



Lesson 14.1 “Neglected Waterways”

Unit 14: Preserving New Hampshire’s Natural Landscape

Lesson Objectives

- Students will analyze primary sources for positive and negative effects of industrialization.
- Students will discuss a literature selection to complete discussion questions about the history of a polluted waterway.
- Students will label a map with watershed vocabulary.
- Students will investigate watershed systems and how human pollution affects them over time.

Lesson Competencies

- I can analyze primary and secondary sources and draw appropriate conclusions. (Moose SS)
- I can determine the central message/lesson/theme of a text and support my interpretation (saying why my evidence is accurate and convincing). (ELA 2)
- I can analyze, use, and construct maps and other geographic representations to explain relationships between people and the environment. (Moose SS)
- I can use evidence from observations, data, and maps to make predictions and support evidence-based explanations about how systems change over time (e.g., weather and climate, Earth’s systems). (Sci 8)

Essential Questions

How has New Hampshire come to be the way it is?
How has New Hampshire been shaped by many voices?

Focus Questions

How did industrialization threaten the landscape in New Hampshire?
What strategies did people use to protect the environment in New Hampshire?

Estimated Time

Three 40-minute class sessions

Materials & Equipment

Group sets of Industrialization Image Set
Positives and Negatives of Industrialization Labels
Lynne Cherry, *A River Ran Wild* (1992)
Class set of “*A River Ran Wild* Discussion Questions”
“Water Power” or “Steam Power” infographic for projection as desired
Class set of “Merrimack River Watershed, 2007” and for projection
“Vocabulary” for projection
“Kinds of Pollution” chart for projection and class set as desired



Educator Introduction & Rationale

While industrialization in New Hampshire in the early 1800s brought many positives, its negatives could not be ignored. The growth of new industries damaged the state's waterways, particularly the Merrimack River, where the earliest textile mills were located in New Hampshire and Massachusetts (both Lowell and Lawrence, two industrial powerhouses, are situated on the Merrimack). The mills depended on the river for water power to run their machinery, so the mill owners constructed dams and canals to manipulate water levels to ensure a steady supply of power. At the same time, for more than a century the mills dumped the byproducts of textile production into the river while sawmills did the same with the byproducts of logging and paper production. Larger cities often deposited untreated human waste into nearby bodies of water while places downriver used the same water for drinking. Clear cutting the forests led to silt in the rivers and by the 1920s, the Merrimack River bottom was covered in sludge, the water was unsafe for drinking, swimming, or boating, and its shellfish beds had been closed.

Water pollution was left largely unchecked until the mid-20th century when Granite Staters began to think differently about their rivers. At roughly the same time, the United States began participating in the global environmental movement, passing laws and regulations that resulted in a substantial improvement in water quality. However, the state's rivers are now at risk again as climate change and population increases disrupt delicate balances. Please see the Education Overview for more information.

This is the first lesson in Unit 14: Preserving New Hampshire's Natural Landscape. It can stand alone from the unit although students should have a basic understanding of industrialization during the 1800s. In this lesson, students examine the positives and negatives of industrialization through matching images and labels. They then delve into the history of the Merrimack River with Lynne Cherry's *A River Ran Wild*. Students then consider what happens to the rain and label vocabulary words on the Merrimack River Watershed map. Finally, they compare kinds of pollution and consider how pollution today is different from the pollution from the Industrial Revolution.

There is a reinforcement activity for students who need more support in understanding what a watershed is. Extension activities invite students to use online sources like videos and interactive maps to engage more with the concepts in the lesson. A variety of educational resource recommendations are found in Supporting Materials. Please adapt all the material in this lesson, as necessary, to meet the needs of the students in your classroom. Please note, lesson vocabulary and definitions are at the end of the document. You may wish to preview these with your students.

Learning Activity

Part I

Activation

Positives and negatives of industrialization. Ask the class for a reminder on the definition of industrialization. What happened during this time period?

- **Industrialization:** (noun) The shift to making many products on a large scale, using machinery and factories

Divide the class into pairs or small groups. Distribute labels and Industrialization Image Set so students can match label to image about the positives and negatives of industrialization. Decide for your class if each group will have both positives and negatives, or whether groups will focus on just one side. If the latter, be sure to report out to the class so everyone hears about both positives and negatives of industrialization. Once groups have finished matching images and labels, discuss together as a class. What did industrialization look like? Do they think it was more positive or more negative?

Guided Practice

Environmental impact. Tell students you will read a book explaining the history of a river in New Hampshire. Distribute “*A River Ran Wild* Discussion Questions” to the class and preview questions. Consider breaking students up into groups and having each group focus on answering just two questions as they listen.

