Long Island Sound Study
A Partnership to Restore and Protect the Sound

Comprehensive Conservation and Management Plan 2020

Supplemental Document 1

Clean Waters and Healthy Watersheds (WW) Theme

Implementation Actions 2020-2024

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 how drivers of pollutant loads and management responses will affect current and future pollutant loads from point and nonpoint sources.	1-1a1, 1-1a2, 1-1a6
WW-2	**Continue to collaborate with municipalities, local partners and stakeholders to strategically plan for and implement capital improvements, Best Management Practices (BMPs), and improved operation and maintenance to mitigate point and nonpoint source pollution loadings, incorporating the analysis of potential future changes in loading (WW1).**	**1-1a1, 1-1a2**
WW-3	Expand point source and establish nonpoint source nutrient trading programs for the Long Island Sound watershed.	1-1a2
WW-4	Pursue opportunities to further improve nitrogen removal, including low-cost retrofits, at WWTFs throughout the watershed but particularly in the upstream states.	1-1a2
WW-5	Encourage municipalities to do sustainable asset management through their sewage collection system.	1-1a2, 1-1a6
WW-6	By 2024, develop a plan to meet the Ecosystem Target of having all practices and measures installed to attain the 2000 Dissolved Oxygen TMDL nitrogen allocations for stormwater and nonpoint source inputs for the entire watershed.	1-1a3, 1-1a6
WW-7	**Enhance implementation of the 2000 Dissolved Oxygen TMDL, particularly for nonpoint sources.**	**1-1a3, 4-2a4, 4-3b2**
WW-8	**Conduct studies and research to better understand the ecosystem's response to nitrogen reductions to support an evaluation of the 2000 Dissolved Oxygen TMDL.**	**1-1a3, 4-2a4, 4-3b2**
WW-9	Improve and enforce pesticide/herbicide/fertilizer regulations and other Best Management Practices for agriculture and urban turf.	1-1a5
WW-10	**Develop a nonpoint source and stormwater tracking system tool for the Long Island Sound watershed.**	**1-1a6, 1-1a7, 4-2a4**
WW-11	Develop and implement performance-based policies and strategies in support of Best Management Practices for decentralized wastewater management districts and on-site wastewater treatment systems.	1-1a7, 4-2a4
WW-12	**Improve understanding, management, design, and implementation of denitrifying decentralized and residential, on-site wastewater treatment systems.**	**1-1a7, 4-1a1, 4-2a4**

IA Number	Implementation Action Title	Major Strategies Addressed
WW-13	**Improve efficiency and resiliency of existing/new waste treatment systems including septic, WWTF and stormwater infrastructure to be resilient to sea level rise, storm surge, and intense storms and flooding.**	**1-1a8, 3-4a1, 3-4b1, 3-4b2, 4-3a1**
WW-14	Support collaborative and inclusive development of new and updated restoration/protection plans for Connecticut and New York embayment sub-watersheds with pollution load reduction targets.	1-1b1
WW-15	**Increase permanent land protection of riparian corridors and wetland buffers at the municipal level.**	**1-1b2, 2-1a2**
WW-16	**Promote establishment and protection of riparian corridors and wetland buffers at the municipal level through development of local ordinances.**	**1-1b2, 2-1a2**
WW-17	By 2024, develop a plan to meet the Ecosystem Target of decreasing by 10% the area of effective impervious cover in the Connecticut and New York portions of the watershed by 2035 relative to a 2010 baseline.	1-1b2, 2-1a2
WW-18	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-19	Improve environmental practices (boat wrap, bottom paint, pump out, etc.) at marinas.	1-2a1, 1-2a2
WW-20	Support activities to achieve trash-free waters.	1-2a1, 1-2a2
WW-21	Develop a comprehensive marine debris reduction plan.	1-2a1, 1-2a2
WW-22	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-23	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-24	Implement field studies with standardized procedures and clearly defined data acceptance metrics to demonstrate the use of microbial source tracking to help resolve local water quality challenges.	1-2b2
WW-25	**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-26	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

