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July 2018

# LONG ISLAND SOUND RESTORATION

Improved Reporting  
and Cost Estimates  
Could Help Guide  
Future Efforts

# GAO Highlights

Highlights of [GAO-18-410](#), a report to the Committee on Transportation and Infrastructure, House of Representatives

## Why GAO Did This Study

Long Island Sound, an estuary bordered by Connecticut and New York, provides numerous economic and recreational benefits. However, development and pollution have resulted in environmental impacts, such as the degradation of water quality. EPA partnered with both states to create the Study to restore and protect the Sound. The Study developed a comprehensive conservation and management plan in 1994 and updated the plan in 2015.

GAO was asked to examine federal efforts to restore the Sound. This report examines, among other objectives, (1) what is known about the progress made toward achieving the 1994 plan, (2) how Study members plan to measure and report on progress toward achieving the 2015 plan, and (3) estimated costs of the restoration. GAO reviewed Study plans, reports, and data. GAO also interviewed 12 Study members—including federal and state agency officials—and representatives of 5 Study work groups about restoration efforts and progress made.

## What GAO Recommends

GAO recommends that EPA work with the Study to ensure that it fully incorporates leading practices into its performance reporting efforts and that its cost estimates include the full range of activities as well as those for which there is uncertainty. EPA agreed with GAO's recommendations and highlighted steps the agency will take to meet the recommendations

View [GAO-18-410](#). For more information, contact J. Alfredo Gómez at (202) 512-3841 or [gomezj@gao.gov](mailto:gomezj@gao.gov).

July 2018

## LONG ISLAND SOUND RESTORATION

### Improved Reporting and Cost Estimates Could Help Guide Future Efforts

## What GAO Found

The Long Island Sound Study (the Study) is a federal-state partnership formed in 1985 to restore Long Island Sound. The Environmental Protection Agency (EPA) and officials from Connecticut and New York provide oversight for the Study, which includes federal and state agencies, nonprofit organizations, and other groups. GAO found the following:

**Progress toward 1994 Plan.** The Study established an initial plan for the Sound in 1994 and has collected data on certain indicators of the Sound's health and published progress reports on its website. However, the Study has not comprehensively assessed progress against the 1994 plan. In the absence of such an assessment, GAO interviewed Study members who generally agreed that moderate progress has been made in achieving goals for five of the six problem areas in the 1994 plan. Without a comprehensive assessment, it is not possible to determine the extent these views reflect actual progress.

**Reporting Progress for the 2015 Plan.** The Study's 2015 management plan identifies 20 long-term targets and associated numerical indicators that will be used to measure future progress. The Study has also updated the format for pages on its website to provide more consistent progress reports for these targets. However, the reports do not yet fully incorporate leading practices for performance reporting that GAO has previously identified. For example, they do not include evaluations of goals that are not met for 15 targets. By ensuring that leading practices are fully incorporated into the Study's performance reporting efforts, EPA can help the Study better assess and report on future progress.

**Estimating Costs of Restoration.** The Study has estimated that the future costs of restoration will be at least \$18.9 billion through 2035. However, the current estimates are understated because they do not include the costs of all activities that will be needed to accomplish the 2015 plan, and they do not reflect the uncertainty associated with some of the costs. By capturing the full costs and uncertainties in cost estimates, the Study can provide decision makers critical information needed to allocate resources effectively.

### A Salt Marsh in the Long Island Sound Watershed



Salt marshes, a type of tidal wetland, help protect against erosion and filter pollutants contained in stormwater runoff.

Source: GAO. | GAO-18-410

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# Contents

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Letter		1
	Background	5
	Although a Comprehensive Assessment of Progress Has Not Been Conducted, Study Members Believe Moderate Progress Has Been Made Since 1994	12
	The 2015 Plan Has Four Goals to Improve Water Quality and Ecosystem Functions, but Study Members Identified Various Factors that May Hinder Progress	26
	Study Members Have Identified Long-Term Targets and Indicators to Measure Progress, but Have Not Yet Fully Incorporated Leading Practices for Performance Reporting	33
	Study Members Expended at Least \$466 Million on Restoration Activities, but the Study's Estimate of At Least \$18.9 Billion for Future Restoration Is Not Comprehensive	39
	Conclusions	46
	Recommendations for Executive Action	47
	Agency Comments and Our Evaluation	48
Appendix I	Objectives, Scope, and Methodology	50
Appendix II	Factors Identified by Members of the Long Island Sound Study	56
Appendix III	The 20 Long-Term Targets and Associated Indicators	59
Appendix IV	Expert Responses on Whether Indicators Are Accurate, Valid, and Reliable	65
Appendix V	Comments from the Environmental Protection Agency	66
Appendix VI	GAO Contact and Staff Acknowledgments	70

---

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Related GAO Products

71

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Tables

Table 1: Priority Problems and Associated Goals in the 1994 Long Island Sound <i>Comprehensive Conservation and Management Plan</i>	8
Table 2: Examples of Indicators and Data from the Long Island Sound Study’s Website as of November 2017 by Priority Problems and Associated Goals in the 1994 Long Island Sound <i>Comprehensive Conservation and Management Plan</i>	13
Table 3: Number of Long Island Sound Study (Study) Members who Believe Moderate Progress Has Been Made Toward Goals Associated with Five Priority Problems in the 1994 Long Island Sound <i>Comprehensive Conservation and Management Plan</i>	18
Table 4: Themes of the 2015 Long Island Sound <i>Comprehensive Conservation and Management Plan</i> and Examples of Associated Outcomes, Objectives, Strategies, and Implementation Actions	28
Table 5: Expenditures on Restoration Activities in Long Island Sound from Fiscal Years 2012 through 2016 According to Long Island Sound Study Members	40
Table 6: Estimated Costs for Clean Waters and Healthy Watersheds Activities in Long Island Sound from 2015 through 2035	43
Table 7: Estimated Costs for Species Management, Land and Open Space Protection, and Education Activities in Long Island Sound from 2015 through 2035	44
Table 8: Long Island Sound Study (Study) Members Identified Factors that May Hinder Long Island Sound Restoration Progress	56
Table 9: Long Island Sound Study Members Identified Different Factors that May Hinder Long Island Sound Restoration Progress Grouped Under 11 Different Factor Categories	57
Table 10: The 20 Long-Term Targets and Associated Indicators in the 2015 Long Island Sound <i>Comprehensive Conservation and Management Plan</i>	59

---

<p>Table 11: Expert Responses on Whether Indicators Associated with 20 Targets in the 2015 Long Island Sound <i>Comprehensive Conservation and Management Plan</i> Are a Valid, Accurate, and Reliable Way to Measure Progress to Achieve the Targets</p>	65
---	----

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Figures

<p>Figure 1: Area of Long Island Sound, Its Watershed, and Surrounding States</p>	6
<p>Figure 2: Sources and Effects of Low Levels of Dissolved Oxygen—or Hypoxia—in Waterbodies Such as Long Island Sound</p>	10
<p>Figure 3: Bioswale in the Long Island Sound Watershed Used to Slow and Filter Pollutants from Stormwater Runoff</p>	22
<p>Figure 4: The 33 Long Island Sound Stewardship Areas with Ecological and Recreational Value</p>	24

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**Abbreviations**

CSO	Combined sewer overflow
EPA	Environmental Protection Agency
OMB	Office of Management and Budget
TMDL	Total Maximum Daily Load

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July 12, 2018

The Honorable Bill Shuster  
Chairman  
The Honorable Peter DeFazio  
Ranking Member  
Committee on Transportation and Infrastructure  
House of Representatives

For centuries, Long Island Sound (the Sound)—an estuary bordered by Connecticut and New York and surrounded by one of the most densely populated areas of the United States—has provided numerous public benefits including fishing, recreation, and a transportation route to the Atlantic Ocean.<sup>1</sup> Development, deforestation, and industrialization across the region have resulted in degradation of water quality from pollution, such as chemicals, sediment, and sewage. Moreover, the degradation of water quality has resulted in declining fish populations. In 1985, congressional committees directed the Environmental Protection Agency (EPA) to work with the states to research, monitor, and assess estuaries including Long Island Sound. Further, in 1987, the National Estuary Program was established under amendments to the Clean Water Act to, among other things, identify nationally significant estuaries threatened by pollution, development, or overuse, and promote comprehensive management of those estuaries. EPA has designated 28 estuaries of national significance, including Long Island Sound.

In 1985, EPA partnered with Connecticut and New York to form the Long Island Sound Study (the Study) to restore and protect the Sound. Dedicated to restoring and protecting the Sound, the Study is a partnership consisting of federal and state agencies, nonprofit and public organizations, and individuals. The director of the Study is an EPA official,<sup>2</sup> and the Study is overseen by EPA and senior officials from the Connecticut Department of Energy and Environmental Protection and the New York State Department of Environmental Conservation. Study members include other federal and state agencies and an interstate

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<sup>1</sup>An estuary is a partially enclosed, coastal water body where freshwater from rivers and streams mixes with salt water from the ocean.

<sup>2</sup>33 U.S.C. § 1269(b) (2018).

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group.<sup>3</sup> The Study also has a Citizens Advisory Committee and a Science and Technical Advisory Committee, and representatives of those committees provide advice for implementing restoration activities or science and technical issues.<sup>4</sup>

Since it was established in 1985, the Study has developed two comprehensive conservation and management plans for the Sound that include recommended actions to restore and maintain the Sound's chemical, physical, and biological integrity, including its water quality. The Study issued the first Long Island Sound *Comprehensive Conservation and Management Plan* in 1994 (1994 plan).<sup>5</sup> In the 1994 plan, it identified six priority problems and goals for each problem: (1) low dissolved oxygen, or hypoxia, (2) toxic substances, (3) pathogen contamination, (4) floatable debris, (5) management and conservation of living resources and their habitats, and (6) land use and development.<sup>6</sup> The Study issued a revised plan in 2015 (2015 plan), which is organized around four themes, each with its own goal: (1) clean water and healthy watersheds,

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<sup>3</sup>Other members of the Study include officials from the Department of Agriculture's Natural Resources Conservation Service, the Department of Commerce's National Marine Fisheries Service, the Department of Defense's U.S. Army Corps of Engineers, the Department of the Interior's U.S. Fish and Wildlife Service and U.S. Geological Survey, the Connecticut and New York College Sea Grant Programs, the Massachusetts Department of Environmental Protection, the New York State Department of State, the New York City Department of Environmental Protection, and the New England Interstate Water Pollution Control Commission. The New England Interstate Water Pollution Control Commission is a nonprofit interstate agency established by statute in 1947 that uses a variety of strategies to meet the water-related needs of its member states, Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

<sup>4</sup>The Study's Citizens Advisory Committee is a volunteer organization that provides ongoing advice to Study members. Membership on the committee is open to representatives of environmental organizations, businesses, industries, local governments, and other public and private organizations in Connecticut and New York with a demonstrable interest in the restoration and protection of the Sound and its ecosystems. The Study's Science and Technical Advisory Committee is made up of engineers, scientists, and representatives from government agencies, academia, industry, and private organizations; its purpose is to provide objective scientific and technical guidance for the restoration and protection of the Sound.

<sup>5</sup>Long Island Sound Study, *The Comprehensive Conservation and Management Plan*, (Stamford, CT: March 1994).

<sup>6</sup>In the introduction to the 1994 plan, the Study identified six priority areas of concern that are precursors to the six priority problems. For this report, we use the phrase priority problems because the plan is organized around them.

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(2) thriving habitats and wildlife, (3) sustainable and resilient communities, and (4) sound science and inclusive management.<sup>7</sup>

You asked us to review federal efforts to restore the Sound. This report examines (1) what is known about the progress made toward achieving the 1994 plan; (2) the goals of the 2015 plan and factors, if any, that may hinder progress according to Study members; (3) how Study members plan to measure and report on progress toward achieving the 2015 plan; and (4) what Study members expended on restoration activities in fiscal years 2012 through 2016 and cost estimates for future activities.

