New Hampshire Trout in the Classroom (TIC) Activity Guide

NH Fish and Game Watershed Education Program (WEP) and
New Hampshire Trout Unlimited (TU)

Developed 2017

INTRODUCTION

In August of 2016, a focus group of experienced Trout in the Classroom (TIC) teachers and volunteers met at Plymouth State University to discuss ways to improve this program in New Hampshire. The group shared ideas to address challenges to make TIC better and more user-friendly to all.

One of the identified barriers to a successful program, especially for new teachers, was the lack of activities to keep the students engaged throughout the egg rearing season. The group proposed developing a series of grade appropriate activities designed with a consistent template that could be used by teachers statewide, no matter what their experience with the program. This TIC Activity Guide is the result of this proposal and uses the Research for Better Teaching (RBT) template. Teachers can add to this "Activity Guide" using the RBT template whenever they have a lesson to share, making this a truly living document.

ACKNOWLEDGMENTS

This guide would not have been possible without the TIC focus group of champions:

- Thomas Ames, Teacher at Indian River School
- Chris Connors, Volunteer with Trout Unlimited, Basil Woods Jr. Chapter
- Nancy Brook Heckel, Educator at Lake Sunapee Protective Association
- Patti Dugan-Henriksen, Teacher at Groveton Middle School
- Karen Healey, Teacher at Mount Prospect Academy
- Alex Hicks, Science and Technology Teacher at Shaker Road School
- Mary Jolles, Ex-Principal and Volunteer at Colebrook Elementary School
- Rich Larcom, Volunteer with Trout Unlimited, Ammonoosuc Chapter
- Rachelle Lyons, Research Assistant Professor, Center for Business & Community Partnerships, Plymouth State University, Focus Group Co-Convener
- Eliza Perreault, Trout Unlimited Conservation Technician, Upper Connecticut Home Rivers Initiative, Invasive Species Educator
- Bryan Smith, Teacher at Bethlehem Elementary School
- Kathleen Stowell, Education Director at Lake Sunapee Protective Association
- Judy Tumosa, NHF&G Watershed Education Specialist, Focus Group Co-Convener

A special note of appreciation goes to Rachelle Lyons and Mary Jolles.

- Rachelle has been engaged in this project from the beginning and has guided us through the process of bringing different minds together to make this a truly collaborative effort.

- Mary has been a stalwart champion of TIC and tirelessly shares her knowledge, experience and love of trout with others. The Research for Better Teaching (RBT) lesson template is her idea and the original activities in the guide are her creation.

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Adaptations

How Do Animals Regulate Body Temperature?

Grade Level: 6-8 but could be adapted to younger grades

Bloom's Cognitive Domain: Knowledge/Understanding/Application/ Analysis, Levels 1-4

NGSS Reference: 3-LS4-3, 4-LS1-1

Goal: To understand the 3 major concepts underlying thermoregulation, or the regulation of body temperature, in animals: metabolic rate (tachymetabolic or bradymetabolic), variations in body temperature (homeothermic or poikilothermic), and sources of heat (endothermic or ectothermic).

Objective: Given a description of an animal, its habitat and ecosystem, and its diet and eating habits, students will explain why it is either (1) endothermic or ectothermic, (2) tachymetabolic or bradymetabolic, (3) homeothermic or poikilothermic.

Activity:

Materials needed:

- Handout entitled "What Do Hummingbirds and Black Bears Have In Common?"
- Handout entitled "Thermoregulation."
- 3 X 5 cards marked with the names of 25-30 different animals, both vertebrate and invertebrate.
- Handout describing the "dwiesel," a fictional animal.

Teacher hands out informational sheet on "What Do Hummingbirds and Black Bears Have In Common?" and reviews it together with the class. Discussion should segue into second informational handout on Thermoregulation, with definitions of terms. Class should read Thermoregulation handout together and ask questions.

Students then choose a card with the name of an animal on it. Cards can be spread face up on a table but there should be more cards than students. Students either pair up or work singly to investigate facts about the chosen animal, and discover through research facts about its body temperature and metabolism. Students use the paragraphs at the end of Thermoregulation handout to help them frame their thoughts. Students report to the class on their chosen animal and why they believe it to be endothermic/ectothermic, etc.

Assessment: As a final activity, students are given a short handout (at the end of this lesson plan) about a fictional animal living on another planet. They must decide whether the animal is endothermic/ ectothermic, etc., and write a one-page paper of 3 paragraphs, giving information from the handout text to back up their claim.

Paragraph 1 should explain whether and why animal is endothermic or ectothermic, Paragraph 2 should explain whether and why it is tachymetabolic or bradymetabolic, and Paragraph 3 should explain whether and why it is homeothermic or poikilothermic.

What do hummingbirds and black bears have in common?

Both animals have special adaptations to help them save energy and get through cyclical periods of food scarcity.

Most people know that black bears hibernate in the winter. If they didn't, they'd get awfully hungry and probably starve to death, because their food sources are either scarce or gone during this time. A bear prepares for hibernation by eating as many as 20,000 calories a day during the fall months. The bear stores this energy in the form of fat. Then as winter begins, bears find a place to hibernate—a den, a cave, or sometimes just on the ground near a protective bank of earth, where snow will collect and create a natural cave. The bear's metabolic rate drops: its heart rate, body temperature, and breathing are greatly reduced. In this way, the bear lives off stored fat during the winter months until the spring.

By contrast, polar bears do not hibernate. Why not?

Hummingbirds are very active birds. Their hearts beat unbelievably fast—250 beats per minute at rest, and over 1,200 beats per minute when flying. During the day they are constantly feeding on nectar from flowers as well as tiny insects. The hummingbird's metabolic rate is so high that if it didn't eat and drink 24 hours a day, it would die of starvation. So what happens at night, when hummingbirds must sleep?

As night falls, the hummingbird perches on a branch and goes into torpor, or a torpid state. Torpor is kind of like hibernation, but it lasts only a matter of hours! The hummingbird's heart rate drops to 50 beats per minute. Its body temperature, normally 107 degrees F, drops to hypothermic levels. Its breathing rate drops. Sometimes hummingbirds hang upside down during torpor! When daylight comes, the hummingbird "powers up" its body over a 20-minute period, coming out of torpor. Its body temperature and heart rate rise, its normal breathing resumes, and it is ready for another active day of feeding!

Now that you know these facts about the hummingbird's metabolic rate, do you think the hummingbird is tachymetabolic or bradymetabolic? Is it homeothermic or poikilothermic? What about the black bear?

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Thermoregulation

Animals can be divided into two groups:

- Animals that regulate their body temperatures using internal, metabolic sources (**endothermic**)
- Animals that regulate their body temperatures using external, environmental sources (**ectothermic**)

We think of **mammals** and **birds** as **endothermic** because their body heat mainly comes from the burning of energy within their bodies which is consumed first as food. We call this quality of an animal "warm-blooded."

Reptiles, fish, amphibians, and many **invertebrates** are considered **ectothermic** because although they eat food for energy to stay alive and move around, they do not heat their bodies through the burning of food energy. We call these animals "cold-blooded."

Cold-blooded animals have many interesting ways of regulating their body temperature. Some ways suggest that they are not completely dependent upon their environment. One way they can warm up is by exercising their muscles. Muscle movement generates heat.

