Day in the Life of the Hudson and Harbor

Topics: Hudson River Estuary, Data collection

NEW YORK STATE | Department of Environmental Conservation

GRADE LEVEL: Elementary

Big Ideas:

- The Hudson River is unique.
- There is a difference between salt, fresh and brackish water
- The Hudson River begins in the Adirondack Mountains and empties into the Atlantic Ocean.
- The Hudson River is an estuary.
- The Hudson River is an important ecosystem.

Learning Objectives: *students will be able to…*

- Identify important characteristics of the Hudson River.
- Identify an estuary.
- Compare and contrast the three types of water in the Hudson River.
- Examine how tides change water levels along the estuary.
- Observe patterns of change in salinity along the estuary.

New York State Science Learning Standards:

K-ESS3-3. Communicate solutions that will reduce the impact of humans on living organisms and nonliving things in the local environment.
K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time
2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.
2-LS4-1 Make observations of plants and animals to compare the diversity of life in different habitats.
3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
3-ESS2-3. Plan and conduct an investigation to determine the connections between weather and water processes in Earth systems.
4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move
4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.
5-ESS2-2. Describe and graph the amounts of saltwater and freshwater in various reservoirs to provide evidence about the distribution of water on Earth.
5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down.

Key Understandings:

- Maps are used to show the shapes and types of landforms and water in an area.
- Maps help locate the different landforms and water features areas of Earth.
- Water transports material through the Hudson River watershed and estuary.
- Water is made up of particles whose properties determine its observable characteristics.
- An estuary is a unique habitat with fresh, brackish and salt water.
- The mixing of salt water from the sea and fresh water from a river's watershed

Essential Questions:

- What is an estuary?
- What are the characteristics of estuaries that make them so important to living organisms?
- What different types of water can be found in the Hudson River?
- How is the Hudson different from other rivers?
- What are the differences between salt water, fresh water, and brackish water?

create ideal environments for a variety of living organisms.
- The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.

Students will know…

- Key vocabulary terms.
- The difference between fresh, brackish, and saltwater.
- What an estuary is, and the characteristics that make them important.
- The Hudson River is important ecosystem.

Vocabulary:

- Brackish water: mixture of fresh and saltwater.
- Estuary: a body of water in which fresh and salt water meet.
- Fresh water: water that is not salty.
- Salt water: seawater or other water that contains salt.
- Watershed: the area of land from which water drains into a body of water.
- Salt front: the leading edge of seawater entering an estuary.
- Tidal cycle: the repetitive rise and fall of the ocean's surface over a 24-hour period.
- Tides: the alternating rise and fall of the surface of the ocean and bodies of water closely linked to it.
- High tide: highest water level in the tidal cycle.
- Low tide: lowest water level in the tidal cycle.
- Sea level: the average height of the ocean.

Learning Plan: We recommend doing these lessons in sequential order; however, they can be done as individual lessons. Lessons have multiple links (videos, songs, diagrams, activities) that can be used at the teacher's discretion depending on class time.

Pre-assess: What makes the Hudson River so unique? Use K-W-L to assess students' prior knowledge, have students write or draw in response to the essential questions.

Progress Monitoring: Formative assessment and teacher feedback should be ongoing throughout the lessons. Teachers should develop assessments based on their individual class needs. Think-pair share, exit tickets, interactive discussions, questions and listening, informal observations, quizzes and student work samples can all be used.

Lesson 1: Meet the Hudson River- Students watch a video about the Hudson then read a short article, interpret and label a New York State relief map, and listen to a story about the River.

- Video: Source to Sea
- Video: What is an Estuary
- From Mountains to the Sea Student Reading

- Meet the Hudson River student worksheet (Grades K-3)
- Rivers Run Through It Mapping Student Activity and Teacher Section (Grades 3-5)
- River Storytime: Video recording of the book River
- Puzzle Video: Hudson River Estuary; Habitat; Navigation
- Watershed Map
- Conservationist for Kids Magazine: Explore the Hudson River
- Optional: Introduction to the Hudson: Journey down the river

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Lesson 2: Lesson 2: Brackish Water Density- Students learn about where the Hudson River Estuary gets its water from and conduct an experiment to explore the differences between fresh, salty and brackish water. Note: have students watch estuary demonstration then do the activity.

