Day in the Life on the Hudson River and Harbor

Linking to NYSSLS/NGSS Cross Cutting Concepts and Science and Engineering Practices
Including the Overarching Phenomena

PHYSICAL SCIENCE: DITL Physical River

Phenomena:

1. The river that flows both ways.
   a. Tides
2. Currents moving in the opposite direction from the tides.
   a. Wind driven currents against a tide.
3. The Hudson River is brown… so it is dirty right?!
   a. No! Turbid water doesn't mean that is it dirty water.
4. At the top of the estuary, 153 miles away from the Atlantic Ocean, the tidal rangers are higher (5 ft.) than in the lower estuary (3 ft.).
   a. The river narrows at the top of the estuary, and therefore, the tidal range is higher.
5. The middle of the river has a persistent, deep channel running up from the harbor to the troy dam that is significantly deeper than the surrounding edges. How did this happen!?
   a. Dredged for boat passage

SCIENCE AND ENGINEERING PRACTICES:

Asking Questions and Defining Problems

- Asking questions regarding the Physical River phenomena.

Developing and Using Models

- Develop models to show the relationships among variables (i.e. weather and water chemistry, turbidity and water chemistry, weather and biology).

Planning and Carrying Out Investigations

- Conduct physical river experiments and investigations to answer the questions about phenomena.

Analyzing and Interpreting Data

- Monitoring and data and changes over sites and over years.

Using Mathematics and Computational Thinking

- Decide is qualitative or quantitative data is best for the different physical river parameters. Perhaps both types of data is collected for the same parameter.

Constructing Explanations and Designing Solutions

- Construct potential explanations pertaining to the data by applying scientific ideas, principles, and evidence.
- Explaining how physical components relate to each other and the other parameters.

Obtaining, Evaluating and Communicating Information

- Communicating their data in writing on their data sheets.
- Sharing the information that they collected today with their family and friends.

CROSS CUTTING CONCEPTS:

- **SITE DESCRIPTION**

Structure and Function:

- Describing the natural and man-made structures and features of your site.
- How structures are designed to serve a purpose or function.
- Structures and functions vary at different sites in the river.

Stability and Change:

- How the site may change from year to year

- **TIDES AND CURRENTS**

Patterns:

- Discovering patterns between the currents and tides, and uncovering when are those patterns broken.
- Patterns of high and low tides throughout the day.

Cause and Effect:

- Identifying when the tides dictate the current or when the wind dictates the current.
- Patterns of the lunar cycle impact the tidal ranges.

Scale, Proportion, and Quantity:

- Measuring the tidal change and current velocity.

- **WEATHER AND WIND**

Patterns:

- Seasonal wind and weather patterns.

Systems and System Models:

- Climate vs Weather systems and models.

Scale, Proportion, and Quantity:

- Measuring wind speed quantitatively by using and anemometer and qualitatively by using the beaufort scale.

Energy and Matter:

- Wind energy can change the energy of the water and cause physical and chemical changes in the river.

Cause and Effect:

- Weather impacts the chemistry and turbidity of the water.

- **AIR TEMPERATURE**

Patterns:

- Seasonal temperature patterns from year to year. Long term temperature data may show an increase in your local area due to climate change.

Scale, Proportion, and Quantity:

- Measuring the air temperature throughout the day .

Cause and Effect:

- The air temperature impacts other parameters including weather, wind, water temperature, salinity, and dissolved oxygen.

- **DEPTH**

Patterns:

- The middle of the river is persistently deeper than the surrounding edges.

Structure and Function:

- The bathymetry of the river shows the structure of the bottom of the river.

Scale, Proportion, and Quantity:

- Navigational Hudson River maps have measured out the depths at low tide all throughout the river to compare the differences.

Cause and Effect:

- Sampling at different depths of the river can impacts data.

- **PLANTS IN THE WATER**

Patterns:

- Location of aquatic plants in similar water conditions/ecosystems.

Cause and Effect:

- Aquatic plants impact the health of the water by contributing to dissolved oxygen.

Scale, Proportion, and Quantity:

- Aquatic plants can be measured using transects.

Energy and Matter:

- Aquatic plants are primary producers that are the base of the food chain in providing energy to other trophic levels.

