Long Island Sound Study

A Partnership to Restore and Protect the Sound

Comprehensive Conservation and Management Plan 2015

Supplemental Document 1

Clean Waters and Healthy Watersheds (WW) Theme

Implementation Actions 2015–2019

Summary Table. Clean Waters and Healthy Watersheds (WW) Implementation Actions

Implementation Actions (IAs) have been formulated to carry out the WW strategies. The IAs are listed in the table with highest priority actions shaded in **bold blue**. The major strategies addressed by the action are also listed in the table.

IA Number	Implementation Action Title	Major Strategies Addressed
WW-1	Evaluate the impact of increasing human population, climate change and land use trends in the Long Island Sound watershed to determine nutrient and contaminant stressors on sewage loads from Wastewater Treatment Facilities (WWTFs)/Combined Sewer Overflows (CSOs) and decentralized/on-site wastewater treatment systems (OSWTS).	1-1a1, 1-1a2, 1-1a7
WW-2	Strategically plan for and implement capital improvements, BMPs, and improved operation and maintenance to mitigate CSO, stormwater, and nonpoint source loadings, taking into account the analysis of potential future changes in loading (WW-1).	1-1a1, 1-1a2
WW-3	Explore expansion of point source and nonpoint source nutrient trading programs for the Long Island Sound watershed.	1-1a2
WW-4	**Pursue opportunities to further improve nitrogen removal, particularly low-cost retrofits, at WWTFs, throughout the watershed.**	**1-1a2**
WW-5	Improve integrity of sewage collection infrastructure and institute sustainable asset management programs.	1-1a2, 1-1a6
WW-6	**Enhance implementation of the 2000 Dissolved Oxygen TMDL and evaluate revision of the TMDL and allocations as needed to attain water quality standards.**	**1-1a3, 4-2a4, 4-3b2**
WW-7	**Improve the reporting requirements of MS4 communities for Dissolved Oxygen TMDL implementation tracking to better quantify the effectiveness of control measures.**	**1-1a4, 4-2a4**
WW-8	Improve and enforce pesticide/herbicide/fertilizer regulations and other Best Management Practices (BMPs) for agriculture and urban turf.	1-1a5
WW-9	**Develop a nonpoint source and stormwater tracking system tool for the Long Island Sound watershed.**	**1-1a6, 1-1a7, 4-2a4**
WW-10	**Develop improved policies for use and performance of decentralized and on-site wastewater treatment systems.**	**1-1a7, 4-2a4**
WW-11	**Improve understanding, management, and design of denitrifying decentralized and residential, on-site wastewater treatment systems.**	**1-1a7, 4-1a1, 4-2a4**
WW-12	**Improve efficiency and resiliency of existing/new waste treatment systems including septic, WWTF and stormwater infrastructure to accommodate sea level rise.**	**1-1a8. 3-4a1, 3-4b1, 3-4b2, 4-3a1**

IA Number	Implementation Action Title	Major Strategies Addressed
WW-13	Develop watershed management plans for sub-watersheds, including urban areas, within the Connecticut and New York portions of the Long Island Sound watershed, and track their implementation and effectiveness.	1-1b1
WW-14	**Promote establishment and protection of riparian corridors and wetland buffers at the municipal level through development of local ordinances and increased permanent land protection.**	**1-1b2, 2-1a2**
WW-15	Support implementation of stormwater permit guidance requiring all new development and substantial redevelopment to capture and infiltrate runoff from the 90th percentile storm, (generally a 0.8-1.3 inch storm).	1-1c1, 1-1a6, 1-1b2, 3-4a1, 3-4a2, 3-4b1, 3-4b2
WW-16	Improve environmental practices (boat wrap, bottom paint, pump out, etc.) at marinas.	1-2a1, 1-2a2
WW-17	Develop a Long Island Sound-specific marine debris reduction plan and implement actions to support trash-free waters.	1-2a2
WW-18	Support and promote pharmaceutical and prescription medicine take-back programs at the state and municipal level to inform the general public about the pathways and impacts of emerging contaminants entering the waters and sediments of Long Island Sound.	1-2b1
WW-19	Encourage state, and local health departments to adopt emerging rapid bacterial detection technologies that would allow shorter duration administrative beach/shellfish closings than those based on rainfall only.	1-2b2
WW-20	Evaluate challenges to implementation of bioextraction in Long Island Sound, including use conflicts, economic viability, permitting and testing requirements and potential environmental impacts, and make recommendations to overcome them.	1-2b3
WW-21	Improve the permitting and certification process for new aquaculture projects with products intended for human consumption, particularly those projects with a bioextraction focus.	1-2b3
WW-22	Estimate future phosphorus loading to Long Island Sound and its impact on Long Island Sound nutrient dynamics.	1-3a1
WW-23	Improve ability of models and/or studies to estimate contaminant and nutrient loads in critical areas and evaluate the effectiveness of remedial actions.	1-3a2, 4-1a1, 4-1c1
WW-24	**Maintain and enhance the utility and efficiency of water quality monitoring of nutrient loads to Long Island Sound science and management efforts.**	**1-3b1, 4-1b4**
WW-25	Develop and implement a water quality monitoring strategy for nitrogen in the upper basin states of Massachusetts, Vermont, and New Hampshire.	1-3b1, 4-1b3, 4-1b4, 4-2a4
WW-26	Assess and identify the impact of emerging (e.g., PBDE, pharmaceuticals) and legacy (e.g., heavy metals, PCBs) contaminants on the ecosystem services and biota of Long Island Sound.	1-3b2, 4-1a1

IA Number	Implementation Action Title	Major Strategies Addressed
WW-27	Develop water quality monitoring programs associated with coastal habitat restoration projects.	1-3b3, 4-1b3
WW-28	**Determine the level of spatial and temporal sampling needed to assess Long Island Sound water quality as impacted by climate change drivers (SLR, warming, acidification).**	**1-3b3, 4-1b3, 4-1b4, 4-3a1**
WW-29	Complete LISS Sentinel Monitoring for Climate Change pilot projects and evaluate results to guide strategy development and future implementation.	1-3b3, 4-3a1
WW-30	Conduct periodic (five year) review and revision of Sentinel Monitoring Strategy document.	1-3b3, 4-3a1
WW-31	**Assess sources of nutrient and pathogen contamination to Long Island Sound embayments.**	**1-3b4, 1-3b1, 4-1b4**
WW-32	**Monitor and track occurrences and contributing factors of biotoxin and harmful algal blooms (HABs) outbreaks.**	**1-3b5**
WW-33	Develop a regional partnership that will continue to support the implementation and advancement of the LISS Sentinel Monitoring for Climate Change Program and integrate it with regional and national efforts.	1-3c1, 4-1b3
WW-34	Continue to support, improve, and utilize the Sentinel Monitoring Data Citation Clearinghouse and other data synthesis, storage, and sharing efforts.	1-3c2, 4-1b3

Implementation Action: WW-1

Evaluate the impact of increasing human population, climate change and land use trends in the Long Island Sound watershed to determine nutrient and contaminant stressors on sewage loads from Wastewater Treatment Facilities (WWTFs)/Combined Sewer Overflows (CSOs) and decentralized/on-site wastewater treatment systems (OSWTS).

Theme	Clean Waters and Healthy Watersheds
Goal	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome	1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective	1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy	1-1a1: Continue mitigation of Combined Sewer Overflows (CSOs) and Municipal Separate Storm Sewer Systems (MS4s), incorporating climate change and sea level rise in planning, regulation, and BMPs. 1-1a2: Evaluate and improve the clean water infrastructure for wastewater treatment facilities (WWTFs), conveyance systems, and associated sewer lines. 1-1a6: Implement low-impact development and green infrastructure for new and existing development, and mitigate pollution from commercial and industrial sources.

Project Description/Background: Population increases, land development, and climate change will increase the demands on sewage treatment infrastructure, both centralized systems in urban areas and onsite treatment systems in suburban and rural areas. It is important to understand the impact of changes in demand over the lifespan of the infrastructure when designing and implementing upgrades. A population and land use study should be conducted that includes an analysis of how these changes will impact flows and nutrient loads and how municipalities and state agencies can mitigate this impact in the design and upgrades of WWTF, storm sewers, and onsite treatment systems. Trends in population, land development, and impervious cover are drivers of nitrogen loading from developed lands. The study should also take into consideration changes in precipitation and temperature patterns from present and anticipated future changes in climate that may affect runoff and groundwater infiltration rates. These data will enable state and municipal managers to reinforce the need for implementing BMPs to mitigate these nutrient stressors. The final report will be sent to all municipalities and stakeholders involved in WWTF/CSO upgrades.

Cooperators and Partners: State agencies of Connecticut, New York, Massachusetts, New Hampshire and Vermont and their respective state municipalities and health departments. Local water resource planning agencies.

Funding Sources: A combination of state and federal grants and loans primarily funded through each states' respective State Revolving Fund (SRF) loan and grant programs and through EPA Grants. Long Island Sound Futures Fund (LISFF), other local grants and private funds. Some limited amount of academic study/modeling could be grant funded (Possibly Enhancement grant or LISFF).

Funding Needs: $$

Expected Outputs:

- Report on impact of population change, land use, and climate on loadings.
- Data to enable state and municipal managers to reinforce need for and implement BMPs for mitigating nutrient stressors to surface and groundwater.

Performance Metric(s):

- Number of State and local policies and regulations that result from or cite data generated as part of this action.
- Recorded number of state municipalities incorporating special sewer districts and number of denitrifying decentralized treatment systems installed in the Long Island Sound watershed as a result of study findings.

Implementation Status: New

Expected Timeframe: Conduct study 2016–2018, issue analysis report in 2018–2019, and implement in 2020.

Implementation Action: WW-2

Strategically plan for and implement capital improvements, BMPs, and improved operation and maintenance to mitigate CSO, stormwater, and nonpoint source loadings, taking into account the analysis of potential future changes in loading (see WW-1).

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a1: Continue mitigation of Combined Sewer Overflows (CSOs) and Municipal Separate Storm Sewer Systems (MS4s), incorporating climate change and sea level rise in planning, regulation, and BMPs. 1-1a2: Evaluate and improve the clean water infrastructure for wastewater treatment facilities (WWTFs), conveyance systems, and associated sewer lines.