IA Number	Implementation Action Title	Major Strategies Addressed
WW-27	**Improve ability of models and/or studies to estimate contaminant and nutrient loads to embayments and evaluate the effectiveness of remedial actions.**	**1-3a2, 4-1a1, 4-1c1**
WW-28	**Maintain and enhance the management utility of water quality monitoring of watershed nutrient loads and ecosystem responses to Long Island Sound and its embayments.**	**1-3b1, 4-1b4**
WW-29	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-30	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
WW-31	Initiate contaminant level and effects monitoring in Long Island Sound embayments through an expansion of the NCCA monitoring protocols.	1-3b2
WW-32	**Improve the monitoring needed to assess the risk of climate change impacts including acidification on water quality.**	**1-3b3, 4-1b3, 4-1b4, 4-3a1**
WW-33	Implement the 2018 Sentinel Monitoring Strategy.	1-3b3, 4-3a1
WW-34	Conduct periodic (five year, or earlier) review and revision of Sentinel Monitoring Strategy document.	1-3b3, 4-3a1
WW-35	Assess sources of pathogens and nutrients and work with communities to abate or alleviate those sources.	1-3b4, 1-3b1, 4-1b4
WW-36	Monitor occurrences of biotoxin and HABs.	1-3b5
WW-37	Research contributing factors of HABs and biotoxin outbreaks and identify and execute mitigation actions.	1-3b5
WW-38	Maintain and strengthen the Long Island Sound Climate Change and Sentinel Monitoring Work Group and conduct 1-2 Sentinel Monitoring workshops by 2024.	1-3c1, 4-1b3
WW-39	Develop, maintain and share research and monitoring resources and supporting infrastructure with regional agencies/partners (USGS, NOAA, NERR, USFWS, EPA, CTDEEP, Project Oceanology, UConn, Stony Brook Univ., etc.) including but not limited to equipment, staff, vessels, docking facilities, etc.	1-3c1, 3-1b1, 4-1b3, 4-2b2
WW-40	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 how drivers of pollutant loads and management responses will affect current and future pollutant loads from point and nonpoint sources.

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. Additionally, the study should incorporate how management responses, such as, existing watershed plans (e.g., Suffolk County Subwatershed Wastewater Plan), BMPs, and non-structural actions (fertilizer legislation, education, etc.), will influence future nitrogen loading. Some work has been completed and some are underway to address this action. In 2020, the Suffolk County Subwatershed Wastewater Plan was developed to evaluate parcel-specific land uses of nearly 200 subwatersheds, establish nitrogen load reduction goals and ecological sensitivity priority ranks, and provide implementation recommendations. Additionally, under an agreement with EPA, NYCDEP awarded a contract to HDR, Inc. to develop the new Integrated Systemwide Eutrophication Modeling Tool by 2024. By integrating physical, biogeochemical, and ecological components researchers will be able to forecast how the Sound may respond to changes in human (e.g., pollution) and natural (e.g., weather) drivers that impact the system. The model will also enable managers to evaluate potential impacts of point and nonpoint source discharges, and sediment fluxes on water quality. These data will enable state and municipal managers to reinforce the need for implementing BMPs to mitigate these nutrient stressors. Currently, point source discharges are in compliance with permits derived from the 2000 Dissolved Oxygen TMDL, in New York and Connecticut, and the upstream states of Massachusetts, New Hampshire, and Vermont. Rhode Island is not included in the 2000 Dissolved Oxygen TMDL but is involved with Connecticut in watershed management of the Pawcatuck River.

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 including each state's respective State Revolving Fund (SRF) loan and grant programs, EPA grants, Long Island Sound Futures Fund (LISFF), and other local grants and private funds.

Funding Needs: $$$

Expected Outputs:

- Reports 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
- Completion of the Integrated Systemwide Eutrophication Modeling Tool

Performance Metric(s):

- Number of research studies investigating drivers and management responses affecting point and nonpoint sources

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-2

Continue to collaborate with municipalities, local partners and stakeholders to strategically plan for and implement capital improvements, Best Management Practices (BMPs), and improved operation and maintenance to mitigate point and nonpoint source pollution loadings, incorporating the analysis of potential future changes in loading (WW1).

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, agricultural practices, CSOs, and on-site wastewater. Continued 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 state's respective SRF loan and grant programs and state and municipal budgets, LISFF, enhancement grant, or other partner grant funding.

Funding Needs: $$$$

Expected Outputs:
- Municipalities incorporating special sewer districts, denitrifying decentralized treatment systems, and innovative and alterative on-site wastewater treatment systems through installation or replacement in the Long Island Sound watershed
- Planning grants will include estimates of expected sewer use, stormwater and agricultural runoff, and population fluctuation as well as anticipated flow rates and nutrient levels

Performance Metric(s):
- Number of watershed plans and LISFF funded plans that address wastewater, stormwater, and agricultural runoff improvements
- Number of projects funded through the states, local municipalities, and LISFF to improve WWTF, CSOs, stormwater runoff, agricultural infiltration and runoff, and septic systems

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-3

Expand point source and establish 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 to expand and support existing point source nutrient trading programs (such as Connecticut's Nitrogen General Permit and Nitrogen Credit Exchange Program) and evaluate establishing 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

Expected Timeframe: Discrete; 2020-2024.

Implementation Action: WW-4

Pursue opportunities to further improve nitrogen removal, including low-cost retrofits, at WWTFs throughout the watershed but particularly in the upstream states.

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 could further improve water and habitat (e.g., eelgrass) quality. 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. Municipalities should work with state agencies to identify and improve nitrogen removal capabilities in WWTF systems, particularly in the upstream states. 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 state's respective SRF loan and grant programs, and the LISS.

