



A Partnership to Restore and Protect the Sound

**COMPREHENSIVE
NEEDS ASSESSMENT
AND
IMPLEMENTATION
PROJECTS**

**THE
LONG
ISLAND
SOUND
STUDY**

*A Partnership to
Restore and Protect
the Sound*

October 2007

This document provides an overview of projects funded by the Long Island Sound Study (LISS) through the LISS base budget, through the LISS Enhancement Grant Program, or through the Long Island Sound Research Grant Program. Also included are the general research, monitoring, and assessment needs identified by the LISS Science & Technical Advisory Committee in 2005 and information on funding needs provided by the LISS work groups. The EPA – Long Island Sound Office’s (EPA-LISO) priority recommendations for October 1, 2008 – September 30, 2009 (using FY2008 appropriations) funding priorities are summarized at the end of the document.

I. HYPOXIA. ELIMINATE THE ADVERSE IMPACTS OF HYPOXIA RESULTING FROM HUMAN ACTIVITIES.

A. 2003 Long Island Sound Agreement Goals & Targets

1. By 2014, achieve a 58.5 percent reduction in the total enriched load of nitrogen to Long Island Sound from point and nonpoint sources within the New York and Connecticut portions of the watershed, as defined by the December 2000 document – *A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound*.
2. By 2003, establish Phase IV nitrogen reduction agreements to address atmospheric deposition and watershed management for portions of the Long Island Sound watershed outside of New York and Connecticut.

B. General Research, Monitoring, and Assessment Needs

1. Discern the response of Long Island Sound (in biological, geochemical, or physical oceanographic processes) to local nitrogen reductions (a local signal) and to ocean climate/variability (e.g., trends in temperature that drive stratification).
2. Evaluate the current understanding of components of the processes that are thought to control the degree and extent of hypoxia in Long Island Sound (e.g., food web interactions, water exchange through the Sound boundaries, sedimentary geochemistry and sediment-water column fluxes, etc) using existing and, if necessary, new observations.
3. Evaluate whether available water quality data exhibit trends that are consistent with the predictions of the LIS 3.0 or SWEM models and develop recommendations for improvements to the models or current monitoring efforts; i.e., analyses of available data linked to model predictions, both at regional scales (western, central, and eastern Sound) or the entire Sound.
4. Propose novel monitoring programs and techniques (continuous measurements of primary productivity, nutrients, zooplankton, tracers for river water and nutrients, harmful algae, microbial pathogens, etc) to fill in gaps in the current monitoring program.

5. Propose new management technologies and approaches to control nitrogen loading to Long Island Sound. In particular, management of sewage treatment plant processes and innovative best management practices to control nonpoint source and storm water runoff from urban areas are critical management needs that warrant research. [also relates to watershed management section]

C. LISS Work to Address Needs

1. **A Biological-Physical Numerical Simulation Model for the Investigation, Prediction and Management of Oxygen Production and Consumption in Long Island Sound: Data analysis and model formulation** (UConn; PI: Goebel/Kremer; LIS 2004 Research Fund; LI-97101801; \$70,578; COMPLETED): The objective of this project is to develop a simple and accurate ecosystem model of oxygen dynamics in Long Island Sound. Unlike other models, the primary productivity component of this model will be corroborated with site-specific measurements of oxygen production and consumption. The focus of these rate measurements on processes directly driving oxygen changes are especially suited to the simulation of the relationship among nitrogen loading, eutrophication, and hypoxia. Rates of primary production are fundamental to predictions of phytoplankton stocks, and primary production and phytoplankton stocks are directly related to predictions of oxygen production and consumption. This model will help improve understanding of the processes that contribute to hypoxia in Long Island Sound. *Result: A simpler empirically based model reduced disagreement between observed oxygen consumption and production that is normally observed between highly parameterized models and empirical observations. However, inconsistencies between model output and oxygen consumption in LIS suggests previously unknown oxygen source or carbon sink in LIS.*
2. **A Synthesis of Water Quality and Planktonic Resource Monitoring Data for Long Island Sound** (UConn; PI: Dam/O'Donnell; LIS 2005 Enhancements Fund; LI-97127501; \$121,908; ENDS: 9/30/08): The objective of this project is to synthesize existing water quality and biological resource monitoring data into information and recommendations useful to Long Island Sound restoration management and decision-making. To meet this objective, the following tasks will be completed: 1) summarize the existing information on water quality parameters and planktonic resources in Long Island Sound; 2) statistically analyze this information for temporal trends and for spatial differences among regions of the Sound; 3) statistically examine the relationships among various water quality parameters; 4) interpret existing data in the context of the LISS management program; and 5) summarize and disseminate key findings to resource managers and the public.
3. **Application of System-wide Eutrophication Model for Hypoxia Management** (Hudson River Foundation and HydroQual; PI: Suskowski; LIS 2001 Base Funds: \$80,000; LIS 2002 Base Funds: \$275,000; LIS 2003 Base Funds: \$20,000): HydroQual prepared a unit response matrix to relate nitrogen loads for different management zones to dissolved oxygen impacts in the Sound. SWEM-based management zone response regions were identified, as were the locations of critical dissolved oxygen response cells. HydroQual also completed a report documenting the degree to which dissolved oxygen response in Long Island Sound to nitrogen and carbon is linear. Efforts to set loads under a Total Maximum Daily Load

(TMDL) scenario are underway, and the TMDL model run completion is expected in September 2006. In February 2006, HydroQual proposed an approach for completing Long Island Sound modeling support for the nitrogen target reassessment. This modeling approach was incorporated into a proposed framework for the overall nitrogen target reassessment, including coordination with the states of Massachusetts, Vermont, and New Hampshire. The framework was approved by the Management Committee at its July 19-20, 2006 meeting. This document, *Framework for Reassessing "A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in LIS (2000),"* should be referred to for details on the modeling work that will be performed.

4. **Assessment of the Effects of Bottom Water Temperature and Chemical Conditions, Sediment Temperature, and Sedimentary Organic Matter (Type and Amount) on Release of Sulfide and Ammonia from Sediments in LIS: A laboratory study** (University of New Haven; PI: Cuomo; LI-97101501; FY2004 LIS Research funding; \$80,186; COMPLETED): The objective of this project was to collect data on the release of sulfide and ammonia from sediments exposed to an array of environmental conditions. The researchers conducted a series of laboratory experiments in which sediment collected from western Long Island Sound was exposed to representative spring, summer and fall conditions. This research examined the fluxes of ammonia and sulfide from the sediments and any associated changes in bottom water dissolved oxygen levels, relative to certain environmental variables. *These data will aid in understanding the development and abatement of seasonal hypoxic conditions in the western Sound and the role that sediment organic matter and sediment oxygen demand play in such events.*
5. **Connecticut River Nitrogen Attenuation Study** (NEIWPC and USGS; FY2005 EPA Regional Applied Research Effort (RARE) funding; ongoing project): The objective of the proposed work is to quantify in-stream nitrogen attenuation at the watershed scale based on sufficient measurements of nitrogen concentrations and loads at chosen locations within the Connecticut River Watershed. Precise measurements of the mass inputs and outputs of nitrogen at selected reaches of the Connecticut River will assist in the quantification of nitrogen attenuation through mass-balance computations. Additional methods are proposed for refining estimates of nitrogen attenuation rates at smaller scales through measurements of dissolved N₂ and/or isotopically enriched nitrate.
6. **Connecticut River Nitrogen Monitoring** (NEIWPC and USGS): A key challenge in implementing the TMDL is to identify nitrogen loads and control strategies for the portion of the Connecticut River originating from upland watersheds, north of the state of Connecticut (i.e., from Vermont, New Hampshire, and Massachusetts). Meeting this challenge requires improved understanding of the magnitude and sources of nitrogen from these upland watersheds and identification of the potential effectiveness and cost of nutrient control options. NEIWPC conducted a 3-year effort to study and model nonpoint and point source nitrogen contributions to the Connecticut River basin from Massachusetts, Vermont and New Hampshire. NEIWPC compiled and assessed new data from the 3-year monitoring study, as well as continued to evaluate the nitrogen loading results of the New England SPARROW water quality model. [base funding in 2003-2006; ongoing project]