Project Description/Background: BMPs consistent with those suggested by the report generated in WW-1 will help municipalities and towns to better plan future infrastructure repairs and upgrades. As the incremental cost of continued WWTF upgrades continues to increase, it is critical to aggressively combat other sources of nutrient and pathogen contamination to Long Island Sound, such as CSOs, stormwater runoff, agricultural infiltration and runoff, and septic systems. The state agencies will use a combination of tools and strategies, including 319 projects, MS4 plans, National Pollutant Discharge Elimination System (NPDES) permits, general permits and other Clean Water Act SRF programs to assist municipalities in reducing contaminant levels in stormwater systems. Collaboration with land developers will provide the capacity to incorporate BMPs into development plans.

Cooperators and Partners: The state agencies of Connecticut and New York, their respective state municipalities, and key developers or professional development organizations.

Funding Sources: A combination of state and federal grants and loans primarily funded through each states' respective SRF loan and grant programs and state and municipal budgets. LISFF, Enhancement grant or other partner grant funding.

Funding Needs: $$$$

Expected Outputs:
- Report on impact of population change on loadings

Performance Metric(s):
- Reports and analyses of population trends based on U.S. census results.
- Planning grants will include estimates of expected sewer use and population fluctuation as well as anticipated flow rates and nutrient levels.

Implementation Status: New

Expected Timeframe: 2015–2019 Initial implementation. Broad scale implementation in future cycles (2020–2035).

Implementation Action: WW-3

Explore expansion of point source and nonpoint source nutrient trading programs for the Long Island Sound watershed.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a2: Evaluate and improve the clean water infrastructure for wastewater treatment facilities (WWTFs), conveyance systems, and associated sewer lines.

Project Description/Background: Nutrient trading programs can assist in attaining water quality objectives by providing economic market-based incentives to support cost effective nutrient reduction strategies. State agencies will continue support of existing point source nutrient trading programs (such as Connecticut's Nitrogen General Permit and Nitrogen Credit Exchange Program) and support expansion of potential new nonpoint source trading programs implemented at the municipal level throughout the Long Island Sound watershed as well.

Cooperators and Partners: The state environmental agencies of Connecticut and New York (as well as the upper basin states) and their respective state municipalities.

Funding Sources: A combination of state Clean Water SRF funding and local municipal and private funding sources.

Funding Needs: $$$$; Eventually could be self-sustaining by implementing a true trading program rather than marketplace.

Expected Outputs:
- Comprehensive review on effectiveness and recommendations for existing/future trading programs

Performance Metric(s):
- Number of municipalities participating in credit exchange.
- Number of credits exchanged.

Implementation Status: Underway; Connecticut Nitrogen General Permit and Nitrogen Trading program is underway as is the New York bubble permit program.

Expected Timeframe: 2015–2019 Maintain current point source trading and assess expansion to include other sources.

Implementation Action: WW-4

Pursue opportunities to further improve nitrogen removal, particularly low-cost retrofits, at WWTFs, throughout the watershed.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a2: Evaluate and improve the clean water infrastructure for wastewater treatment facilities (WWTFs), conveyance systems, and associated sewer lines.

Project Description/Background: Though many WWTFs have already upgraded to advanced wastewater treatment, additional upgrades may be necessary to attain water quality and habitat (e.g., eelgrass) goals and targets. Upgrading WWTFs with available technologies for nutrient removal, particularly low-cost retrofits, remains one of the most cost-effective management strategies to accomplish these goals. Through participation in each states' individual permit or general permit program and by aiming for the goals of the Long Island Sound Dissolved Oxygen TMDL, municipalities should work with State agencies to identify and improve nitrogen removal capabilities in WWTF systems. Onsite monitoring and monthly discharge reports (DMRs) of municipal WWTFs will track nitrogen discharge levels.

Cooperators and Partners: The state environmental agencies throughout the watershed and their respective state municipalities.

Funding Sources: A combination of state and federal grants and loans primarily funded through each states' respective SRF loan and grant programs.

Funding Needs: $$$$

Expected Outputs:
- Facility planning to improve nitrogen removal capabilities in WWTF systems
- Upgrades to WWTFs

Performance Metric(s):
- Reduced nitrogen loads to Long Island Sound waters from WWTFs

Implementation Status: Underway. Both states have already spent hundreds of millions of dollars on nutrient removal upgrades over the last 15 years and will continue this effort in order to meet TMDL limits.

Expected Timeframe: 2015–2019; Ongoing. Plans in place but still underway to meet TMDL.

Implementation Action: WW-5

Improve integrity of sewage collection infrastructure and institute sustainable asset management programs.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a2: Evaluate and improve the clean water infrastructure for wastewater treatment facilities (WWTFs), conveyance systems, and associated sewer lines. 1-1a6: Implement low-impact development and green infrastructure for new and existing development, and mitigate pollution from commercial and industrial sources.

Project Description/Background: Failing sewer infrastructure is a significant contributor to bacterial contamination and groundwater nutrient loading in many coastal municipalities. In New York, 37 percent of sewer infrastructure is assessed as in "fair" or worse condition, with 21 percent assessed as "poor" or "very poor" (http://www.dec.ny.gov/docs/water_pdf/infrastructurerpt.pdf). It is a critical priority to invest in locating and repairing leaking/damaged sewer infrastructure, while at the same time, making infrastructure more resilient to future damage and climate change. This action would employ more active and routine investigations for identifying and eliminating dry weather discharges from combined sewers and sanitary sources using tracking studies. Collaboration is needed to prioritize upgrades to infrastructure based on expected system benefit and need to optimize the use of funds, as well as develop municipal contingency funding plans for infrastructure upgrades.

Cooperators and Partners: A combination of state and federal grants and loans primarily funded through each states' respective SRF loan and grant programs to municipalities. State agencies and LISS could provide logistical and planning assistance and possibly some funding.

Funding Sources: LISFF (tracking studies etc. and work with states to prioritize upgrades based on expected system benefit and need could be developed to optimize the use of funds). Funding for repairs would primarily have to come from State and municipal bonds or federal grants through the SRF programs, as well as USDA and EPA infrastructure grant programs. Development of municipal contingency funding plans could also be incorporated into the action.

Funding Needs: $$$$; NYSDEC estimates that the cost of repairing aging sewer infrastructure in that state is roughly 6.6 billion dollars (http://www.dec.ny.gov/docs/water_pdf/infrastructurerpt.pdf). While this includes a large amount of area outside of the Long Island Sound watershed, the cost for the Long Island Sound portions of New York and Connecticut could cost billions of dollars. (Funding provided from State and municipal bonds or federal grants through the SRF programs)

Expected Outputs:
- Funding plan for infrastructure repairs and upgrades.
- Reduced nitrogen and pathogen loading into Long Island Sound.
- Reduced groundwater and fresh surface water contamination.
- Reduced shellfish/beach closures.

Performance Metric(s):
- Increased repairs of sewer infrastructure.
- Number of municipalities with infrastructure contingency funding planning and mechanisms.

Implementation Status: Underway, however a comprehensive strategic planning effort would be a new undertaking.

Expected Timeframe: 2015–2019. Will be addressed on a rolling basis, since infrastructure that is now performing acceptably will become faulty/obsolete. If upgrades are addressed as need arises, emergencies would be reduced and costs would be spread out.

Implementation Action: WW-6

Enhance implementation of the 2000 Dissolved Oxygen TMDL and evaluate revision of the TMDL and allocations as needed to attain water quality standards.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a3: Enhance implementation of the existing 2000 Dissolved Oxygen Total Maximum Daily Load throughout the watershed; and adapt and revise it based on monitoring, modeling, research, and how climate change may affect attainment of water quality standards in the future. 4-2a4: Enhance opportunities for cooperation and involvement of the tributary states of Massachusetts, New Hampshire, Rhode Island, and Vermont to address stressors that contribute to downstream effects on LIS. 4-3b2: Utilize and learn from cutting edge approaches and methods to improve management options for pollution mitigation and ecosystem protection (e.g., marine spatial planning, innovative source reduction technologies, and in situ extractive technologies)

Project Description/Background: A recent LISS evaluation of TMDL implementation (NEIWPCC 2014) demonstrated areas of success and opportunities to improve nitrogen reduction. Since the 2000 TMDL highlighted the need for additional phases of action to attain water quality standards, there is a need to further enhance nitrogen reductions or alternatives to nitrogen reduction to attain water quality standards. Continued scientific and technical support will be needed to assess attainment of dissolved oxygen water quality standards from implementation of the 2000 TMDL and to assess additional actions needed. The states of Connecticut, New York, Massachusetts, New Hampshire and Vermont should continue to work with EPA to implement a tributary state WWTF permitting strategy, upgrade WWTFs, assess current stormwater and nonpoint source pollution control effectiveness, understand nitrogen loading to groundwater, and continue development of a feasible tracking system for NPS nitrogen reductions. The five-state workgroup will continue to assess the adequacy of the Long Island Sound TMDL nitrogen allocations in attaining water quality standards.

Cooperators and Partners: EPA, CTDEEP, NYSDEC, MassDEP, NHDES and VTDEC, and local government agencies

Funding Sources: Federal and state funding would likely be necessary, Including Connecticut Clean Water Fund (CWF), SRF and other funding

Funding Needs: Technical support for TMDL revision—$$, Implementation to achieve revised TMDL—$$$$

Expected Outputs: Implementation of Long Island Sound TMDL and progress toward a 5-state TMDL revision.

Performance Metric(s):
- Attainment of 2000 TMDL waste load allocation.
- Completion of an evaluation of and plan for TMDL Revision

Implementation Status:
- Underway. The TMDL Work Group is developing enhancements to the existing TMDL.

Expected Timeframe: 2015–2017 achieve 2000 TMDL waste load allocation. Revise TMDL by 2020.

Implementation Action: WW-7

Improve the reporting requirements of MS4 communities for Dissolved Oxygen TMDL implementation tracking to better quantify the effectiveness of control measures

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a4: Ensure cross-department collaboration and cooperation at the municipal level to implement MS4 BMPs (e.g., involve highway departments). 4-2a4: Enhance opportunities for cooperation and involvement of the tributary states of Massachusetts, New Hampshire, Rhode Island, and Vermont to address stressors that contribute to downstream effects on LIS.

