Human Impact on the Hudson River

Grade 4 (differentiated for grades 3 through 6)

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Endeavor Science Teaching Certificate Project

Human Impact on the Hudson River: Lessons to increase understanding of the effects of

pollution on the Hudson River

Throughout history the Hudson River has provided valuable natural resources to those

who settled along its shore. Native Americans and early colonists relied on the river for food,

transportation, and trade. As the population of New York State grew, more river towns sprouted

up. Goods could easily be transported down the river to New York City and sold in Europe.

Consequently, more goods were needed to support the growing communities. As a result,

factories were built along the Hudson River where water was readily available and products

could be easily transported. With the development of industries, pollution threatened the Hudson

River. Although there have been many efforts to clean the Hudson, it will never return to its

pristine state.

Next Generation Science Standards

- K-ESS3-3 Earth and Human Activity

  Communicate solutions that will reduce the impact of humans on the land, water, air,

  and/or other living things in the local environment

- 3-LS2-1 Ecosystems: Interaction, Energy, and Dynamics

  Make a claim about the merit of a solution to a problem caused when the environment

  changes and the types of plants and animals that live there may change.
- 4-ESS3-1 Earth and Human Activity

  Obtain and combine information to describe that energy and fuels are derived from

  natural resources and their uses affect the environment.

- HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics

Design, evaluate, and refine a solution for reducing the impacts of human activities on the

environment and biodiversity.

- MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics
Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Disciplinary Core Ideas

- PS1.A: Structure and Properties of Matter
Different kinds of matter exist and many of them can be either solid or liquid, depending

  on temperature. Matter can be described and classified by its observable properties.

- ESS3.C: Human Impacts on Earth Systems
Things that people do to live comfortably can affect the world around them. But they can

  make choices that reduce their impacts on the land, water, air, and other living things.

  (secondary)

- LS2.C: Ecosystem Dynamics, Functioning, and Resilience
When the environment changes in ways that affect a place's physical characteristics,

  temperature, or availability of resources, some organisms survive and reproduce, others

  move to new locations, yet others move into the transformed environment, and some die.

  (secondary to 3-LS4-4)

- ESS3.A: Natural Resources

  Energy and fuels that humans use is derived from natural sources, and their use affects

  the environment in multiple ways. Some resources are renewable over time, and others

  are not.

- LS4.C: Adaptation
For any particular environment, some kinds of organisms survive well, some survive less

  well, and some cannot survive at all. (3-LS4-3)

- LS4.D: Biodiversity and Humans
Populations live in a variety of habitats and change in those habitats affects the organisms

  living there. (3-LS4-4)

Science and Engineering Practice

Planning and Carrying Out Investigations

Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.

Obtaining, Evaluating, and Communicating Information

Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas.

Analyzing and Interpreting Data

Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS4-1)

Constructing Explanations and Designing Solutions

Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

Obtaining, Evaluating, and Communicating Information

Obtain and combine information from books and other reliable media to explain phenomena.

Cross Cutting Concepts

Cause and Effect

Cause and effect relationships are routinely identified, tested, and used to explain change.

Scale, Proportion, and Quantity

Observable phenomena exist from very short to very long-time periods. (3-LS4-1)

Influence of Engineering, Technology, and Science on Society and the Natural World

Over time, people's needs and wants change, as do their demands for new and improved technologies.

Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes consistent patterns in natural systems. (3-LS4-1)

RI.3.3   Describe the relationship between a series of historical events, scientific ideas or

concepts, or steps in technical procedures in a text, using language that pertains to time,

sequence, and cause/effect. *(3-LS2-1)*
W.3.1   Write opinion pieces on topics or texts, supporting a point of view with reasons.