To examine what is known about the progress made toward achieving the 1994 plan, we analyzed the plan to gain a better understanding of it and to identify any goals associated with the six priority problems. We also reviewed data from the Study's website in November 2017, the Study's most recent progress reports, and the book *Long Island Sound: Prospects for the Urban Sea*, a summary of available science and environmental data for the Sound published in 2014.<sup>8</sup> We reviewed data that were on the Study's website in November 2017 because the time frame coincided with the time frames for our review. These reports, data, and book included examples of progress but did not assess performance toward the goals associated with the priority problems in the 1994 plan. Therefore, we asked Study members for their responses on progress and the data that supported their responses. To do so, we interviewed representatives of the 12 Study members who agreed to participate and 5 Study work groups to learn the extent to which they believe progress has been made toward the goals and to obtain key data that they cited as evidence for their responses.<sup>9</sup> For some priority problems, Study members said that they were unable to provide a response about

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<sup>7</sup>Long Island Sound Study, *Long Island Sound Comprehensive Conservation and Management Plan 2015: Returning the Urban Sea to Abundance*, (Stamford, CT: September 2015).

<sup>8</sup>James S. Latimer, Mark A. Tedesco, R. Lawrence Swanson, Charles Yarish, Paul E. Stacy, Corey Garza, eds. *Long Island Sound: Prospects for the Urban Sea*, 1<sup>st</sup> ed. (New York: Springer-Verlag, 2014).

<sup>9</sup>The Massachusetts Department of Environmental Protection and the New York College Sea Grant Program did not respond to our request for an interview. For the purpose of this report, we counted the New York State Department of Environmental Conservation and Department of State as one Study member because they provided information together. The New England Interstate Water Pollution Control Commission participated in this study but did not provide responses to this question.



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progress toward the associated goals because they did not have sufficient knowledge or data, and as a result, the number of respondents for each problem varied.<sup>10</sup> To examine the goals of the 2015 plan and factors that may hinder progress according to Study members, we analyzed the 2015 plan and interviewed Study members to identify the factors they believe may hinder progress toward achieving the goals of the 2015 plan.

To examine how Study members plan to measure and report on progress toward achieving the 2015 plan, we analyzed sections of the plan that contained goals associated with the four themes and relevant web pages that the Study issued in March 2018 and analyzed them again in June 2018, and interviewed Study members to learn how they planned to report on progress. We also interviewed a nonprobability sample of 19 individuals with expertise on Long Island Sound to obtain their views on these sections of the plan. The 19 experts we interviewed included primarily members of academia. We identified these experts through recommendations from Study members and by reviewing the list of authors in the book *Long Island Sound: Prospects for the Urban Sea*. We did not interview experts who represented a Study member or were involved with the development of the 2015 plan. We asked the experts to identify which topics of the plan they could discuss based on their particular expertise. Because we used a nonprobability sample, the information obtained from these interviews is not generalizable to other individuals with Long Island Sound-related expertise but provides illustrative information.

To examine what Study members expended on restoration activities in fiscal years 2012 through 2016 and cost estimates for future activities, we obtained and analyzed expenditure data from Study members and analyzed cost estimate information in the 2015 plan. Of the 12 Study members described above, 7 provided at least some expenditure data to us, 4 said that they do not fund restoration activities, and 1 did not reply to

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<sup>10</sup>Of the 17 Study members we interviewed, 9 members provided their views about toxic substances, 10 members provided views about pathogen contamination, 10 members provided views about floatable debris, 12 members provided views about management and conservation of living resources and their habitats, 12 members provided views about land use and development, and 11 members provided views about hypoxia.

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our request for expenditure data.<sup>11</sup> We were unable to compare expenditure data across Study members because they did not track expenditures in the same way. To assess the reliability of the expenditure data, we interviewed officials to explain how the data were collected and obtained information about the completeness and accuracy of the data and found the expenditure data to be sufficiently reliable for reporting on expenditures of restoration activities for the period. We also consulted the Office of Management and Budget's general guidance for estimating costs,<sup>12</sup> and analyzed EPA's funding guidance for comprehensive conservation and management plans.<sup>13</sup> Further, we attended two Study meetings (on April 12, 2017, by telephone, and May 11, 2017, in person) to obtain information about how Study members make expenditure decisions. Appendix I contains a more detailed description of our objectives, scope, and methodology.

We conducted this performance audit from January 2017 to July 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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## Background

Long Island Sound is an estuary, a body of water where fresh water from rivers draining from the land mixes with salt water from the ocean, in this case the Atlantic Ocean. The Sound is 113 miles long and 21 miles across at its widest point, with an average depth of 63 feet and a deepest point of 320 feet. The Sound's coastline is 583 miles and includes more than 60 bays, with beaches and harbors where people interact most frequently with the Sound. As shown in figure 1, the Sound is bordered by Connecticut to the north and New York to the south and west, and its watershed includes parts of Massachusetts, New Hampshire, Rhode

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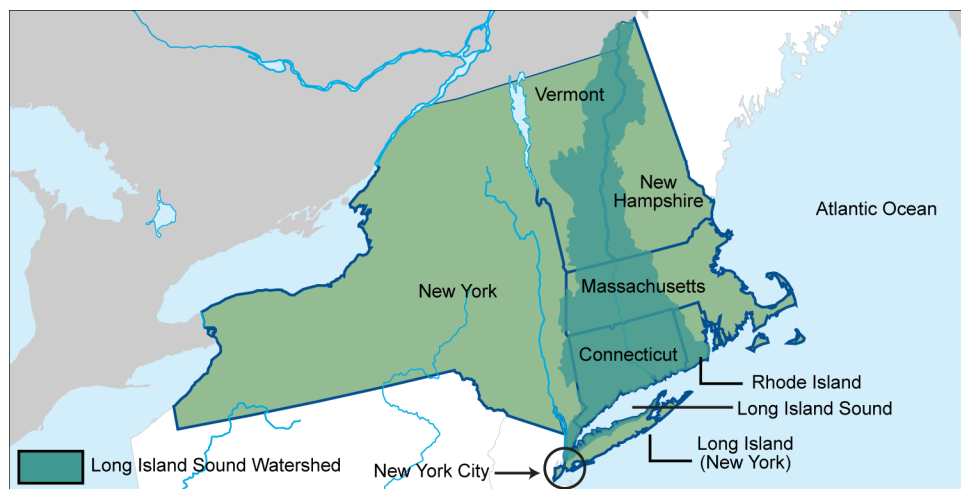
<sup>11</sup>The four Study members who said they do not fund restoration activities are the National Marine Fisheries Service, Connecticut Sea Grant, the Study's Citizens Advisory Committee, and the Study's Science Technical Advisory Committee. The New York City Department of Environmental Protection did not reply to our request for expenditure data.

<sup>12</sup>Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, Circular A-94 (Oct. 29, 1992).

<sup>13</sup>Environmental Protection Agency, *FY2017-FY2019 Clean Water Act §320 National Estuary Program Funding Guidance* (Washington, D.C.: 2016.)

Island, and Vermont. Nearly all of Connecticut's waters drain into the Sound, as do waters from the northern portion of Long Island and the New York City metropolitan area. New York City is the most populous city in the United States.

**Figure 1: Area of Long Island Sound, Its Watershed, and Surrounding States**



Source: GAO; Map Resources (map). | GAO-18-410

In 1985, congressional committees directed EPA to work with states to research, monitor, and assess estuaries including the Sound. Around the same time, Connecticut, New York, and EPA raised concerns about pollution in the Sound due to the presence of a large population living near it, as well as 44 wastewater treatment plants and other industries that discharged into the Sound. In addition, they also raised concerns about pollution coming from sources that were not easily identified, such as runoff from land surrounding the Sound.

To restore the health of the Sound, EPA partnered with the two states in 1985 to form the Long Island Sound Study, a partnership consisting of federal and state agencies, nonprofit and public organizations, and individuals dedicated to restoring and protecting the Sound. The Study has several committees and work groups that help to develop and implement the comprehensive conservation and management plan for the Sound. These groups include the Science and Technical Advisory Committee and the Citizens Advisory Committee, as well as the Water Quality Monitoring Work Group and the Habitat Restoration and Stewardship Work Group, which are responsible for facilitating improved collection, coordination, management, and interpretation of water quality,

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and promoting restoration of the Sound through an improved understanding of current threats.<sup>14</sup>

In 1987, the National Estuary Program was established under amendments to the Clean Water Act; the act further required EPA to give priority consideration to Long Island Sound, among others.<sup>15</sup> According to EPA, the National Estuary Program is a community-based program designed to restore and maintain the ecological integrity of estuaries of national significance. One year after the program was established, EPA designated the Sound as such an estuary. Under the program, each estuary of national significance has a management conference that is required to develop a comprehensive conservation and management plan to restore and maintain the chemical, physical, and biological integrity of the estuary, including water quality, among other things.

In 1990, the Long Island Sound Improvement Act required EPA to establish the Office of the Management Conference of the Long Island Sound Study, to be directed by an EPA official and to assist the Long Island Sound Study in carrying out its goals.<sup>16</sup> The act required the Long Island Sound Study Office, as directed by EPA, to provide administrative and technical support to the management conference, or the Study. The act also required the Long Island Sound Study Office to report biennially on progress made in implementing the comprehensive conservation and management plan starting no more than 2 years after issuing the final plan. The Study, assisted by the Office, developed two reports—the *Protection and Progress* report and *Sound Health* report—to show progress toward the 1994 plan and issued the reports about every 2 years from 2001 through 2013.<sup>17</sup> According to the Study, the purpose of the *Protection and Progress* report was to highlight regional efforts to restore and protect Long Island Sound, and the purpose of the *Sound*

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<sup>14</sup>The other work groups are the Climate Change and Sentinel Monitoring work group, the Five State/EPA TMDL work group, the Public Involvement and Education Work Group, and the Watersheds and Embayments Work Group.

<sup>15</sup>Water Quality Act of 1987, Pub. L. No. 100-4, § 317(a), 101 Stat. 7, 61 (codified as amended at 33 U.S.C. § 1330 (2018)).

<sup>16</sup>Pub. L. No. 101-596, tit. II, § 202, 101 Stat. 3000, 3004 (1990) (codified as amended at 33 U.S.C. § 1269 (2018)).

<sup>17</sup>For the most recent *Protection and Progress* report, see: Long Island Sound Study, *Protection & Progress 2011-2012 Long Island Sound Study Biennial Report* (Stamford, CT: 2013). For the most recent *Sound Health* report see: Long Island Sound Study, *Sound Health 2012: Status and Trends in the Health of Long Island Sound* (Stamford, CT: 2012).

*Health* report was to provide a snapshot of the environmental health of Long Island Sound.<sup>18</sup> In addition, the Study collects, tracks, and publishes information about environmental indicators on its website periodically, and has produced reports that summarized work done to carry out the 1994 plan.<sup>19</sup>

In its 1994 plan, the Study identified six priority problems and created associated goals (see table 1).

**Table 1: Priority Problems and Associated Goals in the 1994 Long Island Sound *Comprehensive Conservation and Management Plan***

<b>Priority problems</b>	<b>Associated goals</b>
Hypoxia	Increase dissolved oxygen levels in the Sound to eliminate adverse impacts of hypoxia resulting from human activities.
Toxic substances	Protect and restore the Sound from the adverse effects of toxic substance contamination by reducing toxic inputs, cleaning up contaminated sites, and effectively managing risk to human users.
Pathogen contamination	Increase the amount of area certified or approved for shellfish harvesting while adequately protecting the public health. Eliminate public bathing beach closures while adequately protecting the public health.
Floatable debris	Reduce the flow of litter from its major sources. Collect and pick up litter once it is in the Sound.
Management and conservation of living resources and their habitats	Assure a healthy ecosystem with balanced and diverse populations of indigenous plants and animals. Increase the abundance and distribution of harvestable species. Assure that edible species are suitable for unrestricted human consumption.
Land use and development	Reduce the impacts from existing development to improve water quality. Minimize the impacts from new development to prevent further degradation of water quality. Expand information, training, and education for land use decisions to effectively incorporate water quality and habitat protection.

