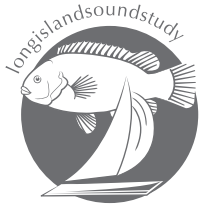
Long Island Sound Comprehensive Conservation and Management Plan 2015

Returning the Urban Sea to Abundance



Long Island Sound Comprehensive Conservation and Management Plan 2015

Returning the Urban Sea to Abundance

Authorized by Congress in 1985, the Long Island Sound Study (LISS) involves federal, state, interstate, and local government agencies, non-government organizations, industries, universities, and community groups to restore and protect the Sound. This report was a collaborative effort prepared by the Long Island Sound Study.

We wish to thank the members of the CCMP core team; they were crucial for completing the CCMP, giving of themselves beyond the call of duty in providing insights and spending many hours of work with stringent deadlines, representing their agencies and the LISS community with integrity. The Long Island Sound Study is also grateful to all the stakeholders who attended public meetings, provided comments, and worked with the program during the CCMP development process.

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All commitments made in this CCMP are subject to the availability of appropriated funds and the budget priorities of the EPA, the states of Connecticut and New York, and the organizations that participate in the Long Island Sound Study. Nothing in this plan, in and of itself, obligates the Long Island Sound Study, EPA, or the states of Connecticut and New York to expend appropriations or to enter into any contract, assistance agreement, interagency agreement, or other financial obligation.

CONTENTS

Four supplemental documents detailing the Comprehensive Conservation and Management Plan Implementation Actions by theme are available at: **www.LongIslandSoundStudy.net**

Over the past 20 years,
federal, state, and local partners
have worked together to reduce
by 40 million pounds the
annual discharge of nitrogen,
restore 1,625 acres of habitat,
reopen 317 miles of fish passage,
and involve hundreds of thousands
of people in education and volunteer
projects to help bring Long Island Sound
back to health and abundance.

✦

Now these partners,
under the Long Island Sound Study,
have developed a new Comprehensive
Conservation and Management Plan
to move forward to achieve more
ambitious ecosystem targets
for the next 20 years.

Town Beach, Old Saybrook, CT. (Photo by Judy Preston)

SECTION 1

RESTORING THE URBAN SEA

INVESTING IN THE FUTURE

Human habitation and use is part of the character of Long Island Sound. It was with that spirit that the American statesman Daniel Webster, in the 1800s, called it the "American Mediterranean." Long Island Sound has proved resilient to the changes human development has wrought to its lands and waters. In the 400 years since Adriaen Block's exploration of its shores, the lands and communities around Long Island Sound have changed from forest to field, from agriculture to town and city, and from a manufacturing-based to service-dominated economy. Active efforts to protect and restore the Sound have succeeded to the point of considering a return to abundance—not to a pristine past, but to an "Urban Sea" (Koppelman et al. 1976), where humans enjoy both a healthy environment and a thriving economy.

In fact, the health of the Sound and the waters that drain into it is inextricably tied to the health of an economy that directly supports the people living in the watershed. Natural, functioning habitats provide a variety of goods and services such as flood and storm protection, water filtration, recreation, commercially and recreationally-important fish and bird populations, carbon sequestration, and other functions. Investing in these natural assets can bring real returns—clean water, healthy habitats, and sustainable and resilient communities. The result? Beaches open for summer fun, increased opportunities for recreational boating and fishing, increased areas for shellfish harvesting, rivers open for ocean-going fish to return to spawn, and wetlands and eelgrass that nurse living resources and protect coastal communities from storms. These are just a few of the tangible benefits of the social, recreational, and commercial uses of the Sound.

◀ **VOLUNTEERS PLANT DUNE GRASS SHOOTS** and native shrubs at Rocky Neck State Park, East Lyme, CT, a Long Island Sound Stewardship Area. (Photo by Bob Lorenz for Save the Sound)

THE LONG ISLAND SOUND STUDY

Federal legislation enacted in the 1970s created the nation's core environmental protection and conservation programs, such as the Clean Water Act, Coastal Zone Management Act, and Endangered Species Act. This legislation and corresponding programs led to measurable improvements in pollution control and water and habitat protection, despite an ever-increasing use of the Sound and an ever-growing population within its watershed. These programs, however, were not tailored to the specific conditions of Long Island Sound as an ecosystem, nor did they address the cumulative impacts from regulated and unregulated activities on its health.

> The health of the Sound and the waters that drain into it is inextricably tied to the health of an economy that directly supports the people living in the watershed.

In recognition of the need to improve management, Congress appropriated funds in 1985 for the US Environmental Protection Agency (EPA) to research, monitor, and assess the health of Long Island Sound. Congress formally strengthened the Clean Water Act in 1987 to protect the nation's coastal waters by creating the National Estuary Program (Section 320). The Act authorized the EPA, in cooperation with the states of Connecticut and New York, to develop a Comprehensive Conservation and Management Plan (CCMP) for protecting and improving the health of Long Island Sound. In 1990, Congress amended the Clean Water Act again, passing the Long Island Sound Improvement Act (Section 119), which established a Long Island Sound

Using the 1994 CCMP as a blueprint for restoration and protection, the LISS refined environmental commitments and management priorities as part of action agreements in 1996, 2003, 2006, and 2011. Cooperating LISS partners have translated the plan, year-by-year, into actions that have resulted in a Long Island Sound with cleaner water, healthier habitats, and a more aware and engaged public.

program office and further strengthened EPA's role in coordinating implementation strategies through cross-jurisdictional partnerships.

To support development of the plan, EPA and the states of Connecticut and New York in March 1988 established the Long Island Sound Study (LISS), a Management Conference involving federal, state, interstate, and local agencies, universities, environmental groups, industry, and the public. The Long Island Sound Management Conference is organized around several committees and work groups, and is coordinated by a program office. The current structure of the Management Conference is shown in Figure 1. The Policy Committee, comprised of the administrators of the EPA Region 1 and Region 2 offices and the commissioners of the Connecticut Department of Energy and Environmental Protection (CTDEEP) and the New York State Department of Environmental Conservation (NYSDEC), approves major policy initiatives and plans such as the CCMP. An Executive Steering Committee, at the Assistant Commissioner, Bureau Chief, or Division Director level within those same agencies, provides direction to the Management Committee on programs and budgets and recommends items for Policy Committee consideration and approval. The Management Committee meets quarterly to develop annual work plans and budgets, plan and oversee projects, and assess progress and challenges. The annual work plans that are approved by the committee provide an overview of the program, highlight specific CCMP goals, reflect implementation of current and past priorities, and highlight the federal, state, local, and regional partners' significant accomplishments to restore and protect the Sound. This Management Committee is comprised of representatives of the major federal, state, and interstate agencies, and the co-chairs of the two advisory committees. Staff-level representatives of the Management Committee participate on an Implementation Team that coordinates and carries out program activities, developing annual work plans and budgets.

There are two advisory committees to the Management Conference. The Citizens Advisory Committee (CAC) communicates citizen concerns about the Sound and its management, provides advice on public education activities, and builds a constituency to support the implementation of the CCMP. Members represent a cross section of groups and organizations that use, or have concerns about, Long Island Sound, including: environmental, conservation, and watershed associations; the user community, including business, industry, real estate, sport and commercial fisheries, recreation, and boating; regional and local government; and environmental education. The Science and Technical Advisory Committee (STAC) provides objective scientific and technical guidance to the Management Committee, working to synthesize research results, identify priority science needs, and support collaboration among the region's scientists. Its members are engineers and scientists from government agencies, academia, industry, and private organizations, who represent a cross section of backgrounds and areas of expertise that are important to understanding and managing Long Island Sound.

The Management Conference includes technical work groups of regional experts to collaborate and coordinate on specific issues. The Management Committee may form and disband work groups as needed to address specific issues or challenges.

In 1994, the states of Connecticut and New York and EPA approved a *Long Island Sound Comprehensive Conservation and Management Plan* (Long Island Sound

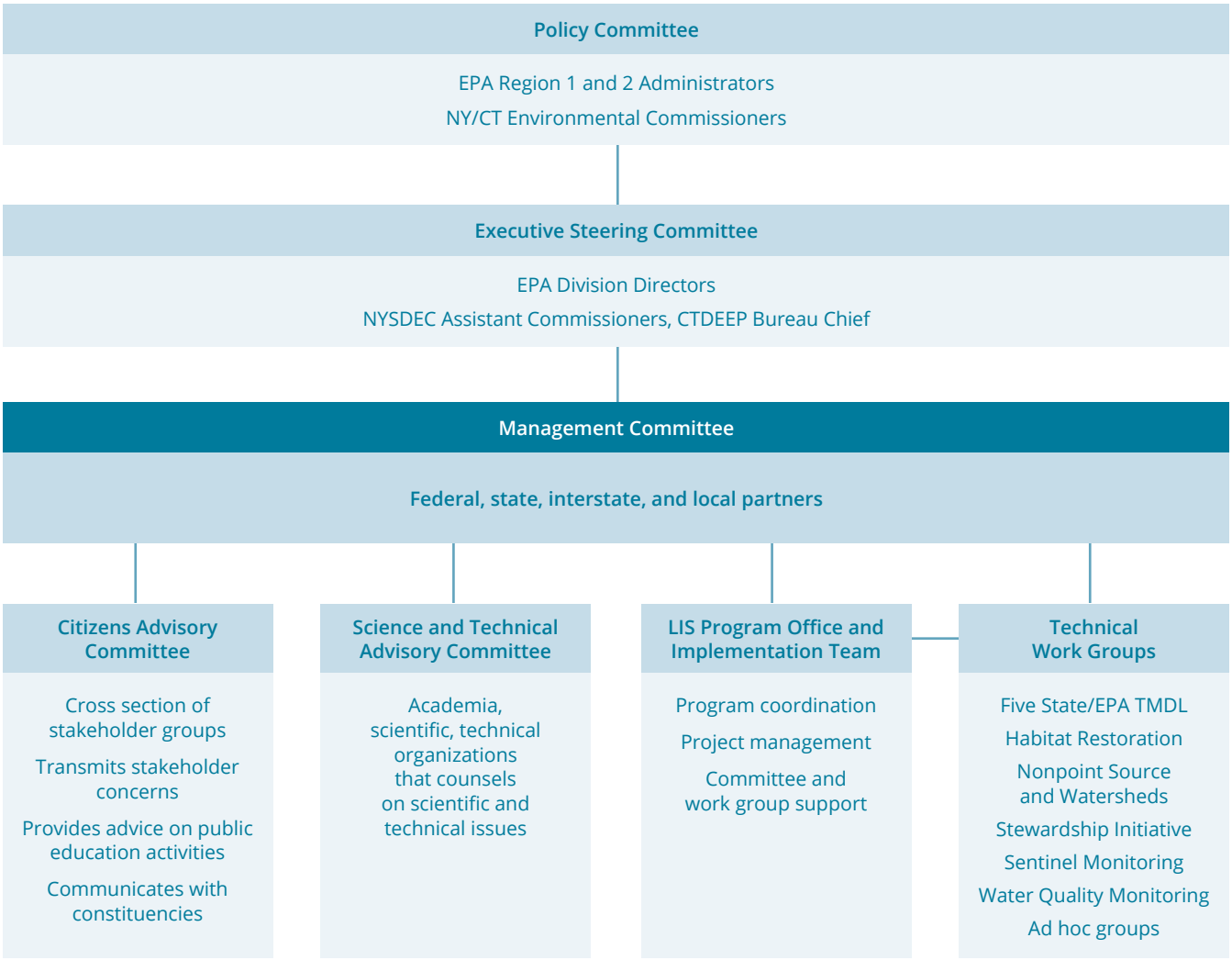


FIGURE 1. Management Conference Structure (under the 1994 CCMP)

Study 1994) to protect and restore the health of Long Island Sound. This plan, developed under the bi-state LISS partnership, outlined actions to improve the quality and health of the waters and habitats of Long Island Sound.

The 1994 plan addressed six priority problems:

1. **Low dissolved oxygen (hypoxia).**
2. **Toxic contamination.**
3. **Pathogen contamination.**
4. **Floatable debris.**
5. **The impact of these water quality problems and habitat degradation and loss on the health of living resources.**
6. **Land use and development resulting in habitat loss and degradation of water quality.**

From its inception, the LISS decided not to involve itself organizationally with fishery management, recognizing that there are existing multijurisdictional planning programs (the New England and Mid-Atlantic fishery management councils and the Atlantic States Marine Fisheries Commission) that operate at the appropriate regional scale. Instead, the LISS focused on water and habitat quality within the Sound, which can affect species abundance and diversity, thus avoiding duplication of effort.

Using the 1994 CCMP as a blueprint for restoration and protection, the LISS refined environmental commitments and management priorities as part of action agreements in 1996, 2003, 2006, and 2011. Cooperating LISS partners have translated the plan, year-by-year, into actions that have resulted in a Long

Island Sound with cleaner water, healthier habitats, and a more aware and engaged public. Coordinated action at multiple levels of government, the private sector, and the public has accomplished much in the 20 years since the original CCMP. A detailed list of accomplishments is included in Appendix A. Documentation on the CCMP, its implementation, environmental issues, and conditions in the Sound are extensively documented in print and on line from the LISS. Readers interested in more detail on any particular issue are encouraged to visit the Long Island Sound Study website at www.longislandsoundstudy.net.

But despite the progress, many challenges remain and new challenges have emerged such as the impacts of climate change. Recognizing that no action plan, no matter how good, can remain static over time, the LISS agreed to revise the CCMP to respond to the changing needs of communities, incorporate scientific and technological advances, and address new environmental challenges. To update the science of the Sound, the LISS STAC synthesized environmental data gathered on the Sound and its ecosystems over many prior years. Published in 2014, with the help of 55 contributing authors, *Long Island Sound: Prospects for the Urban Sea* (Latimer et al. 2014) synthesizes the advances in science made over the past decades in understanding Long Island Sound. To create a community vision of a restored Long Island Sound, the LISS CAC developed *Sound Vision: An Action Plan for Long Island Sound 2011–2020.* The *Sound Vision* document was the product of a collaborative process conducted by the CAC that included an extensive review of the 1994 CCMP, an assessment of LISS program expenditures and outcomes, and input from a wide range of stakeholders through facilitated workshops.

Now, 20 years after the approval of the original, the 2015 CCMP sets a course for the next 20 years, formally incorporating new approaches to:

- re-energize and broaden the current Management Conference around updated shared goals and cross-jurisdictional management;
- set measurable ecosystem targets and management outcomes;
- use strong science, ecosystem service concepts, and environmental indicators to adapt and refine management;
- incorporate new areas such as sustainability, climate change resiliency, and environmental justice; and
- expand public engagement and collaboration.

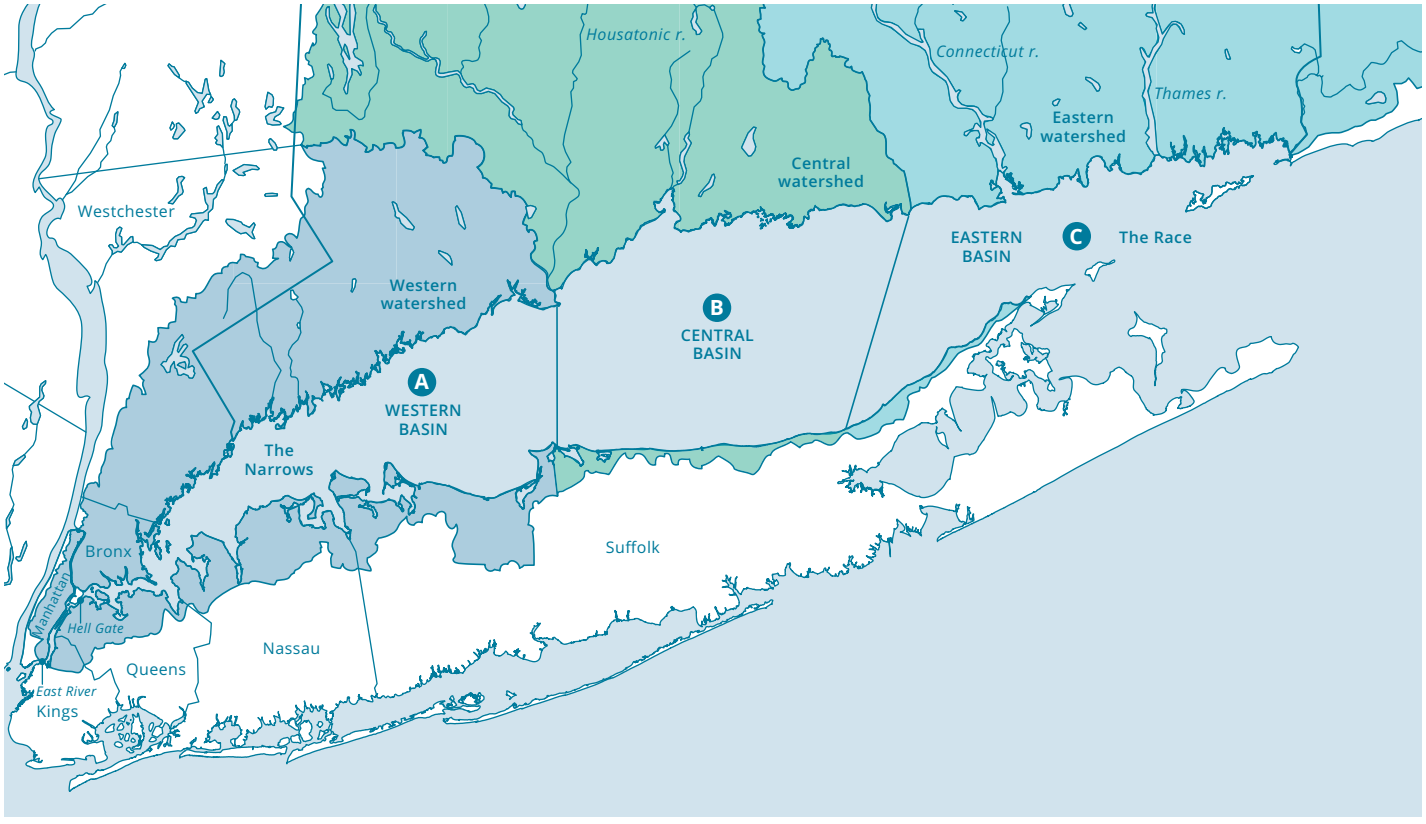
SECTION 2

GEOGRAPHY, HISTORY, AND HEALTH OF THE SOUND

GEOGRAPHY AND HYDROLOGY

Long Island Sound is an estuary, a body of water where salt water from the ocean mixes with fresh water from rivers draining from the land. It abounds in fish, shellfish, and waterfowl, and provides feeding, breeding, nesting, and nursery areas for diverse animal and plant life. The Sound is not a typical estuary, having two openings to the sea—at both its western (Hell Gate to the East River) and eastern (the Race to Block Island Sound) boundaries—and being oriented parallel to the coast. Long Island Sound extends 110 miles along its length and 21 miles across at its widest point. To assist in management and communication, four regions of the Sound have been identified—the Narrows, the Western Basin, Central Basin, and Eastern Basin (Figure 2). Mid-Sound depths range between 60 and 120 feet. Through the connection with the East River to the waters of New York-New Jersey Harbor, the Sound is affected by the New York City metropolis. For purposes of environmental management, the nearshore watershed of the Sound has been designated as the Long Island Sound Coastal Boundary Area (Figure 3). Through the series of south-flowing rivers, including the Housatonic, Connecticut, and Thames, large portions of New England also affect the Sound. In total, the Long Island Sound watershed (or drainage basin) drains an area of more than 16,000 square miles, covering

FIGURE 2. Long Island Sound Basins and Characteristics –
A. With its weaker currents and finer sediments, the Western Basin is more likely to trap pollutants.
B. The Central Basin is a transition zone between the two extremes.
C. The narrow channel and deep-bottom at the Race leads to fast moving currents that help to flush out pollutants.
(Map by Mapping Specialists and Lucy Reading-Ikkanda)



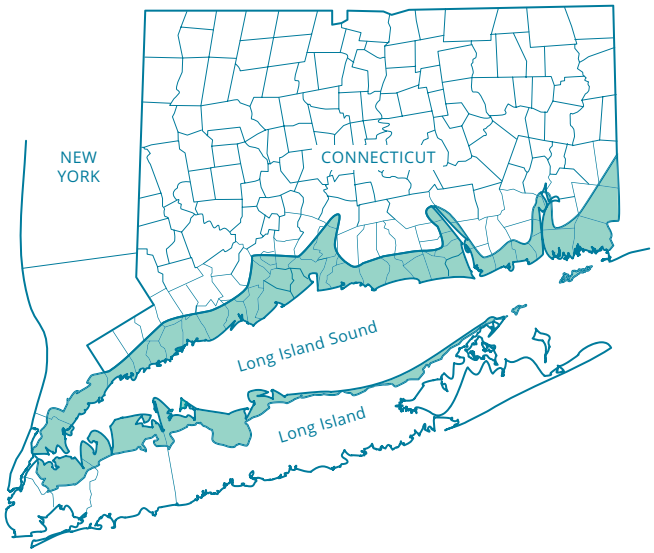
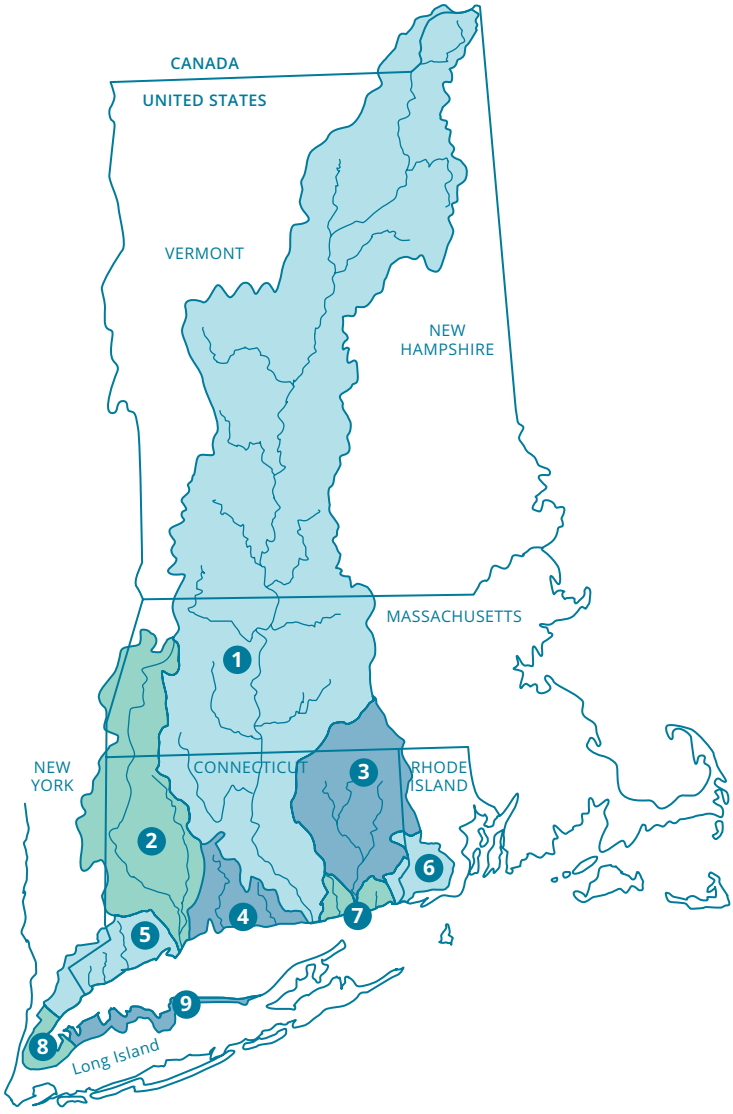


FIGURE 3. Long Island Sound Coastal Boundary Area (Map Source: LISS)



virtually the entire state of Connecticut, portions of New York, Rhode Island, Massachusetts, Vermont, and New Hampshire as well as a small area at the source of the Connecticut River in Quebec (Figure 4).

