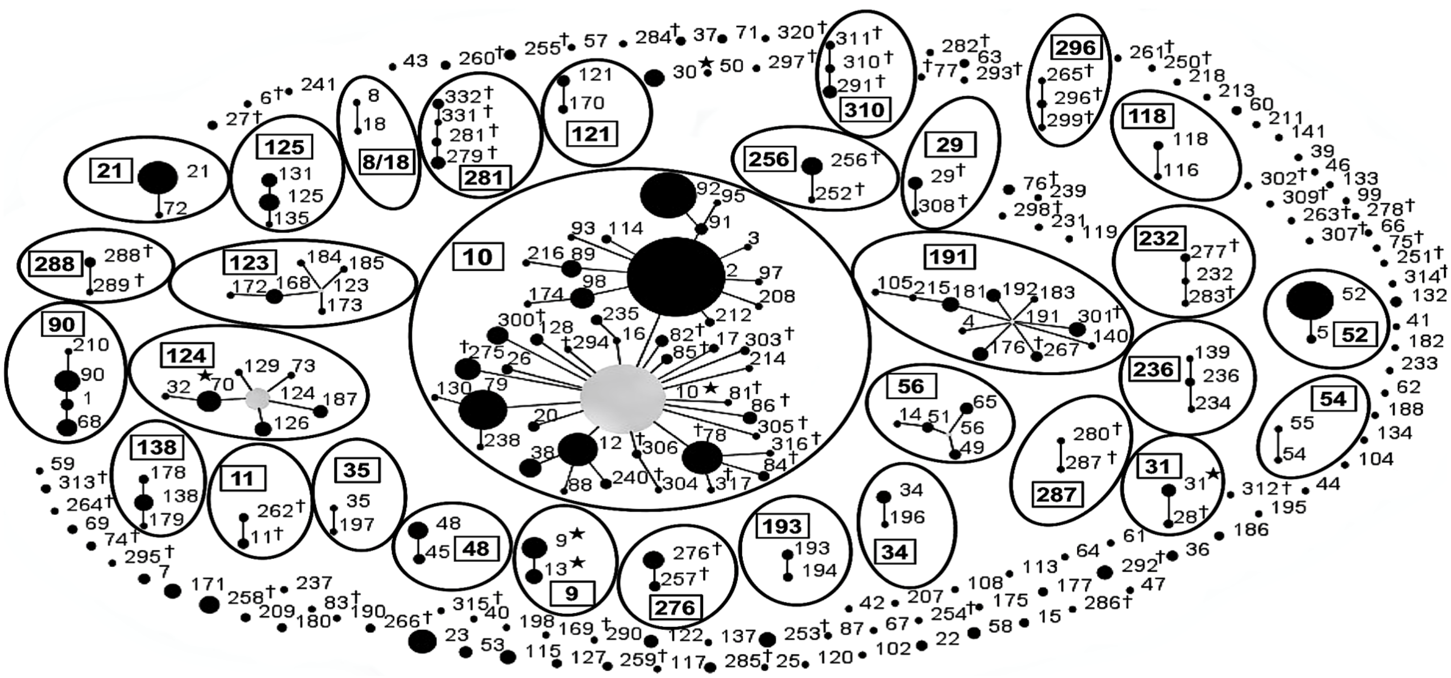
F. psychrophilium Genetic Diversity

F. psychrophilum has been found in 23 states and 1 province since 1981. There are over 470 known *Fp* isolates and that number is constantly growing. An "isolate" is a strain of a species, like a breed of dog.



The chart below plots the known Flavobacteria isolates.

1. The black dots' size indicates occurance rates (larger is more occurances).
2. The oval outlines group "families" of related isolates.
3. The numbers indicate the "name" of the isolates.



While there are many that have been typed, not all are present in Michigan waters/fish. The chart below begins to color code those that are found here.

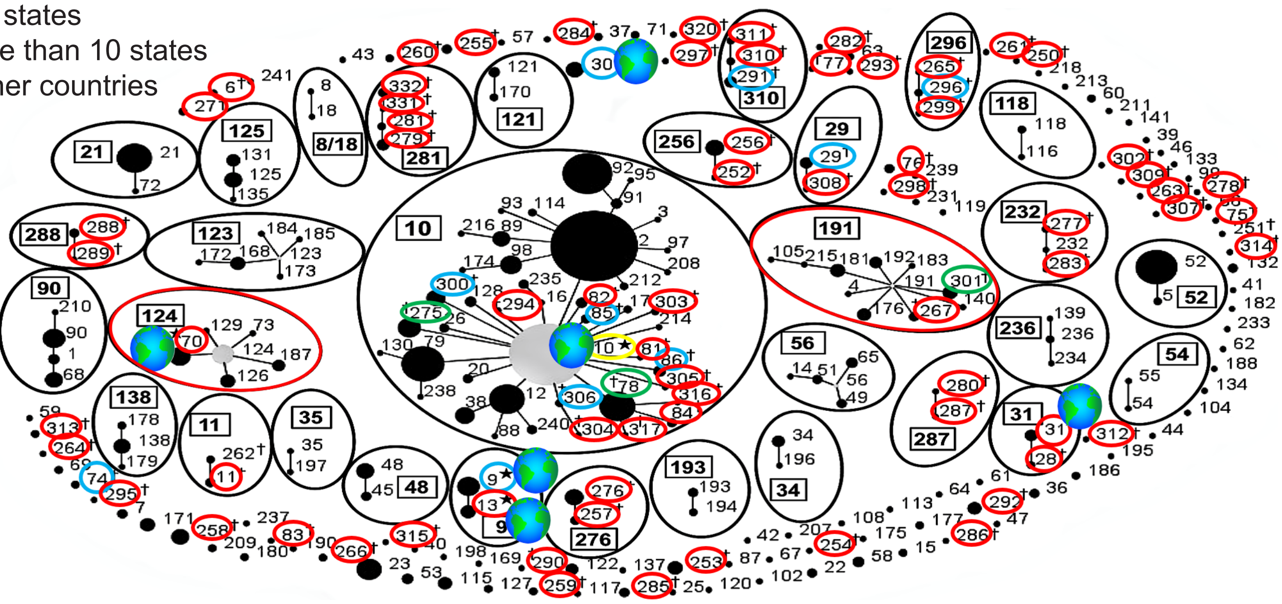
Red = 1 state

Blue = 2-4 states

Green = 5-9 states

Yellos = more than 10 states

Globes = other countries



Vocabulary

Aquatic Epidemiology - Branch of laboratory science that seeks to describe the health, diseases, and welfare of fish populations.

Asymptomatic - Showing no symptoms of the disease

Biostatistics - Branch of statistics that deals with data related to living organisms.

Broodstock - Group of mature fish held in hatcheries for breeding purposes.

Diagnostic Investigations - Procedure to identify areas of weakness or strength to determine a condition, disease or illness.

Health Economics - Field assessing the economic impact of fish health and diseases.

Horizontal Gene Transfer - The transmission of disease between organisms.

Isolate - a culture of microorganisms isolated for study

Multilocus Sequencing - Technique in molecular biology for characterizing isolates of microbial species using DNA sequencing.

Pathogen - A bacterium, virus or microorganism that can cause disease.

Pathology - Branch of science studying the structural and functional manifestations of disease.

Spawning - Release or deposit of eggs.

Vertical Transmission - The transmission of disease from parent to offspring.

Weir - A low dam temporarily placed across a river to prevent the upstream migration of fish. Weirs direct fish into holding ponds for manual spawning.

Wild Stock - Fish growing to adulthood in the wild.

Key to Abbreviations

Isolate infections in the following activities are described with what is called a “lot code”. Below is a chart that describes what each portion of the code means.

Isolate Strain	Year Diagnosed	Production or Broodstock	Species Code	Species Strain	Domestic or Wild Source of Eggs	Year Eggs Taken	Source of Eggs	Hatchery where fish are reared	Hatchery where fish were moved
ST253	2010 -	P -	RBT -	MI -	W -	10 -	LMW -	TH -	WL
ST286	2017 -	B -	RBT -	EL -	D -	12 -		OD	

So for example row 1 means: 2010 Diagnosed, in a Production (rainbow trout), steelhead from Lake Michigan side, wild adult spawned for eggs in 2010, taken at the Little Manistee Weir, eggs incubated at Thompson Hatchery and then transferred to Wolf Lake Hatchery

Source of Eggs Code: LMW=Little Manistee Weir
PLW=Platte River Weir

Hatchery Codes: MA = Marquette Hatchery
TH = Thompson Hatchery
OD = Oden Hatchery
HA = Harrietta Hatchery
WL = Wolf Lake Hatchery

Species Code Key

- **BNT** - Brown Trout
- **CHS** - Chinook Salmon
- **COS** - Coho Salmon
- **LAT** - Lake Trout
  - SE - Seneca
  - LS - Lake Superior
- **RBT** - Rainbow Trout
  - EL - Eagle Lake Strain
  - SR - Sturgeon River Strain
  - GC - Gilcrest Creek Strain
  - WR - Wild Rose Strain
- **RBT** - Steelhead (a strain of rainbow trout)
  - MI - Steehead Michigan Winter

Example Activities

Activity Cards for Example 1

EX1a	EX1b
ST353-2019-P-LAT-SE-D-17-MA	**ST278-2012-P-LAT-LS-D-11-MA**

Example 1 Discussion

These are the only two known instances of these strains. Both were found only at Marquette State Fish Hatchery. Both were only found in production fish (those that will be stocked later), not in broodstock (parent fish that provided the eggs and live at the hatchery all the time). None have been found in wild fish. These two strains were also only found in Lake Trout, and not other species.

How could this bacteria only affect the babies and not the parents? Obvidously these two instances were not transmitted through the eggs from the adults.

How can this bacteria get into the hatchery then? What other sources are there? Options are vertical transmission from parents through eggs, horizontal transmission one fish to another, or natural occurance in water and soil. The current guess is that these are isolates are found naturally in the source water for this hatchery, Cherry Creek and only affect young Lake Trout.

Activity Cards for Example 2

EX2a	EX2b
ST286-2017-B-RBT-EL-D-12-OD	**ST286-2019-P-BNT-WR-D-18-OD-HA**

Example 2 Discussion

What do these two isolate detections have in common? In 2017 ST286 was seen in rainbow trout broodstock at the Oden Hatchery. Then, in eggs taken from Oden broodstock in 2018, production brown trout were seen to be infected at Harietta Hatchery.

How did this occur? This could be a case of horizontal transmission from species to species, and from one location to another via egg transfer. This is an isolate that affects more than one species as well as both broodstock and production fish.

Activity Procedure

- Using the previous pages of background information, and the Power Point provided on the SIC website, introduce the topic of aquatic epidemiolgy to the students. Provide students with copies of the vocabulary and key to review.
- Using Example 1, show the cards on the screen and practice reading the code with students.
- Contintue the discussion for Example 1 and outline the connection between the two outbreak cards.
- Do the same for Example 2.
- Activity 1. Pass out copies of the activity cards. Students should sort the cards by activity number and problem solve the connection between cards. Students should develop a hypotesis for each outbreak.
- Have students present to the class. Using the Teacher Key, discuss the hypothesis for each outbreak.

Extension: Have students develop their own mysteries and produce cards based on the code.

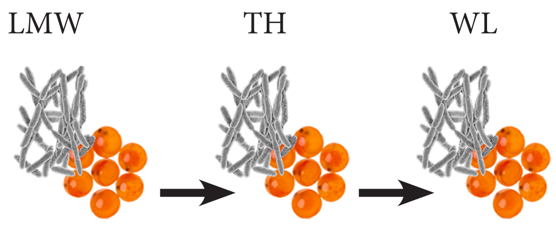
Activity Cards

A1a ST78-2010-P-RBT-LMW-TH-WL	A1b ST78-2011-P-RBT-LMW-WL
A1c ST78-2011-P-RBT-LMW-WL-TH	A2a ST253-2010-B-BNT-GC-D-04-OD
A2b ST253-2013-B-BNT-SR-D-12-OD	A2c ST253-2013-P-BNT-WR-12-OD
A2d ST253-2013-B-RBT-EL-D-09-OD	A2e ST253-2017-B-RBT-EL-D-12-OD
A3a ST267-2017-B-RBT-MI-W-17-LMW	A3b ST267-2013-P-RBT-MI-W-12-LMW-WL
A3c ST257-2013-P-RBT-MI-W-12-LMW-WL	A3d ST257-2016-B-RBT-MI-W-16-LMW
A4a ST13-P-COS-MI-W-18-PL	A4b ST13-P-COS-WASH-W-16

Activity Teacher Discussion Key

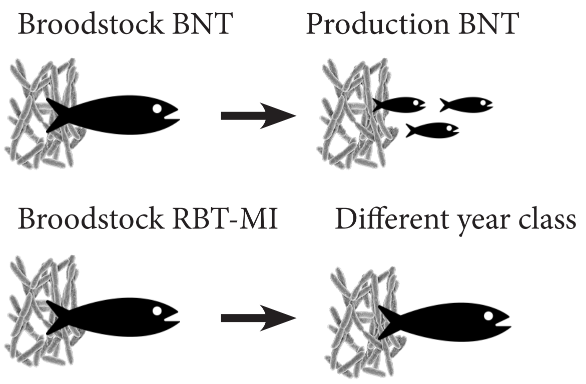
Activity 1

ST78 seems to be a isolate that is not found at the weir where the eggs are collected, so vertical transmission to the eggs/fry does not seem likely. But the fact that eggs moved from LMW - TH - WL in one year, and then LMW - WL - TH seems to suggest that it is horizontal transmission between rainbow trout and was passed between hatcheries when eggs/fry were transferred.



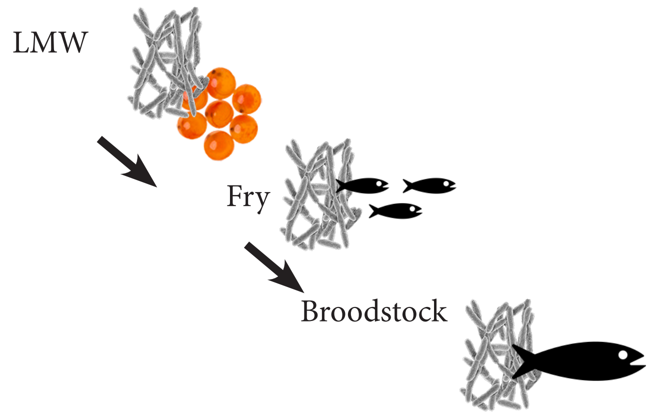
Activity 2

ST235 is an isolate that seems to be bouncing around Oden Hatchery, showcasing horizontal transmission between species at the hatchery, regardless of if they are production fish or broodstock. This would indicate that the flavobacteria source is something universal to all those tanks/raceways. So possibly naturally occurring in the water, or being introduced through common equipment that is not being disinfected enough. This tells a hatchery biologist to enforce stricter disinfection procedures, and to check the watersource.



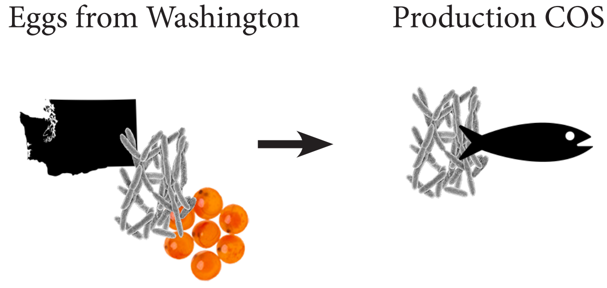
Activity 3

ST267 and ST257 seem to be flavobacteria that is present in the wild populations in the Little Manistee River. ST267 was seen in production fish and broodstock whose eggs were taken at the Little Manistee River Weir in 2012 and 2017. ST257 was also found in fish whose eggs were collected at the Little Manistee River Weir in 2012 and 2016. But, it is only found in steelhead trout, and they are not seen in other species there. Vertical transmission is going on in the river between parent and offspring of RBT-MI.



Activity 4

ST13 is an interesting isolate that appears in coho salmon raised at the Platte River State Fish Hatchery. Card A4b shows us that the only other place we see this isolate in coho is in a stream in Washington State. How could it have gotten to Michigan? That stream in Washington was the location of the egg take to bring coho salmon to Michigan in 1963. This is vertical transmission between parent and offspring, with the original infection coming from a population out of state.



Great Lakes, Great Fish

Grade Levels
3-6

Objectives
Students will learn about different physical characteristics of each Great Lake, and their location in comparison to the other Great Lakes.

Best Taught
September/October; great foundation for other lessons.

Materials
- Great Lakes Basin Silhouette
- Five index cards each labeled from 1-5
- Tape
- Timer or clock

Background
- The Great Lakes comprise 20% of the
- Earth's fresh water
- They hold an estimated six quadrillion gallons of water
- 40 million people rely on the Great Lakes for their drinking water
- Standing anywhere in Michigan, a person is no more than 85 miles from one of the Great Lakes
- Spread evenly across the lower 48 contiguous states, the water of the Great Lakes would be nine-and-a-half feet deep

People travel to Michigan from all over the United States and the World to take part in a variety of recreational opportunities related to the Great Lakes and its surrounding land.

These include fishing, boating, swimming, wildlife viewing, hiking and camping. Michigan's natural resources support many jobs and provide billions in economic revenue for businesses and seasonal destinations.

The Great Lakes are an enormous natural resource that provide a wide variety of recreational opportunities as well as serve the domestic needs of people.

Procedure

Ask the students to name the five Great Lakes. Using the word HOMES may help.

H = Huron
O = Ontario
M = Michigan
E = Erie
S = Superior

Activity 1: H_20 Surface Area

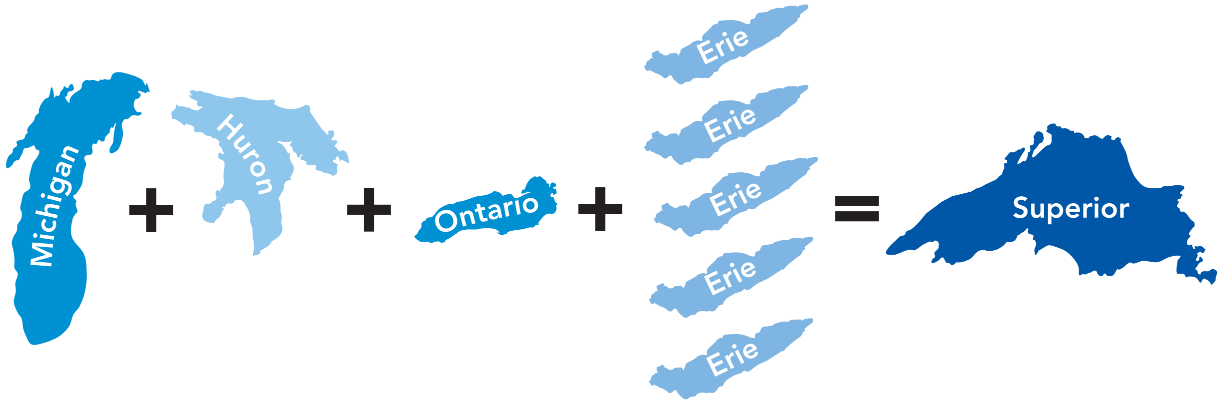
Students will figure out which Great Lake is the largest. (Surface area measured in square miles.) Have 5 different areas of the classroom assigned to each of the five Great Lakes. Post the Basin Map where all students can see it.

1. Hand out the cards numbered 1-5 to five students.
2. Instruct the students to stand next to a different Great Lake corresponding to how big the lake is with 1 representing the largest lake and 5 representing the smallest lake.
3. Set the timer for 30 seconds.
4. When timer sounds, check the students to see if they are in the correct order.

    a. If they are in the correct order, briefly discuss results with students to reinforce order.
    b. If they are not in the correct order (more likely), indicate to students how many are correct (but not WHICH are correct) and instruct them how many need to be changed. Set timer for 15 seconds.
5. Repeat until order is correct as shown below:

    #1: Lake Superior (31,700 square miles)
    #2: Lake Huron Including Georgian Bay (23,000 square miles)
    #3: Lake Michigan (22,309 square miles)
    #4: Lake Erie (9,841 square miles)
    #5: Lake Ontario (7,326 square miles)

Superior Volume



Activity 2: $H_2$0 Volume

Which Great Lake holds the most water by volume? Repeat Activity 1 with the following order being correct for volume:

- #1: Lake Superior (2,935 cubic miles)
- #2: Lake Michigan (1,135 cubic miles)
- #3: Lake Huron (849 cubic miles)
- #4: Lake Ontario (393 cubic miles)
- #5: Lake Erie (103 cubic miles)

Alternative activity

Each student writes the names of all 5 Great Lakes on a piece of paper. They then must rank them in order from smallest to largest by size and/or by volume. Students are called upon to read their answers aloud. The teacher then gives the correct order.

