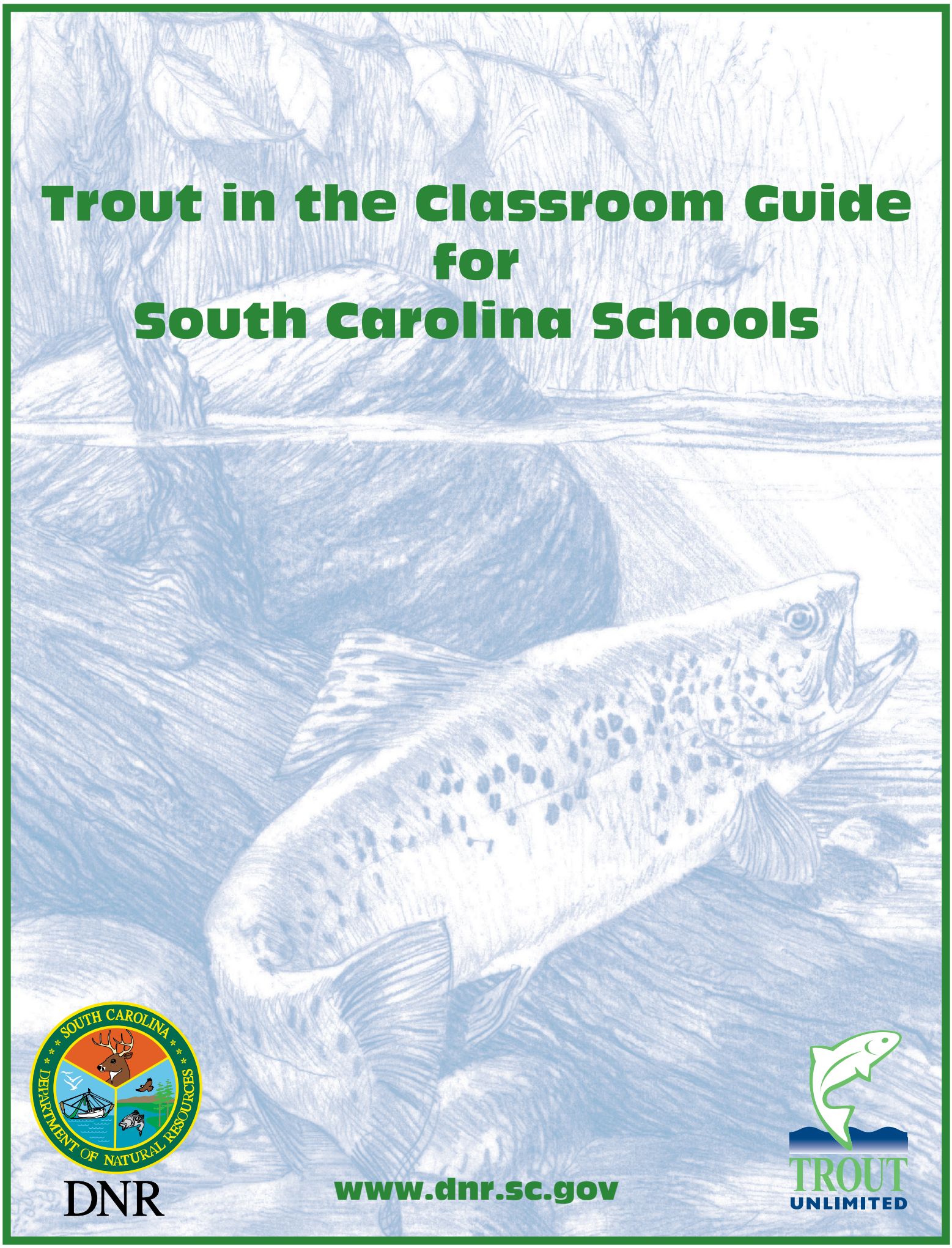
Trout in the Classroom Guide for South Carolina Schools



DNR

www.dnr.sc.gov

TROUT UNLIMITED

Trout in the Classroom Guide for South Carolina Schools

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Trout Fishing in South Carolina

History

Perhaps more than other wildlife, the trout's tenuous survival in South Carolina can be traced back to the effects of man's activities on the environment. Since trout only live in pure, cold water, they are highly sensitive to excessive silt loads, increased water temperatures and lowered oxygen levels. When improperly conducted, practices such as logging, agriculture, residential development and dam and highway construction can effectively destroy many trout-producing habitats. At the same time, a growing number of anglers adds to the pressure on the remaining populations.

The "eastern brook trout" is the only species of the salmon and trout family native to the southern Appalachians and South Carolina. Though called a trout since its discovery by early European settlers, it is actually a char. Biologists believe the brook trout first arrived in the southern Appalachians during the Pleistocene Epoch, which began about 1.8 million years ago and ended about 11,000 years ago. Prior to then, it occurred in the region from New Jersey north to the Hudson Bay. Aided by the cold climate created by advancing and retreating glaciers, the brook trout found a new home in the southern Appalachians.

The brook trout's security in the unspoiled mountain wilderness gradually changed with the influx of European settlers in the 1800s. Records from the 1870s note the presence of healthy populations of eastern brook trout in the upper Chattooga River. Land use practices of the late 19th and early 20th centuries forced the brook trout to retreat to the state's most remote headwaters.

Fortunately, the trout's decline did not pass unnoticed. The rainbow trout from the Western US and the brown trout from Europe were imported. These introductions had both positive and negative implications. On one hand, brown and rainbow trout were arguably able to occupy warmer water temperatures in the degraded habitat, and extend farther downstream of historic brook trout habitat. Therefore, these introductions likely increased available natural trout waters, alerted conservationists to protect the trout's habitat and helped create the vast southern Appalachian trout resource anglers enjoy today. On the other hand, the introduction of non-native trout resulted in the displacement of brook trout from their native range in many cases. The South Carolina Department of Natural Resources (SCDNR), the United States Forest Service and Trout Unlimited are working in partnership to restore the native brook trout to much of its historical range through a program called the Eastern Brook Trout Joint Venture and in SC, "Back the Brookie".

Management

Since South Carolina has only a comparatively small amount of water suitable for trout management, there is very little room to make mistakes. With the help of a supportive public over the years, the trout resource and trout fishing have been preserved. Trout management is defined as any activity having a positive impact on the well being of the trout resource, such as habitat protection and management, population management, regulations, stocking and research. Habitat preservation is the foundation of successful trout management. Every mile of natural stream lost to impoundments, every degree that habitat alteration increases water temperature and every activity that increases the silt load in streams means less habitat and fewer trout. Through public education and outreach, habitat protection and restoration, and population monitoring and management, trout managers

are trying to reverse errors of the past. Private landowners of trout streams are encouraged to contact local SCDNR biologists for information and to learn more about SCDNR programs for protecting and improving trout habitat.

Stocking

In the early 1930s, the SCDNR and US Fish and Wildlife Service began trout culture and stocking programs. Managers concentrated on stocking fingerling size trout, in the early years, in an attempt to reestablish sustaining trout populations or to establish put-grow fisheries where natural trout reproduction was limited. As the program evolved in the 1950s and 1960s, the S.C. Wildlife and Marine Resources Department (today's SCDNR) began an extensive trout stocking program to provide more trout fishing opportunities for the angler. This program included expanding trout management in seasonal, hatchery-supported mountain trout waters by stocking more catchable sized trout. The SCDNR now annually stocks approximately 500,000 fingerling and catchable sized brook, brown and rainbow trout.

