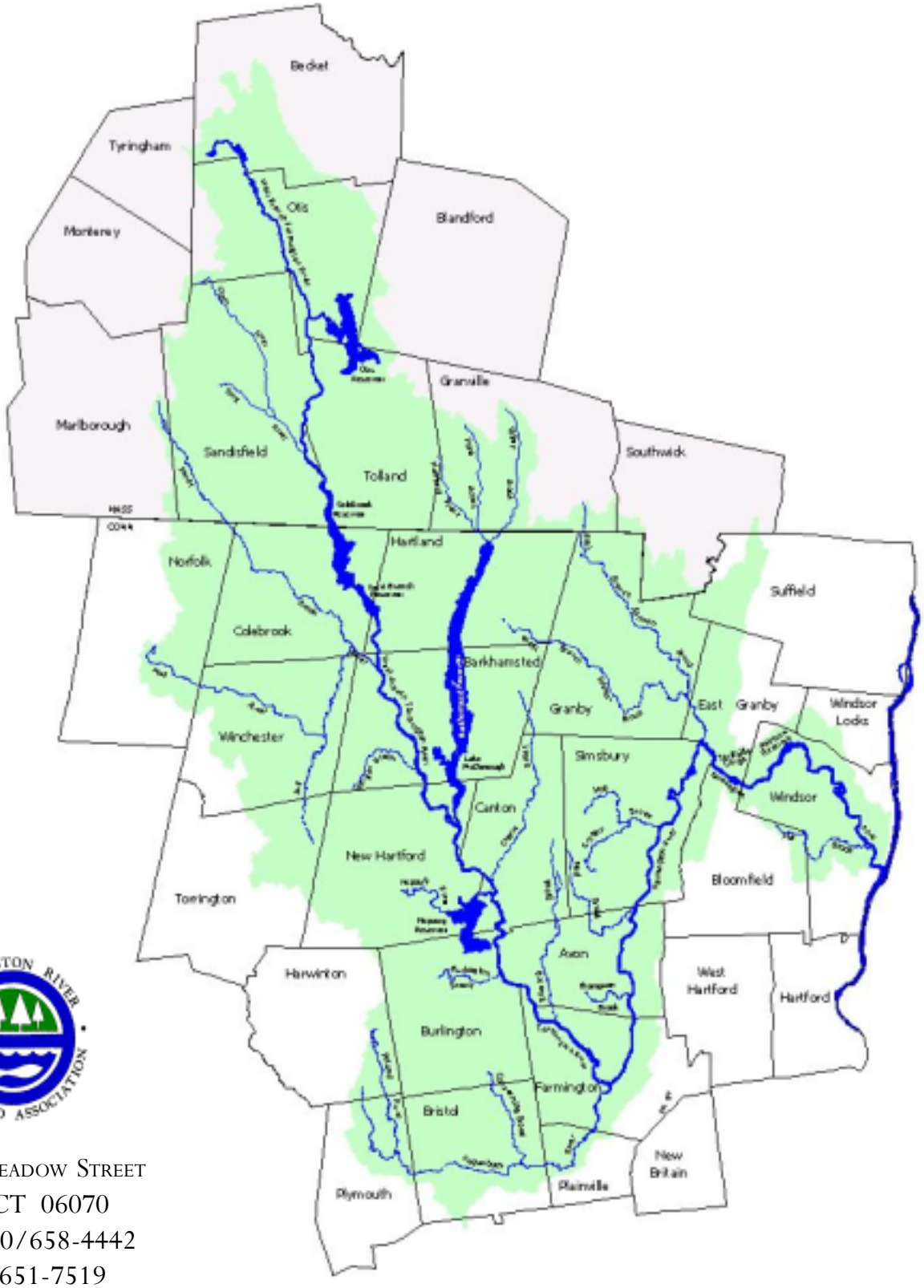
Farmington River Watershed Education Curriculum:

Elementary School



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ACKNOWLEDGMENTS

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INTRODUCTION

The Farmington River Watershed Association (FRWA) has been offering educational programs for schools, civic organizations, and the general public for over 50 years. However, FRWA has typically provided one-day or one-event presentations to meet the specific requests of various organizations. Though FRWA will continue to be responsive to requests from the public, FRWA made a strategic decision to develop materials that could be available to public school teachers who are the most effective day-to-day disseminators of watershed information to children at the elementary, middle, and high school levels.

A strong watershed education curriculum provides a means to help students and teachers better understand the natural world, and to make connections between themselves and the resources they use so that they may make informed decisions and take responsible actions. Most residents of Hartford, for example, don't realize that 100 percent of their drinking water comes from the Farmington River. Indeed, over 600,000 people in the Greater Hartford area and the Farmington Valley receive their water from the Farmington River each year. This means that protecting water quality in the Farmington River is clearly in the region's best interest, but until this connection is made apparent through education, protecting the River will remain a remote rather than an immediate priority. If river protection remains only a priority for environmentalists, the chances of sustaining river protection are greatly reduced. Towns like Simsbury and Windsor have taken efforts to actively recognize the importance of the Farmington River. Hartford students may be least aware of the importance of the Farmington River, but, ironically, depend on it the most.

Why put together a Watershed Education Curriculum?

The following Watershed Education Curriculum was assembled for several reasons:

1) The Farmington River Watershed Association has offered educational programs for over 50 years, but had never assembled a guide for teachers on the Farmington River Watershed. Teachers are invaluable stewards of young minds and a logical choice for effectively disseminating information to students on water;

2) Although there are many water-focused curriculum guides available at the national level – Project WET, Project Wild-Aquatic, the Watershed Educator's Guide, etc. – these guides are most meaningful if they have a LOCAL connection to a LOCAL watershed;

3) Schools and teachers are responsible for meeting state curriculum and core content standards for many subject areas. These materials have been assembled to complement state curriculum standards including the new science core content standards. The following matrix shows where each lesson addresses different content standards; and

4) Innovative teachers are always looking for new ideas, new materials, and new professional development opportunities that might further an integrated approach to science, language arts, social studies, art, and mathematics in their classrooms. This curriculum can be used to replace existing lessons that may not accomplish this goal, or serve as a means to complement existing lessons that do.

How will these materials be made available to schools?

In 2004, FRWA is contacting schools to offer a 15-minute presentation on the availability of the watershed education curriculum materials, OR to offer two hours of teacher training as part of already-scheduled in-service training for teachers at the 2nd, 7th, and 10th grade levels. We recognize that even though we have geared the materials to those grade levels, you may have additional teachers from additional grades who may wish to attend training sessions and/or receive watershed education curriculum materials. FRWA will provide 1 paper copy and 1 CD-Rom copy of the watershed education curriculum materials to each school at no cost. The schools and individual teachers will be responsible for making additional copies and sharing the CD-Rom materials at your school.

How can we learn more about the Farmington River Watershed?

FRWA literally maintains a library of materials on the Farmington River at its office as well as supports staff expertise that we are very willing to share. Please visit our website (www.frwa.org) for an updated list of watershed events and opportunities to learn, or feel free to contact us directly by phone (860/658-4442) or via email (apetras@frwa.org) with questions, to provide input, or to request additional information. If you are interested, of course, consider becoming a member of FRWA to support our ongoing river protection efforts.

What is contained in the Farmington River Watershed Education Curriculum?

The Farmington River Watershed Association partnered with Sotoria Montanari at the Holcomb Environmental Literacy Center in Granby to assemble 30 lessons geared toward 2nd, 7th, and 10th grade teachers respectively. These lessons are grouped into 6 categories: 1) Water, its Uses and Importance; 2) the Watershed; 3) Watershed Ecosystems; 4) Going Back to the Past; 5) Water Pollution and Monitoring; and 6) Water Conservation. The curriculum materials were developed from national environmental curricula such as Project WET, Project Wild-Aquatic, and the Conserve Water Educator's Guide. The curricula is age-appropriate, easy to implement, complementary with state curriculum standards, and is supported by facts and data from the FRWA.

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FRWA Curriculum Guide

Week I – Elementary School

Water

Its Uses and Importance

Water– *Its Uses and Importance*

"It is water, in every form and at every scale, that saturates the mind. All the water that will ever be is, right now." National Geographic, Oct. 1993

Water – nero – vatten – agua – wasser – Water means different things to different people.

To a chemist, water is H2O, a molecule composed of one oxygen and two hydrogen atoms.
To a biologist, water is nourishment necessary for all living things.
To an ecologist, water is a habitat hosting a world of interrelated species.
To municipalities and towns, water is a utility to be managed and sustained.
To a farmer, water is necessary for strong and productive crops.
To a firefighter, water is a useful tool for extinguishing flames.
To a tanker captain, water is a means of transporting goods.
To a young child, water is a refreshing way to cool off on a summer day.
To many areas of the world, water is not as accessible.
To all of us, water is life.

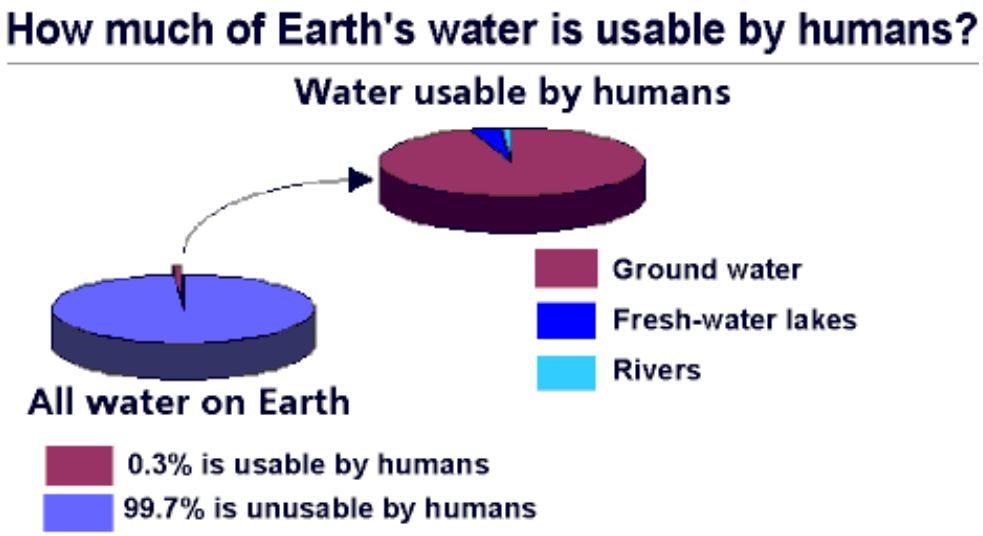
What makes water so important to so many people?

Adapted from Haskin, Kathleen M. Claryville, *1995, The Ways of the Watersheds: An Educators Guide to the Environmental and Cultural Dynamics of New York City's Water Supplies*, NY: The Frost Valley YMCA

BACKGROUND:
Water is essential to all living creatures. It is a precious natural resource, but a limited one. Although the earth is 75% water, it is not all available to us. The global distribution of water breaks down as follows:

Water source	**Water volume, in cubic miles**	**Percent of total water**
Oceans	317,000,000	97.24%
Icecaps, Glaciers	7,000,000	2.14%
Ground water	2,000,000	0.61%
Fresh-water lakes	30,000	0.009%
Inland seas	25,000	0.008%
Soil moisture	16,000	0.005%
Atmosphere	3,100	0.001%
Rivers	300	0.0001%
Total water volume	**326,000,000**	**100%**

Source: Nace, U.S. Geological Survey, 1967 and
The Hydrologic Cycle (Pamphlet), U.S. Geological Survey, 1984



This means that there is less than one percent of fresh water available to us for drinking, washing, brushing our teeth, etc.

Some interesting water facts follow:

- There is approximately the same amount of water on Earth today as there was when the Earth was formed. Water is continually recycled in the Earth's hydrologic cycle. The dinosaurs once drank the same molecules as those that are from your faucet.
- The human brain is 75% water.
- Each day, the sun evaporates 1,000,000,000,000 (one trillion) tons of water (United States Geological Survey).
- At least one billion people must walk three hours or more to obtain drinking water (National Geographic Society).
- One inch of rain falling on one acre of land is equal to about 27,154 gallons of water (United States Geological Survey).
- The 250 million residents of the U.S. have access to the same amount of fresh water as residents did 200 years ago, when the population was four million (National Drinking Water Alliance).
- One percent of the water on earth is available for human consumption.
- Seventy – five percent of a living tree is water.
- You can survive a month without food, but only 5 to 7 days without water.

Food Facts:

1. It takes **6 gallons** of water to make **one order of french fries.**
2. More than **2,600 gallons** of water are needed to produce **one serving of steak.**
3. The average American consumes **1,500 lbs. of food** annually. It takes **1.5 million gallons** to produce food for just one person!
4. Approximately **6,800 gallons of water** are used to feed a **family of four** for one day.
5. **100 gallons** of water are needed to grow **one watermelon.**

Environmental Facts:

1. Only 7 % of the country's landscape is considered riparian, or alongside water— only **2 % of which still supports riparian vegetation**.
2. Of the 1200 species listed as threatened or endangered, **50% are dependant on wetland habitats.**

3. Freshwater species are disappearing **5 times faster** than land animals.
4. **53,000 cubic miles** of water pass through Earth's lakes and streams.
5. If all of the water in the world were to fit in a gallon jug, the available freshwater would equal only **1 teaspoon.**

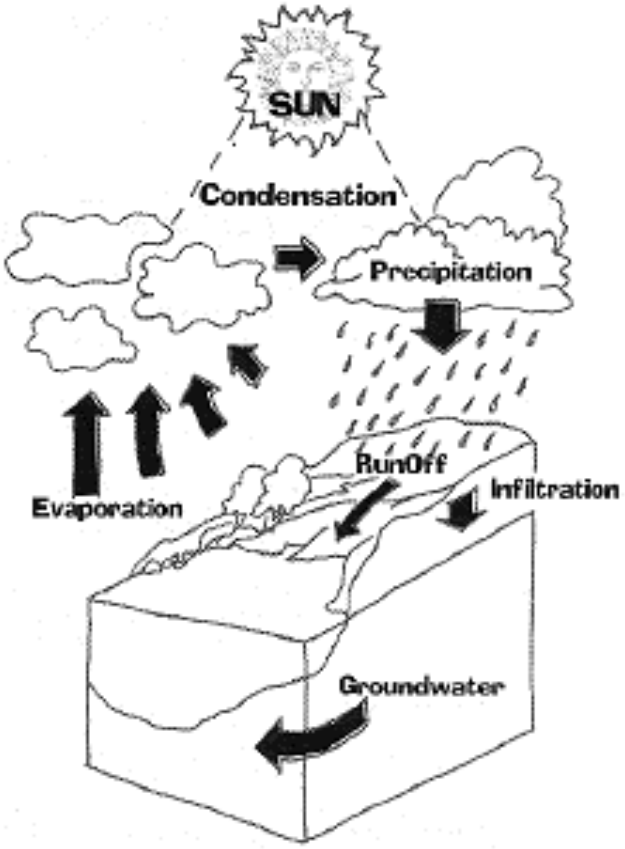
Human Facts:

1. **1.2 billion** of the world's people do not have access to clean water.
2. The United States consumes water at **twice the rate** of other industrialized countries.
3. **6.8 billion gallons** of water are flushed down American toilets each day.
4. **80 %** of freshwater used in the United States goes to irrigating crops and creating hydroelectric power.
5. To survive, the average person needs **2 quarts** of water a day.
6. An average person will drink about 16,000 gallons of water in their lifetime.

THE WATER CYCLE:

The Earth's surface water is recycled among the plants, animals, and atmosphere in a process known as the hydrologic or water cycle. The water cycle refers to the movement of water through the environment by the process of evaporation and condensation. The heat from the sun causes water to evaporate into the atmosphere, and precipitation brings it back down to the earth's surface. The water evaporates, which means that it changes to water vapor. Water vapor rises because it is lighter than cold air. It then cools and turns into liquid water, called condensation, and forms into clouds. Eventually, the rains, snow or hail falls (precipitation) and the cycle begins again!

The water cycle controls the distribution of the earth's water as it evaporates from bodies of



Source U.S. Geological Survey

water, condenses, precipitates, and returns to those bodies of water. Water may be used by plants and animals, frozen in glaciers, evaporated back into the atmosphere, or flow through our waterways. Waterways are part of a watershed.

A watershed, or drainage basin, is a region that drains into a particular body of water. It is an area of land where water from precipitation drains into an individual stream, lake or other body of water. It includes all the water, land, animals, plants, and people within a certain area. Any precipitation that falls that is not used by plants, animals, or people, flows into the watershed in a specific manner. The elevations and topography of the land determine the direction and flow of the water. The bodies of water within a watershed all play a part in how the water flows through the watershed.

Water that stays on the surface of the land is termed surface water and water that seeps into the ground is termed groundwater. Groundwater seeps down through the soil until it reaches rock material. The rock material that is below the surface of the Earth is called bedrock. Bedrock consists of many types of rocks, such as sandstone, granite and limestone. As spaces develop between the rocks, water can then accumulate for water storage. Humans play a vital role in the protection of this essential resource.

Farmington River Watershed is a sub-basin of the Connecticut River Watershed. The Farmington River, itself, is a water supply and recharge area for drinking water for over 600,000 people in the greater Hartford region and Farmington Valley. According to the *State of the Farmington River Watershed Report,* dated August 2003, water resources of the Farmington River Watershed provide 100 percent of the drinking water for about 600,000 people in the Greater Hartford area, including Bloomfield, East Hartford, Farmington, Glastonbury, Hartford, Portland, Newington, Rocky Hill, South Windsor, West Hartford, Wethersfield and Windsor. Many of the towns are not located within the watershed, but rely on drinking water stored within the watershed.

Drinking water may be stored in a variety of ways. Reservoirs are one way in which water is stored within the watershed. Dams prevent the flow of water and therefore, collection basins, or reservoirs, are established.

Water travels through an intricate system in order to reach our faucets. Beginning in the northwest hills, two surface water suppliers, Barkhamsted Reservoir and Nepaug Reservoir hold 30.3 and 9.5 billion gallons of water, respectively. Water flows by gravity through pipes to two Metropolitan District Commission (MDC) treatment facilities in West Hartford and Bloomfield which filter 50 and 21 million gallons of water a day. Once treated, this water flows to the towns previously mentioned.

Approximately 90 percent of the towns in the Farmington River Watershed use groundwater as a drinking water supply, with 32 public water supply wells producing about 8 mgd (million gallons per day). In Simsbury, for example, the Aquarion Water Company provides drinking water to approximately 14,000 residents from groundwater. This groundwater is recharged by the Farmington River Valley aquifer that is intimately connected to the Farmington River.

An aquifer is an underground storage area for water. Water in aquifers is stored in spaces or pores of rocks below the surface of the ground. Wells can be drilled into the aquifer and water may be pumped out. Rain can eventually recharge, or add, water to the aquifer. The Farmington River helps to recharge the Farmington River Valley aquifer, but at the same time, the aquifer helps to maintain base flows in the Farmington River. Protecting the Farmington River reduces the pressures on the Farmington River Valley aquifer, and vice versa.

Lesson 1

Water Limits

How much water is available for human consumption?
What are five important uses of water?
What can you do to use less water?

GOAL To understand that water is a finite resource and that 1% is available for human consumption.

OBJECTIVES Students will:

- ✓ identify words associated with water
- ✓ chart personal, family, school and community uses of water
- ✓ understand that water is a finite resource to be protected
- ✓ describe the effects of lack of water

MATERIALS listing paper, pencils, 10 gallon container with water, 3 empty 5 gallon containers, clear containers, measuring cups, eyedropper

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(2,4)**
- **Math 1(4), 2(3), 4(1)**
- **Science 1(2, 3, 7,11), 8(1-8), 9(8), 11(10), 14(8)**
- **Social Studies 13(1)**

VOCABULARY **water (hydrologic) cycle, finite, resource**

PROCEDURES

1. Students will develop a list of words associated with water and its uses. Students will discuss ways water nourishes (*drink on a hot day*), cleans (*washing hands*, *clothes*) and destroys (*floods*). Examples will be given if the students do not elicit the responses from their own discussions.
2. Students will answer the following questions:
   "How do your bodies use water to survive?"
   "How do you use water to play?"
   Students will create a list or chart of words. This activity may be conducted collectively as a class, in groups, or individually.
3. Ask students to think of how they used water during the last 24 hours. (*Students may keep a log of activities from the day before as a homework assignment)* Students may list on a piece of paper. (s*howering, brushing teeth, washing hands*). Have students walk around schoolyard (this will extend the time frame of the lesson) or think of how their school might use water. Have them list on paper (*watering plants around building, washing floors, water fountains, preparation of lunches*).

4. In a larger group or as a whole class the students will discuss how their families and community might use water. Each student will add to their existing list (*washing clothes, swimming, watering gardens, irrigating, washing windows, putting out fires*).
5. Consider using a beach ball that is a globe of the Earth. Have the children toss it from person to person and record where their right or left thumb lands. Is it on Water or on land? Tally responses on the chart paper. They will be able to see that the world is mostly made of water.
6. Read the quote: "There is approximately the same amount of water on Earth today as when the Earth was formed. Water is continually recycled in the Earth's hydrologic cycle (*water cycle*). The dinosaurs once drank the same water molecules that you are drinking today!" Ask students if they believe that statement.
7. Discuss the distribution of water in the world (*refer to amounts provided in background information).* Explain to students that even though they are able to drink and have water each day, there is a limited amount for all of us to share.
8. Present a container filled with 5 gallons of water. This container represents all the water on Earth. Explain to students that most (97.2%) of all the water is contained in the oceans. You may wish to use paper clips or another familiar item that you have 100 of. This is salt water and unsuitable for drinking or irrigating crops, etc. Leave 97.2% of the water in the 5 gallon container by pouring out approximately 2 ¼ cups of water. Place the 2 ¼ cups of water in another five gallon clear container or have a student conduct this part of the activity. This amount represents the total amount of fresh water. However, most of this water is frozen in glaciers and ice caps and is not available to us. Place ½ cup into another five gallon clear container. This is what is left for us to use. Explain that part of this water is trapped underground or is polluted and is therefore unsuitable for drinking. That leaves approximately 5 drops of water for us to use. Place 5 drops of water in another container with a dropper. Have students think of all the ways they used water and refer back to their lists. The five drops represent the water available for all those uses.
9. Now that students are aware of how much water is available to them, have them think of how their day would be without water. What could they not do?

EXTENSIONS

1) Students may use other items to represent different water sources in lesson one. Using 100 as the beginning number, examples of items that could be counted include tooth-picks, pennies, pebbles, candy pieces, etc.
2) Have students think about where their own drinking water comes from. (Refer to back-ground information.) Examples include wells, reservoirs, etc. Can also be a "take home" lesson.
3) Read the following statement: "Farmington River Watershed provides 100% of drinking water to 600,000 people in the Greater Hartford area." How would they think or react differently knowing that how they protect or take care of their water and land could affect the water they drink? Have students discuss in groups and present to class.
4) Is water a renewable or non-renewable resource? Discuss terms.

RESOURCES

Farmington River Watershed Association, August 2003, *State of the Farmington River Watershed Report*, Farmington River Association, Inc.

