Draft
Comprehensive Conservation and Management Plan Update

Investing in a Regional Asset

September 2014

Long Island Sound Study
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WaterVision, LLC

Dedicated to assessing and restoring New England's surface waters

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This report was prepared with the assistance of WaterVision, LLC under contract to the New England Interstate Water Pollution Control Commission. The project was funded by an agreement awarded by the Environmental Protection Agency to the New England Interstate Water Pollution Control Commission in partnership with the Long Island Sound Study.

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Process for Public Outreach, Review, and Comment on the Long Island Sound Study Plan

The Long Island Sound Study welcomes public comments on the draft Comprehensive Conservation Management Plan (CCMP) Update for Long Island Sound. To make the draft CCMP available to a wide audience, and to encourage an open dialogue, the Long Island Sound Study is taking the following steps:

- Regular updates are being posted about the CCMP update process, news about Long Island Sound, and upcoming opportunities for public comment and input on social media outlets:

    - **Facebook** at the Long Island Sound Study Plan Update page
    - **Twitter** @PlanUpdate, #LISoundPlan
    - **LinkedIn** at the Long Island Sound Study Plan Update page

    Long Island Sound Study Agency and Organization Partners will also be posting links to the update page on their websites.

- A webinar tailored to the issues faced by municipal staff, officials and volunteers and the issues they face will be held on September 10, 2014 from 11:30 to 12:30. To obtain more information and to sign up for the webinar please go to http://longislandsoundstudy.net/Planupdate

- Three public and stakeholder meetings are planned in New York and Connecticut on Tuesday September 16, 2014 and Wednesday, September 17, 2014 respectively to present the new focus of the Long Island Sound Study and to invite the public to comment on the Plan:
    - September 16, 1:00 to 3:00 pm, in Westbury, NY at the Yes We Can Community Center. Judi Bosworth, North Hempstead Supervisor will provide welcoming remarks as well as Mark Tedesco, Director of the EPA Long Island Sound office, on the CCMP update.
    - September 16, 6:00 to 8:00 pm, in the Bronx, NY at Rocking The Boat. Adam Green, Director of Rocking the Boat will provide welcoming remarks as well as Mark Tedesco, Director of the EPA Long Island Sound office, on the CCMP update.
    - September 17, 2:30 to 4:30 in New Haven, CT at Southern Connecticut State University. The meeting will include a presentation from Professor James Tait of SCSU on Hurricanes and Sea Level Rise and Mark Tedesco, Director of the EPA Long Island Sound office on the CCMP update.

More information and registration for these meetings can be found at http://longislandsoundstudy.net/Planupdate

- The CCMP update background materials are on the Long Island Sound Study CCMP update webpage for review. The public review draft is posted at http://longislandsoundstudy.net/Planupdate. Public comments on the document will be accepted via email and post until Saturday, November 8, 2014. Emailed comments should be sent to contact@watervisionllc.com. Mailed comments should be set to:

  EPA Long Island Sound Office
  Stamford Government Center
  888 Washington Blvd.
  Stamford, CT 06904-2152

- The Long Island Sound Study's Citizens Advisory Committee also plans to host a number of events to highlight the draft CCMP update and provide opportunities for additional input and comments. More details on these activities will be posted on the Save the Sound website at http://www.ctenvironment.org/save-the-sound/.

At the close of the public comment period, the LISS will prepare a public responsiveness document that summarizes and responds to all comments provided on the CCMP. Upon completion of the public comment period, the CCMP will be revised and submitted to the Connecticut Department of Energy and Environmental Protection, the Environmental Protection Agency, and the New York State Department of Environmental Conservation for approval.

Executive Summary

Long Island Sound Study
Comprehensive Conservation and Management Plan
Update

What is Long Island Sound?

Long Island Sound is an estuary, a place where salt water from the ocean mixes with fresh water from rivers and the land. It abounds in fish, shellfish, and waterfowl, and provides feeding, breeding, nesting, and nursery areas for diverse animal and plant life.

Bounded by Connecticut and Westchester County, New York, to the north, the Bronx and Queens County in New York City to the west, and by Long Island to the south, Long Island Sound extends 110 miles from east to west and about 21 miles across at its widest point, with mid-Sound depths ranging between 60 and 120 feet. Water flows into the Sound from portions of six states – Connecticut, New York, Massachusetts, Rhode Island, New Hampshire, and Vermont – and Canada.

What is the value of Long Island Sound?

The Sound provides enormous recreational and commercial value to the region. It lies in the midst of the most densely populated area of the United States. More than 9 million people live in the Long Island Sound watershed. Millions flock yearly to the Sound for recreation. It provides a critical transportation corridor for goods and people.

The ecological health of Long Island Sound and the waters that drain into it is inextricably tied to the health of the region's economy. Natural, functioning habitats provide a variety of goods and services, including flood and storm protection, water filtration, recreation, commercially and recreationally important fish and bird populations, and carbon sequestration.

The financial value of the goods and services provided to the region's economy by natural systems within the Long Island Sound drainage basin ranges between $17 billion and $37 billion annually. These natural ecosystems also support more than 190,000 jobs, bringing in over $12 billion in payroll. While it may seem odd to assign a price tag to such things, this valuation illuminates the links among the health of the environment, the quality of life for Sound residents, and a vibrant economy. Clearly, the health of Long Island Sound and the lands within its watershed are worth protecting, restoring, and preserving now and for future generations.

How is Long Island Sound being protected and preserved?

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 have led to measurable improvements in pollution control and water and habitat quality, despite an ever-increasing use of the Sound and an ever-growing population within its watershed.

It wasn't until Congress amended the Clean Water Act in 1987 to create the *National Estuary Program* that there was comprehensive and inclusive planning directly focused on the health of the Long Island Sound ecosystem. The Act authorized the U.S. Environmental Protection Agency (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. To support development of the plan, EPA and the states of Connecticut and New York established the Long Island Sound Study (LISS), a Management Conference involving federal, state, interstate, and local agencies, universities, environmental groups, industry, and the public. In 1990, Congress amended the Clean Water Act again, passing the Long Island Sound Improvement Act, which further strengthened EPA's role in coordinating implementation strategies through cross-jurisdictional partnerships.

In 1994, the states of Connecticut and New York and the EPA approved a CCMP to address 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, and (6) land use and development resulting in habitat loss and degradation of water quality. The plan outlined actions to improve the quality and health of the waters and habitats of 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.

What has been accomplished over the last 20 years?

The cooperating 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. In the 20 years since the adoption of the CCMP, the coordinated action of multiple levels of government, the private sector and the public have accomplished many of the goals of the first CCMP. The states of Connecticut, New York and their municipalities have made billions of dollars in financial commitments to upgrade wastewater treatment facilities and communities have developed local plans to reduce polluted runoff and manage growth while protecting natural assets and community character. 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 deserve special emphasis.

Accomplishments Since the 1994 CCMP Implementation
Water Quality Improvement
Developed an innovative, bi-state plan to reduce nitrogen pollution comprehensively to Long Island Sound that is being implemented through a ground-breaking nitrogen credit exchange and aggregate (bubble) permit limits.
Reduced by 35,000,000 pounds by 2013, the annual the amount of nitrogen discharged from 106 wastewater treatment facilities compared to the early 1990s.
Established all of Long Island Sound as a No Discharge Zone for vessel sewage, keeping more than a million gallons of recreational boat sewage out of the water each year.
Habitat Restoration and Protection
Restored a total of 1,548 acres of habitat from 1998 to July 2014, 77 percent of the goal to restore at least 2,000 acres of habitat by 2020.
Reopened 300 miles of river and stream corridors to fish passage from 1998 to July 2014 by removing dams and obstructions or creating bypasses and fish ladders in selected reaches.
Protected a total of 2,580 acres of open space and coastal habitat since 2006 through easements and land acquisitions.
Climate Change Resiliency Planning
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.
Science and Research Support
Developed and published a synthesis of available scientific information, *Long Island Sound: Prospects for the Urban Sea*, (Springer Publishing, 2013), which provides a sound scientific basis for management.
Developed, funded, and maintained an annual water quality monitoring program in Long Island Sound since 1987 and expanded the network to include fixed real-time buoy data collection.
Established and administered the Long Island Sound Futures Fund - a collaborative grant program with the National Fish and Wildlife Foundation (NFWF) that funds on-the-ground projects in communities around the Sound to help restore Long Island 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, the Long Island Sound Futures Fund has generated a total of almost $36 million for projects in both states.

Partners Engagement and Leveraging of Resources
Created and revitalized the Long Island Sound Science and Technical Advisory Committee composed of scientists and engineers, to synthesize science and identify research priorities.
Leveraged $84 in other federal, state and local funding for Long Island Sound restoration for every EPA Long Island Sound dollar in program funding from 2006-2013, more than $3.2 billion in all.

Public Engagement and Education 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 Long Island Sound
Built local partnerships in under-served communities to involve students and citizens in initiatives to increase access to, and the quality of, urban waters.

What challenges remain and what issues are new to Long Island Sound?

Despite these many accomplishments, much more remains to be done to address the issues identified in the 1994 CCMP, and new unforeseen challenges have emerged.

Continuing Challenges for Long Island Sound
Water Quality Improvement
Increased emphasis will be needed to reduce nutrients from local, diffuse sources to complement the progress made in upgrading centralized wastewater treatment facilities. For example, increased numbers of households are serviced by on-site wastewater treatment systems, less amenable to nitrogen removal technologies applied to centralized wastewater treatment facilities. Suburban lawns remain an intensively fertilized "crop."
Controlling nutrient pollution will require the involvement of the states and communities in the entire watershed, not just in Connecticut and New York.
Aging infrastructure and an increasingly impervious land surface contaminate waters with pathogens, which result in closed beaches and restrictions on shellfish harvest areas.

New Challenges for Long Island Sound
Adapting to Climate Change
The waters of the Sound are warming and increases in atmospheric CO2 concentrations could make the waters more acidic, both of which may alter the food web of Long Island Sound.
Sea level rise threatens coastal areas worldwide, and the Sound and its ecosystems are already experiencing its effects. Tidal marshes, vital and productive coastal habitats, are threatened with drowning from rising seas if they cannot build upward or migrate inland because of natural or man-made barriers.
Coastal properties worth billions of dollars are at risk from rising waters and more intense or frequent storm events, as demonstrated by Hurricane Irene in 2011 and Superstorm Sandy in 2012.

Growing Sustainably
Communities need to be working to integrate transportation planning, conservation of energy and water, resiliency to climate change, and pollution control policies.
Smart growth and low impact development are needed to minimize the environmental impacts of new development while green infrastructure is increasingly added to areas already developed.

Broadening the Partnership
Communities around the Sound are becoming more diverse. Increased effort is needed to fully involve and respond to the needs of underserved communities.

Why is the CCMP being updated?

No action plan, no matter how good, can remain static over time. To build upon the accomplishments of the past 20 years, the CCMP is being updated to respond to the changing needs of communities, incorporate scientific and technological advances, and address new environmental challenges. The intent of the CCMP update is to:

- Re-energize and broaden the current Management Conference around updated, shared goals and cross-jurisdictional management;
- Set measurable ecosystem targets and management outcomes;
- Incorporate new areas such as sustainability, climate change resiliency, and environmental justice;
- Maintain an integrated ecosystem perspective;
- Expand public engagement and collaboration; and
- Use strong science, ecosystem service concepts, and environmental indicators to adapt and refine management.

What is our vision for the next twenty years?

The vision for Long Island Sound as stated in the 1994 CCMP reads:

"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 public, and of a regional consciousness and a way of life that protects and sustains the ecosystem."

This vision still holds true today and continues to guide the work of the Long Island Sound Study. To realize this vision, the updated CCMP is organized around four themes and corresponding goals.

Clean Waters and Healthy Watersheds - Attain water quality objectives by reducing contaminant and nutrient loads to 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 for the benefit of 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.

To assess progress in achieving these goals the plan includes 20 measurable ecosystem targets. In addition, long-term strategies and implementation actions to guide the plan are integrated into each theme to help meet these targets.

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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." More recently dubbed the "Urban Sea," 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 around Long Island Sound have changed from forest to field, from agriculture to town and city, from industry to service economy. Active efforts now have halted degradation and initiated restoration to the point of considering a return to abundance. Not to a pristine past, but to an "Urban Sea," 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 through provision of flood and storm protection, water filtration, recreation, commercially and recreationally important fish and bird populations, carbon sequestration, and other functions. The financial value of goods and services provided to the region's economy by Long Island Sound Basin's natural systems ranges between $17 billion and $36.6 billion annually. Treated as a capital asset, the value of these natural systems, calculated using a standard 4% discount rate with a lifespan of 100 years, is $690 billion to $1.3 trillion (Kocian et.al., 2014). Unlike built systems that depreciate, however, natural assets often accumulate value over time, particularly if they are protected and restored. In addition, an estimated 191,000 direct and indirect jobs in the region result from that the healthy function of these natural systems, and the associated stewardship work (Kocian et. al. 2014).