Project Description/Background: MS4 communities are required to report actions taken to address the six minimum control measures for stormwater runoff and other actions to reduce pollutant loads to impaired waters. Current reporting does not provide sufficient information to determine the impact of these actions in controlling nitrogen discharges. Improved information from the regulated communities will allow the states and LISS to better assess and track the actions taken to address water quality and the relative success of each action. For example, current reporting requires only a listing of actions, but does not require an estimate of the improvement to the entire system. This action also encourages greater state oversight of MS4 permits/permittees. Also included will be the evaluation of the relative source contribution of nitrogen loading to groundwater, e.g., OSWTS, lawn fertilizer, agricultural, legacy land use, etc. LISS will offer guidance to improve tracking actions and reporting. Implementation action WW-9 will help to provide additional tracking and reporting mechanisms.

Cooperators and Partners: The states of New York, Connecticut, and Massachusetts and MS4 regulated municipalities. The state agencies plan on using a combination of tools and strategies, including 319, MS4, and other SRF programs to assist municipalities in reducing contaminant levels in stormwater systems.

Funding Sources: State agency funds would be required to implement revised requirements.

Funding Needs: $$; some costs may be incurred by municipalities to train personnel, collect additional data, and modify reporting systems.

Expected outputs:

- New reporting requirements.
- Better understanding of the relative success of control measures.

Performance Metric(s):

- Municipal tracking that reports actions in terms of percentage improvement of the entire stormwater collection/treatment system and volume of discharge treated.

Implementation Status: Underway. The MS4 programs in both states are currently fully implemented. This particular reporting task would not be a new action but improvements on the existing action. Tracking is now currently required under the MS4 regulations.

Expected Timeframe: 2015–2018 to develop and implement a new reporting system.

Implementation Action: WW-8

Improve and enforce pesticide/herbicide/fertilizer regulations and other Best Management Practices (BMPs) for agriculture and urban turf.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a5: Assess and mitigate agricultural nonpoint source loads.

Project Description/Background: State environmental and agriculture agencies regulate statewide manufacturing, sales, and use of pesticides and herbicides. Legislation passed in Connecticut in 2009 controlled the use of pesticides at daycare and school facilities as well as for the use of agricultural fertilizers and pesticides. Each state should continue to review and refine legislation as needed to regulate safe and prudent chemical applications to the lands within the Long Island Sound watershed. Furthermore, states will continue to evaluate new BMPs with respect to pesticide/herbicide and fertilizer application.

Cooperators and Partners: The state agencies of Connecticut and New York and their respective state municipalities. Some assistance may be provided by Cooperative Extension offices particularly with respect to the future of Integrated Pest Management strategies (IPMs).

Funding Sources: A state and federal grants and loans primarily funded through each states' respective SRF loan and grant programs and through EPA Grants. Other local grants.

Funding Needs: $$

Expected Outputs:
- Reduced contaminated stormwater runoff to Long Island Sound tributaries
- Healthier soils and reduced human, plant, and wildlife exposure to potential chemical hazards.

Performance Metric(s):
- Quality and number of new state regulations for pesticide use.
- Number of IPMs being implemented in the Long Island Sound watershed.

Implementation Status: Underway. Steps were taken under the first LISS CCMP and will be continued by both states.

Expected Timeframe: 2015–2019 and beyond. Continued action on this would be anticipated in future cycles.

Implementation Action: WW-9

Develop a nonpoint source and stormwater tracking system tool for the Long Island Sound watershed.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a6: Implement low-impact development and green infrastructure for new and existing development, and mitigate pollution from commercial and industrial sources. 4-2a4: Enhance opportunities for cooperation and involvement of the tributary states of Massachusetts, New Hampshire, Rhode Island, and Vermont to address stressors that contribute to downstream effects on LIS.

Project Description/Background: The Long Island Sound TMDL and NPS and Watersheds Workgroups identified the need to develop a tracking system in order to account for on-the-ground activities related to reducing nitrogen from nonpoint sources and stormwater. The tool, once developed, will act as a database for tracking both qualitative and quantitative activities, allow for implementation planning through adjustments to scenarios, and permit a more quantitative evaluation of progress relative to the TMDL required nitrogen reductions.

Cooperators and Partners: EPA Region 1, EPA LISS, States of Connecticut, New York, Massachusetts, New Hampshire and Vermont. A contract with a qualified consultant to complete the required tasks will be necessary.

Funding Sources: LISS above-base funding.

Funding Needs: $$. Additional funds will likely be needed in order to obtain required data for the entire watershed once pilot project is complete.

Expected Outputs: A functional tracking and accountability system to store implementation activities related to reducing nitrogen and qualitatively track progress towards attainment of the TMDL. The Tracking system will establish consistency for data collection, implementation planning, and determining progress across the Long Island Sound watershed.

Performance Metric(s):
- Complete and adopt Tracking Tool, successfully implement pilot program.
- Improved municipal and watershed BMP tracking and reporting.

Implementation Status: Underway. Enhancement grant has already been awarded to a contractor to research and assist LISS in developing an NPS tracking tool.

Expected Timeframe: 2016–2019. One year to complete Request for Proposal (RFP) process and select contractor. Two years to complete the above two phases. Fully populating the Tracking System may fall into a future cycle (2020–2025).

Implementation Action: WW-10

Develop improved policies for use and performance of decentralized and on-site wastewater treatment systems.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a7: Improve comprehensive management and performance of decentralized wastewater treatment systems and residential, on-site wastewater treatment systems (OSWTSs). 4-2a4: Enhance opportunities for cooperation and involvement of the tributary states of Massachusetts, New Hampshire, Rhode Island, and Vermont to address stressors that contribute to downstream effects on LIS.

Project Description/Background: Decentralized wastewater treatment facilities are an increasing share of the nitrogen load to Long Island Sound. There is a need to develop and implement nutrient reducing practices at on-site/decentralized wastewater systems for domestic/residential wastewater to restore and protect waters affecting coastal water bodies and habitats. The Connecticut Department of Public Health (CTDPH), New York State Department of Health, and Suffolk County should develop state and county regulations, policies and programs to manage and regulate these facilities. Training and resources should be provided to health and watershed management organizations, septic system inspectors and planning agencies for developing improved policies and implementing best available nutrient and microbial reducing technologies, including, for example, upgrades consistent with Suffolk County Department of Health Services (SCDHS) 2014 Comprehensive Water Resources Management Plan. Connecticut and New York should identify nutrient threatened and sensitive resources needing innovative and alternative technologies and implement the management components of the EPA's *Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems* (2003). Localities should develop, implement, and/or enforce local laws and ordinances that promote and/or govern comprehensive management of on-site and decentralized wastewater treatment systems.

Cooperators and Partners: The state, county and municipal agencies of Connecticut and New York. A contract/research study may be necessary to facilitate and support regulatory and policy development.

Funding Sources: A combination of state and federal grants and loans primarily funded through each states' respective SRF loan and grant programs and through EPA Grants. Possible LISFF, other local grants or private funds could be used for studies or pilot projects.

Funding Needs: $$$

Expected Outputs:

- Strategy/Plan to advocate for state and county resources to support and develop necessary regulations and policies. Improved and adopted regulations policies requiring current advanced nutrient reducing package and on-site septic systems in both states.

Performance Metric(s):

- Recorded number of states and municipalities incorporating special sewer districts to facilitate installation of denitrifying decentralized and residential onsite systems. Adopted state and county regulations.

Implementation Status: New

Expected Timeframe: 2016–2019. Two to three years to solicit and implement study. Broad scale implementation in 2020–2030 time range.

Implementation Action: WW-11

Improve understanding, management, and design of denitrifying decentralized and residential, on-site wastewater treatment systems.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a7: Improve comprehensive management and performance of decentralized wastewater treatment systems and residential, on-site wastewater treatment systems (OSWTSs). 4-1a1: Identify science activities needed to transparently link outcomes and objectives to strategies and actions, setting priorities based on management relevance and scientific merits. 4-2a4: Enhance opportunities for cooperation and involvement of the tributary states of Massachusetts, New Hampshire, Rhode Island, and Vermont to address stressors that contribute to downstream effects on LIS.

Project Description/Background: Substantial effort has been invested in increasing WWTF infrastructure to remove nitrogen. More attention needs to be paid to other sources of nitrogen, and of these, sewage effluent nitrogen from unsewered areas, particularly those near surface waters and the coast, is among the largest remaining contributors. Approximately half of the homes and businesses in the watershed have conventional OSWTS that do little to remove nitrogen. The innovative and alternative technology exists to remove significant amounts of N from these sources, but it is still expensive, rarely required by law, and in some cases, still under development. This action will focus on developing an understanding and guidance on how best to utilize these systems, when to require their installation , and how much of an impact they can have on the nutrient budget of Long Island Sound and its embayments.

Cooperators and Partners: Research would likely be conducted by academic or consulting agency partners. New OSWTS regulations at the state or county level are needed to improve oversight and guidance on the use and application, and permitting of nutrient reducing technologies. Planning and zoning by regional planning agencies should ensure that upgrades to decentralized and residential onsite systems do not lead to increased development density and thus no net reduction in nitrogen load. LISS will assist with logistics, outreach and possibly some funding.

Funding Sources: Planning grants could target LISFF. Implementation would require external sources of funding or state/municipal budgets.

Funding Needs: Feasibility study $$$, Implementation $$$$. Individual upgrades to a nitrogen removing septic system can cost $20–50K depending on size, lot constraints, etc. which would require external funding for state or local subsidized loan programs or other homeowner financing programs and mechanisms.

Expected Outputs:
- Planning/research reports on nitrogen removing OSWTS.
- Improvement and economies of scale in OSWTS nitrogen removal technologies.
- Eventual N load reductions resulting from implementation.

Performance Metric(s):
- Number of nitrogen removing septic systems installed and consequent nitrogen load reduction.

Implementation Status: Underway/New. Efforts to understand the impact of OSWTS are underway nationally and regionally.

Expected Timeframe: 2015–2019 to assess new technology, policy and legislative options, and begin long-term implementation over future cycles.

