Introduction

Welcome to the Michigan Department of Natural Resources (DNR), Salmon in the Classroom program.

A look around the nation shows there are quite a few state resource agencies that now sponsor salmon (or other species) in the classroom programs. Why? One reason is the tremendous interest children through young adults have in working with "live" resources. Salmon in the Classroom is not just another science activity but a very interactive, participatory program in which students raise the resource and ultimately are responsible for its survival and release.

The number one reason that the DNR supports this living resource program is to build a connection between students and the natural resources found around them, often in their own neighborhoods. In Michigan, this program began modestly in 1997 in a handful of schools and experienced steady, moderate growth. Since that time, interest has exploded and the DNR is pleased to see this program has the potential for tremendous growth.

In our state, we face many challenges managing the Great Lakes fishery. Salmon in the Classroom can be a great educational tool for Michigan educators. Many teachers have participated for several years. Yet, the ecology of the Great Lakes is changing at an astounding rate. Today, a new pollution, biological pollution -- defined as the disturbance of the ecological balance by the accidental or deliberate introduction of a foreign organism, animal or plant species into an environment -- may prove to be our greatest challenge.

These threats are real and we need dedicated and qualified educators to assist the DNR by providing "real" science, along with important messages, to students who one day will be the stewards and leaders of our state.

Several states have developed Salmon in the Classroom curricula. Until recently, Michigan had yet to develop its own curriculum. We recognize this attempt at developing a curriculum for Michigan teachers is not yet complete, and expect that it will be constantly evolving. Each year we strive to add activities that will enable you to better teach your students about Michigan's fisheries resources and Great Lakes issues.

Of course, the curriculum is just one piece of our Salmon in the Classroom Teachers Resource Kit. Posters and other resource materials are included to enhance students' learning experience.

Educators, have the ability to readily measure your students' interest in each activity and the useful knowledge that it provides. As scientists, we have created the important messages we need to reconnect our children to our great outdoors. Together, we can develop and nurture the next generation of stewards and anglers. Salmon in the Classroom is an important tool to get young children excited about fishing. Through this program the DNR hopes you as educators will share with your classes the availability of statewide fishing events, because a large part of our mission is to bring outdoor opportunities to the current and future residents of Michigan. There are Free Fishing Weekends in the summer and winter annually, tackle-lending programs at state parks and easily accessible fishing piers. The DNR makes fishing accessible for everyone to enjoy. For more information, visit www.michigan.gov/freefishing.

Finally, many Salmon in the Classroom schools have important sponsors who have helped fund the equipment needed for this project to succeed. We salute them and their important contributions to the education of the next generation.

Acknowledgments

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School Sponsors

Organizations that fund equipment purchases for teachers change annually.
For a complete list visit www.michigan.gov/sic.

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Michigan Sea Grant
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Project F.I.S.H.

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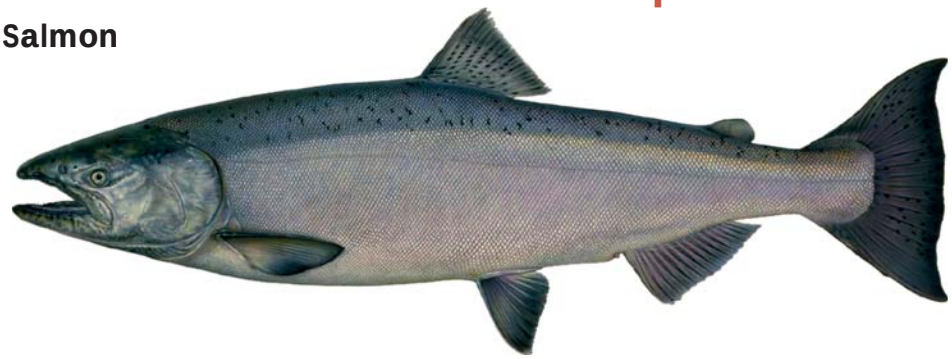
tab 1 About Salmon in the Classroom

What it's About

One of the many reasons for joining the program is the seemingly limitless subject matter that teachers can integrate into their lesson plans through raising salmon. The program can easily cover benchmarks in mathematics, social studies, language and arts, history and, of course, science. Salmon are a great resource for teaching across the curriculum.

Why Chinook Salmon are a Preferred Species

Chinook Salmon



The story of the Great Lakes and its fisheries relies heavily on the introduction of salmon. A myriad of stewardship and natural resource conservation lessons can easily be spawned from the introduction of Chinook salmon into the Great Lakes.

- Spawning in early fall and released in May, the life cycle of salmon matches perfectly with the length of the school year.

- Students will mirror how the DNR raises Chinook salmon in hatcheries, allowing them to learn first hand how fisheries managers are able to successfully rear millions of salmon each year to stock rivers across Michigan.

- Chinook salmon take food readily in an aquarium setting. Students will enjoy watching them eat. On average, Chinook salmon will be 3 – 5" when released in the spring, so students will have the opportunity to observe substantial growth of their fish during the school year.

- Students are able to visit the Little Manistee, The Boardman and/or the Platte River Weir to watch the egg take process as well as the Wolf Lake State Fish Hatchery and Platte River Fish Hatchery to see first hand how the fish are reared by the DNR.

- Although Chinook salmon survival is limited, those released by students have just as good of a chance of surviving as those stocked by the DNR. Chinook salmon are released into the river during the smolting stage. This is the stage where they lose their juvenile markings which help camouflage them from predators. At this time they will turn to a silver color which is a better camouflage while living in the Great Lakes.

Why Chinook Salmon are a preferred species *continued*

Brook Trout

Brown Trout

- Brook and Brown Trout can be very fearful of people and will often times ignore food offered by hand. In a hatchery setting, fish must be either hand fed from a distance or automatic feeders must be used. If raised in an aquarium and hand fed by students, majority of food fed will not be eaten and will sink to bottom of tank. This accumulation of food will lead to degraded water quality. Fish will also be stressed which will make them more susceptible to a disease. Spring released fish would be much smaller (less impact on students).

- These species spawn in late November, so students would have a much shorter period to observe fish development.

- These released fish have a much smaller chance of survival. Our trout are kept in hatchery raceways over the next year and released the following spring to ensure more growth and better survival This is a format impossible for schools to use.

- Brook and Brown trout eggs are collected at the hatchery from broodstock and so a large part of the visible natural history would not be available.

- The main objective of Salmon in the Classroom is to provide students with an opportunity to participate in a hands-on, interactive program to learn about the natural history of the Great Lakes and their ecosystem, so that they are more likely to become future stewards of natural resources and are informed citizens of conservation. It is the conclusion of the DNR that Chinook salmon provide the most excitement and best year-long experience for students to achieve this objective.

Life Cycle of a WILD Chinook Salmon in Michigan

eyed eggs

The life cycle of Chinook salmon in the Great Lakes can be described as potamodramous, which technically means migrations within fresh water and which describes a fish that spends the bulk of its adult life in large, freshwater lakes (like the Great Lakes), but migrates back to its natal stream to spawn. Chinook salmon, like other Pacific salmon, are not native to the Great Lakes. Both Chinook and Coho salmon were brought to Michigan in the 1960s.

Chinook salmon are native to the Pacific Ocean, where their migrations are anadromous (migrations from salt to fresh water). In their native habitat, these fish generally spend three years living in the ocean. The Great Lakes provide an ocean-like habitat for adult Chinooks, where they spend most of their three-year average lifespan, foraging and growing in preparation for spawning.

From mid-to-late August, adult Chinook, which can weigh more than 30 pounds (our state record is 46+ pounds), begin staging off the mouth of their natal river where they were either stocked or hatched. The decreasing day length (photoperiod) and falling water temperatures prompt the mature salmon to enter the river to seek out appropriate spawning habitat. The salmon use their sense of smell to return to their natal stream sometimes traveling hundreds of miles on their journey.

What Does That Mean?

potamodramous - migrates within fresh water

natal stream - the stream where they originated

anadromous - migrates from salt to fresh water

photoperiod - the relative exposure of an organism to daylight

spawning - the act of laying eggs

redd - spawning bed

plankton - microscopic water borne organisms

sac fry - hatched, young salmon with large yolk sac for nourishment

alevins- another name for sac fry

yolk sac - serves as the food source for the developing embryo

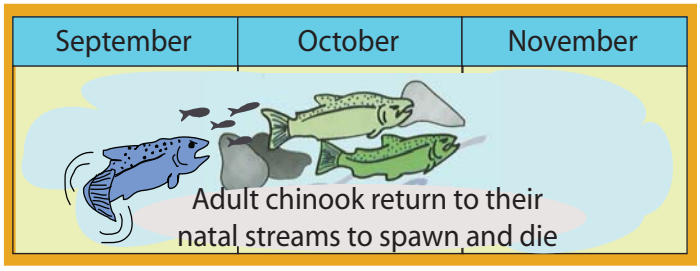
swim-up fry - fry after yolk sac is gone

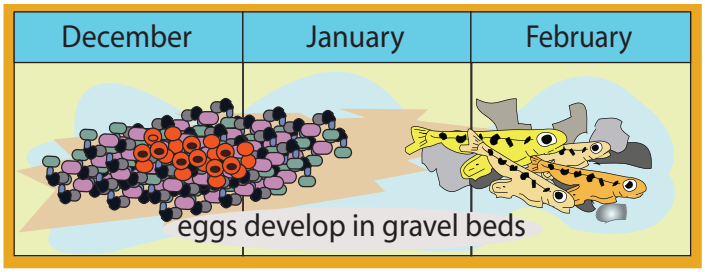
parr - is a juvenile fish, one preparing to leave the fresh waters of its home

smolt/smoltification - process of becoming physiologically adapted to a lake environment. This term in Pacific Salmon refers to them becoming physiologically adapted to salt water.

pelagic fish - spend most the their time foraging offshore in open-water environments

Once in the river, adult Chinook no longer need food and actually stop feeding, living off their body reserves to complete the spawning phase of their life. They still can be caught by anglers, though, as they strike hooks and bait out of aggression. The fish seek out small, clean gravel on which to make their spawning bed called a redd. Once the eggs are fertilized, they are covered over, and remain in the gravel, where they will develop during the winter and early spring. After spawning, all salmon die and their bodies decompose, releasing nutrients into the water to aid plankton production for their offspring.

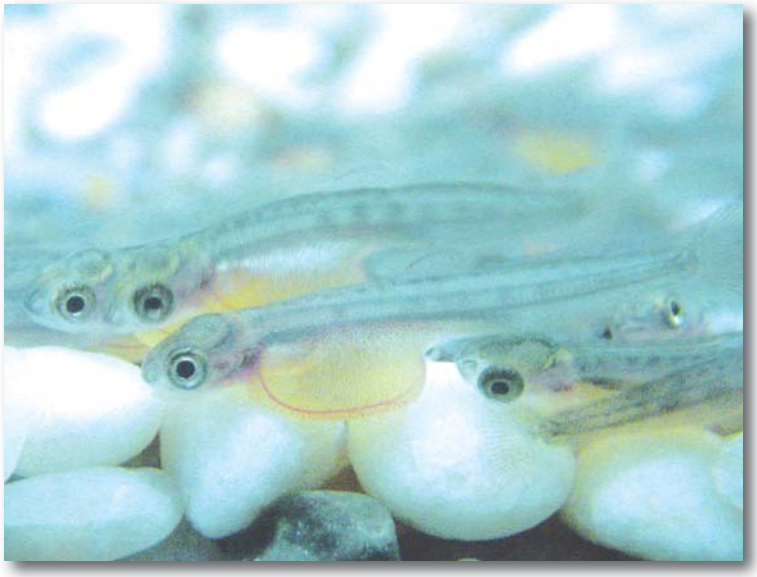




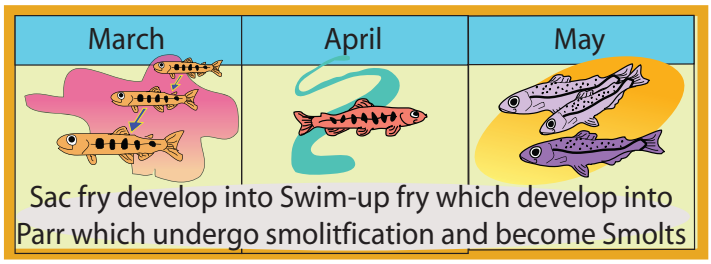
As winter passes and the water begins to warm, ***sac fry*** hatch from the eggs. The sac fry, also called ***alevins***, remain in the gravel while they take nourishment from their ***yolk sac***. Once the yolk sac has been absorbed, the young salmon begin to emerge from the gravel. Now called ***swim-up fry***, they begin feeding on insects and insect larvae in the stream. After the small Chinook, now called ***parr***, have spent a month or two growing in the warming waters of the stream, the increasing day length and water temperature trigger a physiological change in the fish called ***smoltification***. During this process, the fish lose their "parr" marks and take on a much more silvery appearance, which is their protective coloration for the "fish-eat-fish" world they are about to enter. They are now called smolt. In early June, the smolts migrate downstream out of their natal river and into the Great Lakes. This is an especially perilous time for the young Chinook since they must run through a gauntlet of fish-eating predators that include pike, walleyes, smallmouth bass and brown trout, as well as kingfishers, great blue herons, double-crested cormorants, gulls, terns and mergansers. It truly is survival of the fittest!

Once in the Great Lakes, the chinook will continue to feed on aquatic insects until they are large enough to start feeding on small fish. They now will begin growing quickly. The high protein content of their exclusively fish-based diet coupled with the Chinook's voracious appetite results in a very high growth rate. Their preferred food is alewives, but, like most other fish, they are opportunists and will eat whatever is available to them. Chinook salmon are ***pelagic*** fish, which means they spend most of their time foraging offshore in open-water environments.

They will spend two to four years (three is most common) foraging in the pelagic zones of the Great Lakes until they reach sexual maturity. Then, as fall approaches, these fish will begin to stage off the mouth of their natal streams and the cycle begins again.



sac fry



Why We Need Hatcheries!

In an ideal world -- and an angler's dream -- a person could catch naturally reproduced brook, brown and rainbow trout on crystal-clear, cold water streams without another angler in sight. They could fish from a boat on one of Michigan's 11,000 inland lakes, catching their limit of walleyes hatched within that very lake. Anglers could venture out onto a Great Lake, hooking a good-sized Chinook, Coho or steelhead that emerged from the gravel of a connected stream just two or three springs earlier.

All of these situations occur in Michigan. However, our state has nearly one million licensed anglers. The Great Lakes and our inland lakes and streams cannot provide enough naturally reproduced fish. In fact, 40% of all recreational fishing in Michigan depends on ***stocked fish***. That's why we need ***fish hatcheries***, and the money to operate these important facilities comes from all those anglers who purchase a fishing license each year.

Hatcheries also make it possible for fisheries managers to repopulate lakes and streams that historically held species like lake sturgeon or where a significant fish kill was the result of a catastrophic disturbance like an oil spill or dam failure.

What Does That Mean?

fish hatcheries - a place where select fish are spawned, hatched and released

stocked fish - released by fish hatcheries into the wild

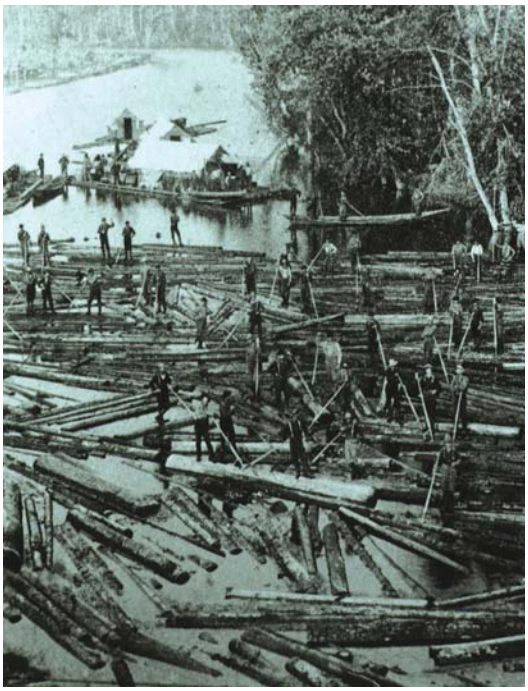
Fishing Licenses

License fees also support the habitat protection and rehabilitation efforts carried out by the Michigan Department of Natural Resources. Fisheries habitat improvement is vital to improving and maintaining quality fishing in Michigan.

Michigan anglers aged 17 and up are required to purchase a fishing license. Children under 17 have an opportunity to support Michigan fisheries too! They can purchase the voluntary youth fishing license for only $3 ($2 license fee + $1 sport card fee). The officially named Young Angler All Species-Type 122 license is a great deal for youth, since their dollars are matched at least two times over by federal government funds to support Michigan fishing programs. Plus, it's a great way for kids to start showing their support for Michigan's outdoors.