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 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 to the social, recreational, and commercial uses of the Sound.

The Long Island Sound Study

In 1994, the states of Connecticut and New York and the U.S. Environmental Protection Agency approved a *Comprehensive Conservation and Management Plan* (CCMP) to protect and restore the health of Long Island Sound. This plan, developed under a cooperative bi-state partnership called the Long Island Sound Study (LISS), outlined actions to improve

the quality and health of the waters and habitats of Long Island Sound. Using the 1994 CCMP as a blueprint for restoration and protection, LISS refined environmental commitments and management priorities as part of action agreements in 1996, 2003, 2006, and 2011.

LISS and many 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 CCMP. Billions of dollars in financial commitments made by the States of Connecticut and New York and their local governments to upgrade wastewater treatment facilities have reduced the annual discharge of nitrogen by thirty-five million pounds. Communities have developed local plans to reduce polluted runoff and manage growth while protecting natural assets and community character.

Three hundred miles of river are again accessible to fish migrating to spawning habitat. More than 1,400 acres of coastal habitat have been restored. Urban areas are rediscovering downtown rivers such as the Bronx River, Norwalk River, and Mill River as community assets, improving water quality and increasing public access. The Long Island Sound water quality monitoring program established in 1991 is recognized by scientists as invaluable for assessing conditions, tracking trends, and supporting original research. Sentinel monitoring, established in 2008, is a national model for tracking the effects of climate change on coastal ecosystems. A more detailed list of accomplishments is included in Appendix A.

Despite 20 years of progress, many challenges remain and new challenges have emerged. Excessive levels of nutrients and pathogens still adversely impact water quality, human health, and living marine resources. Sediment contamination from past industrial and land use sources remains a threat to habitat and water quality. Continuing development and an increasingly impervious land surface also threaten water and living resources.

New concerns have emerged such as the potential impacts of climate change on the Long Island Sound ecosystem and on coastal communities. The waters of the Sound are warming, which may alter the food web of Long Island Sound. Oyster populations are susceptible to old and new disease outbreaks, stimulated by warmer waters. A changing climate will also have some effects on human uses such as swimming, fishing, birding, and boating. Sea level rise threatens coastal areas worldwide, and the Sound and its ecosystems are already experiencing its effects. Coastal properties are at risk from rising waters and more intense or frequent storm events, as demonstrated by Hurricane Irene in 2011 and Superstorm Sandy in 2012. Tidal marshes, vital and productive coastal habitats, are threatened with drowning from rising seas if they are unable to add sediment quickly enough to compensate for marsh elevation loss, or cannot migrate inland because natural or man-made barriers inhibit their expansion.

Recognizing that no action plan, no matter how good, can remain static over time, the LISS agreed to update 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 Science and Technical Advisory Committee (STAC) synthesized environmental data gathered on the Sound and its ecosystems over many prior years by many sources. Published in 2013, with the help of 55 contributing authors, *Long Island Sound: Prospects for the Urban Sea*, (Latimer et al., 2013) synthesizes the advances in science made over the past decades in understanding Long Island Sound. The book identifies historical environmental trends and forecasts future impacts on the resources and ecology of the Sound. To create a community vision of a restored Long Island Sound, the LISS Citizens Advisory Committee (CAC) developed *Sound Vision: An Action Plan for Long Island Sound 2011-2020*. The *Sound Vision* document was a 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, this CCMP update 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;
- Incorporate new areas such as sustainability, climate change resiliency, and environmental justice;
- Maintain an integrated ecosystem perspective;
- Expand public engagement and collaboration; and
- Use strong science, ecosystem service concepts, and environmental indicators to adapt and refine management.

Section 2. Geography and Setting of the Long Island Sound

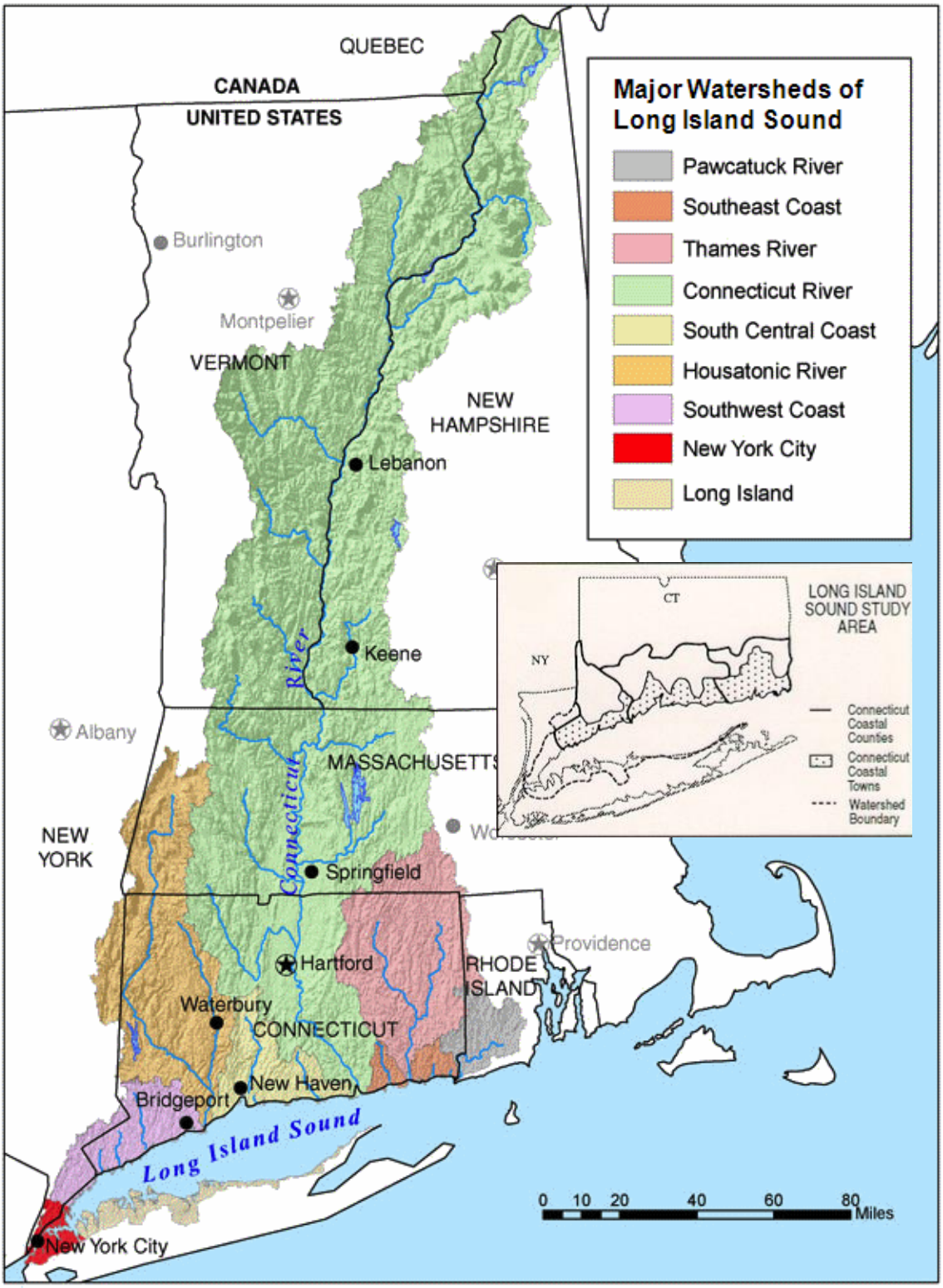
Long Island Sound Geography and Hydrology

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. The Sound is not a typical estuary; it has openings in both the west (Hells Gate to the East River) and the east (the Race to Block Island Sound) and it is oriented parallel to the coast. 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. 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 virtually the entire state of Connecticut, portions of New York, Massachusetts, New Hampshire, Vermont, and Rhode Island as well as a small area at the source of the Connecticut River in Quebec, Canada (Figure 1).

The physical setting for Long Island Sound and its watershed has been shaped by titanic 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 incise the rocky northern shoreline. The Connecticut and Rhode Island coastlines that span the north shore of Long Island Sound are the longest stretch of low-energy, bedrock-dominated shoreline on the US Atlantic coast. This coastline is irregular and includes many coves and peninsulas.

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.

Figure 1. Watershed Map of Long Island Sound – Source of watershed map – US Geological Survey, Inset – Long Island Sound Study coastal watershed map – LISS Website

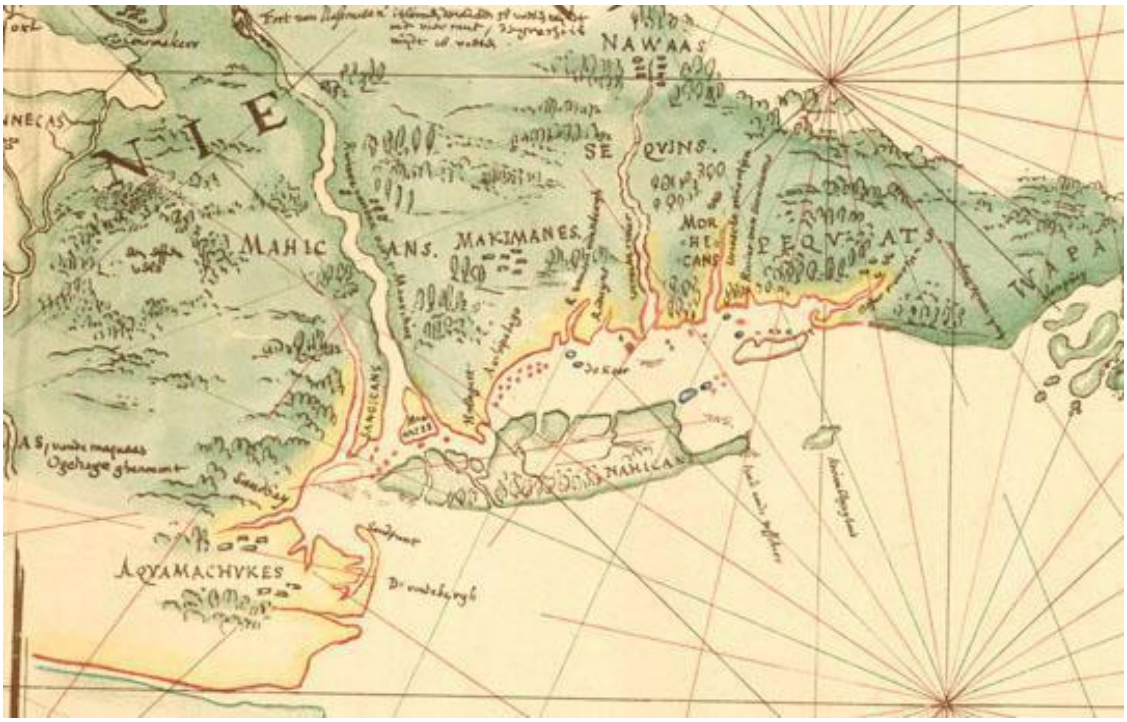


These geological and physical settings, combined with the history of human settlement and economic development, have molded the Long Island Sound of today. Together with the effects of increasingly dominant human activities since its European settlement in the early 1600s, Long Island Sound can truly be considered the "Urban Sea".

The Recent History and Health of Long Island Sound

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 2). Block and his crew

Figure 2. Map of New Netherland – As charted by Adriaen Block Chart in 1616.
From the American Geographical Society Library, University of Wisconsin-Milwaukee Library



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 on the Long Island Sound ecosystem. Over-harvesting, habitat destruction, and pollution resulted in declines in fishery and wildlife resources. Diadromous fish populations suffered first, with current Atlantic salmon and American shad runs a fraction of historic numbers along with declines

in other herring species. Menhaden were harvested intensively all along the Atlantic coast. Oyster reefs in the Sound were exploited with little thought of sustainability. Deforestation and industrialization resulted in the pouring of chemicals and sediments into the Sound; measurable quantities of contaminants still exist in sediments dating back to the mid-1800s.

But Long Island Sound is a resilient body of water. Its waters and coastal habitats provide feeding, breeding, nesting, and nursery areas for diverse animal and plant life. Long Island Sound also supports many recreational and commercial uses. The ability of the Sound to support these uses is dependent on the quality of its waters, living resources, and habitats. Since the adoption of the Clean Water Act (CWA) in 1972, investments in water pollution control programs have led to some measurable improvements in water quality, in spite of increasing numbers of people and activities on the Sound and within its watershed.