Implementation Action: WW-12

Improve efficiency and resiliency of existing/new waste treatment systems including septic, WWTF and stormwater infrastructure to accommodate sea level rise.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources.
Strategy: 1-1a8: Incorporate climate change and sea level rise in planning, regulation, and BMPs for stormwater and wastewater treatment. 3-4a1: Provide support to municipalities to facilitate the development and updating of sustainability and resiliency plans that incorporate current concepts on these topics. 3-4b1: Revise zoning, permitting, and related regulations to ensure that future development and redevelopment conform to sustainability, mitigation, and resiliency plans. 3-4b2: Provide technical assistance and training for homeowners, municipal officials, developers, engineers, and consultants on sustainability, adaptation, and resiliency concepts and opportunities for implementation. 4-3a1: Include important environmental drivers (e.g., climate change) in all relevant management planning initiatives.

Project Description/Background: To minimize and prevent flood-induced discharges of untreated or partially treated sewage containing excess nutrients and pollutants, EPA and state agencies need to work with municipalities to improve and protect wastewater treatment plants and storm sewer infrastructure operations and efficiencies. Activities include promoting the Climate Ready Utilities Program and the Climate Resilient Evaluation and Awareness tool (CREAT) to water utilities and municipalities, and support utilities in modifying treatment plants to withstand future storm surge. Criteria should also be developed for use of State Revolving Fund (SRF) infrastructure investments for building resiliency to climate change impacts. Studies should be conducted to identify where improvements are necessary and the costs associated with those improvements. This would be followed by assistance to municipalities in applying for funding for projects to upgrade infrastructure for pollution control equipment and facilities. Onsite wastewater treatment infrastructure located within coastal flood zones or in areas with minimal or no separation from groundwater are also at risk for flooding and potential operation failure. State and county Health and environmental agencies should provide training and resources to shoreline municipalities and planning agencies for developing and implementing coastal adaptation and resiliency strategies for decentralized treatment plants and on-site sewage systems located within the coastal flood zones of the Long Island Sound municipalities. This includes implementing strategies to deal with depth to groundwater changes as a result of climate change, and its impacts on septic system use and siting. State Health and environmental agencies will need to work with the municipalities to oversee and implement regulations for decentralized treatment plants and on-site septic systems.

Cooperators and Partners: State and local agencies in Connecticut and New York, including the CTDEEP and CTDPH, NYSDEC (for OSWT systems over 1000gpd), NYSDOH (for systems 1000 gpd or less), and Suffolk County.

Funding Sources: Initial study could be LISFF funded. Implementation would be a combination of state and federal grants and loans primarily funded through each state's respective SRF loan and grant programs, to seek funding for NPS infrastructure upgrades

Funding Needs: $ to $$$S

Expected Outputs:
- Report on changes necessary to incorporate sea level rise (SLR) into existing policies.
- List of plants and systems that will require upgrades to accommodate SLR.

Performance Metric(s):
- Number of municipalities that incorporate coastal adaptation and resiliency strategies for wastewater treatment infrastructure into their resiliency plans.

Implementation Status: New

Expected Timeframe: 2015–2019. Report by an outside consultant should take one year and be funded within two to three years. Implementation of report recommendations would be in the 2020–2030 timeframe.

Implementation Action: WW-13

Develop watershed management plans for sub-watersheds, including urban areas, within the Connecticut and New York portions of the Long Island Sound watershed, and track their implementation and effectiveness.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1b: To balance multiple uses and maximize ecosystem services through watershed-based planning.
Strategy: 1-1b1: Develop and implement watershed management plans in Long Island Sound communities and sub-watersheds.

Project Description/Background: While having a Soundwide management plan is important and necessary, so are management plans for sub-watersheds within the larger Long Island Sound watershed as localized physics and geography/geology often render these waterbodies oceanographically distinct from Long Island Sound proper. In order to better understand the different issues and needs of local embayments and subestuaries, it is essential for municipalities in sub-watersheds of Long Island Sound to develop and implement their own watershed management plans. All watershed management plans for impaired or threatened basins should include all nine elements of a Watershed Based Plan recommended by EPA (See http://water.epa.gov/polwaste/nps/handbook_index.cfm). Connecticut has dedicated resources to developing watershed based plans in the watersheds of Connecticut (see http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325628&deepNav_GID=1654). As the plans are being implemented, it is essential to centrally watersheds that have approved plans and the effectiveness of their implementation in reducing stressors causing use impairments.

Cooperators and Partners: States (CTDEEP, NYSDEC), local governments, and watershed organizations (e.g., nonprofits)

Funding Sources: A combination of state and federal grants and loans primarily funded through each states' respective SRF loan and grant programs and through EPA Grants. LISFF, other local grants.

Funding Needs: $$–$$$

Expected Outputs

- Town-by-town database of approved watershed plans and implementation stage.
- Approved watershed management plans for sub-watersheds in the Connecticut and New York portions of the Long Island Sound watershed.

Performance Metric(s):

- Percentage of sub-watersheds in the Connecticut and New York portions of the Long Island Sound watershed with approved watershed management plans.
- Number of water bodies removed from the 303(d) list of impaired waterbodies per watershed.

Implementation Status: Underway

Expected Timeframe: 2015–2019. While some sub-watersheds already have watershed management plans, it would likely take five to ten years to complete coverage throughout the watershed.

Implementation Action: WW-14

Promote establishment and protection of riparian corridors and wetland buffers at the municipal level through development of local ordinances and increased permanent land protection.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1b: To balance multiple uses and maximize ecosystem services through watershed-based planning.
Strategy: 1-1b2: Protect wetlands, healthy watersheds, riparian buffers, and open land to minimize land disturbance and impervious cover through land protection, sustainable development, and green infrastructure. 2-1a2: Restore and enhance connectivity of targeted habitat types.

Project Description/Background: Riparian buffers and wetland buffers provide important ecosystem services such as reducing impervious cover, mitigating contaminated stormwater runoff, improved ground water infiltration and recharge, restored hydrologic function of riparian areas and wetlands, flood control, connectivity of wildlife corridors. This action will provide training and resources at the municipal level to promote permanent land protection and develop local ordinances that will establish riparian and buffer zone regulations, subsequently maintaining the important ecosystem services of riparian corridors and vegetated wetland buffers. Potential tools could include model ordinances such as LID standards and open space set aside provisions.

Cooperators and Partners: Connecticut and New York state agencies, their respective municipalities. Some assistance with specific guidance/BMPs may be provided by organizations such as CLEAR/NEMO, etc. and NGOs and other public and private groups could assist with implementation. For land protection activities, states (CTDEEP, NYSDEC), municipalities, and land protection organizations (e.g., Nature Conservancy, Audubon, Land trusts, etc.)

Funding Sources: A combination of state and federal grants and loans primarily funded through each states' respective SRF loan and grant programs and through EPA Grants. LISFF, other local grants.

Funding Needs: $$–$$$$

Expected Outputs:
- Reduced impervious cover and contaminated stormwater runoff to Long Island Sound tributaries.
- Improved ground water infiltration and recharge.
- Restored hydrologic function of riparian areas and wetlands.
- Provide connectivity of wildlife corridors and greenways.

Performance Metric(s):
- Number of municipalities incorporating riparian and buffer zone regulations into planning and zoning.
- Riparian buffer acres (already tracked by UCONN CLEAR in Connecticut)
- Acres of land permanently protected

Implementation Status: Underway

Expected Timeframe: 2015–2019, but will likely continues into future cycles.

Implementation Action: WW-15

Support implementation of stormwater permit guidance requiring all new development and substantial redevelopment to capture and infiltrate runoff from the 90th percentile storm, (generally a 0.8-1.3 inch storm).

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.
Objective: 1-1c: To restore and protect the natural hydrologic and ecological functions of the watershed.
Strategy: 1-1c1: Preserve hydrologic function (e.g., flooding, buffer zones, resiliency, groundwater, etc.) in developing watersheds and restore in impaired watersheds. 1-1a6: Implement low-impact development and green infrastructure for new and existing development, and mitigate pollution from commercial and industrial sources. 1-1b2: Protect wetlands, healthy watersheds, riparian buffers, and open land to minimize land disturbance and impervious cover through land protection, sustainable development, and green infrastructure. 3-4a1: Provide support to municipalities to facilitate the development and updating of sustainability and resiliency plans that incorporate current concepts on these topics. 3-4a2: Ensure consistency among economic development and sustainability and resiliency planning efforts. 3-4b1: Revise zoning, permitting, and related regulations to ensure that future development and redevelopment conform to sustainability, mitigation, and resiliency plans. 3-4b2: Provide technical assistance and training for homeowners, municipal officials, developers, engineers, and consultants on sustainability, adaptation, and resiliency concepts and opportunities for implementation.

Project Description/Background: Both NYSDEC and CTDEEP require the capture and treatment of stormwater to meet water quality and flood control goals. Changes in frequency and severity of storms as a result of climate change can be addressed in each state's stormwater permit regulations. By supporting a metric (e.g., 90th percentile) that is tied to the measured severity of storms rather than a flat rainfall amount (e.g., one inch), state regulations will keep pace with climate change. Under present conditions, a 90th percentile storm is generally a 0.8-1.3 inch storm. However, if the frequency and intensity of severe storms increases, that number will also increase. This action supports use of both Connecticut and New York regulatory permitting processes to establish criteria for stormwater runoff treatment and to encourage all the coastal municipalities to adopt the state recommendations for onsite retention and infiltration. Because soil conditions, topography, and proximity to waters varies from site to site, a one size fits all approach will not attain optimum preconstruction hydrology and stormwater infiltration. Therefore each state has developed guidelines and recommendations for stormwater management. Current requirements of Connecticut's stormwater permits (including MS4, Construction, and Industrial General Permits) require stormwater management plans for new development and redevelopment. These management plans, as identified in the 2004 Connecticut Stormwater Quality Manual (SQM) (http://www.ct.gov/deep/cwp/view.asp?a=2721&q=325704&deepNav_GID=1654#download), must include identifying & implementing stormwater best management practices (BMPs) with criteria to calculate Water Quality Volume (WQV) and Runoff Capture Volume (RCV) utilizing an equation incorporating percent impervious cover in its volumetric runoff coefficient. The WQV is the amount of runoff from any given storm that should be captured and treated in order to remove a majority of stormwater pollutants on an average annual basis. The recommended WQV, which results in the capture and treatment of the entire runoff volume for 90 percent of the average annual storm events, is equivalent to the runoff associated with the first inch of rainfall. Connecticut added a Low Impact Development Appendix to its SQM and Connecticut Guidelines for Soil Erosion and Sediment Control to assist developers in selecting LID BMPs. New York also requires stormwater permits and the development of a Stormwater Pollution Prevention Plan for certain industrial and construction activities. The 2015 New York Stormwater Management Design Manual's (http://www.dec.ny.gov/chemical/29072.html) recommended WQV is designed to improve water quality sizing to capture and treat the volume of runoff generated from the entire 90th percentile rain event.