Other methods include:

- Using sunlight or shade to heat up or cool down their bodies
- "Storing" heat in their bodies by lying absorbing it through rocks or sunlight
- Burrowing
- Clustering in a group
- Moving away from excessively hot or cold environments

A cold-blooded animal with a large body tends to gain or lose heat more slowly, so there can be an advantage to being a large reptile (like a dinosaur).

But wait a minute-- warm-blooded animals use some of these same methods! Does this mean that endothermic animals are not completely endothermic?

RESTING METABOLISM

An animal's metabolism is how food is converted into and used as energy. Different animals have different metabolic rates.

- Hamsters have a high metabolic rate even at rest, and are said to be **tachymetabolic**.
- Lizards have a low metabolic rate at rest, and are said to be **bradymetabolic**.

RESTING TEMPERATURE

Some animals have an internal body temperature that fluctuates, either between night and day, or between the seasons, while others have a near constant internal body temperature no matter what time of day or year it is.

- A chickadee has a constant internal temperature of about 102 degrees. It is said to be **homeothermic**.
- A dormouse's internal body temperature drops when it hibernates, then rises again when it comes out of hibernation. It is said to be **poikilothermic**.

Choose a card with the name of an animal. Think about where the animal lives, what it eats, and how it interacts with its environment. On a separate piece of paper, write down everything you know about the animal, including its physical characteristics, whether it is a predator or prey, whether it migrates, hibernates, or is active year-round in its habitat, and whether it is diurnal (a daytime animal), nocturnal (a nighttime animal) or crepuscular (a dawn & dusk animal).

Now choose a partner and talk about the animal you chose or that was assigned to you. Do you think it is *ectothermic* or *endothermic*? What information about the animal causes you to believe this?

Think about the animal's metabolic rate—how fast it turns food into energy. Is it *tachymetabolic* (high rate of metabolism) or *bradymetabolic* (low rate of metabolism)? Questions to ask yourself: Does the animal eat nearly all the time? Even if it does not spend most of the time eating, does it eat high-energy sources of food (fats and proteins)? Hint: animals with a rapid heart rate and high energy expenditure are usually tachymetabolic, while cold-blooded (ectothermic) animals are almost always bradymetabolic.

Now think about the animal's internal body temperature at rest. Does it remain constant (*homeothermic*) or does it change regularly depending on the time of day or time of year (*poikilothermic*)?

MEMORANDUM

TO: International Science Foundation
FROM: Deneb 2 Exploration – Biology Team
RE: Discovery of life forms
DATE: January 23, 2186

… Life on Deneb 2 is very diverse. Plants, bacteria, protists, fungi, and animals are plentiful, despite the huge daily fluctuations in surface temperature on the planet and relative lack of water (Deneb 2 has oceans only half the size of Earth's). As you may be aware, the Denebian "day" is actually two weeks long, which means that daylight hours take up one whole week, followed by a week of complete darkness. During the night, the temperature plunges to -40 degrees F, and during the long Denebian day the temperature can rise to as high as 130 degrees. Organisms appear to have developed adaptations in order to cope with these conditions.

One organism in particular is quite unique. We dubbed it "the dwiesel." It is a small, fat, predatory animal covered with a scaly skin, about 20 cm long, with 8 legs or limbs. It can move quite rapidly and has very good eyesight. It has a collar of skin around its neck that serves to cup sounds to its tiny ears, and the collar of skin can be raised or lowered to allow it to pass through narrow spaces. Most often we found it in rocky areas at higher elevations, but we spotted several specimens in grass-covered areas at lower elevations. It is a voracious eater, omnivorous, and supplements its daily diet of "meat" with various edibles, including plants and fungi.

One of our scientists was able to catch a "dwiesel" and fitted it with a radio tracking collar. The collar enabled us to gather data on the dwiesel's heart rate and body temperature, and to map its movements. The dwiesel is incredibly active during the week-long "day" on Deneb 2. Its range covers as many as 100 square miles. But at "night," all dwiesel movement stops. Our scientist located the dwiesel by radio in a burrow. She used a fiber-optic cable/camera inserted into the burrow to observe the dwiesel. The dwiesel was lying motionless in the burrow. Data from the radio collar indicated the dwiesel's body temperature had dropped to almost half its daytime reading, and its heartbeat was only one-sixth what it is during the daytime. The dwiesel remained motionless for the duration of the night. When day returned, the dwiesel regained its normal body temperature and heart rate. After about half an hour, it resumed its routine of hunting. This cycle of activity and sleep was observed by our scientist over a period of weeks, so we conclude that the cycle is normal for the dwiesel...

Use the back side of this sheet to write 3 paragraphs describing how this animal manages thermoregulation. ***Use references from the text to support your writing.***

- Paragraph 1 – *Explain why you conclude that the dwiesel is ectothermic or endothermic*.
- Paragraph 2 – *Explain whether the dwiesel is tachymetabolic or bradymetabolic.*
- Paragraph 3 – *Explain why you believe the dwiesel is homeothermic or poikilothermic.*

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Tetraploid Survivor

Grade Level: 4-8

Bloom's Cognitive Domain:

NGSS Reference: MS-LS4-4, MS-LS4-6

Goal: To understand that salmonid species such as trout enjoy a genetic advantage over other fish species, a mutation called "tetraploidy." Tetraploid species have more genetic material and can develop more varieties--hence they can adapt as a species more rapidly to changing environmental conditions.

Objective: Students will create a model and explain how a tetraploid species can actually form more varieties than a diploid species, using mathematical rules of permutations.

Activity:

Materials needed:

- Gameboard (template at the end of lesson plan)
- "Disaster" cards (template for cards at the end of lesson plan)
- Game pieces – 8 of each of 4 colors for each board (it's helpful to have more on hand).

Teacher takes students through a guided math activity reviewing and comparing permutations, i.e. "How many different ways can you combine 3 vegetables, 3 starches and 3 meat entrées to make a meal, as opposed to one vegetable, one starch and one meat entrée?" or "How many different ways can you combine 3 shirts, 3 pairs of pants, and 3 pairs of shoes to make an outfit, as opposed to 2 shirt, 2 pairs of pants, and 2 pair of shoes?" Discuss how the number of permutations increases as the number of items in each category grows, and have students identify a pattern. Explain that while human beings have 46 chromosomes, Eastern Brook trout have 84 chromosomes, making it possible for the species during reproduction to "create" varieties and adapt to the environment more quickly than humans.

Teacher reinforces this mathematical concept with a hands-on game, "Tetraploid Survivor."

The purpose of the game is to be the last player with pieces on the board.

Each player starts with four game pieces (I used colored glass beads—each player has a different color, e.g. blue, red, green, yellow). Players may place pieces in any blue area and in any combination on the board. For example, a player may place all four pieces in one area, two pieces in two areas, or may place one piece in each of four areas. Areas are marked by black lines and are named for bodies of water, e.g. Mississippi River, Pacific Ocean, etc.

Players take turns drawing "disaster cards" that name an area on the board and a disaster that killed off living things in that area. Player reads the card aloud to the other players, and any pieces in the area named are eliminated from the board. "Disaster cards" are placed face down in a pile and reshuffled and re-used if the game is still in play when the bottom of the pile is reached.

If a player draws a card marked TETRAPLOID, that player gets to double the number of pieces he/she has on the board at that time. For instance, if a player has three pieces on the board, the player may draw three more pieces and place them on the board, for a total of six pieces.

IN CASE OF A TIE: If two players are left with one piece each, and both pieces are in the same water body, then each player moves a piece to another water body, and continues play until one is eliminated.