Habitat Before Conservation

Fish habitat in Michigan has undergone many changes throughout Michigan's history. Prior to the logging era, our streams teemed with native brook trout and grayling (now ***extirpated*** in Michigan). The Great Lakes had plentiful native lake trout and whitefish. The extensive logging that forever changed the Michigan landscape had far-ranging and long-lasting negative effects on fish habitat. The most significant impact was seen in the streams and rivers that were used to float huge rafts of logs to mills near the Great Lakes shorelines. The log rafts scoured out the river bottoms, upsetting gravel beds and destroying countless trout spawning redds. Some rivers had many natural meanders to them which created various pools, ***eddies*** and ***riffles*** that provided cover and feeding areas for trout. These same meanders were viewed as a hindrance in the effort to move logs quickly to the mill. In these areas, straight channels were dug and the rivers were diverted away from their natural meandering channels. The fast-growing country's hunger for more high quality lumber led the lumberjacks to take virtually every tree from Michigan's white pine forests.



There was never any thought given to the idea of leaving a buffer strip of uncut timber along stream banks, which is a best practice today. The timber-harvesting practices of long ago caused tremendous erosion problems. Given the prevalence of sand in most northern Michigan soils, this erosion translated to tons and tons of sand being transported into the once-pristine trout streams. Sand settles to the bottom of the stream bed and covers up the gravel that is needed as spawning substrate and as habitat for the aquatic insects trout feed on.

As Michigan grew and became more industrialized, this growth led to more roads being built which, in turn, caused more erosion at points where roads cross streams. Poorly designed road crossings remain one of the most significant problems threatening trout habitat today. The increased industrialization also led to significant pollution problems both inland and in the Great Lakes. Pollutants such as ***PCBs*** and ***mercury*** impaired the ability of fish to successfully reproduce or, in some instances, to even survive.

What Does That Mean?

buttoned up - absorb yolk sac.

ecosystems - a natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the non-living physical (abiotic) factors of the environment

eddies - water current moving contrary to main current

erosion - natural processes including rain, weathering, dissolution, abrasion, corrosion and transportation, by which material is removed from the earth's surface

equatic Invasives - a non-native plant or animal deliberately or accidentally introduced into a new habitat

extirpated- a species is no longer naturally occurring in a region, but survives in other locations

habitat - environment in which an organism normally lives

mercury - a silvery white poisonous metallic element, liquid at room temperature

PCBs - polychlorinated biphenyls (PCBs) are a class of organic compounds. Used as coolants and insulating fluids for transformers and other electric components

phosphate - a salt or ester of phosphoric acid

phosphorus - a highly reactive, poisonous, non-metalic element occurring naturally in phosphates used in fertilizers

rehabilitation - the process of restoring the land, and natural environment

riffles - rocky shoal or sandbar lying just below a waterway

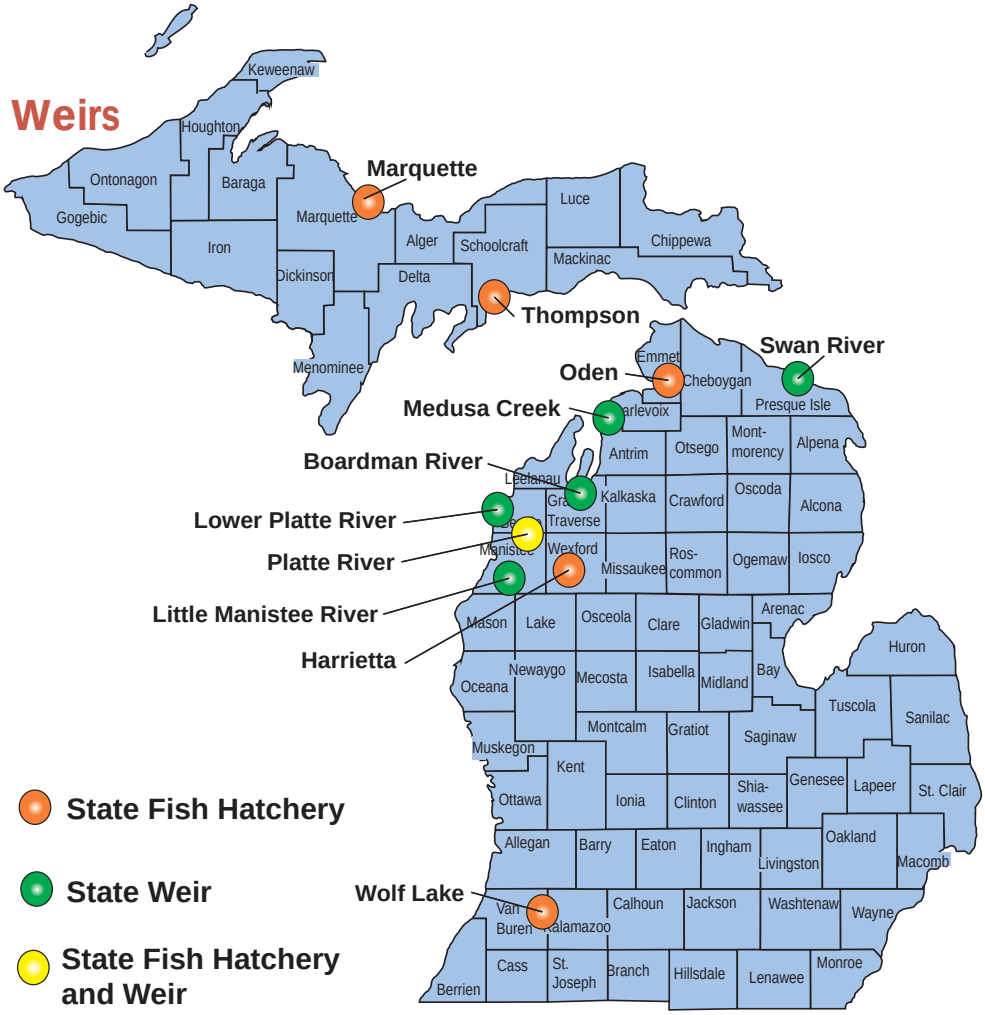
However, times are still changing, and, from a fish-habitat perspective, they have changed for the better over the past decade or two. Although pollution still occurs, it is much reduced from levels seen in the 1950s through the 1970s. As a society, we now are much more aware of how our actions effect the environment. This is also reflected in how we manage our landscape. Buffer strips are demanded in timber harvest operations. People are encouraged to use low *phosphorus* fertilizers. *Phosphate*-containing detergents, which harm fish, are no longer available. Many habitat improvement projects have been completed, making miles and miles of streams suitable for trout reproduction again.

There's still a long way to go in improving ***habitat***, however. Only a fraction of the degradation caused by human activities over the past century and a half has been repaired.

As ***aquatic invasives*** and new diseases enter our waterways, the role hatcheries play will change over time. All of these issues, coupled with the incredible amount of fishing activities in Michigan, make it a certainty that fish hatcheries will continue to play an important role in fisheries management.

A significant threat to the balance and health of our aquatic ***ecosystems*** are invasive species. These biological pollutants make up a significant threat to the balance and health of our aquatic ecosystems. Aquatic Invasive species can bring in fish diseases that previously were not found in Michigan waters, as well as overtake native flora.

Michigan State Fish Hatcheries and Weirs



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Craig Kasmer, 989-348-2537, kasmerc@michigan.gov - Northern Michigan

Salmon in the Classroom Timeline

September

Teachers are e-mailed their Scientific Collector's Permit and two-sided Stocking Permit.

For those teachers seeking ***"Green Eggs"***

- Contact the appropriate Fisheries Biologist as referenced in the Egg Pick-Up Procedure. The most current version can be found on the SIC webpage at www.michigan.gov/sic.
- Set up tank and equipment by September 20.
- Maintain a tank temp of 47 degrees F to delay hatching and feeding until after winter break.

October

For those teachers seeking ***"Eyed Eggs"***

- Dates for pick up can be found in the Egg Pick-Up Procedure.
- Set up tank and equipment by October 20.
- Look for the first issue of "Salmon Sense" in your "e-mail box".
- Maintain a tank temp of 47 degrees F to delay hatching and feeding until after winter break.

November

- During predetermined dates, obtain eyed eggs from hatchery per the Egg Pick-Up Procedure. This includes bringing your Scientific Collector's Permit, lunchbox size cooler, small Tupperware container and ice with you on pick up day.
- Dead white eggs should be removed immediately from the tank.
- Some eggs may begin hatching.
- Maintain a tank temp of 47 degrees F to delay feeding until after winter break.

December

- Look for the latest issue of "Salmon Sense" in your email box. If you don't receive it by winter break, contact a coordinator to let them know.
- Eggs should hatch the beginning of December.
- Dead white eggs should be removed immediately from the tank.
- Check in on salmon periodically during winter break.
- Maintain a tank temp of 47 degrees F to delay feeding until after winter break.

January

- Check in on salmon periodically during winter break.
- When approximately 80% of fry have "buttoned up" (absorbed their yolk sack) and are actively swimming in the tank, begin feeding per Feeding Schedule (page 14).
- Increase water temperature to 52 degrees F to increase metabolism and stimulate feeding.
- Test water quality per Setting up Your Tank (page 15). If ammonia is detected, stop feeding your fish until levels are normal.
- Change approximately 1/3 to ½ of tank water weekly.

February and March

- Continue to monitor water quality and clean tank as directed in Setting up Your Tank.
- Observe salmon and watch for behavioral changes that may indicate stress or sickness.
- Feed as indicated in Feeding Schedule.

April

- Look for the latest issue of "Salmon Sense" in your email box. If you don't receive it by May, contact a coordinator to let them know.
- Smoltification begins and you will observe salmon losing their "parr marks" and becoming more silvery in appearance.
- Continue to monitor water quality and clean tank.
- Observe salmon and watch for behavioral changes that may indicate stress or sickness.
- Feed as indicated in Feeding Schedule.
- You shourld receive your stocking permit and Salmon in the Classroom Annual Report form via email.

May

- Release salmon into pre-approved stocking location following the Releasing Your Salmon guidelines (page 23).
- Submit Stocking Report to DNR within 14 days of release via email, fax or mail to the address on/in the report.
- Indicate your status of participation for the following school year when submitting your stocking report.

PICK UP DATES CHANGE ANNUALLY

GO ONLINE FOR THIS YEAR'S DATES

SALMON IN THE CLASSROOM (SIC) PROGRAM
PROCEDURES FOR PICKING UP SALMON EGGS

1. Adhering to the procedures laid out below is the teacher's responsibility. Failure to do so may result in eggs not being released to teachers, due to concern for the health of the eggs.
2. Pick-up your eggs at a weir or a fish hatchery.
   - Returning teachers have a choice of picking up green eggs from a weir or eyed eggs from a hatchery.
   - New teachers are required to pick up eyed eggs from a hatchery in their first year of participation in the program, because eyed eggs are not as fragile as green eggs.

   GREEN EGGS VS. EYED EGGS

   - Obtaining green eggs from the weir will allow your students to see the entire development of the fish whereas if you obtain eyed eggs from a hatchery, students will not be able to observe the first month of development.
   - Teachers will receive 300 eggs from the weir or 200 eggs from the hatchery. Fewer eggs are given at the hatchery because at this stage, one month into the development, the eggs have been treated several times to discourage fungus and bacteria growth.
   - Eggs that reach the eyed stage at the hatchery have a greater potential to survive because all non-viable eggs that died in the first month of development have been removed.

   GREEN eggs from a weir (only the weirs listed below distribute eggs).

   Typically, green eggs are ready to be picked up at weirs during the first and second weeks of October. Important: the ripeness of the fish dictates when the eggs will be available and as such, these dates may be subject to change.

   It is your responsibility to schedule your egg pick up from the weir you plan on obtaining eggs from by contacting the biologist at that location. Please contact them by mid-September. They will keep you informed about any changes. A map of the following weirs can be found here:
   http://www.michigandnr.com/publications/pdfs/fishing/hatcheries/hatcherymap.asp

   Little Manistee Weir, Manistee
   Scott Heintzelman, Fisheries Technician Supervisor
   (231) 389-2551, heintzes@michigan.gov

   Swan River Weir, Rogers City
   Brian Hoxie, Fisheries Technician
   (989) 732-3541, hoxieb@michigan.gov

   EYED eggs from a hatchery (only the hatcheries listed below distribute eggs).

   Teachers, or a representative for that teacher, should plan to pick up eggs from the appropriate hatchery at the dates and times listed below. If you are unable to pick up your eggs from one of these hatcheries at the dates and times listed, you will forfeit your egg allotment for this year. A map of the hatcheries can be found here:
   http://www.michigandnr.com/publications/pdfs/fishing/hatcheries/hatcherymap.asp

   Wolf Lake State Fish Hatchery, Mattawan, MI (No pre-scheduled appointment is necessary)
   Matt Hughes, Hatchery Biologist, hughesm6@michigan.gov

   Platte River State Fish Hatchery, Beulah, MI (No pre-scheduled appointment is necessary)
   Hatchery Biologist, 231-4611

   Thompson State Fish Hatchery, Manistique, MI
   Randy Espinoza, Hatchery Biologist, espinozar@michigan.gov
3. Be ready on the day of your egg pick-up.
   - Teachers may wish to work together to pick up eggs collectively for several participating schools in a specific geographic region in the state. **The teacher or teacher representative picking up the eggs is required to have the permits of all those teachers they are picking up eggs for, no exceptions**. The fall season is a very busy time for Fisheries staff, please be considerate of their time.
   - Scientific Collector's Permit. Those attending the November workshop at Wolf Lake will receive their permit at the workshop, otherwise the permit will be mailed to you. You wouldn't forget to bring your tickets to a

baseball game, so don't forget to bring your Permit, this is your ticket to pick up your eggs.

- Please remember to bring the following:
  - Clean cooler (lunch box size is sufficient)
  - Small Tupperware container with lid
  - Ice

4. Acclimate your eggs to your aquarium
   - After you have obtained your eggs, whether from the weir or the hatchery, it is important that you acclimate the eggs to the temperature of your aquarium. Introducing the eggs into water that is a substantially different temperature can be stressful and even deadly to the eggs.
   - Once you get home, open the top of the bag and remove about 25% of the water from the bag. Replace this water with the same amount of water from your tank. Float the bag in your tank and bring down the hood opening on the open end of the bag to help keep the bag secure. Every 10 minutes add about 1 measuring cup (use less if the bag is smaller) of your tank water to the bag. Repeat this process for about an hour. By slowly adding small amounts of water from the tank you are slowly acclimating the fish.
5. Additional information
   - Information on dead eggs, replacement eggs and a feeding guide can be found in the "Salmon Care" section of the curriculum manual or on the web at *www.michigan.gov/sic*.
   - Fish food will be distributed when the eggs are picked up.
   - For tank or egg questions please direct your questions to either:

     Natalie Elkins, Office of Communications, elkinsn@michigan.gov, (517) 373-1547

     Shana Ramsey, Wolf Lake Hatchery Interpreter, ramseys2@michigan.gov, (269) 668-2876

     Craig Kasmer, Michigan Forest Visitor Center Interpreter, kasmerc@michigan.gov, (989) 348-2537

We hope you enjoy having Salmon in the Classroom!

The Equipment

Having quality equipment that is properly maintained is one of the most important components of a successful program. **The DNR does not provide this equipment.** You are required to purchase it on your own. The following information will help you research and plan equipment purchases. Remember, you can contact a teacher near you who has participated before to get advice about the equipment.

It is important to set up the equipment at least two weeks before picking up your salmon eggs to ensure everything is working properly. The health of your fish will be compromised if you wait until the last minute to set up your 55 gallon minimum tank.

Coil cooler

Tank

The salmon need a 55 gallon or larger tank for best results. If a used tank is available, wash it thoroughly with a 10% bleach and water solution. Then rinse with water 5 times to remove all bleach residue. Tanks should be up and running to 47 degrees F for at least 2 weeks prior to egg pick up.

Chiller Units

Salmon are a coldwater fish (page 71) and therefore must have the water chilled in order to survive. Tank chillers are necessary for this function. There are two main types of chillers:

- Power coolers (also known as "inline" chillers); these are external filters. These are the quieter choice, at 68 decibels. If using an inline chiller, you will also need to purchase a canister filter. In this system, the water is pumped out of the tank, run through the chiller and filter, and pumped back into the tank.

- Coil coolers (also known as "drop-in" chillers); these are internal filters. These run a bit more loudly than power coolers at 80 decibels.The water is chilled as it encounters copper tubing that rests on the back of the tank. This type of chiller is the one most commonly used by teachers participating in the Salmon in the Classroom program.

Be sure to discuss your tank setup with tank store personnel to find a filter and chiller that suits the needs of your specific tank.

Equipment List

- ☐ Tank (55-gallon minimum)
- ☐ 6-in-1 (pH, hardness, alkalinity, nitrite and nitrate, chlorine) in your resource kit
- ☐ Ammonia (recommended to use titration test vs. test strips)
- ☐ Aerator
- ☐ Cabinet/tank stand
- ☐ Chiller unit
- ☐ Dechlorination tablets (if using municipal water supply)
- ☐ Filter system
- ☐ Fish net
- ☐ Several feet of narrow tubing
- ☐ Siphon
- ☐ Tank scrubber

Filter Systems

- In selecting a filter, it is always better to purchase a larger filter for your tank. For example, if you have a 55-gallon tank, it is recommended that you purchase a filter that is the minimum for a 70-gallon tank versus one that filters only 55 gallons. Either the hanging type or canister type filter is recommended.
- Hanging all necessary setup equipment typically accompanies the purchase of a hanging filter. Replacement filter cartridges will be necessary over the life of the filter.
- Canister; all necessary setup equipment typically accompanies the purchase of a canister filter.
- Undergravel system; this system is **not recommended** because it tends to trap debris, uneaten food and waste contributing to problems with ammonia, bacteria and fungus.

