Cape May Lewes Ferry Monitoring – a Developing Community Resource

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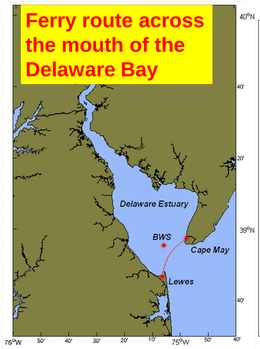
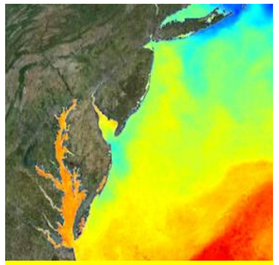


Objective: Program on Cape May Lewes ferry for routine monitoring across mouth of the Delaware Bay. This observation transect - conditions at interphase of Delaware Estuary and adjacent coastal ocean. Started as a research program with University of Delaware Sea Grant funding and in-kind support from the Delaware River and Bay Authority (DRBA). In transition as a future permanent cooperative monitoring program to provide data and information for research, resource management, and general public interest. Exchange between the Bay and coastal waters and the lower Bay ecosystem - greatly influenced by variability in river discharge to the estuary and by upwelling of coastal waters to the lower Bay.

Delaware Estuary watershed: source of major water discharge from Delaware River.


Upwelling of cold (nutrient rich) water from coastal bottom waters shown in green contrasting with warmer surface waters in yellow and orange.

History: Monitoring began in the summer of 2011 on *MV Twin Capes* – ferry with most crossings in summer months, not used in the winter. During the summer of 2011, 403 crossing transects recorded on 55 days; in summer of 2012, 363 transects on 58 days. In August 2011, recordings made of a transect from Cape May to Wilmington and return - ferry ran to cover to avoid Hurricane Irene. In the fall of 2012, similar transect of the bay made to avoid Hurricane Sandy (no return record possible due to damage to measurement equipment by flotsam from storm). Funding to date has been from Delaware Sea Grant, with generous in-kind assistance from the ferry operator, DRBA. Other in-kind and financial assistance desired in the future.


MV Twin Capes

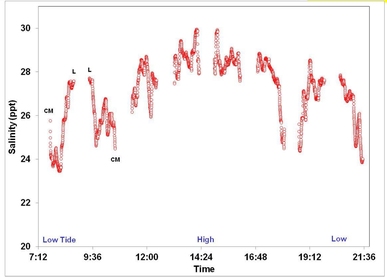
Measurements: Water pumped through a sampling port on the bow of the ferry – measurements made of water along the transect with minimal "contamination" (including air bubbles) from the boat. Water passes through a closed compartment in the boat so measurements are made immediately, logged along with the exact position of the collection. Measurements include temperature and salinity (indicator of water source from up-Bay to offshore), turbidity (indicator of suspended sediment concentration in the water), chlorophyll (indicator of biomass of primary producer algae), and dissolved oxygen (indicator of metabolic balance of the ecosystem).

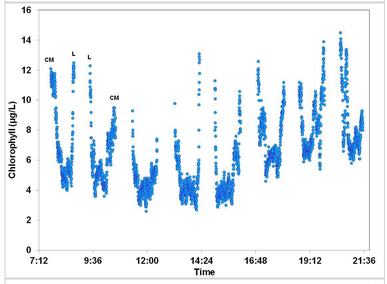
Three panels to the right show data from 8 crossings on 10 June 2012. Each, starts in Cape May (CM) at 7:45 AM ending in Lewes (L) at 8:45 followed by seven more crossings, ending in CM at 21:30 (9:30 PM).

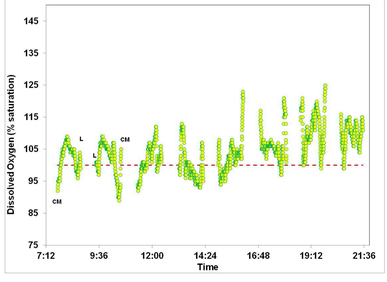
The first panel - salinity with low and high tide times for Lewes shown. Salinity is low, especially in center of transect, around low tide and high around high tide.