Approximately fourteen mountain streams are stocked on a regular basis with catchable sized (9-12 inch) trout from March through June and again during October and November. Additional backcountry streams are stocked less frequently (seasonally) to maintain good trout fishing. These streams are typically located in remote settings. Water temperatures in receiving waterbodies and available fish largely influence stocking during July through September. Over 300,000 catchables are distributed under this program annually along with as many as 100,000 fingerlings. SCDNR does not release the time and location of stocking runs. These efforts are aimed toward perpetuating South Carolina's trout resource and providing a satisfactory angling experience for the sportsman. Healthy trout fisheries are the priceless reward for all South Carolinians for proper trout management. To see a weekly trout stocking summary, visit ***http://www.dnr.sc.gov/fish/stocking/results***.

Walhalla Fish Hatchery

The Walhalla Fish Hatchery, located in northern Oconee County, SC, raises brook, brown and rainbow trout for stocking the state's public waters in support of recreational fishing. Most of the trout are cultured to a catchable size of 9-12 inches before they are released. Fingerling trout are also produced to enhance the trout fishery. Hatchery trout are needed to maintain a sustainable trout population because of different factors in South Carolina trout streams. Generally, the streams of the Southern Appalachian Mountains are pristine and of good water quality. However, they are frequently not as productive as streams in other areas of the country. The northwestern corner of South Carolina is situated along the southeastern geographical margin of trout habitat. South Carolina maintains some high quality wild trout streams, but its geographical limitation restricts the natural trout resource such that it does not meet the high demand for trout fishing in the state. Trout managers have successfully extended trout fishing opportunities by stocking trout in selected streams. This hatchery supported trout fishery is generally created to support the desired fishery in waters where the natural trout population is limited. For more information about the Walhalla Fish Hatchery, trout fish culture and visitors information, visit ***http://hatcheries.dnr.sc.gov/walhalla/index.html***.

SC Trout Species

THE BROOK TROUT
Salvelinus fontinalis

The brook trout is a member of the genus Salvelinus, which contains salmonid species often called char or charr. Ranging from Georgia to the Arctic Circle, the brook trout is the only trout native to the southern Appalachians. Also known as the brookie, native, squaretail, speck or speckled trout, the brook trout's original haunts have diminished because of the deterioration of suitable habitat and the introduction of other non-native trout species.

Known for their distinctive color pattern, the adults are greenish with impressed lines or worm-like vermiculations on the back, top of head and dorsal fin, while the sides are speckled with bright yellow spots mixed with brilliant red spots on sky-blue halos. The olive-green background grades to bright yellow followed by brilliant red on the belly of the fish. All of the bright red ventral fins have a distinctive white stripe along the leading edge margined with black, typical of the Salvelinus genus.

Spawning in October and November in the spring seeps of feeder streams, brook trout grow very slowly in the confines of their small habitat. Because of the restricted environment in South Carolina, most never grow longer than seven inches, with few exceeding eight or nine inches in length. The current state record, 2 pounds 6 ounces, was a fish of hatchery origin, rather than a native brookie. Though wary, brookies are more readily taken than any other trout.

The angler may choose from a wide assortment of baits and lures, including earthworms, spinners, spoons and flies. SCDNR stocks brook trout in some remote streams on a seasonal basis and in late winter and early spring put-take program stockings.

THE RAINBOW TROUT
Oncorhynchus mykiss

A native to the West Coast of North America from lower California to Alaska, the rainbow trout has been widely introduced throughout the southern Appalachians. In its native region, the sea-run (or anadromous) individuals are known as steelheads, while resident fish confined to fresh waters are known as rainbow trout. One of the most widely distributed trout species in the world, its adaptability to hatchery propagation is probably the single-most important factor determining its extensive use in stocking programs. Various strains of captive rainbow trout spawn at different times of the year from fall to late winter. Therefore, by selecting different rainbow strains, with different spawning times, culturists can "program" grow-out to match stocking needs throughout the year.

A beautiful fish, the rainbow's name refers to its colorful pinkish-red band, which extends from its gill plate along its sides. Numerous blackish or brownish spots mark the back as well as the dorsal, adipose and caudal or tail fin. These spots are better developed on the tail fin in this species than on the brown trout. Spots on rainbow trout are generally small and very numerous, unlike brown trout which have larger less numerous spots.

Unlike the other two trout species in South Carolina, wild rainbow trout normally spawn in late winter to early spring, generally in February and March. During the first year, the young feed on insects and other aquatic life until they grow four to five inches long. Wild rainbow trout in South Carolina grow slowly. When they are two years old, they will grow to seven or eight inches; and at three, they'll grow to about nine or ten inches. In contrast, hatchery rainbow trout grow to about eight inches at one year of age, and by age two they are over 12 inches.

