Abstracts

Thursday, May 1

Session L4: Integrated Monitoring and Modeling to Restore and Protect a National Estuary – Barnegat Bay

1:30 – 3:00 pm | Room 237

Collaborative Water Quality Monitoring Program to Support Modeling and Restoration of Barnegat Bay

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Abstract
As part of Governor Christie's 10 point plan to address the ecological health of Barnegat Bay, the Barnegat Bay Ambient Monitoring Program was designed and conducted from June 2011 to June 2013. The objectives of the program were to evaluate the water quality impairments and to construct the modeling tool to establish the linkages between stressors and responses, to identify the water quality targets, and to direct the water quality restoration or potential TMDL development. Using a unique collaborative monitoring network, a total of 15 in-bay stations and 13 tributary stations were sampled and analyzed by multiple partner organizations under the direction of the New Jersey Department of Environmental Protection (NJDEP). Besides the field parameters, laboratory analyzed parameters included: TSS, Chlorophyll *a*, BOD5, CBOD5, CBOD20, dissolved and total nutrients, alkalinity, silica, TOC and DOC. Weekly samples were collected over the growing season, while bi-weekly samples were collected during the non-growing season. Two intensive sampling events were conducted in July and August of 2012, respectively. During the 4-day intensive sampling, the in-bay stations were sampled 6 times per day for all 4 days. Tributary stations were sampled twice per day on the first and last day of the event, and monitored continuously with data sondes throughout the event. The results showed the separation of the bay into different sections and that the distribution of in-bay concentrations varied by parameters, such as higher nitrogen in the northern part of the Bay, with higher phosphorus concentrations in the southern part of the Bay. Toms River and Metedeconk River are the two major tributary nutrient loading sources to the Bay, given the high flow and high concentrations observed. The intensive and continuous samples showed the daily variation of water quality, which is critical to appropriately calibrate the water quality model. The model is being constructed /calibrated based on the monitoring data, along with other information. The calibrated modeling tool will be used, together with the findings from ten ecological research projects sponsored by NJDEP's Office of Science, to set water quality targets for the Bay, which may vary by section of the bay.

Hydrodynamic Modeling of Temperature-Salinity Dynamics in Barnegat Bay-Little Egg Harbor Estuary, NJ

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Abstract
A 3-D hydrodynamic model has been used to simulate currents, water levels, salinity and temperature in the Barnegat Bay-Little Egg Harbor Estuary (BB-LEH). BB-LEH is a shallow, back-barrier system of bays with restricted connection to the ocean through Little Egg Inlet to the south, Barnegat Inlet on the east, and Point Pleasant Canal to the north. The model is forced with tidal water level and currents from the Western North Atlantic tidal database. Additional subtidal water levels and currents, and temperature and salinity climate from a Mid-Atlantic Bight model are imposed at the open boundaries. Fresh water inputs are defined as point sources at the gauged tributaries. Meteorological forcing is derived from the North American Mesoscale Atmospheric Model. Water levels and current velocities are reproduced with good agreement (Brier Skill Score between 0.5 and 0.9). The modeled temperature has a higher skill score than the modeled salinity at the Mantoloking station (0.8 vs. 0.4). Model results indicate that the average temperature in the estuary is about 2 degrees Celsius higher than the

coastal ocean during the March 1-May 1, 2012 simulation period. Salinity is lower in the northern half of the estuary as a result of fresh water input from the Toms and Metedeconk rivers, restricted connectivity with the ocean on the north, and diminished tidal forcing. Most of the domain is well-mixed vertically with minimal salinity stratification. Stronger stratification is observed in the Point Pleasant Canal, and near river mouths, and extending upstream in the Toms and Metedeconk Rivers. Additionally, the recycled cooling water from Oyster Creek Nuclear Generation Station causes thermal stratification with a sharp front halfway across the estuary from Barnegat Inlet. The difference between the average surface and bottom temperatures is on the order of one degree Celsius within an area that stretches a few kilometers north and south of Oyster Creek with an average depth of 3 meters.