7. **Connecticut River Nitrogen Reduction Strategy** (NEIWPCC; PI: Weidman; LIS Base Funding, 2002-2004; LI-98160801: \$200,213; \$231,752; \$427,264; ENDS: 9/30/08): This project is a larger cooperative effort involving staff from NEIWPCC, the states of Connecticut, Massachusetts, New Hampshire, and Vermont, and EPA's Region 1 and Long Island Sound offices. To support the development and implementation of a Total Nitrogen Reduction Plan for the upper basin, NEIWPCC will simulate nitrogen reduction scenarios in the watershed through a cost curve analysis. The work will be accomplished through completion of an EPA-funded project to calibrate and validate the ArcView Generalized Watershed Loading Function (AVGWLF) model for the northeast region. NEIWPCC will use the AVGWLF model to simulate a series of nitrogen reduction scenarios. The scenarios will be developed from a watershed-based screening tool to rank implementation of watershed runoff management practices based on cost and performance.
8. **Development of a Long Island Sound-Specific Water Quality Index Using Cluster Analysis and Discriminant Analysis** (City College of New York; PI: Zhang; LI-97263606; LIS 2006 Research Funding; \$119,217; ENDS: 8/31/08): The objective of this project is to develop a Long Island Sound-specific water quality index. The water quality index will be computed using multivariate cluster analysis and discriminant analysis of a set of individual water quality indicators. A numerical water quality index (around -1 to 1) will result, with a value close to 1 indicating good water quality (oligotrophic), a value close to -1 indicating poor water quality (eutrophic), and a slight negative value representing mesotrophic conditions (intermediate water quality). The new method will be applied to the Long Island Sound water quality data (past 15 years at ~20 stations) collected by CTDEP. Monthly water quality indices will be computed for every station, and seasonal and annual trends in the water quality indices will be examined. The outputs of this project include a new LIS-specific water quality index and an automated procedure for computing the index. The numerical water quality index will give clear indications of the trophic status of LIS waters for routine water quality assessments.
9. **Environmental Change in Long Island Sound over the Last 400 Years** (Wesleyan University; PI: Varekamp; LIS 2000 Research Funding; LI-98129501; \$75,909; COMPLETED): The objective of this project was to document the environmental transition in Long Island Sound from pre-colonial times to the present day using sediment cores. The researchers constructed the levels of dissolved oxygen, the abundance of sewage effluent, turbidity, local productivity of organic carbon, the terrestrial influx of organic carbon, and the levels of toxic metal contamination in Long Island Sound over the last 400 years. Data indicated that the eutrophication of Long Island Sound began almost 200 years ago. With eutrophication, there were changes in the benthic community, with higher productivity and enhanced levels of diatom-consuming foraminifera and the occurrence of hypoxia may have been exacerbated by higher temperatures and increased water stratification. A second ecosystem shift occurred approximately 30-40 years ago, possibly as a result of the combined effect of eutrophication and increased water temperatures. This research indicates that sewage derived from humans led to the over-fertilization of the Sound, to hypoxia, and to fundamental changes in the abundance and types of animal and plant life. *Result: This study suggests eutrophication has been an ongoing process for close to two hundred years, possibly with the associated low oxygen conditions of the LIS bottom waters. With*

eutrophication came the associated changes in benthic ecosystem, with higher productivity and enhanced levels of diatom consuming foraminifera. The occurrence of hypoxia may have been exacerbated by higher temperatures and increased water stratification. A second major ecosystem shift occurred over the last 30-40 years, possibly a result of the change in population dynamics of diatoms which became silica-limited and the take over of dinoflagellates as primary producers and A. beccarii species as benthic foraminifera. Again, a combined effect of eutrophication and increased water temperatures may have played a role.

10. **LIS Eastern/Western Ferry Monitoring** (SBU and URI; 2004-2005 LIS Base Funding; LI-97286204: \$98,304 & LI-97286205: \$69,801 & LI-97106001: \$103,087; COMPLETED)
The LISS provided support for two ferry-based monitoring projects through cooperative agreements with Stony Brook University and the University of Rhode Island. These projects provided water quality data collected along the ferry transects, from Port Jefferson to Bridgeport in the western Sound and from Orient Point to New London in the eastern Sound. *Result: A data acquisition system is now aboard the PT Barnum, a passenger ferry running between Bridgeport Harbor and Port Jefferson. The observation system acquires surface hydrography in the form of temperature, salinity and chlorophyll fluorescence. Additionally the unit captures data necessary to derive high quality estimates of surface momentum, mass and heat flux.*
11. **Long Island Sound Water Quality Monitoring Program** (Connecticut Department of Environmental Protection; LIS annual base funding; ~\$500,000): The Connecticut Department of Environmental Protection (CTDEP) conducts the Long Island Sound Water Quality Monitoring Program. From October to May, water quality is monitored once a month by collecting samples from 18 sites by staff aboard CTDEP's Research Vessel *John Dempsey*. Bi-weekly hypoxia surveys start in mid-June and end in September with up to 48 stations being sampled during each survey. The hypoxia surveys provide a description of the extent and duration of low dissolved oxygen concentrations.
12. **Monitoring of Bottom Water and Sediment Conditions at Critical Stations in Western Long Island Sound** (Yale University, SAIC; EPA 2001 RARE Funding; COMPLETED): Field surveys were conducted in order to obtain sediment profile images and bottom water data (dissolved oxygen, hydrogen sulphide and ammonia) from sampling stations in WLIS. The objective of these field surveys was to examine overall benthic habitat quality, as revealed by SPI photographs, bottom water chemical conditions, and benthic organisms. The data obtained from this study was to be compared to that collected from CTDEP water quality monitoring surveys and other sources for the same time period to look for points of agreement and divergence. Finally, the data obtained in this study was to be compared to the conditions known to be in existence during the summer and fall of 1999 in order to further understand the role that hypoxia, as well as ammonia and other potentially toxic metabolites present in the bottom waters at the time, may have played in the lobster mass mortality.
13. **Natural Isotopic Tracers for Anthropogenic Nitrogen in Long Island Sound** (University of Massachusetts and Wesleyan University; PI: Altabet; LI-97101301; 2004 LIS Research Fund; \$125,353; COMPLETED): The objective of this project was to quantify the impact of

anthropogenic nitrogen loading to Long Island Sound with respect to natural sources. Isotopic tracers were used to characterize the nitrogen sources to the Sound. This approach permits the assessment of the actual contribution of anthropogenic nitrogen to Long Island Sound's nitrogen inventory. These results will help improve understanding of the relationship between anthropogenic nitrogen loading and eutrophication. *Results: The results of this study suggest wintertime accumulation is an important phenomenon, dominant anthropogenic source is input from East River, high historic values are due to high sewage N.*

14. Phytoplankton Dynamics in Long Island Sound: Influence of Environmental Factors on Naturally-Occurring Assemblages (UConn and National Marine Fisheries Service; PIs: Ward/Wikfors; LI-98161301; LIS 2002 Research Funding; \$132,360; COMPLETED): The objective of this project was to determine how phytoplankton dynamics differed in Long Island Sound along an eutrophication gradient (from east to west) and with the seasons. The researchers also examined which environmental factors (i.e., nutrients, hypoxia or temperature) are the best predictors of phytoplankton assemblages. Nutrient over-loading, eutrophication and pollution can alter phytoplankton abundance and community structure. Such changes can lead to the degradation of food webs that support commercially valuable finfish species. *Results suggest that nutrient loads have a greater effect on the composition and abundance of phytoplankton in the Sound than seasonal temperatures, turbidity, dissolved oxygen or salinity.*

15. Simulation of Long Island Sound with the System-wide Eutrophication Model (SWEM): Inter-annual Variability and Sensitivity (UConn/DMS; PI: Dam/O'Donnell; LI-97127101; LIS 2005 Enhancement Fund; \$251,164; ENDS: 9/30/08): The objectives of this project are to evaluate the effectiveness of SWEM and to identify additional studies that will improve our ability to predict the impact of management strategies on the water quality of Long Island Sound. The researchers will establish the sensitivity of SWEM to model parameters, model formulation, and inter-annual variations in weather and river discharge and will provide an independent, quantitative evaluation of the model and its utility as a management tool.

16. Water Column Oxygen Production and Consumption in Long Island Sound: Measurements and Coupled Bio-physical Modeling (UConn; PI: Kremer; LI-98164401; LIS 2002 Research Fund; \$188,277; COMPLETED): The objectives of this project were to measure water column oxygen production and consumption rates for Long Island Sound and to develop a coupled bio-physical simulation model of the Sound. The researchers directly measured plankton oxygen metabolism during the critical summer months in order to further the understanding of the processes leading to hypoxia in Long Island Sound. The model analyzed the relevant biological and physical processes that lead to eutrophication and hypoxia in the Sound. *Results: Calculations demonstrate high levels of production and phytoplankton biomass in LIS. This productivity is consistent with the nitrogen loads into cwLIS, and the level of eutrophication follows a trend shown with other systems. Autochthonous production is a plausible source of organic matter for hypoxia and anoxia in the bottom waters of the Sound. Ranges and temporal variability in daily and annual rates compare favorably to those found throughout nearby, eutrophic estuarine systems, such as Narragansett and Chesapeake Bays, despite variations in spatial distributions of production.*

17. Western Long Island Sound Hypoxia: Isotope Tracers of the East River Nitrate Pump (Columbia University; PI: Fairbanks; LI-98258900; LIS 2002 Research Fund; \$75,004; COMPLETED): The objective of this project was to assess the contribution of discharge from the East River to hypoxia in western Long Island Sound using isotope tracers of East River water and organic particulate matter. A map of the concentration and volume of East River water in the western Sound during the development of hypoxia was produced using isotopic tracers to follow the delivery of East River-derived nitrate and phosphate to the hypoxic region. *The results of this study indicate that four small, deep basins act as “hypoxia incubators” on the seafloor of the western Sound and that these basins spread hypoxia throughout the water column. Nitrogen isotope tracers demonstrate that the organic particulates sampled in the deep basins derive their nitrogen almost entirely from wastewater effluent. Oxygen isotope measurements of water molecules indicate that tidal mixing maintains a high percentage of East River water directly overlying the site of initial hypoxia in the western Sound. Isotope data also show that the eastward spread of low oxygen waters is due to tidal and current mixing with the extremely low oxygen waters pooling in the four deep basins. The researcher recommended that managers should target abatement strategies at the four restricted basins (“hypoxia incubators”) to address the immediate source of hypoxia and that a hypoxia abatement experiment should be conducted in the smallest basin using isotope and purposeful tracers.*

18. Water Temperature Sensor Monitoring. (NYSDEC; PI: D’Amico; LIS 2003 Base Funding; LI-97287800; \$12,000) NYSDEC requested and received funding in 2003 to purchase and install water temperature sensors in key locations in Western LIS. The sensors were to be placed on buoys owned/maintained by the US Coast Guard, and were to collect data at bottom, midpoint and surface conditions.

