Teacher Guide

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

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DEPARTMENT OF NATURAL RESOURCES
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2024 Edition

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You can see the full set of over 30 classroom activities on our website michigan.gov/SIC under

- Current SIC Participants

- SIC Activitys

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 classroom programs.

Why? One reason is the tremendous interest youth 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. In Michigan, this program began modestly in 1997 with a handful of schools. Since that time, interest has exploded and the DNR is pleased to see this program has the potential for tremendous impact.

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, but 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 stewards, voters and leaders of our state.

Teachers in the program receive a free, one-day professional development workshop complete with SCECHs, and this Teaching Guide. 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 their students' interest in each activity and the useful knowledge that it provides. As scientists, we have created the important messages we need to be understood, to reconnect our children to the great outdoors. Together, we can develop and nurture the next generation of stewards and fishers.

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. 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.

Field trip opportunities are available to schools throughout the state at 11 DNR Visitor Centers, including two hatcheries, with expert staff. Self-guided tours are also available at the DNR state fish hatcheries without interpretive staff.

Hard work from teachers, and support from our sponsors and partners is what makes the program a success. 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.

The Salmon in the Classroom Program

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 standards 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

The story of the Great Lakes and its fisheries depends heavily on the purposeful introduction of salmon, originally native to the Pacific Northwest, in the 1960s. A myriad of stewardship and natural resource conservation lessons can easily be spawned from the introduction of Chinook salmon into the Great Lakes.

Chinook Salmon

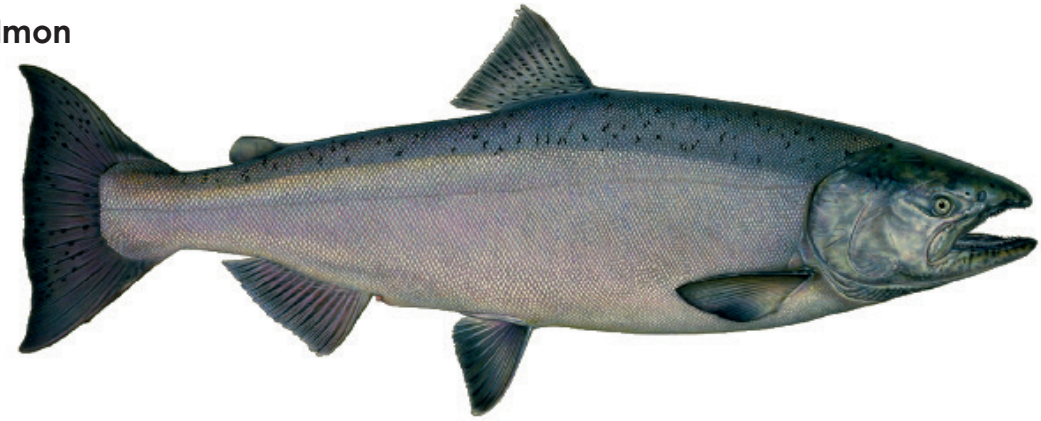


Illustration by
Joseph R. Tomelleri ©

- Spawning in fall and released in spring, 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 Weirs 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 Chinook are reared by the DNR.
- Although 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 in the spring 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

Illustrations by
Joseph R. Tomelleri ©

- 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, the 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 disease. Spring released brook/brown trout or coho salmon would be much smaller (less impact on students).

- Brook and brown trout spawn in late November, so students would have a much shorter period to observe fish development.

- When released, brook trout, brown trout and coho salmon have a much smaller chance of survival. They would be kept in hatchery raceways for an extra year and released the following spring to ensure more growth and higher survival. This is a format impossible for schools to follow.

- 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 they are more likely to become future stewards of natural resources and more 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.

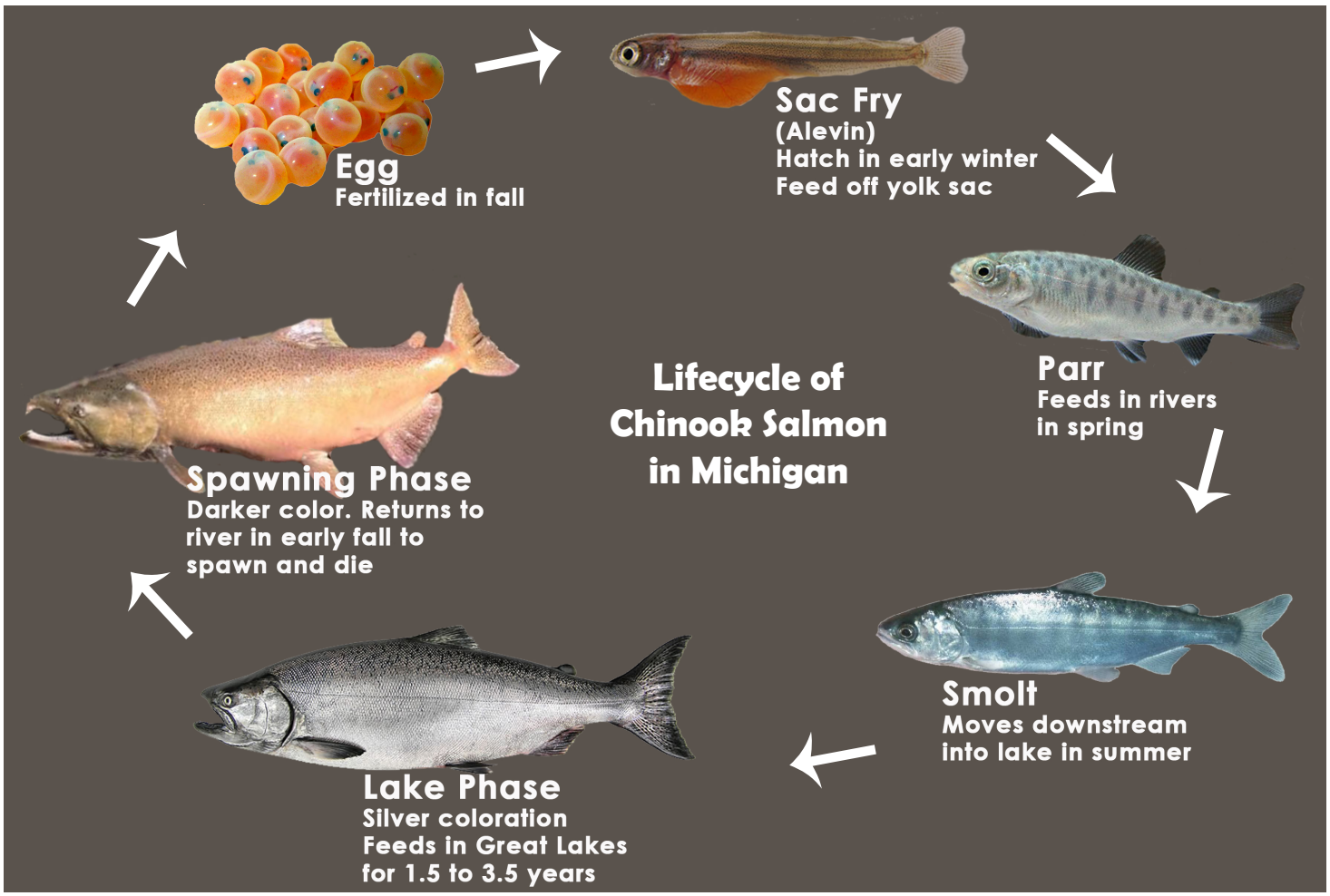
Lifecycle of Wild Chinook Salmon in Michigan

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, Atlantic and pink salmon have also been introduced.

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.

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 fishers, though, as they will 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 Pacific salmon die and their bodies decompose, releasing nutrients into the water which aids **plankton** production for their offspring.



Lifecycle of Wild Chinook Salmon in Michigan

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 (called macro-invertebrates) 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 **smolts**. 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, walleye, 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 invasive 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, usually in the middle of the water column.

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. To learn more about the lifecycle of salmon in Michigan visit https://youtu.be/QYLTqvmO27A

What Does That Mean?

alevins - another name for sac fry

anadromous - migrates from salt to fresh water

forage - search for food

natal stream - the stream where they originated

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

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

photoperiod - the relative exposure of an organism to daylight

plankton - microscopic water borne organisms

potamodramous - migrates within fresh water

redd - spawning bed

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

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.

spawning - the act of laying eggs

swim-up fry - fry after yolk sac is gone

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

Why We Need Hatcheries

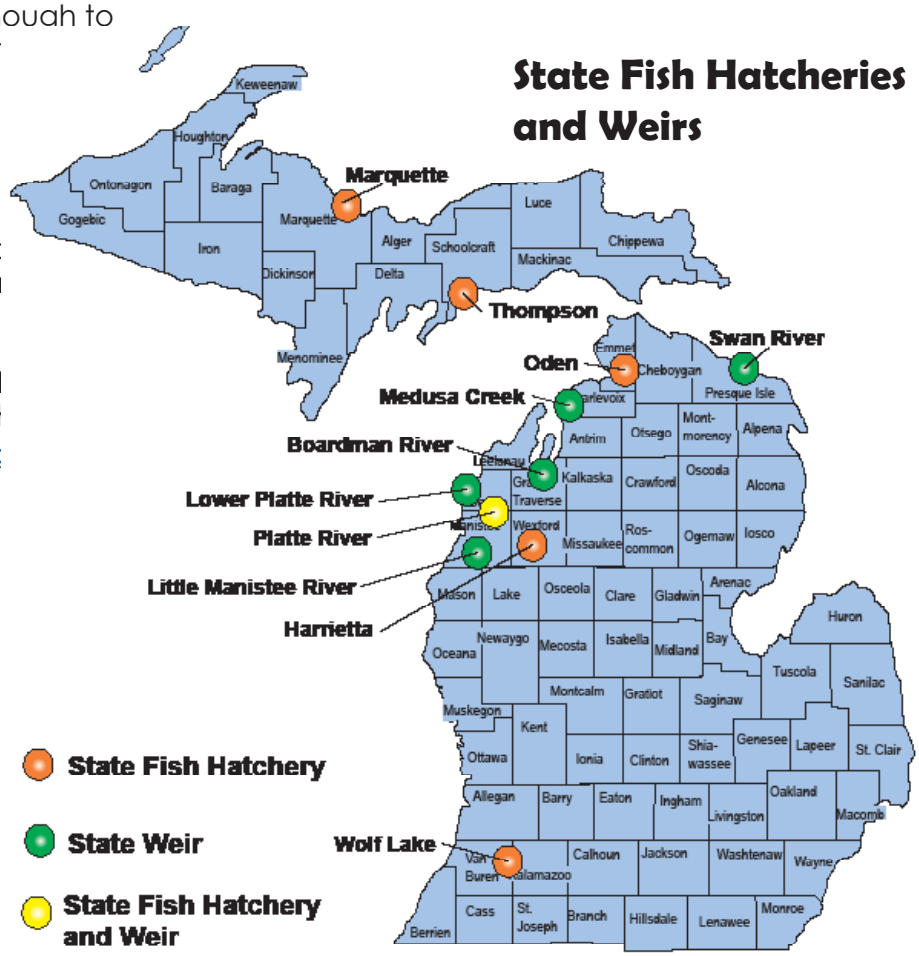
In an ideal world -- and an angler's dream -- a person could catch naturally reproduced brook, brown and rainbow trout on crystal-clear, cold water streams without another fisher in sight. They could fish from a boat on one of Michigan's 11,000 inland lakes, catching their limit of walleyes hatched within 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, and the money to operate these important facilities comes from all those fisher men and women who purchase a fishing license each year.

The DNR hatches, rears and transports fish as part of its Fish Production Program. These activities benefit the state's inland and Great Lakes fisheries and increase angling opportunities. To manage Michigan's fish populations, the DNR sets limits on the size and number of fish that can be caught and kept. Some species are managed with size limits so they can grow big enough to reproduce before they are caught by anglers. Other fish species don't have size limits, but there is still a limit on the number anglers can keep. Find the Fishing Regulation Guide at Michigan.gov/FishingGuide

In some cases, even with the best management, fish are not able to reproduce fast enough to keep up with angler demand. When this happens, the DNR sometimes adds fish in lakes and streams – also called "stocking" fish. To do this, the DNR rears fish in hatcheries until they are large enough to survive on their own. Then they are transferred to waterbodies where they can grow large enough for anglers to keep.