Figure 3. Milford Point Stewardship Area, Charles Wheeler Wildlife Management Area, Connecticut. Mouth of the Housatonic River.

Photo credit: Connecticut Department of Energy and Environmental Protection

Obvious sources of pollution are now regulated and controlled through permit programs, tidal wetlands are protected through wetlands protection acts, and major efforts to build and improve wastewater treatment facilities and control industrial discharges have helped to restore degraded waters. Other federal and state environmental legislation has helped to protect and restore populations of wildlife and natural habitats.

Describing the condition of a water body that is 110 miles in length and composed of three sub-basins (Figure 4) poses a challenge. Water quality in any location varies by season and the level of human impact varies depending on the location or season.

Figure 4. Long Island Sound Basins and Characteristics
Map by Mapping Specialists and Lucy Reading-Ikkada

The EPA's National Coastal Assessment (NCA) program uses a series of environmental indicators to characterize water, sediment, and biota in a given location as "good", "fair", or "poor". Overall, the densely populated and developed Western Sound, which includes the urban communities near the "the Narrows," a restricted, narrow section leading to the East River, is 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 (NCA, 2008). Coastal development has resulted in a 60 percent loss of wetlands (Dreyer and Niering, 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 and cesspools, polluted runoff from storm water, 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. On the positive side, recent wastewater treatment facility (WWTF) upgrades in Connecticut and New York are improving water quality in the Western Basin.

In contrast to the Western Basin, the Eastern Basin water quality is rated by NCA as good most of the time, reflecting watersheds with much less coverage by hard surfaces and 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 tidal wetland regulations, wetland loss has been estimated to be 25-35 percent of historical extent, though 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). Eelgrass beds have modestly increased in size over the past decade (Tiner et al, 2013).

Improving conditions toward the east also reflect geological differences. For example, the Eastern Basin, carved into the glacial lake floor, is deep, dipping to 350 feet at the Race. The narrow channel opening to Block Island Sound funnels fast moving currents that scour the bottom and actively mix the water. In contrast, the Western Basin is shallower, generally less than 60 feet deep, with a sea bottom of fine sand and mud. Tidal and wind driven water currents are weaker, and in the summer months there is little mixing between the lighter, oxygenated surface waters and the denser bottom layer. Together with other factors the combination of higher nutrient loads in the Western Basin, which contributes to increased phytoplankton production, and the weaker currents allowing rapid plankton settling and water column stratification promotes conditions ripe for hypoxia development. As plankton die and decompose near the bottom of the Sound they consume oxygen. The lack of surface to bottom mixing prevents replenishing oxygen from above back to the bottom waters, leading to hypoxia. The weak currents in the Western Basin also make for conditions that are less likely to flush toxic contaminants that settle in the sediment.

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. As a transitional zone between the Western and Eastern basins, the sediment quality in the Central Basin varies, but is also typically better than in the Western Basin. 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.

Many indicators of the health of Long Island Sound are trending positive. Levels of many contaminants have declined in the water, sediments, and wildlife. By the end of 2013, reductions of nitrogen from wastewater treatment facilities achieved 88 percent of the reduction goal established in the 2000 dissolved oxygen Total Maximum Daily Load (TMDL), which means 98,000 fewer pounds of nitrogen discharged every day. These reductions may be starting to have an effect. The maximum area of hypoxia (or low dissolved oxygen levels in the water), which averaged 208 square miles between 1987 and

2000, decreasing to 176 square miles between 2000 and 2013. The summer of 2012 was a relatively severe year, while in the summer of 2013, water quality monitoring of Long Island Sound recorded the third smallest area of hypoxia in the past 27 years. While the stark difference between 2012 and 2013 highlights the high amount of inter-annual variability in hypoxia, there is a general trend of improvement over the last decade.

Eelgrass, 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 WWTF upgrades, are underway to attain 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 have declined in abundance, particularly in spring, due to steadily increasing water temperatures, while warm-adapted species have increased (Howell and Auster, 2012). Oyster populations are susceptible to old and new disease outbreaks, stimulated by warmer waters. Likewise, the die-off of lobsters in 1999 is attributed in part to warming waters stressing this cold-water adapted crustacean (Pierce and Balcom, 2005). These findings highlight perhaps the greatest challenge for the future of Long Island Sound—climate change.

For many, the events of October 29, 2012 will dominate perceptions about the health and resiliency of Long Island Sound and the communities around it. On that day Superstorm Sandy made landfall in southern New Jersey with catastrophic impacts on our region's coasts. The storm surge in parts of western Long Island Sound and the New York-New Jersey Harbor rose as much as nine feet above mean sea level, resulting in billions of dollars in damages to the region's infrastructure. The surging waters overwhelmed many wastewater treatment facilities, mixed with oil and gasoline spilled from flooded cars and homes, and altered coastal habitats.

Superstorm Sandy was not caused by climate change, but the storm 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.

Section 3. Achieving the Vision: Updating Comprehensive Conservation and Management Plan for the Next 20 Years

The vision for Long Island Sound as stated in the 1994 CCMP reads:

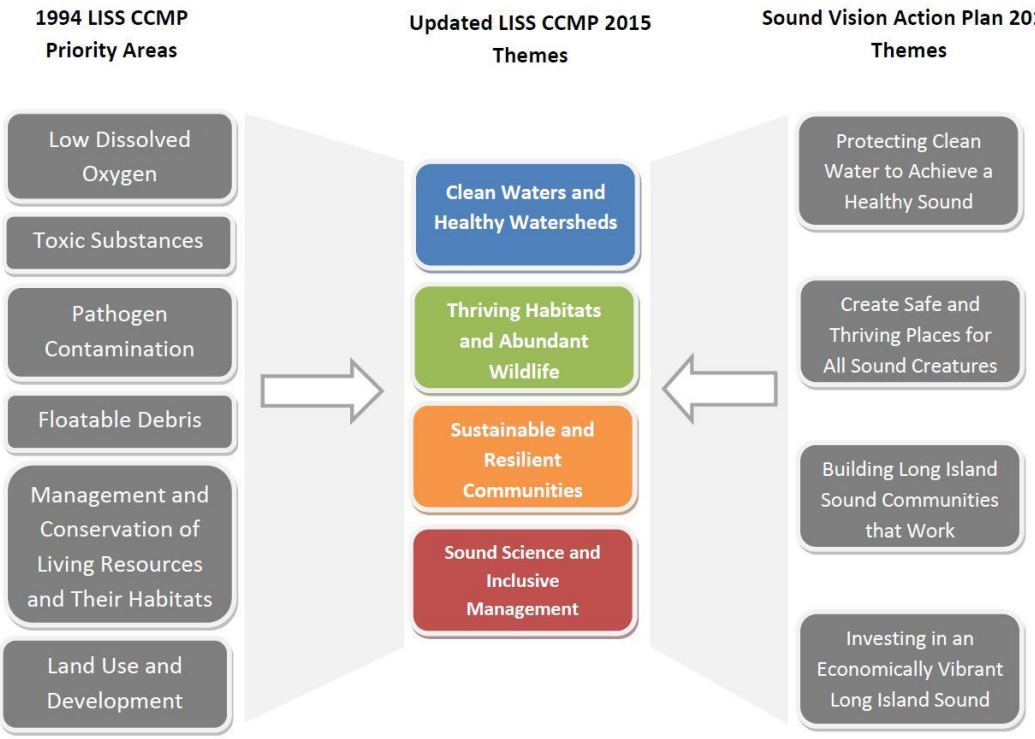
"The vision . . . for the Sound is of waters that are clean, clear, safe to swim in, and charged with life. It is a vision of waters nourished and protected by extensive coastal wetlands, by publicly accessible, litter-free beaches and preserves, and of undeveloped islands. It is a vision of abundant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

This vision still holds true today and continues to guide the work of the Long Island Sound Study.

How is the CCMP Organized?

To realize this vision, the CCMP is organized around four themes: Clean Waters and Healthy Watersheds, Thriving Habitats and Abundant Wildlife, Sustainable and Resilient Communities, and Sound Science and Inclusive Management. Figure 5 shows how the 1994 CCMP and the four Sound Vision themes developed in 2011 compare to the four themes of the CCMP update.

Figure 5. Development of CCMP Update Themes



Each CCMP theme has a long-term goal that describes the desired result.

> ***Clean Waters and Healthy Watersheds* -** Attain water quality objectives 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 for the benefit of 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 CCMP update also includes new, long-term targets for the ecosystem that will be used to help assess progress toward these goals. Indicators of each ecosystem target will be measured, tracked, and reported over time. These targets are described in their relevant theme sections.

The CCMP is built around a framework developed to achieve the goals and meet targets. It comprises 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. Not all strategies will have associated actions for this first implementation action cycle (2015-2019). Many actions also may apply to one or more strategies indirectly so may not be specifically referred to in the text or supplemental Implementation Action document.

Implementation Actions (IAs): Specific, tactical actions to measurably carry out the strategies over the next five years. 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.

What Underlying Principles Guide the CCMP Update?

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, environmental justice, and ecosystem-based management.

Resiliency to Climate Change

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.

A vivid example of the need to increase coastal resiliency was the damage caused by the storm surge of Superstorm Sandy. 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) that migrated into both residential and business communities. Such releases can be detrimental to human and environmental health, in addition to making recovery operations more costly and lengthy. More extreme flooding is predicted as a consequence of climate change. This will increase the vulnerability of infrastructure and facilities to flooding. For example, wastewater treatment facilities discharge more than one billion gallons of effluent into Long Island Sound every day. Over the last decade, billions of dollars have been spent to upgrade wastewater treatment facilities to improve water quality. More intense storm events combined with sea level rise will increase the risk that these facilities, along with on-site septic systems and cesspools,

will release large amounts of untreated waste into the Sound when overwhelmed by flood waters.

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. Likewise, businesses can implement green manufacturing practices to reduce the use of toxic substances and mitigate the risk of spills.

In general, climate change adaptation and resiliency need to be integrated into new and existing development, housing, transportation, emissions control, energy efficiency, and job creation programs. 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.

Understanding the vulnerability of human and natural infrastructure in the face of increased sea level rise and storm intensity and then implementing plans to make these systems more resilient will help to protect property, human health, and the environment. Doing these things will also save residents and governments the cost of cleanup and reconstruction after severe weather events.

In addition to the built environment, natural habitats that are vulnerable to climate change impacts, particularly those that protect against flooding, need to be identified, restored and monitored 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 marine life.

Long-term Sustainability

Increases in population and economic activity over the past 30 to 40 years have been accompanied by 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 enhance water quality. Low impact development planning and engineering practices will reduce runoff and pollutant loading by lessening the area of impervious surfaces and protecting critical natural areas.

Localized ecosystem restoration programs should acknowledge, promote, and support sustainable practices. 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 new 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 using materials in multiple languages. 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 the way the Management Conference partners implement the CCMP, recognizing it as a critical part of healthy communities. Federal, state, local government, and NGO partners should incorporate EJ as an integral part of ongoing work using a variety of approaches.

- Include EJ as a priority topic in request for proposals for implementation projects.
- Involve students from EJ communities into community-based water and habitat improvement projects. For example, high school students have collaborated with scientists from the Wildlife Conservation Society in after-school and summer Youth Development and Job Skills Programs to better understand the migration patterns and population size of the American eel, river herring, and other Bronx River keystone fish species. These data are being used to support long-term restoration planning in the students' Bronx River communities.
- Build local partnerships to capitalize on national EJ initiatives such as the Urban Schoolyard Habitat Program of the US Fish and Wildlife Service and the Urban Waters Program of the Environmental Protection Agency.

- Integrate involvement from underserved communities in new initiatives, building grassroots support for their expansion. For example, middle, high-school and college youth from underserved communities participated in projects to demonstrate the effectiveness of aquaculture to bioextract nitrogen from the waters off of the Bronx, NY and Bridgeport, CT. Coordinated by Rocking the Boat in the Bronx and the Bridgeport Regional Aquaculture Science and Technology Center in Bridgeport, students help plant and harvest ribbed mussels and seaweed—sugar kelp and red algae.
- Promote sustainable development concepts in these communities as in other Long Island Sound communities.

Ecosystem-based Management

The concept of 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 has the following characteristics: plan on an ecosystem level; involve multiple stakeholders and integrate the full spectrum of ecosystem services supporting human wants and needs; develop cross-jurisdictional goals; implement programs through coordinated accountable strategies across levels of government; incorporate adaptive management that acknowledges uncertainty in our understanding; establish long term observation, modeling, and research programs.