(3-LS2-1)
W.4.7   Conduct short research projects that build knowledge through investigation of different

aspects of a topic. (4-ESS3-1)
RI.5.7   Draw on information from multiple print or digital sources, demonstrating the ability to

locate an answer to a question quickly or to solve a problem efficiently. (5-ESS3-1)
RI.5.9   Integrate information from several texts on the same topic in order to write or speak

about the subject knowledgeably. (5-ESS3-1)
 Literacy

Mathematics

MP.2   Reason abstractly and quantitatively. *(4-ESS3-1)*
MP.4   Model with mathematics. *(4-ESS3-1)*
MP.4   Model with mathematics. *(2-PS1-1)*
2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four

simple put-together, take-apart, and compare problems using information presented in a bar graph. *(*
MP.5   Use appropriate tools strategically. *(3-LS4-1)*
3.NBT   Number and Operations in Base Ten. (3-LS2-1)
3.MD.B.3   Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. S

two-step "how many more" and "how many less" problems using information presented in scaled b

(3-LS4-3)

Objectives

- Know and explain the definition of pollution.
- Explain how different pollutants enter the water
- Demonstrate an understanding how water pollution impacts humans and wildlife
- Be able to define vocabulary related to water pollution

- Relate population growth to its effect on the environment
- Recognize how technology meets the needs communities
- Identify ways humans can control pollution

Vocabulary

- Toxic Chemicals
- Adaptations
- Pollution
- Run-off
- Estuary

- Food chain
- Debris
- Sewage
- Disease
- Acid rain

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- Engage-Day 1
- Review the Rules for Producing Questions (QFT) Source: www.rightquestion.org

- Ask as many questions as you can
- Do not stop to answer, judge or to discuss the questions
- Write down every question exactly as it is stated
- Change any statement into a question

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- Students will work in groups of 3-4. The group will choose a note taker who will be responsible for writing down every question as it is stated. When time is up, the students will look over their questions and label open-ended questions with O and closed-ended questions with C. Each group will choose 3 priority questions to share with the class and place them in the O or C column. This process of developing questions generates

students' interests, activates prior knowledge, promotes deeper thinking while introducing the topic. Explain that as we work through the following lessons, we will explore answers to these questions.

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- Teacher: How do we know if water is polluted?
- Introduction
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    - Life on earth depends on a continuous supply of clean water. Over the years as the Earth's population continued to grow, the demand for clean water has increased. People depend on local treatment plants to provide safe water to the public. Human activities place huge demands on our water systems. It's important to make future generations aware of contaminated water and its lasting effect on fragile ecosystems.
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- Explore
    - Students will be given a one-liter beaker and one-liter bottle with the top cut off. The beaker will contain 1 liter of water, 30 ML of oil, ¼ cup dirt, 2 shredded plastic straws, and 5 ML of red food coloring. The other bottle will be empty and also have the top cut off for easy access. Before the exercise begins the teams will observe their full bottles with hand lenses and label their samples from 1 to 5. They will write the number that reflects what they see in their bottle and refer to one being very clear to 5 being very dirty.
        - When the data table is completed, the teacher will introduce the challenge. The goal of this challenge is for students to remove the pollutants from their water samples. Each team will be given the same materials and have to work collaboratively to

clean their liter of water. They will discover that food coloring is the most difficult

material to separate from their samples.

- After receiving the materials, the teams will evaluate their water samples

before clean up. The numbers 1 through 4 will be used to represent the clarity, debris, and

oil that is in the water. Number 1 will represent the least amount of substance in the water

and number 4 will represent the most.   Each team's beaker of polluted water will have

scored before and after the challenge.

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        - Water Sample
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- Students will record their data and add their information to a class data chart.

Groups	Clarity	Debris	OIL	SCORE
Group A				
Group B				

• Grou p C	•	•	•	•
• Grou p D	•	•	•	•

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- Water Clean-up Challenge
- You have discovered that the river is being contaminated by a local manufacturing plant.

  The polluted water is entering the food chain and damaging the fragile ecosystem. The

  water must be cleaned if animals and plants are to survive.
- Materials:
- 1 piece of screen (students must measure and cut a 4inch piece of screen)
- 4 cotton balls
- 1 funnel
- 1 dropper
- 50 ML clean water (students will fill a beaker with 50 ML of water)
- Constraints: Your team has 20 minutes to clean your water sample. The vessel must

  contain the same amount of water when the investigation is completed.
- Team Name:
- Plan and Design: 5 minutes
- Begin Clean-up: 20 minutes

- Test: 5 minutes- Students will view their water sample and decide how to improve the

  water quality.
- Revise: 10 minutes-Teams can continue to remove the pollutants from their water and

  change their strategies.
- Share: The teams will evaluate and compare their samples while the teacher records the

  data using the numbers 1 through 4.