Read *A River Ran Wild* by Lynne Cherry (1992). Throughout the reading or after finishing the book, pause to compare and contrast the images that show changes in the landscape and river over time. If you are unable to secure a copy of the book for the lesson, there are video readings of the book available on YouTube. Share and discuss answers to the questions at the end.

Teaching tip: Question 4 focuses on how the river provided power for machines. Use the infographics “Water Power” or “Steam Power” to help students visualize this process. Also, consider watching *The Merrimack: River at Risk*, starting at 4 minutes 15 seconds, to envision a working river 100 years ago and its transformation. The segment ends at 10 minutes 15 seconds, and there is an excellent visual of the polluted Merrimack at 8 minutes 55 seconds. Watch the movie at www.youtube.com/watch?app=desktop&v=62mWQcQvM3w.

Teaching tip: See Unit 11: Big Factories and New Industries for more information and lesson plans on industrialization. Lesson 11.1 “Water Power” especially focuses on how machines use water power.

Teaching tip: This is a good place to pause between teaching sessions.

Part II

Discussion

What happens to the rain? Ask students: Where does all the water go when it rains? Give students a minute or two to turn-and-talk with their neighbor. Brainstorm as a class and record responses.

Project "Merrimack River Watershed" and pass out student copies of the same. Ask students: What do they notice about the map? What do they wonder about the map? Gather responses.

Direct Instruction & Discussion

Merrimack River Watershed. As you examine the map, review the following questions and have students write information on the map:

- What is the title of the map? What is the date?
 - Merrimack River Watershed, 2007
- What states are shown on the map?
 - New Hampshire, Vermont, Maine, and Massachusetts. Students should label each state and the Atlantic Ocean.
- Identify the blue and black labels on the map in different sizes. What do the labels name?
 - Blue labels name rivers, lakes, and reservoirs. Bigger font means a bigger river.
 - Black labels name cities. Bigger font means a bigger city.
 - Note with students Nashua the river and Nashua the city. These are the locations in the book *A River Ran Wild*.
- Note that the land on the map is shaded differently. What do students notice about the land?
 - The land is shaded where smaller rivers lie. All of the smaller rivers and lakes rivers connect with the Merrimack River and flow into the Merrimack River.

Have students return to talk with their partner and, using the information from the map, develop a definition of watershed. Work together as a class to determine a definition similar to **watershed**:

(noun) the area of land that drains into a particular river or body of water

Have students write it on their map. To prevent misconceptions, be sure to emphasize that even though the word "watershed" contains the word "water," the word "watershed" refers to the area of **land**.

If the class is having trouble with the concept or to reinforce learning, show the video "Watersheds!" from CoCoRaHS (Community Collaborative Rain, Hail and Snow Network) found at www.youtube.com/watch?v=2pwW2rlGIa8. Or, you may wish to use a funnel to cover the basics of how water in a watershed flows toward a common point: all land is part of a watershed and the shape of the land directs the flow of water.

Project the additional vocabulary and have students work in pairs to label their map to identify the words. Project the answer key map if necessary to assist students.

Teaching tip: This is a good place to pause between teaching sessions.

Guided Practice

Pollution. Remind students what happened in *A River Ran Wild* when people did not take care with what they put into the river. Put students in small groups and ask them to brainstorm all the pollution that hurt the Nashua River in the book. At an appropriate time, have students broaden their brainstorming to other kinds of pollution they know of today that hurts watersheds. Are we more careful with our watersheds today?

List pollution as a class and ask the class to make observations about the list. Guide students in ensuring their list is comprehensive. Tell them that scientists put pollution into two different categories: pollution from one source or pollution that comes from a wide area. Scientists do this because how to stop and/or clean up pollution depends upon where it comes from.

Look at your list and challenge students to think through categorizing your pollution into these two categories. Have students make two columns on the back of their map or distribute the "Kinds of Pollution" chart for them. See the Resources file for examples of both kinds of pollution.

Reflection

Point source pollution and nonpoint source pollution. Once you have categorized your pollution, ask the class: Which kind of pollution do you think is the biggest problem for our watersheds today? Why?

After students give their ideas, tell them that the Clean Water Act was passed in 1972, in part because of efforts by citizens like the ones in the book *A River Ran Wild*. Today, point source pollution that was a main problem due to the factories during the Industrial Revolution is regulated in the United States by the government through the Environmental Protection Agency (EPA). However, nonpoint source pollution is much harder to control. Why do they think that is?

See the excellent article from the EPA for much more about nonpoint source pollution, including what citizens can do to protect watersheds from it: www.epa.gov/nps/basic-information-about-nonpoint-source-nps-pollution

To conclude, ask students to respond either in writing or discussion:

- How did industrialization threaten watersheds in New Hampshire?
- How are watersheds threatened today?
- How do people protect the environment in New Hampshire?