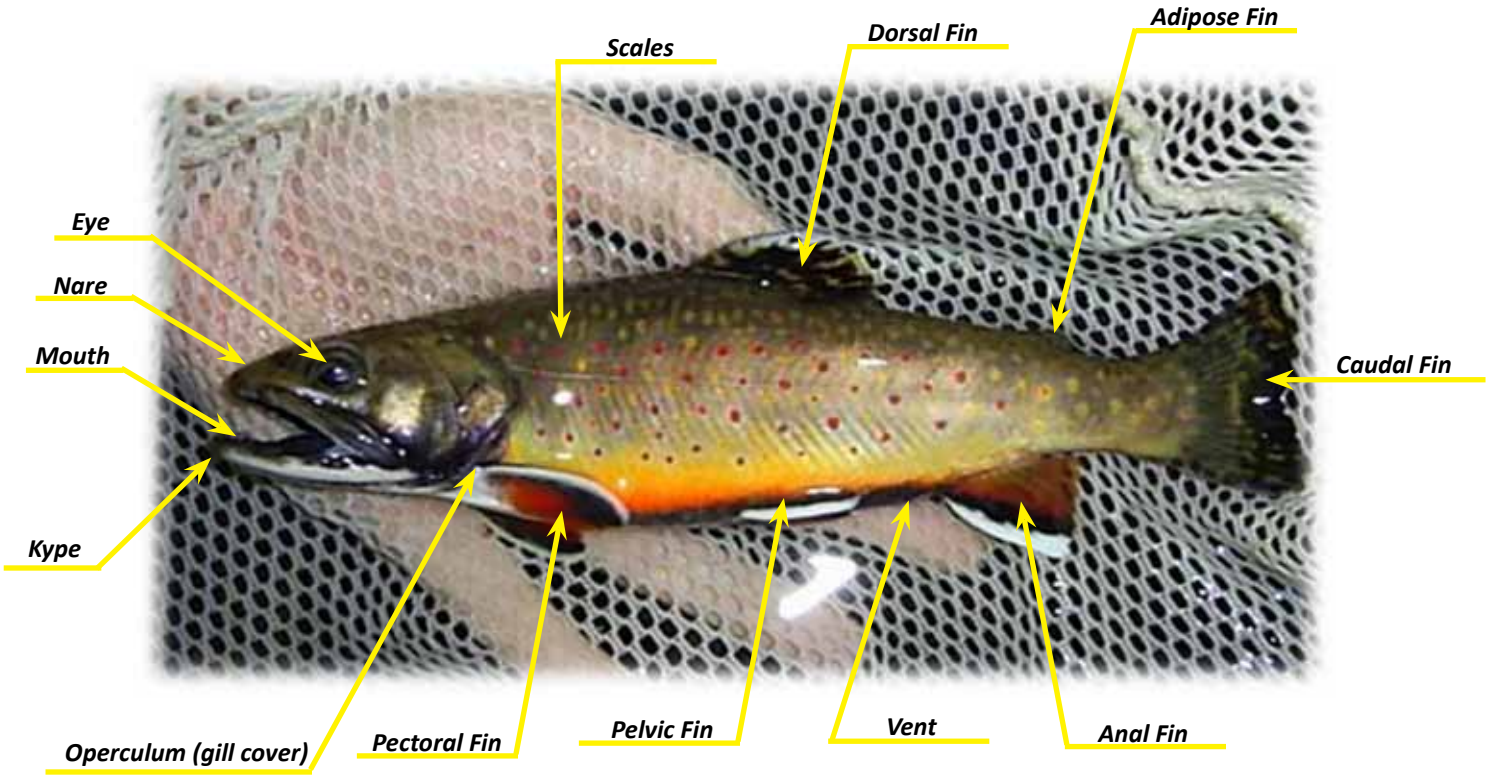
THE BROWN TROUT
Salmo trutta

Brown trout, also known as German brown or Loch Leven brown denoting the source of importation, were imported into the United States in 1883. During the late 1800s and early 1900s, this species was widely distributed throughout North America. The brown is the most prevalent species along the lower gradient mica sand streams along Chattooga Ridge in South Carolina.

The brown and the rainbow share some common characteristics in behavior, habitat and appearance but can still be easily identified as separate species. Adults of the brown trout may be distinguished from the rainbow by the absence of a reddish band along the sides, the presence of orange or reddish spots, sometimes with green margins, and the weak development or absence of dark spots on the tail or caudal fin. The brown trout typically inhabits lower gradient streams with good pool habitat and overhead cover. Brown trout are generally more tolerant of turbid, silted streams and generally out-perform rainbow trout in streams with heavy competition from other fishes. Many of the feeding habits of the two species are similar, although the brown is somewhat more nocturnal in its activities. The brown feeds heavily on insects as the other trout species do, but it is also more inclined to take fish, crayfish and salamanders. In some streams, the crayfish has been found to comprise half of larger wild brown trout's diet. Like the brook trout, the brown spawns in the fall from late October through November.

Brown trout are the favorite of many skilled anglers, not only because they tend to live slightly longer and grow larger than the other two species but also because they are the most difficult of all trout to catch. They take most types of lures and bait well, but these must be presented skillfully and cautiously. Since browns tend to use undercut banks, rock ledges and fallen timber for cover, they are difficult to approach undetected. Brown trout fight very aggressively and tend to make long, forceful runs into deep pools when hooked. Brown trout aren't known for making aerial acrobatic leaps like the rainbow trout.

Basic Trout Biology



External Anatomy

Eye: used for sight, triangular in shape which allows the trout to have a larger field of vision

Nare: similar to nostrils except used for smelling only (nostrils are used for both smelling and breathing)

Mouth: used to consume food

Kype: hooked lower jaw present in males prior to spawning

Operculum: protects the gills (breathing apparatus) from harm; it opens and closes to allow water to pass over the gills

Pectoral Fin: allows for abrupt changes in side-to-side direction and speed; also acts as brakes to decrease speed while swimming

Pelvic Fin: stabilizes the fish while swimming and allows for up-and-down movement in the water

Vent: removes waste and extra water; also the outlet for eggs or milt (sperm) during spawning

Anal Fin: stabilizes the fish while swimming

Caudal Fin: moves, propels or pushes the fish through the water

Adipose Fin: purpose is unknown; just fleshy tissue

Dorsal Fin: helps maintain balance while swimming

Scales: protect the fish from injury

Internal Anatomy

(more to be covered in Trout Dissection powerpoint)

Gills: structure used to allow fish to breathe; water flows in through their mouth and over their gills where oxygen is extracted and passed into the bloodstream

Swim Bladder: long, skinny organ that can inflate/deflate with air allowing fish to float at different levels in the water column

Fish Senses

Eyesight: fish can see in two directions (one eye focusing on an object independent of the other whereas people's eyes can only focus on one object at a time); trout have great eyesight due to their triangular-shaped eyes

Hearing: fish have ears but not external ear openings like people do; their ears lack a middle and outer ear because sound travels faster in water than in air

Smell: used only for smelling

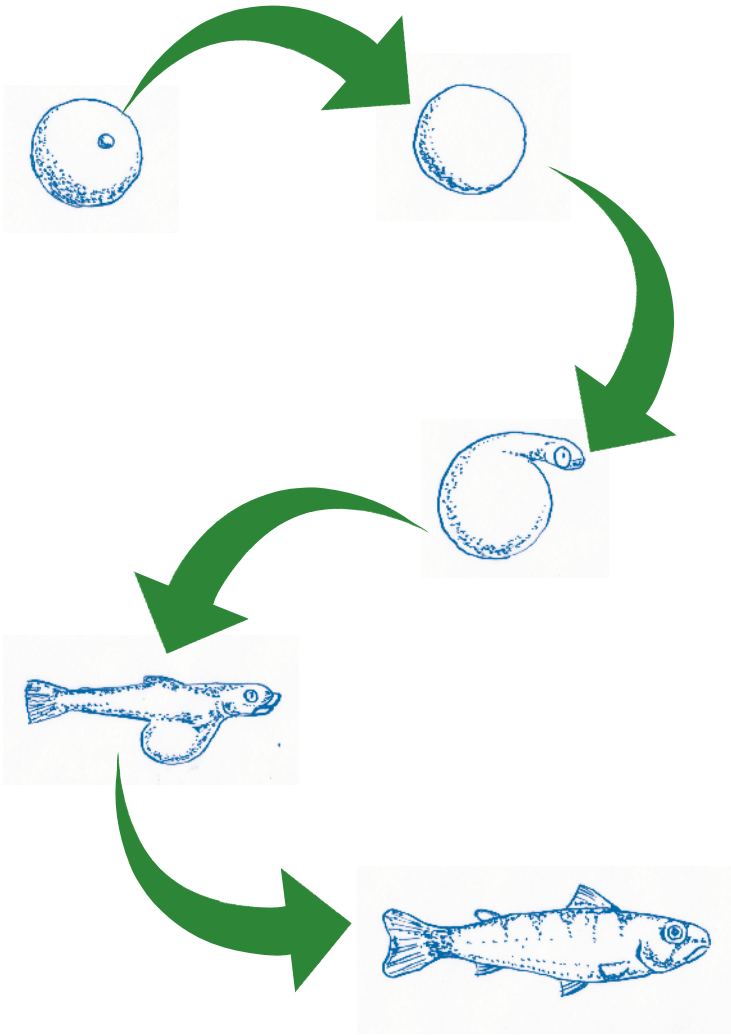
Taste: taste buds inside the fish's mouth may determine the final acceptance or rejection of food

Lateral Line: found alongside a fish's body from the operculum to the tail (aka caudal fin); it senses vibrations or movement in the water; allows fish to locate predators and find prey. This system is made up of a series of fluid-filled canals just below the skin of the fish's head and alongside the body. The canals are filled with tiny hair-like structures that detect changes in the water via tiny pores connected to the system.