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

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-5

Encourage municipalities to do sustainable asset management through their sewage collection system.

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% of sewer infrastructure is assessed as in "fair" or worse condition, with 21% 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 will encourage municipalities to implement sustainable asset management through their sewage collection systems, by employing more active and routine investigations for identifying and eliminating dry weather discharges from combined sewers and sanitary sources using tracking studies. NYSDEC is currently working on revising their Municipal Sewage System Asset Management Guide, published in 2015, to provide technical support to municipalities in developing asset management plans (https://www.dec.ny.gov/docs/water_pdf/mssamguide.pdf). Further 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 state's 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 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
- Increased number of municipalities investigating conditions of wastewater infrastructure
- Increased repairs of sewer infrastructure
- Development of revised Asset Management Plan guidance with supporting tools for municipalities and subsequent increase in implementation of responsible asset management plans

Performance Metric(s):

- Number of municipalities with infrastructure contingency funding planning and mechanisms
- Number of tracking studies to identify and eliminate dry weather discharges from combined sewers and sanitary sources

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-6

By 2024, develop a plan to meet the Ecosystem Target of having all practices and measures installed to attain the 2000 Dissolved Oxygen TMDL nitrogen allocations for stormwater and nonpoint source inputs for the entire 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: 1-1a3: 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. 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: The allocations for nonpoint sources in the Long Island Sound 2000 Dissolved Oxygen TMDL require implementation of a variety of best management practices to control nonpoint source pollution. The ecosystem target is to have all the necessary practices to attain the 2000 Dissolved Oxygen TMDL nonpoint source allocations in place by 2025. Because it is difficult to directly monitor nonpoint source nutrient loads, a BMP tracking and modeling approach will be used to assess attainment of the 2000 Dissolved Oxygen TMDL stormwater and nonpoint source allocations. This approach will produce quantitative estimates of nitrogen load controlled as a result of those practices. The estimation of nitrogen load controlled will be used to measure attainment of the 2000 Dissolved Oxygen TMDL targets to reduce nitrogen loading from stormwater and nonpoint sources. LISS partners are currently engaged in developing a Nonpoint Source Tracking Tool and a Watershed and Nonpoint Source Decision Support Framework and Tool. The tracking tool can assist watershed states and their respective municipalities to develop plans to implement stormwater practices and measures (i.e. Green Infrastructure, stormwater BMPs, and sewer repairments) to meet the Long Island Sound 2000 Dissolved Oxygen TMDL load allocations for nitrogen in their respective portions of the Long Island Sound watershed.

Cooperators and Partners: NEIWPCC, NYDEC, CTDEEP, UConn CLEAR, and other regional partners.

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

Funding Needs: $$$

Expected Outputs:

- Completion of the Nonpoint Source Tracking Tool and Nonpoint Source Decision Support Framework and Tool
- Development of plans for Long Island Sound watershed states and their municipalities to install practices and measures to meet the 2000 Dissolved Oxygen TMDL
- Inventory of total GI and stormwater treatment
- Estimated nonpoint source reductions based on implemented BMPs

Performance Metric(s):

- Number of municipalities with implemented practices (GI and stormwater BMPs) and measures (sewer infrastructure repairments) in place
- Increased compliance levels of MS4s

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-7

Enhance implementation of the 2000 Dissolved Oxygen TMDL, particularly for nonpoint sources.

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: The Ecosystem Target is to have all the necessary practices to attain the 2000 Dissolved Oxygen TMDL nonpoint source allocations in place by 2025. A recent LISS evaluation of 2000 Dissolved Oxygen TMDL implementation (NEIWPCC 2014) demonstrated areas of success and opportunities to improve nitrogen reduction. Since the 2000 Dissolved Oxygen 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. This action will enhance implementation of the 2000 Dissolved Oxygen TMDL, particularly for nonpoint sources, based on the plans developed to meet the Ecosystem Target (WW-6). Currently, the states of Connecticut, New York, Massachusetts, New Hampshire and Vermont are implementing a tributary state WWTF permitting strategy, upgrading WWTFs, assessing current stormwater and nonpoint source pollution control effectiveness, understanding nitrogen loading to groundwater, and continuing development of a feasible tracking system for NPS nitrogen reductions.

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: $$$$–Implementation to achieve the 2000 Dissolved Oxygen TMDL

Expected Outputs:

- Implementation of Long Island Sound 2000 Dissolved Oxygen TMDL

Performance Metric(s):

- Continued reductions in nitrogen loading of point and nonpoint sources

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-8

Conduct studies and research to better understand the ecosystem's response to nitrogen reductions to support an evaluation of the 2000 Dissolved Oxygen TMDL.

