

National Content Standards:

A: Science as Inquiry

C: Life Science

F: Science in Personal & Social Perspectives

G: History & Nature of Science

OBJECTIVE:

To foster an understanding of how human activities and land use affect water quality. To help students identify sources of pollution and how they contaminate water sources.

DESCRIPTION:

Students will learn about sources of pollution by assuming roles of property-users along the Bronx River in New York. Students will connect certain activities with the waste they create and the pollutants they discharge into water. Students will connect the hypothetical game to “real life” environmental circumstances affecting downstream communities all over the world, in particular, Luis’s neighborhood of Hunts Point, in the South Bronx. Students will read Water Stories Supplement to meet Luis. Students will explore and discuss pollution prevention, and why it matters.

MATERIALS:

- Role Playing Cards ([provided](#))
- Pollutants Chart (see below chart)
- 32 post-it notes, 3x5 cards, OR scraps of paper
- Set of color pencils or markers for each group
- Water Stories Supplement** ([provided online as handout](#)) or ([editable PDF](#)).

BACKGROUND:

How we treat our land impacts the body of water into which the land drains. Pollutants can reach the waterways by means of **runoff** (excess water from heavy rainfall, flooding or snowmelt flowing over the land towards a drain or water channel) and direct waste disposal.

Our individual actions can positively or negatively affect water quality and ecosystem health, both locally AND down the river. Understanding the consequences of our activities and the wastes we produce can lead to better decisions and more environmentally and economically sound practices.

Point and non-point source pollution: Talk to any water pollution experts and before long you will hear the terms point and nonpoint source pollution. The pollutants affecting the quality of water bodies and aquifers are characterized by their sources. Point source pollution originates at an identifiable, distinct location though a direct route. They are generally more toxic but easier to control as they have locatable discharge points, or specific dump sites (underground storage tanks, leaching from a particular mine waste pond, a hazardous spill). In addition, they are regulated by federal state and local laws. However, the pollution still occurs as perpetrators



avoid or disobey regulations, or discharges go unnoticed by officials.

Nonpoint source (NPS) pollutants are tricky to define, much harder to regulate and extremely damaging to water, aquatic eco-system and human health. These NPS pollutants are contaminants found dispersed in water bodies and come from a wide range of sources, including natural events. They enter water from an extended area and the timing of the discharge is often sporadic and unpredictable. Therefore, there is a fine line between point and nonpoint source pollution. Nonpoint pollutants actually DO come from MANY specific sources over an unspecified period of time and often collect in a large amount of water. Once dispersed in the water, NPS pollutants are difficult if not impossible to trace: they include chemical compounds related to paint, oil or anti-freeze, nutrients or coliform bacteria from animal waste all of which could and do come from anywhere and everywhere. Hence the complexity and challenge of both sourcing them and stopping them!

In this activity, you are water experts who have found a broad spectrum of contaminants in a substantial section of the Bronx River. Rather than working backwards from the contaminants, you are starting at the “sources;” you will determine what pollutants are created by which activities and will identify if they are point or nonpoint source. You will create a river map on your piece of paper and label the properties and their pollutants on the map. You will then research water regulations, local or in New York, and determine whether the polluters are violating laws, or merely being environmental nuisances – albeit with dire consequences.

ACTIVITY PREPARATION:

- Cut up the Role Play Card sheet into 16 individual role cards.
- Divide students into four groups.
- Distribute four role cards to each group.
- Distribute a Pollutants Chart to each group.
- Provide each group with a poster-size piece of paper

ACTIVITY:

1. Read the Bronx River background information and image below from the Bronx River Alliance: <http://bronxriver.org/?pg=content&p=abouttheriver&m1=9>.
2. Review the Pollutants Chart provided. Discuss as a class or in individual groups the different types of pollutants, where they come from and how they might impact the river and the land around it.

STUDENT INSTRUCTIONS:

1. You are now water experts confounded by persistent and pernicious pollution in the river. You are investigating activities along the river’s shores to determine what pollutants are being created and whether or how they are ending up Down the River. The activities you review will be varied – some land users will be business owners, some employees at local businesses, others are home owners. As a group, look at your four Role Play Cards and discuss the positive and negative contributions the residents have on the riverside community.
2. As a group, look at the Pollutants Chart: Pollutants and their Impacts and discuss what types of pollutants (contaminants) are potentially associated with the activities you are examining.
3. Draw a section of the river. Label the section with the resident roles, associated activities and add a depiction of that role. List the pollutants those activities create. Label each

pollutant, PS or NPS.