Assessment: Students will fill out an incomplete chart comparing numbers of combinations that can be created using 1, 2, 3 or 4 items in 3 categories, and will write several paragraphs comparing/ contrasting this model to the creation of varieties by a tetraploid species.

	1 Item	2 Items	3 Items	4 Items
Outfit with 3 Items	**1 shirt** **1 pair of pants** **1 pair of shoes** **Formula:** **1 X 1 X 1 =**	**2 shirts** **2 pairs of pants** **2 pairs of shoes** **Formula:**		

Extension: After the Tetraploid Survivor Game, hold a discussion among students. What strategies did they use to "survive" in the game? Which strategy was more likely to ensure survival, putting all beads in one water body or spreading the beads around? Why? Were there times when this strategy did not work? When? What did the placement of beads/one species in different water bodies represent? (Diversity of placement represents diversity within a species, or variation). If I put all the beads/trout species in one water body, what statement am I making regarding the diversity of that species? (I am saying that it is only adapted to that water body, and to none of the others.)

What happened to the game as the number of players was reduced from four to two? Why do you think this happened?

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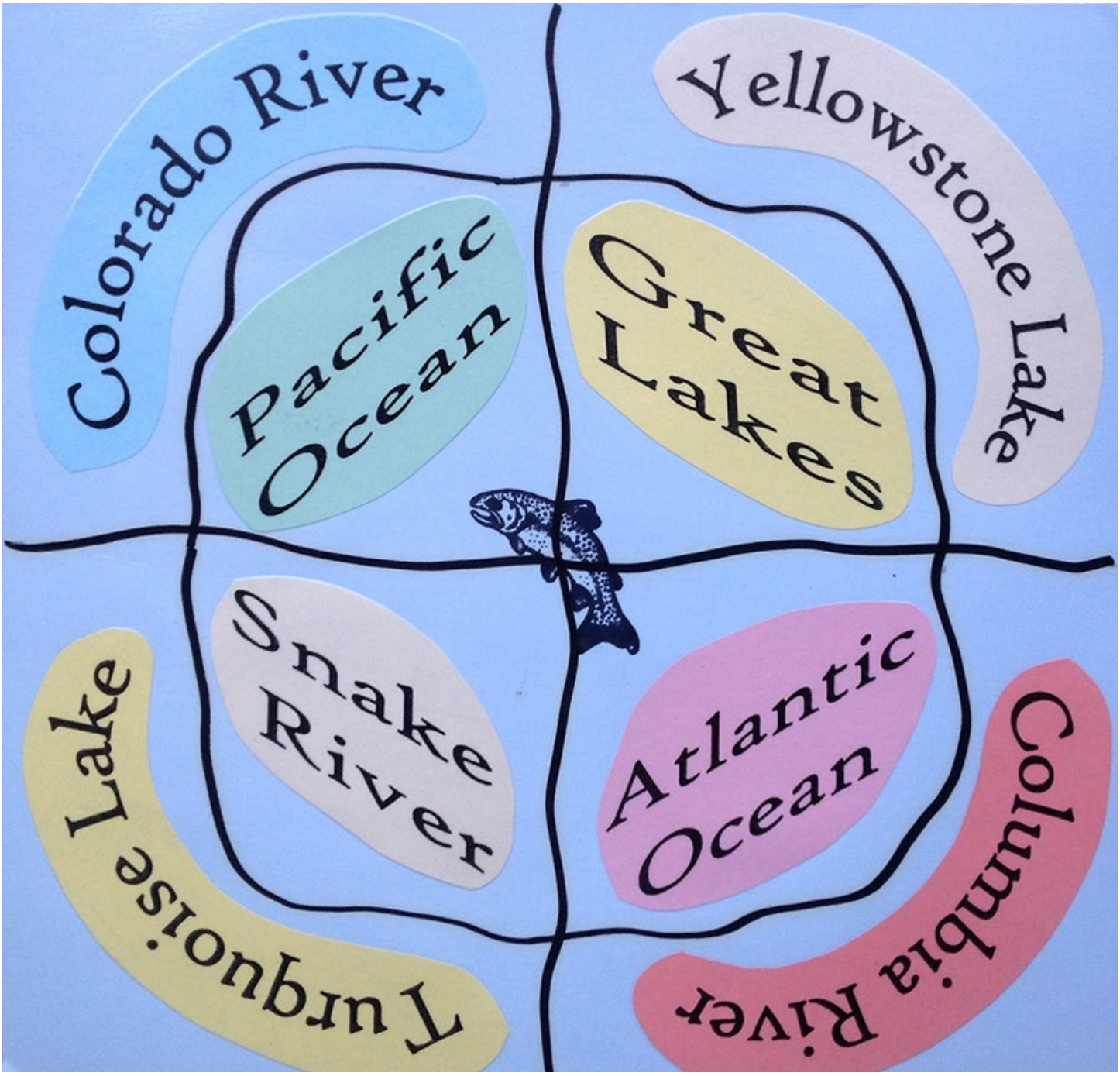

Colorado River
Yellowstone Lake
Pacific Ocean
Great Lakes
Snake River
Atlantic Ocean
Turquoise Lake
Columbia River

Hydroelectric dam is built across SNAKE RIVER—Coastal Rainbow Trout fail to migrate.	Chemical tanker is wrecked in ATLANTIC OCEAN—Atlantic salmon affected!	Avalanche crashes into YELLOWSTONE LAKE causing shoreline sediment—Cutthroat Trout eggs die.
Whirling disease spreads to COLORADO RIVER—Rainbow trout die!	Powerful northeaster in ATLANTIC OCEAN prevents salmon from migrating.	New species of fish introduced to YELLOWSTONE LAKE—eats trout eggs!
Earthquake hits COLUMBIA RIVER—sediment kills off salmon eggs.	Mining near SNAKE RIVER creates sediment in streams—Cutthroat Trout eggs die.	Unusually warm summer affects TURQUOISE LAKE. Cutthroat Trout die.
Fire sweeps along COLORADO RIVER—ash and sediment buries Cutthroat Trout eggs.	Inversion due to storm in PACIFIC OCEAN deprives Salmon of needed oxygen.	Storm wrecks tanker on GREAT LAKES—Lake Trout in area affected.
Cool summer retards snowmelt in TURQUOISE LAKE—Cutthroat trout fail to mature.	Hydroelectric dam built across COLUMBIA RIVER prevents spawning migration.	New species of fish appears in PACIFIC OCEAN—Chinook salmon affected.
Construction on shoreline of GREAT LAKES changes bottom substrate—Lake Trout eggs die.	Earthquake near SNAKE RIVER shakes substrate. Cutthroat trout spawning disrupted.	New species of fish introduced into TURQUOISE LAKE—trout eggs eaten!
Oil tanker wreck along coastline of PACIFIC OCEAN reduces Chinook Salmon population.	Mt. St. Helens erupts, sending sediment into COLUMBIA RIVER. Steelhead trout die.	Logging near streams feeding YELLOWSTONE LAKE causes sediment-ation. Trout eggs die!
Surge of industrial construction on GREAT LAKES affects Lake Trout population.	Sudden spring thaw melts excessive snow along COLORADO RIVER. Floods hit cutthroat trout.	Overfishing in ATLANTIC OCEAN causes Atlantic Salmon population to plummet!
Hydroelectric dam constructed on SNAKE RIVER slows water and raises water temperature—trout die.	TETRAPLOID	TETRAPLOID
TETRAPLOID	TETRAPLOID	TETRAPLOID
TETRAPLOID	TETRAPLOID	TETRAPLOID

Anatomy

How Do Trout Breathe?