Gravel (not recommended)

In a natural coldwater stream, salmon eggs are protected by large pieces of gravel that hide them from predators and allow cool water to pass through the pore spaces providing oxygen to the incubating eggs. In a tank, gravel is purely aesthetic. The gravel is not necessary for the survival of the salmon. In fact, the buildup of waste in the gravel can contribute to water quality issues and requires a substantial amount of effort and time to maintain. If using gravel or rock, place just enough to cover the bottom of the tank.

Purchasing Supplies

Supplies for Salmon in the Classroom can be found at most tank supply stores, such as PetSmart, Petco, Pet Supplies Plus or online. The tank stores also may be a good source for information. It is recommended that you contact the store well in advance to ensure items are in stock.

Below are online suppliers that teachers have found useful:

www.marinedepot.com

www.glaciercorp.com

Swim-up fry

Setting Up Your Tank

Setting up your tank will help familiarize you with the equipment required to properly maintain it. To ensure all equipment is working properly, it is important to set up all equipment approximately two weeks in advance of receiving your salmon eggs.

1. Choose a suitable location for your tank. Your tank should be in a location that is; easily accessible from all sides, within close proximity to an electrical outlet, near a water source (if possible) and in an area that where the tank is readily visible to students and visitors.
2. Set up tank in chosen location. Be sure that the area is properly ventilated so the chiller does not overheat.
3. Place gravel in bottom of tank, if you choose to use it. Remember that it is **not recommended** in an effort to maintain tank cleanliness.
4. Add chiller to tank. Set to 47 degrees F. Follow manufacturer instructions.
5. Add filter. Follow manufacturer instructions.
6. Add aerator/air stone.
7. Fill tank with water. If using municipal water, dechlorinate according to manufacturer instructions for dechlorination tablets.
8. Monitor the tank for proper temperature and water quality for a period of at least two weeks prior to receiving salmon eggs.
9. Initial Water Quality: use a 6-in-1 test kit and an ammonia test kit upon completion of tank set up. It is important to obtain baseline levels when you set up your tank to help you recognize when levels change throughout the year. A Tank Maintenance Sheet follows to help you keep track.

Temperature

The tank should be set at 47 degrees F until the salmon begin feeding. Once the salmon begin feeding, tank temperature should be maintained between 50 and 57 degrees with 52 degrees as the optimal temperature. Colder water dissolves more oxygen than warmer water. Salmon require more oxygen than cool or warm water fish species and therefore require cooler water.

Parr

Feeding Your Salmon

Proper salmon care is essential to a successful program. The salmon will not survive without careful consideration, understanding and implementation of the following guidlines. It is your responsibility to adhere to the following guidelines when participating in the program.

Food and Feeding

Fish food will be provided when you pick up the eggs. Storing the fish food in a refrigerator is not necessary. Do not freeze fish food.

Your eggs should hatch in late November to early December. The sac-fry will remain on the bottom of the tank. Do not start feeding them at this point. They will feed off their yolk sac for approximately one month. Once they have absorbed most of their sac they will swim up in the water column and begin searching for food. Don't be alarmed if they don't all swim up at the same time some will take longer than others. Once approximately 80% are off the bottom and swimming, you should begin feeding. Follow feeding schedule below.

Feeding Schedule

This feeding schedule is to be used as a general guideline. Food amount shown is the total amount to be fed daily. Spread amount over several feedings. All food amounts are based on 200 fish. Food size and amount fed will depend on when your eggs hatch, number of mortalities and rearing water temperature. The duration on each food size may vary. If your fish are growing slower or faster than this guide adjust accordingly. Do not over feed as this will lead to water quality issues!

Salmon Feeding Timeline

Daily:

Feed fish as indicated below in the Feeding Schedule

Fish Length (in)	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.5
Food Size	#1	#2	1.2 mm	1.5 mm	2.0 mm	2.5 mm
Duration on Food	2 wks	2 wks	4 wks	2 wks	3 wks	4-5 wks

Month	January				February				March				April				May	
Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Amount (tsp)	1/4	1/2	3/4	1	1	1.25	1.5	1.5	1.5	1.75	2	2	2	2.25	2.5	2.5	2.75	3

Food

BioVita Starter 1 for approximately two weeks.

Feed the fish often, as much as every half-hour, during this critical learning period for getting fish to eat an artificial food. Be careful not to overfeed. At this early feeding stage most food will not be eaten. Total daily food amount: ¼ tsp. per day. See feeding schedule page 16.

BioVita Starter 2 for approximately two weeks (weeks three and four).

Fish should be feeding well by now. Distribute total daily food amount over several feedings, five to six times per day. Total daily food amount: ½ tsp. per day. See feeding schedule page 16.

Always keep in mind that salmon naturally inhabit clean flowing water. They do not tolerate poor water quality and will become sick and die if the water quality is not maintained.

Biodry 1000 1.2 mm, 1.5 mm, 2.0 mm, 2.5 mm.

Follow feeding schedule to determine when to switch fish to the next food size. You can experiment by feeding a few of the next-sized pellets when the fish appear close to the size shown in the food schedule. They are ready for a larger pellet when they are able to eat the food without spitting it out. Distribute daily amount over several feedings, five to six times per day. Feed amount: Consult the Feeding Schedule (page 16) for the appropriate amount.

Ration Instructions:

To ensure that fish receive their daily food over multiple feedings throughout the day, divide the amount to feed into the number of feedings you are able to do. This portion is called a "ration." Fish should receive either their entire ration or be fed until they are no longer actively feeding, whichever occurs first. It is not uncommon that early in rearing, fish may not eat their entire ration but should once they are feeding well. If fish are not eating their entire ration you may need to increase the number of feedings and decrease the ration amount to accommodate what the fish need. As the fish grow, this will change, so you will be able to increase the ration per feeding and decrease the number of feedings. Observe your fish while feeding. Their behavior will let you know what they need and if you need to make adjustments.

Feeding on the weekends

We understand that it is not possible for someone to care for the fish 24 hours a day, seven days a week. In the event that someone is at the school to feed the fish on weekends, please do so. If not, please feed the fish late on Friday and early on Monday.

Feeding during holiday breaks

It is required that feeding the fish is continued over all holiday breaks including, but not limited to: Thanksgiving, Christmas and Easter. Please make arrangements for the fish to be fed on a daily basis during holiday breaks. Keeping the temperature of your tank at 47 degrees F should delay hatching, and thus feeding, long enough for you to avoid coming in over the Thanksgiving and Christmas holidays to feed the fish. However, the fish should be checked over the breaks as necessary to ensure they are doing well and all equipment is functioning properly.

Maintaining Water Quality

Warning: failure to adhere to the standards below will put your salmon at risk for mortality.

Weekly (minimum) or daily, as needed

- Test water quality including ammonia, pH, nitrite, nitrate, hardness, chlorine and alkalinity. Record results on Tank Maintenance Chart. If levels are unsatisfactory, follow instructions in Troubleshooting Guidelines to remedy. Continue testing on a daily basis until safe levels are reached.
- Perform water exchange by removing approximately 1/4 - 1/3 of water in tank and replace with fresh, clean water. If using municipal water supply, dechlorinate water and test for chlorine prior to putting water in tank.
- Siphon waste from tank. Remove all visible uneaten food and waste from tank. Allowing these to remain in the tank will decrease overall water quality, stress the fish and can cause harm or mortality.
- Remove dead eggs/fry/fish immediately. They can grow bacteria and fungus, which can infect nearby healthy fish.

Water Quality Timeline

Daily:

Test and record fish and tank information on the Tank Maintenance Chart.

Weekly:

Clean tank once each week per directions under Maintaining Water Quality.

Tank Maintenance Chart *This is a copy me page*

Date	Temp. bfr. swim up 47°	Temp. aft. swim up 52°	Ph 7-7.5	Nitrate <40 ppm	Nitrite <.5 ppm	Alkalinity 120-180 ppm	Chlorine 0 ppm	Hardness 75+ ppm	Ammonia 0 ppm	Mortality/Notes/Observations/ steps taken to correct the problem

Troubleshooting Guidlines

Problem	Cause	Recommended Course of Treatment	Notes
Ammonia level is HIGH	Tank is not being cleaned regularly enough; uneaten food or waste is raising levels.	Step 1. Stop feeding your fish and do not resume feeding fish until ammonia has leveled off. Step 2. Siphon tank and do a 1/4 water exchange. Step 3. Retest. Step 4. Repeat steps 2 and 3 until amonia has leveled off.	
Chlorine detected in water	Municipal water supply is being used and chlorine is not being removed.	Add dechlorination tablets to water when performing water exchanges OR, allow water to sit out in the sunlight before a water exchange and the chlorine will dissipate over a period of approximately one day.	
Dead eggs	Natural mortality (if tank nutrient and temperature levels are within acceptable range)	Remove dead eggs to prevent additional problems affecting nearby healthy eggs. Take no additional action.	Not all eggs will survive in your tank and even less would survive in the wild. Use this as a teachable moment. Teachers receiving green eggs from the weir may experience higher egg mortality than eyed eggs picked up from the hatchery. To reduce mortality, eggs are treated at the hatchery and non-viable eggs are removed on a daily basis. At the weir, this process has not yet taken place and therefore the potential for higher mortality exists.
Fish are deformed	Genetic birth defects	Take no action	Birth defects and deformity are naturally occurring genetic variations, they occur in wild salmon streams as well. Use this occurrence as a teachable moment, for example introducing survival of the fittest or favorable adaptations brought on through genetic mutations.
Fish are not uniform in size	Fish vary in size naturally	Take no action.	Egg size varies due to genetic variables (think tall parents tend to have taller offspring). Also, fish grow at varying rates due to environmental variables, i.e. bigger fish may outcompete smaller fish when feeding. Use this as a teachable moment. For example, what traits may be passed on by genetics; eyecolor, body type etc. vs. how our environment shapes our genetic make up, i.e. people who have access to superior food, shelter etc. will typically be healthier, larger. Genetics is not the only determining factor in the development of living things.
Fish lying on bottom of tank or swimming on side	Early Mortality Syndrome (EMS) OR, see below.	If activity occurs after the first few weeks of feeding, the cause is not EMS. Assess other possibliities, see below.	Interpret EMS in an ecosystem perspective. EMS happens both in the wild and in a hatchery setting. Biologists can learn a lot about what is happening to fish in the wild by what they observe in hatchery fish. For example, finding a high prevelance of EMS in fish at a hatchery can indicate there is a high instance of EMS in the wild. However, eggs received by teachers have come and will come from several different females. The chances of having high levels of EMS in the group of eggs received by an individual teacher is therefore reduced.

Troubleshooting Guidlines

Problem	Cause	Recommended Course of Treatment	Notes
Fish lying on bottom of tank or swimming on side	Early Mortality Syndrome (EMS) OR, see below.	If activity occurs after the first few weeks of feeding, the cause is not EMS. Assess other possibliities, see below.	Interpret EMS in an ecosystem perspective. EMS happens both in the wild and in a hatchery setting. Biologists can learn a lot about what is happening to fish in the wild by what they observe in hatchery fish. For example, finding a high prevelance of EMS in fish at a hatchery can indicate there is a high instance of EMS in the wild. However, eggs received by teachers have come and will come from several different females. The chances of having high levels of EMS in the group of eggs received by an individual teacher is therefore reduced.
	Pathogen OR see below.	Take no action.	There are many different pathogens that get passed on from the adult to offspring. If many fish are exhibiting the behavior, it could be a pathogen. If one fish is exhibiting this behavior it could be the result of injury from tank maintenace, see below.
	Injury from tank maintenance OR see below	Be very careful when cleaning dead eggs, siphoning waste or exchanging water in the tank. The harmful effects of injury during tank maintenace may not be visible until later stages of development.	If many fish exhibit the behavior, it could be a pathogen. If one or only a few fish exhibit the behavior, it could be the result of injury from tank maintenance.
	Genetic abnormality	Take no action	Genetic mutations and variance are natural.
Nitrate at unsafe level	Build up of metabolic waste	Step 1. Stop feeding your fish and do not resume feeding fish untill Nitrate has leveled off. Step 2. Siphon tank & do a 1/4 water exchange. Step 3. Retest. if still dangerously high, proceed to next step. Step 4: Add Amquell or similar treatment product per label instructions (not more then once in 24 hrs) Step 5: Repeat St eps 2 & 3 & 4 daily untill Nitrate level has reached safe PPM.	Use it in the classroom: Explain how chemical equilibrium is maintained in nature and how a closed system is different. Another teachable moment.
Nitrite at unsafe level	Build up of metabolic waste	Step 1. Stop feeding your fish and do not resume feeding fish untill Nitrate has leveled off. Step 2. Siphon tank and do a 1/4 water exchange. Step 3. Retest. If still dangerously high, proceed to next step. Step 4. Add Amquell or similar treatment product per label instructions (not more then once in 24 hrs) Step 5: Repeat Steps 2, 3 and 4 daily until Nitrate level has reached safe PPM.	Use it in the classroom: Explain how chemical equilibrium is maintained in nature and how a closed system is different. Another teachable moment.

Troubleshooting Guidlines

Problem	Cause	Recommended Course of Treatment	Notes
pH is HIGH (above 7.5)	Ammonia concentration rising due to build up of metabolic by-products.	Siphon out waste and uneaten food; do water exchange. If levels still do not decrease, add chemical treatment (such as "pH Down") available at most aquarium supply stores. Be sure to follow directions carefully and allow enough time for additive to cycle through before retesting.	If your pH is slightly high or slightly lower than the ideal range of 7.0 - 7.5, don't panic. It is often a fluctuation in water quality parameters (such as pH) that is most stressful and causes the most harm to fish.
pH is LOW (below 7.0)	Soft water	pH will probably never be <7 unless the water supply is surface water. Purchase chemical treatment from local aquarium supply store such as "pH UP" to increase the pH to normal levels.	
Some fish are ready to begin feeding; others still absorbing yolk sac	Genetic variability	Wait until at least 50% are swim up before initiating feeding.	
Uneaten food fouling water	Tank not being cleaned on a regular basis; feeding too much	Siphon out waste and uneaten food, do water exchange. Double check feeding rates.	Do not feed more than the recommended amount. Doing so will reduce water quality. It is always better to underfeed than to overfeed.

Releasing Your Salmon

It is important to understand the goal of the program is to provide students with an educational opportunity to learn about the salmon life cycle and natural resource conservation. It is not intended to be part of a fish stocking or fish recovery program. Because of the small number of fish you will be releasing, survival may be low. However, taking proper care of your fish and releasing them into favorable habitat will increase their chance of survival. Having even one fish survive until release time is a success.

Releasing the salmon that you and your students have cared for over the course of an entire school year is one of the most exciting aspects of the program. It is important that you release your salmon into suitable habitat to provide them with the best possible opportunity of surviving. It also is essential that you adhere to the regulations that have been put in place by the DNR as outlined below. Please read the information carefully.

Stocking Permit

A stocking permit will be mailed to you. You must mail both sides of your permit, complete with your stocking information, back to the DNR (to the address on the form) within 14 days of your release in the spring. This is important because without this information, you will not be sent your Scientific Collectors Permit next year to continue in the program.