The physical setting for Long Island Sound and its watershed has been shaped by climatic and geologic events through time. The collision of the large tectonic plates that made up ancient Pangaea dramatically shaped the region's landscape, creating a north-south oriented bedrock grain sculpted and eroded by wind and water, then scoured by multiple glaciations. Rivers formed from melting glaciers during their wasting and retreat incised the rocky northern shoreline of Long Island Sound. This coastline is irregular and includes many coves and peninsulas. The Connecticut and Rhode Island coastlines are the longest stretch of low-energy, bedrock-dominated shoreline on the US Atlantic coast. In contrast, the south shore of Long Island Sound is formed largely from the coarse sediments deposited during glacial retreat. Long Island itself is a terminal moraine—a long ridge of sediment and rock pushed south by advancing glaciers and left behind during retreat. Within the recent geologic past, glacial meltwater formed the large freshwater lake known as Lake Connecticut, in the location now occupied by Long Island Sound. Large-scale watershed erosion brought massive amounts of sediment into the basin from the north. As the sea level rose with the melting of glaciers, marine waters flowed around Long Island and into the basin to form Long Island Sound.

The Sound has been in its present configuration for nearly 10,000 years. These geological and physical processes, together with the effects of increasingly dominant human activities since its European settlement in the early 1600s, have helped mold Long Island Sound into the "Urban Sea."

FIGURE 4. Land Area Draining to Long Island Sound –
1. Connecticut River
2. Housatonic River
3. Thames River
4. South Central Coast
5. Southwest Coast
6. Pawcatuck River
7. Southeast Coast
8. New York City
9. Long Island

(Map source: US Geological Survey)

HISTORY AND HEALTH

It is estimated that as many as 10,000 to 15,000 Native Americans lived on the shores of Long Island Sound prior to colonial exploration, thriving as hunters, fishermen, and farmers. Between 1612 and 1613, the Dutch merchant Adriaen Block became the first European to sail the length of Long Island Sound, helping to chart the Sound as he sailed (Figure 5). Block and his crew were searching for new commodities, particularly beaver pelts, for export to European markets. So began an intensified regional economy of natural resource exploitation. European settlers bought furs from local Native Americans, exploited oyster beds for food, and later dammed tributaries to power mills for industry (Andersen 2004).

From colonial times until the 1970s, many uses of Long Island Sound and the surrounding watershed were made without considering the environmental impacts. Overharvesting, habitat destruction, and pollution resulted in declines in fishery and wildlife resources. Diadromous fish populations suffered first, with Atlantic salmon and American shad runs becoming a tiny fraction of historic numbers along with declines in other herring species. Fishermen harvested menhaden intensively all along the Atlantic coast and exploited oyster reefs in the Sound with little thought of sustainability. Deforestation and industrialization resulted in the discharge of chemicals and deposition of sediments into the Sound. As the human population grew, sewage fouled waters and led to disease outbreaks.

Today, Long Island Sound lies in the midst of one of the most densely populated areas of the United States, with nearly 9 million people living in the watershed. Millions flock yearly to the Sound for recreation and the passive enjoyment of nature, and the Sound provides a critical transportation corridor for goods and people. Side-by-side these human uses, Long Island Sound continues to provide feeding, breeding, nesting, and nursery areas for diverse animal and plant life. The ability of the Sound to support these uses is dependent on the quality of its waters, habitats, and living resources.

Under the aegis of the 1994 CCMP, the LISS assessed conditions for each priority issue addressed. Technical support documents provided detail on each assessment. As recommended in the 1994 CCMP, LISS partners have continued to support and enhance data collection, management, analysis, and reporting on conditions. The LISS has regularly integrated this information to characterize conditions in a series of reports entitled, *Sound Health: Status and Trends in the Health of Long Island Sound* (LISS 2012). The LISS also tracks and reports on more than 60 environmental indicators (LISS 2014) from diverse data sources to characterize conditions. The 2015 CCMP relies on the extensive documentation of conditions in Long Island Sound from these sources as well as the scientific synthesis book, *Long Island Sound: Prospects for the Urban Sea* (Latimer et al. 2014). A brief summary of conditions and how they vary along the length of the Sound is presented in the following paragraphs.

Today, Long Island Sound lies in the midst of one of the most densely populated areas of the United States, with nearly

9,000,000

people living in the watershed.

Overall, the densely populated and developed Western and Narrows basins are the most stressed, with fair water quality the majority of the time, and with sediment and turbidity conditions rated as poor for half of the basin area (EPA 2008). Coastal development has resulted in a 60 percent loss of tidal wetlands in the most developed portions of the basin (Rozsa 1995). Contaminant levels in sediments, while declining, remain high, reflecting the legacy of historical industrial discharges. Extensive development and high population density results in more pollutants flushed from hard surfaces, such as roads and parking lots, into storm drains that connect to the Sound. The higher population also contributes a higher volume of sewage to wastewater treatment facilities and septic systems, more polluted runoff from stormwater, and increased vehicle emissions that deposit air pollution into the Sound and onto its watershed area. Here and elsewhere, aged sewage infrastructure can "leak" pathogens, particularly during rain events, causing the closure of bathing beaches or shellfish beds.

FIGURE 5. A section of a map of New Netherland showing Long Island Sound, as charted by Adriaen Block in 1614. (From the American Geographical Society Library, University of Wisconsin-Milwaukee Libraries)

In contrast, the Eastern Basin water quality is good most of the time (NCA 2008), reflecting subwatersheds with much less coverage by hard surfaces, much higher tidal basin flushing rates, and stronger subsurface currents (Poppe and Polloni 1998). Sediment and benthic conditions also improve from west to east, but pockets of impaired sediment remain in industrialized harbors in the east. Prior to the implementation of current wetland regulations, coastal development resulted in a 25 to 35 percent loss of tidal wetlands. In addition, tidal marshes that were not filled or dredged were often ditched for mosquito control, which altered hydrology and modified the marsh plant and animal communities (Dreyer and Niering 1995).

As a transitional zone between the Western and Eastern Basins, the water and sediment quality in the Central Basin varies, but is also typically better than in the Western Basin. The Central Basin waters have moderate currents that deposit fine sediments in the broad basin. The water is more quickly flushed and the surrounding land less developed than in the Western Basin, leading to improved water quality. Scientists consider the Central Basin as a harbinger of change in the Sound; it may either tend toward degradation or improvement depending upon human interventions.

Levels of contaminants in the water, sediments, and wildlife have declined over time. Nitrogen pollution is declining. By the end of 2014, wastewater treatment facilities achieved 94 percent of the nitrogen reduction goal established in the 2000 Dissolved Oxygen Total Maximum Daily Load (TMDL), which means 108,000 fewer pounds of nitrogen were discharged into the Sound every day. Eelgrass (*Zostera marina*), a rooted underwater plant with ribbon-like strands that forms meadows ecologically important for fish and shellfish, increased by 4.5 percent between 2009 and 2012, and 29 percent between 2002 and 2012 (Tiner et al. 2013). Additional actions to control nitrogen runoff from streets, landscaping, and farms, along with further wastewater treatment facility (WWTF) upgrades, are underway to reach defined reduction goals by 2017, with further improvements to water quality expected.

Since 1984, the overall biomass of finfish in the Sound has been relatively stable, in part due to cooperative federal-state fishery management programs and regulations beyond the purview of the LISS. However, cold-adapted species (such as winter flounder and Atlantic herring) have declined in abundance, particularly in spring, while warm-adapted species (such as black sea bass, butterfish, and summer flounder) have increased (Howell and Auster 2012). These changes are most likely due to steadily increasing water temperatures. Oyster populations are susceptible to old and new disease outbreaks, stimulated by warmer waters. Likewise, the die-off of lobsters in 1999 and the recent increase in the population of blue crabs can be attributed in part to warming waters (Pearce and Balcom 2005).

These findings indicate a Long Island Sound cleaner and healthier, but still impaired from pollution and habitat loss. Further improving the quality of Long Island Sound requires both addressing ongoing challenges and adapting to new conditions—already being felt—from climate change.

SECTION 3

VISION, GOALS, AND PRINCIPLES

VISION

"The vision for the Sound is of waters that are clean, clear, safe to swim in, and charged with life. It is a vision of waters nourished and protected by extensive coastal wetlands, by publicly accessible, litter-free beaches and preserves, and of undeveloped islands. It is a vision of abundant and diverse wildlife, of flourishing commercial fisheries, of harbors accessible to the boating community, and of a regional consciousness and a way of life that protects and sustains the ecosystem."

CCMP ORGANIZATION

The CCMP is organized around four themes, each with its own goal. The 1994 CCMP, and the Sound Vision themes developed in 2011, contributed to the development of the four themes of the 2015 CCMP (Figure 6).

- **Clean Waters and Healthy Watersheds:** Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.
- **Thriving Habitats and Abundant Wildlife:** Restore and protect the Sound's ecological balance in a healthy, productive, and resilient state to benefit both people and the natural environment.
- **Sustainable and Resilient Communities:** Support vibrant, informed, and engaged communities that use, appreciate, and help protect Long Island Sound.
- **Sound Science and Inclusive Management:** Manage Long Island Sound using sound science and cross-jurisdictional governance that is inclusive, adaptive, innovative, and accountable.

The 2015 CCMP also sets ambitious, but achievable, long-term targets for the ecosystem. These **ecosystem targets** are intended to drive progress toward attaining CCMP goals. Measuring, tracking, and reporting environmental indicators of each ecosystem target will provide information to assess progress and refine and adapt management as needed. The ecosystem targets are described in their relevant theme sections. To achieve each goal and associated ecosystem targets, the CCMP identifies specific outcomes, objectives, strategies, and implementation actions.

- **Outcomes:** Broad results needed to achieve goals.
- **Objectives:** Desired management accomplishments to support outcomes.
- **Strategies:** Broad, strategic actions needed to achieve an objective.
- **Implementation Actions (IAs):** Specific, tactical actions to measurably carry out the strategies over the next five years (2015–2019). Implementation actions may apply to one or more strategies, but are organized around the main strategy addressed. Review and development of implementation actions every five years will allow for adaptive management and inclusion of emerging scientific and technological advances.

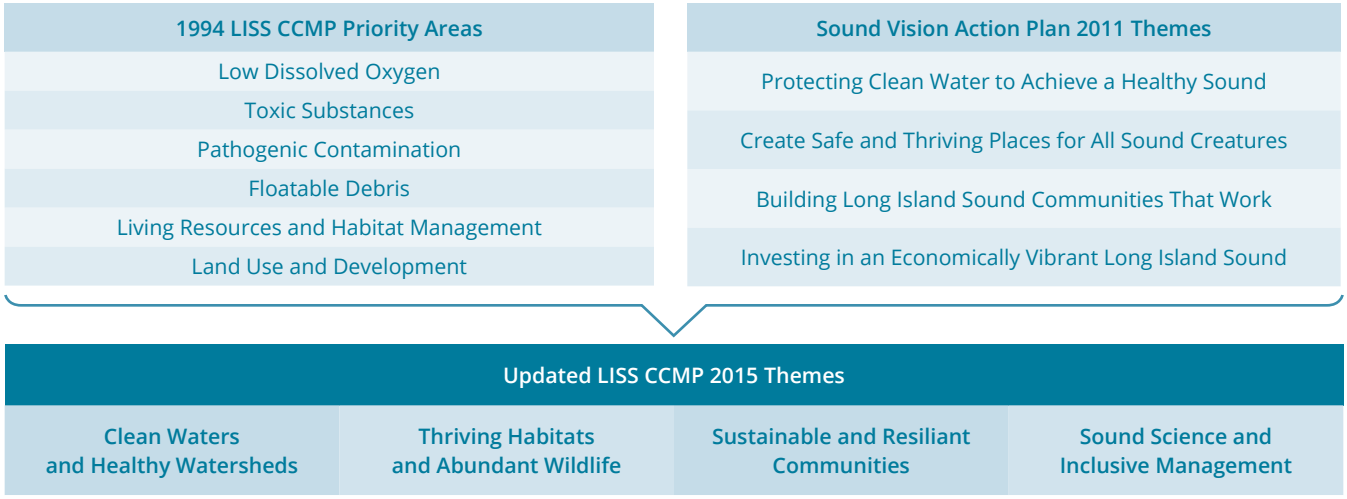


FIGURE 6. Development of Updated LISS CCMP 2015 Themes

UNDERLYING PRINCIPLES

Throughout the four themes, the CCMP incorporates integrative principles that have emerged as key challenges and environmental priorities. These include resiliency to climate change, long-term sustainability, and environmental justice.

RESILIENCY TO CLIMATE CHANGE

On October 29, 2012, Superstorm Sandy made landfall in southern New Jersey. The storm surge in parts of western Long Island Sound rose as much as nine feet above mean sea level. Flooding of industrial, commercial, and residential areas resulted in the release of chemicals and waste by-products (e.g., sludge, contaminated sediments, and hazardous chemicals) detrimental to human and environmental health, and made recovery operations more costly and lengthy.

While not directly caused by climate change, Superstorm Sandy dramatized some of the consequences that can be caused or exacerbated by it. To date, the changes to climate affecting the Sound have been subtle relative to the natural year-to-year variability in weather and to the significant consequences of human activity—port and industrial development, development of watersheds, hardening of the shoreline, destruction of wetlands, diversion of water courses, industrial and sewage pollution, and fishing pressure. But the impact of the storm surge, exacerbated by sea level rise, was anything but subtle. The need to understand and adapt to how a changing climate will affect the future state of Long Island Sound is one of the main reasons for updating this management plan.

The region must plan and prepare for increased air and water temperatures, increased water acidity, sea level rise, saltwater intrusion into aquifers, increased storm intensity and frequency, and changes in rainfall patterns associated with climate change. Understanding and adapting to climate change must be integrated across programs and activities to ensure a resilient Long Island Sound coastline and ecosystem. More frequent extreme weather events predicted as a consequence of climate change will increase the vulnerability of infrastructure and facilities to flooding, both from storm surges and watershed sources (e.g., rivers and streams). More intense storm events combined with sea level rise will increase the risk that wastewater treatment facilities, along with on-site septic systems and cesspools, will release large amounts of untreated waste into the Sound when overwhelmed by flood waters.

In addition to the built environment, natural habitats that are vulnerable to climate change impacts, particularly those that protect against flooding and contribute to carbon storage such as wetlands and eelgrass beds, need to be protected and restored to increase their resiliency to these impacts. Research, monitoring, and assessment should be conducted to better understand the impacts climate change has on Long Island Sound water quality and its marine and terrestrial habitats.

State and local governments are beginning to assess their at-risk infrastructure at many levels and develop resiliency plans to cost-effectively upgrade facilities to protect valuable equipment and minimize disruptions to critical services. Climate change adaptation and resiliency strategies need to be integrated into programs for new and existing development, housing, transportation, emissions

control, energy efficiency, and job creation. An important first step is incorporating sustainability and resiliency principles and objectives into municipal comprehensive plans (including hazard mitigation)—then building these concepts into zoning and building regulations.

LONG-TERM SUSTAINABILITY

Despite increases in human population and economic activity over the past 30 to 40 years, there have been slower rates of increase, or an overall decrease, in many air and water pollutants from regulated sources. This has been achieved mainly through the application of pollution control technologies and product bans, often stimulated by regulatory rulings. But environmental problems remain, caused by more diffuse, unregulated sources of pollution, from landscape changes, and from programs that just move pollution from one media such as air to another such as water. Sustainable development, defined as "meeting the needs of the present without compromising environmental quality and the ability of future generations to meet their own needs," can help mitigate these problems. Sustainability planning strives to balance current use and future need for energy and natural resources to maintain a healthy economy and environment over time.

Residential, industrial, and commercial development will remain a desired human use of landscapes; doing so sustainably will reduce energy costs, lessen the impact on water resources, and reduce the need for post-development remediation. Green infrastructure and low impact development (LID) are key components of sustainability planning and implementation, and can contribute to resilient natural and built environments. Green infrastructure uses natural soils, vegetation, and drainage to provide flood control, enhance habitat quality, and filter pollutants to protect or improve water quality. Planning and engineering LID practices reduce runoff and pollutant loading by lessening the area of impervious surfaces and protecting critical natural areas. Likewise, businesses can implement green manufacturing practices to reduce the use of toxic substances and mitigate the risk of spills.

Interestingly, a side effect of improving water, sediment, and habitat quality in the Sound is increased pressure to redevelop areas that previously were not considered desirable locations because of hazardous waste contamination, industrial activities, odors, or debris. Redevelopment of these sites can reduce pressure to develop green sites. Therefore, redevelopment projects must be seen as opportunities to enhance sustainability, with emphasis on climate change adaptation, stormwater management, public access, and habitat protection.

ENVIRONMENTAL JUSTICE

Environmental justice (EJ) is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. All groups must have access to healthy air and clean water. All communities must benefit from programs to protect and restore the Sound and have equal access to the decision-making process. This requires that special efforts target traditionally underserved communities, and that outreach and involvement programs work with community organizations to address their needs through a culturally aware delivery method. An informed, involved community that reflects the full diversity of the region is needed to ensure the stewardship of the Sound.

Environmental justice must be a priority reflected in how partners implement the CCMP. Federal, state, local government, and NGO partners should incorporate EJ as an integral part of ongoing work using a variety of approaches such as:

- reconnecting urban populations to the Sound and its tributaries, through education, activities, and access improvements (see IA SC-3 and SC-5);
- including EJ as a priority topic in requests for proposals for implementation projects (see IA SC-5);
- involving students from EJ communities into community-based water and habitat improvement projects (see IA HW-13 and HW-21);
- expanding opportunities for engaging traditionally under-represented groups in the LISS (see IA SM-20), and continuing consultation with federally-recognized tribes with ties to Long Island Sound;
- building local partnerships to capitalize on national EJ initiatives such as USFWS's Urban Schoolyard Habitat Program (see IA HW-21) and EPA's Urban Waters Program (see IA WW-13);
- considering the needs and perspectives of underserved communities to build grassroots support for local action (see IA SM-21, SC-6, SC-15, and SC-18); and
- promoting sustainable development such as stormwater management practices (e.g., rain gardens, green roofs, and rainwater harvesting) and natural riverine buffers in these communities (see IA SC-37 and SC-38).

THEME 1

CLEAN WATERS AND HEALTHY WATERSHEDS

Improve water quality by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.

CHALLENGES

- Further reducing nitrogen pollution requires addressing sources that are smaller, more diffuse, or more distant from the Sound.
- Polluted runoff from developed lands contaminates waters with pathogens, which result in closed beaches and restrictions on shellfish harvest areas.
- Aging infrastructure leaks untreated sewage to coastal waters.
- Water quality must be improved in bays and harbors to protect and restore submerged aquatic vegetation and benthic community health.

SOLUTIONS

- Reduce nitrogen from decentralized, on-site wastewater treatment systems and turf fertilizer applications.
- Work with states and communities in the entire watershed, not just in Connecticut and New York, particularly on low-cost upgrades to centralized wastewater treatment facilities.
- Document the economic and ecosystem consequences of nitrogen pollution from hypoxia, eelgrass and wetland loss, and increased vulnerability to acidification.
- Implement smart growth and low impact development policies to minimize the environmental impacts of new development while green infrastructure is increasingly added to areas already developed.
- Continue capital investments in wastewater treatment infrastructure.
- Identify and control local pollution sources through community-based watershed monitoring (including citizen science) and protection programs.

◀ **THE LOWER CONNECTICUT RIVER,** a Long Island Sound Stewardship Area, Old Lyme, CT. (Photo by Jerry Monkman/Ecophotography)

THEME 1

CLEAN WATERS AND HEALTHY WATERSHEDS

Clean water is the foundation of a healthy Long Island Sound—for human use and recreation, for thriving fisheries, and for productive habitats. The condition of the Sound depends on the quality of the waters draining from the landscapes surrounding it. This connection between the land and water, between healthy, sustainable upland communities and a healthy Long Island Sound is the foundation of the Clean Waters and Healthy Watersheds theme.