- Video: Salt Front
- Video: Estuary Water Demonstration
- STEM Activity: Brackish Water Density & Spanish Version
- River Waters Lesson (lesson 2 in packet, p.15)
- Extension activity to do at home: Exploring and Estuary in your Kitchen & Spanish Version

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Lesson 3: Explore the Hudson River- Students watch live footage collected at geographic areas of the Hudson River estuary and use the accompanying worksheets to explore the Hudson. Students can follow along with data collection and take a deeper dive with a guest scientist. Watch one or all four.

- New York Harbor: Day in the Life of the Hudson and Harbor and Data Sheet
- Lower Estuary: Day in the Life of the Hudson and Harbor and Data Sheet
- Upper Estuary: Day in the Life of the Hudson and Harbor and Data Sheet
- Day in the Life of the Hudson and Harbor (2021) and Data Sheet and Teacher Section and Guest Scientist

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Lesson 4: Predictions- Students will complete the predictions worksheet to consider the different parameters they will be measuring at their sampling site. After the event students compare their data to their predictions.

- Predictions Worksheet & Teacher Section
- Day in the Life Definitions
- Follow up diving deeper into your data: Compare each year's data. What are some similarities and differences? Why? Use any parameter you collected data on.

Lesson 5: Fish and Salinity - Students will analyze data collected during DITL about fish and salinity.

- Fish Worksheet: English & Spanish
- Fish Teacher Section: English & Spanish
- Salinity Worksheet: English & Spanish
- Salinity Teacher Section: English & Spanish
- Extensions: Annual activity sheets from Day in the Life student collected data

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Lesson 6: Hudson River Salinity Data Visualization- Student's color and interpret maps according to the salinity data collected during two years of Day in Life.

- Teacher Section
- 2008 Map/Data & 2009 Map/Data

Lesson 7: The Hudson's Ups and Downs- Students watch a video on tides, then examine how tides change water levels along the Hudson River estuary and explore how weather can affect water levels and tides (upper elementary).

- Video(s): Tide Finder & Measuring the Tide
- The Hudson's Ups and Downs Student Activity & Teacher Section

Lesson 8: Which Fish Where? - Students will use tables and graphs of fish collection data to draw conclusions about where fish live in the Hudson estuary.

- Which Fish Where Student Activity & Teacher Section

Lesson 9: Tracking the Salt Front- Students watch a video, then use Hudson River salinity data to track movements of the salt front in response to storms and other weather-related events (upper elementary).

- Video: Turbidity and Salinity of the Hudson River Estuary
- Tracking the Salt Front Student Activity (pg. 21)
- Extension: Finding the Salt Front Student Activity & Teacher Section

Lesson 10: Secrets in Hudson Sediments- Students will observe their sediment sample collected on Day in the Life and make connections to the natural and human origins. This activity can be completed in the field, or back in the classroom.

- Secrets in Hudson Sediments Student Activity

Teachers: Would you like to visit us at Norrie Point environmental education center, or have an educator visit your classroom in-person or virtually? Contact us to schedule a program: hrteach@dec.ny.gov

Resources:

Children's books:

- Rain Rain Rivers by Uri Shulevitz
- River by Elisha Cooper
- Where the River Begins by Thomas Lochner
- Riparia's River by Michael J. Caduto
- Song of the River by Joy Cowley & Kimberly Andrews
- Over in a River flowing out to the Sea by Mairanne Berkes
- River Story by Meredith Hooper
- River of Dreams: The story of the Hudson by Hudson Talbott
- Voyage of the Half Moon by Tracey West
- Hudson River: An Adventure From the Mountains to the Sea by Peter Lourie

Websites:

- Day in the Life of the Hudson and Harbor (supplemental videos and activities)
- Estuaries Tutorial NOAA
- Hudson River Lesson plans

Day in the Life Definitions & Activities
(Common terms & definitions, extended activities, with teacher guidance in red)

What is a Watershed? A watershed is the area of land whose water drains into a body of water, such as a river, lake, or sea. Rain that falls anywhere within a watershed will eventually drain into that body of water. Pollution anywhere within the watershed can potentially affect life anywhere downstream from it.
Extra Discussion Item: Did you know that there can be watersheds inside of watersheds – these are called sub-watersheds. Find out for your area what sub-watershed you are in. If you are in New York City, what is different about your "watershed"? What is often referred to as the New York City Watershed is a created watershed based on service for drinking water. The DEP generally defines it as the Catskill and the Croton Watershed area.