The second panel - chlorophyll - phytoplankton biomass is low in center of transects and high near both shores. Chlorophyll is higher at low tide than high tide - bay has higher biomass than offshore waters.

The third panel - dissolved oxygen (DO), as percent saturation; dashed red line is 100% - equilibrium between the atmosphere and water. Trend - early morning, on the CM side, waters undersaturated, indicating heterotrophic demand from night time respiration. Later, especially in the center of Bay, waters become supersaturated, showing phytoplankton photosynthesis exceeding ecosystem respiratory.

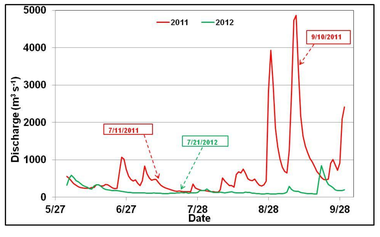


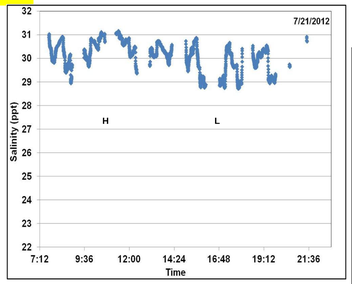


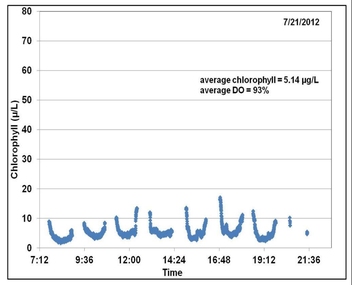


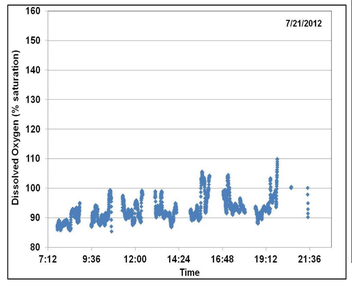
River discharge in 2011 and 2012: Daily discharge of Delaware River at Trenton, NJ is major controller of the lower bay ecosystem. Summer/early fall records shown: average for 2012 summer period close to the long time summer average, relatively regular low discharge. In 2011, summer average more than double long time average. Two periods (late June-mid July, most of Aug) with high discharge periods of 3 weeks duration. Note dates indicated for examples from both summers.

In the spring, sustained high discharge causes stratification of the water column and algal blooms. From independent observations, it would appear during much of the summer of 2011, stratification unusual for the summer occurred and there were summer blooms.









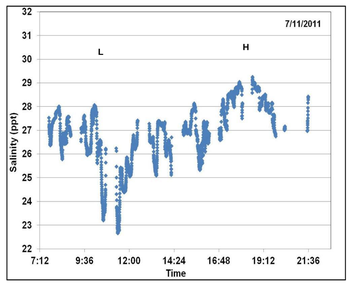
Striking differences between the two summers: Three panels on left - "normal" summer conditions seen in 2012; three panels on right - examples of "anomalous" patterns seen during much of 2011 summer. 8 crossings shown for each day, starting in the morning at CM.

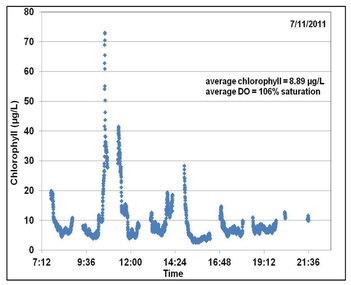
In 2011, salinity (top panels) much lower than in 2012, especially near Cape May at low tide (11:30). 2012 pattern is closer to "normal" based on our research from the past 30 years.