What is different about the lakes?

Lake size/area of lake.

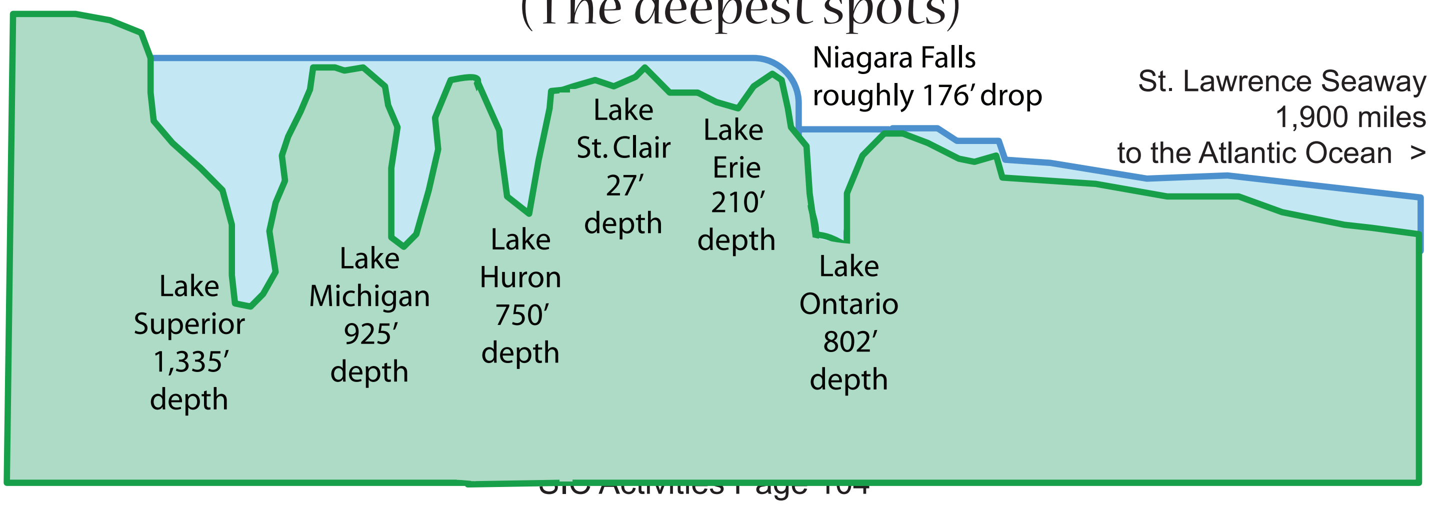
Lake Huron is larger than Lake Michigan by area but holds less water by volume. Because the two lakes have different amounts of water, different fish species are able to flourish in each lake. There is more light penetration in the shallower waters of Lake Huron, which promotes plant growth and supports a larger variety of fish species than Lake Michigan. Although salmon and trout are found in Lake Huron, other coolwater species such as walleye, yellow perch, smallmouth bass, northern pike and muskie also can be found in Lake Huron. Lake Michigan, on the other hand, will have smaller populations of some fish species because of its colder temperature and more open water conditions. Salmon and trout do very well in Lake Michigan.

Lake depth/volume of water

Lake Erie covers more area than Lake Ontario, but Lake Erie is shallower and holds less water. Because Lake Erie is the shallowest of the five Great Lakes, it also is the warmest. Lake Erie is able to provide habitat for fish that can survive in warmer temperatures such as walleye and bass. Great Lakes that are colder, such as Lake Superior, provide habitat for lake trout and other fish that can survive in much colder temperatures.

Great Lakes Profile

(The deepest spots)



Great Lakes Basin Silhouette

What is Your Watershed Address?

Grade Levels
3-12

Objectives
To demonstrate the importance of a healthy watershed, describe water movement in our environment and enhance awareness of our role in a healthy ecosystem. Students will learn the importance of a healthy watershed and be able to list elements of the water cycle. They also will learn how point and non-point sources pollution affect quality of life.

Best Taught
Any time during the school year.

Materials
- 4 large pieces of poster board
- Great Lakes basin map
- State of Michigan map
- Map of the United States
- 4 piles of small and larger rocks
- 4 containers, like salt and pepper shakers
- 4 flavors of sugarless KOOL-AID (choose variety of colors)
- 1 cup of Cocoa Pebbles cereal
- Watering can
- 1 small cup of chocolate sauce (mixed with vegetable oil, used to represent motor oil)
- 1 small cup of grass clippings (used to represent organic human-induced waste).
- Plastic toys: farm animals, cars, houses (raid your MONOPOLY game), a ship or boat.
- 1 picture/illustration of the water cycle
- 5 cards with the following titles:
    - SMOKE STACK
    - LARGE OIL SPILL
    - ANIMAL WASTE
    - FACTORY DRAIN PIPE

Background

Initial terms for beginning discussion: watershed, topography, water cycle, hypothesis. **Watershed:** a region or area bounded peripherally by a divide and draining ultimately to a particular watercourse or body of water. **Topography:** the physical or natural features of a surface. **Water Cycle:** the process by which water moves through the earth's systems; evaporation, condensation, precipitation and transpiration. **Hypothesis:** educated guess based on observation.

Activity 1: Where are you?

1. Take out a state of Michigan map. Ask a student to find their town on the map. Ask other students to find any lakes that are in the school's region. Ask the class to list what components make up a watershed. Watersheds include land and water. Where do watersheds occur? No matter where we are on Earth, we will be in a watershed. How big is the size of a watershed? A watershed can be very tiny to enormous. Is a stream bank a watershed? Yes. Ask for a volunteer to draw a stream with a bank on the board to demonstrate.
2. Discuss the Continental Divide. Have someone help hold up a map of the United States. In the U.S., two large watersheds divide the country. What enormous mountain range is out West? West of this mountain range is the Pacific Ocean watershed. The Atlantic watershed is to the east.
3. Where is Michigan located? What surrounds our state? The Great Lakes. Ask the class to name the Great Lakes. One fifth of the world's fresh water is from the Great Lakes. What percentage is this? Draw a pie chart on the dry erase board to show one-fifth. Have someone hold up the Great Lakes basin map. Where does the Great Lakes watershed eventually drain? The Atlantic Ocean and the Gulf of Mexico. How? Through the St. Lawrence Seaway to the Atlantic Ocean and down the Mississippi River to the Gulf of Mexico.
4. Let's go smaller. What kind of watershed is smaller than all Great Lakes combined? Each Great Lake can be considered a medium-sized watershed. Which Great Lakes border Michigan? No matter where we are, in any state, in any country, we always are in a watershed.

Activity 2: Pollution Demonstration

This activity is best taught outdoors

1. Discussion terms: watershed, point source.
2. Review the components that make up a watershed (land and water).
3. Ask the students to imagine a piece of land if front of the school that is open, flat grassland; no buildings, no houses, just wide open spaces. Is all land in Michigan this flat? No, what makes land flat or hilly? Ancient glacial movement carved out the land, including hills, mountains and lakes.
4. Set out the piece of poster board (this is their piece of land). Have each student find various-sized rocks to position the hills and mountains around the land.
5. Discuss what a hypothesis is. We are going to create a hypothesis on where we think the rain will fall along our land with hills and mountains.
6. Using the watering can, have several students "rain" a little across the land. Was our hypothesis correct? Did the water go where they thought that it would? What would happen if the water was polluted?
7. Distribute the pollution source cards to five students. Discuss point and non-point source pollution, describing what each term means. Do not give examples. Direct the students to look at the five cards and ask which ones are examples of point source pollution. Which ones are examples of non-point source pollution?
8. Begin the watershed pollution demonstration with one of the five pollution types.
    - **Large oil spill**
      Discuss how oil spills occur. Example: You are changing the oil in your car and you spill some on your driveway. Where does that oil end up? Down the storm drain or down through the grass into the soil and into the groundwater. Have the student representing an oil spill point to a place on the watershed where they have spilled oil and have them pour the chocolate. Repeat, using other examples of how this could be a non point and point source pollutant based on size and occurrence.
    - **Animal waste**
      Place the farm animals in one or two areas within the watershed and shake the Cocoa Pebbles in that area. If we are talking about people who don't pick up after their dog, it's non-point source pollution; if we are referring to a mega farm, it's point source pollution.
    - **Smoke stack** Have the smoke stack shake some of the KOOL-AID over an area. Discuss how air pollution eventually ends up in the water cycle and on land. Factory smoke stacks are point source. Ask a student to explain why.
    - **Factory drain pipes/landfills** Have the students decide where the factory should be located in your watershed. Discuss various kinds of factories and what materials they might discharge into a stream or river. This is point source pollution that usually can be seen when it happens. Have the factory drain pipe squeeze mud into the area where the factory is located. Then ask other students to "shake" or "pour" their source of pollution onto the land and the watershed. Mercury and PCBs will get into ground water from landfills. When injested by fish in high levels, fish are inedible.
    - **Organic waste** Organic waste causes dissolved oxygen to disappear in water. How is that harmful? Shake the organic waste (grass clippings) over an area on the watershed. There is a large rainstorm. Have other students 'rain' on the watershed. What happens? Is the pollution staying in one place? Where is it going?

Discussion

The watershed demonstration allows the class to see how every one of us can contribute to the water pollution in our watershed. Would you want to drink that
water? Swim in it?

Activity 3

1. Students form a large circle, shoulder to shoulder.
2. Pick someone who feels bright and sunny. They are the sun. The sun shouts, "Warmth - light - energy!" (Repeat)
3. What happens when sunlight reaches the dew on the morning grass? It evaporates! Choose the next few students standing next to the sun to be the evaporation. The evaporation shouts, "Up high, right to the sky!" (Repeat)

4. What happens when water molecules begin to evaporate and gather in the sky? They form clouds! Choose the next few students standing next to the evaporation to be the clouds. The clouds, using deep voices, shout, "Puffy - puffy - fluffy" (Repeat) What happens when clouds bump into each other? It rains! Choose the next few students standing next to the clouds to be the rain. The rain shouts, "Sprinkle, sprinkle, tinkle!" (Repeat)
5. What happens when there is too much rain on the land? It forms rivers! Choose the next few students standing next to the rain to be the rivers. Tell the rivers to get their Elvis hip-swish going, and with arms waving, shout, "Swish, swish, swish our fish!" (Repeat).

Discussion

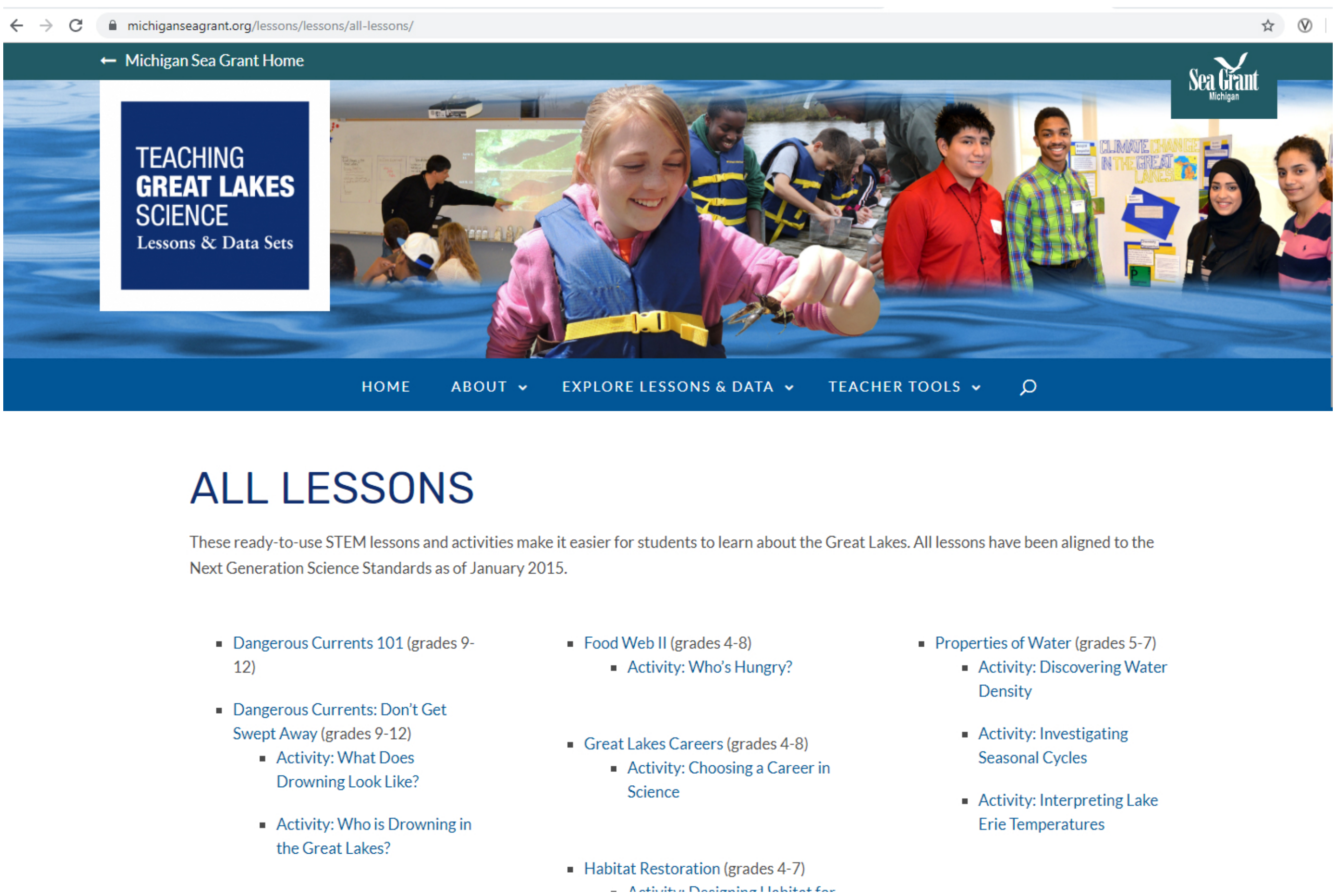
• How does pollution affect our watersheds?
• What can we do to keep pollution out of our watersheds? Can everyone help?
• In what small ways can each of us help keep our water clean?

Extension

Take the class on a watershed tour of local streams, rivers and lakes in your area where they can actually see how water moves in your watershed.

Contact your local Izaak Walton League representative to learn how your class can participate in a Save Our Streams program.

Look online for more hydrology- and fisheries-based programs and lessons plans at Michigan Sea Grants' Project F.L.O.W. (www.projectflow.us)



Water Bug Hunt

Grade Levels
3-12

Objectives
Students learn to identify a variety of macroinvertebrates and understand their role in the aquatic ecosystem. Students will gain knowledge of how these organisms serve as biological indicators for the overall health of these systems.

Best Taught
Any time of the school year

Materials
- Pond nets
- Hand held magnifying lenses
- Magnifying bug viewers/small plastic jars
- Plastic tanks/buckets/ice cube trays
- Hula hoop/shower curtain
- Macroinvertabrate Sorting Sheet-large
- Plastic poster for petri dishes
- Petri Dishes
- Pond Study Field Guide
- Macroinvertebrate Data Sheet
- Pencils
- Clipboards
- Forceps and plastic spoons
- Small trays

Background
Macroinvertebrates are large enough to see with the naked eye (macro) and have no backbone (invertebrate). Benthic macroinvertebrates live in the benthos, or bottom, of a body of water and include insect larvae, crustaceans, mollusks and worms.

The presence or absence of certain macroinvertebrates in an aquatic ecosystem is an indicator of the overall health of the ecosystem. Different organisms can tolerate different levels of pollution. Some are very sensitive to pollution and their presence indicates the water quality is good.

Other organisms are pollution-tolerant and their abundance and lack of sensitive species signifies poor water quality.

Macroinvertebrates are an important part of the food web in an aquatic ecosystem. Many species depend on them as a source of food. For example, the lake sturgeon, a threatened fish species in Michigan, is a bottom-dwelling species that relies on macroinvertebrates as a food source.

Most species of the sunfish family, such as largemouth bass, smallmouth bass and bluegill, feed on crayfish, larval and adult insects, and snails. Members of the pike family, and even your young salmon, feed as juveniles on insect larvae and crayfish.

Macroinvertebrates also serve an important ecological function by digesting organic material such as leaves and dead and decaying plant materials by recycling their nutrients back into the environment and making them available to plants and animals to use.

Activity 1: Indoor Stream Study
If a lake, river, stream or pond is NOT easily accessible:
1. Go out ahead of time with a pond net and bucket to collect samples from the bottom of a lake, river, stream or pond. Put the samples into a bucket filled with water.
2. Using the Macroinvertebrate Sorting Sheet, identify as many of the organisms as possible prior to the program.
3. Place the organisms into the small tank with water for students to view. Remove as much sediment as possible to keep the water clear. Alternatively - lay a hula hoop on a table or floor, cover with a white shower curtain and pour organisms within the hoop. Trays for under washing machines also make excellent viewing and sorting platforms.
4. Using ice cube trays or petri dishes have students sort organisms into like groups.
5. Assist students in identifying each organism. Discuss how they were able to identify the organism. What characteristics helped them? Is it a pollution-sensitive organism, a less sensitive organism or tolerant organism?
6. Students should record the organisms they identify on the Macroinvertebrate Data Sheet.

Activity 2: Outdoor Stream Study

If a river, lake, stream or pond is accessible for students:

1. Take students to the lake, river, stream, or pond where the study will be conducted.
2. Divide the students into groups and discuss rules and safety.
3. Give each group a pond net, identification materials, data sheet, spoons, tank/bucket, hand lens and small plastic jars/bug viewer.
4. Explain that samples should be taken from the bottom, logs, rocks and loose, submerged vegetation.
5. Remind students to take very special care not to harm the organisms. They will be returning them to the water.
6. Students should place sediment and vegetation into a small tray to work through it looking for organisms using the plastic spoons. After removing the material from the body of water, have students take a moment to let the material "come alive" -- the organisms will start to move around. This will help students find the organisms.
7. Students can remove the organisms individually with the spoons and place them in the ice cube trays with water or the small plastic jars.
8. Gather identification sheets at end of the allotted time period. Write results on large sheet of paper or dry erase board.
9. Tally results for all of the groups.

Community Connection

Check with local groups in your area that may conduct macroinvertebrate sampling as a citizen science activity.

Examples of the groups to contact would be:

- Friends of the "   " River
- Watershed council
- Lake Association
- County Conservation District
- Nature Centers and Preserves

For a good source of Michigan based data and study protocols, visit www.micorps.net

Discussion

Were there a lot of pollution-sensitive organisms? This indicates the aquatic ecosystem is of good water quality. Such organisms may include Dobsonfly Larva, Caddisfly Larva, Mayfly Nymph and Stonefly Nymph. Were there a lot of less sensitive organisms? This indicates the water quality is neither really good nor really bad but is somewhere in the middle. This tells us the water quality is not too degraded but that some problems exist.

Indicator organisms include Alderfly Larva, Flatworms, Cranefly Larva, Damselfly Nymph, Dragonfly Nymph, Aquatic Sowbug, Freshwater Scud, Aquatic Snails and Water Mite. Were there a lot of pollution-tolerant organisms? If you find only them, this indicates the water quality is poor and degraded. What could be the cause of the water being degraded? Indicator organisms include Blackfly Larva, Midge Larva, Giant Water Bug, Whirligig Beetle, Whirligig Beetle Larva, Riffle Beetle, Aquatic Worms, Leech, and snails.

How could a lake, river, stream or pond become degraded? There are many ways in which water quality can be degraded, such as excess fertilizer and nutrients entering a water body, erosion, chemical and oil spills, and pesticides. Discuss these possibilities with your students. Ask them how these things could have entered the water body and what steps can be taken to keep them from entering the water.

Potential problems in an aquatic ecosystem that could affect the presence or absence of certain macroinvertebrates:

Non-point source pollution

Non-point source pollution is pollution whose source cannot be directly identified. Examples include oil leaks from cars and equipment, pesticide runoff, animal waste, excess fertilizer and nutrients running off from lawns and farms. Non-point source pollution contributes more to the degradation of our aquatic ecosystems than any other source.

Point source pollution

Pollution whose source can be identified such as a pipe coming from a factory that is directly emptying into a water body.

Erosion

Sediment is the most prominent type of “pollution” in most systems. When sediments and soil leave the earth’s surface (erosion) and enter a water body, they decrease the water clarity and increase its cloudiness or turbidity. Many fish species, such as northern like, depend on eyesight to find their food. If the water is cloudy with sediments that have washed into the water body, it will be more difficult for them to find food.