The issues affecting water quality in Long Island Sound that were the focus of the 1994 CCMP—low dissolved oxygen (hypoxia), toxic contaminants, pathogens, floatable debris, and land use and development—remain. Despite improvements, Long Island Sound still suffers from hypoxic "dead zones," beach closures, and other effects of contamination that keeps the Sound from meeting water quality standards. Addressing these issues requires integrated approaches to address polluted stormwater and ground water, contaminants of emerging concern, the resiliency of natural and built infrastructure, and land use planning that protects water resources, includes adaptation to changing climate and extreme weather, and ensures the sustainable use of the Sound's resources. The 2015 CCMP also places additional emphasis on assessing and improving the water and habitat quality of the Sound's embayments, where much of the public goes for recreation and enjoyment.

ECOSYSTEM TARGETS

The following ambitious, but achievable, ecosystem targets have been developed to drive progress toward attaining the **Clean Waters and Healthy Watersheds (WW)** goal. Achieving these targets can also contribute to the goals for the other themes. Likewise, multiple strategies and implementation actions throughout the four theme areas apply directly and indirectly to these targets. Measuring, tracking, and reporting environmental indicators of each ecosystem target will provide information to assess progress and refine and adapt management as needed. A detailed explanation about the rationale and quantification of these targets is included in Appendix B.

Extent of Hypoxia: Measurably reduce the area of hypoxia in Long Island Sound from pre-2000 Dissolved Oxygen TMDL averages to increase attainment of water quality standards for dissolved oxygen by 2035, as measured by the five-year running average size of the zone.

Nitrogen Loading: Attain WWTF nitrogen loading limits at the 2000 Dissolved Oxygen TMDL allocation level by 2017 and maintain the loading cap. Have practices and measures instituted to attain the allocations for stormwater and nonpoint source inputs from the entire watershed by 2025.

Water Clarity: Improve water clarity by 2035 to support healthy eelgrass communities and attainment of the eelgrass extent target.

Impervious Cover: Through green infrastructure, low impact development, and stormwater disconnections, decrease by 10 percent the area of effective impervious cover in the Connecticut and New York portions of the watershed by 2035 relative to a 2010 baseline.

Riparian Buffer Extent: Increase the percent area of natural vegetation within 300 feet of any stream or lake in the Connecticut and New York portions of the Long Island Sound watershed to 75 percent by 2035 from the 2010 baseline of 65 percent.

Approved Shellfish Areas: Upgrade 5 percent of the acreage restricted or closed for shellfishing in 2014 by 2035.

Sediment Quality Improvement: Reduce the area of impaired sediment in Long Island Sound by 20 percent by 2035 from a 2006 baseline.

Controlling nitrogen pollution remains the top priority for the region. *The Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound* (CTDEP, NYSDEC 2000) set allocations for nitrogen among five watershed states. The plan also identified steps to evaluate additional nitrogen reductions and alternative technologies while continuing monitoring and research programs to assess water quality standards attainment. Wastewater treatment facilities are the largest source of nitrogen. Connecticut in 2014 and New York by 2017 are on target to meet the reduction targets for these sources through investments to upgrade WWTFs. Nitrogen reductions from atmospheric deposition and agricultural sources are also meeting TMDL allocations. Nitrogen from on-site wastewater treatment systems, residential turf fertilizer applications and stormwater runoff, however, have remained level or increased (NEIWPCC 2014). To continue progress in attaining water quality standards it is necessary to manage adaptively, continuing to seek aggressive and practical nitrogen reductions from all sources while evaluating the effectiveness of these reductions. This is all the more important due to the changes in the ecosystem brought about by climate change that may make Long Island Sound more susceptible to hypoxia (Tedesco et al. 2014). With new information on the success of reducing nitrogen and the response of Long Island Sound to these reductions, the TMDL target will need to be assessed and revised as appropriate.

OUTCOMES, OBJECTIVES, STRATEGIES, AND IMPLEMENTATION ACTIONS

To accomplish the Clean Waters and Healthy Watersheds goal and to achieve progress toward the ecosystem targets, the plan includes specific outcomes, objectives, strategies, and actions. The Implementation Actions (IAs) have been formulated to carry out the WW theme strategies. All IAs are important to meeting the plan's objectives and outcomes. While recognizing that the priorities of each implementing organization will vary according to its mission and the purpose of available funds, the CCMP identifies the highest overall priorities, whether for new or underway actions, by consensus of the Management Conference partners. Highest priority actions are indicated by a "✦" symbol. The complete five-year implementation action plans (further described in Appendix C) are included in the supplement to the CCMP posted on the LISS website.

1-1 OUTCOME: 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.	WW-1: Evaluate the impact of increasing human population, climate change, and land use trends in the Long Island Sound watershed to determine nutrient and contaminant stressors on sewage loads from Wastewater Treatment Facilities (WWTFs)/Combined Sewer Overflows (CSOs) and decentralized/on-site wastewater treatment systems (OSWTS). WW-2: Strategically plan for and implement capital improvements, BMPs, and improved operation and maintenance to mitigate CSO, stormwater, and nonpoint source loadings, taking into account the analysis of potential future changes in loading (see WW-1).
Strategy 1-1a2: Evaluate and improve the clean water infrastructure for wastewater treatment facilities (WWTFs), conveyance systems, and associated sewer lines.	WW-3: Explore expansion of point source and nonpoint source nutrient trading programs for the Long Island Sound watershed. ✦ WW-4: Pursue opportunities to further improve nitrogen removal, particularly low-cost retrofits, at WWTFs, throughout the watershed. WW-5: Improve integrity of sewage collection infrastructure and institute sustainable asset management programs. Other Actions that support Strategy: WW-1, WW-2
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.	✦ WW-6: Enhance implementation of the 2000 Dissolved Oxygen TMDL and evaluate revision of the TMDL and allocations as needed to attain water quality standards. Other Actions that support Strategy: SM-23, SM-36

Strategy 1-1a4: Ensure cross department collaboration and cooperation at the municipal level to implement MS4 BMPs (e.g., involve highway departments).	✦ WW-7: Improve the reporting requirements of MS4 communities for Dissolved Oxygen TMDL implementation tracking to better quantify the effectiveness of control measures. Other Action that supports Strategy: SM-23
Strategy 1-1a5: Assess and mitigate agricultural nonpoint source loads.	WW-8: Improve and enforce pesticide/herbicide/fertilizer regulations and other Best Management Practices (BMPs) for agriculture and urban turf.
Strategy 1-1a6: Implement low impact development and green infrastructure for new and existing development, and mitigate pollution from commercial and industrial sources.	✦ WW-9: Develop a nonpoint source and stormwater tracking system tool for the Long Island Sound watershed. Other Actions that support Strategy: WW-1, WW-5, WW-15, SC-25, SC-26, SC-27
Strategy 1-1a7: Improve comprehensive management and performance of decentralized wastewater treatment systems, and residential, on-site wastewater treatment systems (OSWTSs).	✦ WW-10: Develop improved policies for use and performance of decentralized and on-site wastewater treatment systems. ✦ WW-11: Improve understanding, management, and design of denitrifying decentralized and residential, on-site wastewater treatment systems. Other Actions that support Strategy: SM-1, SM-23
Strategy 1-1a8: Incorporate climate change and sea level rise in planning, regulation, and BMPs for stormwater and wastewater treatment.	✦ WW-12: Improve efficiency and resiliency of existing/new waste treatment systems including septic, WWTF, and stormwater infrastructure to accommodate sea level rise. Other Actions that support Strategy: SC-23, SC-24, SC-25, SC-26, SC-29, SM-31

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.	WW-13: Develop watershed management plans for sub-watersheds, including urban areas, within the Connecticut and New York portions of the Long Island Sound watershed, and track their implementation and effectiveness.
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.	✦ WW-14: Promote establishment and protection of riparian corridors and wetland buffers at the municipal level through development of local ordinances and increased permanent land protection. Other Actions that support Strategy: WW-15, HW-3, SC-25, SC-26, SC-27

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.	WW-15: Support implementation of stormwater permit guidance requiring all new development and substantial redevelopment to capture and infiltrate runoff from the 90th percentile storm, (generally a 0.8–1.3 inch storm). Other Actions that support Strategy: WW-14, HW-3, SC-25, SC-26, SC- 27

1-2 OUTCOME: 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.	WW-16: Improve environmental practices (boat wrap, bottom paint, pump out, etc.) at marinas. Other Action that supports Strategy: SC-34
Strategy 1-2a2: Reduce generation of marine debris and improve and increase its cleanup in Long Island Sound waters.	WW-17: Develop a Long Island Sound-specific marine debris reduction plan and implement actions to support trash-free waters. Other Actions that support Strategy: WW-16, SC-34

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.	WW-18: Support and promote pharmaceutical and prescription medicine take-back programs at the state and municipal level to inform the general public about the pathways and impacts of emerging contaminants entering the waters and sediments of Long Island Sound. Other Action that supports Strategy: WW-26
Strategy 1-2b2: Reduce human health risks through increased or targeted pathogen beach and embayment monitoring and fish and shellfish contaminant testing.	WW-19: Encourage state and local health departments to adopt emerging rapid bacterial detection technologies that would allow shorter duration administrative beach/shellfish closings than those based on rainfall only.
Strategy 1-2b3: Develop and implement methods (e.g., bioextraction) for removal of nutrients and contaminants.	WW-20: Evaluate challenges to implementation of bioextraction in Long Island Sound, including use conflicts, economic viability, permitting and testing requirements and potential environmental impacts, and make recommendations to overcome them. WW-21: Improve the permitting and certification process for new aquaculture projects with products intended for human consumption, particularly those projects with a bioextraction focus.

1-3 OUTCOME: RESEARCH, MONITORING, AND MODELING TO SUPPORT ATTAINMENT OF WATER QUALITY OBJECTIVES IS MAINTAINED AND IMPROVED.

Objective 1-3a: To further improve understanding of the causes and impacts of eutrophication and hypoxia:

Strategy 1-3a1: Understand the effects that nutrient ratios (nitrogen, phosphorus, carbon) have on ecosystem structure and function in freshwaters, embayments, and in Long Island Sound and consider them in setting nutrient control policies.	WW-22: Estimate future phosphorus loading to Long Island Sound and its impact on Long Island Sound nutrient dynamics.
Strategy 1-3a2: Better understand eutrophication dynamics, effects, and mechanisms and continue support for modeling and synthesis efforts and their application to management scenarios.	WW-23: Improve ability of models and/or studies to estimate contaminant and nutrient loads in critical areas and evaluate the effectiveness of remedial actions. Other Actions that support Strategy: SM-1, SM-11, SM-13

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.	✦ WW-24: Maintain and enhance the utility and efficiency of water quality monitoring of nutrient loads to Long Island Sound science and management efforts. WW-25: Develop and implement a water quality monitoring strategy for nitrogen in the upper basin states of Massachusetts, Vermont, and New Hampshire. Other Actions that support Strategy: WW-31, SM-4, SM-5, SM-23
Strategy 1-3b2: Research, monitor, and assess emerging and legacy toxic contaminants and their impacts on water and habitat quality.	WW-26: Assess and identify the impact of emerging (e.g., PBDE, pharmaceuticals) and legacy (e.g., heavy metals, PCBs) contaminants on the ecosystem services and biota of Long Island Sound.
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).	WW-27: Develop water quality monitoring programs associated with coastal habitat restoration projects. ✦ WW-28: Determine the level of spatial and temporal sampling needed to assess Long Island Sound water quality as impacted by climate change drivers (SLR, warming, acidification). WW-29: Complete LISS Sentinel Monitoring for Climate Change pilot projects and evaluate results to guide strategy development and future implementation. WW-30: Conduct periodic (five year) review and revision of Sentinel Monitoring Strategy document. Other Actions that support Strategy: WW-31, SM-4, SM-5, SM-31
Strategy 1-3b4: Research, monitor, and assess pathogens, their sources and their impacts on water quality.	✦ WW-31: Assess sources of nutrient and pathogen contamination to Long Island Sound embayments.
Strategy 1-3b5: Research, monitor, and assess Harmful Algal Blooms (HABs) and their impacts on water quality and public health.	✦ WW-32: Monitor and track occurrences and contributing factors of biotoxin and harmful algal blooms (HABs) outbreaks.

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 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.	WW-33: Develop a regional partnership that will continue to support the implementation and advancement of the LISS Sentinel Monitoring for Climate Change Program and integrate it with regional and national efforts. Other Actions that support Strategy: SM-4, SM-5
Strategy 1-3c2: Implement improved data storage and sharing solutions to support collaboration and incorporation of data into management decisions.	WW-34: Continue to support, improve, and utilize the Sentinel Monitoring Data Citation Clearinghouse and other data synthesis, storage, and sharing efforts. Other Actions that support Strategy: SM-4, SM-5

THEME 2

THRIVING HABITATS AND ABUNDANT WILDLIFE

Restore and protect the Sound's ecological balance in a healthy, productive, and resilient state to benefit both people and the natural environment.

CHALLENGES

- Tidal marshes and other coastal habitats are threatened with drowning from rising seas if they cannot build upward or migrate inland because of natural or man-made barriers.
- The balance among coastal habitats such as marshes, beaches, dunes, grasslands, and forests has been altered due to development, decreasing the resiliency of Long Island Sound.
- Remaining open spaces along the coast are under development pressure.
- Invasive/nonnative species threaten ecosystem diversity and compete with native animals & plants.
- Development and use of the coastal zone conflicts with the needs of some wildlife species (e.g., roseate terns) for forage and nursery areas.

SOLUTIONS

- Identify and conserve open space landward of coastal habitats to allow for natural transition upland.
- Enhance the resiliency of coastal habitats by strengthening living shorelines such as marshes, beaches, and dunes.
- Understand the historic balance of natural habitats and work to restore desired values and functions of the ecosystem.
- Prioritize open space protection to save the last remaining high-value undeveloped lands.
- Develop site management plans for eliminating invasive/nonnative species, involving community organizations and volunteers.
- Involve communities in the stewardship of wildlife.

◀ **GREAT GULL ISLAND** supports the largest nesting populations of common terns in the world. (Photo by Venu Challa)

THEME 2

THRIVING HABITATS AND ABUNDANT WILDLIFE

The natural and cultural heritage of Long Island Sound is inextricably connected to its living resources. For hundreds of years humans living along Long Island Sound have relied on the land and wildlife for food, shelter, and other day-to-day necessities. To this day, we still rely on fish and shellfish populations to contribute to the economy and ecosystem, benefiting the residents of all watershed communities. Moreover, the protection and restoration of ecologically significant shorelines and habitats of Long Island Sound will serve to protect the diversity and richness of native species, enhance the public's enjoyment of active and passive recreational opportunities such as hunting, boating, and wildlife viewing, and increase resiliency of communities to storms and flooding.

The 1994 CCMP identified habitats and living resources for management, monitoring, research, and protection. LISS and its partners have made great strides over the last two decades to accomplish these tasks. The LISS has targeted 12 types of coastal habitats for restoration to sustain living resources and ecosystem services: Beaches and Dunes, Cliffs and Bluffs, Estuarine Embayments, Coastal and Island Forests, Freshwater Wetlands, Coastal Grasslands, Intertidal Flats, Rocky Intertidal Zones, Riverine Migratory Corridors, Submerged Aquatic Vegetation Beds, Shellfish Reefs and Tidal Wetlands. Program partners have restored and/or protected thousands of acres of habitat, opened hundreds of river miles to migratory fish and other wildlife species, implemented ecosystem management plans, and funded multiple research and monitoring projects to provide insight into wildlife and ecosystem function.

Despite these successes, much still needs to be done to improve and protect the species and habitats found within and around the Long Island Sound. As a first step, Appendix D of the 2015 CCMP lists five priority sites for habitat connectivity and five priority sites for riverine migratory corridor reconnections in order to assist local and regional funding program administrators with prioritizing and funding grant proposals. In addition, warming waters and sea level rise pose new threats to habitats and wildlife, and there is improved understanding of the impacts of previously

ECOSYSTEM TARGETS

The following ambitious, but achievable, ecosystem targets have been developed to drive progress toward attaining the **Thriving Habitats and Abundant Wildlife (HW)** goal. Achieving these targets can also contribute to the goals for the other themes. Likewise, multiple strategies and implementation actions throughout the four theme areas apply directly and indirectly to these targets. Measuring, tracking, and reporting environmental indicators of each ecosystem target will provide information to assess progress and refine and adapt management as needed. A detailed explanation about the rationale and quantification of these targets is included in Appendix B.

Coastal Habitat Extent: Restore 350 acres of coastal habitat by 2020 and a total of 3,000 acres by 2035 from a 2014 baseline, including:

- **Eelgrass Extent:** Restore and maintain 2,000 additional acres of eelgrass by 2035 from a 2012 baseline of 2,061 acres.
- **Tidal Wetland Extent:** Restore 515 additional acres of tidal wetlands by 2035 from a 2014 baseline.

River Miles Restored for Fish Passage: Open 200 additional miles of fish riverine migratory corridors in the Connecticut and New York portions of the watershed by 2035 from a 2014 baseline.

Shellfish Harvested: Increase the harvest of oysters, clams, and scallops in the Sound through a combination of habitat management and shellfish aquaculture.

Habitat Connectivity: Increase connectivity of coastal habitat by 2035 by restoring and/or protecting habitat patches that increase biodiversity and support migratory pathways.

Protected Open Space: Conserve an additional 4,000 acres of Connecticut land and 3,000 acres of New York land within the LIS coastal boundary by 2035, while maintaining the total area of protected lands.

reported threats such as nitrogen pollution and invasive species. So while the Thriving Habitats and Abundant Wildlife theme continues to emphasize monitoring, research, restoration, and protection, it includes new approaches, such as developing resilient coastal habitats through the creation of living shorelines and green infrastructure, to address current and future threats to habitats and wildlife.

The natural habitats of Long Island Sound and its coastal areas support diverse populations of wildlife and living resources, provide recreational opportunities, and function as an environmental infrastructure that provides services and benefits to the region. The Thriving Habitats and Abundant Wildlife theme addresses the balance between people and the natural environment and the need to continue restoration and protection of priority habitats and wildlife to sustain a healthy, productive, and resilient Long Island Sound benefiting all inhabitants. All of the goals and actions outlined in this theme should provide multiple benefits to both wildlife and humans alike.

OUTCOMES, OBJECTIVES, STRATEGIES, AND IMPLEMENTATION ACTIONS

To accomplish the Thriving Habitats and Abundant Wildlife goal and to achieve progress toward the ecosystem targets, the plan includes specific outcomes, objectives, strategies, and actions. The Implementation Actions (IAs) have been formulated to carry out the HW theme strategies. All IAs are important to meeting the plan's objectives and outcomes. While recognizing that the priorities of each implementing organization will vary according to its mission and the purpose of available funds, the CCMP identifies the highest overall priorities, whether for new or underway actions, by consensus of the Management Conference partners. Highest priority actions are indicated by a "✦" symbol. The complete five-year implementation action plans (further described in Appendix C) are included in the supplement to the CCMP posted on the LISS website.

2-1 OUTCOME: SYSTEM RESILIENCY AND FUNCTION ARE MAINTAINED BY PROTECTING, RESTORING, AND ENHANCING HABITATS.

Objective 2-1a: To restore and enhance targeted habitat types:

Strategy 2-1a1: Develop and implement innovative and effective habitat restoration plans and projects including restoring quality and quantity of coastal habitat and fish passage.	✦ HW-1: Complete projects that result in restoration of coastal habitat. HW-2: Develop a list of current and new or innovative restoration techniques. ✦ HW-3: Complete projects that result in restored habitat connectivity (i.e., river miles reconnected and/or contiguous acres of coastal habitat protected or restored). Generate supporting GIS data to help measure extent of connectivity enhanced. Other Actions that support Strategy: HW-6, HW-7, WW-27
Strategy 2-1a2: Restore and enhance connectivity of targeted habitat types.	✦ HW-4: Develop or apply habitat connectivity models to provide metrics for all restoration and protection projects. Other Actions that support Strategy: HW-3, WW-14

Objective 2-1b: To protect targeted habitat types through acquisition and other mechanisms:

Strategy 2-1b1: Identify high-priority areas to protect using a repeatable, criteria-based process to minimize bias, supplemented by expert knowledge.	✦ HW-5: Use remote sensing, mapping tools, modeling, and field verification to determine sites that are likely to be impacted by sea level rise, and which sites are ideal for habitat migration. ✦ HW-6: Develop and apply habitat quality metrics and assessment methodology across targeted habitat types. HW-7: Develop a habitat quality index for tracking the success of habitat restoration projects and programs on habitat quality. ✦ HW-8: Use leading-edge design tools to prioritize future conservation investment and management plan development for Long Island Sound's most significant and imperiled terrestrial and intertidal coastal habitats. ✦ HW-9: Conduct an ecological assessment of land surrounding Long Island Sound Stewardship Sites and design green infrastructure/low impact development pilot projects that minimize negative impacts and enhance beneficial ecosystem services of lands within or surrounding the Sites. Other Actions that support Strategy: HW-4, SC-38

Strategy 2-1b2: Conserve and enhance natural areas and open space to benefit ecosystem function and wildlife.	✦ HW-10: Protect high-priority conservation land from development through property acquisition and create a registry of protected conservation land in Connecticut and New York, which encompasses both existing protected properties and future acquisitions.
Strategy 2-1b3: Conserve and enhance natural areas and open space to benefit public access, recreation, and shoreline and community protection.	✦ HW-10: See Strategy 2-1b2

Objective 2-1c: To increase or maintain resiliency of coastal habitats and the services they provide:

Strategy 2-1c1: Identify and prioritize upland, wetland, and aquatic habitats that are vulnerable to climate change impacts and take action to mitigate or adapt to these impacts (e.g., remove or mitigate barriers to habitat migration).	✦ HW-11: Develop and promote the use of living shoreline habitat protection methods (dunes, shorelines, coastal marshes) and living shoreline monitoring protocols. HW-12: Promote the conversion of existing armored shorelines (seawalls, riprap, bulkheads, etc.) to softer living shorelines to mitigate the impacts of new (and authorized) armored shorelines. Other Action that supports Strategy: HW-5

2-2 OUTCOME: SYSTEM RESILIENCY AND FUNCTION ARE MAINTAINED BY DIVERSE, BALANCED, AND ABUNDANT POPULATIONS OF FISHES, BIRDS, AND OTHER WILDLIFE.