Cooperators and Partners: The state agencies of Connecticut and New York and their respective state municipalities

Funding Sources: State Clean Water Act State Revolving Fund. Municipal funding sources. Permit fees.

Funding Needs: $$–$$$

Expected Outputs:

- Reduced contaminated stormwater runoff to Long Island Sound tributaries.
- Improved ground water infiltration and recharge.

Performance Metric(s): Number of municipalities incorporating capture and management regulations of stormwater on new development and substantial redevelopment.

Implementation Status: Underway

Expected Timeframe: 2015–2019 with periodic re-evaluation (every five years) of average rainfall amounts.

Implementation Action: WW-16

Improve environmental practices (boat wrap, bottom paint, pump out, etc.) at marinas.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-2: The negative impacts of contaminants and nutrients in the waters and sediments of Long Island Sound and tributaries/embayments are reduced.
Objective: 1-2a: To reduce direct sources of nutrients, contaminants, and debris to the Long Island Sound ecosystem.
Strategy: 1-2a1: Minimize vessel/marina discharge impacts. 1-2a2: Reduce generation of marine debris and improve and increase its cleanup in Long Island Sound waters.

Project Description/Background: Marinas and recreational boating are an important source of direct and indirect revenue for Long Island Sound, but can also be a major source of pollution. Boat wrap is typically non-biodegradable plastic, and is susceptible to being blown into the Sound by wind. Bottom paint for boats contains toxic chemicals (generally copper and/or other pesticides), which can contaminate the Sound or near shore ecosystems when boats are sanded/chipped prior to being repainted each year. Additionally, improper dumping or handling of vessel holding tanks can be a source of bacterial or nutrient contamination.

In general, improving the environmental sustainability of this industry will yield benefits both to the economy and the environment. Information can be found at the Connecticut Clean Marina Program/New York Sea Grant Environmental Best Management Practices (BMPs) website. This action involves designing and initiating a voluntary 'green marina' program which would encourage marinas to use BMPs for boat wrap disposal, bottom paint removal, and vessel pump outs.

Cooperators and Partners: States and municipalities, marina owner/operators (with LISO assistance) CTDEEP web site

Funding Sources: LISFF might fund development/public information campaign. Ultimately, marina owners would shoulder the cost of implementation, which would presumably be passed on to the recreational boating community. States/municipalities would shoulder the cost of enforcing the program but could possibly recoup this cost through implementing fines.

Funding Needs: $$. The ultimate cost of enacting the program would be highly variable from marina to marina depending on their current practices.

Expected Outputs:
- Reduced pollution of Long Island Sound by the recreational boating industry.

Performance Metric(s):
- Number of marinas that adopt these practices and join the 'green marina' program.

Implementation Status: New/underway. Both Connecticut and New York have programs that deal with this issue.

Expected Timeframe: 2015–2017 issue an RFP and grant to spread information on BMPs. Bringing states/municipalities on board and phasing in regulations will occur in future cycles (2020–2025).

Implementation Action: WW-17

Develop a Long Island Sound-specific marine debris reduction plan and implement actions to support trash-free waters.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-2: The negative impacts of contaminants and nutrients in the waters and sediments of Long Island Sound and tributaries/embayments are reduced.
Objective: 1-2a: To reduce direct sources of nutrients, contaminants, and debris to the Long Island Sound ecosystem.
Strategy: 1-2a2: Reduce generation of marine debris and improve and increase its cleanup in Long Island Sound waters.

Project Description/Background: Marine debris can come from many sources, ranging from residential, commercial and industrial development to fishing and boating, to storm damage. Regardless of the source, debris can damage habitats, harm biota, and reduce the aesthetic and recreational value of Long Island Sound. A Long Island Sound-specific action plan should be developed to complement and expand regional efforts to both reduce sources of marine debris and mitigate/remove marine debris that is already in the ecosystem. An example project is reviewed in http://www.oceanconservancy.org/our-work/trash-free-seas-alliance/.

Cooperators and Partners: EPA, States of New York and Connecticut and their respective municipalities, in coordination with regional marine debris control initiatives. Local non-profit and regional grassroots groups.

Funding Sources: LISFF or other sources of grant funding (e.g., non-profit sector).

Funding Needs: Planning process: $$ Implementation: $$. Initial funding needed to develop the plan. Further funding recommendations will be part of this plan

Expected Outputs:
- Long Island Sound specific marine debris reduction action plan.
- Long-term—reduction in amount of marine debris in Long Island Sound.

Performance Metric(s):
- Debris collected per unit effort in clean-ups.

Implementation Status: New

Expected Timeframe: 2016–2018 to contract for, develop, and approve the plan.

Implementation Action: WW-18

Support and promote pharmaceutical and prescription medicine take-back programs at the state and municipal level to inform the general public about the pathways and impacts of emerging contaminants entering the waters and sediments of Long Island Sound.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-2: The negative impacts of contaminants and nutrients in the waters and sediments of Long Island Sound and tributaries/embayments are reduced.
Objective:	1-2b: To mitigate impacts of nutrients and contaminants to human health and to the biota and ecosystem of Long Island Sound.
Strategy:	1-2b1: Mitigate impacts from emerging and existing toxic contaminants in water and sediment.

Project Description/Background: Currently there are many identified contaminants found in LIS waters including mercury and other heavy metals, as well as Persistent Organic Pollutants (POPs) from industrial, pharmaceutical, and hygiene products. Some of these 'emerging contaminants' (EC's) are known to cause reproductive abnormalities in some fish species and growth inhibiting impacts in others. More information needs to be researched to identify the impacts of these contaminants. However, until we learn more about the negative impacts of these ECs on the Long Island Sound we don't have to wait to find ways to remove existing contaminants as well as reduce the pathways by which pollutants enter Long Island Sound waters and sediment.

Both Connecticut and New York have implemented household hazardous waste collection programs, mercury collection programs and pharmaceutical take back programs to address reduction of these types of pollutants. For example in Connecticut – House hold waste collection—permits http://www.ct.gov/deep/lib/deep/Permits_and_Licenses/Waste_General_Permits/hhw_gp.pdf and facilities - http://www.ct.gov/deep/cwp/view.asp?a=2718&q=325446&deepNav_GID=1653
Medicines - http://www.ct.gov/deep/cwp/view.asp?a=2718&q=437868&deepNav_GID=1653 and http://www.ct.gov/dcp/cwp/view.asp?a=1620&q=447504&dcpNav_GID=1881
Mercury - http://www.ct.gov/deep/cwp/view.asp?a=2708&q=324014&deepNav_GID=1638%20 and http://www.ct.gov/deep/cwp/view.asp?a=2708&q=523816
And in New York, DEC promotes information on proper disposal of medications and other health hygiene products, see - http://www.dec.ny.gov/chemical/45083.html , http://www.dec.ny.gov/chemical/8485.html and http://www.dec.ny.gov/chemical/285.html

Pollution prevention is the most economically frugal means of mitigating environmental impacts. These types of programs should be continued and should include some education showing the benefits to Long Island Sound water quality and sediment habitat health. This project proposes that LISS will promote these types of pollution prevention programs by providing educational outreach showing the link from home to the Sound and increasing citizen knowledge of the threats to the health of Long Island Sound. This could be accomplished either through direct production (by LISS) or through local grants, for Education/Outreach or Social Marketing type projects.

Cooperators and Partners: EPA LISO, NYSDEC, CTDEEP, and other LISS partners.

Funding Sources: LISS program funds, Long Island Sound Futures Fund

Funding Needs: $

Expected Outputs:

- Long Island Sound centric brochures and flyers promoting chemical/medicine take back programs
- Local social marketing take-back events and promotional campaigns
- Increase public awareness and participation of proper disposal of mercury containing consumer products.
- Reduced nonpoint sources of metal and harmful organic compounds.
- Reduced levels of in-situ LIS water column contaminants.
- Reduce levels, over time, of embayment sediment contaminants.

Performance Metric(s): Number of take back programs per year in Connecticut and New York. Number of grants and literature products produced/distributed per year.

Implementation Status: Underway

Expected Timeframe: 2015–2019.

Implementation Action: WW-19

Encourage state and local health departments to adopt emerging rapid bacterial detection technologies that would allow shorter duration administrative beach/shellfish closings than those based on rainfall only.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-2: The negative impacts of contaminants and nutrients in the waters and sediments of Long Island Sound and tributaries/embayments are reduced.
Objective:	1-2b: To mitigate impacts of nutrients and contaminants to human health and to the biota and ecosystem of Long Island Sound.
Strategy:	1-2b2: Reduce human health risks through increased or targeted pathogen beach and embayment monitoring and fish and shellfish contaminant testing.

Project Description/Background: While temporary beach and shellfish closures based on rainfall criteria only are an important management tool to avoid bacterial contamination and illness, emerging technologies such as rapid bacterial detection could increase human health protection and reduce resource use impairments. Rapid testing techniques, including QPCR and other DNA based technologies for detecting *E.coli* and fecal coliform are becoming less expensive and a reliable method for more accurately determining when beaches need to close, and when they can re-open. As the feasibility of these technologies are demonstrated, state and local health departments should adopt them in their testing programs.

Cooperators and Partners: Individual municipalities would ultimately be responsible. LISS could provide logistical and planning assistance and possibly some funding for pilot programs in association with state shellfish and beach safety programs. In Connecticut, the State Department of Public Health would oversee monitoring detections technologies for bathing beach monitoring programs and the State Department of Agriculture, Division of Shellfish and Aquaculture would oversee for detection monitoring of shellfish areas.

Funding Sources: LISFF could fund pilot studies, feasibility analysis, etc. Other assessment funding would come from interested municipalities, which already generally do some monitoring.

Funding Needs: $$

Expected Outputs:
- Reduced beach and shellfish closures
- Better science informing management decisions.