What is an Estuary? An estuary is the area of a river where it meets the sea. It is an area where salt water and fresh water mix.
Extra Discussion Item: The Hudson River Estuary is not defined only by the salt water and fresh water mixing. What other ways can an estuary be defined? Estuaries can also be defined by the area of tidal influence. Tide is one force in the exchange between the fresh and saltwater systems, gravity is another. The salinity is the chemical and the tides are the physical components of an estuary.

What does Lake Tear of the Clouds have to do with the Hudson River? Lake Tear of the Clouds is the **source** of the Hudson River. It is on Mount Marcy, and is the highest lake in New York State.
Extra Discussion Item: The Hudson River is a 'drowned river valley' created by glacier melt. Lake Tear of the Clouds is described as a small 'tarn' - or a bowl like mountain lake formed in a valley excavated by a glacier. How can this small tarn be the source of the great Hudson River? All the water in the Hudson does not come from the "source". Many tributaries drain into the Hudson, as well as the Atlantic Ocean contributing saltwater.

What causes the Tides? Tides are the daily rising and falling of the sea level. They are caused by the gravitational pull of the sun and the moon. In most places there are 2 high tides and two low tides every 24 hours.
Extra Discussion Item: Does high tide occur at the same time each day on the Hudson River? If it is high tide in the New York harbor is it high tide in Albany? No tides are on a cycle of 24 hours and 50 minutes so they move each day by approximately an hour. Because of the length of the river it takes many hours for the tidal influence to move through the river. An ebb tide in the northern part of the estuary will have started almost nine hours earlier in the southern end of the estuary.

What is Dissolved oxygen and why is it important? DO, or dissolved oxygen is the amount of oxygen gas that is found in water. It is usually measured in parts milligrams per liter (m/L) or per million (ppm). Aquatic organisms need DO to survive; if it gets low, these organisms begin to die off. The DO count of an aquatic ecosystem is an indicator of how healthy that water is. Oxygen gets into the water through photosynthesis, or by mixing of the water with air (as in wave activity).

Extra Discussion Item: There are several factors that can impact the amount of DO in the water including salinity, temperature, and the number of submerged aquatic plants. What impact does each of these items have on DO? The higher the salinity and temperature the less DO the water is able to hold. Submerged plants will photosynthesize adding DO back into the system during the day.

What is Turbidity? Turbidity is the cloudiness of water that is caused by small particles such as clay, plankton, and dirt that are suspended in it. The more turbid the water, the less light that can get through.
Extra Discussion Item: Turbidity can be considered a negative impact on a healthy water system, but in some instances, it represents a positive measure. Can you explain when it would be considered positive?
Turbidity is actually caused by several very positive things in the Hudson: phytoplankton and zooplankton living in the water column; detritus (or decaying plant and animal matter) which is a major piece in the Hudson River food chain and in its role as a spawning river; small pieces of sediment that move through the river as part of the natural geologic process of weathering (this process contributes to the building of marshes and other habitat for the biological community). There are negative parts to turbidity as well for example: human caused sediment 'loading' caused by increases in sedimentation from land clearing and increases in impervious surfaces; sewage from combined sewage overflows in extreme rain events; algal blooms from increased nutrients from fertilizers etc. washing into the river.

What is Salinity? Salinity is a measure of the amount of salt in water. Ocean water has a high salinity.
Extra Discussion Item: What causes water to get less saline as it moves north into the estuary?
The watermixes with the freshwater coming down from the tributaries and is diluted.

What are Phytoplankton? Microscopic aquatic organisms that float in the currents and carry out photosynthesis. They are the basis of most aquatic food chains.
Extra Discussion Item: Phytoplankton is extremely important to the Hudson River. Can you come up with a hypothesis (explanation) that would explain why?
Phytoplankton is incredibly important for two reasons: it is the primary food source for just about every animal that lives in the River; phytoplankton produces an enormous amount of oxygen, a necessary part ofthe river ecosystem.

How long is the Hudson River? The Hudson River is 315 miles long. It goes from Lake Tear of the Clouds in the Adirondack Mountains to New York City Harbor where it meets the Atlantic Ocean.
Extra Discussion Item: If the Hudson River is 315 miles long why is the estuary only half that long? Once the River meets the Troy Dam there is a large elevation change, and it looses its tidal influence. Without tides or salinity it is no longer considered an estuary.

