Nutrient Monitoring in Foreman Branch in Support of the Chester River Watershed Observatory

Background

Elevated levels of Nitrogen and Phosphorous are the primary causes of poor water quality in Chesapeake Bay. These resulted in over-enhanced primary productivity, principally in the form of excessive algae growth, which leads to reduced water clarity and dissolved oxygen depletion.

Presently, land runoff – primarily from agricultural use – is the single largest source of nutrient and sediment entering Chesapeake Bay. In an attempt to reduce nutrient inputs and restore Chesapeake Bay water quality, Total Maximum Daily Load restrictions are being mandated by watershed states. At considerable cost to taxpayers and agricultural interests, Best Management Practices (BMPs) in land useare being implemented. There have been few opportunities, however, to directly evaluate the effects of agricultural BMPs on nutrient load reductions.

In cooperation with the Chester River Watershed Observatory (CRWO) and Washington College, Sea-Bird Scientific and Hach Hydromet have developed a real-time nutrient and water quality monitoring platform to evaluate the use of direct water monitoring in collaboration with a working farm. Chino Farms is a 5200-acre farm near Chestertown, MD, owned by Dr. Henry Sears and managed stressing best practices in conservation and minimal environmental impact while still maintaining successful agricultural operations.

Monitoring Program

The unique platform developed for this application is based on a simple Taylor float, typically used for Chesapeake Bay oyster gardening. The instruments – Sea- Bird SUNA V2 Nitrate monitor and Cycle-P Phosphate sensor, along with a Hach Hydromet DS5 multiparameter sonde measuring Water Temperature, Conductivity, Pressure, pH, Dissolved Oxygen, Turbidity, and Chlorophyll-A and an Air Temperature / Relative Humidity sensor – report hourly in real time via an OTT netDL 1000 controller and cellular modem. All instrument mounts can be adjusted for sensor depth. The platform is moored in approximately 5 feet of water just downstream from the weir controlling flow from Foreman Branch into the Chester River.

Figure 1. Sea-Bird Coastal / Hach Hydromet Foreman Branch Nutrient and Water Quality monitoring platform located on Chino Farms.

Location

Chino Farms is located on the Chester River on the Eastern Shore of Chesapeake Bay, about 25 miles upstream from the river mouth and the Bay (Figure 2a). Through an agreement with Washington College, farm management data are available for cooperative research. Foreman Branch is a primary watershed for the Farms (Figure 2b), draining a mixture of actively cultivated and other managed land. The monitoring platform is located just downstream of the spillway in the weir that controls flow from Foreman Branch into the Chester River.

Figure 2. Foreman Branch is located on Chino Farms, on the Chester River near Chestertown on the upper Eastern Shore of Chesapeake Bay. **(a)** Foreman Branch drains a substantial portion of the Chino Farms managed land. **(b)** Monitoring platform is located just downstream of the spillway that controls flow from the Branch into the Chester River.

The Chester River Watershed Observatory is an integrated, real-time observing system designed to 'take the pulse' of the Chester River. Managed by the Washington College Center for Environment and Society, the CRWO emphases includes education and understanding the complex relationship among society, land use, and water quality. Through this Foreman Branch pilot project, Sea-Bird hopes to show the value of continuous real-time nutrient and water quality monitoring evaluated in direct cooperation with scientific and agricultural partners. Ultimately we feel that broad implementation of similar systems will be necessary to maximize efficiency and cost savings for agricultural management practices that contribute to Chesapeake Bay restoration.

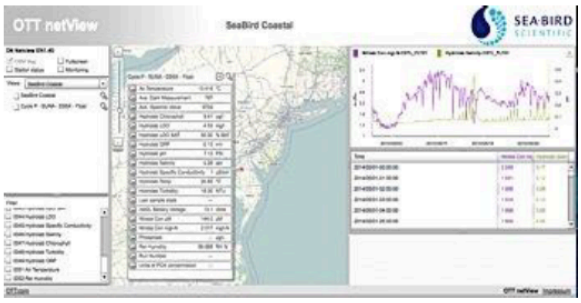

Figure 3. Real-time data is collected by an OTT netDL 500 controller and transmitted hourly via the built-in GPRS modem. Data is available online via the OTT netView application.