<sup>18</sup>In addition to the two progress reports issued by the Study, in 2015 the University of Maryland Center for Environmental Science released the first Long Island Sound Report Card to provide a geographic assessment of annual Long Island Sound ecosystem health for 2013. The University created the Report Card using data from the Connecticut Department of Energy and Environmental Protection and the New York State Department of Environmental Conservation.

<sup>19</sup>The most recent implementation tracking report was released as several documents on the Study's website on February 2, 2018. Individual Study members are also expected to report progress to EPA, such as by reporting habitat accomplishments into the National Estuary Program On-line Reporting Tool (NEPORT).

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**Priority problems****Associated goals**

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Conserve natural resources and open space.

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Improve public access so that the public can use and enjoy Long Island Sound.

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Source: GAO analysis of Long Island Sound Study information. | GAO-18-410.

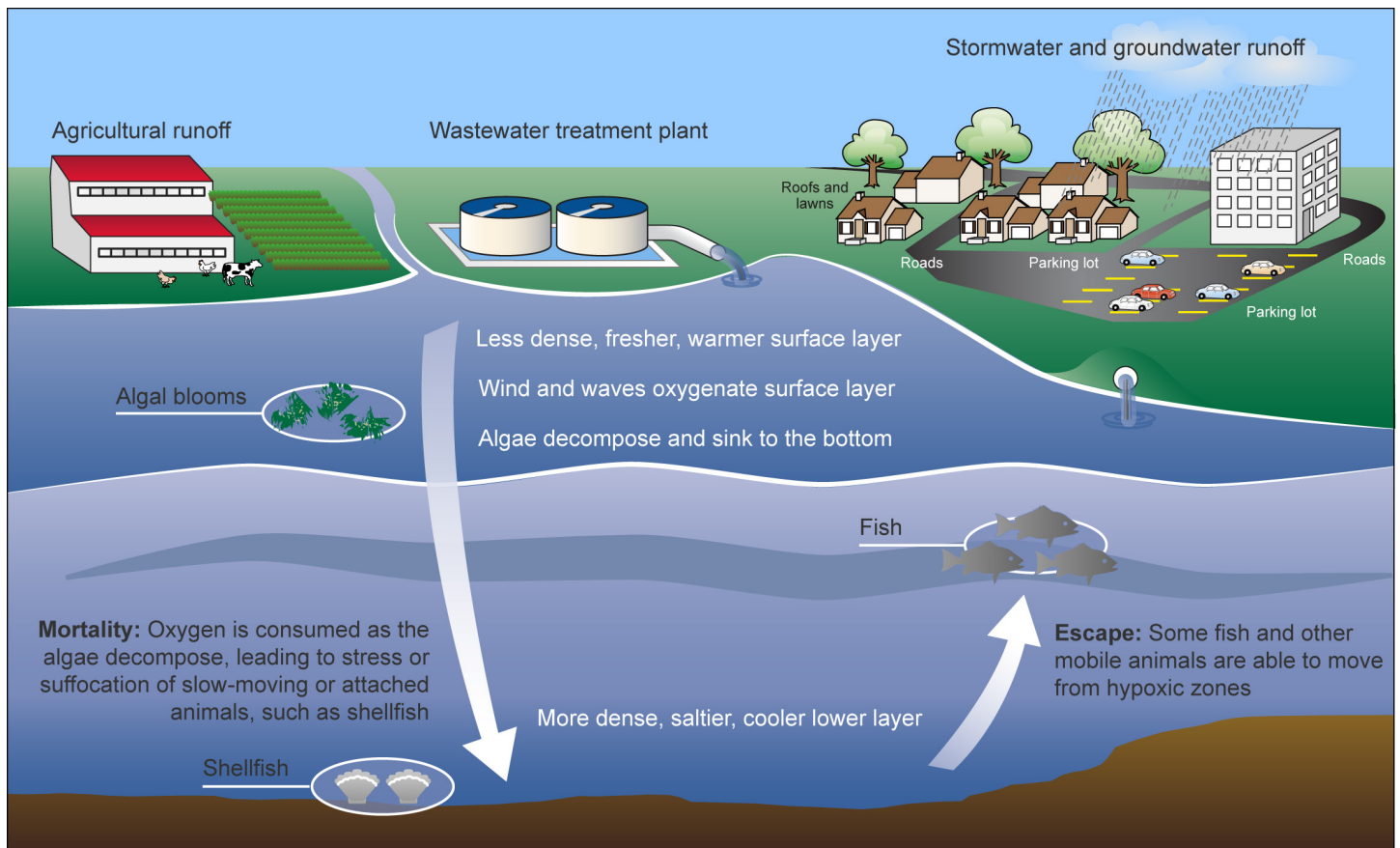
In the 1994 plan, the Study identified hypoxia as the major water quality problem in the Sound, defining hypoxia as dissolved oxygen concentrations of less than 3 milligrams of oxygen per liter of water and noting that levels less than that are inadequate to support healthy populations of estuarine organisms. The Study noted that hypoxia caused significant, adverse ecological effects in the bottom water habitats of the Sound, such as reducing the abundance and diversity of adult fish and possibly reducing other species' resistance to disease.

According to the National Oceanic and Atmospheric Administration, the most common cause of hypoxia is nutrient pollution, specifically discharges of nitrogen and phosphorus. As shown in figure 2, sources of nutrient pollution include wastewater discharged from wastewater treatment plant pipes and runoff from agricultural fields, stormwater, and groundwater.<sup>20</sup> Excess nutrients can cause algae—which occur naturally in oceans, lakes, rivers, and other water bodies—to rapidly multiply, resulting in algal blooms that can discolor the water or accumulate as thick scums and mats. When the algae die they sink and decompose, and this decomposition consumes oxygen that is dissolved in water and used by fish and shellfish to live. Reduced oxygen levels, in turn, can lead to increased mortality for fish, shellfish, and other aquatic populations, or can drive some species to relocate to more oxygenated waters. Water in estuaries is naturally stratified, with less dense fresh warmer water generally staying on top, and denser salty cool water on the bottom.

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<sup>20</sup>Stormwater runoff is generated from rain and snowmelt events that flow over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground. The runoff picks up pollutants like trash, chemicals, oils, and dirt or sediment that can harm rivers, streams, lakes, and coastal waters.

**Figure 2: Sources and Effects of Low Levels of Dissolved Oxygen—or Hypoxia—in Waterbodies Such as Long Island Sound**



Source: GAO analysis of Long Island Sound Study information. | GAO-18-410

Note: Excess nutrients from wastewater treatment plants, and runoff from agriculture, stormwater, and groundwater can cause algae to rapidly multiply. When the algae die they sink to the bottom and decompose. As they decompose, they consume oxygen that is dissolved in water and used by fish and shellfish to live. Reduced oxygen levels, in turn, can lead to increased mortality for fish, shellfish, and other aquatic populations that are unable to leave the area. Water in estuaries is naturally stratified—fresh on top, salty on bottom.

In 2000, Connecticut and New York developed a total maximum daily load (TMDL) to achieve water quality standards for dissolved oxygen in

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Long Island Sound.<sup>21</sup> In the TMDL, the states described efforts to manage hypoxia and identified nitrogen as the key contributor to hypoxia and identified the sources and amounts of nitrogen contributed to the Sound. These include wastewater treatment plants in Connecticut and New York; combined sewer overflows (CSO); nonpoint source pollution, or runoff from sources such as residences and farms that includes stormwater and groundwater; and atmospheric deposition.<sup>22</sup> The TMDL set a 15-year nitrogen reduction goal for Connecticut and New York, from both point and nonpoint sources of nitrogen, to be achieved by August 2014. The TMDL also calls for implementing management actions for nitrogen entering the Sound from other states where feasible. In the TMDL, Connecticut and New York identified the need for an adaptive management approach because it would require nitrogen reduction beyond the limits of technology current at the time.<sup>23</sup> The states also agreed to reassess the nitrogen reduction goals and revise the TMDL as necessary.

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<sup>21</sup>A TMDL sets a pollutant target—or the maximum amount of a specific pollutant that a water body can contain and still be considered in compliance with water quality standards. Under section 303(d) of the Clean Water Act, states must develop a TMDL for each of the pollutants affecting each water body identified as impaired. For additional information about TMDLs, see GAO, *Clean Water Act: Changes Needed If Key EPA Program Is to Help Fulfill the Nation's Water Quality Goals*, [GAO-14-80](#) (Washington, D.C.: Dec. 5, 2013).

<sup>22</sup>Combined sewer systems collect stormwater runoff, domestic sewage, and industrial wastewater into one pipe. Under normal conditions, the wastewater collected in combined sewer pipes is transported to a wastewater treatment plant for treatment and then discharged into a nearby stream, river, lake, or other water body. However, during heavy rain or snow storms, when the volume of the wastewater can exceed a treatment plant's capacity, combined sewer systems release excess untreated wastewater directly into nearby water bodies. These releases are known as CSOs.

<sup>23</sup>Adaptive management is a systematic approach for improving resource management by learning from management outcomes.



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**Although a Comprehensive Assessment of Progress Has Not Been Conducted, Study Members Believe Moderate Progress Has Been Made Since 1994**

Although the Study has collected a wide range of data to measure the health of Long Island Sound and has issued periodic progress reports since 2001, these progress reports have not contained a comprehensive assessment of progress toward the goals of the 1994 plan. In the absence of a comprehensive assessment of progress, Study members we interviewed said that they believe that moderate progress has been made toward goals associated with five of the six priority problems identified in the 1994 plan.

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**The Study Collected a Wide Range of Data and Issued Progress Reports, but Did Not Conduct a Comprehensive Assessment of Progress Toward Achieving the 1994 Plan**

The Study has collected a wide range of data used to measure the health of Long Island Sound. According to a Study member, the Study began identifying and collecting these data in 1998 with the purpose of evaluating progress toward achieving the goals of the 1994 plan. The data were gathered by federal and state agencies and universities, and were provided to the Study, which published the data on its website. As of November 2017, the data on the website were organized into groups of environmental indicators including water quality, marine and coastal animals, land use and population, and habitats. We found that many of the indicators and their data could be linked to goals associated with the six priority problems in the 1994 plan. Examples of these indicators and the related data and associated goals are shown in table 2.