Anyone is welcome to come and visit a state's six fish hatcheries to see how they work. Plan a trip by visiting Michigan.gov/ha



Education Contacts at State Fish Hatcheries

Wolf Lake State Fish Hatchery
Shana Ramsey, 269-668-2876
ramseys2@michigan.gov

Oden State Fish Hatchery (Seasonal)
Christine Steensma, 231-347-4689
steensmac@michigan.gov

Habitat Before Conservation

Fish **habitat** in Michigan has undergone many changes throughout state 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. (Salmon were not introduced until the 1960s.) 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 paths. The fast-growing country's hunger for more lumber led the lumberjacks to harvest almost all Michigan's white pine forests.

At this time, 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 is a form of pollution that settles to the bottom of the stream bed and covers up the gravel that is needed as spawning substrate and as habitat for the macro-invertebrates 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 and salmon nesting 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?

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

buffer strip - vegetated area streamside, provides erosion control, habitat and nutrients

buttoned up - yolk sac absorbed

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

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 electronics

phosphate - a salt or ester of phosphoric acid

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

pools - area of river where the water is deeper and slower

rehabilitation - the process of restoring the land and natural environment

riffles - rocky shoal or sandbar lying just below a waterway

substrate - pebbles, sand an sediment on the stream bottom

Change on the Horizon

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 affect 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.

Another significant threat to the current and future balance and health of our aquatic ecosystems are invasive species. **Aquatic invasive species** are biological pollutants including fish, diseases and plants that previously were not found in Michigan waters and can take over and harm ecosystems or economy.
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.

Aquatic Invasive Species Classroom Activities

The Michigan Department of Natural Resources, the Michigan Department of Environment, Great Lakes and Energy, and the Michigan Department of Agriculture and Rural Development have produced a set of Aquatic Invasive Species Enrichment Activities that would be useful classroom tools. Activities span grades 2-12, and can be done in your classroom to supplement your SIC program, or as a release day activity.

Find the activities under the "Current Teachers" tab on the michigan.gov/sic website.

The Invasion of the Great Lakes

The Great Lakes' food web has changed significantly in the last 200 years - incoming invasive species had an enormous impact.

The Great Lakes invasion by two non-native species, the sea lamprey and the alewife, completely changed the **ecosystem** and fishery. By the 1950s, sea lamprey had decimated the native Lake trout population. Then, to make matters worse, another non-native species, the alewife, was no longer kept in check by Lake trout predation. The alewife population exploded and then crashed, causing massive, stinking die-offs along beaches.

Great Lakes fisheries managers were on the lookout for a new predator to help keep alewife populations in check. During the 1960s, they started stocking the lakes with Chinook and coho salmon. Anglers were lined up in record numbers to take advantage of the salmon's success. Salmon preyed on the invasive alewife, and took some sea lamprey predation pressure off of the native Lake trout. Not only did the salmon help re-balance the ecosystem in the Great Lakes, but it also created a multi-billion dollar sport fishery. But, the story does not end there. A new threat came into the Great Lakes, and during the late 1980s, invasive Zebra and Quagga mussels arrived in the ballast water discharge from ocean-going lake freighters called "salties". The mussels consume plankton in large numbers, filtering food out of the ecosystem, leaving less for native consumers in the food web. Now, prey species are declining and so, too, are the salmon that eat them.

Should we keep stocking salmon at high levels and risk a collapse of the alewives in Lake Michigan, or should we reduce salmon numbers? What is best for the economy? What is best for the fishery? And what is best for the ecosystem? Since the 1970s, Chinook salmon populations have risen and plummeted, while native Lake trout have rebounded.

As the density of Quagga mussels has increased in Lake Michigan, the density of the plankton has declined. With less food to eat, the biomass of prey species preferred by salmon is at a historic low in Lake Michigan. The goals of fisheries managers are to preserve fishing opportunities without allowing the prey species to collapse. The tale of invasive species in the Great Lakes is not over.

Salmon in the Classroom Timeline

September

- ☐ Complete Scientific Collector's Permit App
- ☐ ***Returning teachers seeking "Green Eggs"***
  - ☐ Register for pickup (link in fall newsletter) Set up tank and equipment by Sept. 20 and complete cycling protocol (pg 32-33)
  - ☐ Maintain tank temperature of 52° F

**Green egg pickup can change daily. Teacher is responsible for registering ahead, and checking status of egg take

**Green eggs are potentially more difficult to rear. Mortality of green eggs requires completion of Fish Loss Report, and travel to the hatchery for replacement eggs.

October

- ☐ Check email for Scientific Collector's Permit, must be in your possession to pick up eggs.
- ☐ Check email for "Salmon Sense Newsletter." If not received, email paget3@michigan.gov
- ☐ For those teachers seeking "Eyed Eggs"
  - ☐ Register for egg pickup via link in newsletter
  - ☐ Attend "Tank Setup" Zoom
  - ☐ Set up tank and equipment and run cycling protocol (pg 32-33).
  - ☐ Let tank grow good bacteria at room temp.

November

- ☐ Week of egg pickup, slowly drop temp. to 52
- ☐ When picking up eggs you must have:
  - ☐ Scientific Collector's Permit
  - ☐ Lunch box sized cooler with ice
  - ☐ Small tupperware container
- ☐ Eggs must be taken back to your classroom, acclimated and placed in tank immediately after pick-up
- ☐ Dead white eggs should be removed daily
- ☐ Eggs may begin hatching
- ☐ Monitor water quality and record data

December

- Check email for "Salmon Sense Newsletter"
- Eggs should all hatch by winter break. If you have substantial die-off or unhatched eggs contact paget3@michigan.gov
- Dead white eggs/debris should be removed
- Begin training/feeding when all have absorbed yolk sac, and 80% are swimming up
- Over winter break - feed and check water every other day. Siphon when needed.

If you are experiencing mortality, email paget3@michigan.gov to help discuss options, and adjustments

January

- Check on fry during break, feed and siphon as needed. (Auto-feeders are ok)
- All fry should have "buttoned up" (Absorbed their yolk sack) and should be "swimming up"
- Follow the feeding schedule in this manual
- Maintain water temperature at 52° F
- Test water quality twice weekly (using this guide). Rinse sponge filter in tank water
- Follow trouble shooting guide if levels are off. If ammonia spikes, hold off feeding.
- Siphon debris and change 25% water weekly.
- Look for abnormal behavior, email if seen

February and March

- Record water quality data and siphon tank twice weekly (25% water change)
- Observe salmon & watch behavior. Email paget3@michigan.gov with concerns
- Continue feeding as indicated in Feeding Schedule
- To help maintain stable water quality, add an additional sponge filter to handle increasing bioload
- Check email for "Salmon Sense Newsletter" to help with your release day event
- Rinse sponge in old tank water, replace HOB filter pads

April and May

- Test water quality and siphon debris and change 25% of water twice a week
- Observe salmon for stress or sickness - contact paget3@michigan.gov with concerns
- Continue feeding per the schedule
- Retrieve Stocking Permit **Fish release: April 15-May 15 Lower Peninsula**
  April 15-May 30 for Upper Peninsula
- Submit completed Stocking Report within 14 days after release
  - Indicate continuation (or not) for next year
  - ***Any reports not submitted by June 1 are dropped from the program***

Policies and Procedures

Designated "Permittee" on Scientific Collector's Permit is legally obligated to follow all guidelines and submit all reports by their deadlines

Co-teachers are not legal permit holders, but can attend a workshop and co-teach the curriculum

Current Scientific Collector's Permit must be in your possession (paper, or on phone as PDF) when transporting eggs or fish, and displayed in the classroom during the year. You must apply for this permit each year by September 1, using the electronic form.

New Permittees must attend a workshop, where they will receive their stocking permit and eggs

Tank setup must be done at least two weeks in advance of egg pickup, preferrably one month.

Egg Pick Up and Workshop reservations must be done through the interactive form. Link will be in the Salmon Sense Newsletter

Egg Pick-up must be done on your reserved day & time. Pick-up person must have:

- Scientific Collector's Permit in hand
- lunch box sized cooler
- small tupperware container
- ice

Eggs must be taken back to your tank and acclimated immediately following their pick-up

Water Quality Data Sheets must be completed at least once a week. This data is mandatory.

Fish mortality or odd behavior should be reported to the coordinator, so suggestions can be given to increase fish health

SIC and related curriculum must be used with your 3rd - 12th grade students for at least 1 unit of study

Students should actively be involved in the care of your salmon

The **Facebook "Michigan Salmon in the Classroom" group** is an excellent source of peer advice and resources

The SIC Coordinator is available for questions and advice at paget3@michigan.gov or 517.284.6033

Fish feeding should be done following the schedule included in this guide, using only the food provided.

Automatic feeders are ok. Look for a high quality feeder, and test it off the tank to ensure it is not overfeeding the fish. Utilize for school breaks only. Daily feeding should be done by the teacher or student.

Replacement fish may be possible. Requirements are:

- Loss of 75% of eggs or fish
- Submission of:
  - Fish Loss Report
  - Water quality data sheets
  - Picture of tank and filter setup
- Make changes to maintenance or care based on the coordinators suggestions
- Replacements are at the discretion of the coordinator and hatchery biologist
- If granted, replacement eggs/fish must be picked up within 2 weeks or by March 31
- When submitting your Stocking Report you must add both the original and replacement fish

Fish Release:

- April 15 - May 15 for the Lower Peninsula
- April 15 - May 30 for the Upper Peninsula

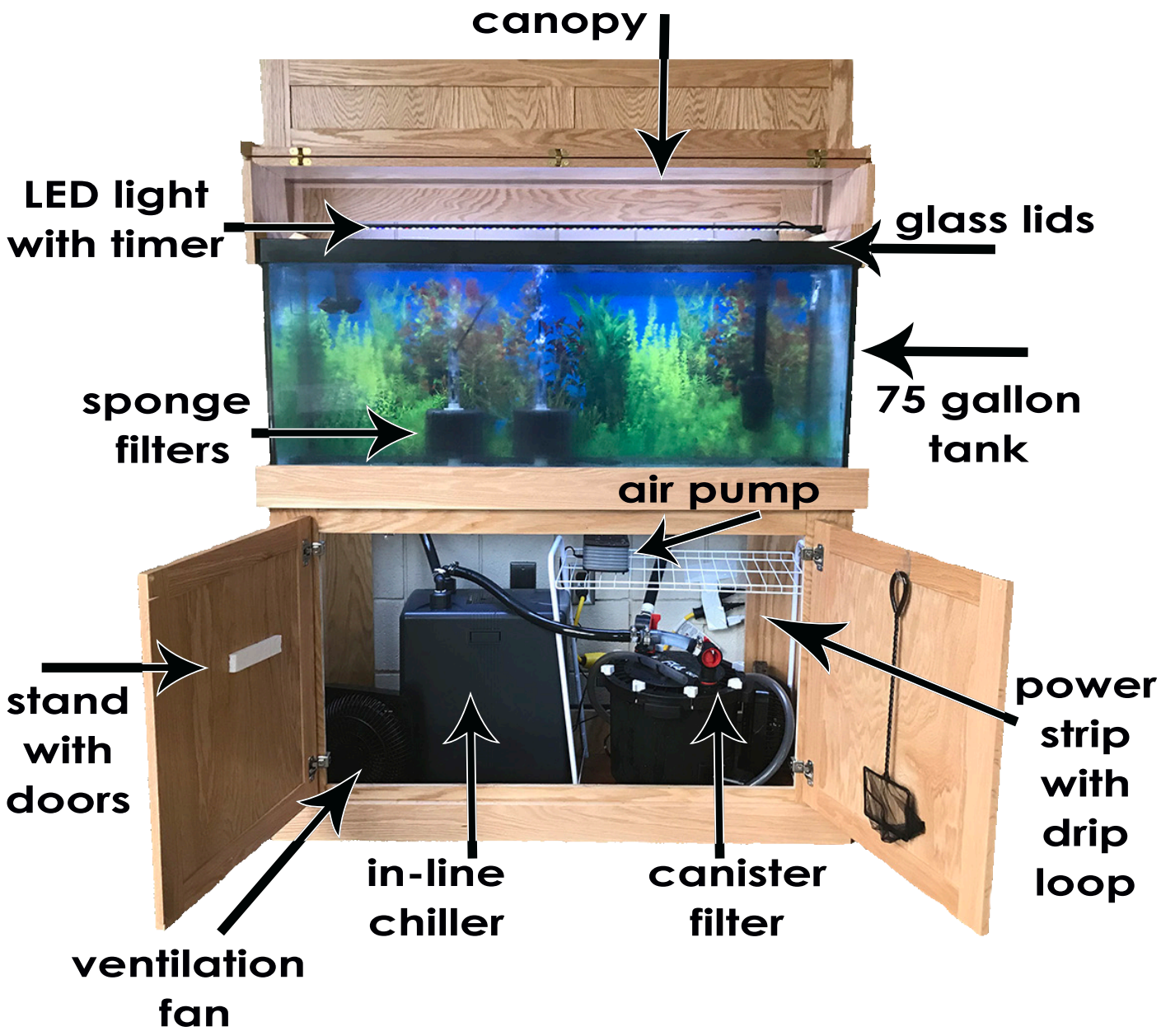
Stocking Permit must be downloaded from the website and in your possession during fish release.

