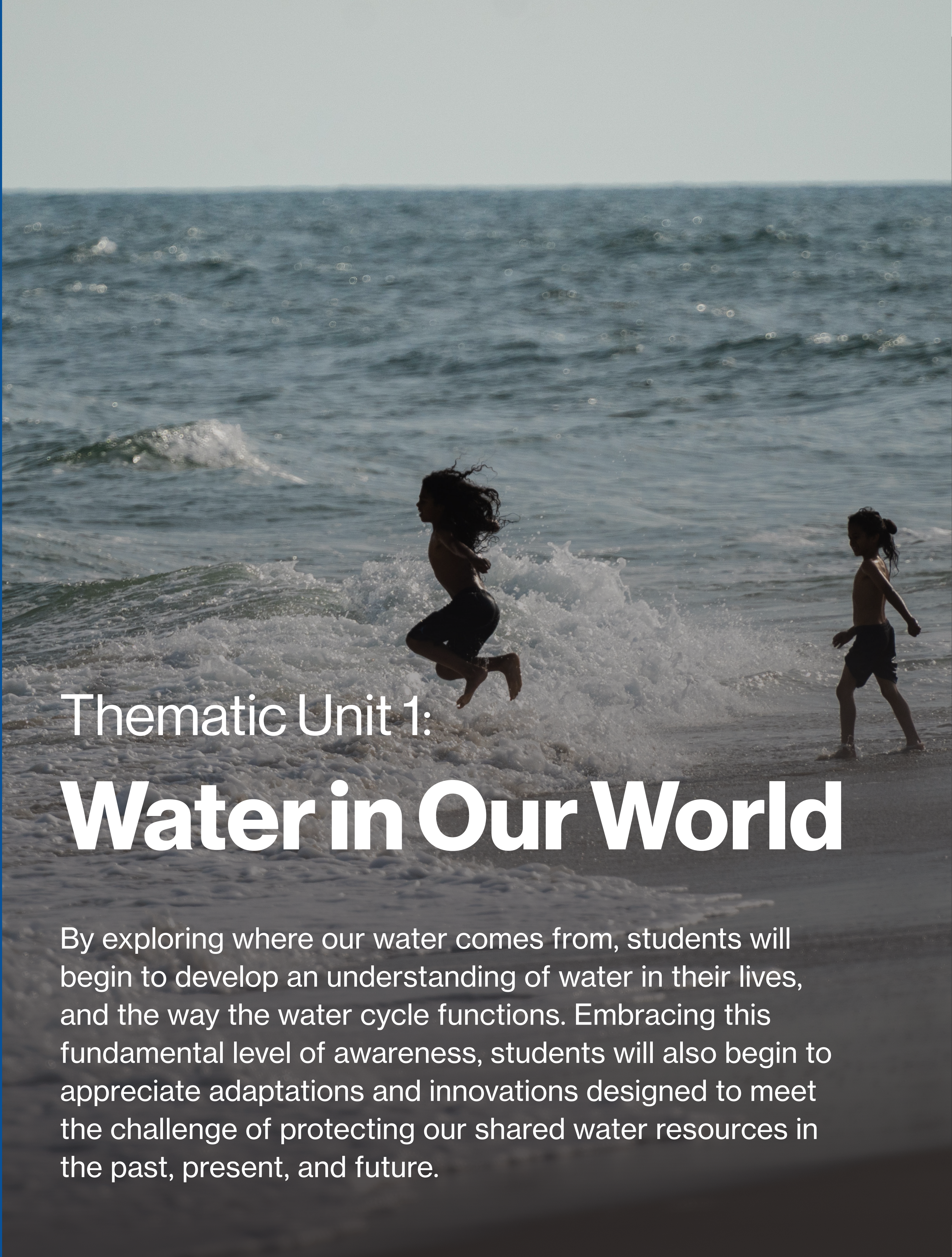

Thematic Unit 1:

Water in Our World

By exploring where our water comes from, students will begin to develop an understanding of water in their lives, and the way the water cycle functions. Embracing this fundamental level of awareness, students will also begin to appreciate adaptations and innovations designed to meet the challenge of protecting our shared water resources in the past, present, and future.