Performance Metric(s):
- If a method can be shown to be effective, fewer beach/shellfish bed closure days compared to rainfall based criteria only.

Implementation Status: New

Expected Timeframe: 2016–2019 for pilot scale/feasibility studies. If shown effective, wide scale implementation would take an additional two to five years.

Implementation Action: WW-20

Evaluate challenges to implementation of bioextraction in Long Island Sound, including use conflicts, economic viability, permitting and testing requirements and potential environmental impacts, and make recommendations to overcome.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-2: The negative impacts of contaminants and nutrients in the waters and sediments of Long Island Sound and tributaries/embayments are reduced.
Objective:	1-2b: To mitigate impacts of nutrients and contaminants to human health and to the biota and ecosystem of Long Island Sound.
Strategy:	1-2b3: Develop and implement methods (e.g., bioextraction) for removal of nutrients and contaminants.

Project Description/Background: Pilot studies have demonstrated that aquaculture of shellfish and seaweeds such as kelp may have benefits in reducing nitrogen in the sound or in embayments. However, more widespread implementation of bioextraction will be difficult without further evaluation of the potential for use conflicts, economic viability, potential environmental impacts, public health concerns, and permitting and testing requirements. Shellfish filter the water, removing suspended solids, nutrients, and contaminants, and some algal species have very high growth and nitrogen assimilation rates. These aquaculture industries have the benefit of providing an ecosystem service, while also producing jobs and saleable consumer goods. However, the process of establishing bioextraction based aquaculture facilities is hampered by uncertainties about where the activities can take place and whether the activities can be sustainable over time. This action involves developing a report on the broader applicability and factors affecting implementation of bioextraction in Long Island Sound.

Cooperators and Partners: LISS could provide logistical and planning assistance and possibly some funding for a third party evaluation.

Funding Sources: LISFF. Possibly a LISS enhancement grant could fund the evaluation.

Funding Needs: $$

Expected Outputs:

- Report on factors affecting implementation of bioextraction in Long Island Sound and adoption by aquaculture industry.

Performance Metric(s):

- Implementation of bioextraction evaluation and permitting in Long Island Sound based on informed decisions by industry and regulators.

Implementation Status: New

Expected Timeframe: 2016–2019, with two to five years to contract and complete analysis.

Implementation Action: WW-21

Improve the permitting and certification process for new aquaculture projects with products intended for human consumption, particularly those projects with a bioextraction focus.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-2: The negative impacts of contaminants and nutrients in the waters and sediments of Long Island Sound and tributaries/embayments are reduced.
Objective:	1-2b: To mitigate impacts of nutrients and contaminants to human health and to the biota and ecosystem of Long Island Sound.
Strategy:	1-2b3: Develop and implement methods (e.g., bioextraction) for removal of nutrients and contaminants.

Project Description/Background: The ecosystem services provided by shellfish and rooted macrophytic seaweeds (e.g., kelp) are well known. Shellfish filter the water, removing suspended solids, nutrients, and contaminants, and some algal species have very high growth and nitrogen assimilation rates. Aquaculture industries, not only foster and enhance these ecosystem services, but they also produce jobs and saleable consumer goods. However, the process of establishing bioextraction based aquaculture facilities is hampered by the inability of these sites to be permitted for human consumption. Testing and permitting currently is a very lengthy process, involving many permit applications, regulatory constraints, and fees. A more streamlined process needs to be implemented. State permitting agencies, working with existing and perspective farmers, should evaluate opportunities to streamline the process of certification for new farms and/or farms seeking to expand to new products,

Cooperators and Partners: State agencies responsible for permitting. LISS/Sea Grant could provide logistical and planning assistance and possibly some funding for pilot programs.

Funding Sources: LISFF could fund pilot studies etc. Funding would ultimately come from the states, but in this case, the farmers might be asked to pay for their own expenses, as long as a process is in place.

Funding Needs: $$

Expected Outputs:
- Improved and streamlined ingredient testing procedures.
- Streamlined and timely permitting processes.
- More bioextraction based aquaculture operations.

Performance Metric(s):
- Acreage of bioextraction based aquaculture operations or N removal from bioextraction.

Implementation Status: New

Expected Timeframe: 2015–2019. With an improved process and other enhancements to shellfish management, aquaculture markets should drive expansion.

Implementation Action: WW-22

Estimate future phosphorus loading to Long Island Sound and its impact on Long Island Sound nutrient dynamics.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective:	1-3a: To further improve understanding of the causes and impacts of eutrophication and hypoxia.
Strategy:	1-3a1: Understand the effects that nutrient ratios (nitrogen, phosphorous, carbon) have on ecosystem function in freshwaters, embayments, and in Long Island Sound and consider them in setting nutrient control policies.

Project Description/Background: A great deal of attention is devoted to the management of nitrogen into Long Island Sound and reduction of nitrogen loading. As nitrogen loads continue to decrease, however, understanding phosphorus loads will become more important, as primary productivity in nearshore and mesohaline areas is sometimes limited by availability of phosphorus rather than nitrogen. Since phosphorus is the nutrient of concern in freshwater systems, we need to better understand the impact of these upstream management efforts on Long Island Sound nutrient dynamics and possible future impacts to the Sound water quality.

Cooperators and Partners: University/ independent research, USGS, with logistical and possibly funding assistance from LISS

Funding Sources: LISS program funds, Connecticut and New York Sea Grant programs, USGS, CTDEEP, NYSDEC.

Funding Needs: $$$

Expected Outputs:

- A better understanding of phosphorus dynamics on nutrient cycling in Long Island Sound. Incorporation into modeling efforts
- Published research papers and reports

Performance Metric(s): N/A

Implementation Status: New

Expected Timeframe: 2018–2019.

Implementation Action: WW-23

Improve ability of models and/or studies to estimate contaminant and nutrient loads in critical areas and evaluate the effectiveness of remedial actions.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective:	1-3a: To further improve understanding of the causes and impacts of eutrophication and hypoxia.
Strategy:	1-3a2: Better understand eutrophication dynamics, effects and mechanisms, and continue support for modeling and synthesis efforts and their application to management scenarios. 4-1a1: Identify science activities needed to transparently link outcomes and objectives to strategies and actions, setting priorities based on management relevance and scientific merits. 4-1c1: Transition existing and new models to a community modeling framework that provides open source access to facilitate external collaboration, assessments.

Project Description/Background: Despite extensive development, present ecosystem models of Long Island Sound are insufficiently sensitive to accurately run predictive eutrophication scenarios (such as estimating the impact of future wastewater treatment plant reduction), particularly in near-shore areas. By supporting projects from academic and independent analysts using modeling tools to estimate impact of nutrient (and potentially contaminant) load scenarios to Long Island Sound, we can better understand how potential nutrient management scenarios will impact the biology, chemistry, and physics of Long Island Sound. This could include field and synthetic efforts to refine parameter estimation in existing models, as well as efforts to implement an ensemble modeling approach to better manage uncertainty.

Cooperators and Partners: The LISS Management Conference partners and independent contractors.
5-state TMDL workgroup.

Funding Sources: LISS program funds, EPA/NOAA research grants. LISFF, other local grants.

Funding Needs: $$$

Expected Outputs: Improved capacity for eutrophication modeling either through improvements to existing models or development of an ensemble approach.

Performance Metric(s): Management decisions based on modeled load estimates. Reduced nutrient loads based on management actions.

Implementation Status: Underway. This IA would build on substantial ongoing modeling efforts in Long Island Sound

Expected Timeframe: 2015–2019 with future efforts likely to include broader ecosystem modeling.

Implementation Action: WW-24

Maintain and enhance the utility and efficiency of water quality monitoring of nutrient loads to Long Island Sound science and management efforts.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective: 1-3b: To research, monitor and assess water quality and factors that contribute to water quality change.
Strategy: 1-3b1: Improve identification and source tracking of nonpoint sources (e.g., watershed, groundwater, atmospheric deposition) and sinks of nutrients and their impacts on water and habitat quality.
4-1b4: Strengthen monitoring of conditions in embayments and near-shore waters, and integrate the resulting data and assessments into open water monitoring programs.

Project Description/Background: The Long Island Sound Study has a long-standing commitment to water quality monitoring. With the recent expenditures by Connecticut and New York towards reducing nutrient loading and hypoxia, it is critical to maintain a comprehensive, but efficient monitoring program, and to invest in new technologies that will improve the efficiency and/or resolution of our monitoring as we strive to manage adaptively in response to these changes. Rapid advancements in automation and miniaturization have fueled the development of new instruments and sensors that can greatly reduce lab and field sample analysis times. It is critical for LISS to invest in these technologies as soon as they are proven to be robust and reliable, as the long term cost savings could be substantial. Pilot studies for two such technologies (*in situ* primary productivity via fast repetition rate fluorometry and *in situ* nutrient analysis) are currently ongoing. This action will involve a systematic review of the Long Island Sound water quality monitoring program. Review findings will be used to further improve the program.

Cooperators and Partners: CTDEEP and IEC/New England Interstate Water Pollution Control Commission (NEIWPCC) presently conduct the LISS funded monitoring program. USGS and UCONN as well as many smaller agencies have other extant monitoring programs. LISS research and monitoring partners (DEEP, IEC, NOAA, UCONN, etc.). LISS could provide logistical support and possibly funding through the Water Quality working group.

Funding Sources: Approximately $1M of the LISS program funds support water quality monitoring, with additional funds *(approximately $200k)* coming from the state and from EPA 604(b) funding.

Funding Needs: $–$$.

Expected Outputs:
- Workshop in spring 2015.
- Assessment of ongoing pilot study using fast repetition rate fluorometry for primary production rate measurements and NERACOOS funded pilot study of *in situ* nutrient analyzers.
- Systematic review of long-term water quality monitoring dataset. Regular review and updates to monitoring technologies.

Performance Metric(s): N/A

Implementation Status: Underway

Expected Timeframe: 2015–2019. Assessments are ongoing with a workshop to be held in spring 2015. Future assessments may recommend substantial infrastructure investment to improve spatial and/or temporal resolution (e.g., increasing number of buoys and/or outfitting with *in situ* nutrient sensors).