Objective 2-2a: To manage invasive species:

Strategy 2-2a1: Develop volunteer stewardship programs to manage invasive species to ensure habitats are healthy and include representative plant and animal species.	HW-13: Promote volunteer-driven invasive species reconnaissance and removal work. Other Action that supports Strategy: SC-11
Strategy 2-2a2: Teach and promote measures that will help to prevent the introduction and spread of invasive biota in Long Island Sound and connected upland areas.	HW-14: Develop and implement invasive/non-native species management plans for priority sites, including promoting the widespread use of BMPs or Hazard Analysis and Critical Control Point plans. HW-15: Assess adequacy of current legislation and programs that target prevention and spread of invasive/non-native species. Other Actions that support Strategy: HW-14, SC-11

Objective 2-2b: To manage state and federal listed species and species whose Long Island Sound population is regionally or globally important:

Strategy 2-2b1: Prioritize habitat restoration projects for targeted and Trust Species.	✦ HW-16: Collect data on, and restore habitat for, listed and forage species.
Strategy 2-2b2: Manage habitat threats (e.g., climate change driven threats and predator-prey relationships) to targeted and Trust Species.	HW-17: Reduce and manage threats to populations of targeted listed species.

Objective 2-2c: To manage and restore populations of harvested species:

Strategy 2-2c1: Create or update species management plans for commercially and recreationally important species.	HW-18: Develop a shellfish management plan that supports BMPs for aquaculture, recreation, and restoration that ensure sustainable marine populations.

Objective 2-2d: To maintain or improve diverse/resilient communities of native fish, birds, and other wildlife:

Strategy 2-2d1: Promote projects that protect and restore biological and ecological diversity.	HW-19: Update and implement Connecticut and New York State Wildlife Action Plans, and continue to update or draft new site-specific management plans as needed. Other Actions that support Strategy: HW-13, HW-14, HW-15, SC-11

2-3 OUTCOME: THE PUBLIC IS EDUCATED AND INVOLVED IN RESTORATION AND PROTECTION OF HABITATS AND LIVING RESOURCES.

Objective 2-3a: To educate and engage the public, particularly in urban areas, in both large and small-scale habitat restoration projects, research, monitoring, management, and stewardship associated with priority habitat types and living resources:

Strategy 2-3a1: Promote the creation of educational and outreach programs tailored for multiple user groups.	HW-20: Develop programs to assist landowners with using habitat protection and management methods on their own properties. Other Actions that support Strategy: SC-5, SC-10, SC-11, SC-15
Strategy 2-3a2: Communicate the importance of ecosystem services to the public and municipal leaders.	HW-20: See Strategy 2-3a1 Other Actions that support Strategy: SC-10, SC-11

Objective 2-3b: To instill a sense of stewardship by increasing people's awareness of, and visitation to, priority habitats and LISS Stewardship Sites:

Strategy 2-3b1: Enhance and promote innovative and relevant ways of connecting people to Stewardship Sites.	HW-21: Design, develop, and promote coupled habitat restoration and monitoring projects that incorporate meaningful citizen science, engagement, and participation.

2-4 OUTCOME: KNOWLEDGE OF HABITATS AND LIVING RESOURCES IS ADVANCED THROUGH MONITORING, ASSESSMENT, AND RESEARCH.

Objective 2-4a: To enhance knowledge of habitats and living resources through research, collaboration, and distribution of useful habitat and living resource data:

Strategy 2-4a1: Support ecosystem science research such as habitat modeling and landscape design efforts to enhance protection of living terrestrial and aquatic resources.	HW-22: Collect data on targeted habitat types to assist with development of habitat quality metrics and assessment methodology. Other Actions that support Strategy: HW-4, HW-5
Strategy 2-4a2: Inventory status and trends in quality, quantity, and distribution of priority habitats and species.	HW-23: Assess additional habitat types to target for habitat restoration and protection, considering opportunities for restoration and new information on submerged habitats. ✦ HW-24: Continue Long Island Sound eelgrass abundance surveys and promote eelgrass management. Other Actions that support Strategy: HW-6, HW-7, HW-9, HW-22
Strategy 2-4a3: Identify surrogate/representative species for long-term monitoring to evaluate ecosystem health.	HW-25: When merited, use a species-based approach (i.e., surrogate species or species by species restoration targets) in conjunction with a habitat restoration focused approach to understand and monitor habitat health. Other Action that supports Strategy: HW-17
Strategy 2-4a4: Identify water quality conditions necessary to support priority habitats and use suitability models to evaluate appropriate restoration priorities through pollution controls.	✦ HW-26: Assess locations of tidal marsh loss and the parameters impacting tidal marshes through research and monitoring, and use this information to create a suitability model to determine sites for restoration. Other Action that supports Strategy: SM-1


Triumph

THEME 3

SUSTAINABLE AND RESILIENT COMMUNITIES

Support vibrant, informed, and engaged communities that use, appreciate, and help protect Long Island Sound.

CHALLENGES

- Coastal properties are at risk from rising waters and more intense or frequent storm events.
- Environmental protection and economic development are not fully integrated into local community planning and development.
- Building environmental stewardship for urban waters.

SOLUTIONS

- Support coastal communities in developing and adopting resiliency plans.
- Coastal communities integrate transportation, conservation of energy and water, and pollution control policies through sustainable development plans.
- Fully involve underserved communities and respond to their needs and perspectives.

◀ **YOUTH FROM ROCKING THE BOAT,** a Bronx environmental organization, on board a student-built boat on the Bronx River. (Photo by Joaquin Cotten)

THEME 3

SUSTAINABLE AND RESILIENT COMMUNITIES

The coastal counties in Connecticut and New York bordering Long Island Sound have the second highest population density in the northeast, second only to those bordering New York/New Jersey Harbor. Local government decisions affecting development, land use, and population density have a strong impact on water and habitat quality in the Sound and its tributaries. Ultimately, local government leadership, private sector engagement, community organization empowerment, and individual stewardship are vital to efforts to restore the Sound.

Long Island Sound has a venerable maritime heritage. Important marine trades such as shipbuilding, transportation, and fishing mingle with many recreational, residential, and commercial uses of its dynamic shorelines and waters. The economy, culture, and environment all interact to influence the quality of life in the communities around the Sound.

The Sustainable and Resilient Communities theme emphasizes that restoring Long Island Sound can increase human appreciation, use, and enjoyment of the resource. It emphasizes that there are opportunities to redefine normal, accepted practices in a sustainability framework and instill them in our culture. What becomes customary should contribute to our economy and lifestyle while protecting the Long Island Sound ecosystem. Communities and businesses that use less energy to produce needed goods and services can save money and reduce their carbon footprint while improving public health and the environment. Residential landscapes that are more compatible with our climate and water resources cost less money and require less time than traditional yards. Resilient shorelines that include stable areas of tidal wetlands and dunes will help to prevent shoreline erosion and protect built infrastructure and are necessary for the long-term sustainability of these uses.

ECOSYSTEM TARGETS

The following ambitious, but achievable, ecosystem targets have been developed to drive progress toward attaining the **Sustainable and Resilient Communities (SC)** goal. Achieving these targets can also contribute to the goals for the other themes. Likewise, multiple strategies and implementation actions throughout the four theme areas apply directly and indirectly to these targets. Measuring, tracking, and reporting environmental indicators of each ecosystem target will provide information to assess progress and refine and adapt management as needed. A detailed explanation about the rationale and quantification of these targets is included in Appendix B.

Waterfront Community Resiliency and Sustainability: All coastal municipalities have prepared plans for shoreline resiliency and infrastructure sustainability and resiliency by 2025, with all future development compliant with those plans by 2035.

Harbor and Bay Navigability: Maintain all federal navigation channels in harbors and bays and manage dredged material in a cost-effective and environmentally sound manner, consistent with a bi-state Dredged Material Management Plan, by 2035.

Public Engagement and Knowledge: Increase the knowledge and engagement of the public in the protection and/or restoration of Long Island Sound compared to the 2006 public perception survey.

Public Beach Closures: Reduce by 50 percent the number of beaches reporting at least one closure day or the total number of beach-day closures per monitored beach due to water quality impairments by 2035, compared to a five-year rolling average from 2014.

Marine Debris: Decrease the mass of marine debris in Long Island Sound by 2035.

Public Access to Beaches and Waterways: Increase by at least 10 percent the number of public access points to the Sound and its rivers by 2035.

It is critical to the health and sustainability of the Sound to engage the communities that use the Sound to understand, appreciate, and protect it. The Sustainable and Resilient Communities theme addresses the need to support vibrant, informed, and engaged communities as stewards of the resource.

OUTCOMES, OBJECTIVES, STRATEGIES, AND IMPLEMENTATION ACTIONS

To accomplish the Sustainable and Resilient Communities goal and to achieve progress toward the ecosystem targets, the plan includes specific outcomes, objectives, strategies, and actions. The Implementation Actions (IAs) have been formulated to carry out the SC theme strategies. All IAs are important to meeting the plan's objectives and outcomes. While recognizing that the priorities of each implementing organization will vary according to its mission and the purpose of available funds, the CCMP identifies the highest overall priorities, whether for new or underway actions, by consensus of the Management Conference partners. Highest priority actions are indicated by a "✦" symbol. The complete five-year implementation action plans (further described in Appendix C) are included in the supplement to the CCMP posted on the LISS website.

3-1 OUTCOME: RESIDENTS HAVE THE AWARENESS, KNOWLEDGE, AND SKILLS TO PROTECT THE SOUND.

Objective 3-1a: To increase appreciation of Long Island Sound and opportunities for residents to get a meaningful experience on the Sound and on its shoreline:

Strategy 3-1a1: Encourage opportunities to enjoy Long Island Sound through activities such as fishing, swimming, and bird watching.	SC-1: Provide technical and grant assistance to support festivals and celebrations that encourage appreciation and use of the Sound. SC-2: Provide support through technical and grant assistance to organizations that promote environmentally sustainable recreational activities along Long Island Sound. SC-3: Continue programs to promote youth and adult fishing and boating as healthy and sustainable recreational sports.
Strategy 3-1a2: Support maritime and cultural heritage awareness.	SC-4: Seek a National Heritage Area designation for Long Island Sound that will promote the Sound's heritage as the "Urban Sea" and the Sound's cultural, historical, maritime, and natural resources. Other Actions that support Strategy: SC-1, SC-2, SC-3
Strategy 3-1a3: Connect/reconnect urban populations, including underserved and non-English language communities, to the Sound.	✦ SC-5: Provide technical and grant assistance to support federal and local initiatives that increase appreciation and understanding of the Sound for underprivileged and non-traditional audiences in urban areas. Other Actions that support Strategy: HW-20, HW-21

Objective 3-1b: To increase public knowledge and understanding of the ecological health of Long Island Sound:

Strategy 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.	✦ SC-6: Produce informational materials that can be distributed through multiple formats to encourage stewardship and increase the public's understanding of the ecological, cultural, and recreational value of Long Island Sound. SC-7: Develop innovative projects with partners to disseminate knowledge and results from Long Island Sound monitoring and research. SC-8: Raise awareness through various media formats about the Sound's water quality conditions that could impact human health. SC-9: Expand efforts, through the LISS website and social media channels, to educate the public about the impacts of climate change on Long Island Sound and in Long Island Sound Stewardship Areas.

Objective 3-1c: To increase public stewardship, at home and in the community, to protect the natural resources of the Sound

Strategy 3-1c1: Involve the public in the cleanup and restoration of Long Island Sound through volunteerism and community action.	SC-10: Provide technical and grant assistance to local volunteer organizations working towards the ecological restoration of the Sound. SC-11: Continue staff support for Sound Stewardship volunteer projects and other outreach activities at New York and Connecticut Stewardship Areas. SC-12: Continue the Long Island Sound Citizens Summit, and support other Sound-wide events that encourage dialogue between resource managers, environmental stakeholders, and residents. Other Actions that support Strategy: HW-13, HW-21
Strategy 3-1c2: Encourage residents, both homeowners and renters, to engage in environmentally-friendly practices around their homes and communities.	SC-13: Provide natural landscaping guidance to communities and homeowners to encourage the use of alternatives to chemical and nutrient-intensive landscaping, and the establishment of natural vegetated buffers near bodies of water. ✦ SC-14: Support efforts through technical and grant assistance to develop behavior change campaigns that result in measurable environmental improvements to the Sound's ecosystem. SC-15: Develop a Sound-wide marketing campaign to increase the public's safe and sustainable use of the Sound.

3-2 OUTCOME: FUTURE GENERATIONS HAVE THE SKILLS TO BECOME LEADERS AND STEWARDS FOR THE SOUND.

Objective 3-2a: To incorporate Long Island Sound topics, including its ecology and history, into New York and Connecticut classrooms and curriculum, and informal settings:

Strategy 3-2a1: Support professional development of formal and informal educators.	SC-16: Continue programs such as the Long Island Sound Mentor Teacher Program that provide formal and informal K-12 educators with opportunities to learn how to include Long Island Sound instruction in their classrooms.
Strategy 3-2a2: Provide science-based information products and supplemental resources such as lesson plans for specific Long Island Sound topics.	SC-16: See Strategy 3-2a1

Objective 3-2b: To provide youth with opportunities to learn about Long Island Sound and its related issues:

Strategy 3-2b1: Support informal education at aquariums, museums, and coastal environments with facilities such as nature centers.	SC-17: Provide technical and grant assistance to encourage informal education activities on Long Island Sound. SC-18: Create an annual "get out on Long Island Sound day" of informal educational activities around the Sound to promote "on-the-water" experiences.
Strategy 3-2b2: Engage youth in stewardship opportunities.	SC-11: See Strategy 3-1c1 Other Actions that support Strategy: HW-13, HW-21

3-3 OUTCOME: POLICY MAKERS, RESOURCE MANAGERS, AND OTHER STAKEHOLDERS HAVE THE INFORMATIONAL RESOURCES TO UNDERTAKE COLLABORATIVE EFFORTS TO RESTORE AND PROTECT THE SOUND.

Objective 3-3a: To ensure that policy makers, environmental professionals, health professionals, and other stakeholders have the best available information in order to make decisions that will improve the management of Long Island Sound:

Strategy 3-3a1: Support the dissemination of the best practices to reduce contaminants, improve water quality, and protect habitats through professional development training and workshops.	SC-19: Provide training to municipalities on low impact development and green infrastructure. ✦ SC-20: Develop and implement regional outreach and training programs on innovative/sustainable flood and erosion control for municipalities.
Strategy 3-3a2: Update and disseminate information on the best available scientific, socioeconomic, and environmental trends to policy makers, resource managers, and stakeholders.	SC-21: Provide support, including funding and technical assistance, for the development and dissemination of environmental technical manuals and studies to environmental decision makers and resource managers. ✦ SC-22: Use the best available social science research methods to understand the public's role in the Long Island Sound ecosystem, and use that information to help support campaigns to reduce pollution and improve water quality.

3-4 OUTCOME: NEW AND EXISTING DEVELOPMENT IS SUSTAINABLE AND RESILIENT.

Objective 3-4a: To encourage and facilitate the development of regional, state, and local sustainability, mitigation, and resiliency plans and integrate them into community comprehensive plans:

Strategy 3-4a1: Provide support to municipalities to facilitate the development and updating of sustainability and resiliency plans that incorporate current concepts on these topics.	✦ SC-23: Develop a handbook, website, and, or, other materials (e.g., regulations, funding sources, and best practices) to be used by municipal officials to aid in the development of sustainability and resiliency plans and their integration into comprehensive plans. ✦ SC-24: Conduct region-wide and town-specific workshops to assist municipalities in developing sustainability and resiliency plans and integration into their comprehensive plans. ✦ SC-25: Support communities as they develop and adopt new or updated stand-alone Municipal Sustainability Plans. ✦ SC-26: Support communities as they develop and adopt new or updated Coastal Resiliency Plans. Other Actions that support Strategy: WW-12, WW-15
Strategy 3-4a2: Ensure consistency among economic development and sustainability and resiliency planning efforts.	SC-27: Conduct reviews of waterfront revitalization, economic development, and, or, redevelopment plans, to assess the degree to which sustainability and resiliency concepts are incorporated. SC-28: Develop guidance for quantifying the benefits and costs of sustainability activities and economic development to incorporate into sustainability and resiliency planning efforts. Other Action that supports Strategy: WW-15

Objective 3-4b: To develop and implement sustainability and resiliency plans for new and existing development, housing, transportation, emissions control, energy efficiency, and job creation programs for all municipalities:

Strategy 3-4b1: Revise zoning, permitting, and related regulations to ensure that future development and redevelopment conform to sustainability, mitigation, and resiliency plans.	✦ SC-29: Identify and recommend removal and, or, protection of sensitive infrastructure in the coastal zone (e.g., oil tanks, pump, power stations, etc.) and work to prevent future siting of such infrastructure in vulnerable coastal floodplains. Other Actions that support Strategy: SC-25, SC-26, WW-12, WW-15
Strategy 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.	✦ SC-30: Implement standards, best practices, and educational materials for Green Infrastructure/Low Impact Development planning and implementation. SC-31: Develop regional outreach programs and training modules on sustainability and resiliency planning topics. Other Actions that support Strategy: SC-25, SC-26, WW-12, WW-15
Strategy 3-4b3: Balance waterfront recreational, commercial, and industrial uses according to sustainability and resiliency plans.	SC-32: Remediate and sustainably develop abandoned and underutilized sites (brownfields). SC-33: Develop and implement the Long Island Sound Dredge Material Management Plan. SC-34: Conduct a review of the implementation of resiliency and sustainability plans as they relate to community and waterfront development and redevelopment.

3-5 OUTCOME: PUBLIC ACCESS AND SUSTAINABLE ECONOMIC ACTIVITIES ALONG THE WATERFRONT ARE ENHANCED, BALANCED, AND RESILIENT.

Objective 3-5a: To encourage communities to identify priority waterfront economic development activities and then to implement economic development strategies and infrastructure planning that result in vibrant, resilient, and environmentally sustainable communities:

Strategy 3-5a1: Establish programs and provide support to communities to help them in obtaining recognition for exemplary sustainability programs.	SC-35: Establish a sustainability and resiliency grant program to encourage implementation of sustainability and resiliency plans. SC-36: Develop a municipal sustainability recognition program that incorporates ideas from other states to incentivize sustainable development and economic planning.
Strategy 3-5a2: Improve access to Long Island Sound and its embayments, maintain and enhance view corridors and blueways, and enhance water-dependent uses.	✦ SC-37: Develop a Public Access Plan to increase public access points and the length of shoreline accessible by the public to the Sound and its rivers. SC-38: Encourage the sustainable use of natural coastal areas, including Long Island Sound Stewardship Areas, through support of sustainable blueways, bikeways, and greenways. Other Action that supports Strategy: HW-8

THEME 4

SOUND SCIENCE AND INCLUSIVE MANAGEMENT

Manage Long Island Sound using sound science and cross-jurisdictional governance that is inclusive, adaptive, innovative, and accountable.

CHALLENGES

- Coastal waters are becoming warmer and potentially more acidic, both of which may alter the food web and negatively impact human uses.
- Assessing the health of the Long Island Sound ecosystem and linking it to human pressures that impair it.
- Developing diverse funding strategies that consider the social, environmental, and economic benefits of actions.
- Changes in fish and shellfish populations and habitats have made Long Island Sound more susceptible to nutrient pollution.
- Demands for uses of Long Island Sound such as energy transmission lines can result in conflicts with existing uses.

SOLUTIONS

- Integrate climate change science into management and adaptation activities.
- Integrate research and monitoring (including citizen science) to refine and adapt management solutions.
- Estimate changes in the value of ecosystem services that result from impairment or restoration to inform and sustain investment in protecting and restoring those assets.
- Increase the capacity of Long Island Sound to assimilate nutrients without harmful effects by restoring wetlands, eelgrass, and harvesting (aquaculture) of shellfish and seaweed.
- Increase collaboration among marine users and stakeholders through coastal and marine spatial planning.

◀ **CTDEEP SCIENTISTS CONDUCT** trawl surveys of the Sound's marine life, including horseshoe crabs, on board the Research Vessel *John Dempsey*. (Photo by Richard Howard)

THEME 4

SOUND SCIENCE AND INCLUSIVE MANAGEMENT

The Long Island Sound watershed covers more than 16,000 square miles in six states and encompasses hundreds of local watersheds. Effective and efficient management of Long Island Sound, as with any large waterbody, requires collaboration and governance among numerous cross-jurisdictional partners and stakeholders. In March 1988, the Long Island Sound Study Management Conference was convened, representing a partnership of federal, state, interstate, and local agencies, universities, environmental groups, industry, and the public to guide the management of Long Island Sound and become the coordinating entity of the CCMP.

Inherent to effective management is thorough scientific understanding through strengthened research, monitoring, assessment, mapping, and modeling programs. As new data, research, knowledge, and issues emerge, it is critical that implementation and management is adapted and improved. Ecosystem-based management (EBM) provides a framework for both science and management that accounts for the complex interrelationships of human society and the environment. It means planning on an ecosystem level, involving multiple stakeholders and integrating the full spectrum of ecosystem services supporting human wants and needs, developing cross-jurisdictional goals, implementing programs through coordinated, accountable strategies across levels of government, incorporating adaptive management that acknowledges uncertainty in our understanding, and establishing long-term observation, modeling, and research programs (McLeod et al. 2005).

Our estuarine and coastal systems have been impaired primarily from overharvesting of living natural resources, pollution, and habitat loss and degradation. Invasive species and climate change also have had an impact that will likely become more influential in the future. To address these drivers and pressures successfully, LISS management must develop and support integrated, adaptive, and coordinated relationships among fisheries, coastal zone, and pollution management programs in the context of human use of the Sound. Societal needs and the economic consequences of activities to ecosystem services that society relies upon are vital elements to be integrated into management. In this way, EBM is an integral part of meeting pressing social needs in environmentally sustainable ways.