A **Stocking Report** must be filed within 14 days after stocking, or before June 1 (even if stocking zero fish). You must indicate your intention to remain or drop from the program.

Replacement Permittees must file an SIC application and attend a workshop in the event that the original teacher is no longer participating

Returning Permittees must re-attend a workshop if they have been out of the program for more than one year

The Optimal Tank Setup



Teachers in the SIC program have a wide variety of tank setups. The picture above is the ideal setup to make maintenance easier and your water quality more stable. But, simpler setups can work as well.

Using oversized filters, multiple sponge filters, an oversized air pump, and a 75 gallon tank will help your water parameters will be more stable, and your equipment easier to maintain. We recommend you plan to filter for 150, 3" fish.

Using a cabinet style stand, you can utilize magnetic baby locks on the doors to keep equipment secure. Locking lids are also recommended. Metal stands hold up better against condensation.

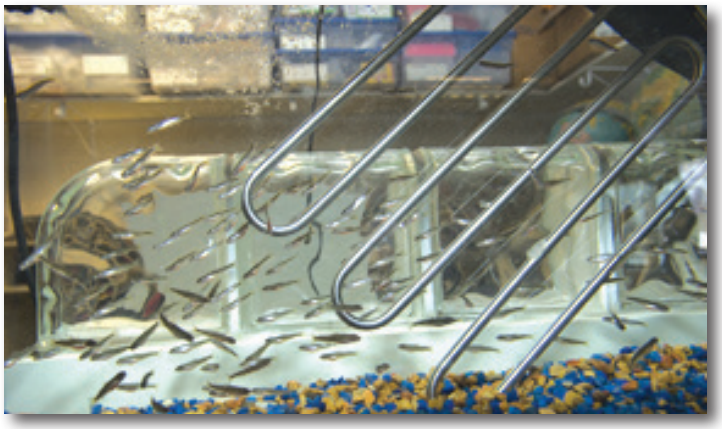
Outlet/plug protection boxes, as well as power strip protector boxes are recommended to aid in reducing accidental unplugging of your fishes' life support systems. Use signs to show that these plugs and equipment are for "fish life support".

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 tank. See the "Nitrogen Cycle" for more information.

Coil Chiller in tank



Tank

The salmon need a 75 gallon or larger tank for best results. Bigger is better as it buffers water quality changes. 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 and filters should be up and running at 52° F for at least 2 weeks prior to egg pick-up. When purchasing, plan for 150 fish, 3" long by the end of the year.

Chiller Units

Salmon are a coldwater fish 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 chillers. 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. If installed in a cabinet, drill vent holes to prevent overheating. This will also extend the life of the chiller. Vacuum dust off screens and check fuses if there are issues.
- Coil coolers (also known as "drop-in" chillers); these are internal chillers. 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. Vacuum dust off the intake screen.

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. Chiller discounts may be available through distributors.
Email paget3@michigan.gov for more information.

Chiller Troubleshooting

If your chiller is not holding the temperature, or stops working there are a few steps you need to take:

- Float ice in ziplock bags in your tank to help maintain the temperature
- Call the manufacturer of your chiller unit and troubleshoot the problem
- Vacuum intake screens, check for blown fuses, and backflush if needed.
- If maintenance is needed - contact a local air conditioning specialist
- Add an additional air stone to increase oxygen exchange (warmer water holds less oxygen)
- Contact Tracy Page at paget3@michigan.gov for advice and help

Filter Systems

In selecting a filter, it is always better to purchase a larger filter for your tank. Plan for filtering for 150, 3" fish. For example, if you have a 75-gallon tank, it is recommended that you purchase a filter that is the minimum for a 100-gallon tank versus one that filters only 55 gallons. Either the hanging type or canister type filter is recommended in tandem with at least one sponge filter rated for 100 gallons.

- Canister Filter- all necessary setup equipment typically accompanies the purchase of a canister filter. These filters save money in the long run as you can use "permanent media" that will only need rinsing, not replacement.
- Hanging (HOB) Filter - all necessary setup equipment typically accompanies the purchase of a hanging filter. Replacement filter cartridges will be necessary over the life of the filter. You will need to purchase filter replacements every couple of weeks.
- Sponge Filters - Additionally, it is recommended that you run at least one sponge filter on your airline. Multiple sponge filters are a great way to help buffer your water quality at the end of the school year when the fish are large. These are a cost effective addition.
- **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

Teachers and/or their sponsors are responsible for obtaining all equipment and supplies. Preuss Pets in Lansing, a SIC Partner, specializes setups for SIC teachers. If you are not near Lansing, check with your locally owned fish store to create a partnership. These stores also will often offer free water testing and have experts on staff to answer questions. Take the supply list in the following pages.

Supplies for Salmon in the Classroom can also be found at most tank supply stores, such as PetSmart, Petco, Pet Supplies Plus or online. It is recommended that you contact the store well in advance to ensure items (especially chillers) are in stock. Websites such as www.marinedepot.com and www.glaciercorp.com are also helpful.

Choosing Your Equipment

Step 1: Choose a tank and stand

Tank = Glass 75 gallons or larger. Length > height

Larger aquariums help keep water parameters more stable, and reduce maintenance.

AND

Stand = Metal or wooden aquarium stand that adequately supports edges. Must hold 700lbs.

Metal stands hold up well to condensation that may occur. However, cabinet style stands work well for locking up equipment. Drip trays are good additions.

Step 2: Choose a chiller type

Inline Chiller

Inline chillers hook to a canister filter or pump. Maintenance includes flushing at end of school year. Cabinet stands must have good ventilation.

OR

Coil Chiller (in tank)

Coil chillers drop into the tank and do not require an extra pump. Coil chillers are slightly louder than inline.

Step 3: Choose main filter type

Canister Filter

Canister filters go in the stand, and hook to the tank with hoses. A turn-over rate of 300 gallons per hour is the minimum. Canister filters will also hook directly to inline chillers. Very little cost associated with changing media.

OR

Hang On the Back Filter (HOB)

HOB filters hang on the tank and pour water over biowheels. Filter pads must be replaced alternating weeks, adding to maintenance costs. A turnover rate of 300 gallons per hour is the minimum.

Step 4: Add an air pump and 2 sponger filters

Air pump

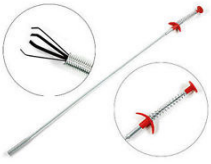
An air pump rated for 90 gallon tanks or higher is recommended. Also needed is 20ft of airline tubing, two backflow valves and an airline splitter.

AND

Sponge Filters

Sponge filters provide ample surface area for beneficial bacteria and increase water parameter stability. Airline tubing attaches to the sponge through the hard tube. This also provides air bubbles. You can put airstones inside them to increase flow.

Step 5: Other Necessary Equipment

Siphon Python brand hooks to sink   Regular style siphons into bucket	Pythons hook to the sink, cleans tank, and then flips to fill tank from the tap. Regular siphons drain into a bucket and you can haul dirty water away, and clean water to your tank.	**Plug Protectors** 	Protect your cords from accidental unplugs! Baby-proofing outlet boxes and power strip covers are a great solution. Also post signs saying "Do not unplug - fish life support!"
API Test Kit 	You are required to test your water parameters at least weekly and record results in the tank maintenance chart. The API test kit makes this easy.	**Battery Air Pump** 	In case of power outage, you should have a battery back-up airpump hooked to your tank at all times. These can also be used to transport fish for release day.
Prime 	Prime is an additive that stabilizes new water for your tank and treats chlorine. Add the recommended dose with each water change.	**Tank Lid** 	Chinook are jumpers! Your tank must have a lid, and glass lids are recommended since they are heavier.
Net 	You should have a dedicated net for this tank. Cross-contamination can occur if you use equipment from other tanks.	**Algae Scraper** 	Occasionally algae will grow on your tank walls. This sponge scraper tool will help you remove it effectively. There are also magnetic cleaners that you drag on glass.
Turkey Baster 	Turkey basters are great for suctioning up debris or egg shells.	**OR** **Tool Grabber** 	This tool helps you remove debris from the bottom of the tank without getting your arms wet.
Thermometer 	A reliable thermometer is a must. Use the values here to ensure your chiller is running properly.	**Aquarium Salt** 	Aquarium salt should always be on hand just in case you need to treat tank/fish ailments.

Step 6: Optional Supplies (to make your life easier)

Ammonia Alert 	This visual indicator sticks to the glass in your tank. It provides a warning if total ammonia levels are too high.	**GH/KH Test Kit** 	This test kit provides two more tests than the API test kit. It measures general hardness and alkalinity which can hamper fish growth and water parameters.
Stability, Paraguard, Fishless Fuel 	Stability provides a kick start to your beneficial bacteria colony combined with Fishless Fuel to run cycling protocol. Paraguard is good to have on hand for treating disease outbreaks.	**Gloves** 	Long-sleeved gloves help to protect your arms from the cold water in your tank.
Light & Timer 	A light is optional, but can be used to help students see the fish. If you use a light, use a timer as well. Keep the light on the minimum amount possible to reduce algae growth.	**Auto Feeder** 	Auto feeders are helpful during breaks. Be sure to test it over a dish for a day prior to putting it on the tank. Underfeeding with the auto feeder is recommended.
Vitamin Tray 	A multi-day vitamin tray can be helpful in setting aside food rations. Makes student or helper feeding easier.	**Measuring Spoons** 	Measuring spoons dedicated to your fish food make rationing allotments easier.
Background 	Tank backgrounds are not necessary, but can make the tank look more natural and hide cords and tubes.	**Goggles** 	Safety goggles are recommended when using the water test kit chemicals.

Step 7: Consumables to budget for

- Filter media (pads for HOB, carbon, etc)
- Prime (about 2 bottles per year)
- Stability (about 2 bottles per year)
- API Test Kit (expires 3 years after purchase)
- Aquarium salt (1 box per year)

