Long Island Sound Study Science and Technical Advisory Committee
Meeting Summary, July 9, 2010 – University of New Haven

Carmela Cuomo brought the meeting to order at 9:30 a.m. and participants introduced themselves.

STAC Fellow Presentation

Amina Schartup, the 2009 Connecticut STAC Fellow, spoke about her ongoing doctoral research related to methylmercury in Long Island Sound. She reported that sulfur, organic matter quality and quantity; sediment structure and composition can all affect the conversion of inorganic mercury to methylmercury, a process mostly mediated by bacteria. The relative importance of these factors with regard to mercury methylation in an economically and environmentally important estuary, Long Island Sound (LIS), was investigated during summer 2009 and fall 2009 at two stations, in the western and central LIS. Unlike previous studies in LIS, the water column (3 depths) and sediments were sampled for mercury speciation and ancillary parameters. Preliminary results: 1) Mercury methylation in the western sound in summer of 2009 is lower than methylation at the same station in summer of 2001, which could be explained by a milder hypoxia in 2001. 2) An inverse relationship between % methylmercury and total sulfur content of the western LIS sediments. 3) 3D Fluorescence of the water column in the western LIS showed the presence of humic-like peaks (A, C and M) as well as a 4th humic peak A', which has only been observed in sediment pore water by Burdige et al., 2004. 4) Peak A' corresponds to a red shift of the humic peak A, its fluorescence increases with depth and becomes dominant mid depth. This peak A' might indicate a more refractory nature of western LIS waters in the summer.

Enhanced Formulation of LIS Science Needs: Introduction

Jim Latimer spoke about his new role in the Long Island Sound Study. He will be devoting 50% of his time over the next six months to science coordination activities, with the potential for continuation at the end of this time period. Jim's background is in organic and inorganic geochemistry, and his recent work within EPA Office of Research and Development in Narragansett has focused on nutrients and science policy. He presented a conceptual model of the Long Island Sound management process, highlighting the ways in which science informs this process and providing suggestions for enhancing the management-science cooperative. Jim reminded STAC members that the set of explicit science questions on which the Needs Assessment and LISS Research RFP are based were originally formulated through STAC subcommittees. He announced a revisitation of this process over the next year, including a revival of the STAC subcommittees and a series of scientific discussions to be held during the regularly scheduled STAC meetings.

Hans Dam commented that not enough arrows point upward in flow chart, and there is a need to increase opportunities for scientists to inform the management process. Larry Swanson stated that not enough scientific guidance went into setting specific management targets and that they may not be based on the best science. Mark Tedesco replied that the Citizens Advisory Committee is starting the process to revisit the CCMP through the SoundVision project and that it is important that scientists be part of this discussion. The SoundVision contractors will be contacting local scientists as part of this

process. Additionally, Mark pointed out that the environmental indicators are an important tool to evaluate how the system is changing and feedback from the STAC into the indicators program will be crucial in the next year.

Science Discussion: Linkages Between Nutrients and Hypoxia in Long Island Sound

The science discussion for this meeting was centered on linkages between nutrients and hypoxia in Long Island Sound. The format for the discussions was a series of short presentations by any STAC member as well as several outside invited speakers, intended to generate larger discussion among all attendees. Presentations were given at this meeting by Carmela Cuomo (UNH), Hans Dam (UConn), Chris Gobler (SBU), Kamazima Lwiza (SBU), John Mullaney (USGS), Gillian Stewart (Queens College), Gordon Taylor (SBU), Johan Varekamp (Wesleyan) and Gary Wikfors (NOAA). Speaker presentations will be posted on the Long Island Sound Study website (www.longislandsoundstudy.net). The following is a brief summary of each presentation:

Johan Varekamp spoke about his work with sediment cores from several locations in Long Island Sound. His data indicates that hypoxia in Long Island Sound dates back to the 1800s. Data from the medieval warm period showed no indication of hypoxia, suggesting that while climate is a modulator of hypoxia it is not a primary driver in Long Island Sound. Varekamp examined storage rates of marine vs. terrestrial carbon within the historical record and reported that the rate of storage of marine carbon increased until the early 1900s, then declined, but the rate of storage of terrestrial-based carbon steadily increased from the 1800s (it was noted that the differing lability of the carbon sources may obscure conclusions on source magnitudes). These patterns were observed in cores from very different locations in the Sound.