Modeling of Water-quality Dynamics and Responses to Nutrient and Other Stresses in Barnegat Bay-Little Egg Harbor, New Jersey

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Abstract
Increased development of Atlantic coastal watersheds in recent decades and associated transport of nutrients to adjacent waters have accelerated estuarine eutrophication. Barnegat Bay-Little Egg Harbor, part of the National Estuary Program, is a shallow, lagoonal estuary located along the central New Jersey coast that has been classified as highly eutrophic due to nutrient over-enrichment and concomitant degradation of water quality. The estuary is particularly vulnerable to the effects of nutrient loading due to restricted circulation and poor flushing rates, and exhibits symptoms of eutrophication such as increases in micro- and macro-algae, harmful algal blooms, degraded seagrass habitat, oxygen depletion, and elevated turbidity. To better understand the impacts of nutrient dynamics in the estuary, a three-dimensional coupled hydrodynamic and water-quality model is being developed. The hydrodynamic model is discussed in a separate abstract.

The water quality model is developed using the Water Quality Analysis Simulation Program (WASP), a dynamic compartment model widely applied to estuarine environments. The water quality model integrates nutrient sources from the watershed, ocean, and atmosphere and considers climatic conditions, sediment transport, sediment diagenesis and benthic exchange, and a range of algal processes to simulate nutrient, dissolved oxygen, and chlorophyll *a* dynamics in the estuary. A linkage is being developed to pass the necessary flow, salinity, temperature and sediment information from the hydrodynamic model to the water quality model. Boundary conditions in the water quality model are derived from continuous and discrete field measurements and enhanced using statistical analysis. The model is calibrated and validated to spring and summer 2012 conditions. Estimated model inputs and kinetic coefficients are adjusted to achieve the best match between simulated concentrations and measured data.

The coupled models will be used to further investigate causes of eutrophication of the estuary and to assess the feasibility of management alternatives for water-quality restoration. Potential alternatives include nutrient-load reduction, engineered circulation enhancement, and change in power plant operation. The models will provide the foundation for addressing current and future water-quality issues in the estuary.

Monitoring and Assessing the Restoration and Protection of the Barnegat Bay: Quo vadimus?

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Abstract

The Barnegat Bay was identified as an “estuary of national significance” by the USEPA with its acceptance into the National Estuary Program in 1995. Periodic snapshots of the bay over the following decade concluded that the bay was in fair overall condition in comparison to other coastal ecosystems. In 2003, the Barnegat Bay Partnership (BBP) established a Monitoring Program Plan which identified nine primary indicators for the bay, including metrics for (1) submerged aquatic vegetation, (2) land use and land cover, (3) signature species, (4) watershed integrity, (5) shellfish beds, (6) bathing beaches, (7) water supply wells, (8) harmful algal blooms, and (9) freshwater flows. Since that time, two BBP State-of-the-Bay reports (2005 and 2011) made various use of available components to assess

the bay's conditions. The BBP, with support from EPA, NJDEP, the Partnership for the Delaware Estuary (another NEP) and others, also initiated an integrated assessment of NJ's coastal wetlands for water quality, habitat management, and restoration planning. Over that same period, studies funded by the Barnegat Bay Partnership and its state and federal partners increasingly documented moderate eutrophication and other deteriorating conditions (*e.g.*, harmful algal blooms, eelgrass declines, localized hypoxia) in the bay ecosystem. In response to widespread concern about the bay's declining health, the NJ Department of Environmental Protection committed to an intensive water quality monitoring study and other comprehensive studies to assess the bay's condition and trends. Thus, over the past 20 years, monitoring and assessment efforts have increased but remained inconsistent. The purpose of this talk is to explore various local, state, and national perspectives on the bay's monitoring and assessment, and to help coalesce and guide future monitoring efforts toward a unified vision for the restoration and protection of the bay.