"Some things we know and some things we don't know. The mystery is really important" This was the response of the HRECOS project manager, Simon Litten, when I brought him a mysterious correlation I found in the HRECOS data set.

In the previous HRECOS story, I examined the impact of acid rain on the pH of the Hudson River. The river is well buffered so the impact of heavy rainfalls is small if we can see it at all. However, we can observe larger pH changes in the HRECOS data set and these often occur when there has been no rainfall. I was inspired by this observation to try and find causes of these larger changes.

With this purpose in mind I stumbled across a mysterious correlation: the pH at Schodack Island increases when the discharge from the Upper Hudson increases. The USGS maintains a gage in the Hudson River at Green Island, just upstream from the Troy lock and dam. This gage reports river discharge every fifteen minutes. Provisional 2009 data and approved 2008 data are available on the USGS Streamflow website. When I plotted this data against HRECOS pH measurements at Schodack Island, I found that pH consistently increased when the discharge from the Upper Hudson increased.
This correlation is robust. It can be seen in 2008 and 2009 data. It can be seen when the Mohawk, a major tributary of the Upper Hudson, contributes the majority of the discharge. It can be seen when the discharge of the Upper Hudson far exceeds that of the Mohawk. Something from the upper watershed is consistently impacting pH in the Hudson at Schodack Island. The question is, who or what is it?

One possible explanation is that concentrations of carbon dioxide in the river are being diluted. The discharge spikes observed at Green Island are the result of storm events that occur anywhere in the Upper Hudson and Mohawk watersheds. Rainwater contains very little dissolved carbon dioxide, a molecule that forms a weak acid when mixed with water. It’s possible that large amounts of rain water collected by the watershed dilute carbon dioxide concentrations in the river causing an increase in pH. If rainwater is diluting carbon dioxide concentrations, this would explain why pH at Schodack Island increases when discharge from the Upper Hudson increases.

A second possible explanation for this response is photosynthesis. Carbon dioxide concentrations are also influenced by the photosynthetic activity of small floating and larger rooted aquatic plants (a topic discussed in the HRECOS Story: Plant Breath in the Hudson River). As photosynthesis increases, carbon dioxide concentrations decrease and consequently pH increases. Rain water traveling across the landscape picks up nutrients necessary for photosynthesis and transports them to the river. The addition of nutrients from the Upper Hudson could increase photosynthesis and cause an increase in pH. If the floating and rooted plants in the Hudson River at Schodack Island are limited by nutrient availability, this would explain why pH at Schodack Island increases when discharge from the Upper Hudson increases.

At this point, we can’t know for certain what causes this correlation. The photosynthesis explanation is corroborated by corresponding increases in dissolved oxygen concentrations, a known impact of increased photosynthetic activity. Plants in the Hudson River Estuary, however, are thought to be more limited by light than by nutrients which would contradict the photosynthesis explanation. The dilution explanation is intriguing but we would require direct measurements of carbon dioxide to know for certain that concentrations are decreased by Upper Hudson Discharge. In addition, there could be other environmental influences we have not yet considered!

The mystery is important. Even without a clear explanation we have stumbled across a consistent pattern and a significant influence on the conditions of the Hudson River Estuary. Without the magnifying lens provided by HRECOS high-frequency data, our discovery would not have been possible.