19. Cost-effective Strategies to Reduce Nitrogen Discharges into the Long Island Sound: Optimization of Partial Nitrification and External COD Based Denitrification at Stamford WPCA (The Trustees of Columbia University in the City of New York, DO Fund 2007, \$204,000) The project will develop and implement state of the art biological tools to remove nitrogen that enters the Long Island Sound’s bays and harbors from sewage treatment plants. A high level of nitrogen reduces the amount of oxygen in water available to sustain fish and other aquatic animals. This condition of low “dissolved” oxygen is known as hypoxia. Too much nitrogen also leads to excessive algae growth which clouds the water and blocks sunlight to marine plants that provide prime nursery and spawning habitat for juvenile finfish and shellfish. The tools piloted at the Stamford Water Pollution Control Authority will be useful to publically owned treatment works in Connecticut and New York major point sources of nitrogen loads into local watersheds affecting water quality and the recreational, ecological and economic values of the estuary.

20. Assessing nitrogen loading to western Long Island Sound from submarine groundwater discharge. (USGS - Woods Hole Science Center, DO Fund 2007, \$579,104) The project will quantify the significance of groundwater’s contribution to nitrogen into the Long Island Sound. The project results will provide useful technical information to the current public dialogue about nitrogen loading from sewered and unsewered watersheds. It will compare groundwater discharge from those types of watersheds as well as other types of pollution found in groundwater (fertilizer, pesticides, air). The information generated from the study will help

resource managers determine circumstances where sewers and/or other tools (e.g. filtration beds etc.) reduce nitrogen loads into local watersheds.

21. Numerical Evaluation of Larval Survival in Long Island Sound as Influenced by Exposure to Varying Levels of Dissolved Oxygen. (Manhattan College, DO Fund 2007, \$74,654) This project will develop a tool that will improve the long-term survival of fish, shellfish and crabs by allowing resource managers to better determine and manage the amount of nutrients allowed in the open waters of the Long Island Sound. The project will look at the different amounts of dissolved oxygen required to sustain juvenile and adult fish and shellfish. Among other benefits, the project will improve our ability to pinpoint and protect important spawning habitat and to tailor nutrient reduction goals to improve propagation of fish and shellfish.

22. Tools to Monitor the effects of management actions on DO and its interactive effects with sewage-derived endocrine disrupting chemicals in wastewater affected coastal environments. (The Research Foundation of SUNY, DO Fund 2007, \$181,253) The project will develop an innovative approach to evaluate the effect of chemicals (including common pharmaceuticals) that increase the amount of natural and synthetic estrogens found in sediments in Jamaica Bay and Long Island Sound fish. Estrogens are now strongly believed to result in hormonal changes that increase the ratio of female to male fish and lower reproduction in fish both findings of great significance to the humans, plants and animals along the coast.

23. Soundkeeper Clean Boater Program. (Soundkeeper, DO Fund 2007, \$421,740) This highly popular annual program provides free sewage pumpout services to 2,500 recreational boaters in both New York and Connecticut. Pumping 2,000 pounds of raw sewage from boats improves water quality and the environment generally for recreation and fish and wildlife. Soundkeeper will also provide a clean boater guide as a resource for boaters describing how they can operate and manage their boats to reduce water quality impacts on the Long Island Sound.

25. 2007 Hempstead Harbor Water Quality Monitoring Program. (Village of Sea Cliff, LIS Futures Fund, \$67,500) The Village of Sea Cliff will implement the annual water quality monitoring program for Hempstead Harbor in concert with municipal and nongovernmental partners of the Coalition to Save Hempstead Harbor (CSHH). The CSHH is comprised of Town of North Hempstead, Town of Oyster Bay, Nassau County Department of Health, Hempstead Harbor Protection Committee, University of Connecticut, Marine Sciences Department, and the Nassau County Marine Police.

D. LISS 2008 Priority Needs

The System-wide Nutrients Work Group recommended that SWEM be applied to assess the dissolved oxygen response to the nutrient reduction target established to attain water quality standards through the TMDL reassessment effort. Support is also requested to examine additional factors that may affect hypoxia management, such as climate change effects and evaluating aeration or other alternatives to nutrient control for response regions where attainment of standards is not otherwise possible.

E. EPA-LISO Recommendations

1. Continue LIS 2008 Base funding for the LIS water quality monitoring program
2. Consider funding for SWEM simulations to support the TMDL reassessment effort, possibly through the NYCDEP contract sources.
3. Evaluate results of ongoing enhancement and research projects before identifying additional enhancement or research needs related to hypoxia management

II. TOXIC SUBSTANCES. ELIMINATE TOXICITY OR BIOACCUMULATION IMPACTS ON LIVING RESOURCES BY REDUCING CONTAMINANT INPUTS AND CLEANING UP CONTAMINATED SITES, AND MANAGE RISK TO HUMANS FROM SEAFOOD CONSUMPTION.*A. 2003 Long Island Sound Agreement Goals & Targets*

1. By 2004, EPA, in conjunction with the Army Corps of Engineers, will complete the Environmental Impact Statement for the designation of dredged material disposal sites in central and western Long Island Sound and, by 2008, will complete the EIS for designation of dredged material disposal sites in eastern Long Island Sound.
2. By 2003, update the Long Island Sound Contaminants of Concern list after considering National Coastal Assessment monitoring results and other sources of data. By 2005, evaluate current contaminant monitoring and control programs and identify strategies to address priority issues.
3. By 2003, New York and Connecticut will meet to jointly review their approaches for Long Island Sound fish consumption advisories and to discuss a process to achieve the goal of consistent fish consumption advisories for Long Island Sound.

B. General Research, Monitoring, and Assessment Needs

1. Evaluate mass loadings of toxic contaminants and determine their relationship to ambient water and sediment quality.
2. Characterize the geographic distribution and the relative concentrations of organic contaminants and dissolved metals in water, sediment and fish tissue.

C. LISS Work to Address Needs

1. **Chemical Residues in Long Island Sound Indicator Fish and Lobster: A Bi-state Update** (NYSDEC and CTDEP/DOHs: LIS base funding in 2006-2007; PI: Skinner; LI-97267505: \$150,967 & LI-98246501: \$168,800; ENDS: 9/30/08]: The goal of this project is to determine the current status of chemical residues in selected indicator fish species. The project was proposed in two parts, and the LISS provided funding for the Tier 1 efforts in FY2006. Tier 1 encompasses a study of striped bass and bluefish, which are recreationally and commercially important species that have historically had excessive chemical residue

concentrations. This project includes the assessment of the current status of PCB and mercury concentrations in striped bass and bluefish taken from Long Island Sound and an analysis of temporal and spatial changes in PCB levels in striped bass from the Sound. These data will be used by the CT and NY Departments of Health to assess the current health advisories regarding PCB and mercury levels in fish. These data also will be useful in determining whether controls of these analytes are producing positive results and indicating whether additional controls, where feasible, may be necessary. Tier 2 of the project includes assessing the current status of PCB, mercury, cadmium, and chlorinated dioxin and furan concentrations in hepatopancreas of American lobster. The current status of PCB and mercury concentrations in weakfish taken from the Sound and in American eels taken from major tributaries or bays of the Sound would also be assessed. These data could then be used by the CT and NY Departments of Health to evaluate the current health advisories regarding PCBs, mercury, cadmium, and dioxins/furans in lobster, weakfish, and eels.