The Sound Science and Inclusive Management (SM) theme addresses EBM through research, monitoring, modeling, and assessment. Monitoring is further detailed in Section 4. These efforts need to be maintained and enhanced to increase understanding of Long Island Sound and support management outcomes. In addition, this theme addresses the coordination of the many entities involved in CCMP implementation, funding, and application of an adaptive management framework.

OUTCOMES, OBJECTIVES, STRATEGIES, AND IMPLEMENTATION ACTIONS

To accomplish the Sound Science and Inclusive Management goal and to achieve progress toward the ecosystem targets, the plan includes specific outcomes, objectives, strategies, and actions. The Implementation Actions (IAs) have been formulated to carry out the SM theme strategies. All IAs are important to meeting the plan's objectives and outcomes. While recognizing that the priorities of each implementing organization will vary according to its mission and the purpose of available funds, the CCMP identifies the highest overall priorities, whether for new or underway actions, by consensus of the Management Conference partners. Highest priority actions are indicated by a "✦" symbol. The complete five-year implementation action plans (further described in Appendix C) are included in the supplement to the CCMP posted on the LISS website.

4-1 OUTCOME: THE SCIENTIFIC UNDERSTANDING OF LIS TO SUPPORT MANAGEMENT IS INCREASED THROUGH STRENGTHENED RESEARCH, MONITORING, ASSESSMENT, MAPPING, AND MODELING.

Objective 4-1a: To enhance the research portfolio to answer questions relevant to Long Island Sound management:

Strategy 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.	✦ SM-1: Identify and communicate high-priority science needs relating to the understanding and attainment of management objectives and ecosystem targets, and support research programs to fulfill these needs. Other Actions that support Strategy: WW-11, WW-23, WW-26, HW-26

Objective 4-1b: To maintain and enhance monitoring and assessment programs to increase understanding of Long Island Sound and assess progress toward management outcomes:

Strategy 4-1b1: Characterize, inventory, and map open and shallow water habitats to support resource management and marine spatial planning.	SM-2: Complete seafloor mapping conducted under the Sound Cable Fund, and use results to guide additional mapping.
Strategy 4-1b2: Characterize, inventory, and map human uses, both recreational and commercial, of open and shallow water habitats to support resource management and marine spatial planning.	SM-3: Identify key datasets needed to support coastal and marine spatial planning for Long Island Sound and initiate collection.
Strategy 4-1b3: Evaluate, enhance, integrate, and coordinate ongoing monitoring programs.	SM-4: Develop an integrated Monitoring Plan considering developing technologies and citizen science. SM-5: Develop an integrated Data Management Plan considering local, regional, and national observing initiatives. SM-6: Incorporate the Interstate Environmental Commission's monitoring efforts into the Long Island Sound water quality monitoring program. SM-7: Continue National Coastal Assessment monitoring of Long Island Sound. Other Actions that support Strategy: WW-25, WW-27, WW-28, WW-33, WW-34
Strategy 4-1b4: Strengthen monitoring of conditions in embayments and near-shore waters, and integrate the resulting data and assessments into open water monitoring programs.	✦ SM-8: Coordinate and leverage community water quality monitoring programs, enhancing citizen science and the utility and application of data. Other Actions that support Strategy: WW-24, WW-25, WW-28, WW-31
Strategy 4-1b5: Improve regional identification, storage, and sharing of spatial and temporal data.	SM-9: Assess options for establishing a secure, long-term Long Island Sound data portal that can be accessed by other regional data systems, such as the Northeast Ocean Data Portal. ✦ SM-10: Improve the use and utility of Long Island Sound data for GIS applications.

Objective 4-1c: To develop and improve modeling capabilities to provide predictive assessments of resources, physical dynamics, and water quality:

Strategy 4-1c1: Transition existing and new models to a community modeling framework that provides open source access to facilitate external collaboration, assessments, and enhancements.	✦ SM-11: Enhance modeling of eutrophication in Long Island Sound to support nitrogen management and Dissolved Oxygen TMDL implementation. SM-12: Make publicly available the System-wide Eutrophication Model code and products to enhance transparency and collaboration. SM-13: Link water quality models of Long Island Sound to watershed and groundwater pollutant loading models to better elucidate sources and relative contributions of nitrogen, including all coastal watersheds. Other Action that supports Strategy: WW-23

4-2 OUTCOME: ACTIONS ARE IMPLEMENTED THROUGH COORDINATED STRATEGIES BY ALL LEVELS OF GOVERNMENT AND DIVERSE STAKEHOLDERS.

Objective 4-2a: To increase communication, coordination, and reduce institutional barriers to cooperation on an ecosystem level among all levels of government, stakeholder groups, and the general public:

Strategy 4-2a1: Maintain and enhance the Long Island Sound Management Conference as the coordinating entity to implement the CCMP, and expand opportunities for local government involvement.	SM-14: Continue program administrative, financial, and technical assistance support to Management Conference. SM-15: Continue state program coordination and involvement in the Management Conference. ✦ SM-16: Optimize structure and function of the Management Conference with a focus on implementation of the revised CCMP. SM-17: Reauthorize Clean Water Act sections 119 and 320, and other relevant statutes to support LIS. SM-18: Support involvement of, and communication with, the bi-state LIS Congressional Caucus and bi-state Connecticut and New York legislative caucus on issues of common concern. ✦ SM-19: Support involvement of, and communication with, local governments, which have front line authority for implementing many of the CCMP strategies. ✦ SM-20: Reach out to traditionally underrepresented stakeholders and encourage them to participate in the Management Conference.
Strategy 4-2a2: Ensure that the CCMP is incorporated into and carried out through existing state and local policies and regulatory programs.	SM-21: Incorporate relevant updated elements of the CCMP into state regulatory and planning programs such as coastal zone management program consistency reviews and state environmental equality reviews (State Environmental Quality Review Act in New York).
Strategy 4-2a3: Maintain EPA, NYSDEC, and CTDEEP support of the Management Conference to provide leadership and accountability.	SM-22: Convene senior EPA and state management to help direct, inform, and coordinate policy relevant to Long Island Sound.
Strategy 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.	SM-23: Foster involvement of the tributary states in Management Conference activities by maintaining the Five State/EPA TMDL Work Group. Other Actions that support Strategy: WW-6, WW-7, WW-9, WW-10, WW-11, WW-25
Strategy 4-2a5: Through Marine Spatial Planning, facilitate the management of multiple human uses of the Sound compatible with the conservation of natural resources and habitats.	✦ SM-24: Develop a bi-state framework (or guidance) for Coastal and Marine Spatial Planning for Long Island Sound to more comprehensively manage Long Island Sound resources.

Objective 4-2b: To maintain and enhance efficient public investments in restoration and management:

Strategy 4-2b1: Apply concepts of economic valuations of the natural capital of LIS and its watershed (i.e., the value of the goods and services supported by natural ecosystems) to inform and sustain investment in protecting and restoring those assets.	SM-25: Conduct primary valuations of the critical ecosystem goods and services supported by Long Island Sound and its coastal habitats. SM-26: Conduct return on investment analysis for Long Island Sound restoration and preservation strategies to inform priority setting for implementation of the CCMP.
Strategy 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.	SM-27: Capitalize Connecticut Clean Water Fund and New York State Revolving Fund adequately to finance Clean Water infrastructure needs. ✦ SM-28: Research and develop innovative, locally appropriate funding mechanisms to provide sustained, reliable sources of investment capital to restore and protect ecosystem services. SM-29: Coordinate and target funding for implementation of protection and restoration, science, and education and involvement projects.

Strategy 4-2b3: Evaluate cross-agency expenditures on Long Island Sound to identify how funding levels match with priority needs, assess whether resources are being optimally applied, and identify leveraging opportunities.	SM-30: Develop an annual budget for each Federal department and agency involved in the protection and restoration of the Long Island Sound watershed.

4-3 OUTCOME: IMPLEMENTATION IS ADAPTED AND IMPROVED THROUGH THE APPLICATION OF NEW INFORMATION AND KNOWLEDGE.

Objective 4-3a: To frame sustainability, adaptation, and resilience in relation to the drivers of ecosystem change:

Strategy 4-3a1: Include important environmental drivers (e.g., climate change) in all relevant management planning initiatives.	SM-31: Incorporate climate change-driven factors such as temperature and sea level rise in model applications to assess factors that can influence future attainment of water quality standards and habitat protection and restoration goals. SM-32: Develop a vulnerability assessment of how climate change will affect attainment of the CCMP goals and objectives. Other Actions that support Strategy: WW-12, WW-28, WW-29, WW-30
Strategy 4-3a2: Consider the spectrum of desired ecosystem outcomes when planning and implementing resiliency of both built and natural systems.	SM-33: Incorporate desired ecosystem outcomes for planning and implementation of Hurricane Sandy Relief funds and ongoing coastal resiliency programs. SM-34: Collaborate with the Connecticut Institute for Resiliency and Climate Adaptation (CIRCA).

Objective 4-3b: To apply an adaptive management framework to CCMP implementation when warranted by the level of uncertainty in the underlying science:

Strategy 4-3b1: Establish baselines of historical or pre-historical conditions of ecosystem attributes and magnitudes of change to help provide a basis for setting restoration goals.	✦ SM-35: Refine the ecosystem metrics and targets based on the underlying science of the Long Island Sound ecosystem to clearly identify the characteristics of a "restored" Long Island Sound.
Strategy 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).	SM-36: Incorporate bioextraction analyses in Dissolved Oxygen TMDL assessments on the assimilative capacity of Long Island Sound to process nutrients without loss of designated uses. Other Action that supports Strategy: WW-6
Strategy 4-3b3: Prepare periodic progress reports on the health of the Sound and on implementation progress.	SM-37: Prepare and make available to the public annually the LISS Implementation Tracking Report using *E-Sound.* ✦ SM-38: Issue a "report card" on water quality conditions in Long Island Sound. SM-39: Refine and communicate information on the Long Island Sound ecosystem and watershed using environmental indicators (drivers, pressures, conditions, and response indicators).
Strategy 4-3b4: At five-year intervals refine implementation actions and priorities by incorporating and integrating new information (including emerging issues) relating to science and management.	SM-40: Develop annual Long Island Sound Study work plans that consider progress made and recommendations for improving implementation to achieve desired outcomes. ✦ SM-41: Every five years develop a comprehensive, specific, target-oriented implementation plan engaging all Long Island Sound partners.

SECTION 4

MONITORING

Monitoring the condition of Long Island Sound and tracking implementation of management actions undertaken by the LISS and its partners are critical components of adaptive, ecosystem-based management. These activities, in combination, support evaluations of whether management actions are being implemented as planned and have resulted in progress toward stated environmental goals, thus promoting accountability. Monitoring also establishes baselines from which to evaluate the environmental response to perturbations (e.g., storms, oil spills, climate change).

ENVIRONMENTAL MONITORING

The LISS developed a monitoring plan for Long Island Sound (LISS 1994) in support of the 1994 CCMP. The primary goals of the monitoring program are to: 1) measure the effectiveness of the management actions and programs implemented under the CCMP; 2) provide essential information that can be used to redirect and refocus the CCMP during implementation; and 3) inform and facilitate research and modeling efforts by providing a suite of baseline data on spatial and temporal variability of environmental conditions. As articulated in the plan, successful monitoring programs share certain attributes:

- Have clear goals and objectives that are articulated as questions that are meaningful to the public and that provide the basis for scientific investigation.
- Include only what is needed so that the likelihood of being sustained during difficult budget times will be enhanced.
- Take full advantage of existing monitoring programs, including opportunities for citizen science.
- Generate a long-term commitment, one designed to answer key questions and to test key hypotheses.
- Take full advantage of new technologies and methodologies as they become available, while doing everything possible to make new observations compatible with historical data.
- Pay as much attention to data management, synthesis, analysis, integration, and transformation into information as to data collection.
- Develop and sustain a rich array of informational products that are carefully tailored to the special needs and interests of different constituencies.

These attributes have guided LISS efforts and resources in implementing the Long Island Sound monitoring program, which has generated, for the first time, a comprehensive dataset on Long Island Sound water quality. Components of the program are carried out by federal, interstate, state and local agencies, academic institutions, and volunteers and community organizations. Typically, community organizations focus on rivers, bays, harbors, and inlets, while the open Sound is generally monitored by governmental agencies and academic institutions. The LISS has focused on financial support, coordination, synthesis, and communication to varying degrees for those components. The major elements, but not a comprehensive listing, of the monitoring program are described in Table 1. Information on the overall program with links to specific monitoring elements is available on the monitoring page of the LISS website.

The LISS program utilizes monitoring data from its partners to track more than 60 environmental indicators of the status and trends in conditions. These indicators are communicated in fact sheets and the biennial reports *Sound Health* and *Protection and Progress*. The LISS spearheaded a synthesis of monitoring and research data leading to the publication in 2014, with the help of 55 contributing authors, of *Long Island Sound: Prospects for the Urban Sea,* (Latimer et al. 2014), which documents the advances in science made over the past decades in understanding Long Island Sound. The volume brings together data collected by researchers from the academic and agency communities as it applies to understanding the environmental dynamics of Long Island Sound. Throughout the synthesis, an emphasis

TABLE 1. Major Elements of the Long Island Sound Monitoring Program

Activity	Lead	Timeframe	Relevant Strategies (and Actions)	Reference
Open water quality monitoring, including temperature, salinity, dissolved nitrogen, nutrients, and dissolved oxygen	CTDEEP	1991-ongoing	1-1a3, 1-3a1, 1-3a2, 1-3b1, 1-3b3, 1-3b5, 1-3c1, 1-3c2, 2-4a4, 4-1b3 (WW-6, 20, 23, 24, 28; HW-6, 7, 18; SM-5, 6)	CTDEEP LISWQMP
LIS tributary and Connecticut River nonpoint source riverine nutrient flow loads and salinity monitoring. USGS benthic mapping of LIS	CTDEEP USGS	1975-ongoing	1-1a3, 1-3a1, 1-3a2, 1-3b1, 1-3b3, 1-3b5, 1-3c1, 2-4a4, 4-1b1, 4-1b3 (WW-6, 22, 23, 24, 25, 33; SM-4, 5, 13, 15)	CTDEEP USGS
Marine fisheries survey	CTDEEP	1984-ongoing	1-3b1, 1-3b3, 1-3c1, 1-3c2, 2-1a1, 2-2c1, 2-2d1, 2-4a1, 2, 3, 4, 4-1b3 (WW-26; HW-17, 25; SM-5, 6)	CTDEEP
CT Dept. of Agriculture's Aquaculture Shellfish Division and the NYSDEC's Growing Area Certification Unit monitor shellfish beds in accordance with the US FDA's National Shellfish Sanitation Program	CTDEEP, NYSDEC	1920s-ongoing	1-2b1, 1-2b2, 1-3b1, 1-3b2, 1-3b4, 1-3c1, 1-3c2, 2-1b2, 2-2c1, 2-4a2, 2-4a3, 4-1b3 (WW-19, 20, 21, 26, 31, 32; HW-18, 25; SM-5, 6)	CTDEEP NYSDEC
Buoy-based time-series monitoring of wave, weather, and water quality data	Marine Science UCONN	2003-ongoing	1-1a8, 1-3a2, 1-3b1, 1-3b3, 1-3b5, 1-3c1, 1-3c2, 2-4a4, 4-1b3 (WW-6, 20, 23, 24, 28; SM-5, 6)	UCONN-LISICOS
National Coastal Assessment of water quality, sediment quality, biota, habitat, and ecosystem integrity	EPA	1990-ongoing	1-2b1, 1-3a1, 1-3b2, 2-1c1, 2-4a1, 2-4a3, 2-4a4, 4-1b3 (WW-23, 26; HW-16, 17, 22, 26; SM-8)	EPA-NCA
Waters at 240 swimming beaches are monitored by local health departments and other agencies to test if the water is safe from disease-causing microorganisms	States EPA	2001	1-1a1, 1-2b2, 1-3b1, 1-3b4, 1-3c1, 1-3c2, 4-1b3 (WW-6, 15, 19, 31; SM-5, 6)	EPA-Beacon
Harbor Water Quality Survey provides data on fecal coliform and enterococcus pathogens in the Upper East River and Western Long Island Sound that have been monitored by the NYCDEP as well as data for water quality indicators such as dissolved oxygen levels and concentrations of microscopic plants and animals	NYCDEP	1909-ongoing	1-1a3, 1-1a8, 1-2b1, 1-3a1, 1-3a2, 1-3b1, 1-3b3, 1-3b4, 1-3b5, 1-3c1, 1-3c2, 2-4a4, 4-1b3 (WW-6, 15, 19, 20, 21, 23, 24, 28, 31; HW-6, 7, 18; SM-5, 6)	NYCDEP
Embayment water quality monitoring programs	Community groups	Variable	1-3a1, 1-3a2, 1-3b5, 4-1b4 (SM-8)	Various
Narrows and Western LIS Basin water quality monitoring	IEC	1991-ongoing	1-1a3, 1-3a1, 1-3a2, 1-3b1, 1-3b3, 1-3b5, 1-3c1,1-3c2, 2-4a4, 4-1b3 (WW-6, 20, 23, 24, 28; HW-6, 7, 18; SM-5, 6, 7)	IEC
Sentinel Monitoring for Climate Change, including an overall strategy and pilot monitoring projects	Sentinel Monitoring for Climate Change work group	2009-ongoing	1-1a8, 1-3b3, 1-3c1, 1-3c2, 2-1c1, 2-4a1, 2-4a3, 4-1b3 (WW-28, 29, 30, 33, 34; HW-17, 21, 23, 25, 26; SM-5, 6)	LISS
Periodic eelgrass surveys to determine extent and health of vegetation	USFWS	Every 3-5 yrs since 2002, last survey in 2012	1-3a1, 1-3b3, 1-3c1, 2-1a1, 2-1a2, 2-1c1, 2-2d1, 2-4a2, 2-4a3, 2-4a4, 4-1a1, 4-1b1, 4-3b1 (WW-27, 28; HW-5, 11,12, 22, 24, 26; SM-5, 26, 36, 39)	LISS

is placed on summarizing the current knowledge of the physical and biological processes in an encyclopedic format that can serve as a primary reference volume for scientists conducting research in Long Island Sound. In addition to the data summaries, the book recommended strategies for ecosystem-based management of Long Island Sound that have influenced this CCMP.

The monitoring program is not static. Data collection has evolved with changes in technology, management needs, and ecosystem responses. The LISS has regularly assessed monitoring activities (LISS 2002), changing stations, parameters, and approaches in response. This CCMP includes a number of recommendations for ongoing enhancements to monitoring. The work plans and quality assurance plans of individual monitoring components will be regularly updated as these changes are incorporated.

PROGRAMMATIC MONITORING

Ultimately, the success of the management program will be judged by indications of improved health and abundance of living resources and increased uses and value of the Sound's resources. Environmental monitoring is necessary to detect and chronicle these responses. However, because of the natural variability of the Sound and the time it may take for expected improvements to be observed, the implementation of management actions should be tracked to provide early indications of program success. Programmatic monitoring is needed to track, on a regular basis, the status and progress of management plan implementation. This information provides the basis for expected changes in environmental conditions, such as reductions in pollutant loading or habitat degradation that will lead to improvements in water and habitat quality. The LISS Implementation Tracking Reports annually document and assess progress in implementing the CCMP. This information is used in combination with environmental condition data, and the CCMP recommends that these program assessments be continued.

SECTION 5

FUNDING STRATEGIES

The CCMP recommends an ambitious agenda to invest in the health of the Long Island Sound ecosystem and its watershed. These investments can produce real value, not just from improved environmental quality, but also to the region's economic vitality and quality of life. Long Island Sound is an asset with real value, worth investing in to protect and enhance that value.

The needed investments will not come from a single program or level of government. Funding will be needed across jurisdictions, including federal, state, and local governments in partnership with the private sector, with each contributing its fair share. Organizations will need to dedicate resources and commit staff. Funding is needed to continue cooperative efforts under the Long Island Sound Study to coordinate implementation of the plan through ecosystem-based management. Ongoing federal and state environmental programs need to be maintained and enhanced, particularly for sustainability and resiliency, and to support project implementation, most significantly upgrading wastewater and stormwater infrastructure.

ONGOING FEDERAL AND STATE PROGRAM FUNDING

There are numerous environmental programs that provide the foundation upon which ecosystem-based management of Long Island Sound is built. Implementation of the CCMP's strategies and actions relies on the continued support for core, ongoing environmental programs conducted by CTDEEP, NYSDEC, the EPA, and other federal, state, and local agencies. As presented in Table 2, the total estimated annual statewide funding in New York State for water quality, natural resource, and coastal zone management is $126.59 million. Federal grants to New York State for these activities provide an additional $48.41 million statewide. As shown in Table 3, the total statewide annual funding in Connecticut for water quality, natural resource, and coastal zone management is $10.43

TABLE 2. Existing Annual Program Funding Statewide[1] in New York (in millions of dollars)

Program Element	State	Federal
Water Quality Management	13.70	19.00
Natural Resources Management[2]	110.60	26.90
Coastal Zone Management	2.29	2.51
Total	126.59	48.41

1. These funds are for programs statewide. LIS is one of 17 drainage basins in NY State encompassing less than one percent of the area and approximately 23 percent of the population of the state.
2. These numbers represent funds spent by the NY State Department of Environmental Conservation on the Fish, Wildlife, and Marine Program.

