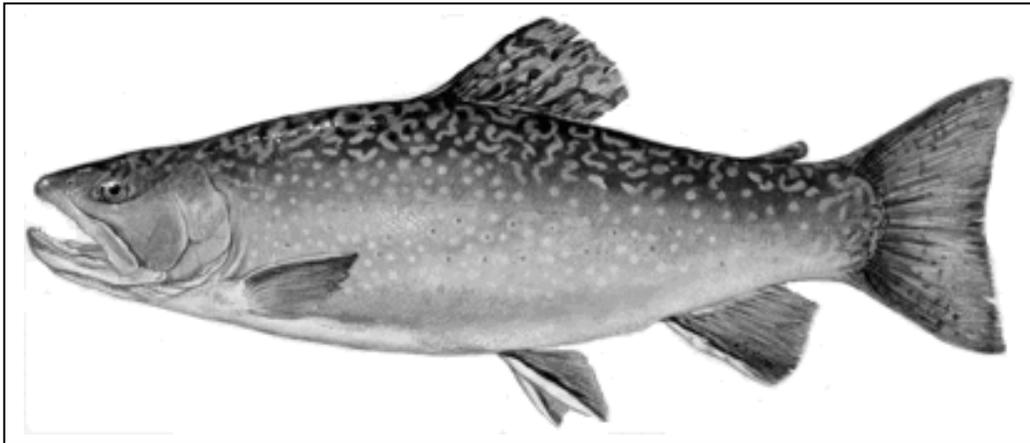


Trout in the Classroom



Activity Guide and Reference for Teachers

New Jersey Department of Environmental Protection,
Division of Fish & Wildlife

And

NJ Chapters of Trout Unlimited

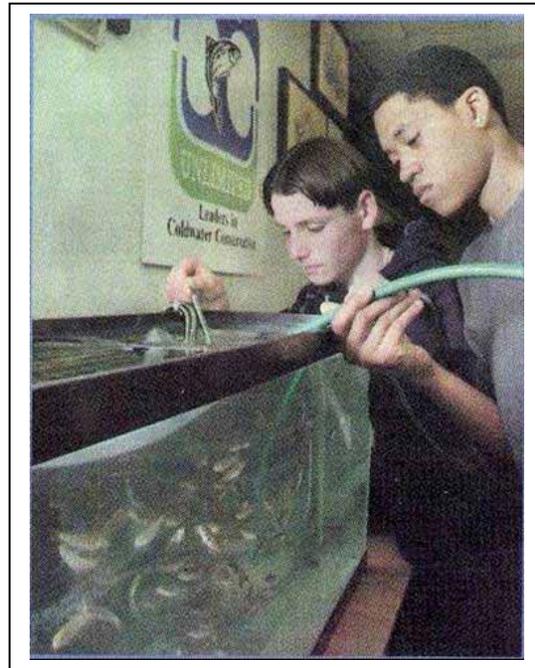
Updated March 2012

Trout in the Classroom

A Cooperative Program Sponsored by
New Jersey Department of Environmental Protection
Division of Fish & Wildlife

And

New Jersey Chapters of Trout Unlimited



Activity guide modified from New York State Trout in the Classroom, 2005

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Trout in the Classroom

Introduction

Raising trout in your classroom is a hands-on activity that engages students and helps to connect them to real-life water quality, fish and wildlife issues and problems, and inspires them to seek solutions. Hatching eggs in the classroom and watching fish develop from eggs to fry generates enthusiasm among students and helps them develop caring attitudes about fish species and their habitats. This is the first step in fostering in students a sense of stewardship for the planet.

The program encompasses not only science, but many other curriculum areas including language arts, mathematics, social studies, ecology, and art. The program is easily adapted to the needs and abilities of students, whether they are 2nd graders or high school students. One feature of the program is that it is hands-on and flexible. Teachers can implement it as a complete yearlong unit of study or it can be an extension of the regular science curriculum. The TIC curriculum is correlated to the New Jersey Science Standards. The activities in this guide are written for the middle school level and correlated to the standards for 8th grade, but teachers are encouraged to modify the activities to fit the grade level of their students.

Brook trout eggs are supplied by the Division of Fish and Wildlife at no charge to teachers who want to raise trout in their classrooms. Brook trout are used rather than rainbow or brown trout because they are a native fish to New Jersey. Members of the conservation group Trout Unlimited (TU) in New Jersey have pledged to support this program through their chapters. This program is a partnership between TU, teachers, and the NJ Division of Fish & Wildlife.

This Resource

This resource will guide you in setting up and maintaining a TIC program in your classroom. It will also provide stand-alone lesson plans and activities that you can use to enhance your program. The contents include:

- Background and General Information
- Care and Maintenance of the Classroom Aquarium
- Trout Activity Guide
- Glossary
- Contact Information

Acknowledgements (NY TIC)

Thanks to Joan and Arthur Stoliar

Whose tireless efforts and devotion have made TIC
the wonderful, inspiring program it is today.

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The following resources were consulted in preparation of this guide:

River Watch Network: River Monitoring Study Design Workbook

California's Salmon and Steelhead: Our Valuable Natural Heritage

(Published by Trout Unlimited, California Council)

Trout Unlimited Coldwater Conservation Guide

Fish Eggs to Fry: Hatching Salmon and Trout in the Classroom

(Oregon Department of Fish and Wildlife)

An Educator's Resource Guide for Hatching Salmon and Trout in the Classroom

(Oregon Department of Fish and Wildlife)

Macroinvertebrate Identification Sheet (U of Wisconsin Environmental Resources)

New Jersey version of Trout in the Classroom Activity Guide edited by Jessica Griglak, NJ Department of
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From Eggs to Fry: An Overview of Trout Development in the Classroom

Egg Development

In the hatchery, eggs are taken from the female fish and fertilized with milt (sperm) from the male. The sticky eggs are soaked in water during which time they become firm. These are called green eggs. They are very delicate and any roughness can kill them at this stage.

As the eggs develop, an eye can be seen forming in the embryo. These eyed eggs are still fragile, but stronger than green eggs. At the eyed stage, eggs are ready for your classroom aquarium. You will receive eyed brook trout eggs in mid-October from the NJ Division of Fish and Wildlife's Pequest Trout Hatchery.

Eggs will be delivered by Trout Unlimited members to your school. The eggs will be kept moist and cool during the transport to your classroom. An insulated cooler will keep the eggs cool during the trip to the school.

Back in the classroom, gently open the plastic bag that contains your eggs and divide them into petri dishes filled with water. Have your students pick out the dead, non-viable eggs with the tweezers or eye dropper. These eggs will appear white or opaque in color. Students will need to work quickly at this stage, but it gives them an immediate hands-on experience with the program. After the eggs have been picked through, they will need to go into your Vibert box or hatching basket. The eggs need to be in one single layer. Do not expose the eggs to sunlight or fluorescent light. Even fifteen minutes of light can kill both eggs and fry. It is suggested to enclose three sides of the tank with foam. Leave the front side open so students can see what is happening in their tank.

Check the aquarium each day for dead eggs or eggs with fungus—they will appear white. Some eggs will die, even though all your systems are working properly. Remove dead eggs to prevent the spread of fungus that will form on them. Use an eye dropper or turkey baster to remove the eggs. Record the number of dead eggs you take out of the tank on your daily record sheet.

Alevins

When the eggs hatch the alevins (pronounced *Al-a-vin*) will swim out of the Vibert box to the spaces in the bottom of the tank. They will remain there until they consume their yolk sacs. They are still fragile at this stage, so avoid any handling of them. Any egg cases with fungus and any dead alevins should be removed and their numbers recorded on your daily record sheet. If you are using a hatching basket, leave your alevins in the hatching basket until they are free swimming.

During development, alevins use the food in their yolk sacs. The size of the sac will gradually become smaller. After a week or so the sac will be used up. The alevins will begin to swim about looking for food. At this stage you will begin feeding the fry.

Guidelines for Feeding the Fry

courtesy of Scott Covert, DeBruce Hatchery

The food comes in three different sizes...smallest to largest, 0 to 2. Start feeding with the bag marked 0, then 1, then 2. You will receive the food in the Trout Care Box that will be delivered to you along with your eggs in mid-October. You will receive enough food to last the entire school year. If you run out, chances are high that you are overfeeding your fish. More fish food can be obtained from your local pet store.

Size 0...First Feeding

Timing: Your hatchlings do not require feeding for 7 to 14 days after hatching. They will feed from their yolk sack as they stay low, at the bottom of the hatching basket. When you see the first hatchling begin to rise off the bottom of basket, you can start providing food. Much of this first food will go uneaten, but by providing it to the developing fish, it will be there when they're ready to eat.

NOTE

There WILL be some mortality as the fish start to feed...some hatchlings just never start eating, and die.

- When your fish reach about 1" in length, it is time to switch to Size 1.
- When your fish reach about 1 1/2" in length, it is time to switch to Size 2.

Quantity

When born, your hatchlings are very small...Assuming 200 trout, feed them approximately the following amount of food each day...interpolate as needed:

- First feedings fish still in hatch box: feed very little food
- Fish just out of hatch box: 0.34 grams (0.01 oz) of food
- Fish = approx. 1": 1.36 grams (0.05 oz) of food (Switch to size 1 now)
- Fish = approx. 1 1/2": 3.4 grams (0.12 oz) of food (Switch to size 2 now)
- Fish = approx. 2 1/4": 10.9 grams (0.38 oz) of food (This is about the size where you will release)

NOTE

You can calculate feeding amounts quite precisely, but this is totally unnecessary. We have provided the formula at the end of this page for those of you into the math.

The 0 and 1 sized feed needs to be sunk down to the fish, because the oil added to the food will cause it to float. A small plastic paddle will work fine. When the food is introduced to the water directly above the fish, a slight back and forth motion should get the food down to the fish.

It is important NOT to overfeed your fish. Wasted food will degrade water quality. If you start to see clumps of dull yellow forming on the bottom or sides of your tank, gently remove it with your net. You can also use a small siphon, but use care not to suck up your fish.

When the fish get larger and you switch over to the 2s, you will be able to see them actively feeding more than you will with the 0s and 1s. Be sure to take out dead fish...the reasons are obvious.

Keep your food in a dark place out of direct sunlight. When you are about to run out of one size of food, mix a little of what's left into the next size larger before switching. It is better to feed less food, more often, than a lot of food all at once.

A Note About Enthusiastic Help

Every year, many schools enlist the assistance of security and maintenance staff members to feed the fish on the weekends and holidays. These well-meaning folks often become great fans of the fish, and are soon spending their breaks watching...and yes...feeding the fish. People with different schedules feed the fish unaware that others are doing the same. You might want to warn these fans about over-feeding by having a sheet of paper near the tank so they can track how often the fish have been fed. You can also leave out the correct amount of food, pre divided and marked in daily increments.

Calculating Food Quantity

The formula is simple.

$$\frac{1}{(P/N)} \times 0.03 = \text{weight of food needed to feed fish in POUNDS}$$

Where

P = Number of fish per pound

N = Number of fish in tank

EXAMPLE

If you started with 200 eggs, they will require only 0.012 ounces or 0.34 grams per day. They will reach about 1" before you need to move up to size 1, by then they will weigh about 2000 to the pound (bigger fish, less per pound), and will require about 0.048 ounces or 1.36 grams of food.

Approximate number of fish per pound...based on average length:

At Birth: 8000

At 1": 2000

At 1 1/2": 800

At 2 1/4": 250

If you have any questions, you can call Scott Covert at the DeBruce Hatchery (845-439-4328), or Jeff Matthews at Pequest Trout Hatchery in Oxford, NJ (908-637-4173).

Over the next six months you and your students will watch the fry develop and grow. During this stage it is important to keep a check on water temperature (twice a day). You will also be testing pH, dissolved oxygen and ammonia. As the fry grow, ammonia levels in the aquarium will rise. Be prepared to change the water. A 1/2 to 2/3 water change will improve water quality. Always keep buckets of dechlorinated water available for changes.

Releasing Trout

Trout must be released at a site approved by the proper authorities.

You cannot put trout into every ecosystem. Why? Releasing trout in unauthorized areas can taint native and wild fisheries with hatchery fish. They are also better suited to some streams and not others. When you undertake a TIC project in New Jersey, you should look at the list of approved TIC trout stocking streams for New Jersey. The TIC Coordinator will provide you with the list of streams that are approved for TIC trout and the permit application that you will need to fill out before releasing the fish.

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. Transporting the trout can be tricky especially if you are traveling a long distance to the release site. Place the young trout in a cooler or large bucket. You will need to obtain a small aerator to keep the oxygen flowing for the fish. The temperature of the water in traveling containers must be the same temperature as that in the aquarium. That temperature must be maintained throughout the trip. It is a good idea to use ice or ice packs in the cooler with your fish, just make sure that they are inside a closed ziplock bag.

When you reach the release site you will want to adjust the water temperature in the bucket so that it is equal to the stream water. To do this, have students slowly add stream water to the containers. Use a thermometer to avoid large fluctuations (greater than 5 degrees F.) in water temperature.

When the water temperature is more or less equal, have students fill small plastic bags or cups with water. Place a trout in each bag or cup and allow students to release them.

Some do's and don't's when releasing trout:

- Don't release trout in deep pools where large fish may be present.
- Don't release trout in streams with a fast moving current.
- Do release trout in shallow pools.
- Do release them in an area with shade or plant cover.
- Do try to release the trout at different spots along the stream.

To release trout:

- Place trout from the tank into a cooler or large bucket so that the water stays cool.
- Add ice or ice packs into the water. Make sure they are in a ziplock bag.
- Make sure you have a small aerator in your cooler or bucket to keep the fish alive.
- Hold the plastic bag or cup in the water.
- Allow some stream water to enter the container.
- The trout should swim out at this point.

Ideas for trout releases:

- Measure the temperature at the release site and compare to your tank.
- Have the students assess why that was a chosen release point (food, cover, shelter, etc)
- Ask someone to help you look at the insects in the river and classify the stream based on the insects that you find.
- Teach the kids to fish.
- Take a hike and look at the riparian areas.
- Do a stream clean-up at your release site.
- Talk about a trout's web of life or food chain and look for those things that you can find in either one.
- Release the fish on the way to a facility, such as the Pequest Trout Hatchery, where your students can learn about trout, aquatic wildlife, upland wildlife and so much more.
- Reach out to other groups and organizations with an interest in water and conservation and ask them to join you for an education session on their organization and what they are doing to help conserve and protect the waters of New Jersey.

Creating a Fish Habitat in Your Classroom

In nature, healthy streams provide the physical and chemical conditions fish eggs need to develop and survive. Your classroom set-up will simulate natural conditions. This chart shows optimum conditions for trout development in nature and how a classroom aquarium can model those conditions.

Optimum conditions	In Nature	In the Classroom
Limited light (as eggs and alevin)	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	Aquatic plants produce oxygen. Streams gather oxygen as they flow over rocks.	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	Fry feed on insects and on zooplankton.	Fry are fed until release date.
Predators	Eggs in gravel are safe from predators. Protective coloration of fry helps to protect them.	No predators in classroom aquarium.

Setting up the Aquarium

Time Line

- First week of September:
 - School receives funds with which teachers can purchase required equipment (contact TIC Coordinator for latest list)
 - Teachers buy parts and assemble setup (see equipment list and diagram)

- Last week of September (two - three weeks before eggs arrive):
 - Set up the bio-system in the tank:
 - Temperature, 65 degrees Fahrenheit
 - Biozyme or StressZyme

- 12 hours before eggs arrive:
 - Set temperature to 50-55 degrees Fahrenheit

What's Next?