Haskin, Kathleen M. Claryville, 1995, *The Ways of the Watersheds: An Educators Guide to the Environmental and Cultural Dynamics of New York City's Water Supplies*, NY: The Frost Valley YMCA.

GLOSSARY

finite - having bounds; limited
resource - something that can be used for support or help
water (hydrologic) cycle - the cycle of evaporation and condensation that controls the distribution of the earth's water as it evaporates from bodies of water, condenses, precipitates, and returns to those bodies of water

Lesson 2

Water Reflections

What are some examples of water reflections?
How may water uses be expressed in art?
How may water reflections be expressed in writing?

GOAL To understand that water as a finite resource provides opportunities for reflections and expressions in art.

OBJECTIVES Students will:

- ✓ identify words associated with water
- ✓ reflect on uses and aspects of water
- ✓ create a collage from re-used art materials
- ✓ write a poem or paragraph about the importance of water

MATERIALS 11 x 17 construction paper, oak tag or cardboard, assortment of re-used materials for art, glue, tape, music or sounds of water, book, Water, Water, Everywhere, pencils

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 2(1,2)**
- **Science 1(4), 7(5), 8 (6-8)**
- **Arts 2(3)**

VOCABULARY **collage, reflection**

PROCEDURES

1. Ask students to refer back to water words and uses of water from *Water Limits* lesson. Provide students with a piece of construction paper, oak tag or card board. Explain that they will be creating a collage of water.
2. Explain that a collage is an expression of art. Students use different materials that are glued together onto one sheet of paper, cardboard, etc. to reflect an idea(s) or aspect of water. The artwork should have personal meaning to the students. Have students write the words, "water use(s)" in the middle of the paper.
3. For inspiration, the book, Water, Water, Everywhere, by Mark J. Rauzon and Cynthia Overbeck Bix may be read to students.
4. Have students take time to imagine a favorite memory associated with water. They may think about how water was used and the importance of water.

5. Once they have an idea or ideas, students may use an assortment of materials to form their collage. They may use items that are on hand in the classroom or brought in by students. Examples include pieces of cut up magazine pictures or photos, scraps of construction paper, Styrofoam pieces, scraps of cloth material or any other re-used material.
6. Have students place a variety of items on paper to form a collage or piece of artwork that reflects water usage. Students may glue, staple or tape items onto the paper.
7. After creating their artwork, students may write a poem or a few sentences explaining the importance of water.
8. Listening to soothing, recorded sounds of a river or other calming music may provide motivation to the students.
9. An example of a type of poem that may be created:

    a) The Haiku – a Japanese form of poetry that expresses a reaction to nature.

    Ex. Water flows to streams (5 syllables – 1st line)
    Trickling down the mountain tops (7 syllables – 2nd line)
    Calmly forming pools (5 syllables – 3rd line)

EXTENSIONS

1. Have students reflect upon how water can be used for recreational purposes. Have them name and list (swimming, fishing, boating, catching insects, etc.). Have students think of bodies of water around their community that can be used for recreation. What bodies of water are in the Farmington River Watershed that they could use for recreational uses?
2. Have students visit a stream, brook, river, or other type of body of water. Let them listen to the sounds of water and wildlife around them. On a pad, journal, or piece of paper, students can write down their thoughts.

GLOSSARY

collage - an artistic composition of materials and objects pasted over a surface, often with unifying lines and color
reflection - something, such as light, radiant heat, sound or an image, that is reflected

Lesson 3

Water Ups and Downs

What is the water cycle or hydrologic cycle?
Name a body of water (stream, river, brook) that runs through your town or city?
How are clouds and rivers connected in the water cycle?

GOAL To understand that water is a cycle that connects the water, land and atmosphere.

OBJECTIVES Students will:

- ✓ identify different components of the water cycle and how they are connected
- ✓ create a simulated water cycle to observe
- ✓ relate the water cycle to where they live

MATERIALS **water cycle diagram or poster, ball, oak tag or cardboard on which to copy water connections words or cardboard, plastic soda bottle, ice, sand, construction paper, crayons or markers, pencils, permanent marker, lamp (optional)**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1 (9,10,12)**
- **Science 1 (1,2,4,7), 8 (1 - 3,6), 9 (2,8)**
- **Social Studies 10(1)**

VOCABULARY **evaporation, atmosphere, condensation, transpiration, precipitation, run-off, surface water, ground water**

PROCEDURES

Elicit response from students with the following question(s):

1. Have you ever been out in the rain? Do you know where rain comes from? Elicit responses (*clouds, sky, etc*.) Ask if they are aware of where the water goes after it falls on the grass, on the surface of the parking lot, etc. (*Elicit responses of where it might flow – soil, storm drains, rivers.*)
2. Explain that this is part of the water cycle and special "science words" are used to describe this process or cycle.
3. Show poster or picture of water cycle. Draw cycle on board if picture or poster is unavailable to introduce term *hydrologic or water cycle*.
4. Discuss with students that Earth's surface water or rain is recycled among the plants, animals, and atmosphere in a process known as the hydrologic or water cycle. The water cycle refers to the movement of water through the environment by the processes including evaporation and condensation. The heat from the sun causes the water to evaporate into the atmosphere, and then precipitation in the form of rain, snow, sleet, etc. brings it back down to the earth's surface. Drawings and/or acting out the processes

can also help to "depict" the water cycle.

5. Water comes down to earth in the form of rain or other precipitation. Water runoff flows onto surfaces such as mountain or ridge tops in rural areas or parking lots, parks, or streets in more urban areas.
6. Explain that this runoff water may remain on land as surface water in bodies of water, such as lakes, ponds, rivers, oceans, etc. or may seep below the surface water into what is termed *groundwater*. Groundwater is below the soil that our feet stand on.
7. Water is also recycled by plants through the process of transpiration. Water is sucked in from ground water by the roots of plants, up the stem or trunk, to the branches, to the leaves and out through the pores (called stomata).
8. Explain to students that they will participate in an activity that demonstrates that the hydrologic cycle is a process that is connected. (*Instructor may copy water words below on oak tag or glue words on pieces of cardboard prior to beginning lesson.*) Students receive a card that has a particular word(s) relating to the water cycle and directions for who they may roll the ball to. Examples of words written on cards are: clouds, precipitation, plants, condensation, evaporation, ocean, river, etc. Have students sit in a circle. Give a ball to the student who will begin the activity. The student rolls the ball to a student that has a card with a word relating to the water cycle that connects the previous word in sequential order. For example, if the first student holds the card with the word *cloud* on it, then he/she may roll the ball to the person that holds a card with the word *precipitation* or *rain.* Or if the first student begins with a card that says *ocean*, then the student with the word *evaporation* might follow. Students participate in this activity until connections to the water cycle are made and students understand that the water cycle connects water, land and atmosphere together.
9. Have students relate the generic bodies of water to areas they are able to associate. For example, the *ocean* may be the Atlantic Ocean, *the river* The Connecticut or Farmington River, etc.
10. To demonstrates the water cycle, cut out the bottom of a soda bottle (1 liter). Set aside. Turn the top of the bottle upside down. Place a screen into bottle (at bottle neck) and replace cap. Fill approximately 2/3rds of the way up with sand. Pour approximately 1/3 of a liter of water into the same bottle. Let the water settle. Using the previously removed bottom section of the bottle, insert it in a cup-like manner into the top of the inverted top section (see diagram on following page). Put crushed ice into bottle bottom (which is at the top of the capped bottle). Set the whole model in the sunlight or by a strong lamp to observe. Students may have to wait overnight for process to occur. (*water evaporation, condensation and precipitation)*
11. Have students write what they think will happen- Introduce the word Hypothesis. Have them write down observations- (review what this means) of water cycle. Label water bottle with permanent marker. Use the following terms: ground water, surface water, evaporation, condensation, precipitation.

EXTENSIONS

1) Have students set out rain gauges (upside down liter soda bottles with bottoms removed may be used) in schoolyard. Label, calibrate and mark inches. Have students record data and graph rainfall.

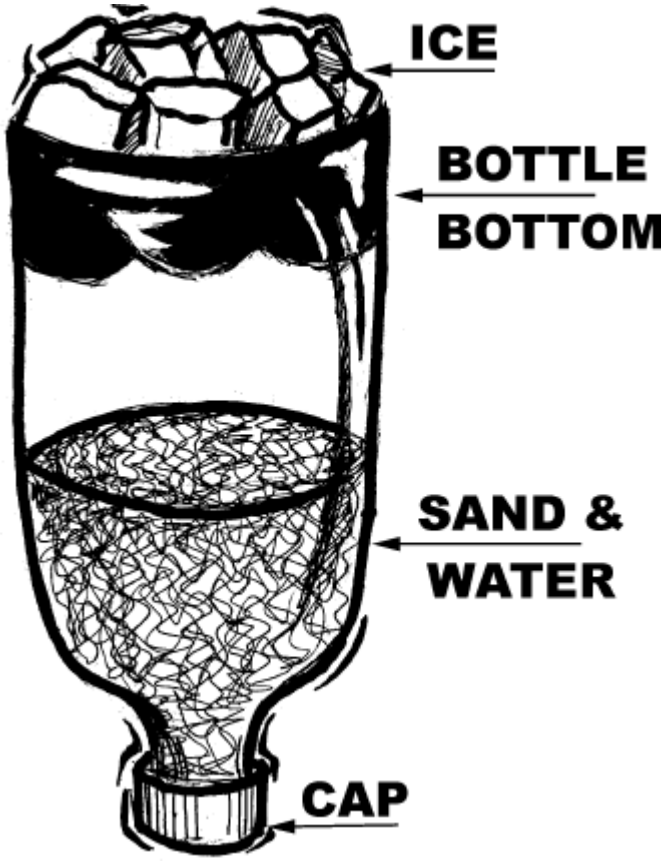
RESOURCES

http://eerc.ra.utk.edu/tnswep/ReuseGuide/watercycle.html. Tennessee Solid Waste Education Project.
http://web.em.doe.gov/soda/cycle.html. U.S. Department of Energy, Office of Environmental Management.

GLOSSARY

atmosphere - the gaseous mass or envelope surrounding the earth
condensation - the process by which a gas or vapor changes to a liquid
evaporation - to covert or change into a vapor
ground water - water beneath the earth's surface, often betewwn saturated soil and rock, that supplies wells and springs
precipitation - any form of water, such as rain, snow, sleet, or hail, that falls to the earth's surface
run-off - rainfall not absorbed by soil
surface water - water above the surface of the ground
transpiration - the act or process of transpiring, especially through the stomata of plant tissue or the pores of the skin

Water Cycle in a Soda Bottle Activity



Procedure:

Cut bottom off a 2L soda bottle, set aside.
Put a screen into the model bottle and put a cap on it.
Fill your model bottle with sand to the 1,000 milliliter mark (approximate, see diagram).
Holding the bottle with your hand or a ring stand, slowly pour in ~200 milliliters of water.
Let the water settle.
Turn the cut out bottle bottom upside down and insert it into the top of the model bottle, so you can add material to the bottle bottom.
Put some crushed ice into the bottle bottom (which is at the top of the model bottle).
Set the bottle in a ring stand in sunlight or beside a strong lamp and observe.
With a grease marker, based on your observations and the descriptions above, label the ground-water model bottle with the following:
Groundwater
Surface water
Evaporation
Condensation
Precipitation
Draw the water cycle on a piece of paper.
Clean up.

WATER CYCLE WORDS

OCEAN	RUNOFF
EVAPORATION	SUN
CONDENSATION	RAIN
CLOUDS	WATER VAPOR
STREAMS	GROUNDWATER
PRECIPITATION	MOUNTAINS
TRANSPIRATION	SOIL
PLANTS	LAKE
TREES	ATMOSPHERE

Lesson 4

Water Wheres

Where does our drinking water come from?
How is water stored?
What type of soil is best suited to contain water?

GOAL To understand that different soils determine the type of storage that is best suited for water.

OBJECTIVES Students will:

- ✓ identify types of water storage areas
- ✓ understand that different soil materials affect permeability of soil
- ✓ determine best soil material for water storage
- ✓ identify difference between reservoir and aquifer

MATERIALS **gravel, sand, clay, three plastic containers, stop watch or second hand on watch, soda bottle, pump spray, straw, rocks, piece of nylon, rubber band**

CORE CURRICULUM CONTENT STANDARDS

- **Science 1(2,7), 7(4,5), 8(6 - 8)**
- **Social Studies 12(5,7)**
- **Arts 6(2)**

VOCABULARY **gravel, sand, clay, aquifer, reservoir, well, permeate**

PROCEDURES

1. Students brainstorm ideas about the source of their drinking water. Have them think about where their water comes from. Identify possible sources for them (*wells, ground water, reservoirs, aquifers*). Explain that drinking water may be stored in a variety of ways. Sometimes water is stored in man-made lakes, called *reservoirs* or underground.
2. Reservoirs are artificial lakes that collect and store water. Dams prevent the flow of water and establish collection basins.
3. An underground spring or storage area is called an *aquifer*. Water is stored in pores and spaces of rocks and gravel. Wells are holes that can be drilled into the aquifer and through which water may be pumped out to the surface. Rain can eventually recharge or add water to the aquifer. Pose the question, “What happens if water is pumped out of the more quickly than it is put in by rain?”
4. Explain that water moves through different materials at different rates of time. For example, water moves through gravel faster than sand and through sand faster than clay. Tell students that they will become soil scientists and test different materials.

5. Have students test different materials to determine how quickly or slowly water is absorbed into soil materials. Place equal amounts of gravel, sand, and clay in three different containers. Pour the same quantity of water into containers and note how quickly (or slowly) the water is absorbed.
6. Based on test results, have students answer following questions:
   - What type of rock materials would be best suited for an aquifer, the best storage capacity for groundwater? (Answer: *gravel – to allow for free flowing of the water)*
   - If you were to drill a well for water, what type of material would be the easiest to drill through? (Answer: *sand – have students experiment by pushing toothpicks through soil)*
   - If they were lining the bottom of a new reservoir, what would be the best material to use? What type of material would be difficult for water to permeate? (Answer: c*lay- have students feel different soil textures with hands to determine which soil is more packed together)*
7. Students or student groups are now prepared to create a flow model that demonstrates the pumping action of a well. Cut a liter bottle in half. Fill one-third with rocks or gravel. Secure a piece of nylon over the bottom end of a pump sprayer with a rubber band.
8. Place pump sprayer into rocks and fill with sand two inches from top.
9. Insert straw into the sand just inside the wall of the container and opposite the pump sprayer.
10. Add water to container, observing how the water affects the water table. This demonstrates the action of wells utilizing groundwater.
11. Use the pump sprayer to withdraw water. Observe the flow of water and drop in water level (around the well) when the water is being pumped out. The water will gradually fill back in once the pumping stops. Record observations.
12. Discuss with students how the well eventually fills up again (*more water added through sprayer or precipitation).*

EXTENSIONS

1. Spill a pollutant (food coloring) into well on top of the sand. Use the pump and observe the reaction of the pollutant.
2. Spray water on top of the sand and observe what happens to the pollutant.
3. Make the same model well with different types of material (ie. silt).
4. Have students place the pollutant through the straw. Spray water and observe what happens.

RESOURCES

Haskin, Kathleen M. Claryville, 1995, *The Ways of the Watersheds: An Educators Guide to the Environmental and Cultural Dynamics of New York City's Water Supplies*, NY: The Frost Valley YMCA

GLOSSARY

aquifer - an underground layer of earth, gravel or porous stone that yields or holds water
clay - a fine-grained, firm earthy material that is plastic when wet and hardens when heated, and widely used in making bricks, tiles, and pottery
gravel - a mixture of rock fragments or pebbles
permeate - to spread or flow throughout; pervade
reservoir - a natural or artificial pond or lake used for the storage and regulation of water
sand - small, loose grains of worn or disintegrated rocks
well - a deep hole or shaft sunk into the earth to obtain water, oil, gas or brine

Lesson 5

Water Reserves

Where does our drinking water come from?
What is the largest reservoir in Farmington River Watershed?
What does the term, "carrying capacity" mean?

GOAL To understand that reservoirs are used to store surface water (water above soil).

OBJECTIVES Students will:

- ✓ identify reservoirs in Farmington River Watershed.
- ✓ add carrying capacities of reservoirs
- ✓ understand that pipes and gravity help water flow
- ✓ understand that drinking water goes through many steps before reaching our faucets

MATERIALS sheet with listing of reservoirs and carrying capacities, raindrop story, pencils, question and answer sheet; reservoir map from CD

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(1,5,7,13)**
- **Math 1(2,3), 2(2)**
- **Science 7(3), 8(2,6 – 8), 9(2), 13(6)**
- **Social Studies 9(3),10(3,4), 12(5)**

VOCABULARY **gravity, wetlands, ridge, turbulent**

PROCEDURES

1. Inquire if students are familiar with the term reservoir. (*stores water*) Determine if they are aware of the purpose of a reservoir and what carrying capacities mean? (*how much water can they hold or carry)*
2. Ask students if they know of any reservoirs close to their homes. Discuss reservoirs that exist in Farmington River Watershed. How big are they? What are their carrying capacities?
3. List reservoirs on the board. Have students add up carrying capacities (*gallons of water*) of all reservoirs listed. (*Listing is provided on separate sheet.*)
4. Discuss the transport mechanism of the water. How is water brought to our homes and faucets?
5. Have students read *raindrop story* or read aloud. When completed, they should be able to answer questions that follow.

EXTENSIONS

1. Have students act out raindrop story.
2. Have students draw the path of the raindrop.

RESOURCES

Farmington River Watershed Association, August 2003, *State of the Farmington River Watershed Report*, Farmington River Association, Inc.

GLOSSARY

gravity - the natural force of attraction exerted by a celestial body, such as Earth, upon objects at or near it surface, tending to draw them toward the center of the body
ridge - a long, narrow upper section or crest
turbulent - violently agitated or disturbed
wetland - a lowland area, such as a marsh or swamp, that is saturated with moisture, especially when regarded as the natural habitat of wildlife

Lesson 5 – Student sheet 1

It happened one rainy day…

I fell to the ground one rainy and cloudy day with a thump and a crash. I was high above the valley looking down over 2,000 feet. Boy, was I scared of heights! I was high up in Becket, MA in Berkshire Hills. Before falling to the top of the mountain, I had been cramped inside the cloud, bumping into other water droplets, when suddenly the cloud burst with water molecules and exploded.

I am a raindrop and I was pounded down into a strange area surrounded by forests, hills, wetlands. It was difficult to catch a view and very slippery. I started to fall. I was sliding, sliding down a high ridge and fell with a plop into the west branch of the Farmington River. What a ride! It was so big and flowing very quickly. I was bobbing up and down, below and above the turbulent, rushing waters. Would I ever be able to enjoy the scenic view? I traveled 16 miles down hill (one of the biggest drops or slides I have been on) and finally entered the state of Connecticut.

I dropped into a huge pool of water, called the Colebrook Reservoir. This is a flood control reservoir and can store up to 32 billion gallons. I was still 1,300 feet high in the town of Colebrook, CT. I was happy here, as the water was flowing much more slowly and I was even here long enough to make a few friends. Within a few days, I was off on my journey again and flowed rapidly through the openings of the dam and continued down the Farmington River. I traveled awhile until I met up with other drops that recently left the watershed's biggest drinking water reservoir, called Barkhamsted. They told me that they floated over 2,276 acres and 30.3 billion gallons of water for weeks. Then they passed by a lot of swimmers and boaters in Lake McDonough.

When I finally left, I was back on the Farmington on my way to the last reservoir, called the Nepaug. This was smaller, holding 9.5 billion gallons of water. It was here that I was pumped into a pipe heading towards Bloomfield or West Hartford. The pipes were long and wide and I was swiftly heading to the last leg of my journey. Gravity carried me to what is called a treatment plant, a place to make me drinkable.

I heard the words, "Turn on the faucet and get yourself a drink," to a small girl as she raced in from soccer practice. Quenching her thirst, I reached my final destination!

Questions:

1) **Where does the raindrop's journey begin?**
2) **How high is the mountain ridge?**
3) **What is the name of the river?**
4) **How long is the river in Massachusetts?**
5) **What is the name of the first reservoir the droplet passed through? How much water can it hold?**
6) **What is the biggest reservoir and how much water can it hold?**
7) **What is the name of the last reservoir and how much water can it hold?**
8) **How was the droplet carried in the pipes?**
9) **What was the final destination of the raindrop?**

Otis Reservoir
5.8 billion gallons

Colebrook Reservoir
32.1 billion gallons

West Branch Reservoir
6.5 billion gallons

Barkhamsted Reservoir
30.3 billion gallons

Lake McDonough
2.9 billion gallons

Nepaug Reservoir
9.5 billion gallons

Mad River Detention Reservoir
3 billion gallons

Highland Lake
482 million gallons

Rainbow Reservoir
4 billion gallons

Whigville Reservoir
37 million gallons

Find the Reservoirs

What do Reservoirs look like?

EXAMPLE OF MAP
SEE CD

FRWA Curriculum Guide

Week II

Watershed

Watershed – Background Information

"The river moves from land to water to land, in and out of organisms, reminding us what the native peoples have never forgotten; that you cannot separate the land from the water, or the people from the land. – Lynn Noel, Voyages Canada's Heritage Rivers

A watershed consists of an area of land and water where water drains into particular water basins, such as rivers, lakes, ponds, wetlands, or streams. It encompasses all the land, animals, plants, buildings, towns and people within the area. The precipitation that falls that is not used by the plants or animals travels within the watershed. Land elevation determines the flow of water, while surrounding ridge areas define the boundaries.

Farmington River Watershed is a sub-basin of the Connecticut River Watershed. All the tributaries of the Farmington River are included in the watershed. The area of land encompasses 386,000 acres, or 609 square miles, which drains into the Farmington River and its tributaries. Included in the watershed are 10 towns in Massachusetts and 23 towns in Connecticut. The Farmington River, in turn, drains into the Connecticut River.

The 81 miles of river begin at an elevation of 2,180 feet in the Berkshire Hills of Becket, MA, traveling 16 miles through Otis and Tolland, and enter Connecticut in Colebrook at 1,300 feet. The west branch river flows through land areas that feature hills, ponds, wetlands and lakes.

The river continues in a southeasterly direction, entering the towns of Barkhamsted and New Hartford. The confluence of the west and east branches occurs, creating the main stem of the Farmington River. As the main stem flows through New Hartford, a deep gorge, known as Satan's Kingdom, results in the formation of significant rapids.

As the river continues downstream, into Farmington, the river turns north and enters a section known as the "bathtub" because of slower, moving waters. It then meanders through Farmington, Avon, and Simsbury. The Tariffville Gorge restricts the flow as the river turns east towars the towns of East Granby, Bloomfield and Windsor. Meeting the Connecticut River downstream of the Loomis Chaffee School in Windsor, the Farmington River has joined the biggest river in New England.

In 1994, the federal government designated 14 miles of the Farmington River as a National Wild and Scenic River. The designation highlights the section from Hartland to the New Hartford/ Canton line as an area of particular beauty, importance to wildlife, and recreational value, and grants federal protection to the river. Visitors canoe, kayak, fish, visit historic mills and state parks, and observe bald eagles and other wildlife that call this section of the river "home".