Trout Life Cycle

Two to four weeks before spawning, male trout undergo physical changes that include developing a kype, a hooked lower jaw with strong teeth, and exhibiting vibrant colors. As mating time approaches, the females will begin searching for a site in the shade with clear water, gravel and a good water flow to build her redd, or nest. When a female finds a suitable site, she scoops out a little depression using her fins. The female works hard to create her nest while males attempt to impress her with mating dances. When the female is ready, the male swims up alongside her. The female releases the eggs and the male releases his milt and the eggs will be fertilized. The female covers the eggs with gravel and moves on to another site to lay more eggs with two or three different males at different sites. A 13-inch female trout may produce about 1,000 eggs over the course of a couple of days.

The fertilized eggs remain in darkness and undergo a process in the first hour of being laid called water hardening, where the pores in the eggs seal. The sticky eggs are now in the green egg stage and will remain so for approximately 20 days after spawning. Green eggs are very fragile and can be easily damaged during this stage. The eggs begin to change and become clear and pinkish in color and a set of eyes becomes recognizable. They look like two dark dots. This is called the eyed egg stage. The trout remain in the eyed egg stage for approximately 2-3 weeks. Alevins then appear! This form of the trout is not yet free-living, but feeds from a yolk sac attached to their bellies. As the alevins grow and develop, they remain in the redd until all the yolk sac is absorbed. Eggs and alevins are both very vulnerable to environmental disturbances at this stage. When the alevins no longer have yolk sacs, they become fry and float up to the surface actively looking for food. It may take up to 2-3 weeks for alevin to develop into fry.

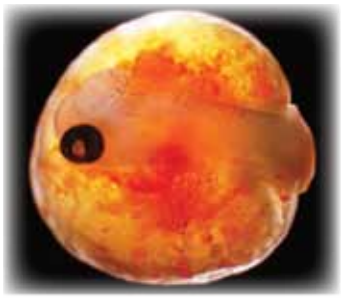


Life Cycle of a Trout in the Walhalla Fish Hatchery

Trout broodstock or parent fish live at the hatchery. Female trout produce eggs that are manually stripped from the fish in October or November to produce the fry.

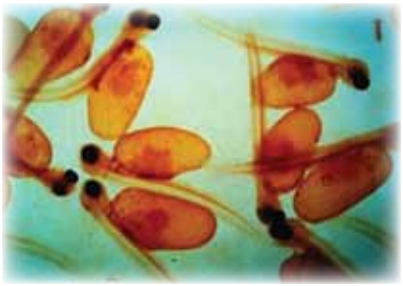
The eggs are fertilized with milt (sperm) from male trout.

The eggs are then placed in special incubators where they receive a constant supply of oxygen rich water. At this early stage, the eggs are very tender and cannot be handled. Total incubation time from spawning to hatch is normally 4 to 6 weeks.



Halfway through incubation, eyes of the developing embryo can be seen through the transparent egg shell. This is called the “eyed” stage. At this time, eggs can be handled and transported without harm to the fish.

After hatching, the small fry have their own food supply in the form of a yolk sac which is still attached and visible. The yolk sac is the young fish's only source of food for the first two or three weeks of life. As time goes by, the yolk sac is absorbed or used and the fish are ready to feed.

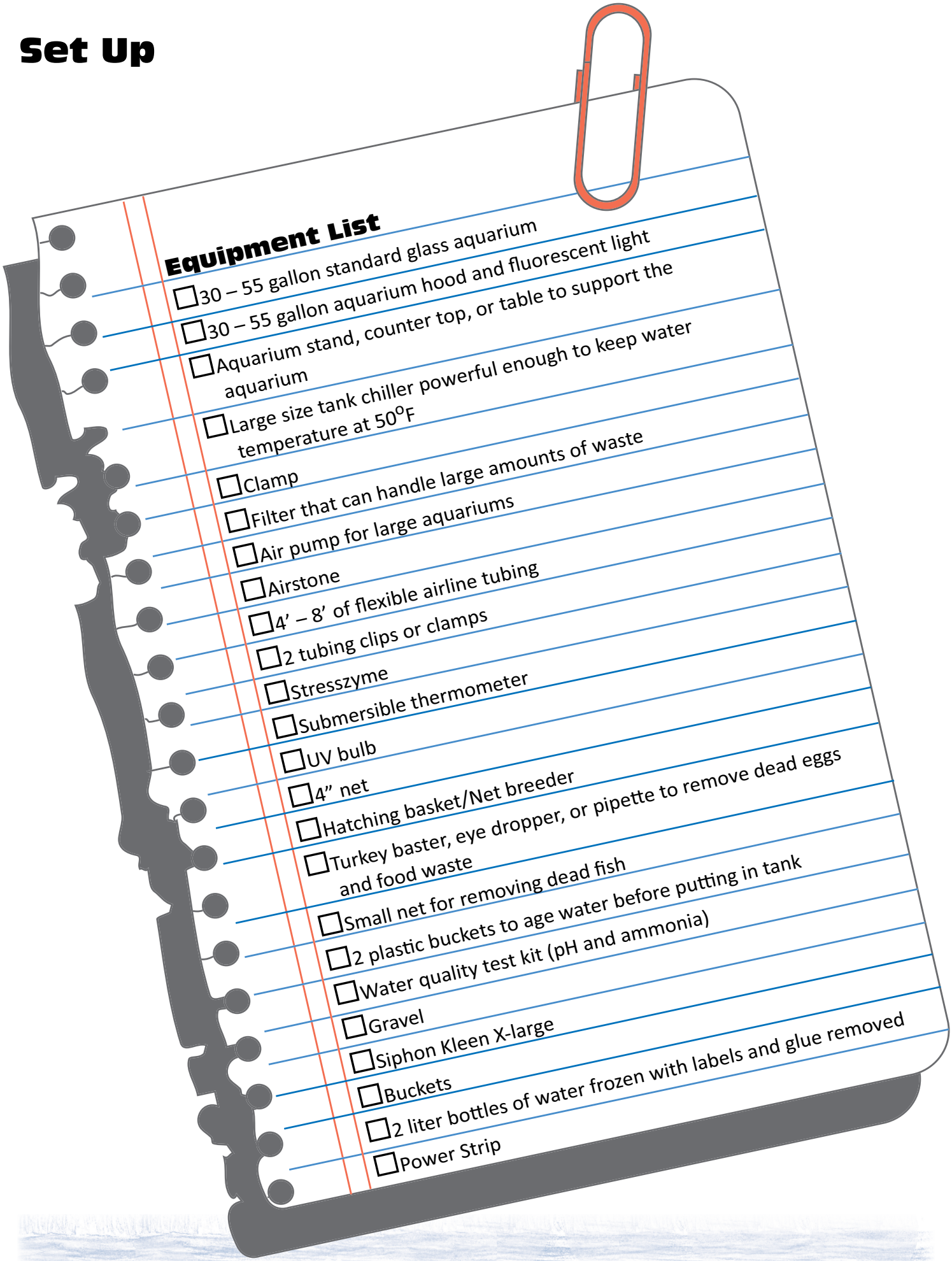


Trout at the hatchery in the fry stage are fed a special food that is high in protein and other nutrients.