Many species of fish lay their eggs on the bottom of a lake or river. If the water is turbid, eventually that sediment will settle on the lake or river bottom. Sediment could smother the eggs and keep them from getting oxygen, but could also smother macroinvertebrates.

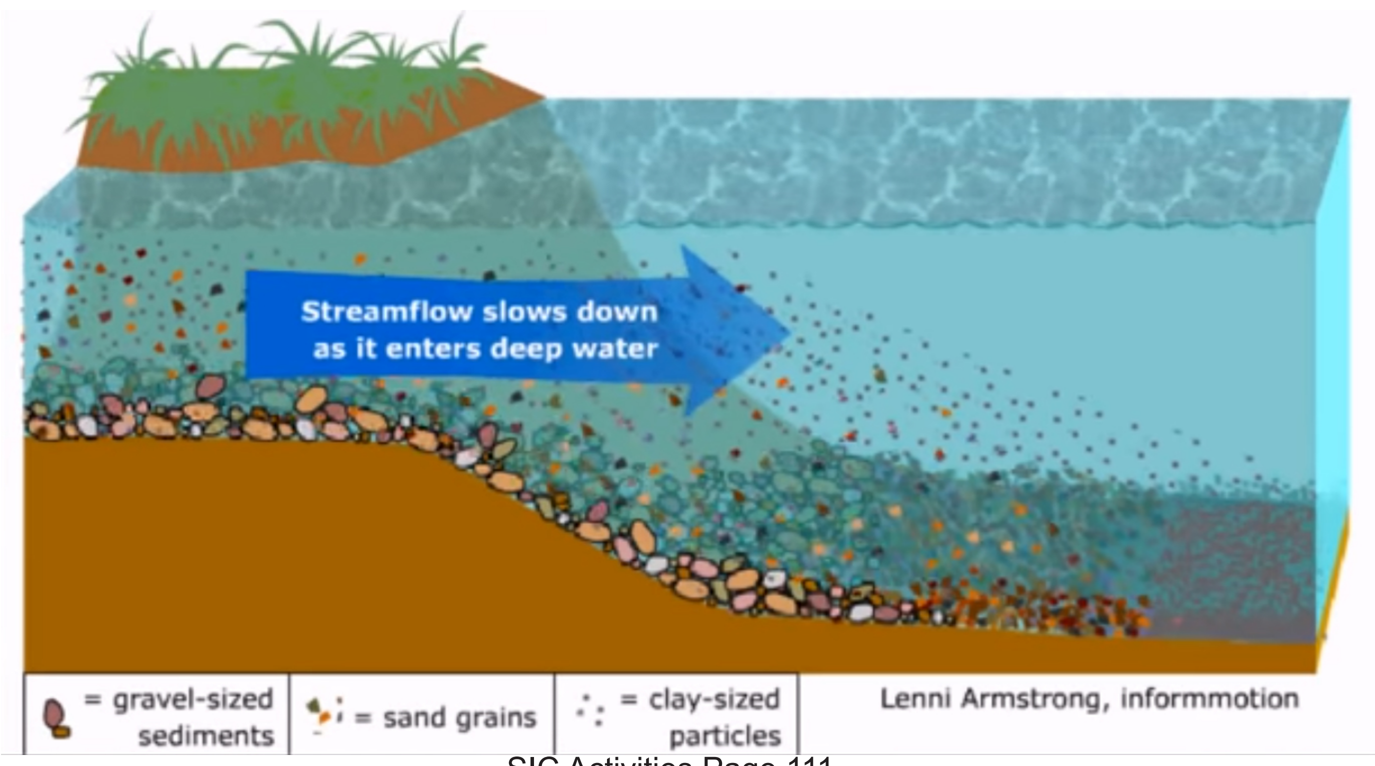
Sunlight is necessary for photosynthesis to occur. Photosynthesis is the process by which plants convert light energy into chemical energy that is usable by biological systems. If the water is cloudy with sediments, it is very difficult for the light to reach the plants and for photosynthesis to take place.

How can we reduce erosion? If you live on a lake or river, one way is to have plants on the shoreline that will help reduce erosion from occurring. The roots of the plants help stabilize the soil.

Low oxygen content

Plants and animals need oxygen to live. If there is not enough oxygen in the water, organisms will not survive. How does the oxygen level in a water body decrease?

As plants decompose, they use up oxygen. If a water body has a lot of algae (caused by too many nutrients, often the result of excess fertilizer being applied to lawns and farms) that algae dies and consumes oxygen, thus depleting the supply available to other aquatic organisms. Warm water holds less oxygen than cold water.

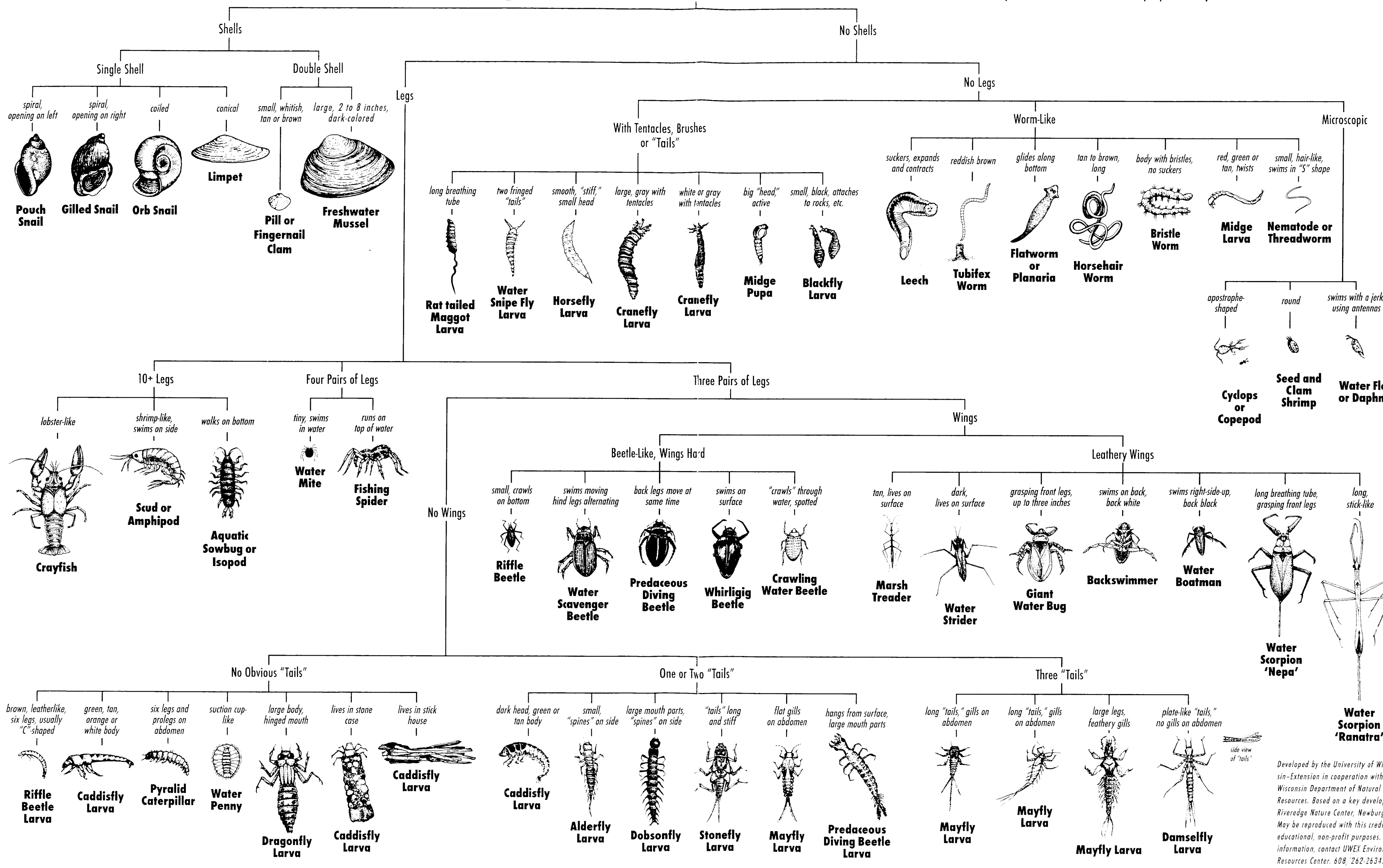


Macroinvertebrate Data Sheet

Date:	Body of Water:	
Aquatic Organism	**Number Found**	**Sensitivity to Pollution**
Aquatic Sow Bug		
Aquatic Worm		
Backswimmer		
Black Fly		
Brook Stickleback Fish		
Caddisfly		
Clam and Mussel		
Common Net Spinning Caddisfly		
Crane Fly		
Crayfish		
Damselfly		
Dobsonfly		
Dragonfly		
Fairy Shrimp		
Giant Water Bug		
Gilled Snail		
Hellgrammites		
Leech		
Mayfly		
Midge Fly		
Pouch Snail		
Riffle Beetle		
Scud		
Stonefly		
Water Boatman		
Water Penny		
Water Scorpion		
Water Strider		
Whirligig Beetle		

Key to Macroinvertebrate Life in the River

(Sizes of illustrations are not proportional.)



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What's In the Water

Grade Levels
3-12

Objectives
Students will learn how to test water quality parameters in a lake, river or stream. Students also will learn what types of fish can survive in a variety of conditions and will discover how human activities can affect water quality.

Best Taught
Any time during the school year.

Materials
- Water Quality Testing Kit
- Clip boards
- Water Quality Test Sheet
- Water Temperature and Fish Chart
- pH Chart
- Floating pool thermometer

A single, basic test kit containing pH, temperature, turbidity and dissolved oxygen tests is included in the Teacher Resource Kit. Additional testing medium is recommended (like your aquarium test kit) so all students may participate in the testing. Instructions are based on students having the opportunity to conduct water quality tests in small groups.

Background
Fish need oxygen, clean water and nutrients to survive. To measure these requirements in a lake, river or stream, biologists look at water quality parameters such as temperature, dissolved oxygen, pH and nitrates. Each of these parameters is a limiting factor. If the level of each is too high or too low, fish can be negatively affected. These factors determine what kind of habitat a body of water can support. Habitat is directly related to the different species of fish that are found in a body of water. Hatchery biologists can use these parameters to decide what types of fish are stocked into different bodies of water.

Activity Background

Temperature
Different fish have different temperature requirements. Salmon are a coldwater fish. They have an ideal temperature range of 50°F to 60°F. Largemouth bass are warmwater fish that have an ideal temperature range of 70°F to 85°F. Cold water holds more oxygen than warm water, thus salmon require colder water and more oxygen than largemouth bass which require warmer water and less oxygen.

Dissolved Oxygen
Oxygen that is dissolved in water and is available to aquatic plants and animals is called dissolved oxygen (DO). Oxygen enters the water by absorption from the atmosphere and by photosynthesis. When water travels over riffles in a stream, the water droplets are broken up into smaller droplets and are able to absorb oxygen from the atmosphere. Slowly moving water has less dissolved oxygen than more rapidly moving water. DO levels vary based on temperature and the rate of decomposition occurring in a body of water. If DO levels are too low, fish and other organisms will not be able to survive.

pH
PH stands for “the power of hydrogen” and measures how much hydrogen is in a solution, such as water. A scale of 0-14 is used to measure pH. Lower levels are considered acidic and have a pH of less than 7. Readings greater than 7 are considered basic. A pH of 7 is considered neutral -- it is neither acidic nor basic. Different organisms have different pH requirements. Some organisms are able to survive in environments with a very high or very low pH. Most fish, however, prefer water with a pH that is close to neutral. Immature stages of aquatic insects, such as mayfly nymphs and stonefly nymphs as well as snails, tadpoles and crayfish are very sensitive to changes in pH and prefer a range of 6-8. Many things can affect the pH of a body of water. For example, industrial emissions from factories can cause acid rain. Acid rain lowers the pH of a body of water. Different household items also have different levels of pH. For example, lemon juice is acidic and has a low pH whereas ammonia is basic and has a high pH.

Turbidity

Turbidity refers to the clarity of water. The more solids that are suspended in water, the cloudier the water is and the higher the turbidity. Some factors that contribute to turbidity are rainstorms, erosion, pollution and bottom feeders (i.e. carp) that stir up sediment. If waters are too turbid, photosynthesis can be slowed and there is an overall negative effect on fish health. Turbid water also causes water temperature to rise. Nitrogen (nitrates/nitrites) Nitrogen is essential for many biological processes. In plants, it is essential for photosynthesis and growth. Algae and other plants use nitrogen as a source of food. If algae have an unlimited supply of nitrogen, their growth will continue unchecked and water quality can decline. Fish need nitrogen to build protein. They are able to get nitrogen by eating plants or by eating other protein (such as other fish or insects). Some forms of nitrogen can be harmful to fish when there is too much in the water. However, in general, levels of DO and pH have a more direct effect on aquatic organisms than levels of nitrates and nitrites in the wild.

Activity 1: Water Testing

1. Break class into groups of 3-4 students.
2. Hand out data sheets on clipboards to each group.
3. Water tests should be done individually; not all at once.
4. Choose a lake, river or stream on which to perform the tests. If a body of water is not readily available for students, obtain fresh samples from a body of water prior to class.

Test 1: Temperature

- Discuss basics of why temperature is important and how different species of fish require different temperatures.
- Give each group a thermometer.
- Instruct students to wrap thermometer rope/string around their hand several times (this will prevent them from dropping it into the water).
- Submerge the thermometer in the water for at least two minutes to ensure an accurate reading.
- Remove the thermometer from the water, record the temperature.

Test 2: Dissolved Oxygen

- Discuss how levels of oxygen determine what kind of organisms can survive.
- Perform test according to instructions.

Instruct students to record DO level on sheet.

pH

- Briefly review the basics of what pH is and why it is important to fish.
- Give each group a pH testing strip.
- Follow testing instructions.
- After students have performed the test, go round to each group and determine what the pH is by comparing their test strip color to that on the scale provided with the test strips.
- Instruct students to record their finding on data sheet.

Test 4: Turbidity

- Discuss the impacts of turbid water on fish populations. What causes turbidity? What can be done to prevent it?
- Follow instructions included with kit or secchi disk.

Test 5: Nitrates/nitrites (Optional)

- Discuss basics of importance of nitrates and nitrites for fish.
- Give each group a nitrate/nitrite testing strip.
- Follow testing instructions.
- After students have performed test, determine level by comparing their test strip to the scale.
- Instruct students to record in their data sheet.

Discussion

Use a table, chalkboard or dry erase board to record data collected from all groups. Discuss results. What kind or fish or other organisms could have survived in the environment of this particular body of water? What human factors could have contributed to the varying levels of temperature, pH, nitrates and DO? How could these results help biologists with making decisions on where to plant fish in lakes, rivers and streams?

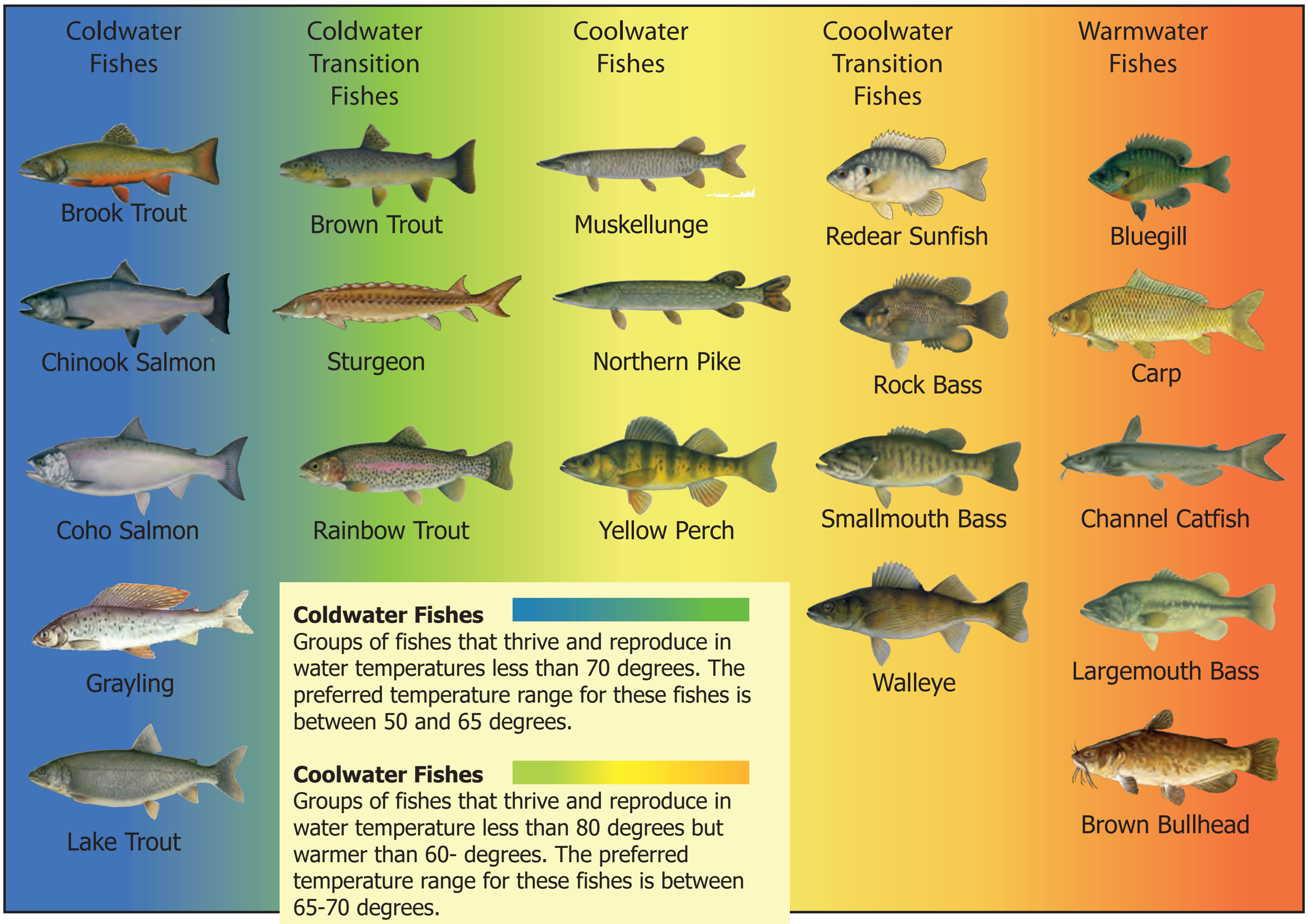
Extensions

Have students participate in a stream monitoring/ macroinvertebrate study on a local lake, river or stream. Also see “Water Bug Hunt” and “Saving Salmon Streams” activities in the curriculum guide. Check out the US Geological Survey’s stream monitoring map at http://waterdata.usgs.gov/mi/nwis/rt

Water Quality Data Sheet

Date: **Testing Location:**	
Group Members:	
Body of Water Type (check one)	
☐ **Wetland** ☐ **Pond** ☐ **Lake** ☐ **River** ☐ **Stream**	
Weather Conditions	
Water Temperature	**Other Tests Conducted**
pH	
Nitrate	
Dissolved Oxygen	
Visible Signs of Pollution?	
Animals and Plants Identified	
Sketch the Sample Area	

Water Temperature and Fish



Coldwater Fishes
Groups of fishes that thrive and reproduce in water temperatures less than 70 degrees. The preferred temperature range for these fishes is between 50 and 65 degrees.

Coolwater Fishes
Groups of fishes that thrive and reproduce in water temperature less than 80 degrees but warmer than 60- degrees. The preferred temperature range for these fishes is between 65-70 degrees.

Warmwater Fishes
Groups of fishes that thrive and reproduce in water temperature warmer than 80 degrees. The preferred temperature range for these fishes is between 70 and 85 degrees.

Habitat influences the species and numbers of fish found in a waterway. If the habitat meets a fish's needs, it can survive there. If the habitat doesn't meet the fish's needs, it won't be found there. One very important habitat factor is water temperature. The temperature of a waterway is determined by many variables. Water temperature is influenced by the time of year, the amount of sunlight reaching the water, the amount and speed of the water (flowing and currents), the source of the water (springs or runoff), and the amount of material suspended in the water.

Fish can't maintain their body temperature at a constant level as humans and other warm-blooded animals can. They are what biologists call "exotherms." The temperature of their surroundings influences their body temperature and bodily functions. This is why water temperature is such an important habitat factor for fish. Each fish species has a specific range of water temperatures in which it can live. If the water is outside that range, the fish can't survive. Within that range is a narrower range of temperatures. This is called a fish's "preferred temperature." Fish can live, grow and reproduce when they are within their preferred temperature range. The preferred temperatures are ideal for the fish's survival.