Grade Level: 6-8, but can be adapted for younger grades.

Bloom's Cognitive Domain: Knowledge/Application, Level 1-2

NGSS Reference: 4-LS1-1, MS-LS1-3

Goal: To understand how dissolved oxygen (DO) passes from water into a trout's bloodstream. Trout, which require larger amounts of DO than other species of fish, prefer to live in cold, fast-flowing streams and rivers. They maximize the efficiency of their gills by generally facing into the stream, which allows DO to pass over their gills at a faster rate than in slow-moving or still water.

Objective: Students will explain how and why molecules of oxygen are picked up more efficiently by a trout's gills when the trout is facing upstream in a fast-flowing brook or stream.

Activity: Teacher hands out and reviews "How Do Trout Breathe?" with students. Concept of dissolved oxygen pickup by gills is reinforced by the following hands-on activity.

Oxygen Pickup

Materials needed:

- 2 dozen ping pong balls (or as many students as you have in your class) each labeled "O2" or "Oxygen" in magic marker
- A small box or bag, large enough to hold the ping-pong balls
- A stopwatch
- Optional: Props such as a crown of red construction paper or some other way to designate the student who represents the gills; blue streamers to designate students who represent water.

One student is selected to be the gills. His/her job is to collect the ping pong balls as quickly as possible and put them in the box s/he carries. All other students represent water carrying dissolved oxygen (ping pong balls). Teacher times the activity using a stopwatch. With a class of about 20-25 students, the first round should take less than two minutes.

ROUND ONE: "Water" students make a circle in the room, preferably around the perimeter. When the signal is given to begin, they walk (no running!) in that circle around the room in a clockwise direction. Student representing gills also walks clockwise in the same circle, collecting the ping pong balls from the other students and putting them in the box as quickly as possible. Teacher uses the stopwatch to time how fast it takes the ping pong balls to be collected.

ROUND TWO: Select another student to be the gills. Students make a circle but walk in a counterclockwise direction around the room. "Gills" walks in a clockwise direction and collects the ping pong balls. Teacher uses the stopwatch to time how fast it takes the second "Gills" to collect the balls. (It should take far less time.)

WRAP-UP: Have the students compare the results and discuss why "gills" could pick up the same amount of DO in a shorter time. Have students discuss whether trout can breathe better when they are moving or holding still; also what strategies trout have developed to keep water circulating over their gills while holding still in the water.

Activity: Students draw a diagram showing how water is picked up by a fish's gills in a flowing stream as opposed to a body of still water. Students also write a short description of what happens and why the amount of DO picked up increases when the fish is facing upstream. Students with written language disabilities can dictate their responses to a scribe. Diagram and written piece will be graded according to the following rubric:

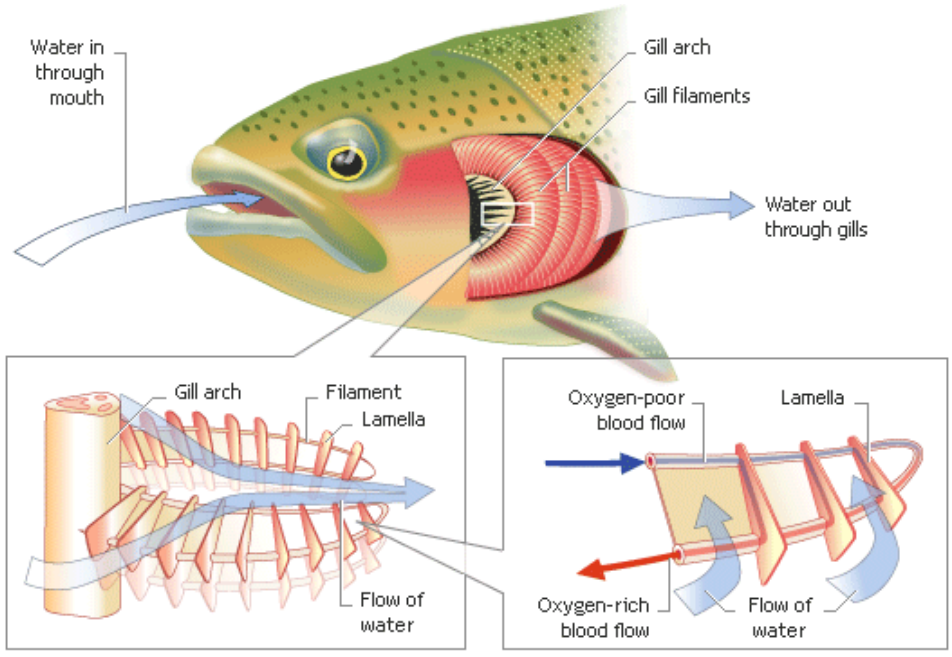
	10	8	6
Diagram	Diagram clearly shows direction of water current with respect to trout (in at mouth, out through gill cover), presence of DO and action of trout gills	Diagram shows water current and trout but no correct representation of water passage through trout	Diagram shows water and trout but doesn't show current or how water passes over gills; poor labeling, no reference to DO
Written Piece	Describes how water passes through trout & how DO is picked up by gills and why this happens more quickly when trout is headed upstream; mentions parts per million of DO in water	Mentions water and that DO is picked up by the gills, but does not explain how this is increased by trout heading into current	Mentions that trout live in water and breathe air but doesn't explain how DO is picked up by gills or how direction of current affects amount of DO picked up.

Extension: Students can explore whether Harry Potter in "The Goblet of Fire" could have actually "breathed" enough oxygen underwater for an hour to keep himself alive using gills.

HOW DO TROUT BREATHE?

Like all fish, trout breathe oxygen that has been dissolved in the water around them. Oxygen gets dissolved into water when plants give off oxygen underwater, or when water is splashed around by waves or waterfalls.

To breathe the oxygen, fish have organs called **gills**, located behind their heads. A cover, called the **operculum**, protects the gills from injury. But the operculum can be opened to allow water to come in through the fish's mouth and pass over the gills. The **gill arches** enable the fish to hold its gills open and allow as much water as possible to flow over them. (Image: www.myuniversalfacts.com)



Just in front of the gills is the **gill raker**, a gill part that acts like a comb. It removes sand, sticks, or plant matter or other debris from the water so the gills don't get damaged.

The most delicate parts of the gills are the **lamellae** and **filaments**. These are membranous structures that hold a capillary network. Blood flows through the capillaries. As the water flows over the lamellae, dissolved oxygen from the water passes through the membrane into the bloodstream. Then as the water continues to flow over the lamellae, carbon dioxide from the blood passes through the membrane into the water.

To get as much oxygen from the water as possible, trout swim against the current. Water flows more rapidly over the gills, allowing the dissolved oxygen to be collected more quickly than if the trout was at rest in the water, or was swimming with the current.

JUST HOW MUCH OXYGEN IS THERE IN WATER?

Dissolved oxygen (DO) is measured in **milligrams per liter**, or **parts per million (ppm)**. A trout likes to have a DO level of 8-10 ppm.

How does that compare to oxygen levels in our atmosphere?