Preliminary Data

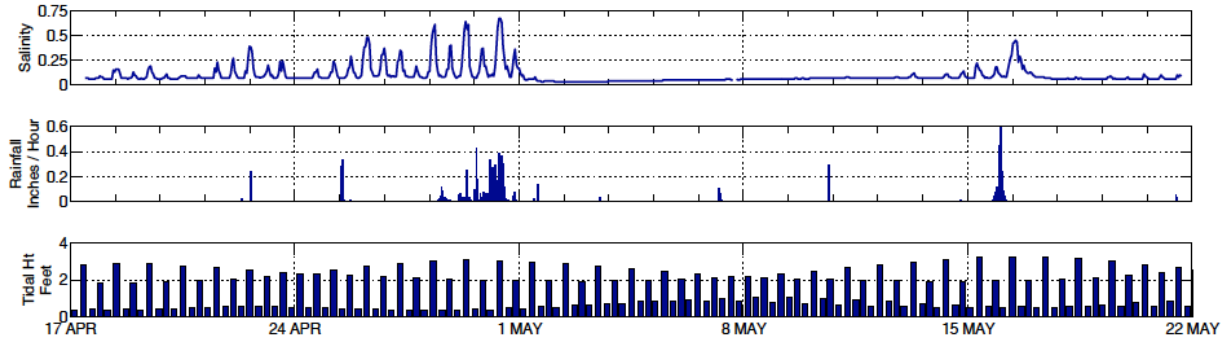

Figure 4. The Salinity sensor on the Hach Hydromet DS5 clearly resolves the small tidally driven salinity differences between Foreman Branch and the Chester River, until the large rain events in late April and mid May reduce the River salinity to nearly zero.

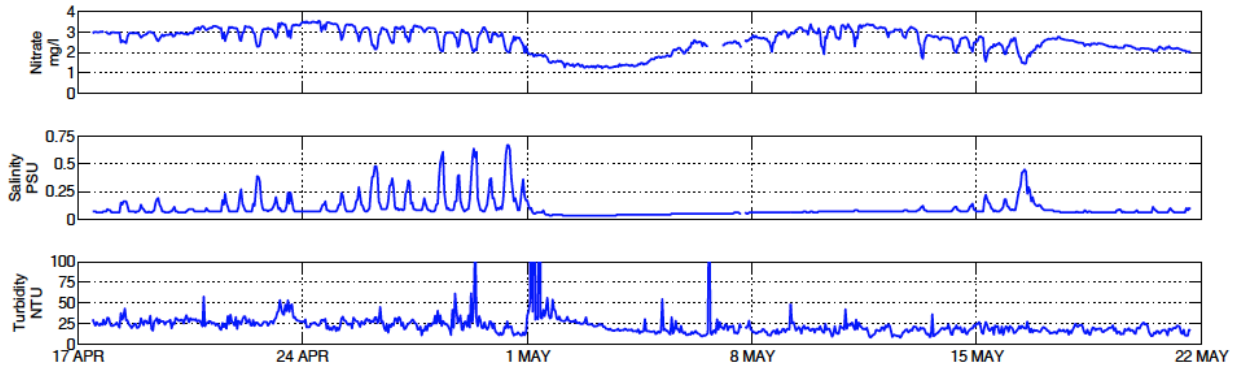

Figure 5. At times of lower flow, Foreman Branch Nitrate concentration varies from around 3 mg/l at low tide (representing flow through the weir) to around 2 mg/l at high tide (influenced by the lower mean Chester R concentration). High post-rain flows dilute the concentrations to around 1 mg/l (but total Nitrate input likely increases due to the larger flows). Turbidity spikes >100 NTU immediately follow the rain event.

