Level 3: Changes in Water Quality in Wetlands

Tidal wetlands Estuary at Little Nutten Hook. Photo courtesy of Scenic Hudson.

- **Background Information:** The Hudson River Estuary is home to tidal wetlands from the Troy Dam to Battery Park in New York City. Wetlands play a vital role in protecting habitats for fish and other wildlife, improving water quality, and creating a buffer for storm surges and floodwaters. Wetlands are subject to environmental changes, just like every other ecosystem, but the vital role they play in stabilizing other ecosystems make it very important to understand how they work and how they are affected by human impact.

  Tidal wetlands play an additional role in recycling the chemicals and nutrients that all life requires in order to live. During tidal exchange (the ebb and flood of tides that exchanges old water for new), these wetlands alter their concentrations of particles as part of nutrient cycling.

Stuart Findlay, a researcher at the Cary Institute of Ecosystem Studies, wanted to learn more about the role these wetlands play in cycling nutrients within an ecosystem. By studying different aspects of water quality in these tidal wetlands, he could begin to understand the role that variability played in effectively recycling these vital compounds.

- Nitrogen: Nitrogen is a building block for proteins and amino acids, making it an essential nutrient for plants and animals. The nitrogen molecule (N_2) is found in a gaseous state in our atmosphere, but the compounds nitrate (NO_3), nitrite (NO_2), and ammonia (NH_3) are the usable forms of nitrogen. Since nitrate (NO_3) is the most stable, it is usually used to test water quality, but you will see data for all three of these compounds, as well as TN, a measure of total nitrogen in the water.

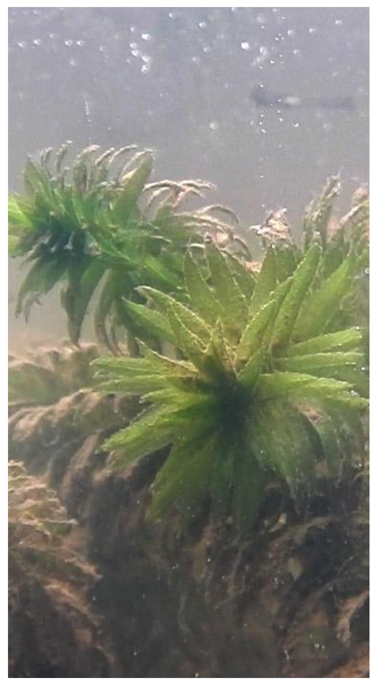
Eutrophication event along the Potomac. Courtesy of Wikimedia Commons

  As with everything in an ecosystem, the issue is balance. Nitrogen in its various forms is necessary for organismal growth and it is returned to the system through decay. If high levels of nitrate enter a water supply, the algae and other water plants grow rapidly, as long as other essential nutrients like phosphorous are present, and nothing else (like light) is limiting. Water can become thick with algae as a result of the increase in growth. When algae die and sink to the bottom of the water body, the bacteria that decompose these tiny plants use up the available oxygen. The oxygen levels get so low that many types of fish and insects can no longer survive in the water. This process is called eutrophication and can happen in freshwater and coastal ecosystems.

- Dissolved Oxygen: Dissolved oxygen (DO) is defined as the molecules of oxygen gas (O_2) that are mixed in among water molecules. It is extremely important, because DO is the oxygen that fish and other organisms use to respire. Certain ecosystems can survive with low levels of DO, but many need much higher levels in order to support large organisms like striped bass. Dissolved oxygen can enter the water in two ways. Atmospheric oxygen can mix into a stream in a turbulent area (i.e. rapids, waterfalls, etc.). Oxygen is also released from plants during photosynthesis. If those plants are respiring underwater, that oxygen becomes DO.

- Vegetation: Because DO is so important, and because plants provide a majority of that form of oxygen, different types of vegetation were measured in order to understand if respiration or turbidity was playing a large role in regulating DO levels. One of the most important types of vegetation that play a role in DO levels is submerged aquatic vegetation (SAV). Submerged means that the entire plant is underwater, which means that all of the oxygen that it excretes as a waste product is considered DO and can be used by underwater organisms to respire. Other plants are partially submerged, which means some of its oxygen excretion becomes DO and some becomes atmospheric oxygen.