Where You Can Stock Your Fish

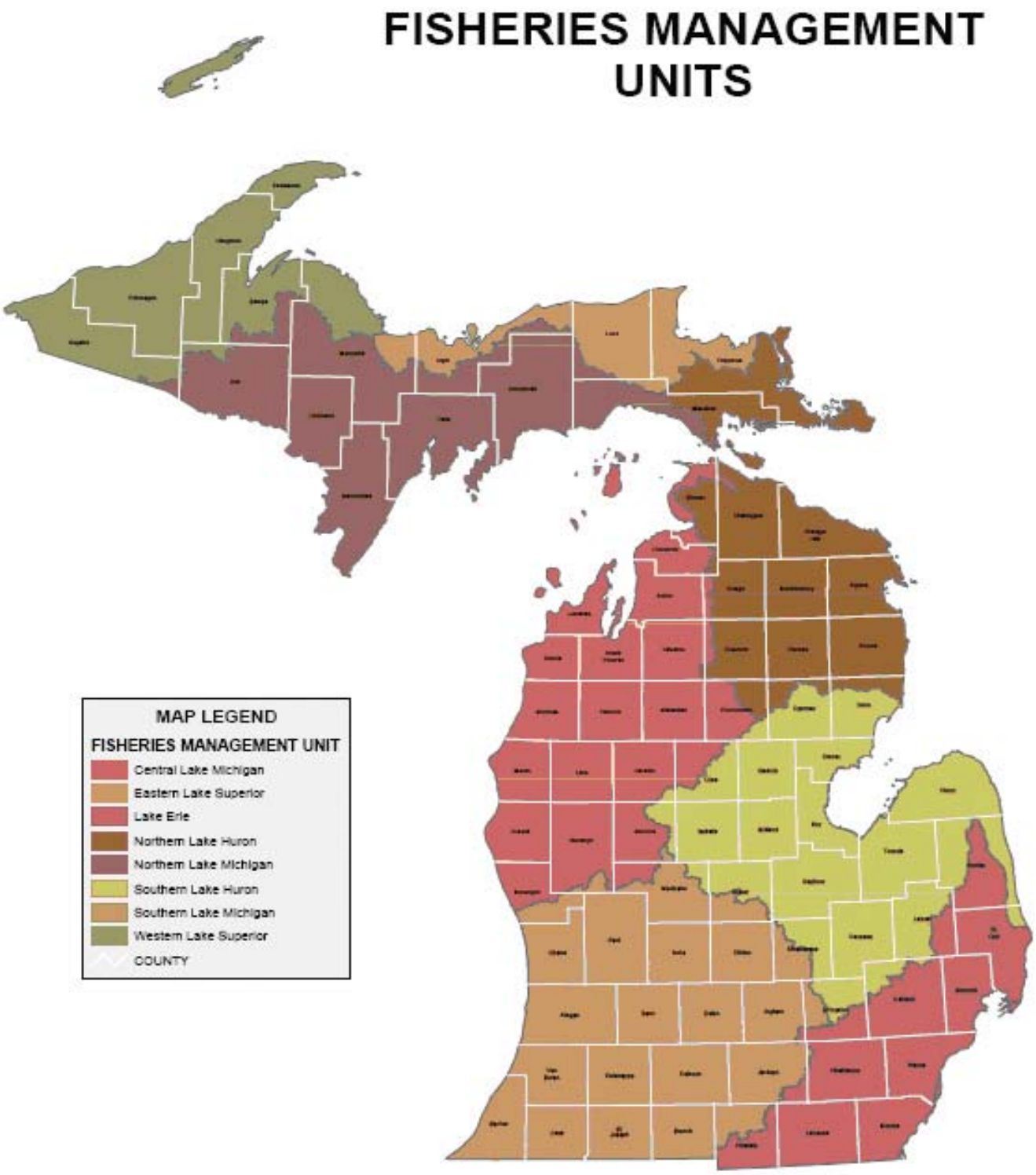
Step 1: Determine which Fisheries Management Unit (FMU) your school is located in. (page 24)
Step 2: Choose a stocking location in your FMU by going to the list of approved stocking locations. (page 25)

Pre-approved Release Locations

You may stock your salmon in any of the rivers, lakes or streams on the approved list. If you are still unsure of your stocking location, contact your Salmon in the Classroom coordinator.

How to Transport the Fish to Your Stocking Location

- Transfer your fish and the water from your tank into a 5-gallon bucket. Do not overcrowd the fish; use more than one 5-gallon bucket if necessary.
  - Fill a 5 gallon bucket ¾ of the way full with clean, fresh, cold water - from the tank if possible. If fish are 3-4" in size and will be in the bucket for 30 minutes or less, place 40 – 50 fish per bucket.
  - If fish are greater than 4" in size and/or will be in the bucket for longer than 30 minutes, place only 25 – 30 fish per bucket.
  - It is important to understand that no matter what size the fish are, the longer they are in the bucket, the more stressful it is on them.
- If the fish will be transported for more than an hour, aerate the water in the bucket with a battery-operated bubbler, or pack ice in a plastic bag around the bucket.
- Upon arrival at the river, take the temperature of the river water and the temperature of the water in your bucket. If there is a difference of five degrees or more between the two, you will need to acclimate the fish before releasing them into the water.
- To acclimate the fish, gradually replace the water in the bucket with river water. You should replace only one-quarter of the bucket water volume every 15 minutes with river water to avoid temperature shock.



Pre-approved release locations

You may stock your salmon in any of the rivers, lakes or streams on the approved list. If you are still unsure of your stocking location or you think there is a more appropriate stocking location near your school, contact your Salmon in the Classroom coordinator. See the list of approved release locations on the following page.

List of Approved Stocking Locations

Preapproved stocking locations for the Salmon in the Classroom program listed by Fisheries Division Management Unit

Southern Lake Huron Management Unit

- Any stream within the Management Unit
- Lake Huron

Eastern Lake Superior Management Unit

- Anna River
- Big Two Hearted River
- St. Mary's River

Lake Erie Management Unit

- Belle River mainstream below the town of Memphis
- Black River below dam in Port Huron State Game Area
- Clinton River below the City of Pontiac
- N. Branch Clinton River
- Huron ow Flat Rock Dam in Flatrock

Western Lake Superior Management Unit

- Black River
- Black River Harbor (Lake Superior)
- Carp River
- Trap Rock River

Northern Lake Huron Management Unit

- Black River
- Cheboygan River
- Mill Creek
- Ocqueoc River
- Thunder Bay River
- Trout River
- Van Etten Creek

Central Lake Michigan Management Unit

- Bear River
- Bear Creek
- Betsie River
- Boardman River
- Bowen Creek
- Boyne River
- Carp Lake Outlet
- Chippewa River
- Crown Creek
- Crystal River
- Manistee River below Tippy Dam
- Maple River
- Medusa Creek
- Muskegon River below Croton Dam
- Pentwater River
- Pere Marquette River
- Platte River
- Tamarack Creek
- White River

Southern Lake Michigan Management Unit

- Black River
- Blue Creek
- Galien River
- Grand River below Moores Park Dam
- Kalamazoo River below Allegan Dam
- Macatawa River/Lake
- Mill Creek (Berrien County)
- Paw Paw River
- Pine Creek (Van Buren County)
- Red Cedar River
- St. Joseph River (Berrien County)

Northern Lake Michigan Management Unit

- Fairport
- Ford River below M-35
- Lower Escanaba River
- Lower Manistique River

Below refers to downstream

Required Permits and Instructions

Instructions for Current Participants

You will receive both your Scientific Collector's Permit (allowing you to keep a native species in your tank) and your Stocking Permit in the fall. To continue to receive both permits annually, thereby staying in the Salmon in the Classroom Program, you need only fill out and return the Stocking Permit and report on the reverse side, 14 days after stocking your fish (or after you have a die-off). By checking "yes" on the back where it asks if you'd like to participate again the following year, you are activating the Permit process, and will automatically receive both permits again the following fall.

Instructions for New Participants

In your first year of participation in the program, you must apply for a Scientific Collector's Permit. This permit is required by law. Follow the instructions below.

Permit Basics

Two permits will be required, by law, to participate in the program; a Scientific Collector's Permit and a Stocking Permit.

To Receive the Required Permits:

1. Fill out and submit a Scientific Collector's Permit online at www.michigan.gov/sic
2. In late September, you will receive the following permits by mail;
   a) Your Scientific Collector's Permit
   b) Your Stocking Permit (this will automatically be created when you apply for the SCP permit)
3. After you have released your salmon in the spring, COMPLETE AND SEND IN A HARD COPY OF YOUR TWO-SIDED STOCKING PERMIT TO THE ADDRESS LISTED ON THE PERMIT.
   - This must be done WITHIN 14 DAYS OF YOUR RELEASE.
   - Don't forget to fill out the questionnaire on the back of the Stocking Permit.

PLEASE COMPLETE BOTTOM SECTION AND PAGE 2 OF THIS FORM AND RETURN TO:
DNRE/FISHERIES DIVISION P.O. BOX 30446, LANSING, MI 48909-7946

Michigan Department of Natural Resources & Environment – Fisheries Division

ERMIT TO STOCK FISH INTO PUBLIC WATERS OF MICHIGAN

This permit is i ority of Section 48735 of Part 487, Sport Fishing, of Act 451, P.A. 1994, as amended. Failure to comply with t tions o and permit shall be cause for revocation of this permit. The penalty for stocking fish into public waters of the ithout a p a misdemeanor, punishable by imprisonment for not more than 90 days, or a fine of not more than $500.00

TEACH HOLDING A VALID SCIENTIFIC COLLECTOR'S PERMIT FOR THE SALMON IN CLASS PROGRAM, ORITY IS HEREBY GRANTED TO STOCK FISH INTO C WA OF THE S SH MAY BE STOCKED ONLY IN PRE-APPROVED L a list go to http://www.michigan.gov/sic)

By: _____ _____
Kelley Date
Chief, F eries

LAWS, CODES AND PERM Permit at this permi s not obviate other requirements of federal, state, or local law. Permit ees t wi pplicable tions, and codes, and shall obtain any other necessary permits in connec n wi tivit are th ermit.

LIABILITY. Permittee hereby rele , waiv ts not the State of Michigan, its departments, officers, employees and agen and to Pe fficers, employees and agents, for all losses, injury, death or damage, and a dem eto, o to person or property, or resulting in death of Permittee, its officers, yees o in refe the authorized by this permit.

INDEMNIFICATION. Permittee hereby covenants ees to and save h s, the State of Michigan, its departments, officers, employees and agents, from and all mands oss death or damage, that any person or entity may have or make, in any manner bout elat 1) issuance of this permit; (2) the activities authorized by this permit; and (3) or occup em ich are the subject of this permit by the Permittee, its employees, contractors, or uthorized representatives

PUBLIC WATERS STOCKING R T
Submit within 14 Days of S

This report is required under the authority of Section 48735 of Part 487, Sport Fish 451 ended.

Teacher's Name: _____ **School Name:** _____ **hool e No.** _____

Waterbody _____ **County** _____ **Date d** _____

Species stocked _____ **Average Size of fish (Inches)** _____ **Number Stocked** _____

CONTINUED ON REVERSE SIDE >>>>>

SAMPLE

Please Complete The Following Questionnaire

If Necessary, Attach Additional Sheets

1. If you are not stocking any fish back into a Michigan waterway due to fish die off, please explain the probable cause (i.e., bacteria, chemical levels in the water, equipment failure, or no obvious cause, etc.):

2) Are you planning to participate in the Salmon in the Classroom program again next year? Answering "Yes" here qualifies as your renewal request and you need not reapply for a SIC Permit for the following year.

Yes [ ] No [ ] Uncertain At This time [ ]

3) If your answer is "Yes", are there any changes to the previous permit? I.E., name of school, school address and/or phone number, e-mail contact information, teacher change, etc.

4) How many students participated in your SIC program this year? Participation is defined as students who followed all or part of the curriculum over a length of time, not just walked by the aquarium to see it once:

5) How many hours each week were spent using the SIC curriculum?

6) What single improvement would make this program better for your classroom?

TAB 3 Classroom Activities

Great Lakes, Great Fish

Topic or Grade Level Content Expectation(s)

Great Lakes introduction, L.EC.06.11, S.RS.M.1

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

(P=Provided in Teacher Resource Kit)
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 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_2O 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 has sounded, 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)

Activity 2: H_2O 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

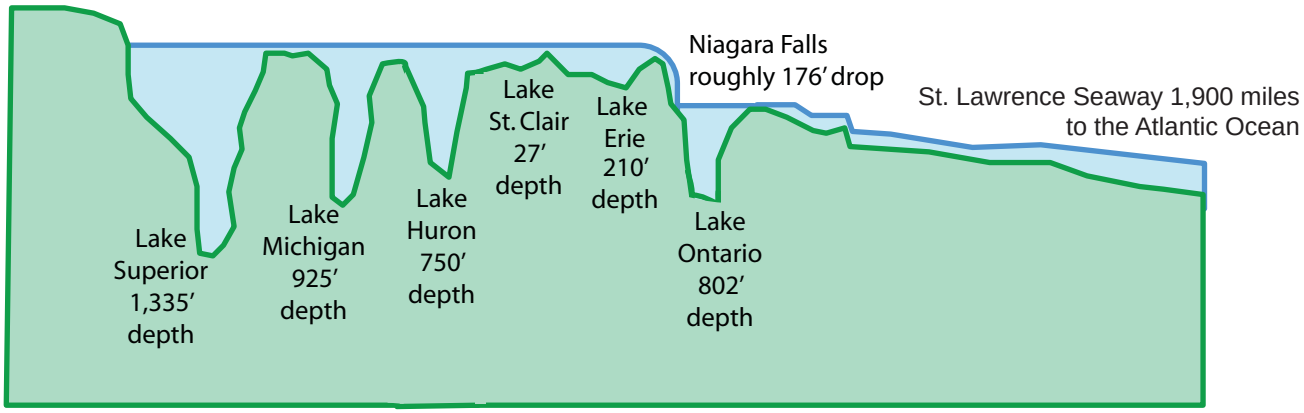
Lake Huron is larger than Lake Michigan by area but holds less water by volume. Because the two lakes have different amounts of water, different fish species are able to flourish in each lake. There is more light penetration in the shallower waters of Lake Huron, which promotes plant growth and supports 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.

Each of the five Great Lakes has different characteristics that support a variety of plants and animals. Wrap up discussion on Great Lakes.

Great Lakes Profile



Great Lakes Basin Silhouette *This is a copy me page*

Fish Finder

Topic or Grade Level Content Expectation(s)

Basic fish identification
S.IP.03.11, L.OL.03.32, L.EV.03.12, S.IP.04.11, S.IA.04.12, L.OL.04.16, L.EV.04.21/22, S.IP.05.11, S.RS.05.15, L.HE.05.11, L.EV.05.12, S.IP.06.11, S.RS.06.15, L.EC.06.11, L.EC.06.21, S.IP.07.11, S.RS.07.15, B1.1, B2.L2.p4, B4.L4.p2, B5.L5.p2

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

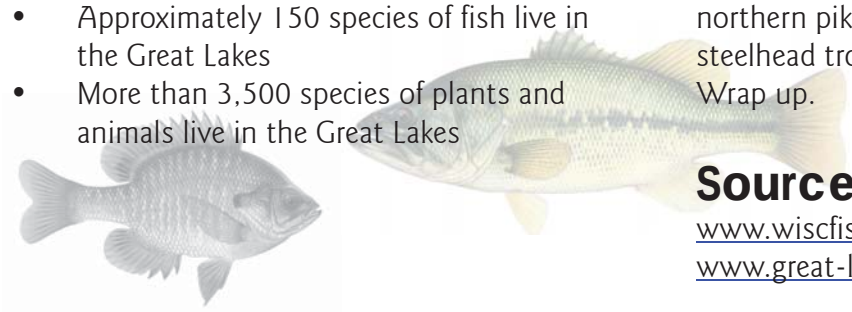
September/October; great foundation for other lessons

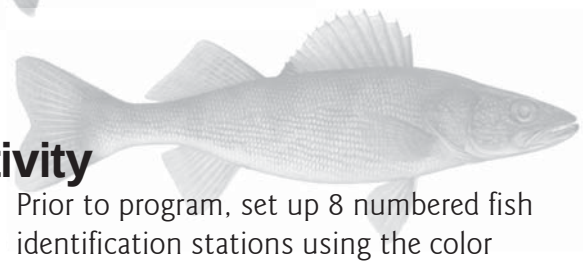
Materials

(P=Provided in Teacher Resource Kit)
Fish of Michigan field guide (P)
Michigan fish species illustrations (P)
External Anatomy of a Fish
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. Each station should have a copy of the External Anatomy of a Fish.
2. Break students into groups of 3-4.
3. Each group should receive the following: clipboard, data sheet and dichotomous key.
4. 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.
5. Each group will start at a different station.
6. Each station should last approximately five minutes and then students will rotate to another station.
7. 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.

Discuss the physical characteristics they used to determine what kind of fish they were asked to identify.

How could they tell the difference between a northern pike and a muskellonge? Or between a steelhead trout and a Chinook salmon?

Wrap up.

Sources

www.wiscfish.org/fishid/frames.aspx
www.great-lakes.net

Dichotomous Key to Common Fish of Michigan

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1. Does the fish have an adipose fin?

A. Adipose fin present > Go to 2.

B. Adipose fin not present > Go 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 bars 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

> Largemouth Bass

B. The upper jaw does not extend past the eye

> Smallmouth Bass

Dichotomous Key Data Sheet

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

Fish Finder Data Sheet

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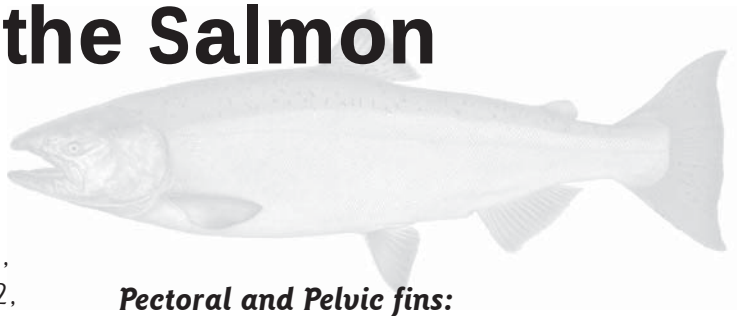
Grps	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								

Pin the Parts on the Salmon



Topic or Grade Level Content Expectation(s)

Fish anatomy, fish identification. S.IP.03.12, S.IA.03.12, L.OL.03.32, L.EV.03.12, S.IA.04.13, L.EV.04.22, S.IA.05.13, L.OL.05.41, L.OL.05.42, L.EV.05.12, S.IP.06.11, S.IA.06.13, S.IP.07.11,

Grade Levels

3 - 7

Objective

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

Best Taught

September/October; good background information.

Materials

(P=Provided in Teacher Resource Kit)
Pin the Parts on the Salmon Handouts - Silhouette and pieces for each student
Scissors
Glue or tape

Background

Dorsal fin:

How do humans keep their balance? Would it be hard to maintain our balance if we had only one leg? What do fish have that serves this same purpose? 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 for protection from predators and serves as a stabilizer while fish are swimming. The dorsal fin also is used for precise movement and provides the fish with the ability to move forward or backward with ease. If a fish has a spiny dorsal fin, it only 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.