There are many tributaries and water bodies of the watershed that contribute to the flow and health of the Farmington. Some of the major ones include Otis Reservoir, located in Otis, MA. It was originally a series of three ponds (Messenger, Little, and Rand) until a dam was built in 1865 to provide water to downstream mills. It encompasses1,050 acres and is a vacation spot that offers fishing and camping facilities.

The Clam River, approximately 8 miles south of Otis, supports timbering and fishing industries and has a number of dams for flood control and recreational purposes. Sandy Brook flows in a southeasterly direction from Colebrook, CT and joins Still River between Robertsville and Riverton. The terrain runs through rocky glens or valleys in the Algonquin State Forest.

Continuing south, The Mad River joins Mill Brook above Winsted and contributed to the destruction of Winsted during the flood of 1955. Since then, it has been contained by a flood control dam built under the direction of the U.S. Corps of Engineers. The Highland Lake outlet connects with the Mad River at Winsted and joins the Still River in East Winsted. The Still River also flows through Winsted, connects with Mad River before joining Sandy Brook.

Once a whitewater boating stream, the East Branch originally ran through a deep, forested area. Numerous mountain streams fed into the river, but in 1940, Metropolitan District Commission impounded the entire Connecticut section to create the Barkhamsted Reservoir. Its sole purpose is to supply drinking water to the Greater Hartford area; therefore, no recreational activities are allowed. It still affords a fine view from the Saville Dam.

Below the Saville Dam, Lake McDonough provides a recreational area for boating, fishing and swimming. Cherry Brook flows through North Canton to to the Farmington at the New Harford/ Canton line. Starting in New Hartford, the Nepaug River meanders through open country and woods, flowing through a deep glen to the Nepaug Reservoir. This area comprises another closed reservoir administered by Metropolitan District Commission.

Roaring Brook flows through Secret Lake in Canton into the Farmington in Unionville. The Pequabuck River originates in Harwinton and flows southeasterly through Plymouth, Bristol, Forestville and Plainville. It then connects with the Farmington River in Farmington, reaching its most southerly point. The Talcott Range forces the river to change direction to flow north.

The Thompson Brook flows through Avon into the Farmington and the Nod Brook runs through Avon and Simsbury to join the Farmington at the Avon/Simsbury town line. Stratton and Hop Brook both meander through Simsbury before linking up with the Farmington. The east branch and west branch of the Salmon Brook run through Granby and flow through East Granby before connecting with the Farmington.

The Massachusetts portion of the watershed consists of mostly forested land and hilly terrain. Wetland resources are abundant and current land use is limited to forest and agriculture. Overall, the watershed is rural, but there have been substantial changes in land use in Connecticut as residential development has expanded into agricultural areas. The communities most greatly affected by the change in land use include Farmington, Avon, Simsbury, Bloomfield, and Windsor.

Lesson 6

Water Ways

Where does the Farmington River flow?
Where does the Farmington River meet the Connecticut River?
How can I identify a water body on a map?

GOAL To follow the path of the Farmington River from Massachusetts to the Connecticut River

OBJECTIVES Students will:

- ✓ identify areas on map as they listen and follow instructions
- ✓ become familiar with the flow of rivers
- ✓ understand that land and water are part of the watershed
- ✓ follow a river from a raindrop's perspective

MATERIALS **overhead transparency of map, copies of watershed maps, pencils, markers, relief map**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(12)**
- **Science 7(3-5), 8(2,6), 14(4)**
- **Social Studies 9(3-6), 10(5,6), 11(4,6,7), 12(1-3)**

VOCABULARY **confluence, tributary, watershed, map, border**

PROCEDURES

1. Instruct students to observe map of Farmington River Watershed on overhead transparency. Ask if they are familiar with the term *watershed*. Define watershed for the students (*refer to background information*.).
2. Explain that a watershed consists of an area of land and water where water drains into particular water basins, such as rivers, lakes, ponds, wetlands or streams, etc. Show a relief map if available. Distribute copies of watershed map for students to see.
3. Have students look at map and determine whether they are able to identify rivers, tributaries, reservoirs, lakes by sight. Discuss differences and similarities of how the bodies of water appear on the map. Identify a pond, stream, or a reservoir. (*a stream is narrower, pond is wider as it appears on map).*
4. Show examples on overhead of river and tributaries. Ask if they are able to identify a town. Show an example of a town's border. Continue until you are comfortable with beginning the activity.
5. Explain to students that they are following the path of the Farmington River from Massa

chusetts to where it flows into the Connecticut River. They will be embarking on a journey from Massachusetts to the Connecticut River. They can imagine that they are traveling down the Farmington River as a fish or flying over the river as an eagle or riding in a canoe or raft. They will be traveling 81 miles to get to their destination. Have students refer to map on overhead and match it to their own maps.

a. Read narratives and mark the map as students follow along marking their own maps.
b. Mark an "x" where the west branch of the Farmington River begins (*hint – Becket, Massachusetts at the top left side of map*) Mark area on overhead.
c. Have students follow the Farmington River with their finger or pencil down to Colebrook, CT. Have them mark the wider body of water in Colebrook. This is called the Colebrook Reservoir. Following across the top of Colebrook *(the boundary line or border*) to Hartland and parts of Granby, have them identify the boundary line of Massachusetts and Connecticut. Have the students circle Massachusetts.
d. Return to the Colebrook Reservoir and follow the river south through Barkhamsted to the northeastern corner of New Hartford. This is where the west and east branch of the Farmington River meet. This is called the confluence. Mark an "x".
e. Now the river follows southeasterly through Canton, Burlington and Farmington. A stretch of 14 miles through Barkhamsted, New Hartford, and Canton is designated as a "National Wild and Scenic" section, a designation that recognizes its value to recreation, wildlife and beauty.
f. Still flowing in a southeasterly direction, the Farmington River goes through Farmington and turns to head in a northeasterly direction towards Avon and Simsbury. Place an x on the Simsbury section of the Farmington River. Once past Simsbury, the Farmington River makes a turn in an easterly direction towards Windsor. Place an "x" on the Windsor section of the Farmington.
g. The Farmington River connects with the Connecticut River eight miles from the Rainbow Dam in Windsor. Draw an arrow in the direction of the Connecticut River.
h. Refer to raindrop story in week one, lesson five. Follow the path of the raindrop to the Nepaug Reservoir.
i. The raindrop flows through a piping system to treatment plants in West Hartford and Bloomfield before arriving in Hartford. Instruct students to imagine the path of the raindrop from the reservoir to Hartford and think about how the pipes would flow to the treatment plants and then to a faucet in Hartford. Then, have them imagine the water flowing to Windsor. Discuss the path the water would take.

EXTENSIONS

1. Have the students imagine that they are an eagle. Their nest is located at the Barkhamsted Reservoir. The eagle is traveling over to Simsbury, following the path of the river. Describe what an eagle might see. Have students write what they see from an eagle's view. What does the river look like?
2. Have students trace the Farmington River Watershed map. Eliminate the names of towns, rivers, or reservoirs, but have students write in names of areas.

RESOURCES

Farmington River Watershed Association, August 2003, *State of the Farmington River Watershed Report*, Farmington River Association, Inc.

GLOSSARY

border - a part that forms the outer edge of something
confluence - a flowing together of two or more streams
map - a representation, usually on a plane surface, of a region of the earth or heavens
tributary - river or stream flowing into a larger river or stream
watershed - a ridge of high land dividing two areas that are drained by different river systems

Lesson 7

Water Lines

How is a river formed?
How do hills direct the flow of water?

GOAL To understand that the elevation of the land determines the flow of water

OBJECTIVES Students will:
- ✓ create a model watershed
- ✓ determine flow of water in a watershed

MATERIALS **newspaper (two pieces each student), spray mist bottle, masking tape, permanent markers, water soluble markers**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(12)**
- **Science 7(3,4), 8(2,5,6), 13(6,7)**
- **Social Studies 9(3-6), 10(3,4,6), 11(4), 12(5,7)**

VOCABULARY **ridge line, topography, flow, model, man-made, dam**

PROCEDURES

1. Explain to students that they will be making a simple model of a watershed to simulate or demonstrate river flows. The flow and direction of the water is determined by the elevation of the land. Hills, ridgelines, mountains all influence the flow of water. Students will create a paper watershed (*based on "What is a Watershed?" from Global River's Environmental Education Network*). Students may work in small groups.
2. Each group will receive two sheets of paper. Instruct students to crumple one sheet of paper, then open it up but do not straighten it all the way. Tape the edges of the crumpled sheet to the surface of the other sheet of paper. The model should resemble a relief map. Show a relief map if available.
3. Identify the land that the model represents. The higher elevations are hills, and mountains, and the lower levels represent valleys. Instruct the students to trace the ridgelines (the border) with blue soluble markers.
4. Have the students predict where they think the major rivers might be. Have students mark those areas with permanent markers.
5. Place models on newspaper to absorb water. Provide students with spray bottles. Instruct students to spray mist onto their models. Observe and discuss where the water collected, how it flowed, etc.
6. Ask students how the hills (topography) of the land affected the way the water flowed.

7. If this model included towns, people, parks, etc. what natural elements and man-made elements might these be? (*trees, soil, animals, people are examples of natural elements; buildings, dams, malls, shops, etc are examples of man-made elements.)*
8. Have students imagine that the river has flooded into the surrounding towns. What is a man-made way that a river can be blocked (dam)? Ask students if they know what a dam is and what is its purpose is. Name one dam in the Farmington River Watershed.
9. Have students research the reasons (*on Internet or other resources*) why dams are built. (*flood control, reservoirs for drinking water, hydroelectric power*). Present to class.

EXTENSIONS

1. Ask students what is the highest point of elevation in the Farmington River Watershed. (*2,180 feet in Becket, Massachusetts*)
2. Ask students to determine where they want to live in the model watershed and why.
3. Inquire whether there has ever been a flood in the area or surrounding area. Why did it happen and what was done to prevent another flood?
4. Draw a model of a dam and watershed (three dimensional or on paper).

RESOURCES

Rosselet, Dale A., A Watershed Approach to Teaching the Ecology of Regional Systems, 1999, New Jersey Audubon Society, Bernardsville, New Jersey 07924.

GLOSSARY

dam - a barrier constructed across a waterway to control the flow or raise the level of water
flow - to move or run smoothly with unbroken continuity, as a stream
man-made - made by humans rather than occurring in nature; synthetic
model - a small object, usually built to scale, that represents in detail another, often larger object
ridge line - a long, narrow chain of hills or mountains
topography - graphic representation of the surface features of a place or region on a map, indicating their relative positions and elevations

Lesson 8

Water Connections

How do tributaries connect to the main stems of rivers?
Why is it important to be concerned with all aspects of the watershed and not just where you live?
What is a special aspect of the Farmington River?

GOAL To understand that tributaries of rivers are connected to the main stem of the river and need to be monitored and protected carefully as the main branch.

OBJECTIVES Students will:

- ✓ identify tributaries of the Farmington River
- ✓ understand the "wild and scenic" designation
- ✓ connect the branches to the main stem of the river

MATERIALS **overhead map transparency, copies of watershed maps, pencils, butcher block paper for five groups, markers or crayons**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(12)**
- **Science 1(7), 7(3), 8(2,5,6)**
- **Social Studies 9(3-6), 10(1,4-6),11(4,7,8), 12(1-3)**
- **Art 2(1)**

VOCABULARY **riparian area, buffer zones, erosion**

PROCEDURES

1. Explain to students that main rivers branch out like trees and the smaller parts of the river are called tributaries. The rivers and tributaries are all part of the watershed. Suggest to students that they stretch arms out. Explain that their bodies represent the main stem of the river and their arms represent the tributaries. The streams and brooks are connected to the main branches of the river and need to be monitored and protected.
2. Have students participate in an activity that connects the rivers and tributaries in the Farmington River Watershed. Explain that the quality of river water is dependant on how river or riparian areas are developed. Vegetation and trees around river areas provide buffer zones for waterways. Some of the water flows into the waterways and some of it is absorbed into the soil around it to prevent erosion. These areas are valuable in preserving the quality of water. They also provide habitats to wildlife and recreational opportunities for people living in the surrounding areas. Explain that how the area upstream is treated will ultimately affect the area downstream.
3. Break up students into smaller groups. Distribute copies of watershed maps to students

groups

4. Have student groups read the following clues (a – d) to find the tributaries on the map. Label them. An overhead map transparency may be used to help guide students.
   a. I am called Clam River. I am located in the town of Otis and Sandisfield, Massachusetts. Where am I and where do I connect to the Farmington River? Mark an "x" where I connect.
   b. I am the Pequabuck River. I connect with the Farmington where it makes a "u" turn and flows north. I flow through the towns of Farmington, Plainville, and Bristol. Where do I connect to the Farmington River? Mark an "x".
   c. I am the Nod Brook, Stratton Brook and Hop Brook in Simsbury, Connecticut. Nod Brook flows through the town of Avon too, but Stratton and Hop Brooks only flow through Simsbury. Label where I am and mark an "x" where I connect to the Farmington River.
   d. I am the Farmington River. I am flowing through the town of Windsor. Where do I connect to the Connecticut River? Make an "x".
5. After the student groups have completed this exercise, ask students the following: Knowing that the river and its tributaries are connected, how would that change how they treat all branches of the river and how they think others should treat the river? Have groups discuss and present ideas to the class.
6. Explain to students that in 1994, 14 miles of the Farmington River were designated as "Wild and Scenic". This refers to the particular section of the river known for its beauty, wildlife habitat and recreational value. Visitors canoe, kayak, fish, visit historic mills and state parks, and the river is home to bald eagles and other wildlife. Distribute butcher block paper.
7. Have students draw a river with tributaries in the middle of the sheet of paper. It should resemble a tree. Color river blue.
8. On the sheet of paper, have students draw what "wild and scenic" means. Have students draw vegetation and trees along the river banks.

EXTENSIONS

1. Ask students if they think that homes, businesses or factories are allowed to be built along the 14 mile stretch of the "wild and scenic" section of the Farmington River. Why or why not? Have students work in groups and discuss.
2. Ask students if it is important that we care how communities other than our own develop their towns.

RESOURCES

Farmington River Watershed Association, August 2003, *State of the Farmington River Watershed Report*, Farmington River Association, Inc.

GLOSSARY

buffer zones - an area that lessens or absorbs an impact
erosion - the group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface
riparian area - the vegetative area or bank of a river

Lesson 9

Water Flows

How are puddles and reservoirs alike?
How does water flow differently over grass and parking lots?

GOAL To understand and predict the flow of rain water through observing features of the land.

OBJECTIVES Students will:

- ✓ predict where rain water will form puddles
- ✓ recognize the difference between pervious and impervious surfaces
- ✓ identify causes of erosion

MATERIALS **clipboard, pencils, paper**

CORE CURRICULUM CONTENT STANDARDS

- **Science 1(1,4-7), 7(3,4,7), 8(2,6)**
- **Social Studies 9(3-5), 10(3), 12(1-7)**

VOCABULARY **pervious, impervious, erosion, storm drain, orient**

PROCEDURES

1. Have students refer back to their watershed model. Ask what affected the direction of the flow of water. (*elevations*) Have students walk outside into their schoolyard with a clip-board, paper, and pencil. Students may work in groups or pairs.
2. Have students determine which direction is North. Draw an arrow on the paper and write "N" for the direction of north. Instruct students to draw a square with a flag on top for the school building. Ensure that school building is oriented properly.
3. Have students draw parking lot, field, etc. on their sheets.
4. Divide student into groups or pairs so that different groups are observing different areas of school grounds. Have students predict where the catch basins or puddles will form on the school grounds. Have students mark on their sheets with an "x".
5. After rain (*at a later time or date*), determine whether predictions are correct. Have students check their "x's" to actual puddles.
6. While students are outside, explain *impervious* and *pervious* surfaces. When it rains and the water is able to filter down into soil, then that is considered a pervious surface. If the rain "runs off" into a storm drain and is not able to penetrate or filter down through the surface, it is considered impervious. Ensure that students are familiar with the term *storm drain*.

7. Ask students what areas in the schoolyard would be considered impervious (*parking lot*) and what areas would be considered pervious (*grass, landscaping*).
8. Determine whether they are familiar with the term *erosion*. If there is no grass or vegetation and the soil "runs off" into the storm drain, this is considered erosion. Ask students if they see any potential areas of erosion (*uncovered soil*).
9. Have students mark these areas on their sheets. After rain storm, have students observe where the water flows. Does anything flow with it? Is there any difference in flow between those areas that are pervious and those that are not?

EXTENSIONS

1. Take a walk along the Farmington River bank. Observe if there is erosion or if there is a lot of vegetation (trees, plants). Draw or describe in writing what the bank looks like.
2. Have students look around their houses or apartments. Ask what areas are considered impervious or pervious surfaces. (*Those that absorb water such as grass or landscaping are considered pervious; those that are pavement and water "runs off" are considered impervious).*

RESOURCES

Charles, Dr. Cheryl, Hawksong Associates, Project Wild Aquatic Education Activity Guide, 1992, Council for Environmental Education, Gaithersburg, MD 20878.

GLOSSARY

erosion - the group of natural processes, including weathering, dissolution, abrasion, corrosion, and tranportation, by which material is worn away from the earth's surface
impervious - incapable of being penetrated
orient - to align or position with respect to a point or system of reference
pervious - open to passage or entrance; permeable
storm drain - a storm sewer

Lesson 10

Water Recreation

What type of water-related activities do you enjoy?
What types of water-related activities are available in the Farmington River Watershed?

GOAL To understand that water activities are recreational but require safety measures

OBJECTIVES Students will:

- ✓ identify how they have fun in around water
- ✓ think about how they behave in and around water
- ✓ create a poster that increase water safety awareness
- ✓ write a poem or paragraph about the importance of water

MATERIALS **posters, crayons, markers**

CORE CURRICULUM CONTENT STANDARDS

- **Science 8(6-8)**
- **Social Studies 9(1,5,6), 11(5,7)**
- **Art 1(1-4), 2(3), 5(1)**

VOCABULARY **safety measures, recreation, awareness**

PROCEDURES

1. Begin by asking students if they have opportunities to participate in water-related activities. (*elicit responses, such as fishing, canoeing, water skiing, swimming, etc.)*.
2. Have students list all water-related activities in which they participate. Discuss areas they travel to. Inquire about the type of waterways they visit. (*rivers, oceans, lakes*)
3. Have students think of ways they can enhance their visits and/or activities (*safety precautions, bringing friends)*.
4. Have students discuss ideas about how they can ensure their safety and the safety of others when participating in a water-related recreational activity. Have students break up into groups, provide them with a water activity idea and have them think of ways they can follow safety measures.
5. Give each group a poster board and instruct them to draw and write this information on the poster as a public service message to the rest of the school. Posters may be displayed in hallways or classrooms.
6. Have students refer back to the waterways map of Farmington River. Instruct them to imagine kayaking, canoeing or fishing in particular areas of the watershed. Are there particular areas they would like to visit? Research what the Farmington River has to offer.
7. Have students research the type of recreational water activities in their town and surrounding area and share results with rest of the class.

EXTENSIONS

1. Have students think of a water activity they have not participated in. Think of reasons why not. Have them establish goals and try it (*under supervision and permission of adult*).

2. Divide students into two groups. Give each group cards with water activities and corresponding safety measures. Take turns acting out the activities, with the other group guessing the action.

GLOSSARY

awareness - having knowledge
recreation - refreshment of one's mind or body after work through activity that amuses or stimulates; play
safety measures - device used to prevent accidents

FRWA Curriculum Guide

Week III

Watershed Ecosystems

Watershed Ecosystems Background Information

"For many of us, water simply flows from the faucet, and we think little about it beyond this point of contact. We have lost a sense of respect for the wild river, for the complex workings of a wetland, for the intricate web of life that water supports."
– Sandra Postel, Lost Oasis; Facing Water Scarcity

An ecosystem encompasses a community of plants and animals that can exist simultaneously within a certain area. The health of an ecosystem depends upon the health of the water and the diversity of plant and animal populations is indicative of overall health. Aquatic life supports a variety of life: plants, fish, reptiles, insects, mammals, birds etc. Proper water temperature ranges, preventing erosion along the riparian bans with trees and vegetation, shading effects of trees, fast, moving cool waters with riffles and pools all support a diversity of aquatic life.

Evidence of benthic macroinvertebrates provide an indication of the health of the stream and river. *Benthic* refers to animals that live on the bottoms of streams, rivers, or ponds and spend part of their lives in a body of water. *Macroinvertebrates* do not have backbones and are large enough to be seen without a microscope. Such insects are sensitive to conditions of the water and the existence of certain insects in streams can indicate water quality.

Different organic and inorganic components comprise the ecosystem. The manner in which interaction takes place among these components all contribute to the state of the ecosystem. Organic components include producers, primary consumers, secondary consumers, tertiary consumers, and decomposers. Producers, or plants, make their own food through the process of photosynthesis while plant eaters, also called primary consumers or herbivores, eat the plants within an ecosystem. Secondary consumers, known as carnivores or meat eaters, are predators to plant eaters. Lastly, tertiary consumers are at the top and eat secondary or primary consumers. Also included are decomposers: organisms that return nutrients to the soil to be re-used by the producers. Two examples of inorganic components include rocks and water.

An ecosystem can be represented by food chains, food pyramids, and food webs. A food chain shows the flow of energy through the trophic levels. For example, the sun begins the food chain. Producers are plants that need the sun to make food, consumers eat the plants, and so on. Food chain models demonstrate how energy passes through an ecosystem.

A food pyramid demonstrates the amount of food required to sustain an organism at each trophic level. For example, plants are at the base and obtain their energy from the sun. They are eaten and 90% of the energy from the plant is lost as the consumer uses the energy to survive. As a result, less energy is available to the carnivores higher up on the food chain. Therefore, it takes many plants to sustain fewer herbivores and even fewer carnivores.

A food web, meanwhile, demonstrates the connectedness of all the organisms and illustrates the many possibilities of energy flow. The larger the diversity of organisms within an ecosystem, the better an ecosystem is able to withstand natural or man-made disruptions.

The Farmington River Watershed provides habitats where many species thrive. 400 different animals, inhabit the area between Otis, MA and Colebrook Lake in Colebrook, CT. State-endangered swollen wedge mussel, which are highly sensitive to pollution, bears, beavers, peregrine falcons inhabit this area.

The Barkhamsted Reservoir area hosts bobcat, bear, fisher, and beaver. Beaver were eliminated in the late1800's due to farming and trapping. Additionally, porcupine and muskrat, as well as eagles, turkey vultures, osprey, flycatchers, warblers, swallows, and songbirds have been spotted. Aquatic insects, state-threatened spring salamanders, waterfowl, trout, and salmon abound in the riffles and pools of the river.

In the area of New Hartford and Satan's Kingdom, trout, salmon, beavers, and muskrats can be seen. Cherry Brook provides a haven for songbirds, including cedar waxings, vireos and orchard orioles. Nighthawks, Canadian geese, common and hooded mergansers, and an occasional red-breasted merganser dot the sand bars, as do gulls, and shorebirds. Killdeer, solitary and spotted sandpipers, great blue heron, and great egrets are regulars at the reservoir.