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 watershed-wide 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. Two examples of management initiatives that consider the total ecosystem including people are bioextraction of nutrients through enhanced aquaculture and marine spatial planning.

Bioextraction is a relatively new method to remove nitrogen and other nutrients from natural water bodies by farming and harvesting shellfish and seaweed. Two recent pilot programs tested the effectiveness of ribbed mussels and seaweed in removing nitrogen from the water column. Preliminary results of these studies suggest that bioextraction complements traditional nutrient source reduction measures, and can provide opportunities for local jobs and strengthened economies. Questions of scale, viable markets, use conflicts, and ecological impacts still to be investigated to before they are implemented Sound-wide (Kim, et al., 2014, Rose et. al. 2014).

Marine spatial planning (MSP) is a future-oriented process of evaluating and managing the spatial and temporal components of three-dimensional marine environments - balancing the demands for development, human uses, and conservation. Long Island Sound supports a diverse range of commercial activities including marine transportation, fishing, aquaculture, shipbuilding, recreational activities and tourism, often in conflict with each other. MSP works to reduce these conflicts while recognizing the importance of conservation and minimizing ecosystem impacts. The application of MSP to the Long Island Sound is included in the revised CCMP strategies and implementation actions.

Section 4. Clean Waters and Healthy Watersheds

GOAL – Attain water quality objectives by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound.

Introduction

The waters of Long Island Sound influence all aspects of the Sound's natural environment and inhabitants. The gradient of fresh to saline, calm to turbulent, and high quality to impaired waters influences the health of biological communities, including humans. The Clean Waters and Healthy Watersheds theme recognizes that healthy waters in the drainage basin are a prerequisite for a healthy Long Island Sound, with diverse and abundant wildlife. Because of the density of coastal development, special effort must be made to mitigate the pollution, both coastal and upland, that threatens clean, productive coastal waters.

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 storm water and ground water, contaminants of emerging concern, resource sustainability, the resiliency of natural and built infrastructure, and land use planning that protects water resources and includes adaptation to changing climate and extreme weather. The CCMP update 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.

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 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 Clean Waters and Healthy Watersheds theme.

Ecosystem-Level Indicators and Targets

The following indicators and targets have been developed in order to measure overall progress toward the ***Clean Water 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. Additional explanation about the measurement of these targets is included in Appendix B.

Hypoxia: By 2035, achieve a measurable reduction in the zone of hypoxia in Long Island Sound from pre-2000 Dissolved Oxygen TMDL averages as measured by the 5-year running average size of the zone.

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 in nonpoint source inputs from the entire watershed by 2025.

Water clarity: By 2035, improve water clarity as defined by the LISS report card to support healthy eelgrass communities.

Pervious Cover: Through green infrastructure and low impact development, maintain or increase the area of pervious cover in the watershed in 2035 relative to a 2010 baseline.

Riparian buffer extent: By 2035, increase natural vegetation within 300 feet of any stream or lake by 10 percent compared to 2010 baseline of 65 percent.

Open space extent protected: Preserve 21 percent of the Connecticut land, or 673,210 acres, by 2023; maintain or increase protected land within the Long Island Sound coastal boundary by 2035.

Clean Waters and Healthy Watersheds - Outcomes, Objectives, and Strategies

To accomplish the Clean Waters and Healthy Watersheds goal and to achieve progress toward the ecosystem targets, specific outcomes, objectives, and strategies have been developed. These elements are designed to address specific issues within this theme but some apply to multiple issues and themes.

Outcome 1-1: Contaminant and nutrient loads from land-based sources in the watershed of Long Island Sound are reduced.

Objective 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources

Strategy 1-1a1: Evaluate and reduce contaminant and nutrient contributions from Combined Sewer Overflows and from Municipal Separate Storm Sewer Systems (MS4s), incorporating climate change and sea level rise in planning, regulation and best management practices (BMPs)

Strategy 1-1a2: Evaluate and reduce contaminant and nutrient loads from wastewater treatment facilities (WWTFs), conveyance systems and other associated sewer lines

Strategy 1-1a3: Develop pathogen Total Maximum Daily Load or alternate control plans for Long Island Sound Study harbors, coasts, and embayments using the existing pathogen Total Maximum Daily Load

Strategy 1-1a4: Continue enhanced implementation of existing 2000 Total Maximum Daily Load for nitrogen in Long Island Sound and embayments, and adapt and revise as appropriate based on monitoring, modeling, and research findings

Strategy 1-1a5: Reduce contaminant and nutrient loads from commercial, industrial, and Concentrated Animal Feeding Operations (CAFO) point sources

Strategy 1-1a6: Encourage cross department collaboration and cooperation at the municipal level to meet MS4 BMPs (e.g., involve highway departments)

Strategy 1-1a7: Reduce contaminant and nutrient loads from agricultural nonpoint sources of runoff

Strategy 1-1a8: Reduce contaminants, nutrients, and runoff volume from new and existing residential development

Strategy 1-1a9: Reduce contaminants, nutrients, and runoff from commercial/industrial development/redevelopment, including supporting reductions from power plants and other industrial sources

Strategy 1-1a10: Improve and manage decentralized, package, and on-site wastewater treatment systems (OSWTSs) to reduce contaminant and nutrient loading

Strategy 1-1a11: Incorporate climate change and sea level rise in planning, regulation and best management practices (BMPs) to control contaminant and nutrient loads

Objective 1-1b: To balance multiple uses and maximize ecosystem services through watershed-based planning

Strategy 1-1b1: Minimize negative impacts of new development on water quality of Long Island Sound

Strategy 1-1b2: Protect healthy watersheds through land protection and retaining green infrastructure

Objective 1-1c: To restore and protect the hydrologic and ecological functions of the Long Island Sound watershed to protect groundwater and reduce the contaminant/nutrient load to Long Island Sound

Strategy 1-1c1: Preserve hydrologic function in developing watersheds

Strategy 1-1c2: Protect wetlands, riparian buffers, and existing open land to minimize land disturbance and impervious cover

Strategy 1-1c3: Restore hydrologic function (e.g. flooding, buffer zones, resiliency, groundwater, etc.) to impaired watersheds

Outcome 1-2: The negative impacts of contaminants and nutrients in the waters and sediments of Long Island Sound and tributaries/embayments are reduced.

Objective 1-2a: To reduce direct sources of nutrients and contaminants to the Long Island Sound ecosystem

Strategy 1-2a1: Minimize vessel/marina discharge impacts

Strategy 1-2a2: Maintain and improve spill prevention and disaster preparedness and response planning

Strategy 1-2a3: Reduce generation of marine debris and improve and increase its cleanup in Long Island Sound waters

Objective 1-2b: To mitigate impacts of nutrients and contaminants to human health and the Long Island Sound biota and ecosystem.

Strategy 1-2b1: Understand and mitigate impacts from emerging and existing contaminants in water and sediment

Strategy 1-2b2: Reduce human health risk through increased beach and embayment monitoring and fish and shellfish contaminant testing

Strategy 1-2b3: Develop and implement methods (e.g., bioextraction) for removal of nutrients and contaminants

Objective 1-2c: To improve understanding of the sources of nutrients and contaminants and how they interact with the ecosystem and human health

Strategy 1-2c1: Understand drivers and impacts of harmful algal blooms (HABs) and develop and implement methods to minimize the impact on ecosystem services

Outcome 1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.

Objective 1-3a: To continue management efforts that improve understanding of the causes and impacts of hypoxia

Strategy 1-3a1: Understand the effects that nutrient ratios (nitrogen, phosphorus, carbon) have in freshwater, embayments, and Long Island Sound ecosystem function and consider them in setting nutrient control policies

Strategy 1-3a2: Better understand eutrophication dynamics, effects, and mechanisms and continue support for modeling and synthesis efforts and their application to management scenarios.

Objective 1-3b: To research, monitor, and assess water quality and factors that contribute to water quality change

Strategy 1-3b1: Research, monitor, and assess sources (e.g., watershed, groundwater, atmospheric deposition) and sinks of nutrients and their impacts on water quality

Strategy 1-3b2: Research, monitor, and assess pathogens, their sources and their impacts on water quality

Strategy 1-3b3: Improve identification and source tracking of NPS nutrients and contaminants

Strategy 1-3b4: Research, monitor and assess Harmful Algae Blooms (HABs) and their impacts on water quality

Strategy 1-3b5: Research, monitor, and assess emerging and legacy contaminants and their impacts on water quality

Strategy 1-3b6: Improve understanding of impacts of climate change (e.g., acidification, sea level rise, temperature) on Long Island Sound water quality and biota

Objective 1-3c: To improve access and usage of information, databases, and resources and incorporation of data into management actions

Strategy 1-3c1: Support collaboration between Long Island Sound Study (LISS) partner organizations including upper basin agencies/partners (USGS, CTDEEP, CTDA, NYSDEC, MADEP, SCDHS, etc.) to improve utility of monitoring data

Strategy 1-3c2: Implement improved data storage and sharing solutions to support collaboration and incorporation of data into management decisions.

Objective 1-3d: To incorporate the sentinel monitoring program in Long Island Sound programs to evaluate and address the impacts of climate change on Long Island Sound and its embayments

Strategy 1-3d1: Fully implement the sentinel monitoring program in Long Island Sound to evaluate and address the impacts of climate change on Long Island Sound and its embayments

Strategy 1-3d2: Develop a regional partnership that will continue to support the implementation and advancement of the sentinel-monitoring program

Clean Waters and Healthy Watersheds - Implementation Actions

Implementation Actions (IAs) have been formulated to carry out the WW strategies. The IAs are listed in Table 1 with highest priority actions shaded in bold blue. The major strategy addressed by the action is also listed in the table below. The complete five-year implementation action plans are included in the supplemental CCMP Implementation Action Document.

Table 1. Clean Waters and Healthy Watersheds Implementation Actions (Priority actions are shaded in bold blue)

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
WW-1	Evaluate impact of the changing Connecticut and New York Long Island Sound Watershed population on wastewater treatment plant/combined sewer overflow loads.	1-1a1
WW-2	Using the results of the population/loading analysis (Action WW-1), strategically plan for, and implement BMPs to mitigate combined sewer overflow loadings.	1-1a2
WW-3	Explore expansion of point source and nonpoint source nutrient trading programs for the Long Island Sound watershed.	1-1a2
WW-4	**Encourage wastewater treatment plant upgrades, combined sewer overflow mitigation and elimination (where possible) to support goals and targets of LISS programs.**	**1-1a2**
WW-5	**Continue enhanced implementation of the Long Island Sound TMDL for dissolved oxygen and evaluate revision of those TMDL targets.**	**1-1a4**
WW-6	**Modify the reporting requirements of MS4 communities to improve dissolved oxygen TMDL implementation tracking and to better quantify the success of control measure actions.**	**1-1a6**
WW-7	**Improve and enforce pesticide/herbicide /fertilizer regulations and other Best Management Practices (BMPs) for agriculture and urban turf.**	**1-1a7**
WW-8	Provide technical guidance for incorporating Low Impact Development (LID) / Green Infrastructure into development and redevelopment projects and through zoning and planning changes.	1-1a8

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
WW-9	Conduct a population and land use change study in the Long Island Sound upper and lower watersheds to determine nutrient load stressors as a result of new development and redeveloped areas.	1-1a8
WW-10	**Develop a nonpoint source and stormwater tracking system tool for the Long Island Sound watershed.**	**1-1a8**
WW-11	Reduce the amount of impervious cover that discharges directly into waterbodies.	1-1a8
WW-12	Fix leaking sewer pipes and collection infrastructure.	1-1a8
WW-13	Remediate abandoned and underutilized sites (brownfields).	1-1a9
WW-14	Develop improved policies for packaged/decentralized wastewater treatment facilities and on-site septic systems.	1-1a10
WW-15	Improve understanding, management, and design of denitrifying on-site wastewater treatment systems to reduce nitrogen and pathogens.	1-1a10
WW-16	**Modify septic system use and siting policies to accommodate climate change and sea level rise (SLR).**	**1-1a11**
WW-17	**Improve efficiency and resiliency of existing/new waste treatment systems including septic, WWTF and stormwater infrastructure to accommodate sea level rise (SLR).**	**1-1a11**
WW-18	Track implementation and effectiveness of approved watershed plans by local municipalities.	1-1b1
WW-19	Promote establishment and protection of riparian corridors and wetland buffers at the municipal level through development of local ordinances and promoting permanent land protection.	1-1b2
WW-20	Increase land protection efforts by municipalities and land protection organizations that permanently protect wetlands and riparian areas and buffers.	1-1b2
WW-21	Improve environmental practices (boat wrap, bottom paint, pump out etc.) at marinas.	1-2a1
WW-22	Develop water quality monitoring programs associated with coastal habitat restoration projects.	1-3b6