Structure and Function:

- The structure of the aquatic plants varies by species because each plant plays a different role and serves a different purpose in the Hudson River Estuary.

Stability and Change:

- The abundance and species diversity of aquatic plants are always changing in the Hudson due to a variety of factors including invasive species, increased competitive, devastating storms, and other human influence.

LIFE SCIENCE: DITL Biological River

Phenomena:

1. Certain fish are only found in particular sections of the river.
2. Some fish adapt to live in different parts of the river outside their typical home range. Why?!
3. A fish's anatomical structure determines its role/function in the Hudson River ecosystem.
4. Hudson River fishes have varying morphologies (i.e. sizes, shapes, number of fins, fin shapes, color…), but they all live in the same ecosystem.
5. Some juvenile fish look completely different than when they are adults.
   a. I.e. Flounders and fluke
6. Some male species of fish look different than the same female species.
   a. I.e. Mummichogs
7. Delicate nickel sized predator filter a liter of water (over 4 cups) each day for food particles, which simultaneously clarifies the water.
   a. Zebra Mussel
8. Fish that use "legs" to walk on the bottom of the estuary.
   a. Sea Robin
9. Fish that don't have scales.
   a. Lampreys, American Eel…
10. Fish that can slither on land.
    a. American eel
11. Tropical fish found in the Hudson river, East river, and Harbor.
    a. Tropical Strays.

SCIENCE AND ENGINEERING PRACTICES:

Asking Questions and Defining Problems

- Asking questions regarding the Biological River phenomena.

Developing and Using Models

- Develop models to show the relationships among variables (i.e. water chemistry and biology, time of year and biology).

Planning and Carrying Out Investigations

- Conduct fishing investigations to answer the questions about phenomena.

Analyzing and Interpreting Data

- Monitoring and data and changes over sites and over years.

Using Mathematics and Computational Thinking

- Decide is qualitative or quantitative data is best for the different biological data. Perhaps both types of data is collected.

Constructing Explanations and Designing Solutions

- Construct potential explanations pertaining to the data by applying scientific ideas, principles, and evidence.
- Explaining how biological components relate to each other and the other parameters.

Obtaining, Evaluating and Communicating Information

- Communicating their data in writing on their data sheets.
- Sharing the information that they collected today with their family and friends.

1. FISH IDENTIFICATION- DICHOTOMOUS KEY

STRUCTURE AND FUNCTION:

- Different fish species are structured to live and function in different environments of the estuary.

2. FISH DIVERSITY AND ABUNDANCE

PATTERNS:

- Dive into past data to identify trends in 1. Fish abundance vs time, 2. Fish diversity or abundance vs location , 3. Fish diversity vs water conditions…

CAUSE AND EFFECT:

- The biology that you catch is dependent on the impact from 1. Tides and Weather, 2. Rain and water run-off, 3. Water quality

SCALE, PROPORTION, & QUANTITY:

- Fish abundance caught at different times of year. Species abundance could increase or decrease depending on a variety of factors (i.e. fishing rules and regulations for species protection vs overfishing/competition with invasive species)

3. FISH STAGE OR SIZE

SCALE, PROPORTION, & QUANTITY:

- The size or stage of fish are caught at different times of year. Fishing in the spring typically means you will catch lots of juvenile fish.

STRUCTURE AND FUNCTION:

- Some fish juveniles have different morphology than the adults. In some species, the males look different from the females.

4. MACROINVERTEBRATES

PATTERNS:

- Dive into past data to identify trends in 1. Macro abundance vs time, 2. Macro diversity or abundance vs location , 3. Macro diversity vs water conditions…

CAUSE AND EFFECT:

- The biology that you catch is dependent on the impact from 1. Tides and Weather, 2. Rain and water run-off, 3. Water quality

SCALE, PROPORTION, & QUANTITY:

- Macro abundance caught at different times of year. Species abundance could increase or decrease depending on a variety of factors.

5. **PLANKTON**

PATTERNS:

- Dive into past data to identify trends in 1. Plankton abundance vs time, 2. Plankton diversity or abundance vs location , 3. Plankton diversity vs water conditions…

CAUSE AND EFFECT:

- The biology that you catch is dependent on the impact from 1. Tides and Weather, 2. Rain and water run-off, 3. Water quality

SCALE, PROPORTION, & QUANTITY:

- Plankton abundance caught at different times of year. Species abundance could increase or decrease depending on a variety of factors.