What you should know:

We use water all the time in our daily lives. We drink it, bathe with it, cook with it, water our plants, give it to our pets, and also flush and brush with it. Did you know that New York City's drinking water, considered some of the best quality water in the world, can travel from as far as 125 miles away to reach your faucet? It starts as rain and snow falling on the mostly forested mountains and valleys north of New York City. This vast, 2000-square mile area of protected and managed land that collects and stores our drinking water is called the New York City **Watershed** and is delineated both geographically and topographically into three regions -- the Croton, Catskill, and Delaware – located on both the east and west sides of the Hudson River.

Water flows downhill through a complex, interconnected system of streams, lakes, reservoirs, aqueducts, and tunnels to New York City's nearly nine million consumers. When it reaches the city, drinking water is distributed into nearly 7,000 miles of pipes to homes, schools, and businesses throughout the five boroughs. The New York City Department of Environmental Protection (DEP) is the public agency responsible for protecting, operating, and maintaining this supply, but it is ultimately our collective responsibility to care for all the water in our world.

WATER: EARTH'S PRECIOUS RESOURCE

Water is essential to life and **freshwater** resources on Earth are limited. While 70% of the world is covered by water, only about 3% of the water on Earth is freshwater (97% is saltwater). Most of the Earth's freshwater is found frozen or trapped underground, which means the less than 1% of freshwater that is actually available is in high demand.

The Earth has a very efficient method of cycling water through the atmosphere and the land. As **precipitation** falls from the sky and hits the Earth's surface, it takes one of many different routes: some soaks into the ground (**infiltrates**), replenishing groundwater; some is taken up by plants, keeping them healthy; and some runs into waterways, refreshing surface water. The heat from the sun warms the water in oceans and streams and turns it into a gas (**water vapor**), causing it to rise back into the atmosphere, a process called **evaporation**. **Transpiration**, or "sweating," releases water from plants as a gas into the atmosphere. Water vapor collects to form clouds through **condensation**. These steps make up the **water cycle**, or **hydrologic cycle.** When it rains, the land that drains (or sheds) this water to the nearest water body is called a **watershed.** A watershed can be thought of as a big bowl or basin, collecting all the surface and groundwater within a specific area and draining it from the highest to the lowest point.

NYC'S WATER HISTORY

Precisely because of the way the water cycle functions, there is an inseparable connection between water and land. Indigenous communities developed near fresh, clean, and reliable water sources. As populations grew, so did the demands on freshwater ponds, rivers, and groundwater sources. With the rise of cities, these sources grew foul with human and animal waste. Without access to clean water, and a yet to be discovered scientific understanding about water pollution, cities could not thrive.

By the early 1800s, New York City's polluted water supply led to dire consequences of disease, filth, and a lack of a plentiful supply to fight fires. In the interest of public health and safety, we needed to find a new, reliable source of drinking water. Like other ancient and modern cities facing similar challenges, we searched for clean water in the less populated areas beyond city boundaries, and that's where we found the Croton River. By 1842, a remarkable system was engineered to collect and convey water by **gravity** through a system of **reservoirs** and **aqueducts.** This was the beginning of a continuous and ever-growing dependence on New York City's watershed neighbors for our abundant and consistent water supply.

Although the waterways surrounding our city are not the source of drinking water, they have always been an integral part of the commercial, industrial, and recreational fabric of our city. In the 21st century, protecting beaches, wetlands, rivers, canals, bays, and the harbor has been an ongoing collective effort. After all, these areas are home to native New Yorkers of other kinds--birds, fish, reptiles, amphibians, and small mammals.

Artwork by Lindsay Espana, Hillside Arts and Letters Academy, Queens

In the past, water flowing into New York Harbor could be effectively filtered and cleaned by nature because pollution existed on a small scale. In modern times, in order to keep up with the daily flushing, brushing, showering, and other healthy habits of millions of busy New Yorkers and visitors, we needed to engineer a wastewater system. Our **wastewater** is now carried in pipes called **sewers** to one of 14 **wastewater resource recovery facilities (WRRF)** in the city. In just 8-10 hours, harmful waste is removed and clean water is returned to the waterways surrounding New York City. DEP manages and monitors this process to make sure that the treated water from these facilities is safe to discharge into local waterways and the water cycle. Additionally, nearly two-thirds of rainwater from our streets is collected in sewers and carried to these same facilities for treatment. Processing and treating the wastewater of New York City is no small task!