- ❑ The eggs you receive will be "eyed" – ready to hatch in about two weeks. Keep the tank shaded with the styrofoam cover. You can remove it for viewing...or cut a viewing window in it. The cover will also help keep the temperature down.
- ❑ Check your eggs twice a day. Dead eggs MUST be removed each day. Dead eggs appear opaque or white white. Use an eye dropper or tweezers to remove them.
- ❑ When they hatch, the trout (called alevins at this stage) will lie on their sides. A yolk sac will still be attached. The yolk sac will be their source of nourishment until it is absorbed. These fish can not swim and will remain in the gravel at the bottom of the tank or on the bottom of their hatching basket.
- ❑ Soon the alevins will "right" themselves, but remain low in basket. As the yolk sac is consumed, they begin to rise.
- ❑ You will receive food from the hatchery on the day your eggs are delivered. This food should last a full year. If you run out of food, you can purchase it from your local pet store. Do not feed the trout until the entire yolk sac is absorbed. The hatchery will provide 3 sizes of food, and instructions on when to begin, quantity and frequency of feeding.
- ❑ Eventually the trout (called *fry* at this stage) will swim up over the basket edge into the larger area of the tank. You may want to put a bit of screen or stocking net over open tubes to keep tiny fish from getting sucked up into the system. Screens are included in your Trout Care Box.
- ❑ At this point you can expect some losses. There may be non-eating pinheads, deformities, two-headed trout, etc. Continue with the feeding and monitoring of the tank.
- ❑ In about six months the fry will be ready to release. You will need to get a permit for the release from the NJ Division of Fish and Wildlife. Applications for release permits are due at the end of December.
- ❑ We encourage communication between classes, particularly within similar age groups.

Equipment List

From your local pet store...

- 55 gallon standard glass aquarium with stand (available at any pet shop).
- 55 gallon glass hood with fluorescent lights built in (available at any pet shop)

From your local pet store or order as a TIC Kit #1 from That Fish Place...

- Aqua Euro USA 1/4hp Chiller
- Fluval 405 Canister Filter
- Whisper 60 Air Pump (Tetra)
- Sandstone (Blue) 12" Airstone – 206 (Blue Ribbon)
- 8' Flexible Airline Tubing ST-8 (Penn Plax)
- Check Valve – 1 pk (Lee's)
- Net Breeder (Lee's)
- Battery Operated Digital Thermometer (ESU)
- Floating Thermometer – Economy (Penn Plax)
- 4" Net (Penn Plax)
- Stress Zyme 16 oz. (Aquarium Pharmacy)
- Tap Water Conditioner 16 oz. (Aquarium Pharmacy)
- Mag Drive Water Pump 700 GPH (Supreme)
- 15' Clear Flexible Tubing
- ½" x ½" Female Adapter FPT x INS (IPS)
- 5 – Stainless Steel Hose Clamps 7/16" x 25/32"
- Freshwater Master Test Kit (Aquarium Pharmacy)
- Siphon Kleen X-Large (Marineland)
- Swift Creek Gravel – 10 lbs. (Estes)
- Outlet Tube and Diffuser for Magnum 220
- Teflon Tape
- Chemi-Pure, 5 oz (2)

Optional Equipment...

- Eye Dropper or Turkey Baster (or more for multiple students) for daily removal of eggs
- Sheets of Styrofoam to cover tank on all sides, except the front of the tank
- Two five gallon plastic buckets (not metal) to age water before putting it in the tank.
- Battery-operated aerator, to give trout oxygen during transport (available at sporting good stores)
- Long-handled scrub brush to loosen grime and growth in the tank
- Clean ice packs, for use in transportation and/or chiller emergencies

Equipment Replaced Yearly...

- Filter Pads and Charcoal
- Biozyme
- Airstone – these can degrade or build up with waste.
- Water Quality Test Kit

To call and place an order, please contact Stephanie Welsh from That Fish Place at 717-299-5691 x 1288 and tell her you'd like to place an order for Trout in the Classroom Kit #1 for New Jersey.

Critical Water Quality Elements

Temperature

Use a standard aquarium thermometer to monitor the water 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. When doing a water change, make sure the new water is within 1 to 2 degrees Fahrenheit of that in the aquarium.

Dissolved Oxygen

Dissolved oxygen 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 is 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 you can expect some problems for eggs and fry. Use a dissolved oxygen test kit (available from aquarium supply stores) to check for 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. 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 through excretion. Ammonia is highly toxic to fish. High levels can cause gill damage, anemia, and even death for eggs and fry. At pH levels above 7 the ammonia increases its concentration. Total ammonia levels (the sum of both forms) should be less than 5 mg per liter. 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.

Pollutants and Chlorine

Pollutants are not a problem if you are using tap or well water in your aquarium. Chlorine in drinking water is toxic to fish and to the bacteria making up the aquarium's biofilter. Because chlorine is an active element it can be quickly and easily removed from tap water. Dechlorinate a bucket of tap water by leaving it exposed to the air for 24 hours. Tap Water Conditioner also rids your water of chlorine.

Monitoring and 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 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 and solutions
- Water quality testing results
- Mortality
- Observations: hatching, predation, etc.

At the end of each week, student inspectors should report to the class on the data they collected for the week.

Use the daily inspection record and progress report that follows or have students create recording sheets of their own.

Trout Inspection Record

Week of:

Inspectors:

Date	Temp	pH	Water: clear? Correct level?	Powerhead or air pump plugged in?	Number of live trout	Mortality (dead picked and recorded)	Initials of inspectors
MON							
TUE							
WED							
THU							
FRI							

Average Temperature:

Mortality (total number for week):

Average pH:

Water change: 1/4 tank 1/3 tank 1/2 tank

Weekly Water Testing

pH:

Dissolved Oxygen:

Observations:

Frequently Asked Questions

How large must the aquarium be?

A 55-gallon aquarium will easily accommodate 300 eggs. This is the standard size for New Jersey.

Where do the eggs go?

The eggs should be placed in a Vibert box or hatching 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 oxygenation and water 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 55-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 of this, and it should be cleaned occasionally.

How often do I need to test the water?

Water should be tested at least once weekly. 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 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 a day or so 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.

Can We Release the Trout in Any Stream or Brook?

No! Trout raised in the classroom must be released at approved sites ONLY! To do otherwise would interfere with native trout. You will need to get authorization from the NJ Division of Fish & Wildlife. (See Contact Information for more on where and how to release trout.)

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. 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 to survive in the wild?

Fry

Observe how the fry move.

- How many fins are there? Draw the fish. Draw 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 than others?
- What happens to the fish's fins when it is still?

Color

- What colors can you identify on the fish?
- Are the back and stomach the same color? Why do you think the fish are colored this way?
- 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?
- Can you see the lateral line? What purpose does it serve?

Behavior

- What do fish do when they are startled? Why?
- Do the fish move as a group? What is this called?
- Are all the fish the same size?
- 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?

NOTES ON KEEPING A TROUT JOURNAL

To the student:



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. You can use whatever tools work best for you. Try working with pens, pencils or watercolors to capture an image. Some people record their observations in charts, list and labels, while others will write long, detailed descriptions. 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. Did you know that scientists share their field journals? Their journals are a permanent record of their work and are kept in libraries for scientists to study in the future.

Introducing Students to the Aquarium

Preparation:

The aquarium should be set up and running for a month before doing this activity.

Materials:

- Inspection chart (one per student)
- Water testing kit

Procedure:

- 1 Tell students that, during the next 6-8 months, they will participate in raising trout in the classroom. At the end of that time they will go to a stream to release the trout into their natural habitat. Point out that the purpose of the program is not to stock a stream, but to learn about fish development, water quality and the problems wildlife, like trout, face in the wild. Emphasize that this program is not about raising trout, but it is a lesson on coldwater conservation. Not all of your fish will survive. You may have none survive.
- 2 Display the aquarium set up to students. Have them gather around as you describe the equipment and the purpose of each item. Tell students that one important aspect of raising trout will be monitoring the trout, the water, and the equipment. Display and distribute the daily inspection charts to students. Tell students the charts will provide the class with valuable data that can be used to evaluate the project and improve it.
- 3 Discuss with students what their roles will be during the project. Explain that every student will keep a journal in which they will record their observations of the trout both in words and in drawings. In addition, they will each be responsible for monitoring the aquarium. Each week three students will do daily monitoring of the aquarium. At the end of the week, one student will leave the team and a new student will join the team. Using this rotating basis there will always be experienced students monitoring the aquarium. At the end of the program they will all participate in the release.
- 4 Do a “run-through” of how students will monitor the aquarium. Ask students to fill out the daily inspection chart as they complete the inspection with you. Conduct the water quality testing using the instruction in your test kit. Point out that the water quality will change when eggs are introduced to the tank and that it is critical to trout survival to maintain a healthy water quality.
- 5 Provide time for students to draw and label a diagram of the aquarium and equipment in their journals.

Lesson 1: The Trout Body

Preparation:

Duplicate Trout Body handout and Trout Body crossword.

Materials:

- Trout Body handout (one per student)
- Trout Body Crossword (one per student)
- Index cards (one per student)

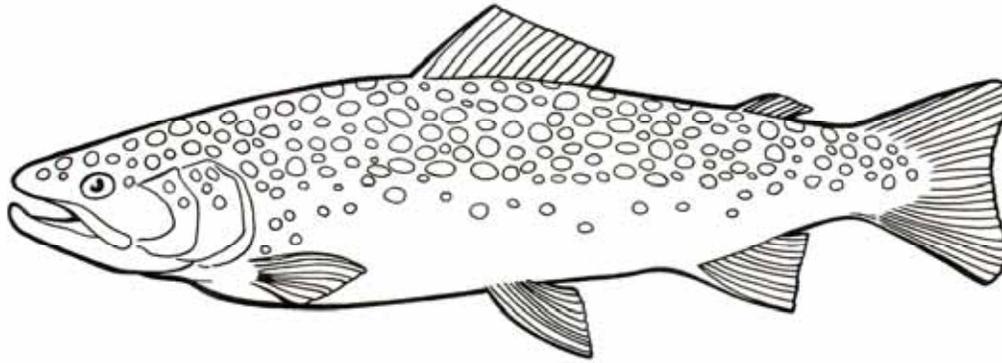
Standard Correlations:

NJ CCCS Science 5.5 Grade 8 A.2, B.1

Procedure:

- 1 Briefly discuss with students how our senses and our physical features allow us to function in our environment. Point out that humans move through air; trout through water. Ask students to think about how things might look, taste, smell, sound, and feel in a water environment. If necessary, use these questions to stimulate discussion.
 - What physical features would an animal, like a trout, need to function in a water environment?
 - What sort of body shape would a trout need to move quickly through the water?
 - What helps propel a trout through the water?
 - What sense organs help a trout find food?
- 2 Have students work in small groups. Explain that they are going to examine the features of a trout and how those features help the trout function in its environment. Distribute the Trout Body hand-out to students. Instruct them to read the information on the hand-out and to identify each body part and how it helps the trout to function. (Allow 15 minutes)
- 3 Distribute one index card to each student. Have students write a question about a trout feature on the front of the card and the answer on the back. For example, "What is the biggest fin?" (answer: caudal fin). Collect the cards and use them to play a quick question-answer game.
- 4 Have students draw and label a diagram of a trout in their journals.
- 5 Distribute Trout Body crossword to students to complete during their free time.

Trout Body



Mouth: Trout do not gulp their food, they suck it up using their mouths. Mouths are also used to feel things.
Kype: The kype is the hooked part of the lower jaw. Males use the kype to fight over mates during spawning time.

Nare: The nare is a closed sac and functions as a nostril, helping the trout to detect odors.

Gills: Gills work much the same way our lungs do. Trout draw water in through their mouths. The water passes through the gills where oxygen is exchanged for carbon dioxide.

Operculum: The delicate gills are covered by a hard plate called the operculum.

Eyes: The eyes provide sight. The pupil has a slight triangle shape which gives the trout a larger field of vision.

Lateral line: This sense organ runs from the operculum to the tail. This sensor detects pressure waves or vibrations. It helps the trout maintain position without bumping into other fish or objects in the water.

Vent: The vent is an opening through which extra water is excreted. The vent is the opening through which eggs or sperm (milt) pass during spawning.

Caudal fin: The caudal fin or tail fin is the biggest fin. It provides the “push” for the trout to start moving and also acts as a rudder for steering through the water.

Dorsal fin: The dorsal fin is used for swimming and stabilization.

Anal fin: The anal fin is used for swimming and stabilization.

Adipose fin: The adipose fin is used for swimming and stabilization. (Adipose means that it is a “fatty” fin without rays.)

Pectoral fins: The pectoral fins are paired fins which act as brakes and help with side to side movement. They are below the gills.

Pelvic fins: The pelvic or ventral fins are paired fins which are set back from the pectoral fins. They help with up and down movement.

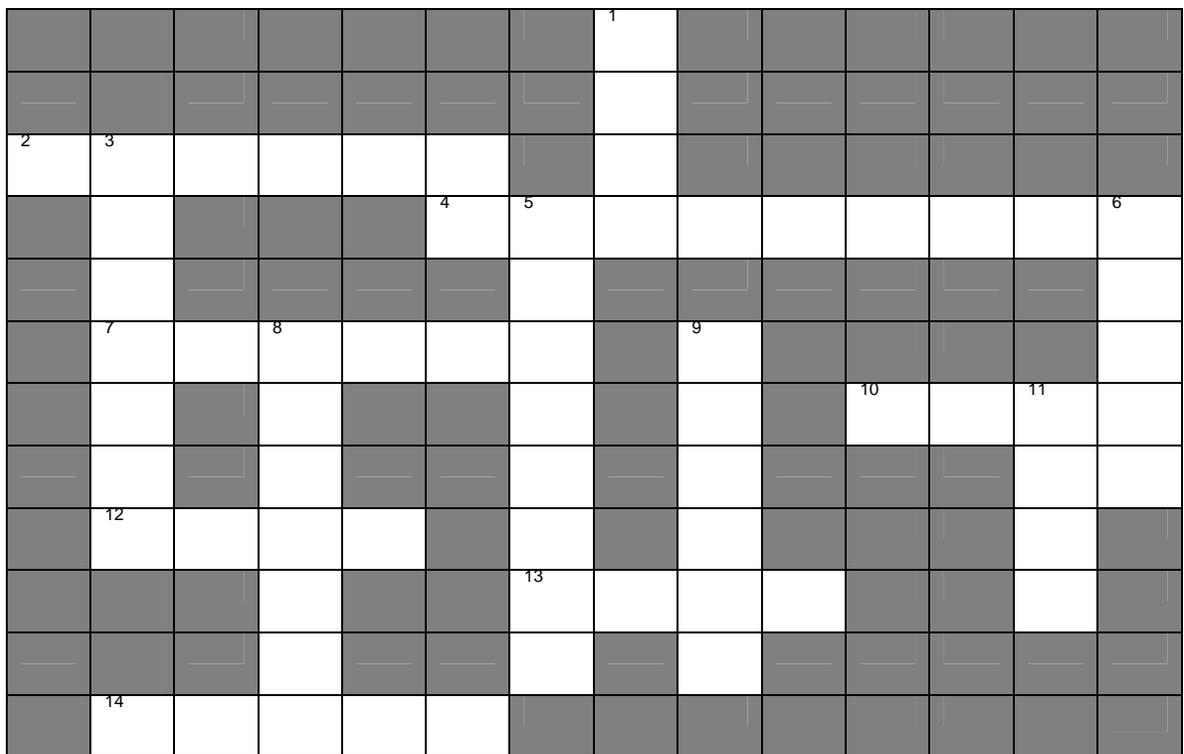
Trout Body Crossword

Across

- 2 the fin that gives the trout a 'push' and acts as a rudder
- 4 a hard plate covering the gills
- 7 this fin is used as a brake and helps with up and down movement
- 10 the opening through which eggs or sperm (milt) pass during spawning
- 12 these organs have triangle-shaped pupils
- 13 one of the fins used for swimming and stabilization
- 14 this organ works the same way our lungs do

Down

- 1 the hooked part of the lower jaw
- 3 this "fatty" fin does not have rays
- 5 fins below the gills
- 6 the trout use this body part to suck up food
- 8 this line is a sense organ running from the operculum to the tail
- 9 one of the fins used for swimming and stabilization
- 11 this organ helps the trout detect odors



Lesson 2: Trout Dissection

Preparation:

Read the background information on trout anatomy and functions. Duplicate Fish Anatomy diagram (one for each student).