TABLE 3. Existing Annual Program Funding Statewide[1] in Connecticut (in millions of dollars)

Program Element	State	Federal
Water Quality Management		
Permitting and Enforcement	3.17	2.13
Water quality planning, standards, monitoring, and nonpoint source management	1.88	4.14
LIS monitoring	0.15[2]	1.00
Natural Resources Management[3]		
Coastal structures, dredging permits	0.50	0.00
Aquaculture	0.93	0.00
Coastal zone management	1.00	1.00
Coastal fish and wildlife management	1.50	3.30
LIS research	0.00	0.30
Tidal wetlands restoration	0.75	0.80
Coves and embayments restoration	0.50	0.00
LIS education and outreach	0.05	0.15
Total	10.43	12.82

1. Almost all of the state is included in the Long Island Sound drainage basin.
2. Does not include $500,000 capital investment in research vessel and depreciation
3. CT OPM Biennial Budget 2014-2015 and FY2014-FY2015 Biennium Governor's Budget

TABLE 4. Recommended Enhanced Ecosystem-based Management Funding Support (in dollars/year averaged over five years)

Program Element		Annual
Monitoring		
Open Sound Water Quality		1,500,000
Embayment Water Quality		500,000
Tributary Water Quality		150,000
Sentinel Climate Change		150,000
	Subtotal	**2,300,000**
Modeling		**350,000**
Assessment		
Seafloor mapping and spatial planning		150,000
Pathogen track down surveys		150,000
Nitrogen Pollution Tracking		200,000
Coastal resiliency		200,000
	Subtotal	**700,000**
Research		**500,000**
Living Resources and Habitat		
Habitat restoration		1,000,000
Habitat protection		1,000,000
Monitoring		300,000
	Subtotal	**2,300,000**
Coordination		
Coordination of Management Conference		250,000
State coordination of implementation		400,000
Public involvement and education		250,000
	Subtotal	**900,000**
Data Management and Reporting		**250,000**
Community Implementation Support		**2,700,000**
	Total	**10,000,000**

million. Federal grants to Connecticut for these activities provide an additional $12.82 million statewide. Support for these core programs should continue, at a minimum at these levels. Project funding through state revolving fund loan programs are not included in these totals, but are discussed under Project Implementation Funding.

ENHANCED PROGRAM FUNDING

While some of the CCMP's strategies and actions proposed to be carried out over the next five years would be accomplished through ongoing support of existing programs, many actions will require new, Long Island Sound-specific funding to be accomplished. As presented in the Sound Science and Inclusive Management theme, coordination of all stakeholders is key to the efficient use of scarce resources to attain desired results. Congress, through provisions in the Clean Water Act, has charged EPA with providing overall coordination of, and support for, the regional effort. The legislation supporting these efforts includes Section 320 and Section 119 of the Clean Water Act. The federal fiscal year 2015 budget provided approximately $4.5 million.

As summarized in Table 4, this plan recommends annual funding of $10 million for Long Island Sound priority enhancements to ongoing federal/state management programs. A portion of these funds would be used to continue the Long Island Sound Futures Fund, a grant program administered by the National Fish and Wildlife Foundation (NFWF) to fund on-the-ground projects in communities (Community Implementation Support). Since 2005, the Futures Fund has invested $11.7 million in 285 projects in communities surrounding the Sound. With grantee match of $24 million, Long Island Sound Futures Fund projects have totaled almost $36 million.

PROJECT IMPLEMENTATION FUNDING

The project implementation costs associated with the plan are large and are dominated by the potential cost of upgrading sewage treatment plants to remove nitrogen, the cost of remediating combined sewer overflows, and the cost of property acquisition (Table 5). The capital costs of implementing the nitrogen reduction to date are $2 billion in New York State and $330 million in Connecticut. Additional investments are needed to continue nitrogen reduction in New York and Connecticut. Over the next 20 years, these costs would

be in addition to the $4.4 billion in Connecticut and $8 billion in New York State needed to implement ongoing combined sewer overflow and separate sanitary system overflow abatement programs critical to reducing pathogens and floatable debris in the Sound. Because of the inclusion of upstream nitrogen sources in the Dissolved Oxygen TMDL, the LISS has involved the upstream states of Massachusetts, New Hampshire, and Vermont in regulatory and non-regulatory programs for nitrogen management. Based on a LISS-funded study, the application of biological nutrient removal retrofits at select WWTFs in the upstream states could be a cost-effective means of enhancing nitrogen reduction. The estimated cost of implementing those retrofits is included as a subcategory of the WWTFs element.

The two states have concluded that the existing State Revolving Funds are the preferred vehicles for funding major capital projects for wastewater programs; substantial funds have already been obligated to the programs for project implementation (Table 6). The total capital need for the wastewater program in Connecticut for the next 20 years has been estimated to be $8 billion, almost all of which is for needs within the Long Island Sound drainage basin. The Connecticut State Revolving Fund needs an infusion of $40 million per year in federal funds and $300 million per year in state funds over 20 years to continue to meet statewide needs, including Long Island Sound nutrient control needs, into the future. The 2008 Clean Watersheds Needs Survey for New York identified a total of $29.7 billion in needs over 20 years. Of these needs, $15.8 billion is within the Long Island Sound basin. The New York State Revolving Fund needs an infusion of $1.2 billion per year in combined federal and state funds to meet statewide needs, including those for Long Island Sound.

Cost estimates for the necessary level of control for nonpoint sources of nitrogen have not been developed but are expected to be substantial.

Significant project implementation costs are also associated with the habitat-related commitments and recommendations. The total project costs for the priority habitat and riverine migratory corridor restoration projects targeted for completion over the next five years is $63 million. The estimated needs in Connecticut between 2015–2019 for protection of open space and improving species management are $37.5 million and $30 million, respectively.

TABLE 5. Total Project Implementation Funding Estimates (in millions of dollars)

Program Element	New York	Connecticut[1]	Total
Waters and Watersheds			
WWTFs	2,000[2]	3,000	5,000
WWTFs retrofits in upstream states	–	–	5
Urban stormwater	NA[3]	700[4]	NA[3]
Combined sewer overflows	NA[3]	3,000	NA[3]
Habitats and Wildlife			
Habitat restoration (five years)[5]	–	–	45
Riverine migratory corridors (five years)[5]	3	15	18
Species management	NA[3]	120	NA[3]
Open space protection	500	140	640
Sound Communities			
Education	4	4	8
Climate preparedness, resiliency and sustainability (five years)	NA[3]	20	NA[3]

1. Based on anticipated annual funding required to meet the five- and 20-year Implementation Action goals.
2. Funding estimates for CSOs are included with the WWTFs row since most of the CSO program funds are used to get more stormwater flow to WWTFs.
3. Not available
4. Urban stormwater capital improvement costs were estimated from two sources, the 2004 USEPA Clean Watersheds Needs Survey and the 2009 Interim Stormwater Pilot Program Reports. Estimates include the cost of implementing BMPs related to nitrogen, pathogens, and floatable debris controls as well as some overall local stormwater drainage infrastructure improvement cost.
5. See Appendix D for priority project descriptions.

TABLE 6. Average Annual Obligations to the State Revolving Fund Program for Wastewater Treatment Statewide in New York and Connecticut (in millions of dollars)

Program Element	New York[1]	Conneticut[2]	
	State/Federal	State	Federal
Wastewater Treatment	880.2	57.5	13.7
Combined Sewer Overflows	359.9	11.8	2.2
Total	1,240.1	69.3	15.9

1. NYS CWSRF financing varies year to year; these values represent the FFY 2014 Annual Report to EPA.
2. CT SRF wastewater treatment cost exclude CSO costs (Federal Categories I-X except V (CSO)).

EXISTING FUNDING SOURCES

Funding through the EPA LISS's budget was never intended to be the primary means of supporting implementation of the CCMP's strategies and actions. Other federal and state programs will be essential sources of funding. Some of these programs are described below.

Clean Water State Revolving Funds

The existing State Revolving Funds are the preferred vehicles for funding major capital projects for wastewater programs, such as upgrading wastewater treatment facilities to remove nitrogen, remediating combined sewer overflows, and maintaining sanitary and stormwater sewer systems. Funds are awarded as low-interest rate loans, or with partial principal forgiveness, typically to municipalities conducting the work. Substantial federal, state, and local funds have been obligated for Long Island Sound-related projects over the past twenty years.

TABLE 7. Funding and Technical Support Programs

Federal Programs
EPA Smart-Growth grants and other EPA funding opportunities
USFWS Clean Vessel Act Grant Program and other USFWS funding opportunities
NOAA Habitat Conservation grants and other NOAA funding opportunities
NRCS Regional Conservation Partnership Program and other NRCS funding opportunities
New York Programs
Environmental Protection Fund (EPF)
Environmental Facilities Corporation
Cleaner, Greener Communities Program
Environmental Finance Center, Syracuse University
Connecticut Programs
Connecticut Long Island Sound License Plate Fund
Landowner Incentive Program
Connecticut's Clean Water Fund
Small Town Economic Assistance Program
Open Space and Watershed Land Acquisition Grant Program
Recreation and Natural Heritage Trust Program
Connecticut's Clean Vessel Act Program
Connecticut Nitrogen Credit Exchange Program
Connecticut Farmland Preservation Program

Other Funding Programs

Depending on the project focus, a variety of funding and technical support may be available. A partial list of programs are listed in Table 7.

FUTURE SUPPORT FOR LONG ISLAND SOUND'S PROTECTION AND RESTORATION

The historical support for the LISS from federal and state sources has led to the end of the decline of the ecosystem and, in some areas, marked improvements. However, the next generation of ecosystem level protection and restoration will require new and enhanced support to address smaller, more diffuse pollutant sources, continued land development, and the effects of climate change.

Wise investment in the natural assets of Long Island Sound and its watershed can secure more resilient and sustainable returns in property values, water quality, storm protection, recreation and tourism, and other goods and services, particularly during a changing climate. Rising productivity, lowered risk, and greater resiliency are ingredients for providing job growth, rising real wages, and a more prosperous economy.

Implementation of the 1994 CCMP was immensely aided by environmental bond acts passed by Connecticut and New York. For example, the Connecticut Bond Commission has approved extensive state overmatch to capitalize the state's Clean Water Fund to provide grants and loans for local and regional wastewater improvement projects. Under this program, grants range from 20 percent to 50 percent of costs depending upon the nature of the project, and loans are repaid at just two percent interest over 20 years. Even before the CCMP was completed, Connecticut provided $15 million in state funds to municipalities to implement low-cost biological nutrient removal at 11 WWTFs. New York's 1996 Clean Water/Clean Air Bond Act devoted $1.75 billion to protect and restore the state's environment. Of that amount, $790 million in funding was devoted to clean water projects to help carry out existing management plans for major water

resources, including $200 million for Long Island Sound. The state made funds available for municipal wastewater treatment improvement, pollution prevention, agricultural and nonagricultural nonpoint source abatement and control, and aquatic habitat restoration.

One of the priority actions in the Sound Science and Inclusive Management theme (SM-28) is to evaluate creative funding mechanisms to meet the financial needs for protecting and managing the natural, environmental assets of Long Island Sound. This includes market mechanisms designed to obtain a desired value from Long Island Sound's natural assets by providing incentives and disincentives for practices that protect or degrade them while also creating a revenue base to invest in their management. The establishment of creative funding mechanisms will be aided in coming years by new market opportunities for habitat protection and restoration, climate change mitigation and resiliency, and water quality. Current funding mechanisms are limited. Those benefiting from many aspects of the Long Island Sound Basin (property values, storm protection, and drinking water) might be willing to further contribute to investments that improve those assets. Thoseharming natural assets (e.g., through pollution) would benefit from a system that internalizes those costs and more efficiently allocates funds to mitigate damages or repair natural assets. Researching the full range of locally appropriate funding mechanisms could provide a sustained, reliable source of investment capital to restore and protect ecosystem services.

Wise investment in the natural assets of Long Island Sound and its watershed can secure more resilient and sustainable returns in property values, water quality, storm protection, recreation and tourism, and other goods and services, particularly during a changing climate.

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GLOSSARY

Acidification (ocean) – Increased concentrations of carbon dioxide in sea water causing a measurable increase in acidity (i.e., a reduction in ocean pH). This may lead to reduced calcification rates of calcifying organisms such as corals, mollusks, algae, and crustaceans.

Adaptation Plan – A plan developed by a community to pro-actively adapt to future changes in climate and plan for associated riparian and coastal impacts.

Adaptive Management – A systematic approach for improving resource management by learning from management outcomes.

Anadromous – see **Diadromous**.

Anaerobic – In the absence of oxygen, e.g., anaerobic decomposition of organic matter leads to the production of methane (CH_4).

Anoxic – In the absence of oxygen. In some cases, management may functionally define water below a certain threshold (e.g., 1mg/l) as anoxic, since it supports very little life, but to be truly anoxic, the concentration must drop to zero.

Anthropogenic – Caused by, or resulting from, human activities.

Aquaculture – The farming of aquatic organisms such as fish, shellfish and even plants. The term aquaculture refers to the cultivation of both marine and freshwater species and can range from land-based to open-ocean production.

Benthic – Pertaining to, or living on, the seafloor or river bottom.

Best Management Practice – Methods or techniques found to be the most effective and practical means of achieving an objective. Often used to refer to a management practice to control nonpoint source runoff.

Biodiversity – The number and variety of organisms found within a specified geographic region.

Bioextraction – Nutrient bioextraction (also called bioharvesting) is the practice of farming and harvesting shellfish and seaweed for the purpose of removing nitrogen and other nutrients from natural waterbodies.

Biological Nutrient Removal – Wastewater treatment technology that uses microorganisms to remove nitrogen and phosphorous from effluent.

Biota – All living organisms within an area or region; includes both plants and animals.

Blueway – A water trail or path that is developed with launch points, camping locations and other points of interest for canoeists, paddle boarders and kayakers. Blueways are typically developed by state, county or local municipalities to encourage recreation, ecological education and preservation of wildlife resources.

Brownfield – Land previously used for industrial purposes or commercial uses. The land may be contaminated by low concentrations of hazardous waste or pollution and has the potential to be reused once it is cleaned up.

Climate Adaptation and Resiliency – Preparing for the impacts of climate change by understanding the risks from predicted changes and taking steps to reduce vulnerabilities to those risks.

Coastal Habitat Extent – A category of habitat that includes all of the twelve priority habitat types identified by the LISS Habitat Restoration Work Group for management and restoration. This category includes eelgrass and tidal wetlands. While separate and specific restoration targets are set for these two habitat types, gains in these two areas can be used to reach the total coastal habitat restoration targets.

Combined Sewers – Sewer systems, which are designed to carry both rainwater runoff and municipal sewage in a single pipe to a wastewater treatment facility (WWTF). During heavy storms or snow melts, this type of system can overwhelm the capacity of the WWTF, resulting in discharge of some of the water (including some raw sewage) directly into nearby waterbodies through combined sewer overflow (CSO) pipes.

Contaminant – Any physical, chemical, biological, or radiological substance found in air, water, soil or biological matter that has a harmful effect on plants or animals (including humans); harmful or hazardous matter introduced into the environment.

Decentralized Wastewater Treatment System – A system that is used to treat and dispose of relatively small volumes of wastewater, generally from institutions and businesses. Onsite, decentralized wastewater systems treat sewage that is generated from residential or commercial activities from the same location. These systems include conventional septic systems, cesspools, and sewage treatment systems.

Diadromous – A species, which spends part of its life cycle in fresh water, and part in salt water. Diadromous species can be anadromous, living in the ocean and migrating to fresh water to breed (e.g., salmon, alewife, herring) or, less commonly catadromous, living in fresh water but migrating to the ocean to breed (e.g., American eel).

Economic Development Plan – A plan developed by a community to promote economic growth and development.

Ecosystem – A cohesive system formed by the interactions between a community of living organisms in a particular area with each other and the nonliving environment around them.

Ecosystem-based Management – An environmental management approach that recognizes the interactions within an ecosystem, rather than considering single issues, species, or ecosystem services in isolation.

Ecosystem service – The processes by which the environment produces resources that humans use such as clean water, timber, and habitat for fisheries, and pollination of native and agricultural plants.

Eelgrass – A marine flowering plant rooted in the sediment. It is the most abundant seagrass in Long Island Sound, and is an important habitat for many species of fish and invertebrates. Its Latin species name is *Zostera marina.*

Effective Impervious Cover – The impervious area that is directly connected to stream channels.

Environmental Indicator – Documented measurement, statistic, or value of a substance or effect in an environment. Used as a barometer to identify the presence or level of the factor/characteristic impacting the environment. The overall condition or quality of the environment is detailed by the set of such indicators and their periodic trend points.

GLOSSARY

Environmental Justice – The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Estuary – A partially closed coastal body of water where freshwater and saltwater mix.

Eutrophication – The process by which a body of water becomes enriched in dissolved nutrients that stimulate the growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen.

Green Infrastructure – Describes an array of technologies, approaches, and practices that protect and use natural systems, or systems engineered to mimic natural processes, to manage rain water as a resource, to solve combined sewer overflows (CSOs), enhance environmental quality, and achieve other economic and community benefits. Also this term can be synonymous with natural infrastructure, in contrast with grey infrastructure, which uses traditional practices, such as sewers and pipes, for stormwater management and wastewater treatment.

Greenway – A stretch of undeveloped land close to urban area that is kept for recreational use.

Habitat – The physical and chemical environment in which a plant or animal lives.

Harmful Algal Bloom (HAB) – A bloom of algae (often phytoplankton) that causes negative impacts to other species often through use of toxins, but also through mechanical or other means.

Hazard Analysis and Critical Control Point (HACCP) plans – A written document that identifies food (i.e., shellfish) safety hazards that are reasonably likely to occur in a food process, creating controls to prevent the hazard, and then monitoring those controls to ensure food safety.

Hazard Mitigation Plan – A municipal plan developed to reduce or eliminate long-term risk to human life and property from natural hazards.

Heavy Metals – A loosely defined term often used to refer to the group of metals and metalloids, which are associated with contamination or ecotoxicity. Typically includes transition metals, lathanoids, actinoids, and some metalloids.

Hydrology – The study of movement of water and the interactions of the body of water with its boundaries.

Hypoxic – Low in dissolved oxygen. While no universal threshold exists for what is considered hypoxia, most organizations use an operational definition of less than approximately 3mg/l of oxygen (See **Anoxic**).

Impervious Cover – Any surface in the landscape that cannot effectively absorb or infiltrate rainfall.

Invasive Species – Non-native species whose introduction does, or is likely to, cause economic or environmental harm or harm to human health.

Legacy Contaminants – Pollutants or chemicals, often produced by industry, which remain in the system long after they are discharged, such that their ecological impact continues even after discharge has been curtailed.

Living Shorelines – A shoreline stabilization technique using plants, sand, and limited use of rock to provide shoreline protection and maintain valuable habitats.

Low Impact Development – Management approach and set of practices that can reduce runoff and pollutant loadings by managing runoff as close to its source(s) as possible.

Management Conference – The Long Island Sound Study management conference is a partnership of federal, state, interstate, and local agencies, universities, environmental groups, industry and the public working together to implement the goals and objectives set forth in the CCMP. It is made up of the LISS committees and working groups— http://longislandsoundstudy.net/about/committees/.

Marine Spatial Planning (MSP) – A future-oriented process of evaluating and managing the spatial and temporal components of three-dimensional marine environments in order to achieve ecological, economic, and social objectives.

Monitoring – A series of measurements of water quality or other parameters made with the goal of detecting changes in the environment.

Moraine – An accumulation of boulders, stones, and debris carried and deposited by a glacier.

Municipal Comprehensive Plan – Provides a general, broad overview of the physical development in a community and provides a plan for how the community should develop or re-develop in the future.

Nitrogen – The most abundant element in Earth's atmosphere. Constitutes approximately 78 percent of the air we breathe. Nitrogen is an essential nutrient for all organisms, forming a component of many proteins and amino acids, but virtually all of the nitrogen on earth is in the form of dinitrogen gas (N2), which cannot be used by most organisms. These organisms are instead dependent on the much rarer dissolved inorganic nitrogen, which is frequently the nutrient that limits primary production in marine ecosystems. Anthropogenic activities contribute a large amount of nitrogen to coastal marine ecosystems, primarily through sewage discharge, agricultural fertilizer, and industrial emissions.

Nitrogen Trading Program – A nutrient reduction program developed by CTDEEP in which communities that reduced nitrogen through upgrading WWTPs, and have exceeded their targets, can sell credits in an exchange, which can then be purchased by communities that have not yet met their targets.

Nonpoint Source – A source of pollutants not restricted to a clearly identifiable discharge location like a river, pipe, or culvert (See **Point Source**).

Nutrient Loading – The mass of reactive nitrogen entering an aquatic system from external sources, e.g., WWTFs, OSWTSs, atmospheric deposition, fertilizer, etc.

Nutrients – Essential elements required by an organism for growth. In a marine context, this term is typically used to refer to nitrogen and phosphorus, but can also include silica (required by diatoms) and micronutrients such as iron, zinc, magnesium, etc.

Pathogen – Disease-causing bacteria, viruses, and protozoan often transmitted to people when they consume or come in contact with contaminated water.

Phosphorus – An essential nutrient for all organisms naturally contributed to marine systems primarily from the weathering of rocks. Phosphorus readily binds up into forms that are not biologically available and is typically the nutrient limiting primary productivity in freshwater and oligohaline environments. Humans contribute phosphorus to marine systems primarily from detergents and industrial surfactants, but also from sewage and fertilizer.

Photosynthesis – The process carried out by plants and some bacteria, in which light energy is harvested by pigments (mostly chlorophyll) and utilized to convert carbon dioxide and water into organic molecules (sugars) and oxygen. This process requires nutrients such as nitrogen and phosphorus as well as several other trace nutrients (iron, manganese, zinc, etc.).

Point Source – A specific localized and stationary source of a pollutant (e.g., nutrients, sediment, toxic metals) such as a pipe, culvert, or outfall (See **Nonpoint Source**).

Remote Sensing – The science of obtaining information about objects or areas from a distance, typically from aircraft or satellites.

Resilience – The ability of a community (both human and natural) to "bounce back" after hazardous events such as hurricanes, coastal storms, and flooding—rather than simply reacting to impacts.

Resiliency Plan – A plan developed by a community to evaluate the vulnerability of infrastructure, riparian and coastal areas and develop strategies for making these features and infrastructure more resilient to hazardous events (e.g., sea level rise and/or weather events). The plan should include the preservation of natural means to protect built environment where practical and also preserve and protect ecosystem services.