•	• CLARITY	• DEBRIS	• OIL	• AMOUNT OF WATER	• SCORE
• Group A	•	•	•	•	•
• Group B	•	•	•	•	•
• Group C	•	•	•	•	•
• Group D	•	•	•	•	•

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- Assessment:

- When your team has completed the task answer the questions on the back of your challenge sheet.

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1. Did everyone participate in the challenge?
2. Do you feel your ideas were appreciated and accepted by the team? Explain why or why not?
3. Were the strategies successful? Did the team make any changes during the challenge?
4. What did the team change? Did it work better?
5. If you attempted this challenge again, what would you do differently?

- Explain

  - The students will share their experiences with the class. They will evaluate the difficulty of removing each pollutant from their water sample and explain why or why not they were successful. A discussion will follow to relate each pollutant to what is found in the Hudson River. The students will learn that plastic is not biodegradable and is a danger to animals. Oil represents the many spills that occur in the river and fuel discharged from boats. Dirt is the sediment that settles to the river's bottom and is disturbed by natural occurrences, construction, and large vessels. Finally, they will understand that the food coloring is the most dangerous pollutant in the Hudson River. It represents the toxic chemicals that have been released into the water throughout the years. They will also learn that acid rain affects the safety of our water and cannot be easily removed. This challenge will act as the jumping point for an interdisciplinary unit that will incorporate the fourth-grade standards for science, math, social studies, and literacy.

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  - Elaborate/Extend

- Read the Lorax by Dr. Seuss
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- Discuss these questions before reading the book.
- What do you enjoy about your own environment? What parts of your own environment would you be sad to see go?
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- Discuss these questions after reading the book.
- With your partner use evidence from the story to write a description of the Land of the Lorax before the Once-ler arrived.
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- As the Once-ler's Thneed business grows the environment is affected. Based on your experiences, have you seen parts of your environment change? Explain what changes have occurred and how they have affected your area?
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- Why does the Lorax speak for the trees and how why are his actions important?
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- Evaluate
- Students will use what they have learned to influence their peers to reduce pollution.
- They can choose one of the following activities to present to the class.
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- Make a poster to demonstrate the cause of pollution and suggestions to reduce its effects.
- Write and perform a puppet show to explain how water pollution endangers species and how people can help clean up.
- Create a short video to convince their peers that pollution to keep the environment clean.
- Research ways they can help local groups protect the environment.
- Recycle materials and build something useful that people would need.

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- Rubric

Focus	1	2	3	4	Score
	• minimally address topic	• slightly related to topic or may offer little relevant information	• generally focused on topic but may include extraneous or loosely	• focuses on topic	

			related material		
• Organization	• does not exhibit organizational pattern	• little evidence of organization •	• organization attempted •	• well organized	•
• Support	• few supporting ideas	• little supporting ideas	• some supporting ideas	• adequate supporting ideas	•
• Purpose	• purpose of material unclear	• purpose of material attempted	• purpose of material adequate	• purpose of material focused and relativ	•

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- Day 2
  - Engage
    - What do we know about water quality in the Hudson River?
- Show the students two photographs of the same area of the Hudson River.
- Have them compare and contrast the pictures on a Venn Diagram.
- Ask the students to brainstorm in their teams and complete the Venn diagram.

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  - Explore
- Teacher will use the students' responses to complete a class Venn diagram. The students will work in their groups to analyze the changes that occurred between the pictures while referring to the data below.
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  - Explain
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- Refer to the data below. How can you connect the growth of population to the results in the tables below? The teacher will use the data to show the students the connection between population growth and the development of communities. The students will investigate how increased population affects the Hudson River.

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    - Elaborate
- Complete the chart using the information from today's lesson to show the causes and

  effects of population growth on the Hudson River.

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- Evaluate

- Read the attached article and complete the graphic organizer. Identify the causes and effects of water pollution.