At the Lower Collinsville Dam and in Unionville, songbirds are prevalent. Osprey, otters, mink, eastern hog-nosed snake, and trout are found and in warmer sections of the river, yellow perch, calico bass and other breeds are caught.

Throughout the sixteen mile riparian stretch from Farmington to Simsbury, rare-billed cuckoo songbird, hooded warbler, American woodcock, eastern screech owl, eastern bluebird, kingfisher, willow flycatcher, and orchard oriole are prevalent. Other species of wildlife that inhabit this section of the Farmington include bats, otters, beavers, deer, musk and wood turtles. Painted turtles bask at an oxbow lake and frogs and dragonflies all contribute to the diversity of the ecosystem.

Along the riparian banks of Tariffville, Simsbury, and Windsor, crows, red-tailed hawks, great horned owls, red-wing blackbirds, and great blue herons abound. Additionally, trout are stocked for fishing enthusiasts. Blueback herring, salmon, American shad, alewife spawn at the Rainbow Reservoir in Windsor. Double-crested camorants fly close to water and ospreys, herons, kingfishers, eastern screech owls, red-tailed hawks, muskrats, wood ducks, and leopard frogs can all be spotted.

Because of dam construction and other restrictions to waterways, salmon and other *anadromous (return from the sea or ocean to where they were originally born to spawn)* fish populations have declined. Fish use the ladder at the Rainbow Reservoir as a passageway to return to spawn. In order to promote the proliferation of salmon, CT DEP Whittemore fish hatchery, housed one-mile downstream of the Goodwim Dam, produces 150,000 to 300,000 Atlantic salmon eggs.

Connecticut DEP and its partners continue to help restore Atlantic salmon to the Connecticut River watershed. The program involves incubating Atlantic salmon eggs in a chilled aquarium tank beginning in early January. These eggs were previously harvested from salmon that returned to the Connecticut River. The eggs hatch around mid-February into alevin, a small fish of about one to one and half inches. Supported by a yolk sac (the egg residual), its sole source of food supply, the salmon alevin approaches the "fry" stage at the end of April or early May.

At this point, the sac will be gone and the fish look like streamlined small minnows. The fish are ready for stocking in the Farmington River and tributaries in late April or early May. Many schools participate in programs that involve raising salmon and releasing them into rivers as fry. The salmon restoration project for the Connecticut River Watershed and the subsequent stocking of the Farmington River and its tributaries are helping to retain the salmon and other types of fish in this area.

Lesson 11

Water Creatures

How do insects survive under water?
How are insects indicators of the health of a stream?

GOAL To understand that aquatic macroinvertebrates have special adaptations that allow them to survive in stream waters and determine the health of the stream.

OBJECTIVES Students will:

- ✓ identify special features or adaptations of aquatic insects
- ✓ act out an adaptation
- ✓ create a creature based on an adaptation
- ✓ draw an insect

MATERIALS **pictures of insects on CD, adaptation cards, construction paper, water colors, markers, black permanent marker, materials such as clay, plastic, Styrofoam, paper towel rolls and other re-used materials**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(12), 2(2,5)**
- **Science 3(1-3), 4(1,2), 5(1,4,6), 6(1,8)**
- **Arts 3(1,2), 5(1)**

VOCABULARY **macroinvertebrate, adaptations, metamorphosis, larva, nymph, pupa**

PROCEDURES

1. Benthic macroinvetebrates are animals that live on the bottoms of streams, rivers, or ponds.The term refers to organisms that spend part of their life in a body of water. A macroinvertebrate does not have a backbone and are large enough to be seen without a microscope. Such insects are sensitive to conditions of the water and indicate water quality of the water bodies.
2. Explain to students that they will become water scientists throughout the next two lessons. Their task is to study the water and insects that live there.
3. Lead a discussion on adaptations or special features that help aquatic insects survive in the stream habitat. For example, mayflies, stoneflies and caddisflies have particular features that allow them to live in a river's current. They may flatten their body, have hooks that allow them to grasp onto rocks and/or may encase themselves in houses made of sticks, stones or vegetation.
4. Have students view pictures of different insects (Macroinvertebrate1.pdf, Macroinvertebrate2.pdf and Macroinvertebrate3.pdf). Key to Macroinvertebrate Life in the River available on CD - Macroinvertebrate Chart.gif. Inquire whether students have any

type of insect. Ask students where (*flying, ground, soil, water).*

5. Explain that insects have similar features, such as six legs, wings, head, thorax and abdomen. Have students draw different parts of insects on board to demonstrate.
6. Explain that some insects are born in the water and live the first part of their lives there.
7. Explain the process of metamorphosis. Some of the insects undergo complete metamorphosis and others undergo incomplete metamorphosis. Complete metamorphosis is when the insect is transformed from the beginning stages to adult. The insect life cycles through the following four stages: egg, larva or nymph, pupa and adult. Incomplete is when the young stage of the insect's life resembles the adult stage. The insect is smaller than the adult, but is not completely transformed or changed. Refer to metamorphosis diagram on CD - Insect Lifestyle.pdf
8. Pair or group students and distribute two aquatic creature adaptations. Explain that the adaptations pertain to the larva or nymph stage of the insect's life. Its special adaptations apply to water habitats.
9. Adaptations may include how the insect moves, breathes, swims, or eats. Examples of adaptations include a flat body, constructs its own house, sticks to rocks with special hooks, has three tails, fills up with water and expels out of abdomen and propels itself through water, breathes through gills, etc. (*Adaptations are listed on a separate sheet for teachers to copy and cut out for students. As you learn more, you may wish to make your own).*
10. Have students act out their adaptations, while the rest of the class tries to guess the adaptation. List adaptations on the board.
11. Once students have an understanding of the term "adaptations", have them create a creature based on these adaptations. Have students draw and color with markers or crayons or build a three-dimensional creature with Styrofoam, clay, cardboard, plastic, construction paper, etc.
12. After making their insect, have students name and write a paragraph about their creature. Have them include their special feature and how it allows it to live in the stream or other type of body of water.
13. Have students think about which insects indicate healthy water habitat. (*caddisflies, mayflies, stoneflies*)

EXTENSIONS

1. Instruct students to imagine they are sitting on the bottom of a clear, cool stream. The water is flowing rapidly. There are fish, aquatic insects, plants and many other living creatures in this clean water. Draw or describe in writing what it is like at the bottom of the stream. Have them think about where they are sitting and the type of aquatic life there.
2. Now instruct students to imagine they are sitting in the same stream. The water is murky because a tree has fallen and the soil has eroded away from the side of the banks. Ask what it look like and how it feels. Have them draw a picture and write about their feelings or reflections.

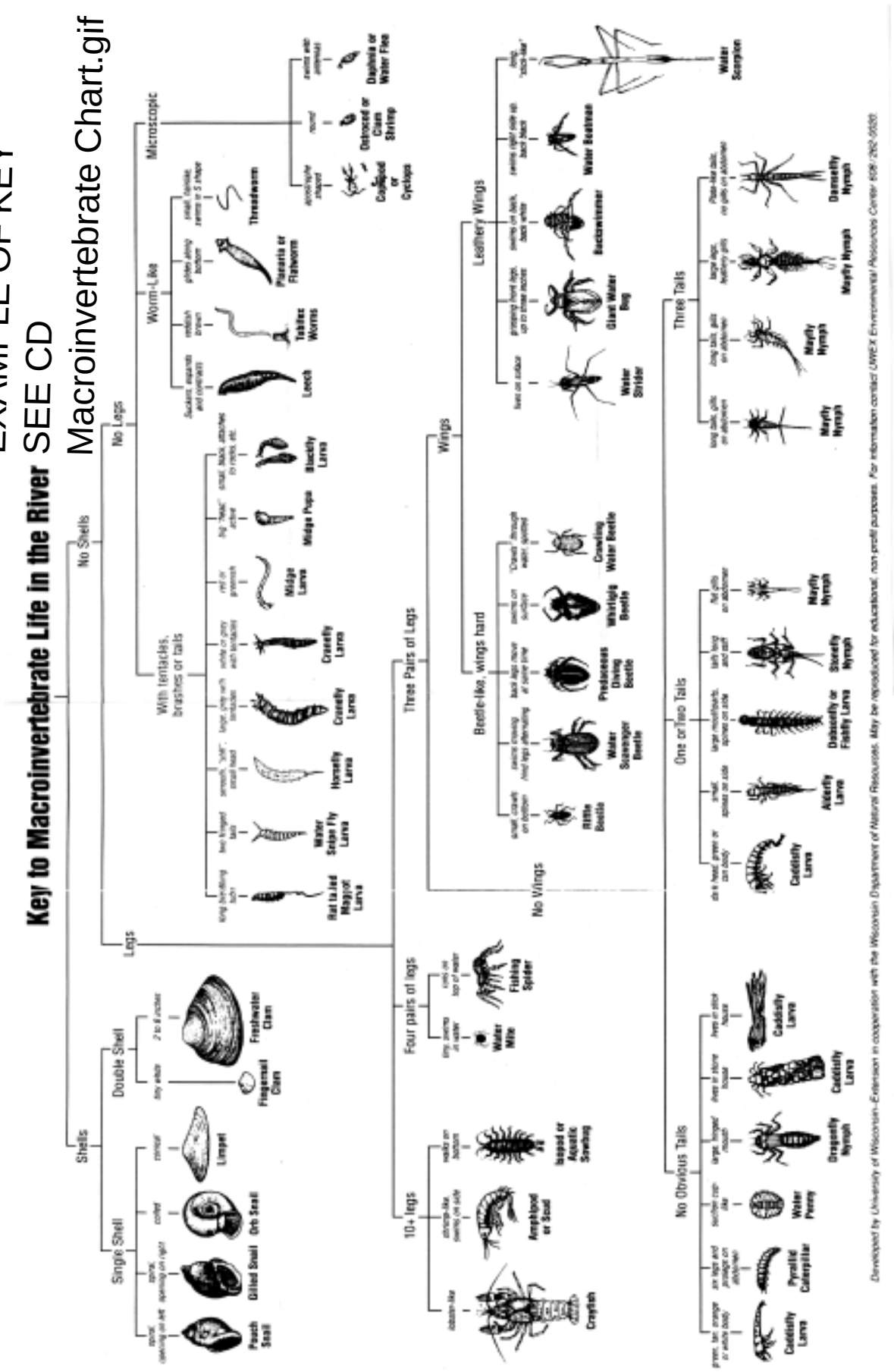
RESOURCES

Edelstein, Karen, *Pond and Stream Safari: A guide to the Ecology of Aquatic Invertebrates*, 1993, Cornell Cooperative Extension.
http://www.bellmuseum.org/mnideals/macroinv3.gif, Key to Macroinvertebrate Life in the River
http://www.kidfish.bc.ca/frames.html, Caddis Life Style and Cases

GLOSSARY

adaptations - special features that allow an organism to survive in its environment
larva - the newly hatched, wingless, often wormlike form of many insects before metamorphosis
macroinvertebrate - an invertebrate animal (animal without a backbone) large enough to be seen without magnification
metamorphosis - a change in the form and often habits of an animal during normal development after the embryonic stage
nymph - the larval form of certain insects, such as silverfish and grasshoppers, usually resembling the adult form but smaller and lacking fully developed wings
pupa - the intermediate stage of a metamorphic insect

EXAMPLE OF KEY
SEE CD
Macroinvertebrate Chart.gif



Macroinvertebrate Insect Adaptation Cards

MOVES BY EXPELLING WATER

Dragonfly nymph

LIVES IN A PROTECTIVE HOUSE

Caddisfly larva

HAS BREATHING GILLS

Damselfly nymph, Mayfly nymph

HAS A FLAT SHAPE

Mayfly nymph, water penny

HAS A BIG APPETITE

Dragonfly nymph

AVOIDS BRIGHT LIGHTS

Stonefly nymph, Caddisfly larva

USES ITS BIG JAWS TO EAT

Dragonfly nymph, Dobsonfly larva
Damselfly nymph

NEEDS A LOT OF OXYGEN IN WATER TO LIVE

Mayfly nymph, Stonefly nymph,
Caddisfly larva

HAS BREATHING GILLS

Damselfly nymph, Mayfly nymph

WALKS ON WATER

Water Strider

INJECTS CHEMICALS TO CAPTURE PREY

Water strider

IS CAMOUFLAGED

Stonefly, Mayfly,
Dragonfly nymphs

Lesson 12

Water Finds

Why do we examine aquatic insects?
Why are they important to determining the health of the stream?
What other observations about the stream indicate health?

GOAL To understand that aquatic insects determine health of stream.

OBJECTIVES Students will:

- ✓ identify names of aquatic insects found
- ✓ work together to search for and collect insects
- ✓ use equipment in the proper manner

MATERIALS plastic containers, clipboards, worksheets, pencils, magnifying lenses, biotic index sheets, wading boots (optional)

CORE CURRICULUM CONTENT STANDARDS

- **Math 1(2,3), 2(2), 7(1), 10(1)**
- **Science 3(1-3), 4(1-3), 5(3-7), 6(1)**

VOCABULARY **biotic index, magnify, identify, observations, macroinvertebrates, pollution tolerance index**

PROCEDURES

1. Select a site for a field trip within the watershed. Have students study site to determine health of stream by examining *macroinvertebrates* found there.
2. Prior to site visit, determine safety considerations and access to stream.
3. Upon arriving at site location, distribute equipment and explain protocol.
4. Have students search for and identify aquatic insects. Have them conduct search with smaller groups with an adult leader.
5. Instruct students to look under rocks, in vegetation and bottom of streams. Have them use plastic containers, nets, clipboards, pencils and biotic index sheets. Provide wading boots, if available.
6. Explain to students how to use magnifying lenses or pocket scopes to observe some of the smaller insects.
7. Ensure that students put water in plastic containers and place macroinvertebrates there for further study.
8. Have students record insects on macroinvertebrate identification sheet and draw it.
9. After insects are identified and studied, have students return them to stream.
10. Explain identification process to students. Have students use the biotic index key to determine macroinvertebrate species found. Have them determine the pollution tolerance index by multiplying index value by number of species. (Sheet at end of lesson) This will help students determine health of stream.
11. Have students release macroinvertebrates into stream.

12. Discuss finds with students and determine health of stream.
13. If students are not able to visit a stream or as a follow-up activity, have students participate in a simulated stream field trip.
14. In the classroom, have students imagine they are going on a field trip to a stream bank. Have them "walk" down to the edge of the stream and listen to the ripples of the water. Instruct them to imagine the current of the stream flowing rapidly over the rocks and carrying cool, clear water downstream.
15. Have them draw a picture of the stream bank. Have them reflect on how the stream looked they had previously observed or have them imagine a healthy stream.
16. Once completed with their drawings instruct students to listen to two descriptions of insects to identify. Have them use on-line dichotomous key to determine insect type. http://www.people.virginia.edu/~sos-iwla/Stream-Study/Key/MacroKeyIntro.HTML
17. Descriptions are
    a. insect has segmented legs, six legs, long body, 3 tails, and gills (*mayfly*)
    b. insect has segmented legs, six legs, long body, no tail, hard, wide abdomen and large eyes (*dragonfly*)
18. Have students find web-site and click on components of (a): segmented legs, six legs, long body, etc. to identify mayfly. Have students click on components of (b) to identify dragonfly.

EXTENSIONS

1. Have students use water thermometers to take temperature of water. Ask what conclusions they can infer regarding the temperature and insects that live there. Ask if the insects require a cool or warm environment.
2. Have students ponder what the absence of insects indicates about the stream. (*problem with water quality)* Ask students if the stream had only one type of insect what does that indicate.

RESOURCES

Edelstein, Karen, *Pond and Stream Safari: A guide to the Ecology of Aquatic Invertebrates*, 1993, Cornell Cooperative Extension.
Etgen, John E. and Garver, Keri, *Healthy Water, Healthy People, Water Quality Educators Guide*, 2003, The Watercourse, Bozeman, Montana 59717-0575.
http://fluvarium.ca/bioticindex.html, The Fluvarium, St. John's, Newfoundland.

GLOSSARY

biotic index - an index of or having to do with life or living organisms
identify - to ascertain the origin, nature, or definitive characteristics of
macroinvertebrate - an invertebrate animal (animal without a backbone) large enough to be seen without magnification
magnify - to increase the apparent size of, especially by means of a lens
observations - the act or faculty of observing
pollution tolerance index - a measurement of how much pollution an organism may bear or tolerate

Macroinvertebrate Identification Chart

Macroinvertebrate	Count		Index Value
Sensitive			
Mayflies (Order *Ephemeroptera*)	_____	X 3 =	_____
Stoneflies (Order *Plecptera*)	_____	X 3 =	_____
Caddisflies (Order *Trichoptera*)	_____	X 3 =	_____
Somewhat Sensitive			
Dobsonflies (Order *Megaloptera)*	_____	X 2 =	_____
Dragonflies (Order *Odonata)*	_____	X 2 =	_____
Craneflies (Order *Diptera*)	_____	X 2 =	_____
Snails (Class *Glastropoda*)	_____	X 2 =	_____
Tolerant			
Midges (Order *Chironomidae*)	_____	X 1 =	_____
Tubifex worms (Class *Oligochaeta*)	_____	X 1 =	_____
Scuds (Order *Amphipoda*)	_____	X 1 =	_____
Leeches (Class *Hirudinea*)	_____	X 1 =	_____

Lesson 13

Water Webs

What is the difference among food chains, food pyramids and food webs?
How are food webs affected naturally and unnaturally?

GOAL To understand that living organisms are connected.

OBJECTIVES Students will:

- ✓ identify a food chain, food pyramid and food web
- ✓ identify connections among living things
- ✓ become familiar with the terms producer, consumer and other trophic levels
- ✓ recognize the importance of protecting our ecosystems

MATERIALS **food chain cards, yarn**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(9)**
- **Math 2(2,4,5)**
- **Science 3(2-6), 4(6), 5(1-5)**

VOCABULARY **ecosystem, components, producer, consumer, herbivores, carnivores, decomposer, food chain, food pyramid, food web, energy, tertiary, trophic**

PROCEDURES

1. Explain to students they will examine a stream ecosystem and its components (parts).
2. Explain to students that components of an ecosystem include producers, plant eaters, consumers (primary, secondary and tertiary). Primary consumers are plant eaters (herbivores), secondary consumers are meat eaters (carnivores) and tertiary are at the top of the food chain. Decomposers are essential because they help break down plant and animal materials back into the soil. Food chains models can show how energy is passed through the ecosystem. For example, the top of the food chain is the sun. Producers, or plants, make their own food through the process of photosynthesis. Primary consumers eat plants and so on.
3. Separate students into groups of five. Distribute five cards to each group and have students formulate food chains. Have students hold cards in food chain order. Have them begin with the sun, then a plant, plant eater, meat eater and top of the food chain. Have them either stand or place the cards in order of the trophic levels of the food chain. (copy words in food chains on oak tag, cardboard or construction paper to be made into cards at end of lesson)
4. The various trophic levels of the food chains include the following:

a. Producers - algae, diatoms, grasses, leaves, and plankton.
b. Primary consumers - mayflies, stoneflies, caddisflies, crayfish and snails.
c. Secondary consumer - dragonflies, salamanders, frogs, trout and damselflies
d. Top or tertiary level - heron, otter, eagle, bear and people.

5. After students create food chains, explain that food chains are simplified in nature. Dragonflies, herons, otters may eat a variety of items and not just one type of species. This would create more of a food web, which includes a number of food chains.
6. Before creating a web, demonstrate a food pyramid model. Show how many organisms it may take to sustain, support or feed the top of the food pyramid or tertiary level. For example, one of the food chains may include sun, algae, caddisfly, salmon and heron.
7. Beginning with the highest trophic level, have the students estimate how many trout a great blue heron may eat in one day.
   a. Have students guess the number. For example, if the guess for the blue heron is five salmon, then the next estimate involves how many caddisfly the salmon eats in one day. Maybe, that amount is twenty.
   b. Then, have students estimate how much algae is needed to support the 20 caddisflies. Maybe, each caddisfly eats 50 algae, then the total amount would equal to 20 x 50 or 1,000 algae. In this manner, students can visualize the numbers that are required to support a food chain.
8. Now students are ready to create food webs. Have students sit in a circle with their cards from the food chains.
9. Begin activity with student who has the sun card. Have student with sun card hold an end of a ball of yarn or string.
10. Pass the other end of the yarn to the next person who has the card that depicts the next trophic level.
11. Have students go up and down the food chains until everyone has had a chance to hold the string and become part of the web.
12. As everyone is holding a section of the yarn, ask the students what happens if there is a drought and some of the plants do not grow. How would that affect the next level? Have those students gently tug their yarn and have those that feel the tug pass it along. All eventually are affected by the disappearance or reduction of the first level.
13. Have students think how humans affect the food chain or web? (*development, pollution, cut down trees, etc*.)

EXTENSIONS

1. Identify an aquatic insect that is a predator. Name one that is prey. Can an aquatic insect be both?
2. Ask students the significance of forest fires, pesticide use, and water pollution. Ask how the factors affect the ecosystem.

RESOURCES

Bechdol, Michael, Cheo, Martha S., O'Neal, Vicky J., Slater, Meredith, The Pawcatuck Watershed Education Program Curriculum Guide, 1993, The Southern Rhode Island Conservation District and The University of Rhode Island Department of Natural Resources Science

GLOSSARY

carnivore - a predatory, meat-eating animal
components - a part of a system
consumer - a heterotrophic organism that ingests other organisms or organic matter in a food chain
decomposer - an organism, often a bacterium or fungus, which feeds on and breaks down dead plant or animal matter, thus making organic nutrients available to the ecosystem
ecosystem - an ecological community together with its environment , functioning as a unit
energy - the capacity for work or vigorous activity
food chain - a succession of organisms in an ecological community that constitutes a continuation of food energy from one organism to another as each consumes a lower member and in turn is preyed upon by a higher member
food pyramid - a graphic representation of the structure of a food chain, depicted as a pyramid having a broad base formed by producers and tapering to a point formed by end consumers
food web - a complex of interrelated food chains in an ecological community
herbivore - an animal that feeds chiefly on plants
producer - a photosynthetic green plant or chemosynthetic bacterium, constituting the first trophic level in a food chain; an autotrophic organism
tertiary - third in place, order, degree, or rank
trophic - of or involving the feeding habits or food relationship of different organisms in a food chain

Chain/Food Web Cards

Sun	**Leaves**	**Algae**
Diatoms	**Grasses**	**Plankton**
Mayfly	**Stonefly**	**Caddisfly**
Snail	**Crayfish**	**Salamanders**
Frog	**Heron**	**Damselfly**
People	**Otter**	**Bear**
Eagle	**Salmon**	**Dragonfly**

Lesson 14

Water Wilds

Is there threatened wildlife in CT?
What types of habitats exist in Farmington River Watershed?
What animal would you like to know more about?

GOAL To understand that there is a diversity of wildlife to be protected in Farmington River watershed.