One problem in comparing dissolved oxygen to atmospheric oxygen is that water is not a gas, like the rest of the atmosphere is. 21 percent of the atmosphere is oxygen, but it is mixed not with water, but other gases. The rest of the atmosphere (79%) is mostly nitrogen, but the atmosphere also contains other gases such as argon, carbon dioxide, and ozone.

Water is a liquid, about 800 times as dense as air. This means there are many more water molecules in one liter of water than there are gas molecules in a liter of air. When you adjust for the density of water, it turns out that there is about 20 times more oxygen "dissolved" in the atmosphere than there is oxygen dissolved in water.

WHY DO TROUT BREATHE SO MUCH LESS OXYGEN THAN WE DO?

A trout's gills take in about 80% of the dissolved oxygen they find in water. By contrast, when we breathe, our lungs only pick up about 25% of the oxygen we actually inhale. But because the atmosphere is so much richer in oxygen, it means that overall our lungs take in with each breath much more oxygen than a trout's gills.

Oxygen is needed by animals in order to burn food for energy. Trout do not need as much oxygen as mammals do, because they are **ectothermic** (cold-blooded). They burn food for energy to grow and move, but they do not burn food just to keep their bodies warm. On the other hand, we need lots of oxygen because we are **endothermic** (warm-blooded). Just to stay alive, we must also burn energy in order to maintain our body temperatures at a constant rate.

Activity created by: Mary Jolles, Colebrook Elementary School, for NH F&G Trout in the Classroom program, for educational use only.

Classification

To Tell The Trout

Grade Level: 3-8

Bloom's Cognitive Domain: Knowledge/ Understanding/ Application/ Analysis (Levels 1-4)

NGSS Reference: 3-LS3-1, MS-LS4-4

Goal: Students will become generally familiar with factual information about four species of trout. Information includes description of habitat, diet, notable physical characteristics, country or region of origin, native or invasive, spawning season, and other names the species is known by (e.g. nicknames).

Objective: By the end of the activity, students will be able to identify Rainbow Trout, Eastern Brook Trout, Cutthroat Trout or Brown Trout by asking critical questions about specific factual information regarding each trout species, and will compare and contrast their characteristics.

Activity:

Materials needed:

- Game cards (can be created by reproducing pages at end of lesson plan, using 5 X 7 cards).

Competitive game, "To Tell the Trout." This activity can be played by an entire class, or by multiple groups of 3 or 4 students paired up with another group of 3 or 4 to play against each other. In this last case, teacher will need multiple sets of cards. Teacher should lead the class in a quick review of the information on the back of each card before playing. OPTION: Teacher may remove Cutthroat Trout from the set if class is focusing on only trout common to eastern US.

3 (or 4) players are different "trout" and stand side by side facing the class. Remainder of the class remains seated. Each "trout" player holds a card with blank side facing out, text side toward the body. The text on each card gives information; native region, habitat, diet, spawning period, whether invasive or not, nicknames, and notable physical characteristics, about a species of trout. The three species are: Eastern Brook Trout, Rainbow Trout & Brown Trout.

The class (or other team) may ask ONLY ONE QUESTION of EACH player. The questions must be YES or NO questions. They cannot be answered with any other response from the players. Each question must be different for each player questioned. In other words, a team cannot ask all three players the same question. Teamwork in deciding on the questions to be asked is critical! It is suggested that one person on a team should be selected to ask the questions aloud. If entire class is the team, teacher may select students at random to ask the questions.

Based only on the answers to the 3 (or 4) questions, the other team must figure out which player is holding which species of trout. Points can be given based on which species are guessed correctly: 1 species = 1 point; 4 species = 4 points. Activity should end after 3-4 rounds, but this can be left up to teacher's discretion. A class review of what factual information students learned is helpful, with teacher writing bulleted information on the board or on an overhead for student reference as they complete the assessment.\

Assessment:

Written piece, at least three paragraphs in length, comparing and contrasting specific trout characteristics, behaviors, and regions where they live, using 3 of the trout species in the activity. Use attached rubric to grade the written piece.

Rubric For Assessment

	4	3	2	1
Trout species	All 3 trout species named in activity are used.	Only 2 trout species named.	Only one trout species is named.	Trout are not named by species.
Comparisons	Complete, specific comparisons made between all 3 trout species.	Specific comparisons made between only 2 trout species.	Description of some specific trout characteristics but no real comparisons made.	No comparisons; description of trout characteristics general or vague.
Contrasts	Complete, specific contrasts made between all 3 trout species.	Specific contrasts made between only 2 trout species.	Description of specific trout characteristics but no real contrasts made.	No contrasts; description of trout characteristics general or vague.
Characteristics of trout	3 or more characteristics from the following are used: spawning season, range, native region, specific behaviors or attributes, physical appearance.	Only 2 characteristics from the following are used: spawning season, range native region, specific behaviors or attributes, physical appearance.	Only 1 characteristic from the following list is used: spawning season, native region, specific behaviors or attributes, physical appearance.	Description of trout characteristics general or vague; no specific characteristics described fully.
Organization	Piece is organized in paragraphs where each paragraph compares and contrasts one characteristic of trout.	Piece is generally organized, but comparisons/ contrasts do not concentrate on 1 characteristic at a time for all 3 species of trout.	Piece is fairly organized, but comparisons/ contrasts are random and do not include reference to all 3 species of trout.	Piece is poorly organized, with information/ comparisons/ contrasts random or non-existent.
Grammar and Writing Skills	Complete sentences used, correct grammar, spelling and punctuation, rich language.	Complete sentences used, correct grammar, spelling & punctuation, "bare" language.	Grammar & spelling contains some errors, language lacks descriptiveness or "richness."	Poor grammar & spelling, lack of descriptiveness or richness in vocabulary.

Activity created by: Mary Jolles, Colebrook Elementary School, for NH F&G Trout in the Classroom program, for educational use only.

BROOK TROUT

- Native to Eastern United States
- Inhabits cold freshwater streams, lakes, rivers & ponds, often the only trout species in the water body in NH
- Considered an invasive species in the Pacific Northwest and Rockies
- Nickname “Speckled Trout” or “Squaretail”
- Eats snails, crayfish, shrimp, worms, small fish, beetles, tadpoles & frogs Spawns in October/November

RAINBOW TROUT

- Best-known species of trout worldwide
- Wild species spawns in spring
- Inhabits cold fresh water streams, lakes, rivers & ponds but some types are anadromous
- Originally native to Pacific NW, has invaded habitat of Eastern Brook Trout
- Often found with Brown trout
- Eats snails, crayfish, shrimp, worms, small fish, beetles, frogs, salmon eggs

BROWN TROUT

- Originally a native of Germany and imported to the United States
- Inhabits cold fresh water streams, lakes, rivers & ponds but some types are anadromous
- Often displaces Brook trout in habitat
- Eats snails, crayfish, shrimp, worms, small fish, other fish eggs, bugs
- Spawns in fall
- Very hard to catch—vision is excellent

CUTTHROAT TROUT

- Native to western US and Rocky Mts.
- Discovered & named by Lewis & Clark
- More diverse subspecies than other trout (14 altogether)
- Inhabits cold freshwater streams, lakes, rivers & ponds
- Can live at very high elevations
- Spawns in the spring
- Eats snails, crayfish, shrimp, worms, bugs, other small fish

Habitat

"Connections" Activity (Also called "Snowball")

Grade Level: 1-12 (can be adapted using different word lists)

Bloom's Cognitive Domain: Knowledge & Understanding (Levels 1-2)

NGSS Reference: 5-LS2-1

Goal: Students will understand that living organisms and the different elements of their habitat are connected to each other in many different ways.