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.

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.

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.

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.

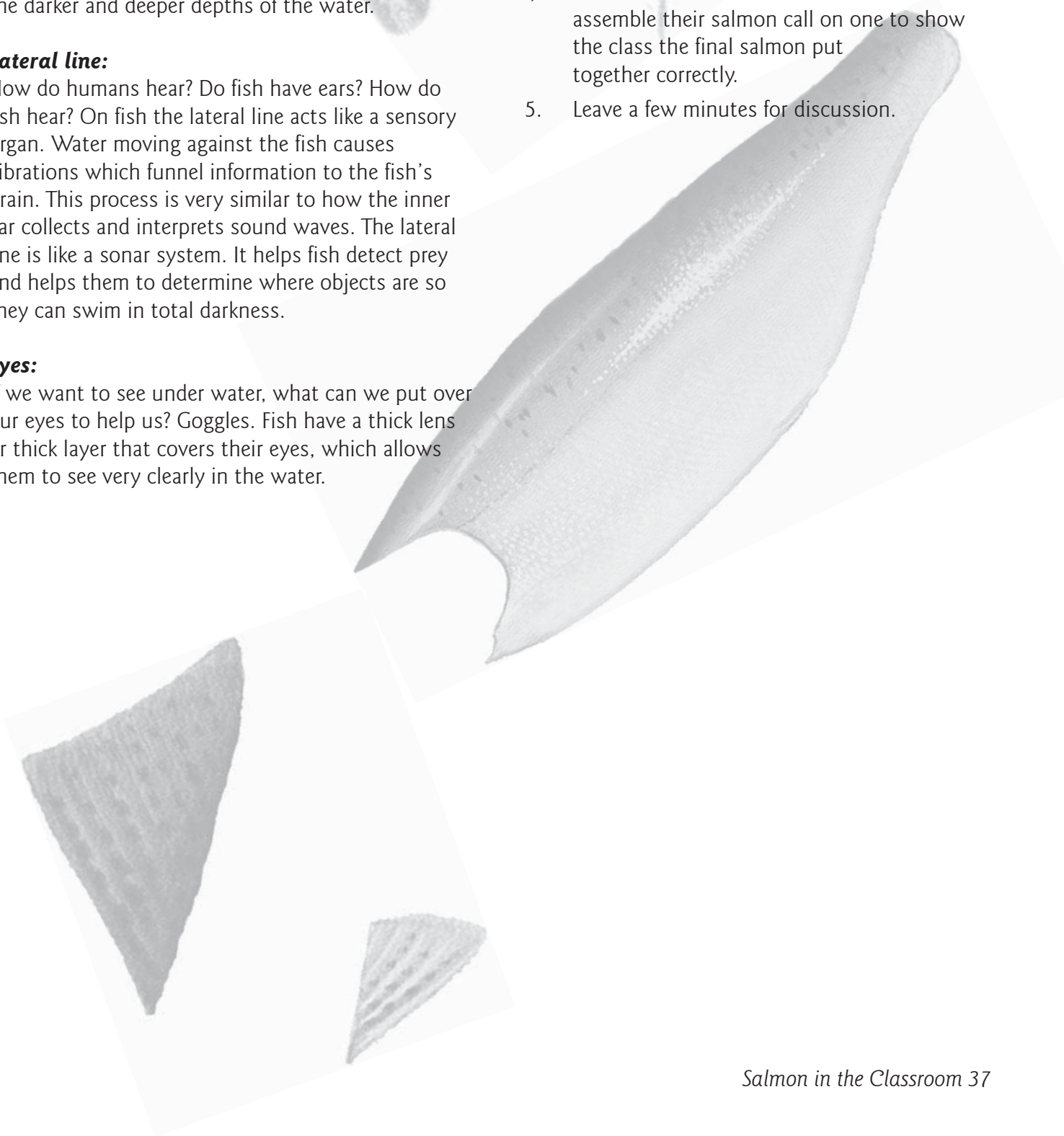
Example:
Largemouth bass have lightly colored scales on their underside and darker colored scales on their upper portion. The lighter scales help to camouflage the fish from predators swimming below them because when a predator is looking up at a largemouth bass, the lighter colored scales blend with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

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.

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.

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.



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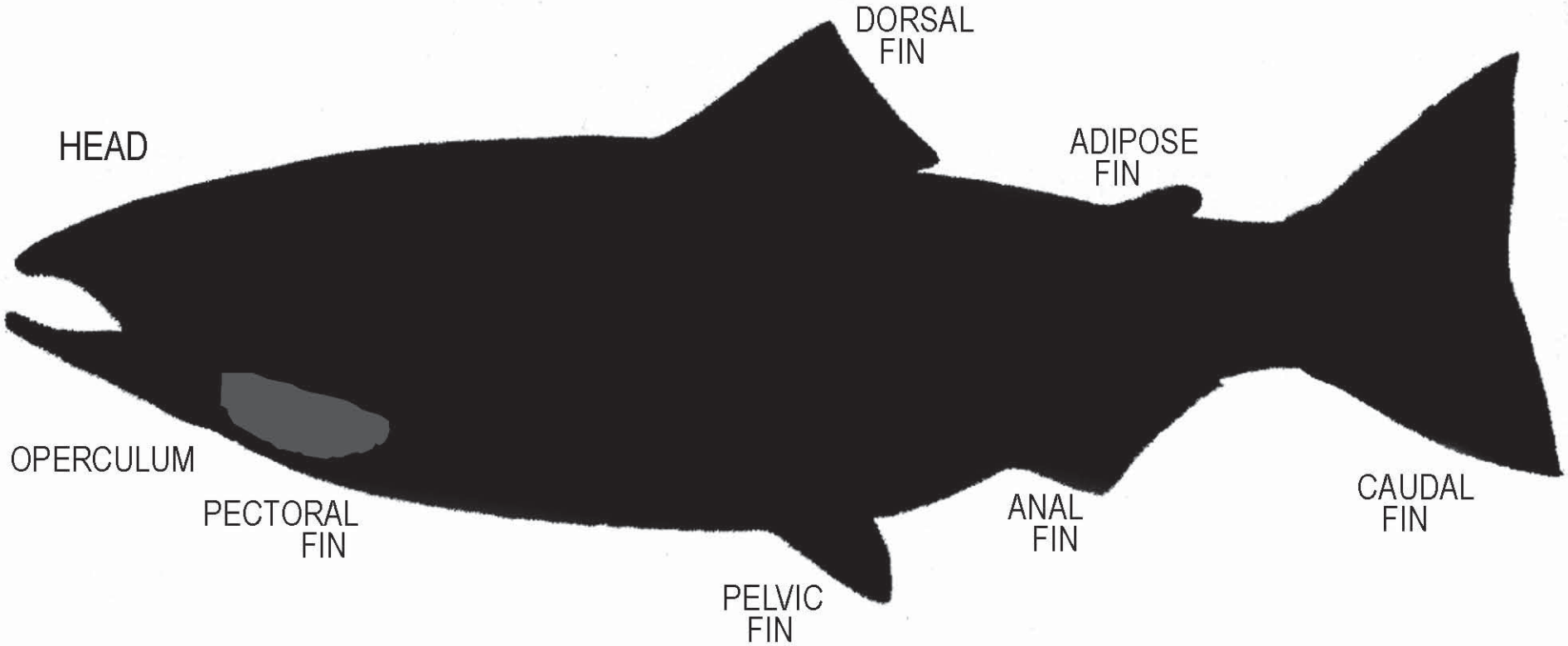
Pin the Parts on the Salmon!



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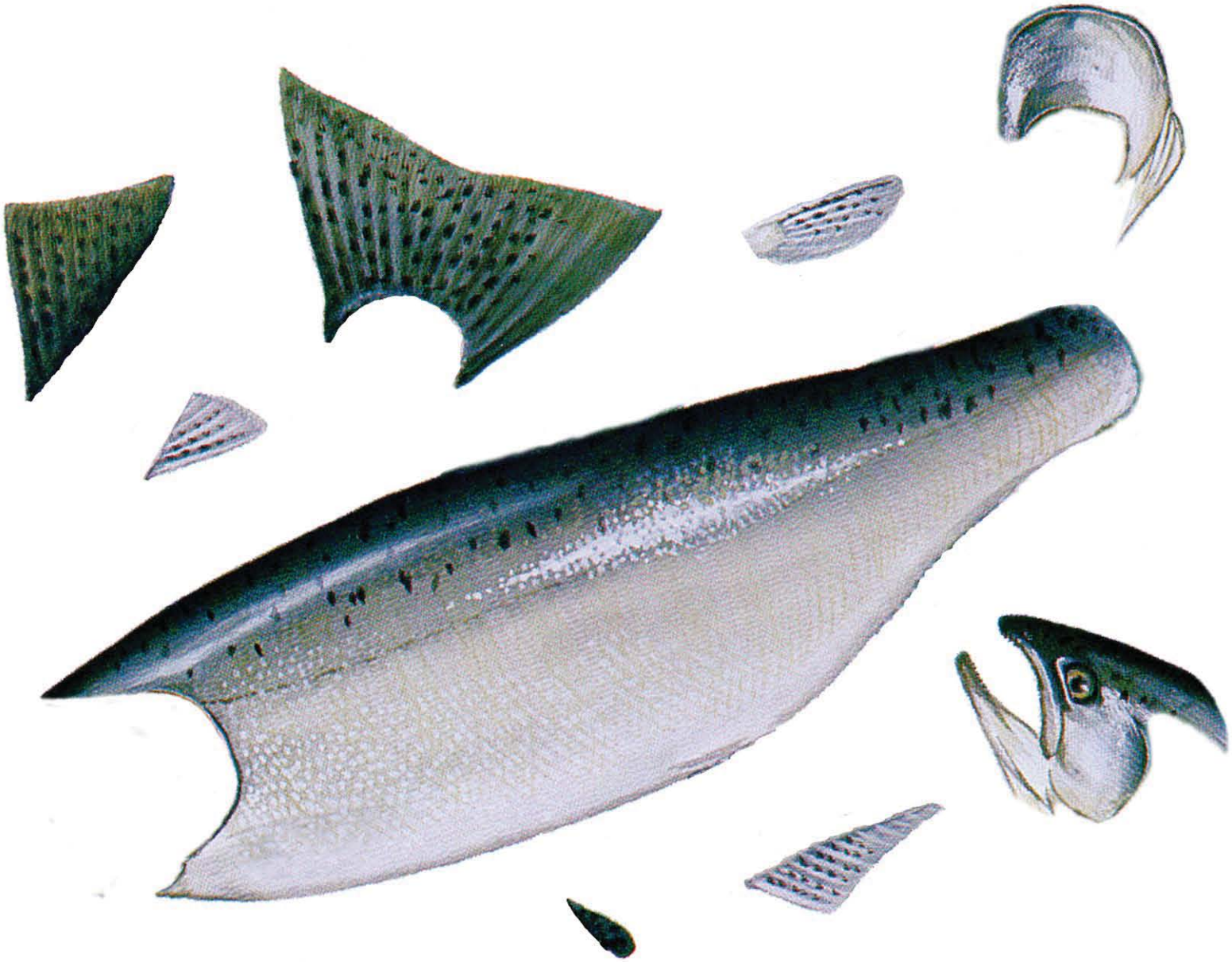
Pin the Parts on the Salmon!



Fashion a Fish – *adapted from Project WILD Aquatic*

Topic of Grade Level Content Expectaton(s)

Adaptation, coloration, camouflage, habitat, art, S.IP.M.1, L.HE.M.2

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 desgined a fish adapted for various aquatic habitats.

Best Taught

Any time during the school year.

Materials

(P=Provided in the Teacher Resource Kit)
Fashion a Fish Adaptation Cards sheets (P) teacher can prepare in advance or students can design and cut out (page 42)
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.

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

In this activity, the students design a fish. Students choose the adaptation that their fish will have. Each choice would actually take countless years to develop. As those adaptations become part of the fish's design, the fish becomes better suited to the habitat in which it lives. Because of the variety of conditions within each habitat, many different fish can live together and flourish. Some common adaptations of fish are listed below.

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 on page 41: Mouth type, body shape, coloration/camouflage, reproduction type AND a new category the students devise.

Activity 2: Build a Fish

1. Divide the Fashion a Fish Adaptation Cards into five groups of four cards each. Each group of cards should have one card for: Mouth, body shape, coloration and reproduction type.

2. Split class into five groups, and hand one group of Adaptation cards to each group.

3. Ask the students in each group to Fashion a Fish using all four 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.

Adaptation	Advantage	Examples
MOUTH TYPE		
Sucker-shaped	Feeds on very small plants and animals	Carp, Sucker
Elongated upper jaw	Feeds on prey it looks down on	Spoonbill, Sturgeon
Elongated lower jaw	Feeds on prey it sees above	Barracuda, Snook
Duckbill jaws	Grasps prey	Muskellunge, Pike
Extremely large jaw	Surrounds prey	Bass, Grouper
BODY SHAPE		
Torpedo shaped	Fast moving	Trout, Salmon
Flat bellied	Bottom feeder	Catfish, sucker
Vertical disk	Feeds above or below	Bluegill, Sunfish
Horizontal disk	Bottom dweller	Flounder, Halibut
Hump backed	Stable in fast-moving water	Sockeye Salmon, Chub
COLORATION/CAMOUFLAGE		
Light-colored belly	Difficult to see from below	Minnows, Perch, Tuna
Dark upper side	Difficult to see from above	Bluegill, Crappie
Vertical stripes	Can hide in vegetation	Perch, Muskellunge
Horizontal stripes	Can hide in vegetation	Yellow & White Bass
Mottled coloration	Can hide in rocks and on bottom	Trout, Rock Bass
REPRODUCTION TYPE		
Eggs at bottom	Hidden from predators	Trout, Salmon
Eggs in nest	Protected by adults	Bass, Stickleback
Floating eggs	Dispersed in high numbers	Striped Bass
Eggs attached	Stable until hatching	Perch, pike, carp
Live bearers	High survival rate	Guppies

Fish Adaptation Cards *This is a copy me page*

Shape

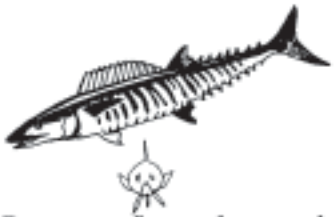
Flat Bellied (Catfish)

Mouth/Feeding

Sucker Shaped Jaw (Sucker)

Shape

Torpedo Shape (Wahoo)



Mouth/Feeding

Extremely Large Jaws (Grouper)

Shape

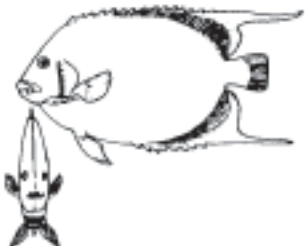
Horizontal Disc (Halibut)

Mouth/Feeding

Elongated Lower Jaw (Barracuda)

Shape

Vertifal Disc (Butterfish)



Mouth/Feeding

Duckbill Jaws (Muskellunge)

Shape

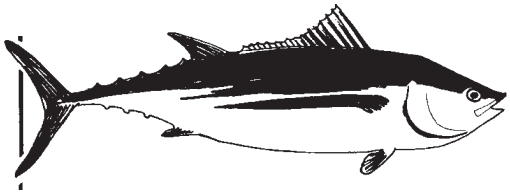
Humpbacked (Sockeye)

Mouth/Feeding

Elongated Upper Jaw (Cod)

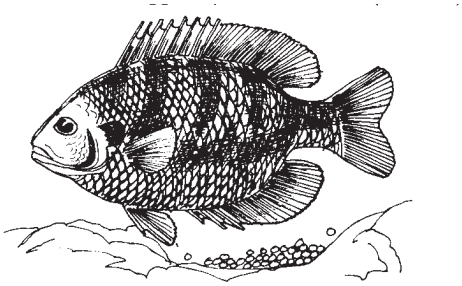
Fish Adaptation Cards *This is a copy me page*

Coloration



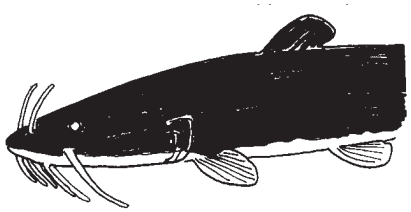
Light Colored Belly (Albacore)

Reproduction



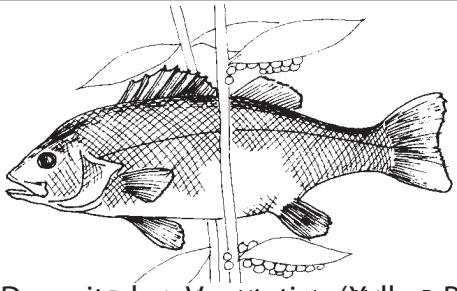
Eggs Deposited in Nests (Blue Gill)

Coloration



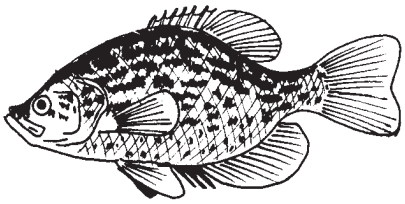
Dark Upper Side (Catfish)

Reproduction



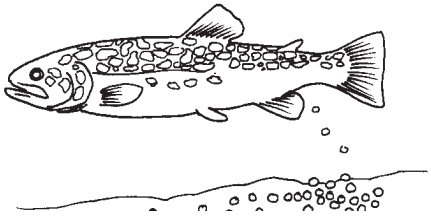
Eggs Deposited on Vegetation (Yellow Perch)

Coloration



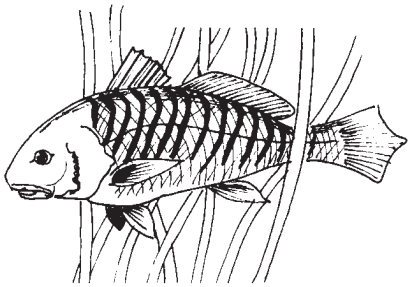
Mottled (Crappie)

Reproduction



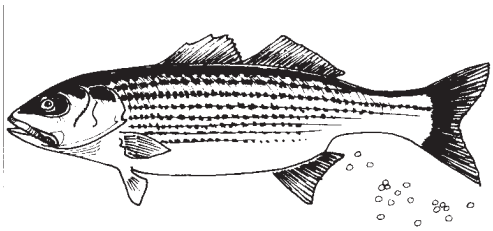
Eggs Deposited on Bottom (Trout)

Coloration



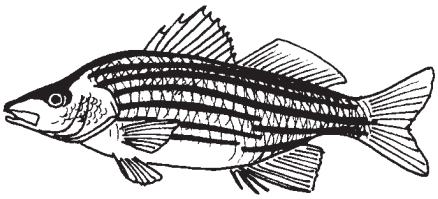
Verticle Stripes (Croaker)

Reproduction



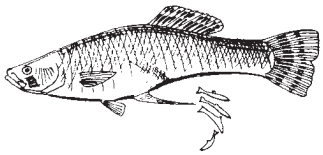
Free Floating Eggs (Striped Bass)

Coloration



Horizontal Stripes (Yellow Bass)

Reproduction



Live Birth (Gambusia)

Migration Fixation

Topic or Grade Level Content Expectation(s)

Life cycle, migration. L.OL.E.3/4/5/6, L.EV.05.12

Grade Levels

3 - 6

Objectives

To enhance understanding of salmon behavior and 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

(P=Provided in Teacher Resource Kit)
20 salmon cards (P)
Great Lakes basin map (P)
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.