OBJECTIVES Students will:

- ✓ identify an animal they would like to research
- ✓ use a web site to research
- ✓ create a poster with information about their animal to present to the class

MATERIALS **poster, pencils, crayons, markers**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 2 (2,3)**
- **Science 1(7), 3(1-4), 6(1), 8(8)**
- **Art 1(1-4), 2(1-3)**

VOCABULARY **wildlife, threatened, species, endangered**

PROCEDURES

1. Have students conduct research on wildlife in CT. They may look up information on website www.dep.state.ct.us/burnatr/wildlife/pdf.htm. Have them scroll down to pick a type of animal that exists in CT. Discuss that they may choose a non-threatened species or threatened.
2. A graphic from the website page follows, but students are required to go to actual website to pull up fact sheets.
3. Print particular fact sheets and have students gather information, if computer is not available to all students.
4. Have students list specific information about animal from fact sheet. Have them draw their animal on a poster board. Each corner of the poster board should include facts about the wildlife chosen. One corner includes habitat information, one corner food requirements (predator, prey), one corner facts such as height, weight, color, etc. and the fourth corner may include either interesting facts about the wildlife or if threatened, why it is so.
5. Have students write a fact sheet with visuals and present information to class.

EXTENSIONS

1. Ask how people affect wildlife both positively and negatively.
2. Discuss threatened species in the Farmington River Watershed.
3. Have students take measures to preserve or help habitat or animal homes in your area.

GLOSSARY

endangered - to be threatened with extinction
species - a fundamental category of taxonomic classification, ranking below a genus or subgenus and consisting of related organisms capable of interbreeding
threatened - to express a threat against
wildlife - wild animals and vegetation, especially animals living in a natural, undomesticated state

WILDLIFE IN CONNECTICUT

INFORMATIONAL SERIES

FISHER

Martes pennanti

http://www.dep.state.ct.us/burnatr/wildlife/pdf/fisher.pdf

Lesson 15

Water Threats

What is the reason salmon populations have declined?
Why is the Rainbow Dam fish ladder in Windsor important to the salmon?
What are Farmington River Watershed and DEP doing to help the salmon?

GOAL To understand that salmon were once plentiful in the Farmington River Watershed and restoration projects are ongoing.

OBJECTIVES Students will:

- ✓ become familiar with the life cycle of the salmon
- ✓ understand the reasons for the decline of salmon
- ✓ identify ways that schools and organizations participate in the restoration of salmon to this area
- ✓ create and participate in a salmon game

MATERIALS **butcher block paper, markers, scissors,**

CORE CURRICULUM CONTENT STANDARDS

- **Science 3(1-3), 5(4,6,7), 6(1), 14(2,8)**
- **Social Studies 4(1,2), 9(2), 11(7), 12(4)**

VOCABULARY **fish ladder, incubating, alevin, fry, restoration, anadromous, pollutants**

PROCEDURES

1. Discuss the salmon restoration project with students. Explain that the Connecticut River Watershed and the stocking of the Farmington River and its tributaries are helping to restore Atlantic salmon to the Connecticut River watershed. Because of dam construction and other restrictions to waterways, salmon and other *anadromous (return from the sea or ocean to where they were originally born to spawn)* species of fish population declined. With the construction of the fish ladder at the Rainbow Reservoir, fish use the ladder as a passageway to return to spawn. In order to promote the proliferation of salmon, CT DEP Whittemore fish hatchery, housed one-mile downstream of the Goodwim Dam, produces 150,000 to 300,000 Atlantic salmon eggs. Connecticut DEP and its partners continue to help restore Atlantic salmon to the Connecticut River watershed. The program involves incubating Atlantic salmon eggs in a chilled aquarium tank beginning in early January. These eggs were previously harvested from salmon that returned to the Connecticut River. The eggs hatch around mid-February into alevin, a small fish of about one to one and half inches. See Atlantic Salmon Life Cycle - ASF (by P.O. Pennenan) on CD. Supported by a yolk sac (the egg residual), its sole source of food supply, the salmon alevin approaches the “fry” stage at the end of April or early May. At this point, the sac will be gone and the fish look like streamlined small minnows. Many schools participate in programs that involve raising salmon and releasing them into rivers as fry. Many species of salmon are anadromous—they spawn, or lay their eggs, in fresh water; the young migrate to salt water and grow

up there; and the fish return to fresh water to breed after they reach maturity. The migratory instinct of members of the salmon family is remarkably specific, each generation returning to spawn in exactly the same breeding places as the generation before it. Some salmon migrate hundreds or even thousands of miles to reach their spawning grounds. Even those species that do not migrate from fresh water to salt water spawn in the same freshwater streams as did their ancestors.

1. Inquire about the reasons salmon populations decline. Provide time for students to reflect on this. Before the colonization when Native Americans inhabited this area, salmon fish were plentiful in the rivers. Since salmon migrate to the ocean and then return, an unobstructed passageway is necessary to its survival. Also, salmon are sensitive to changes in water quality.
2. Discuss with students and explain that paper factories and other industries grew along the river, and a lot of pollutants flowed into the river from the factory wastes. Environmental laws did not exist, so plants were not regulated or restricted as they are today.
3. Also, dams were built to control the river flow and in some cases, to prevent flooding. This wall or dam prevented the salmon from returning to their original home.
4. The salmon's diet consists of microscopic plants and small animals, such as insects.
5. In order for students to understand the challenges of a salmon, have them participate in a salmon game that demonstrates the migratory route.
    a. Have students create 17 circles out of butcher block paper. Inside circles, have them write the information listed at the end of this lesson. Have circles arranged on floor to demonstrate the migratory route of the salmon.
    b. Ask if the salmon will make it to the CT River and return to its original habitat. Explain that the purpose of the game is for salmon to be able to return to its original habitat.
    c. Have students make several games so more students can participate. Have them use one die to determine amount of spaces.
    d. The information for the circles follows:
        1. Small fry are released in Stratton Brook, Simsbury CT. Go forward 5 spaces.
        2. Salmon continue to Hop Brook and feed on lots of water insects. Go forward 2 spaces.
        3. Salmon connect to Farmington River. Go forward 3 spaces.
        4. Salmon take wrong turn and head towards Salmon Brook, Granby. Go back 1 space.
        5. They enjoy the cool waters in a shaded area and decide to remain in this habitat for awhile. Lose a turn.
        6. High river levels cause turbulence in river waters. Salmon head in opposite direction. Go back two spaces.
        7. Perfect conditions to head towards East Granby and Windsor. Go forward 6 spaces.
        8. Salmon make it to Rainbow Reservoir in Windsor. Go forward 4 spaces.
        9. The water is calm. Salmon remain for two weeks. Lose a turn.
        10. Salmon continue on their journey making it to CT River and to Atlantic Ocean. Go forward 10 spaces.
        11. Salmon returns to head back to original release area. Go forward 1 space.
        12. Low levels near the CT River turn to Rainbow Fish Ladder. Go back 5 spaces.
        13. Goes up fish ladder. Go forward two spaces.
        14. Gets caught in turbine. Go back 3 spaces.

15. Salmon continues on Farmington River in Windsor. Go forward 2 spaces.
16. Stream flows enable salmon to make turn towards Simsbury. Go forward 2 spaces.

j. Ask students what a fish ladder is.(passageway that helps the salmon go upstream when there is a dam).
k. Ask why the Rainbow Reservoir in Windsor and fish ladder are important to the continuation and restoration of salmon.

EXTENSIONS

1. Have students create their own salmon game and migratory route.
2. Have students read a salmon story and write a story from the salmon's viewpoint.
3. Draw a poster of the salmon's life cycle - visit the Atlantic Salmon Federation's website atwww.asf.ca for details.
4. Follow a salmon's route on a map.

RESOURCES

http://www.asf.ca/Overall/lifecycle.html, Atlantic Salmon Federation, J.O. Pennanen.

GLOSSARY

alevin - young fish; fry
anadromous - migrating up rivers from the sea to breed in fresh water
fish ladder - a series of pools arranged like ascending steps at the side of a stream, enabling migrating fish to swim upstream around a dam or other obstruction
fry - small fish, especially young, recently hatched fish
incubating - to sit on (eggs) to provide heat, so as to promote embryonic development and the hatching of young; brood
pollutants - something that pollutes, especially a waste material that contaminates air, soil or water
restoration - something, such as a renovated building, that has been restored

FRWA Curriculum Guide

Week IV

Going Back to the Past

Going Back to the Past
Background Information

"I came where the river ran over stones; my ears knew an early joy. And all the waters of the streams sang in my veins that summer day" – Theodore Rothke, The Waking, 1948

The Farmington River Watershed is rich with history. Evidence of early inhabitants is shown throughout the watershed and the formation of the land, itself is reflected in its geology. The Farmington River provided a home for Native Americans in the valley. The Natives called the river, Wattunkshausepo, "the fast, flowing winding river". The Europeans later shortened it to Tunxis, "the beautiful river that ripples down through the hills". The land was forested and the river abounded in salmon, American shad, alewives, sea lamprey, sturgeon and other fish that fed the tribes that lived here. Native Americans lived in different areas of the watershed and some tribes were considered nomadic. They lived by the river to fish, planted corn in small, forest clearings and hunted in the woods.

In the area going through Avon, Burlington, Canton, and Farmington, through the abrupt northerly bend in the river, a large group of Tunxis Natives were located there when English settlers arrived in the 1600's. The Poquonock Native Americans settled in Windsor and lived at the "mouth of the Farmington River".

In the 1600's English settlers moved to valley where Poquonock Natives lived at the mouth of Farmington River, known today as Windsor. Settlers moved to other areas, such as plantations in Simsbury (known as Massaco) and at Tunxis (known now as Farmington). They depended on the river for food. They planted crops and used river for transportation.

When building dams and mills, settlers disturbed Indian fishing and prevented salmon and other fish from moving upstream to spawn. The forests were clear cut for farmland and pastures were fenced off. This created a hostile situation, and wars emerged. The Indians were no match to the settlers rifles, so they retaliated by burning towns. In Simsbury, the meadows that line the river were planted by the Indians and called Nod Lands. King Phillip (Anglicized name) or Chief Metacomet gave the orders to burn the city of Simsbury in 1676 in retaliation to the settlers. The Tariffville Gorge was once traversed by settlers from Windsor going to Simsbury and back again to escape the raids of the Wampanoags.

During the 1800's, industrialism emerged. The invention of machinery and the development of mass production in factories were prevalent during this time period. In 1820, the quality of the water was degraded because of paper and cotton mills, tanneries, and saw mills dumping wastes into various rivers (Clam, Sandy Brook, Nepaug). In Windsor, the river was a port-of-entry for trade with England and the West Indies until a bridge was constructed crossing the Connecticut River in 1809. Mills were situated along the river in Windsor, similar to other towns in the 1800's. Factories manufacturing textiles, yarns, and paper goods were located in Windsor as well as three electricity generating plants.

One historical landmark still visible today is the remnants of an aqueduct in Farmington. As part of the Farmington Canal built on July 4,1825, it stretched from New Haven, CT to Westfield, MA and then 10 years later to Northampton, MA. The transportation link remained in operation until the railroad made it obsolete. Now, all the tracks have been removed from the rail bed and it is being slowly converted to a park area. The path is being paved much of the way and is frequented by cyclists and hikers.

During the mid-19th century, depression caused mills to shut down along the Farmington River. The east and west branch of Salmon Brook were, however, spared pollution. The trout located in the Salmon Brook helped sustain renewal of upper river stocking programs because it was not polluted during the industrialism as other rivers had been.

There has been an active effort to protect the river since 1950's to present. The1955 flood, carried away houses, railroad bridges and buildings. The devastation inspired the construction of major flood control reservoirs. Additionally, factories installed waste treatment systems to reduce pollution, floodplain regulations were implemented, and laws went into effect, such as the Clean Water Act of 1972. Because of the laws and other factors affecting the protection of the rivers and waterways being instituted, the Farmington River conservation and renewal efforts have been met with success.

Geological formations and remnants from glacial activities provide a look into the past. According to the Farmington River Guide, dated 2002, "the steep ridges from Otis to Colebrook literally tumble into the Farmington forcing it to twist and turn and often obstructing it with boulders". The vertical cuts in bedrock overlooking the Colebrook Reservoir are more than 500 million years old, showing white streaks of magma in the rock. Continuing downstream through Barkhamsted approaching People's State Forest, the river turns east. Large hills rise up on both sides of the river. The south side of the hills are made of one-billion year old Precambrian rock.

In New Hartford, the mountains at Satan's Kingdom blocked water flow, creating a lake extending northwest for miles. Later, geological pressures forced water to cut through the rock, creating the formation of the gorge. During pre-glacial times, the Farmington flowed to join the Quinniapiac and emptied into New Haven. A glacial phenomenon was responsible for changing the direction of the river's flow. A wedge-shaped glacial deposit of debris or rock, called a moraine, slowed Farmington flow to south, causing the river to turn north.

A glacial lake grew in size until it reached as far north as Tariffville and was then was able to top the ridge and cut a gorge which now permits the Farmington to drain into the Connecticut River in Windsor. A reminder are the sand and gravel pits, effects of river and glacial deposits as well as Tariffville Gorge.

From Farmington to Simsbury, huge accumulations of rock debris, called talus slides, can be seen at the foot of Talcott Mountain. The mountain divides the valley floors of the Farmington and Connecticut Rivers and the ridge is the result of molten rock forced through the earth's crust.

Lesson 16

Water Matches

What is significance of certain dates in history?
How do events change history or the geology of the land?
What is a timeline?

GOAL To understand that some dates have significance in history

OBJECTIVES Students will:

- ✓ match dates to events
- ✓ identify the importance of certain events
- ✓ create a poster with importance information about date
- ✓ create a timeline

MATERIALS **paper, pencils, poster, crayons or markers, paper for timeline**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 2(3)**
- **Science 2(1,4), 7(3), 9(2)**
- **Social Studies 1(1,6), 2(2), 4(2,5), 9(5), 12(4-6)**
- **Arts 1(1-4)**

VOCABULARY **geology, flooding, historical**

PROCEDURES

1. Distribute dates and events that occurred that affect the geology of the land or that provide a historical reference to the land.
2. Have students try to match the dates with the events. After matching, have them answer the following questions
   a. What is significance of the date? (Why is this date important?)
   b. How did this event change the land and/or history of the land?
3. Dates and events are as follows:
   a. (1936, 1938, 1955, & 1984) – flooding of the Connecticut River occurred.
   b. 1940 – Saville Dam completed forming Barkhamsted Reservoir, the largest drinking water reservoir holding 30.3 billion gallons of water.
   c. 1976 – fishway constructed for anadromous fish at Rainbow Dam in Windsor.
   d. 1994 – Wild and Scenic designation of 14 mile west branch of Farmington River at base of Goodwin Dam in Hartland to Canton town line.
   e. 1633 – town of Windsor established
   f. Dates and events may be mixed up so students can match. Flood dates may be used together or instructor may choose one date, such as 1936 or 1955.
4. After students match dates, have students put them in sequential order and create a timeline.
5. Have students choose one event. Have them research facts about the event and create a poster that announces the importance of what happened.

Answers to significance of date:

a. (1955) – flooding of the Farmington and Connecticut Rivers occurred.
(a dam was constructed to prevent flooding)

b. 1940 – Saville Dam completed forming Barkhamsted Reservoir, the largest drinking water reservoir holding 30.3 billion gallons of water. (Prior to Saville Dam, East Branch River flowed with rapids and flowing water)

c. 1976 – fishway constructed for anadromous fish at Rainbow Dam in Windsor.
(fish were not able to travel upstream, no evidence of certain fish)

d. 1994 – Wild and Scenic designation of 14 mile west branch of Farmington River at base of Goodwin Dam in Hartland to Canton town line. (nothing can be constructed in this section of the river, will be free flowing)

e. 1633 – town of Windsor established
(settlers from Windsor traveled to other parts of CT, such as Simsbury)

GLOSSARY

flooding - an overflowing of water onto land that is normally dry
geology - the scientific study of the origin, history, and structure of the earth
historical - based on or concerned with events in history

Lesson 17

Native Waters

Why is the river important to Native Americans?
How is life different now?
How did Native Americans pass down traditions to other generations?

GOAL To understand that Native American stories provide a glimpse into traditions and culture of the people.

OBJECTIVES Students will:

- ✓ understand the significance of the river to Native American people
- ✓ identify the storyteller as an important aspect of Native American culture
- ✓ understand that traditions were passed down to other generations through the repetition of stories.

MATERIALS **story, cardboard or oak tag, natural items, such as grasses, twigs, bark, glue. Masking tape, stapler,**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(1,11-14), 4(4,5)**
- **Science 2(4), 7(5), 8(7)**
- **Social Studies 1(1,3,5,6), 2(1,3), 3(1-3), 4(1,5), 11(3,5)**
- **Art 1(3,4), 2(3), 4(1-3), 6(2)**

VOCABULARY **culture, tradition, storyteller, ancestors, elders, generations, cattails, glacier, drift, wigwam**

PROCEDURES

1. Have students go back in time and compare and contrast land and water use during Native American settlement and now.
2. Have them listen to a prelude to the story. When the storyteller delivers the story, in order to create a more interactive atmosphere, the Storyteller says “ho” throughout the story and the listeners answer with the word “hey”. The storyteller can speak softly at times and louder at other times to create interest in the listeners.
3. Explain the significance of the storyteller to Native American times. Traditions were passed down through stories.
4. Have students or read aloud the story about a youngster who is listening to a Native American elder. The story that follows is based on the story about the Nash-a-way River, but may be interchanged with rivers they are more familiar with, such as the Farmington or Connecticut Rivers. The elder provides some background information before commencing with the river story. Read this part to students or have them read silently:

(Prelude to river story read by instructor)

It was a cool, autumn day and we sat around the campfire listening to stories that were passed down from our ancestors. “Grandfather, tell us a story.” I wanted to hear of a time past. My grandfather would tell us stories that were handed down from generation to generations. Listening to stories helped us remember our roots, what our traditions and cultures are and most importantly why it is so important to preserve the river. “What was it like many years ago?” Before telling my favorite story, grandfather told about our ancestors.

“Ancestors of Connecticut’s Native American people once lived by a great lake,” the grandfather said. He went on to tell us that it was later called Glacial Lake Hitchcock. The people swam and fished in this lake many thousands of years ago. The lake no longer exists, because the unstable dam of drift that held the water back broke through. All that is left are the fertile fields for farmland. Ancestors moved from the area of the lake to a valley.

They settled in the valley of the river called Wattunkshausepo, meaning ‘fast flowing and winding river’. The river was significant to the Native Americans. Life was based on more of a nomadic (wandering) lifestyle. Whole villages were moved to a river in the spring for fishing, to small forest crop clearings in the summer and thick woods for hunting in the winter. That is why the land and river were always cared for, because the American Indians did not use up all its resources. The river provided most of the food for the tribes living in the Farmington River Valley. Wildlife, birds, salmon all thrived in this river. In meadows in what was later called the town of Simsbury, corn was planted, a staple of Native American life.

“Tell us the story of the river,” I begged my grandfather. And so he did…

Excerpt from (The River Ran Wild, by Lynne Cherry)

“Long ago a river ran wild through towering forests. Bears, moose and herds of deer, hawks and owls all made their homes in the peaceful river valley. Geese paused on their long migration and rested on its banks. Beavers, turtles, and schools of fish swam in its clear waters.

One day a group of native people, searching for a place to settle, came upon a river valley. From atop a mountain, they saw the river nestled in its valley, a silver sliver in the sun.

They came down from the mountain, and at the river’s edge they knelt to quench their thirst with its clear water. Pebbles shone from the bottom.

“Let us settle by the river, “said the chief of the native people.

The people built a village. They gathered cattails from the riverbanks to thatch their dwellings. In the forest they set fires to clear brush from the forest floor. In these clearings, they planted corn and squash for eating. They made arrows for hunting and canoes for river travel.

When the Indians hunted in the forest or caught salmon in the river, they killed only what they needed for themselves for food and clothing. They asked all the forest creatures that they killed to please forgive them.

The people saw a rhythm to their lives and in the seasons. The river, land and forest provided all that they needed.”

5. After both the prelude and story are either read to the students or the students read themselves, lead a discussion about the Native American life. Group students and divide questions for student groups to answer for a later discussion. The last question may be

answered by all the groups. Use the following questions as a guide:

1. Who is the storyteller? (*grandfather or elder*)
2. What is the significance of the storyteller to the Native American culture? (*The storyteller shared Native American traditions and culture through the stories)*
3. Where did the first Native Americans live in Connecticut, according to the elder? (*Lake Hitchcock*)
4. What happened to this lake? (*the unstable dam of drift broke*)
5. What does the "unstable dam of drift" mean? (*drift is glacial rock that held the water as a dam would – it later eroded and broke away)*
6. Where did the ancestors move? (*valley – Farmington Valley*)
7. What was the river called and what does it mean? (*Wattunkshausepo – fast flowing and winding river)*
8. Describe the river. What type of fish swam in it? (*clear, cool, rocks on bottom – salmon)*
9. Describe the valley and surrounding area*. (tall forests, mountains, wildlife plentiful)*
10. What is the time period for this story*? (approximately 500 years ago)*
11. What was used to make houses? *(Cattails thatched houses, wood)*
12. What did the Native Americans grow and eat? *(corn, squash)*
13. Compare your lifestyle to the Native Americans.

6. Have students refer to a picture of a Native American house, a wigwam. Have students work in groups to create a wigwam. They may use construction paper or a sturdier paper, such as oak tag or cardboard. Students can collect natural items, such as leaves, sticks or grasses to glue on their wigwam form. Have students place wigwam on a piece of cardboard. Add a river, trees, garden and wildlife pictorial to your model.

EXTENSION:

1. Read the following Native American story:

How the Fly Saved the River

A Native American Tale

Many, many years ago when the world was new, there was a beautiful river. Fish in great numbers lived in this river, and its water was so pure and sweet that all the animals came there to drink.
A giant moose heard about the river and he too came there to drink. But he was so big, and he drank so much, that soon the water began to sink lower and lower.
The beavers were worried. The water around their lodges was disappearing. Soon their homes would be destroyed.
The muskrats were worried, too. What would they do if the water vanished? How could they live?
The fish were very worried. The other animals could live on land if the water dried up, but they couldn't.
All the animals tried to think of a way to drive the moose from the river, but he was so big that they were too afraid to try. Even the bear was afraid of him.
At last the fly said he would try to drive the moose away. All the animals laughed and jeered. How could a tiny fly frighten a giant moose? The fly said nothing, but that day, as soon as the moose appeared, he went into action.
He landed on the moose's foreleg and bit sharply. The moose stamped his foot harder, and each time he stamped, the ground sank and the water rushed in to fill it up. Then the fly jumped about all over the moose, biting and biting and biting until the moose was in a frenzy. He dashed madly about the banks of the river, shaking his head, stamping his feet, snorting and blowing, but he couldn't get rid of that pesky fly. At last the moose fled from the river, and didn't come back.
The fly was very proud of his achievement, and boasted to the other animals, "Even the small can fight the strong if they use their brains to think."