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
WW-23	**Identify and recommend removal or protection of sensitive infrastructure in the coastal zone (e.g., oil tanks, pump/power stations, etc.) and work to enact legislation to prevent future siting of such infrastructure in vulnerable coastal floodplains.**	**1-1a11**
WW-24	Encourage state, and local health departments to adopt emerging rapid bacterial detection technologies that would allow shorter administrative beach/shellfish closings than those based on rainfall only.	1-2b2
WW-25	**Monitor and track occurrences and contributing factors of biotoxin and HAB outbreaks.**	**1-3b4**
WW-26	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.	1-2c2
WW-27	Improve the permitting and certification process for new aquaculture projects with products intended for human consumption, particularly those with a bioextraction focus.	1-2c2
WW-28	Estimate future phosphorus loading to Long Island Sound and its impact on Long Island Sound nutrient dynamics.	1-3a1
WW-29	Improve ability of models and/or estimated load studies to evaluate contaminant and nutrient loads in critical areas and the effectiveness of remedial actions.	1-3a2
WW-30	Maintain and enhance the utility and efficiency of water quality monitoring of nutrient loads to Long Island Sound science and management efforts.	1-3b1
WW-31	Develop and implement a water quality monitoring strategy for nitrogen in the upper basin states of Massachusetts, Vermont, and New Hampshire.	1-3b1
WW-32	Continue to develop and implement emerging technologies to maximize the effectiveness of monitoring programs.	1-3b3
WW-33	Establish a monitoring program to identify and assess the impact of emerging and legacy contaminants on the ecosystem services and biota of Long Island Sound.	1-3b5
WW-34	Through peer review, determine the adequate level of spatial and temporal sampling needed to assess Long Island Sound water quality as it is impacted by climate change drivers. (SLR, Acidification)	1-3b7

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
WW-35	Continue to support, improve, and utilize the Sentinel Monitoring 'Data Citation Clearinghouse' and other data synthesis, storage, and sharing efforts.	1-3d1
WW-36	**Complete sentinel monitoring pilot programs and evaluate results to guide strategy development and future implementation of full-scale sentinel monitoring effort.**	**1-3d1**
WW-37	Conduct periodic (5 year) review and revision of Sentinel Monitoring Strategy Document.	1-3d1
WW-38	Develop a Long Island Sound specific marine debris reduction action plan.	1-2a3
WW-39	Assess sources of nutrient and pathogen contamination to Long Island Sound embayments	1-1a3

Section 5. Thriving Habitats and Abundant Wildlife

GOAL – Restore and protect the Sound's ecological balance in a healthy, productive, and resilient state to support fish and wildlife and benefit public use.

Introduction

The natural and cultural heritage of Long Island Sound is inextricably connected to its living resources. Sustainable fish and shellfish populations contribute to the economy and ecosystem, benefiting the residents of all watershed communities. Moreover, the protection and restoration of ecologically significant shorelines and habitats will serve to protect important species, enhance the public's enjoyment of Long Island Sound, and increase resiliency to storms and flooding.

The natural habitats of Long Island and its coastal areas support populations of wildlife and living resources, provide recreational opportunities, and function as an environmental infrastructure that provides services and benefits to the region. The 12 habitats that are currently considered priority habitats are listed on the Habitat section of the LISS website. 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 maintain a healthy, productive, and resilient Long Island Sound benefiting all inhabitants.

Ecosystem-Level Indicators and Targets

The following indicators and targets have been developed in order to measure overall progress toward 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. Additional explanation about the measurement of these targets is included in Appendix B.

> **River miles restored for fish passage:** By 2035, open 200 additional miles of fish riverine migratory corridors from a 2014 baseline.
>
> **Tidal wetland extent**: By 2035 restore an additional 532 acres of tidal wetlands from a 2014 baseline.
>
> **Eelgrass extent:** Restore and maintain an additional 2,000 acres of eelgrass by 2035 from a 2012 baseline of 2061 acres.

Coastal habitat extent: Restore a total of 450 acres of coastal habitat by 2020 and a total of 3,000 acres by 2035 from a 2014 baseline.

Sediment Quality Improvement: By 2035, improve sediment quality in Long Island Sound by 20 percent from a 2006 baseline.

Thriving Habitats and Abundant Wildlife - Outcomes, Objectives, and Strategies

To accomplish the Thriving Habitats and Abundant Wildlife goal and to achieve progress toward the ecosystem targets, specific outcomes, objectives, and strategies have been developed. These elements are designed to address specific issues within this theme but many apply to multiple issues and themes.

Outcome 2-1: Ecosystem services are maintained by protecting, restoring, and enhancing habitats.

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

Strategy 2-1a1: Develop and implement innovative and effective habitat restoration projects and plans including restoring quality and quantity of coastal habitat and fish passage

Strategy 2-1a2: Restore and enhance connectivity of priority habitat types

Strategy 2-1a3: Identify water quality conditions necessary to support priority habitats and use suitability models to evaluate appropriate restoration priorities through pollution controls

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

Strategy 2-1b1: Use a repeatable criteria-based process to minimize bias, supplemented by expert knowledge, to identify high priority areas to protect

Strategy 2-1b2: Conserve and enhance natural areas and open space to benefit public access, recreation, shoreline, and community protection

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

Strategy 2-1c1: Promote the use of living shoreline habitat protection methods (dunes, shorelines, coastal marshes)

Strategy 2-1c2: Identify and prioritize upland 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 impediments to coastal processes, habitat migration)

Outcome 2-2: Ecosystem resiliency and function are maintained by diverse, balanced and abundant populations of fishes, birds, and wildlife

Objective 2-2a: To manage invasive species

Strategy 2-2a1: Develop volunteer stewardship programs to manage invasive species to ensure habitats are resilient to climate change

Strategy 2-2a2: Teach and promote measures that will help to prevent the introduction of invasive biota in Long Island Sound and connected upland areas

Objective 2-2b: To manage state and federal listed species and species of concern

Strategy 2-2b1: Prioritize habitat restoration projects for targeted Trust species

Strategy 2-2b2: Advance research and manage habitat and threats to protect targeted Trust species (e.g. climate change driven threats and predator-prey relationships)

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

Strategy 2-2c1: Create or update species management plans for commercially / recreationally important species

Strategy 2-2c2: Enhance aquaculture harvests while minimizing conflicting uses or impacts on native populations

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

Strategy 2-2d1: Promote projects that protect and restore biological and ecological diversity

Strategy 2-2d2: Promote projects that protect and restore representative communities for the Long Island Sound priority habitats including populations where a large fraction of worldwide distribution occurs in Long Island Sound

Outcome 2-3: The public is educated and involved in restoration and protection of habitats and living resources.

Objective 2-3a: To support education and outreach programs that focus on priority habitat types and living resources

Strategy 2-3a1: Promote the creation of educational and outreach programs tailored for multiple user groups

Objective 2-3b: To engage the public, particularly in urban areas, in both large and small-scale habitat restoration projects, research, monitoring, and outreach

Strategy 2-3b1: Communicate the importance of ecosystem services to the public and municipal leaders

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

Strategy 2-3c1: Enhance and promote innovative and relevant ways of connecting people to Stewardship Sites

Outcome 2-4: 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 and collaboration and distribute useful habitat and living resource data

Strategy 2-4a1: Support ecosystem science research to enhance protection of living terrestrial and aquatic resources for example support important habitat modeling and landscape design efforts.

Strategy 2-4a2: Inventory trends in quality and quantity of priority habitats and species

Strategy 2-4a3: Identify surrogate / representative species for long term monitoring to evaluate ecosystem health.

Thriving Habitats and Abundant Wildlife - Implementation Actions

Implementation Actions (IAs) have been formulated to carry out the strategies. The IAs are listed in Table 2 with highest priority actions shaded in bold blue. The major strategy addressed by the action is also listed in the table below. The complete five-year implementation action plans are included in the supplemental CCMP Implementation Action Document.

Table 2. Thriving Habitats and Abundant Wildlife Implementation Actions (Priority actions are shaded in bold blue)

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
HW-1	Develop a list of current and new / innovative restoration techniques.	2-1a1
HW-2	**Complete projects that result in river miles reconnected and/or contiguous acres of coastal habitat that are protected or restored.**	**2-1a1**
HW-3	Develop or apply connectivity models and metrics for all restoration and protection projects.	2-1a2
HW-4	Pursue and leverage additional research, monitoring, and habitat restoration funding.	2-1a4
HW-5	**Develop and apply habitat quality metrics and assessment methodology across priority habitat types.**	**2-1b1**
HW-6	**Develop a habitat quality index for tracking habitat restoration projects and programs.**	**2-1a1**
HW-7	Use the updated LISS Stewardship Initiative Geographic Tool (SIGT) to prioritize future conservation investment and management plan development for Long Island Sound's most significant imperiled terrestrial and intertidal coastal habitats.	2-1b1
HW-8	Conduct an ecological assessment of land surrounding Long Island Sound Stewardship Sites and design green infrastructure/low impact development (GI/LID) pilot projects that minimize negative impacts and enhance beneficial ecosystem services of lands within or surrounding the Sites.	2-1b1
HW-9	Assess level of habitat connectivity to determine priority level for habitat restoration and land protection (acquisition) projects.	2-1a2
HW-10	Develop a habitat quality assessment tool for research and analysis.	2-4a1

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
HW-11	Authorize pilot studies for permanent living shoreline construction projects.	2-1c2
HW-12	Develop programs to assist landowners with using habitat protection and management methods on their own properties.	2-2d1
HW-13	Use remote sensing, mapping tools, and field verification to determine sites that are likely to be impacted by Sea Level Rise (SLR), and which sites are ideal for habitat migration.	2-1b1
HW-14	Promote volunteer-driven invasive species reconnaissance and removal work.	2-2a1
HW-15	Reduce and manage threats to and monitor populations of targeted listed species.	2-2b2
HW-16	Develop and implement invasive/nonnative species management plans for priority sites including promoting the widespread use of Best Management Practices (BMPs) or Hazard Analysis and Critical Control Point (HACCP) plans	2-2a1
HW-17	**Design, develop, and promote coupled habitat restoration and monitoring projects that incorporate meaningful citizen and municipal engagement and participation, particularly in urban areas.**	**2-3b1**
HW-18	Promote strong and effective legislation that targets prevention and spread of invasive/ non-native species.	2-2a2
HW-19	**Conduct data collection and habitat restoration projects that target priority species.**	**2-2b1**
HW-20	Develop a shellfish management plan and support Best Management Practices (BMPs) for aquaculture, recreation, and restoration that ensure sustainable marine populations.	2-2c1
HW-21	Assess new habitats for inclusion in LISS priority habitat list.	2-1a2
HW-22	Continue Long Island Sound eelgrass abundance surveys.	2-4a2

Section 6. Sustainable and Resilient Communities

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

Introduction

The coastal counties in the Connecticut and New York bordering Long Island Sound have the second highest population density in the northeast, second only to the 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, including shipbuilding 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 will 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 our 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, for example, that are more compatible with our climate and water resources employ yard practices that 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 protected built infrastructure and are necessary for the long-term sustainability of these uses.

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 that live along the Sound as stewards of the resource.

Ecosystem-Level Indicators and Targets

The following indicators and targets have been developed in order to measure overall progress toward 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. Additional explanation about the measurement of these targets is included in Appendix B.

Approved shellfish areas: By 2035 upgrade 5% of the acreage currently restricted or closed for shellfishing from the 2014 baseline.

Shellfish harvested: Increase the sustainable harvest of oysters, clams, and scallops in the Sound from the 2014 baseline based on a 5 year rolling average, through a combination of habitat management and sustainable shellfish aquaculture.

Waterfront communities with resilient shorelines and sustainable, resilient infrastructure: By 2035, all waterfront communities have developed plans for shoreline resiliency and infrastructure sustainability and resiliency, with half actively implementing them.

Harbors and bays with navigable channels that are maintained sustainably: By 2025, 100 percent of Long Island Sound harbors/bays will be maintained with navigable channels consistent with the Dredged Material Management Plan being developed.

Contaminant levels in fish and shellfish: Through regional PCB and mercury management programs, reduce the level of contaminants in Long Island Sound finfish and shellfish.

Knowledgeable and engaged public: 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 beaches are open and safe for swimming: By 2035, 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 compared to a 5-year rolling average from 2014.

Marine debris removed from shoreline: By 2035, decrease the volume of marine debris in Long Island Sound.

Public access to beaches and waterways: By 2035, increase, by at least 10 percent, the number of public access points and/or the number of miles accessible by the public, to the Sound and its rivers

Sustainable and Resilient Communities - Outcomes, Objectives, and Strategies

To accomplish the Sustainable and Resilient Communities goal and to achieve the progress towards the ecosystem targets, specific outcomes, objectives, and strategies have been developed. These elements are designed to address specific issues within this theme but some apply to multiple issues and themes.