Overview

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

The object of the simulation is to have the team's student token reach the end of the board – the Great Lakes!

1. Tape 8.5 x 11 pieces of paper down in a curvy line, mimicking a stream. Place 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.

2. Place 20 'salmon cards' upside down, one per sheet.

3. Divide the class into two teams; one will be the Chinooks, the other will be the Cohos.

4. Each team chooses a 'token' piece -- a student who will wear a colored T-shirt, red for the Chinooks team, blue for the Cohos.

5. 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.).

6. 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

Pages 45 through 47 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 muskellunge (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 sak has buttoned up.
MOVE AHEAD ONE SPOT.

Latin Lingo

Topic or Grade Level Content Expectation(s)

Language Arts, Classification, Taxonomy, L5.p2,

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 Specific epitat) and know what fish names mean in Latin.

Best Taught

Any time during the school year.

Materials

(P=Provided in Teacher Resource Kit)
Index cards (one for each student)
Yarn to string cards like a necklace
Fish of Michigan Book (P)
Michigan Fish illustration on front, common and latin name on reverse (P)
Latin Word, English word, Common Fish Name Cards (P)

Background

Latin was first encountered in ancient times as the language of Latium, the region of central Italy in which Rome was 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: Origins 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 mach 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.

That's Latin for...

Common Name	Latin Name	Meaning of Latin Name (Obviously, the students can have fun with some of these names!)
Brown trout	Salmo trutta	Salmo from Salio meaning to leap. Trutta means trout.
Chinook salmon	Oncorhynchus tshawytscha	Onchorhynchus = hooked snout, tshawytscha = old Russian name for this species.
Brook trout	Salvelinus fontinalis	Salvelinus = root is German for a little salmon, fontinalis = living in springs
Coho salmon	Oncorhynchus kisutch	Onchorhynchus = hooked snout, kisutch = old Russian name for this species.
Muskellunge	Esox Masquinongy	Exox = pike (Latin), Masquinongy = American Indian name for this species.
Alewife	Alosa pseudoharengus	Alosa = shad (Latin), pseudoharengus = false herring (Greek).
Lake sturgeon	Acipenser fulvescens	Acipenser = sturgeon (Latin), fulvescens = reddish/yellow (Latin).
Sea lamprey	Petromyzon marinus	Petromyzon = stone to suck (Greek), marinus = marine.
Lake whitefish	Coregonus clupeaformis	Coregonus = angle eye (Greek), clupeaformis = herring shaped (Latin).
Channel catfish	Ictalurus punctatus	I ctalurus = fish cat (Greek), punctatus = spotted (Latin).
Bluegill	Lepomis macrochirus	L epomis = scaled gill cover (Greek), macrochirus = large hand (Greek).
White crappie	Pomoxis annularis	Pomoxis = opercle sharp (Greek), annularis = having rings (Latin).
Rainbow darter	Etheostoma caeruleum	Etheostoma = filter mouth (Greek), caeruleum = blue (Latin).

Extension

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

Sources

Carl Linnaeus, July 7, 2000, Ben M. Waggoner. February 27, 2007, www.ucmp.berkeley.edu/history/linnaeus.html

Philips, Gary L. et al. Fishes of the Minnesota Region, University of Minnesota Press, Minneapolis, Minnesota.

Pages 50 through 62 are Copy me pages. Copy and cut on the dotted line.

Brown

Trout

Chinook

Salmon

Coho

Salmon

Muskellunge

Alewife

Lake

Sturgeon

Sea

Lamprey

Lake

Whitefish

Channel

Catfish

Bluegill

White

Crappie

Salmo

Trutta

Oncorhynchus

Tshawytscha

Salvelinus

Fontinalis

Oncorhynchus

Kisutch

Esox

Masquinongy

Alosa

Pseudoharengus

Acipenser

Fulvescens

Petromyzon

Marinus

Coregonus

Clupeaformis

Ictalurus

Punctatus

Lepomis

Macrochirus

Pomoxis

Annularis

From Salio meaning to leap in Latin

Means trout in Latin

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 hooked snout in Latin

Old Russian name for this species

Means pike in Latin

American Indian 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

Means fish cat
in Greek

Means spotted
in Latin

Means scaled gill
cover
in Greek

Means large hand
in Greek

Means sharp opercle in Greek

Means having rings in Latin

Means filter mouth in Greek

Means blue in Latin

Water Bug Hunt

Topic or Grade Level Content Expectation(s)

Pond Study, water quality, insect identification, data collection. S.IP.E.1, S.RS.M.1, B3.4x, L3.p4

Grade Levels

3 - 12

Objectives

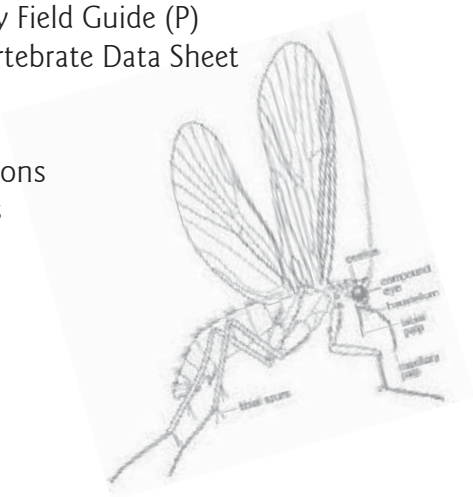
Students learn to identify a variety of macroinvertebrates and understand their role in the aquatic ecosystem. Students will gain knowledge of how these organisms serve as biological indicators for the overall health of these systems.

Best Taught

Any time of the school year

Materials

(P=Provided in Teacher Resource Kit)
Pond nets
Hand held magnifying lenses
Magnifying bug viewers/small plastic jars
Plastic tanks/buckets
Macroinvertabrate Sorting Sheet-large plastic poster for petri dishes(P)
Petri Dishes (P)
Pond Study Field Guide (P)
Macroinvertebrate Data Sheet
Pencils
Clipboards
Plastic spoons
Small trays



Background

Macroinvertebrates are large enough to see with the naked eye (macro) and have no backbone (invertebrate). They are big, no-backbone bugs. 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 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 usually 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 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.
4. 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?

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 of the water body or from loose, submerged vegetation.
5. Remind students to take very special care not to harm the organisms. They will be returning the organisms back to the body of water after the study has concluded.
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 plastic tank filled with water or the small plastic jars.
8. Gather identification sheets at end of the allotted time period.
9. Write results on large sheet of paper or dry erase board.
10. Tally results for all of the groups.

Discussion

Were there a lot of pollution-sensitive organisms? This indicates the aquatic ecosystem is of good water quality. Such organisms may include Fishfly Larva, Snipefly Larva, 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? This indicates the water quality is poor and degraded. What could be the cause of the water being degraded? Indicator organisms include Blackfly Larva, Horse/Deerfly Larva, Midge Larva, Backswimmer, Giant Water Bug, Water Penny, Water Boatman, Waterstrider, Whirligig Beetle, Whirligig Beetle Larva, Riffle Beetle, Aquatic Worms, Leech, Crayfish and snails.

Discussion

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:

Nonpoint source pollution

Nonpoint source pollution is pollution whose source cannot be directly identified. Examples include erosion, oil leaks from cars and equipment, pesticide runoff, animal waste, excess fertilizer and nutrients running off from lawns and farms. Nonpoint 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.

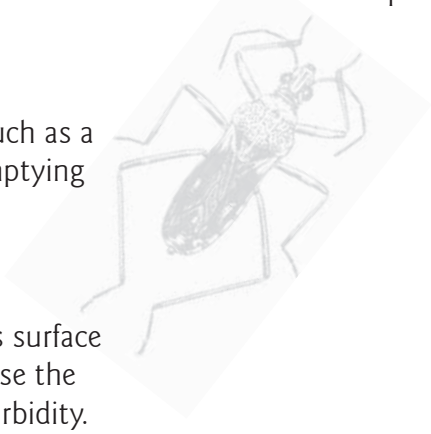
Erosion

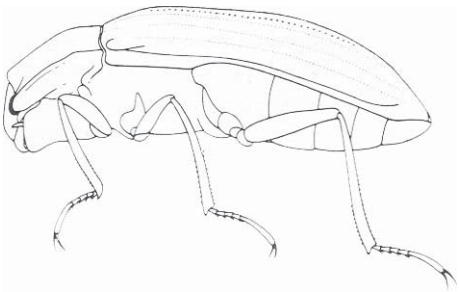
When sediments and soil leave the earth's surface (erosion) and enter a water body, they decrease the water clarity and increase its cloudiness or turbidity.

- Many fish species, such as northern pike, 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. This could smother the eggs and keep them from getting oxygen.
- Sunlight is necessary for photosynthesis to occur. Photosynthesis is the process by which plants convert light energy into chemical energy that is useable 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.





Macroinvertebrate Data Sheet *This is a copy me page*

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 and Dragonfly		
Dobson Fly/Hellgrammites		
Fairy Shrimp		
Giant Water bug		
Gilled Snail		
Leech		
Lunged Snail		
Mayfly		
Midge Fly		
Nematode		
Riffle Beetle		
Scud		
Stonefly		
Water Boatmen		
Water Penny		
Water Scavenger Beetle		
Water Scorpion		
Water Snipe Fly		
Water Strider		
Whirligig Beetle		
Other Organisms:		

What's in the Water

Topic or Grade Level Content Expectation(s)

Measuring Water Quality, Chemistry (pH and Dissolved Oxygen), Using Tools, Ecology, Human Impact on the Environment, S.RS.E.1, S.IP.E.1, S.RS.M.1, C5.7, C1.1, B3.5x

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 kinds 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

(P=Provided in Teacher Resource Kit)
Water Quality Testing Kit (P)
Clip boards
Water Quality Test Sheet
Water Temperature and Fish Chart (page 71)
pH Chart (page 69)

A single, basic test kit containing pH, temperature, turbidity and dissolved oxygen tests is included in the Teacher Resource Kit. Additional water testing medium is recommended 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.

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 water 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, 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.

Activity: Water Testing

1. Break students into groups of 3-4 students. Hand out data sheets on clipboards to each group.
2. Water tests should be done individually; not all at once.
3. 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 in a given body of water.
- Perform test according to instructions.
- Instruct students to record DO level on data sheet.

Test 3: 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 around 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 provided.
- Instruct students to record their finding on 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 .

Sources:

http://peer.tamu.edu/

http://www.elmhurst.edu/~chm/vchembook/184ph.html

pH Levels Chart

pH	Examples of Solutions at this pH
0	Battery Acid
1	Hydrochloric acid secreted by stomach
2	Lemon juice, vinegar
3	Grapefruit, orange juice, soda
4	Tomato juice, acid rain
5	Black coffee
6	Urine, saliva
7	"Pure water"
8	Seawater
9	Baking soda
10	Great Salt Lake, Milk of Magnesia
11	Ammonia solution
12	soapy water
13	Bleach, oven cleaner
14	Liquid drain cleaner

Water Quality Test Sheet

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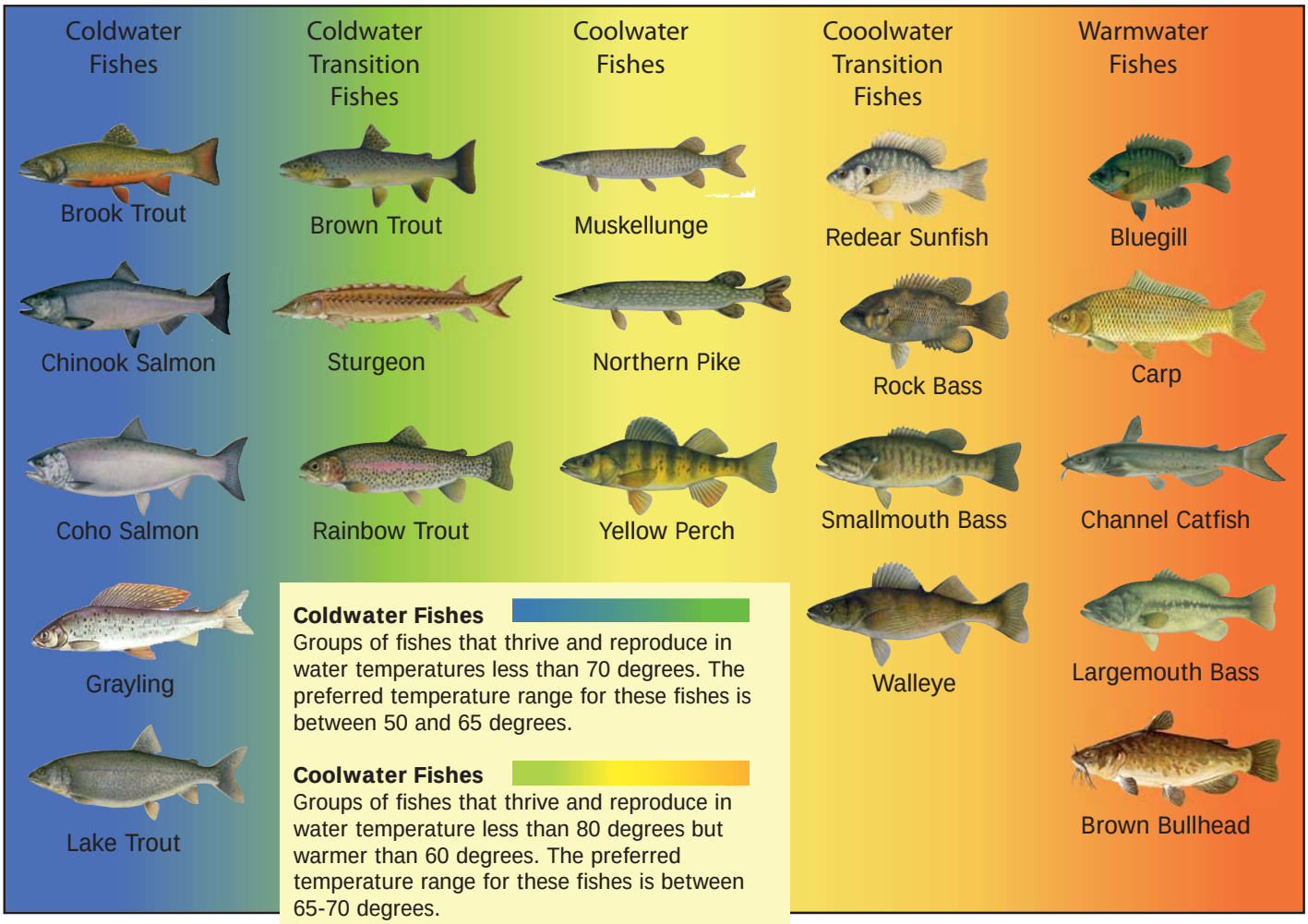
Date	Testing Location
Group Members	
Body of Water Type (check one)	
☐ Wetland ☐ Pond ☐ Lake ☐ River ☐ Stream	
Weather Conditions	
Water Temperature	**Other Tests Conducted**
pH	
Nitrate	
Dissolved Oxygen	
Notes:	

Water Temperature and Fish



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 "endotherms." 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 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 do overlap, however. They 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

Scales and Tails

Topic or Grade Level Content Expectation(s)

Fish Identification, Use of Microscope, Classification, Fish Anatomy, S.IA.E.1, L.OL.M.4, B4.1, L5.p2,

Grade Levels

4 - 12

Objectives

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

Best Taught

Anytime during the school year.

