Long Island Sound Study (LISS) Science & Technical Advisory Committee (STAC) and Water Quality Monitoring Workgroup Meeting Notes
2/17/2017

In Attendance:

STAC Members: James Ammerman, Paul Anderson, Vincent Breslin, Hans Dam, Sylvain DeGuise, Charles DeQuillfeldt, Anthony Dvarskas, Penny Howell, David Lipsky, Darcy Lonsdale (Acting NY Co-chair), Kamazima Lwiza, John Mullaney, James O'Donnell (CT Co-chair), Julie Rose, Kelly Streich, Larry Swanson (NY Co-chair), Mark Tedesco, Andy Thuman (Alternative for Robin Miller), Jamie Vaudrey, Robert Wilson, Charles Yarish (on the phone)

Water Quality Monitoring Workgroup Members: James Ammerman, Alison Branco, Charles DeQuillfeldt, Lorraine Holdridge, Peter Linderoth, Kamazima Lwiza, John Mullaney (Alternative for Jon Morrison), James O'Donnell, Jamie Vaudrey, Robert Wilson

Others: Cassie Bauer (NYSDEC/LISS), Soren Dahl (NYSDEC), Nickitas Georgas (Stevens Institute, on the phone), Laura Grieco (NYCDEP), Keith Mahoney (NYCDEP), Dan O'Rourke (CDM Smith), Chris Schubert (USGS), Lane Smith (NY Sea Grant), Mike Whitney (U Conn.), Rick Winfield (NYC S.W.I.M.)

Jim O'Donnell (CT) Co-Chair, opened the meeting at 9:15 AM: Jim Ammerman noted the STAC members who had recently resigned or retired (Brett Branco, James Fitzpatrick, and Gillian Stewart), and mentioned that Penny Howell was attending her last STAC meeting as she would soon be retiring from CT DEEP. He introduced two new STAC members, David Lipsky and Kamazima Lwiza, and noted that a third new member, Robin Miller, was unable to attend but was represented by Andy Thuman from HDR.

Jim O'Donnell conducted the election for New York STAC Co-chair. Darcy Lonsdale was the only nominee and was elected to the position for the next two years.

Mark Tedesco, Director of the Long Island Sound Office: Mark addressed the goals of the meeting as well some concerns about EPA under the new administration. He noted the success of the 2000 TMDL in reducing nitrogen loading from waste water treatment plants by 60%. The goal of the TMDL was to reduce bottom water hypoxia in the Western Sound. Seventeen years later this hypoxia reduction effort is continuing but there is a need to connect it with local watersheds and embayments. The EPA nitrogen strategy is continuing to address upgrades of waste water treatment plants but is also focusing on nitrogen loading from tributaries and embayments. It is also cooperating with active nitrogen reduction strategies in New York (Long Island Nitrogen Action Plan) and Connecticut (2nd Generation Nitrogen Strategy). The purpose of this STAC meeting is to discuss needed modeling and measurements to help Long Island Sound Study to move forward on goals.

Mark also addressed concerns about EPA. He stated that the federal government is currently funded through the end of April. EPA has provided a portion of the fiscal year 2017 budget for the LISS. Congress will need to pass a budget for the remainder of the 2017 fiscal year (through September 2017), as well as start discussions on appropriations for the 2018 fiscal year beginning October 1. The outcome of both of those budgets is unclear at this time. He also mentioned that the LISS is not a regulatory program, and it is often EPA's regulatory programs that are the most controversial. In general, there remains a lot of uncertainty about EPA's future directions.