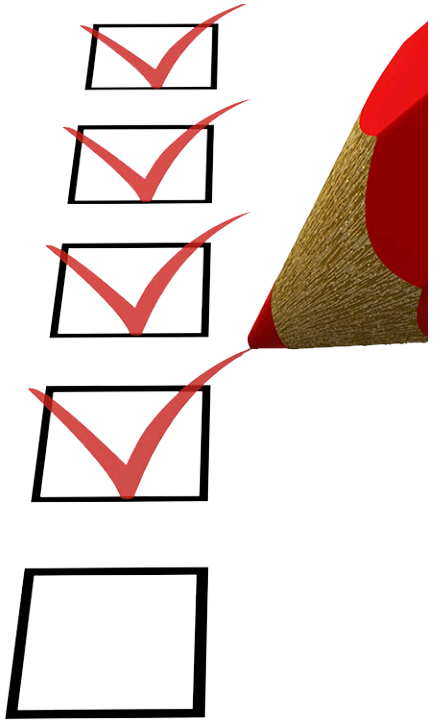
SIC Shopping List

Item	Description	Average Cost
Glass aquarium	75 gallon or larger. Longer than it is tall.	$200
Stand	Metal frame, or wooden cabinet stand	$160-$400
Chiller (choose 1 below)		--
a. Inline Chiller	1/4 hp. Typical brands include Arctica or Glacier	$965
b. Coil Chiller	1/6 hp. Glacier brand	$850
Main Filter (choose 1 below)		--
a. Canister filter	Fluval FX4 is recommended	$350
b. Hang on the back	Aquaclear 110 is recommended	$80
Air pump	Rated for 90 gallons. 2 outputs	$50
Air line	20 ft. Silicone holds up better.	$8
Backflow valves (qty 2)	Prevent water from siphoning down airline	$2.50 ea
Airline splitter	Split airline between two sponge filters	$10
Sponge filters (qty 2)	Boost good bacteria colonies	$10 ea
Air stones (qty 2)	Insert into sponge filters to boost flow	$2
Siphon (Choose 1 below)		--
a. Python style	Hooks to sink, to drain and refill tank.	$50-$80
b. Regular style	Drains to bucket.	$15
API Test Kit	Tests your water parameters	$40
Seachem Prime (qty 2)	Additive to treat chlorine and temporary spikes in levels	$15-$25
Fish net	To remove fish if needed	$5
Removal tool	Turkey baster or tool grabber to remove dead eggs, etc	$5
Thermometer	LCD style recommended	$8
Battery Air Pump	Emergency back up for outages, and fish transport	$20x2
Glass Tank Lids	Contain jumping fish and reduce water loss to evap.	$60
Algae scrubber	Long handled scrubber to clean tank walls	$10
Aquarium Salt	On hand in case of emergency to treat tank ailments	$3
Outlet box protector	Covers your cords plugged into outlets	$12
Power strip plug cover	Covers cords plugged into your power strip	$10
Optional Additions:		--
Ammonia Alert	Visual indicator of toxic ammonia levels	$13
gH/kH test kit	Measures hardness and alkalinity	$10
Seachem Stability	A bacteria kick-start additive	$10
Fritz Fishless Fuel	Ammonia additive to complte cycling protocol	$10
Long sleeved gloves	Waterproof gloves for reaching in your tank	$20
LED tank light & timer	LED lights used sparingly to highlight fish. Timer is a must.	$50-100
Auto Feeder	Eheim autofeeder is recommended	$40
Vitamin tray	To set aside food allotments	$5
Measuring spoons	To measure food allotments	$5
Tank background	To give your tank a more natural look	$20
ADDITIONAL:	Be sure to budget for filter media that needs replacing	
	Prices are variable **Approximate Average Total**	**$2800-$3000**

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 at least two weeks in advance of receiving your salmon eggs.

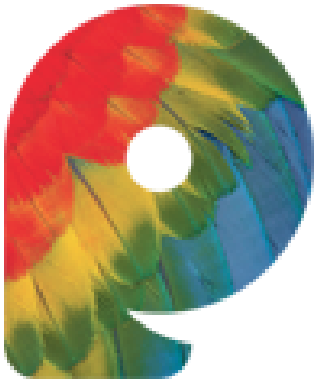
1. Choose a suitable location for your tank. Your tank should be in a location that is:
    - easily accessible from all sides
    - not near an uncovered window
    - within close proximity to an electrical outlet
    - near a water source (if possible)
    - in an area where the tank is readily visible to students and visitors.
2. Set up tank in chosen location. Be sure that the area or cabinet is properly ventilated so the chiller does not overheat. Tank must be level or you risk leaks.
3. Add chiller to tank. Test it. Then turn off. Follow manufacturer instructions.
4. Add filters. Follow manufacturer instructions.
5. Add aerator/air stone to your air pump and airline using the check-air valve and splitter if needed.
6. Fill tank with water. If using municipal water, dechlorinate according to manufacturer instructions for dechlorination additive.
7. In October, run the cycling protocol.
8. A week before egg pickup, start dropping the temperature down to 52 degrees F, and monitor water quality for a period of at least two weeks prior to receiving salmon eggs.
9. Initial Water Quality: use an API test kit upon completion of tank set up. It is important to obtain baseline levels for nitrate, nitrite, ammonia, etc. when you set up your tank to help you recognize when levels change throughout the year.
10. A Tank Maintenance Sheet follows to help you keep track. Keeping water parameter data at least once a week is mandatory. In the case of troubleshooting or replacement fish you will be asked to provide those sheets.



Temperature

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 and its oxygen carrying ability.

From a Sponsor



Preuss Pets

Preuss Pets offers many services and supplies for SIC teachers:

- Expert advice on design and installation of aquariums
- Home of 75 gallon aquariums for $99.99
- Pre-seeded sponge filters
- Specialty equipment (chillers, filtration, battery back up, aquarium controllers) generally in stock year round.
- Consultation throughout the year via e-mail, phone, or store visit to troubleshoot issues - water testing, filtration maintenance etc.
- 10+ years of experience with SIC systems.

Ask us about the peace of mind and technical data that come from Neptune Systems APEX controllers and Seneye monitors.

www.preusspets.com
1127 N Cedar St, Lansing, MI 48906

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 guidelines. 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, or use past year's.

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 up to 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 on the data sheet.

Feeding Schedule

The feeding schedule on page 26 is to be used as a general guideline. Food amounts shown are the total amount to be fed daily. Spread amount over several feedings. All food amounts are based on 150 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! Past teachers have found that splitting the daily food amount into several slots of a vitamin tray makes feeding easy by students. Automatic feeders can be helpful during winter and spring breaks. Be sure to purchase a high quality auto-feeder and test it off the tank prior to use. Be sure that the auto-feeder is not overfeeding your fish while you are away. Be sure, even with an auto-feeder, that you still plan to collect water quality data and siphon the bottom and exchange 25% of the water from the tank at least once a week.

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.

Food Types

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. Siphon uneaten food off bottom daily.

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.

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.

Biodry 1000 1.2 mm, 1.5 mm, 2.0 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.

Feeding Measurements

A printable feeding chart is on the following page. Amounts are for each day. Daily rations can be split into multiple servings. A vitamin tray works well for splitting feedings.

As you start a new size, feed 1/2 ration of larger, then 1/2 ration of smaller to make sure fish of all sizes are eating.

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: Winter and Spring Breaks. Please make arrangements for the fish to be fed at least every other day during school breaks. However, the fish should be checked over the break as necessary to ensure they are doing well and all equipment is functioning properly, as well as collecting water quality data and siphoning the tank at least once per week.

Feeding Schedule and Data Sheet *Mandatory Copy Me Page*

Calendar Date										
Week	1	2	3	4	5	6	7	8	9	10
Fish Length	1-1.5”	1-1.5”	1.5-2”	2-2.5”	2-2.5”	2-2.5”	2-2.5”	2.5-3”	2.5-3”	2.5-3”
Food Size	#1	#1	#2	#2	1.2mm	1.2mm	1.2mm	1.2mm	1.5mm	1.5mm
Amount per day	1/8 TSP	1/4 TSP	1/2 TSP	3/4 TSP	3/4 TSP	1 TSP	1 1/8 TSP	1 1/4 TSP	1 1/4 TSP	1 1/4 TSP
Notes										

Calendar Date										
Week	11	12	13	14	15	16	17	18	19	20
Fish Length	3-3.5”	3-3.5”	3-3.5”	3.5” +	3.5” +	3.5” +	3.5” +	3.5” +	3.5” +	3.5” +
Food Size	2.0mm	2.0mm	2.0mm	2.0mm	2.0mm	2.0mm	2.0mm	2.0mm	2.0mm	2.0mm
Amount per day	1 1/2 TSP	1 1/2 TSP	1 3/4 TSP	1 3/4 TSP	2 TSP	2 TSP	2 1/4 TSP	2 1/4 TSP	2 1/2 TSP	2 1/2 TSP
Notes										

Tank Maintenance Chart

This is a mandatory copy me page

Date	# of fish lost	Temp.	pH (7-7.5)	Ammonia (0 ppm)	Nitrite (< .5 ppm)	Nitrate (< 40 ppm)	Chlorine (0 ppm)	Hardness (GH 75+ ppm)	Alkalinity (KH 120-180 ppm)	Additives	Notes / Observations / Steps to correct issues

For a fillable PDF version of this form, visit the website michigan.gov/SIC. **To use a Sheets version of the Tank Maintenance Chart visit https://tinyurl.com/SICwaterdata**

Maintaining Water Quality

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

Completing water quality testing/data sheets is mandatory.

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 25% 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.

Filter Maintenance

Canister Filters with carbon filters

- Once a month change carbon and filter material

Canister Filters with permanent filter media

- Once every two months, rinse media in old tank water

Hanging Filters (HOB)

- Every week, replace one filter pad (alternating)
- Biowheels only need rinsing in old tank water if visibly clogged, or not spinning

Sponge Filters

- Once a month - remove from tank, and squeeze in a bucket of tank water until it mostly runs clear.
- With multiple sponge filters, space out maintenance to not be the same week.

General Guidelines

- Never change/rinse all filter media in the same week. This will disrupt or wipe out your beneficial bacteria. Always rotate media changes.
- Always use old tank water to rinse filter media. Chlorinated tap water can kill your beneficial bacteria.
- Always immediately clean any filter that looks clogged or covered in debris.
- To prevent eggs or fry getting sucked up into filters, you can cover the end of intake tubes with window screen and a rubber band.

Water Quality Timeline

Mandatory:

Daily, or at least weekly, test and record fish and tank information on the *Tank Maintenance Chart.*

Weekly:

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

***For hard scale and lime buildup you can soak plastic/glass parts in 1 part vinegar & 1 part water for a day and scrub. Rinse 3 times with fresh water and dry before using with fish.*

Fish Mortality

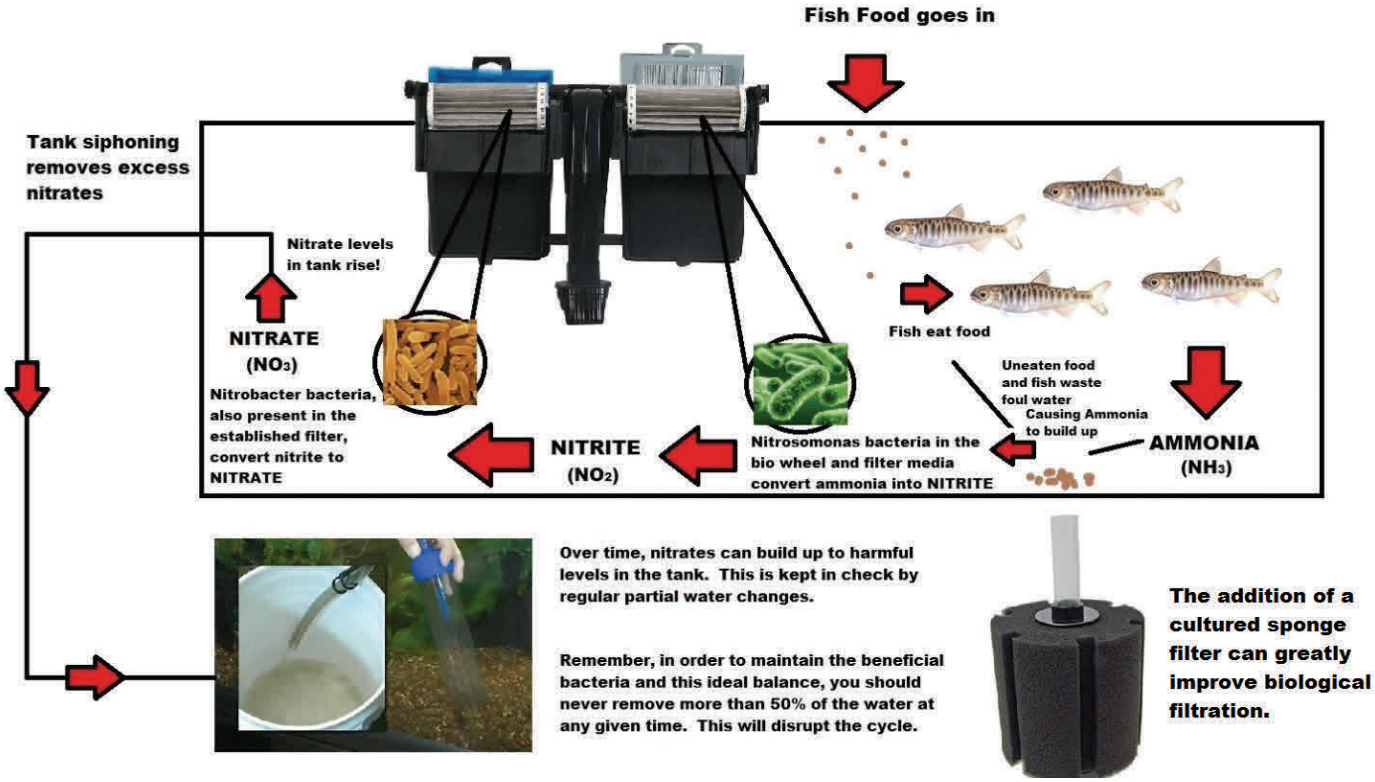
Occasionally fish may die due to disease, water quality issues, equipment failure or other issues.