  By looking at these variables, scientists can begin to see patterns in the cycling of chemicals and nutrients. They can also look to see if the vegetation is impacted by the regular change in water quality.



Submerged Aquatic Vegetation. Courtesy of Wikimedia Commons.

- **Dataset Timeframe:** June through September in 2008 and 2009.

- **Data Collection Methods:** Vegetation cover was organized using aerial photography. A YSI Sonde was placed in each study site to measure dissolved oxygen, temperature, pH, turbidity, water depth, and conductivity every 15 minutes over a two-week neap-spring tidal cycle. Some water samples were collected over a 24-hour period using an auto-sampler to look at additional water quality parameters, like nitrate-nitrogen.

- **Dataset Variables:**
  - **DO (mg/L):** Dissolved oxygen can be reported in either milligrams per liter (mg/L) or parts per million (ppm). 1 mg/L is equal to 1 ppm.
  - **DO %**: Dissolved oxygen can also be reported as a measure of how saturated the water is (water can only hold so much oxygen). The percent indicates the saturation level.
  - **Nitrate-N (mg/L):** The amount of nitrate in the water. Nitrate-N (or NO3-N) stands for "nitrate as nitrogen," which means this is a test for nitrate (which has 1 nitrogen atom and 3 oxygen atoms in it), but the concentration units are being reported as nitrogen only.
  - **Ammonium-N (mg/L):** The amount of ammonia in the water. Ammonium-N (or NH3-N) stands for nitrogen-ammonia, which means this is a test for ammonium (which has 1 nitrogen atom and 3 hydrogen atoms in it), but the concentration units are being reported as nitrogen only.
  - **TN (mg/L):** The total amount of nitrogen in the water. This variable encompasses nitrogen in nitrate (NO_3), nitrite (NO_2), and ammonia (NH_3).
  - **Graminoid vegetation:** Herbaceous plants that are structured similarly to grasses. It is usually tall and includes cattails and common reed.
  - **Broadleaf vegetation:** Found in the middle zone of the marsh. It includes arrowhead, pickerelweed, spatterdock, etc.
  - **Submerged aquatic vegetation:** Vegetation that is always underwater.

Saltmarsh cordgrass; an example of graminoid vegetation. Courtesy of Wikimedia Commons.

- **Information about Sites:** For this data, four different wetlands were surveyed that span the Hudson River Estuary. Iona Island is in Stony Point, NY, Rogers Point is in Hyde Park, NY, Vanderburgh Cove is north of Mills Norrie State Park, and Athens South Marsh is in Athens, NY.

- **Source of Datasets:** Stuart Findlay, Cary Institute of Ecosystem Studies. Data were published in Findlay & Fischer. 2013. Ecosystem attributes related to tidal wetland effects on water quality. Ecology, 94(1): 117-125.

- **Inquiry Idea Starters:**
  - *How do different wetlands compare in their DO, nitrogen, or vegetation measures? What does that tell you about the ecosystems or about the Hudson River as a whole?*
  - *What trends do you see over the course of a day or a few days? What might account for these trends?*
  - *How do nitrogen, DO, and vegetation levels relate to each other in an ecosystem?*

- **Extension Ideas:**
  - What other variables play a role in these ecosystems? Doing more research on salinity or population counts may help you explain whether the trends you see in the data are healthy or unhealthy.
  - Nitrogen is an important nutrient for ecosystems that sometimes gets overlooked in favor of more accessible molecules such as oxygen. Do some further research on the effects of nitrogen changes in an ecosystem in order to better understand what the data in each ecosystem is telling you. You can start here.

References:
Nitrogen Reading from Changing Hudson Project:
http://www.caryinstitute.org/sites/default/files/public/downloads/curriculum-project/4A1_Nitrogen_reading.pdf

Stuart Findlay, Cary Institute of Ecosystem Studies. Findlay & Fischer. 2013. Ecosystem attributes related to tidal wetland effects on water quality. Ecology, 94(1): 117-125.