Biologists group fish with similar temperature preferences into three groups: cold, cool and warm. Fish in groups often have other similar habitat needs. The groups overlap because temperature preferences among groups overlap. The habitats where they overlap are called "transition waters." Transition waters may be ideal for one group, but not for both. Brown trout, for example, are considered coldwater fish. However, they can tolerate warmer water than brook trout. Because they can tolerate higher water temperatures, they may be found with coldwater fish and in transition waters.

Adapted from Smart Anglers Notebook by Carl Richardson www.fish.state.pa.us

Saving Salmon Streams

Grade Levels
4-8

Objectives
Define the different ways in which human activities impact salmon habitat and explain basic natural resource stewardship practices.

Best Taught
Anytime of year.

Materials
- Food coloring (several colors)
- Small, clear tank
- Small bag of torn up pieces of paper
- Small amount of soil
- *Fertilizer bag/ container (empty)
- *Plastic drink rings (soda-pop)
- *Oil quart container (empty)
- *Plastic toy fish

**Optional*

Background
Plants, animals and humans need clean water to survive. Pollution, both non-point source and point source, contributes to degraded water quality in lakes, rivers and streams. Properly managing and conserving water resources will provide healthy habitat for salmon. People can protect salmon habitat by becoming stewards of our natural resources.

Discussion
The quality of salmon habitat is determined by the impact of human activities and how our water resources are managed. Human activities impacting salmon habitat include, but are not limited to, excess fertilizer use, improper pesticide use, improper disposal of oil and gasoline, erosion and sedimentation.

Fertilizer
When used in excess, fertilizer can pollute lakes, rivers and streams, and cause too much algae growth. The algae consume nutrients, making them unavailable to other aquatic plants and animals. When the algae die, oxygen is used in decomposition. This use of oxygen reduces the amount available to other organisms, including fish, and may result in fish kills.

Pesticides
When used inappropriately, pesticides can contaminate bodies of water negatively affecting plants, animals and drinking water supplies. Examples of misuse include not following directions, using excessive amounts of pesticides and not considering weather conditions prior to their application. Proper use of pesticides and the utilization of pesticide alternatives can reduce the threat of contamination.

Motor oil
The improper disposal of oil can pollute surface and ground water. Oil used in lawn mowers and automobiles needs to be changed periodically to ensure optimum performance of these machines. When removed it is important to recycle and properly dispose of the used oil. One quart of oil can contaminate two million gallons of groundwater. That is approximately the amount of water that can be found beneath an area the size of an entire football field.

Gasoline
Tanks used to store gasoline can, over time, deteriorate and begin leaking into the surrounding groundwater. Michigan currently has more than 9,000 known leaking underground storage tanks. Cleanup of these sites is costly and time consuming.

Litter/trash
Trash, such as plastic beverage rings, fast-food wrappers and similar items, can harm wildlife and create unsightly messes if not properly disposed of or recycled. Plastic and metal rings can become twisted around birds, fish and other wildlife preventing them from eating and even causing strangulation.

Erosion/sedimentation

Erosion is the natural process of wind and water wearing away rocks and soil. When the rate at which erosion occurs is increased as the result of human activities, the effects can be detrimental to fish and other wildlife. Salmon require a clean, gravel-covered river substrate on which to lay their eggs. If the substrate is covered in sediment that has washed into the river, they will be unable to spawn. If the sediment washes on top of their eggs after they have been laid, the eggs could suffocate. The gills of fish also can become clogged by sediment. The removal of trees and vegetation that normally would help keep soil in place contributes not only to soil erosion but also to increasing the temperature of water by reducing shade.

Procedure

1. Fill small tank with water and add the toy fish.
2. Set the tank on a table so all students can see.
3. Place the "pollutants" around the tank (torn up paper represents trash or litter, soil represents erosion and the various colors of food coloring represent pesticides, fertilizer, motor oil, etc.)
4. Discuss the different ways that lakes, rivers and streams can become polluted.
5. Write responses on board and create list.
6. Throughout this discussion, as each example is given, hold up the various pollutants that you have gathered around the tank.

Activity

1. Ask for a volunteer to choose one of the pollutants.
2. The student then is instructed to "pollute" the stream (tank) with their pollutant. Several drops of food coloring may be used for the pollutant it represents.
3. Repeat until all pollutants have been added to the water.

Is this a clean or polluted stream? Could a salmon live in a stream like this? Discuss why or why not.

Individually and collectively, these types of pollution can adversely affect salmon habitat. It is the responsibility of individuals to become stewards of our natural resources to conserve and protect our lakes, rivers and streams.

Extension

Ask students to write an essay about how they can help protect salmon habitat. Examples include organizing a river cleanup day, making a list of places that will recycle used motor oil and distributing the list to the community, informing their community about recycling and holding a recycling day, hosting a litter cleanup event at a local park, planting trees to help prevent soil erosion, helping organize a hazardous waste collection day, etc.

Connect with your local County Conservation District to utilize their groundwater model.

Freshwater Frenzy

Grade Levels
3-6

Objectives
Students will learn about the importance of conserving water resources.

Best Taught
Any time during the school year.

Materials
- Inflatable globe
- One 2 liter bottle filled with water, preferably tinted with blue food coloring
- Clear plastic cups
- Eye dropper

Background
Most of the water on Earth is salt water (97%). Only 3% is fresh water. Salt water is not suitable for everyday human use, including drinking, cleaning, bathing, cooking, irrigating crops and gardens, and manufacturing.

A large portion of the Earth's freshwater supply is locked in ice caps and glaciers (two-thirds of the fresh water or 2% of all the water on Earth).

Only 1% of the fresh water on Earth makes up our lakes, rivers and streams. Of that 1% fresh-water supply, just .00003% is drinkable water.

Extensions
Ask students to list ways they can use less water. Provide ideas to help get them started, such as taking a shorter shower, turning off the faucet while brushing their teeth, etc.
Have students keep a journal of what they use water for every day. How is water used to develop household products, cars and other everyday items?

Sources
This program was adapted from "Drop in the Bucket" developed by Project WET.

Activity
1. Toss the globe to a student. Where is their right thumb? Is it on land or water?
2. Record the numbers with tally marks on the board.
3. The student must throw the globe back to the teacher. Repeat several times or until there are far more "water" landings than "land" landings.
4. Ask students why more people landed on water. Seventy percent of the Earth's surface is covered with water. But what part of that water is usable for everyday human needs? Ask students what the different types of water are. Hint: one type is found in oceans and the other is found in lakes, rivers and streams. The Earth contains salt and fresh water.
5. What do we use fresh water for? Have students compile a list. Cleaning, cooking, bathing, drinking, watering gardens/crops, manufacturing, etc. Can humans use salt water for these needs? No.
6. Show students the two-liter bottle(filled with blue-colored water). Tell them to imagine that all water on Earth, both salt and fresh, is inside the two-liter bottle. Ask which type of water is the most. Salt water. What percent is salt water? Have students answer until the correct amount, 97% is reached. That leaves 3% as fresh water.
7. Ask for a volunteer. Have the volunteer separate the salt water (97%) from the fresh water. Have the volunteer pour approximately 3% from the two-liter bottle into a clear cup marked with a line labeled "3%." Set the two-liter bottle aside as "unusable."
8. Hold up the cup with the Earth's freshwater supply. Two-thirds of the fresh water or two percent of the total water on Earth is locked in ice caps and glaciers. Is that water usable? No. That leaves 1%. Ask for another volunteer. Have the volunteer pour one-third of the water in the cup into another clear cup with a line labeled "1%." This 1% represents all of the water that makes up our lakes, rivers, streams and groundwater. Of the 1%, only .00003% or the equivalent of one drop of water from the entire two liters is drinkable water.
9. Hold eye dropper above cup and drop one drop of water into cup. Is this a lot of water? No. It is important that we conserve and protect our water resources for drinking water, salmon, other wildlife and future generations. What can you do to help?

Latin Lingo

Grade Levels
4-12

Objectives
To teach students about the Latin language and its influence on standardizing science. Students should come away with a basic understanding of how Latin originated, how it is used in modern times, be able to name several fish by Latin (Genus and Species) and know what fish names mean in Latin.

Best Taught
Any time during the school year.

Materials
- Index cards (one for each student)
- Yarn to string cards like a necklace
- Fish of Michigan Identification Guide
- Michigan Fish illustration on front, common and Latin name on reverse
- Latin Word, English word, Common Fish Name Cards in this activity

Background
Latin was first encountered in ancient times as the language of Latium, the region of central Italy in which Rome is located. As the Roman Empire spread through Europe, Vulgar Latin metamorphosed into the Romance languages: Spanish, French, Italian and Portuguese. The Latin alphabet is derived from the ancient Greek alphabet.

During the Middle Ages, Latin became the international language of science, academia and the law. We continue to use Latin in the scientific community because local dialect within a single language can change from region to region. For example, in the tree kingdom, Larix larician commonly means Tamarack in the northern United States or Larch in the southern U.S.

Nomenclature is an ordered set of names in science. Carl Linnaeus was a Swedish botanist born in 1707. He was known as the father of taxonomy because of his work in botany and classifying and organizing living things into groups. Taxonomy is the orderly classification of flora and fauna according to their presumed natural relationships.

Activity 1: Origin of Fish Names
- Review the chart on the following page in class for a few weeks before trying this activity.
- Centers should be set up so that four or fewer students begin at each center.
- Each center should have a complete set of Latin Word, English Definition and Fish Common Name Cards.
- Students match each group of cards that belong together. For instance, these five cards should be in the same group
  1) Brown Trout 2) Salmo 3) From Salio meaning "to leap" 4) Trutta 5) Means"trout".
- After 30 minutes or so each group should be asked to report out with their correct answers.
- Fish ID Sheets can be placed with the teacher as the answer key, at the front of the classroom, for review after each group has presented.

Activity 2: Fish Crossword Puzzle
The list of common Great Lakes fishes can be also be used by the students to create crossword puzzles or word finds depending on their grade level.

Extension
Have the students write a class report on Carl Linnaeus and his contributions to science.

The following pages are Copy me pages. Copy and cut on the dotted line.

That is Latin for...

Common Name	**Latin Name**	**Meaning of Latin Name**
Brown Trout	Salmo trutta	Salmo from Salio meaning to leap. Trutta means trout.
Chinook Salmon	Oncorhynchus tshawyts-cha	Onchorhynchus means hooked snout. Tshawytscha is old Russian name for this species.
Brook Trout	Salvelinus frontinalis	Salvelinus root is German for little salmon. Fontinalis means living in springs.
Coho salmon	Oncorhynchus kisutch	Onchorhynchus means hooked snout. Kisutch is old Russian name for this species.
Muskellunge	Esox masguinongy	Esox means pike in Latin. Masquinongy is Native American name for this species.
Alewife	Alosa pseudoharengus	Alosa means shad in Latin. Pseudoharengus means false herring in Greek.
Lake Sturgeon	Acipenser fulvescens	Acipenser means sturgeon in Latin. Fulvescens means reddish/yellow in Latin.
Sea Lamprey	Petromyzon marinus	Petromyzon means stone to suck in Greek. Marinus means marine.
Lake Whitefish	Coregonus clupeaformis	Coregonus means angle eye in Greek. Clupeaformis herring shaped in Latin.
Channel Catfish	Ictalurus punctatus	Ictalurus means fish cat in Greek. Punctatus means spotted in Latin.
Bluegill	Lepomis macrochirus	Lepomis means scaled gill cover in Greek. Macrochirus means large hand in Greek.
White Crappie	Pomoxis annularis	Pomoxis means opercle sharp in Greek. Annularis means having rings in Latin.

Brown

Trout

Chinook

Salmon

Coho

Salmon

Muskellunge

Alewife

Lake

Sturgeon

Sea

Lamprey

Lake

Whitefish

Channel

Catfish

Bluegill

White

Crappie

Oncorhynchus

tshawytscha

Salvelinus

fontinalis

Oncorhynchus

kisutch

Esox

masquinongy

Alosa

pseudoharengus

Acipenser

fulvescens

Petromyzon

marinus

Coregonus

clupeaformis

Ictalurus

punctatus

Lepomis

macrochirus

Pomoxis

annularis

Salmo

trutta

Means hooked snout in Latin

Old Russian name for this species

The root is German for little salmon

Means living in springs, in Latin

Means pike in Latin

Native American name for this species

Means shad in Latin

Means false herring in Greek

Means sturgeon in Latin

Means reddish/ yellow in Latin

Means stone to suck in Greek

Means marine in Latin

Means angle eye in Greek

Means herring shaped in Latin

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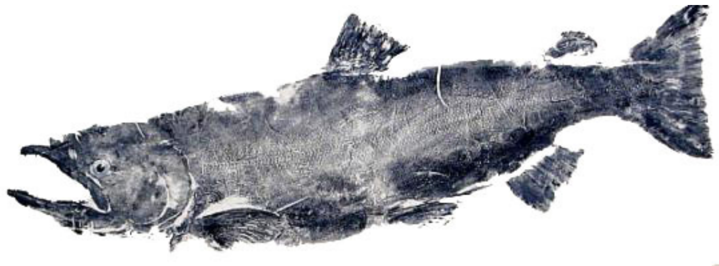
Means scaled gill cover in Greek

Means large hand in Greek

From Salio meaning to leap in Latin

Means trout in Latin

Gyotaku



Grade Levels
K-12

Objectives
Students will practice the traditional Japanese art of gyotaku, or fish printing. Students can also use fish prints to learn and label external anatomy of their fish.

Best Taught
Any time of the school year.

Materials
- Whole fish (Asian or fish markets) or rubber fish replicas (Acorn Naturalist)
- Paint
- Paintbrushes
- Large paper or fabric pieces
- Baby wipes
- Clothesline with clothespins
- Newspaper
- Table coverings
- Paint smocks

Background
Gyotaku (gyo = fish, taku = rubbing) was created in the early 1800s by Japanese fishermen. Looking for a way to keep records of their catch, the fishermen packed newsprint paper, ink and a paint brush out to sea with them. When they caught a nice specimen, they would wipe the fish clean, paint a layer of ink on it, then press the newsprint on top. Once they peeled it off, they were left with a print of their trophy fish, but could still sell it!

The prints were hung in homes as a "trophy" or these were used for more mundane record keeping of fish species, size and quantity caught.

Now, gyotaku is a highly valued art form displayed in museums around the world. The first art exhibition featuring gyotaku was in Tokyo in the 1950s. Some prints go for hundreds, if not thousands of dollars when sold.

Procedure
Discuss the history of gyotaku fish printing with your students. Today they will replicate the art that those fishermen invented over 200 years ago.

Activity 1: Fish Printing
- Hang up the clothes line and have the pins ready.
- Cover tables with disposable table cloths and an unfolded section of newspaper at each child's station.
- Set out paint colors, and a brush for each.
- Prepare your fish for printing. Fresh fish should be wiped down carefully to remove all fluids. Rubber fish should be clean and dry.
- We recommend an assembly line for printing. Have two or three students paint at a time, quickly help them print their fish before the paint dries, and hang the paper to dry. Wash fish and repeat.
- Lay the fish on the newspaper and have the student carefully paint their fish. Have student paint against the "grain" of the fish to make sure they are highlighting the scales.
- Once the body is painted, have the students go back and add details like the eye and fin rays.
- Carefull move the fish to a clean spot of newspaper (to not transfer messy paint)
- Gently lay your large paper or fabric over the fish. Hold the corners of the paper for the student so it does not slide.
- Students should place one hand in the middle and press, and use their other hand to move around the fish and gently press each fin and edge.
- Careful peel the paper up and hang to dry.
- Wash the fish quickly before the paint dries. Wipes also work well to clean the fish.

Optional: Fish Print on Shirts

Fish printing can also be done on t-shirts and other items. Acrylic paint works, but you could also buy paint or ink made for fabric.

- Follow the steps above.
- Be sure to add a thick layer of newspaper inside the t-shirt so the paint does not bleed through.
- Once the shirt dries, if using acrylic paint, we recommend throwing the shirts in the dryer on high for a while to set the paint before they are ever washed.
- Rice paper, cheese cloth, velum, and other mediums all make unique fish prints.

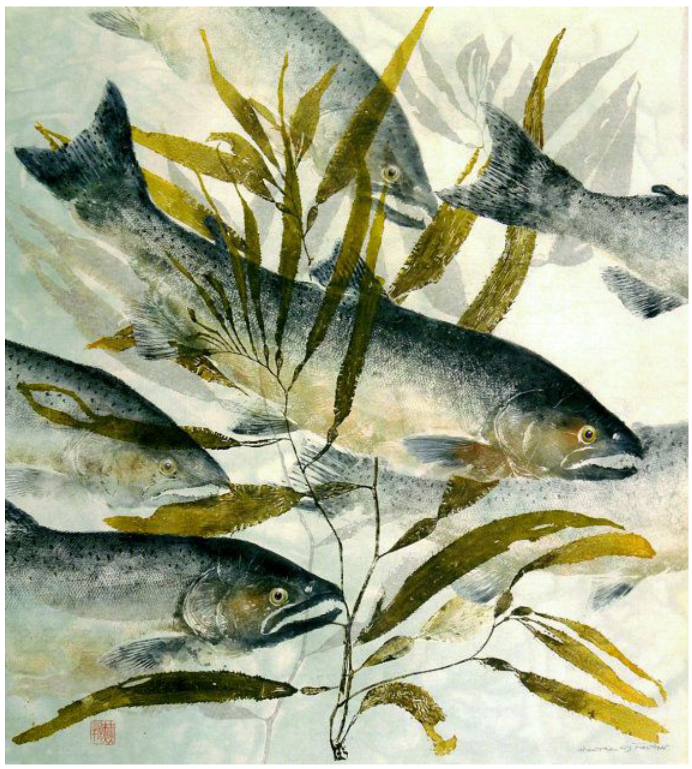
Activity 2: Anatomy of a Fish Print

When fish printing, have students each do at least two fish prints. One can be to keep and display at home. One can be used for this activity.

- Have students use their dried fishprint to become familiar with their fish's external anatomy.
- Using the guide in the "Scales and Tails" activity, have students label the anatomy of their fish.
- As an extension: have students put the purpose under its label. (ex: pectoral fin is used for turning right or left)

Activity 3: Habitat Painting

On their fish print, have them paint or draw in the habitat of their fish to make a more complete piece of art.



It's Your Niche

Grade Levels
2-8

Objectives
Students will be able to define habitat and niche and create business cards for native, non-native and invasive aquatic species.

Best Taught
Any time of the school year.

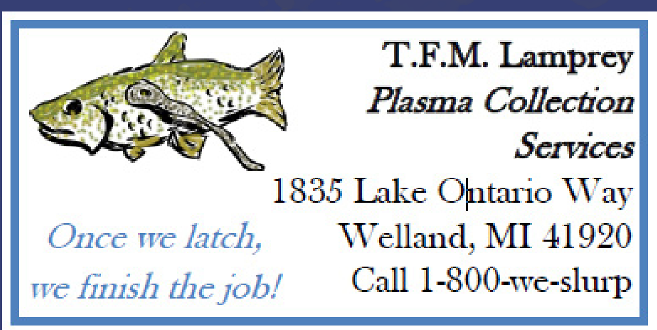
Materials
- 3"x5" blank index cards
- Coloring materials
- Animal ID guides/posters/internet
- Large paper

Background
An animals habitat is made up of several important components - food, water, shelter and space in a suitable arrangement. The animals habitat can be considered its address.

Different animals play different roles in the environment. While a keystone species is vitally important to its environment, an invasive species could displace it.

Some roles of animals are viewed by humans as "positive" - like bees pollinating plants. While other natural behaviors are seen by humans as "destructive" - like beavers building dams that flood property.

Understanding these roles from both an ecological and anthropomorphic standpoint is important.



Activity 1: Animal Business Cards
1. Review habitat with students (food, water, shelter and space in a suitable arrangement). Tell students that habitat can be considered an animal's address. Explain to students that in this activity they will be not only looking at animals' addresses, but animals' jobs (niche), as well.
2. Talk about roles in the environment. What makes an invasive species good at his job? (Reproduces fast/a lot, can eat anything/more, flexible habitat, etc.) Invasive carp are a great example.
3. Discuss the neighborhood the students live in. Everyone has an address and most people have jobs. The job might be a role that a person plays in the community. Animals have roles in the ecosystem or community they live in. This role is called the animal's ecological niche. It includes such things as where and how it gathers its food; its role in the food chain; what it gives and does for the community; its habits, periods of activity, etc. It can also be described as what an animal does for a living. What happens if they are not there? What if someone steals their niche?
4. Allow students time to choose and research an aquatic species found in the Great Lakes. They should find out its niche and choose one thing this animal does well. Their assignment will be to create a business card for that animal advertising its job in the community. To help them, you may want to bring in a few "real" business cards to look at.
5. Here is an example of an animal business card.
6. Business cards should include the following: name of animal, job title, company name, address, phone number, slogan and illustration or symbol for business.
7. 8.Hang business cards on the bulletin board and call it "Whose Niche?" Discuss the ecosystem you have created. How do invasive species play a role?