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 2000 Dissolved Oxygen TMDL implementation (NEIWPCC 2014) demonstrated areas of success and opportunities to improve nitrogen reduction. Since the 2000 Dissolved Oxygen 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 Dissolved Oxygen TMDL and to assess additional actions needed. To evaluate the efficacy of the 2000 Dissolved Oxygen TMDL, this action will conduct studies and research to better understand the ecosystem's response to nitrogen reductions.

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, and the LISS.

Funding Needs: $$–Technical and scientific support for 2000 Dissolved Oxygen TMDL assessment

Expected Outputs:
- Better understanding of ecosystem's response to lower nitrogen levels
- Completion of an evaluation of and plan for 2000 Dissolved Oxygen TMDL assessment

Performance Metric(s):
- Attainment of 2000 Dissolved Oxygen TMDL waste load allocation
- Number of research studies completed to better understanding of ecosystem response to nitrogen reductions

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-9

Improve and enforce pesticide/herbicide/fertilizer regulations and other Best Management Practices 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 state's 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

Expected Timeframe: Ongoing, 2020-2024.

Implementation Action: WW-10

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. 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: The Long Island Sound 2000 Dissolved Oxygen TMDL and NPS and Watersheds Workgroups identified the need to develop a Nonpoint Source Tracking Tool 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 2000 Dissolved Oxygen TMDL required nitrogen reductions.

Cooperators and Partners: EPA Region 1, EPA LISS, NEIWPCC, 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 2000 Dissolved Oxygen TMDL
- Consistent guidance for data collection, implementation planning, and determining progress across the Long Island Sound watershed
- Complete and adopt Nonpoint Source Tracking Tool

Performance Metric(s):
- Number of implemented pilot programs
- Number of municipal and watershed tracking and reporting of BMPs
- Number of municipalities incorporating the Nonpoint Source Tracking Tool

Expected Timeframe: Discrete; 2020-2024.

Implementation Action: WW-11

Develop and implement performance-based policies and strategies in support of Best Management Practices for decentralized wastewater management districts 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, performance-based 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). In 2020, Suffolk County developed and adopted a Subwatershed Wastewater Plan to evaluate parcel-specific land uses of nearly 200 subwatersheds, establish nitrogen load reduction goals and ecological sensitivity priority ranks, and provide implementation recommendations. Other localities should also develop, implement, and/or enforce local laws and ordinances that promote and/or govern comprehensive management of on-site and decentralized wastewater treatment systems, including increased inspections, pump-outs, retrofits, and BMPs.

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 state's 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
- Number of adopted state and county regulations

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-12

Improve understanding, management, design, and implementation 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 and support 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 nitrogen from these sources, but it is still expensive, rarely required by law, and in some cases, still under development. Currently, NYSDEC is aggressively addressing this issue by using state and county funding programs to increase the efficiency and use of innovative and alterative septic systems. To date, Suffolk and Nassau Counties provided an immense amount of technical and financial support to their municipalities to improve existing OSWTS and install nitrogen removing septic systems. Additionally, Suffolk County has changed their local laws to require innovative and alternative systems on new construction, major home renovation, and at the time of system failures. CTDEEP is also making progress towards this action through the development of a Watershed and Nonpoint Source Decision Support Framework to inform policy makers, land managers and owners about nitrogen loading implications through a decision-support tool that connects land cover metrics to overall aquatic ecosystem health and nitrogen loadings. Additionally, CTDEEP is involved in modeling efforts to support future development of watershed scale action plans (TMDLs, TMDL alternatives, and Watershed Based Plans) to address nutrient-related impacts on coastal embayments. This action will continue to focus on and further improve the management, design, operations, and implementation of these systems throughout priority areas of the watershed.

Cooperators and Partners: Stony Brook University and other academic institutions. 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 nitrogen load reductions resulting from implementation

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

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-13

Improve efficiency and resiliency of existing/new waste treatment systems including septic, WWTF and stormwater infrastructure to be resilient to sea level rise, storm surge, and intense storms and flooding.

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 supporting utilities in modifying treatment plants to withstand future storm surge and developing Asset Management Plans. 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: $–$$$$

Expected Outputs:
- Projects focusing on improving efficiency and resiliency of existing and new waste treatment infrastructure
- List of plants and systems that will require upgrades to accommodate SLR, storm surge, and intense storms and flooding

Performance Metric(s):
- Number of municipalities that incorporate coastal adaptation and resiliency strategies for wastewater treatment infrastructure into their Asset Management Plans
- Number of assessments of changes necessary, and associated costs, to incorporate sea level rise (SLR), storm surge, and intense storms and flooding into existing policies

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-14

Support collaborative and inclusive development of new and updated restoration/protection plans for Connecticut and New York embayment sub-watersheds with pollution load reduction targets.