Jim O'Donnell (CT) Co-Chair: *"LIS Water Quality Modeling".* Jim O'Donnell provided an extensive history of Long Island Sound (LIS) water quality modeling and monitoring starting in the late 1980s. He reviewed the multiple generations of models leading up to the Systems Wide Eutrophication Model (SWEM), developed by HydroQual (now HDR), and used for LIS nutrient management and the assessment of the 2000 TMDL. Jim O'Donnell also collaborated with Jim Fitzpatrick of HDR on more recent revisions of SWEM applied to LIS. Jim O'Donnell also reviewed some of the extensive experimental studies and past analyses of monitoring data. Jim O'Donnell concluded that though there has been a significant reduction of nitrogen loading, there is too much variability to conclude that the area of hypoxia is declining, and even less evidence for the decrease in the duration of hypoxia. (However, this warrants more detailed evaluation.) The SWEM model grid is coarse in Long Island Sound, and while it can correctly model the general physics of circulation, there are issues with properly representing vertical stratification and with predictions of biological processes, namely both the algal production and respiration are too low. This required unrealistic manipulation of vertical mixing rates calculated by the hydrodynamic model in the water quality model to more closely represent the dissolved oxygen data (as agreed to by the Model Evaluation Group appointed by EPA to evaluate SWEM). There were a series of questions focused on poorly understood biological processes, including mechanisms and variation (including seasonal) of overall production and respiration, benthic respiration (sediment oxygen demand, SOD), and bacterial activities.

Nickitas Georgas (Stevens Institute of Technology): Nickitas Georgas, on the phone, described some of his work with the NYHOPS model and applications to the New York Harbor area and Long Island Sound. NYHOPS is related to the hydrodynamic portion of SWEM, but updated and improved, and its current resolution in LIS is 400 m. Model data and operational forecasts are available for use by others, though the availability of very high frequency data (hourly), would require a source of funding. The model would be enhanced by adding models of groundwater and riverine inputs.

Panel (Open Sound): Nickitas Georgas (by phone), Kamazima Lwiza, Jim O'Donnell, Andy Thuman, Bob Wilson: The panel discussed SWEM and its history as well as additional efforts and important unknows. Bob Wilson described soundwide ROMS modeling for harmful algal blooms (HABs). Kamazima Lwiza noted that 1 dimensional process models, such as ROMS or FVCOM models can be insightful. He stressed that we need a much better understanding of bacterial respiration and its role in hypoxia, as well as the impact of nitrogen loading on bacteria. Andy Thuman mentioned that SWEM had been further revised with biological oxygen demand (BOD) information and applied to New York Harbor and embayments, but not Long Island Sound except for the work done in collaboration with Jim O'Donnell mentioned above. Andy mentioned that HDR is modeling the embayments in Suffolk County as part of the Long Island Nitrogen Action Plan. He also emphasized the importance of long term BOD rates for sewage treatment plant effluent and river discharges.

Mike Whitney (U. Connecticut): "*Model applications for Long Island Sound and its embayments".* Mike Whitney discussed some of his modeling and measurement studies with the major rivers flowing into Long Island (Connecticut, Housatonic, and Thames) and the embayments inshore of the Norwalk Islands, an area important for oyster aquaculture. He used the ROMS model with a grid size of 0.5 to 1 km. The CT DEEP water quality monitoring program and the LISICOS (U. Connecticut) buoys are essential for evaluating the performance of the model. Mike used simulated dye releases to model river plumes and their flows into LIS. While dye flushing was rapid overall, some was retained in rivers, harbors, and

embayments, indicating much longer residence times in embayments compared to the open Sound. There was also a large variability in nutrient concentrations over a tidal cycle.

Chris Schubert (USGS): *"Modeling groundwater inputs and loads to Long Island surface waters: USGS projects ongoing and proposed".* Chris Schubert presented a brief overview of a current project which will delineate groundwater recharge areas, travel times (<1 to >500 years), and outflows to Long Island surface waters with a groundwater flow model under development. They will analyze more than one thousand stream, pond, and estuary segments with particle-tracking techniques. He emphasized that due to the groundwater travel times, one could expect continued increases in nitrogen loadings due to legacy inputs. Future projects may examine nitrogen loading to the Peconic estuary from wastewater and fertilizer.

Dan O'Rourke (CDM Smith): *"Nitrogen modeling to evaluate management strategies to restore Suffolk County's estuaries".* Dan O'Rourke started with a broad view of recent subwatershed modeling of groundwater flows in Suffolk County, with a detailed example from the South Fork of Long Island. The initial nitrogen load calculations use spreadsheet models for a first approximation. They determine travel time and ultimately generate a simulated total nitrogen map using the Nitrogen Loading Model (NLM). The models are then compared with shallow water supply wells for ground truth. He noted that the degree of nitrogen attenuation in the NLM is a matter of controversy but that it is very low on Eastern Long Island. Jon Mullaney noted that Connecticut geology is very different, information is limited, and travel times are different.