2. **New Approaches for Assessing Mutagenic Risk of Contaminants in the Long Island Sound Environment** (Stony Brook University and Brookhaven National Laboratory; PI: McElroy; LIS 2002 Research Fund; LI-98258200; \$74,453; COMPLETED): The objectives of this project were to evaluate the potential capacity of contaminants in the sediments of Long Island Sound to cause mutations in vertebrates and to determine the types of mutations induced and the classes of contaminants responsible for these mutations. The researchers collected sediment samples from the Sound and identified those samples that were mutatoxic. Eggs from a fish species that is particularly susceptible to environmental mutagens were then exposed to the mutatoxic sediments from six sites. After the eggs hatched, the fish larvae were examined to determine the mutation frequency related to the sediment samples. Mutation frequency in the fish embryos increased after exposure to sediments from only one of the LIS sites. The sediment sample from this site contained extremely high levels of polycyclic aromatic hydrocarbons (PAHs). *Results illustrate that transgenic embryos can be used to help quantify and characterize mutations induced by exposure to environmental mutagens. Data from this small-scale study also indicate that the mutagenic risk of LIS sediment contaminants to vertebrate organisms is generally low. The researchers recommended that additional work to evaluate the mutagenic risk of sediments at contaminated urban sites be conducted to substantiate their preliminary findings.*
3. **Public Scoping Meetings and Preliminary Studies in Support of a Regional Dredged Material Management Plan (DMMP) for Long Island Sound** (EPA Region 1 and US Army Corps of Engineers, New England District; LIS 2005 Base Funding, (06/07) PI: Coté; \$100,000): The objective of this project is to initiate the development of a DMMP for Long Island Sound. The goal of the DMMP is to reduce the quantity of dredged material that is disposed of at open-water disposal sites by conducting a comprehensive evaluation of alternatives to open-water disposal and promoting their use. The DMMP will also evaluate and promote methods to reduce the rate of sedimentation in the Sound's harbors and potential treatment technologies for contaminated sediments.
4. **Temporal and Spatial Changes in Copper Speciation and Toxic Metal Concentrations in Long Island Sound: Effect of Changes in Water Temperature and Dissolved Oxygen Levels** (SBU/RF; PI: Sañudo-Wilhelmy; LIS 2004 Research Fund; LI-97296600; \$101,135;

COMPLETED): The objective of this project was to establish the chemical speciation and vertical profiles of dissolved and particulate toxic metals in the water column in Long Island Sound. Dissolved metals undergo many changes in the estuarine environment, and this research provided valuable information regarding the temporal and spatial variations in the chemical speciation of dissolved copper in the Sound. This research will also provide resource managers with critical information regarding the distribution of toxic metals both in the water column and throughout Long Island Sound. These factors are important for evaluating the health of Long Island Sound and examining the bioavailability of metals in the water column. *Results: The results of this study showed significant amounts of labile copper throughout the Long Island Sound, with the highest levels in the western Sound near New York City. This was the same pattern we found for total dissolved copper. During the spring season, "toxic" copper was higher in surface waters and was probably delivered during these high-flow conditions by river runoff and sewage. In both seasons, there was evidence that microscopic algae in the surface waters were producing organic compounds to complex the dissolved copper, thereby making it less toxic. In the summer, bottom waters of the western LIS were characterized by poor water quality, very warm and depleted of oxygen. In these deep waters, "toxic" copper was greatly elevated relative to the spring season and other places within the LIS. The data showed that poor water quality resulted in increased levels of toxic copper species. The greatest influencing factor was temperature; as water temperature reached a threshold greater than about 20°C, "toxic" (labile) copper concentrations increased very rapidly. Analyses of other chemical constituents suggested that the source of this "toxic" copper was the sediments.*

5. **Toxic Contamination in Long Island Sound: 2006 Update** (Yale University; PI: Enion; LI-97147501; \$64,067 (2 years) COMPLETED): The objective of this project was to conduct a literature review of existing data on contaminants in Long Island Sound and to use these data to update the list of contaminants of concern. The investigators compiled data on contaminant concentrations in the water column, sediments, and biota for the period from 1994 through 2005 and compared these data to measurements collected over the previous decade. Based on this review, it was recommended that nickel, silver, tin, endosulfan, endrin, and chlorpyrifos be added to the contaminants of concern list. *Results: The researchers suggested that the occurrence and effects of manganese and dioxin-like PCBs should be further evaluated. They also recommended that a research and monitoring plan be developed to address the occurrence and effects of emerging contaminants associated with wastewater discharges, such as pharmaceuticals, musks, and flame retardants.*
6. **Trace Metals, Organic Carbon and Inorganic Nutrients in Surface Water of Long Island Sound: Sources, Cycling and Effects on Phytoplankton Growth** (SBU and Southampton College; PI: Sañudo-Wilhelmy; LI-98227701; LIS 2000 Research Fund; \$91,622; COMPLETED): The objective of this project was to establish the concentration and distribution of dissolved metals and inorganic nutrients in the surface waters of Long Island Sound and to examine the relative importance of various sources (i.e., riverine inputs, sewage) of these nutrients and metals. *Results: This study suggests that the East River is the most dominant external source of trace metals during low flow conditions, but the Connecticut River is the most important external force during high flow conditions. Large internal sources of copper, nickel and zinc were detected under low flow conditions,*

highlighting the potential importance of internal processes such as remobilization from contaminated sediments in the Sound. Additional work, such as the direct measurement of diffusive benthic fluxes, should be conducted to substantiate these preliminary findings.

III. LIVING RESOURCES AND HABITAT MANAGEMENT & CONSERVATION.

ASSURE A HEALTHY ECOSYSTEM WITH BALANCED AND DIVERSE POPULATIONS OF INDIGENOUS PLANTS AND ANIMALS, MAINTAIN OR INCREASE THE ABUNDANCE AND DISTRIBUTION OF HARVESTABLE SPECIES, AND RESTORE THE ECOLOGICAL FUNCTIONS OF DEGRADED AND LOST HABITATS.

A. 2003 Long Island Sound Agreement Goals & Targets

1. By 2003, complete the mapping of eelgrass in the Long Island Sound area to determine trends. Continue to promote investigations and research into determining the impacts of nitrogen upon the degradation of aquatic habitats (i.e., loss of eelgrass, increases in macroalgae and benthic algae) in shallow embayments and bays in Long Island Sound.
2. By 2005, characterize the scope and rate of tidal wetland losses in the Sound and promote research that will determine to what degree accelerated sea level rise, sediment supply disruptions, or other factors are responsible for the loss of habitat that is critical to the Sound's birds, finfish, and overall productivity.
3. By 2004, complete research and monitoring studies into the causes of the lobster mortality event in Long Island Sound and identify any management measures that could be implemented to prevent future mortality.
4. By 2003, identify critical issues related to the management and conservation of living resources (such as fish and birds) and their habitats, and develop strategies to improve conditions, as appropriate.
5. By 2003, produce a list of the invasive species of concern in Long Island Sound.
6. Restore at least 2000 acres of habitat and 100 river miles for fish passage during the ten-year period from 1998 to 2008 and monitor these sites to confirm restoration progress over time.
7. By 2004, identify sites of outstanding and exemplary scientific, educational, or biological value.

B. General Research, Monitoring, and Assessment Needs

Eelgrass

1. Perform comparative studies in embayments with recovering (e.g. Mumford Cove), declining (e.g. Niantic Bay), and lost populations of eelgrass. Estimate historic trends in nitrogen loading rates and partition loads among all potential nitrogen sources. Quantify existing water quality conditions, particularly those parameters that are important to the growth and

maintenance of *Zostera* (e.g., DIP, DIN, Chl A, TSS, light attenuation, benthic algae, epiphytes, CDOM, canopy height, sediment OM, etc.). Compile historic water quality data for comparative purposes. Evaluate where and to what degree existing nitrogen and sediment loading rates, or other factors, such as temperature, result in water quality conditions that do not support eelgrass.

2. Assess groundwater nitrogen loads. Define groundwater hydrology patterns for an embayment that has experienced declines of *Zostera* including determining nitrogen concentrations (seasonal) and rates of groundwater movement. Calculate nitrogen loading rates to the embayment from groundwater. Determine how long it will take for groundwater nitrogen levels to decline in response to sewerage or other nitrogen management efforts.

Food Web Dynamics

1. Data Review, Synthesis, and Gap Analysis. Refine conceptual models of LIS food webs in coves, near-shore, and open waters to determine the roles of the most important food web components (e.g., system filtration, nursery function, etc.). Identify critical data gaps in our present understanding of the major food web components and their potential interactions. Determine how important components of the food web may have changed over time, with emphasis on those influenced primarily by anthropogenic stressors and those that can be affected by management. From the questions above, recommend research priorities to fill critical data gaps, begin to quantify the role of critical food web components, and identify management options.
2. Data Collection to Better Quantify Critical Food Web Components. Determine how changes in nutrient ratios (e.g., N/P/Si) may have affected the phytoplankton species composition and overall productivity in LIS in the past, and monitor possible future changes. Determine how nutrients (mainly nitrogen) are processed by the different components of the food web in the coves and near-shore LIS environments. Determine the relative magnitude and functional group make-up of primary productivity in coves, near shore, and open water regions of LIS. Determine the relative importance of different stressors (e.g., eutrophication, climate change, habitat alteration, hypoxia, fishing pressure) on food webs in LIS. Determine what and how food web component(s) are driving the processing of labile organic matter in LIS.