Riparian Buffer – The vegetated area adjacent to a river, stream, or other waterbody.

Runoff – Flows of water into a stream, lake, or estuary; typically from a rainfall event where rate of accumulation exceeds losses from infiltration and evapo-transpiration.

Sentinel Monitoring – A national model for tracking the effects of climate change.

Smart Growth – A range of development and conservation strategies intended to protect the natural environment, while simultaneously making communities more attractive, economically stronger, and more socially diverse.

Social Media – The strategies by which people interact and create, share or exchange ideas and information through the Internet (e.g., Facebook, Twitter, and LinkedIn).

Stewardship – The conserving and managing of natural areas to plan for multiple uses, increase public access, and protect important habitats.

Stewardship Area – One of 33 areas in Long Island Sound identified by the Long Island Sound Study as having significant recreational and/or ecological value to Long Island Sound. The boundaries of the Stewardship Areas are not strictly defined.

Stewardship Site – A property, with defined parcel boundaries, within a Stewardship Area that has been identified as representing the values or features for the Area that is being highlighted. The landowner of each Stewardship Site has granted permission for the land to be designated as a Stewardship Site.

Sustainability – Meeting the needs of the present without compromising the ability of future generations to meet their own needs: in particular using natural resources wisely to ensure their availability in the future.

Sustainability Plan – A plan developed by a community to ensure they are meeting the needs of the present without compromising the ability of future generations to meet their own needs; this includes proper stewardship of the natural environment to preserve it for the future.

Targeted Habitat Types – Twelve habitat types that are targeted by the Long Island Sound Study Habitat Restoration Work Group for restoration and management. The twelve habitats types are Beaches and Dunes, Cliffs and Bluffs, Estuarine Embayments, Coastal and Island Forests, Freshwater Wetlands, Coastal Grasslands, Intertidal Flats, Rocky Intertidal Zones, Riverine Migratory Corridors, Submerged Aquatic Vegetation Beds, Shellfish Reefs, and Tidal Wetlands.

Tidal Wetland Extent – A category of habitat that is included in the twelve habitat types identified by the LISS Habitat Restoration Work Group for management and restoration. Tidal wetland acres restored are included in the coastal habitat extent target as well as tidal wetland restoration target.

Total Maximum Daily Load (TMDL) – The total maximum amount of a pollutant a waterbody can assimilate while still meeting water quality standards.

Trade Equalized Nitrogen – A calculation of the effect a pound of nitrogen leaving a point source will eventually have when it reaches Long Island Sound.

Tributary – A river or stream, which flows into a larger river or lake.

Trust Species – Migratory birds, threatened species, endangered species, inter-jurisdictional fish, marine mammals, and other species of concern.

Turbidity – Measure of the amount of suspended particulate matter in water, which is inversely related to water clarity.

Wastewater Treatment – A process designed to clean and treat raw sewage to remove pollutants. Generally a three-part process, consisting of primary treatment involving screening and settlement of large particles, secondary treatment, involving anaerobic digestion of organic sludge. Water is then chlorinated and/or treated with UV sterilization to remove bacterial contaminants and discharged into the receiving waterbody. Tertiary or advanced wastewater treatment removes inorganic nutrients (nitrogen and/or phosphorus) from effluent prior to discharge.

Watershed – The region draining into a river, river system, or other body of water.

ACRONYMS

ADA – Americans with Disabilities Act

BADD – Biomass Area Depletion Days

BMP – Best Management Practice

CAC – (see LISS CAC)

CARE – Connecticut Aquatic Resources Education

CBSM – Community- Based Social Marketing

CCMP – Comprehensive Conservation and Management Plan

CMSP – Coastal and Marine Spatial Planning

CIRCA – Connecticut Institute for Resiliency and Climate Adaptation

CLEAR – Center for Land Use Education and Research (University of Connecticut)

CTDECD – Connecticut Department of Economic and Community Development

CTDEEP – Connecticut Department of Energy and Environmental Protection

CTDOA – Connecticut Department of Agriculture

CTSG – Connecticut Sea Grant

CSO – Combined Sewer Overflows

CWA – Clean Water Act

DA/BA – Connecticut Department of Agriculture/ Bureau of Aquaculture

DCC – Data Citation Clearinghouse

DMMP – Dredge Material Management Plan

EBM – Ecosystem-based Management

EPA – (see USEPA)

FEMA – Federal Emergency Management Agency

GI – Green Infrastructure

GIS – Geographic Information System

HAB – Harmful Algal Bloom

HACCP – Hazard Analysis and Critical Control Point plan

HUD – (see USHUD)

IEC – Interstate Environmental Commission

LDEO – Lamont-Doherty Earth Observatory

LID – Low Impact Development

LIS-EMP – Long Island Sound Embayment Monitoring Plan

LISFF – Long Island Sound Futures Fund

LIS-IDP – Long Island Sound Integrated Data Management Plan

LIS-IMP – Long Island Sound Integrated Monitoring Plan

LISICOS – Long Island Sound Integrated Coastal Observing System

LISRC – Long Island Sound Resource Center

LISS – Long Island Sound Study

LISS CAC – Long Island Sound Study Citizens Advisory Committee

LISS HRWG – Long Island Sound Study Habitat Restoration Work Group

LISS MC – Long Island Sound Study Management Conference

LISS STAC – Long Island Sound Study Science and Technical Advisory Committee

LISS SMWG – Long Island Sound Study Sentinel Monitoring Work Group

LISS SMCC – Long Island Sound Study Sentinel Monitoring for Climate Change

MACOORA – Mid-Atlantic Coastal Ocean Observing Regional Association

MARCO – Mid-Atlantic Regional Council on Oceans

MASSDEP – Massachusetts Department of Environmental Protection

MS4 – Municipal Separate Storm Sewer Systems

NCA – National Coastal Assessment

NCCR – National Coastal Condition Report

NEERS – New England Estuarine Research Society

NEIWPCC – New England Interstate Water Pollution Control Commission

NEMO – Nonpoint Education for Municipal Officials

NEP – National Estuary Program

NFWF – National Fish and Wildlife Foundation

NGO – Non-Governmental Organization

NHA – National Heritage Area

NHDES – New Hampshire Department of Environmental Services

NOAA – National Oceanic and Atmospheric Administration

NERACOOS Northeastern Regional Association of Coastal and Ocean Observing Systems

NRCS – Natural Resources Conservation Service

NROC – Northeast Regional Ocean Council

NSF – National Science Foundation

NYC DPR – New York City Department of Parks and Recreation

NYSOPRHP – New York State Office of Parks Recreation and Historic Preservation

NYSDEC – New York State Department of Environmental Conservation

NYCDEP – New York City Department of Environmental Protection

NYSDOS – New York State Department of State

NYSERDA – New York State Energy Research and Development Authority

NYSG – New York Sea Grant

OSWTS – On-Site Wastewater Treatment System

PBDE – Polybrominated diphenyl ethers

PCBs – Polychlorinated Biphenyls

QAPP – Quality Assurance Project Plan

SCDHS – Suffolk County Department of Health Services (New York)

SEQRA NY – State Environmental Quality Review Act

SIGT – Stewardship Site Identification GIS Tool

SLR – Sea Level Rise

SMCC – Sentinel Monitoring for Climate Change

SMCCP – Sentinel Monitoring for Climate Change Plan

SSPWG – Sound Spatial Planning Work Group

SUNYSB – State University of New York at Stony Brook

SWEM – System Wide Eutrophication Model

TMDL – Total Maximum Daily Load

TNC – The Nature Conservancy

UCONN – University of Connecticut

UNH – University of New Hampshire

URI – University of Rhode Island

USEPA – United States Environmental Protection Agency

USFWS – United States Fish and Wildlife Service

USGS – United States Geological Survey

USHUD – United States Housing and Urban Development

VTDEC – Vermont Department of Environmental Conservation

WWTF – Wastewater Treatment Facility

APPENDICES

APPENDIX A

LISS AND PARTNER KEY ACCOMPLISHMENTS, 1994–2014

The LISS has assessed and documented the progress the many partners have made in restoring and protecting the Sound through a series of reports available online at www.longislandsoundstudy.net. Some regional accomplishments stand out.

IMPROVED WATER QUALITY

- Developed an innovative, bi-state plan to reduce nitrogen pollution comprehensively to Long Island Sound.
  - Reduced nearly 40 million pounds per year the amount of nitrogen discharged from 106 wastewater treatment facilities in Connecticut and New York.
  - Reduced atmospheric deposition of nitrogen due to air emission controls.
  - Reduced severity of hypoxia (or low dissolved oxygen levels).
  - Increased the area of eelgrass beds, a rooted underwater plant sensitive to water quality conditions, by 4.5 percent between 2009 and 2012 and 29 percent between 2002 and 2012.
- Established all of Long Island Sound waters as a No Discharge Zone for marine boat pump out waste.
- Decreased releases of toxic contaminants in the Long Island Sound watershed by 86 percent from 1988 to 2010 (from 16.5 million pounds to 2.3 million pounds).
  - Declining concentrations of many contaminants observed in sediment on the seafloor.
  - Decreased PCB concentrations in striped bass by 82 percent between 1987 and 2007.
  - Decreased concentrations of many contaminants in seafloor marine life as measured by the NOAA National Status and Trends program.
- Adopted an action plan in 2007 to address sources of mercury to the region, with New York and Connecticut joining with other New England States.

◀ **A COMMON TERN** within the Oyster Bay Long Island Sound Stewardship Area, Lattingtown, NY (Photo by Lisa Franceski)

- Expanded community involvement in local watershed protection.
  - Created the Nonpoint Education for Municipal Officials (NEMO) program, which developed into a national program to educate municipal officials about local land use decision-making and nonpoint sources of pollution.
  - Developed watershed management plans for more than half of the sub-watersheds in the bi-state watershed.
  - Established Advanced Master Gardener Coastal Certificate program to focus on sustainable landscaping—alternatives to nutrient, chemical, and water intensive landscaping—for clean waters, engaging cooperative extension volunteers in over 600 hours of outreach and an estimated public audience of over 5,000.
  - Established an organic lawn care certification program for lawn professionals, providing alternatives to nutrient and chemical intensive landscaping to 160 service providers who attended workshops in 2013 and 2014.

RESTORED AND PROTECTED HABITAT

- Restored a total of 1,650 acres of habitat from 1998 to 2014, 83 percent of the goal to restore at least 2,000 acres of habitat by 2020.
- Reopened 317 miles of river and stream corridors to fish passage from 1998 to 2014 by removing dams and obstructions or creating bypasses and fish ladders in selected reaches.
- Developed the Long Island Sound Stewardship Initiative, which identified 33 areas that warrant special protection due to outstanding or exemplary scientific, recreational, or ecological value.

- Protected a total of 2,850 acres in the Long Island Sound Study Area since 1998 through easements and land acquisitions. Of that total, 2,675 have been protected since 2006, when the Long Island Sound Stewardship Act of 2006 was enacted.

PLANNED FOR CLIMATE CHANGE RESILIENCY

- Anticipated the need for information about climate change to support adaptation by creating the Long Island Sound Sentinel Monitoring program in 2008. The program identified six key flora/fauna native to the Sound as indicators of change, created a database of climate change science, and piloted projects to observe and document change over time.
- Installed 79 individual Surface Elevation Tables in 16 different tidal marsh areas to measure elevation changes in the marsh surface.
- Supported Groton, CT in developing a model process for municipalities to identify climate change vulnerabilities and prepare for them.

SUPPORTED SCIENCE AND RESEARCH

- Developed and published a synthesis of available scientific information, *Long Island Sound: Prospects for the Urban Sea*, (Latimer et al. 2014).
- Developed, funded and maintained a 28-year record of water quality monitoring data in Long Island Sound at fixed stations (one of the longest-term water quality monitoring datasets available nationally) and expanded the network to include fixed real-time buoy data.
- Piloted innovative bioextraction projects to evaluate the potential for aquaculture expansion to improve water quality and support local community jobs.
- Expanded support for scientific research.
  - Partnered with the New York and Connecticut Sea Grant College Programs to administer and manage the Long Island Sound Study Research Grant program that through 2013 funded 33 investigations, resulting in numerous scientific publications, and improved knowledge upon which to base management of the Sound.
  - Coordinated a multi-partner effort to map the seafloor of Long Island Sound through the collection of high-resolution geophysical data. This information will aid management of marine resources and comprehensive marine spatial planning.

ENGAGED PARTNERS, LEVERAGED RESOURCES

- Created and revitalized the Long Island Sound Science and Technical Advisory Committee (STAC) composed of scientists and engineers to synthesize science and identify research priorities.
- Established and administered the LIS Futures Fund (LISFF)—a collaborative grant program with the National Fish and Wildlife Foundation that funds on-the-ground projects in communities around the Sound to help restore the Sound. Since 2005, the Futures Fund has invested $11.7 million in 285 projects in communities surrounding the Sound. With grantee match of $24 million, LISFF has generated a total of almost $36 million for projects in both states.
- Leveraged more than $3.2 billion in other federal, state and local funding from 2006-2013, a ratio of $84 leveraged for every EPA Long Island Sound dollar in funding for the Management Conference.

EDUCATED AND ENGAGED THE PUBLIC INCLUDING DISADVANTAGED COMMUNITIES

- Created and supported a robust and active Citizens Advisory Committee to provide public input and advice to the Management Conference on program direction, priorities, and funding needs.
- Convened an annual Citizens Summit to increase awareness of efforts being made to protect and restore the health of the Sound.
- Developed and supported a bi-state Mentor Teacher Program for K-12 educators who attended 37 training sessions and are certified as "train-the-trainers" mentors in their school district, with more than 350 educators trained, reaching 25,000 students in New York and Connecticut through 2013.
- Included Environmental Justice (EJ) as a priority topic in the LISFF annual request for proposals for CCMP implementation projects.
- Involved students from EJ communities into community-based water and habitat improvement projects.
- Built local partnerships to capitalize on federal EJ initiatives (such as USFWS Urban Wildlife Refuge Program and the EPA Urban Waters Program).
- Integrated involvement from underserved communities in new initiatives, building grassroots support for their expansion.
  - Involved youth from underserved communities in projects that demonstrated effectiveness of aquaculture to bioextract nitrogen from LIS waters.

APPENDIX B

TECHNICAL EXPLANATION OF ECOSYSTEM TARGETS

The following section provides a technical background and explanation of the quantitative ecosystem targets in the CCMP. Explanation is provided for each target on how and why the given metric and specific target were chosen and how progress toward the target will be measured (e.g., what the baseline value is, clarification of specific terms, what datasets will be used, etc.).

CLEAN WATERS AND HEALTHY WATERSHEDS

EXTENT OF HYPOXIA

Measurably reduce the area of hypoxia in Long Island Sound from pre-2000 Dissolved Oxygen TMDL averages to increase attainment of water quality standards for dissolved oxygen by 2035, as measured by the five-year running average size of the zone.

The average size of the maximum summertime extent of hypoxia (DO ≤ 3.0 mg/L) from 1987–2000 was 208 square miles. Based on the last 20 years of interannual variability, a 28 percent reduction would be necessary to achieve a "measurable reduction," defined as the ability to statistically differentiate (either by regression or by ANOVA) that a change has occurred with 95 percent confidence after 20 years (in 2035). We chose areal extent from the available hypoxia metrics tracked by LISS (areal extent, duration) because this metric is most closely correlated to the severity of impact and is the least environmentally variable of the metrics.

NITROGEN LOADING

Attain WWTF nitrogen loading at the recommended 2000 Dissolved Oxygen TMDL allocation level by 2017 and maintain the loading cap. Have all practices and measures installed to attain the allocations for stormwater and nonpoint source inputs from the entire watershed by 2025.

Discharges from wastewater treatment facilities are tracked for compliance with permit limits consistent with the LIS Dissolved Oxygen TMDL for nitrogen (CTDEEP, NYSDEC 2000). This target is to attain the TMDL allocation for wastewater treatment facilities (in trade equalized pounds per day) by 2017 and maintain compliance with that cap into the future. The allocations for nonpoint sources in the LIS TMDL require implementation of a variety of best management practices to control nonpoint source pollution. This target is to have all the necessary practices to attain the TMDL nonpoint source allocation 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 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 TMDL targets to reduce nitrogen loading from stormwater and nonpoint sources.

WATER CLARITY

Improve water clarity by 2035 to support healthy eelgrass communities and attainment of the eelgrass extent target.

Water clarity is one of the major factors affecting eelgrass health and therefore extent. For most of LIS water clarity is correlated with phytoplankton levels and measured using standard light penetration techniques (e.g., Secchi disk, photosynthetically active radiation sensors). For the purposes of this goal, "improved" is defined as an increase in the overall numeric criterion for water clarity in the Long Island Sound water quality report card (under development) by at least half letter grade (e.g., B to B+) between the initial 2015 report card evaluation and the evaluation conducted in 2035.

IMPERVIOUS COVER

Through green infrastructure, low impact development, and stormwater disconnections, decrease by 10 percent the effective area of impervious cover in the Connecticut and New York portions of the watershed by 2035 relative to 2010 baseline.

The degree of impervious cover, particularly near waterbodies, has been shown to be associated with degradation of water quality in rivers and streams. The analysis is based on UCONN Center for Land Use Education And Research (CLEAR) Land use data (http://clear.uconn.edu/publications/research/Statewide_riparian_final.pdf) (Wilson and Arnold 2008) and can be tracked using the CLEAR estimate of impervious cover. Low impact development projects (e.g., green roofs, permeable parking lots) logged in the CLEAR Low Impact Development Atlas would be considered pervious for the purpose of this analysis. The 2010 baseline is 296,000 acres (463 square miles) of impervious cover in the LISS Study area. The study area is defined by the TMDL, and the study area boundary can be found here: http://longislandsoundstudy.net/wp-content/uploads/2010/01/LISSHabMap02.pdf.

RIPARIAN BUFFER EXTENT

Increase the percent area of natural vegetation within 300 feet of any stream or lake in the Connecticut and New York portions of the Long Island Sound watershed to 75 percent by 2035 from 2010 baseline of 65 percent.

Naturally vegetated zones around the shorelines of all waterbodies provide a buffer that has been shown to be effective in removing contaminants from groundwater before it enters into receiving waters. The target is to have 75 percent of areas within 300 feet of a stream or lake within the Connecticut and New York portions of the LIS watershed naturally vegetated by 2035, based on UCONN CLEAR land use data (http://clear.uconn.edu/projects/riparian_buffer/results/CLEAR_%20Summary_021508.pdf). Naturally vegetated includes forest, grassland, shrub, and wetland land use categories, but not turf grass or agriculture field classes. This target is based on analysis of land use and water quality in CT (Goetz, 2003; Wilson and Arnold 2008).

APPROVED SHELLFISH AREAS

Upgrade 5 percent of the acreage currently restricted or closed for shellfishing by 2035 from 2014 baseline.

Each state has designated areas for safe shellfishing; the "growing waters" designation is common to both CT and NY. Currently Connecticut has approximately 128,000 approved acres, 248,000 acres of conditionally approved or restricted beds, and 23,500 acres prohibited, while New York has 412,000 acres certified 1,613 acres seasonally certified (restricted), and 75,500 acres uncertified. Thus, to meet this target, 17,400 of the 349,000 closed or conditionally closed acres would need to be upgraded. This metric is reported by the states and tracked by the Long Island Sound Study Indicators program.

SEDIMENT QUALITY IMPROVEMENT

Reduce the area of impaired sediment in Long Island Sound by 20 percent by 2035 from 2006 baseline.

Sediment quality is determined by EPA's National Coastal Assessment Sediment Quality Index. This index is based on concentrations of 28 contaminants, characterized as "good," "fair," or "poor" for each station based on the number and severity of exceedances, and weighted by the portion of the Sound represented by each station. Our target is to reduce the net area that is impaired (rated as fair or poor) in Long Island Sound by 20 percent.

In 2006, 34 stations had data sufficient to establish a rating, and of those, 15 scored good, 11 fair, and eight poor. Spatially weighted (because sampling density is higher further west in LIS), 51.5 percent of LIS scores "good," 30 percent "fair," and 18.5 percent "poor." By this definition, 48.5 percent of LIS is considered impaired. To accomplish the goal of reducing this impairment by 20 percent we need to see net improvement in 10 percent (48 %*0.2 = 9.6%) of the area weighted stations.

We define "improvement" to be upgrading from "poor" to "fair" or from "fair" to "good," and net improvement to be the area of stations improving minus the area of stations regressing (from "good" to "fair" or "fair" to "poor"). By this definition, our goal can be accomplished by reducing the percentage of LIS scoring poor from 18.5 percent to less than 8.5 percent (as long as the percentage scoring "fair" does not increase to more than 40 percent) or by increasing the percentage scoring "good" from 51.5 percent to more than 61.5 percent, or a combination of both (e.g., 57% good, 33% fair, 10% poor = 5.5% increase in good + 8.5% decrease in poor = 13.5% of LIS area improved = 27% decrease in impairment).

THRIVING HABITATS AND ABUNDANT WILDLIFE

COASTAL HABITAT EXTENT

Restore 350 acres of coastal habitat by 2020 and a total of 3,000 acres by 2035 from a 2014 baseline.

Between 1998 and 2014, LISS partners have restored 1,650 acres of coastal habitat. The interim goal is to restore an additional 350 acres by 2020, for a cumulative total of 2,000 acres. The final goal is to restore an additional 2,550 acres between 2021 and 2035, bringing the cumulative total of acres restored since 1998 to 4,550 acres. The target for the coastal habitat extent includes restoration in any of the 12 targeted habitat types, including eelgrass and tidal wetlands. While separate and specific restoration targets are set for these two habitat types, gains in these two areas can be used to reach the total coastal habitat restoration targets. The Habitat Restoration Work Group tracks coastal habitat restoration projects that are in progress within the watershed by various partners and reports the total acres restored annually.