Outcome 3-1: 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 and activities such as fishing, swimming, and bird watching on the Sound and its shoreline

Strategy 3-1a2: Support maritime and cultural heritage awareness

Strategy 3-1a3: Connect/reconnect urban populations, including underserved and non-English language communities, to the Sound

Strategy 3-1a4: Improve access to Long Island Sound and its embayments, maintain view corridors and enhance water-dependent uses (e.g., reduce beach closures) throughout the watershed and the Sound

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

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

Strategy 3-1c1: Promote public participation in the cleanup and restoration of Long Island Sound through volunteerism and community action.

Strategy 3-1c2: Promote campaigns to encourage residents, both homeowners and renters, to engage in environmentally friendly practices around their homes and communities.

Outcome 3-2: 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

Strategy 3-2a1: Integrate Long Island Sound education with the latest and relevant academic standards

Objective 3-2b: To provide educators with knowledge to bring Long Island Sound education into the classroom and informal settings

Strategy 3-2b1: Provide research-based information products and supplemental resources such as lesson plans for specific Long Island Sound topics

Strategy 3-2b2: Support professional development of informal and formal educators

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

Strategy 3-2c1: Support informal education at aquariums, museums, and coastal environments with facilities such as nature centers

Strategy 3-2c2: Engage youth in stewardship opportunities

Outcome 3-3: Policy makers, resource managers, and stakeholders in New York, Connecticut, and the upper basin states have the resources to undertake collaborative efforts to restore and protect the Sound.

Objective 3-3a: To ensure that policy makers, environmental professionals, and 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

Strategy 3-3a2: Update and disseminate information on the best available scientific, socioeconomic, and environmental trends to policy makers, resource managers, and stakeholders

Objective 3-3b: To encourage opportunities to collaborate between groups involved in the restoration and protection of Long Island Sound

Strategy 3-3b1: Support collaboration and sharing of resources among governments, universities, and private organizations, and stakeholder groups working to restore and protect the Sound

Outcome 3-4: New and existing development is sustainable and resilient

Objective 3-4a: To encourage and facilitate revised regional, state, and local comprehensive plans that integrate sustainability, resiliency, and adaptability objectives and are integrated into the appropriate hazard mitigation plans.

Strategy 3-4a1: Integrate sustainability/resiliency/adaptability concepts within municipal comprehensive and mitigation plans

Objective 3-4b: To integrate sustainability, climate change adaptation, and resiliency objectives into new and existing development, housing, transportation, emissions control, energy efficiency, and job creation programs

Strategy 3-4b1: Revise zoning, permitting, and other regulatory authority to ensure that future development and redevelopment actually conforms to the sustainability/resiliency/adaptation objectives incorporated into local, state, and regional comprehensive plans

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

Strategy 3-4b3: Implement revised and updated comprehensive plans for all municipalities to ensure that sustainability/resiliency/adaptability concepts are employed in new and existing development

Strategy 3-4b4: Ensure that waterfronts balance recreational, commercial, and industrial uses according to their sustainability/resiliency/adaptability plans

Strategy 3-4b5: Promote the design and construction of stormwater and wastewater treatment systems that are sustainable and resilient

Outcome 3-5: Public access and sustainable economic activities along the waterfront are enhanced and balanced

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 and environmentally sustainable communities.

Strategy 3-5a1: Establish programs and provide support to communities to help them in obtaining recognition for exemplary sustainability programs

Strategy 3-5a2: Ensure consistency among economic development, mitigation, and sustainability planning efforts

Strategy 3-5a3: Encourage communities to balance recreational, commercial, industrial and residential uses according to their sustainability and mitigation plans and resiliency efforts

Strategy 3-5a4: Improve access to Long Island Sound and its embayments, maintain view corridors and enhance water-dependent uses (e.g., reduce beach closures) throughout the watershed and the Sound

Sustainable and Resilient Communities - Implementation Actions

Implementation Actions (IAs) have been formulated to carry out the strategies. The IAs are listed in Table 3 with highest priority actions shaded in bold blue. The major strategy addressed by the action is also listed in the table below. The complete five-year implementation action plans are included in the supplemental CCMP Implementation Action Document.

Table 3. Sustainable and Resilient Communities Implementation Actions (Priority actions are shaded in bold blue)

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
SC-1	Provide technical and grant assistance to support festivals and celebrations that encourage appreciation and use of the Sound.	3-1a1
SC-2	Provide support through technical and grant assistance to organizations that promote environmentally sustainable recreational activities at Stewardship sites and other shoreline access points.	3-1a1
SC-3	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.	3-1a2
SC-4	Continue state programs to promote youth and adult fishing as a healthy and sustainable recreational sport.	3-1a2
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.**	**3-1a3**
SC-6	Produce informational materials that can be distributed through multiple formats, including, print, web, social media, and traveling displays to increase the public's understanding of the ecological, cultural, and recreational value of Long Island Sound, and to encourage the stewardship of Long Island Sound.	3-1b1
SC-7	Develop and distribute multilingual information materials, including signage, about the ecological health of Long Island Sound to reach non-traditional audiences.	3-1a3
SC-8	Develop innovative projects with partners to disseminate knowledge and results from Long Island Sound monitoring and research.	3-1b1

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
SC-9	Raise awareness through various media formats about the Sound's water quality conditions that could impact human health.	3-1b1
SC-10	Develop a website and use other media to educate the public about the impacts of climate change on Long Island Sound and in Long Island Sound Stewardship Areas.	3-1b1
SC-11	Provide technical and grant assistance to local volunteer organizations working towards the ecological restoration of the Sound.	3-1c1
SC-12	Continue staff support for Sound Stewardship volunteer projects and other outreach activities at New York and Connecticut Stewardship Sites.	3-1c1
SC-13	Continue the Long Island Sound Citizens Summit, and support other Sound wide events that encourage dialogue between resource managers, environmental stakeholders, and residents.	3-1c1
SC-14	Provide Natural Landscaping guidance to communities and homeowners to encourage the use of alternatives to chemical and nutrient intensive landscaping, and establishment of natural vegetated buffers near bodies of water.	3-1c2
SC-15	**Support efforts through technical and grant assistance to develop community-based behavior change campaigns that result in measurable environmental improvements to the Sound's ecosystem.**	**3-1c2**
SC-16	Develop a Sound wide marketing campaign to increase the public's use of the Sound.	3-1c2
SC-17	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 into their classrooms.	3-2b2
SC-18	Provide technical and grant assistance to encourage informal education activities on Long Island Sound.	3-2c1
SC-19	Create a "get out on Long Island Sound day" of informal education activities around the Sound to promote "on-the-water" experiences.	3-2c1
SC-20	Provide training to municipalities on low impact development and green infrastructure.	3-3a1
SC-21	**Develop and implement regional outreach programs on innovative/sustainable flood and erosion control for municipalities.**	**3-3a1**

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
SC-22	Provide support, including funding and technical assistance, for the development and dissemination of environmental technical manuals and environmental management studies to environmental decision makers and resource managers.	3-3a2
SC-23	**Conduct a Sound-wide citizen survey, and compare with the 2006 baseline survey, in order to identify the public's perception of the health of Long Island Sound and their understanding of the environmental issues.**	**3-3a2**
SC-24	Support the efforts of LISS to circulate the availability of grant programs, including through social media and personal contacts.	3-3b1
SC-25	**Support Communities as they develop and adopt new stand-alone Municipal Sustainability Plans**	**3-4b2**
SC-26	**Support Communities as they develop and adopt new or updated Coastal Resiliency Plans**	**3-4b2**
SC-27	Develop standards, best practices and educational materials for Green Infrastructure/Low Impact Development Planning and Implementation.	3-4b1
SC-28	Develop regional outreach programs and training modules on sustainability and resiliency planning topics.	3-4b1
SC-29	Develop a municipal sustainability recognition program that incorporates ideas from other states to incentivize sustainable development and economic planning.	3-5a1
SC-30	Develop guidance for quantifying the benefits and costs of sustainability activities and economic development to incorporate into sustainability and resiliency planning efforts.	3-4b1
SC-31	**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.**	**3-5a1**
SC-32	Encourage the sustainable use of natural coastal areas, including Long Island Sound stewardship sites, through support of sustainable blueways, bikeways, and greenways.	3-5a3

Section 7. Sound Science and Inclusive Management

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

Introduction

The greater 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 this water resource, as with any large water body, requires collaboration and governance among numerous cross-jurisdictional partners and stakeholders. In March of 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 sound 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.

The ***Sound Science and Inclusive Management*** **(SM)** theme addresses the research, monitoring, modeling, and assessment programs that 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.

Sound Science and Inclusive Management - Outcomes, Objectives, and Strategies

To accomplish the Sound Science and Inclusive Management goal and to achieve the progress towards the ecosystem targets, specific outcomes, objectives, and strategies have been developed. These elements are designed to address specific issues within this theme but some apply to multiple issues and themes.

Outcome 4-1: The scientific understanding of Long Island Sound 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: Develop and maintain an integrated science plans that transparently link outcomes and objectives to strategies and actions, setting priorities based on management relevance and scientific merits

Strategy 4-1a2: Support a focused Long Island Sound research program

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 and map open and shallow water habitats to support resource management and marine spatial planning

Strategy 4-1b2: Characterize and map human uses (recreational/commercial) of open and shallow water habitats to support resource management and marine spatial planning

Strategy 4-1b3: Evaluate, enhance, integrate, and coordinate ongoing monitoring programs

Strategy 4-1b4: Strengthen monitoring of embayments and near-shore waters, and integrate data and assessments into open water monitoring programs

Strategy 4-1b5: Improve regional identification, storage, and sharing of spatial and temporal data.

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

Outcome 4-2: 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

Strategy 4-2a2: Ensure that the CCMP is incorporated into and carried out through existing state policies and regulatory programs

Strategy 4-2a3: Maintain USEPA, NYSDEC, and CTDEEP sponsorship of the Management Conference to provide leadership and accountability

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 Long Island Sound.

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

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

Strategy 4-2b2: Identify critical funding needs for protection and restoration projects, science, and education and involvement, and relate these needs to available or new funding sources

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.

Outcome 4-3: 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

Strategy 4-3a2: Consider the spectrum of desired ecosystem outcomes when planning and implementing resiliency of both built and natural systems

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

Strategy 4-3b1: Establish baselines of historical or prehistorical conditions of ecosystem attributes and magnitudes of change to help provide a basis for setting restoration goals

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)

Strategy 4-3b3: Prepare periodic progress reports on the health of the Sound and on implementation progress

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

Sound Science and Inclusive Management - Implementation Actions

Implementation Actions (IAs) have been formulated to carry out the strategies. The IAs are listed in Table 4 with highest priority actions shaded in bold blue. The major strategy addressed by the action is also listed in the table below. The complete five-year implementation action plans are included in the supplemental CCMP Implementation Action Document.