Materials:

- A fresh, whole trout
- Dissecting scissors
- Tweezers or forceps
- Newspapers
- Probe
- Paper towels
- Magnifying glass
- Fish Anatomy diagram

Standard Correlations:

NJ CCCS Science 5.5 Grade 8 A.2, B.1

Procedure:

- 1 Choose a location where all students can view the dissection clearly. Cover the surface with newspaper. Refer to the reference sheet (if needed) to help explain the function of each organ or characteristic.
- 2 Have students feel the fish's skin and discuss what purpose the slime serves. (It protects against growth of fungus and it allows the fish to glide more easily through the water.) Have students use the magnifying glass to carefully examine the scales and note how they are arranged.
- 3 Have students describe the color pattern of the fish and talk about the function of coloration (protection, camouflage).
- 4 Observe the lateral line. Discuss what it is used for and the way it works.
- 5 Have students describe the fish's overall shape and how this adaptation is beneficial to the fish. Look at the placement of the fins and ask students to imagine the fish swimming in the water. How does it move? How are the fins used? Note the range of movement of each fin.
- 6 Allow students to feel the bony rays that support the fins. Have a volunteer count the number of rays on the anal fin. Point out that this is one of the most distinguishing characteristics of salmonids.
- 7 Note the size of the eye. Its relatively large size, and the large pupil tells us how important vision is for this animal. Have students note that there is no eyelid. Have them observe the tough, clear membrane that covers the eye. Rotate the eye in the socket.
- 8 Locate the nostrils. Describe the large olfactory lobes that are located in the brain. Ask students to speculate why a salmonid's smell receptors are so highly developed.
- 9 Open the mouth and have students note the color of the gums. Have volunteers feel the teeth along the gum margins and on the roof of the mouth. Ask students what function these teeth perform. Are they used for chewing? (The teeth are used for grasping and holding onto prey.) Make note how wide the mouth can open and have them comment on why this is so. Point out that the mouth is also used for

breathing. In low oxygen conditions, fish can actively pump water over gills by opening and closing the mouth. Demonstrate this action with the fish's mouth.

- 10 Point out the gills arches by having students look down the fish's mouth. Use a probe to separate the arches and explore how they are arranged.
- 11 Place the fish on its side and look at the operculum—the bony plates which protect the gills. Lift the operculum and look at the gills. Cut the operculum away from its base, exposing the gills.
- 12 Remove the gills by cutting the upper and lower attachments of the arch. Look at the gill rakers, the bony projections along the inside curve of the arches. Observe the large surface area provided by the gill filaments, and the thin tissue which allows blood vessels to come into contact with the oxygen in the water. Compare and contrast gills and lungs.
- 13 Carefully cut the fish open using the scissors or scalpel. Before moving any organs, let students observe how all the internal organs fit together. Look for the thin transparent membrane that encloses the organs. Cut away the flap of skin and look for fat deposits, which are found around the stomach.
- 14 Look for the swim bladder. It is made of very thin tissue and is located in the upper body cavity, below the kidneys. It will be less developed in small fish and since it will not be inflated, it may be hard to find. If you can't find it, point to its location and discuss its function.
- 15 The male reproductive organs will be a flaccid white or orange tissue near the intestines. Eggs may or may not be noticeable in females. They will vary in size depending on the maturity of the fish.
- 16 Put the fish on its back and find the kidneys, located just under the backbone. They are thin, dark in color and run the whole length of the body cavity. Call on a volunteer to discuss the function of the kidneys.
- 17 Investigate the digestive track by starting in the mouth and following the route that food would take. Put the probe through the mouth and into the esophagus to show the beginning of the route. Then follow the course of the stomach using your finger or the probe. The first area of the stomach is called the cardiac stomach; this is where digestion begins. Have students notice the different kinds of tissue that make up the stomach.
- 18 The pyloric stomach is that portion from which the pyloric ceca project. It begins at the bend below the cardiac stomach, and is made of different tissue. Discuss how the stomach area is increased by the pyloric ceca and how this improves the function of the stomach.
- 19 The intestines extract nutrients from food. Notice the network of blood vessels which are used for nutrient exchange. Follow the intestines to the anal opening, where waste products are eliminated.
- 20 Lift the stomach to show the spleen. It is a reddish organ found at the end of the cardiac stomach. Ask a volunteer to discuss the spleen's function.
- 21 The liver is in front of the stomach. Discuss the liver's role in the digestion of fats. Point out the gall bladder, a mass of darker tissue on the liver.

- 22 Move the liver to locate the heart—which can be found near the fish’s mouth. You should be able to make out the different chambers. Point out that the fact that the gills, heart, and liver are so close together is no accident. Blood pressure is best near the heart (pump). Blood is filtered by the liver, and absorbs oxygen from the gills; both are vital functions.
- 23 Cut through the fish to expose the backbone and muscles and have students note the arrangement of muscle mass. Point out that this is the part of the fish that we eat.
- 24 Carefully cut away the skin by lifting it while running the scalpel along the skin-muscle interface. If you have a small fish, the skin may be thin enough to place under a microscope. If so, observe the pattern of the scales, the growth rings on the scales. If the skin is too thick, use a magnifying glass. Try to remove some of the scales so that you can look at the rings.
- 25 Discuss with students how the trout’s body parts and functions compare to a mammal’s.
- 26 Distribute the Fish Anatomy diagram to students. Have them label the organs and include the diagram in their Trout Journals.

Trout Anatomy

All animals are adapted to their environments. The streamlined shape of trout allows them to swim through the water with the minimum of resistance. They can maintain their position in a stream with little effort.

EXTERNAL FEATURES

Skin: The outer layer of skin, the epidermis, contains pigment cells and mucous glands. The dermis is the layer of skin that lies under the epidermis. It contains nerves, blood vessels, and connective tissue. The trout's scales grow from and are imbedded in the dermis.

Scales: imbedded in the dermis, only a small portion of each scale is visible. The scales overlap with their margins pointing toward the tail. This helps to reduce friction in the water. Scales grow with the fish. The age of a trout can be determined by counting the concentric rings on a scale.

Teeth: Teeth can be found along the margins of the upper and lower jaws.

Fins: The fins (except for the adipose fin) are composed of a tough membrane that is supported by bony fin rays.

- ❑ The caudal fin, or tail fin, propels the trout through the water and helps it to stay upright. Females use the caudal fin as a fan when making a redd.
- ❑ The anal fin helps the trout propel forward, balance and steer.
- ❑ The dorsal fin helps the trout to stay upright and on course.
- ❑ The pelvic and pectoral fins, the paired fins, help the trout maneuver, turn, brake, and balance.
- ❑ The adipose fin is a fatty fin. It is used for swimming and stabilization.

SENSORY ORGANS

Eyes: Trout can see things both near and far away. The eyes have large pupils which allow available light to be admitted. This is probably why trout tend to stay away from sunny areas.

Nostrils: Trout have a well-developed sense of smell. The nostrils are covered with flaps that guide incoming water into the olfactory sac, which contains the smell receptors. Water passes through the sac and exits through another opening in the nostril.

Ears: Trout hear well, although there are no external openings to the inner ear mechanism. The inner ear is composed of chambers that contain pieces of bone, called otoliths. As the trout moves through the water, the bones move and hit against nerve endings, sending messages to the brain.

Lateral Line: This mucous-filled canal runs the length of the trout and is located in the skin. The lateral line acts as a sonar device, picking up vibrations by movement in the water or on nearby land.

INTERNAL SYSTEMS

Nervous System: As in most vertebrates, the nervous system is made up of the brain, spinal column, and nerves. The trout's brain is encased in a bony skull.

- ❑ Olfactory and optic lobes: process information from the nostrils and eyes.
- ❑ Semi-circular canals: help maintain balance
- ❑ Cerebellum: controls muscle movement
- ❑ Medula: controls vital processes, such as heart rate and respiration
- ❑ Nerves: send impulses to the brain, which reacts to the stimuli.

Respiratory System: The gills take in oxygen and eliminate gaseous waste. Water is taken in through the mouth and passes through gill openings. The gill arches have filaments along their back edges. Blood flows through the very thin filament, which allows for waste to be exchanged for oxygen. Gill rakers on the edges of the arches strain particles out of the water to prevent injury or clogging to the gills.

Skeletal and Muscular Systems: The trout's skeleton is comprised of bone and cartilage. Its muscles are laid down in segments and have thin sheets of connective tissue between each segment. Muscles are connected to the tissue. Dark muscle tissue has better blood circulation and is used for prolonged activity, such as swimming. Light muscle tissue has less of an oxygen supply and is used for short bursts of activity.

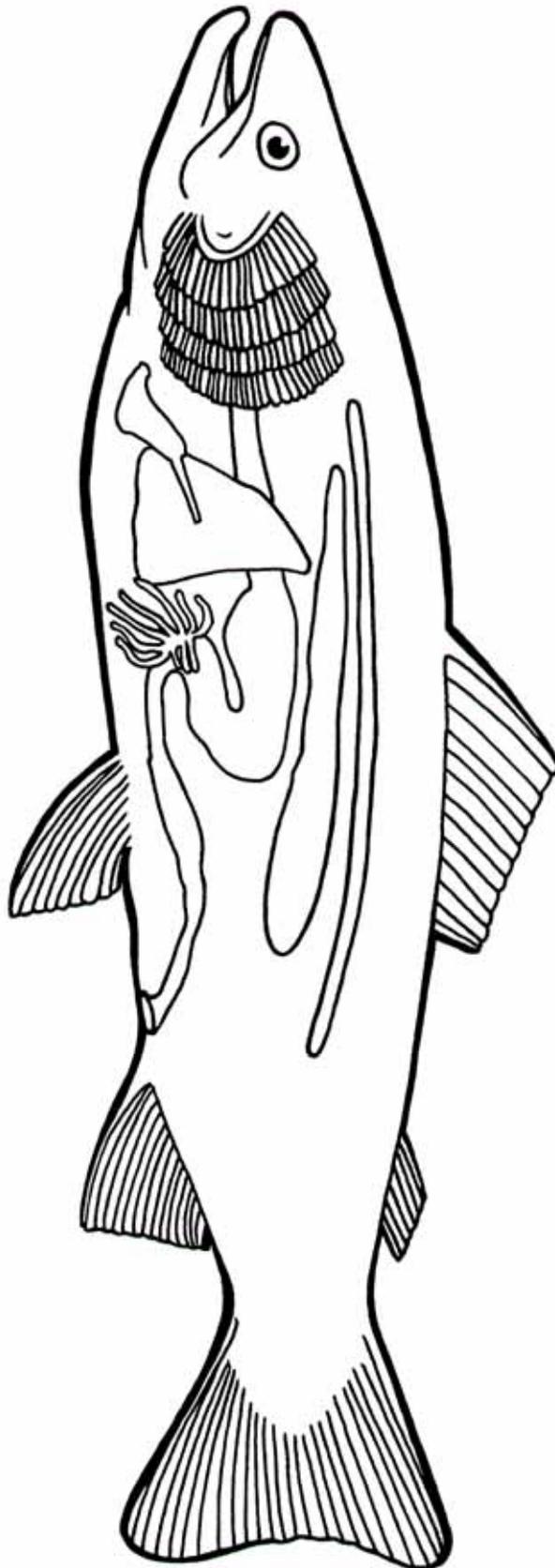
Circulatory System: The heart and blood vessels carry oxygen from the gills to the tissues and carry waste back to the gills and kidneys.

Digestive System:

When a trout eats both food and water enter its mouth. Water is directed to the gills and food to the esophagus which leads to the stomach. In the stomach food is mixed with hydrochloric acid and mucous and then passes to the intestines. Food is broken down in the intestines by enzymes. Nutrients are absorbed. Waste is eliminated through the anus.

Liver: The liver produces bile which is stored in the gall bladder. The bile breaks down fat.

Spleen: The spleen manufactures and stores blood.



Kidneys: The kidneys filter waste from the blood stream and also manufacture blood. Two canals, ureters, carry waste from the kidneys to the bladder. From the bladder, the waste passes to the outside.

Swim Bladder: The swim bladder allows the trout to remain suspended in the water at any depth. Air enters the swim bladder through a duct when the fish gulps air.

Reproductive System: The gonads produce the sex cells. The females ovaries are generally an orange hue and appear granular. The granules are developing eggs. The male testes are limp white organs which produce sperm. Sperm and eggs pass through passageways from the gonads to the urogenital opening.

Trout Anatomy

Lesson 3: Trout Life Cycle

Preparation:

Duplicate the Trout Life Cycle handout.

Materials:

- Trout Life Cycle handout

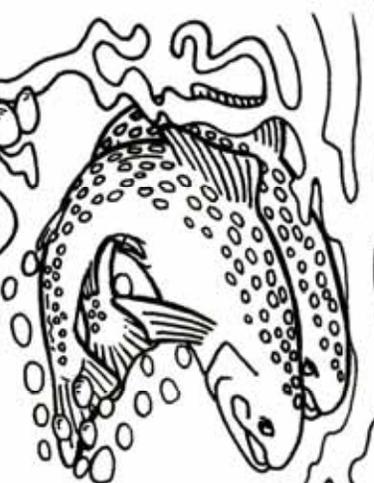
Standard Correlations:

NJ CCCS Science 5.5 Grade 4 A.1, C.1, Grade 6 C.1, Science 5.10 Grade 6 A.1

Procedure:

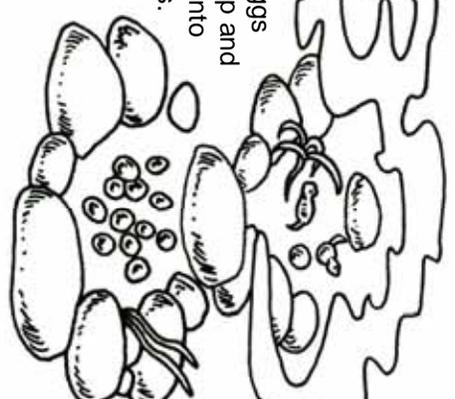
- 1 Call on students to describe what a life cycle is. Tell students they are going to work in groups to learn about the life cycle of the trout. Then each group will use their creative talents to present the life cycle of the trout to the rest of the class. Distribute Trout Life Cycle hand-out to students.
- 2 Brainstorm with students to discover some creative ways of presenting the trout life cycle. Encourage ideas such as: presenting the life cycle in a play, a short story, or poetry; present the life cycle in a series of artistic drawings or a poster; make up a song with lyrics that describe the life cycle and present it to the class. After brainstorming, have students work in small groups.
- 3 The groups should decide how they will present their life cycle. Each member should be responsible for some aspect of the presentation.
- 4 Groups can work on their presentations during class time or as a homework activity. When groups are ready, set aside time for groups to make their presentations to the rest of the class. Afterwards, discuss which presentations were the most informative and the most engaging.

Trout life cycle

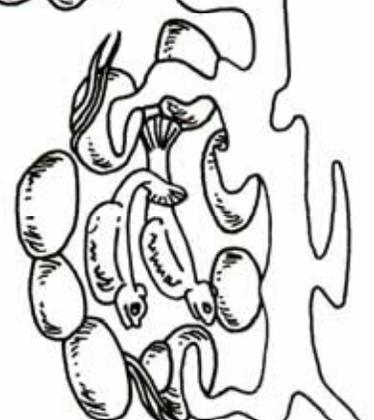


The eggs develop and hatch into alevins.