4. Feel free to brainstorm other activities that your group might also associate with the residents you were assigned. Identify wastes produced by these activities and create additional pollutants.

For example, if you were assigned to investigate the Landfill Manager's property, you might draw a dump, and include the following labels:

- role = landfill manager
 - activities = compacting and storing garbage
 - pollutants = household and commercial waste, industrial toxins that seep into the groundwater, petroleum products (see Pollutants Chart).
5. Your group will present to the class: describe the roles you are investigating in the Bronx River community; how those people use the water and the land around the river, and the pollutants they might produce. Share with the class how you labeled the pollutants by source.
 6. Discuss with the class and see if they agree with your hypotheses. Draw any additional pollutants from class' feedback.
 7. If you are still unsure about whether or not the pollutants you have associated with the roles are point or nonpoint source, you may refer to several comprehensive resources on the subject:
 - NOAA's http://oceanservice.noaa.gov/education/tutorial_pollution/; or
 - an academic paper from Stanford <http://pangea.stanford.edu/~keith/111.pdf>; or
 - EPA's water sites: http://www.epa.gov/owow_keep/nps/, and <http://water.epa.gov/polwaste/nps/urban.cfm>

WRAP-UP AND REFLECTION:

1. Consider how the pollutants flowing from the locations on your map would affect the water and the eco-system downstream. What effects might you see in local fish, plant-life, even humans?
2. Research local water regulations in your own town or city and/ or in New York City. Decide if your local land-users are behaving legally, and if not, is there any way to prevent their pollutants from entering the water? Do you believe the existing regulations are adequate protection for the water and all that live there? What about federal law, as in the Clean Water Act, how does it protect your local river, or the Bronx river?
3. Investigate the term **social equity**, often described as the commitment to promote fairness, justice and equality in the operation of a community. Discuss: Is it fair that people downstream are affected by the activities and resulting pollutants of their neighbors upstream? Do the downstream neighbors have an equal right and expectation to clean water?
4. **Water Stories Supplement Connection:** Investigate the term **Environmental Injustice** (or Environmental Discrimination.) Environmental injustice occurs when environmentally hazardous activities and infrastructure (transfer stations, bus depots, highways, factories, landfills, etc.) are predominantly located in areas with a high concentration of minorities, and or poor people. Take a closer look at the Bronx River Background below and the following study on health in The Bronx (South Bronx Environmental Health and Policy Study) http://www.icsnyu.org/south_bronx/admin/files/NYUWagnerPhaseVIreport.pdf.

Also see Luis's story in the **Water Stories Supplement**.

- a. Does the situation in the South Bronx fit the definition of Environmental Injustice? Why or Why not? Complete the **Water Stories Supplement** and create your own Stories, then submit them online to contribute to the growing online library of Water Stories from students and teachers around (look online in 2013).
- b. Discuss the following excerpt from James K. Boyce's paper: "Is Inequality Bad for the Environment?"

"How humans interact with nature is intimately tied to how we interact with each other. Those who are relatively powerful and wealthy typically gain disproportionate benefits from the economic activities that degrade the environment, while those who are relatively powerless and poor typically bear disproportionate costs. All else equal, wider political and economic inequalities tend to result in higher levels of environmental harm. For this reason, efforts to safeguard the natural environment must go hand-in-hand with efforts to achieve more equitable distributions of power and wealth in human societies."

Political Economy Research Institute, University of Massachusetts, Amherst.

http://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1108&context=peri_workingpapers

5. Suggest at least one pollution prevention behavior (see "Pollution Prevention Behaviors" below) that you and your family could do at home to reduce the amount of waste and/or pollution that you are creating.