1. What does the last sentence in the story mean to you?
2. Can the animals mean other things? For example, the moose drinking all the water, leaving nothing left, what can that signify? (industry, big developments, colonization)
3. When did the Native American tribes live in your area? What are the names of the tribes?
4. Are Native Americans alive today? How are they different and how are they the same as their ancestors?

RESOURCES

Bell, Michael, The Face of Connecticut, People, Geology, and the Land, 1986, Connecticut Geological and Natural Survey, Hartford, CT 06106
Cherry, Lynne, A River Ran Wild, 1992, AA Gulliver Green Book, Harcourt Brace & Company, New York, NY 100110.
http://www.ilhawaii.net/~stony/lore09.html

GLOSSARY

ancestors - a person from whom one is descended, especially if more remote than a grandparent; a forebear
cattails - any of various perennial herbs of the genus *Typha*, widespread in marshy places and having long strap-like leaves and a dense cylindrical cluster of minute flowers and fruit
culture - patterns, arts, beliefs, institutions, and all other products of human work and thought
drift - rock debris transported and deposited by or from ice, especially by or from a glacier
elders - greater than another in age or senority
generations - all of the offspring that are at the same stage of descent from a common ancestor
glacier - a huge mass of ice slowly flowing over a land mass, formed from compacted snow in an area where snow accumulation exceeds melting
storyteller - one who tells or writes stories
tradition - the passing down of elements of a culture from generation to generation, especially by oral communication
wigwam - a Native American dwelling commonly having an arched or conical framework overlaid with bark, hides, or mats.

Lesson 18

Colonial Changes

How was the way of life different for the colonists?
What was the attitude of the colonist towards the land and water?
How did the Native Americans react?

GOAL To compare and contrast lifestyles of the colonists and Native Americans

OBJECTIVES Students will:

- ✓ read a story that reflects colonial lifestyles
- ✓ identify particular aspects of colonization, such as land changes, water changes, houses, foods, and community differences.
- ✓ identify what the colonist did for a living

MATERIALS **story, paper, pencils, poster board or butcher block, markers**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(1,11-14), 4(4,5)**
- **Science 2(4), 7(5), 8(7), 14(1-3, 5)**
- **Social Studies 1(1,3,5,6), 2(1,3), 3(1-3), 4(1,5)**
- **Arts 1(3,4), 4(1-3)**

VOCABULARY **sawmills, traders, colonial, gorge**

PROCEDURES

1. Begin by referring to previous lesson about Native Americans. Explains that the story about the river is continued and depicts the colonial way of life.

(Excerpt from A River Ran Wild, by Lynne Cherry)

"The Native Americans had lived for generations by the clear, clean flowing river when one day a pale-skinned trader came with a boatload full of treasures. He brought shiny metal knives, colored beads, and cooking kettles, mirrors, tools, and bright cloth. His wares seemed like magic. The Native Americans welcomed him, traded furs, and soon a trading post was built. In the many years that followed, the settler's village and others like it grew. The settlers worked together to clear land by cutting down forests, which they thoughts were full of danger – wilderness that they would conquer. They hunted wolves and beaver, killing much more than they needed. Extra pelts were sent to England in return for money and goods.

The settlers built sawmills along the river that the river's current powered. They built dams to make the millponds to store water. They cut down the towering forest and floated tree trunks down the river. The logs were cut up into lumber, which was used for building houses.
The settlers built fences for their pastures, plowed the fields, and planted crops. They called the land their own and told Indians not to trespass. Hunting land disappeared as the settlers cleared the forest. Indian fishing rights vanished as the settlers that lived during that time claimed the river. The Indians' ways were disrupted and they began to fight the settlers. The settlers' rifles drove the Indians away from the land.
Through a hundred years of fighting, the river was healthy, still flowing wild and free. Muskrats, fish and turtles still swam from bank to bank. Deer still came to drink from the river, and owls, raccoons, and beaver fed there."

1. Have students work collectively in groups to answer the questions.
2. Compare the colonist way of life to the Native American.
    a. What did the colonist look like? How did this compare to the Native Americans?
    b. How did they make their homes?
    c. What did they eat?
    d. Why did they clear the forests?
    e. What are sawmills and how were they powered?
    f. How was the way they treated the land and river different from the Native American way of life?
    g. Approximately what time frame or dates did the colonists arrive?
    h. How did they travel?
3. Ask what story tells of how the Native Americans felt when their "ways" were disrupted. Ask what happened. Ask how they would feel if you lived during that time. (from a colonist perspective and from a Native American viewpoint)
4. Referring back to the previous lesson, remind students that there were tall forests during the Native American times. Later, when the colonists arrived, the story mentions that the colonists cut down the trees for fear of the woods, pastures for the animals and to grow crops on farmland. Ask what this indicates about the trees that they see where they live. How old are they?
5. Early settlers that went from Windsor to Simsbury had to pass the Tariffville Gorge. The same settlers that had to escape back to Windsor because of the wars and raids of the Native Americans. This is a deep, narrow valley or cut in rock formations where falls are located. Instruct students to imagine they had to travel by foot or by horse in this manner and cut across a gorge. It was very dangerous and people could easily be swept down the river to drown. (*The spray of water from the falls, rapids in the river below, the rocks were very slippery and sharp*) Describe what you think the settlers experienced at the gorge. Draw a picture.

EXTENSIONS

1. Create a colonial farm, pasture and house. What did it look like?

GLOSSARY

colonial - of or relating to the 13 British colonies that became the original United Stated of America
gorge - a deep, narrow passage with steep rocky sides; a ravine
sawmills - a plant where timber is sawed into boards
traders - one that trades; a dealer

Lesson 19

Farmington Canal

How was the Farmington Canal built?
How did boats travel on the canal?
Do you know about other canals?

GOAL To understand that the Farmington canal was a major undertaking

OBJECTIVES Students will:

- ✓ learn facts about the Farmington Canal
- ✓ create a drawing of the canal from a worker on a boat's perspective
- ✓ write a story about the canal

MATERIALS **Farmington Canal map (on CD), poster board or butcher block paper, markers, crayons, pencil, paper**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(1,7), 4(5)**
- **Science 8(7,8), 14(2,5)**
- **Social Studies 1(1-4), 2(1,2), 3(6,7), 9(1-6), 11(6), 12(5-8)**
- **Arts 1(3,4), 4(1-3)**

VOCABULARY **canal, man-made, natural, booming, structure, locks**

PROCEDURES

1. Begin by asking students if they know what a canal is. Ask if it is a man-made or natural structure.
2. Determine if students are familiar with any canals in the U.S. or any other country.
3. Explain that there was a canal built in Connecticut in the 1800's from New Haven, CT to Northampton, MA. It was called the Farmington Canal.
4. Have students viewFarmington Canal map (on CD) to determine length and route of canal.

5. Provide the following facts about the canal:
   a. early 1800's – Hartford and Middletown enjoying wealth because of CT River - booming
   b. sell goods and ship via boats and barges
   c. New Haven receiving goods from West Indies – wanted to trade with rural areas
   d. Decided to build canal from New Haven to Mass to trade goods with other areas
   e. 4 feet deep, 20 feet wide and 80 miles long
   f. tools were shovels, wheelbarrows, picks
   g. 1822 – 17 towns agreed to project – sold stock to finance
   h. 1828 – completed - *James Hillhouse* – first boat to travel
   i. finished construction to Northampton, MA in 1835 – 10 years later
   j. soil was sandy loam and rock – did not hold water very well
   k. costs more than expected, so costs cut in canal banks
   l. banks washed out during storm
   m. drought in 1843 closed canal four months; ice blocked canal
   n. land taken from landholders – lawsuits files
   o. streams blocked so water did not flow
   p. bridges constructed over canal that cut through farms – hard for wagons to cross
   q. canal leaked making pastures swamps
   r. locks on route (mechanism to lift boats)
   s. canal boats powered by horses – tow path next to canal
   t. no steamboat traffic
   u. interesting for public to watch – means of travel for some
   v. repairs very costly in 1830's
   w. 1847 – railbed constructed replacing canal
   x. now area converted to a park area
6. Break up students into smaller groups. Distribute poster board or butcher block paper.
7. Have students draw the canal's route. Instruct them to imagine they worked on a boat and had to travel on the canal. Describe in words how the horses had to tow the boats and canal locks lifted boats. Have students use the facts above to describe the travels of this worker. Have students draw scenery along the canal on poster board.

EXTENSIONS

1. Make a three-dimensional model of a canal and describe to class.
2. Conduct research on a canal from a different area.

RESOURCES

http://www.kelseypub.com/ct-guide/historic/farmcanl.shtml

GLOSSARY

booming - to grow, develop, or progress rapidly; flourish
canal - an artificial waterway or artificially improved waterway used for travel, shipping or irrigation
locks - a section of a waterway, such as a canal, closed off with gates, in which vessels in transit are raised or lowered by raising or lowering the water level of that section
man-made - made by humans rather than occurring in nature; synthetic
natural - present in or produced by nature
structure - the way in which parts are arranged or put together to form a whole

Lesson 20

Walk to the Past

What clues are provided about our town's or city's history?
Does understanding our past help us understand the present day?

GOAL To decipher clues provided to determine time period, event, or place.

OBJECTIVES Students will:
- ✓ read clues and try to determine time period or place

MATERIALS **pencils, paper**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(1,11-14)**
- **Science 8(7,8)**
- **Social Studies 1(1,3,5,6), 2(1,3), 3(1-3), 4(1,5), 11(3,5)**

VOCABULARY **aqueducts, decipher, uncover, clues**

PROCEDURES

1. Begin by explaining to the students that certain clues are given to us about the past. The clues might be in the form of an abandoned bridge, a huge rock or boulder, sand pits, old mills, etc.
2. Provide students with clues that they will need to decipher the past. It could be a clue to a time period, event or place. Explain that they are historians that were given a huge task. They have to enter a time machine to go back to the past and uncover a mystery.
3. Provide the answers to the clues (they may be written on the board) and the students have to match the clues to the answers. Decide that students can guess answers, as they listen to a narration of the clues.
4. Break up students into groups and have each team listen to clues or receive clues and try to decide the answer. Clues are as follows:
   e. We entered a time when the trees towered over the land. The clear, cool water of the river flowed rapidly and we noticed it was filled with pinkish fish. We could see the bottom of the river and rocks were scattered forming riffles in the water. We walked through the thick woods, carefully and came upon a clearing. There were houses made of bark rounded like igloos, deer pelts hanging from the entrances. Gardens had been planted and we noticed the small ears of corn, pumpkins and beans sneaking out of the stalks and vines. What time period are we in? (*Native American – 1600's*) What are the pink fish and bark houses called? (*salmon and wigwam*).
   f. We were settlers from an area at the mouth of a river. We decided to move our

families to a near distant place. We needed more land to plant our farms and build fences for our pastures. We walked and rode our horses, but came upon a dangerous area. It appeared to be the only way to go. We were frightened because we heard the rage of the water falls and the only way to cross was through the huge crevice or hole in the rocks and boulders. Where are we and where are we going? (*Tariffville Gorge and going to Simsbury)* What town did they come from? (*Windsor*).

g. We entered the town of Tunxis. The crowd was bubbling with excitement. It was opening day for a great canal that would travel from New Haven to Westfield, MA. The celebration was contagious. While we were walking towards the river, we noticed an aqueduct crossing the river. Where are we? (*Farmington*) What are we celebrating? (*opening day of the Farmington Canal*) What is the date? (*July 4, 1825)*.

h. There was a stench in the air and we were gasping for breath. We could not believe our eyes. The river spewed colors that were unnatural to the river. We looked behind us and saw a factory's pipe pouring an unknown substance into the river. We were horrified at what we saw. Dead fish, darkened skies and no trees were sights we will never forget. Where are we? (*any area along the river that had factories – Windsor, Hartford, New Hartford, etc.*) What time period are we in? (*Industrialism – 1800's*).

5. Discuss how they were able to determine the answers. Explain that there are many items in our towns that provide clues to our past.
6. Have students go on a real walk through the past in their town to uncover the town's history. Suggest walks by the river, bike path's, woods, etc.

EXTENSIONS

1. Have students create drawing to correspond with historical events.
2. Have students visit an area of historical significance in the Farmington River Watershed.

RESOURCES

Farmington River Association, *Farmington River Guide*, 2002, Farmington River Watershed Association, Inc.

GLOSSARY

aqueducts - a pipe or channel designed to transport water from a remote source, usually by gravity
clues - things that serve to guide or direct in the solution of a problem or mystery
decipher - to read or interpret
uncover - to remove the cover from; to manifest or disclose

FRWA Curriculum Guide

Week V

Pollution and Monitoring

Pollution and Monitoring Background Information

"We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect." – Aldo Leopold

Pollution is defined as contamination; something that causes harm to an area of the natural environment, the air, soil, or water, usually by introducing damaging substances such as chemicals or waste products. Pollutants can enter the environment either naturally or by human activities. When the source of the pollution is identified, it is termed point source pollution. Examples of source point pollution are drainage from factory pipes, exhaust from a car, leakage from an underground oil tank or smoke from a power plant.

When it is difficult to identify the source or location of the pollution, then it is considered non-point source pollution (NPS). The pollution may stem from run-off water. Impervious surfaces refer to pavement, parking lots and roadways. The water "runs-off" the surfaces and is not absorbed into the ground to recharge groundwater. The surfaces may also contain oil or gas leaks that can flow into the waterways, causing non-point source pollution. Other examples, including motor oil, are as follows:

1. **motor oil** – improper disposal or leakage of motor oil can seriously pollute ground water and surface waters. It can kill plants, smother animals and contaminate fish and drinking water.
2. **acid rain or deposition** – when rain, snow or dry particles from the atmosphere is more acidic than normal (normal is usually a pH of 5.6). Carbon dioxide combines with the water droplets to form carbonic acid. Sources can stem from the burning of fossil fuels, such as oil, and emissions from industry and cars. Acid rain can contribute to the depletion of nutrients in the soil and the addition of metals into the water.
3. **animal wastes** – livestock, pets and concentrated populations of wildlife can cause diseases in the water.
4. **excessive nutrients** – oversupply of nitrogen and phosphorous can come from leaking septic tanks, fertilizers or manure from farms and lawns, sewage, laundry detergents and some grass clippings and leaves.
5. **household hazardous waste** – toxic or poisonous substances in the home, such as gasoline, nail polish remover, paints, and oven cleaners should not be dumped down sinks or drains.

6. **litter** – roadside trash, unswept parking lots, and wind blown trash can cause hazards to wildlife and contamination of waterways.
7. **pesticides** – these substances contain chemicals that are used agriculturally (farms) and on lawns. The chemicals harm both the environment (soil) and can also impact human health.
8. **road salts** – used to de-ice highway surfaces, parking lot pavements and other road surfaces and paved areas. Too much going into waterways can change the salinity of water that support certain animals and plants.
9. **sediment** – tiny soil and rock particles are carried away by rain into the waterways, increasing turbidity and reducing light penetration; sedimentation can occur as a result of erosion.
10. **toxic metals** – metals such as mercury, nickel, zinc and lead are toxic to human organisms because they can accumulate and become concentrated in the body. The metals can originate from cars, industry and pesticide misuse.

Changes in land use and increases in population correlate to declines in water quality. The loss of open space, buffer zones, increases in impervious surfaces, contaminants from identified and unidentified sources, decreases in water supply and increases in wastewater treatment all contribute to the health of our waterways. Monitoring the streams and rivers becomes the first step in protecting this valuable resource. Monitoring can be accomplished in a variety of ways; physically, biologically and chemically.

The stream or river itself, along with the riparian banks and surrounding area may be visually or physically monitored. Stream watch groups may observe erosion or vegetative buffers along the banks to determine health of the stream. If there is substantial erosion along the river banks, then there may be a higher turbidity level in the water way.

Vegetative buffers along stream banks provide protection by controlling soil erosion, filtering pollutants at potential access points, supplying habitats for aquatic and land life, and keeping water temperatures lower with shade. Unchecked stream bank erosion can lead to excess sedimentation and disturb the macroinvertebrates and spawning fish

Monitoring the diversity of plant and animal life are biological or biotic indicators. Macroinvertebrates are indicators of the stream health because of their high oxygen requirement. Streams and rivers that are swift moving have higher levels of oxygen compared to stagnant ponds. Temperature also influences the health of the stream as cool waters are able to hold onto dissolved oxygen longer than warm water does.

Macroinvertebrates are a good measure of water quality since many are pollution sensitive. Samples of insects are best taken in riffles, where water is flowing over rocks, and is well-aerated with higher dissolved oxygen levels .The most sensitive to water quality are caddisfly, mayfly and stonefly.

Since aquatic plants and animals require oxygen to live, dissolved oxygen tests are conducted to measure the amount of oxygen in the water. Chemical testing are abiotic indicators of the health of the stream. Measuring pH, dissolved oxygen, nitrates and phosphorous levels are all ways to monitor the stream health.

Lesson 21

Storm Waters

What is the purpose of a storm drain?
Where does water in the streets go when it rains?
What is non-point source pollution?

GOAL To understand that run-off can carry identified and unidentified pollutants down the storm drain to waterways.

OBJECTIVES Students will:

- ✓ simulate polluting a waterway
- ✓ realize the effect of pollutants going down a storm drain
- ✓ realize that some pollution sources are difficult to identify
- ✓ understand run-off from rain sometimes carries pollutants down a storm drain

MATERIALS **5 gallon plastic container (clear), canisters, masking tape, permanent markers, "pollution" - leaves, oil, sand/salt mixture, plastic or styrofoam pieces, green food coloring**

CORE CURRICULUM CONTENT STANDARDS

- **Science 1(7), 8(2-8), 11(6), 14(5,7)**
- **Social Studies 9(2), 10(1,3), 12(4,5,7)**

VOCABULARY **non-point source pollution, pollution, storm drain, run-off**

PROCEDURES

1. Ask students if they are familiar with a storm drain. (*a drain on the side of the road that carries away excess water during rainstorms*) Determine if the students know its purpose (*prevent flooding in streets*) Explain that the excess water is called run-off.
2. Ask if they know where the run-off water goes (*nearest waterway*).
3. Pose the following question: What happens if there is trash on the road or oil spots? Does that go down the drain, too?
4. Have students simulate storm drain activity. Fill up a clear and plastic container with water. This will simulate their waterway, such as Connecticut River or Farmington River.
5. Before beginning activity, introduce the term non-point source pollution, and pollution. Pollution refers to harm to a natural area by chemicals, wastes, etc. Non-point source pollution refers to a source that can not be clearly identified.
6. Begin by explaining that the waterway (*container*) is clear and fresh. Many fish and other wildlife thrive in the waterway. Swimmers have recently been banned from going into the water because of an unknown source of pollution. Lay a piece of cardboard on top of the container. Cardboard should have cut-outs simulating storm drains.
7. Explain to the students that the cut-outs are storm drains. The canisters near the water-

way are filled (*instructor fills prior to activity*) with "unidentified sources of pollution". They are marked with a number on the outside (*use masking tape and permanent marker to mark numbers*)

8. Explain to students that possible sources of pollution are written on pieces of paper that may be picked from a box, jar or envelope. The papers have a number on them to correspond to the sources of pollution. Their challenge is to identify the sources.
9. Choose a student to pick a paper and read the source. Distribute canisters filled with a source of simulated pollution (*There may be several canisters with the same pollution since the storm drains may be around the whole city or town*). As student reads the source, the student (s) pours the "pollution" from the canister into the storm drain. Two or more students may have canisters of the same "pollution" source to simulate more than one household.
10. The pollution sources are listed as follows:
    1. The lawn at my house was mowed this weekend. I was composting leaves, but it was very windy. Lots of leaves blew out of the yard and down the storm drain. (Have students place *leaves* down simulated drain)
    2. My car was parked on the road for several days. Unfortunately, I forgot to get my oil leak fixed. The oil leaked on to the street and it rained last night. The oil went down the storm drain. (Have student(s) pour *oil* down the storm drain.).
    3. It was a snowy winter and the public works crew in my town decided to use a mixture of sand and salt to melt the snow and ice. It really melted the ice and caused the melted snow and ice to flood the storm drain. Down went the sand and salt into the drain. (Students pour *sand and salt* mixture down storm drain).
    4. We went to a park and had a picnic lunch with our friends. After eating, we played a game of football. I noticed squirrels carrying pieces of trash away. Some of it blew onto grass and parking lot. I was too busy playing. The automatic sprinklers went on to water the grass. The trash went down the drains. (Have students place *plastic pieces, styrofoam*, etc. into drain).
    5. My father fertilized the lawn. He was happy that it rained so the fertilizer would absorb into the soil. The fertilizer went down the drain (Have students pour *water with green food coloring* down the drain).
11. Once completed, ask students why there was no swimming. Pose the questions: What were the sources of pollution? What could be done to prevent this from happening?
12. Ask students to list ways they can clean up the waterway.

EXTENSIONS

1. Have students break up into groups. What can they do to prevent pollution in the water, air and land? Ask them to list five things they could do to keep the environment clean. Have students present options to class. Have students choose one item from the list that they can put into action.
2. Ask students if they can think of other sources of pollution that may harm our waterways. Have them also think of ways to prevent pollution.

RESOURCES

Haskin, Kathleen, *The Ways of the Watersheds, An Educators Guide to the Environmental and Cultural Dynamics of New York City's Water Supplies*, 1995, The Frost valley YMCA, Claryville, NY.

GLOSSARY

non-point source pollution - pollution caused by rainfall or snowmelt moving over and through the ground; as the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water
pollution - a substance that makes a resource unclean, especially by environmental contamination by man-made waste
run-off - rainfall not absorbed by soil
storm drain - a storm sewer

Copy and cut the following scenerios:

1. The lawn at my house was mowed this weekend. I was composting leaves, but it was very windy. Lots of leaves blew out of the yard and down the storm drain. (Students places leaves down simulated drain)

2. My car was parked on the road for several days. Unfortunately, I forgot to get my oil leak fixed. The oil leaked on to the street and it rained last night. The oil went down the storm drain.(Students pour oil down the storm drain)

3. It was a snowy winter and the public works crew in my town decided to use a mixture of sand and salt to melt the snow and ice. It really melted the ice and caused the melted snow and ice to flood the storm drain. Down went the sand and salt into the drain. (Students pour sand and salt mixture down storm drain).

4. We went to a park and had a picnic lunch with our friends. After eating, we played a game of football. I noticed squirrels carrying pieces of trash away. Some of it blew onto grass and parking lot. I was too busy playing. The automatic sprinklers went on to water the grass. The trash went down the drains. (Students place plastic pieces, styrofoam, etc. into drain).

5. My father fertilized the lawn. He was happy that it rained so the fertilizer would absorb into the soil. The fertilizer went down the drain (Students pour water with green food coloring in it down the drain).


DUMP NO WASTE
DRAINS TO STREAM

Lesson 22

Water Spills

What happens to wildlife during oil spills?
What happens to water if oil spills?
How is it cleaned?

GOAL To understand that oil can pollute the waterways and can harm the wildlife.