Trout spawn in gravel stream bottoms. The female digs a redd with her body and deposits eggs. The male deposits sperm (milt) over the eggs. The eggs are covered with gravel.



Alevins remain in the gravel. They obtain nourishment from their yolk sacs.



When the sacs are consumed, the tiny fish, called fry, swim out of the gravel to find food. They stay near the stream bank where the water is calmer until they grow bigger.



As they grow, they move to the main current of the stream. They feed on insects and small animals that live in or fall into the stream.



Some trout may live in lakes, but often return to streams to spawn.



Trout mature at age three and rarely live past the age of five.

Lesson 4: What Trout Need

Preparation:

Review Creating a Fish Habitat in Your Classroom. Duplicate the brook trout information sheet for students.

Materials:

- Brook Trout information sheet

Standard Correlations:

NJ CCCS Science 5.5 Grade 8 A.2, Grade 12 A.4, Science 5.10 Grade 6 A.1

Procedure:

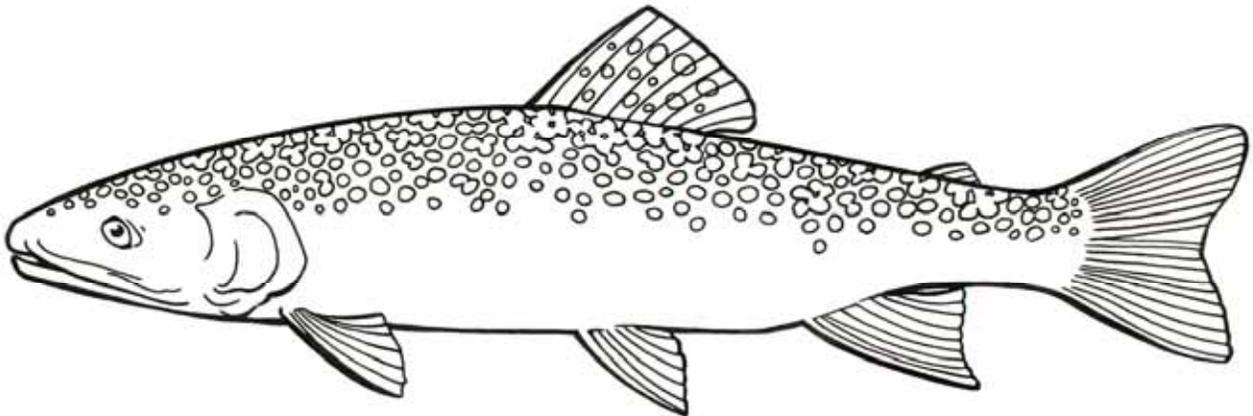
- 1 Discuss with students how the aquarium will simulate a trout's environment in nature. Review the conditions for trout development. Copy this chart on the board:

Conditions for Trout Development

	In Nature	In the Aquarium
Limited light		
Cold water (42° F. to 55° F.)		
Oxygen		
Clean water		
pH (6.5 to 7.5)		
Predators		
Food		

- 2 Have students work in small groups. Distribute the Trout Information Sheet to each student. Give groups 20 minutes to read the sheets and to discuss how a trout's natural habitat meets the conditions listed.
- 3 Allow time for groups to share their findings. Record responses on the board. For each item, call on students to say how the aquarium will meet those same conditions.
- 4 After the discussion, have students copy the chart in their journals.

Brook Trout *Salvelinus fontinalis*



Brook trout are native to the northeastern United States and Canada. Brook trout require clean, clear, cold streams with temperatures ranging from 53° F. to 60° F. They generally live in spring-fed streams with many pools and riffles. There they hide in undercut banks, under large rocks, in deep pools and near banks with overhanging trees and plants. Brook trout are mostly carnivorous. They feed on many water and land insects such as mayflies, caddis flies, midges and beetles. As they increase in size they will go after larger prey, such as leeches, small fish, mollusks, frogs, and salamanders.

Brook trout spawn in late fall in shallow, gravelly areas of streams with clean bottoms and good water flows. Spring-fed headwaters are ideal, but they will also spawn in the gravel-bottomed areas of lakes where spring waters occur. The female uses her body to make a redd in the gravel. The redd is about 4 to 6 inches deep. The female lays eggs and the male deposits sperm. After spawning, the female covers the eggs with gravel. Over the winter the eggs slowly develop. Clean, oxygenated water flowing through the redd keeps the eggs clean and helps them to develop successfully.

When alevins hatch in late spring they have a yolk sac attached. They remain in the gravel and grow using nourishment from the yolk sac. When the yolk sacs are absorbed the fry emerge from the gravel and begin to search for food. They feed on aquatic insects. They reach a size of 2 to 4 inches in a year. They are preyed upon by larger fish, birds, and small mammals, such as otters and minks.

Brook trout are the only trout that are native to New Jersey – they were here before European settlers colonized our state. For more than 100 years, people have introduced many other kinds of fish into New Jersey, including rainbow trout (from the western U.S.) and brown trout (from Europe). The brook trout has been designated as the “state fish”.

Lesson 5: Trout in the Ecosystem

Preparation:

Duplicate Trout in the Ecosystem handout (one for each student).

Materials:

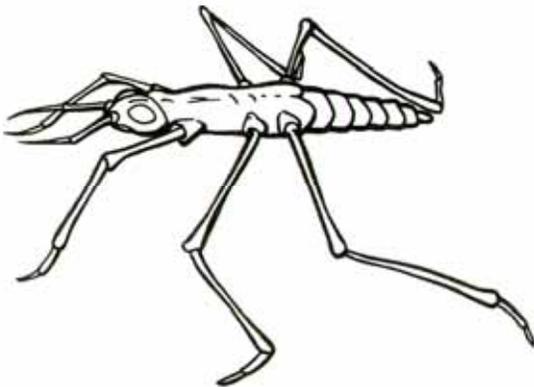
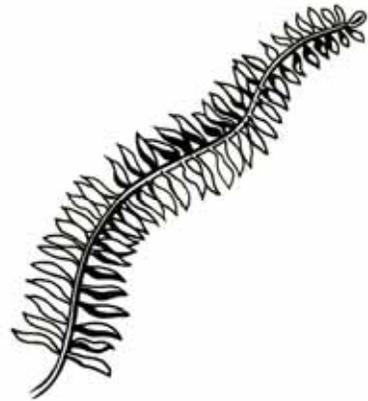
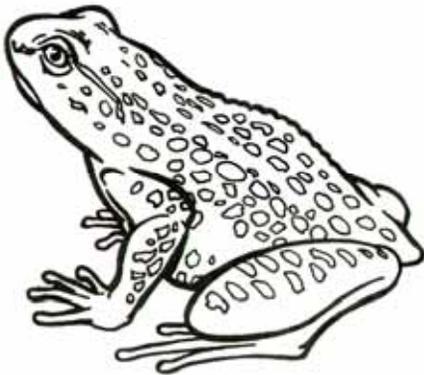
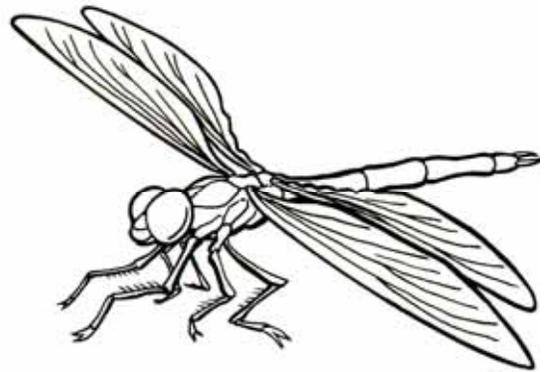
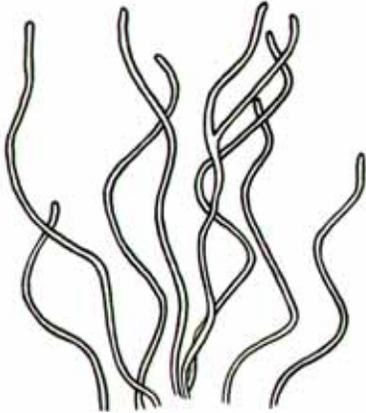
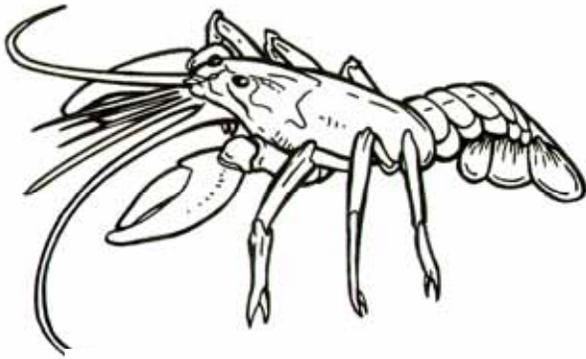
- Trout in the Ecosystem handout
- Scissors
- Glue or tape
- Additional sheets of paper

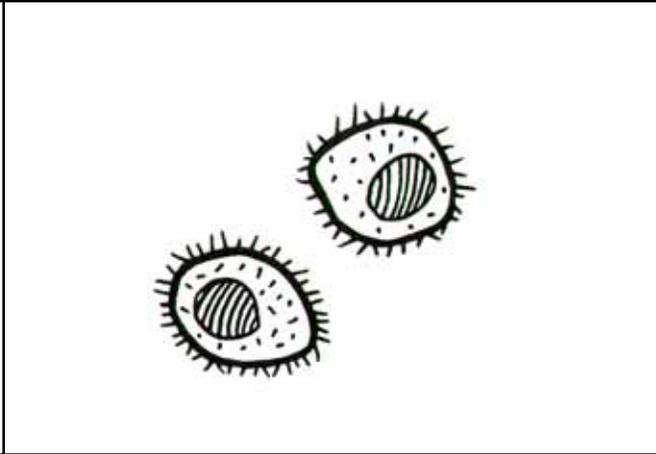
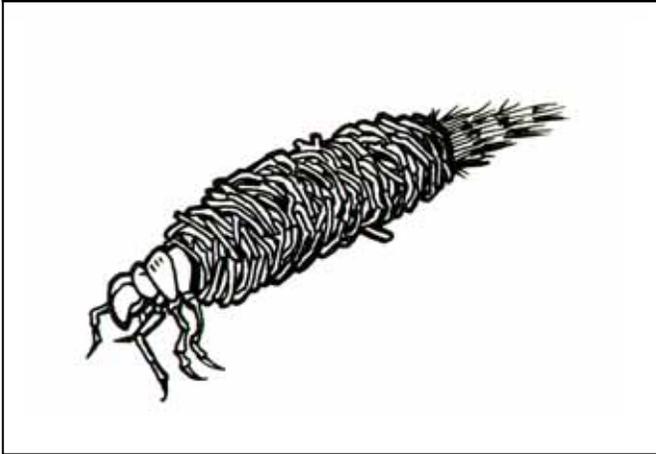
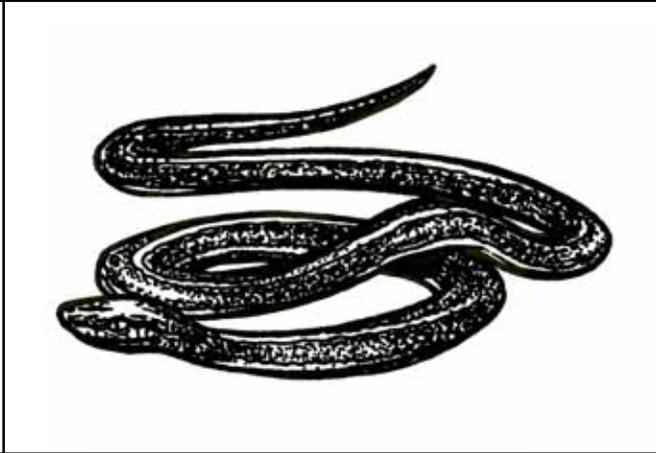
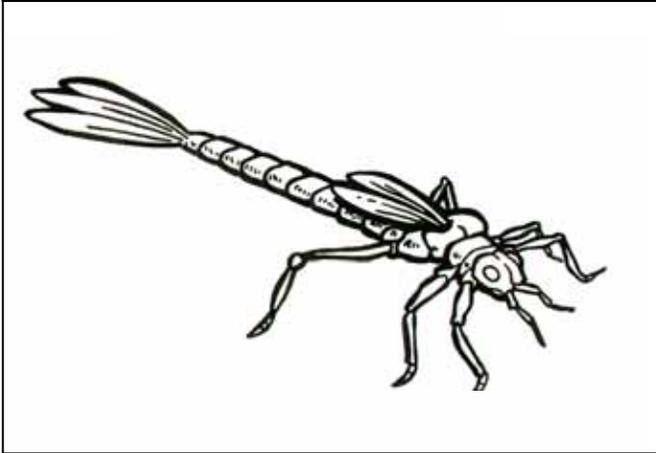
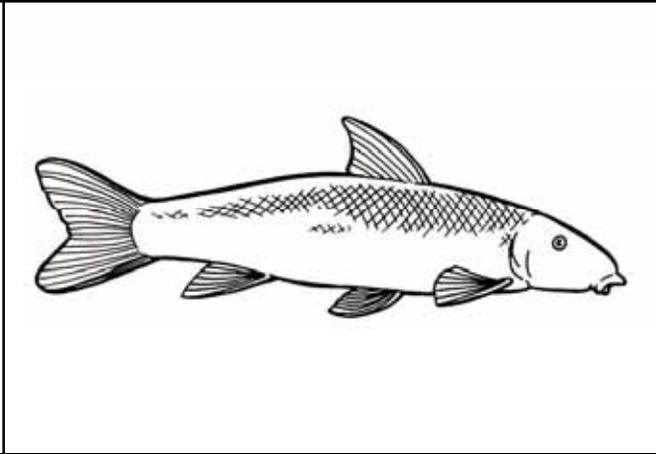
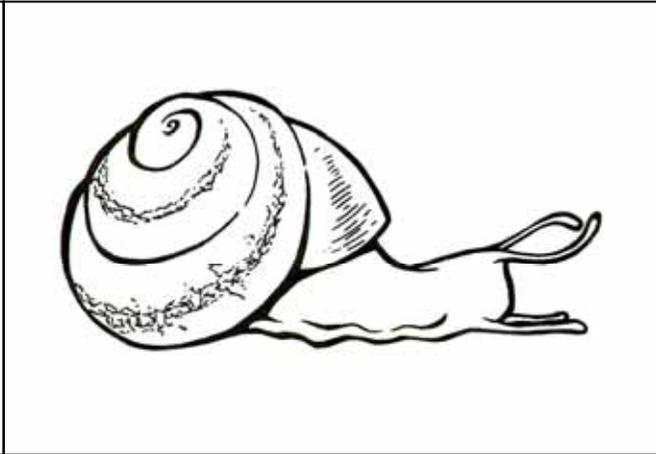
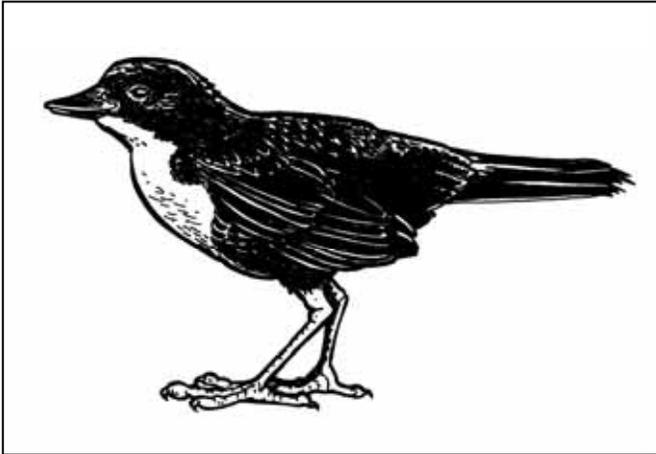
Standard Correlations:

NJ CCCS Science 5.5 Grade 8 A.2, Grade 12 A.4, Science 5.10 Grade 6 A.1, B.1, Grade 12 B.1

Procedure:

- 1 Call on students to define ecosystem. (Answers should include all the living and nonliving things in an area. There is an interaction among living and nonliving things in an ecosystem.) Ask students to consider the ecosystem that trout inhabit and to name some of the living and nonliving things in that ecosystem. Write their responses on the board. (Answers can include: sun [energy], algae, water plants, insect larvae, insects, small fish, frogs, turtles, snakes, trout.)
- 2 Ask students to define food chain. (Answers should include that a food chain moves the sun's energy through a community from producers to consumers.) Point out that in a food chain there are producers and consumers. Have students identify which of their responses are producers and which are consumers (Algae and water plants are producers; insect larvae, fish, frogs, turtles, and trout are consumers.)
- 3 Write minnow, dragonfly, algae, caddisfly larva, trout, and sun on the board. Call on a volunteer to use these examples to draw a diagram showing how the energy moves through this food chain. Ask for volunteers to help explain the flow of energy. (Answer: the sun provides energy for the algae to grow; algae is consumed by caddisfly larva; larva consumed by dragonfly; dragonfly consumed by minnow; minnow consumed by trout.)
- 4 Point out to students that there are other ways of showing energy flow through an ecosystem. In an Energy Pyramid the producers are at the base and the top consumer at the tip of the pyramid. As you move from the base to the tip there is less and less food and energy available. Ask students to define a food web and discuss how it is different from food chains and energy pyramids. (Answers should include that a food web shows the relationship between all of the species in an environment. It shows the competition for food and is basically a map of overlapping food chains.) Point out that every food chain and food web ends with decomposers-- worms, insects, bacteria, and fungi--organisms that break down dead organisms and waste into matter that can be absorbed by the decomposers or returned to the environment to be used by producers.
- 5 Have students work with a partner. Distribute Trout in the Ecosystem handout to each student. Explain that partners will use one two-page handout to create an energy pyramid. The other two-page handout will be used to create a food web. Instruct students to cut out the pictures and to arrange them on a separate piece of paper into an energy pyramid. With the other pictures they are to construct a food web, drawing arrows to show the relationship among the members of that community.
- 6 When students have finished have them share and compare their energy pyramids and food webs. Discuss with them what would happen if some of the members of community died. How would it effect the trout?





Lesson 6: Threats to Trout Habitat/Threats to Trout Survival

Preparation:

Duplicate *Threats to Trout Habitat* and *Threats to Trout Survival* handouts (one for each student).

Materials:

- Threats to Trout Habitat and Threats to Trout Survival handouts
- Poster material
- Colored markers

Standard Correlations:

NJ CCCS Science 5.10 Grade 6 A.1, A.2, B.1, Grade 8 B.1

Procedure:

- 1 Discuss with students the factors in their own environment that make it habitable. Their responses may include clean water, air, food, housing, etc. Discuss with them how their environment would be impacted if, for example, there was significantly less oxygen in the air. Discuss with students the types of disease pathogens in humans – bacteria, viruses, parasites.
- 2 Call on students to describe factors in a trout's environment that make it habitable. Write students' responses on the chalkboard. If students have trouble coming up with ideas, suggest categories such as habitat (lake or stream), water quality, availability of food, oxygen, etc. Tell students they are going to examine the trout habitat and factors that threaten it, as well as disease pathogens that affect trout in hatcheries, aquaria, and in the wild. Have students work in small groups. Distribute *Threats to Trout Habitat/ Threats to Trout Survival* to each student. Have groups read and discuss the information in the hand-outs.
- 3 Have each group choose one threat to further research. Suggest the groups use the information in the hand-out along with internet resources. Have each group make a poster that highlights the threat and its affect on trout and on the trout habitat.
- 4 When groups are ready, have them present their posters to the rest of the class. Display the posters in the classroom or in the school corridor.

Threats to Trout Habitat

Trout need cold, clear water to survive and grow. Snow melt, underground springs, and rainfall feed streams and lakes where trout live. Trees and vegetation that line the banks make the banks stable and provide shade. The shade helps to keep the water cool and offers a hiding place for fish. Leaves that drop into the stream or lake decay and become food for insects, which in turn are eaten by fish.

There are several habitats within a stream. Each habitat has different features and contains a different community of inhabitants. Young trout live in the calm, shallow waters near the banks. As they grow they move into the deep pools. Pools are the slower moving stream sections with smooth surface water. Many kinds of aquatic insect larvae make the pool their home. Dragonfly larvae hide in the silt at the bottom. There they can ambush unsuspecting prey. Caddisflies in the larval stage consume dead leaves.

Riffles are the area of streams where the water is shallow and runs swiftly over rocks. More organisms live in riffles than in pools. Many of the riffle inhabitants live in the cracks between rocks or under rocks. The swift current of the riffle oxygenates the water and quickly moves out waste. Organisms in riffles are adapted to this habitat. The swimming mayfly is streamlined so it can move in the fast current without being swept away. The black fly larvae attach themselves to the bottom of the riffle. The stonefly has a flat body and sprawling legs, which allow it to stay close to the surface of the rocks where there is a slower current. The riffle is a favorite place for trout. In the riffle they cannot be spotted by predators, there is plenty of oxygen, and the current brings them a fresh and constant food supply.

The natural balance in a stream is often threatened by pollution. Pollution isn't necessarily poison or waste being introduced into the stream. In fact many pollutants are, in small doses, harmless substances, but in large doses prove deadly to streams. Organisms in streams can tolerate substances at a range of levels. Outside the range, the organism will die. The optimum temperature for trout is between 40 degrees F and 68 degrees F. Trout can survive temperatures as low as freezing and as high as 77 degrees F. Outside this range, however, they will die. The insects that trout eat are more vulnerable to pollution than the trout themselves. Without insects, the trout starve.

In New Jersey and throughout the Eastern United States, brook trout are facing threats to their habitat. For more detail see: [Conserving the Eastern Brook Trout: An Overview of Status, Trends and Threats](#).

Dams

An on-stream dam impounds water that becomes susceptible to warming during the summer. This warm water may cause stressful or lethal water temperatures for trout both in the impounded area and downstream. Silt and sediment that collect behind the dam can impact in-stream habitat by smothering spawning sites and macroinvertebrate species that are important prey items for trout. Dams are also barriers to fish migration – a particular concern for streams that have spawning populations of trout. Manmade dams are responsible for damaging trout habitat in more streams than would first seem apparent. Many dams built long ago on New Jersey streams are no longer used for their original purpose (milledams and diversion dams), but have stood the test of time.

The Musconetcong River is a prime example of trout stream habitat that has been significantly degraded by numerous dams. On other streams, dams have been built to provide drinking water and these situations are causing increasing problems for trout streams not only in terms of high water temperatures but also with regard to maintenance of in-stream flows.

In the Pequannock River system the operation of dams in connection with drinking water supplies has caused mortality of wild brown trout downstream due to the release of excessively warm water. The failure to maintain sufficient flow downstream during the summer has also been problematic for trout. The release of anoxic bottom waters is also a concern with dams that have controlled releases. Dams built by beavers also cause problems in trout production watershed such as the Flatbrook, Pequannock River, and Van Campens Brook.

Loss of nearstream vegetation

The removal or loss of nearstream vegetation, particularly on the headwaters of trout streams, can result in undesirable thermal warming patterns. Construction activities in stream corridors such as road widening, bridge and culvert construction, etc. have resulted in short term or permanent losses of nearstream vegetation. Livestock grazing that destroys nearstream vegetation, causing unstable banks, has been observed along trout production streams and could be prevented or minimized through fencing.

Roadway culverts improperly designed or installed culverts can prevent or impede fish passage and can be particularly problematic during low and high flow situations. In-stream fish habitat can also be lost if native substrate is not re-established in the culvert.

Nonpoint source pollution

Land disturbances within the watershed can increase pollutants. Urban development contributes to the stream pollution. During dry weather, gasoline, oil, dust, pesticides and other chemicals collect on roadways, sidewalks, and parking lots. When it rains, these chemical substances are washed into streams and lakes. Runoff from roadways and a variety of sources may not pass through quality basins or other filtering devices prior to entering the stream. Silt is frequently a primary constituent of nonpoint source pollution and is a major threat to the state's trout resources. Runoff from poor farming practices and land disturbances are major contributors of silt.

Point source pollution

Discharges emanating from a point source, such as wastewater from treatment plants, can cause summer thermal alterations and increased pollutant loads that can stress or kill trout.

Channelization, channel relocation and stream cleaning

The first of these two activities are occasionally performed as part of stream crossing and road widening projects. Municipalities, county Mosquito Commissions, and farmers are probably most active in stream cleaning activities intended to improve runoff patterns. These small scale projects can cause localized damage by leaving a uniform stream bottom devoid of cover and structure for fish. Beneficial woody debris, that should be left in the stream channel unless causing a significant blockage, may often be removed under the guise of stream cleaning.

Global warming

Climatic changes associated with global warming may pose a problem for those trout streams in New Jersey where summer water temperatures approach critical levels for trout survival.

Acid rain

Acid rain is also a big problem for trout. Factories in the Midwest burn fossil fuels (coal, oil, gas) which release sulfur dioxide and nitrous oxide into the atmosphere. When these chemicals are combined with rainwater or snow, they form acids. Soil in the northeast cannot neutralize the acid effectively. The optimum pH reading is 7, which means the water is neutral. It is neither too acidic (low pH), nor too alkaline (high pH). Some lakes in the northeast have a pH reading of 5, which is highly toxic to organisms. In addition, the acidity leaches aluminum from the substrate, which is deadly to fish and other organisms.

Threats to Trout Survival

Trout in hatcheries or in the wild face biological threats that can weaken or kill them. These threats come in the form of bacteria, viruses, fungi, parasites and other diseases. As a hatchery “manager”, it is important to recognize and minimize the threat from disease in your own aquarium.

Trout in hatcheries or aquaria are crowded more closely together than they would be in a stream, and diseases are spread more quickly because of crowding. Keeping the water cool and changing it frequently are two good methods of controlling disease. Pathogens that can harm trout are carried by other fish, so it is extremely important that you not introduce any other fish besides trout to your aquarium – even as food.

Streams naturally contain lots of bacteria that are not specific to fish disease. These microorganisms break down plant and animal life so that the nutrients can be recycled. Under stressful conditions for fish (low oxygen levels), common soil and water bacteria can harm fish. They can produce lesions or skin ulcers, and cause damage to internal organs.

There are many types of diseases caused by bacteria and viruses that are specific to fish. Crowding the fish and not changing the water frequently enough are the main culprits of infectious outbreaks. Gill disease, skin lesions, and kidney disease are some of the main bacterial infections caused by fish-specific bacteria. Skin lesions resulting from the bacterial disease Furunculosis may result when fish are stressed.

Fish are also susceptible to viral infections. At the fingerling stage, Infectious Pancreatic Necrosis (IPN) is especially tough on hatchery fish. Infected fish will swim in a spiral and large numbers of fish die at once. The disease is transmitted from the broodstock, so controlling infection there is the only solution.

Parasites are always present in streams and a healthy fish can usually survive a light parasite load. A common parasite of trout is an external protozoan called *Ichthyophthirius* (ICK-thee-oph-thir-ee-us), also known as Ich. This organism gets under the lining of the skin, fins and gills. It can be seen without magnification, and looks like grains of salt and pepper under the skin. The lumps have a horseshoe-shaped macronucleus visible under a low-power microscope. Fish will behave wildly with an Ich infection – thrashing around and jumping out of the water. Formalin can be used to treat infected fish.

An internal parasite that is especially troublesome for trout causes whirling disease. The disease organism is *Myxobolus cerebralis*, an internal protozoan. This organism attacks cartilage in the head and spinal column causing deformities, and a mad tail-chasing behavior; hence the name whirling disease. The disease cycle includes an aquatic worm host. Once the worms are burrowed into the sediment, the disease is impossible to get rid of. Getting rid of the pond material is the only way to eradicate the disease.

Lesson 7: Where Does Our Water Come From?

Preparation: Copy the excerpt from the USGS Hydrologic Primer for New Jersey. Obtain map of state outlining the watersheds.

Materials: State map of NJ outlining watersheds.

Standard Correlations:

NJ CCCS Science 5.10 Grade 6 A.1, B.1

Procedure:

1. Have students read the excerpt below from the USGS Hydrologic Primer for New Jersey.
2. Ask for volunteers to identify the watershed that they live in. Using the DEP website or state map of watersheds, have each student locate what watershed they live in:
<http://www.state.nj.us/dep/dwq/pdf/pspmapco.pdf>, <http://www.state.nj.us/dep/watershedmgt/surfNJ/index.html>
3. Have students contact their municipal water supply authority, county health department, or private water supply company to find out the source of their drinking water whether it be surface water or groundwater. Have students brainstorm questions that they want to ask about where their water supply comes from, if there are threats to the supply (drought, pollution, diversion of water, etc.)

Water use

In New Jersey, water is used for public, industrial, domestic and commercial supply, in addition to irrigation, mining, and thermoelectric-power generation. The source of your water depends on where you live, how populated the area is, and what the geology is like. About 73% of all water used in N.J. is surface water, and about 27% is ground water (Nawyn, 1997). Public supply is the largest use category; in northern New Jersey, about 85% of the water used for public supply is surface water, and 15% is ground water. In southern New Jersey, the percentages are reversed – 15% is surface water and 85% is ground water (Nawyn, 1999). This is the result of several factors. Northern New Jersey is densely populated, and ground water is concentrated in rock fractures, bedding planes, and solution cavities in the carbonate rocks. Because the ground water is not uniformly distributed, it is less accessible than the groundwater in southern N.J. In some areas, the quality of the ground water may be unsuitable for particular uses. Reservoirs are heavily used and water-transferring systems are used to transfer water from the more pristine rural areas to urban centers. Southern New Jersey is less densely populated, and aquifers are able to store and produce large amounts of ground water. In addition, well drilling is easier in the unconsolidated sediments of southern New Jersey than in the consolidated rocks of northern N.J. *from USGS A Hydrological Primer for New Jersey Watershed Management. Water-Resources Investigations Report 00-4140. Prepared in cooperation with New Jersey Department of Environmental Protection. U.S. Department of the Interior, U.S. Geological Service.*

Lesson 8: Determining the Health of a Stream

Note:

Field visits to a stream and determining the health of the stream will help students make connections between the trout in the classroom aquarium and the trout in their natural habitat. They will gain an understanding and appreciation of the relationship between a healthy habitat and the organisms that live in that habitat. Several visits to the stream where the trout will be released will provide the optimal experience for students. Depending on where your school is located and the availability of transportation, this may not be feasible. In that case, a visit to a local stream—or even a local pond or lake, would still provide students with a valuable experience. Two visits is preferable, but if you have just one day then you should prepare your students to do both the stream assessment and macroinvertebrate population assessment on the same day. If you can't physically do a field trip, use the Leaf Pack Study Activity at the end of this section.

Preparation:

It is advisable for you to visit the site before the class visit in order to better plan the investigation and deal with any logistical problems. Duplicate the Stream Description handout for each student.

Materials:

- Water testing kit
- Thermometer
- Secchi disc
- Pencils, pens, colored pencils
- Stream Description handout

Standard Correlations:

NJ CCCS Science 5.10 Grade 6 A.1, A.2, B.1, Grade 8 A.1, Grade 12 A.1, B.1

Procedure:

- 1 Call on students to name some factors that might affect the health of a stream. Suggest they consider both point source and non-point source pollution. (Pollutants restrict light needed by plant plankton and reduce food production. Fertilizers, pesticides, animals waste, and sewage runoff deplete oxygen and kill stream organisms.) List student responses on the board.
- 2 Tell students that they are going to visit a stream to assess how healthy the stream is and whether the stream would be able to support trout. They will do a visual assessment, test water quality, and then assess the health of the stream by conducting a macroinvertebrate population survey. Ask students to recall some of the stream habitat characteristics and water quality factors that are necessary for trout survival. Write responses on the board.