- If you start losing fish regularly, please reach out right away to our Coordinator Tracy Page at paget3@michigan.gov for help diagnosing and solving the issue. You can also receive peer advice on the Michigan Salmon in the Classroom Facebook group.
- If you suffer a catastrophic loss of your eggs or fish (75% or more), you can complete a Fish Loss Form and submit it with your tank maintenance charts and a tank picture. We can then help solve your issues, and may grant new fish that the teacher would be responsible for driving to the hatchery to obtain. Fish must be picked up within two weeks or by March 31.

The Nitrogen Cycle

In natural ecosystems, there exists a diverse community of organisms that break down waste. This biotic community contributes to a common life cycle called the NITROGEN CYCLE. *Nitrosomonas* and *Nitrobacter* bacteria are key components of the cycle and are considered a type of beneficial bacteria. The bacteria act as a natural filter. After a series of conversions, toxic waste products are rendered benign. The ideal fish tank environment will mimic this, but on a much smaller scale.

The Nitrogen Cycle in the Salmon Tank



The Salmon Tank

A newly set up tank is not instantly ready to support life. The process of tank maturation, better known as cycling, describes how organic wastes are dealt with as bacteria establish within the confines of the aquarium. An aquarium is essentially a ecosystem in a box. The tank must completely "cycle" for the salmon to begin to thrive - which can take up to a month. Cold water is slower than warm water.

Prior to hatching, the fish are not producing waste. Therefore, it won't be until you have swim-up fry and then begin feeding that your nitrogen cycle begins. As the fish begin to produce waste, harmful ammonia levels in the tank will rise until beneficial nitrifying bacteria begin to colonize and convert it to less toxic forms. Unassisted, this process can take many weeks to establish. Use of a bacterial additive such as *Seachem's Stability* or *Seed* or a cultured sponge filter, will reduce the time it takes to cycle the tank.

Beneficial bacteria establish themselves on your sterile filter material slowly over time. Porous filter material provides a home for these species of bacteria. Tank filtration consists of 3 phases: mechanical, chemical, and biological. Mechanical filtration traps waste, chemical fitlration is carbon media that absorbs impurities, and biological is the benefical bacteria that convert toxic ammonia and nitrite into less harmful nitrate.

The Importance of Cycling

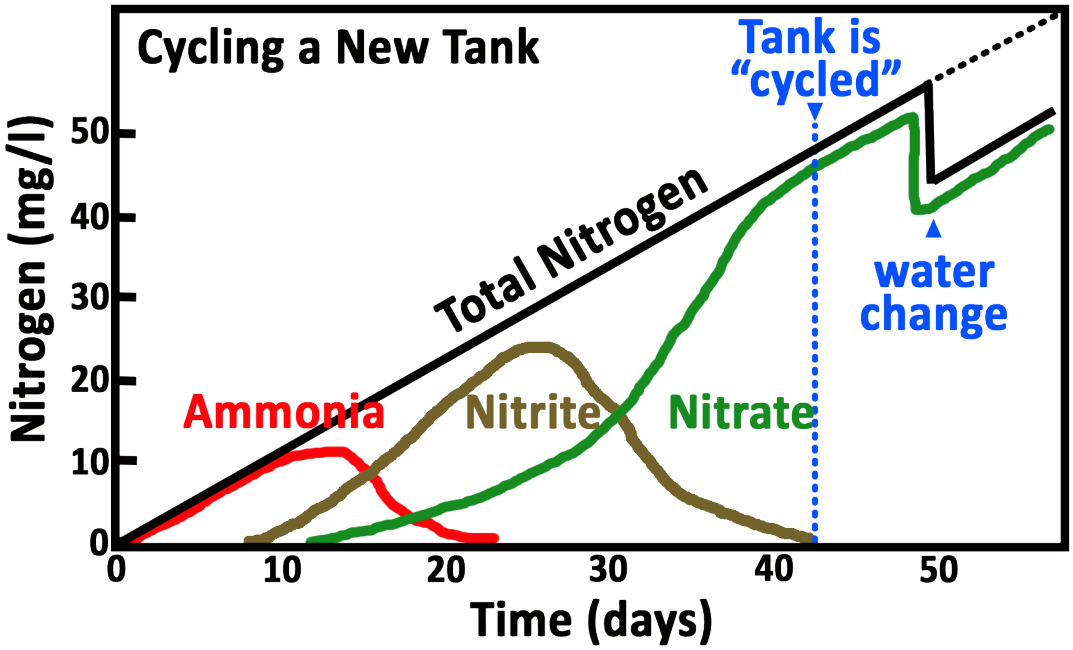
Your tank will require a large colony of beneficial bacteria to function properly. If your fish are introduced into a tank that has not cycled, the salmon can suffer what is called "new tank syndrome". This equals the loss of fish. Again, using an additive like Stability or a cultured sponge filter, you can buffer these effects as the tank cycles. In our cold water tanks, the cycling process can take longer than in a tropical fish tank you might have had at home.

A cycle consists of:

1. Spike in ammonia levels
2. Drop in ammonia as nitrite levels spike
3. Drop in nitrite as nitrate levels spike

A cycled tank = no ammonia, no nitrite and low nitrate that you remove with weekly water changes.

Until you get test results that indicate cycling is complete, do not change filter media or perform water changes except in the case of dramatic spikes. Once cycle is complete - never change the media all at one time.



The chart above illustrates the typical progression of tank cycling. Cycled = no ammonia, no nitrite and nitrate that you keep below 40 ppm with weekly water changes.

Testing Your Water - How to tell when the tank has cycled

Water parameters should be tested at least weekly. When setting up your tank, be sure to test your tap water to have a baseline value. Testing ammonia (NH4), nitrite (NO2), and nitrate (NO3) will be critical in determining the health of your tank. Be sure to read the instructions on your API test kit carefully, and shake bottles vigorously as intructed. Hold bottles vertically above the tube to get uniform drop sizes. Hold the tube against a white background to compare colors to the test chart. Students should wear safety goggles when performing water tests.

Normal Water Quality Progression in a Cycling Tank

Readings	What's Happening	Prognosis
Ammonia = 0 - 0.25 ppm Nitrite = 0 Nitrate = 0	Phase 1: Water may have trace levels of ammonia, but no other readings, indication it is fresh and has little to no beneficial bacteria activity.	Add *Seachem Stability* or a cultured sponge filter to kick-start the cycling process. These are the readings you will get before your fish begin to feed.
Ammonia = 0.50 - 4.0 ppm Nitrite = 0 - 0.50 ppm Nitrate: 5 ppm	Phase 2: Ammonia is spiking as the tank begins to cycle. The nitrites are begining to build and you are starting to get nitrate readings.	At this point it is important to monitor ammonia levels. The Ammonia Alert can indicate quickly if there is a problem. But - it is not a replacement for testing ammonia with your kit, as the two tests measure different forms of ammonia.
Ammonia = 0 - 2.0 ppm Nitrite = 0.25 - 2.0 ppm NItrate = 5.0 - 20 ppm	Phase 3: Ammonia levels drop off, nitrites spike, and you start to get consistent nitrate readings. This is the half-way point.	Ammonia spiking has passed. The tank will soon reach a balance. Continue to pay close attention to ammonia and nitrates.
Ammonia = 0 - 0.25 ppm Nitrite = 0 - 0.25 ppm Nitrate = 10 - 40 ppm	Phase 4: The tank is now cycled. Ammonia and nitrite levels have spiked and dropped back to zero. Nitrate readings indicate that your benefical bacteria are doing their job.	This is the ideal range of parameters. Once the tank is cycled, your job is to keep nitrates below 40 ppm by doing weekly 25% water changes.

Using Your Understanding of the Nitrogen Cycle

Ammonia and nitrites are kept in check by established bacterial colonies, but that doesn't mean you don't have to clean the tank. Regular siphoning of debris/waste and exchanging 25% of the water weekly is required. Every week rotate changing or rinsing 1 filter media type. Long gaps between water changes can cause a nitrate build up which is a chronic exposure risk and can lead to fish loss. If the bio-load exceeds what the tank can handle, the ammonia, nitrite and nitrate will spike once again. Adding additional sponge filters can provide more surface area for the benficial bacteria to colonize.

Important things to remember

- Stress is often the underlying cause of fish death/disease
- Poor water quality is a major cause of stress
- Water quality is improved by beneficial bacteria. When in doubt - add another sponge filter.
- Bacteria and filtration work together to keep the tank clean for a fintie amount of time.
- The long-term balance and health of this tank "ecosystem" requires regular maintenance (water changes, water testing, and maintaining filter media)

Can't get a handle on your water parameters?

Feel free to contact the Salmon in the Classroom coordinator, Tracy Page at paget3@michigan.gov. Send your water parameter data, a picture of your tank/filters, and your concerns.

Forced Pre-cycling Protocol (Recommended)

Cycle your tank before you receive eggs.

Naturally letting your tank cycle can take a long time at our low temperatures. To speed up this process and ensure you have stable and safe water parameters by the time you introduce eggs, you can do a "forced cycle" using a couple of additives. Follow the instructions below. Adjust the dates as needed to align with the school week each year.

Forced Cycling Supplies

You need just a few supplies to get your cycle going.

- 10ml syringe
- Seachem Stability 3.4 oz. or larger
- Fritz Zyme Fishless Fuel 2 oz.
- 2 oz. container of fish food
- Optional: tank heater

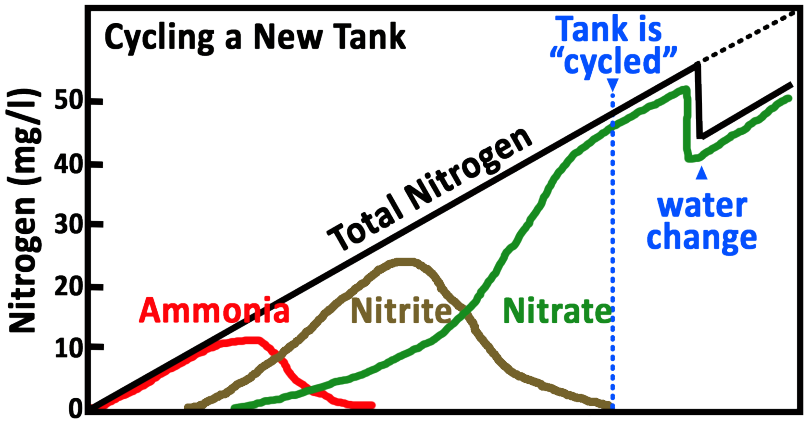
* Stability and Fishless Fuel are available as a combo here.

General Dosing Guidelines

You will see different additives suggested in the cycling protocol table.
Below is the suggested dosing for each additive.

Tank Size	Stability	Fishless Fuel	Seachem Alkaline Buffer
50 gallon	5 capfuls	10 ml (2 tsp)	2.5 tsp will raise KH ~ 2.8 degrees
75 gallon	7.5 capfuls	15 ml (3 tsp)	3.75 tsp will raise KH ~ 2.8 degrees
90 gallon	9 capfuls	20 ml (4 tsp)	4.5 tsp will raise KH ~ 2.8 degrees

Cycling Process



The chart above illustrates the typical progression of tank cycling. Cycled = no ammonia, no nitrite and nitrate that you keep below 40 ppm with weekly water changes.

Remember that this is the process we are forcing to happen in a short time frame.

Once nitrite and ammonia are consistently reading below 0.5ppm your tank is cycled and you can discontinue adding the Fishless Fuel.

Once cycled, be sure to add a tiny pinch of fish food to the filter intake at least twice a week. This "feeds" your good bacteria to keep them alive and your tank cycled until you begin feeding your fish.