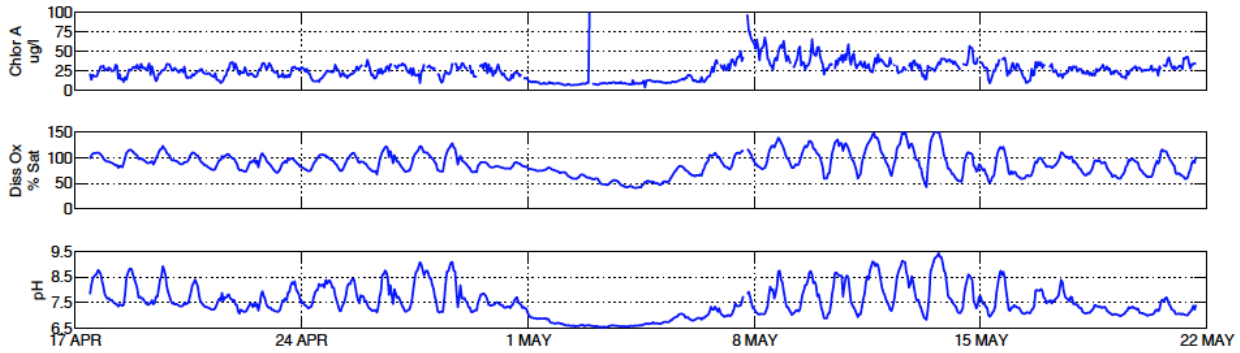

Figure 6. Somewhat counterintuitively, high flows *lower* local Nitrate and Chlorophyll concentrations. Highest chlorophyll values – and thus largest swings in Dissolved Oxygen concentration and pH – occur during the warm, dry, lower flow, higher N periods.

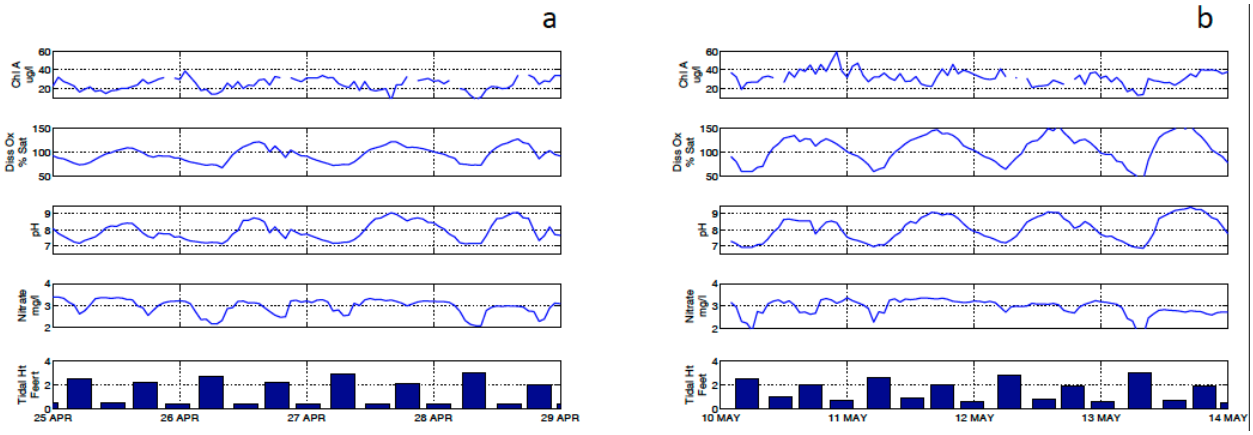

Figure 7. Four days of data collected before (25-29 April, 7a) and after (10-14 May , 7b) the precipitation event.

Mean Property	25-29 April	10-14 May	Mean Property	25-29 April	10-14 May
Water Temperature ° C	17.6	24.3	Ph	7.9	8.1
Chlorophyll µg/l	25.0	32.4	Nitrate mg/l	2.94	2.94
Dissolved Oxygen %| Sat	95	107	Salinity	0.17	0.07

With mean Nitrate concentrations in both time periods the same, warmer waters have increased productivity. While Nitrate fluctuates with the semidiurnal tidal exchange with the Chester River, Chlorophyll, Dissolved, Oxygen, and pH are driven by daily cycle of algal photosynthesis and respiration.

Summary

Relating best management practices on land to watershed water quality can now be supported by direct in-situ nutrient and water quality measurements. This collaboration with a working farm and as a component of a larger Watershed Observatory provides Sea-Bird and Hach Hydromet an opportunity to further develop instrumentation and techniques to support the expansion of this important sensor application.