Stream habitat characteristics should include:

- Banks lined with vegetation, shady areas with overhang
- Gravel streambeds
- Calm shallow waters near the bank
- Deep pools with smooth surface water
- Shallow riffles with fast moving water
- Rocks

Water quality factors should include:

- pH (pH levels between 6.5 and 7.5)
- Temperature (cool water temperature between 48 degrees F. and 52 degrees F. is optimal, however trout can survive at both slightly lower and slightly higher temperatures)
- Dissolved Oxygen (dissolved oxygen at 10-12 ppm is most desirable)
- Turbidity or sediment (clear water with little sediment is most desirable for trout)
- Pollutants (water free of pollutants)

- 3 Tell students that they will examine these characteristics and factors when they visit the stream.

- 4 Have students work in small groups. Remind students to bring their trout journals and writing implements (pencils, pens, colored pencils) with them on the field trip. At the stream, have students spend 20 to 25 minutes drawing a map of the stream and its banks and noting vegetation, surrounding area (farmland, highway, industrial area, etc.), pollution (cans, paper, trash) both in the stream and on the banks. Give them additional time to write a description of the stream—including what they see, smell, hear, etc. Distribute stream description hand-out and have students use it to guide their writing.
- 5 Have each group test one water quality factor. Students can use a secchi disk or make a visual assessment for the turbidity factor. If time is limited, take a water sample and have it tested at a local laboratory.
- 6 Back in the classroom, discuss students' observations. Identify those characteristics and factors that are beneficial to trout survival and those that would be harmful to trout survival.
- 7 If the stream is polluted, brainstorm to find solutions for making the stream healthier. Find out about land use regulations in your area. Develop a plan that is both appropriate and realistic for improving the stream's health. For example, plan a stream pick-up day. Have students along with family and friends meet at the stream to pick up trash and other debris. Have students hand out flyers in the community so that other residents can help.

Stream Description

After drawing a picture of what you see, write a physical description of the stream. Use these questions to guide your writing.

- How fast is the water moving? Is it clear, cloudy or muddy? Can you see any traces of chemicals, such as an iridescent film on the water?
- Do you see large rocks in the water? Are they smooth or rough?
- How many riffles do you see?
- Estimate the width and depth of the stream.
- Does the stream run in a more-or-less straight line or does it twist and turn?
- What is the streambed like? Is it sandy or rocky?
- Are there algae, weeds or other plants growing in the water?
- What is the stream bank like?
- Is it sandy or rocky? Does it look like it's eroding?
- Are there plants growing on the bank? Are there trees on the bank that provide shade?
- What evidence of human activity do you see? Is there trash or fishing tackle?
- Are sources of pollution evident—highway, parking lot, farm, industrial area?
- Does the stream smell clean or stagnant?

Lesson 9: Macroinvertebrate Survey

(Part 1: Identification of Macroinvertebrates)

Note:

Environmentalists, biologists, and water quality researchers all conduct aquatic invertebrate surveys to measure the health of a stream. They monitor changes in the stream over time and assess the effects of environmental problems on stream life. Some aquatic invertebrates, such as mayfly larvae, gilled snails, and riffle beetles, are extremely sensitive to pollution. Some will leave polluted areas for friendlier habitats; others will die. Crayfish, sowbugs, and damselfly larvae are somewhat sensitive to pollution. They prefer good stream quality, but can survive in polluted conditions. Mosquitoes, worms, black fly larvae, and leeches have a high tolerance for pollution. They will thrive in polluted conditions. By surveying the numbers and types of aquatic invertebrates present, the health of the stream can be determined.

You do need a permit to collect/possess macroinvertebrates. This activity requires two classroom periods in addition to the field visit.

Preparation:

Duplicate the Macroinvertebrate Identification handout.

Materials:

- Waders or high waterproof boots
- Thermometer
- Several light colored plastic wash basins
- Plastic containers for collecting invertebrates
- Dip nets or strainers
- Large spoons or small gardening spades
- Macroinvertebrate Identification handout

Standard Correlations:

NJ CCCS Science 5.5 Grade 4 A.1, Grade 6 B.1, Grade 8 B.1, B.2, Science 5.10 Grade 6 A.1, B.1

Procedure:

- 1 Call on volunteers to name some of the food that trout eat in the wild. Write the following on the chalkboard:
 - Arthropods (aquatic)
 - Arthropods (terrestrial)
 - Crustaceans
 - Mollusks
 - Nematodes
 - Flatworms
 - Annelids
- 4 Point out to students that these are some of the invertebrates that trout feed on. Divide the class into 7 small groups and assign one invertebrate to each group to research and report on. Each report should include a short description of the group, an overview of the life cycle of some of the members of the group, and conditions the members of the group must have to survive (clean water, cool water, oxygen, etc.). Have students use internet and library resources to investigate their groups. Then have students present their findings to the rest of the class. Information should include the following:
 - Arthropods (aquatic)—organisms with segmented bodies and hard exoskeletons. The most common arthropods are insects. Some are aquatic or have aquatic stages, like the damselfly.
 - Arthropods (terrestrial)-- organisms with segmented bodies and hard exoskeletons. The most common arthropods are insects. Terrestrial insects can fall from trees or vegetation on the bank into the stream where they become food for trout.

- Crustaceans – a class of arthropods with hard exoskeletons. Crayfish are an example of a food trout eat.
- Mollusks – many have soft bodies, some have hard shells. Clams, mussels, and slugs are common mollusks.
- Nematodes – roundworms—which trout eat.
- Flatworms – planaria are aquatic flatworms which trout eat.
- Annelids – worms with segmented bodies. Leeches and earthworms are annelids.

4 Tell students that they are going to visit a stream to take a survey of the aquatic invertebrates. Ask:

- How could a survey be useful? (It could be useful in assessing the health of a stream. In addition, if the food a trout eats is not available, then it is not a good habitat for trout.)
- Do different parts of the stream need to be surveyed or sampled? Why? (Yes, because different invertebrates inhabit different parts of the stream.)
- Are the numbers and kinds of invertebrates found important? Why? (Some invertebrates might be less tolerant of pollution than others. If they are not present in the stream, it would mean that the stream is possibly polluted.)

4 Distribute the Macroinvertebrate Identification hand-out and have students read over and identify the organisms on it. If necessary, review the meaning of naiad, larva, pupa and nymph. Tell students these are the organisms they will be collecting in order to determine the health of the stream.

Macroinvertebrate Survey

Part 2: Field Trip

Note:

Before conducting the field trip, it is best to visit the site to determine if there are any potential hazards, such as poisonous plants, dangerous wildlife, etc. Check the stream for depth, velocity, and temperature. Identify several different areas of the stream as collection sites (for example, shallow areas near the bank, areas in the middle of the stream, riffle areas, etc).

Procedure:

- 1 Review ground rules and safety rules with students prior to the field trip. Divide the class up into small groups. Distribute several Macroinvertebrate Survey sheets to each group. Explain that groups will use one survey sheet for each area in the stream that they sample. They will begin downstream and work their way upstream to avoid muddying locations they might want to sample later. They will first describe the part of the stream they are sampling. (Students might be encouraged to make a simple map with a star or arrow indicating where along the stream the sample comes from.) Is it a location near the bank, mid-stream, near a riffle? Is the sample from the streambed, from under a rock, or from the plants on the bank? How deep or shallow is the area they are sampling? What is the water temperature?
- 2 Describe the procedure for collecting invertebrates. Muckraking: Use a large spoon or gardening spade to scoop up some muck from the bottom of the stream. Put it in the dishpan. Look for things that are moving. Add some water and swish it around as you look for organisms. Collecting from under rocks: Simply turn over rocks and look for scuds, nymphs and other arthropods. Collecting from the water: Use a strainer or dip net to catch organisms you see moving in the water.
- 3 After collecting, carefully move any invertebrates into the collection containers. Be sure to label the containers with the name of the site where the organisms were collected. Repeat the procedure.
- 4 When students have sampled several areas and collected invertebrates from each area, have them return to the classroom to assess their data and draw conclusions.

Macroinvertebrate Survey

Part 3: Assessing Data and Drawing Conclusions

Materials:

- Macroinvertebrate Identification Sheet
- Macroinvertebrate Survey Sheet
- Macroinvertebrate Background Information/Assessment Worksheet
- Hand lenses
- Insect field guides
- Old newspapers
- Tweezers (optional)

Procedure:

- 1 Discuss the field trip with students encouraging them to share their observations. Tell students they will now identify and record the macroinvertebrates they collected and use the data to determine whether or not the stream is healthy.
- 2 Have students work in their original groups. Distribute Background Information/Assessment Worksheet to students. Review the background information with them. Have them identify those organisms that are tolerant to pollution, somewhat tolerant, and sensitive. Review the formulas for determining index value.
- 3 Cover work areas with newspaper. Have groups work with the organisms they collected their sites. They should use the Macroinvertebrate Identification sheet (and insect field guides, if needed) to identify each organism. The type of organism found should be recorded just once. (For example, if three mayfly larvae are found at three different sites, only one check is marked on the assessment sheet.) After identifying each organism students should calculate the water index value for each group and the water quality rating for the stream.
- 4 When groups finish, allow them time to discuss their findings within the group. Call on one person from each group to present the group's findings to the rest of the class. Have them write the water quality ratings on the board and ask students to compare the findings. Discuss the diversity of organisms found. Were there a large number of pollution tolerant organisms? How did they compare to the number of pollution sensitive organisms found. Based on their findings, have students determine whether or not the stream is healthy.

Macroinvertebrate Background Information

Environmentalists, biologists, and water quality researchers all conduct aquatic invertebrate surveys to measure the health of a stream. They monitor changes in the stream over time and assess the effects of environmental problems on stream life. Some aquatic invertebrates, such as mayfly larvae, gilled snails, and riffle beetles, are extremely sensitive to pollution. Some will leave polluted areas for friendlier habitats; others will die or will be unable to reproduce. Crayfish, sowbug, and damselfly larvae are somewhat sensitive to pollution. They prefer good stream quality, but can survive in polluted conditions. Mosquitoes, worms, black fly larvae, and leeches have a high tolerance for pollution. They will thrive in polluted conditions. By surveying the diversity of aquatic invertebrates present in a stream, the health of the stream can be determined.

Assessment Worksheet

Stream name: _____

Site location: _____

Put a checkmark next to the name of each macroinvertebrate that you found.

Sensitive to Pollution	Somewhat Sensitive to Pollution	Tolerant to Pollution
<input type="checkbox"/> Mayfly larvae <input type="checkbox"/> Stonefly larvae <input type="checkbox"/> Caddisfly larvae <input type="checkbox"/> Dobsonfly larvae <input type="checkbox"/> Gilled snails <input type="checkbox"/> Planarians <input type="checkbox"/> Water penny larvae <input type="checkbox"/> Adult Riffle beetle	<input type="checkbox"/> Clams <input type="checkbox"/> Cranefly larvae <input type="checkbox"/> Crayfish <input type="checkbox"/> Alderfly larvae <input type="checkbox"/> Scuds <input type="checkbox"/> Sowbugs <input type="checkbox"/> Damselfly larvae <input type="checkbox"/> Dragonfly larvae <input type="checkbox"/> Whirligig beetles <input type="checkbox"/> True bugs (including water boatman, backswimmers, water scorpions, water striders)	<input type="checkbox"/> Lunged snails <input type="checkbox"/> Black fly larvae <input type="checkbox"/> Midge larvae <input type="checkbox"/> Leeches <input type="checkbox"/> Worms <input type="checkbox"/> Mosquito larvae
Types found ___ x 3 = ___ index value	Types found ___ x 2 = ___ index value	Types found ___ x 1 = ___ index value

To determine the water quality rating, add the index values together. Then compare them to the chart below.

Water quality rating	Stream health assessment
11 and below	Very poor
11-16	Fair
22-27	Good
27-32	Excellent

Macroinvertebrate Survey Sheet

Date:

Stream location:

Stream temperature:

Approx. stream width:

Approx. stream depth:

Group members:

Site location: (draw a simple map and identify location of the site using a *)



Observations:



Alternate macroinvertebrate study ideas

"Leaf Pack Study" Lesson Plan

Prepared by: Kristina Rogers, Loyalsock Township High School from the website www.Lamotte.com

Materials

- access to local stream
- Leaf Pack from LaMotte Company, or a simple onion sack from the grocery store
- [data sheets](#)
- identification cards and sorting charts from the Leaf Pack kit, downloaded from the Internet, or from Golden Guide's *Pond Life* from St. Martin's Press, which is an excellent field guide
- magnifiers and stereo microscopes if possible
- white trays

- bowls
- brushes
- petri dishes
- strainers
- classification keys can be ordered through [Save Our Streams](#)

Procedure

- This lesson should come after students have been introduced to and worked with macroinvertebrates.
- Explain the concept of a leaf pack to students and discuss how they may be used to study a stream community. Involve your students in deciding what will be studied, reminding them that they must have a control leaf pack.
- Divided the class into small groups and have them decide on experimental leaf packs. Some choices of variables may include different types of leaves in the leaf pack or different locations of the leaf pack. Have the students develop a hypothesis about what will happen to each leaf pack.
- After students have designed a study and written a hypothesis they should share their ideas with the class and receive constructive feedback. As the teacher you will get a chance to hear all the students ideas and make sure that the experiment is controlled and acceptable. Other students have a chance to hear different ideas and make suggestions about the different experiments.
- Have groups bring in various leaves to be tested. Each bag will need about 10 cups of leaves.
- Have groups work through the lab activity and prepare the leaf packs.
- Obtain and copy the data sheets from The Leaf Pack Network.
- After each group has prepared their leaf packs schedule time to place them in the chosen stream.
- The leaf packs should be kept in the stream for at least a week, preferably three, then retrieved and brought back to the classroom for the macros to be observed as soon as possible. You will find the most macros in the fall and late spring.
- Retrieve the packs on the day you will be doing the classification activity with your class. If you wait many of the macros will die as the water warms. Most aquatic insects can be refrigerated or kept in coolers with ice overnight. Some invertebrates are very sensitive to changes in temperature.
- The laminated flashcards and the sorting sheets found in the LaMotte Leaf Pack Kit are excellent resources, or use available handouts. Students can classify what they find in the leaves. If your macros are abundant you might also consider preserving some of the larger ones of each type or species for later use and study.
- Have students use magnifiers to make careful observations. They should go back and forth between what they are looking at and the handouts, field guide, or cards with the illustrations. Students should record what they are finding and how many of each.
- Draw conclusions about water quality based on Lesson 9 worksheets.

References

[Lamotte Company](#), [Stroud Water Research Center](#). "Leaf Pack Network."
[Washington Virtual Classroom](#). "Macroinvertebrates."

Lesson 10: Managing Trout Stocking by the Numbers

Preparation:

Duplicate the Trout Management background handout.

Materials:

- none

Standard Correlations:

NJCCCS Science 5.4 Grade 8 B.1, Grade 12 A.1, Science 5.10 Grade 8 B.1, Grade 12 B.1, 2

Procedure:

Have students read the *Managing Trout Stocking by the Numbers* background information, and then working in teams, answer the questions derived from hypothetical situations that follow.

As an alternative, students can pick a real body of water (either a lake or a stream), research its habitat suitability and capability of supporting trout, and then make recommendations on how many and what kind of trout it can support.

A trip to Pequest Trout Hatchery & Natural Resource Education Center can be part of this activity.