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 Sound-wide 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). In New York, Suffolk County has completed their Subwatershed Wastewater Plan, incorporating all nine elements (https://suffolkcountyny.gov/Departments/Health-Services/Environmental-Quality#SubWWPlan). In addition, Nassau County's Subwatershed Wastewater Plan is underway. This action will continue to support collaborative and inclusive development of new and updated embayment sub-watershed plans to achieve pollution load targets. As plans are being implemented, it is essential to track the effectiveness of the approved plans and their implementation in reducing stressors that cause 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 state's respective SRF loan and grant programs and through EPA Grants. LISFF, other local grants.

Funding Needs: $$–$$$

Expected Outputs

- 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 Nine Element watershed management plans
- Number of waterbodies removed from the 303(d) list of impaired waterbodies per watershed

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-15

Increase permanent land protection of riparian corridors and wetland buffers at the municipal level.

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 corridors 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 increase permanent land protection of riparian corridors and wetlands buffers at the municipal level. These goals may be progressed through the acquisition of real property, or by educating, incentivizing, and facilitating protection of riparian buffers on private property since acquisition isn't always an option. At the municipal level, land use, zoning, and setback requirements, implemented by local ordinances, can be used to achieve this increase in land protection. LISS partners will work with local officials and private landowners to encourage permanent land protection at the municipal level.

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 state's 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):
- Acres of land permanently protected

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-16

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

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 develop local ordinances that will promote the establishment and protection of riparian corridors and wetland buffers, in which will maintain the important ecosystem services of these systems. 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 state's 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 trainings and resources provided to municipalities
- Number of municipalities incorporating riparian and buffer zone regulations into planning and zoning
- Riparian buffer acres (already tracked by UCONN CLEAR in Connecticut)

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-17

By 2024, develop a plan to meet the Ecosystem Target of decreasing by 10% the area of effective impervious cover in the Connecticut and New York portions of the watershed by 2035 relative to a 2010 baseline.

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: Impervious cover, particularly near water bodies, has been shown to be associated with degradation of water quality into the Long Island Sound. Compared to pervious cover, which filters runoff, impervious cover causes rainfall to carry pollutants to storm drains and tributaries of rivers that flow into the Sound. Through implementation of green infrastructure and low impact development (green roofs, permeable parking lots, rain gardens, etc.), pollutants carried by runoff can be filtered and treated before entering into the Sound. LISS has established Impervious Cover as an Ecosystem Target with the goal to decrease the area of effective impervious cover in the Connecticut and New York portions of the watershed by 10% by 2035, relative to a 2010 baseline. To achieve this goal, there is a need to develop a plan, by 2024. Meeting this target requires an average reduction in the effective impervious cover of 0.4% per year from 2010-2035. This is a difficult target to address and developing a plan by 2024 will facilitate efficient future progress.

Cooperators and Partners: LISS, UConn CLEAR, state agencies of Connecticut and New York and their respective state municipalities.

Funding Sources: LISS program funds.

Funding Needs: $$–$$$

Expected Outputs

- A plan that describes the strategy and activities needed to attain the effective impervious cover target

Performance Metric(s):

- Funds allocated and project partners established
- Estimates of impervious surfaces from satellite imagery
- Estimates of effective impervious cover due to green infrastructure (GI)

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-18

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. Additionally, 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. This action will support the implementation of each states' stormwater permit guidance requiring all new development and substantial redevelopment to capture and infiltrate runoff from the 90th percentile storm. LISS partners will encourage all coastal municipalities to implement the state recommendations for onsite retention and infiltration.

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

Expected Timeframe: Discrete; 2020-2024.

Implementation Action: WW-19

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: 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, and marina owner/operators (with LISO assistance).

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

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-20

Support activities to achieve 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: 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: 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. This action will support activities to achieve trash-free waters.

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: $$

Expected Outputs:
- Long-term reduction in amount of marine debris in Long Island Sound
- Annual #DontTrashLISound campaign

Performance Metric(s):
- Debris collected per unit effort in clean-ups
- Number of projects that include reducing, preventing, or educating about marine debris

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-21

Develop a comprehensive marine debris reduction plan.

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: 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: 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. Funding has been granted to Connecticut and New York Sea Grant to develop a Long Island Sound marine debris management plan 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: Connecticut Sea Grant, New York Sea Grant, 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: $$

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):
- An engaged interagency Long Island Sound Marine Debris Planning Team meeting regularly to collaborate and make progress on the reduction plan
- Debris collected per unit effort in clean-ups