**Table 2: Examples of Indicators and Data from the Long Island Sound Study’s Website as of November 2017 by Priority Problems and Associated Goals in the 1994 Long Island Sound *Comprehensive Conservation and Management Plan***

Priority problems	Associated goals	Indicator	Data
Hypoxia	Increase dissolved oxygen levels in the Sound to eliminate adverse impacts of hypoxia resulting from human activities.	Area of hypoxia	Square miles per year of hypoxia
		Duration of hypoxia	Length of time in days per year during which hypoxia is observed
		Point source nitrogen-trade equalized loads <sup>a</sup>	Pounds per day per year of trade-equalized nitrogen discharged <sup>a</sup>
Toxic substances	Protect and restore the Sound from the adverse effects of toxic substance contamination by reducing toxic inputs, cleaning up contaminated sites, and effectively managing risk to human users.	Industrial chemical discharges	Pounds per year of chemicals released according to the Toxics Release Inventory <sup>b</sup>
		Sediment quality index	Average condition per basin of sediment contamination, sediment toxicity, and total organic carbon <sup>c</sup>
Pathogen contamination	Increase the amount of area certified or approved for shellfish harvesting while adequately protecting the public health.	Approved shellfish acreage	Acres per year approved for shellfish harvesting
	Eliminate public bathing beach closures while adequately protecting the public health.	Number of beach closures and advisory days <sup>d</sup>	Number of days per year that beaches are closed and advisories are posted
Floatable debris	Reduce the flow of litter from its major sources.	New York City boom and skim collection <sup>e</sup>	Cubic yards per year of water-borne litter and debris collected
	Collect and pick up litter once it is in the Sound.	Coastal cleanups	Pounds per mile of beach per year of debris collected
Management and conservation of living resources and their habitats	Ensure a healthy ecosystem with balanced and diverse populations of indigenous plants and animals.	Coastal habitat acres restored	Acres and cumulative average per year of coastal habitat restored
		Horseshoe crab abundance	Kilograms per tow per year of horseshoe crabs <sup>f</sup>
		Least terns	Count per year of nesting pairs
	Increase the abundance and distribution of harvestable species.	Game fish	Count per tow per year of fish (bluefish, scup, striped bass, summer flounder, tautog, weakfish, or winter flounder) <sup>f</sup>
		Oyster harvest	Bags and bushels per year of oysters
		River miles restored	Miles and cumulative miles per year of river restored
		Lead concentration in sediment by basin <sup>c</sup>	Concentration of lead in surface sediments
Ensure that edible species are suitable for unrestricted human consumption.			

Priority problems	Associated goals	Indicator	Data
Land use and development	Reduce the impacts from existing development to improve water quality.	Impervious cover and stream health in Long Island Sound basins <sup>9</sup>	Amount of and change in impervious cover, and square miles of impervious surfaces
	Minimize the impacts from new development to prevent further degradation of water quality.	No applicable indicator on website in November 2017	No applicable data on website in November 2017
	Expand information, training, and education for land use decisions to effectively incorporate water quality and habitat protection.	No applicable indicator on website in November 2017	No applicable data on website in November 2017
	Conserve natural resources and open space.	Open space	Acres per year of statewide land and coastal area protected as open space
	Improve public access so that the public can use and enjoy Long Island Sound.	No applicable indicator on website in November 2017	No applicable data on website in November 2017

Source: GAO analysis of Long Island Sound Study information. | GAO-18-410

<sup>a</sup>According to the Study, trade equalization is a calculation of the effect a pound of nitrogen leaving a point source will eventually have when it reaches Long Island Sound. Point sources include wastewater treatment plant pipes.

<sup>b</sup>The Toxics Release Inventory is a database that tracks the management of certain toxic chemicals that may pose a threat to human health (e.g. cancer and other chronic effects) and the environment. Over 650 chemicals are covered by the database. U.S. facilities in different industry sectors that manufacture, process or otherwise use these chemicals in amounts above established levels are to report annually how much of each chemical is released to the environment—that is, the emissions to air, land, or water.

<sup>c</sup>Basin refers to three areas within the Sound—western, central, and eastern—defined by currents and geology.

<sup>d</sup>Beach closures refers to a combination of the number of days beaches are closed in a year and the number of days advisories are posted warning beachgoers that conditions might be unsafe for swimming or even for walking.

<sup>e</sup>According to the Study, booms—or floating barriers—were used to capture debris discharged from combined sewers, and skimmer vessels were used to remove floatable debris from those sites. Skimmers are devices for recovering material from the water's surface.

<sup>f</sup>Per tow refers to the use of a trawler net to capture and count fish and other marine animals.

<sup>g</sup>Basins refers to the 194 small watersheds in the Long Island Sound region that drain into Long Island Sound.

As required by the Long Island Sound Improvement Act, since 2001, the Study has issued periodic progress reports—five *Protection and Progress* reports and six *Sound Health* reports, available on the Study's website—that have focused on specific examples of the restoration effort. The most recent of these reports were organized into sections that can be linked to the priority problems identified in the 1994 plan. For example, the most recent Protection and Progress report, issued in 2013, included sections on water quality and habitat restoration efforts that can be linked to the

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priority problems “hypoxia” and “management and conservation of living resources and their habitats.”

The most recent progress reports also included examples of progress using indicator data that we could link to some of the goals and priority problems in the 1994 plan, such as the following:

- Both reports included examples of progress that could be linked with the priority problem “hypoxia.” The *Protection and Progress* report identified pounds of nitrogen discharged into the Sound from 2001 through 2012 and provided data showing reduced nitrogen discharges over time, which the Study stated it expected to result in decreased hypoxic areas and increased dissolved oxygen. The *Sound Health* report identified both the area, in square miles, and duration, in days, of hypoxia in the Sound from 1987 through 2012.
- The *Protection and Progress* report included examples of progress that could be linked to the goal to increase the abundance and distribution of harvestable species, which is associated with the priority problem “management and conservation of living resources and their habitats.” For example, the *Protection and Progress* report included examples of progress in the number of river miles restored from 1998 through 2012 as well as the number of fish returning to the rivers.
- The *Sound Health* report included examples of progress that could be linked to both goals associated with the priority problem “pathogen contamination.” These goals were to (1) increase the amount of area certified or approved for shellfish harvesting while adequately protecting the public health and (2) eliminate public bathing beach closures while adequately protecting the public health. The *Sound Health* report identified the number of beach closure and advisory days from 1993 through 2011 and the number of acres approved for shellfish harvesting from 2005 through 2011.

However, the Study’s progress reports did not contain a comprehensive assessment of the progress toward the goals of the 1994 plan. Specifically, the progress reports included examples of progress using indicator data and they did not include a comparison of that progress against a specific amount to be achieved—a numerical goal. For example, the *Protection and Progress* report included an example of progress on pathogen contamination, but the report did not include a comparison of the data on acres of shellfish harvesting areas against a numerical goal for the amount of acres of shellfish approved for

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harvesting. In addition, the *Sound Health* report included examples of progress on toxic substances, but the report did not include a comparison of the reduction of toxics discharged into the Sound against a numerical goal for the reduction of toxic inputs. As we have previously reported, having a numerical goal permits expected performance to be compared with actual results.<sup>24</sup> Part of the challenge for the Study to conduct such an assessment arises from the fact that only one of the goals in the 1994 plan had numerical goals against which the Study could compare progress.<sup>25</sup> According to a Study member, because the rest of the goals were not numerical goals, a comprehensive assessment of progress toward achieving the 1994 plan was not conducted.

Although such an assessment was not conducted, the Study has made available a comprehensive assessment of available science and data about the environmental dynamics of the Sound in the 2014 publication *Long Island Sound: Prospects for the Urban Sea*. The book—written by scientists from federal and state agencies and universities—includes sections on the geology and chemistry of the Sound; development patterns in the area surrounding the Sound; metals, contaminants, and nutrients discharged to the Sound; and management options for the Sound. *Prospects for the Urban Sea* identified science gaps and research needs and made several recommendations, including better characterizing the relationship between smaller bays and inlets and the Sound, integrating climate change across programs, prioritizing management of existing pollution sources and impairments, and improving data management and interpretation. According to Study members, the book served as a reference for scientists conducting research in Long Island Sound and as the basis for the 2015 plan.

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<sup>24</sup>GAO, *Defense Logistics: Improved Performance Measures and Information Needed for Assessing Asset Visibility Initiatives*, [GAO-17-183](#) (Washington, D.C.: Mar. 16, 2017).

<sup>25</sup>The goal in the 1994 plan that had numerical goals was associated with the priority problem “hypoxia.”

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**Study Members Believe Moderate Progress Has Been Made Toward Goals Associated with Five Priority Problems, but Not Toward the Goal Associated with Hypoxia**

In the absence of a comprehensive assessment of progress, we asked study members for their views regarding progress made since 1994.<sup>26</sup> Nearly all of the Study members we interviewed who provided a response about progress made toward the goals of the 1994 plan agreed that the restoration effort has made moderate progress, and they cited various data to support their views. Specifically, Study members believed that moderate progress has been made toward achieving goals for five of the six priority problems: (1) toxic substances, (2) pathogen contamination, (3) floatable debris, (4) management and conservation of living resources and their habitats, and (5) land use and development. However, Study members agreed that they have not made similar progress toward the goal associated with the priority problem hypoxia because they had not observed the reductions in hypoxia that they expected; representatives from the New York State Department of Environmental Conservation said that the defined hypoxia goals have been met.

Table 3 shows the number of Study members we interviewed who said moderate progress has been made toward goals associated with five of the priority problems in the 1994 plan and the number of Study members who provided views about progress. Although the Study members we interviewed cited various data to support their views, without a comprehensive assessment of that data it is not possible to definitively determine to what extent their assessment of progress reflects actual progress made.

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<sup>26</sup>We asked Study members and representatives of the work groups how much progress has been made addressing the priority problems in the 1994 plan since 1994: no progress, little progress, moderate progress, or goals met. We refer to both Study members and work group representatives as Study members for the purpose of reporting their responses to these questions for a total of 17 Study members. For some priority problems, Study members said that they were unable to answer the question because they did not have sufficient knowledge or data about progress toward the associated goals. As a result, the total number of Study members who answered these questions varies by priority problem, and for each priority problem, we identified the total who provided a response.

**Table 3: Number of Long Island Sound Study (Study) Members who Believe Moderate Progress Has Been Made Toward Goals Associated with Five Priority Problems in the 1994 Long Island Sound *Comprehensive Conservation and Management Plan***

Priority problems	Number of Study members who provided a view about progress made	Number of Study members who said moderate progress was made
Toxic substances	9	9
Pathogen contamination	10	9
Floatable debris	10	9
Management and conservation of living resources and their habitat	12	11
Land use and development	12	11

Source: GAO. | GAO-18-410

Note: We asked 12 selected Study members and representatives of 5 Study work groups how much progress has been made addressing the priority problems in the 1994 Long Island Sound *Comprehensive Conservation and Management Plan* since 1994: no progress, little progress, moderate progress, or goals met. We refer to both Study members and work group representatives as Study members for the purpose of reporting their responses to these questions. For some priority problems, Study members said that they were unable to answer the question because they did not have sufficient knowledge or data about progress toward the associated goals. As a result, the total number of Study members who answered these questions varied by priority problem, and for each priority problem, we identified the total who provided a response.

The following summarizes Study members’ views about all six of the priority problems and data they cited.

### Toxic Substances

The goal in the 1994 plan associated with the priority problem “toxic substances” was to protect and restore the Sound from the adverse effects of toxic substance contamination by reducing toxic inputs, cleaning up contaminated sites, and effectively managing risk to human users. Toxic substances include metals, such as mercury and lead, and chlorinated hydrocarbons, such as the pesticide dichlorodiphenyltrichloroethane, commonly known as DDT. These substances were released from industrial and wastewater treatment plants into the air and into rivers and streams that flow to the Sound. The Study reported in a 2012 progress report that bans of toxic substances, stricter regulation of industrial facilities, and a decline in manufacturing contributed to the reduction of toxic substances.<sup>27</sup>

All nine Study members who provided a response about progress toward this goal said that moderate progress has been made. As evidence that moderate progress has been made, Study members cited data from

<sup>27</sup>Long Island Sound Study, *Sound Health 2012*.

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EPA's Toxics Release Inventory. For example, two Study members said that the EPA data showed that toxic releases into the Long Island Sound watershed have been reduced.<sup>28</sup>

In addition, two Study members identified concerns about new toxic substances identified in the Sound. Specifically, they said that monitoring and research is needed to understand how toxic substances found in pharmaceutical and personal products may affect the Sound. One program that monitors toxic substances in the Sound is the Mussel Watch program, run by the National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science. The program examines tissues of shellfish, such as oysters, to measure toxic substances that were previously unknown or unidentified that may negatively affect the Sound or human health. The research includes monitoring of substances found in everyday products including pharmaceuticals, personal care products, furniture, and plastics.