Reinforcement

1. **What is a watershed?** For students who need additional help understanding the concept of a watershed, this short video reviews concepts taught in the lesson. From caringforourwatersheds.com, a watershed protection program out of the Battle River Watershed in Alberta, Canada.
www.youtube.com/watch?app=desktop&v=QOrVotzBNto

Extension

1. **The Merrimack: River at Risk.** The movie *The Merrimack: River at Risk* is approximately one hour long and contains many interviews and locations that might be familiar to students. Especially, at 26 minutes 45 seconds, they ask the question, "What is the biggest challenge the river faces in the future?" The next 10 minutes explain the problems the river faces today, especially nonpoint source pollution. Interested students would benefit from this segment.
2. **Work of 1000.** Marion Stoddart, one of the champions in the *A River Ran Wild* book, is interviewed in the documentary about her, *Marion Stoddart: Work of 1000*. The 30-minute movie is summarized in 10 minutes in a more accessible format here: www.youtube.com/watch?app=desktop&v=Wrl-wyqHjMA
3. **Merrimack River Interactive Map.** Engage students in exploring the Merrimack River watershed with this interactive map tool. Users can customize layers of data to help visualize some of the watershed's greatest challenges and attributes. Find it at:
epa.maps.arcgis.com/apps/MapSeries/index.html?appid=922e1c016c6e42b199f902d1cfb84bbd



Supporting Materials

Industrialization Image Set:

1. Women Working at the Amoskeag Manufacturing Company, undated, Courtesy of the Manchester (NH) Historic Association
2. Amoskeag Locomotive, circa 1856, New Hampshire Historical Society
3. Trolley Cars from Manchester, circa 1910, Courtesy of the Goffstown Historical Society
4. Aerial View of Manchester, 1967, Courtesy of the Library of Congress
5. Amoskeag Fire Engine, 1914, Courtesy of the Manchester (NH) Historic Association
6. Immigrants Arriving at New York, 1917, New Hampshire Historical Society
7. New York the Wonder City, 1918, Courtesy of the New York Public Library Digital Collections
8. Bird's Eye View of Berlin Mills, 1888, New Hampshire Historical Society
9. Side View of Tenement Living, 1865, From House Divided: The Civil War Research Engine at Dickinson College
10. Trash on the Street Outside Tenement, 1912, National Child Labor Committee collection, Library of Congress, Prints and Photographs Division
11. Patrol Wagon, 1887, Courtesy New York Public Library Digital Collections
12. Factories During the Industrial Revolution, circa 1873, Digitized by Robarts Library, University of Toronto, for flickr's The Commons
13. Pile of Trees from Logging, circa 1894–1948, New Hampshire Historical Society
14. Dump on the Banks of the Nashua River, 1973, Records of the Environmental Protection Agency, U.S. National Archives and Records Administration
15. Children Working in a Textile Mill, 1909, National Child Labor Committee collection, Library of Congress, Prints and Photographs Division
16. Asking for Charity, 1881, Google Books

Sources in the lesson plan:

- Lynne Cherry, *A River Ran Wild*. (1992)
- Marion Stoddart: *Work of 1000 10 Minute Short*.
www.youtube.com/watch?app=desktop&v=Wrl-wyqHjMA
- *The Merrimack: River at Risk*, New Hampshire PBS. nhpbs.org/merrimackriver/ or watch online at www.youtube.com/watch?app=desktop&v=62mWQcQvM3w
- Merrimack River Interactive Map:
epa.maps.arcgis.com/apps/MapSeries/index.html?appid=922e1c016c6e42b199f902d1cfb84bbd
- *Basic Information about Nonpoint Source (NPS) Pollution*, EPA.
www.epa.gov/nps/basic-information-about-nonpoint-source-nps-pollution
- *Watersheds!* from CoCoRaHS www.youtube.com/watch?v=2pwW2rGIa8
- *What Is a Watershed?* www.youtube.com/watch?app=desktop&v=QOrVotzBNto

Sources for the lesson plan:

- *Basic Information about Nonpoint Source (NPS) Pollution*, EPA. www.epa.gov/nps/basic-information-about-nonpoint-source-nps-pollution
- Ellen Moyer, *How a Housewife Transformed an Open Sewer into a Swimmable River* (2017) www.huffpost.com/entry/nashua-river-transformed- b_5552680
- *The Merrimack: River at Risk*, New Hampshire PBS. nhpbs.org/merrimackriver/ or watch online at www.youtube.com/watch?app=desktop&v=62mWQcQvM3w
- *Nonpoint Source Pollution*, National Ocean Service. oceanservice.noaa.gov/education/tutorial_pollution/welcome.html
- *Point Source and Nonpoint Sources of Pollution*, National Geographic. www.nationalgeographic.org/encyclopedia/point-source-and-nonpoint-sources-pollution/