Objective: Given two vocabulary words or terms having to do with brook trout and its habitat, students will be able to describe specifically how the two terms are related.

Activity:

Materials needed:

- Set of 3 X 5 cards, each labeled with a different vocabulary word taken from the list at the end of this lesson plan. (Set size will vary according to class size, but suggested set size is 30 cards.)

Each student gets a card on which a word or term related to the brook trout's habitat or life is written. Cards can be distributed randomly by the teacher, or can be placed face down on a table where students can choose at random a card. (Word list follows this page.) After reading his or her card, each student finds another student in the room with a word card which he/she thinks is related in some way to his/her own word card. Teacher then invites students to share the "relationship" they discovered with the rest of the class. A relationship can be simple or complex and there are multiple "right" responses. Cards are then passed in, reshuffled, and distributed once more for another round.

Extension #1:

For students third grade and up, the activity can be made more challenging by having each pair of students find another student pair in the room. They must then describe a relationship between all four terms or words. Students may NOT repeat the two original relationships they described earlier, and must connect all four words with each other.

Extension #2:

For a real challenge, a group of four students can then match up with another four and discuss the 8 words between them. At this point, the teacher tells the students, "Which words in your group describe a general concept or idea? Which words describe something specific? Arrange your words in a pyramid from most general to most specific, and show their relationship."

For example, a group has the following words: brook trout, gravel, parr marks, adaptation, camouflage, water, predator, trees.

Adaptation, camouflage and predator are concepts. These are the most general terms. Brook trout and trees are living organisms. Water and gravel are parts of the habitat. Parr marks are characteristics of brook trout. These are more specific terms.

Of the three conceptual words, which word do the students think is more general than the other two? Why? Have them discuss this. (For instance, "camouflage" and being a "predator," are both "adaptations," so "adaptation" is the most general of all.

Activity created by: Mary Jolles, Colebrook Elementary School, for NH F&G Trout in the Classroom program, for educational use only.

Primary Grades (1-3)

Brook trout
Species
Habitat
Hatchery
Water
Trees
Stream
River
Rocks
Gravel
Shade
Plants
Insects
Camouflage
Adaptation
Survival
Predator
Algae
Dissolved oxygen
Mayflies
Caddisflies
Spawning
Eggs
Fry
Smolt
Yolk sac
Food
Shelter
Pollution
Environment

Middle Grades (4-6)

Brook trout
Salmonids
Habitat
Environment
Ecosystem
Conservation
Hatchery
Adaptation
Survival
Predator
Water
Plants
Decomposition
Bacteria
Dissolved Oxygen
Caddisflies
Mayflies
Spawning
Stages of Development
Developmental Index
Eggs
Yolk Sac
Pollution
Algae
Shelter
Sedimentation
Life Cycle
Stream
River
pH
Watershed
Indicator Species
Temperature

Upper Grades (7-12)

Brook trout
Salmonids
Genus
Habitat
Environment
Ecosystem
Conservation
Restoration
Hatchery
Adaptation
Tetraploidy
Survival
Limiting Factors
Predator
Water
Plants
Decomposition
Bacteria
Dissolved Oxygen
Macroinvertebrates
Spawning
Stages of Development
Developmental Index
Temperature Units
Eggs
Yolk Sac
Pollution
Algae
Shelter
Sedimentation
Life Cycle
Stream
River
pH
Watershed
Indicator Species
Temperature
Nitrates and Nitrites
Metabolism
Ectothermic

Evaluating Riparian Habitat

Grade Level: 4-8 (adaptable)

Bloom's Cognitive Domain: Evaluation – Level 6

NGSS Reference: 4-ESS2-1, 4 ESS3-2, 5-ESS3-1, 5-LS2-1, MS-LS2-1, MS-LS2-5

Goal: Students will learn that brook trout have specific habitat needs: clean, cold water—no pollution, shaded areas, overhanging banks, bushes or fallen trees to provide cover, rapids or waterfalls for aeration, rocks to provide cover, gravel or sandy bottom. Students will also learn that Brook Trout do not live well in streams or brooks where these conditions may exist: pollutants such as runoff from roadways or farm fields, sedimentation/mud due to erosion of the stream banks, no shade at all (unless water is very deep and cold), no cover such as fallen logs, rocks, or overhanging banks, other species of predatory fish such as brown trout and rainbow trout, no rapids or waterfalls to provide aeration.

Objective: Students will name the characteristics of a suitable Eastern brook trout habitat (e.g. cold, clean water, rapids or waterfalls to provide oxygen, overhanging banks, shade, rocky or gravelly bottom). Given a picture or photograph of any riparian habitat, students will be able to explain why the habitat is or is not suitable for Eastern brook trout.

Activity:

Materials needed:

- 20-24 pictures of riparian habitat (take your own)
- Pencil & paper

Divide the group into four or five smaller "teams" (e.g. partners, trios). Give each group a packet of 4 pictures to study. Each picture represents a riparian habitat—a water habitat suitable for aquatic organisms—that may or may not be suitable for brook trout.

STUDENTS:

Using what you know about the needs of brook trout, do the following:

- Discuss the pictures with your teammates. Make a note of any good or bad conditions that may affect the habitat's suitability for trout.
- Then rank the 4 pictures by suitability, #1 being the MOST SUITABLE and #4 being the LEAST SUITABLE for trout habitation.
- Write a response to each picture, giving your REASONS FOR RANKING, e.g. no shade, lots of shade, possible runoff present, rocks and logs in stream for cover, too much sedimentation, etc.
- Share your findings with the other teams.

As an extension, have students consider whether a particular habitat's suitability is dependent upon whether young fry or older trout are going to live there.

Assessment:

Exit card listing the characteristics of a suitable Eastern brook trout habitat. Card can be assessed using a simple rubric from 1-6 based on number of characteristics listed on exit card: (1) Cold water, (2) Clean water, (3) Rapids or waterfalls to provide aeration, (4) Rocks to provide cover, (5) Gravel, sand or rocky bottom, (6) Some shade provided by overhanging bank or fallen trees.

Activity created by: Mary Jolles, Colebrook Elementary School, for NH F&G Trout in the Classroom program, for educational use only.

Fish Kills

Grade Level: 6-8

Bloom's Cognitive Domain: Analysis (Level 4)

NGSS Reference: MS-LS1-6, LS2-4

Goal: Students will learn about how and why large numbers of fish die in "fish kills."

Objective: Given the details of an incident known as a "fish kill," students will be able to identify primary and secondary causes of the deaths, and the impact such deaths have on fish populations.

Activity:

Materials needed:

- 7-8 short news articles on "fish kills" (For articles, go online and google "fish kills.") Read the articles beforehand and choose articles students will not have much difficulty reading. Length of each article should not be more than 1 to 1 ½ pages.)
- Blank copies of visual organizer (template found at the end of lesson plan)

In this reading/language arts activity, students work in groups of two, three or four reading an article and filling out the visual organizer. The purpose of the visual organizer is to help them prepare a short oral presentation to the rest of the class about the article they read. Each group reads a different article about a large number of fish deaths, commonly known as a "fish kill." Fish kills occur frequently, more often than people realize. In most articles, the fish kills were associated with oxygen depletion in the water, which can occur in several different ways.