## Pathogen Contamination

The two goals in the 1994 plan associated with the priority problem "pathogen contamination" were (1) to increase the amount of area certified or approved for shellfish harvesting while adequately protecting the public health and (2) to eliminate public bathing beach closures while adequately protecting the public health. Pathogens include bacteria or viruses from animal waste or inadequately treated sewage discharge that can accumulate in shellfish. Human consumption of contaminated shellfish can lead to illness and disease.<sup>29</sup> Nine of the 10 Study members who provided a response about progress toward these goals said that moderate progress has been made. As evidence that moderate progress

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<sup>28</sup>EPA's Toxics Release Inventory is a database that tracks the management of certain toxic chemicals that may pose a threat to human health (e.g., cancer or other chronic effects) and the environment. Over 650 chemicals are covered by the database. U.S. facilities in different industry sectors that manufacture, process or otherwise use these chemicals in amounts above established levels are to report annually how much of each chemical is released to the environment—that is, the emissions to air, land, or water. We reported in November 2007 on a change to reporting requirements made in a new EPA rule. We found that EPA estimated that its rule would affect reporting on less than 1 percent of the total pounds released nationally, but that this aggregate national estimate masked a disproportionate impact on individual communities. As a result, more than 22,000 of the 90,000 reports would no longer be available to hundreds of communities across the country. See GAO, *Toxic Chemical Releases: EPA Actions Could Reduce Environmental Information Available to Many Communities*, [GAO-08-128](#) (Washington, D.C.: Nov. 30, 2007).

<sup>29</sup>Exposure to pathogens through consumption of contaminated shellfish can lead to illness, such as gastroenteritis, and disease, such as salmonellosis or hepatitis A.



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has been made, some Study members cited data on the number of acres approved for shellfish harvesting and on the number of beach closures and advisory days.<sup>30</sup> For example, according to one Study member, since 2010 there has been an increase in the number of acres certified for shellfishing in New York's portion of Long Island Sound.

Seven of the nine Study members who said that moderate progress has been made toward this priority problem also said that improvements in wastewater treatment plants and regulation of sewage discharge from boats have reduced the amount of pathogens in the Sound, such as by reducing the amount of waste discharged into the Sound. Several of the Study members said that these improvements have included municipalities investing in wastewater treatment plant upgrades to address combined sewer overflow (CSO) pollution. For example, New York City officials said that the city spent \$2.5 billion on infrastructure projects, such as improvements in wastewater treatment plants and CSO retention tanks. As a result, the officials said that New York City's wastewater treatment plants can manage more stormwater, leading to fewer CSOs and reduced pathogen discharges overall.

## Floatable Debris

The two goals in the 1994 plan associated with the priority problem floatable debris were (1) to reduce the flow of litter from its major sources and (2) to collect and pick it up once it is in the Sound. Floatable debris in the Sound mostly consists of plastic bags, plastic bottles, and food wrappers. This debris is washed into the Sound through stormwater and CSOs. In the 1994 plan, the Study proposed actions to reduce the flow of floatable debris into the Sound in two ways, engaging volunteers in cleanup efforts and collecting it from combined sewers before it enters the Sound. Nine of the 10 Study members who provided a response about progress toward these goals said that moderate progress has been made. Three Study members said that recycling or public outreach programs may have contributed to progress made in part by increasing public awareness of the problem. As evidence that moderate progress has been made, Study members cited data from coastal cleanups and

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<sup>30</sup>Beach closures refers to a combination of the number of days beaches are closed in a year and the number of days advisories are posted warning beachgoers that conditions might be unsafe for swimming or even for walking. According to the Study, both heavy rainfall and dry seasons can affect the number of beach closures. For example, the Study attributed high incidents of beach closures in certain years to a specific storm event.

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Management and  
Conservation of Living  
Resources and Their Habitats

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from New York City's boom and skim program.<sup>31</sup> For example, one Study member said that beach cleanup data show a reduction in debris collected from beach cleanups and another Study member stated that New York City has installed screens at some CSO outflows to capture debris in runoff released to the waters of Long Island Sound.<sup>32</sup>

The three goals in the 1994 plan associated with the priority problem "management and conservation of living resources and their habitats" were to (1) assure a healthy ecosystem with balanced and diverse populations of indigenous plants and animals, (2) increase the abundance and distribution of harvestable species, and (3) assure that edible species are suitable for unrestricted human consumption. In the 1994 plan, the Study reported that it would focus on managing water quality, habitats, and species to address these goals. In particular, the Study reported in the 1994 plan that the destruction of coastal habitats has had a major impact on the diversity and abundance of plants and animals in and along the Sound.

Eleven of the 12 Study members who provided a response about progress toward these goals said that moderate progress has been made. As evidence that moderate progress has been made, Study members cited data on several indicators, including acres of coast habitat and acres of eelgrass restored, marine mammal sightings, and the number of nesting pairs of coastal birds. For example, one Study member cited an increase in the abundance of eelgrass beds as support for moderate progress toward that type of habitat. Two other Study members cited increased sightings of dolphins and whales in the Sound as an indicator of improved habitat.

Land Use and Development

The five goals in the 1994 plan associated with the priority problem "land use and development" were to: (1) reduce the impacts from existing development to improve water quality, (2) minimize the impacts from new development to prevent further degradation of water quality, (3) expand information, training, and education for land use decisions to effectively incorporate water quality and habitat protection, (4) conserve natural

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<sup>31</sup>According to the Study, booms—or floating barriers—were used to capture debris discharged from combined sewers and skimmer vessels were used to remove floatable debris from those sites. Skimmers are devices for recovering material from the water's surface.

<sup>32</sup>According to the Study, weather, the number of volunteers, and timing can affect the amount of debris collected in a beach cleanup.

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resources and open space, and (5) improve public access so that the public can use and enjoy Long Island Sound. According to EPA, impervious cover—land cover that does not allow water to infiltrate into the ground—increases the amount of stormwater that runs off into streams, rivers, and other water bodies. Stormwater runoff can carry pollutants such as pathogens, toxic substances, and nutrients to storm drains, rivers, and streams that flow into the Sound. According to the 1994 plan, one way to reduce impervious cover and control stormwater runoff is through the use of green infrastructure. Green infrastructure includes practices and structures to manage stormwater that use or mimic natural processes to slow stormwater runoff, filter pollutants from the runoff, and facilitate stormwater storage for future use or to replenish groundwater. An example of a green infrastructure project implemented around the Sound is a bioswale, a vegetated area adjacent to a road, designed to collect and filter stormwater, cleaning the water and improving water quality by allowing it to seep into the soil. Figure 3 shows a bioswale developed for use in New Haven, Connecticut, as part of a Long Island Sound restoration project.

**Figure 3: Bioswale in the Long Island Sound Watershed Used to Slow and Filter Pollutants from Stormwater Runoff**



This bioswale—a vegetated area along the road designed to slow and filter stormwater, allowing it to seep into the soil—is part of a restoration project in the Long Island Sound watershed.

Source: GAO. | GAO-18-410

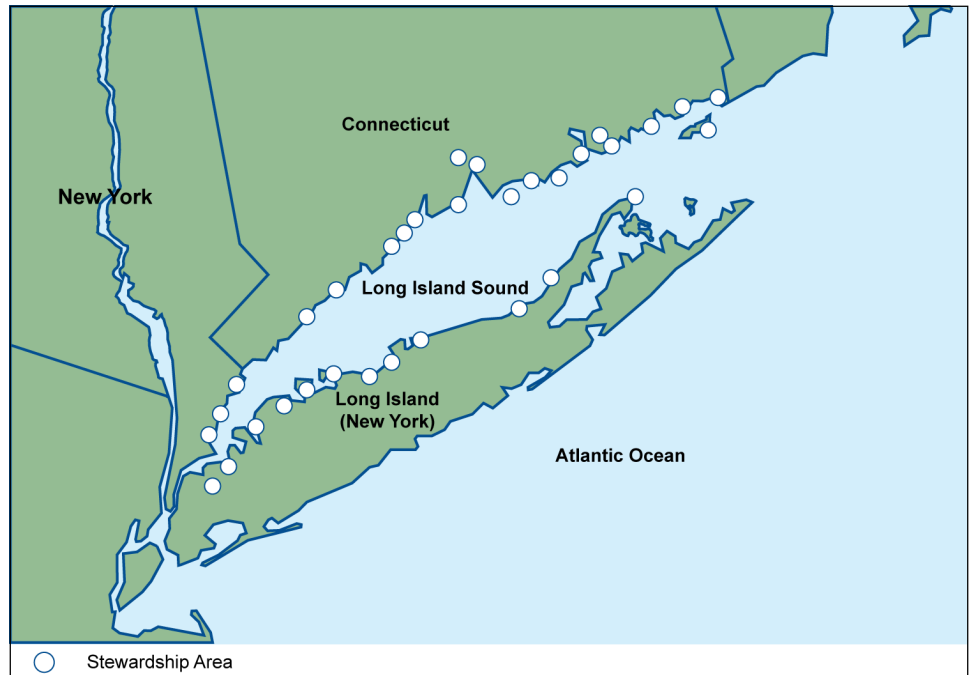
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Eleven of the 12 Study members who provided a response about progress toward these goals said that moderate progress has been made. As evidence, Study members cited data on changes in impervious cover. Study members also cited data on open space acquisitions as showing progress toward the goals related to this problem. According to Study members, one way that the Study protected open space was by identifying locations around the Sound that should be acquired and protected from development. Specifically, in 2006, the Study designated 33 locations, called Stewardship Areas, to protect habitat and wildlife from encroaching development.<sup>33</sup> Stewardship Areas are locations within the Long Island Sound region that have significant ecological, educational, open space, public access, or recreational value and are protected from development. Figure 4 shows the locations of the 33 Stewardship Areas in the Long Island Sound region.

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<sup>33</sup>The Study identified the locations in response to the Long Island Stewardship Act of 2006. Pub. L. No. 109-359, 120 Stat. 2049 (33 U.S.C. § 1269 nt.). The act's purpose was to establish an initiative to identify, protect, and enhance areas within the Long Island Sound ecosystem with significant ecological, educational, open space, public access, or recreational value. The act defined stewardship to include various activities designed to enhance and preserve natural resource-based recreation and ecological function—including the purchase of land, land conservation agreements, public access improvements, and habitat management.

**Figure 4: The 33 Long Island Sound Stewardship Areas with Ecological and Recreational Value**



Source: GAO analysis of Long Island Sound Study information. | GAO-18-410

Note: The Long Island Sound Stewardship Areas are locations within the Long Island Sound ecosystem with significant ecological, educational, open space, public access, or recreational value. Locations in the map are approximations.

## Hypoxia

The goal in the 1994 plan associated with the priority problem “hypoxia” was to increase dissolved oxygen levels in the Sound to eliminate adverse impacts of hypoxia resulting from human activities. All 11 of the Study members who provided a response about progress toward this goal agreed that nitrogen has been reduced in the Sound since the 1994 plan, while 4 said that they have not observed the expected reduction in hypoxia. According to the 1994 plan, Study members based their expectation on a water quality model they used at the time. As evidence for nitrogen reduction in the Sound, Study members said that both Connecticut and New York met their 15-year TMDL wasteload allocation target to reduce nitrogen discharged into the Sound by 58.5 percent. To achieve their nitrogen targets, the Study reported that the states upgraded wastewater treatment plants.<sup>34</sup> For example, communities in

<sup>34</sup>Long Island Sound Study, *Protection and Progress 2013*.