OBJECTIVES Students will:

- ✓ examine feathers under a magnifying lenses
- ✓ simulate an oil spill into a waterway
- ✓ determine how to clean water
- ✓ examine the effects of oil spills on waterways

MATERIALS **5 gallon plastic container, several feathers, a cup of vegetable oil, magnifying lenses, detergent, paper towels**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(1)**
- **Science 1(1,2,3,7), 8(2-8), 11(6), 14(5,7)**

VOCABULARY **oil, oil spills, tanker, magnifying lenses**

PROCEDURES

1. Have students simulate an oil spill and observe its affect on wildlife, particularly birds.
2. Fill up plastic container with water. Break up students and distribute a feather. Have students observe it dry and examine it under magnifying lenses. Have them place the feather under water and observe any changes. Again, examine under lenses.
3. Tell the students that there was an oil spill in the river. Have students pour a cup of vegetable oil into waterway. Part of the oil spills on feather. Now, have them examine feather with oil spill. Note the changes in texture. Ask how they think a bird would be affected if oil were spilled on them. Would the bird be able to move, fly, or breathe?
4. Provide students with dish detergent, paper towels. Ask them to clean up feather. How difficult or easy was this?
5. Instruct students to imagine a large area of oil spilled into a waterway. What would be the affect on the water, wildlife?

6. Ask students how they would feel if they saw a bird covered in oil and it could not move. Have them write their feelings on a piece of paper.
7. Have students place petroleum jelly on a piece of paper. Place paper outside of window with either window or rock holding it down. Observe paper after several days (paper will have pollution on it).
8. Discuss different types of pollution and its effect on society (polluted air can cause problems with breathing; polluted water can make people or animals sick, etc.) Are there any health related problems associated with pollution?

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EXTENSIONS

1. Have students research how oil spills from tankers are contained in an area and cleaned.
2. Ask how wildlife is cleaned.
3. Since oil tankers can not navigate on Farmington River, have students think other possible sources of oil pollution (oil from storm drains, oil truck , underground oil tanks).
4. Ask where oil come from. Is it a renewable or non-renewable resource?

RESOURCES

Haskin, Kathleen, *The Ways of the Watersheds, An Educators Guide to the Environmental and Cultural Dynamics of New York City's Water Supplies*, 1995, The Frost valley YMCA, Claryville, NY.

GLOSSARY

magnifying lenses - tools used to increase the size of an item
oil - any of numerous mineral, vegetable, and synthetic substances and animal and vegetable fats that are generally slippery and combustible, but not soluble in water, and used in a great variety of products, especially lubricants and fuels
oil spills - accidental spills from tanks that can pose serious threats to the environment
tanker - a ship, plane, or truck constructed to transport liquids, such as oil, in bulk

Lesson 23

Water Wear

What types of surfaces absorb water and what types do not?
What can farmers do to prevent the land from eroding?

GOAL To understand that different types of surfaces can affect how water run-off flows or is absorbed.

OBJECTIVES Students will:
- ✓ Determine ways farmers can prevent erosion
- ✓ Identify impervious and pervious surfaces

MATERIALS **paint trays for 4 or 5 groups, soil (5 lb bag), grass, sticks, rocks and hay (optional), plastic cups (6), plastic wrap (piece to cover trays), various Styrofoam, cardboard and/or plastic pieces, water**

CORE CURRICULUM CONTENT STANDARDS

- **Science 1(2,7), 7(3,4,7), 8(6), 14(8)**
- **Social Studies 9(1-3), 10(3,4), 11(4,6-8)**
- **Arts 1(3,4)**

VOCABULARY **erosion, cover crops, contour plowing, terrace farming, impervious, pervious, pavement**

PROCEDURES

1. Ask students if they are familiar with the term *erosion*. Explain that it is the gradual wearing away of soil or rock by water, wind or ice. Ask if they think this would be good or bad for farmers, the rivers, lawns, etc.
2. Explain that they will be participating in an activity that simulates soil erosion. This activity is best completed outdoors or with a covering placed on desks or tables in classroom.
3. Have students work in cooperative groups. Each group will receive a paint tray or plastic container. The paint tray will be slanted (bricks may be placed underneath paint tray). Soil will be placed in top portion of paint tray.
4. Challenge students to become farmers and prevent erosion on this simulated farm field.
5. Demonstrate soil erosion by pouring water on to the “farm field”. Water may be collected by tilting paint tray and catching water in a plastic cup. Cup may be retained for comparison purposes.

6. Distribute rocks, sticks, grass, leaves and hay, if available to prevent erosion on their field.
7. Have students build up their "farm" to prevent further erosion. Have students add materials, such as grass, hay, sticks, etc.
8. Conduct water demonstrations collectively, so students can compare how much soil eroded. Pour water over students' build up "farms" to demonstrate techniques to control erosion used by students.
9. Discuss terrace farming (walls or fences built to prevent erosion), contour plowing (furrows or gullies made across field rather than up and down), and cover crops (putting organic material to build up soil).
10. After demonstrations, have students discuss what happens if this area were a park or field and not a farm field. Ask what would happen if trash or a type of pollution is placed on the soil (they may place trash pieces and simulate rain), food coloring to simulate pollution. Have them collect trash pieces.
11. Add plastic wrap on part of soil and pour water on the plastic. Ask how this is different than the soil and the organic materials previously placed on top. Ask if they know what the plastic wrap represents (pavement).
12. Explain that this is called an impervious surface. When water is absorbed into soil, it is called a pervious surface. When water is not absorbed, then it is considered impervious.
13. Have students look around schoolyard. What surfaces are considered pervious? (grass, trees) What are considered impervious? (parking lot)

EXTENSIONS

1. Ask students how they could add pervious surfaces to their schoolyard or any other area.
2. Discuss erosion along a river's bank. Find out how to prevent erosion.

RESOURCES

Haskin, Kathleen, *The Ways of the Watersheds, An Educators Guide to the Environmental and Cultural Dynamics of New York City's Water Supplies*, 1995, The Frost valley YMCA, Claryville, NY.
Rosselet, Dale A., A Watershed Approach to Teaching the Ecology of Regional Systems, 1999, New Jersey Audubon Society, Bernardsville, New Jersey 07924.

GLOSSARY

contour plowing - following the curve lines of uneven terrain to limit erosion of topsoil
cover crops - a crop planted to prevent erosion and to provide humus
erosion - the group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface
impervious - incapable of being penetrated
pavement - a hard, smooth surface, especially of a public area or thoroughfare, that will bear travel
pervious - open to passage or entrance; permeable
terrace farming - building a series of steps to prevent erosion

Lesson 24

Riparian Wear

What does a healthy river bank look like?
What does an unhealthy bank look like?
What can be done to prevent erosion?

GOAL To understand that riparian banks are indicators of health of stream

OBJECTIVES Students will:

- ✓ draw a picture of a healthy stream bank
- ✓ draw a picture of an unhealthy bank
- ✓ measure turbidity
- ✓ write a poem or paragraph about the importance of water

MATERIALS **construction paper, markers, pencils, small clear, plastic container with cover, flashlight**

CORE CURRICULUM CONTENT STANDARDS

- **Science 1(2,4,7), 7(3,4,7), 8(6)**
- **Social Studies 9(1-3), 10(3,4), 11(4, 6-8)**
- **Arts 2(3)**

VOCABULARY **riparian, erosion, turbidity**

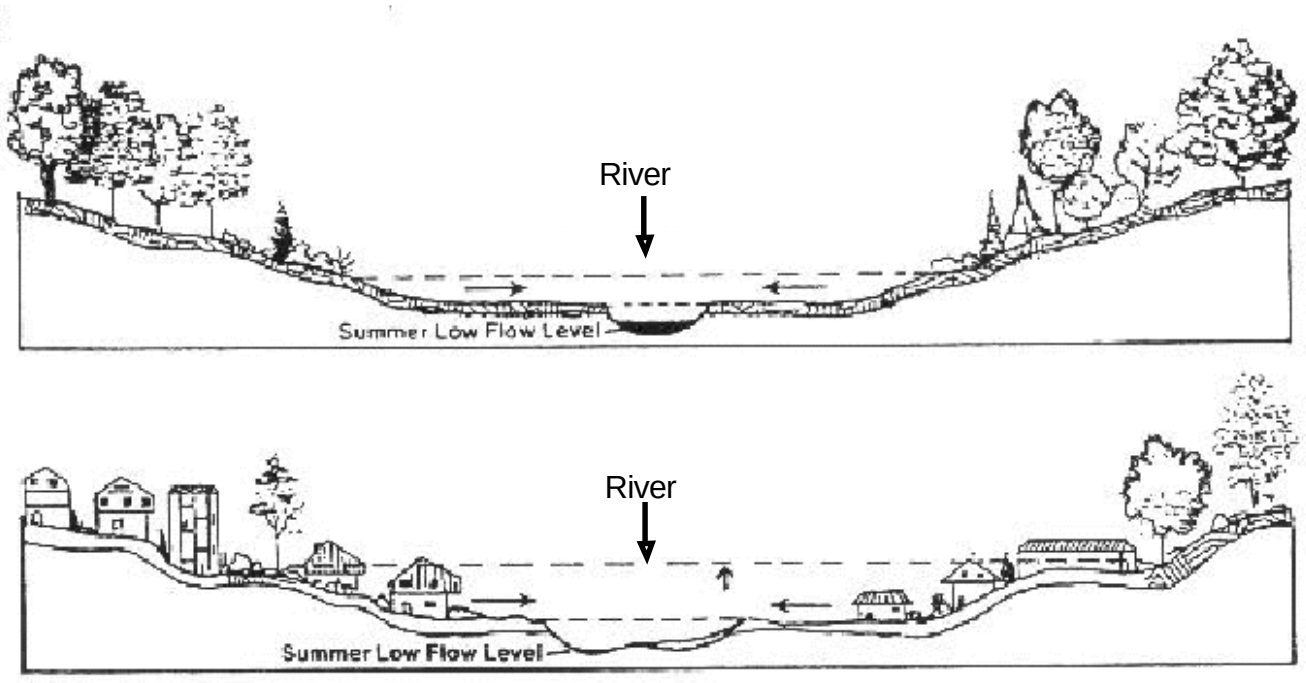
PROCEDURES

1. Explain that river edges or banks are in riparian zones or river areas. Buffer zones are areas that absorb water to prevent flooding, etc. Buffer zones are especially important on the sides of rivers to prevent erosion from going down the river.
2. Have students imagine they are sitting on the edge of a forest close to a river. Have them think of what characteristics would make this a good buffer zone. (trees, grass, and plants growing). Ask students what a healthy river bank looks like. Discuss.
3. Have students draw a healthy riparian area. Compare to unhealthy area. (roots of trees, lots of soil erosion) Draw a comparison picture.
4. Distribute small, clear, plastic containers. Add water to containers and soil. Place cover and shake. Hold container up to light. Shine flashlight through container. Explain to students that this is considered turbidity. How clear is the water with soil in it? Compare this to river erosion.
5. Ask students how they are able to prevent erosion in their yards or schoolyards.

EXTENSIONS

1. What types of projects is the Farmington River Watershed Association participating in to prevent erosion of the banks?

2. Show the pictures below (or draw your own) and ask the following questions:
Which riparian buffer area do you think would absorb more water? Why?
Which riparian buffer area do you think would have more erosion? Why?



GLOSSARY

erosion - the group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface
riparian - of, on, or relating to the banks of a natural course of water
turbidity - having sediment or foreign particles stirred up or suspended; muddy

Lesson 25

Industrial Water

What were the effects of Industrialism on water?
What impact on the water did the factories have?
What types of factories existed during Industrialism?

GOAL To understand that Industrialism adversely impacted the water quality

OBJECTIVES Students will:

- ✓ read an excerpt about Industrialism
- ✓ reflect on how the water was impacted
- ✓ imagine the pollution
- ✓ write and list ways they can positively affect water quality

MATERIALS **writing paper, poster board, markers or pencils**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(1,4), 2(2,4)**
- **Science 7(5,12), 8(7,8), 14(2-4,8)**
- **Social Studies 1(1,3-5), 2(3), 4(5), 9(1,2-6), 11(3,5, 6), 12(4-8), 13(3)**
- **Arts 1(2,4)**

VOCABULARY **pollute, Industrialism, chemical, machine, factory**

PROCEDURES

1. Introduce term, “Industrialism”. Ask students how it contributed to polluting rivers.
2. Ask students if they are familiar with the Industrial Revolution (*machines, factories, etc. were invented and developed).*
3. Determine whether they know the time frame of when Industrialism began. Was it before the Native American settlement or after? (*during 1700’s and 1800’s*)

4. Have students read an except from, A River Ran Wild, by Lynne Cherry.

   "At the start of a new century, an industrial revolution came to the banks and waters. Many new machines were invented. Some spun thread from wool and cotton. Others wove the thread into cloth. Some machines turned wood to pulp, and others made the pulp into paper. Leftover pulp and dye and fiber were dumped into the river, whose swiftly flowing current washed away the waste. ..Chemicals and plastic waste were also dumped into the river. Soon the fish and wildlife grew sick from this pollution.
   The paper mills continued to pollute the waters. Every day for many decades pulp was dumped into the river, and as the pulp clogged up the river, it began to run more slowly… Soon no fish lived in this river. No birds stopped on their migration. No one could see pebbles shining up through the murky water. The river was dark and dirty. It was slowly dying."

5. Have students think back to the first excerpt. Think of the river then and now. How is it different?
6. How do they feel about what has happened to the river?
7. Have students separate into groups. Have them write five things that they and or the community can do to clean up the river. Discuss as a group.
8. Compare the river in the story to the Farmington River and Connecticut River. Do you think the same situation (polluting the river) occurred in Connecticut during the Industrial Revolution or at another time in history? Why or why not? Is it still going on?
9. Have students imagine what the impact of the pollution was. Have them write and draw what they imagine it to be like. Have students present their ideas and drawings.

EXTENSIONS

1. Instruct students to imagine the land and the impact Native Americans had on it and the impact the colonists had on it. Discuss any differences.
2. Have students draw the topography of the land.

GLOSSARY

chemical - a substance with a distinct molecular composition that is produced by or used in a chemical process
factory - a building or group of builds in which goods are manufactured; a plant
industrialism - an economic and social system based on the development of large scale industries and marked by the production of large quantities of inexpensive manufactured goods and the concentration of employment in urban factories
machine - a device consisting of fixed and moving parts that modifies mechanical energy and transmits it to a more useful form
pollute - to make unclean, especially by environmental contamination by man-made waste

FRWA Curriculum Guide

Week VI

Water Protection and Conservation

Water Protection and Conservation Background Information

"Children of a culture born in a water-rich environment, we have never really learned how important water is to us. We understand it, but we do not respect it." – William Ashworth, Nor Any Drop to Drink, 1982

The average person needs two and a half quarts of water a day to maintain good health. In the United States, the average person uses 120 to 150 gallons of water for cooking, washing, flushing and watering. When water is readily available, people do not think about conserving water. Water wasting habits are difficult to change, but the average household can save up to 50,000 to 100,000 gallons a year.

Along with conservation practices, protection of this vital resource is essential. Stream monitoring and testing are ways that students and volunteers can help maintain the quality of the water. Educating others as community service, decreasing negative impacts on water quality and a commitment to insuring that water is clean are all ways to insure that water quality is preserved.

Food Facts:

- It takes **6 gallons** of water to make **one order of french fries.**
- More than **2,600 gallons** of water are needed to produce **one serving of steak.**
- The average American consumes **1,500 lbs. of food** annually. It takes **1.5 million gallons** to produce food for just one person!
- Approximately **6,800 gallons of water** are used to feed a **family of four** for one day.
- **100 gallons** of water are needed to grow **one watermelon.**

Environmental Facts:

- Only 7 % of the country's landscape is considered riparian, or alongside water— only **2 % of which still supports riparian vegetation**.
- Of the 1200 species listed as threatened or endangered, **50% are dependant on wetland habitats.**
- Freshwater species are disappearing **5 times faster** than land animals.
- **53,000 cubic miles** of water pass through Earth's lakes and streams.
- If all of the water in the world were to fit in a gallon jug, the available freshwater would equal only **1 teaspoon.**

Human Facts:

- **1.2 billion** of the world's people do not have access to clean water.
- The United States consumes water at **twice the rate** of other industrialized countries.
- **6.8 billion gallons** of water are flushed down American toilets each day.
- **80 %** of freshwater used in the United States goes to irrigating crops and creating hydroelectric power.
- To survive, the average person needs **2 quarts** of water a day.
- An average person will drink about 16,000 gallons of water in their lifetime.

Lesson 26

Water Preserves

How much water do we use?
How can we conserve water?

GOAL To understand that water is a finite resource to be conserved

OBJECTIVES Students will:
- ✓ count how many cups of water it takes to wash hands
- ✓ estimate how many cups of water are used in water activities

MATERIALS **large plastic bucket, worksheet, pencils, clipboards (optional)**

CORE CURRICULUM CONTENT STANDARDS

- **Math 1(1-6), 2(2,3), 3(1-4)**
- **Science 1(3), 8(7,8), 14(5,7,8)**

VOCABULARY **conservation, estimate**

PROCEDURES

1. Begin activity with students discussing water conservation strategies. Have one student wash his hands as they normally would. Have a bucket collecting water as student washes hands. After washing hands, count how many cups of water was used.
2. Writes other activities that use water. Have students estimate or guess how much water Americans use each day for particular activities. Distribute worksheets to students so they can record answers. Have students work in groups to calculate answers.
3. The amounts used are as follows:

   a. washing/showering – 865 cups
   b. toilet flushing – 769 cups
   c. running washing machine – 545
   d. doing dishes – 449
   e. cooking/drinking – 321
   f. gardening/washing car - 256
4. Have students brainstorm ways of reducing water usage and try it that week. Have them retain a log of their activities.
5. Have students create posters to place in classroom on using less water.

GLOSSARY

conservation - preservation or restoration from loss, damage or neglect
estimate - a tentative evaluation or rough calculation, as of worth, quantity, or size

NAME_____

How many cups of water each day do you use?

1. washing/showering _____
2. toilet flushing _____
3. running washer _____
4. doing dishes _____
5. cooking/drinking _____
6. gardening/washing car_____

Lesson 27

Water Watchers

What can I do to help prevent a water shortage?
What are some water saving tips?

GOAL To understand that conservation of water can help prevent water shortages.

OBJECTIVES Students will:
- ✓ list conservation methods
- ✓ implement a change in behavior

MATERIALS **paper, pencils**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 1(3)**
- **Science 8(7,8), 14(5, 7,8)**
- **Social Studies 13(1,3,5)**

VOCABULARY **water shortage, dilemma**

PROCEDURES

1. Explain to students they are faced with a water shortage dilemma. They were told that effective immediately, they have to find ways of reducing the amount of water they use in their families.
2. Break students up into groups. Have them brainstorm ways they can decrease the amount of water they use during the day.
3. Have them present to class and have class list their ideas.
4. Have students research water saving tips on web site www.wateruseitwisely.com/regions/100tips/ne_index.html
5. Have student become water saving activits, use tips to educate others in their family or at school.
6. Have students try to implement one change that week.
7. Assess at the end of week. Determine how challenging it was.

GLOSSARY

dilemma - a situation that requires a choice between options that are or seem equally unfavorable or mutually exclusive
water shortage - a deficiency in water

Lesson 28

Water Protection

What organization(s) help protect the watershed?
What can you do to help with conservation and protection measures?

GOAL To understand that organizations help monitor and protect resources in the watershed

OBJECTIVES Students will:

- ✓ conduct research about organizations that help protect watershed
- ✓ discuss their roles protection of water

MATERIALS **papers, pencils**

CORE CURRICULUM CONTENT STANDARDS

- **Language Arts 2(1)**
- **Science 8(7,8), 14(7,8)**
- **Social Studies 13(1,3,5)**

VOCABULARY **organization, protection**

PROCEDURES

1. Have students learn about water protection organizations, such as the Farmington River Watershed Association (www.frwa.org or 860-658-4442). Have students learn about other organizations at www.rivernetwork.org.
2. Discuss mission statements, accomplishments and goals of organization(s).
3. Discuss their role as protecting the natural resources of the river and watershed.
4. Research accomplishments including the designation of wild and scenic river, salmon restoration, protection of wildlife, clean-up river events, recreational activities, such as canoeing, kayaking, swimming, and fishing, and biodiversity studies.
5. Present information to class. Have students discuss the importance of having organizations and people that are concerned about our watersheds (help maintain water quality, protect land, be a watch dog for the watershed).
6. Have students think about and discuss how they can be part of protecting our resources.
7. Discuss if their attitudes have changed about drinking water.

GLOSSARY

organization - something that has been organized or made into an ordered whole
protection - the act of protecting

Lesson 29

Water Around the World

How much water is used in the United States?
How much water is used in other countries?

GOAL To understand that United States uses the most water in the world each day

OBJECTIVES Students will:
- ✓ match countries to how many cups of water used in a day
- ✓ identify countries on a map

MATERIALS **papers, pencils**

CORE CURRICULUM CONTENT STANDARDS

- **Math 1(1-6), 2(2,3), 3(1-4)**
- **Science 8(7,8), 14(7,8)**
- **Social Studies 11 (6,7), 12(3,5,6), 13(1,3- 5)**

VOCABULARY **water usage, country**

PROCEDURES

1. Discuss water usage in the United States. Ask students if they think United States uses the most water.
2. List countries and amounts separately on board.
3. Have students match amounts to countries from highest water usage to lowest.
4. The amounts follow:
   a. United States – 26,734 cups/person/day
   b. Canada – 17,470 cups/day
   c. Australia – 14,044 cups/day
   d. Italy – 12,521 cups/day
   e. Spain – 11,210 cups/day
   f. Japan – 10,702 cups/day
   g. Germany – 7,910 cups/day
   h. France – 5,795 cups/day
   i. Sweden – 5,541 cups/day
   j. Switzerland – 1,227 cups/day
5. After matches are made discuss results.
6. Have students identify countries on a map.

GLOSSARY

country - a state or nation
water usage - the act of using water

Lesson 30

Water Locations

What factors are important in planning a community around a river?

GOAL To understand that buildings and development impact waterways

OBJECTIVES Students will:
- ✓ draw a community

MATERIALS **poster board or butcher block paper, markers and pencils**

CORE CURRICULUM CONTENT STANDARDS

- **Science 8(7,8)**
- **Social Studies 9(3)**
- **Arts 1(2,4)**

VOCABULARY **location, community, biodiversity**

PROCEDURES

1. Explain to students that they will be creating a new community. They will be drawing their community on a piece of construction paper.
2. Break students into groups.
3. Have students place paper horizontally in front of them. Have them draw a river in the middle of the paper going across the paper horizontally. Color the river blue.
4. Have groups place two trees on the side of the river. Color them green. This is a park.
5. Then, have students place their school, a square box in their community and color it red.
6. Students will draw a mountain in their community. Color it brown.
7. Have students draw a store (box) and color yellow.
8. Have students place a landfill or trash-to-energy plant in their community. Color it orange.
9. Where in their watershed do they want their homes? Have them draw their homes and color purple.
10. Discuss why they chose the particular spot for their homes.
11. Have student groups connect “maps”. Discuss with students location of items on maps.
12. Discuss concept of biodiversity (a.k.a. biological diversity - the variety of life in all its forms and inter-relationships) while planning a community.