Questions to answer as a hatchery manager/fisheries biologist:

1. Mellow Brook is a small stream, less than 15 CFS. Y-O-Y rainbow trout have been documented. Is this a suitable stream for stocking the brook trout that you've raised? Why or why not?
2. Whitecap Lake is a large lake (100 acres) that has temperature less than 21 degrees C all year long, with dissolved oxygen levels greater than 4 mg/L. What kind of trout would you stock, if any, and at what time of year?
3. Rippling River is one of the major drainages in this area. The Incidence of Occurrence is 25%. No trout smaller than 100 mm in length have been documented during surveys. What kind of trout would you stock, if any, and during what times of year? Is this a suitable river to stock the brook trout you've raised?
4. Boggy Brook is a small stream with a pH of 5.4. There are no documented Y-O-Y brook trout in it, and it has flows of 25 CFS. Would this be a good place to release your brook trout?
5. City Park Pond is bustling with activity all year long. It is less than 15 acres in size, and the summer water temperature is usually 25 degrees C. Is this a place that's suitable for trout stocking? What kind of trout would you stock here, and during what time of year? Would you stock your brook trout here?

Managing Trout Stocking by the Numbers

Angler demand for trout means that fishery managers must develop programs and strategies aimed at providing this user-group with a satisfying angling experience. Trout raised in a hatchery provide resource managers with an effective management tool for creating and enhancing recreational coldwater fisheries. The NJDFW raises trout at two facilities, the Pequest Trout Hatchery and the Charles O. Hayford Fish Hatchery at Hackettstown. Cultured (hatchery-reared) brook, brown, rainbow, and lake trout are stocked in a variety of settings and seasons. All funds used to operate the hatcheries come from the licenses and stamps that anglers are required to buy when they are 16 years of age and older.

On an annual basis, more than 750,000 catchable and sub-catchable trout are reared and stocked during the spring, fall, and winter. Brook trout are the only native trout species that is raised in hatcheries and by TIC classrooms.

Fisheries biologists must have a plan for where fish will be stocked. The plan is based on the biological characteristics of the water bodies – water quality and quantity and existing trout and other fish populations. Only public owned open space is stocked – no private waters receive fish.

Trout and Surface Water Quality Standards

The general classification applied to freshwaters of the state is FW. Waters located wholly within state or federal land or special holdings are typically classified as **FW1**. These waters receive the highest protection possible and are maintained as to quality in their natural state. All other surface freshwaters (excluding the Delaware River and Pinelands waters) are classified **FW2**. Waters are then further classified according to their suitability to support trout.

TP - Trout production Waters designated for use by trout for spawning or nursery purposes during their first summer.

TM - Trout maintenance Waters designated for the support of trout throughout the year.

NT - Nontrout Freshwaters that have not been designated as trout production or trout maintenance. These waters are generally not suitable for trout because of their physical, chemical, or biological characteristics, but are suitable for a wide variety of other fish species.

Fresh waters classified as **FW2** may be further designated as “Category One Waters” (**C1**). C1 waters are protected from changes to the existing water quality. These waters can be identified because of their clarity, color, scenic setting, other characteristics of aesthetic value, exceptional ecological significance, exceptional water supply significance, or exceptional fisheries resource(s).

“Category Two waters” (**C2**) means those waters not designated as outstanding quality waters or Category One.

Classification Methods

Lakes

Lakes are classified as trout maintenance or nontrout according to their ability to support trout year round. Trout survival in lakes is dependent upon summer water quality conditions, which can reach critical levels during the summer months. Lakes are surveyed mid-August when water temperatures are highest and dissolved oxygen levels are typically at the lowest levels. To support trout, lakes must have a layer of water with favorable conditions of temperature (21° C or less) and dissolved oxygen (4 mg/l or greater) all year long.

Streams

Streams are classified based on the documented occurrence of natural reproduction, and the presence or absence of trout and/or trout associated species. Streams which lack naturally reproduced trout in their first year of life are classified as trout maintenance or non-trout based upon the streams total fish population.

- **Trout Production** – Young-of-the-year trout must be documented within the sampled stream segment. Young-of-the-year (y-o-y) trout can be visually distinguished from older trout in the field, based upon their size (typically less than 100 mm in length).

- **Trout Maintenance** – Incidence of Occurrence of trout and/or trout associated species > 20 %.
- **Non-Trout** - Incidence of Occurrence of trout and/or trout associated species <20%.

The *Incidence of Occurrence* was developed based upon fisheries data. The number of times that the species was found to inhabit a stream with a naturally reproducing trout population was proportionally compared to the total number of stream segments in which the species was found. The result was an **Incidence of Occurrence**, expressed as a percentage, for that particular species with reproducing trout populations. The higher the *Incidence of Occurrence* the greater the species' "association" with trout.

Management of Habitat

To survive, fish need a healthy environment that satisfies their life requirements. Fish habitat is aquatic space, as determined by chemical, physical, and biological factors. Habitat characteristics play a key role in determining fish assemblages (fish species and their numbers, and sizes). Habitat also influences biotic interactions (competition, predation) that affect fish communities. Three habitat factors that affect the distribution and abundance of trout in streams and lakes are water quantity, water quality, and in-stream habitat.

Management Factors for Cultured Trout

Cultured trout in New Jersey are presently managed according to two general management strategies:

Put-and-Take

Catchable-size brook, brown, and rainbow trout are stocked for immediate harvest to provide a short-term, seasonal fishery. Survival of these trout through the summer period is not expected (or poor) because suitable summer trout habitat (temperature < 21°C and dissolved oxygen > 4 mg/L) is absent. The trout-stocked waters managed under this stocking strategy include park ponds, shallow lakes, and warmwater streams. These waters are stocked in the spring and may be stocked again under the fall or winter program.

Put-Grow-Take

Brook, brown, rainbow, and lake trout are stocked for immediate and/or delayed harvest to provide a long-term, year-round fishery. Suitable habitat is consistently available to sustain trout throughout the year, and trout are expected to survive over more than one growing season. Trout-stocked waters managed under this stocking strategy include coldwater streams and deep lakes that are capable of supporting trout year round, where wild trout populations are limited or absent. These waters are stocked in the spring and may be stocked again in the fall or winter.

Timing of Stocking Programs for catchable trout

The timing of trout stocking can greatly influence the success of the program. The NJDFW trout stocking program for catchable trout currently includes a spring, fall and winter component. The spring stocking program is by far the largest and most popular of the three, but fall and winter stockings programs are successful in providing additional opportunities for New Jersey anglers.

Trout Allocations

The number of trout that are distributed in any body of water is determined using a formula developed in 1990. The formula takes into consideration stream size, access, proximity to other trout stocked waters and population.

Species Selection Criteria

For each trout-stocked water the trout species that will have the least impact upon the resident fish population, and provide the highest survival and angler catch rates, is selected for stocking.

For many waters, the species selection is not critical and brook, brown, and rainbow trout may be stocked in any combination. However, in these situations brook trout are typically stocked first because their willingness to bite usually results in high angler catch rates and satisfaction on opening day. By the 1st or 2nd week following opening day, when the hatchery supply of available brook trout has been exhausted, rainbow trout

are then stocked. Towards the end of the spring stocking season (4th or 5th week), brown trout are stocked. Most waters stocked late in the season are generally capable of supporting trout year round and brown trout survival rates in these waters are generally better than the other two species.

Trout Production Streams – Streams having reproducing trout populations are stocked with a cultured species that minimizes unfavorable interactions (interbreeding, inter-specific competition, etc.). Brook trout raised by Trout in the Classroom schools can only be stocked into waters where brook trout are not currently reproducing on their own.

Reproducing trout species	Acceptable cultured trout species
brook	rainbow
brown	brook and/or rainbow
rainbow	brook
brook and brown	rainbow
rainbow and brown	brook
brook and rainbow	rainbow or brook (the opposite of the dominant wild species)

The frequency of the stockings is based upon the size of the stream, and flow. Although current stocking practices are designed to minimize the impacts of hatchery trout in streams already supporting natural populations, the consequences of these stockings on the natural populations has not been investigated.

Low pH Waters

Streams and lakes which have been identified as having poorly buffered, low pH (< 5.5) conditions are stocked with brook trout due to the species ability to tolerate low pH conditions.

Marginal Trout Lakes

Lakes having marginal summer trout habitat (i.e. holdover trout are occasionally, but not regularly caught) are stocked early in the season with brook and rainbow trout, and receive brown trout during their last in-season stocking. A number of these waters historically supported trout year round but over the years declining water quality has resulted in the reduction or elimination of summer trout habitat.

Non-trout Lakes and Streams

Lakes and streams that lack supportive capabilities for trout during the critical summer months are stocked with brook and rainbow trout. The proportion of each particular species stocking is dependent on hatchery production.

Size Selection Criteria

The size of catchable trout that will have the least impact upon on the resident fish population, is compatible with the available habitat, and will provide a high return to the creel is selected for stocking. Catchable-size trout stocked in the spring are categorized into two sizes – quality (10.5 inch average) and broodstock, sometimes referred to as breeders (15 inches and larger). All waters stocked with trout in the spring receive quality-size trout. Broodstock are mixed in with the quality trout early in the stocking season (2% per load, until the supply is exhausted) unless the receiving water falls into one of the following four categories:

- 1) Trout Production Streams – These streams contain naturally reproduced trout that are seldom more than 12 inches long and do not compete well with the much larger broodstock trout.
- 2) Trophy Trout Lakes – Quality-size stocked trout put into these lakes are able to grow to trophy size in 1 – 2 years, negating the need to stock larger broodstock.
- 3) Holdover Trout Lakes – Quality-size stocked trout put into these lakes are able to grow to trophy size in 1 – 2 years, negating the need to stock larger broodstock.
- 4) Small Streams – Streams less than 33 feet wide and having flows less than 19 CFS that do not have a sufficient living space to adequately accommodate the larger broodstock.

Reference: Coldwater Fisheries Management Plan. 2004. New Jersey Department of Environmental Protection, Division of Fish & Wildlife, Bureau of Freshwater Fisheries. Principal authors: Patricia Hamilton and Lisa Barno. www.njfishandwildlife.com/cwfmp.htm

Lesson 11: How Much Water Do We Use?

Note:

This lesson requires two class periods.

Preparation:

Duplicate Household Water Usage handout (1 per student, some may require 2).

Standard Correlations:

Procedure:

1. Discuss water usage with students. Ask them to think about all the ways they and their families use water at home. Remind them to include things like watering the lawn, washing a car, doing laundry, washing dishes, etc. Write their responses on the board.
2. For each water usage listed, ask students to estimate how many gallons of water are used. If there is a wide range suggested, see if you can get students to come to a consensus of how much water is used.
3. Based on the list, ask students to each estimate how much water their family uses each day. Give students 5 to 10 minutes to calculate their family's usage. Have students divide the number of gallons they came up with by the number of family members to get an average of each person's daily usage.
4. Call on a few volunteers to share their water usage averages with the class. Point out to students that these are estimates. Tell them that over the next 24 hours they are going to monitor their families' water usage.
5. Distribute Household Water Usage to each student. Read over the handout with them. Have them compare actual water usage for each activity with their estimates. Explain that they should interview each family member to find their daily water activity and the number of times they did the activity, such as, brushing their teeth. Have students complete the sheet as a homework assignment.
6. When students have completed their Household Water Usage charts, have them work in small groups.
7. Provide each group with a Water Usage Chart. Have students use the chart to determine how many gallons of water was used for each activity. Have them write the number of gallons used and multiply that by the times per day to get the daily use for that activity. Have students total each individual's daily usage, add them together and divide by the number of people in their household to find the average.
8. Call on volunteers to share their findings. Have students compare their estimates to the actual amount of water used. Point out that the average American uses 100 gallons of water a day. The average person in a developing country uses just 13 gallons a day. Discuss with students what might account for the discrepancy.
9. Brainstorm with students ways that they might cut down on water usage. Write their suggestions on the board. Suggest students encourage their families to adopt some of these water-saving practices to see if they can bring the total water usage for the class down.
10. You may wish to conduct the water usage survey again a few weeks later to see if the water-saving practices were effective. Have them calculate the savings per home, per year. If people in your area pay for water, have students calculate the monthly water bill before and after conservation measures are adopted.

Household Water Use

Your Name:

Date:

Family Member:

Activity	X/day	Gallons Used	Daily use
Wash hands		.25	
Brush teeth		2	
Wash face		3	
Flush toilet		2-7	
Laundry		40/load	
Shower		25-40	
Bath		35-50	
Wash car		80-100	
Hand wash dishes		20	
Machine wash dishes		12-20/load	
Water lawn		6,797/acre	
Food prep/drinking water		1	
Total			

Family Member:

Activity	X/day	Gallons Used	Daily use
Wash hands		.25	
Brush teeth		2	
Wash face		3	
Flush toilet		2-7	
Laundry		40/load	
Shower		25-40	
Bath		35-50	
Wash car		80-100	
Hand wash dishes		20	
Machine wash dishes		12-20/load	
Water lawn		6,797/acre	
Food prep/drinking water			
Total			

Additional Activities: Fish Art (or *Gyotaku*, Japanese Fish Printing)

Preparation:

You will need to gather the materials described below. You can choose to have a small group of students do the *Gyotaku* while the rest of the class is engaged in another activity or you can have the entire class working in small groups do the *Gyotaku*. In that case you will need the following materials for each group of students.

Materials:

- Fresh trout
- Linoleum block print ink speedball, or any other thick water soluble ink
- Stiff 1 inch paint brush, a small brush (for painting eye)
- Modeling clay
- Lemon
- Old newspapers
- Paper towels
- Colored newsprint paper
- Hairdryer (optional)

Procedure:

- 1 Have students work in small groups. Instruct them to cover the work table with newspaper. Have them clean the outside of the fish by squeezing lemon juice on its body and gently wiping to remove the slime. They should be careful not to dislodge the scales.
- 2 Have them place modeling clay under the fins for support. The fins should be arranged to look natural. If the fish has been gutted, paper towels can be stuffed inside so that the belly is firm. The anus should be plugged with a piece of paper towel to avoid any leaking. Have students cover the eye with a small piece of cotton.
- 3 The fish must dry completely. A hairdryer can be used to hasten the process. Check for dryness by removing some of the clay. If the fins stay in place, students can proceed with the art activity.
- 4 Have students place a stack of newspaper sheets under the fish (sheet should be unfolded). Instruct students to brush a thin coat of ink on the fish, using the ½ inch brush beginning at the head and working down to the tail. The ink should be thick, not runny. When the fish is covered, reverse the direction of the strokes, going from tail to head. This puts ink under the edges of the scales and spines and will improve the print. The small brush should be used to coat the fish's lips and tips of fins and tail. Do not paint the eye at this time.
- 5 When the fish is inked, have students carefully remove the clay and slide the top sheet of newspaper out from under the fish so that the top sheet is clean.
- 6 Instruct them to take a sheet of newsprint and hold it several inches above the fish. The paper should be positioned so that the print will be made in the location and angle they desire. Let go of the paper and let it fall on the fish. Do not move the paper once it has touched the fish.
- 7 One student should hold the head of the fish while the other gently pats and presses it with his/her hands. All parts of the fish should be pressed so that there won't be any black or faint areas of the print. The fins must be pressed as well. Try not to move the paper around as it will cause smudging. If the paper wrinkles, that's okay. Try not to rub the same part twice. After the entire fish has been pressed, gently and carefully peel off the paper.
- 8 Paint in the eye using the small brush (practice on scrap paper first). Allow the print to dry.

Glossary

Acid rain: Rainwater with an abnormally low pH level, generally caused by industrial pollution.

Adaptation: The ability of an organism to adjust to a change.

Alevin: Larval fish that receive nutrients from a yolk sac.

Ammonia: NH₃, a waste produced by eggs and fry.

Annelid: advanced, segmented worm.

Aquatic: inhabiting a fresh water environment.

Aquifer: An underground layer of sand, porous rock, or gravel containing water.