Extensions
1. Have students work to create billboards for their animal's business page on large paper.
2. Have students create a commercial advertising their animal's business.

Chinook Book Journal

Grade Levels
3-6

Objectives
Students will use a journal to observe, measure and record observations of their Chinook egg to fry growth.

Best Taught
All school year.

Materials
- Copy of Chinook Book Journal for each student

Background
Daily or weekly observations of their salmon will help students observe the changes their fish are going through as the progress through their lifestages.

The journal activity helps to create a cross-curricular connection for the SIC program in schools where the tank is a main focal point of a hallway, media center or other central location.

Activity 1: Journaling
On a set schedule (daily, weekly, etc) have students journal their observations of their Chinook salmon.

Activity 2: Teach Back
Using the Chinook Book Journals, have students teach back content about their SIC experience to younger students.

Thanks
go to long time SIC teacher Kari Roy of DeWitt. This activity is adapted from a journal she has used with their entire school of students to engage with the SIC tank in their media center.

Chinook Book!

Sketch a Chinook salmon below:

Original lesson plan and design by
Kari Roy of DeWitt Public Schools

Fins, Tails and Scales

Salmon Journal

Ichthyologist: ______________________________

School year: ___________ **Class Hour:** ___________

Illustration(s) by Joseph R. Tomelleri ©

Chinook salmon

Raising salmon at my school has been…..

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I will never forget….

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Other thoughts….

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Salmon Release Day

Date ____________

Using your descriptive words, describe what happened today.

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When our group's salmon entered the river……..

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I will always remember how ____________…

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I will never forget how____________…

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Chinook "king" salmon

Scientific Classification

Kingdom:	**Animalia**
Phylum:	**Chordata**
Class:	**Actinopterygii**
Order:	**Salmoniformes**
Family:	**Salmonidae**
Genus:	***Oncorhynchus***
Species:	***O. tshawytscha***

Binomial name:

Oncorhynchus tshawytscha

Chinook salmon

Did you know? Chinook salmon are not native to Michigan or the Great Lakes. They were introduced on purpose in the 1960's as a sportfish opportunity, and as a predator for invasive alewives. DNR State Fish Hatcheries raise young salmon, and then stock them around the state. Chinook salmon are native to the pacific northwest area of North America. In those areas, they would travel from their natal stream to the ocean, where they would spend 1 to 8 years before returning to their stream to spawn and die. In Michigan, they travel out to one of the Great Lakes from their stream and spend a few years in the big lake, then, travel back to their stream in the fall to spawn and die.

Scientific Name: *Oncorhynchus tshawytscha*, from the Greek words onkos (hook), rynchos (nose), and tshawytschia (the common name for the species in Siberia and Alaska).

Common names: King salmon, hook bill salmon, winter salmon, and blackmouth

Description: The Chinook salmon is blue-green on the back and top of the head with silvery sides and white bellies; black spots on the upper half of its body with gray/black mouth coloration. They can grow as large as 44 inches in length and up to 46 pounds.

3.. **Using complete sentences, name 3 new facts, or ideas, that you learned.**

A. ____

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B. ____

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C. ____

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4. **Would you recommend this field trip to your friends?** ____

Why or why not?________________________________

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3. **What else do you want to remember about this fieldtrip?**

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Field Trip Reflection

Date ___________

1. **Where did you go?** ______________________________________

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2. **What was your favorite part about this field trip?**

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3. **Explain WHY** ____

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Lifecycle: Spawning in streams that are larger and deeper than other salmon utilize, Chinook salmon spawn in the fall and bury their eggs in gravel Fry emerge from the streambed the following spring. Young salmon grow quickly and the smolts are ready to move out to the Great Lakes in June. They live in the big lake eating small fish like invasive alewives for a few years and then return to their natal stream to spawn and die.

Habitat and Ecology: Freshwater streams provide important habitat for Chinook salmon. They feed on terrestrial and aquatic insects, amphipods, and crustaceans while young, and then on primarily other smaller fish when adults. Eggs are laid in a stream with usually larger gravel, and need cool, clean water with a good flow (to supply oxygen). Mortality of Chinook salmon in early life stages is usually high due to predation and human impacts on their habitat. Sediment washing in the rivers and potentially bringing pollutants, is a big problem.

Economic Value: Chinook salmon is a highly valued sportfish. The Great Lakes fishery is worth about 7 billion dollars annually, and salmon are a big part of that equation.

Questions:

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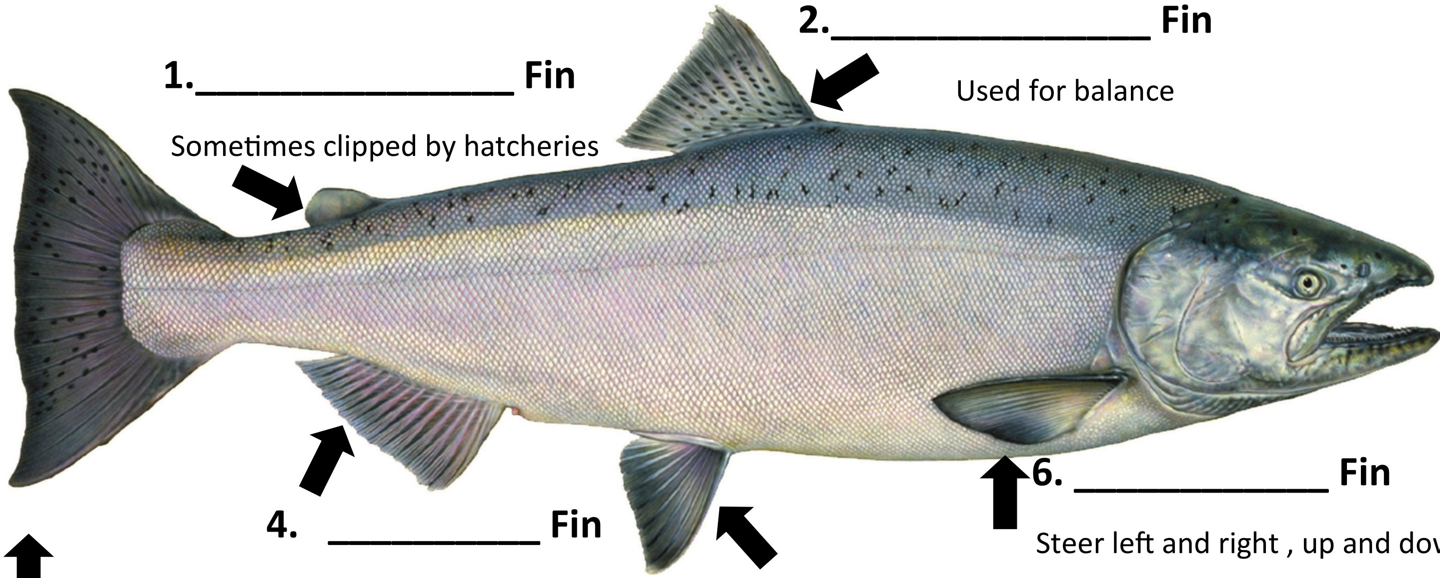
Fin Functions

1. ________________ Fin

Sometimes clipped by hatcheries

2. ________________ Fin

Used for balance



3. ____________ Fin

Used for propulsion

4. ___________ Fin

Used for balance

5. _____________ Fin

Steer sharply, and act as brakes

6. _____________ Fin

Steer left and right , up and down

Date ____________ Water Temperature ____________

Stage ____________ Salmon length ____________

Appearance

Behavior

Other Observations

Date ______________ Water Temperature __________

Stage ____________________ Salmon length _______________

Appearance

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Behavior

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Other Observations

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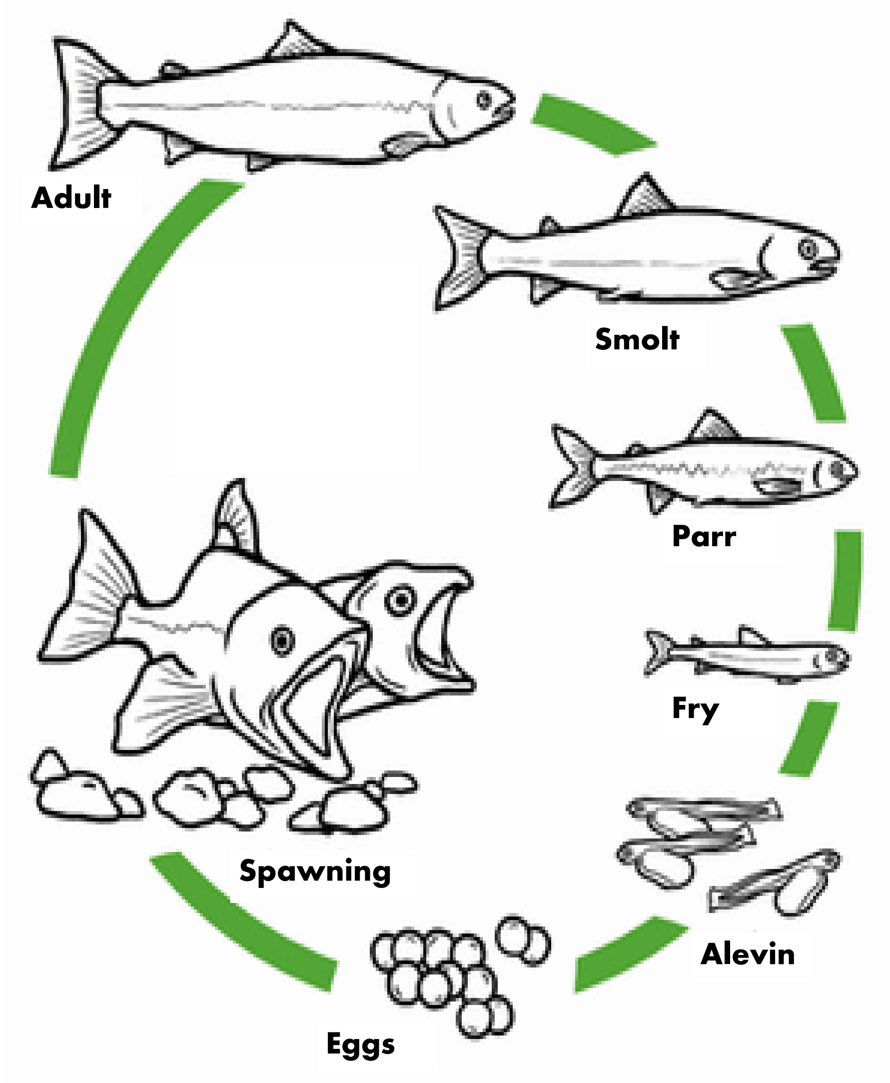
Life Stages



Vocabulary

Date ______________ Water Temperature __________

Stage ____________________ Salmon length _______________

Appearance

Behavior

Other Observations

Date ______________ Water Temperature __________

Stage ____________________ Salmon length _______________

Appearance

Behavior

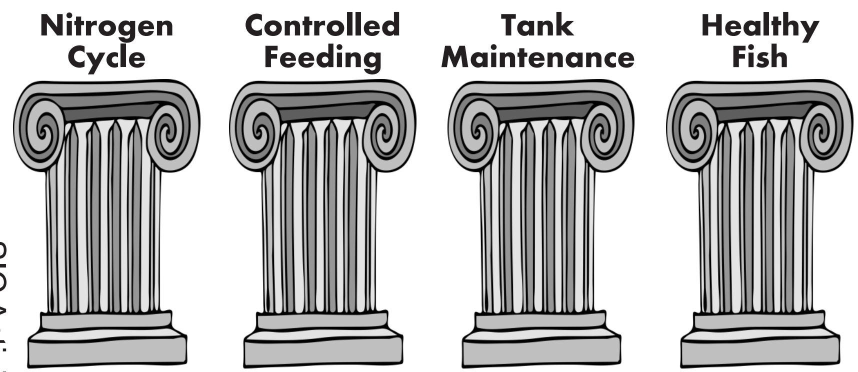
Other Observations

Vocabulary

Aquatic Adventures in Chemistry

Four Pillars of a Successful Aquarium

There are 4 foundations of knowledge that, when understood and practiced, make keeping healthy fish simple and easy!



Our success is our legacy in our aquatic adventures!

The best place to start is at the beginning and that is WATER!

Good Bacteria

Our tank goes through an amazing transformation in order to support life.

- A new tank is void of the good bacteria which is necessary to break down fish waste and excess food
- Good bacteria will naturally colonize and thrive in our filter materials, but it takes time to do so
- In the first 6-8 weeks your aquarium goes through a period where ammonia and nitrite reach varying levels of toxicity that are harmful to fish
- Overfeeding your fish will also raise your ammonia and nitrite to spike, potentially killing your fish

Date _______________ **Water Temperature** __________

Stage ______________________ **Salmon length** ________________

Appearance

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Behavior

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Other Observations

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Date ______________ Water Temperature __________

Stage ____________________ Salmon length _______________

Appearance

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Behavior

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Other Observations

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Bacteria and Filtration can only do so much…

When too much waste accumulates, ammonia, nitrite, and nitrates increase. Not from lack of bacteria, but simply from an excess of food and waste (aka poop).

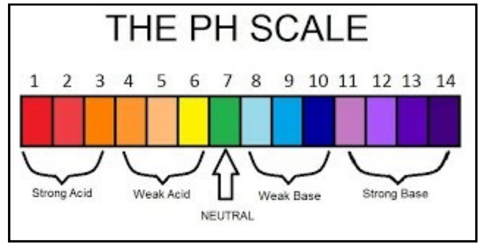
Partial Water Changes

- Using a siphon, waste and debris should be removed from the tank bottom, and 25% of the water should be removed and replaced each week
- Once fish are big (March—May), you will need to siphon twice per week
- When putting clean water back in the tank it is important to treat to remove chlorine, and to use water as close to the tank temperature as possible

A Quick Chemistry Lesson…

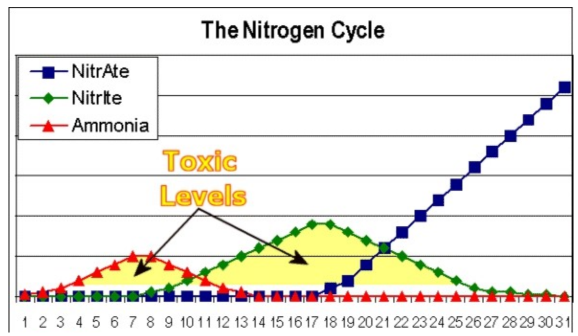
Organics such as excess food and fish waste break down into acids which reduces pH.

When the pH gets below 6.0 good bacteria starts to die and water can turn toxic quickly.



Nitrogen Cycle

Ammonia builds up, and then bacteria convert it to nitrite. Nitrite builds up and another type of bacteria convert it into nitrate which must be siphoned out.



Salmon in the Classroom Journal

Instructions:

1. **Write the date at the beginning of each entry**
2. **Record the water temperature (degrees Fahrenheit)**
3. **Record the "stage" in which the salmon are**
4. **Measure and record the length of the salmon (in centimeters)**
5. **Record their appearance and note changes from last observation**
6. **Record how their behavior has changed since last time**
7. **Draw a pencil sketch to show these changes**

Date ______________ **Water Temperature** __________

Stage ____________________ **Salmon length** _______________

Appearance

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Behavior

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Other Observations

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Date _______________ **Water Temperature** ___________

Stage ______________________ **Salmon length** ________________

Appearance

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Behavior

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Other Observations

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Date _______________ **Water Temperature** ___________

Stage ______________________ **Salmon length** ________________

Appearance

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Behavior

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Other Observations

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Date _______________ **Water Temperature** __________

Stage ____________________ **Salmon length** _______________

Appearance

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Behavior

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Other Observations

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Date _______________ **Water Temperature** __________

Stage ____________________ **Salmon length** _______________

Appearance

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Behavior

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Other Observations

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Date _______________ **Water Temperature** ___________

Stage ______________________ **Salmon length** ________________

Appearance

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Behavior

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Other Observations

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Date _______________ **Water Temperature** ___________

Stage ______________________ **Salmon length** ________________

Appearance

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Behavior

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Other Observations

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Date ______________ Water Temperature __________

Stage ____________________ Salmon length _______________

Appearance

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Other Observations

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Date ______________ Water Temperature __________

Stage ____________________ Salmon length _______________

Appearance

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Other Observations

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Date _______________ **Water Temperature** ___________

Stage ______________________ **Salmon length** ________________

Appearance

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Behavior

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Other Observations

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Date _______________ **Water Temperature** ___________

Stage ______________________ **Salmon length** ________________

Appearance

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Behavior

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Other Observations

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Date ______________ **Water Temperature** __________

Stage ____________________ **Salmon length** _______________

Appearance

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Behavior

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Other Observations

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Date ______________ **Water Temperature** __________

Stage ____________________ **Salmon length** _______________

Appearance

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Behavior

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Other Observations

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Date ______________ **Water Temperature** __________

Stage ____________________ **Salmon length** _______________

Appearance

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Behavior

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Other Observations

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Date ______________ **Water Temperature** __________

Stage ____________________ **Salmon length** _______________

Appearance

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Other Observations

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Date ______________ Water Temperature __________

Stage ____________________ Salmon length _______________

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Other Observations

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Date ______________ Water Temperature __________

Stage ____________________ Salmon length _______________

Appearance

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Behavior

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Other Observations

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Great Lakes Grief

Grade Levels
4-8

Objectives
To introduce students to the long-term impacts and environmental consequences of aquatic invasive species. Students will learn to identify at least three invasive species in our Great Lakes watershed, understand how those species are harmful and learn ways to control their spread.

Best Taught
Any time during the school year.

Materials
- Invasive species images
- Great Lakes basin map
- Sea Grant Invasive Poster Set
- Dry erase markers in different colors
- A ball of string or yarn
- Index cards with a hole punched through
- the top center. Loop string through the
- hole to create signs students can place
- around their necks
- Masking tape
- Scissors
- PowrePoint online (www.michigan.gov/sic)
-

Background
Michigan's environmental well-being and economy, especially our recreation and tourism industries, depend on the health of our watersheds. Since the late 1880s, more than 180 exotic species have been transported and released into the Great Lakes in a variety of ways. Over one-third of the species were introduced in the last half of the 20th century coinciding with the expansion of the St. Lawrence Seaway in 1959. Most species have been introduced by oceangoing ships carrying and releasing ballast water into our ports.

Although ships entering the Great Lakes have been subject to high-seas ballast exchange since 1993, then regulations were first adopted, more measures are needed to control the spread of the invaders already here. These species cause significant ecological problems because they have been introduced into a habitat in which there are no natural controls, such as pathogens, parasites and predators. The invaders may prey upon, out-compete or cause disease in native species.

Activity 1: How did they get here?

Start by asking what it means to be an exotic or alien species. Explain what exotics are and explain that some exotics also can be invasive. When does an exotic species become invasive?
1. Distribute the photographs of the invasive species, one at a time, and tell their names. Using zebra mussels, for example, explain the animal's appetite for plankton (microscopic aquatic plants and animals), which creates a die-off of native clams. One common misconception to see crystal clear water in an inland lake and think the ecosystem is healthy. Water that is filtered by zebra mussels means there is no microscopic feeding for other forage fish or small fry, which affects the food chain all the way up to the big fish.

Without plankton particles suspended in water, sunlight can penetrate to the lake bottom and cause a growth spurt for the rooted aquatic plants which can lead to large dense vegetative mats across the lake. Have the students explain why the manner in which zebra mussels colonize (clogging intake valves and pipes) is bad.

2. Review feeding and behavior patterns of all the species and have students discuss why each of these invasive species could be detrimental, beneficial or neither.

3. Have a student hold the Great Lakes basin map for all to see (or place it on an easel, wall or table). Ask the students how each of these species was introduced into Michigan waters of the Great Lakes and ask for a volunteer to use an erasable marker.

Draw a directional arrow tracing the path of introduction. (The majority of arrows will come from the St. Lawrence Seaway, constructed in 1959. One-third of all aquatic invasive species have been introduced this way). Ask the students to take a close look at the map to identify other possible means of entry (the Chicago Sanitary Ship Canal, for example, has a new electroshock fence built to curb the arrival of the Asian carp).

Take the erasable marker and draw arrows from Lake Ontario to Lake Erie to Lake Huron to Lake Michigan and to Lake Superior, and even down the Mississippi River to show students how these aquatic invasive species can spread, causing more damage and costs to control.