Materials

(P=Provided in Teacher Resource Kit)
One whole fish per 2 students (available by contacting your nearest bait shop, local supermarket, or aquaculture facility-locations listed by county at www.michigan.gov/doa.

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
External Fish Parts
A tree cookie (P)
Fish Scales and Tails Poster (P)

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:

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 home streams for spawning. In some cases this scent is also helpful in avoiding predators. Fish breathe through their gills, not their nostrils.

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).

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.

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 membranes into the fish's blood. Carbon dioxide is simultaneously released from the blood into the water across the same membranes.

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. 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 mucous (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 - These organs remove waste from the blood and produce urine.

Liver - A digestive, storage and excretory organ.

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.

Extension

Try surfing online to obtain opercules (fish gill plates) or ototliths (inner ear bones) to extend the discussion on fish anatomy and physiology.

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

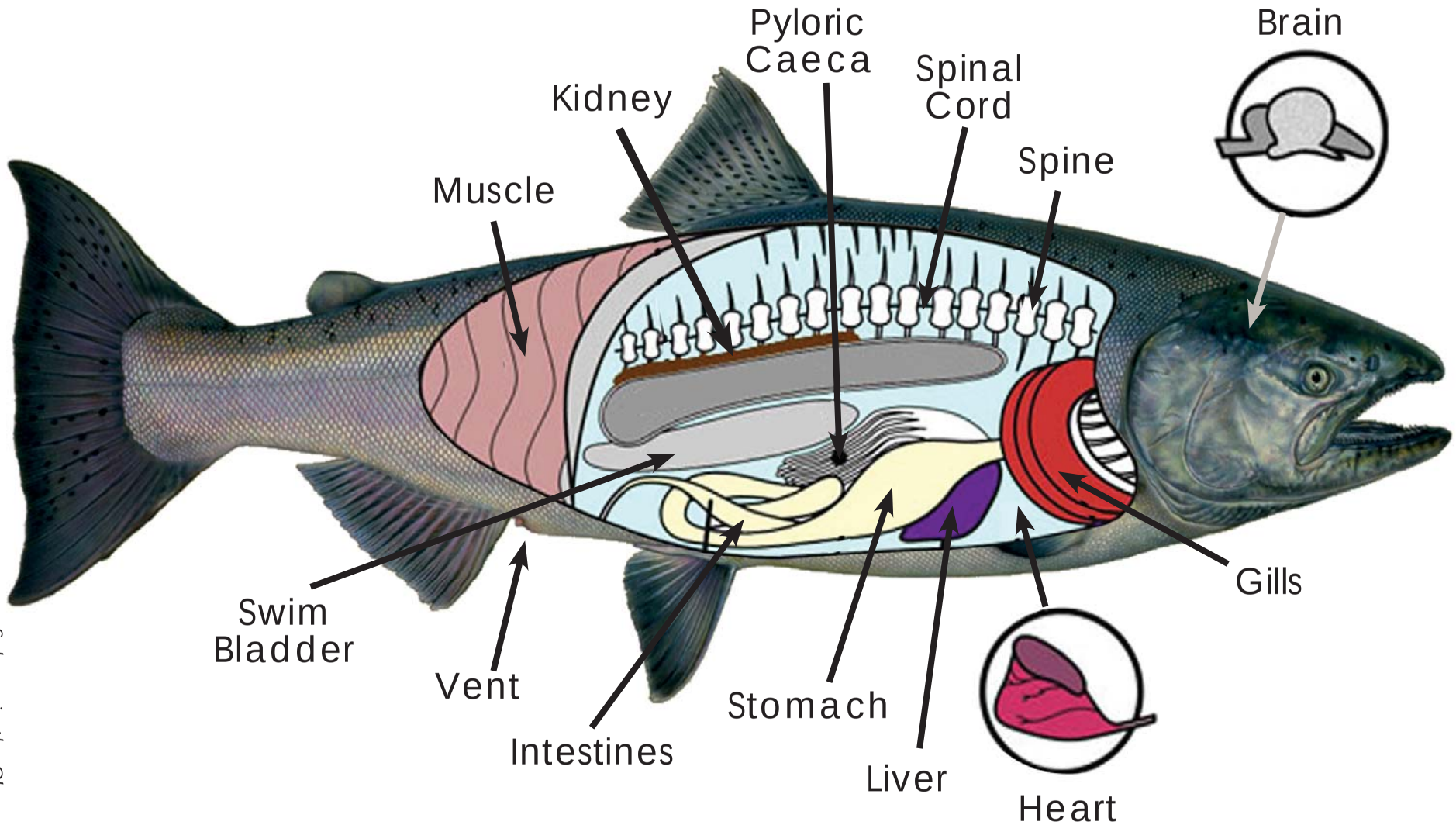
Otoliths – (fish inner ear bones which rest on a bed of sensory hairs, that send messages to the brain about the orientation of the fish) available from many online science learning stores.

Visit your local private fish farm with the students and arrange for a tour of the facilities.

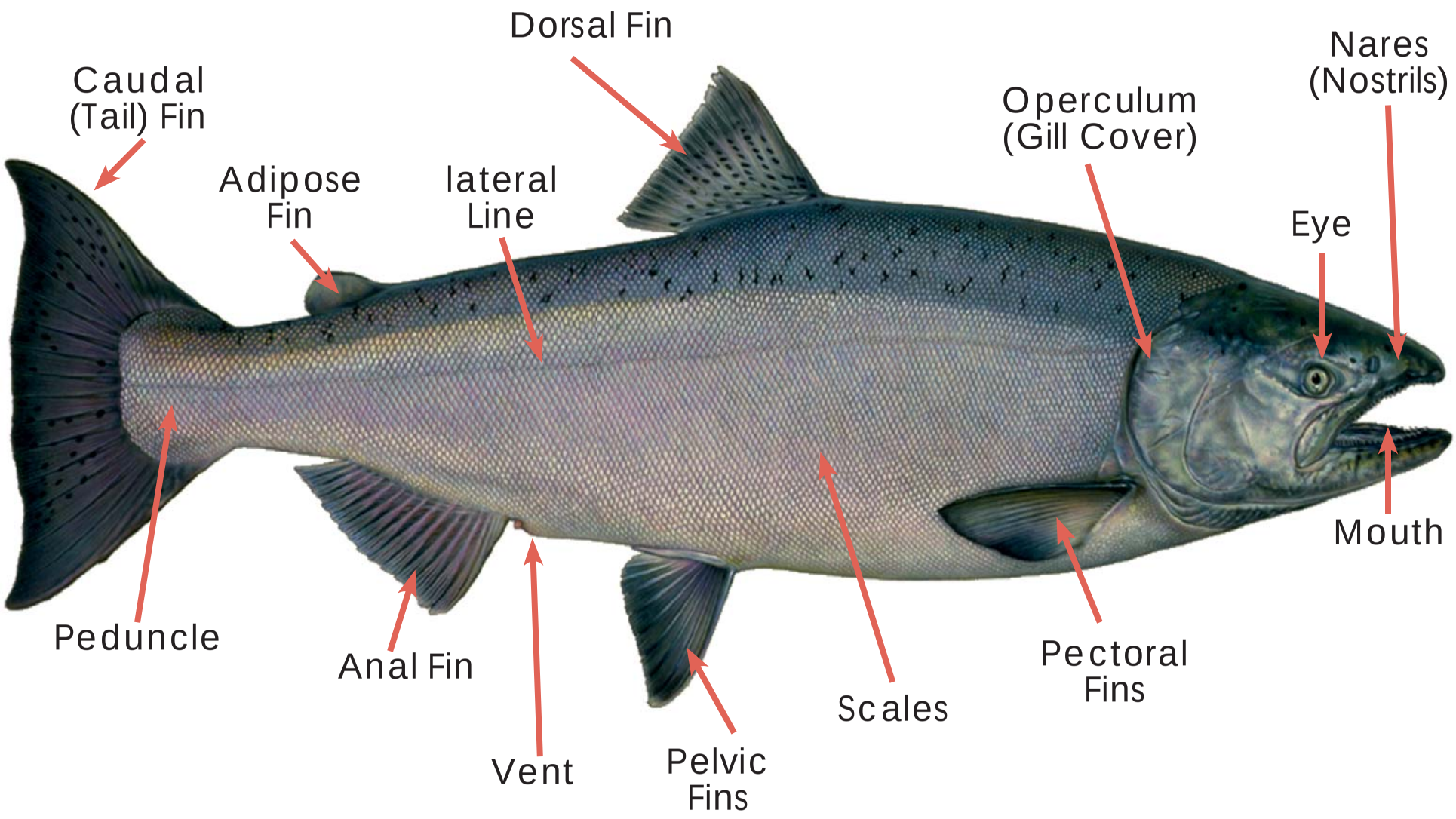
Sources

Gilbert, C.R., Williams, J.D. *A Field Guide to Fishes Revised Edition, North America.* National Audubon Society. Alfred A. Knopf, Publishing, New York, New York. 607 pages.

Internal Anatomy



External Anatomy



Saving Salmon Streams

Topic or Grade Level Content Expectation(s)

Water Pollution, Human Impact on the Environment, S.RS.E.1, S.IP.E.1, S.RS.M.1

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

Any time during the school year.

Materials

Food coloring (several colors)
Small, clear tank
Small bag of torn up pieces of paper or similar items
Small amount of soil
*Fertilizer bag/ container (empty)
*Plastic drink rings (from water bottles, soda pop, etc.)
*Oil quart container (empty)
*Plastic toy fish
*Optional

Background

Plants, animals and humans need clean water to survive. Pollution, both nonpoint 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.1 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.2 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

- Fill small tank with water and add the toy fish.
- Set the tank on a table so all students can see.
- 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.)
- Discuss the different ways that lakes, rivers and streams can become polluted. Write responses on board and create list. 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.

Sources

1. www.epa.state.oh/us/opp/consumer.protect.html

2. www.sierraclub.org/toxics/leaking_USTS/factsheets/michigan.pdf

Freshwater Frenzy

Topic or Grade Level Content Expectation(s)

Water Conservation, S.1A.E.1, S.1P.E.1

Grade Levels

3 - 6

Objective

Students will learn about the importance of conserving water resources.

Best Taught

Any time during the school year.

Materials

(P=Provided in Teacher Resource Kit)

Inflatable globe (P)
One two-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% freshwater supply, just .00003% is drinkable water.

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 chalkboard or dry erase 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 useable for everyday human needs?
5. 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.
6. What do we use fresh water for? Have students compile a list. Cleaning, cooking, bathing, drinking, watering gardens and crops, manufacturing, etc. Can humans use salt water to fulfill these needs? No.
7. 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.
8. 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."
9. Hold up the cup with the Earth's freshwater supply. Two-thirds of the fresh water or 2% of the total water on Earth is locked in ice caps and glaciers. Is that water useable? 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 or "potable" water.
10. 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?

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.

What's Your Watershed Address

Topic or Grade Level Content Expectation(s)

Basic water ecology and conservation, Human Impact on the Environment, S.IP.E.1, S.IA.E.1, B3.4x

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 nonpoint sources pollution affect quality of life.

Best Taught

Any time during the school year.

Materials

(P=Provided in the Teacher Resource Kit)

4 large pieces of poster board
Great Lakes basin map (P)
1 state of Michigan map
1 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 a variety of colors)
1 cup of Cocoa Pebbles cereal
1 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 MONOPLY 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 PIPES
ORGANIC WASTE

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 eventuallydrain? 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.

5. 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 pollution
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 freshwater 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 nonpoint 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 nonpoint 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. This also could be a point or nonpoint source pollutant due to size and occurrence. If we are talking about people who don't pick up after their dog, it's nonpoint; if we are referring to a mega farm, it's point source.

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 everyone 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)

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)

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)

Smoke Stack

Large Oil Spill

Animal Waste

Factory Drain Pipes, Landfills

Organic Waste

This is a Copy Me page for Activity 2.
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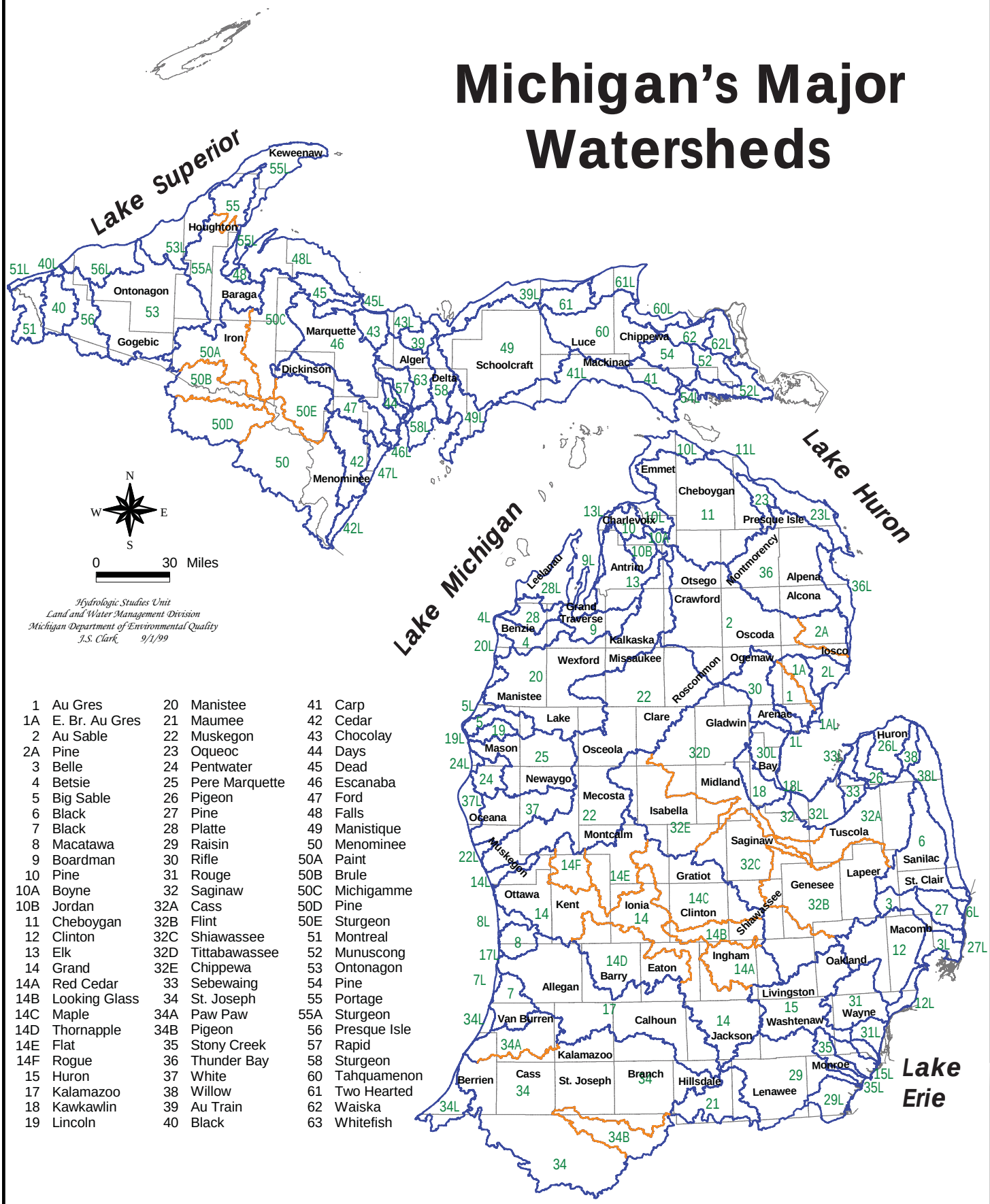
Michigan's Major Watersheds



Hydrologic Studies Unit
Land and Water Management Division
Michigan Department of Environmental Quality
J.S. Clark 9/1/99

1	Au Gres	20	Manistee	41	Carp
1A	E. Br. Au Gres	21	Maumee	42	Cedar
2	Au Sable	22	Muskegon	43	Chocolay
2A	Pine	23	Oqueoc	44	Days
3	Belle	24	Pentwater	45	Dead
4	Betsie	25	Pere Marquette	46	Escanaba
5	Big Sable	26	Pigeon	47	Ford
6	Black	27	Pine	48	Falls
7	Black	28	Platte	49	Manistique
8	Macatawa	29	Raisin	50	Menominee
9	Boardman	30	Rifle	50A	Paint
10	Pine	31	Rouge	50B	Brule
10A	Boyne	32	Saginaw	50C	Michigamme
10B	Jordan	32A	Cass	50D	Pine
11	Cheboygan	32B	Flint	50E	Sturgeon
12	Clinton	32C	Shiawassee	51	Montreal
13	Elk	32D	Tittabawassee	52	Munuscong
14	Grand	32E	Chippewa	53	Ontonagon
14A	Red Cedar	33	Sebewaing	54	Pine
14B	Looking Glass	34	St. Joseph	55	Portage
14C	Maple	34A	Paw Paw	55A	Sturgeon
14D	Thornapple	34B	Pigeon	56	Presque Isle
14E	Flat	35	Stony Creek	57	Rapid
14F	Rogue	36	Thunder Bay	58	Sturgeon
15	Huron	37	White	60	Tahquamenon
17	Kalamazoo	38	Willow	61	Two Hearted
18	Kawkawlin	39	Au Train	62	Waiska
19	Lincoln	40	Black	63	Whitefish

Note: Basin Numbers followed by an "L" denotes Lake Drainage that is clockwise from the basin outlet.