WATER PROTECTION & STEWARDSHIP

New York City has many buildings, as well as paved (**impervious**) sidewalks and streets that are unable to absorb water when it rains, disrupting the natural processes of the water cycle. Catch basins and a network of underground sewer pipes, were designed to help drain the rain quickly. Rainwater rushing over streets, rooftops, and other impervious surfaces picks up pollutants in its path, such as pet waste, litter, lawn fertilizer, and oil. This is referred to as **stormwater runoff.** About 40% of our sewer system collects and drains stormwater runoff directly to waterways through the **municipal separate storm sewer system (MS4).** The other 60% of our sewers convey stormwater runoff and wastewater together to a wastewater resource recovery facility through the **combined sewer system**. On most rainy days, the combined sewage goes to a facility to be cleaned. During heavy downpours, the sewers and facilities may reach capacity, and a mixture of untreated stormwater and wastewater can overflow to the nearest waterway.

One way to fix this problem is through **grey infrastructure,** or the building of large underground tanks and tunnels to hold untreated wastewater until the rain ends. Another, more innovative solution is **green infrastructure,** or the use of natural systems that divert rainwater into planted areas. Rain gardens and green roofs are examples of green infrastructure that help absorb stormwater like a sponge. The engineered wetlands on Staten Island, called **Bluebelts**, are another form of green infrastructure, designed to help filter and absorb stormwater naturally, enhance habitats for wildlife, create public green spaces, and help with flood control.

In order to determine the health of our waterways and effectiveness of our water systems, scientists observe nature by using biological and chemical indicators. Biological indicators are plant and animal species that tell us about the health of the **ecosystem**. DEP scientists monitor the health of the rivers, streams, and tributaries that comprise the New York Harbor through ongoing water sampling and testing of bacteria, chlorophyll, turbidity, temperature, and dissolved oxygen.

This is our New York City water story; its narrative connects people in New York City to each other and to our watershed neighbors, and gives us all a common purpose in protecting our shared water resources. Students and teachers play a key role in ensuring the future of clean water by exploring our water story and connecting to **stewardship** opportunities. You can start this unit by asking your students what the value of fresh water means to them. Student observations and experiences can help segue the conversation from a personal level of understanding to a more holistic perspective on their community, city, and the world.

"Because environmental education, like much education, often fails to acknowledge the crucial role of emotions in the learning process, activities that both inform the mind and engage the heart proved to be a powerful and effective combination... Helping children fall in love with earth is what we do. Because people protect what they love, this is a powerful prescription for stewardship and ultimately, we hope kinship."

MK Stone and Z Barlow (eds)
Ecological Literacy: Educating Our Children for a Sustainable World. San Francisco, CA: Sierra Club Books (2005). P. 116.

Sequence of Lessons

1. Water for Life
2. The Water Cycle
3. Landforms and Watersheds
4. Trees, Plants, and other Buffers
5. Ecology of Waterways: Diverse and Abundant Communities
6. Life Aquatic: Microscopic Organisms and Macroscopic Invertebrates

L1 Water for Life

All living things need water to live and all living things contain a certain percentage of water. From your students to the clams at the beach, everything living in this world needs water to survive. We should also consider aspects of water that we simply enjoy, such as running through the sprinkler, jumping in waves at the beach, and ice-skating with friends at the park.

ESSENTIAL QUESTION

How can we understand and appreciate the importance of water?

VOCABULARY

Water *(noun and verb)*
The liquid that descends from the clouds as rain or snow, forms streams, lakes, and seas. Water is a major component of all living matter. When pure it is odorless and tasteless; freezes at 0° C (32°F) and boils at 100° C (212°F). It is the only substance that can naturally occur as a solid, liquid, and gas.

SUGGESTED IDEAS AND ACTIVITIES

a. Compare how much water exists in a variety of everyday living things. Have students choose something related to what they bring for lunch, something larger that helps your school function, or even their bodies! Research and illustrate in diagrams.
b. Create a chart of water words around the room. Record new and important words shared during class activities, discuss and define as a class.
c. Research the word "water" in many different languages. For example, in Spanish (agua), French (eau), and Chinese (shuǐ). How do other cultures and communities relate to and value water? Interview family members.
d. How have you used water today? Why do we need water in our life (what else relies on water)? Write a love letter to water. Illustrate the love letters on droplet-shaped blue paper; hole punch and thread string through to create a hanging display (like a rainstorm!).
e. Write a story using rivers as symbolism. Discuss terms like flow, rhythm, light, grace, fluidity or even rushing, raging, and flooding. Use the landscape as metaphor.
f. Survey the landscape paintings of 19th century "plein air" or Hudson River School of artists. Analyze composition and color before having students copy a work or create their own artwork outside.
g. Have students collect water in jars from different locations (sink, bathtub, rainwater, stream, beach, puddle, garden hose), and in different states of matter (ice cube, water vapor from breath or living plant); observe and record similarities and differences (color, smell, temperature, chemical phase, salinity, and more). Discuss how water from different sources is the same and different. What factors influence these water samples?