Eelgrass extent

Restore and maintain an additional 2,000 acres of eelgrass by 2035 from a 2012 baseline of 2,061 acres.

The 2012 eelgrass baseline comes from a 2012 USFWS survey that found 2,061 acres of eelgrass in the Eastern Basin of the Long Island Sound. While the survey was only conducted in the Eastern Basin, eelgrass experts believe that eelgrass beds in the Central Basin are small or nonexistent while beds are absent from the Western Basin. Therefore we use 2,061 acres as an estimate of total eelgrass coverage in the Sound, and the goal is to increase this to 4,061 acres of areal eelgrass extent as measured by aerial imagery.

This target will be achieved through the successful implementation of additional water quality protections and associated reductions in land based inputs of nutrients, as well as restoration (replanting) efforts led by academic, government, and nonprofit agencies and partners. The Habitat Restoration Work Group tracks eelgrass restoration projects that are in progress within the watershed by various partners and reports the total acres restored annually. However, this ecosystem target is influenced by both habitat restoration projects as well as natural gains and losses in eelgrass extent.

Tidal wetland extent

Restore an additional 515 acres of tidal wetlands by 2035 from a 2014 baseline.

As of 2014, 985 acres of tidal wetland habitat have been restored in the LISS study area since 1998. The 2035 target is to restore an additional 515 acres, bringing the cumulative total of restored tidal wetland acres since 1998 to 1,500. For the purposes of this metric, a wetland is considered "restored" after a successful effort to restore tidal flow (e.g., culvert enlargement, fill removal). The Habitat Restoration Work Group tracks tidal wetland restoration projects that are in progress within the watershed by various partners and reports the total acres restored annually.

RIVER MILES RESTORED FOR FISH PASSAGE

Open 200 additional miles of fish riverine migratory corridors in the Connecticut and New York portions of the watershed by 2035 from a 2014 baseline.

This target will be attained by reopening, either through dam removal or fish passage projects, an additional 200 riverine migratory corridor miles (RMC). The 2014 baseline is 317 open RMC miles in Connecticut and three open RMC miles in NY. For context, there are an estimated 1,850 total RMC miles in Connecticut, more than half of which are dammed or otherwise not passable for fish. The length of New York total RMC miles has not been estimated, but is much smaller. The Habitat Restoration Work Group tracks fish passage projects that are in progress within the watershed by various partners and reports the total miles restored annually.

SHELLFISH HARVESTED

Increase the harvest of oysters, clams, and scallops in the Sound through a combination of habitat management and shellfish aquaculture.

This is defined as the total harvest, by weight, of oysters, clams, and scallops harvested commercially or recreationally from open areas and/or shellfish leases. These data are collected by the states, and reported by the LISS Indicators program. Specific targets and timeframes will be developed after considering shellfish management plans under development such as the Connecticut statewide plan.

HABITAT CONNECTIVITY

Increase connectivity of coastal habitat by 2035 by restoring and/or protecting habitat patches that increase biodiversity and support migratory pathways.

Research shows that improving habitat connectivity allows for genetic and ecological flow. Corridors provide fish and wildlife with greater ability to move for the purposes of feeding, breeding, and resting. Promoting restoration and protection projects which increase aquatic and terrestrial connectivity, is an important component of ecosystem resilience, or the ability of an ecosystem and the fish and wildlife it supports to maintain function in the face of change. Connectivity gains can be both targeted and monitored by mapping restoration and protection projects in a GIS database and using decision support tools like the Stewardship Site Identification GIS Tool (SIGT) and Landscape Conservation Cooperative Connecticut River Pilot Landscape Design Tool which highlights the best areas of intact, resilient and connected habitat and identifies corridors between these areas of high quality patches. Using decision support tools like these will help to guide land protection decisions by highlighting areas on the landscape that have the greatest ecological value and identifying corridors between them. Efforts to refine these decision support tools are still underway as part of Implementation Action HW-4. Once these tools are complete, they will be used to establish a quantitative metric which will be used to estimate a baseline and set a more specific quantitative goal to be accomplished by 2035.

PROTECTED OPEN SPACE

Conserve an additional 4,000 acres of Connecticut land and 3,000 acres of New York land within the Long Island Sound coastal boundary by 2035, while maintaining or increasing the total area of protected land.

Connecticut's goal is to conserve an average of 200 acres per year within the Long Island Sound coastal boundary over the next 20 years, resulting in a total of 4,000 acres.

New York State is currently working on the latest version of their New York Open Space Conservation Plan. The Plan serves as the blueprint for the State's land conservation efforts and is required by law to be revised every three years. The most recent revision will be released in 2015. In the Plan, open space is considered an area of land that is either publicly or privately owned that will remain in its natural state or is used for agriculture, free from intensive development for residential, commercial, industrial or institutional use. The Plan identifies conservation projects and objectives for all counties found within the Long Island Sound watershed. These projects and objectives were determined by Regional Advisory Committees composed of county and state, land conservation organizations, and community interest group representatives, along with public comments received through the Plan review process. This Plan will help guide land acquisition in New York State for the coming years. The target number of acres to be acquired each year within the Long Island Sound watershed for New York is 150 acres per year. This number was determined by reviewing and averaging the total number of acres acquired each year and reported to the National Estuary Program Online Reporting Tool (NEPORT). The total number of acres acquired each year (includes acres acquired by all possible land acquisition entities: state, municipal, and land conservation organizations) for the last eight years (2007-2014), within the Long Island Sound watershed in New York State, was analyzed. Thus, the target is to preserve 3,000 acres of New York land within the Long Island Sound watershed by 2035. There is, however, a need for an accurate, complete inventory of protected land statewide in Connecticut and in the coastal area of Connecticut and New York to assess progress toward these goals.

SUSTAINABLE AND RESILIENT COMMUNITIES

WATERFRONT COMMUNITY RESILIENCY AND SUSTAINABILITY

All coastal municipalities have prepared plans for shoreline resiliency and infrastructure sustainability and resiliency by 2025, with all future development compliant with those plans by 2035.

Sustainable development and redevelopment as well as the protection of urban and suburban infrastructure from the effects of climate change are two of the main principles driving the revision of the CCMP. This target will encourage municipalities, within the coastal zone, to develop and implement comprehensive plans, which will have long lasting benefits to their residents. The implementation of these plans should not sacrifice ecosystem integrity. The Sound-wide enumeration of coastal municipalities will be quantified and tracked by the LISS (in Connecticut there are 36 coastal municipalities, in New York there are 96).

HARBOR AND BAY NAVIGABILITY

Maintain all federal navigation channels in harbors and bays and manage dredged material in a cost-effective and environmentally sound manner, consistent with a bi-state Dredged Material Management Plan, by 2035.

Maintenance of navigational channels is essential to sustain both recreational and commercial activities in harbors and embayments along the Connecticut and New York shorelines. This target ensures that dredging and dredged material disposal operations are accomplished in a sustainable manner, consistent with the Marine Protection, Research, and Sanctuaries Act, Clean Water Act, National Environmental Policy Act, and the Long Island Sound Dredged Material Management Plan so that future generations can enjoy boating in LIS and be assured that environmental degradation does not occur from the maintenance of harbors and embayments. The LIS Dredged Material Management Plan is presently under development. Project lists and dredge material amounts can be found at http://www.epa.gov/region1/eco/lisdreg/index.html.

PUBLIC ENGAGEMENT AND KNOWLEDGE

Increase the knowledge and engagement of the public in the protection and/or restoration of Long Island Sound.

A 2006 public perception survey supported by the LISS was conducted to gauge the knowledge of residents in the watershed. The survey correlated environmental knowledge with behaviors contributing to environmental stewardship. However, achieving positive behavior changes requires understanding and addressing the specific barriers preventing individuals and communities from their adoption. This target will require the development of baseline and trends metrics through best available research methods (SC-14 and SC-22) or review of existing social data that assess the degree to which the public understands its role in the protection of Long Island Sound and acts on that knowledge.

PUBLIC BEACH CLOSURES

Reduce by 50 percent the number of beaches reporting at least one closure day or the total number of beach-day closures per monitored beach due to water quality impairments by 2035 compared to a five-year rolling average from 2014.

LISS presently tracks closure days at 648 Connecticut and New York beaches using the EPA BEACON system (http://watersgeo.epa.gov/beacon2/reports.html). The five-year rolling average is 1,317 closure/advisory days, which translates to almost exactly two closure days per monitored beach. Of the 648 beaches reporting, 132 (20.5 percent) had at least one closure day. The target therefore is to reduce the five-year rolling average to about one closure day per monitored beach per year (658 total closure days assuming constant number of beaches sampled), or to reduce the total number of beaches reporting a closure to less than 10.25 percent of the total number of tracked beaches (66 at present sampling level).

MARINE DEBRIS

Decrease the mass of marine debris in Long Island Sound by 2035.

While LISS tracks several measures of marine debris, including boom/skimmer data, debris collected by vessels, and various annual beach cleanup statistics, the currently tracked indicator of pounds of debris removed per mile of beach cleanup performed is the best "effort independent" metric of the presence of debris in LIS. The data are obtained from Long Island Sound coastal cleanup days conducted as part of the International Coastal Cleanup coordinated by the Ocean Conservancy. The target is to reduce the five-year rolling average of this indicator, compared to the 2013 baseline (five-year rolling average from 2009 to 2013) of 313 pounds of debris removed per mile surveyed.

PUBLIC ACCESS TO BEACHES AND WATERWAY

Increase the number of public access points accessible by the public to the Sound and its rivers by at least 10 percent by 2035.

Public access to the shore for all members of the LIS community is an important design principle for the CCMP. There is not much undeveloped waterfront left along the coast. The CCMP includes an action (SC-37) to undertake a Sound-wide evaluation of coastal public access needs including a re-evaluation of existing public access for state/municipal sites that would most benefit for improvements to existing facilities. Such as plan would include the following steps: identify the current number of points and miles accessible; identify specific potential public access sites that could be re-developed in the future, as well as areas and stretches requiring additional attention; describe planning challenges to be considered in adding new access sites; summarize findings and set out steps for implementing the plan and increasing access. Measurement methods for shoreline accessibility will be based on this Sound-wide public access plan.

The current suggested metric for this is the quantity of public access points. Currently in Connecticut, there are 328 access points, so a 10 percent increase would require 33 new access points. New York does not currently track this metric, but would begin doing so as part of SC-37. Additional measurement methods and numeric targets for shoreline accessibility (e.g., ADA compliant access points) may arise upon completion this Sound-wide public access plan.

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APPENDIX C

KEY TO IMPLEMENTATION ACTIONS SUPPLEMENT

The CCMP has a 20-year horizon and includes specific implementation actions (IAs) organized by theme to help attain the plan goals and ecosystem targets. In addition to the work of ongoing programs, these specific, tactical actions will carry out the strategies over the next five years. Four supplemental documents detailing the CCMP Implementation Actions by theme are available at: www.LongIslandSoundStudy.net.

Implementation actions may apply to one or more strategies, but are organized around the main strategy addressed. Review and development of implementation actions every five years will allow for adaptive management and inclusion of emerging scientific and technological advances. Refining the implementation actions every five years will keep the CCMP current and incorporate the most effective management practices on a regular basis.

These IAs are presented by theme; however, many of the actions will achieve progress in multiple theme areas. The actions with the highest priority were chosen for their timeliness, application to ecosystem indicators and targets, and support of the four CCMP underlying principles. These actions will likely be completed within the first five years of implementation.

The four funding level categories (see Implement Action box) represent broad ranges in which to distinguish and group funding needs of implementation actions. The needed level of funding for an implementation action will also determine the types of funding sources (e.g., government grants, local foundations, clean water infrastructure grants and loans) most applicable to meeting that need.

The LISS will assess implementation progress yearly as part of annual work plan development process, as well as regularly reporting on the indicators of ecosystem targets. At the end of year four of each implementation cycle, the LISS will revisit the outcomes, objectives, and strategies based on implementation successes and on new drivers, pressures, or issues. New implementation actions will be developed for the next five-year planning cycle to support attainment of the goals and ecosystem targets, allowing for adaptive management and adjustment of priorities and actions.

EACH IMPLEMENTATION ACTION INCLUDES:

- A description and background about the proposed action.
- The lead or cooperating agencies and organizations.
- Potential sources for funding and the level needed within four categories –
  $ Less than $25,000
  $$ $25,000 to $150,000
  $$$ $150,000 to $1,000,000
  $$$$ Greater than $1,000,000
- Expected outputs or products that the action will generate.
- Indicators that will be used to measure the success of the implementation action.
- The implementation status of the action—either a new action or one that is already underway.
- An approximate time frame for action completion.

APPENDIX D

PRIORITY RESTORATION PROJECTS

TOP 5 PRIORITY HABITAT RESTORATION PROJECTS IN LIS

1 Coastal Island Stabilization and Restoration

Approx. cost: $1.5M in planning and permitting ($250,000 per island), $4M for construction

Long Island Sound's coastal islands are a unique and important resource. Great Gull Island in New York and Falkner Island in Connecticut are critically important to the survival of the federally endangered roseate tern. Great Gull plays a globally significant role in roseate tern survival as it is the largest nesting colony for this endangered tern in the Western Hemisphere. Falkner Island, part of the Stewart B. McKinney National Wildlife Refuge, is home to the only roseate tern colony in Connecticut as well as the largest least tern colony in the State. Both islands were badly damaged by Hurricanes Irene and Sandy. The hurricanes damaged infrastructure and about 70 percent of the nesting habitat on the islands. In addition to Great Gull and Falkner; Sheffield, Chimon (Stewart B. McKinney National Wildlife Refuge Units located in Norwalk, CT) Duck (Westbrook, CT) and Charles Islands (Milford, CT) are also in need of restoration and stabilization. These islands support populations of great egret, snowy egret, black-crowned night heron, glossy ibis and the American oystercatcher. Without stabilization all of these islands they will continue to lose critical nesting habitat for the Sound's waterbirds. The objective of this project is to model coastal stressors, plan, and engineer island stabilization projects to restore nesting area and stabilization function the islands. In addition to stabilization, some habitat restoration is needed. The project would also support removal of downed trees and storm debris, vegetation control and planting of native species.

2 Urban Habitat Restoration

Approx. cost: $4M (1-2 years); $15M (3-5 years); $19M total

The majority of Long Island Sound's coastal areas are highly urbanized. Urban areas offer a unique opportunity to forward habitat restoration in a very visible, meaningful way throughout communities. Habitat restoration in urban areas has significant ecological and societal value including providing vital stop over habitat for migrating wildlife, reducing pollution to the Long Island Sound and controlling flooding in cities and neighborhoods. Habitat restoration in urban areas also provides aesthetic benefits. The easy projects are done. Increasingly, we need to rethink traditional forms of restoration and get creative within the well-established urban centers around the Sound- finding lines of overlap and opportunity for both wildlife and humans to thrive.

The objective of this project is to support small and medium scale restoration of priorities habitat types in highly urbanized areas particularly within Alley Creek and Little Neck Bay watershed, New Haven Harbor watershed, and Bridgeport Harbor. These are three of the most densely populated urban centers in the Long Island Sound, with established partnerships, strong management and urban habitat restoration projects that are currently moving forward. These projects and future iterations need continued support. Partners in Alley Creek and Little Neck Bay, New Haven, and Bridgeport have identified locations for restoration. At Alley Creek, restoration is focused on invasive species removal, fill removal, clean fill replacement, and native planting at coastal forest, freshwater wetland, riparian corridors, coastal grassland, and tidal wetlands habitat as well as incorporating green infrastructure design and stormwater capture techniques in buffer zones surrounding the sites. In New Haven and Bridgeport restoration includes incorporating LID into highway medians, naturalization of riparian areas in

urban rivers, restoring native grassland habitat and improving the quality of coastal forests throughout the cities. Innovative wetland restoration plans have been proposed at some of these sites but not yet implemented. Engaging the public in restoration is a key component at all these sites.

3 Sandy Point Habitat Restoration Project

Approx. cost: $10M

Sandy Point in West Haven, CT is a Long Island Sound Study Stewardship Site and a key migratory bird area. It is one of Connecticut's top five nesting sites for least terns and the endangered piping plover as well as a proposed globally significant area for the semipalmated sandpiper. The site also supports American oystercatcher and the salt marsh sparrow in the adjacent wetland area.

Sandy Point has a sewage outfall pipe from the West Haven Sewage Treatment plan running across the beach. This pipe is becoming unearthed. A leak in the pipe could be catastrophic to the wildlife that uses the site, cause a major public health issue and water quality decline in New Haven Harbor into which the pipe drains. Moreover, the sand near the pipe has eroded over time and is going into Old Field Creek. This causes a blockage in the creek draining, subsequent freshwater retention and an overall reduced salinity which is spurring the growth of invasive *Phragmites* and causing major flooding in the nearby neighborhoods. The root of the problem is the configuration of the sewage outflow pipe which needs to be buried deeper. Once this is done Old Field Creek can be dredged which will help abate flooding. This project would provide funding to bury the pipe deeper, remove sediment build up from Old Field Creek and help the area regain tidal flow.

4 Resiliency Enhancing Techniques for Tidal Wetland Restoration

Approx. cost: $1.5M to 10M

Sea level rise is occurring at a quicker rate on the East Coast than other parts of the world. Experts are concerned this could threaten the health of our tidal wetlands by leading to more water up on the marsh, compressing the peat and causing the marsh to sink. Broadly speaking there is concern that more frequent storm events coupled with rising seas and sinking marshes could lead to a regime shift whereby resiliency of marshes is decreased to such a degree that they can no longer maintain themselves as marsh but shift to a less desirable habitat type, namely mud flat and eventually open water. These factors, combined with other possible factors such as nitrogen and sediment input into these systems, are having a detrimental impact on marsh health. Resiliency enhancing restoration techniques including thin layer deposition, facilitating marsh migration and creating living shorelines may increase resiliency of tidal wetlands. These techniques are being tried in some areas along the East Coast and in a few areas in Connecticut (Stratford Point living shoreline project, Yale University Marsh Migration Study). Other sites exist where good pilot efforts could be launched, specifically areas losing large areas of tidal marsh. In Connecticut, examples of these include Leetes Island in Guilford, Mile Creek in Old Lyme, Bride Brook in East Lyme and the marshes at Goshen Cove in Waterford. In New York, examples of areas exhibiting the greatest marsh loss include the Porpoise Islands and Stony Brook Harbor in Stony Brook, Crab Meadow Marsh in Huntington, Mount Sinai Harbor Islands in Mount Sinai, Baiting Hollow wetlands in Baiting Hollow, and Lloyd Point Harbor in Lloyd Harbor. Increased understanding of how and where resiliency enhancing restoration techniques are working will be critical to maintaining tidal marsh habitat. This project aims to fund tidal wetland resiliency enhancing restoration projects for example living shoreline work, thin layer deposition or facilitated marsh migration.

5 Flax Pond Habitat Restoration Project

Approx. cost: $500,000

Native intertidal and high marsh habitat in the Southern Long Island Sound estuary has decreased 23.8 percent from 1974 to 2005 (Cameron Engineering & Associates, LLC, 2015). Tidal marshes, like that found at Flax Pond in Old Field, NY are critical ecosystems that provide essential habitat and ecosystem services for Long Island Sound inhabitants. Flax Pond is a 135-acre tidal marsh system that has been labeled as an area of "Significant Coastal Fish and Wildlife Habitat" by NYSDEC and a Stewardship Site for LISS. The current inlet that supplies the tidal waters of the Sound to the pond has been slowly closing through silt build up over time, resulting in additional water remaining in the marsh even at low tide causing tidal wetland loss. It is essential that the inlet and marsh are studied and that the inlet is restored to return proper tidal flow to the marsh system so that this critical habitat can be protected.

TOP 5 PRIORITY RIVERINE MIGRATORY CORRIDOR RECONNECTIONS TO LIS

1 Rainbow Dam Fishlift, Farmington River, Windsor, CT

Approx. cost: $5M

Rainbow Dam is a 60-foot high, privately-owned hydroelectric dam. The dam has an existing concrete fishway that was installed in 1974. This fishway is approximately 750-feet long. The Farmington River supports a salmon run, and this species is able to efficiently utilize the fishway. However, many of the smaller species like American shad and river herring are unable to overcome the velocity of the flowing water running down the fishway. Of the individual fish that do make it all the way through, many emerge with injuries from bumping up against the concrete walls. The proposed solution is to eliminate the fishway and install a fish elevator, or fishlift as they are commonly known. The state of Connecticut funded the fishlift design. The next step is to fund construction.

2 Bronx Zoo Dam Fish Passage, Bronx River, Bronx, NY

Cost estimate: $1.5M

The Bronx Zoo Dam, which consists of two dams on either side of an island, are mason dams that are 10-feet high, extending nearly 60 feet from either side of the island. The final designs for this project were completed in September 2014. When complete, this fish passage will open 0.6 miles of river for targeted species including alewife, blueback herring, and American eel.

3 Stone Mill Dam Fish Passage, Bronx River, Bronx, NY

Cost estimate: $1.3M

The Stone Mill Dam is approximately six-feet high and 50-feet wide. It is located in a bedrock-lined ravine in the steepest section of the Bronx River. The dam is listed on the National Registry of Historic Landmarks. The final designs for this project were completed in September 2014. This fish passage will open seven miles of river for targeted species including alewife, blueback herring, and American eel.

4 Derby Dam Fishlift, Housatonic River, Derby, CT

Approx. cost: $5M

Derby Dam is an exceptionally tall hydroelectric dam in need of fish passage. Planning is still in an early stage so the cost estimate for this project is based on the cost for the Rainbow Dam Fishlift. Targeted species include American shad, alewife, blueback herring, and sea-run brown trout.

5 Scotland Dam Fishlift, Shetucket River, Windham, CT

Approx. cost: $5M

Scotland Dam is a 25-foot high hydroelectric dam in need of fish passage. This project is in the early planning stages, therefore the cost estimate for the project is based on the cost for the Rainbow Dam Fishlift. Targeted species include American shad, alewife, blueback herring, gizzard shad, American eel, sea lamprey, and sea-run brown trout.

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