Table 4. Sound Science and Inclusive Management Implementation Actions (Priority actions are shaded in bold blue)

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
SM-1	**Identify and communicate high priority science needs relating to the understanding and attainment of management objectives and ecosystem targets.**	**4-1a1**
SM-2	Support research priorities through the Long Island Sound Study Research Program, and the Connecticut and New York Sea Grant Programs.	4-1a2
SM-3	**Complete seafloor mapping conducted under the Sound Cable Fund.**	**4-1b1**
SM-4	Identify key datasets needed to support Coastal and Marine Spatial Planning for Long Island Sound.	4-1b2
SM-5	Develop an integrated Monitoring Plan considering developing technologies.	4-1b3
SM-6	Develop an integrated Data Management Plan considering local, regional, and national observing initiatives.	4-1b3
SM-7	Incorporate the Interstate Environmental Commission's (IEC) monitoring efforts into the Long Island Sound water quality monitoring program.	4-1b3
SM-8	Continue National Coastal Assessment monitoring of LIS	4-1b3
SM-9	**Coordinate and leverage community water quality monitoring programs, enhancing the utility and application of data.**	**4-1b4**
SM-10	Complete LISS Sentinel Monitoring for Climate Change pilot projects and evaluate results to guide strategy development and future implementation.	4-1b5

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
SM-11	**Integrate the LISS Sentinel Monitoring for Climate Change Program with regional and national efforts such as the Northeast Regional Ocean Council, Northeast Regional Association of Ocean Observing Systems, and the National Estuarine Research Reserve System.**	**4-1b5**
SM-12	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.	4-1b6
SM-13	Improve the use and utility of Long Island Sound data for GIS applications.	4-1b6
SM-14	**Enhance modeling of eutrophication in Long Island Sound to support nitrogen management and dissolved oxygen TMDL implementation.**	**4-1c1**
SM-15	Make publically available the Systemwide Eutrophication Model code and products to enhance transparency and collaboration.	4-1c1
SM-16	Link water quality models of Long Island Sound to watershed and groundwater models to better elucidate nutrient and water budgets.	4-1c1
SM-17	Continue program administrative, financial, and technical assistance support to Management Conference.	4-2a1
SM-18	Continue state program coordination and involvement in the Management Conference.	4-2a1
SM-19	Optimize structure and function of the Management Conference with a focus on implementation of the revised CCMP.	4-2a1
SM-20	Reauthorize Clean Water Act sections 119 and 320, and other relevant statutes to support Long Island Sound.	4-2a1
SM-21	Support involvement of and communication with the bi-state Long Island Sound Congressional Caucus and bi-state Connecticut and New York legislative caucus on issues of common concern.	4-2a1
SM-22	**Support involvement of, and communication with, local governments, which have front line authority for implementing many of the CCMP strategies.**	**4-2a1**

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
SM-23	**Reach out to traditionally underrepresented stakeholders and encourage them to participate in the Management Conference.**	**4-2a1**
SM-24	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 (SEQRA in New York).	4-2a2
SM-25	Convene senior EPA and State management to help direct, inform, and coordinate policy relevant to Long Island Sound.	4-2a3
SM-26	Foster involvement of the tributary states in Management Conference activities by maintaining the Five State/EPA TMDL Work Group.	4-2a4
SM-27	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.	4-2a5
SM-28	Conduct primary valuations of the critical ecosystem goods and services supported by Long Island Sound and its coastal habitats.	4-2b1
SM-29	Conduct return-on investment analysis for Long Island Sound restoration and preservation strategies to inform priority-setting for implementation of the CCMP.	4-2b1
SM-30	Capitalize Connecticut Clean Water Fund and New York State Revolving Fund adequately to finance Clean Water infrastructure needs.	4-2b2
SM-31	**Research and develop innovative, locally appropriate funding mechanisms to provide sustained, reliable sources of investment capital to restore and protect ecosystem services.**	**4-2b2**
SM-32	Coordinate and target funding for implementation of CCMP public involvement and education priorities. Develop an annual budget of the United States Government regarding each Federal department and agency involved in the protection and restoration of the Long Island Sound watershed.	4-2b3
SM-33	Coordinate and target funding for implementation of CCMP water, habitat and living resources priorities.	4-2b3

Implementation Action Number	Implementation Action Title	Major Strategy Addressed
SM-34	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.	4-3a1
SM-35	Incorporate desired ecosystem outcomes for planning and implementation of Hurricane Sandy Relief funds.	4-3a2
SM-36	Collaborate with the Connecticut Institute for Resiliency and Climate Adaptation (CIRCA).	4-3a2
SM-37	**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.**	**4-3b1**
SM-38	Incorporate bioextraction analyses in nitrogen TMDL assessments on the assimilative capacity of Long Island Sound to process nutrients without loss of designated uses.	4-3b2
SM-39	Prepare and make available to the public annually the LISS Implementation Tracking Report using E-Sound.	4-3b3
SM-40	Develop, complete, and evaluate a "report card" on water quality conditions in Long Island Sound.	4-3b3
SM-41	Refine and communicate information on the Long Island Sound ecosystem and watershed using environmental indicators (drivers, pressures, conditions, and response indicators).	4-3b3
SM-42	Develop annual Long Island Sound Study work plans that consider progress made and recommendations for improving implementation of the implementation actions.	4-3b4
SM-43	Every five years develop a comprehensive, specific, target-oriented implementation plan engaging all Long Island Sound partners.	4-3b4

Section 8. Implementation Actions and Metrics

The CCMP Update has a 20-year horizon and includes specific implementation actions 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. 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.

Implementation actions 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. These priority actions are indicated in bold blue within the Implementation Action tables in the CCMP.

Each implementation action includes:

- A description and background about the proposed action,
- The agencies or organizations that will carry out or collaborate on the task,
- The level of funds needed and source of the funds. The levels of funding roughly fall into the following categories –
    - $ <$25,000;
    - $$ - $25,000 to $150,000;
    - $$$ - $150,000 to $1,000,000, and
    - $$$$ - 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, and
- An approximate timeframe for action completion.

Implementation progress will be assessed yearly as part of annual workplan development. Progress toward the goals and ecosystem targets will also be reviewed. 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.

Section 9. Funding Strategies to Implement the Updated CCMP

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 for maintaining core programs, implementing new programs and strategies for sustainability and resiliency, and, most significantly upgrading wastewater and stormwater infrastructure.

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 the Long Island Sound Improvement Act and the Long Island Sound Stewardship Act. The federal fiscal year 2014 budget provided approximately $4.5 million. This plan recommends that annual funding be provided at a level of $10 million. With the required 50 percent match requirement, this would provide a total of $20 million per year to support water quality and habitat improvement projects, research, monitoring, and education. 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. 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.

Other federal and state programs will be important sources of funding. Some of these programs are described below.

Clean Water State Revolving Funds. The project implementation costs associated with the plan are large and are dominated by the potential cost of upgrading sewage treatment facilities to remove nitrogen, the cost of remediating combined sewer overflows, and maintaining sanitary and stormwater sewer systems. The existing State Revolving Funds are the preferred vehicles for funding major capital projects for wastewater programs. These 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.

Following release of this draft plan, the states will estimate the federal and state funds needed over the next 20 years to meet statewide needs, including additional Long Island Sound-specific project needs.

Other Funding Programs. Depending on the project focus, a variety of funding and technical support may be available. A partial list of programs includes:

Federal

- EPA water grants - http://water.epa.gov/grants_funding/
- EPA smart-growth grants - http://www.epa.gov/smartgrowth/grants/
- USFWS grants - http://www.fws.gov/grants/
- National Oceanic and Atmospheric Association Habitat Conservation grants - http://www.habitat.noaa.gov/funding/index.html

New York

- **Environmental Protection Fund (EPF).** New York's Environmental Protection Fund supports projects related to land protection and acquisition, public land stewardship, water quality improvement, and invasive species eradication. EPF monies are used by state agencies and distributed to municipalities and non-profits through grant-making programs. More information is available at http://keepprotectingny.com/the-epf.html.
- Environmental Facilities Corporation - http://www.nysefc.org
- Cleaner, Greener Communities Program - http://www.nyserda.ny.gov/Statewide-Initiatives/Cleaner-Greener-Communities.aspx
- Environmental Finance Center, Syracuse University - http://efc.syracusecoe.org/efc/sub.html?skuvar=5

Connecticut

- **Connecticut Long Island Sound license plate fund** – supports activities related to public education and outreach, public access, habitat restoration, and research. See http://www.ct.gov/deep/cwp/view.asp?a=2705&q=323786&deepNav_GID=1635
- **Landowner Incentive Program** - provides technical advice and cost assistance to private landowners for habitat management that will result in the protection, restoration, reclamation, enhancement, and maintenance of habitats that support fish, wildlife, and plant species considered at-risk. See http://www.ct.gov/deep/cwp/view.asp?a=2723&q=325734&deepNav_GID=1655
- **Connecticut's Clean Water Fund** - provides a combination of grants and loans to municipalities, which undertake wastewater infrastructure projects at the direction of the DEEP. See http://www.ct.gov/deep/cwp/view.asp?a=2687&q=322344&deepNav_GID=1511
- **Small Town Economic Assistance Program** - funds economic development, community conservation and quality of life projects. See http://www.ct.gov/opm/cwp/view.asp?a=2965&q=382970&opmNav_GID=1793

- **Lakes Grant Program -** provides matching grants for lake restoration studies and projects at lakes that have public access. See http://www.ct.gov/deep/cwp/view.asp?a=2687&q=322344&deepNav_GID=1654
- **Open Space and Watershed Land Acquisition Grant Program** – may be used for the purchase of land based on seven eligibility categories http://www.ct.gov/deep/cwp/view.asp?a=2687&q=322338&deepNav_GID=1511)

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 some modest improvements. However, the next generation of ecosystem level protection and restoration for abundance will require new and enhanced support since the challenges posed by growing diffuse pollutant sources caused by increasing development superimposed on the effects of climate change are substantial.

Wise investment in the natural assets of Long Island Sound and its watershed can secure more resilient, less risky, and more sustainable returns in property values, food security, water quantity and quality, storm protection, recreation and tourism, and other goods and services. A healthy environment will provide greater ecological and economic resilience and productivity, 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.

A major recommendation is to evaluate creative funding mechanisms to meet the financial needs for protecting and managing the natural, environmental assets of Long Island Sound. They include 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 utility and efficiency of funding mechanisms will become more apparent in coming years as new market opportunities develop for habitat, climate change mitigation and resiliency, and water quality. Current funding mechanisms are limited. The people who benefit from many aspects of the Long Island Sound Basin (property values, storm protection, and drinking water) do not have a means to pay for investment in asset improvements that directly benefit them. In addition, those who may harm these assets (pollution, blight, impervious surfaces) do not have a system for paying to mitigate for these damages or repair the 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. This plan recommends that a regional taskforce be formed to evaluate options for establishing new funding tools to generate the financial resources needed to sustain investment in Long Island Sound's natural assets.

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Glossary

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

Anadromous – see diadromous.

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

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 – Aquaculture is 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 in achieving an objective.

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 water bodies.

Bioremediation – The use and engineering of biological processes to solve environmental problems (e.g. bacterial nitrogen removal from wastewater (BNR) or creation of shellfish habitat to improve water quality).

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.

Brackish – Of intermediate salinity lower than that of full strength seawater.

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.

Catadromous – see diadromous.

Chlorophyll – Primary pigment group that captures light for **photosynthesis**, found in cells of plants and photosynthetic bacteria. Measurement of the specific pigment chlorophyll a (Chl *a*) in a water sample is often used as a surrogate for **primary productivity.**

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

Combined Sewers – Sewer systems, which are designed, carry both rainwater run-off 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 pipes or CSOs.

Cultural Eutrophication – refers to the process by which humans cause eutrophication through the contribution of excess nitrogen and phosphorus from sewage, run-off, and fertilizer use, which can cause increases in algae or phytoplankton production.

Decentralized Wastewater Treatment System – An onsite or cluster wastewater system that is used to treat and dispose of relatively small volumes of wastewater, generally from dwellings and businesses that are located relatively close together. These include conventional septic systems, cesspools, and alternative/package 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 – is 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.

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

Estuary – Ecosystem occurring in the region of mixing of fresh and salt water in the lower reaches of a river.

Eutrophication – The addition of excess organic matter to an ecosystem.

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.

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.

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

Grey Infrastructure – refers to traditional practices for stormwater management and wastewater treatment, such as pipes and sewers.

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.

Hydrodynamics – 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: **anoxia**)

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

Indicator Species – A species whose presence, abundance, or condition in a given environments indicative of the condition of the ecosystem as a whole.

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 more natural bank 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.

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 continuous 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 (N_2), which cannot be used by most organisms. These organisms are instead dependent on the much rarer **dissolved inorganic nitrogen,** which is frequently the nutrient, which 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. ((See Ammonium, Nitrate, Nitrite)

Nonpoint source – A source of, for example nutrients or sediment, which is not restricted to a clearly identifiable discharge location like a river, pipe, or culvert (see also Diffuse Source, Point Source) **Nonpoint source** of pollution such as sediment or nutrients such as runoff, groundwater inputs or atmospheric fall-out. (See Point Source, Nonpoint Source)

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.

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

Nitrogen Trading Program – the nitrogen general permit administered by CTDEEP to reduce nitrogen loading to Long Island Sound by trading nitrogen credits among 79 wastewater treatment facilities located throughout the state.

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, Diffuse Source).

Red Tide – a harmful algal bloom, producing toxic or harmful effects on people, fish, shellfish, marine mammals, and birds.

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 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 sea level rise and/or weather events.

Riparian Buffer – the vegetated area adjacent to a stream.

Runoff – **Nonpoint Source** 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.

Sea Grass – Marine flowering plants, which are generally rooted in the sediments. *Zostera marina* (eelgrass) is the most abundant sea grass in Long Island Sound, and is an important habitat for many species of fish and invertebrates.

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

Shellfish Biotoxins – toxins that concentrate in shellfish to dangerous levels, making shellfish unsafe to eat; Paralytic Shellfish Poisoning (PSP) and Diarrhetic Shellfish Poisoning (DSP).

Social Media – the strategies by which people interact and create, share or exchange ideas and information through the Internet; ex. Facebook, Twitter, LinkedIn.