Cycling Protocol (Start this process on or near October 20)

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1 (~ Oct. 20)	***Set up tank*** - Chiller off - Filter running - Do initial water tests - Adjust KH to above 120 and pH below 8. - Use a heater (if available) to maintain 75 degrees	- Record water data - Add ammonia - 2 hrs later test ammonia levels (should be between 1ppm and 5ppm, add more if it isn't) - Add Seachem Stability	- Measure ammonia and nitrite and record. - If pH drops below 7.0 do a 25% water change. - If KH is below 150ppm add baking soda.	- Measure ammonia and nitrite and record.	- Measure ammonia and nitrite and record. - If pH is below 7.0 do a 25% water-change. - If KH is below 150ppm add baking soda. - If ammonia and nitrite are below 3ppm, add more ammonia.
Week 2 (~ Oct. 27)	- Measure ammonia, nitrite and nitrate and record.	- Measure ammonia and nitrite and record.- If pH drops below 7.0 do a 25% water-change. - If KH is below 150ppm add baking soda. - If ammonia and nitrite are below 3ppm, add more ammonia.	- Measure ammonia, nitrite and nitrate and record.	- Measure ammonia, nitrite and nitrate and record. - If your tank is cycled, BOTH ammonia and nitrite will be below 0.5 ppm and some nitrate will be measure. - If you are still reading high ammonia or nitrite, dose with Stability.	- Measure ammonia, nitrite and nitrate and record. - Check pH and KH and adjust if needed.
Week 3 (~Nov. 3)	- Measure ammonia, nitrite and nitrate and record. - If you are still reading high ammonia or nitrite, dose with Seachem Stability.	- Measure water parameters. If reading ammonia or nitrite contact paget3@michi-gan.gov for next steps.	- If cycled, 5ml fishless fuel to feed good bacteria. - Remove heater.		- Turn chiller on and set to 65. - Add 5ml fishless fuel
Week 4 (~Nov. 10)	- Adjust chiller slowly to 60 degrees. - Add 1 pinch fish food to filter.		-Test water and record. - Adjust chiller to 55 degrees. - Add 1 pinch fish food.		- Adjust chiller to 52 degrees. - Add 1 picnh fish food to filter.
Week 5 (~Nov. 17 egg arrival)	- Add 1 small pinch of fish food to the filter.		- Test water parameters and record. - Add 1 small pinch of fish food to the filter.		- Add 1 small pinch of fish food to the filter.
Week 6 - 13 (until you start feeding your fish)	- Add 1 small pinch of fish food to the filter.		- Test water and record. - Add 1 small pinch of fish food to the filter.		- Add 1 small pinch of fish food to the filter.

Troubleshooting Guide

Problem	Cause	Recommended Treatment	Notes
Ammonia level is above 2.0 ppm	Uneaten food or dead fish have not been cleaned out.	Step 1: Stop feeding fish. Resume once levels are normal. Step 2: Siphon tank debris and do a 25% water change. Step 3: Retest. Step 4: Repeat steps 2 and 3 daily until ammonia has leveled off. If you can't repeat for a day, add a 5x dose of Prime to temporarily abate ammonia.	Beware - your API test kit and the Ammonia Alert wheel measure two different forms of ammonia. Always use both, but record the test kit results in your data sheet.
Nitrite levels above 0.5 ppm	Not enough "good" bacteria has built up	Step 1: Stop feeding fish. Resume once levels are normal. Step 2: Siphon tank debris and do a 25% water change. Step 3: Retest. Step 4: Add a cultured sponge filter, or a bacterial additive of Seachem Stability, or Aquavitro Seed to boost goo bacteria. Step 5: Repeat steps 2 and 3 daily until ammonia has leveled off. If you can't repeat for a day, add a 5x dose of Prime to temporarily abate nitrite.	Use it in the classroom. Explain how chemical equilibrium is maintained in nature, and how a closed system is different. Another teach-able moment.
Nitrate levels are above 40 ppm	Build up of metabolic waste.	Step 1: Siphon tank debris and do a 25% water change. Step 2: Retest. Step 3: Repeat steps 2 and 3 as needed to keep nitrate below 40 ppm. The only way to remove nitrate is through water changes.	Use it in the classroom. Explain how chemical equilibrium is maintained in nature, and how a closed system is different. Another teach-able moment.
pH is suddenly above 7.5	Ammonia concentration rising due to build up of metabolic by-products	Step 1: Siphon tank debris and do a 25% water change. Step 2: Retest. If levels still do not decrease, go on to #3. Step 3: Using tank water in a bucket, rinse debris from 1/2 of your filter material. Do the other half a week later. Step 4: If level do not decrease after washing half the filter material, add pH down additive.	If your pH is slightly higher or slightly lower than the ideal range of 7.0 -7.5 don't panic. Stable pH is much more important than the actual value. If pH is rising please address ammonia levels.
pH is below 7.0	Soft water	pH will probably never be <7 unless the water supply is surface water. Mix in tap water from another source with higher pH. Or carefully use "pH Up" additive.	Stable pH is more important that the value. As long as your pH does not change drastically, your fish will adjust.
Chlorine detected in the water	Municipal water supply is being used. Or your school has chlorinated the water.	Add dechlorination tablets or Seachem Prime additive to water when performing water exchanges OR allow water to sit out for 24 hours before a water change.	Large rolling trash cans are great for letting water age. You can then use a small pump to put the water in your tank after it has aged.

Troubleshooting Guide

Problem	Cause	Recommended Treatment	Notes
Dead eggs (white)	Natural mortality (if tank water parameters are in within normal levels)	Remove dead eggs daily to prevent additional problems affecting nearby healthy eggs. Take no additional action. Contact the coordinator to prevent further loss if it is more than a couple per day.	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 from a hatchery. To reduce mortality, eggs are treated at the hatchery and non-viable eggs are removed on a daily basis.
Fish are deformed	If water parameters are normal, it may be normal genetic birth defects or naturally occurring anomalies.	Remove if dead. Take no other action. View this video for more information https://youtu.be/zyuvsDrjJxo	Birth defects and deformity are naturally occurring genetic variations, they occur in wild salmon streams as well. Use this 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	Try rotating in a small amount of the next size smaller food. Feed larger food first, then smaller to ensure everyone eats.	Egg size varies due to genetic variables, and fish grow at different rates due to environmental conditions. Bigger fish may out compete smaller fish.
Fish loss	Water parameters are off, chiller malfunction, over feeding, or underfeeding.	Contact the coordinator at paget3@michigan.gov and post in the Facebook group for immediate help. Data needed: water parameter sheets, picture of tank/filter setup.	If you suffer more than a 75% fish loss early in the year, replacement fish may be available. If problem is remedied, you could request replacement fish if you submit a Fish Loss Report. Replacement quantity is prorated as we go through the year. No replacement fish can be picked up after March 31.
Uneaten food is fowling the water	Tank not being cleaned enough. Fish are being overfed.	Siphon out waste and left over food daily. Check water parameters and complete water changes to keep nitrate below 40 ppm.	Do not feed more that the recommended amount. Feed slowly so that food does not reach the halfway point of the tank. Your fish will not eat food off the bottom.
Chiller error	Power outage, overheating, blown fuse or component failure.	Check that the chiller has adequate ventilation and vacuum the screen. Install vent holes in your cabinet and an exhaust fan if needed. Adjust chiller settings slowly to not shock fish. Contact the manufacturer for advice. Local fountain beverage maintenance and aquaponics supply stores might also be knowledgeable.	Components are available at fish shops, hardwares and aquaponics stores. If you have an issue call around to find an expert.
Chiller failure	Equipment failure or power outage.	Place ziplock bags of ice in the tank. Run an extra airline to increase oxygenation. Trouble shoot the chiller with your manual or the manufacturer. Clean coils or intake screen with a vacuum.	Call an air condition or fountain beverage maintenance company. A hardware or aquaponics store should have parts.

Troubleshooting Guide

Problem	Cause	Recommended Treatment	Notes
Fish lying on the bottom of tank or swimming on side	Water parameters are outside of normal range. Or, very rarely, Early Mortality Syndrome (EMS) OR see below.	If activity occurs after the first few weeks of feeding, the cause is not EMS. Measure your water parameters, increase your siphoning and water change routine and contact the coordinator for help. Assess other possibilities, 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 prevalence of EMS in fish at a hatchery can indicate there is a high instance of EMS in the wild. However, eggs received by the 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.
Fish have white, red or fuzzy spots	Pathogen (white/red/ fuzzy spots, etc)	Treat the tank with Seachem Paraguard. Contact the coordinator for advice.	There are many different pathogens that get passed on from the adult 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 maintenance.
Fish has injury or bloody spot	Injury	Be careful when cleaning dead eggs, siphoning waste or exchanging water in the tank. The harmful effects of injury during tank maintenance may not be visible until later stages of development. Aquarium salt treatments can help.	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.

For any water quality or fish health issues, you can always post in the Michigan Salmon in the Classroom Facebook group for peer advice, and email the Coordinator Tracy Page at paget3@michigan.gov

Troubleshooting - Why is my ammonia so high?

So you have tested your water parameters and your ammonia are really high (over 2 ppm). There are three primary reasons: 1. Overfeeding/dead fish. If uneaten food or dead fish are left in the tank to decompose, they will release toxins in the water. 2. Too few or too small water changes. 3. The tank has not cycled.

Stress from high ammonia can be lethal for your fish. The Ammonia Alert device is a quick way to notice, but then should be followed with a full water parameter test. Send your water parameter data sheets to Tracy Page at paget3@michigan.gov for advice.

Remember - we do not recommend using gravel in your tank. Gravel can trap waste and uneaten food. These break down and spike ammonia. Out of sight out of mind = less likely to succeed.

In their natural environment, salmon thrive in very clean and highly oxygenated streams. They are sensitive to toxins, especially ammonia. In the aquarium, ammonia is generated by dead fish, uneaten food and waste. Too much ammonia manifests as labored breathing and odd behavior in your fish. Always check filters for dead/decaying fish. Place screens over your filter intakes to prevent egg shells, and fry from getting sucked up. Daily, you can use a tiny siphon to remove the uneaten food.

In a water parameter emergency - do a 25% water change then add a 5x dose of Seachem Prime additive. This temporarily binds ammonia and nitrite for 24 hours.

Other water parameters

Alkalinity, hardness and pH

The pH of a tank is heavily influenced by hardness and alkalinity. Hardness can be broken down into gH (general hardness) and kH (alkalinity or carbonate hardness). Alkalinity (kH) measures the buffering capacity of the water. It is important that the kH be above 70 ppm so it can buffer pH changes. The pH can crash levels of ammonia and organic wastes and contribute to acidity. This occurs when maintenance is being neglected. Tanks with low kH readings will require more frequent water changes than those with higher kH.

If you have extremely high gH, it is recommended that your water changes consist of 50% reverse osmosis or distilled water. Sponsors or local donors will sometimes donate RO systems that can be installed right on the sink in your room. Some pet stores sell RO water as well.

Avoid tampering with your source water as much as possible

As long as your source water is above 70 ppm kH, don't fuss over pH and alkalinity. If you have extremely low kH you can add 1 tsp alkaline buffer and 1/2 tsp acid buffer for every 10 gallons. Use tap water if you can. If you use reverse osmosis water, or distilled water, they have no buffering capacity - so mix them 50/50 with tap water.

Chlorine and chloramines in the source water

Tap water treated in a municipal facility will have chlorine or chloramine. Call your local water treatment plant and find out which they use. Test your tap water to monitor levels. When you do a water change you must treat for chlorine. One way is to put the water in a bucket over night to off-gas before adding it to the tank. Another is to treat the water with the additive Seachem Prime. This can be done as you are adding the water back into the tank.

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 a 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. Watch this video to learn more.

Stocking Permit

A stocking permit is available on michigan.gov/SIC after March 15 each year. The permit must be in your possession when stocking your fish, and you need a new one each year.

Where You Can Stock Your Fish

Step 1: Determine which Fisheries Management Unit (FMU) your school is located in.
Step 2: Choose a stocking location in your FMU from the list of approved stocking locations.

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, Tracy Page.

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 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.
- Aerate the water in each bucket with a battery operated bubbler, and pack ice in a plastic bag around or in 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. See a video here.
- You can also measure the river temperature a week ahead and adjust your chiller 1 degree per day to get the temperature closer for release day.

Stocking Report

We now have an online form for our Stocking Report. This report must be completed each spring by all SIC teachers. It is due June 1, regardless of if you released fish or not. This report keeps you active in the system so you can participate the next year.

Scientific Collector's Permit

Our Scientific Collector's Permit is an online form and must be manually renewed by you each year. Complete your application for the year between August 1 and September 30.