Activity 2: Aquatic invasive species in the web

1. Have all but one of the students form a circle.
2. Ask the circle of students to choose an aquatic plant or animal they would like to be for this activity. Go around the circle and write down on an index card what each student wants to be. As you hand them their card, have them put them around their necks to hang from the yarn as a sign, showing the others what they are.
3. Once everyone has their plant or animal sign around their neck, pass the ball of string to a student and have them tell the group what they are, what they eat, what they look like, etc.
4. Have them choose one other species in the circle that they might depend on as a food source or maintain a symbiotic relationship with. They should hold onto a piece of the string while passing the ball to the plant or animal they depend on. Help the students make plant and animal connections (feeding, breeding, predation, habitat or mutualism).
5. Continue until everyone holding is piece of the string and is connected in this "web of life." It is time to introduce an aquatic invasive species, such as the sea lamprey. Use the student who is not in the circle to represent this species.
6. Give the sea lamprey a pair of safety scissors. Have the student tell the group that they just got into the lake and how they got in.
7. Allow that lamprey to snip one line within the web the goes to an animal they would impact (salmon, trout). How many other animals did that impact?
8. Choose another student to be a zebra mussel. Have them take the scissors and snip another line. Who did that impact?
9. Continue that pattern using species from your poster until the web is well shredded During the wrap-up, discuss again how problematic aquatic invasive species can be and what steps are needed to control them.

Activity 3: Lamprey Tag (outdoors)

If the sea lamprey was not one of the aquatic invasive species that you already have introduced to your class, begin by showing them the photo of the sea lamprey and then discuss the lamprey's life cycle, feeding patterns and problems they have caused in the Great Lakes. Discuss all five species of lamprey found in the Great Lakes, explaining that only the sea lamprey, chestnut lamprey and silver lamprey are parasitic. The American brook lamprey and northern brook lamprey are non-parasitic. Discuss the terms parasitic and non-parasitic.

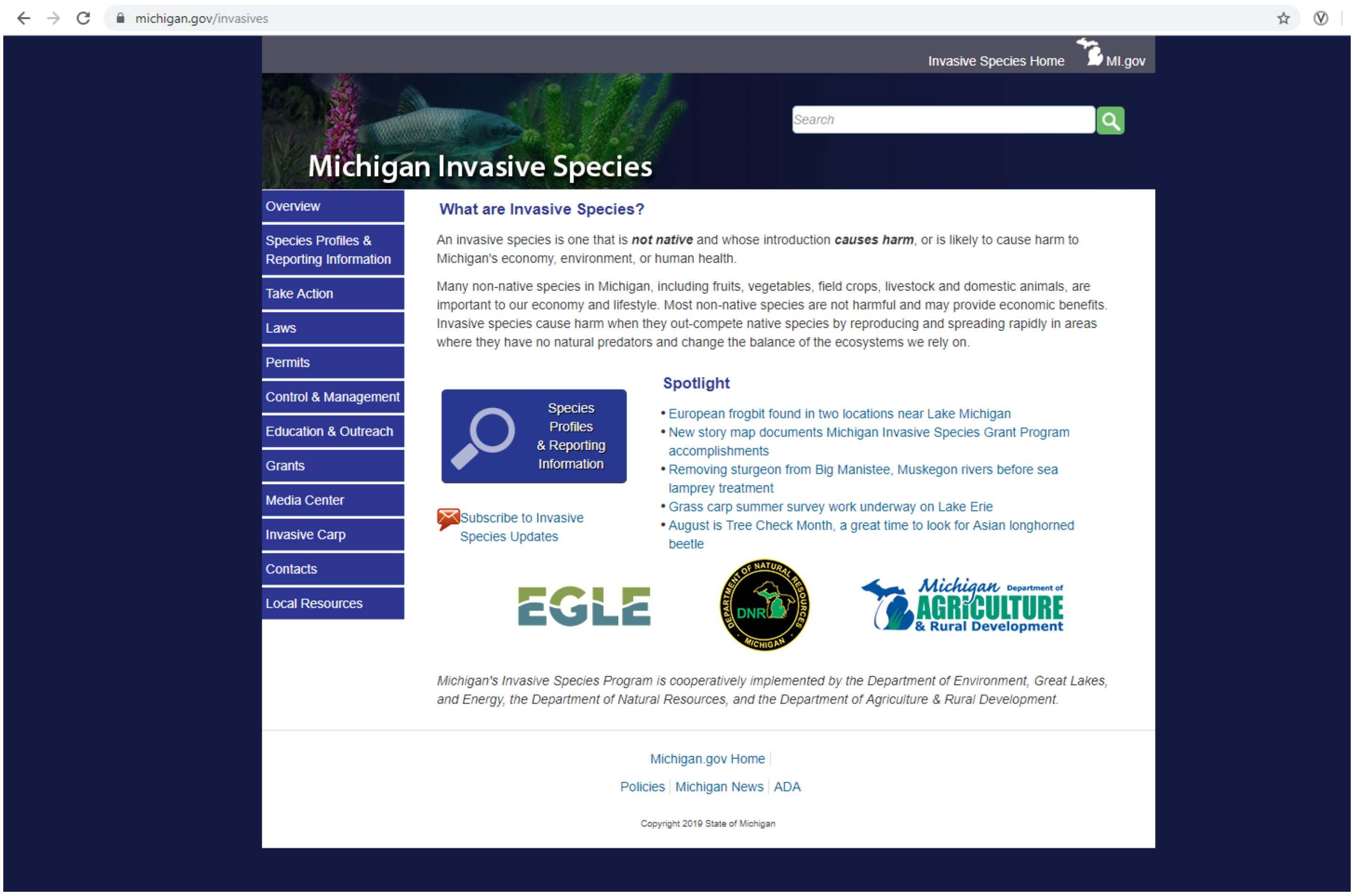
1. Begin the activity by having all but one of the students line up and tell them they are either a salmon or a trout.
2. Choose one student to be the sea lamprey. The trout and salmon stand shoulder to shoulder facing the lamprey across a field or grass that will be the lake. Discuss the boundaries to be used for the activity.
3. When you say, "start swimming," the trout and salmon will swim over to the other side of the lake, trying to avoid the lamprey. The lamprey swims toward the line of fish; chooses one trout or salmon and tags them before they reach the safe zone on the other side of the lake. If tagged by the lamprey, the fish must sit in the grass (die) and then come back to life as a hungry lamprey.
   There is no running during this activity. The fish and lamprey must walk toward their boundaries. If anyone runs, they must sit out one round as a penalty.
4. Continue until all the salmon and trout die and become sea lamprey. During the wrap-up, ask students what they think happens to the food chain in a body of water if the sea lamprey predate upon large fish, such as trout or salmon? How does that affect aquatic systems (flora and fauna) down the chain?

Discussion

- Remind students that as adults they will be faced with the consequences of the impacts of past generations, both positive and negative, on our Great Lakes, inland lakes and streams in our state. Significant strides have been made to correct past problems.
- Ask them for their solutions to these problems and what each of them could do to control the spread of aquatic invasive species.
- Review what causes the spread of aquatic invasive species, fish disease and what students can do to help prevent that spread.
- Also discuss the impacts of some terrestrial invasive species, such as the emerald ash borer or purple loosestrife, so that students understand that invasive species can affect a variety of ecosystems and habitats.
-

Extensions

- Begin a classroom campaign (grant research and writing) for a conservation stewardship project such as the purchase of a high-pressure washer for the local public boat launch and/ or public education signs. Work with local lake associations and units of government, such as the township, for support and partnerships.
- Have the class raise funds for the Great Lakes Protection Fund (see www. michigan.gov/egle)
- Hold a classroom debate and have your students represent different viewpoints such as, conservation officers, ship captains, officials with the Shipping Federation of Canada or the U.S. Environmental Protection Agency, etc. Students can conduct research online at www.michigan. gov/egle and gather information on Ballast Water Reporting, the Great Lakes Protection Fund and Aquatic Nuisance Species, Lake Carriers' Associations, etc.
- Research aquatic nuisance control measures being taken on inland lakes in your county. Have students write a paper on the Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990.



Least Wanted: Sea Lamprey

Grade Levels
6-12

Objectives
Understand the relationship between native, invasive and non-native species in the Great Lakes, and how scientists use control measures to help stabilize these ecosystems.

Best Taught
Early in the school year.

Materials
- Name tag cards on next pages
    - "invasive species" 1 per student
    - "control" 1 per student
    - "first invasive" 1 total
    - "habitat biologist" 3 or less total
- Chart paper and markers
- Cones for marking field boundaries

Background
This activity will engage students in an active simulation of the relationship between native lake trout, the invasive sea lamprey, and the biological control of the introduced, non-native (non-harmful) Chinook salmon.

This activity illustrates the importance of the early warning detection of invasive species (cause ecological, or economic harm) as they attempt to establish themselves in an ecosystem. It is a demonstration of a professional biologist's management of an invasive species before and after its establishment, and conveys the understanding that once an invasive population is established it remains indefinitely.

Procedure
- Print and cut out name tag cards.
- Outline the playing field with cones. (Approximately 50 square yards.)
- Set up chart paper.

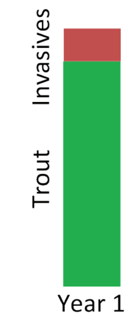
Ask students how they think the sea lamprey got into the Great Lakes and spread. Discuss.

Tell the students they are going to simulate the sea lamprey entering a local native ecosystem (represented by the playing field) and the impact it has over five years.

Activity

Round 1

1. One student will be the "first invasive" sea lamprey (have them wear their card). The rest of the students represent lake trout. Ask all the students, the "first invasive" and the native lake trout to spread out on the playing field. (representing Lake Huron).
2. Chart "Year #1" using a bar graph, with one invasive and the total of the remaining participants as "X# of lake trout".



Round 2

1. The goal of the "first invasive" student is to tag as many fish as possible. The fish try not to get tagged. If they are tagged, they must freeze with their arms out to their side.
2. Stop the round before all the fish are tagged. Ask those that are frozen to raise their hands. Give each an "invasives" tag to wear as they have been overtaken by lamprey. Chart these results on "year #2".

Round 3

1. Repeat for another 30 seconds with all the new “invasive” sea lamprey able to tag lake trout. Chart as “year #3”.
2. Ask the class what they could do to stop or reverse the impact the invasive sea lamprey has had on the great lakes ecosystem. What can stop or slow the spread of invasives including the sea lamprey?

Round 4

1. Introduce a “habitat biologist”, they tag “invasives” and hand them a “control” name tag. During the round, the “Control” tag keeps them safe from being frozen by the “invasive species”. Examples of biological control may be introducing a new species like Chinook to control invasive alewives, or a chemical control like lampricide (TFM), there are even mechanical controls—sea lamprey traps
2. Run a 30 second round and chart the results with the “invasives” and the “habitat biologist” both tagging species.
3. Did adding a biologist slow the spread of the invasive species?

Round 5

1. Add a second/third “habitat biologist” and chart “year #5” results.

Wrap Up Discussion

- Lead student discussion about the chart results.
- Lead student discussion about invasive, non-native, native (here in mid-1800s before European

Habitat Biologist (fisheries management)	**Habitat Biologist (fisheries management)**
Habitat Biologist (fisheries management)	**Habitat Biologist (fisheries management)**
Invasive Species	**Invasive Species**
Invasive Species	**Invasive Species**
Invasive Species	**Invasive Species**

Biological Control	**Chemical Control**
Biological Control	**Chemical Control**
Biological Control	**Chemical Control**
Biological Control	**Chemical Control**
Biological Control	**Chemical Control**

Invasive Species	**Invasive Species**
Invasive Species	**Invasive Species**
First Invasive	

Social Carrying Capacity: AIS Edition

Grade Levels
6-12

Objectives
Discuss how different interested parties affect the management of fisheries through a hands-on balancing act.

Best Taught
Early in the school year.

Materials
- At least 3, 20ft lengths of rope. Each tied to make a skinny oval. (1 length of rope per 2-4 students)
- Both "Natural Resource Issue Cards" and "Stakeholder Cards" printed and cut out.
- Natural resource/wildlife issue props

Background
Wildlife management is defined as "the science and art of managing wildlife and its habitat, for the benefit of the ecosystem, the animals and humans. But how do fisheries biologists do that?

They do it by following a few basic rules:
- Good management must be based on solid biological information.
- Good management must include the management of humans, because our activities affect the ecosystem.
- Good management must benefit plants and other animals, not just one species of wildlife.
- Good management must put animals' numbers at a level we can live with—not too many and not too few.
- Good management must balance animal numbers with the habitat (food, shelter, water and space) available for those animals.
- Good management must balance conservation (wise use) of the resources—not total preservation (non-use) of the resources.

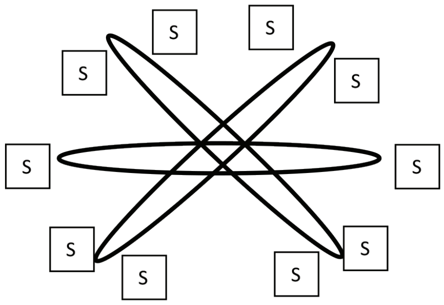
Biological carrying capacity is the number of animals an area can support throughout the year without permanently damaging the habitat or starving the animals. Example—when there are too many animals for the habitat, the animals may eat too much of the vegetation that makes up its food and cover. Once that vegetation is gone, the habitat is damaged and the carrying capacity of the area goes down. With less habitat or poor habitat, the weaker animals will die from disease, starvation, predators or other causes. Fewer animals will be able to live there. As habitat is improved and food becomes more abundant (often initiated by DNR biologists), the carrying capacity goes up again.

Social tolerance (Social Carrying Capacity/Cultural Carrying Capacity) is the number of animals the resource managers or public will allow in an area.

Activity
1. Have the students choose a natural resource issue that people may have varied or opposing opinions about (or introduce one). Examples can be found in the Issues Cards copy me pages. Discuss the scientific facts surrounding the issue and why controversy may be present.
2. Each student should choose one Stakeholder Card that they feel would have an opinion about the issue, and develop their position statement from that stakeholder's perspective. If there are more students than cards, students may pair up.
3. Place the Issue Card you've discussed in the middle of a table. One at a time have students announce which Stakeholder Card they chose, and present their position about the issue, then place their Stakeholder Card in a circle surrounding the Issue Card.
4. Ask the students if there is a way to balance the opinions of the stakeholders to fix the issue, or implement a unified strategy about the issue, if there are solutions list them. What happens if there are none?

Stakeholder Card	Stakeholder Card	Stakeholder Card
Stakeholder Card	Issue Card/ Picture	Stakeholder Card
Stakeholder Card	Stakeholder Card	Stakeholder Card

5. Next, lay out the 3 ropes, with the centers over-lapping in a starburst pattern.



6. Have the students choose another issue by selecting from your prop choices. For example, a stuffed salmon. Discuss the scientific facts surrounding the raising of salmon in hatcheries for the purpose of stocking the great lakes. Which lakes are successful? How do you balance the fishers need for more fishing opportunities?
7. Have each student or pair of students choose a Stakeholder Card to build a position statement, and have them state their position, then place their card at one end of a rope, so that each rope end ends up with at least one Stakeholder Card next to it-shown by the S boxes above.
8. Place the stuffed animal on the nexus of the 3 ropes, have the students each grab an end of each rope next to their card.
9. Direct the students to work together to raise and balance the stuffed fish in the center of the ropes. Is it easy? What happens if you drop the bottom rope a few inches-which stakeholders does that rope represent? Are all stakeholders equal in this simulation? What happens if one rope goes off center? When is it easiest to balance the fish.
10. Ask the students if they know the definition for Biological Carrying Capacity. Ask them if they know what Social Carrying Capacity is? Explain that Social Carrying Capacity is often lower than the Biological Carrying Capacity—and ask them why?
11. Have the students run through another round with a familiar issue. Have them choose their Stakeholder Card and determine their position statement, and place their cards on the rope ends where they feel their impact fits (maybe animal rights activists and universities at either end of the bottom rope, with fishers and boat owners on the top rope), place a small toy boat on the center of the ropes.
12. Have them again manipulate the ropes to see if they can balance the boat, and discuss what happens to the social carrying capacity when the bottom rope is removed, or others move off center.
13. Have the students summarize what inferences they could make about future resource issues.

Elementary Extensions

- With younger students, you can skip the stake-holder discussion portion of the activity and begin with the rope balance as a game. Have them wear the stakeholder cards as name badges, and have them work to balance the stuffed animal on the center of the ropes.
- Discuss how there are a lot of people involved in helping our lakes to be balanced. Do they have people in their family that use or depend on the lakes? (Fishers, boaters, scientists, etc.)
- Use larger and smaller stuffed animals to make the game easier and harder. Are some species easier to make a decision about?

Boat Owner	**Fishers**
Law Enforcement	**Media**
Animal Rights Activists	**Department of Natural Resources**
Canadian Government	**Department of Environment, Great Lakes and Energy**
Department of Agriculture and Rural Development	**Stakeholders (Trout Unlimited, Steelheaders, etc)**

Universities	**Local Community Citizens**
Lakeshore Property Owners	**Economic Development Agencies**
Business Partners (oil, gas, minerals)	**Retail Sales (bait shops, sporting goods)**
Local Businesses (restaurants, hotels)	**Commercial Fishers**
Other Great Lakes State Governments	**Fisheries Commission**

Introduced Salmon

Invasive Mussels

Invasive Carp Threat to Great Lakes

Invasive Goby

Great Lakes Fishing

River/Stream Fishing

Recreational Boaters

Beach Home Owners

Coastal Recreation Businesses

Native Great Lakes Species

Invisible Migration

Grade Levels
2-8

Objectives
Students will understand how invasive species were able to travel from other continents, through the Atlantic Ocean, through rivers and canals and into the Great Lakes.

Best Taught
Any time.

Materials
- Plastic boat
- Water body name cards
- GloGerm or Vaseline
- Hand held blacklight
- Map and route from this activity

Background
Invasive species have gotten to Michigan through a variety of paths. Aquatic invasive species specifically have gotten here on boats, in boats, and in the water that carries boats. The opening of canals 100+ years ago, connected waterways that had never been connected before.

Shipping, ballast water, canals, purposeful introduction, release of bait, accidental release, the pet trade and more are all ways that invasive species have gotten into the Great Lakes.

There are many species (sea lamprey, zebra and quagga mussels, Eurasian watermilfoil, red swamp crayfish, etc) that have been introduced.

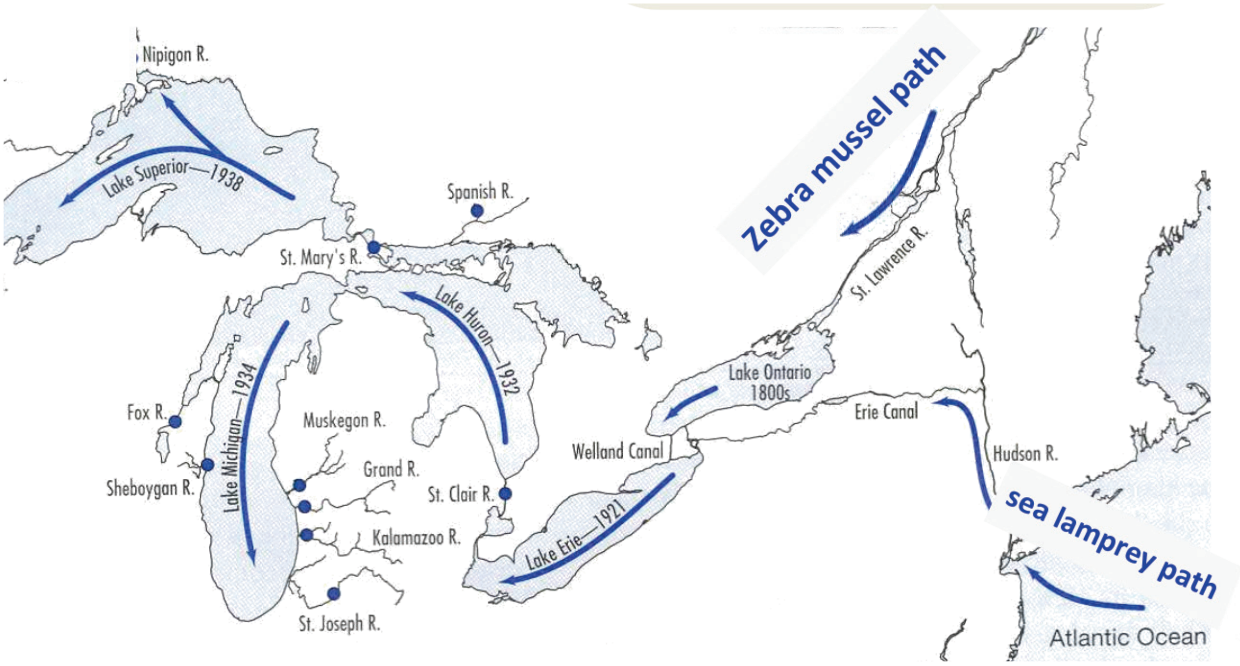
Sea lamprey were once thought to have come into the Great Lakes via the St. Lawrence Seaway and the Welland Canal around Niagara Falls. But historical data shows their presence in Lake Eries prior to Lake Ontario, leading scientists to believe they can through the Hudson River and the Erie Canal.