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-22

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: 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 Long Island Sound 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, CTDEEP promotes information on household and facility waste collection permits - https://portal.ct.gov/DEEP/Waste-Management-and-Disposal/Hazardous-Waste/Permitting-and-Reporting-Requirements-for-HHW and 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, and 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. In New York, NYSDEC promotes information on proper disposal of medications - http://www.dec.ny.gov/chemical/45083.html, household hazardous waste - http://www.dec.ny.gov/chemical/8485.html, and mercury - http://www.dec.ny.gov/chemical/285.html. In addition, NYSDEC has a Take Back Law requiring pharmaceutical manufacturers to fund statewide pharmaceutical drug take-back programs. Pharmaceutical manufacturers are responsible for all costs of the initiative including public education and awareness, as well as the collection, transport, and proper disposal of unwanted drugs. The law requires chain pharmacies (with 10 or more locations) and mail-order pharmacies to provide consumers with on-site collection using kiosks, prepaid mail back envelopes, or other federally approved methods to encourage, safe, convenient and environmentally responsible disposal of unwanted medications. The law also allows other pharmacies to voluntarily serve as authorized collectors and participate in the Drug Take-Back program, with costs covered by the manufacturers.

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, LISFF.

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
- Increased 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 Long Island Sound water column contaminants

- Reduced 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

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-23

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: 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 bed 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
- Number of studies evaluating the effectiveness of rapid testing techniques/methods

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-24

Implement field studies with standardized procedures and clearly defined data acceptance metrics to demonstrate the use of microbial source tracking to help resolve local water quality challenges.

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: 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: Significant rainfall events can trigger precautionary closure of beaches and shellfish harvest areas in anticipation of stormwater overflow that increases risk of potential contamination. An increased understanding of bacterial sources combined with improvement of emerging rapid bacteria detection technologies will ensure closures are in response to actual environmental conditions and hazards.

In response to stakeholders' needs for validated methods for microbial source tracking to characterize human sources of fecal pollution in recreational waters, EPA conducted a study to assess method performance of Methods 1696 and 1697. In March 2019, the EPA published guidance on these two methods to characterize human fecal pollution in water using quantitative polymerase chain reaction (qPCR) assays: EPA 821-R-19-002 (Method 1696) and EPA 821-R-19-003 (Method 1697). These methods can be used to identify trends in human fecal contamination, to provide additional information to support water quality management decisions, and to help determine actionable outcomes that can potentially improve public health protection of recreational waters. Additionally, the LISS community should support piloting emerging rapid bacterial detection technologies and implementation of technologies that are shown to be scientifically sound and feasible. The piloting of these technologies can lead to a better understanding in the use of these methods in beach and/or shellfish bed closures – leading to greater public use of the Sound.

Cooperators and Partners: Local, State, Regional, and Federal Agencies and NGO's, Water Quality Monitoring networks.

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:

- Development of standardized procedures and defined data acceptance metrics

Performance Metric(s):

- Number of field studies tracking microbial sources
- Number of studies using new microbial source methods (listed in summary)

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-25

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.

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: 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 state differences in permitting and testing requirements. Shellfish filter the water, removing suspended solids, nutrients, and contaminants, and some algal species, like seaweed, remove nutrients through their 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. Through NYSDEC's Nutrient Bioextraction Initiative, efforts are underway to develop a shellfish aquaculture permitting guide based on existing permitting requirements, and an interactive shellfish aquaculture permitting roadmap. These projects will help current and new aquaculturists understand the permitting requirements, and create a more streamlined process. Additionally, the initiative is conducting a study to deliver market information for bioextracted products and the economics of bioextraction, which will help overcome the economic viability challenge. This action will continue to develop reports 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:

- Reports on technical and regulatory components (use conflicts, economic viability, environmental impacts, public health concerns, and permitting and testing requirements) 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

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-26

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: 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, like seaweed, remove nutrients through their 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. Bioextraction efforts are most useful in impaired waterbodies (excess nutrients), and these nutrient-impaired waterbodies often have other related issues (pathogens, pharmaceutical, and other contaminants) that may affect their ability to grow food for human consumptions. Because of this, 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. Efforts are underway in Suffolk County to implement their Shellfish Aquaculture Lease Program Ten Year Review Process to further seaweed cultivation. It is important to recognize that Connecticut and New York handle permitting processes differently, and are at different stages in the process (specifically, seaweed aquaculture), and therefore each 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
- Increased bioextraction based aquaculture operations

Performance Metric(s):

- Acreage of bioextraction based aquaculture operations or nitrogen removal from bioextraction

Expected Timeframe: Discrete; 2020-2024.

Implementation Action: WW-27

Improve ability of models and/or studies to estimate contaminant and nutrient loads to embayments 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 and support 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 embayments. 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.

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
- Reduced nutrient loads based on management actions
- Management decisions based on modeled load estimates

Performance Metric(s):
- Number of improved modeling tools to estimate nutrient loading impacts
- Number of management decisions based on modeled load estimates

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-28

Maintain and enhance the management utility of water quality monitoring of watershed nutrient loads and ecosystem responses to Long Island Sound and its embayments.

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 LISS 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 to address watershed nutrient loads and ecosystem responses. Additionally, it is essential 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.