Arthropod: Organisms from the phylum Arthropoda, characterized by a hard exoskeleton and segmented appendages.

Benthic: Living in or at the bottom of a sea or lake.

Brood stock: Sexually mature fish from which eggs and milt are taken.

Brood year: The year eggs are produced.

Button-up: The stage in fry development when the belly seam closes as the yolk sac is consumed.

Catch and Release: The practice of releasing, live, all the fish caught.

Competition: The utilization of common resources that are in short supply by a number of organisms.

Condensation: The process by which a gas is changed into a liquid.

Consumer: An organism that eats (consumes) other living things.

Dissolved Oxygen (DO): Oxygen in its gaseous form dissolved in aqueous water.

Ecological Niche: Role of an organism in its habitat and its interactions with other organisms.

Ecology: The science that studies the interactions among living organisms with each other and their environment.

Ecosystem: A living (biotic) community and its non-living (abiotic) environment.

Egg: A mature female sex cell, also called the ovum.

Eutrophication: The process by which plant nutrients cause algal blooms resulting in oxygen depletion.

Eyed Egg: A stage in the development of the egg in which the embryo's eye can be seen.

Food Chain: A description of an ecosystem that focuses on the dependence for food of organisms upon others in a series beginning with plants and ending with top predators.

Food Web: A description of an ecosystem that focuses numerous connections among organisms.

Fry: Larval fish that no longer depend on their yolk sac for nutrients and actively seek food.

Generalist: An organism that feeds on a variety of other organisms.

Gill: The breathing organ that fish use to exchange oxygen from water with carbon dioxide from their blood.

Green Egg: A newly spawned egg that is very vulnerable at this stage of development.

Habitat: The area where an organism normally lives that provides the organism with food, water, and shelter.

Hatchery: A location where fish eggs are collected, incubated, hatched and reared for release.

Hydrology: The study of the Earth's waters, their distribution, and the cycle involving evaporation, condensation, and precipitation.

Invertebrate: An organism without a backbone.

Kype: The hooked lower jaw of a spawning male trout.

Larva: In most insects, the immature, flightless stage that transforms into a resting stage called a pupa or another stage before becoming an adult.

Metamorphosis: The physical change that some organisms undergo as they mature from egg to adult.

Milt: A milky fluid produced by male fish that contains sperm.

Nematode: A roundworm from the phylum Nematoda.

Nonpoint Source Pollution: Pollution caused by land use practices, rather than from a single, identifiable source.

Nutrient: A substance that provides nourishment and encourages growth.

Nymph: An immature larval stage of various insects.

pH (the power of Hydrogen): A measure of the acidity or alkalinity of a substance. The pH scale indicates the concentration of hydrogen (H⁺) ions in the substance.

Point Source Pollution: Pollution that is caused by a single, identifiable source.

Pollution: Contamination of air, water, or soil.

Pollution Tolerance: An organism's ability to withstand the effects of pollution.

Pool: A deep area within a stream that is characterized by low velocity.

Predator: An organisms that kills and eats other organisms.

Prey: An organism that is eaten by other organisms.

Producer: The first trophic level in a food web. Plants, for example, convert the sun's energy into food that consumers can access by eating the producers.

Redd: A nest dug in the gravel by a female fish during spawning. The eggs are deposited in the redd where they incubate until hatching.

Respiration: The process by which oxygen is exchanged for carbon dioxide.

Riffle: A shallow portion of a stream where water breaks over rocks producing surface agitation.

Riparian: Of or pertaining to the banks of a river or a stream.

Sac-fry: A newly hatched alevin with the yolk sac still attached.

Salmonid: A fish in the trout or salmon family.

Sediment: Solid matter that settles to the bottom of a stream, lake, or pond.

Spawning: the act of laying and fertilizing eggs.

Specialist: An organism that eats only one type of food or prey.

Temperature: A key habitat component of the classroom aquarium. Temperatures must be kept at 42 degrees F. to 55 degrees F. for egg and fry survival.

Trophic level: An organism's place in the energy pyramid. Producers are found at the first trophic level, primary consumers are found at the second level, secondary consumers at the third level...and so on.

Turbidity: Cloudiness in the water caused by sediments that have been stirred up.

Vertebrate: An organism with a backbone.

Watershed: A drainage area or basin in which all water areas drain or flow toward a central collector (such as a stream, river, or lake) at a lower elevation.

Yolk sac: Sac attached to newly hatched fish which contains nutrients for growth.

Online Resources

CLASSROOM WATER EDUCATION RESOURCES

- **New Jersey Division of Fish & Wildlife:**
www.njfishandwildlife.com

- **Educating Young People About Water Guides**

www.uwex.edu/erc/ey paw/guides.html
This series of guides, created by the Environmental Resources Center, University of Wisconsin-Madison, educates young people about water.

- **National Project WET**

www.projectwetusa.org
Project WET is a national program that is grounded in the belief that informed people are more likely to participate in the decision making process and to make a difference through their actions. The core of the program is the Project WET Curriculum and Activity Guide. The guide, designed for the K-12 classroom, is a collection of over 90 water-related activities that are hands-on, easy to use, and fun! The New Jersey contact for Project WET is Ray Nichols (ray.nichols@dep.state.nj.us).

- **Project WILD**

www.projectwild.org
Project Wild is an interdisciplinary, supplemental environmental and conservation program designed for students in grades K-12. New Jersey contact is Liz Jackson at NJ Division of Fish & Wildlife's Pequest Trout Hatchery (liz.jackson@dep.state.nj.us). The contact for Aquatic WILD is Sue Canale at NJ Division of Fish & Wildlife's Nacote Creek Research Station (sue.canale@dep.state.nj.us).

- **Water Education Foundation**

www.water-ed.org
The mission of the Water Education Foundation, an impartial, non-profit organization, is to develop and implement education programs leading to a broader understanding of water issues and to resolution of water problems.

- **Water Share, U.S. Department of the Interior, Bureau of Reclamation**

www.usbr.gov/mp/watershare
Water Share, the Virtual Water Conservation Center provides information for all ages and

interests ranging from local water conservation programs to a series of interactive activities. This site also provides lesson plans for elementary, junior high, and high school classes.

- **US Geological Survey Water Science for Schools**

water.usgs.gov/education.html
(USGS) Water Science for Schools website offers information on many aspects of water, along with pictures, data, maps, and an interactive center where visitors can give opinions and test your water knowledge.

- **WOW: Water on the Web**

waterontheweb.org
WOW is a three-year cooperative educational project coordinated through the University of Minnesota and funded by the National Science Foundation that began in 1997. Water on the Web collects data from several water sampling robots, called Remote Underwater Sampling Station (RUSS). Each unit includes a solar-powered water quality instrument capable of making several measurements at different depths throughout the day. The RUSS units provide current water conditions from a variety of diverse water bodies in Minnesota. This data is available to the public through the website.

SCIENCE EDUCATION AND ENVIRONMENTAL EDUCATION RESOURCES

- **Educator's Reference Desk (Formerly Known as AskERIC)**

www.eduref.org
This is the on-line version.

- **EnviroLink (Environmental Education Network)**

www.envirolink.org/index.html
This research engine is a very useful tool for students using the web to research a topic.

- **Eisenhower National Clearinghouse (ENC)**

www.enc.org
The Eisenhower National Clearinghouse for Mathematics and Science Education (ENC) is funded through a contract with the U. S. Department of Education to provide K-12 teachers with a central source of information

on mathematics and science curriculum materials.

- **EE-Link**
www.eelink.net
A project of the North American Association for Environmental Education. This site provides additional links for educators who are looking for ways to use the Internet in environmental education.
- **North American Association for Environmental Education**
www.naaee.org
NAAEE is a network of professionals and students working in the field of environmental education throughout North America and in over 55 countries around the world. Since 1971, the Association has promoted environmental education and supported the work of environmental educators.

GOVERNMENT RESOURCES

- **New Jersey Department of Environmental Protection**
www.dep.state.nj.us
- **Natural Resource Conservation Service, U.S Department of Agriculture**
www.nrcs.usda.gov
The Natural Resources Conservation Service is a Federal agency that works in partnership with the American people to conserve and sustain our natural resources. The mission: To provide leadership in a partnership effort to help people conserve, improve, and sustain our natural resources and environment.
- **United States Environmental Protection Agency's Office of Wastewater Management**
www.epa.gov/owm
This agency oversees a range of programs contributing to the well-being of the nation's waters and watersheds. Through its programs and initiatives, OWM promotes compliance with the requirements of the Federal Water Pollution Control Act.
- **U.S. Geological Survey**
www.usgs.gov
Mission: The U.S. Geological Survey provides the nation with reliable, impartial information to describe and understand the Earth. The U.S. Geological Survey was established on March 3, 1879, and charged with the following

responsibilities: classification of the public lands, and examination of the geological structure, mineral resources, and products of the national domain.

- **Environmental Impact Analysis Data Links**
water.usgs.gov/eap/env_data.html
- **Toxics Release Inventory**
www.epa.gov/tri
- **U.S. Forest Service Software & Databases**
www.fs.fed.us/database

WATER RELATED ASSOCIATIONS AND FOUNDATIONS

- **American Water Works Research Foundation**
www.awwarf.com
The AWWA Research Foundation sponsors practical, applied and future-need based research for the drinking water community.
- **National Watershed Network**
www.ctic.purdue.edu/KYW/NWN/Watershed_02.html
When you register with the National Watershed Network, you're registering with an exclusive network of watershed partnerships. Watershed groups listed on the Network actively work to make their watershed healthier. Partnerships of stakeholders search for options that they can implement on a voluntary basis in the watershed. NOTE: Be sure to try all links, several link names are inexact and do not reveal the full content linked to.
- **Water Environment Federation**
www.wef.org
Founded in 1928, the Water Environment Federation is a not-for profit technical and educational organization. Its goal is to preserve and enhance the global water environment. Federation members number more than 41,000 water quality professionals and specialists from around the world, including engineers, scientists, government officials, utility and industrial managers and operators, academics, educators and students, equipment manufacturers and distributors, and other environmental specialists.

– **Water Online**

www.wateronline.com

Water Online provides timely information about the water and wastewater industry. The Water Online database has information of interest to engineers, planners, operational and financial managers, consultants, elected officials, government personnel, municipal water supply industry, municipal and industrial wastewater treatment field. It provides a timely collection of water related news stories from around the world.

– **Water Quality Association**

www.wqa.org

The Water Quality Association (WQA) is the international trade association representing the household, commercial, and industrial water quality improvement industry. Its 2,200 corporate member companies manufacture and sell point-of-use/point-of-entry (POU/POE) equipment, package water treatment plants, and customized water treatment systems.

Trout Unlimited Today

Mission:

Trout Unlimited (TU)'s mission is to conserve, protect, and restore North America's trout and salmon fisheries and their watersheds.

TU accomplishes this mission on local, state and national levels with an extensive and dedicated volunteer network. TU's national office, based just outside of Washington, D.C., and its regional offices employ professionals who testify before Congress, publish a quarterly magazine, intervene in federal legal proceedings, and work with the organization's 125,000 volunteers in 500 chapters nationwide to keep them active and involved in conservation issues.

History:

July 2004 marked the 45th anniversary of TU's founding, on the banks of the Au Sable River near Grayling, Michigan. The 16 fishermen who gathered at the home of George Griffith were united by their love of trout fishing, and by their growing disgust with the state's practice of stocking its waters with "cookie cutter trout"—catchable-sized hatchery fish. Convinced that Michigan's trout streams could turn out a far superior fish if left to their own devices, the anglers formed a new organization: Trout, Unlimited (the comma was dropped a few years later).

From the beginning, TU was guided by the principle that if we "take care of the fish, then the fishing will take care of itself." And that principle was grounded in science. "One of our most important objectives is to develop programs and recommendations based on the very best information and thinking available," said TU's first president, Dr. Casey E. Westell Jr. "In all matters of trout management, we want to know that we are substantially correct, both morally and biologically."

In 1962-63, TU prepared its first policy statement on wild trout, and persuaded the Michigan Department of Natural Resources to discard "put-and-take" trout stocking and start managing for wild trout and healthy habitats. On the heels of that success, anglers quickly founded TU chapters in Illinois, Wisconsin, New York, and Pennsylvania.

TU won its first national campaign in 1965: Stopping the construction of the Reichle dam on Montana's Big Hole River. Five years later, TU helped secure a ban on high-seas fishing for Atlantic salmon. And in 1971, TU took legal action to protect the last free-flowing stretch of the Little Tennessee River. Perhaps one of the most significant early applications of the Endangered Species Act, the action stopped the Tellico dam, but only temporarily: An eleventh-hour congressional appropriations rider later doomed TU's victory.

TU New Jersey was started in 1969 by Fred Burroughs with the formation of the North Jersey Chapter. Fred then helped to start the East and Central New Jersey chapters and founded the state council in 1971. The North Jersey Chapter was one of the founding groups of the Save the Delaware Coalition.

Driven by a powerful and dedicated grassroots network, TU is meeting the challenges of coldwater conservation and protecting our rivers and fisheries for generations to come.

Background on Trout in the Classroom

Students in California and other western states had the initial classroom rearing facilities for salmon in the western U.S. The North Jersey Chapter of Trout Unlimited pioneered the Trout in the Classroom program with Hopatcong science teacher Ellen Soriano in the early 1990s. The chapter purchased the equipment to raise the trout, and eggs were supplied at no charge by the Musky Trout Hatchery. As part of her work with coldwater fisheries, she and her students successfully petitioned the state legislature to designate the brook trout as the “state fish”. As a result of her work with Trout in the Classroom, the national office of Trout Unlimited presented her with an award at their national meeting in 1993. The students at Hopatcong School also received a regional EPA award from Vice President Al Gore.

North Jersey TU continues to support the program by loaning equipment and assisting with the efforts of Sparta Middle School teacher Marilyn Steneken who has taken the program to new heights. Other New Jersey chapters of Trout Unlimited have pledged to support teachers who want to get started.

In 1995, Trout in the Classroom was brought to classrooms in New York City and the upstate watershed region by energetic and conservation-minded Joan Stoliar. Her vision was to connect these students and help develop in them an awareness and understanding of their shared water resources. With the support of Theodore Gordon Flyfishers, Inc., Joan worked to install chilled aquariums in four classrooms. These students and their teachers enthusiastically raised their trout and released them as fingerlings the following spring. It was a very successful year.

Word of the program rapidly spread and soon other schools were setting up chilled aquariums in their classrooms. By the end of the third year, nineteen schools were participating in the program. When Joan Stoliar passed away, her equally enthusiastic husband, Arthur, carried on her legacy. He continued to expand and promote the program, bringing Trout in the Classroom to over 100 classrooms in 2004. In the same year, Trout Unlimited, a national cold water conservation organization, agreed to help promote and coordinate the program. The first full-time Trout-in-the-Classroom Coordinator was hired through funds and in-kind donations raised by Trout Unlimited, the Catskill Watershed Corporation, and the New York City Department of Environmental Protection. As part of this growth, this curriculum was developed through the financial support of Susan and Peter J. Solomon, the Peter J. Solomon Family Foundation, and the Peter J. Sharp Foundation.

The program’s success is reflected in the stories that teachers tell. Brian Hugick, an Earth Science Teacher at Somers High School, had one student who frequently cut class. He put the student in charge of the morning trout feedings. The young man did not miss a day after that and requested to assist in the trout release. Natasha Walkowitz, a teacher at Harlem Day Charter School reported that both kindergartners and first graders were writing observations about the trout. Other teachers reported that students, who had never before taken an interest in science, were now very involved in it. By raising trout, students connect to the natural world around them—specifically the rivers and streams that sustain their communities.

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Hacklebarney Ch. TU (includes parts of
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Jersey Shore TU (includes Monmouth,
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South Jersey/Ray Nierle TU (includes
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