Zebra mussels are though to have traveled the Atlantic Ocean, the St. Lawrence Seaway and into the Great Lakes in ballast water of ships.

Procedure
- Immediately prior to starting the game, coat the plastic boats with GloGerm or petroleum jelly. (Don't let students see you—surprise!)
- Assign students name badges (up to 2 per name.)
- Utilize a map of the great lakes to familiarize the students with the geography. A Great Lakes basin map is available here: www.miseagrant.umich.edu/files/2012/10/Sept-2012-msg-pub-list.pdf

Activity
1. Discuss with your students what invasive species are, and the many ways they got to the Great Lakes region (shipping, ballast water, canals, introduction, bait, accidental release, pet trade, etc.).
2. Can they give examples of animals that have come to our area this way? (Sea lamprey, zebra mussels, quagga mussels, Eurasian watermilfoil, red swamp crayfish, etc.)
3. We are going to highlight the path of sea lamprey via the Hudson River and Erie Canal; or the zebra mussel introduction via the St. Lawrence Seaway and Lake Ontario. See map on the next page of the zebra mussel invasion.
4. Have students wear their name badges and arrange themselves in the proper order from the Atlantic Ocean (where ships enter our waters) through the rivers and canals to the Great Lakes.
5. Once students are arranged, have them hold hands with their peers on both sides.
6. Starting at the Atlantic Ocean, hand the coated boat to the first student. **Students must touch the boat with both hands, pass it to the next student, then rejoin hands with them after they pass it on.
7. If you have more than one boat to send through, start the next boat after the first goes halfway.
8. After the boats have sailed from the Atlantic Ocean all the way to Lake Michigan/Superior have the students let go of their peers hands.
9. Ask them what they think happens as the boats move through the rivers and canals into the lakes. Do they take invaders? The more boats the more invaders?

10. Turn off the lights and shine the black-light on the students hands. Did they pass invaders along and didn't know it? Were there higher concentrations in certain locations?
11. Run another round, but when the boat reaches the Detroit River, add more GloGerm at the port, then have them pass it on.
12. Recheck with the black-light. What did adding more symbolize?
13. Run the simulation with different scenarios and discuss.



Path of the Invaders

Zebra Mussels

Baltic Sea → Atlantic Ocean → St. Lawrence Seaway → Lake Ontario
Port of Detroit ← Detroit River ← Lake Erie ← Welland Canal
Lake St. Clair → Lake Huron → St. Marys River → Lake Superior
Straits of Mackinac → Lake Michigan

Sea Lamprey

Atlantic Ocean → Hudson River → Erie Canal → Lake Ontario → Welland Canal
St. Clair River ← Lake St. Clair ← Port of Detroit ← Detroit River ← Lake Erie
Lake Huron → St. Marys River → Lake Superior
Straits of Mackinac → Lake Michigan

Curriculum Connections

There are many great partner curriculums available to teachers to help teaching about the environment easier. Most of these guides are available through professional development workshops and include tons of curriculum support. Contact the state coordinator of each to become certified. Some of these guides include:

- Project WILD, Aquatic WILD, Growing Up WILD
- Project WET
- Project Learning Tree
- MEECS (MI Environmental Education Curriculum Support)

For more on the water cycle, see:

The Incredible Journey. Grades K-12.
In: Project WET.
With a roll of a cube, students simulate the movement of water within the water cycle.

Nature's Recycling! Part A: The Water Cycle. Grades 4-6.
In MEECS Ecosystems and Biodiversity.
Introduction to Hydrologic Cycle.

Activity 44: Water Wonders. Grades 4-8.
In: Project Learning Tree: Pre K-8 Environmental Education
This interactive activity allows students to experience a simulation of the water cycle as though they were an individual water molecule.

For more on watersheds, see:

Poster Activity: Introduction to Watersheds. Grades 3-5.
In MEECS Land and Environment.
Could use with activities "Salmon Scents" or "Migration Fixation" from Aquatic Wild.

Blue River. Grades 4-8.
In: Project WET.
Students participate in a whole-body exercise to simulate the movement of water through a river and its watershed.

Do You Know YOUR Watershed? Grades 6-8.
In MEECS Water Quality.
Is There Hardpan Underfoot? In Science and Civics: Sustaining Wildlife. Students measure and calculate the impervious surface of the school grounds or community property, measure or find data of rainfall on the area, calculate the runoff from the area, and determine the effects on local aquatic and wetland ecosystems.

Curriculum Connections

For more on water chemistry, see:

To Breathe or Not to Breathe? Grades 9-12.
In Science and Civics: Sustaining Wildlife.
By measuring and comparing the salinity, the concentration of oxygen, and the temperature of six water samples, students determine relationships between these factors and form hypothesis on the role of these factors in aquatic ecosystems. Extension: Based on the temperature of the water in the salmon tank, have students calculate the dissolved oxygen concentration in the tank.

Is there water on Zork? Grades 6-12.
In: Project WET.
Students describe the unique characteristics of water and design investigations to distinguish water from other clear liquids. An activity good for coordinating with other science teachers.

For more on water quality and water supplies, see:

Common Water. Grades Pre-K-8.
In: Project WET.
Students analyze the results of a simulation to understand that water is a shared resource and is managed.

A-maze-ing Water. Grades Pre-K-8
In: Project WET.
Student guide a drop of water through a maze of “drainage pipes” to learn how activities in their homes and yards affect water quality.

Would You Drink This Water? Grades 6-8.
In MEECS Water Quality.
See Point 7, “Discuss How Water Quality Standards are set” and corresponding activity “Who Cares About Water Quality? Why Do They Care?”.

Bioaccumulation and the Great Lakes Ecosystem. Grades 6-8.
In MEECS Water Quality.
See supporting materials, “A Lake Trout Food Web in the Upper Great Lakes” and “Bioaccumulation of Contaminants in the Great Lakes Food Chain”.

Curriculum Connections

For more on fish biology and lifecycles, see:

Fishy Who's Who. Grades 4-8.
In Aquatic Wild.
Use supporting materials from SIC Manual activity "Latin Lingo" to help students identify fish found in the Great Lakes, or to discuss how scientists decide how to classify fish.

Hooks and Ladders. Grades 6-8.
In Aquatic Wild.
Pacific Salmon life cycle activity.

For more on habitats and ecosystems, see:

Ecosystems Basics. Grades 4-6.
In MEECS Ecosystems and Biodiversity.
Points 5 and 6, use Is That Really an Ecosystem? cards alongside tank water monitoring to discuss differences between managed and unmanaged ecosystems, and the importance of measuring and maintaining the tank's water parameters.

Designing a Habitat. Grades 4-8.
In Aquatic Wild.
Prior to tank set-up,this activity can be adapted to focus on salmon specifically to get students thinking about what incoming salmon eggs will need to survive.

For more on fisheries management, see:

The Commons Dilemma. Adaptable to Grades 4-12.
In: Project F.I.S.H.
Demonstrates the role of fisheries management in relation to carrying capacity and overfishing.

How Healthy is This Stream? Grades 6-8.
In MEECS Water Quality.
See Activities, "Where Should the Brook Trout Be Planted?" and "Stream Assessment Data Table". Can adapt this activity to "Where Should the Salmon Be Planted?" by altering the section "Brook Trout Requirements" to instead include parameters for salmon.

Weighing the Options: A Look at Tradeoffs, Grades 9-12.
In Project Learning Tree: Exploring Environmental Issues: Focus on Risk.
See Part B particularly. Students consider the tradeoffs and benefits in introducing and stocking salmon in the Great Lakes Region.

Curriculum Connections

For more on fisheries management, see:

Do You Hear What I Hear, See What I See? Grades 9-12.
In Science and Civics: Sustaining Wildlife.

Students compare different media messages about an environmental topic or media in general. Can be easily adapted to discuss many topics and perspectives by selecting the media to analyze or giving students a topic to research.

- Extension possibility: Fish Fight. Have students compare the social media, news and press releases, and other publications produced by the Great Lakes Salmon Initiative or similar organization, by academic researchers studying the great lakes salmon fisheries (for example, Dr. Adlerstein-Gonzalez at U of M), and by the Conservation Gateway or similar organization in regards to the stocking of salmon in the Great Lakes. What are the goals and perspectives of each of these entities? How are those perspectives reflected in the media each entity produces? Look into the history of salmon stocking by checking out “Something Spectacular: My Great Lakes Salmon Story” on the SIC book list!

For more on human impacts, see:

The Carbon Cycle: Sources and Sinks. Grades 6-12.
In MEECS Climate Change: Science and Impacts.

Explore the Carbon Cycle by discussing how climate change impacts in Michigan include increased sediment deposition and acidification of the Great Lakes, and how these impacts might affect the food web.

- For more on sedimentation, See “Silt: A Dirty Word” in Section 3 of Aquatic WILD, for grades 4-8.

Water Balance and the Great Lakes. Grades 6-12.
In MEECS Climate Change: Science and Impacts.

See supporting Material “Climate Change and the Great Lakes” to start a conversation how changing lake temperatures, changing lake levels, and natural distribution barriers (such as the inability of aquatic life to travel beyond shorelines) threatens the stability of the Great Lakes ecosystem.

Dam Design. Grades 6-12.
In Aquatic Wild.

Students identify and evaluate factors that contribute to salmon’s difficulty migrating and develop a dam design that mitigates these.

Alternative to “What I Did on Summer Vacation- What Can I Do on Summer Vacation?”
In: The Water Sourcebook. Grades 9-12.

Students discuss what they might like to do on a vacation to a coastal area and then discuss the effect of these activities on coastal and aquatic ecosystems. In groups, they then research and create a travel brochure for environmentally friendly summer activities in their chosen area.

Curriculum Connections

For more on cultural aspects of water and aquatic ecosystems, see:

Activity 87: Earth Manners. Grades K-4.
In: Project Learning Tree: Pre K-8 Environmental Education Activity Guide.
This activity includes the story Trapper by Stephen Cosgrove and Robin James to help students understand good stewardship practices and respect for natural resources, and to come up with their own rules for learning outdoors. Use this activity prior to release day to encourage earth-minded behavior.

Raining Cats and Dogs. Grades 4-8.
In: Project WET.
Students analyze and interpret water sayings—through a card game, skits, pantomime, and creative writing—to compare figures of speech across cultures and climate zones.

Water Wings. Grades 4-8.
In Aquatic Wild.
Students create artwork after visiting a stream or lake to develop awareness of the water cycle and the importance of water.

Activity 59: Power of Print. Grades 6-8
In: Project Learning Tree: Pre K-8 Environmental Education Activity Guide.
Students study how ideas and opinions are expressed through word choice by comparing various newspaper articles on the same topic.

Structure Review. Grades 9-12.
In Science and Civics: Sustaining Wildlife.
Students research the different branches of government to learn about the functions and powers government has in relation to the environment. Extension: research the structural organization of the State of Michigan and then delve into the DNR. How are programs like Salmon in the Classroom created and implemented? Which people are responsible for salmon fisheries management, permits, and workshops? Are they all the same?

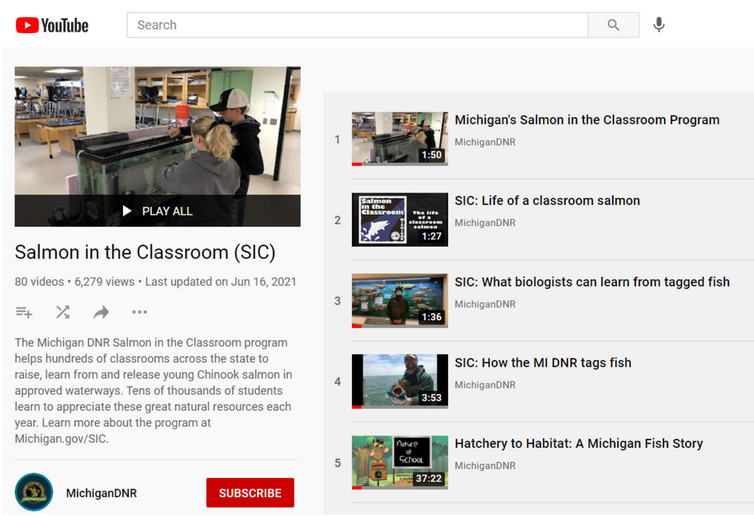
Do You Hear What I Hear, See What I See? Grades 9-12.
In Science and Civics: Sustaining Wildlife.
Students compare different media messages about an environmental topic or media in general. Can be easily adapted to discuss many topics and perspectives by selecting the media to analyze or giving students a topic to research.

- Extension possibility: social media discussion—have students find and compare or compare pre-selected social media posts, music, or other forms of social media that involves water, watersheds, or aquatic species. Or, have them discuss social media posts and interactions they recall from their own lives regarding water and aquatic ecosystems, if appropriate for the classroom. Have these interactions influenced their values, behavior, or opinions? How so? What messages do students receive from social media regarding water use? What messages do they send out on their social media regarding water use?

Video Resources

Michigan SIC has two YouTube playlists to help you teach all about our Great Lakes resrouces.

Student Friendly Playlist



Our student friendly playlist has videos explaining hatchery processes, fisheries research techniques, fish anatomy and more. It also has videos documenting the growth and maintenance of the salmon for an entire school year.

Find it at tinyurl.com/SICstudentplaylist

Teacher Specific Playlist

Our teacher specific playlist has videos to help teachers with tank maintenance, behind the scenes information, workshop sessions for refresher, and other expert sessions.

Find it at tinyurl.com/SICteacherplaylist

Fishing How-to Videos

Do you want to teach about fishing, bait, tackle and more? The Aquatic Resources Education Association (AREA) has a great set of playlists with how-to videos on just about everything fishing related from around the country!

Find it at tinyurl.com/AREAfishingvideos

Equipment List

Teachers often ask "If I got a large grant, and could by any equipment I want, what would you suggest?"

We have put together the start of a "dream" equipment list. If you have other items that are favorites that are not on this list, please email paget3@michigan.gov and let us know!

Catalogs

WildCo - professional sampling gear
Eagar Inc - professional sampling and hatchery gear
Carolina Biological - classroom gear
Fisher Scientific - classroom gear
Acorn Naturalists - environmental education gear
Nature Watch - environmental education gear

Equipment

Waders

(For invasive species decontamination, you want boot soled PVC/canvas waders. Cabelas/Basspro offer teacher discounts. We have had good longevity with Cabelas brand as well as Compass brand)

D nets

- Professional grade
- User friendly
- Budget friendly - projectfish.org

River sampling tools

- Secchi Disk - measure turbidity off a bridge or boat
- Plankton net (use off boat or bridge with good flow)
- Benthic samplers (for sediment investigation)
- Current meters
- Water samplers

Macroinvertebrate sampling

- Macro sorting trays (Washing machine tray from Home Depot / Lowes)
- White ice cube trays (for sorting bugs)
- Glass jars
- Ethanol
- Forceps (paint handles bright orange to find when dropped in the grass)
- Magnifying lenses
- Microscope with cell phone adapter
- Field Dissecting Scope

Fishing

Connect with Mark Stephens at ProjectFISH for training and all the gear you would need to fish with students! We recommend:

- Backyard Bass
- Tackle Crafting
- "Fish Sticks" pvc casting practice

Book List

Kids Books

Ecosystems Thinking

Big Fish Dreams. By Lori Fisher Peelen. ISBN-13: 978-0988350878. Fiction. Grades: 2-3. Big Fish Dreams depicts the interconnectedness of ecosystems, watersheds, and fisheries, by following boy as he follows a salmon travelling upstream to spawn.

The Sockeye Mother. By Brett D. Huson. ISBN-13: 978-1553797395. Fiction. Grades: 3-7. Winner of the 2017 Science Writers and Communicators of Canada book award, and others, The Sockeye Mother contextualizes the importance of salmon to the Canadian Skeena River and to the Gitxsan People, opening discussion for the role of the environment in shaping culture and wellbeing.

Salmon Forest. By David T. Suzuki. ISBN-13: 978-1553651635. Fiction. Grades: 5-8. As Kate visits the river her father studies as a biologist, Salmon Forest links the spawning of sockeye salmon in West Coast Rainforests to the health of forest ecosystems and the people that rely on them.

Watersheds & Hydrogeography

The Legend of the Sleeping Bear. By Kathy-jo Wargin. ISBN-13: 978-1886947351. Folktale. Grades 1-5. Wargin recounts the Ojibwe folktale of the legend of the sleeping bear dunes. This folktale represents the movement of the sand dunes through the eyes of a mother bear's desire to protect her cubs.

The Great Lakes. By Kathy Henderson. ISBN-13: 978-0516011639. Non-fiction. Grades 2-4. A straightforward guide to the formation of the Great Lakes Basin, touching on some of the challenges the lakes face today.

Paddle-to-the-Sea. By Holling Clancy Holling. ISBN-13: 978-0395292037. Fiction. Grades 5-7. Paddle-to-the-Sea explores the Great Lakes region through the eyes of a wooden canoe traveling along Michigan's Lakes and Rivers.

Stewardship

The Water Walker / Nibi Emosaawdang. By Joanne Robertson. ISBN-13: 978-1772601008. Fiction, based on a true story. Grades 1-3. Robertson recounts the story of her grandmother's journey to protect Great Lakes water.

Come Back, Salmon. By Molly Cone. ISBN-13: 978-0871565723. Non-fiction. Grades: 4-5. The true and inspiring story of elementary school students from Everett, Washington, who decided to clean up a local river and revitalize the salmon spawning grounds there.

Just for Fun

Michigan Chillers #18: Sault Ste. Marie Sea Monsters. By Johnathan Rand. Fictional thriller, mystery. Grades 5-7. Vacationing with family, Brittany she thinks she sees something lurking beneath the surface of the St. Mary's River. What—or who—will she discover?!

Shipwrecks, Monsters, and Mysteries of the Great Lakes. By Ed Butts. ISBN-13: 978-1770492066. Historical non-fiction. Collection of short stories about unsolved shipwrecks in the Great Lakes engages the imagination.

Kids Books Continued

Maritime History

The Edmund Fitzgerald: The Song of the Bell. By Kathy-jo Wargin. Historical Fiction. Grades K-4. ISBN-13: 978-1585361267.
Weaving together poetry, prose, and vibrant art, this book describes the tragedy of the Edmund Fitzgerald at an age-appropriate level.

Steamboats and Sailors of the Great Lakes (Great Lakes Books Series). By Mark L. Thompson. Historical Non-fiction. Grades 9-12.
Thompson details the history of transportation in the Great Lakes watershed, giving insight to the economic importance of freighters and the cultural experience of life as a sailor.

Western Great Lakes Lighthouses: Michigan and Superior, and Eastern Great Lakes Lighthouses: Huron, Erie and Ontario. By Ray Jones and Bruce Roberts.
ISBN-13: 978-0762709335.
Featuring beautiful photos, this guide includes many of the lighthouses along the Great Lakes coasts and their history.

Foghorns Saved Lives, Too: Lighthouse living in Michigan's Upper Peninsula. By Vivian DeRusha Quantz. ISBN-13: 978-0739201572. Memoir.
Written by the daughter of a lighthouse keeper, this book describes life as a lighthouse keeper in northern Michigan.

Adult / Grades 11-12

Science Communication

The Death and Life of the Great Lakes. By Dan Egan. 2018. ISBN-13: 978-0393355550.
Non-fiction. A Finalist for the Pulitzer Prize, The Death and Life of the Great Lakes reminds us of the global importance of the freshwater in Michigan's Great Lakes, weaving ecological, political, and historical stories to illustrate looming threats from invasive species and toxic algae, and what we can do about them.

Ruin and Recovery: Michigan's Rise as a Conservation Leader. By David Dempsey. 2001. Non-fiction. ISBN-13: 978-0472067794.
Major conservation failures in Michigan's forests and rivers gave rise to best practices in conservation, making Michigan a leader in environmentalism.

Pandora's Locks: The Opening of the Great Lakes-St. Lawrence Seaway. By Jeff Alexander. 2011. ISBN-13: 978-0870138720. Non-fiction.
Alexander intersperses science with personal accounts to document how the influence of politicians and engineers led to the construction of the St. Lawrence Seaway, opening the Lakes to invasive species and their consequences.