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both states upgraded their plants with biological nutrient removal, a process in which bacteria break down and remove the reactive nitrogen found in human waste. According to EPA officials, recovery from hypoxia in coastal waters will not be rapid or predictable and evidence shows that dissolved oxygen levels in the Sound are recovering because of nitrogen reductions.

According to Study members, hypoxia is a complex phenomenon affected by a number of factors that help to explain characteristics of hypoxia in the Sound. For example, three Study members said that an increase in water temperature can exacerbate hypoxia; warmer water holds less oxygen than cold water. As a result, in summer months the combination of temperature and salinity contributes to the isolation of the bottom layer of water from the usually well-oxygenated surface layer. Two Study members said that another factor that affects hypoxia is precipitation. For example, heavy rainfall could increase the amount of stormwater runoff that carries nutrients, such as nitrogen, into the Sound, which could lead to an increase in algal blooms and hypoxia. According to the 2012 Sound Health report, in 2012, Hurricane Sandy's storm surge overwhelmed many wastewater treatment plants, and stormwater runoff entered the Sound.<sup>35</sup> In addition, four Study members said that there may be a lag between a reduction in nitrogen and a reduction in levels of hypoxia.

Several Study members said that the water quality model they used in 1994 to predict the relationship between hypoxia and nitrogen may have incorrectly predicted the effect of reducing nitrogen on hypoxia or could be improved to better show the relationship between the two. Beginning in 2005, the Study conducted an evaluation of its water quality model that identified fundamental weaknesses with how the model captured the dynamics of hypoxia and mixing of water layers in the Sound. Subsequently, the Study has funded the development of a new model that it expects will more accurately reflect the relationship of the various sources of nitrogen and hypoxia. A Study member said that it was not possible to predict when the new model would be ready because of the nature of the work. However, the Study member added that it may be 10 to 20 years before the data show if and how nitrogen reduction efforts based on the new model reduce hypoxia.

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<sup>35</sup>Long Island Sound Study, *Sound Health 2012*.

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## The 2015 Plan Has Four Goals to Improve Water Quality and Ecosystem Functions, but Study Members Identified Various Factors that May Hinder Progress

The 2015 plan has four goals to improve water quality and restore and protect ecosystem functions, among others. Each goal is associated with one of four broad themes: clean water and healthy watersheds, thriving habitats and wildlife, sustainable and resilient communities, and sound science and inclusive management. To achieve the goals, the Study developed specific outcomes, objectives, strategies, and action plans but stated that factors such as insufficient funding and climate change may hinder restoration efforts. In addition, most Study members stated that even if the goals of the 2015 plan are met, new and emerging challenges will require restoration efforts to continue, at a minimum, to monitor the Sound.

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## The 2015 Plan Has Four Goals and Associated Themes to Improve Water Quality and Other Ecosystem Functions

The 2015 plan has four goals, associated with four themes to improve water quality and other ecosystem functions in the Sound while creating sustainable communities and using sound science as a basis for restoration. According to the 2015 plan, the goals and associated themes were developed by building upon the progress already made toward the 1994 plan and years of research and monitoring of the Sound. As previously mentioned, Study members said that the book they published with many scientists helped to develop the 2015 plan. The book *Long Island Sound: Prospects for the Urban Sea*, synthesized the advances in science made over the past decades in understanding the Sound.<sup>36</sup> Study members also said that an update of the plan was needed to incorporate an improved understanding of the Sound and to address new issues that might affect restoration of the Sound. The four goals and their associated themes are as follows.

- **Clean water and healthy watersheds.** The goal associated with this theme addresses improving water quality through reducing contaminant and nutrient loads from the land and waters impacting the Sound. According to the 2015 plan, the condition of the Sound depends on the quality of the water draining from the land around it and, although progress has been made, the issues affecting water quality in the 1994 plan remain. These issues include hypoxia, pathogens, and development.

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<sup>36</sup>Latimer et. al., *Long Island Sound: Prospects for the Urban Sea*.

### Eelgrass

Eelgrass (*Zostera marina*) is a rooted underwater plant with ribbon-like strands that form beds and meadows in estuaries. These beds are a haven for crabs, scallops, numerous species of fish, and other wildlife because the beds provide for them a habitat, protection from predators, nursery grounds, food, and oxygen. Additionally, eelgrass improves water clarity by filtering pollutants from runoff and by absorbing nutrients such as nitrogen and phosphorus. It also protects shorelines from erosion by absorbing wave energy. Eelgrass health can be negatively affected by excessive nutrients, limited sunlight exposure, and high water temperatures. For these reasons, the Long Island Sound Study uses eelgrass growth as an indicator for good water quality.



Source: National Oceanic and Atmospheric Administration. | GAO-18-410

A bed of eelgrass

- **Thriving habitats and abundant wildlife.** The goal associated with this theme addresses restoring and protecting the Sound’s ecological balance, including fish and shellfish populations and ecologically significant shorelines and habitats along the Sound, to benefit both people and the environment. According to the 2015 plan, the 1994 plan identified habitats and living resources to manage and protect and the Study identified 12 types of coastal habitats for restoration, including beaches and dunes, cliffs and bluffs, estuarine embayments, coastal and island forests, freshwater wetlands, coastal grasslands, intertidal flats, rocky intertidal zones, riverine migratory corridors, submerged aquatic vegetation such as eelgrass, shellfish reefs, and tidal wetlands. While progress has been made through acquiring thousands of acres of land, according to the 2015 plan, habitat connectivity and riverine migratory corridor reconnection can be improved.
- **Sustainable and resilient communities.** The goal associated with this theme addresses supporting communities to use, appreciate, and help protect the Sound. According to the 2015 plan, local government leadership, private sector engagement, community organizations, and individual stewardship will be needed to restore the Sound. The theme focuses efforts on communities, which was not a focus of the 1994 plan.
- **Sound science and inclusive management.** The goal associated with this theme seeks to ensure the Study is using sound science and cross-jurisdictional governance that is inclusive, adaptive, innovative, and accountable throughout its restoration efforts in the Sound. According to the 2015 plan, the Sound and its watershed covers more than 16,000 square miles in six states and includes hundreds of local watersheds. Management of the Sound involves collaboration and governance among numerous partners and stakeholders who need thorough understanding of the issues. According to the plan, such understanding comes from research, monitoring, assessment, mapping, and modeling programs.

To achieve the goals associated with the plan’s four themes, the Study also developed outcomes, objectives, strategies, and implementation actions and published these in the 2015 plan and supplemental documents. The 2015 plan defines outcomes as “broad results needed to achieve the goals.” For example, as shown in table 4, an outcome associated with the “clean water and healthy watersheds” theme is “to improve research, monitoring, and modeling for water quality.” Each outcome has multiple associated objectives, which are the accomplishments needed to achieve each outcome, and each objective



has multiple strategies. To carry out each strategy, the Study has developed 139 implementation actions, which are specific actions such as estimating future phosphorus loads or promoting eelgrass management. The Study also developed four supplemental documents, one for each theme, that describe the 139 implementation actions and steps to be taken in 2015 through 2019 and the expected outcomes.

**Table 4: Themes of the 2015 Long Island Sound *Comprehensive Conservation and Management Plan* and Examples of Associated Outcomes, Objectives, Strategies, and Implementation Actions**

Theme	Outcome	Objective	Strategy	Implementation action
Clean water and healthy watersheds	Improve research, monitoring, and modeling for water quality	Further improve the understanding of the causes and impacts of eutrophication and hypoxia <sup>a</sup>	Understand the effects that varying amounts of nutrients, such as nitrogen and phosphorus, have on ecosystem function in the Sound	Estimate future phosphorus loading and its impact on the Sound
Thriving habitats and abundant wildlife	Advance knowledge of habitats and living resources through monitoring, assessment, and research	Enhance knowledge of habitats and living resources through research, and distribution of habitat and living resource data	Update inventory status and trends in quality, quantity, and distribution of priority habitats and species	Continue the Sound's eelgrass abundance surveys and promote eelgrass management
Sustainable and resilient communities	Ensure that citizens have the awareness, knowledge, and skills to protect the Sound	Increase public knowledge and understanding of the ecological health of the Sound	Provide information products that can educate communities about the health of the Sound	Raise awareness through various media formats about the Sound's water quality and its impact on human health
Sound science and inclusive management	Support management by increasing scientific understanding of the Sound through research, monitoring, assessment, mapping, and monitoring	Develop and improve modeling capabilities to provide predictive assessments of resources, physical dynamics, and water quality	Transition existing and new models to a community modeling framework that provides open source access to facilitate external collaboration, assessments, and enhancements	Make the System-wide Eutrophication Model code and products publicly available to enhance transparency and collaboration <sup>b</sup>

Source: GAO analysis of Long Island Sound Study information. | GAO-18-410

<sup>a</sup>Eutrophication is the process by which a body of water becomes enriched in dissolved nutrients that stimulate the growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen.

<sup>b</sup>The System-wide Eutrophication Model is a computer model used within the 2015 Long Island Sound *Comprehensive Conservation and Management Plan* to assess the likely impact of reductions in nitrogen discharged from wastewater treatment plants, combined sewer overflows, storm water overflows, and other nonpoint sources, riverine inputs, and atmospheric deposition directly impinging onto the waters of the Sound.

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## Study Members Cited Numerous Factors, Including Insufficient Funding, Climate Change, and Development and Growth That May Hinder Progress

Study members we interviewed said numerous factors may hinder Long Island Sound restoration progress, including insufficient funding, climate change, insufficient scientific understanding or data-related issues, development and population growth, and insufficient public appreciation of the Sound. (See app. II for a list of all the factors Study members identified that may hinder progress.)

Of the 17 Study members we interviewed about factors that may hinder progress, 14 said that insufficient funding can, for example, hinder their ability to manage restoration efforts, mitigate the effects of development and population growth, implement new projects, or effectively conduct existing projects. One Study member said that development and population growth can be overcome with mitigation activities, but that these require funding. Another Study member said that insufficient funding leads to vacant staff positions and that the Study member's organization is strained with small staff numbers. This limits the Study's ability to coordinate among the many agencies and programs working on restoration. Another Study member identified the effects of insufficient funding on a restoration project. Specifically, a town received a Study grant for a green infrastructure project near the Sound, but the town modified the project because the grant was smaller than what the project needed. The project plan included constructing the building with permeable parking surfaces and green features, such as rain gardens, to help improve water quality. According to a town official, the town wanted to do more green features but because it received a smaller grant, the number of permeable surfaces and green features the town could build were limited.

Nine of the 17 Study members we interviewed said that climate change can hinder restoration progress. Study members discussed different types of effects that may be possible, such as affecting water temperature, weather, and sea level. For example, two Study members said that warmer waters caused by climate change could increase the Sound's susceptibility to hypoxia by increasing the risk of potential harmful algal blooms and the length of time low-dissolved oxygen remained at hypoxic levels. Another Study member stated that warmer waters can cause outbreaks of the naturally occurring bacterium *Vibrio parahaemolyticus*,

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which accumulates in shellfish and affects the shellfishing industry.<sup>37</sup> In addition, two Study members said that changes in weather caused by climate change could cause an increase in stormwater and therefore the amount of pathogens washed into the Sound; another Study member said that increased storm activity could destroy marshes. According to the Study, salt marsh vegetation in tidal wetlands helps protect against erosion and typically manages to accumulate enough sediment and organic matter to keep up with naturally-occurring, gradual sea level rise. However, the Study reported that tidal wetlands in the Sound may not be able to keep up with the rise in sea level projected to result from climate change.<sup>38</sup> One Study member said that marshes are already being affected by increased coastal flooding that may be caused by sea level rise.