6. **FOOD WEB**

ENERGY & MATTER:

- The flow of energy in the Hudson River estuary begins with the primary producers and decomposing detritus in the system. The zooplankton play and important role in linking energy to the tertiary predators in the system.

SYSTEMS AND SYSTEM MODELS:

- Each species play a different role in the greater Hudson River ecosystem.

CHEMICAL REACTIONS: DITL Chemistry of the River

Phenomena:

12. A salty estuary that suddenly runs fresh.
13. In the same location, the salinity taken at the surface is lower than the salinity taken at depth.
    a. Salty water is more dense than fresh water.
14. In the same location, the salinity in the morning is lower than the salinity in the afternoon.
    a. Morning there was an ebb tide, afternoon there was a flood tide.
15. In locations higher up in the HRE, a sample taken at the surface had the same salinity as a sample taken at depth.
16. In the same location, the salinity taken on an ebb tide is higher than the salinity taken on a flood tide.
17. Dissolved oxygen levels that gets higher as the water gets warmer.
18. Fresh sections of the river have a spike in salinity.
    a. Runoff from rain can carry road salt into the Hudson
19. In a bed of photosynthesizing water chestnuts, the dissolved oxygen is much lower than the main stem Hudson without plants.
20. In the spring, the salinity is often very low even though we hadn't had a rain event in weeks.
    a. Snowmelt

SCIENCE AND ENGINEERING PRACTICES:

Asking Questions and Defining Problems

- Asking questions regarding the Chemical River phenomena.

Developing and Using Models

- Develop models to show the relationships among variables (i.e. water temperature and dissolved oxygen, air temperature and salinity, weather and pH, water chemistry and biology).

Planning and Carrying Out Investigations

- Conduct chemical river experiments and investigations to answer the questions about phenomena.

Analyzing and Interpreting Data

- Monitoring and data and changes over sites and over years.

Using Mathematics and Computational Thinking

- Decide is qualitative or quantitative data is best for the different chemical river parameters. Perhaps in some experiments you will be using both types of data (i.e. dissolved oxygen).

Constructing Explanations and Designing Solutions

- Construct potential explanations pertaining to the data by applying scientific ideas, principles, and evidence.
- Explaining how chemical components relate to each other and the other parameters.

Obtaining, Evaluating and Communicating Information

- Communicating their data in writing on their data sheets.
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1. **DISSOLVED OXYGEN**

   ENERGY & MATTER:
   - Wind energy can drive the dissolved oxygen to be higher in the river.

   PATTERNS:
   - Can identify patterns in the dissolved oxygen in relation to tides, time of year, time of day, etc.

   CAUSE AND EFFECT:
   - Dissolved oxygen can be driven by temperature, aquatic plants, wind energy, high nutrients and eutrophication.

2. **pH**

   STABILITY AND CHANGE:
   - pH is relatively stable in the river (neutral to slightly basic) due to the geology of the river. However, pH can lower due to increased rainfall or the threat of ocean acidification.

   CAUSE AND EFFECT:
   - pH is variable due to rainfall, ocean acidification, photosynthesis, decomposition, etc.

3. **SALINITY**

   STABILITY AND CHANGE:
   - Salinity is highly variable and can even in a couple of hours.

   PATTERNS:
   - Comparing salinity trends to the fluctuating tides, weather, and season.

   CAUSE AND EFFECT:
   - Salinity is subject to change in the river depending on location, tides, weather, temperature, sea level rise, etc.

4. **TURBIDITY**

   CAUSE AND EFFECT:
   - Turbidity impacts light availability for aquatic plants and phytoplankton, and therefore, impacts the dissolved oxygen in the water.

   SCALE, PROPORTION, & QUANTITY:
   - There is a proportional relationship between weather (rain, wind, storms, etc.) and the turbidity in the water.

5. WATER TEMPERATURE

STABILITY AND CHANGE:

- While air temperature is subject to change rapidly, water temperature fluctuates more slowly due to heat capacity

PATTERNS:

- Water temperature seasonal and daily patterns.
- Observe water temperature patterns throughout the water column

CAUSE AND EFFECT:

- Water temperature can be influenced by weather, air temperature, aquatic plants, etc.