Cooperators and Partners: CTDEEP and IEC/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 $3M of the LISS program funds support water quality monitoring.

Funding Needs: $$$$

Expected Outputs:
- Systematic report of long-term water quality monitoring dataset
- Regular review and updates to monitoring technologies

Performance Metric(s):
- Increased number of existing monitoring programs, parameters collected, and new technologies

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-29

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 a nitrogen trend analysis and to confirm if 2000 Dissolved Oxygen 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. Long Island Sound 2000 Dissolved Oxygen 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.

Funding Needs: $$$

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

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-30

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 and support 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
- Number of studies assessing and investigating contaminant impacts on ecosystem services and biota

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-31

Initiate contaminant level and effects monitoring in Long Island Sound embayments through an expansion of the NCCA monitoring protocols.

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.

Project Description/Background: Monitoring of emerging and legacy contaminant (PBDE, pharmaceuticals, heavy metals, PCBs, etc.) levels and effects in the Long Island Sound is needed to fully understand their status and impacts on the ecosystem. In 2015 and 2020, CTDEEP conducted a field program under the National Coastal Condition Assessment (NCCA) Program to characterize nutrients, sediments, and benthic macroinvertebrate communities at 23 open water sites of the LIS. In addition, LISS has provided $500,000 of FY20 funds to extend this effort to 60 sites in Long Island Sound embayments, where the NCCA will also be implemented. Through these projects, the LISS has initiated this action in 2020, but should further evaluate and consider opportunities to continue embayment sampling on a more frequent basis (i.e., more than every 5 years). This action will continue contaminant monitoring through this NCCA program, and therefore improve and protect water quality, habitat, and biological and ecological diversity in the Sound and its embayments that suffers from contamination effects.

Cooperators and Partners: EPA, CTDEEP, NYSDEC, and research institutions.

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

Funding Needs: $$-$$$; will vary depending on project and partners

Expected Outputs:

- Data on 60 embayments using he NCCA monitoring protocols

Performance Metric(s):

- Partnership agreement with NCCA
- Number of embayments monitored for key emerging contaminant indicators

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-32

Improve the monitoring needed to assess the risk of climate change impacts including acidification on water quality.

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). 4-1b3: 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. 4-3a1: Include important environmental drivers (e.g., climate change) in all relevant management planning initiatives.

Project Description/Background: With billions of dollars invested in infrastructure upgrades to improve water quality in Long Island Sound, water quality and quantity monitoring is more critical than ever, since a comprehensive 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 changes, 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:

- An analysis that identifies data gaps in monitoring for climate impacts
- A more streamlined monitoring program and potential cost savings
- Improved understanding of the impact of changing climate on water quality

Performance Metric(s):

- Number of studies investigating combined climate stressors of SLR, temperature increase, and acidification on the Long Island Sound

Expected Timeframe: Discrete; 2020-2024.

Implementation Action: WW-33

Implement the 2018 Sentinel Monitoring Strategy.

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 2018 Sentinel Monitoring Strategy (see https://longislandsoundstudy.net/wp-content/uploads/2018/07/LIS-SMstrategy-Version2_FINAL.pdf) has been developed to quantify local changes in the environment brought about by climate change. 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. The ultimate goals of the strategy are to 1) collect and synthesize data that will indicate how Long Island Sound and its associated habitats, biota, and processes are changing, and 2) utilize sentinel data to provide scientists and managers with the information necessary to prioritize climate change impacts and determine appropriate adaptation and mitigation strategies for these impacts to the Long Island Sound ecosystem. With FY2020 funds, there will be a sentinel monitoring workshop held in either the fall 2021 or spring 2022 to make progress towards achieving the strategy's goals.

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

Funding Sources: LISS, Federal and State Agencies, LISFF.

Funding Needs: $$/year

Expected Outputs:
- Development of a Sentinel Monitoring Network
- Identification of current monitoring programs and gaps in parameter monitoring
- Synthesis report of outcomes of the sentinel monitoring workshop, and recommended next steps in the implementation of the strategy
- Identification of opportunities for collaboration to establish critical research programs (that do not already exist), foster needed technological advancements, and implement long term monitoring and modeling
- Increased communication and outreach to managers about available data and predictions to develop and implement management decisions and adaptation strategies
- Actively update the Long Island Sound sentinel monitoring webpage

Performance Metric(s):
- Number of LISS sentinel monitoring workshops to help identify additional data, centralize all the available data, and develop a monitoring network
- Number of community science groups to help collect sentinel data, such as marsh trends
- Completed project in support of Sentinel Monitoring efforts

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-34

Conduct periodic (five year, or earlier) 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." Volume 2 of the Strategy was finalized and published in 2018, identified priority sentinels for long-term monitoring, and provided recommendations for next steps. The next review is due by 2023.

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: LISS and the EPA climate ready estuaries program.