WHAT IS BIODIVERSITY

There are millions of species of plants, birds, reptiles, mammals, fish, shellfish, amphibians, insects, and microorganisms such as bacteria living on earth. Try to imagine them all, and don't forget to put yourself in the picture! Now think about what makes each one of those species different from each other. Think about what makes them look and act differently, what different kinds of habitats and climates they live in, what their different needs are, and how they interact with one another. Now think about your community and the many kinds of people, animals, plants, insects, etc. you find there. Think about what it takes for these critters to co-exist, and think about how you might plan for community growth (more colored boxes) while protecting biodiversity in your town.

(Adapted from endangered.fws.gov/kids/biodivrs.htm)

GLOSSARY

biodiversity - biological diversity in an environment as indicated by numbers of different species of plants and animals
community - a group of people living in the same locality and under the same government
location - a place where something is or could be located; a site

APPENDIX A:

ELEMENTARY CURRICULUM CONTENT STANDARDS

SECOND GRADE STATE CONTENT STANDARDS

Language Arts

1-1 Students will describe the thoughts, opinions, and questions that arise as they read, view, or listen to a text and use relevant information from the text to summarize the content.

1-2 Students will use what they know to identify or infer important characters, settings, themes, events, ideas, relationships or details within a work.

1-3 Students will analyze, elaborate on and respond critically to works.

1-4 Students will identify the type of text and use strategies (talking and writing, utilizing graphic organizers, drawing, listening, creating time lines, etc.) to accomplish a range of reading tasks.

1-5 Students will ask and answer their own and each other's literal and inferential text-related questions.

1-7 Students will practice using strategies to monitor and self-correct their comprehension as they read their texts.

1-9 Students will learn and use effectively the complete variety of word recognition strategies to aid in comprehension.

1-10 Students will read extensively, cluster, define, identify word parts and use other such strategies to build their comprehension skills.

1-11 Students will generate a variety of responses based upon the experiences they have had.

1-12 Students will participate in a variety of cooperative group activities to apply collaborative skills (e.g., making eye contact, waiting turns, listening, taking others' ideas into account, explaining clearly, restating) to their reading, writing , listening and viewing.

1-13 Students will retell and evaluate stories and select the most important facts from informational texts.

1-14 Students will support their inferences, orally and/or in writing, by referring to the materials read.

2-1 Students will decide upon purpose, audience and point of view, then select from a group of text types, such as narrative, nonfiction and poetry, the most appropriate genre to convey their meaning.

2-2 Students will speak, write or draw in a variety of modes (narratives, "all-about" nonfiction pieces, poetry) to tell stories that their audience understands.

2-3 Students will generate questions for gathering data from appropriate first-hand, visual and print sources, and categorize the data to produce a product.

2-4 Students will compose a piece of writing based on ideas generated through a variety of ways (writing, drawing, talking, webbing, listing, brainstorming), revise and proofread it, and present it to an audience.

2-5 Students will collect and examine, individually or with classmates, an array of their own stories and drawings, discuss the features they like, and say what they might do differently the next time.

4-4 Students discuss how the works they read and write are dependent upon factors such as time, culture and experience of the readers and writers.

4-5 Students will identify the literary conventions and devices used in such genres as folk tales, fairy tales, tall tells and poems, and tell how those conventions and devices help the reader understand the genre.

Math

1-1 Use real-life experiences, physical materials and technology to construct meanings for whole numbers, commonly used fractions and decimals.

1-2 Understand our numeration system by modeling, counting, grouping, and using place-value concepts.

1-3 Use numbers to count, as measures, labels and as indicators of location.

1-4 Use models and pictures to demonstrate understanding of equivalent forms of numbers.

1-5 Understand and use properties of numbers, including odd, even, ordinal and cardinal.

1-6 Develop a sense of magnitude of numbers by ordering and comparing whole numbers, commonly used fractions, decimals and money amounts.

2-2 Develop proficiency with basic addition, subtraction, multiplication, and division facts through the use of a variety of strategies and contents.

2-3 Use informal language, mathematical language and symbols to relate problem situations to operations.

2-4 Recognize that any one operation can be used to represent diverse problem situations, e.g., subtraction can be used in “take away,” as well as comparison situations.

2-5 Construct, use and explain a variety of procedures for performing whole number calculations.

3-1 explore, construct and use a variety of estimation strategies.

3-2 Recognize when estimation is appropriate and understand the usefulness of an estimate as distinct from an exact answer.

3-3 Use estimation to determine the reasonableness of an answer.

3-4 Visually estimate length, area, volume and angle using various referents.

4-1 Describe simple ratios when comparing quantities.

7-1 Pose questions, make predictions and solve problems that involve collecting, organizing and analyzing data.

10 -1 Classify data according to attributes

Science

1-1 Recognize that when a scientific investigation is done in the same way in different places or when repeated many times, the investigation generally has the same results.

1-2 Raise questions about their surroundings and seek answers by making careful observations and trying things out.

1-3 Recognize that tools such as thermometers, magnifiers, rulers and balances often give more information than can be obtained by making observations without them.

1-4 Describe things as accurately as possible because careful, complete observations enable people to compare their observations with those of others.

1-5 Use their senses, i.e. sight, taste, sound, touch, smell, to make observations about the natural world and discuss their findings.

1-6 Use open-minded and willing to modify opinions based upon evidence.

1-7 Design and conduct (both in groups and individually) simple experiments, keep accurate records of their findings, and communicate their findings to others using graphs, charts, maps, and oral and written reports.

1-11 Recognize that measuring instruments can be used to gather information for making scientific comparisons of objects and events and for designing and constructing things that will work properly.

2-1 Recognize that science is an adventure that people everywhere can take part in, as they have for many centuries.
2-4 Recognize that, although men and women doing scientific inquiry have learned much about the objects, events and phenomenon in nature, there is still much more to be understood.
3-1 Describe the basic needs of organisms (e.g., food, water, air, shelter and the need for sunlight by plants).
3-2 Discuss how organisms depend on other organisms and their environments for basic needs.
3-3 Explain how different organisms may interact within the ecosystem in a variety of ways.
3-4 Describe how a variety of organisms, such as producers, consumers and decomposers, obtain their basic needs (e.g., food, water, air).
3-5 Explain how organisms interact with other organisms in different environments (e.g., mutualism, parasitism, competition).
3-6 Explain that some source of energy is needed for all organisms to stay alive and grow.
4-1 List features which distinguish living, nonliving and once-living things from one another.
4-2 Discuss basic life functions, such as respiration, movement, elimination, responding to stimuli, taking in food, and reproduction.
4-3 Use instruments, such as magnifying glasses, to observe living and nonliving things more clearly.
4-6 Compare and group living and nonliving materials for similarities and differences.
5-1 Identify the structures found in a variety of organisms.
5-2 Show how living and nonliving things can be groups using the characteristics they share.
5-3 Organize, compare and categorize similarities and differences among organisms.
5-4 Describe features that help organisms to survive in different environments.
5-5 Employ different ways of classifying organisms into groups using a variety of common features.
5-6 Identify anatomical and behavioral adaptations that allow organisms to survive in specific environments.
5-7 Explain that the features of living things can be good indicators of their roles and places in an ecosystem.
6-1 Identify external features of organisms that help them survive in different kinds of places.
6-8 Describe the life cycle of familiar organisms.
7-3 Recognize that the Earth has different land forms.
7-4 Observe changes that happen to many Earth's materials and land forms.
7-5 List ways people use Earth's resources.
7-7 Describe how waves, wind, water and ice reshape the Earth;s land surface by eroding rock and soil in some areas and depositing them in other areas.
7-12 Recognize that some energy sources cost more and cause more pollution than others.
8-1 Recognize that water can exist as a solid, liquid or gas and can be changed from one form to another.
8-2 Recognize that water on Earth exists in different forms.
8-3 Recognize that plants and animals need water to live.
8-4 Recognize that water can exist as a gas in the air and can reappear as a liquid, if cooled, or as a solid, if cooled below the freezing point of water.
8-5 Recognize that three-fourths of the Earth's surface is covered by water.

8-6 Identify major sources of water.
8-7 Recognize the importance and uses of water.
8-8 Recognize that water is essential to life.
9-2 Know that air contains water, that clouds are made of water and ice, and that precipitation comes from clouds.
9-8 Recognize there are different forms of precipitation and identify these forms.
11-6 Recognize that a chemical change occurs when substances interact to form new materials with properties that differ from those of the original substances.
13-6 Give examples of some forces that can change the motion of objects without touching them.
13-7 Recognize that the motion of an object can be described as a change in the position of the object with respect to another object or background.
14-1 Understand that people create tools to help them to do things better and to do things that otherwise could not be done at all.
14-2 Identify the contributions of science and technology to individuals and society.
14-3 Recognize that simple machines can help people do work.
14-4 Describe the role and use of technological devices in everyday life.
14-5 Recognize possible negative consequences to people, other organisms or the environment, of technological solutions to specific problems.
14-7 Identify alternative strategies to solve existing and potential environmental and technological problems.

Social Studies

1-1 Gather historical data from multiple sources
1-2 Engage in reading challenging primary and secondary historical source materials, some of which is contradictory and requires questioning of validity.
1-3 Describe sources of historical information.
1-4 Identify the main idea in a source of historical information.
1-5 Identify ways different cultures record their histories, compare past and present situation events, and present findings in appropriate oral, written and visual ways.
1-6 Create timelines which sequence events and peoples, using days, weeks, months, years, decades and centuries.
2-1 Demonstrate a familiarity with peoples, events and places from a broad spectrum of human experience through selected study from historical periods and from various regions.
2-2 Locate the events, peoples and places they have studied in time and place (e.g., on a time line and map) relative to their own location.
2-3 Demonstrate knowledge of major trends in state and local history, including history of original peoples, early settlements and selected changes over the past two centuries.
3-1 Recognize that people develop traditions that transmit their beliefs and ideals.
3-2 Examine family life and cultures of different peoples at different times in history.
3-3 Explain different types of conflict, different ways in which conflicts have been resolved, and different ways that conflicts and their resolutions have affected people.
3-6 Describe the impact of various technological developments on the local community and on the nation.
3-7 Identify individual achievements of scientists and inventors from many cultures and different historical periods and describe their achievements.

4-1 Exhibit curiosity and pose questions about the past when presented with artifacts, records or other evidence of the past.
4-2 Seek historical background when confronted with problems and issues of the past, as well as of today's world and their own lives.
4-5 Recognize relationships between events and people of the past and present circumstances, concerns and developments.
9-1 Define and identify natural and human characteristics of places.
9-2 Explain how human and natural processes shape places.
9-3 Provide reasons why and describe how places and regions change and are connected.
9-4 Observe and describe how places and regions are identified, defined and bounded.
9-5 Locate places within their own and nearby communities in Connecticut.
9-6 Locate major physical and human features in the New England region and the United States.
10-1 Identify the types of physical systems and their characteristics that affect the Earth's surface.
10-3 Explain the factors that affect the location distribution and associations of features of physical environment.
10-4 Define local environmental features
10-5 Draw a simple map of continents and oceans.
10-6 Locate Earth's major physical and human features.
11-3 Understand the elements of culture and how they change.
11-4 Locate Earth's major physical and human features.
11-5 Explain locations and characteristics of human settlements and how they have changed over time.
11-6 Describe the characteristics of a physical and human system
11-7 Locate places within their own and nearby communities in Connecticut.
11-8 Locate major physical and human features in New England and the United States.
12-1 Explain the characteristics and purposes of maps, globes and other geographic tools and technologies.
12-2 Create information from maps, globes and geographic models in graphs, diagrams and charts.
12-3 Use maps, globes, graphs, models, computer programs and texts, as appropriate.
12-4 Explain how human and natural processes shape places.
12-5 Explain ways in which humans use and interact with environments.
12-6 Identify locations of various economic activities and understand how physical and human factors influence them.
12-7 Describe how and why physical and human systems function and interact and the consequences of these interactions.
13-1 Define scarcity and abundance.
13-3 Identify and give examples if resources; human, natural and capital, and explain how they are used.
13-5 Identify alternative uses of resources found in their home, school or neighborhood.

Arts

1-1 Differentiate between a variety of media, techniques and processes.
1-2 Describe how different media, techniques, and processes cause different effects and personal responses.
1-3 Use different media, techniques and processes to communicate ideas, feelings, experiences and stories.
1-4 Use art media and tools in a safe and responsible manner.
2-1 Identify the different ways visual characteristics are used to convey ideas.
2-2 Describe how different expressive features, and ways of organizing them, cause different responses.
2-3 Use elements of art and principles of design to communicate ideas.
3-1 Discuss a variety of sources for art content.
4-1 Recognize that the visual arts have history and different cultural purposes and meanings.
4-2 Identify specific works of art as belonging to particular styles, cultures, times and places.
4-3 Create art work that demonstrates understanding of how history or culture can influence visual art.
6-2 Identify connections between the visual arts and other disciplines in the curriculum.

New Science Standards

2.1 Answers to questions about the natural world can come from reliable sources of scientific information and from our own observations and investigations.
2.2 Properties of objects and materials can be observed using our senses and measured using simple tools.
2.3 We use materials that have suitable properties for the jobs you want them to do.
2.4 Living things have certain characteristics that distinguish them from nonliving things.
2.5 Many different kinds of living things inhabit the earth.
2.6 Plants and animals have characteristic life cycles that include birth, maturation and death.
2.7 Organisms have basic needs and different body parts that help them satisfy those needs.
2.8 Weather can be measured, described and predicted.
3.2 Substances have characteristic properties and a mixture of substances can be separated using one or more of these characteristics.
3.3 Organisms can survive and reproduce only in environments that meet their basic needs.
3.4 All animals depend on plants. Some animals eat plants and others eat the animals that eat plants.
3.5 Water covers the majority of the Earth's surface and it circulates through the crust, oceans and atmosphere.
3.6 Earth materials provide resources for all living things, but these resources are not unlimited and should be conserved.
4.2 Changes in speed or direction of motion are caused by forces; the greater the force is, the greater the change.
4.3 The living and nonliving things in a region interact with one another.
4.4 Organisms have physical and behavioral adaptations that improve their chances of survival in certain environments.
4.5 The Earth's surface is shaped by slow processes, such as erosion and weathering, and by rapid processes, such as earthquakes and volcanoes.

APPENDIX B: GLOSSARY

adaptations – special features that allow an organism to survive in its environment
alevin – young fish; fry
anadromous – migrating up rivers from the sea to breed in fresh water
ancestors — a person from whom one is descended, especially if more remote than a grandparent; a forebear
aqueducts – a pipe or channel designed to transport water from a remote source, usually by gravity
atmosphere — the gaseous mass or envelope surrounding the earth
aquifer – an underground layer of earth, gravel, or porous stone that yields or hold water
awareness – having knowledge
biodiversity - biological diversity in an environment as indicated by numbers of different species of plants and animals
biotic index – an index of or having to do with life or living organisms
booming - To grow, develop, or progress rapidly; flourish
border — a part that forms the outer edge of something
buffer zones – an area that lessens or absorbs an impact
canal – an artificial water way or artificially improved waterway used for travel, shipping, or irrigation
carnivore – a predatory, meat eating animal
cattails – any of various perennial herbs of the genus *Typha*, widespread in marshy places and having long strap like leaves and a dense cylindrical cluster of minute flowers and fruit
chemical – a substance with a distinct molecular composition that is produced by or used in a chemical process
clay — a fine-grained, firm earthy material that is plastic when wet and hardens when heated, and widely used in making bricks, tiles, and pottery
clues — things that serve to guide or direct in the solution of a problem or mystery.
collage – an artistic composition of materials and objects pasted over a surface, often with unifying lines and color
colonial — of or relating to the 13 British colonies that became the original United States of America
community – a group of people living in the same locality and under the same government
components — part of a system
condensation – the process by which a gas or vapor changes to a liquid
confluence — a flowing together of two or more streams
consumer — a heterotrophic organism that ingests other organisms or organic matter in a food chain
conservation — preservation or restoration from loss, damage, or neglect
contour plowing – following the curve lines of uneven terrain to limit erosion of topsoil
country – a nation or state
cover crops - a crop planted to prevent erosion and to provide humus
culture — patterns, arts, beliefs, institutions, and all other products of human work and thought
dam — a barrier constructed across a waterway to control the flow or raise the level of water
decomposer — An organism, often a bacterium or fungus, which feeds on and breaks down dead plant or animal matter, thus making organic nutrients available to the ecosystem
decipher — to read or interpret
dilemma — a situation that requires a choice between options that are or seem equally unfavorable or mutually exclusive
drift — rock debris transported and deposited by or from ice, especially by or from a glacier

ecosystem — an ecological community together with its environment, functioning as a unit
elders — greater than another in age or seniority
endangered – to be threatened with extinction
energy — the capacity for work or vigorous activity
erosion — the group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface
estimate — a tentative evaluation or rough calculation, as of worth, quantity, or size
evaporation — to convert or change into a vapor
factory — a building or group of buildings in which goods are manufactured; a plant
finite — having bounds; limited
fish ladder — a series of pools arranged like ascending steps at the side of a stream, enabling migrating fish to swim upstream around a dam or other obstruction
flooding — an overflowing of water onto land that is normally dry
flow — to move or run smoothly with unbroken continuity, as a stream
food chain — a succession of organisms in an ecological community that constitutes a continuation of food energy from one organism to another as each consumes a lower member and in turn is preyed upon by a higher member
food pyramid — a graphic representation of the structure of a food chain, depicted as a pyramid having a broad base formed by producers and tapering to a point formed by end consumers
food web — a complex of interrelated food chains in an ecological community
fry — small fish, especially young, recently hatched fish
generations — all of the offspring that are at the same stage of descent from a common ancestor
geology — the scientific study of the origin, history, and structure of the earth
glacier — a huge mass of ice slowly flowing over a land mass, formed from compacted snow in an area where snow accumulation exceeds melting
gorge — a deep narrow passage with steep rocky sides; a ravine
gravel – a mixture of rock fragments or pebbles
gravity — the natural force of attraction exerted by a celestial body, such as Earth, upon objects at or near its surface, tending to draw them toward the center of the body
ground water — water beneath the earth's surface, often between saturated soil and rock, that supplies wells and springs
herbivore — an animal that feeds chiefly on plants
historical — based on or concerned with events in history
hydrologic cycle (water) — the cycle of evaporation and condensation that controls the distribution of the earth's water as it evaporates from bodies of water, condenses, precipitates, and returns to those bodies of water
identify — to ascertain the origin, nature, or definitive characteristics of
impervious — incapable of being penetrated
incubating — to sit on (eggs) to provide heat, so as to promote embryonic development and the hatching of young; brood
industrialism — an economic and social system based on the development of large scale industries and marked by the production of large quantities of inexpensive manufactured goods and the concentration of employment in urban factories
larva — the newly hatched, wingless, often wormlike form of many insects before metamorphosis
location — a place where something is or could be located; a site
locks — a section of a waterway, such as a canal, closed off with gates, in which vessels in transit are raised or lowered by raising or lowering the water level of that section
machine — a device consisting of fixed and moving parts that modifies mechanical energy and transmits it in a more useful form

macroinvertebrate — an invertebrate animal (animal without a backbone) large enough to be seen without magnification
magnify — to increase the apparent size of, especially by means of a lens
magnifying lenses — tools used to increase the size of an item
man-made — made by humans rather than occurring in nature; synthetic
map — a representation, usually on a plane surface, of a region of the earth or heavens.
metamorphosis — a change in the form and often habits of an animal during normal development after the embryonic stage
model — a small object, usually built to scale, that represents in detail another, often larger object
natural — present in or produced by nature
non-point source pollution — pollution caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water
nymph — the larval form of certain insects, such as silverfish and grasshoppers, usually resembling the adult form but smaller and lacking fully developed wings
observations — the act or faculty of observing
oil — any of numerous mineral, vegetable, and synthetic substances and animal and vegetable fats that are generally slippery and combustible, but not soluble in water, and used in a great variety of products, especially lubricants and fuels
oil spills — accidental spills from tanks that can pose serious threats to the environment
organization — something that has been organized or made into an ordered whole
orient — to align or position with respect to a point or system of reference
pavement — a hard smooth surface, especially of a public area or thoroughfare, that will bear travel
permeate — to spread or flow throughout; pervade
pervious — open to passage or entrance; permeable
pollutant — something that pollutes, especially a waste material that contaminates air, soil, or water
pollute - to make unclean, especially by environmental contamination by man-made waste
pollution - a substance that makes a resource unclean, especially by environmental contamination by man-made waste
pollution tolerance index — a measurement of how much pollution an organism may bear or tolerate
precipitation — any form of water, such as rain, snow, sleet, or hail, that falls to the earth's surface
producer — a photosynthetic green plant or chemosynthetic bacterium, constituting the first trophic level in a food chain; an autotrophic organism
protection — the act of protecting
pupa - the intermediate stage of a metamorphic insect
recreation — refreshment of one's mind or body after work through activity that amuses or stimulates; play
resource — something that can be used for support or help
reflection — something, such as light, radiant heat, sound, or an image, that is reflected
reservoir — a natural or artificial pond or lake used for the storage and regulation of water
restoration — something, such as a renovated building, that has been restored
ridge — a long narrow upper section or crest
ridge line — a long narrow chain of hills or mountains
riparian — of, on, or relating to the banks of a natural course of water
riparian area — the vegetative area or bank by a river
run-off — rainfall not absorbed by soil
safety measures — device used to prevent accidents
sand — small loose grains of worn or disintegrated rock
sawmills — a plant where timber is sawed into boards

species — a fundamental category of taxonomic classification, ranking below a genus or subgenus and consisting of related organisms capable of interbreeding.
storm drain — a storm sewer.
storyteller — one who tells or writes stories.
structure — the way in which parts are arranged or put together to form a whole
surface water — water above the surface of the ground
tanker — a ship, plane, or truck constructed to transport liquids, such as oil, in bulk.
terrace farming — building a series of steps to prevent erosion
tertiary — third in place, order, degree, or rank
threatened — to express a threat against
topography — graphic representation of the surface features of a place or region on a map, indicating their relative positions and elevations
traders — one that trades; a dealer
tradition — the passing down of elements of a culture from generation to generation, especially by oral communication.
transpiration — the act or process of transpiring, especially through the stomata of plant tissue or the pores of the skin
tributary — river or stream flowing into a larger river or stream.
trophic — involving the feeding habits or food relationship of different organisms in a food chain
turbidity — having sediment or foreign particles stirred up or suspended; muddy
turbulent — violently agitated or disturbed
uncover — to remove the cover from; to manifest or disclose
watershed — a ridge of high land dividing two areas that are drained by different river systems
water shortage — a deficiency in water
water usage — the act of using water
well — a deep hole or shaft sunk into the earth to obtain water, oil, gas, or brine.
wetlands — a lowland area, such as a marsh or swamp, that is saturated with moisture, especially when regarded as the natural habitat of wildlife
wigwam — a Native American dwelling commonly having an arched or conical framework overlaid with bark, hides, or mats
wildlife — wild animals and vegetation, especially animals living in a natural, undomesticated state

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