Panel (Tributaries and Embayments): Dan O'Rourke, Chris Schubert, Jamie Vaudrey, Mike Whitney, Bob Wilson: There is a need to link loading to embayments with residence time to understand the susceptibility to nutrient impairments. Current embayment modeling is underway on Long Island but will need further work in Connecticut. There is also a need for additional water quality measurements in embayments and biogeochemical modeling to fully link nutrient loading to impairments. There was brief discussion of endpoint analysis and the usefulness of intermediate endpoints for determining water quality improvements. Hysteresis effects are also common in estuaries undergoing ecological changes (especially in seaweed-dominated systems), and can be difficult to model.

Facilitated Discussion to Develop Recommendations: See attached SCIENCE NEEDS FOR EUTROPHICATION MANAGEMENT recommendations from that discussion.

SCIENCE NEEDS FOR EUTROPHICATION MANAGEMENT

MEASUREMENTS

- Continue time series measurements, including meteorological packages.
- Need long-term biological oxygen demand (BOD) rates for effluents, rivers. Characterize labile/refractory ratios and fDOM and CDOM (fluorescent dissolved organic matter and colored dissolved organic matter). (IEC makes BOD measurements at selected stations.)
- Define seasonal and geographic variations in sediment oxygen demand (SOD) and sediment fluxes (evaluate LISS-funded studies first).
- Better define carbon/Chlorophyll *a* ratios in phytoplankton. (This a widespread problem but there should be both LIS and other estuarine data available.)
- Need more measurements in embayments. May be easier to detect system responses in these systems.
- Need to understand high-frequency variability of production and respiration. Very few rate measurements of production and respiration available. This is also true for the rate and variability of bacterial respiration.

ANALYSIS

- Assess decade-long phytoplankton and zooplankton patterns, trends from LIS monitoring program. Are mesozooplankton and microzooplankton (protist) predation important?
- Assess yearly variability of DO/hypoxia conditions against annual variation in nitrogen loading (for point source and point source + river loads) and Chlorophyll *a*.
- Assess DO metrics (e.g. maximum area < 3 mg/l, < 2 mg/l, < 1 mg/l, etc.) from bi-weekly and time series DO measurements.

MODELING

- Predict the annual DO cycle AND get the production and respiration rates in WLIS correct. To have confidence that it can predict changes, there should be skill in the predictions of the inter-annual variation in the DO concentrations.
- Start with simplest modeling framework that explains O_2 patterns.
- Develop simple empirical nitrogen loading model to predict annual area of hypoxia. Useful for both understanding and as a potential outreach tool.
- Eventually develop more complex mechanistic model which can nest embayment models.
    - Characterize all nutrient loads accurately.
    - Quantify the relative impact of nutrient sources (rivers, wastewater discharges, atmospheric deposition, boundary fluxes through the East River and the Race, etc.) have on hypoxia in LIS.
    - Increase resolution where needed to improve water quality simulations.
    - Link to ground water models to input fresh water and nutrients.
    - Characterize exchange between the open Sound and embayments influencing water quality (sources or sinks).
    - Predict how long-term climate-driven changes may influence the expression and severity of nutrient-related impairments.
    - Evaluate the potential of bioharvesting or other removal processes to mitigate nutrient-related impairments.
- Support ensemble modeling, but within limited budgets.
- Include endpoints in addition to O_2; e.g., water clarity, nutrient concentrations in embayment models and relate nutrient loads to use impairments.

DESIRABLE MODEL CHARACTERISTICS

- An open-source modular design that facilitates implementation of alternative parameterizations
- NETCDF input and output files

- A system to revise and improve model elements
- Thorough documentation (e.g. a user guide)
- Solution file sharing
- Complementary analysis and visualization tools
- An ability to work with alternative hydrodynamics models.