The fry live in the hatchery building until they reach about 2 inches in length and they are considered "fingerlings." The fingerlings are then moved to the outdoor raceways to continue growing.

The fingerlings are allowed to grow for 14 to 16 months until they reach the stocking size of 9 inches in length. The fish are loaded onto a truck with a hauling tank and leave the Walhalla Fish Hatchery. The biologists travel to streams with adequate habitat and temperatures to stock the fish. Trout stocking helps reduce pressure on existing trout populations and establishes more trout fishing opportunities for anglers.

Set Up



Equipment List

- ☐ 30 – 55 gallon standard glass aquarium
- ☐ 30 – 55 gallon aquarium hood and fluorescent light
- ☐ Aquarium stand, counter top, or table to support the aquarium
- ☐ Large size tank chiller powerful enough to keep water temperature at 50°F
- ☐ Clamp
- ☐ Filter that can handle large amounts of waste
- ☐ Air pump for large aquariums
- ☐ Airstone
- ☐ 4’ – 8’ of flexible airline tubing
- ☐ 2 tubing clips or clamps
- ☐ Stresszyme
- ☐ Submersible thermometer
- ☐ UV bulb
- ☐ 4” net
- ☐ Hatching basket/Net breeder
- ☐ Turkey baster, eye dropper, or pipette to remove dead eggs and food waste
- ☐ Small net for removing dead fish
- ☐ 2 plastic buckets to age water before putting in tank
- ☐ Water quality test kit (pH and ammonia)
- ☐ Gravel
- ☐ Siphon Kleen X-large
- ☐ Buckets
- ☐ 2 liter bottles of water frozen with labels and glue removed
- ☐ Power Strip

Tank Setup

Unpack tank and inventory all items present and email list of missing items to TIC Coordinator.

Tank

- Place tank in a location away from heat, excessive light and activity—but near an electric outlet. If the tank must go next to a window, make sure there are blinds to prevent direct UV light on the egg or alevin stage. Do not put the tank next to an active radiator. Also, since a filled tank may be top heavy, put it in a secure place where students won't accidentally bump it.
- Clean out any dirt inside the tank with a wet paper towel. DO NOT use soap or any cleaning chemicals in cleaning the tanks as the residues from these compounds may harm your trout.
- Clean the gravel rocks by rinsing them several times with water only in a separate bucket.

Chiller

- Place the chiller to the side of or below the tank with the metal front facing out. Make sure to leave at least a 4-inch clearance all the way around the chiller to allow airflow.
- Take the metal coil end that is attached to the chiller and, using a clamp, attach to the side of the tank. Make sure that only the metal portion of the coil is in the water. The connecting wire/cable should not be submerged.
- Do NOT plug the chiller into the power strip. It needs to be plugged directly into a wall electrical outlet.

Filter

- Priming the filter or filling with a cup until water flows back into the tank from the filter.

Airstone & Pump

- Attach one end of the airstone tube to the airstone and the other to the air pump. Place the air pump on the ground near the power strip. The rubber feet of the air pump should be on the ground to prevent excessive noise. Place the airstone in the tank away from the filter intake tube.

Gravel & Hatching Basket

- Add the gravel very carefully to the bottom of the aquarium to prevent cracking.
- Assemble the hatching basket by stretching the net over the outside of the plastic frame or carefully securing the net to the inside of the frame. Hang the basket on the tank wall by bending the metal clips.

Filling the Tank

- Using any clean container or tubing, fill the tank with tap water about 2 inches from the top of the tank. It should not be so close that it will spill easily. Your tank must sit without fish in it for at least 48 hours to allow any chlorine to dissipate. Add a small amount of StressZyme to the tank. This will start bacteria growth within your tank.

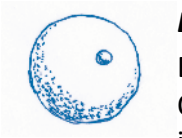
Plugging In

- Plug all cords into the power strip while the power strip is in the OFF position, EXCEPT for the chiller which needs to plug directly into a wall electrical outlet.

• Turn on the power strip and prepare for operation.

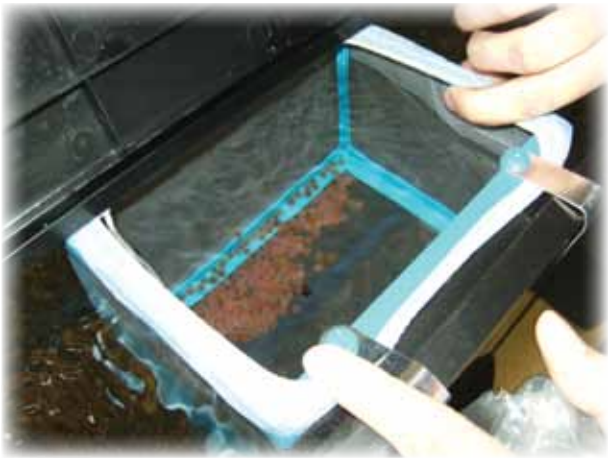
- ☐ Any leaks?
- ☐ Airstone working?
- ☐ Is the filter pumping water into the tank? Place your hand in front of the output in the tank. If the filter is not pumping water within one minute, turn off the powerstrip and recheck connections.
- ☐ Adjust the chiller temperature to the appropriate setting (50 degrees Fahrenheit with a deviation of 1 or 2 degrees).
- ☐ Fill several containers with tap water to be aged for your first water change.

Trout Timeline



Egg Arrival

Eggs will arrive in either September, October or December. The eggs will arrive in the eyed egg stage and will be very vulnerable to environmental stimuli such as light and changes in temperature. Do not expose these eggs to sunlight or fluorescent light. Make sure the tank cover is on at all times to provide shade and prevent objects from polluting the water. The basket should be placed in the tank with the filter output water flowing in the basket's direction for high oxygen. Tank temperature should remain within 1 degree above/ below 50 degrees Fahrenheit.



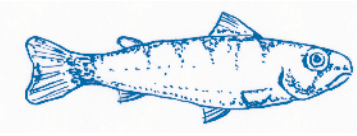
Make sure before handling the fish or putting your hands in the tank for any reason you have cleaned your hands with water so that they are free of lotions or soap residue. Remove any eggs that are dead which can be detected due to lack of pink coloration (they become a white, milky color) and loss of eye spots. Remove these eggs very carefully with a turkey baster, pipette or eyedropper. Eggs that are left in the basket that are dead will begin to decay and grow fungus that is harmful to the remaining live eggs.

Alevins

The eggs are hatching! Yay! You now have alevins! You will notice they are beginning to look a lot like fish at this stage. You may notice white foam on the surface during hatching. This is the result of embryonic fluid being released from the egg during hatching. After hatching is complete (or at the end of each day during hatching), scoop the white foam from the tank, use a net or a plastic spoon to remove any of the embryonic fluid foam and change half the water.

During this time, check the pH carefully.

Be careful to not poke or handle the alevins as they are still very vulnerable and the yolk sac can be easily damaged. Observe the changes in the yolk sac by looking at the belly or ventral side of the fish. When the yolk sac has completely disappeared, the fish are now fry! Don't forget to remove dead fish daily as they can spread disease and cause fungus to grow, harming your remaining fish. Make sure to change half the water once a week.



Fry

Fry will rise to the top of the hatching basket. At this time, you may release them from the basket and begin feeding. Much of the first food will go uneaten but it will be there when they are ready to eat. Unfortunately, this is the point where you will have some noticeable mortality as some eggs will never hatch or some fry will never begin to feed.