As we reported in November 2013, changes in the climate—including warmer temperatures, changes in precipitation patterns, rising sea levels, and more frequent and intense storms—affect water resources in a number of ways, such as erosion and inundation in coastal areas.<sup>39</sup> In particular, we reported that a 2011 federal agency review of the potential impacts of climate change on water resources identified four interrelated areas of concern for water resource managers. One of the four is protecting coastal and ocean resources as rising sea levels and changes in storm frequency, intensity, and duration impact coastal infrastructure. Also, in September 2014, we reported that ocean acidification—the increased absorption of carbon dioxide emitted by humans into the oceans—is resulting in chemical changes in the oceans that may pose risks for some marine species and ecosystems, as well as for the human communities that rely upon them for food and commerce.<sup>40</sup>

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<sup>37</sup>*Vibrio parahaemolyticus* is found in coastal waters and is prevalent during the summer months when the water is warmer. The bacteria can cause the human illness vibriosis through consumption of raw or undercooked shellfish.

<sup>38</sup>Long Island Sound Study, *Sound Health 2012*.

<sup>39</sup>GAO, *Climate Change: Federal Efforts Under Way to Assess Water Infrastructure Vulnerabilities and Address Adaption Challenges*, [GAO-14-23](#) (Washington, D.C.: Nov. 14, 2013).

<sup>40</sup>GAO, *Ocean Acidification: Federal Response Under Way, but Actions Needed to Understand and Address Potential Impacts*, [GAO-14-736](#) (Washington, D.C.: Sept. 12, 2014).

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### Tidal wetlands and salt marshes

Wetlands are areas that are inundated or saturated by surface or groundwater and that have a prevalence of vegetation adapted for life in saturated soil conditions. Tidal wetlands are specifically linked to estuaries—locations where sea water mixes with fresh water to form an environment of varying salinity. Tidal wetlands are among the most productive ecosystems in the world, providing food, shelter, and breeding or nursery grounds for many species of wildlife. Salt marshes are a type of tidal wetlands that have been flooded and drained by salt water brought in by the tides. Salt marshes help protect the land from flooding and erosion in stormy weather, and filter pollutants contained in storm water runoff. Tidal wetlands are threatened by changes in the climate causing sea levels to rise more rapidly, which can cause tidal wetlands to convert to open water.



Source: GAO. | GAO-18-410

Tidal Marsh Restoration Project in Alley Pond Park, Douglaston, New York

In addition, one expert we interviewed said that gains in restoring marshes and wetlands already made by the Study may be lost due to rising sea levels. To address this problem, another expert we interviewed said that techniques such as spraying material dredged from the Sound, such as sand and silt, across these areas for the purpose of raising wetlands or marshes are being tested to keep up with sea level rise. One expert also said that increased water temperatures around the Sound may make the water uninhabitable for shellfish. EPA officials said that while increased water temperatures will affect the relative abundance and distribution of shellfish in the Sound, it cannot be concluded that the Sound will become uninhabitable for shellfish because of increased water temperatures. In addition, as we reported in October 2016, unusually high water temperatures may enhance the growth of harmful algal blooms that produce toxins causing neurological and other damage in fish populations.<sup>41</sup> Warming waters will also increase the Sound's susceptibility to hypoxia because the solubility of oxygen decreases as water temperature increases.

Five of the 17 Study members we interviewed said that insufficient scientific understanding and data related issues would hinder progress toward restoration of the Sound. For example, one Study member highlighted the need to better understand the relationship between nutrients and hypoxia. That Study member also said that incomplete data on nutrients, particularly from nonpoint sources, may hinder progress. Another Study member said that obtaining data is difficult, in particular for areas such as embayments and tributaries that are still affected with nonpoint source pollution.

Three of the 17 study members we interviewed said that development and population growth will also hinder the progress of restoration. In addition, 7 of the 17 Study members said that the Sound cannot be restored to past conditions, and a key reason why is that development and increased human population have led to changes in the Sound that hinder full restoration. For example, one Study member said that increased population and development can negatively affect water quality because it resulted in a greater amount of impervious cover such as highways and roads, which in turn increases the nutrient and sediment pollution in runoff.

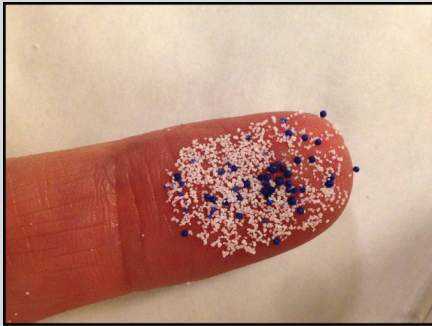
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<sup>41</sup>Harmful algal blooms are algal blooms that produce toxic or harmful effects. GAO, *Environmental Protection: Information on Federal Agencies' Expenditures and Coordination Related to Harmful Algae*, [GAO-17-119](#) (Washington, D.C.: Oct. 14, 2016).

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### Microbeads

Microbeads are pieces of manufactured polyethylene plastic 5 millimeters or less in size that are added as exfoliants to health and beauty products, such as some cleansers and toothpastes. These tiny particles may pass through some water filtration systems and end up in the oceans and the Great Lakes, posing a potential threat to aquatic life. For example, microbeads can look like food to fish and other marine organisms. Once ingested, microbeads can obstruct an animal's digestive system. In addition, microbeads can absorb contaminants that can be hazardous to animals that eat the microbeads, and, in turn, can harm the animals and people that consume them.



Source: Alliance for the Great Lakes. | GAO-18-410

Microbeads (blue) are smaller than 5 millimeters in diameter

Three of the 17 Study members we interviewed said that insufficient public appreciation of the Sound would hinder progress toward restoration. In this context, two Study members highlighted that much of the land along the Sound is privately owned, which makes it difficult for some to travel to the Sound or to appreciate it.

Nearly all of the Study members who we interviewed said that even if the goals associated with the four themes of the 2015 plan are achieved, restoration efforts will need to continue into the future because the Sound will continue to face new challenges and threats and that the Study will need to continue monitoring the Sound to understand them. For example, microbeads are an emerging issue that was not addressed in the 2015 plan. In 2015, after the Study issued the 2015 plan, a Southern Connecticut State University research team reported that it had found microbeads in New Haven Harbor, Connecticut. Microbeads are small pieces of plastic found in common household products that can make their way into waterbodies and threaten aquatic life. In December 2015, the federal government enacted the Microbead-Free Water Act of 2015, which banned the manufacturing, distribution, and offer for sale into interstate commerce of rinse-off cosmetics that contain intentionally-added plastic microbeads.<sup>42</sup> In addition, in June 2015, Connecticut had enacted legislation that phased in bans on the manufacturing, import, sale, or offer for sale of personal care products and over-the-counter drugs that contain microbeads in that state.<sup>43</sup> New York had proposed legislation to address the issue of microbeads in early 2015 but did not enact it.<sup>44</sup>

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<sup>42</sup>Microbead-Free Waters Act of 2015, Pub. L. No. 114-114, 129 Stat. 3129 (codified at 21 U.S.C. § 331 (2018)).

<sup>43</sup>2015 Conn. Acts 5 (Spec. Sess.) (codified as amended at Conn. Gen. Stat. § 22a-462a (2018)).

<sup>44</sup>N.Y. Assembly Bill No. A5896 (2015) (proposed).

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## Study Members Have Identified Long-Term Targets and Indicators to Measure Progress, but Have Not Yet Fully Incorporated Leading Practices for Performance Reporting

Study members said that they plan to use 20 long-term targets with associated indicators to measure progress toward the goals associated with the four themes of the 2015 plan. While 18 of the long-term targets currently have numerical goals, they do not yet have associated intermediate targets that can be used to monitor progress; but EPA officials said that the Study is working to establish them. In March 2018, the Study issued web pages for each of the 20 targets to report on such progress, but, as of June 2018, these pages do not yet fully incorporate leading practices of performance reporting.

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## Twenty Long-Term Targets and Associated Indicators Will Be Used to Measure Progress and Intermediate Targets Are Being Developed

Study members said that they have identified and plan to use 20 long-term targets with associated indicators to measure progress toward the goals of the 2015 plan (see app. III for a complete list of the 20 long-term targets and their associated indicators). The 20 targets are grouped by the four themes in the 2015 plan. All of the targets include indicators that describe how the targets will be achieved, and all but two of those indicators currently have numerical goals, with a value to be achieved by 2035. For example, the indicator for the target “approved shellfish areas” in the “clean waters and healthy watersheds” theme has a numerical goal to upgrade the percentage of shellfish acreage restricted or closed for shellfishing in 2014 in Connecticut and New York by 5 percent by 2035.<sup>45</sup> According to the 2015 plan, to achieve a 5 percent increase, the states would need to upgrade 17,400 of the 349,000 acres of closed or conditionally closed shellfish areas.

Of the 20 targets in the 2015 plan, the 2 that do not yet have indicators with numerical goals are “habitat connectivity” and “public engagement and knowledge.” Two of the Study members responsible for updating the indicators said that the Study is developing numerical goals for each target. According to these Study members, the main reason that these

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<sup>45</sup>Each state has established designated areas for safe shellfish. This target would be achieved by opening acres in those areas that are currently closed for shellfishing, not by adding to the number of shellfishing acres in a state.

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targets do not yet have numerical goals is that presently there are insufficient data that can be analyzed and interpreted to establish them. Study members are in the process of collecting data that will be used to finalize a numerical goal. These Study members said that it may take a year or more to collect the necessary data.

Generally, the 19 experts we interviewed agreed that the indicators used by the Study were valid, accurate, and reliable ways to measure progress for the 20 long-term targets, but some experts also suggested improvements.<sup>46</sup> For 12 of the 20 indicators, all of the experts we interviewed agreed that they were valid, accurate, and reliable. For example, one expert pointed out that the indicator for the riparian buffer extent target is the only practical way to measure progress.<sup>47</sup> Another expert said that the indicator for the coastal habitat extent target is a good choice because it can show progress that the public can easily understand.<sup>48</sup> A few experts suggested improvements to make some of the indicators more useful for measuring progress. For example, one expert said that the indicator for the target “extent of hypoxia” would be better if the focus were on the Western Sound, where hypoxia is a greater problem.<sup>49</sup> The expert also questioned why the Study is concerned with hypoxia across the entire Sound when some areas are only slightly hypoxic and not big enough to have a great impact on the overall level of hypoxia in the Sound. EPA officials responded that the target “extent of hypoxia” is focused on the Western Sound. They added that it must be noted that target applies everywhere in the Study because changes in water quality could occur anywhere in the Sound.

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<sup>46</sup>We asked experts whether each indicator is a valid, accurate, and reliable way to measure progress to achieve the target. For some indicators, experts said that they were unable to answer the question because they did not have sufficient knowledge or data about the indicator. As a result, the total number of expert responses varies for each indicator. See appendix IV for the number of experts who responded to this question for each indicator and the responses provided.

<sup>47</sup>The indicator is: to increase the percent area of natural vegetation within 300 feet of any stream or lake in the Connecticut and New York portions of the Long Island Sound watershed to 75 percent by 2035 from the 2010 baseline of 65 percent.

<sup>48</sup>The indicator is: to restore 350 acres of coastal habitat by 2020 and a total of 3,000 acres by 2035 from a 2014 baseline, including restoration in any of the 12 targeted habitat types such as eelgrass and tidal wetlands.

<sup>49</sup>The indicator is: to measurably reduce the area of hypoxia in Long Island Sound from pre-2000 dissolved oxygen TMDL averages to increase attainment of water quality standards for dissolved oxygen by 2035, as measured by the 5-year running average size of the zone.