Fisheries Management Units - Find your potential release site

List of Approved Stocking Locations

Pre-approved stocking locations for the Salmon in the Classroom program listed by Fisheries Division Management Unit. Last updated 04/2023. *If your potential location is not on this list, please reach out to paget3@michigan.gov.* See where other teachers release on this interactive map.

Western Lake Superior Management Unit

Big Iron River
Black River
Black River Harbor (Lake Superior)
Carp River
Dead River (From Tourist Park to the river mouth)
Trap Rock River

Eastern Lake Superior Management Unit

Anna River
Big Two Hearted River
Lower Tahquamenon River (including river mouth)
St. Mary's River
Sucker River

Northern Lake Huron Management Unit

Black River
Carp River
Cheboygan River
Mill Creek
Ocqueoc River
St. Mary's River
Thunder Bay River
Trout River
Van Etten Creek

Southern Lake Huron Management Unit

Any stream within the Management Unit
Lake Huron

TRIBUTARIES of the bodies of water listed through this sheet are acceptable stocking locations.

Northern Lake Michigan Management Unit

Menominee River below Hattie Street Dam
Cedar River below Veterans Park Dam @ Powers
Ford River
Escanaba River below Dam 1 @ US-2
Thompson Creek below US-2
Manistique River below Papermill Dam
Black River
Millecoquins River below Millecoquins Lake outlet
Brevoort Lake before Brevoort Lake outlet

Central Lake Michigan Management Unit

Bear Creek
The Bear River, Charlevoix County
Betsie River
Boardman River, below the Union Street Dam
Bowen Creek
Boyne River
Carp Lake Outlet
Crystal River
Jordan River, downstream of Jordan River Fish Hatchery
Little Manistee River
Manistee River below Tippy Dam
Medusa Creek
Muskegon River below Croton Dam
Pentwater River
Pere Marquette River
Platte River
Sable River, below the dam at Ludington State Park
White River

Southern Lake Michigan Management Unit

Black Creek
Black River
Blue Creek
Galien River
Grand River, prefer below Moores Park Dam Lansing
Kalamazoo River, prefer below Lake Allegan (Calkins) Dam
Macatawa River/Lake
Mill Creek, Berrien County
Paw Paw River
Pigeon River, Ottawa County
Pine Creek, Van Buren County
Red Cedar River
Rogue River, prefer below Rockford Dam
St. Joseph River, Berrien County

Lake Erie Management Unit

Belle River mainstream below town of Memphis
Black River below dam in Port Huron State Game Area
Clinton River below the City of Pontiac
Huron River, downstream of the Flatrock Dam in Flatrock. There is a city park (Huroc Park) just upstream (west) of Telegraph Road and just down stream of the dam.
Lower Rouge River

**Below refers to downstream

Release Day Activities

Releasing your salmon is a fun culmination to your year. Some teachers release salmon near their school with little fanfare. Others plan elaborate field days, invite other grade levels, community partners, and make a day of it. Anything in between is fine!

To help you plan your release day, here are some ideas from past SIC teachers.

Release day rotations:

- SIC Activities
    - The Great Swim
    - Fish Finder
    - Migration Fixation
    - Water Bug Hunt
    - What's in the Water
- Fishing
- Macroinvertebrate sampling
- Gyotaku
- Water quality testing
- Turbidity
- Stream flow (orange and a timer)
- Water temperature
- Invasive species pull
- Trash cleanup
- Tree planting
- Native flower planting
- Nature hike
- Knot tying
- Stream-side sketch
- Journaling
- Sit spots
- Bird identification
- Plant identification

Guest speakers that may be in your area:

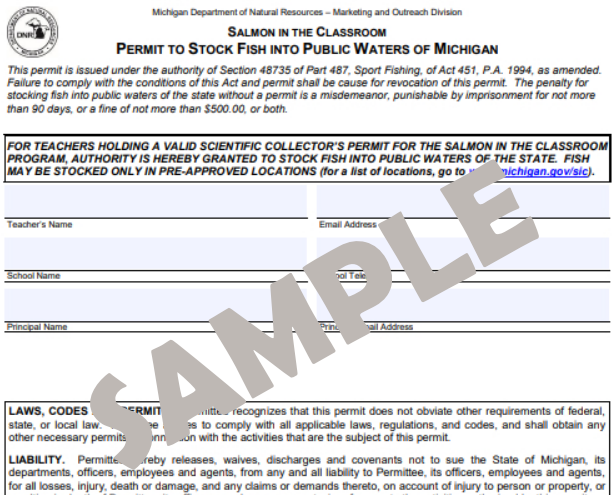
- Friends of the "river" group
- County Conservation District
- Sportsman groups (Trout Unlimited, Steelheaders, Wildlife Forever, etc)
- Nature centers
- Michigan Sea Grant
- Department of Environment, Great Lakes and Energy (EGLE)
- Department of Natural Resources (DNR)
- University professors and grad students
- Project FISH

REPORTING AND PERMIT REQUIREMENTS FOR EACH YEAR

Stocking Permit

Must be printed, completed, and with you at your release.

Link will be emailed in your Salmon Sense newsletter at the end of winter.



Michigan Department of Natural Resources – Marketing and Outreach Division

SALMON IN THE CLASSROOM
PERMIT TO STOCK FISH INTO PUBLIC WATERS OF MICHIGAN

This permit is issued under the authority of Section 48735 of Part 487, Sport Fishing, of Act 451, P.A. 1994, as amended. Failure to comply with the conditions of this Act and permit shall be cause for revocation of this permit. The penalty for stocking fish into public waters of the state without a permit is a misdemeanor, punishable by imprisonment for not more than 90 days, or a fine of not more than $500.00, or both.

FOR TEACHERS HOLDING A VALID SCIENTIFIC COLLECTOR'S PERMIT FOR THE SALMON IN THE CLASSROOM PROGRAM, AUTHORITY IS HEREBY GRANTED TO STOCK FISH INTO PUBLIC WATERS OF THE STATE. FISH MAY BE STOCKED ONLY IN PRE-APPROVED LOCATIONS (for a list of locations, go to michigan.gov/sic).

Teacher's Name | Email Address

School Name | ool Tele

Principal Name | Prin ail Address

LAWS, CODES ERMIT mitted recognizes that this permit does not obviate other requirements of federal, state, or local law es to comply with all applicable laws, regulations, and codes, and shall obtain any other necessary permits nn on with the activities that are the subject of this permit.

LIABILITY. Permitte reby releases, waives, discharges and covenants not to sue the State of Michigan, its departments, officers, employees and agents, from any and all liability to Permittee, its officers, employees and agents, for all losses, injury, death or damage, and any claims or demands thereto, on account of injury to person or property, or

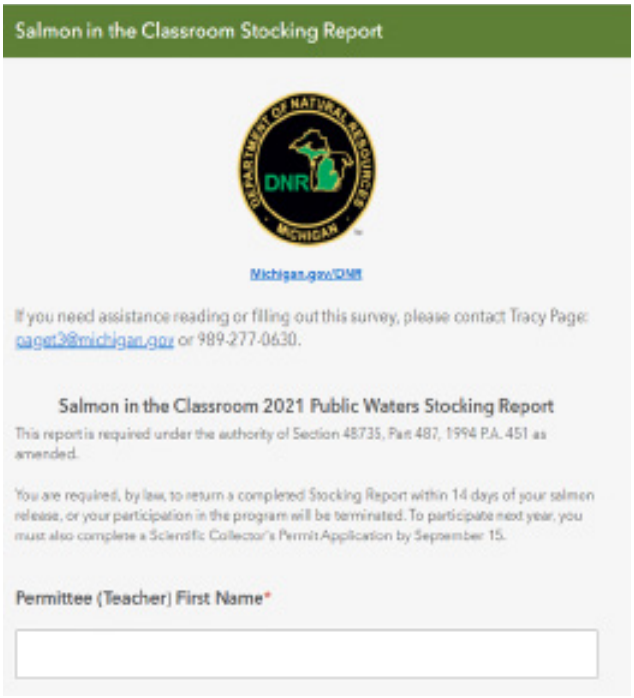
SAMPLE

Stocking Report

Due each year within 2 weeks after release or before June 1.

Online form must be completed by all teachers that received a Scientific Collector's Permit for the year regardless of if they released fish or not.

Form at [Michigan.gov/SIC - Current Teachers]



Salmon in the Classroom Stocking Report

Michigan.gov/DNR

If you need assistance reading or filling out this survey, please contact Tracy Page: paget3@michigan.gov or 989-277-0630.

Salmon in the Classroom 2021 Public Waters Stocking Report

This report is required under the authority of Section 48735, Part 487, 1994 P.A. 451 as amended.

You are required, by law, to return a completed Stocking Report within 14 days of your salmon release, or your participation in the program will be terminated. To participate next year, you must also complete a Scientific Collector's Permit Application by September 15.

Permittee (Teacher) First Name*

Scientific Collector's Permit Application

Must apply each year between August 1 and September 30.

Online form must be completed by all teachers that wish to participate for that school year. If you need to pause your participation, email grayp@michigan.gov

Find the form at [Michigan.gov/SIC - Current Teachers]

Scientific Collector's Permit Application

Michigan Department of Natural Resources - Wildlife Division and Fisheries Division

SCIENTIFIC COLLECTOR'S PERMIT APPLICATION

If you need assistance filling out this form, please contact
Fisheries Scientific Collector Permit: Tom Goniea goniea@michigan.gov or 517-599-5734
Wildlife Scientific Collector Permit: Casey Reitz reitzc@michigan.gov or 517-284-6210

From a Supporter

Project F.I.S.H. (Friends Involved in Sportfishing Heritage)

What is Project F.I.S.H.

Involvement of youth in a long term and continuous, community supported, sportfishing and aquatic resource education program.

Vision:

To initiate and provide fishing education and fishing skills to interested adults and youth from Michigan's many diverse populations. This will preserve a natural heritage that ensures the future of fishing, which includes natural resources and environmental awareness, ethical fishing practices, fisheries stewardship, and positive developmental activities for children, families, and the community.

The Michigan Project F.I.S.H. program works through national, statewide and local partnerships including: Michigan 4-H Youth Programs, Michigan State University's Dept. of Fisheries and Wildlife, Michigan Dept. of Natural Resources Fisheries Division, recreation departments, service organizations, sportfishing industries/retailers, volunteers, and many others. Through this network of partners we further sportfishing education by supporting and training communities to create sustainable programming.

Project Goals:

- Provide multiple experience sportfishing giving youth gradual, sportfishing mentoring and a lifelong learning process.
- Develop in kids an appreciation of the outdoors and outdoor ethics and behaviors. Encourage kids to spend time outdoors.
- Introduce youth to sportfishing as a hobby and lifetime pursuit.
- Reach youth through clubs, schools, and sportsmen's organizations.
- Help adults as mentors spend time with youth.
- Involve teachers, adult volunteer youth leaders, teen leaders, and retirees as mentors.
- Provide training for volunteers, with volunteers attending as members of a local team.
- Help instructors develop willingness and ability to start and sustain a long term program in their local communities (including management/coordinator strategies)
- Help instructors and youth gain new knowledge and confidence, enjoyment of the outdoors, aquatic biology/ecology, ethics and angling skills.
- Show local teams of instructors how to use available resources that highlight accessible fishing opportunities.

Contact : Mark Stephens 480 Wilson Rd, Room 13 Natural Resources Bldg. East Lansing MI 48824

517-432-2700 email steph143@msu.edu website www.projectfish.org

Check us out on Facebook at https://www.facebook.com/MSUProjectFISH/

and on Twitter @projectfish

Decontamination

Be Invasive Species Aware!

During your release event, and any aquatic sampling activities you may do, you run the risk of coming in contact with invasive species.

There are easy ways you can help to reduce the spread of these harmful organisms:

- Select release or activity sites that are low traffic and low risk
- Always visit low risk sites first, and higher risk sites later
- Learn to identify invasive species common to your area and avoid them
- Utilize waders with lug soles rather than felt soles
- Decontaminate your gear between sites
- Decontaminate your gear at the end of your activities and store correctly

For advice on decontamination and when it is necessary, view this video

https://www.youtube.com/watch?v=ESnJ2Sl25Mo

For a handy step by step reference, utilize this presentation

https://www.michigan.gov/documents/invasives/AISDecontaminationModule_NoQuiz_ADA_622958_7.pdf

How to decontaminate your gear:

Bleach: Chlorine bleach (e.g., Clorox® Regular Bleach [sodium hypochlorite] or equivalent products) 5.25% is commercially labeled for use as a disinfectant.