CONSIDER AND DISCUSS

- Where there is water, there are lifeforms. When we explore other planets, water is the first indication that there may be life. Find articles that describe the most recent space expeditions.
- Many communities have often celebrated water through rituals, annual events, artwork, and writing. Look at civilizations that developed near waterways and their dependence on the availability of water. Find past and present poetry, passages in literature, and music that reflect this theme and discuss. For younger students, talk about their own personal rituals around water – how is it used every day at home?

ASK THE EXPERT

The love of water does not require a professional degree! Ask yourself, and talk to family and friends about the importance of water in their lives from work and chores to hobbies and play.

L2 The Water Cycle

Technically known as the "hydrologic" cycle, the water cycle is the ultimate sustainable process. As human beings, we depend on clean, safe freshwater. We can't make new water. The water we depend on exists in a closed system--an endless loop from land to sky and back again. Encouraging students to understand this fundamental concept will serve as the foundation for any study of water and will help them explore and understand the value of water in their world.

ESSENTIAL QUESTION

How does water cycle through the environment?

VOCABULARY

Hydrology *(noun)*
A science dealing with the properties, distribution, and circulation of water on and below the Earth's surface and in the atmosphere.

H_2O *(noun)*
The chemical formula for water; each water molecule consists of two hydrogen atoms bonded to one oxygen atom.

SUGGESTED IDEAS AND ACTIVITIES

a. Create simple icons on cards depicting each stage of the water cycle and place them in the proper order on a pre-drawn circle. With younger students, write a script and perform a song or play, acting out with sounds and movement of the water cycle (use DEP's New York City Water Cycle Rain Dance activity as an example).
b. Read *The Magic School Bus: Wet All Over* by Joanna Cole aloud to students and discuss the stages of the water cycle. Have students write and illustrate a list of the many ways they find H2O as a solid, liquid, and gas.
c. Read *Water Dance* by Thomas Locker aloud to students and discuss the images and first-person narrative (e.g., "I am rain."). Have students write additional lines of poetry elaborating on the statements (e.g., "I am rain, and I give life." or "I am rain, I fall from the sky and make rivers.").
d. Seek out the root of the word "evaporation" to discuss vapor and states of matter. Make observations using classroom demonstrations (e.g., put plastic wrap over a cup of water and place in the sun; watch as water evaporates and forms condensation). Go outside after a rainstorm or to see morning dew.
e. Using pennies and pipettes, see how many droplets students can add and count on the surface of the penny. Demonstrate and discuss cohesion (H2O molecules sticking to each other) and adhesion (H2O molecules sticking to other surfaces).
f. Put water in a clear bin, and mark and measure the height of the water. Place the bin outside on a sunny day and monitor how the water level changes over time. Have students make hypotheses beforehand and calculate the difference afterwards.
g. Memorize and review the different stages of the hydrologic cycle by creating a song, a dance, a poster, or a computer graphic.

CONSIDER AND DISCUSS

- Water as a finite resource. Fresh water exists in a limited quantity. We can't make new water, but we can deplete existing freshwater resources.
- Where does water come from? After we use it, where will it go next? Will it rejoin the hydrologic cycle?
- Are we responsible for thinking about where our water comes from and what happens to it after we use it?
- Can the water cycle be altered?

ASK THE EXPERT

Hydrologist – a scientist who studies water by sampling and analyzing the properties of waterbodies and examining the environmental impacts of pollution.


The Water Cycle
Condensation
Precipitation
Transpiration
Infiltration
Evaporation
Stormwater Runoff


DEP

L3 Landforms and Watersheds

Our natural landscape consists of many features, including mountains, valleys, forests, and bodies of water. A watershed is the area of land where rain and snow collects and drains, or "sheds," into rivers, lakes, streams, and underground. We can think of a watershed as a big sink – because of its slope and gravity, the water flows down its sides to the drain. Before discussing the concept of watersheds, help students understand the fundamental relationship between water and land, whether you observe a "stream" forming in the parking lot during a rainstorm, wonder where all the water in the Hudson River originates, or consider the quality of water at your local beach.