Assessment:

Completion of visual organizer (attached) which can be graded with a rubric.

Extensions:

Discuss with class the general / specific reasons why the fish deaths occurred. Much factual information will at first seem counter-intuitive to students. We have been taught that plants produce oxygen (which they do) and that the presence of plants in a water body is a good thing for fish. The fact that plants die and decay, and that bacteria consume oxygen as they help plant matter decompose, is not often discussed. The fact that water contains dissolved oxygen, and that cold water can contain more DO than warm water, is also something many people do not know. Students can research fish kills articles by themselves and explore other reasons for this phenomenon. Why does this happen frequently to fish but not often to mammals? Do birds ever suffer mass deaths? Why or why not?

Activity created by: Mary Jolles, Colebrook Elementary School, for NH F&G Trout in the Classroom program, for educational use only.

Fish Kills

Name: _____

Name of Article:

What Species of Fish Died? How Many?

When Did This Happen (date and time of day)?

Where (state, name and type of water body):

Why? What caused the fish to die:

PRIMARY (Immediate) Reason:

SECONDARY Reason (What caused the PRIMARY one):

Supporting details about how the secondary cause occurred:

-
-
-
-

A word we didn't know:	**What it means:**

A fact in this article that we found weird or interesting:

The Invasive Plant Story: Word Connections

Grade Level: 5-6

Bloom's Cognitive Domain: Remember/Understand

NGSS Reference: Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena. (5-ESS1-2)

Goal: Students will understand how to identify invasive plants in the environment and recognize potential invasive plant spread into the ecosystems of the Upper Connecticut River.

Objective: Students will learn basic vocabulary used to identify invasive plants and the terms used to describe invasive plant spread. Given a stack of cards having to do with invasive plant information, students will organize them into three identifying categories: Plant Names, Plant Description, and General Terms.

Activity:

Each group of students gets a stack of cards on which a word or term related to an invasive plants is written. (Supplements for the activity follow this page.) After reading the cards, the group decides which column the cards fit into. Teacher then invites students to share the connection between the groups of words in each column they discovered with the rest of the class. A relationship can be simple or complex and there are multiple "right" responses.

Extension #1:

For students fifth grade and up. Expand the focus of the activity by having students create a list of five additional words for each category. The teacher asks the students to describe the connections between the groups of words they added to each column and the original group of words used.

Activity created by: Eliza Perreault, Trout Unlimited Conservation Technician, Upper Connecticut Home Rivers Initiative, for NH F&G Trout in the Classroom program, for educational use.

Wild Parsnip *Pastinaca satvia*	**Japanese Knotweed** *Polygnum cuspidatum = Fallopia japonica*
Common Reed *Phragmites australis*	**Purple Loosestrife** *Lythrum salicaria*
Honeysuckle *Lonicera spp.*	**Buckthorn** *Rhamnus Spp.*
Garlic Mustard *Allaria petiolata*	**Goutweed** *Aegopodium podagraria*
Yellow Flag Iris *Iris pseudacorus*	**Oriental Bittersweet** *Celastrus orbiculatus*

Biennual	**Perennial**
Tubular	**Seed Dispersal**
Hollow Stem	**Propagate**
Rhizome	**Pith**
Alternating	**Herbaceous**

Invasive Species	**Riparian Area**
Alien Species	**Ecosystem**
Habitat Generalist	**Spread Mechanism**
Ornamental	**Biodiversity**
Vector	**Early Detection Rapid Response (EDRR)**

Plant Names	Botany Descriptors	Environmental Terms

Life Cycle

Calculating Brook Trout Hatching Date Using the Developmental Index

Grade Level: 6-12

NGSS Reference: MS-LS1-5

Goal: To learn that water temperature influences brook trout development, and that we can calculate the rate of growth using the developmental index. EBT hatch when they are 73% developed. When the eggs are "strongly eyed," they are about 47% developed and able to be moved to a cold-water aquarium in a classroom setting.

Objective: Students will use the developmental index, plus a calendar and water temperature data from the fish hatchery, to calculate the hatching date of brook trout eggs.

Activity:

Materials needed:

- Brook Trout Developmental Index
- Growth Chart (included at the end of lesson plan)

Teacher should distribute the developmental index sheet and explain to the class how to read the index. (It may be helpful to discuss with the class that "index" refers to a collection of essential information arranged in a certain order, for instance, alphabetical order or numeric order. The index of a book is usually organized in alphabetical order, and is a list of important concepts, names or references in the book. A telephone book is a form of index. The developmental index for trout growth is a chart with whole degrees on the vertical side, tenths of degrees horizontally, and percent development displayed in the boxes.)

How to calculate rate of growth:

- The numbers in the column on the left side of the chart are whole degrees Fahrenheit.
- The numbers in the row along the top of the chart are tenths of degrees.
- Each day the trout grows a tiny fraction of its total growth. The columns under the tenths of degrees show decimals to the thousandths' place, which is the amount the trout grows in one day at that temperature. This decimal is called the percent development value.
- For example, if the temperature in our tank is 40.6 degrees, you will look across the row from 40 degrees to find the number under 0.6 (it is 0.760). This number, 0.760, is the percent development value.
- The hatchery should be able to tell you exactly how much growth the eggs have made up until the date of arrival in your classroom. Record this on the growth chart on the following page, in the last column labeled "Cumulative % Development."
- Record the date and temperature in the tank each day and find the daily percent development value of the trout's growth. Record the daily percent development value.
- Add each day's percent development value to the previous days and record the cumulative percent development in the last column.

Assessment: After using the developmental index to calculate the hatching date, students should be able to explain how they came up with the answer.

Extension:

Class can discuss ways to avoid a specific date as a hatching date (e.g. school vacation week). This will give further evidence to the teacher that students actually understand how water temperature affects the growth rate of trout.

Activity created by: Mary Jolles, Colebrook Elementary School, for NH F&G Trout in the Classroom program, for educational use only.

Brook Trout Growth Chart

Keep a record of the growth of our brook trout, using the following chart.

- Record the date and daily temperature in the tank.
- Then record the daily percent development value that corresponds to that temperature.
- Add the daily percent development value to the cumulative development in the last column, to see how much growth our brook trout have made.

Date	Temp	% Development	Cumulative % Development

Brook Trout's Life Cycle & Stages of Development

Grade Level: Can be adapted to Grades 3-12

Bloom's Cognitive Domain: Knowledge/ Application, Level 1 & 2

Goal: Students will understand that Brook trout go through multiple stages of growth from egg to adult: (1) spawning/ green egg, (2) "eyed" egg, (3) hatching/alevin, (4) swim-up/fry, (5) parr, (6) smolt, (7) adult.

Objective: Given a description of physical characteristics and behaviors, students will identify a specific stage of development in the life of Brook trout.

Activity:

After reading and discussing a narrative of the characteristics and life cycle of Brook trout (following this lesson plan and written for a Grade 4 reading level), each student will choose a card from a set of cards scattered face down on a table (alternately, teacher can hand out the cards at random). Each card describes a stage of growth in the life of an Eastern brook trout: Spawning/ green egg, "eyed" egg, hatching/alevin, swim up/fry, parr, smolt, adult. Students will then find other students in the class holding cards describing the same stage of growth. Depending upon the number of students in the class, there may be as many as four students in a group with cards describing the same stage of growth. The descriptions are worded differently, so matching them is challenging. (The activity also allows for an extra group with cards describing some of the problems facing EBT populations.)