Tidal Wetland Loss

1. Marsh elevation and accretion rates with respect to relative sea level rise. Marshes in LIS have displayed stable rates of accretion from sediment loads, but the elevations of marshes do not appear to be rising with relative sea level. Studies of marsh elevation processes might include changes in composition of sediment supply and budget on a 300-year time scale; changes in the communities of Foraminifera in LIS marshes over time; and/or radioisotope studies.
2. The relative importance of above vs. below-ground biomass on the health and stability of LIS marshes. Little is known about the relationship between above-ground and below-ground biomass in *Spartina alterniflora* marshes in LIS. Studies of the marsh structure with respect

to this relationship may include correlations between biomass and marsh stability and health.

3. Nitrogen compounds and their effects on marsh health. Changes in the types of available and limiting nutrient compounds available to LIS marshes are hypothesized to play a role in *Spartina* marsh vigor and stability. Investigations may include greenhouse and field experiments and studies of potential synergistic effects of nitrogen and other nutrient compounds.
4. Holistic assessments of marsh systems in the embayments and subestuaries of Long Island Sound. Observations of marsh losses have yielded few clues about typical characteristics of fragmenting marshes. Some of the characteristics noted indicate that geographic position of the marsh may be significant in some of the tidal river subestuaries of Connecticut, specifically, those marshes in the mid-axial sections and lagoons. The patterns in lagoon and bay locations in New York are less clear. Desirable studies of this topic will include a complete approach to characterizing one or more of the marsh systems in the subestuaries of the LIS. Desired measures include marsh elevation, tidal hydrology, sediment accumulation rates, sediment chemistry, biomass measures, vegetation density, stem height, and others.

C. LISS Work to Address Needs

Benthic Mapping

1. LI Embayment Benthic Mapping (NYSDEC; PI: D'Amico; LIS 2003 Base Fund; LI-97297800; \$110,967): NYSDEC was provided funds to conduct benthic mapping of key north shore Long Island embayments. NYSDEC has contracted Stony Brook University to develop benthic maps for Port Jefferson Harbor, Huntington – Northport Bays, and Oyster Bay – Cold Spring Harbor. The side scan photography has been completed for all three embayments and benthic sampling will be conducted in Port Jefferson and Huntington – Northport Bays.

2. Linking Seafloor Habitat Mapping Protocols to Management and Policy Needs (UConn/DMS and National Undersea Research Center; PI: Auster; LI-97150101; LIS 2006 Research Fund; \$179,027; ENDS: 04/30/08): The objective of this project is to produce a singular flexible habitat classification protocol that can be used by a range of workers focused on the Long Island Sound region. The research component of developing the habitat classification protocol will be explicitly linked to those who will implement and use the map products derived from the protocol (i.e., to insure that map products are both user-friendly and user-useful). To accomplish this task, an initial email survey of managers, policy-makers, researchers, engineers and other stakeholders (fishers, energy industry, environmentalists, coastal land developers) will be conducted to ascertain the range of habitat attributes that they deem relevant in their work. This initial survey will assist in the identification of a set of habitat attributes that are common across user groups and in the selection of a range of published marine habitat classification schemes to test with existing data. An interactive workshop with representatives of all stakeholder groups will be convened to assess the utility of the range of classification approaches tested and determine where modifications for a final protocol are needed. The final protocol and example applications will be produced as a technical document for web delivery.

Eelgrass

1. **Long Island Sound Eelgrass Survey** (USFWS; PI: Halavik; LIS2002/2004 Base Funding; \$32,380; \$60,123; conduct triennially). The US Fish & Wildlife Service conducted a survey of Long Island Sound to document the actual areal distribution of eelgrass in the Sound. These data suggest a possible recovery of eelgrass in the open Sound and the continuance of long-term declines in the shallow embayments, but an adequate database to assess status and trends does not exist. In June 2006, the US Fish & Wildlife Service initiated a second survey of the Sound's eelgrass beds. Aerial photography was acquired in June 2006, and these data were ground-truthed in the field in 2006, and a final report issued.
2. **Restoration Objectives for Eelgrass in Long Island Sound** (CTDEP and USGS; PI: Rozsa; LIS 2004 Base Funds: \$47,000) CTDEP and USGS are working to establish restoration objectives for eelgrass beds in the coastal waters of Long Island Sound. The focus of the project is primarily on how nitrogen loading may affect eelgrass in Connecticut's coves, embayments and tidal rivers and on identifying management measures that can be taken to address this issue. The objectives of the project include the following: 1) determine relationships between typical eastern Long Island Sound watersheds, nitrogen loading and eelgrass status; 2) develop nitrogen criteria for the protection and restoration of eelgrass; and 3) assess the potential for attaining the nitrogen criteria in case study areas. The long-term goal of this effort is to implement nitrogen criteria to effect management of watershed and point discharges that achieve nitrogen levels that can sustain or lead to the restoration of eelgrass populations.

Food Web Dynamics

1. **Food Webs in Long Island Sound: Review, Synthesis and Potential Applications** (UNH/CTDEP: PI: Zajak; FY2004 LIS Research Funding; LI-97101401; \$117,545; ENDS: 08/31/08): The objective of this project is to develop conceptual and quantitative food web models for different habitats in Long Island Sound. Using these models, the researchers will assess the critical food web components in each habitat type and identify data gaps in the present understanding of major food web components and their potential interactions. These models can be used to develop simulations and analyses to evaluate the impacts of management decisions on food webs and ecosystem dynamics in Long Island Sound.

Habitat Protection

1. **GIS-based Assessment of Undeveloped Parcels in New York Coastal Counties** (Center for International Earth Science Information Network, Columbia University; PI: Gorokhovich; LIS 2006 Enhancement Grant; NEIWPC; \$76,556): The objective of this project is to assemble existing parcel data from coastal counties of New York State that will be used by LISS and NYSDEC officials in conservation of the most significant remaining unprotected and undeveloped parcels. This work will complement similar work completed for coastal Connecticut parcels. The project staff will gather digital parcel data in GIS format (primary data) from coastal counties and extract undeveloped parcels greater than five acres, publicly owned land and protected open space. Additional

data collection (secondary data) will include GIS layers of LIS stewardship areas, tidal and freshwater wetlands, areas of Significant Coastal Fish and Wildlife habitats, watercourses and water bodies. Parcel data will be analyzed, checked (aerial photos and field) and documented. This effort will help NYS DEC target land protection efforts to further open space and habitat conservation goals.

2. **Tidal Lake and Wetlands Restoration Project at Manursing Lake.** (Westchester County Department of Planning, DO Fund 2007, \$702,000) The project will first construct gates to restore the natural movement of tides in the southern part of Manursing Lake aka Playland Lake which is part of the Edith G. Read Sanctuary, the largest tidal marsh system in Westchester County. With improved tidal flow, a new area of 8.7 acres of low and high marshes will be then be restored around the Lake as a buffer to reduce pollution flowing from the area into the Long Island Sound. The project will eventually shelter and provide spawning and nesting habitat for fish and birds including diving and migratory waterfowl.
3. **Pelham Bay Park Turtle Cove Salt Marsh Restoration.** (NYC Parks & Recreation, Pelham Bay Park Administrator's Office, DO Fund, \$282,800) The project will restore 4 acres of tidal salt marsh in Pelham Bay Park. The project is part of a larger initiative to improve water quality in the parts of the Park that flow into the Long Island Sound and Eastchester Bay by increasing buffers of native plants that trap pollution. The return of the ebb and flow of natural tides provides conditions for the restoration of native low marshes which were once abundant. Community volunteers will revegetate the land with 50,000 plants and help steward the site long-term with assistance from NYS DEC Bureau of Marine Resources and the NYC Department of Parks and Recreation Natural Resources Group.
4. **Jamaica Bay Debris Removal & Marsh Restoration Project.** (American Littoral Society, DO Fund 2007, \$91,505) The project will expand the Jamaica Bay CleanSweep program to remove 80,000 pounds of large debris and garbage from the estuary. With removal, marsh grasses regenerate naturally. This natural regeneration will be combined with opportunities for community restoration at more significantly degraded sites with 5,000 salt marsh plantings done by a corps of volunteers from Jamaica Bay EcoWatchers, NYC Audubon and the Sierra Club; and help from government agencies including: Port Authority of New York and New Jersey, NYS DEC, NYC DEP, National Park Service and NYC Police Harbor Unit.
5. **Idlewild Park Preserve Habitat Restoration and Trail Project.** (Eastern Queens Alliance, Inc., DO Fund 2007, \$465,000) The project will support the design of a plan to restore natural tidal flush and intertidal and 2 acres of high marsh wetlands in a part of Idlewild Park Preserve. The project will also eventually include a trail and ecofriendly boardwalks to allow for passive recreational enjoyment of the restored marshes which host plentiful bird species. The Park is at the headwaters of Jamaica Bay and contains one of the largest expanses of high quality salt marsh in Jamaica Bay. It is an ecological jewel in southeast Queens.