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- Water pollution: an introduction
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- by Chris Woodford. Last updated: June 4, 2017.
- Over two thirds of Earth's surface is covered by water; less than a third is taken up by

  land. As Earth's population continues to grow, people are putting ever-increasing pressure

  on the planet's water resources. Poorer water quality means water pollution.
- We know that pollution is a human problem because it is a relatively recent development

  in the planet's history: before the 19th century Industrial Revolution, people lived more in

  harmony with their immediate environment. When Earth's population was much smaller,

  no one believed pollution would ever present a serious problem. It was once popularly

  believed that the oceans were far too big to pollute. Today, with around 7 billion people

- on the planet, it has become clear that there are limits. Pollution is one of the signs that humans have exceeded those limits.
- According to the environmental campaign organization WWF: "Pollution from toxic chemicals threatens life on this planet. Every ocean and every continent, from the tropics to the once-pristine polar regions, is contaminated."
- *Photo: Detergent pollution entering a river. Photo courtesy of US Fish & Wildlife Service Photo Library.*
- **What is water pollution?**
- Water pollution can be defined in many ways. Usually, it means one or more substances have built up in water to such an extent that they cause problems for animals or people. If you poured a cup of black ink into a river, the ink would quickly disappear into the river's much larger volume of clean water. If you poured gallons of ink into a river every few seconds through a pipe, the river would quickly turn black. The chemicals in the ink could very quickly have an effect on the quality of the water. This, high level of ink could affect the health of all the plants, animals, and humans whose lives depend on the river.

- *Photo: Pollution means adding substances to the environment that don't belong there— like the [air pollution](#) from this smokestack. Pollution is not always as obvious as this, however. Photo courtesy of [US Department of Energy/National Renewable Energy Laboratory (DOE/NREL)](#) (image id 6312198).*
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- **What are the main types of water pollution?**

- The most obvious type of water pollution affects huge oceans, lakes, and rivers. For example, a spill from an oil tanker creates an oil slick that can affect a huge area of the ocean. Groundwater pollution is much less obvious than surface-water pollution but is no less of a problem. Groundwater is the water found underground in the cracks and spaces in soil, sand and rock. In 1996, a study in Iowa in the United States found that over half the state's groundwater wells were contaminated with weed killers.
- **How do we know when water is polluted?**
- How can we measure water pollution when we cannot see it? How do we even know it's there? There are two main ways of measuring the quality of water. One is to take samples of the water and measure the concentrations of different chemicals that it contains. If the chemicals are dangerous or the concentrations are too great, we can regard the water as polluted. Another way to measure water quality involves examining the fish, insects, and other invertebrates that the water will support. If many different types of creatures can live in a river, the quality is likely to be very good; if the river supports no fish life at all, the quality is obviously much poorer.
- **What are the causes of water pollution?**
- Sometimes the causes of water pollution are quite surprising. Chemicals released by smokestacks (chimneys) can enter the atmosphere and then fall back to earth as rain, entering seas, rivers, and lakes and causing water pollution. Water pollution has many different causes and this is one of the reasons why it is such a difficult problem to solve.
- **Sewage**
- With billions of people on the planet, disposing of sewage waste is a major problem. Sewage disposal affects people's immediate environments and leads to water-related disease. Flush toilets take sewage waste quickly and hygienically away from their homes. However, when you flush the toilet, the waste has to go somewhere and, even after it leaves the sewage treatment works, there is still waste to dispose of. Sometimes

sewage waste is pumped untreated into the sea. Until the early 1990s, around 5 million tons of sewage was dumped by barge from New York City each year.