Funding Needs: $; 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

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action WW-35

Assess sources of pathogens and nutrients and work with communities to abate or alleviate those sources.

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:	1-3: 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:	1-3b4: 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. Current embayment efforts are ongoing through New York's Long Island Nitrogen Action Plan, and Connecticut's 2nd Generation Nitrogen Strategy. Both plans will work with communities to abate or alleviate pathogen and nutrient sources to the Long Island Sound and its embayments.

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 2000 Dissolved Oxygen TMDLs or other management plans to protect resources and human use.

Cooperators and Partners: NYSDEC, CTDEEP, local governments, academic institutions.

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:

- Number of embayments that have specific plans/studies that assess pathogens or nutrients

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-36

Monitor occurrences of biotoxin and HABs.

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:	1-3b5: 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)

Performance Metric(s):

- Number of monitoring programs that document HAB occurrences

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-37

Research contributing factors of HABs and biotoxin outbreaks and identify and execute mitigation 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:	1-3b: To research, monitor and assess water quality and factors that contribute to water quality change.
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. Continued research is necessary to determine contributing factors of HABs and biotoxin outbreaks, and identify and execute mitigation actions.

Cooperators and Partners: Academic institutions, LISS, NYSDEC, and other federal and state agencies.

Funding Sources: LISS program funds and NOAA HABs program funds.

Funding Needs: $$

Expected Outputs:

- Safer seafood
- Improved water quality and habitats
- Increased recreational opportunities
- Develop a predictive coupled nutrient-hydrodynamic tool that is calibrated/verified by monitoring data to help prevent eutrophication and HAB outbreaks

Performance Metric(s):

- Number of studies researching contributing factors of HABs and biotoxin outbreaks
- Reduction of frequency and duration of HABs/HAB related closures
- Frequency of pass/fail for DSP/PSP in shellfish

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-38

Maintain and strengthen the Long Island Sound Climate Change and Sentinel Monitoring Work Group and conduct 1-2 Sentinel Monitoring workshops by 2024.

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. This action will support the continuation of the Long Island Sound Climate Change and Sentinel Monitoring Work Group and will conduct 1-2 Sentinel Monitoring workshops in 2021-2022. In addition, the SMCC program will coordinate, to the extent possible, with regional and national observational organizations, including, but not limited to New York Ocean Acidification Task Force and Connecticut's Governors Council on Climate Change.

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):

- Proportion of entities participating in regional sentinel monitoring collaborative

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-39

Develop, maintain and share research and monitoring resources and supporting infrastructure with regional agencies/partners (USGS, NOAA, NERR, USFWS, EPA, CTDEEP, Project Oceanology, UConn, Stony Brook Univ., etc.) including but not limited to equipment, staff, vessels, docking facilities, etc.

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. 3-1b1: Provide information products that educate communities about the health of Long Island Sound and about the collaborative efforts to restore and protect the Sound. 4-1b3: Evaluate, enhance, integrate, and coordinate ongoing monitoring programs. 4-2b2: Identify critical funding needs for protection and restoration projects, science, education, and involvement, and relate these needs to available or new funding sources.

Project Description/Background: Protecting the Long Island Sound has been and will continue to be a collaborative effort. Much of the progress that has been completed to date was accomplished through partnerships working toward a common goal. This action is intended to provide a tool for project collaboration and resource sharing. Knowledge, monitoring data, resources, assets, and infrastructure that can be shared via partnerships create opportunities for reduced cost and implementation time and thus increase efficacy of the program. Partnerships with federal, regional, and state agencies, non-governmental organizations, and other LISS partners should be considered whenever possible. More specifically, this action will provide a tool for project collaboration with the proposed Long Island Sound National Estuarine Research Reserve (NERR) and other LISS partners (SC-8).

Cooperators and Partners: LISS, USGS, NOAA, NERR, USFWS, EPA, CTDEEP, Project Oceanology, UConn, Stony Brook University.

Funding Sources: LISS, federal and state agencies, academic institutions.

Funding Needs: $; A repository for data sharing has been a continuous topic of discussion that relates to this action. Additional specific needs are unclear but require partners to think creatively about implementing programs in collaborative ways.

Expected Outputs:
- Increased collaborations
- Increased compatibility of programs and data utility

Performance Metric(s):
- Number of collaborations that use resources and funding efficiently

Expected Timeframe: Ongoing; 2020-2024.

Implementation Action: WW-40

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 publicly-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: LISS, EPA climate ready estuaries program.

Funding Needs: $–Maintenance, $$–Substantial Upgrades.

Expected Outputs:
- Improved data sharing and collaboration
- Continue to have a functioning and expanded Sentinel Monitoring Data Clearinghouse

Performance Metric(s):
- Number of webpage visits
- Increased number of projects utilizing Sentinel Monitoring Data Clearinghouse

Expected Timeframe: Ongoing; 2020-2024.