6. **Milford Point Restoration.** (Town of Stratford, LIS Futures Fund, \$325,000) The Town of Stratford will remove exotic plants and restore 6.37 acres of tidal wetland located at the confluence of the Housatonic River and Long Island Sound. The restoration site will contribute habitat for shorebirds because it is within the Great Meadows Marsh complex one of the most important areas for birds in Connecticut and part of the State's remaining undeveloped coastline. Multiple community commissions in the Town of Stratford are partners in this project which is a locally driven initiative to protect natural resources and provide educational and public access to the community.
7. **Conservation Strategies for the Great Meadows Area in Stratford and Bridgeport, Connecticut.** (Audubon Connecticut, LIS Futures Fund, \$57,000) Audubon Connecticut will develop a toolkit of conservation strategies to support landowners and resource managers including those at the Stewart B. McKinney National Wildlife Refuge, Long Beach and Pleasure Beach to steward the Great Meadows area one of the most important areas for birds in Connecticut hosting 270 plus species and 25% of the State's remaining undeveloped coastline.
8. **Conservation Action Plans for Long Island Stewardship Sites.** (Audubon New York, LIS Futures Fund, \$64,500) Audubon New York starts phase 2 of a project working with local stakeholders to identify priority actions that further conservation at 4 Important Bird Areas (IBAs) (Lighthouse Point Park, Mamacoke Island and coves, Orient Point/Plum Island and Edith Reade Sanctuary); and to develop a transferable model for educating and engaging the public in the Long Island Sound Study Stewardship Initiative. These 4 IBAs are oasis for over 300 species of birds including: raptors, landbirds, Greater Scaup ducks, Double-crested Cormorants, Ospreys, Great Egrets, Snowy Egrets, Little Blue Herons, Black-crowned night Herons, Roseate and Common terns, Piping Plovers, American Oystercatchers and for residents of local areas who enjoy the beaches, bays and forests.

Invasive Species

1. **Aquatic Nuisance Species in Long Island Sound: Fostering a Cooperative and Comprehensive Approach to Management, Research and Education** (UConn/CT Sea Grant College Program; PI: Balcom; LIS 2006 Enhancement Fund; NEIWPC: \$53,814): This project will produce an interstate Long Island Sound Aquatic Nuisance Species (ANS) Management Plan that achieves the following: 1) focuses on the prevention and control of ANS in a cost-effective, environmentally-friendly manner; 2) provides a comprehensive and cohesive framework for management, outreach, and research addressing ANS issues in LIS; 3) facilitates interstate and inter-agency cooperation to focus limited resources on mutually-identified and agreed-upon priorities; and, 4) fosters a coordinated, rapid response effort to prevent or combat new introductions of ANS in LIS. The plan will be developed in concert with a regional working group representing state and federal agencies, industry, non-governmental organizations, universities, and marine trade organizations. The plan will be made available for public comment and submitted to the federal ANS Task Force for preliminary review before being submitted to the States of Connecticut and New York for regulatory approval and adoption. Expected outcomes include a summary of current ANS knowledge with respect to LIS, pertinent state and federal regulations and policies, existing

ANS research, monitoring, and educational programs, and regional resources currently directed to ANS issues in LIS.

2. Multi-component Evaluation to Minimize the Spread of Aquatic Invasive Seaweeds and Harmful Algal Bloom Microalgae via Live Bait Vectors in Long Island Sound (UConn and State University of New York, Purchase; PI: Yarish; LIS 2006 Research Fund; LI-97149601; \$101,756; ENDS: 08/31/08): The goal of this project is to quantify the importance of bait products and associated packing materials as vectors for the introduction of non-indigenous species and harmful algal bloom (HAB)-forming microalgae to Long Island Sound. Non-native, invasive seaweeds and HAB-forming organisms represent threats to the ecological and economic health of the Sound. Samples of bait will be examined for non-indigenous species and cultured to identify microscopic stages and HAB microalgae using molecular analysis. Specific outputs include reports of the frequency of non-native, invasive seaweeds and HAB-forming microalgae by taxon as functions of season and the location of bait product purchase. A workshop on the project's findings will be held at the end of the research to bring together relevant stakeholders.

3. Invasive Phragmites Control in Poquetanuck Cove. (Avalonia Land Conservancy, LIS Futures Fund, \$51,400) The Avalonia Land Conservancy will survey plants and animals, remove exotics and monitor and develop a water quality management plan for Poquetanuck Cove a two-mile long tidal embayment of the Long Island Sound. The Cove is known for its wintering and migrating waterfowl and its diversity of native fisheries including: blue-back herring, Atlantic sturgeon, sea trout, bluefish and alewife. Project partners include: Thames River Basin Partnership, US Fish and Wildlife Service, Quinebaug-Shetucket Heritage Corridor Water Quality Monitor, CT Department of Environmental Protection, The Nature Conservancy, Ledyard Conservation Commission, and Preston Conservation Advisory Committee.

Indicators

1. Environmental Indicator Review and Assessment for Long Island Sound (Yale University, PI: Anisfeld; FY2006 LIS Enhancement Funding; NEIWPC: \$56,811): The objectives of this study are to evaluate the scientific validity, management usefulness, and public acceptance of the way that environmental indicators are currently used by the LISS and to recommend any appropriate changes to the data collection program, the indicators used, and the interpretation and communication of those indicators. The researchers will evaluate the current suite of indicators by judging them against a clear set of criteria for what constitutes an "ideal" indicator. They will propose improvements in indicator use, including specific recommendations regarding current indicators, potential additional indicators, and improved tools for analysis, organization, and communication. Emphasis will be placed on ensuring the following: a) that sampling and interpretation are scientifically credible and defensible; b) that indicators evaluate the entire range of stressors, including emerging threats such as climate change and personal care products; c) that indicators are organized and used in an integrated way that focuses on ecosystem endpoints and – where relevant – economic endpoints; and d) that communication with the public is both clear and accurate, and includes a discussion of uncertainties. The project will result in an improved framework for collecting, evaluating, and presenting indicators for LIS. This will give managers, scientists, stakeholders, and the general public a more accurate sense of both the health of

LIS and the success of the LISS.

2. Salt Marsh-Breeding Sparrows in Long Island Sound: Status and Productivity of a Globally Important Species. (UConn; PI: Elphick; LIS 2002 Research Fund; LI-98161201; \$102,869; COMPLETED) The main objectives of this study were to (1) assess the population size of salt marsh sharp-tailed sparrows and seaside sparrows at key coastal marshes in Connecticut in order to fully understand the global significance of this region for both sparrow species, (2) compare traditional methods for indexing population size with more complex, time consuming, methods that give absolute population sizes, in order to calibrate the traditional indices and facilitate the calculation of regional population estimates, (3) determine within and among marsh variation in sparrow abundance in order to evaluate the consequences of habitat change, marsh management, and sea-level rise, (4) obtain estimates of breeding productivity, and (5) identify suitable indicators of salt marsh health. *Results: Juncus gerardi is a good indicator of the very best saltmarsh sharp-tailed sparrow habitat, providing the resolution needed to distinguish among areas of high marsh that differ in the abundance of birds and, to a lesser extent, nests. At a grosser level, the presence of Spartina patens also indicates good areas for saltmarsh sharp-tailed sparrows, but this grass is so common that it lacks the resolution provided by J. gerardi and is therefore not as good an indicator. Marsh size, and perhaps associated landscape features, have a large effect on seaside sparrow abundance and are perhaps more important than local habitat features. The presence of tall vegetation, however, is also a good indicator of seaside sparrow abundance, and it is possible that interactions between vegetation height and landscape features account for discrepancies in the relationship between marsh area and seaside sparrow abundance. Areas with abundant short-form Spartina alterniflora are avoided by nesting seaside sparrows.*

Tidal Wetland Loss

- 1. Application of Remote Sensing Technologies for the Delineation and Assessment of Coastal Marshes and their Constituent Species** (UConn/Wesleyan University; PI: Gilmore/Civco; LIS 2004 Research Fund; LI-97101801; \$70,578; COMPLETED): The objective of this project was to identify and delineate coastal marshes around Long Island Sound and distinguish various types of marsh vegetation using moderate and high resolution remote sensing satellite imagery coupled with in situ radiometry and other field data collection. The researchers identified and inventoried the current extent and condition of the Sound's coastal marshes and developed a cost-effective way to track changes in the condition of wetlands over time. *These datasets and protocols can help provide coastal resource managers, municipal officials and researchers with baseline information for current land management and for long-term monitoring of habitat changes.*
- 2. Rates of Tidal Wetland Loss** (CTDEP and NYSDEC; LIS 2002 Base Funds: CTDEP; PI: Rozsa/Yamalis; \$25,000; LIS 2003 Base Funds: NYSDEC; PI: Holst/Young: \$27,103): The LISS provided funding to CTDEP and NYSDEC to determine the rates of tidal marsh loss in the Sound. Through an agreement with CTDEP, the USFWS completed interpretation of wetland boundaries from archival aerial photographs, taken between 1974 and 2000, of strategic coves and tidal rivers in the Connecticut portion of the western Sound. USFWS staff developed a database containing wetland polygons and acreage information, and these

data were used to calculate rates of tidal wetland loss by habitat type. In New York, NYSDEC will acquire aerial infrared photography of tidal marshes and will examine wetland trends using these images and aerial photographs dating back to 1930. Aerial photography was acquired in the fall of 2005 and additional photography will be acquired in the fall of 2006. The data from the 2005 and 2006 aerial photography are directly comparable to the 1974 tidal wetland inventory and will be used to conduct a qualitative and quantitative analysis of wetland loss/gain.