- **Waste water**
- Waste water (chemicals washed down drains and discharged from factories) can cause serious pollution problems. Around half of all ocean pollution is caused by sewage and waste water. Each year, the world generates perhaps 5–10 billion tons of industrial waste, much of which is pumped untreated into rivers, oceans, and other waterways. In the United States alone, around 400,000 factories take clean water from rivers, and many pump polluted waters back in their place.
- Virtually everyone pours chemicals of one sort or another down their drains or toilets. Even detergents used in washing machines and dishwashers eventually end up in our rivers and oceans.
- Toxic pollution also enters waste water from highway runoff. When it rains, these chemicals wash into drains and rivers. It is not unusual for heavy summer rainstorms to wash toxic chemicals into rivers in such concentrations that they kill large numbers of fish overnight.
- **Chemical waste**
- Highly toxic chemicals such as polychlorinated biphenyls (PCBs) were once widely used to manufacture electronic circuit boards, but their harmful effects have now been recognized and their use is highly restricted in many countries. Nevertheless, estimated half million tons of PCBs were discharged into the environment during the 20th century. [9] Although PCBs are widely banned, their effects will be felt for many decades because they last a long time in the environment without breaking down.
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- **Oil pollution**

- *Photo: Oil-tanker spills are the most spectacular forms of pollution and the ones that catch public attention, but only a fraction of all water pollution happens this way. Photo courtesy of US Fish & Wildlife Service Photo Library.*
- When we think of ocean pollution, huge black oil slicks often spring to mind, yet these spectacular accidents represent only a tiny fraction of all the pollution entering our oceans. However, what makes tanker spills so destructive is the sheer quantity of oil they release *at once* — in other words, the concentration of oil they produce in one localized part of the marine environment. The biggest oil spill in recent years (and the biggest ever spill in US waters) occurred when the tanker Exxon Valdez broke up in Prince William Sound in Alaska in 1989. Around 12 million gallons (44 million liters) of oil were released into the pristine wilderness—enough to fill your living room 800 times over! Estimates of the marine animals killed in the spill vary from approximately 1000 sea otters and 34,000 birds to as many as 2800 sea otters and 250,000 sea birds. Several billion salmon and herring eggs are also believed to have been destroyed.
- **Plastics**
- If you've ever taken part in a community beach clean, you'll know that plastic is far and away the most common substance that washes up with the waves. There are three reasons for this: plastic is one of the most common materials, used for making virtually every kind of manufactured object from clothing to automobile parts; plastic is light and floats easily so it can travel enormous distances across the oceans; most plastics are not

biodegradable (they do not break down naturally in the environment), which means that things like plastic bottle tops can survive in the marine environment for a long time. (A plastic bottle can survive an estimated 450 years in the ocean and plastic fishing line can last up to 600 years.) Plastic fishing lines and other debris can strangle or choke fish. (This is sometimes called ghost fishing.) In one study of 450 shearwaters in the North Pacific, over 80 percent of the birds were found to contain plastic residues in their stomachs.

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- **What are the effects of water pollution?**
- Take oil spills, for example. The oil can wash up on nearby beaches, devastate the ecosystem, and severely affect tourism. Sewage is another good example of how pollution can affect us all. Sewage discharged into coastal waters can wash up on beaches and cause a health hazard. People who bathe or surf in the water can fall ill if they swallow polluted water—yet sewage can have other harmful effects too: it can poison shellfish (such as cockles and mussels) that grow near the shore. People who eat poisoned shellfish risk suffering from an acute—and sometimes fatal—illness called paralytic shellfish poisoning. Shellfish is no longer caught along many shores because it is simply too polluted with sewage or toxic chemical wastes that have discharged from the land nearby.
- **How can we stop water pollution?**
- There is no easy way to solve water pollution. There are different things that can help to tackle the problem.
- **Education**- Greater public awareness can make a positive difference.
- **Laws**- Environmental laws can make it tougher for people to pollute. In the United States, for example, there is the 1972 Clean Water Act and the 1974 Safe Drinking Water Act.
- **Our clean future**

- Pollution matters because it harms the environment on which people depend. The environment is everything that surrounds us that gives us life and health. Destroying the environment ultimately reduces the quality of our own lives.
- We can work together to keep the environment clean so the plants, animals, and people who depend on it remain healthy. We can take individual action to help reduce water pollution, for example, by using environmentally friendly [detergents](), not pouring oil down drains, reducing pesticides, and so on. We can take community action too, by helping out on beach cleans or litter picks to keep our rivers and seas that little bit cleaner. And we can take action as countries and continents to pass laws that will make pollution harder and the world less polluted. Working together, we can make pollution less of a problem—and the world a better place.
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