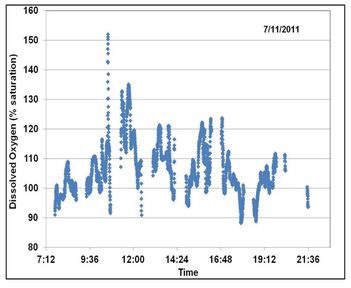
Chlorophyll shown in middle panels. In 2011, biomass was higher and showed major blooms, especially near Cape May at low tide. In 2012, biomass was at "normal" level, around 5 – 10 µg/L. Averaging over 3000 readings for each date, 2011 example has a chlorophyll double that of 2012.

Larger phytoplankton biomass in 2011 indicates higher primary production and should give higher DO. With relatively low biological activity, DO should be close to 100% saturation.

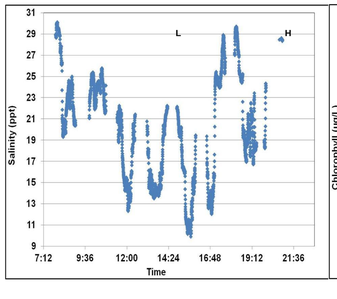
DO concentration was above 100% saturation most of the time in 2011. Note - correlation of very high chlorophyll and DO near Cape May at 11:30 in 2011 example. In 2012, average DO undersaturated most of the time, indicating total respiratory demand exceeding photosynthetic production.

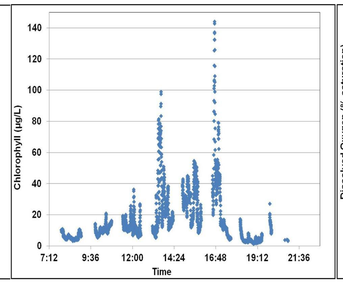


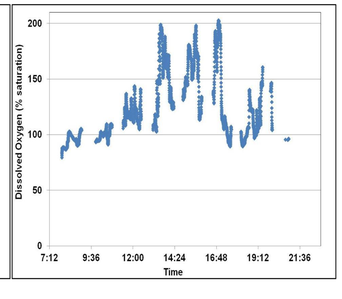




Extreme events in 2011: In addition to anomalously high discharges earlier in 2011 - massive floods from Hurricane Irene (8/28-9/1) and Tropical Storm Lee (9/6-9/15). On September 10, massive flooding from TS Lee pushed salinity to 10 ppt at low tide. Lowest salinity ever recorded for the mouth of the bay. Massive bloom developed with chlorophyll as high as 140 µg/L and DO over 200% saturation. With these transects, we are able to document what is probably one of the largest algal blooms to ever occur in the lower Delaware Bay – a direct result of the massive river discharge from storm flooding.

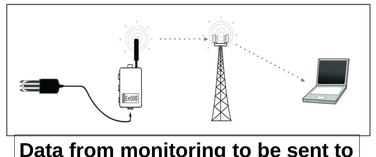






The Next Steps: 1. The monitoring equipment has been used on the *MV Twin Capes*, which is in operation only during the summer months. A second ferry, the *MV New Jersey*, will be fitted with the sample valve system and signal cables when in dry dock this spring. This will give the ability to transfer the monitoring equipment for year-round measurements (hopefully starting in April, 2013). If a second smaller boat, *MV Delaware*, goes into dry dock in May, it will also be fitted with the valve and cables. 2. Data acquisition has been manual to date – it has been necessary to go on board the ferry boat and capture the data using the wireless signal on board. In the next few months, we plan to set up an automated data transmission system to transfer data to a server in Lewes. With this automated data capture, we will also set up a webiste that will allow anyone to get data anywhere in the world – the design of this webiste is still in progress. 3. Information kiosks will be set up with background murals, probably on the measurement ferry as well as the two ferry terminals,– the locations and numbers of these are negotiable. 4. Additional sensors can be added to the measurement system. If the current budget will permit, probes to measure carbon dioxide and nitrate will be added before the end of the current grant. Other sensors and sampling can be added.


MV New Jersey


Data from monitoring to be sent to server at least once a day?