3. **Surface Elevation Tables** (NYSDEC; PI: Holst/Young; LIS 2003 Base Funds: \$25,908; LI-98297800): The objective of this project is to deploy SETs in Long Island marshes to monitor marsh elevation. NYSDEC is working with the Marine Sciences Research Center (MSRC) at Stony Brook University to select marshes for the SET installations, and MSRC will monitor the SETs. These efforts will complement CTDEP's work to deploy SETs in Connecticut marshes. With funding from the Coastal Zone Management Program, CTDEP plans to establish 60 new benchmarks in Connecticut's coastal marshes in 2006.
4. **Tidal Wetlands Loss Workshop** (NYSDEC; PI: Chytalo; LIS 2002 Base Funds: \$15,000; COMPLETED): In June 2003, NYSDEC sponsored a conference for researchers to discuss and share information regarding the possible causes of tidal marsh loss in Long Island Sound. The goal of the workshop was to develop research, monitoring and management recommendations. The participants highlighted the need to gather baseline information on the health and spatial distribution of the Sound's marshes and identified priority research topics, which were included in the 2004 Research Grant Program Request for Proposals. As a result, two research grants were awarded for projects investigating possible causes and the extent of tidal wetland loss in the Sound (see Ongoing Research Projects in this section). To follow up on this conference, the LISS Habitat Restoration work group has recommended that a special session on tidal wetland loss be included at the Estuarine Research Federation November 2007 conference in Providence, RI.
5. **Understanding the Role of Nutrient Enrichment in Tidal Marsh Loss in Long Island Sound** (Yale University; PI: Anisfeld; 2004 LIS Research Funds; LI-97100801; \$125,372; ENDS: 11/18//07): The objective of this project is to test the hypothesis that excessive loading of nutrients (nitrogen or phosphorus) plays a role in causing tidal marsh loss. Tidal marsh loss due to drowning (i.e., loss of elevation relative to sea level and conversion of vegetated marsh to mudflat) has been observed in recent years in Long Island Sound, primarily in the western Sound. However, the mechanisms and causes of this marsh loss are poorly understood. The results of this research will help ascertain if nutrient loading is a factor in tidal marsh loss and, if so, identify which nutrient is likely responsible.

D. LISS 2008 Priority Needs

The Management Committee incorporated the biennial Long Island Sound eelgrass surveys as a priority into the LIS Base program. Additional years of data are needed in order to determine trends in eelgrass abundance and distribution. The LISS should provide support for an eelgrass survey in FY2008 for Spring 2009.

The “Linking Seafloor Habitat Mapping Protocols to Management and Policy Needs” project serves as an important first-step in developing protocols for conducting benthic mapping in Long Island Sound. Systematic efforts to map the Sound’s benthic habitats will provide valuable information to enhance decision-making and to support ecosystem-based management. The Cross-Sound Cable Fund has been proposed as a funding source for efforts to conduct comprehensive mapping of the Sound’s benthic habitats. This proposal was adopted by LISS Policy Committee on September 28, 2006.

E. EPA-LISO Recommendations

1. Continue LIS 2008 Base funding to conduct the LIS eelgrass survey in Spring 2009.
2. Evaluate results of completed Enhancement and Research projects to identify additional enhancement or research needs related to living resources or habitat.
3. Per Policy Committee designation, support efforts to conduct systematic mapping of the Sound’s benthic habitats through the Cable Settlement Fund and other funding sources, e.g., DO Fund. Establish mapping goals and targets for LIS 2008 Agreement.

IV. WATERSHED MANAGEMENT. ASSURE A VIABLE LONG ISLAND SOUND WATERSHED THAT SUPPORTS VIBRANT AND HEALTHY AQUATIC LIFE, AND MINIMIZES THE NEGATIVE EFFECTS OF EROSION, SEDIMENTATION, AND FLOODING ON THE SOUND AND ITS TRIBUTARIES AND EMBAYMENTS.

A. 2003 Long Island Sound Agreement Goals & Targets

1. By 2010, Connecticut and New York will work toward a goal of having 50 percent of their respective areas in the watershed developing or implementing watershed restoration strategies.
2. By 2003, Connecticut and New York will identify the amount of impervious surface in their respective portions of the watershed, based on available land use/land cover data. Through watershed planning efforts the states will encourage municipalities to adopt limitations on impervious surfaces, with an overall goal of minimizing increases in impervious cover to a rate consistent with population change.
3. By 2004, Connecticut and New York will assess the amount of riparian forest buffer in their portions of the watershed using available land use/land cover data. Through watershed planning efforts, the states will encourage the establishment of targets to expand the percentage of riverine miles with forested buffers.

B. General Research, Monitoring, and Assessment Needs

1. Study the relationship between development and nutrient enrichment in small, coastal embayments and determine specific activities and sources that increase flux of nutrients to the embayment. Identify management practices that would help alleviate any observed impacts on the embayment and, if possible, relate trends in effects to changes in land use practices and pollutant loading.

2. Study the contributions of nutrients from ground water to Long Island Sound or its tributaries and examine the implications of ground-water travel time.
3. Evaluate the benefits of storm water best management practices (BMPs), such as wet ponds and wetlands, compared to the quality of storm water contributions with minimal or no BMP application.
4. Identify typical unit area export rates of nitrogen from forests in Connecticut and how much is enrichment compared to a natural export rate. Determine if forest health has been compromised by cation leaching from acid deposition or nitrogen saturation. Identify critical loads of nitrogen that would lead to abnormal nitrogen leaching to streams and estuaries and determine the value of forests and buffers as a nitrogen management tool.
5. Support research investigating relationship of watershed urbanization to nitrogen processing capacity of riparian buffers.
6. Explore potential and consequences of nitrogen saturation of forests and riparian areas.

C. LISS Work to Address Needs

1. **Coastal Riparian Buffer Analysis** (UCONN/CLEAR; PI: Arnold; LIS 2005 Enhancement Funds; LI-97128801; \$90,611; ENDS: 09/30/07): The purpose of this project is to survey Long Island Sound coastal watershed areas in New York and Connecticut to assess the condition of the Sound's riparian buffers. The project's objectives are to provide an overall picture of the Sound's riparian buffers, develop diagnostic information at the subregional watershed level that LISS and state and local managers can use to direct future efforts, and to create highly accurate information for at least one high priority basin. [FINAL REPORT PENDING, DUE 12/29/07]
2. **Connecticut River Riparian Area Mapping** (CT River Estuary Regional Planning Agency; PI: Preston; LIS 2004 Enhancements Fund; LI-97105801; \$26,144; COMPLETED): This project builds upon existing GIS databases to identify and map the occurrences of riparian buffers along the main stem and major tributaries of the lower Connecticut River. This work included the creation of a linked parcel and ownership database for all properties adjacent to the river, as well as existing protected, developed, and undeveloped land. GIS maps identifying protection and restoration opportunities were developed. These maps are available to all lower Connecticut River communities. An educational brochure regarding the importance of riparian buffers was produced. Project information is posted on the Tidewater Institute website: <http://www.crerpa.org/RiparianBuffers.html>.
3. **Decision Support Tool for Nitrogen Reductions** (Manhattan College; PI: Farley; LIS 2004 Enhancement Fund; LI-97286104; \$80,800; COMPLETED): The goal of this project was to develop a simple modeling approach to estimate and track nonpoint source nitrogen loads in the Connecticut and New York portions of the Long Island Sound watershed. To achieve this goal, the following tasks were completed: 1) review available tools to estimate and track

nonpoint source nitrogen loads based on land use and best management practices; 2) consult with the LISS to select the most appropriate tool; 3) verify the nitrogen mass balance for existing land uses based on previous studies and those estimated using this tool; and 4) apply the tool to demonstrate its use evaluating the effectiveness of management strategies.