When you feed, it is very important to not feed in excess. You should only feed as much as the trout can consume. The food for captive fish is very high in protein and nutrients which will also jumpstart a nice colony of fungus if you aren't careful! Any excess food that the trout do discard should be siphoned out with a siphon, turkey baster, pipette, dropper, etc. Don't forget to remove dead fish daily.

Trout Timeline	
Life Cycle Stage	**Duration**
Eggs (eyed)	5-15 days
Hatching	2-3 days
Yolk Sac absorbed	1-2 weeks
Fry to Fingerling*	3-4 weeks
Fingerling	4+ weeks
Release Date	Anytime between April to May
*Fry=fish less than 1 inch Fingerling=fish 1 inch or larger	

Trout Release

Releasing the trout can be a bittersweet experience for your students. They will be sad to see the trout go, but happy to put the trout into their proper habitat. Students often worry about what is going to happen to the fry and their ability to survive when released. Take this opportunity to discuss survival chances and threats to fry in the natural environment. Help students understand that the percentage of fry that survive depends on many factors including predation, pollution, water conditions, food availability, amount of cover, living space, environmental conditions, physical obstacles and competition with other fish. Some fry will die and others will survive.

SCDNR is the only approved authority to release these trout into South Carolina public waterways. Therefore, SCDNR will arrange a pick up date from your school to get the trout.

Care and Monitoring
Caring for the Eggs/fish

Feeding

It is very important whenever feeding to not feed in excess. You should only feed as much as the trout can consume in a few minutes. The food for captive fish is very high in protein and nutrients which will also jumpstart a nice colony of fungus if you aren't careful! Any excess food that the trout do discard should be siphoned out with a siphon, turkey baster, pipette, dropper, etc.

Feed your trout several times a day beginning in the fry stage, but no more than once an hour. Uneaten food will kill your fish! Your trout can survive a 2-day weekend, but NO LONGER without food. If you are on vacation, someone has to come and feed the fish and conduct a water change! Keep in mind that when you begin to feed your fish, there will be more maintenance.

Trout feed comes in 3 sizes: smallest to largest. Bags of the food will be labeled 0-2 with 0 being the smallest and 2 the largest. See the guidelines chart below for when to start feeding your fry!

Trout Feeding Guidelines	
Trout Fry Size	**Feeding Size**
Less than 1" in length	0=smallest size
1" to 1½" in length	1=medium size
Greater than 1½" in length	2=largest size

How much to feed your fry?

You should only give a small amount of food to your fish as overfeeding will pollute your tank and cause water quality problems that will negatively impact your fish. Give only one pinch (between your thumb and pointer finger) at a time and then remove all extra food particles. Feed your fry 2-3 times daily but not more than once an hour. You may want to create a feeding chart that you or your students can initial as to who fed the fish, what day, amount and time.

It is better to feed less food more often than a lot of food all at once!

Cleaning

Once the eggs arrive, the most important job of this project is keeping the trout healthy! The key to keep your trout healthy is to keep your tank clean! After hatching, the fish will begin producing more waste especially once you begin feeding.

Weekly water changes are a must and sometimes you may have to change the water more than once a week. Since your tap water is contaminated with chlorine and other chemicals, you need to let it sit for 48 hours to allow these chemicals to dissipate out. Siphon any debris off of the bottom of the tank. Move the gravel around with the siphon to make sure you are getting any debris that may have settled in between. You can also use the turkey baster to blow debris from between the rocks while someone else siphons it up. When siphoning, make sure you check your dirty water bucket before discarding the water as there may be a couple of fry who accidentally got siphoned too!

The best water change method is to do small daily water changes and one large change a week. You can set up an assembly line of 5 one-gallon plastic jugs (the kind for drinking water). Leave the jugs UNCAPPED! After the first jug is 48 hours old, you can change one gallon of water a day (one out, one in) and then refill that jug and put it in the back of the line to age. This method ensures that all of the water has been aged for an adequate amount of time (allowing all chlorine to dissipate). When doing a water change, make sure the new water is within 1 to 2 degrees Fahrenheit of that in the aquarium.

Clean tanks equal healthy fish which will lead to a much higher survival rate.

Optimum conditions	In Nature	In the Classroom
Limited light (as eggs and alevins)	The eggs are buried under the gravel in a redd.	Aquarium is positioned away from direct sunlight and/or enclosed in Styrofoam.
Cold water (42° F -55°F)	Shade trees, snowmelt and underground water sources keep stream water cool.	A chiller maintains optimum water temperature.
Oxygen	Cold, rushing water gathers and holds oxygen from the air. Aquatic plants also produce oxygen.	Aeration unit adds and circulates oxygen in the water.
Clean water	Clean water is stored and gradually released by a healthy watershed system. Bacteria break down decaying matter in streams. Plants absorb nitrates.	Dechlorinated water is used. Filters remove wastes and encourage microorganisms which turn harmful ammonia into harmless nitrates.
pH (6.5-7.5)	Runoff from highways, lawns, farms, and decaying organic matter all affect pH.	Proper balance between acidity and alkalinity (optimum is 7.0) is maintained in the aquarium.
Food	Aquatic insects that live in the gravel or terrestrial insects that fall into the water and tiny zooplankton are food for fry.	Fry are fed a special diet of fish food until release date.
Predators	Eggs in gravel are safe from predators. Fry have protective coloration and hide under rocks and other stream habitat.	No predators in classroom.

Daily Checklist

- ☐ Test pH and ammonia daily.
- ☐ Check water temperature daily.
- ☐ Remove dead eggs or fish every day.
- ☐ Feed fish daily beginning in the fry stage.
- ☐ Check the filter and chiller daily to make sure it is still working properly.
- ☐ Change 10-20% of the water per week. Do not let the tank temperature fluctuate (other than the 1 degree deviation)!!

Observations & Record Keeping

Before the eggs arrive, instruct students on how to conduct a daily inspection of the aquarium. Show them how to check that the equipment is working properly and how to read and record the temperature. Explain that when the eggs arrive, they will also be checking for egg mortality.

Assign three students to conduct the inspection twice daily for a week. At the end of the week rotate out one student and put a new student in. That way, after the first week, you will always have two students with experience in conducting the inspection. Have students inspect the aquarium early in the morning and at the end of the day and record their findings both on the daily inspection record and on the progress chart.

Record Keeping

Record keeping is an essential part of the program. Records can identify potential problems and can be used to reference experiences from past years. Students should record everything that is done or observed. For example: dates, temperatures, egg/alevin/fry numbers, problems/solutions, water quality testing results, mortality, hatching, predation, etc. At the end of each week, student inspectors should report to the class on the data they collected for the week. Monitor the tank daily to prevent potential problems. Allow the students to make their own record keeping sheet or make one of your own.

Inspection

Do a "walk around" inspection of the incubator and associated equipment at least twice daily (first thing in the morning and just before leaving at the end of the day). Assign the inspection to an individual student or rotate the assignments among groups of students.

Water Quality

Fish, trout especially, are easily affected by changes in water temperature, pH and many other factors. To help ensure you maintain a healthy tank, water quality tests for pH and ammonia should be done daily, as well as checking the temperature. Your pH should always stay neutral or near neutral (pH 7). Small traces of ammonia are inevitable, however, the ammonia levels should stay between 0-2. Ideally 0 is the best! If you have an unusual imbalance in pH or excessive ammonia levels, you should do a water change as soon as possible. If fish behave erratically or die off in large numbers, poor water quality is usually the culprit. Be prepared to have to make a 1/2 or 2/3 water change.