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

Sustainability – meeting the needs of the present without compromising the ability of future generations to meet their own needs.

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

Total Maximum Daily Load (TMDL) – the total maximum amount of a pollutant a water body 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, interjurisdictional 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.

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

Wastewater Treatment – A process designed to clean and treat raw sewage to remove contaminants and pathogens. 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 water body. In some cases tertiary or advanced wastewater treatment is added to remove inorganic **nutrients** (nitrogen and/or phosphorus) from effluent prior to discharge.

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
CTDECD	Connecticut Department of Economic and Community Development
CTDEEP	Connecticut Department of Energy and Environmental Protection
CTDOH	Connecticut Department of Public Health
CTSG	Connecticut Sea Grant
CSO	Combined Sewer Overflows
CWA	Clean Water Act
DCC	Data Citation Clearinghouse
DMMP	Dredge Material Management Plan
DSP	Diarrhetic Shellfish Poisoning
EBM	Ecosystem-Based Management
EPA	(see USEPA)
FEMA	Federal Emergency Management Agency

GI	Green Infrastructure
GIS	Geographic Information System
HAB	Harmful Algal Blooms
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
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 Resources Center
LISS	Long Island Sound Study
LISS CAC	Long Island Sound Study Citizens Advisory Committee
LISSFF	Long Island Sound Futures Fund
LISS HRWG	Long Island Sound Study Habitat Restoration Workgroup
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 Workgroup
LISS SMCC	Long Island Sound Study Sentinel Monitoring for Climate Change
MACOORA	Mid-Atlantic Coastal Ocean Observing Regional Association
MADEP	Massachusetts Department of Environmental Protection

MARCO	Mid-Atlantic Regional Council on Oceans
MS4	Municipal Separate Storm Sewer Systems
NCA	National Coastal Assessment
NCCR	National Coastal Condition Report
NEERS	New England Estuarine Research Society
NEIWPCC	New England Water Pollution Control Commission
NEMO	North East Map Organization
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 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
NYEFC	New York State Environmental Facilities Corporation
NYSOPRHP	New York State Office of Parks Recreation and Historic Preservation
NYSDEC	New York State Department of Environmental Conservation
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	Polychlorinated Dibenzodioxins and Furans and Polybrominated
PCBs	Polychlorinated Biphenyls
PSP	Paralytic Shellfish Poisoning
QAPP	Quality Assurance Project Plan
SEQRA NY	State Environmental Quality Review Act
SIGT	Stewardship Initiative Geographic Tool
SLR	Sea Level Rise
SMCC	Sentinel Monitoring for Climate Change
SMCCP	Sentinel Monitoring for Climate Change Plan
SSPWG	Sound Spatial Planning Workgroup
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
UCONN CLEAR	University of Connecticut Center for Land Use Education and Research
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

Appendix A

Long Island Sound Study and Partner Key Accomplishments 1994-2014

Long Island Sound Study and Partner 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 by 35,000,000 pounds per year the amount of nitrogen discharged from 106 sewage treatment plants.
  - 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 pumpout 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 sea floor.
  - 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.
- 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 1,548 acres of habitat from 1998 to July 2014, 77 percent of the goal to restore at least 2,000 acres of habitat by 2020.
- Reopened 300 miles of river and stream corridors to fish passage from 1998 to July 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 2,750 acres in the Long Island Sound Study Area since 1998 through easements and land acquisitions. Of that total, 2,580 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*, (Springer Publishing, 2013), which provides a sound scientific basis for addressing problems identified.
- Developed, funded and maintained a 28-year record of water quality monitoring data in Long Island Sound at fixed stations for established parameters, one of the longer-term water quality monitoring datasets available nationally and expanding the network to include fixed real-time buoy data in the Sound.
- 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 Long Island 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 and 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.
- Supported development of *Sound Vision* – a community action plan that lays out a collaborative vision for the Sound
- Leveraged more than $3.2 billion in other federal, state and local funding from 2006-2013, a ratio of $84 leveraged for every EPA LIS 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 LIS
- 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 as a priority topic in the LISFF annual request for proposals for CCMP implementation projects.
- Involved students from Environmental Justice communities into community-based water and habitat improvement projects.
- Built local partnerships to capitalize on national Environmental Justice initiatives such as the Urban Wildlife Refuge Program and Schoolyard Habitat Program of the US Fish and Wildlife Service and the Urban Waters Program of the Environmental Protection Agency.
- Integrated involvement from underserved communities in new initiatives, building grassroots support for their expansion.
    - Involved middle, high school and college youth from underserved communities in projects to demonstrate the effectiveness of aquaculture to bioextract nitrogen from the waters off of the Bronx, NY and Bridgeport, CT. Students helped plant and harvest ribbed mussels and sea vegetation—sugar kelp and red algae.

Appendix B
Technical Explanation of Ecosystem Targets

Technical Explanation of Ecosystem Targets

The following section provides a technical background and explanation of the percentages, baseline and tracking used or to be used to measure progress towards the targets. This section is in draft form and will be further expanded for the public and final draft of the CCMP.

Clean Waters and Healthy Watersheds

Hypoxia: By 2035, achieve a measurable reduction in the zone of hypoxia in Long Island Sound from pre-2000 Dissolved Oxygen TMDL averages as measured by the 5-year running average size of the zone.

The average size of the maximum summertime extent of hypoxia (DO $\leq$ 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% 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 in 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 TMDL for nitrogen (CTDEEP, NYSDEC 2000). This target is to attain the TMDL allocation for wastewater treatment facilities by 2017 and maintain compliance with that cap into the future. The allocations for nonpoint sources in the LISS TMDL require implementation of a variety of best management practices to control

nonpoint source pollution. This target is to have all the necessary practices in place by 2025 necessary to attain the TMDL nonpoint source allocation.

Water clarity: By 2035 achieve improved water clarity as defined by the LISS report card to support healthy eelgrass communities

Water clarity is one of the major factors affecting eelgrass health and therefore extent. For most of LIS water clarity is tied to phytoplankton levels and measured using light penetration techniques (e.g., secchi depth). For the purposes of this goal, "improved" is defined as an increase in the overall numeric criterion used by the report card to assess water quality by at least ½ letter grade (e.g. B to B+)

Pervious Cover: Through green infrastructure and low impact development, maintain or increase the area of pervious cover in the watershed in 2035 relative to a 2010 baseline

The degree of impervious cover, particularly near water bodies, has been shown to be associated with degradation of water quality in rivers and streams. For the purpose of this analysis, pervious cover is defined as any vegetated or open unpaved space, whether developed or undeveloped. 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). 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.

Riparian buffer extent: By 2035 increase natural vegetation within 300 feet of any stream or lake by 10 percent compared to 2010 baseline of 65 percent

Vegetated zones around the shorelines 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% of area within 300' of a stream or lake be 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, 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).

Open space extent protected: Preserve 21 percent of the CT land, or 673,210 acres by 2023; maintain or increase protected land within the Long Island Sound coastal boundary by 2035

Connecticut state law sets a goal of conserving 21 percent of Connecticut's land area, with Connecticut's official land conservation plan establishing 2023 as the target date. That goal includes conservation land owned by towns and cities, land trusts and other nonprofit organizations, water utilities, and the state. There is 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.

Thriving Habitats and Abundant Wildlife

River miles restored for fish passage: By 2035 open 200 additional miles of fish riverine migratory corridors from a 2014 baseline.

This target will be reached by adding an additional 200 riverine migratory corridor miles connected either through dam removal or fish passage to the 2014 total. The 2014 baseline is 301.85 open river migratory corridors (RMC) miles in CT and 2.9 open RMC miles in NY.

Tidal wetland extent: By 2035 restore an additional 532 acres of tidal wetlands from a 2014 baseline.

As of 2014, 968 acres of tidal wetland habitat have been restored in the LISS study area since 1998. The 2035 target is to restore an additional 532 acres by 2035, 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, mosquito ditching removal) and/or eradicate invasive species (e.g. Phragmites).

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.

This target will be achieved through the successful implementation of additional water quality protections and associated reductions in land-side inputs of nutrients, as well as restoration (replanting) efforts led by academic, government, and nonprofit agencies and partners.

<u>Coastal habitat extent</u>: Restore a total of 450 acres of coastal habitat by 2020 and a total of 3,000 acres by 2035 from a 2014 baseline.

Coastal habitat extent: Between 1998 and 2014, 1,550 acres of coastal habitat have been restored. The interim goal is to restore an additional 450 acres by 2020, or a cumulative total of 2,000 acres. The final goal is to restore an additional 2,550 acres between 2020 and 2035, bringing the cumulative total of acres restored since 1998 to 4,550 acres. Coastal habitat extent includes restoration in any of the priority 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.

<u>Sediment Quality Improvement</u>: By 2035 improve sediment quality in Long Island Sound by 20 percent from a 2006 baseline

Sediment quality is determined by EPA's National Coastal Assessment Sediment Quality Index (SQI). This index is a multimetric indicator based on loadings of 28 contaminants, estimated as "good", "fair" or "poor" for each station based on the number and severity of exceedances. Our target is to show a net improvement (from poor>fair or from fair>good) at 20% of the stations measured in Long Island Sound. In 2006, 49 stations were measured, so a net improvement at 10 stations would be required to meet this goal. By net improvement we mean that if 2 stations regressed (from good>fair or fair>poor) an improvement at 12 stations would be necessary to meet the goal.

Sustainable and Resilient Communities

<u>Approved shellfish areas:</u> By 2035 upgrade 5% of the acreage currently restricted or closed for shellfishing from the 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.

<u>Shellfish harvested</u>: Increase the sustainable harvest of oysters, clams, and scallops in the Sound from the 2014 baseline based on a 5 year rolling average, through a combination of habitat management and sustainable 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. The baseline value for this is the 5-year rolling average in 2014 (2010-2014).

<u>Waterfront communities with resilient shorelines and sustainable, resilient infrastructure</u>: By 2035 all waterfront communities have developed plans for shoreline resiliency and infrastructure sustainability and resiliency, with half actively implementing them.

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 update of the CCMP. This target will encourage communities, within the coastal zone, to develop and implement comprehensive plans, which will have long lasting benefits to their residents.

<u>Harbors and bays with navigable channels that are maintained sustainably</u>: By 2035, 100 percent of Long Island Sound harbors/bays will be maintained with navigable channels consistent with the Dredged Material Management Plan being developed.

Maintenance of navigational channels is essential to sustain both recreational and commercial activities in harbors and embayments along the CT and NY shorelines. This target ensures that dredging and dredge spoil disposal operations are accomplished in a sustainable manner, so that future generations can enjoy boating in LIS and be assured that environmental damage does not occur in the maintenance of harbors and embayments. The LISS Dredge Material Management Plan is presently under development. Our goal is to have all bays and harbors in compliance with this plan by 2035.

Contaminant levels in fish and shellfish: Through regional PCB and mercury management programs, reduce the level of contaminants in Long Island Sound finfish and shellfish

PCB and mercury contamination in edible fish pose threats to some populations that eat fish caught in LIS. Every 5 years, fish and shellfish will be evaluated to ensure that these contaminants show a decreasing level in the edible portions of fish and shellfish.

Knowledgeable and engaged public: 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

Recently the LISS has undertaken a public perception survey to gage the knowledge of residents in the watershed. There were many individual questions posed to respondents and a general assessment of the status has been completed. The survey will be upgraded and repeated every 10 years to evaluate changes in response to LISS educational outreach efforts.

Public beaches are open and safe for swimming: By 2035, 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 compared to a 5-year rolling average from 2014.

LISS presently tracks closure days at 648 CT and NY beaches using the EPA BEACON system (http://watersgeo.epa.gov/beacon2/reports.html). The five-year rolling average is 1317 closure/advisory days, which translates to almost exactly 2 closure days per monitored beach. 132 of 648 beaches reported at least one closure day. The target therefore is to reduce the 5-year

rolling average to about one closure day per monitored beach per year (658 total closure days assuming constant level of sampling), or to reduce the total number of beaches reporting a closure to less than 66.

Marine debris removed from shoreline: By 2035, decrease the volume of marine debris in Long Island Sound.

While LIS tracks several measures of marine debris, including boom/skimmer data, debris collected by vessels, and various annual beach clean up 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. We aim to have a reduction in the 5-year rolling average of this indicator, with the baseline being the 5-year rolling average in 2014 (2010-2014)

Public access to beaches and waterways: By 2035, increase, by at least 10 percent, the number of public access points and/or the number of miles accessible by the public, to the Sound and its rivers

Public access to the shore for all members of the LIS community is an important design principle for the CCMP update. Measurement methods for shoreline accessibility will be based in part on partner measurements of accessible shorelines as well as unobstructed shoreline miles.

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