Bleach is a widely used biocide and disinfectant agent, but it is corrosive to metal and rubber.

• Recommended bleach solution is ½ cup (4 fluid ounces) bleach to 5 gallons of water.

• Apply by spraying or use a sponge so surface is thoroughly exposed to the bleach solution. Contact time should be at least 10 minutes. Some gear types may require rinsing with tap water after decontamination with bleach.

• Chlorine bleach degrades over time and effectiveness as a disinfecting agent is diminished. After opening the original bottle of bleach, it may only be used for a maximum of two months.

• Use diluted bleach within a 24-hour period post-dilution because chlorine dissipates rapidly. The words "Bleach Solution" and the date and time of dilution must be written on the container holding the diluted bleach.

• Dispose of unused bleach and diluted bleach solution in the sanitary sewer.

Equipment	Decontamination Method by Risk Level for Aquatic Activities and Equipment			Equipment Needed	Estimated Time
	Low	Medium	High		
Waders	Visually inspect. Remove mud and debris before leaving and upon entering a new site. Rinse and dry.	Follow steps for low risk. Clean with pressure washer.	Follow steps for medium risk. When possible, dry waders for > 5 days before using at new site. If not possible, disinfect with bleach solution or hot water pressure wash (140°F/60°C for 10 second contact time)	Scrub brush, rinse water, towels, heated pressure washer, pressure washer or pump sprayer; bleach solution: ½ cup [4 oz] bleach to 5 gallons of water 10 minutes contact time	5-15 minutes (or 5 days dry time)
Sampling Gear (nets, traps, etc.)	Inspect and clean exterior surfaces, removing visible vegetation, dirt and debris.	Follow steps for low risk. Spray with pressure washer to clean.	Follow steps for medium risk. Disinfect aquatic equipment and gear with bleach solution before entering new waterbodies, hot water pressure wash, or dry for >5 days	Brush, heated pressure washer, pressure washer or pump sprayer; bleach solution: ½ cup [4 oz] bleach to 5 gallons of water 10 minutes contact time	10-20 minutes (or 5 days dry time)

End of the Year:
Sanitizing and Storing Your Equipment

Shutting Down your Aquarium

Following the release of your fish you will need to properly clean, sanitize and store your equipment until the fall. Aside from disposable filter material, most of your equipment can be reused for many years if properly cared for.

Cleaning Equipment

In the least, you should heavily clean all components before storage. This includes reusable filter material, hoses, filters, nets, syphons, etc.

To clean equipment:

- Take apart and rinse all equipment, filters, and hoses.
- Remove and toss disposable filter material
- Scrub debris from all surfaces.
- Squeeze and flush sponge filters until the water runs clear.
- Rinse permanent filter material.
- Use 1 part vinegar and 1 part water to soak or scrub all equipment. This removes hard water build-up as well as algae slime. Items can be soaked for 24 hours. You can even fill your tank and run this mixture through your filters, chiller and pumps.
- Rinse thoroughly with fresh water multiple times.
- Completely drain and dry.
- For in-line chillers, most recommend running water (with vinegar) through in the opposite direction, Rinse well with fresh water, and drain. Follow your manual's instructions.

Sanitizing with Bleach

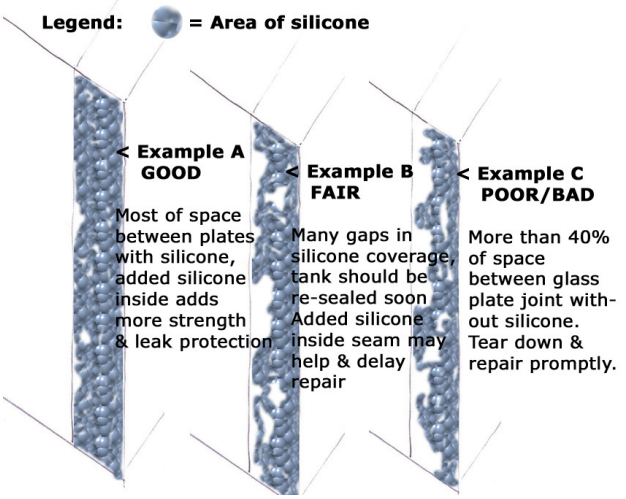
To reduce the transmission of disease and parasites it is always good to sanitize all equipment, not only in the aquarium, but your nets, syphon, etc as well. When sanitizing - DO NOT USE VINEGAR WITH BLEACH

To Sanitize:

- Rinse, scrub and flush all equipment with fresh water to remove debris.
- Prepare a bleach solution of 2 teaspoons per gallon of hot water. (Use new bleach each year as it expires. Use the 8.25% sodium hypochlorite, unscented regular bleach)
- Remove disposable filter material.
- Soak, flush, and scrub equipment, nets, syphon, etc (wear gloves and goggles).
- Items can be soaked in bleach up to 2 hours.
- Rinse 3 times and let completely dry before adding water for fish.

Storing Equipment

- Be sure to store your equipment where it will not be bumped or broken. Trash bags, or rubber maid tubs are excellent choices to store loose equipment and can be gently placed inside the tank until fall. Be sure to always store your tank on a level surface. If unlevel, it can cause stress cracks and pop seals.
- Always do a thorough check of all equipment before storage and plan for replacement pieces if necessary.
- Check the seals on your tank. The silicone along the seams should not be pitted, or missing any sections. If the silicone is pitted it is in need of replacement. This is a fairly simple DIY with YouTube videos to follow. Or your can ask a local fish store if they offer this service.



From Our Sponsors

TROUT UNLIMITED

Your Cold Water Conservation Partner

For information on programs and partnering opportunities, contact your local TU chapter or visit www.michigantu.org

Michigan Sea Grant provides support for SIC teachers

Visit the website for resources

www.miseagrant.umich.edu/lessons

Sea Grant Michigan

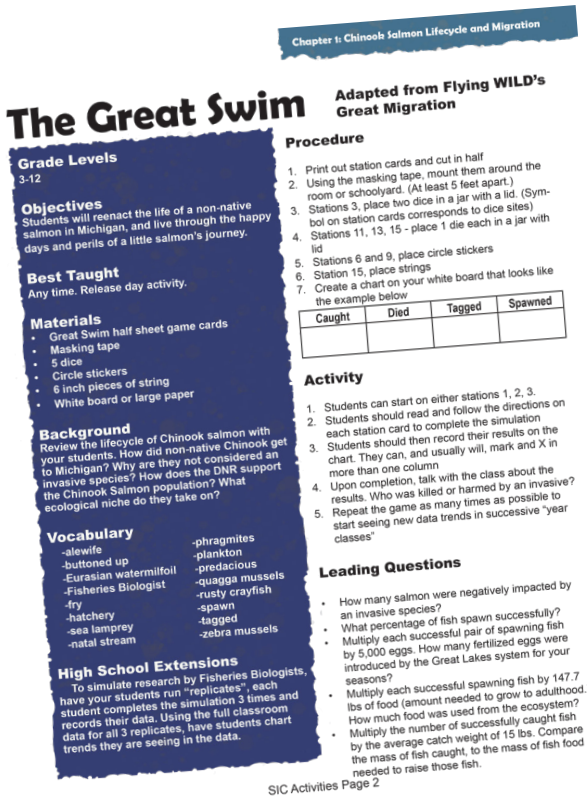
This website features a suite of lessons, activities and data sets focused on the Great Lakes. Any of these resources may be easily incorporated into formal and informal educational settings.

All the lessons, activities, teacher tools and data sets are free and targeted for 4-12th grades.

Curriculum Guide

The Salmon in the Classroom program has a separate SIC Classroom Activities guide that includes over 30 activities. All are correlated with NGSS and the guide includes appendices to connect to other resources. Be sure to download the latest version each October, we constantly add activities, resources and update science.

Find the SIC Classroom activity Guide at
Michigan.gov/SIC
Under "Current SIC Participants", "Program Materials"
Then scroll to the activity guide bullet.



Chapter 1: Chinook Salmon Lifecycle and Migration

The Great Swim

Adapted from Flying WILD's Great Migration

Grade Levels
3-12

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

Best Taught
Any time. Release day activity.

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

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

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

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

Procedure

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

Caught	Died	Tagged	Spawned

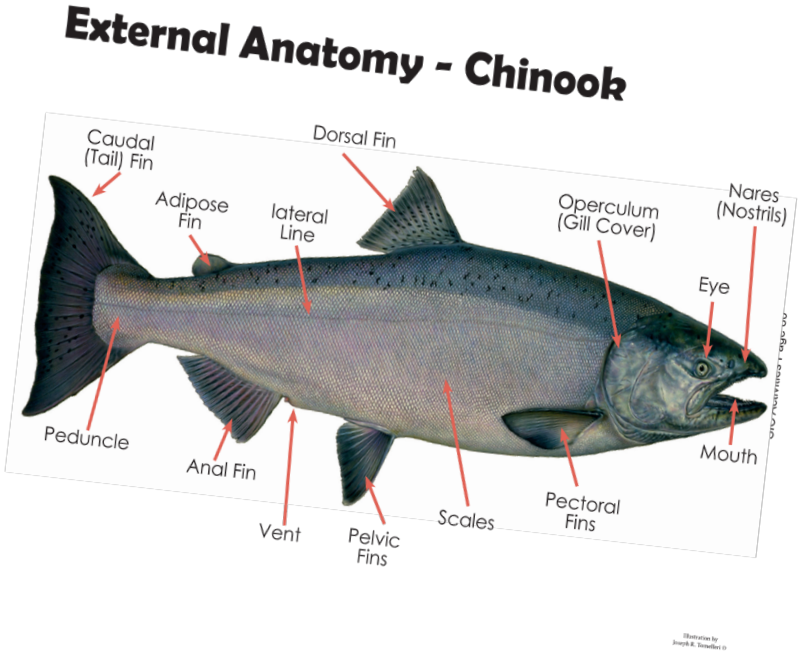
Activity

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

Leading Questions

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

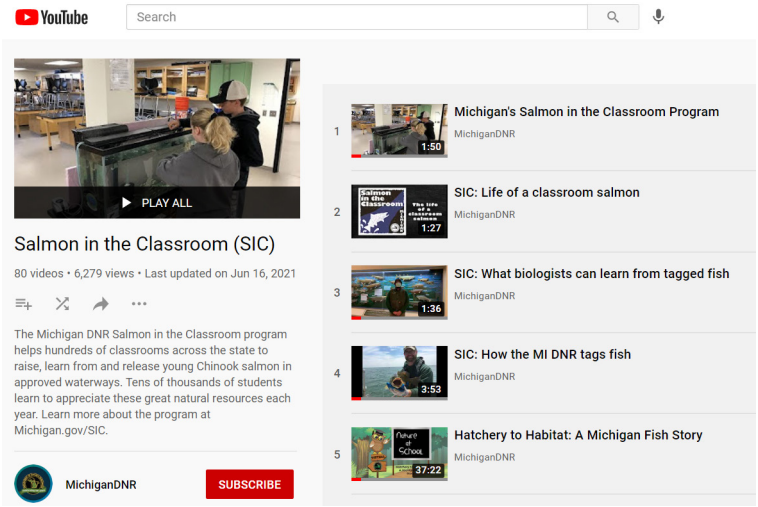
SIC Activities Page 2



Video Resources

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

Student Friendly Playlist



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

Find it at tinyurl.com/SICstudentplaylist

Teacher Specific Playlist

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

Find it at tinyurl.com/SICteacherplaylist

Fishing How-to Videos

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

Find it at tinyurl.com/AREAfishingvideos

Equipment List

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

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

Catalogs

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

Equipment

Waders

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

D nets

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

River sampling tools

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

Macroinvertebrate sampling

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

Fishing

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

- Backyard Bass
- Tackle Crafting
- “Fish Sticks” PVC casting practice

Book List

Kids Books

Ecosystems Thinking

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

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

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

Watersheds & Hydrogeography

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

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

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

Stewardship

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

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

Just for Fun

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

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

Kids Books Continued

Maritime History

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

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

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

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

Adult / Grades 11-12

Science Communication

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

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

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

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

Adult / Grades 11-12 Continued

Academic

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

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

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

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

Fishing

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

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

Historical

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

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

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

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

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