ESSENTIAL QUESTION

What is a watershed?

VOCABULARY

Topography *(noun)*
The art or science of making maps that show the height, shape, or other features of the land in a particular area. The arrangement of the natural and artificial physical features of an area of land.

Watershed *(noun)*
An area of land that drains and collects water, by gravity, in rivers, lakes, streams, and underground.

SUGGESTED IDEAS AND ACTIVITIES

a. Start by having students hold their hands palm side up with their fingers together. Spray water on hands using a spray bottle and observe how water moves and where it collects. Why does this happen? Discuss how the whole hand is the watershed and the palm is where the puddle (lake, pond, or reservoir) collects and holds the rain.

b. Using clay or papier mache, have students create mountains and a river (hint: create enough slope to allow for "runoff"). Use water or beads dropped on the mountaintop to model rain.

c. Make a working model, in a carton or plastic bin, to demonstrate the different landforms and watersheds (use DEP's What is a Watershed? lesson). After working in small groups, bring the class together to create a larger watershed model using backpacks piled centrally and draped with a sheet; add in beads, ribbons, and blue fabric to show where rain falls, drains, and collects.

d. Locate and share varying scales of topographic maps (check out USGS maps). Trace ridgelines, major waterways, and tributaries. Predict and then show the direction of the flow. Compare to a topographic map of the United States. Compare or overlay varying kinds of maps such as a watershed and municipal boundary map to consider the defining nature of a watershed.

e. Use Google Earth to further study the topography and landscapes of the New York City watershed. Map out the path that water takes from high points to low points.

f. Take a rainy day hike around your school grounds or plan a field trip to a local park to observe water flow, slope, and land use. Discuss how activities on land may impact the quality of water.

g. Using a blank sheet of paper, or a simple map, draw and label the waterbodies that surround New York City or your local community. Discuss student experiences on or near these waterways.

h. Plan a field trip to a local museum exhibiting water and watershed education. Visit the Queens Museum's Watershed Model to view a large-scale relief map of New York City's water supply system, which was constructed for the 1939 World's Fair. Experience more hands-on, interactive exhibits, including "Connected Worlds" at the NY Hall of Science and "Dynamic H2O" at the Children's Museum of Manhattan.

i. Apply for a Watershed Forestry Bus Tour grant from the Watershed Agricultural Council or funding for a class trip to the New York City watersheds from the Catskill Watershed Corporation. Education opportunities supported by these grants vary, but all are designed to enhance student understanding of the New York City water supply system and watersheds, urban and rural landforms, and community partnerships.

CONSIDER AND DISCUSS

- Discover the relationship of geography, geology, and landforms. Explore your community and identify various local geological landmarks. Use Google Earth or other maps to explore regional geological landmarks. Discuss the geological formation of rivers.
- What can impact the quality of water in a waterbody? Who is responsible for ensuring our water is clean and safe? Explore DEP's NYC Watershed Virtual Tour for video interviews, maps, and more activities on the importance of watershed protection.
- How can a fluctuation or change in weather and climate affect a watershed? Consider local and regional rainfall data and study the impacts of droughts and floods.

ASK THE EXPERT

Geologist – a scientist who studies the solid and liquid matter that constitute the Earth.

L4 Trees, Plants, and Other Buffers

Nature has filtered pollutants from water long before people began building infrastructure to do the same. Trees play a vital role in the water cycle related to infiltration and transpiration. Along the edges of our waterways, trees and other plants act as buffers by catching sediment, keeping soil in place to prevent erosion, and by absorbing and using nitrogen and phosphorous as nutrients before they reach our waterways. In upstate watersheds where our drinking water flows from, forested areas make up nearly 75% of the land and play an essential role in watershed protection.

ESSENTIAL QUESTION

How do forests protect a watershed?

VOCABULARY

Forest *(noun)*
A dense growth of trees and underbrush covering a large area.

Riparian *(adjective)*
Relating to, living or located on the bank of a natural waterway.

Buffer *(noun)*
Something that serves as a protective barrier.

Filter *(verb)*
To pass or move through in order to separate out or hold back elements.