Recommended educational sources:

- *Educational Resources*, New Hampshire Department of Environmental Services. NHDES offers a variety of environmental education programs and publications for teachers, nature educators and leaders, including structured curriculums, fact sheets and videos. <https://www.des.nh.gov/resource-center/education-resources>
- *Lesson Plans, Teacher Guides and Online Environmental Resources for Educators: Water* from the United States Environmental Protection Agency. Lesson plans and activities for all ages curated from the EPA and other sources. www.epa.gov/students/lesson-plans-teacher-guides-and-online-environmental-resources-educators-water
- *Water Data for the Nation*, United States Geological Survey. Searchable by location, this website provides data on surface water, ground water, water quality and use for the United States. waterdata.usgs.gov/nh/nwis/current/?type=flow



Standards

“Moose on the Loose” Content:

- ✓ Students will understand that improved technology such as the steam engine and telegraph made transportation and communication faster and easier. They will understand that this led to rapid industrialization in the state and the world and the growth of various industries and manufacturing. (3-5.T5.1)
- ✓ Students will understand that by the end of the 19th century, the results of the development of industry had led some to prioritize preserving New Hampshire’s natural landscape. (3-5.T6.2)

“Moose on the Loose” Skills:

- ✓ Gathering, Interpreting, and Using Evidence (3-5.S1.1)
- ✓ Communicating and Critiquing Conclusions (3-5.S2.1)
- ✓ Effective Historical Thinking (3-5.S3.1)
- ✓ Comprehensive Geographic Reasoning (3-5.S4.1, 3-5.S4.2)

New Hampshire Social Studies Frameworks:

- ✓ Geography: The World in Spatial Terms (SS:GE:4:1.2, SS:GE:4:1.3)
- ✓ Geography: Places and Regions (SS:GE:4:2.2)
- ✓ Geography: Physical Systems (SS:GE:4:3.1, SS:GE:4:3.4, SS:GE:4:3.5)
- ✓ Geography: Environment and Society (SS:GE:4:5.1, SS:GE:4:5.3, SS:GE:4:5.5)

NCSS Themes:

- ✓ Theme 3: People, Places, and Environments
- ✓ Theme 6: Power, Authority, and Governance
- ✓ Theme 8: Science, Technology, and Society

C3 Frameworks:

- ✓ Determining Helpful Sources (D1.5.3-5)
- ✓ Civic and Political Institutions (D2.Civ.6.3-5)
- ✓ Processes, Rules, and Laws (D2.Civ.12.3-5, D2.Civ.14.3-5)
- ✓ Geographic Representations: Spatial Views of the World (D2.Geo.2.3-5)
- ✓ Human-Environment Interaction: Place, Regions, and Culture (D2.Geo.5.3-5)
- ✓ Human Population: Spatial Patterns & Movements (D2.Geo.7.3-5, D2.Geo.8.3-5)
- ✓ Causation and Argumentation (D2.His.14.3-5)

Common Core ELA:

- ✓ Key Ideas and Details in Reading Literature (RL.4.1, RL.4.2)
- ✓ Integration of Knowledge and Ideas in Reading Literature (RL.4.7)
- ✓ Range of Reading and Level of Text Complexity in Literature (RL.4.10)
- ✓ Vocabulary Acquisition and Use (L.4.4a, L.4.6)

NextGen Science:

- ✓ Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment (4-ESS3-1)
- ✓ Analyze and interpret data from maps to describe patterns of Earth’s features (4-ESS2-2)

Lesson Vocabulary

downstream	(adjective) Describing the direction of the flow of water towards the mouth of a river
industrialization	(noun) The shift to making many products on a large scale, using machinery and factories
main river	(noun) The river into which other tributary rivers flow; it empties into a body of water like the ocean, or sometimes a lake
nonpoint source pollution	(noun) Harmful or poisonous material that comes from a wide area
pollution	(noun) Harmful or poisonous material that enters the environment
river mouth	(noun) The end point of a river, where a river enters a lake, ocean, or larger river
river source	(noun) Where a river begins
runoff	(noun) Rainwater that washes over land and roads into waterways
source point pollution	(noun) Harmful or poisonous material that comes from a specific place
tributary	(noun) A smaller river that empties into a larger one
upstream	(adjective) Describing the direction of the flow of water away from the mouth of a river and toward a river's source
watershed	(noun) An area of land that drains into a particular river
watershed boundary	(noun) The border around an area of land that drains into a particular river