Gillian Stewart discussed the potential role of embayments in the temporal and spatial variability of hypoxia in the main stem of western Long Island Sound. There is high tidal discharge from the embayments, suggesting net export of material (POM-BOD) and the potential for fresher waters in the embayments to contribute to stratification in the main stem. An observed 3-6 year periodicity in hypoxic events at station E10 seems to be unrelated to stratification or nutrients. Additionally an observed 3-4 week signal in variability at station E10 is suggestive of the export time from embayments. Larry Swanson pointed out that many embayments used to have sills promoting retention, but after sills were removed, all the material going into the bays is now readily transported out. Kamazima Lwiza suggested that variability in winds could also affect transport out of the embayments.

Carmela Cuomo discussed a series of laboratory experiments and field work in Smithtown Bay. She observed sulfide and ammonia release from the sediments, decoupled from hypoxia, highest in the fall (but present in spring as well). Lab experiments linked the release primarily to temperature, but also organic content, presence of benthic communities and dissolved oxygen. Results from field work in Smithtown Bay suggest the presence of a gyre favors sediment accumulation and the retention of materials. Ammonia and sulfide concentrations in bottom waters were higher on the ebb tide than the flood, probably due to current speed, temperature and salinity. Overall, nutrients in Smithtown Bay were extremely low during the study period (May through September).

Chris Gobler discussed linkages between food webs and hypoxia. His work with bottle incubations of Long Island Sound phytoplankton assemblages indicated that Si additions favored diatoms, while ammonium and dissolved organic matter additions favored dinoflagellates. He discussed the importance of zooplankton grazing, which can alter plankton community composition, carbon fluxes and therefore hypoxia. He suggested that the observed decrease in chlorophyll in the late 1990s might be related to an imbalance in zooplankton grazing vs. phytoplankton growth, since experiments from that time period suggested that 40-95% of phytoplankton biomass was consumed daily by zooplankton. Chris stated that climate change could also affect plankton community composition, carbon fluxes and hypoxia. Warmer winters may increase zooplankton grazing pressure relative to phytoplankton growth, resulting in reduced phytoplankton biomass during the spring bloom. He suggested that excess copepod production is increasingly being consumed by gelatinous zooplankton rather than fish. Gillian Stewart pointed out that gelatinous zooplankton preferentially consume the smaller, herbivorous copepods that feed directly on phytoplankton. Johan Varekamp indicated that according to his core records, Si has increasingly become a limiting nutrient. Hans Dam stated that the data from the CT DEP indicates dissolved silicate is accumulating in the water column in Long Island Sound.

Gary Wikfors continued the discussion of food webs, nutrients and hypoxia. He reviewed the seminal paper by Ryther and Dunstan (1971) that indicated nitrogen is the critical limiting factor in coastal marine ecosystems. He also reviewed the Long Island Sound time series presented in Capriulo et al. (2001). This study reported a large seasonal variance in dissolved inorganic nitrogen (DIN), with nearly all inorganic N drawn down in the summer. The concentration of dissolved organic nitrogen (DON) was similar to DIN, but only 50% of DON was drawn down in the summer. A seasonal cycle of total dissolved phosphorus was also observed, with very large drawdown in summer. Since DON is still left in the summer after total dissolved phosphorus is drawn down, this suggests the potential for overall phosphorus limitation in the water column.

Gordon Taylor presented a preliminary analysis of trends in nutrients and Long Island Sound hypoxia based on the CT DEP water quality monitoring dataset. He observed that excess DIN decreased by 0.7 $\mu M\ year^{-1}$ in western Long Island Sound between 1994 and 2006. The trend was consistent at all stations along the axial transect but was greatest in the west. Dissolved inorganic phosphorus increased over the same time period. Chlorophyll *a* had a slight positive trend, but particulate carbon and particulate nitrogen decreased, particularly in the western stations. There were no consistent trends between hypoxia and water column nutrients. The reductions in water column DIN were proportional to the reduction in N loading from wastewater treatment plants (WWTP) over the same time period. Chris Gobler asked if the decrease in WWTP-based N loading could explain the decreases observed in particulate nitrogen and particulate carbon. Gillian Stewart answered that there are other sources of particulates aside from WWTP but they have a higher C:N ratio. It was suggested that the increased phosphorus in the western Sound might be partially attributed to the addition of phosphorus to New York City drinking water in order to remove lead.