Implementation Action: WW-25

Develop and implement a water quality monitoring strategy for nitrogen in the upper basin states of Massachusetts, Vermont, and New Hampshire.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective: 1-3b: To research, monitor and assess water quality and factors that contribute to water quality change.
Strategy: 1-3b1: Improve identification and source tracking of nonpoint sources (e.g., watershed, groundwater, atmospheric deposition) and sinks of nutrients and their impacts on water and habitat quality. 4-1b3: Evaluate, enhance, integrate, and coordinate ongoing monitoring programs. 4-1b4: Strengthen monitoring of conditions in embayments and near-shore waters, and integrate the resulting data and assessments into open water monitoring programs. 4-2a4: Enhance opportunities for cooperation and involvement of the tributary states of Massachusetts, New Hampshire, Rhode Island, and Vermont to address stressors that contribute to downstream effects on LIS.

Project Description/Background: Understanding the sources and partitioning of nutrient loading coming from the upper portions of the Connecticut River watershed is critical to understanding how to best implement effective nutrient management strategies for the upper basin states. This action involves developing and implementing a water quality monitoring strategy for nitrogen in the upper basin states with a stream gage near the Massachusetts/New Hampshire/Vermont state border on the Connecticut River. These data obtained from monitoring will be used to calibrate existing watershed models and/or conduct Nitrogen trend analysis and to confirm if TMDL allocations for the upper basin states have been achieved. Nitrogen trend analysis will be conducted and subsequent modeling (as needed) using in-basin and upper basin ambient water quality monitoring data on watershed contributions of nitrogen delivered to the Sound by source, tributary, and state. The most recent in-stream nitrogen trend study will be enhanced with additional analyses to examine the influences of precipitation and in-stream flow on nitrogen loading, and implications for nitrogen source load (nonpoint versus point source).

Cooperators and Partners: The state agencies of Massachusetts, New Hampshire, and Vermont their respective state municipalities. LISS TMDL workgroup and NEIWPCC.

Funding Sources: A combination of state and federal grants and loans primarily funded through each state's' respective SRF loan and grant programs and through EPA Grants. LISFF, LISS Enhancement grants or other local grants.

Level of Funds Needed: $$$

Expected Outputs: Regular monitoring and reporting on nitrogen concentrations in the upper watershed.

Performance Metric(s):
- Number of sites actively monitored for nitrogen.
- Quality of consolidated reporting and trend analysis of nitrogen levels in upper watershed.

Implementation Status: New

Expected Timeframe: 2016–2019.

Implementation Action: WW-26

Assess and identify the impact of emerging (e.g., PBDE, pharmaceuticals) and legacy (e.g., heavy metals, PCBs) contaminants on the ecosystem services and biota of Long Island Sound.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective:	1-3b: To research, monitor and assess water quality and factors that contribute to water quality change.
Strategy:	1-3b2: Research, monitor and assess emerging and legacy toxic contaminants and their impacts on water and habitat quality. 4-1a1: Identify science activities needed to transparently link outcomes and objectives to strategies and actions, setting priorities based on management relevance and scientific merits.

Project Description/Background: While many advances have been made with respect to reducing sources and managing legacy loads of contaminants such as heavy metals and PCBs, new research regarding the potential impacts of many emerging contaminants such as *pharmaceuticals, PBDEs, triclosan, etc.*, is raising concerns and new chemicals are continuing to be developed. In order to minimize environmental damage, research and monitoring is needed to better to understand and regulate new and emerging contaminants.

Cooperators and Partners: Academic partners, US EPA

Funding Sources: LISS program funds could fund small pilot tests/localized programs if identified. EPA funding for larger scale EPA-based effort.

Funding Needs: $$$

Expected Outputs: A report detailing loading sources, impacts, and management options for specific emerging contaminants.

Performance Metric(s): Number of areas monitored for key emerging contaminant indicators.

Implementation Status: New

Expected Timeframe: 2017–2019.

Implementation Action: WW-27

Develop water quality monitoring programs associated with coastal habitat restoration projects.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective: 1-3b: To research, monitor, and assess water quality and factors that contribute to water quality change.
Strategy: 1-3b3: Improve understanding of climate change impacts (e.g., acidification, sea level rise, temperature) on Long Island Sound water and habitat quality and biota, and their interaction with other water quality issues (e.g., eutrophication). 4-1a1: Identify science activities needed to transparently link outcomes and objectives to strategies and actions, setting priorities based on management relevance and scientific merits. 4-1b3: Evaluate, enhance, integrate, and coordinate ongoing monitoring programs.

Project Description/Background: In order to understand the impact of coastal habitat restoration projects on water quality and improve project design, it is necessary to monitor water quality conditions and changes at, in, and around habitat restoration projects. The need exists to develop water quality and shoreline transition monitoring programs associated with coastal habitat restoration projects in order to quantify nutrient, bacteria, and turbidity benefits. This action involves developing water quality monitoring programs that will document baseline (pre-restoration) conditions and post restoration conditions to determine level of project success, and steps to for improving post restoration management, as well as future project design. A water quality database will also be developed to document water quality changes at restoration project sites, as well as sites where there is anticipated water quality improvement. Additionally, a list of resources should be compiled for assistance in developing water quality monitoring plans/programs.

Cooperators and Partners: Various—based on lead partner for projects, and/or property owner; water quality monitoring groups (ex, at state and municipal level); LISS-NPS workgroup

Funding Sources: Various federal, state, and local funding sources

Funding Needs: $$-$$$ Will vary depending on project and partners

Expected Outputs:
- Water quality database to document water quality changes at restoration project sites
- A list of resources and contacts that can be called upon to develop water quality monitoring plans/programs.

Performance Metric(s):
- Number of water quality monitoring programs developed for coastal habitat restoration projects.
- Accessible water quality database for coastal habitat restoration projects
- List of specific areas of anticipated water quality improvement for certain restoration projects (ex. impervious surface reduced, riparian buffer widened etc.)

Implementation Status: New

Expected Timeframe:
2015—Identify existing and planned restoration projects for piloting (pre- and post-restoration).
2016—Initiate pilot water quality monitoring.
2017–2019—Establish monitoring guidelines for future restoration projects.

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Implementation Action: WW-28

Determine the level of spatial and temporal sampling needed to assess Long Island Sound water quality as impacted by climate change drivers (SLR, warming, acidification).

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective:	1-3b: To research, monitor and assess water quality and factors that contribute to water quality change.
Strategy:	1-3b3: Improve understanding of climate change impacts (e.g., acidification, sea level rise, temperature) on Long Island Sound water and habitat quality and biota, and their interaction with other water quality issues (e.g., eutrophication). 4-1b4: Strengthen monitoring of conditions in embayments and near-shore waters, and integrate the resulting data and assessments into open water monitoring programs. 4-3a1: Include important environmental drivers (e.g., climate change) in all relevant management planning initiatives. 4-1b3: Evaluate, enhance, integrate, and coordinate ongoing monitoring programs.

Project Description/Background: With billions of dollars invested in infrastructure upgrades to improve water quality in Long Island Sound, water quality monitoring is more critical than ever, since a comprehensive water quality monitoring program will help us adaptively manage and react to how the system responds to existing and future upgrades and to the impacts of climate change on those processes. Our understanding of how estuarine systems respond to the combined climate stressors of SLR, temperature increase, and acidification is limited. In addition, local conditions, such as nutrient enrichment and eutrophication, can amplify acidification through the microbial degradation of accumulated biomass, increasing the production of CO_2 and lowering pH. In a time of tight budgets, it is critical to statistically assess and review the extent (spatial and temporal) of monitoring that is necessary to detect anticipated results, and adjust monitoring to be as efficient as possible.

Cooperators and Partners: This is predominantly a research based project, and would likely be undertaken by a university or outside consulting firm. Probably with funding assistance from and oversight by LISS.

Funding Sources: LISS through LISFF, the research program, or the enhancement grant (Base +) program.

Funding Needs: $$–$$$

Expected Outputs:

- A more streamlined monitoring program and potential cost savings. Improved understanding of the impact of changing climate on water quality.

Performance Metric(s): N/A

Implementation Status: New. Some preliminary groundwork for this type of study is already underway

Expected Timeframe: 2017–2019, with one year for the study and depending on recommendations one to two years to implement changes, or potentially more if substantial infrastructure purchases (e.g., buoys) are required.

Implementation Action: WW-29

Complete LISS Sentinel Monitoring for Climate Change pilot projects and evaluate results to guide strategy development and future implementation.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective:	1-3b: To research, monitor and assess water quality and factors that contribute to water quality change.
Strategy:	1-3b3: Improve understanding of climate change impacts (e.g., acidification, sea level rise, temperature) on Long Island Sound water and habitat quality and biota, and their interaction with other water quality issues (e.g., eutrophication). 4-3a1: Include important environmental drivers (e.g., climate change) in all relevant management planning initiatives.

Project Description/Background: A comprehensive plan to monitor climate change impacts on key wildlife and ecosystem resources in Long Island Sound has been initiated. The focus is on coastal indicators with high biological potential to show climate responses, available historical data, ease of cost-effective future data collection, and the ability to inform real-world management decisions. A project has been funded to collect new data which and to compile existing data. Three projects have been funded to collect new data and to gather and compile historical data.

Cooperators and Partners: LISS Sentinel Monitoring Workgroup; NEIWPCC, UCONN, CTDEEP

Funding Sources: No funds needed

Funding Needs: In-kind

Expected Outputs:
A summary of the new and current data for the three sentinels identified in the project.

Performance Metric(s):
- A database for sentinel (I): several metrics of abundance, distribution, productivity, and phenology for focal bird species that depend on tidal marshes, beaches, and mudflats.
- A database for Sentinel (v): in zones where marine transgression is likely, in focal habitats (coastal forests, shrublands, grasslands) avian community composition, presence of tidal marsh plant indicators, and tree mortality.
- A database for sentinel (vi): areal cover, diversity, species composition, and phenology of dominant saltmarsh plants in conjunction with the bird monitoring, and at sites with past data
- Synthesis report of project data and development of next steps in the implementation of the strategy.

Implementation Status: New

Expected Timeframe: 2016—Completion of the second two pilot projects. 2017–2018—Synthesis of project reports and update of the Sentinel Monitoring for Climate Change Strategic Plan.

Implementation Action: WW-30

Conduct periodic (five year) review and revision of Sentinel Monitoring Strategy document.