Fish For All: An Oral History of Multiple Claims and Divided Sentiment on Lake Michigan (Michigan And The Great Lakes). By Michael Chiarappa. 2003. ISBN-13: 978-0870136344.
Using oral history to contextualize the multiple claims of various stakeholders in Lake Michigan's fisheries, Fish For All provides a fair and multi-faceted consideration of competing claims to the resource.

Adult / Grades 11-12 Continued

Academic

The Life of the Lakes: A Guide to the Great Lakes Fishery. 4th Edition. By Brandon C. Schroeder, Dan M. O'Keefe, and Shari L. Dann. 2019.
ISBN-13: 978-0472037216. Scientific Non-fiction. The most recent edition of Life of the Lakes offers a an excellent resource for educating about the historical and modern relationships that comprise the Great Lakes fisheries.

The Great Lakes: The Natural History of a Changing Region. By Wayne Grady. 2011.
ISBN-13: 978-1553658047. Scientific Non-fiction. Grady provides a comprehensive look at the geologic history of the Great Lakes region, as well as the environmental, ecological, and climatic factors to illustrate the environmental shaping of the three major Great Lakes forest biomes.

Biodiversity, Conservation and Environmental Management in the Great Lakes Basin. By Eric Freedman and Mark Neuzil. 2019.
ISBN-13: 978-0367376994. Scientific Non-fiction. A multidisciplinary work, this first edition looks at threats to the Great Lakes region from the perspective of multiple authors.

Alexis Rockman: The Great Lakes Cycle. By Dana Friis-Hansen. 2018.
ISBN-13: 978-1611862911. Scientific non-fiction. Combining beautiful artwork and scientific knowledge, Friis-Hansen and Rockman engage with the Great Lakes as they stand today.

Fishing

Great Lakes Steelhead, Salmon & Trout: Essential Techniques for Fly Fishing the Tributaries. By Karl Weixlmann. 2009.
ISBN-13: 978-0811735834. Non-fiction. Weixlmann's illustrated guide provides fly-fishers with the inside scoop on tying, baiting, and best spots for steelhead and trout in Michigan.

Seines to Salmon Charters, 150 Years of Michigan Great Lakes Fisheries. Produced by the Department of Fisheries and Wildlife. 1977.
A walkthrough on the variety of fisheries changes and technologies used throughout the Great Lakes region, past and present, this is a resource for practicing fishers or those who are interested in the changes in fisheries over time.

Historical

Something Spectacular: My Great Lakes Salmon Story. By Howard A. Tanner. 2018.
ISBN-13: 978-1611863031. Non-fiction scientist biography. In 1964, Tanner became the new chief of the Fish Division in Michigan's Department of Conservation. Documents his struggles and accomplishments as he re-oriented the Fisheries Division from commercial to sportfishing, celebrating the steps it took to create salmon fisheries and salmon sportfishing in Michigan's Great Lakes.

Peoples of the Inland Sea: Native Americans and Newcomers in the Great Lakes Region, 1600–1870 (New Approaches to Midwestern History). By David Nichols. 2018.
ISBN-13: 978-0821423202.
Historical non-fiction. An ethnohistorian account of the turbulent experiences of various the Great Lakes Native empires and their people throughout a 300 year span.

Great Lakes Sea Lamprey: The 70 Year War on a Biological Invader. By Cory Brant. 2019.
ISBN-13: 978-0472131563.
Historical Non-fiction. A researcher for the USGS, Brant provides an historical account of the invasion of sea lamprey into the Great Lakes and their ongoing impact.

King of FIsh: The Thousand-Year Run of Salmon. By David Montgomery. 2004.
ISBN-13: 978-0813342993. Non-fiction.
Outlines the natural and human forces that have impacted Pacfic salmon in their native habitat.

NGSS Correlations

The Great Swim
Grades 3-12
3-LS1-1
DCI-LS1: Growth and Development of Organisms,
SEP: Developing and Using Models, CCC: Patterns
MS-LS2-4
DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
SEP: Engaging in Argument from Evidence, CCC: Stability and Change
HS-LS2-2
DCI-LS2: Ecosystem Dynamics, Functioning and Resilience,
DCI-LS2: Interdependent Relationships in Ecosystems,
SEP: Using Mathematics and Computational Thinking,
CCC: Scale, Proportion, and Quantity

Why Fish Go To School
Grades 9-12
HS-LS2-4
DCI-LS2: Cycles of Matter and Energy Transfer in Ecosystems,
SEP: Using Mathematics and Computational Thinking,
CCC: Energy and Matter

How Many Fish
Grades 6-8
MS-LS1-4
DCI-LS1: Growth and Development of Organisms,
SEP: Engaging in Argument from Evidence,
CCC: Cause and Effect

Salmon Scents
Grades 3-6
4-LS1-2
DCI-LS1: Information Processing,
SEP: Developing and using models,
CCC: Systems and System Models

NGSS Correlations, continued

Migration Fixation
Grades 3-6
- **3-LS4-3**
  - DCI-LS4: Adaptation,
  - SEP: Engaging in Argument from Evidence,
  - CCC: Cause and Effect
- **MS-LS2-4**
  - DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
  - SEP: Engaging in Argument from Evidence,
  - CCC: Stability and Change

Salmon Survival
Grades 4-12
- **4-LS1-1**
  - DCI-LS1: Structure and Function,
  - SEP: Engaging in Argument from Evidence,
  - CCC: Systems and System Models
- **MS-LS2-4**
  - DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
  - SEP: Engaging in Argument from Evidence,
  - CCC: Stability and Change
- **HS-LS4-5**
  - DCI-LS4: Adaptation,
  - SEP: Engaging in Argument from Evidence,
  - CCC: Cause and Effect

Salmon Lifecycle Mini Unit
Grades Prek-3
- **3-LS1-1**
  - DCI-LS1: Growth and Development of Organisms,
  - SEP: Developing and Using Models,
  - CCC: Patterns

Salmon Timeline Shuffle
Grades 3-12
- **3-LS1-1**
  - DCI-LS1: Growth and Development of Organisms,
  - SEP: Developing and Using Models,
  - CCC: Patterns
- **3-LS4-3**
  - DCI-LS4: Adaptation,
  - SEP: Engaging in Argument from Evidence,
  - CCC: Cause and Effect

NGSS Correlations, continued

Fish Finder
Grades 4-6
4-LS1-1
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models

Scales and Tails
Grades 4-12
4-LS1-1
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models
4-LS1-2
DCI-LS1: Information Processing,
SEP: Developing and using models,
CCC: Systems and System Models
MS-LS1-3
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models
HS-LS1-1
DCI-LS1: Structure and Function,
SEP: Developing and Using Models,
CCC: Systems and System Models

Pin the Parts on the Salmon
Grades 3-7
4-LS1-1
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models
MS-LS1-3
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models

NGSS Correlations, continued

Fashion a Fish
Grades 3-6
3-LS3-2
DCI-LS3: Inheritance of Traits, DCI-LS3: Variation of Traits,
SEP: Constructing Explanations and Designing Solutions,
CCC: Cause and Effect;
4-LS1-1
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models
MS-LS4-4
DCI-LS4: Natural Selection,
SEP: Constructing Explanations and Designing Solutions,
CCC: Cause and Effect

Research Revolution
Grades 4-12
4-LS1-1
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models
MS-LS1-4
DCI-LS1: Growth and Development of Organisms,
SEP: Constructing Explanations and Designing Solutions,
CCC: Cause and Effect

Squid Dissection
Grades 3-12
3-LS4-2
DCI-LS4: Natural Selection,
SEP: Constructing Explanations and Designing Solutions,
CCC: Cause and Effect
4-LS1-1
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models
4-LS1-2
DCI-LS1: Information Processing,
SEP: Developing and using models,
CCC: Systems and System Models
MS-LS1-3
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models

NGSS Correlations, continued

Great Lakes, Great Fish
Grades 3-6
- **3-LS3-2**
  - DCI-LS3: Inheritance of Traits,
  - DCI-LS3: Variation of Traits,
  - SEP: Constructing Explanations and Designing Solutions,
  - CCC: Cause and Effect
- **5-ESS2-2**
  - DCI-ESS2: The Role's of Water in Earth's Surface Processes,
  - SEP: Using Mathematics and Computational Thinking,
  - CCC: Scale, Proportion, and Quantity

What is Your Watershed Address
Grades 3-12
- **5-ESS3-1**
  - DCI-ESS3: Human Impacts on Earth Systems,
  - SEP: Obtaining, Evaluating, and Communicating Information,
  - CCC: Systems and System Models
- **MS-LS2-3**
  - DCI-LS2: Cycle of Matter and Energy Transfer in Ecosystems,
  - SEP: Developing and Using Models, Energy and Matter
- **MS-ESS2-4**
  - DCI-ESS2: The Role's of Water in Earth's Surface Processes,
  - SEP: Developing and Using Models, CCC: Energy and Matter

Water Bug Hunt
Grades 3-12
- **3-LS4-3**
  - DCI-LS4: Adaptation,
  - SEP: Engaging in Argument from Evidence,
  - CCC: Cause and Effect
- **MS-LS2-4**
  - DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
  - SEP: Engaging in Argument from Evidence,
  - CCC: Stability and Change
- **HS-LS2-2**
  - DCI-LS2: Interdependent Relationships in Ecosystems,
  - DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
  - SEP: Using Mathematics and Computational Thinking,
  - CCC: Scale, Proportion, and Quantity

NGSS Correlations, continued

What's in the Water
Grades 3-12

3-LS4-3
DCI-LS4: Adaptation,
SEP: Engaging in Argument from Evidence,
CCC: Cause and Effect

MS-LS2-1
DCI-LS2: Interdependent Relationships in Ecosystems,
SEP: Analyzing and Interpreting Data,
CCC: Cause and Effect;

HS-ESS2-5
DCI-ESS2: The Role's of Water in Earth's Surface Processes,
SEP: Planning and Carrying Out Investigations,
CCC: Structure and Function

Savin' Salmon Streams
Grades 4-8

MS-ESS3-3
DCI-ESS3: Human Impacts on Earth Systems,
SEP: Constructing Explanations and Designing Solutions,
CCC: Cause and Effect

MS-LS2-4
DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
SEP: Engaging in Argument from Evidence,
CCC: Stability and Change

Freshwater Frenzy
Grades 3-6

5-ESS2-2
DCI-ESS2: The Role's of Water in Earth's Surface Processes,
SEP: Using Mathematics and Computational Thinking,
CCC: Scale, Proportion, and Quantity

Gyotaku
Grades K-12

4-LS1-1
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models

NGSS Correlations, continued

It's Your Niche
Grades 3-8

4-LS1-1
DCI-LS1: Structure and Function,
SEP: Engaging in Argument from Evidence,
CCC: Systems and System Models

MS-LS2-2
DCI-LS2: Interdependent Relationships in Ecosystems,
SEP: Constructing Explanations and Designing Solutions,
CCC: Patterns

Chinook Book Journal
Grades 3-6

3-LS1-1
DCI-LS1: Growth and Development of Organisms,
SEP: Developing and Using Models,
CCC: Patterns

3-LS3-2
DCI-LS3: Inheritance of Traits,
DCI-LS3: Variation of Traits,
SEP: Constructing Explanations and Designing Solutions,
CCC: Cause and Effect

MS-LS1-4
DCI-LS1: Growth and Development of Organisms,
SEP: Constructing Explanations and Designing Solutions,
CCC: Cause and Effect

Great Lakes Grief
Grades 4-8

5-ESS3-1
DCI-ESS3: Human Impacts on Earth Systems,
SEP: Obtaining, Evaluating, and Communicating Information,
CCC: Systems and System Models

MS-LS2-4
DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
SEP: Engaging in Argument from Evidence,
CCC: Stability and Change

MS-LS2-5
DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
DCI-LS4: Biodiversity and Humans, DCI-ETS1: Developing Possible Solutions, SEP: Engaging in Argument from Evidence, CCC: Stability and Change

NGSS Correlations, continued

Least Wanted: Sea Lamprey
Grades 6-12

MS-LS2-2
DCI-LS2: Interdependent Relationships in Ecosystems,
SEP: Constructing Explanations and Designing Solutions,
CCC: Patterns

HS-LS2-6
DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
SEP: Engaging in Argument from Evidence,
CCC: Stability and Change

HS-LS4-5
DCI-LS4: Adaptation,
SEP: Engaging in Argument from Evidence,
CCC: Cause and Effect

HS-ESS3-4
DCI-ESS3: Human Impacts on Earth Systems
DCI-ETS1: Developing Possible Solutions,
SEP: Constructing Explanations and Designing Solutions,
CCC: Stability and Change

Social Carrying Capacity: AIS
Grades 6-12

MS-LS2-2
DCI-LS2: Interdependent Relationships in Ecosystems,
SEP: Constructing Explanations and Designing Solutions,
CCC: Patterns

HS-LS2-1
DCI-LS2: Interdependent Relationships in Ecosystems,
SEP: Using Mathematics and Computational Thinking,
CCC: Scale, Proportion, and Quantity

HS-LS2-7
DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
DCI-LS4: Biodiversity and Humans,
DCI-ETS1: Developing Possible Solutions,
SEP: Constructing Explanations and Designing Solutions,
CCC: Stability and Change

NGSS Correlations, continued

Invisible Migration
Grades 3-8

MS-ESS3-4
DCI-ESSC3: Human Impacts on Earth Systems,
SEP: Engaging in Argument from Evidence,
CCC: Cause and Effect

MS-LS2-4
DCI-LS2: Ecosystem Dynamics, Functioning, and Resilience,
SEP: Engaging in Argument from Evidence,
CCC: Stability and Change

MS-ETS1-1
DCI-ETS1: Defining and Delimiting Engineering Problems,
SEP: Asking Questions and Defining Problems,
CCC: Influence of Science, Engineering, and Technology on Science, Natural World

NGSS Standards

3-LS1-1: From Molecules to Organisms: Structures and Processes
The Great Swim (grades 3-12)
Salmon Lifecycle Mini Unit (grades Prek-3)
Salmon Timeline Shuffle (grades 3-12)
Chinook Book Journal (grades 3-6)

3-LS3-2: Heredity: Inheritance and Variation of Traits
Fashion a Fish (grades 3-6)
Great Lakes, Great Fish (grades 3-6)
Chinook Book Journal (grades 3-6)

3-LS4-2: Biological Evolution: Unity and Diversity
Squid Dissection (grades 3-12)

3-LS4-3: Biological Evolution: Unity and Diversity
Migration Fixation (grades 3-6)
Salmon Timeline Shuffle (grades 3-12)
Water Bug Hunt (grades 3-12)
What's in the Water (grades 3-12)

4-LS1-1: From Molecules to Organisms: Structures and Processes
Salmon Survival (grades 4-12)
Fish Finder (grades 4-6)
Scales and Tails (grades 4-12)
Pin the Parts on the Salmon (grades 3-7)
Fashion a Fish (grades 3-6)
Research Revolution (grades 4-12)
Squid Dissection (grades 3-12)
Gyotaku (grades K-12)
It's Your Niche (grades 3-8)

4-LS1-2: From Molecules to Organisms: Structures and Processes
Salmon Scents (grades 3-6)
Scales and Tails (grades 4-12)
Squid Dissection (grades 3-12)

MS-LS1-3: From Molecules to Organisms: Structures and Processes
Scales and Tails (grades 4-12)
Pin the Parts on the Salmon (grades 3-7)
Squid Dissection (grades 3-12)

MS-LS1-4 From Molecules to Organisms: Structures and Processes
How Many Fish (grades 6-8)
Research Revolution (grades 4-12)
Chinook Book Journal (grades 3-6)

MS-LS2-1: Ecosystems: Interactions, Energy, and Dynamics
What's in the Water (grades 3-12)

MS-LS2-2: Ecosystems: Interactions, Energy, and Dynamics
It's Your Niche (grades 3-8)
Least Wanted: Sea Lamprey (grades 6-12)
Social Carrying Capacity: AIS (grades 6-12)

MS-LS2-3: Ecosystems: Interactions, Energy, and Dynamics
What is Your Watershed Address (gr 3-12)

MS-LS2-4: Ecosystems: Interactions, Energy, and Dynamics
The Great Swim (grades 3-12)
Migration Fixation (grades 3-6)
Salmon Survival (grades 4-12)
Water Bug Hunt (grades 3-12)
Savin' Salmon Streams (grades 4-8)
Great Lakes Grief (grades 4-8)
Invisible Migration (grades 3-8)

MS-LS2-5: Ecosystems: Interactions, Energy, and Dynamics
Great Lakes Grief (grades 4-8)

MS-LS4-4: Biological Evolution: Unity and Diversity
Fashion a Fish 3-6

NGSS Standards, continued

HS-LS1-1: From Molecules to Organisms: Structures and Processes
Scales and Tails (Grades 4-12)

HS-LS2-1: Ecosystems: Interactions, Energy, and Dynamics
Social Carrying Capacity: AIS (grades 6-12)

HS-LS2-2: Ecosystems: Interactions, Energy, and Dynamics
The Great Swim (grades 3-12)
Water Bug Hunt (grades 3-12)

HS-LS2-4: Ecosystems: Interactions, Energy, and Dynamics
Why Fish Go To School (grades 9-12)

HS-LS2-6: Ecosystems: Interactions, Energy, and Dynamics
Least Wanted: Sea Lamprey (grades 6-12)

HS-LS2-7: Ecosystems: Interactions, Energy, and Dynamics
Social Carrying Capacity: AIS (grades 6-12)

HS-LS4-5: Biological Evolution: Unity and Diversity
Salmon Survival (grades 4-12)
Least Wanted: Sea Lamprey (grades 6-12)

5-ESS2-2: Earth's Systems
Great Lakes, Great Fish (grades 3-6)
Freshwater Frenzy (grades 3-6)

5-ESS3-1: Earth and Human Activity
What is Your Watershed Address (grades 3-12)
Great Lakes Grief (grades 4-8)

MS-ESS3-3: Earth and Human Activity
Savin' Salmon Streams (grades 4-8)

MS-ESS3-4: Earth and Human Activity
Invisible Migration (grades 3-8)

HS-ESS2-5: Earth's Systems
What's in the Water (grades 3-12)

HS-ESS3-4: Earth and Human Activity
Least Wanted: Sea Lamprey (grades 6-12)

MS-ETS1-1: Engineering Design
Invisible Migration (grades 3-8)

Research Revolution

Grade Levels
4-12

Objectives
To demonstrate various techniques of fish aging and fish tagging practices of the DNR, and why such research is used.

Best Taught
Anytime during the school year.

Materials
- Tree "cookie"
- Coded Wire Tag card
- Microscope and slide
- Fins, Tails and Scales poster
- Fish scale (from the grocery store)
- Enlarged image of fish scale (included)
- Images of various scale forms – have students research and print online

Background
The DNR Fisheries Division Research Stations and State Fish Hatcheries across Michigan participate in tagging and aging fish to determine migration patterns, status and trends of bodies of water, year classes, and the dynamics of the fisheries of inland lakes and rivers. Coded wire tags are one of many methods used to track hatchery born fish statistics. A coded wire tag is a tiny piece of stainless steel wire that has a microscopic identification number listed on it. Fisheries biologists and technicians use a machine that injects the small tag into the snout of a fish. After the tag is successfully injected, the adipose fin of the salmon is clipped, and the fish is loaded onto a fish stocking truck for release.

Background Continued

A Michigan angler who catches a trout or salmon with a missing adipose fin is asked to hand deliver the head of the fish (if they are not catch and release fishing) to a participating state hatchery of state research station. Once the head of the fish is received by the DNR, staff remove the tag, and view it under a microscope to read where the fish originated from. The angler is asked where the fish was caught (to determine migration patterns), what size the fish was when caught (growth/health patterns), and other pertinent information. The goals of the Coded Wire Tag Program are to measure the relative return of Chinook salmon and steelhead trout, distribution, fish movements, and evaluate the success of any stocking program.

Activity 1: Tagging Fish
1. Have the students place a Coded Wire Tag on a slide and under a microscope to see if they can read the number from the tag.
2. Using the Michigan DNR website on coded wire tags (CWT) Locate the nearest drop site for tagged salmon or trout.
3. Using the CWT Recovery Form from the web, have students practice collecting the data needed on the form.
4. Use real data to talk about trends in Chinook salmon populations and movements.

Activity 2: Aging Fish

There are four types of fish scales. Students determine which scales would be prevalent on the fish of Michigan (cycloids, ctenoid)

- **Placoid scales**, also called dermal denticles, are similar to teeth in that they are made of dentin covered by enamel. They are typical of sharks and rays.
- **Ganoid scales** are flat, basal-looking scales that cover a fish body with little overlapping. They are typical of gar and a family of fish called bichirs, found in tropical Africa and in the Nile river.