SUGGESTED IDEAS AND ACTIVITIES

a. Meet a tree! Go outside to a nearby park or green space, have students find a tree that intrigues them and spend a few minutes observing its unique aspects including leaf and branch patterns, trunk texture, roots, and growth location. Share out as a group, introducing everyone to your tree.

b. Observe trees planted along the street or growing in a local park throughout the seasons. Keep a journal of sketches, and leaf and bark rubbings. Research and identify native species and their properties. Consider the impacts of invasive species on native plants; learn about invasive species that are common to your local ecosystem.

c. Create your own riparian buffer (birds-eye view, line drawing of stream bank and river, mural). Ask students to imagine their own natural world by populating the stream bank with plants and animals. Create pre-cut pieces (insects, flowers, mammals, trees) and glue them to the sheet of paper.

d. Demonstrate capillary action by placing fresh cut flowers (white carnations work well) into cups of warm water and adding different color food dye to each cup. Make observations and discuss the changes. Discuss absorption and consider how plants can prevent pollution from getting into waterways.

e. Make a model depicting four different kinds of surfaces on a slope with a drain and collection container at the bottom. Surfaces may include a planted area, a forested area, a grassy or sandy area (low lawn-type setting), and a paved surface. Use something to represent water such as beads, beans, or rice. Predict and compare the amount and speed of the runoff from each of the surfaces.

f. Research and delineate maps of streams, and their surrounding landscape, that lead directly into New York City reservoirs. How do forests play a role in stream flow, shade, water quality, and wildlife habitat?

g. Plant native seedlings in the classroom and monitor plant needs and activity over the course of the season in order to understand what plants require to live. Create a plan to transfer plants outside.

h. Go outside and identify areas with abundant plant-life or permeable surfaces and other open areas with little plant life and hard, impervious surfaces. Pour water on these surfaces and observe how it moves (consider slope and amount of runoff). Stick a wooden tongue depressor or stake into the ground in different places where dirt, grass, and other plants grow. Pour water on the ground in front of the stake to see how water (and soil!) splashes up. What role do plants play in keeping the soil in place?

i. After spending time outside observing trees, use your bodies to identify the benefits of trees – fingers as leaves (intercept rain), arms as branches (with leaves that provide shade for habitat), legs as trunks (absorb water), and feet as roots (stabilize tree, reduce erosion, intake water and nutrients that might otherwise pollute waterways like nitrogen and phosphorous).

j. Visit the New York Botanical Garden to explore Thain Family Forest, the largest preserved area of old-growth woodland forest in the city. Take a trip to a Model Forest in the New York City watershed to learn about forest management practices that help protect water quality and provide other benefits like biodiversity, recreation, and jobs.

CONSIDER AND DISCUSS

- What other benefits are there to creating and maintaining riparian buffers and large forested areas in our watershed? What is habitat fragmentation?
- How do watershed residents and visitors utilize and value the watershed landscape (forests, farmland, etc.)?
- Why do we need trees? Have students develop a list of forest products and ecosystem services; consider the balance of use and protection.

ASK THE EXPERT

Forester – a professional who plans, manages, and cares for forests.

L5 Ecology of Waterways: Diverse and Abundant Communities

There is an integral connection between the health of a river and the diversity of living things in and around it. Diversity and abundance are indicators for our scientists who test and monitor fish and other wildlife to measure the health of our waterways. A simple walk by a creek or along the beach can give us an idea of how we're doing. How many birds do you see? Can you see insects? Wait for that surprise splash on the surface that tells us—there are fish in there!

ESSENTIAL QUESTION

Why is diversity a positive ecological indicator?

VOCABULARY

Biodiversity *(noun)*
The variation of life in the world or in a specific habitat or ecosystem.

Ecology *(noun)*
A branch of science concerned with the interrelationship of organisms and their environments.

Community *(noun)*
An interacting population of various kinds of individuals (as species) in a common location.