Students may elect to do further research on this topic:

- For younger students: <http://www.epa.gov/owow/NPS/kids/whatwrng.html>.
- Older students may explore environmental health concerns associated with a variety of activities and locations at: <http://toxtown.nlm.nih.gov/index.php>;
World River pollution: <http://www.smithsonianmag.com/people-places/ganges-200711.html>; What to do? <http://www.rivernetwork.org/we-all-live-downstream>

Pollutants Chart: Pollutants and their Impacts

- ◆ **Pesticides** - Toxic chemicals are used to get rid of pests (insects and animals that eat crops or plants). These compounds can threaten the health of both humans and aquatic species and do not decompose or break down easily, so they remain in the environment for a long time, causing harm. Organisms that ingest (eat) these chemicals have problems developing and breeding, and sometimes die.
- ◆ **Fertilizers** - Nutrients (human-made or natural) are used to enrich lawns, gardens and flowerbeds, helping them grow faster and larger. Fertilizers can introduce large amounts of nitrates and phosphates into the water, eventually decreasing the amount of oxygen available in the water, harming or even killing aquatic life. Even a small increase in phosphorus might cause numerous problems, including accelerated plant growth and algae blooms in the water. Excess algae growth blocks the sunlight needed by plants on the water's bottom, often killing them. As the plants die, they decay, using up oxygen in the water. Without this oxygen, fish and other animals can't survive. Although nitrogen is essential to all living systems, excess nitrates from fertilizers can become toxic to warm-blooded animals. When manure is spread on fields as a fertilizer, it can also spread some of the more toxic substances present in that manure, such as antibiotics or bacteria which can then seep into water. Water pollution from manure as well as synthetic fertilizers can lead to serious environmental damage and harm human health.
- ◆ **Animal Waste** - Animal waste can contain antibiotics from feed or medications and releases a lot of harmful bacteria like e-coli and coliform. Pet droppings and manure "lagoon" overflows can cause diseases and infections if they contaminate drinking water and recreation areas. Excess animal feces (poop) in water can also cause algae blooms, and the same harmful effects as manure-based fertilizer.
- ◆ **Petroleum Products** - Petroleum products are materials made from crude oil, such as gasoline or motor oil. Oil, petroleum products and other toxins from automobiles kill fish, plants, aquatic life and even people. One quart of oil will contaminate thousands of gallons of water because it doesn't dissolve. The effects of oil spills can spread for miles through ocean or freshwater sediments, groundwater leaching or through aquatic food chains and ecosystems. Animals that get caught in oil spills need to be rescued. The oil prevents them from swimming or flying.
- ◆ **Industrial Toxins** - Industrial toxins are the waste products of hazardous chemicals used to manufacture items that we use every day (i.e.: plastic drink bottles, T-shirts). Some of these toxins and metals are absorbed in various sea life and cause medical problems in people when eaten. Nitrogen and phosphorus coming from smokestacks can cause explosive growth of algae, which depletes water of oxygen.
- ◆ **Sewage Waste** - Water carrying waste away from residential, institutional, commercial and industrial establishments is known as sewage waste. Sewage is the term used for wastewater that often contains feces (poop), urine, laundry waste, even pharmaceuticals (medications) flushed down the drain. When untreated, sewage can have serious impacts on the quality of an ecosystem and on the health of people. Pathogens and chemicals in the waste can cause a variety of illnesses in both animals and people.
- ◆ **Household and Commercial Waste** - Our trash, sometimes containing toxins (for example, paint cans, plastic items, chemicals, outdated over-the-counter medicines), must be disposed of properly. Toxins can leak into the ground and ground water, harming animals and people. Plastic pieces that end up as litter on the ground or in waterways can be mistaken for food and ingested by wildlife and fish.

Pollution Prevention Behaviors include:

Pet and Human Waste

- Clean up after pets and other animals to keep feces from polluting water. Carry and use a pooper scooper and/or plastic bag to dispose of waste in the trash or appropriate location.
- Keep animals out of lakes and streams.

Yard and Garden

- Use natural fertilizers such as compost and bone meal.
- Use natural pesticides such as garlic, hot pepper, soapy water and lady bugs for aphids.
- Mulch leaves, instead of blowing and removing them.

Household Maintenance

- Do not pour household chemicals (such as cleaners, solvents, thinners and paints) onto soil or down drain.
- Research and properly handle and dispose of such wastes by recycling or taking them to a treatment facility.

Around Your Neighborhood

- Do not litter. Litter can be carried into local streams and lakes where it can harm wildlife habitat and water quality.
- Help with community clean ups to prevent litter from polluting streams/rivers.

BRONX RIVER BACKGROUND

Excerpted from The Bronx River Alliance, "About the River" <http://bronxriver.org/?pg=content&p=abouttheriver&m1=9>



The Bronx River is a 23-mile long river that runs from the Kensico Dam in upper Westchester County through 13 Westchester municipalities and through the heart of the Bronx to the confluence of the East River and the Long Island Sound. New York City's only freshwater river, it offers a slice of nature amid the strains of urban life.