What are Zooplankton? Microscopic aquatic organisms that float in the currents, and do NOT carry out photosynthesis.
Extra Discussion Item: If zooplankton don't carry out photosynthesis how do they survive?
Zooplankton are small animals and larvae that eat phytoplankton. Complete an aquatic food chain and see how both zooplankton and phytoplankton fit in.

What is "brackish water"? Brackish water is between the salinity of ocean water and fresh water. The lower portion of the Hudson River is brackish.
Extra Discussion Item: Brackish waters are highly productive areas, and are excellent fish nurseries, yet species diversity is often lower than rivers or the ocean. Can you 'hypothesize' why this would be?
While brackish waters are considered excellent nursery areas for several species of fish, it is a select group of fish that can tolerate the uncertain salinity ranges of brackish water. Examine our fish data for DITL and see if you can determine which fish are tolerant of brackish conditions by where they were found in the estuary (you will need to look at the salinity readings for the day to determine this).

What is photosynthesis? Using sun as a catalyst, photosynthesis is a process of converting light energy into food energy. It occurs in green plants and other organisms that contain chlorophyll. Photosynthesis involves 6 molecules of water plus 6 molecules of carbon dioxide recombining to form one molecule of sugar (or energy) and six molecules of oxygen.
Extra Discussion Item: Chlorophyll 'a' is green pigment found in all photosynthetic organisms that allows plants to conduct photosynthesis? During DITL we look at the amount of chlorophyll 'a' which we sampled as a proxy for productivity. Looking at a 24 hr. clock, when would you expect the highest amount of photosynthesis to take place?
During daylight hours, and especially at mid day when the sun is at its height.

What does pH measure? pH is a measure of how acidic or how alkaline a solution is. A pH scale goes from 0 to 14. Acidic solutions have a pH of below 7, alkaline (or basic) solutions have a pH of above 7, and neutral solutions have a pH of 7.
Extra Discussion Item: Some substances release hydrogen ions (H+), or cause hydrogen ions to be formed when they dissolve in water, others release or create hydroxyl ions (H-). The pH is the balance sheet of which one has the most present at any time. What are some items that affect the pH balance sheet in the Hudson River?
The river bottom bedrock (alkaline), seawater (alkaline), acid rain (acid), fish respiration (acid), photoshynthesis (alkaline).

What is an invertebrate? An invertebrate is an animal that doesn't have a backbone. Crabs, insects, sponges, mussels, worms and crayfish are all examples of invertebrates.
Extra Discussion Item: The river's invertebrates can be classified by their habitat: Benthic (river bottom dwelling); and water column inhabitants. List some invertebrates of each type.
Benthics: aquaticworms, crabs, mollusks, aquatic insect larvae; Water column: zooplankton, jelly fish and comb jellies.

Water Chestnut (Trapa natans): Trapa natans is the scientific name for the water chestnut. It is an aquatic plant found in the Hudson River and also many other freshwater ecosystems in the northeast. It originally came from Eurasia and was brought to the United States in the late 1900's. It has become an invasive species here.
Extra Discussion Item: What makes something an invasive species? Are all introduced plants invasive species? Why or why not? What are some of the issues or concerns with Water Chestnut?
Invasive species are highly adaptable and have no natural predators in their new location, out competing native species. Not all introduced species are invasive. Water chestnut grows as a dense mat on top of the water blocking out the sun used for photosynthesis for any plants below. Water chestnut also respires into the air, therefore not adding oxygen back into the water system.

Why do we study the movement of sediments in the Hudson: We study the deposition (collecting) and erosion (removal) of sediments in the river, as well their grain sizes. Where sediments collect or erode can influence what habitat is available for marine life, both plant and animal. Sediments also have surface areas where contaminants can attach. A river bottom composed of lots of small grain sized sediments has more surface areas to combine with contaminants than a river bottom composed of fewer larger grain sized sediments.
Extra Discussion Item: If contaminated sediments become buried by other sediments do we need to be concerned about them any longer? This is a question that is debated by educated adults. Sediments can be uncovered and redistributed through a variety of ways. Storms, dredging, repairs and renovations on piers & waterfront areas can cause re-exposure of once buried sediment. In addition worms and benthic inhabitants are known to process and re-suspend sediments.