SUGGESTED IDEAS AND ACTIVITIES

a. Choose an activity in which every student's participation is essential to meeting a goal, such as a clean classroom. Give each student a job to demonstrate interdependence within a community as it relates to the goal. You can even name the students different species and have the classroom become a waterway. Try again giving each student a role to play; for example, a student who takes over the activity is an invasive species.

b. Assign a journaling activity for your students during a visit to the nearest waterway. Have them document and illustrate what they observe in 5, 10, and 20-minute intervals. Return to the classroom and use guide books to help students identify what they saw.

c. Characterize the diversity and abundance of fish species in fresh and marine waterways using real data to help students understand the work of aquatic and marine biologists. Refer to the New York State Department of Environmental Conservation for information, maps, and photos on the variety, distribution, and status of each of New York's freshwater and marine fishes – some of which can be found in New York City. Make simple graphs and illustrate maps using the data. Create a story about the journey of migrating fish.

d. Learn about the Trout in the Classroom program, a yearlong study that includes raising trout, from eggs to juvenile fingerlings. Students learn about the trout life cycle, watershed protection, stream habitats, and discover how trout are indicative of healthy water quality, before releasing their fish into upstate watershed streams at the end of the school year.

e. Visit the NY Aquarium in Coney Island, Brooklyn to learn more about marine species found in local waterways. Identify a species to research and observe. Take photographs or make sketches while documenting characteristics and behavior. What is required to maintain a healthy marine ecosystem for these species?

f. Adopt oyster beds to study and monitor the habitat and life cycle of oysters in a nearby waterway. Work with the Billion Oyster Project to identify a suitable location for a harvesting, and for teacher and student support throughout the school year.

g. Have students act out an aquatic food web by standing in a circle, assigning each student to represent a different organism. Pass a ball of string from person to person to demonstrate important interrelationships. Have one species drop the string; ask students what happened to their web, discuss what this means for the ecosystem. Make a mural using mixed media to show how these species interact and depend on each other.

CONSIDER AND DISCUSS

- What is a biological or wildlife indicator? Why do we use wildlife to measure ecological health? Fish, migratory birds, reptiles, and amphibians are all visual indicators of the health of our waterways.
- How do we balance the interrelationship of humans (collectively and individually) and the environment (past, present, and future)?

ASK THE EXPERT

Aquatic Biologist – a scientist who studies living organisms in fresh- and saltwater.

L6 Life Aquatic: Microscopic Organisms & Macroscopic Invertebrates

Fish, migratory birds, reptiles, and amphibians, as well as riparian and aquatic plants, are important indicators of the health of our waterways. With the benefits of a microscope, we can examine the diverse world of living things through a new lens. Even the smallest drop of water has a story to tell. Both microorganisms and macroinvertebrates help share that story and are often important biological indicators of water quality and food sources for larger aquatic species.

ESSENTIAL QUESTION

Why do scientists rely on smaller living organisms to help diagnose the health of a waterway?

VOCABULARY

Microorganism *(noun)*
An extremely small living thing that can only be seen with a microscope.

Macroinvertebrate *(noun)*
An animal without a backbone that can be seen with the naked eye (mostly aquatic insects).

SUGGESTED IDEAS AND ACTIVITIES

a. Explore a neighborhood park to look for aquatic macroinvertebrates. Collect water samples and look under a microscope. Use mesh bags and old leaves to assemble a leaf pack in the classroom before setting in a stream a few weeks prior to the activity.

b. Create an exhibit of images showing the variety of shapes and sizes of the world of macro- and microorganisms. Make an exhibit label that describes the relationship of the organism or plant to water quality. Create a gallery of artwork in your classroom.

c. Write a research paper on environmentalists such as Dr. Ruth Patrick and Rachel Carson who studied pollution's effects on organisms. Have students present their findings or display in the classroom or hallway for others to read.

d. Visit a freshwater stream or river in the city (Bronx River) or New York City watershed (Cross River in Ward Pound Ridge Reservation) to observe the habitat, and discover macroinvertebrates (check if a permit is necessary ahead of time). Using nets, a bucket, trays, spoons, and a microscope, students can observe organisms found beneath leaf litter and rocks in streams. Use a dichotomous key to identify species before returning them to the stream.

e. After conducting the above biological water quality analyses, use chemical water quality test kits to continue analyzing water quality indicators. Collect data on pH, dissolved oxygen, nitrate and phosphate, turbidity, temperature, and fecal coliform levels. Discuss what each of the different parameters tell us about the health of the waterway.

CONSIDER AND DISCUSS

- Which microorganisms are indicators of the health of a stream?
- How do we use macroinvertebrates as water quality indicators? What is the difference between an abundance of macroinvertebrates and a diversity of species?

ASK THE EXPERT

Research Scientist – a scientist that researches, investigates, and experiments on a wide variety of topics.