4. **Development of a Riparian Buffer Toolbox** (Columbia University; PI: Gorokhovich; LIS 2005 Enhancement Funds; LI-97269601; \$34,354; COMPLETED): This project developed a “Riparian Buffer Toolbox,” an online tool to provide information in support of watershed protection efforts. The PI assembled existing materials regarding the protection of riparian buffer zones and is developing a user-friendly website to display this information. *The website provides municipal officials and the public with easy access to educational brochures and scientific information regarding riparian buffers, which are essential to reducing nonpoint source pollution to Long Island Sound. The website address is: <http://www.hydroqual.com/projects/riparian>.*
5. **Mapping and Monitoring Changes in Impervious Surfaces in the Long Island Sound Watershed** (UCONN CLEAR; PI: Arnold; LIS 2003 Enhancement Funds; LI-98178101; \$99,006; COMPLETED): The objective of this project was to track historical changes in impervious coverage in Long Island Sound’s coastal watershed over the period from 1985 to 2002. *The project provides a standardized basis by which to compare changes in impervious surface in the future, as well as an opportunity to study how these changes relate to population growth, water quality, and other factors of interest to LIS managers.*
6. **Adoption of CT River Estuary Riparian Regulations through the CT River Gateway Commission.** (Tidewater Institute, CT River Estuary Regional Planning Agency; PI: Preston; LIS 2007 Enhancement Grant; NEIWPC: \$46,714) The objective of this project is to create and facilitate the adoption of effective riparian regulations that will protect and restore riparian buffers within the eight-town Gateway Conservation Zone located in the CT River estuary. This project will build on the 2006 completed LISS-funded project, CT River Riparian Mapping, but using baseline data to inform the extent and location of estuary shoreline in need of riparian creation or restoration. Expected outputs include educational information and material, including a PowerPoint presentation to support outreach efforts that will include press, literature for local publication, and interview, in advance of individual zoning commission presentation and public hearings. Anticipated environmental benefits to LIS include increased protection for and public awareness of the values of healthy riparian buffers, particularly for water quality, but including habitat protection, benefits to air quality and scenic preservation.
7. **Watershed Management Workshop** (NEIWPC; PI: Weidman; LIS 2006 Base Fund; LI-98198801; \$15,000;): The objective of this project is to convene a workshop to highlight results of previous years’ work and to outline tools available for communities for watershed and riparian area restoration, protection and enhancement for NPS management. The two-day Watershed Management Workshop will focus on the following: 1) the state of watershed management in CT and NY; 2) the success of and disincentives for watershed management; 3) the identification and integration of federal, state, and local watershed management needs; and 4) watershed management strategies. Primary sources of information for the conference

will be information on impervious surfaces, buffers mapping, and other LISS-funded projects. [Workshop was cancelled in 2007; will be rescheduled in 2008.]

8. **Simulation of the Water Quality Impacts of Urban Low Impact Development (LID).** (The Trustees of Columbia University in the City of New York, DO Fund 2007, \$200,000) The project will develop reliable low impact development tools and techniques; and determine the magnitude of “usefulness” of various individual tools towards improving water quality in densely populated urban communities with a focus on the lower Bronx River. This project pushes the envelope of conventional approaches to managing urban stormwater runoff which are effective but also expensive and difficult to site. Low Impact Development (LID) is a relatively new approach in urban water quality management. LID emphasizes the community-based and broad-scale or “distributed” use of tools like roof leaders, rain barrels, rain gardens, porous pavement and rooftop detention etc. by individual citizens and municipalities to reduce runoff.
9. **Oyster Bay/Cold Spring Harbor Watershed Action Plan.** (Friends of the Bay, LIS Futures Fund, \$136,000) The Friends of the Bay will develop a watershed management plan for the Oyster Bay/Cold Spring Harbor complex which addresses historic trends, environmental and land use conditions; and establishes priority actions to protect and improve the ecological integrity of the estuary. The Oyster Bay – Cold Spring Harbor Estuary is recognized by New York State as a Significant Coastal Fish and Wildlife Habitat and as an Outstanding Natural Coastal Area. The U.S. Fish and Wildlife Services recognizes the area as habitat or regional significance for restoration of anadromous fish passage. The watershed hosts the Oyster Bay National Wildlife Refuge and the Shu Swamp Nature Preserve -- both anchor sites for the Long Island Sound Stewardship Initiative.
10. **Saugatuck River Watershed Partnership.** (The Nature Conservancy, LIS Futures Fund, \$100,500) The Nature Conservancy will design fishways for two dams with a goal of opening up 1.5 miles of habitat for diadromous fish on the Aspetuck and Saugatuck Rivers. Partners include: Aquarion Water Company, Saugatuck Valley Audubon, Trout Unlimited, Southwest Conservation District, Connecticut Department of Environmental Protection, Yale School of Forestry, American Rivers among others.

D. LISS 2008 Priority Needs

1. When conducted, the Watershed Management Workshop will provide an excellent forum through which the Watersheds Work Group can identify additional priorities. The current NPS work plan does not identify any funding needs for FY2008.
2. A 2008 priority for the LISS is to reactivate the nonpoint source work group and seek new leadership with the retirement of its former chair.

E. EPA-LISO Recommendations

The results of the ongoing projects and the Watershed Management Workshop should be evaluated before additional needs are identified.

V. INTERDISCIPLINARY AREAS

A. Long Island Sound 2003 Agreement Goals & Targets

1. Continue federal and state support and continue to build partnerships at all levels to implement the CCMP for Long Island Sound and to effect the specific elements in this Agreement.

B. General Research, Monitoring, and Assessment Needs

1. On June 16, 2006, the LISS STAC and Citizens Advisory Committee (CAC) identified the development of a Long Island Sound synthesis report. The STAC and CAC recommended that data on chemical, biological, physical, and geological aspects of the Sound be synthesized to articulate what is known, identify where data gaps exist, and help inform the establishment of priorities.
2. The STAC and CAC also felt that the LISS should evaluate the effects of climate change on the Sound, which could be incorporated into the synthesis document, and should promote mapping of the Sound's benthic habitats, as described in the above Living Resources section of this document, to inform management decisions related to energy projects. The Management Committee approved this project at its January 2007 meeting.

C. LIS Work to Address Needs

1. **LIS Environmental Data Synthesis** (CT Sea Grant; PI: Garza/DeGuise; LIS 2007 Base Funding; LI-97183601; \$39,783) The purpose of this effort is a systematic synthesis of information on the patterns and processes that characterize the Long Island Sound ecosystem. Throughout the synthesis emphasis will be placed on how these patterns and processes may be altered in response to global and regional change and the implications for improving ecosystem-based management of the Sound. The document would be developed for a technical audience to guide both science and management activities, but would provide the basis for brochures, fact sheets or other publications for the general public. Each section will be written by an expert or experts as a review of existing data on Long Island Sound. Lead authors, once assigned, will further develop the outline within their topic area. A proposal for a workshop to bring all contributing authors together to present the topic outlines, elaborate and expand on content, and discuss cross-cutting issues, will be submitted to EPA. Following the workshop, lead authors would prepare topic manuscripts with an honorarium provided.
2. **Long Island Sound Stewardship Coordination** (Regional Plan Association; PI: Freudenberg ; LIS 2006 Enhancement Grants; NEIWPC: \$25,204) This project will focus on one of the elements listed in the RFP for outcome 3. LIS Stewardship Coordination – identify and document threats and opportunities at inaugural stewardship sites. Under the title Task 2: Stewardship Area Research and Outreach, the original proposal describes identifying key stakeholders in Stewardship areas and conducting interviews to determine issues

including threats or opportunities with a deliverable of a publication describing threats and opportunities of Stewardship Areas. The specific objectives of the project are to assess threats in four of the inaugural stewardship areas, resulting in a GIS map and data table identifying threats for these areas, as well as a final report. Together this process and these products will serve as prototypes for assessing the threats of the remaining stewardship areas. Deliverables for the project will include a GIS layer identifying threats to stewardship areas on map (by threat, by location), a publication describing threats and opportunities at each of the chosen Stewardship Areas, and a “how-to” manual describing the processes carried out at the four sites to be used in identifying threat and mapping in other sites.

SUMMARY OF EPA-LISO RECOMMENDATIONS

Hypoxia

1. Continue LIS 2008 Base funding for the LIS water quality monitoring program conducted by CTDEP.
2. Consider conducting SWEM simulations to support the TMDL reassessment effort, possibly through NYCDEP’s existing contract mechanism.
3. Evaluate results of ongoing enhancement and research projects to identify additional enhancement or research needs related to hypoxia management

Toxics

None.

Living Resources & Habitat

1. Continue LIS 2008 Base funding to conduct a LIS Eelgrass Survey in Spring 2009.
2. Evaluate results of ongoing enhancement and research projects before identifying additional enhancement or research needs related to living resources or habitat
3. Support efforts to conduct systematic mapping of Long Island Sound’s benthic habitats through the Cable Settlement Fund.

Watersheds

1. Evaluate results of ongoing projects and the Watershed Management Workshop before identifying additional needs.
2. Assign LIS personnel to support NPS work group in 2008.

Interdisciplinary Areas

None.