Temperature

The ideal temperature range for raising trout is between 48° F. and 52° F. Temperature affects ammonia and oxygen concentration and fish metabolism. A sudden increase or decrease of 3 to 5 degrees within a 15-minute period (even within the acceptable temperature range) can create major problems for eggs and alevins.

Dissolved Oxygen (not required to test)

Dissolved oxygen (DO) is defined as the amount of oxygen, measured in parts per million (ppm), that will dissolve in water at a given temperature. Trout are active and consume a lot of oxygen from the water. Dissolved oxygen levels of 10-12 ppm are most desirable. 8 ppm for developing eggs and alevins is the absolute minimum. 5 ppm is the absolute minimum for fry. At the 5-8 ppm level you can expect some problems for eggs and fry. Temperature and DO are inversely proportional, meaning that when the temperature decreases, DO increases and vice versa.

Use a dissolved oxygen test kit (available from aquarium supply stores) to check dissolved oxygen.

pH

pH (the power of Hydrogen) is an indicator of water acidity or alkalinity. The pH values range from 1 to 14. Pure, pH-balanced water has a value of 7. Any number less than 7 is acidic. Any number more than 7 is basic or alkaline. A pH below 6.0 or above 8.0 in your aquarium water is reason for concern. Fish take oxygen from the water through their gills and give off carbon dioxide. When carbon dioxide is expelled into water, a simple chemical reaction occurs producing a weak acid called carbonic acid. Too many fry in a closed aquarium system can change the pH to dangerously low pH levels. Acidic water (low pH) irritates gills, causes excess mucus production and reduces the gills' ability to exchange oxygen. Low pH also limits the fish's ability to regulate its blood salts, although adding calcium ions can reduce this effect. To combat pH problems, make a partial water change or use a buffering agent, such as baking soda, to correct the situation. Use a pH test kit (available from aquarium supply stores) to test pH.

Ammonia

As the eggs, alevins and fry develop, both ammonium ions (NH4) and ammonia (NH3) are produced from the breakdown of their foods through excretion. Ammonia is highly toxic to fish. High levels can cause gill damage, anemia and even death for eggs and fry. In nature, plants and plankton reabsorb the ammonia (nitrogen) waste, eliminating the problem of high ammonia levels. At pH levels above 7 the ammonia increases its concentration. Total ammonia levels should be between 0-2. Monitor ammonia levels with a test kit (available from an aquarium supply store). If the ammonia level is high you will need to do a partial water change.

Chlorine

Chlorine found in most drinking water is toxic to fish and the good bacteria in the aquarium. Since chlorine is an active element, meaning it changes forms quickly, it is easily removed from tap water by allowing the water to sit in a bucket for 48 hours.

Storage and Cleaning

Tank

1. Turn off the electrical pumps, chillers, filters, etc.
2. Empty the tank almost all the way.
3. Finish emptying the tank.
4. Disconnect the airstone, chiller and filter.
5. Using a solution of 1 part Chlorine bleach and 10 parts water, wipe down the interior and exterior of the tank. A new, soft sponge can be used to remove algae growth.
6. Wipe dry with clean cloth and let air-dry.
7. Aquarium gravel should be removed, washed and dried by laying out on a cloth or towel in the sun or a well ventilated area.

Chiller

- Clean the stainless steel coil with a dedicated sponge and the bleach solution if you have to.
- Remove dust and lint from the outside of the chiller with a damp towel.

Filter

1. Take the filter apart.
2. Scrub out the plastic parts with the bleach solution.
3. Thoroughly rinse out all filter cartridges (filter sponges, charcoal, etc.) with regular water, and dry them in the sun or a well ventilated area. For many filters, it is recommended that you simply discard the cartridges and replace with new ones the following year. If you do have to discard any of the filter medium or sponges, you must report this to your TIC Coordinator to reorder for the next school year.
4. Air-dry entire filter apparatus.

All equipment should be stored in a clean and dry location.

Troubleshooting

Water Quality Problems

Dissolved Oxygen Problems

Clue: many fry gasping at surface (note new fry will gulp air at the surface to fill the swim bladder, but after that they should remain in the middle of the aquarium's water column).

Make sure the airstone is working and that the entire filter system is free of obstructions and running. You may also decrease the water temperature (one degree per hour). Sacrificing some of the fish to reduce the population may also increase oxygen levels.

pH Problems

Clue: discolored eggs, eggs with eyes extending outside the shell

pH levels indicate the accumulation of hatching and fry waste. As the waste increases, pH levels drop, creating a more acidic condition. Check the pH level daily. If the pH falls below 6.5, eggs and fry could die or be seriously damaged. To correct this, change at least half the water, using de-chlorinated water the same temperature as in the aquarium. If pH values remain low, you can use baking soda to add calcium carbonate and increase the pH. If pH values are too high (7.5 and above), adjust the pH with white vinegar. If pH levels continue to be a problem, your water source may contain dissolved materials which may be causing the problem.

CAUTION: Changing from one pH value to another is a 10-fold change in magnitude and may be more than eggs or fry can survive.

Ammonia Problems

Clue: changes in pH, compression of fins on fry

Ammonia levels should be kept as close to zero as possible. If the level rises too much, a partial water change is advised. Use de-chlorinated water, the same temperature as in the aquarium. A buffering product, which can be placed in the corner of the aquarium, is also available at supply stores.

Disease Problems

Clue: white cloudy eggs, purple eggs, white fuzz on

eggs, fry swimming in circles, oily red spot in egg, discolored yolk, fry swimming on their sides

Diseases can be transmitted from parent to egg or from other eggs and fry. The hatchery makes every effort to provide healthy eggs, so disease is rare in an uncrowded aquarium. There's not much you can do with diseased eggs or fry in your classroom. Consult your area biologist or hatchery personnel. NEVER release sick fry!

Weird Egg Colors

White cloudy, purple or white fuzzy eggs: remove these eggs as soon as possible. They are dead or infected with a fungus.

Oily red spot on egg: remove these eggs immediately. This is a result of an injured or ruptured egg sack. This was most likely caused by late shocking or jostling at the hatchery.

Mechanical Problems

Chiller

Clue: Increasing, decreasing or inconsistent temperature.

Most chillers are trouble-free and require little maintenance. But as mechanical devices they can fail. Check to be sure the chiller is plugged in. If it still isn't running, check the outlet with other appliances to be sure it has power. If the outlet has power and the chiller is plugged in, try reducing the temperature setting. If this fails to trigger the compressor, then there is a more serious problem in the chiller. If the water is freezing, the thermostat may be defective. If the chiller runs constantly, but the coil is not cold, the refrigerant has probably leaked out.

Have a backup system, such as a refrigerator, to put the aquarium in or bottles of frozen water to float in the tank. Be sure to completely remove labels and glue from the bottles before use, as they can pollute the water.

Filter

Clue: Water is not moving in the tank.

If bubbles and flow are not coming from the filter output, the unit may be defective or clogged. Make sure the filter is plugged in and getting power. If the pump is working, but not aerating, check lines for blockage. Filter lines can clog with algae, slime and even adventuresome fry. Remove the tube and blow through it. Unplug and remove the pump. Check for blockage in the intake. If needed, disassemble the top of the filter and clean the magnet and the fan.