It is suggested that the teacher adapt the number of cards to the number of students in the classroom. For classes of up to 30 students, the entire pack of cards can be used. For classes of 24-26, remove the cards that discuss issues of habitat quality affecting trout. For classes smaller than 24, remove one card from each developmental stage description if necessary, to get the appropriate number of cards for students to each have one card.

Assessment:

Exit card listing the 7 stages of EBT growth.

Activity created by: Mary Jolles, Colebrook Elementary School, for NH F&G Trout in the Classroom program, for educational use only. .

Brook Trout New Hampshire's State Fish

The Brook Trout is a beautiful fish that lives in the cold, fresh water of eastern North America's streams and rivers. It is New Hampshire's State Fish.

The Brook Trout's spectacular colors make it one of the most beautiful fish in New Hampshire. It has orange-pink fins trimmed with black and white, red spots with blue haloes, and yellowish dots and worm-like markings on its greenish back. Fishermen enjoy catching Brook trout because they are quick, strong, and jump a lot.

Brook Trout belong to a family of bullet-shaped fish called Salmonids. They include trout, salmon, and char. "Trout" is a common name people give these fish, because they all have spots. But some fish called "trout" are not really trout at all. True trout, such as the rainbow trout and the Colorado cutthroat trout, have black spots on a pale skin. Char, on the other hand, have light spots on a dark skin. The Brook Trout is actually a char, not a trout.

Like all salmonids, Brook Trout have a number of fins that help them move with great speed and agility in the water. They have scales that protect their skin. Brook Trout have nasal receptors that sense chemical changes in the water. Their gills allow them to breathe air in the water. Their eyesight is extremely good. They are unusually strong and fast swimmers.

Brook Trout also have sensors located along the sides of their bodies. These sensors are called the lateral lines. The lateral lines allow them to sense motion and vibrations in the water around them.

Brook Trout are very wary. They usually hide under a fallen log or rock in the stream where they live, or even under an overhanging bank. They dart out to snap up an insect or smaller fish, then hide again. Their coloring acts as a camouflage. They are good at holding still and escaping detection by other predators.

Brook Trout are predators and eat many kinds of creatures, mostly insects. Three insects on which brook trout often prey are mayflies, stoneflies and caddisflies. These insects live in the water as babies.

The Brook Trout life cycle starts in November, when a mother Brook Trout digs several nests with her tail in the gravel of a stream bed. The nests are called redds. The mother trout lays as many as 5,000 to 7,000 eggs in these redds. The father Brook Trout fertilizes the eggs with a milky substance called milt. Then the mother Brook Trout covers the eggs with gravel and swims away.

Inside the eggs, the baby trout embryos grow slowly through the winter. The egg membrane is clear and you can see the baby trout growing inside the egg.

In the spring, the eggs hatch. When this happens, foam rises to the top of the water. A newly hatched trout is called an alevin. They are not fully developed and have a large yolk sac on their bellies. The yolk sac is full of nutrition, which they will absorb for about three weeks.

At first, the alevin just lie on their sides. They cannot swim because they have no fins. They have tails, but just little ones. They are not very strong. By instinct, they wriggle under a rock for protection from predators. They remain here for several weeks. They don't need to look for food because they have their yolk sacs.

As the baby fish slowly absorbs the contents of the yolk sac through its bloodstream, it develops all the body parts it will need to survive as an adult fish.

In about three weeks, the yolk sac is used up. The baby trout come out from under the rock to look for food. They have changed! They have a mouth, fins, and a well-developed tail. They even have spots. Now they are called fry.

The little fry develop dark, bar-like markings on their skin, which help camouflage them. These marks are called parr marks. In a few months, when the little fry is three or four inches long, it is known as a parr. The parr also develops orange fins and tail like an adult.

Life is dangerous for a baby Brook trout. In the wild, most of them are eaten by predators. Not many of them survive to adulthood. Only about two of the original thousands of eggs laid by the mother trout will live to adulthood. Those who survive will grow to be about 8 to 10 inches long in a stream or brook.

The Brook Trout is a vertebrate of the genus Salvelinus. Its scientific name is Salvelinus fontinalis.	The Brook Trout is cold-blooded, which means its body temperature is the same as its surrounding environment.
Brook Trout are native only to the eastern part of the North American continent, but they have been imported to other parts of the country, where they are considered invasive.	Brook Trout live in clean, fresh water streams and rivers with a pH of 6.5 to 7.5.
Brook Trout spawn in the fall during late October and early November, when the water gets colder and the days are shorter.	The female releases eggs and the male releases milt simultaneously, to insure fertilization.
The female trout digs a nest in gravel, called a “redd,” in which to lay her eggs.	After fertilization, the “shell” of the eggs harden in the water. Unfertilized eggs turn white.
After several months of development the eggs become “eyed,” which means the eyes of the developing embryo can be seen through the “shell.”	You can also see the spinal column (vertebrae) of the developing baby fish through the membrane.
At this stage of development, the eggs can be moved from one hatchery to another.	Before moving the eyed eggs, hatchery personnel “shock” the eggs, which means they shake them to break any weak or infertile eggs.

Brook Trout eggs hatch in early spring. The young fry are about 75% developed when they hatch. They are about one-half inch in length.	The little fry are called “sac fry” because they have a yolk sac on their bellies which will be their food for the next few weeks.
The little fry or “alevin,” as they are called, have no fins or other fish-like features. They remain grouped together and stay fairly still, sometimes wriggling a few inches.	The little trout tend to stay near a current of water, or huddle together under rocks for safety.
When the yolk sac is gone, the Brook trout fry start looking for food. This stage is known as “swim up.”	At this stage, the little fry are about 1 to 1 ½ inches long. They have dorsal, ventral, and anal fins, and a tiny fin called the “adipose” fin near the tail.
The little fry develop markings—dark vertical bars on their sides. These marks help camouflage the baby fish.	Their first food is a grainy, sand-like feed made of crushed shrimp. The little fry swim up to the surface to feed, but will also eat grains of food off the bottom.
When the young Brook Trout is about 3 inches long it is known as a “parr” because of the dark markings on its sides.	The parr are very quick and will jump or dart when frightened.
At this stage of development, if the fry are being raised in a school or hatchery, they are ready for release into a stream.	They can no longer be caught using the turkey baster, but instead must be caught with a small net.

A teenage trout is known as a “smolt.”	At this stage of development, the fish loses its dark vertical bar markings and develops the beautiful spots of an adult.
This is also the stage of development when a trout “imprints” on the water around it, and develops the ability to “smell home.”	At this time trout will often migrate from one body of fresh water to another, such as from a stream to a river or lake, to spend their early adult life.
As adults, Brook Trout use their nasal receptors to “smell their way home” to shallower streams to spawn.	At this age, trout are territorial—they do not travel in schools, but have a special place in the stream that they guard jealously.
During spawning, the male Brook trout becomes bright orange on the belly and lower sides.	Adult Brook trout are commonly about 5-9 inches long if they live in streams.
Brook trout have been affected by the logging industry, which causes sedimentation in streams, killing the eggs.	Another factor which has affected Brook trout is acid rain, caused by pollutants given off by factories in the Midwest mixing with rain that falls on New England.
Dams have created barriers to migration and Brook trout numbers have dwindled.	Overfishing in the past has diminished the population of Brook trout in the United States.