John Mullaney presented an analysis of USGS records of long-term N and P loads and nutrient ratios for selected tributaries of Long Island Sound. There were general declines in total nitrogen loads over the time period 1975-2008, with greater contributions from decreased ammonium and organic nitrogen

than from decreases in nitrate. He noted that declines were observed even given substantial population increases over the same time period. In general total phosphorus declined over most of the study period but there have been recent increases in total phosphorus in several of the tributaries in recent years. The ratio of Si:N increased in all tributaries examined. John reported that the timing of the spring freshet appears to be getting earlier, with overall flows increasing and snowpack decreasing. Larry Swanson said that increased flows are also being observed in the Hudson River.

Kamazima Lwiza presented his analysis of factors impacting hypoxic volume in Long Island Sound. The combined effect of chlorophyll a (2 month lag) + wind + river discharge (2 month lag) + total nitrogen + precipitation resulted in a correlation of 0.97 with hypoxic volume. Wind appeared to be the biggest contributor to this correlation. Kamazima presented data for the small scale flow field variability in western Long Island Sound, and noted that flows converge around Execution Rocks. Kamazima observed the occurrence of a strong tidal front near the Execution Rocks buoy in his data and suggested that a transient front could be moving back and forth across buoy at times and contributing to high variability observed in the buoy data.

Hans Dam presented his evaluation of the general management plan by which nutrient reduction is thought to reduce phytoplankton abundance, which should reduce hypoxia. He noted that nitrogen loads have declined 25%, but phytoplankton and hypoxia have not declined. He suggested there is a need to rethink our conceptual framework and our mechanistic understanding of hypoxia. Hans reported that while there have been declines in total nitrogen and dissolved inorganic nitrogen, there has not been a change in ammonia over time. He stated that stratification and temperature (i.e. physics) are driving variability in dissolved oxygen concentrations, not total nitrogen or chlorophyll *a*. The predominant wind conditions over the last 50 years seem to favor stratification (and therefore hypoxia). Hans argued that stratification is modulating the effects of multiple stressors on the system response (applying the filter concept from Cloern 2001).

STAC Co-chair Synthesis: Larry Swanson said there is a clear need to look into issues of scale, and pointed out that increasingly, researchers are partitioning the Sound within their work. He emphasized the importance of bays/embayments. Larry stated that phytoplankton/zooplankton dynamics need to be more carefully examined. He also said that it is possible the Long Island Sound Study relied too much on hydrodynamic model predictions and bought too much into the traditional nitrogen-hypoxia model. He suggested we need to proceed with caution. Carmela Cuomo also discussed the importance of scale and emphasized that different processes dominate at different scales. She stated that wastewater treatment plant upgrades are very important and necessary but that there is a growing recognition that nitrogen is not the only factor driving hypoxia.

Open Discussion: Hans Dam stated that hypoxia has remained relatively stable over the course of the Long Island Sound Study and asked how much worse the situation would be if we hadn't undertaken WWTP upgrades? John Mullaney pointed out that N loads have been declining even with large population increases. Hans said that observed declines in water column dissolved inorganic nitrogen have not been accompanied by changes in hypoxia. Carmela argued that a lot of the processes related to hypoxia occur in the sediments, not in the water column, and that there is a huge legacy of nutrients

in the sediments. Milan Keser stated that temperature drives a lot of system-level processes, also there was no discussion of pH trends in LIS. Mickey Weiss suggested that model runs should be undertaken to see what the Sound would look like had we not undertaken reductions in nitrogen loading. He also argued for the need to discuss management implications of the science presented today and for the need to inform the CAC and politicians. Art Glowka asked if it is worth $750 million for the residents of Westchester County to reduce their WWTP nitrogen outputs from 7 to 3 mg/L? Carmela replied that yes it is worth the cost because of the direct impacts of WWTP on embayments, and she emphasized the importance of scale when managing.

Mark Tedesco stated the need for actionable questions about nitrogen and hypoxia that we can direct towards monitoring and research. He said that we need to be able to explain what is happening and have ideas for monitoring, research and implementation that we can then test. He asked if there are things we can do to affect some of these possible drivers (e.g. changes in phyto/zoo community) in a positive manner? Mark also said there appeared to be support for a review of monitoring programs in the Sound. Penny Howell indicated that the R/V Dempsey is currently in dry dock and may need to be replaced soon.

Topics for Future Discussion: Topics suggested for future discussion included climate change, living resources and monitoring.

Larry ended discussion by emphasizing the need for progress on the synthesis book.

The next meeting is scheduled for Friday November 19, 2010. Meeting adjourned.