Miscellaneous Problems

Deformities (e.g. two heads) occur naturally

Sac fry lying on the bottom of the hatching basket is natural as they would normally be hidden amongst gravel. Do not release fry in the sac-fry/alevin stage.

Power failure can occur any time. Have your chiller backup ready. Inform custodial staff and others who may be in the building on a weekend or break so they can take emergency measures if power goes out when school is not in session. Provide emergency numbers at the aquarium site in the event that a problem is discovered in your absence. Have your frozen 2-liter bottles label/glue free and ready to place in the tank in case of a power failure to keep temperatures down.

FAQs

How large must the aquarium be?
A 30-gallon aquarium will easily accommodate 60 eggs. If you would like to raise more trout, a larger aquarium will be needed.

Where do the eggs go?
The eggs should be placed in a floating tray or basket in a single layer. This will make it easier to remove dead eggs. The tray must float deep enough in the tank to provide adequate oxygen and circulation for the eggs.

How much water circulation is needed?
A powerhead or riser tube attached to an air pump creates sufficient circulation in a 30-gallon tank. Water circulation moves waste products (ammonia) away from the eggs and provides the eggs with oxygenated water.

Should the water be filtered?
Filters can reduce the need for frequent water changes. Charcoal filters remove some of the waste products and impurities from the aquarium. An undergravel filter traps particles as the water is drawn down through the gravel. The microbes that develop in gravel function as a biofilter. They consume ammonia that fish excrete and convert it to nitrogen. Food particles may be trapped underneath this, and it should be cleaned occasionally.

How often do I need to test the water?
Water should be tested at least once daily. Inexpensive water testing kits are available from

pet shops. You should test for dissolved oxygen, pH and ammonia. If there is ammonia build-up you can change 1/2 to 2/3 of the water in the tank.

Can I use tap water in the aquarium?
The answer is yes and no. You cannot put water directly from the tap into the aquarium. The water needs to sit for 48 hours to lose the chlorine content. Fill a 5-gallon bucket and keep it handy for emergency water changes. The water must be the same temperature as water in the tank.

Why does the water have to be this temperature?
Water temperature determines how quickly the eggs develop and hatch and how quickly the fry grow to fish. The colder the water is, the slower the eggs develop and the fish grow. If the water is too warm the eggs and fish may become diseased or die. If the water is too cold development may stop and the fish may die.

Why does the water have to move around?
Eggs and fry need lots of dissolved oxygen, that's oxygen that's "mixed" in the water. Eggs use oxygen that they exchange from the water through their egg shells. Fish don't breathe the water, they actually "net" the air out of the water with their gills. That's the white, feathery stuff inside the gill slits on the sides of their heads. Fish pull water in through their mouth and push it out through their gills and the gills "grab" the oxygen and carry it into the fish. The powerhead moves the water around in the tank and puts oxygen in the water.

Why do we have to clean the water and gravel so much?
In a natural stream, the water is always flowing by. The pump in the powerhead just moves the water around and puts oxygen in the water. Since the water never leaves the tank, the egg and fish waste accumulates in the tank and changes the pH and ammonia levels and even chokes the oxygen out of the water or spreads disease in the eggs and fish.

Why do we have to release the fish?
Release dates are calculated to take best advantage of the developmental stages of the fish, avoid overcrowding in the incubator and provide the best chance for fry survival. Fish kept too long get too big for the tank, in large numbers, and are prone to disease, injury, deformities and eating each other. Egg delivery, development, hatching and release are best timed to avoid keeping eggs and fish over long breaks, when no one is around to care for them. Enough development time should be allowed to provide the fry with the best chance of survival.

Can we release the trout in any stream?
NO! Trout raised in the classroom must be released at approved sites ONLY! To do otherwise would interfere with native fish. SCDNR will pick up the fry and release them in an approved site.

Classroom Activities

Trout Journals

Raising trout in your classroom will provide many opportunities for students to use their observation skills. It will also generate opportunities for recording, measuring, formulating and answering questions, writing, illustrating, hypothesizing and drawing conclusions. Journaling is a natural way for students to record their findings about trout. Suggest students purchase a loose-leaf notebook to use as their trout journals.

Encourage them to write in the journals daily, focusing on notable events – from setting up the aquarium to the release day. Descriptions of changes as the trout grow, drawings of them at various stages, observations about trout behavior, and completed hand-outs should be included in journals.

By using a free blog site, such as ***http://www.blogger.com or http://www.blogspot.com***, the students can keep an online journal of their experiences with the rest of the world. This is a great opportunity to compare trout development from other participating schools. It is recommended that the students keep a standard journal and then update a blog site once per week.

Below are some questions you might pose to students as they observe the trout during different stages of development.

Alevin

- Describe the alevin.
- What color are they?
- Do they have fins?
- What is most interesting about them?
- How well do alevin swim?
- What do alevin do when light shines on them?
- How might this reaction help them?

Fry

- Observe how the fry move.
- How many fins are there? Draw the fish and label the fins.
- Describe the motion of each fish. What is the direction and range of movement?
- Do paired fins move together in the same way? Are some fins used more often?
- What happens to the fins when the fish is still?

Color

- What colors can you identify on the fish?
- Are the back and stomach the same color? Why?
- Which is easier to see, a fish swimming near the top of the tank or near the gravel?

Senses

- Do you think fish have good eyesight? Why?
- Can fish hear? How do you know?

Behavior

- What do fish do when they are startled? Why?
- Do the fish move as a group? Why?
  How do the fish interact with each other?
  Do individual fish have established areas of the aquarium that they stay in?
- What do fish do at feeding time? Do they all get the same amount of food?

A NOTE TO THE STUDENTS ON KEEPING A TROUT JOURNAL

A field journal is essential to a scientist's fieldwork.

As you observe the trout you will make sketches and record all your observations, thoughts and questions in your field journal. Your field journal will be unique to you, reflecting your personal style. There is no "right" way to keep a field journal. Some scientists will sketch simple pencil drawings, and others will paint colorful, detailed images. Some record their observations in charts and lists, while others write long, detailed descriptions. You can use whatever tools work best for you. Try working with pens, pencils, crayons, or watercolors to capture an image. Here are some questions that may help you get started:

- What do I see?
- What is the condition of the water in the tank? Temperature?
- Do I see anything that surprises me?
- How have the trout changed since the last time I observed them?

The answers to these questions, along with all your observations, interpretations and data will be a valuable source of information as you complete your trout study.

Trout Dissection

You may download the trout dissection powerpoint from the Publications link on the following site: ***www.dnr.sc.gov/aquaticed***

The knowledge provided in this manual has been provided by:

- Arizona Game & Fish Department and Trout Unlimited Arizona Council Trout in the Classroom Reference Manual and Curriculum Guide
- Idaho Department of Fish and Game's Aquatic Education Program's Trout in the Classroom Curriculum Resources Materials
- Nevada Department of Wildlife Trout in the Classroom Curriculum and Resource Guide
- New Jersey Department of Environmental Protection, Division of Fish and Wildlife and NJ Chapters of Trout Unlimited
- Pennsylvania Fish and Boat Commission and Pennsylvania Council of Trout Unlimited Trout in the Classroom Aquarium Resource Guide
- SCDNR SC Trout Fishing Guide