The Bronx River went from a flourishing and beautiful resource to a contaminated conduit for industrial and residential wastes two centuries ago.

Natural and Social History

Although no one can be certain about the geological origin of the Bronx River, many believe that prior to the Pleistocene Period, the Bronx River was a pre-glacial stream that wound its way from its source in present-day upstate New York to the present Long Island Sound. When a glacier came through the Bronx, approximately 240,000 years ago, it blocked part of the original path of the Bronx River and subsequently reshaped and modified the path of the River. Over the past 200 years the River's course has been altered dramatically by human impact and industry.

Called Aquehung or "River of High Bluffs" by the Mohegan Indians who first lived and fished along it, the river attracted European traders in the early 1600s for the sleek, fat beaver that proliferated there. In 1639, a wealthy Swede, Jonas Bronck, purchased 500 acres from the Mohegans, and mills began to sprout up and down "Bronck's River." By the mid-1700s as many as 12 mills were manufacturing paper, flour, pottery, tapestries, barrels and snuff, powered by water from the stream. The River valley remained thickly forested well up into the 1800s. In his 1817 poem "Bronx," Joseph Rodman Drake described "rocks" and "clefts" full of "loose ivy dangling" and "sumach of the liveliest green." The water was considered so "pure and wholesome" that during the 1820s and 1830s the New York City Board of Alderman debated ways to tap into it to supply the growing city with drinking water. In 1898, when all five boroughs were integrated into New York City, the Bronx was chosen for the name of the Borough—after the Bronx River.

Bronx River Watershed

The completion of the Kensico Dam in 1915 diverted the upper reaches of the River into the reservoir near New Castle and cut off the River's water supply twenty-five percent or by one quarter. The construction of the New York Central Railroad in the 1840s turned the valley into an industrial corridor, and by the end of the 19th century the Bronx River had degenerated into what one official commission called an "open sewer." The history of the river since the 1880s has been one of efforts to reclaim and protect it from the escalating forces of urbanization.

The consolidation of various properties to form the 662-acre Bronx Park in 1888 (718.1 in 2002) provided a buffer against development on either side of the river. The Bronx River Valley Sewer, initiated by Westchester County in 1905, began absorbing some of the worst sewage. The largest project was the Bronx River Parkway, completed in 1925. The 15.5-mile ribbon of parks, lakes and limited access roadway stretching from the Kensico Dam to Bronx Park provided a landscaped recreation zone and a pleasure drive for cars passing through at low speeds. However, the areas along the river south of the Bronx Zoo were left virtually untouched/restored.

During the era of Robert Moses, the Bronx fell into a period of urban decay. The quality of life, particularly in the South Bronx decreased dramatically. Neighborhoods were fragmented by the construction of numerous highways. In particular, the construction of the Sheridan and Cross-Bronx Expressways further distanced the Bronx River communities from each other and from the River itself.

In 1974, a small band of community activists formed Bronx River Restoration and began the arduous process of cleaning up and restoring the river. Their effort gained strength and numbers in 1997, when Partnerships for Parks convened the Bronx River Working Group and brought together more than 60 community organizations, public agencies and businesses committed to reclaiming the river and improving access to it throughout the Bronx.

Efforts to restore the Bronx River took a tremendous step forward in 2001 when the Bronx River Working Group created the Bronx River Alliance as a permanent 501(c)(3) organization to continue this work for the long term. Working closely with the New York City Parks Department, which provides substantial in-kind support, they are headquartered within the Parks Department's facility on the Bronx River Parkway.

SOURCES:

New York State Department of Environmental Conservation <http://www.dec.ny.gov/26.html>

NOAA's National Ocean Service Education: Nonpoint Source Pollution
http://oceanservice.noaa.gov/education/tutorial_pollution/03pointsource.html

What is Nonpoint Source Pollution? | Polluted Runoff | US EPA
<http://water.epa.gov/polwaste/nps/whatis.cfm>

Guadalupe-Blanco River Authority: *Don't be Clueless about Water Quality* www.gbra.org

For more information about the environmental situation in the South Bronx and what is being done about it look at the following resources:

http://bronxriver.org/puma/images/usersubmitted/file/011_Ecosystems.pdf

<http://prattcenter.net/greening-south-bronx>

<http://abridgeovertroubledwater.blogspot.com/2007/10/bronx-river-history.html>