Research Revolution

Topic or Grade Level Content Expectation(s)

Structure and function of fish anatomy, S.IP.E.1, S.IA.E.1, B3.5

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

(P=Provided in Teacher Resource Kit)
Tree Rounds (P)
Coded Wire Tag (P)
Microscope and slide
Fins, Tails and Scales poster (P)
Fish scale (from the grocery store)
Enlarged image of fish scale (below)
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 mehods used to track hatchery born fishstatistics. 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.

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. Locate the nearest drop site for tagged salmon or trout on the map located under the Background tab.

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.

Cycloid scales are small oval-shaped scales with growth rings. Carp and similar fish have this type of scale.

Ctenoid scales are similar to the cycloid scales, with growth rings. They are distinguished by spines that cover one edge. Cichlids, are members of a family of ornate fish often purchased for aquariums and have this type of scale. They are not found in the Great Lakes.

Ctenoid and cycloid scales, grow proportionally to the fish. Evidence of this growth can be seen in the circuli, or concentric lines laid down on a scale. The spacing between circuli is an indication of the environmental conditions present in the waterway. Large gaps in circuli indicate favorable environmental conditions and a plentiful food supply. During periods of environmental stress or decreased metabolism, fish growth will be slow and the circuli will be very close together. These lines are often so close that they appear as a heavy line on the scale. These heavy lines are called annuli and generally occur during the winter months. These lines resemble the growth rings on trees that indicate periods of growth and rest. (from CreekConnections. alleghany.edu).

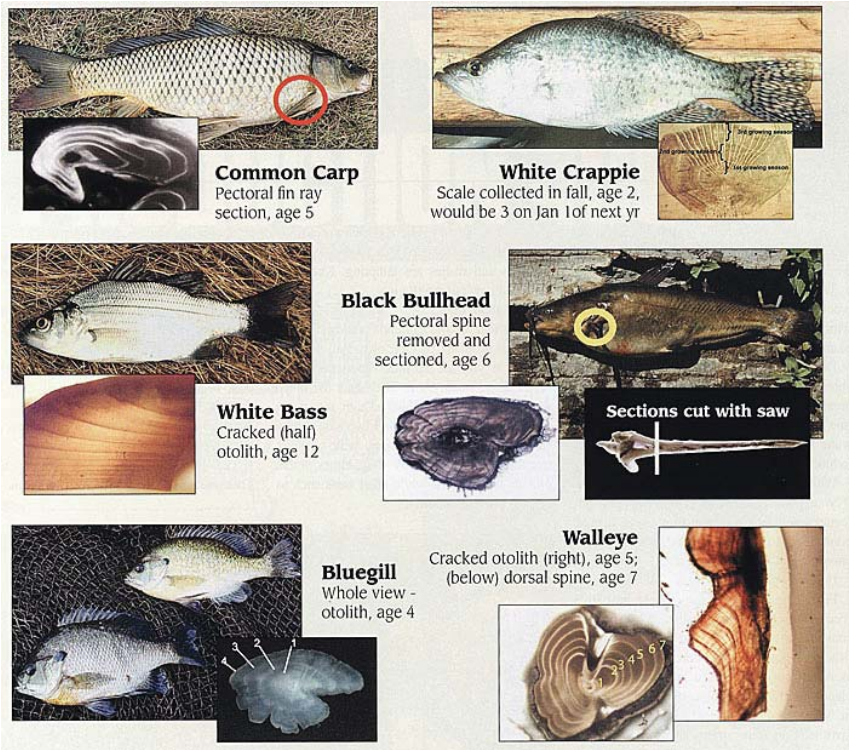
The image on this page is from http://www.wdfw.wa.gov/fishing/salmon/chum/life_history/life_ages.html, visit it to see more aging examples.

Give each student at least one scale to observe under a microscope. Discuss the difference between the annuli rings and circuli rings on a fish scale. Have them determine the difference between summers and winters circuli.

Extension

Visit the local weir or research station by arranging a tour.

Visit www.michigan.gov/fisheries.



How Many Fish Does it Take?

Topic or Grade Level Content Expectation(s)

Math percentages

Grade Levels

6 - 8

Objective

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

Best Taught

Anytime during the school year.

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 300 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: 255

If 95% of the eggs that eyed up eventually hatched, how many sac fry do you have left? Answer: 242

Assuming 93% of your sac fry successfully started feeding, how many healthy, feeding fry would you have? Answer: 225

During the rest of fish rearing, you lose only another 2%. What is the final number of fish you have to plant? Answer: 220

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

Why Fish Go To School

Topic or Grade Level Content Expectation(s)

Mathematics, probability models, L3.p1, B1.1

Grade Level

9 – 12

Objective

To 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.

Best Taught

Anytime during the school year.

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 (chinook salmon) and prey (alewives).

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 at them.

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.

Food Allotment Data Sheet *This is a copy me page*

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	20.4

What is the number of fish per kilogram on the last day of the treatment?
Answer: 195.9 fish per kilogram.

Salmon Scents (out of Project Wild Aquatic)

Topic or Grade Level Content Expectation(s)

Salmon life cycle, S.IP.E.1, S.IA.E.1

Grade Levels

3 through 6 (also adaptable for older groups)

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 throughout the school year

Materials

(P=Provided in the Teacher Resource Kit)
100 yards of string
Scissors
50, 1 – 3 ounce Solo cups with lids
50 cotton balls
5 distinctly different essential oils (such as peppermint, cinnamon, clove, vanilla and orange)
Masking tape or clothesline, at least 50' in length
River figures 1 and 2 (P)

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.

Activity

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. 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.

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. 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 you use the main scent inbetween 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 cottonball 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 (cottonball placed there) to determine if it is the right path. The goal is to discover their natal stream by finding the same scent (cottonball) 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 lands, 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.

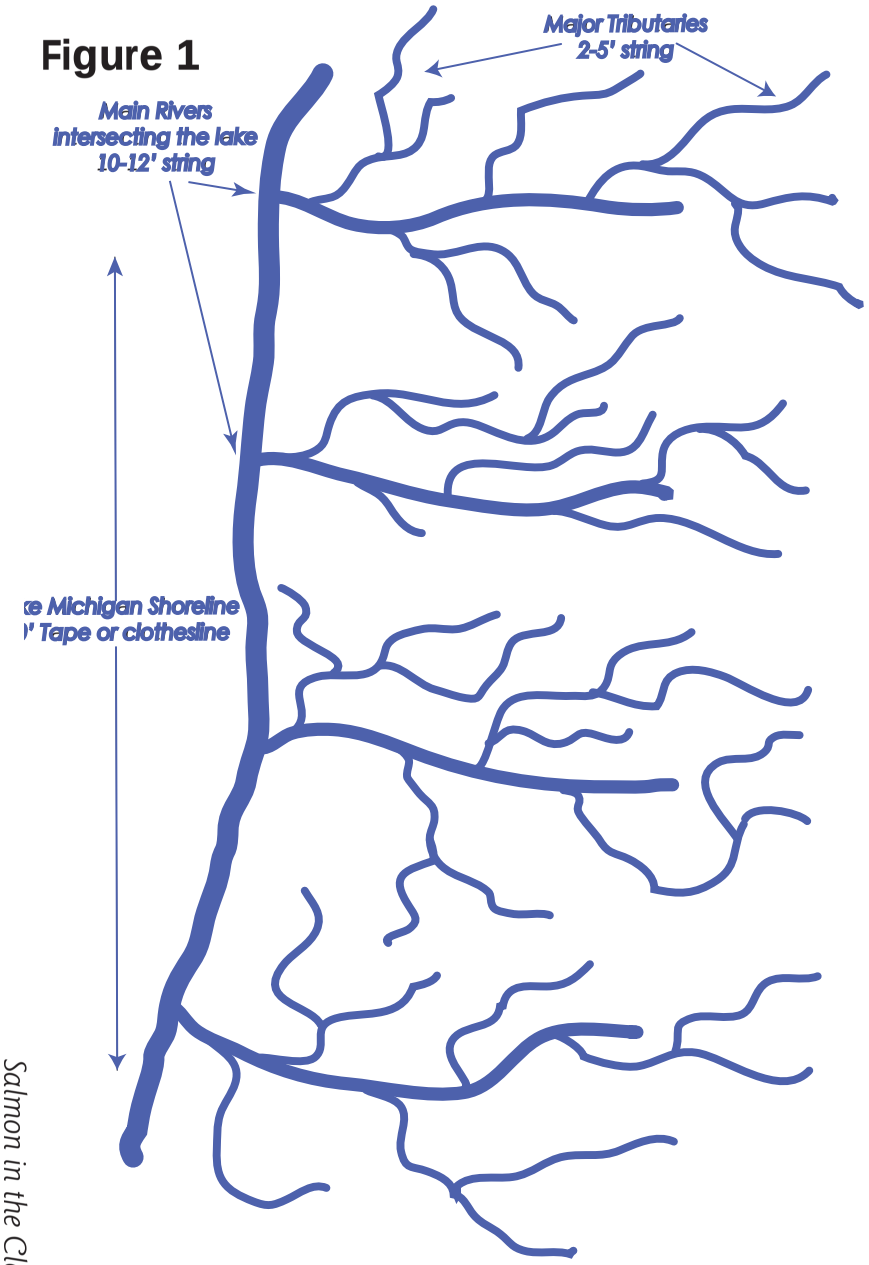


Figure 1
Major Tributaries
2-5' string
Main Rivers
Intersecting the lake
10-12' string
ke Michigan Shoreline
' Tape or clothesline

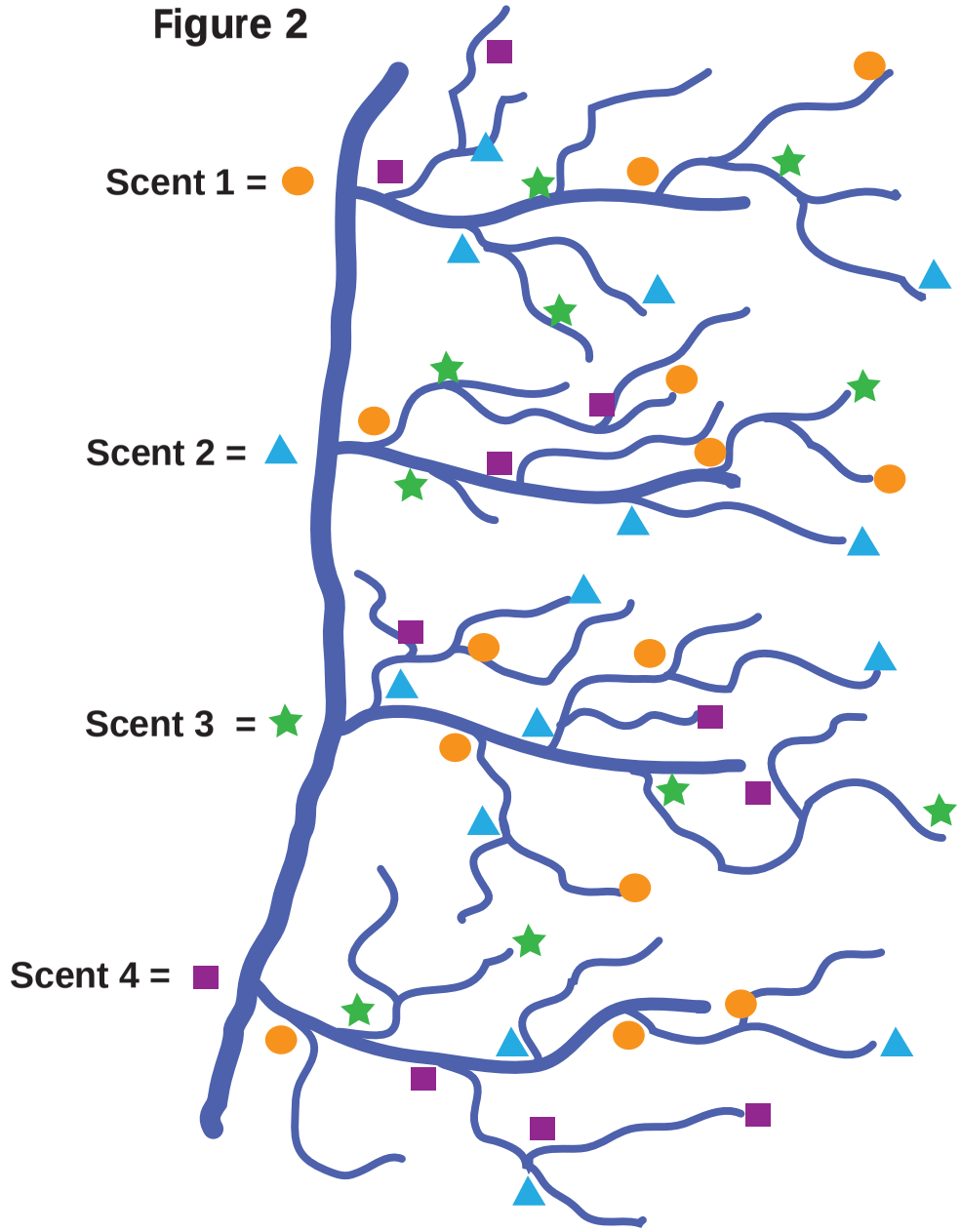


Figure 2
Scent 1 =
Scent 2 =
Scent 3 =
Scent 4 =

Great Lakes Grief

Topic or Grade Level Content Expectation(s)

Michigan's aquatic invasive species, non-native species, L.EC.E.1, L.OL.M.6

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

(P=Provided in Teacher Resource Kit)
Google for photographs of four or five invasive species
Great Lakes basin map (P)
Sea Grant Invasive Poster Set (P)
Dry erase or other erasable markers in different colors.
A ball of string or yarn.
Index cards with a hole punched through the top center. Loop string or through the hole to create signs students can place around their necks.
Masking tape
Pair of 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. The flora and fauna associated with these watersheds depend on their sustainability. 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, when 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 maker to 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 if they are having difficulty (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 at random. How many other animals around the circle 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 (outside activity)

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.

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 and 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 and 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/deq.

- 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/deq 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: http://www.michigan.gov/deq/0,1607,7-135-3313_3681_3710---,00.html

- Have students write a paper on the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990.

- Raise funds to take a field trip to the Welland Canal or the Sanitary and Ship Canal in Chicago to see the electro-barrier fence installed to prevent the Asian carp from moving up the Chicago River into Lake Michigan (the Shedd Tank could be a fun side trip).

Sources
Michigan Department of Environmental Quality, Office of the Great Lakes
Michigan Department of Natural Resources
University of Michigan, Michigan Sea Grant Program Communications
University of Minnesota Sea Grant Program
Michigan State University Extension

TAB 4 Nature News

Click here for the Let's Go Fishing Booklet

tab 5 Glossary

Glossary

A

alevins - hatched salmon still having a large yoke sack for nourishment

alkalinity- is a measure of the ability of a solution to neutralize acids to the equivalence point of carbonate or bicarbonate

ammonia - is a compound with the formula NH3

anadromous - migrates from salt to fresh water

aquatic invasives - a non-native plant or animal deliberately or accidentally introduced into a new habitat

E

ecosystem - a natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the non-living physical (abiotic) factors of the environment

eddies - water current moving contrary to main current

erosion - natural processes including rain, weathering, dissolution, abrasion, corrosion and transportation, by which material is removed from the earths surface

F

Fish Hatcheries - a place where select fish are spawned, hatched and released

fry - a recently-hatched fish

H

habitat - environment in which an organism normally lives

hardness - a type of water that has high mineral content

M

mercury - a silvery white poisonous metallic element, liquid at room temperature

N

nitrates - a salt of nitric acid with an ion composed of one nitrogen and three oxygen atoms

nitrite - is either a salt or an ester of nitrous acid.

natal stream - the stream where fish originated from

P

parr - parr is a juvenile fish, one preparing to leave the fresh waters of its home

PCBs - polychlorinated biphenyls (PCBs) are a class of organic compounds. used as coolants and insulating fluids for transformers and capacitors, PCB production was banned in the 1970s due to the high toxicity of most PCB congeners and mixtures. PCBs are classified as persistent organic pollutants which bioaccumulate in animals.

pH - is the measure of the acidity or alkalinity of a solution

phosphate - a salt or ester of phosphoric acid

phosphorus - a highly reactive, poisonous, nonmetallic element occurring naturally in phosphates used in fertilizers

photoperiod - the relative exposure of an organism to daylight

plankton - microscopic water borne organisms

potamodromous - migrates within fresh water

R

redd - spawning bed

rehabilitation - the process of restoring the land, and natural environment

riffles - rocky shoal or sandbar lying just below a waterway

S

sac fry - young salmon called Alevins

smoltification - process of becoming physiologically adapted to saltwater and begins its trek to its salt water environment

spawning - the act of laying eggs

stocked fish - released by fish hatcheries into the wild

Y

yolk sac - serves as the food source for the developing embryo