Theme: Clean Waters and Healthy Watersheds
Goal: Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome: 1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective: 1-3b: To research, monitor and assess water quality and factors that contribute to water quality change.
Strategy: 1-3b3: Improve understanding of climate change impacts (e.g., acidification, sea level rise, temperature) on Long Island Sound water and habitat quality and biota, and their interaction with other water quality issues (e.g., eutrophication). 4-3a1: Include important environmental drivers (e.g., climate change) in all relevant management planning initiatives.

Project Description/Background: The bi-state effort for the development of a Sentinel Monitoring Climate Change Program (SMCCP) in Long Island Sound was formally adopted in 2009 and has continued efforts since then. A formal strategy was finalized and published to the LISS website in June 2011. The program was developed in response to a request from the Management Committee to be able to incorporate climate change impacts into their management decisions. The Sentinel Monitoring for Climate Change Strategic Plan identified 'Long Term Next Steps' that included "this strategy is intended to be a dynamic document, the bi-state work group recommends that it is reviewed in five years. In the long-term, the SMCCP will also seek funding for a full-fledged sentinel monitoring program."

Cooperators and Partners: The bi-state work group has representation from US EPA, NYSDEC, CTDEEP, NOAA, New York Sea Grant, and Connecticut Sea Grant. Additionally, the work group has state leads that can and have organized state technical work groups to contribute to the development of the program. The workgroup members would be responsible for review/revision

Funding Sources: Long Island Sound Study. EPA climate ready estuaries program

Funding Level: $. Since this task would be completed primarily by WG members, minimal funding would be required, but a small amount of funding would allow specific experts to help evolve the program.

Expected Outputs:

- Up to date sentinel monitoring strategy.

Performance Metrics: N/A

Implementation Status: New

Expected Timeframe: 2018–2019.

Implementation Action WW-31

Assess sources of nutrient and pathogen contamination to Long Island Sound embayments.

Theme:	Waters and Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-2: The negative impacts of contaminants and nutrients in the waters and sediments of Long Island Sound and tributaries/embayments are reduced.
Objective:	1-2b: To mitigate impacts of nutrients and contaminants to human health and to the biota and ecosystem of Long Island Sound.
Strategy:	1-3b4: Research, monitor, and assess pathogens, their sources and their impacts on water quality. 1-3b1: Improve identification and source tracking of nonpoint sources (e.g., watershed, groundwater, atmospheric deposition) and sinks of nutrients and their impacts on water and habitat quality. 4-1b4: Strengthen monitoring of conditions in embayments and near-shore waters, and integrate the resulting data and assessments into open water monitoring programs.

Project Description/Background: Embayments and near-shore area are in close proximity to sources of contamination from point and nonpoint sources and in many cases are hydrographically distinct from the main body of the sound. While steps have been taken to reduce overall loading to Long Island Sound, Sound wide reductions are often insufficient to address localized embayment level concerns. Pathogen contamination causes beach and shellfish closures and excess nutrients have the potential to affect wetlands and other resources and cause blooms of macroalgae and phytoplankton, including HABs, which can impact human health. This effort is currently underway in New York. A three-year project beginning in April 2015 will categorize Long Island embayments into "like groups" and then a representative from each category will be selected for a detailed analysis of the pathogen and nitrogen loads to those representative embayments from all sources. Once the loads from the representative embayments are determined, relative contributions from each source will be applied to estimate the pollutant loads within each of the embayments of a "like group". The Long Island Embayment project could act as a template for looking at embayments in other areas of Long Island Sound.

It is necessary to evaluate the relative contribution of sources of pathogens and nutrients to Long Island Sound embayments through sampling and modeling as a first step in the development of TMDLs or other management plans to protect resources and human use.

Cooperators and Partners: NYSDEC, CTDEEP, local governments, academic researchers

Funding Sources: States of New York and Connecticut and local governments, nonprofits and citizen action groups

Funding Needs: $$$

Expected Output:

- Enumeration and/or estimation of pathogen and nutrient loads from point and nonpoint sources to embayments

Performance Metrics: N/A

Implementation Status: Underway. A LISS research project (Vaudrey et. al) is measuring and modeling nutrients in embayments and New York State will be evaluating embayment pathogen and nutrient sources. Connecticut is developing TMDLs.

Expected Timeframe: 2015–2019.

Implementation Action: WW-32

Monitor and track occurrences and contributing factors of biotoxin and harmful algal bloom (HAB) outbreaks.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective:	1-3c: To improve understanding of the sources of nutrients and contaminants and how they interact with the ecosystem and human health.
Strategy:	1-3b5: Research, monitor, and assess Harmful Algal Blooms (HABs) and their impacts on water quality and public health.

Project Description/Background: Red tides, shellfish biotoxin (PSP, DSP), and other Harmful Algal Blooms (HABs) can have significant deleterious effects on biota and ecosystems services provided by Long Island Sound in addition to direct and indirect financial impacts (e.g., beach and shellfish closures; contaminated seafood). While there are a wide range of drivers, human activity, particularly eutrophication, is linked to an increased frequency of these events. Accurate monitoring and documentation of occurrences and contributing factors is necessary to help tease apart the causal factors of HABs and understand the impact of nutrient reduction actions for mitigating HABs.

Cooperators and Partners: Some monitoring is conducted by the states (CTDEEP/Interstate Environmental Commission (IEC)/NYSDEC). Additional sampling at a municipal/embayment level may be necessary. States/municipalities need to pay for testing, which could be passed on to harvesters via license fee.

Funding Sources: LISS program funds, NOAA HAB program funds. Additional study would likely require either an extramurally funded research grant, or a commitment to increased long term monitoring.

Funding Needs: Pilot $$. Full monitoring program $$$

Expected Outputs:

- A better understanding of HABs and the factors which drive them.
- Better tracking of pollutants to Long Island Sound (from embayment monitoring)
- Safer seafood.
- Develop a predictive coupled nutrient-hydrodynamic tool that is calibrated/verified by monitoring data to help prevent eutrophication and HAB outbreaks.

Performance Metric(s):

- Reduction of frequency and duration of HABs/HAB related closures.
- Frequency of pass/fail for DSP/PSP in shellfish.

Implementation Status: Underway

Expected Timeframe: 2016–2018 to establish a pilot monitoring program. Broad scale implementation would require sustained funding.

Implementation Action: WW-33

Develop a regional partnership that will continue to support the implementation and advancement of the LISS Sentinel Monitoring for Climate Change Program and integrate it with regional and national efforts.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective:	1-3c: To improve access and usage of information, databases, and resources and incorporation of data into management actions.
Strategy:	1-3c1: Support collaboration between Long Island Sound Study (LISS) partner organizations including upper basin agencies/partners (USGS, CTDEEP, CTDOA, NYSDEC, MassDEP, SCDHS, etc.) to improve utility of monitoring data and the sentinel monitoring program. 4-1b3: Evaluate, enhance, integrate, and coordinate ongoing monitoring programs.

Project Description/Background: The Sentinel Monitoring for Climate Change (SMCC) in Long Island Sound Program was developed to quantify local changes in the environment brought about by climate change. The SMCC workgroup, together with other elements of the Long Island Sound, works to integrate the results of the pilot study and next steps of the SMCC into the regular monitoring program of the LISS. However, the power of sentinel monitoring for climate change will only be realized if implemented on a regional basis. In addition, the LIS SMCC program will coordinate, to the extent possible, with regional and national observational organizations.

Cooperators and Partners: SMCC Work Group, LISS STAC, NOAA, Northeast Regional Ocean Council, Northeast Regional Association of Ocean Observing Systems, National Estuarine Research System.

Funding Sources: LISS program funds, NOAA, NROC, NERACOOS,

Funding Needs: $–$$

Expected Outputs:

- Regional sentinel monitoring

Performance Metric(s):

- Number of entities participating in regional sentinel monitoring collaborative.

Implementation Status: Underway

Expected Timeframe: 2015–2019. Efforts are already underway to establish and promote regional collaboration on sentinel monitoring. Full scale regional collaboration is likely to carry into the next cycle (2020–2025).

Implementation Action: WW-34

Continue to support, improve, and utilize the Sentinel Monitoring Data Citation Clearinghouse and other data synthesis, storage, and sharing efforts.

Theme:	Clean Waters and Healthy Watersheds
Goal:	Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
Outcome:	1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.
Objective:	1-3c: To improve access and usage of information, databases, and resources and incorporation of data into management actions.
Strategy:	1-3c2: Implement improved data storage and sharing solutions to support collaboration and incorporation of data into management decisions. 4-1b3: Evaluate, enhance, integrate, and coordinate ongoing monitoring programs.

Project Description/Background: A bi-state effort for the development of a sentinel monitoring climate change program in Long Island Sound was formally adopted in 2009 and has continued efforts since then. The program was developed in response to a request from the Management Committee to be able to incorporate climate change data and impacts into their management decisions. A formal strategy was finalized and published to the LISS website in June 2011. In response to need for a publically-available, geospatial database to serve as a central repository of research pertaining specifically to climate change in Long Island Sound, an online data citation clearinghouse was developed which includes data type, location, years of data collection and researcher contacts. The clearinghouse will facilitate collaboration, encourage data assessment and synthesis, and aid in the identification of data gaps and other research priorities. This will improve management of resources and climate adaptation Sound-wide. A computer server was purchased to house the clearinghouse at UCONN. A web portal cover page is currently being developed on the Long Island Sound Resources Center (LISRC) web site to allow for data manipulation. Long-term, it is anticipated that the 'Data Citation Clearinghouse' will be housed at the UCONN/ DEEP newly created Connecticut Institute for Resiliency and Climate Adaptation (CIRCA). This database structure may serve as a model for other programs, so this action may be applicable across many programs.

Cooperators and Partners: The bi-state Sentinel Monitoring work group has representation from US EPA, NYSDEC, CTDEEP, NOAA, and Connecticut Sea Grant. Additionally, the work group has state leads that can and have organized state technical work groups to contribute to the development of the program.

Funding Sources: Long Island Sound Study. EPA climate ready estuaries program

Funding Needs: Maintenance $ Substantial Upgrades: $$

Expected Outputs:
- Improved data sharing and collaboration

Performance Metric(s):
- Number of projects utilizing SM data clearing house.
- Number of webpage visits

Implementation Status: Underway

Expected Timeframe: 2015–2019.