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For the other eight indicators, not all experts we interviewed agreed on these indicators. For example, for the tidal wetlands indicator—the acreage of tidal wetlands restored to help restore tidal flow—eight of nine experts we interviewed said that the indicator was valid, accurate, and reliable, but one expert said that it was too simplistic. This expert said that a better indicator would focus on the amount and health of marsh grasses that are planted to restore the tidal wetlands. This is because marsh grass health is affected by nitrogen levels and sea level rise, which also impact tidal wetlands. For the approved shellfish area indicator—the acreage of approved shellfishing areas—six of eight experts we interviewed said that the indicator was valid, accurate, and reliable, but two experts disagreed. One of these experts said that the target is part of the theme to improve water quality and that shellfishing areas can be approved for administrative reasons that are not related to water quality improvement. The other expert added that certain shellfish areas in New York are closed because budget constraints limit the number of reviews that can be conducted to reopen shellfishing areas.

The use of numerical goals to monitor progress toward the 20 long-term targets is consistent with leading practices for performance management that we have identified in our previous work.<sup>50</sup> We have found that a key attribute of successful performance measures is that they have quantifiable numerical goals or other measurable values that permit expected performance to be compared with actual results.<sup>51</sup> Additionally,

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<sup>50</sup> See GPRA Modernization Act of 2010, Pub. L. No. 111-352, §3, (codified at 31 U.S.C. § 1115(b)(2), (6) (2018)). Although the act's requirements apply at the departmental level (for example, Department of the Interior), we have previously stated that they can serve as leading practices at other organizational levels, such as component agencies, programs, and projects. As previously noted, the Long Island Sound Study is directed by EPA, and so these leading practices would apply to the agency's efforts to lead the Study. See, for example, GAO, *Motor Carriers: Better Information Needs to Assess Effectiveness and Efficiency of Safety Interventions*, [GAO-17-49](#) (Washington, D.C.: Oct. 27, 2016), and GAO, *Environmental Justice: EPA Needs to Take Additional Actions to Help Ensure Effective Implementation*, [GAO-12-77](#) (Washington, D.C.: Oct. 6, 2011).

<sup>51</sup> [GAO-17-183](#).



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we have reported that intermediate goals and measures can be used to show progress or contribution to intended results.<sup>52</sup>

During the course of our work, we shared with Study members our concern that only 2 of the 20 long-term targets have intermediate targets.<sup>53</sup> In response, in web pages for the 20 targets available in June 2018, the Study had established intermediate targets for an additional 10 of the 18 long-term targets that did not have intermediate targets.<sup>54</sup> For these 10 targets, the Study identified how much progress would need to be made each year to achieve each target's numerical goal by 2035.<sup>55</sup> For example, for the approved shellfish areas target, the intermediate target is "to approve more than 850 acres of currently closed shellfish areas per year to reach the goal of approving 17,400 acres by 2035." For the remaining 13 targets without intermediate targets, EPA officials said that the Study is working to establish intermediate targets using the indicator data collected by federal and state agencies. By incorporating intermediate targets into its web pages to report on progress, the Study can better ensure its members, the public, and Congress have important information on whether the Study is making progress toward achieving its long-term targets or whether additional actions need to be taken.

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<sup>52</sup>GAO, *Agency Performance Plans: Examples of Practices That Can Improve Usefulness to Decisionmakers*, [GAO/GGD/AIMD-99-69](#) (Washington, D.C.: Feb. 26, 1999). We found that intermediate goals and measures, such as outputs or intermediate outcomes, can be used to show progress or contribution to intended results. For instance, when it may take years before an agency sees the results of its programs, intermediate goals and measures can provide information on interim results. Also, when program results could be influenced by external factors, agencies can use intermediate goals and measures to identify the programs' discrete contribution to a specific result.

<sup>53</sup>Two of the 20 targets—coastal habitat extent and waterfront community resiliency and sustainability—have intermediate targets because, according to two of the Study members responsible for updating the indicators, the Study set these intermediate targets before they wrote the 2015 *Comprehensive Conservation and Management Plan*. Therefore, the Study included the pre-existing targets in the plan and added numerical targets for 2035.

<sup>54</sup>The 10 additional targets that have intermediate targets as of June 2018 are: (1) approved shellfish areas, (2) eelgrass extent, (3) impervious cover, (4) protected open space, (5) public beach closures, (6) public access to beaches and waterways, (7) riparian buffer extent, (8) river miles restored for fish passage, (9) sediment quality improvement, and (10) tidal wetland extent. In commenting on a draft of this report, EPA officials stated that 11 additional targets had intermediate goals. However, the agency included the target "coastal habitat extent," which we had identified in the draft report as one of the two long-term targets that originally had an intermediate target.

<sup>55</sup>The Study did not identify how much progress would need to be made each year for the coastal habitat extent and waterfront community resiliency and sustainability targets but did maintain their intermediate targets.

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## Progress Reports Do Not Yet Fully Incorporate Leading Practices

As previously mentioned, the Long Island Sound Improvement Act of 1990 required the Study to report every 2 years on progress made in implementing the comprehensive conservation and management plan.<sup>56</sup> The Study reported through 2013, using the *Protection and Progress* and Sound Health reports but did not report again until it issued web pages for the 20 long-term targets in March 2018. According to an EPA official, the Study did not report on the evaluation of progress during that 5-year period because EPA was working with Study members to adapt the Study's reports to the 2015 plan indicators and to update the format of its web pages to report on progress. An EPA official said that the Study plans to use the web pages the agency issued in March 2018 to report progress on each of the 20 long-term targets.

Our previous work on performance management states that reporting on performance should involve leading practices such as (1) evaluating performance compared to a plan, (2) reviewing performance for a preceding period of time (for example, 5 years), and (3) evaluating actions for unmet goals.<sup>57</sup> We have found the following benefits of these leading practices:

- **Evaluating performance compared to a plan** allows agencies to describe the performance indicators established in the plan and the performance achieved to meet them. In addition, evaluating performance could help agencies understand the relationship between their activities and the results they hope to achieve.
- **Reviewing performance for a preceding period of time**, including baseline and trend data, can help agencies ensure that individuals using the report review the information in context and identify whether performance targets are realistic given the past performance. In addition, the data can assist individuals who use the report to draw more informed conclusions than they would by comparing only a single year's performance against a target.
- **Evaluating actions for unmet goals** explains why the goal was not met, provides plans and schedules to achieve the goal, and, if the

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<sup>56</sup>Pub. L. No. 101-596, § 201, 104, Stat. 3000, 3004 (codified as amended at 33 U.S.C. § 1269 (2018)).

<sup>57</sup>GAO, *Results-Oriented Government: GPRA Has Established a Solid Foundation for Achieving Greater Results*, [GAO-04-38](#) (Washington, D.C.: Mar. 10, 2004); and *GPRA Performance Reports*, [GAO/GGD-96-66R](#) (Washington, D.C.: Feb. 14, 1996).

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goal is impractical, why it is impractical. Explaining the reasons for any unmet goals allows agencies to recommend actions that can be taken to achieve the goals, or needed changes to the goals.

In our review of the Study's web pages in June 2018, we found that the Study has not yet fully incorporated the three leading practices for reporting on performance. The Study used the three practices to varying extents, as described below.

- **Evaluating performance compared to the 2015 plan for 19 targets.** We believe that the Study fully incorporated this practice by creating a status bar on the web pages for 19 of the 20 ecosystem targets to indicate if progress toward a target's numerical goal was behind schedule, on track, ahead of schedule, or if the numerical goal was met.<sup>58</sup> For example, the Study reported that progress for the target "approved shellfish areas" was behind schedule.
- **Reviewing performance for a preceding period of time for 11 targets.** We believe that the Study partially incorporated this practice by reporting progress data for 5 or more preceding years for 11 targets but not the remaining 9.<sup>59</sup> For example, on the web page for the tidal wetlands extent target, the Study reported progress data for each year from 1998 to 2017.
- **Evaluating actions for unmet goals for four targets.** We believe that the Study partially incorporated this practice by explaining why the goal was not met for 4 targets but did not explain why the goal was not met for 15 targets.<sup>60</sup> For example, for the target "public access to beaches and waterways," the Study reported that increasing the number of public access points may be difficult because there are many privately owned properties along the Long Island Sound coast. However, the Study provided plans and schedules to achieve unmet goals for only two targets. For example,

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<sup>58</sup>The Study did not create a status bar for the target "sediment quality improvement."

<sup>59</sup>We provided a draft of this report to the New York State Department of Environmental Conservation in May 2018. In response, representatives from the department informed us that the Study had added information to the web pages that incorporated this leading practice for additional targets. We analyzed the web pages available in June 2018 and determined that the Study had incorporated this leading practice to one additional target by adding progress data for 5 or more preceding years.

<sup>60</sup>According to the web pages available in June 2018, the goal for one target, "nitrogen loading," has been met. As a result, the leading practice "evaluating actions for unmet goals" cannot be applied to this target.

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the Study reported that to achieve the numerical goal for protected open space, an average of 200 acres of Connecticut land and 150 of New York land needs to be protected each year.<sup>61</sup>

An EPA official said that the web pages may undergo further modifications and that the Study plans to update information about the targets annually or according to how frequently the underlying data are collected. By working with the Study as it finalizes its reporting format to incorporate the leading practices of performance reporting, EPA could help ensure that the Study provides the public and Congress with the information they need to determine whether the Study is making progress toward achieving the long-term targets associated with the goals of the 2015 plan, or whether the Study should take additional action to meet the targets.

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## Study Members Expended at Least \$466 Million on Restoration Activities, but the Study's Estimate of At Least \$18.9 Billion for Future Restoration Is Not Comprehensive

Seven Study members who provided expenditure data to us expended at least \$466 million on restoration activities in the Sound from fiscal years 2012 through 2016, although the total expenditures by all Study members over this period are unknown. In the 2015 plan, the Study estimated that future activities will cost at least \$18.9 billion over 20 years, but these estimates may not reflect all future restoration costs because they address only some of the plan's long-term targets.

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<sup>61</sup>The indicator is: to conserve an additional 4,000 acres of Connecticut land and 3,000 acres of New York land within the Long Island Sound coastal boundary by 2035.

**Four Study Members Expended At Least \$466 Million to Restore Long Island Sound, and Three Others Funded Activities that Contributed to Restoration**

Of the seven Study members who provided expenditure data to us, four Study members said that they provide funding for restoration activities specifically for the Sound. Officials from EPA, the states of Connecticut and New York, and the U.S. Fish and Wildlife Service said that they expended at least \$466 million on activities to restore Long Island Sound from fiscal years 2012 through 2016. Table 5 shows their reported expenditures on restoration activities in Long Island Sound from fiscal years 2012 through 2016.

**Table 5: Expenditures on Restoration Activities in Long Island Sound from Fiscal Years 2012 through 2016 According to Long Island Sound Study Members**

Dollars in millions

<b>Long Island Sound Study members</b>	<b>Expenditures<sup>a</sup></b>
New York State Department of Environmental Conservation	337
Connecticut Department of Energy and Environmental Protection	106
Environmental Protection Agency	22
U.S. Fish and Wildlife Service	1
<b>Total</b>	<b>466</b>

Source: GAO analysis of agency information. | GAO-18-410

<sup>a</sup>These expenditures do not represent the full amount of funds expended on restoration efforts in Long Island Sound because New York State Department of Environmental Conservation officials said that they do not track expenditures for restoration activities. The officials provided examples of three restoration activities instead.

The states of Connecticut and New York expended the majority of the \$466 million to restore Long Island Sound from fiscal years 2012 through 2016. According to a Connecticut Department of Energy and Environmental Protection official, Connecticut expended about \$106 million on restoration activities from fiscal years 2012 through 2016. These activities included more than \$10 million for habitat restoration, more than \$14 million for land acquisition, and more than \$81 million for nitrogen reduction. According to the official, Connecticut expended more than \$21 million in fiscal year 2012 to upgrade equipment at three wastewater treatment plants to reduce nitrogen discharged from the plants into the Sound. New York State Department of Environmental Conservation officials said that the agency could not provide us with the total amount the agency expended on Sound restoration activities in fiscal years 2012 through 2016 because the agency does not track expenditures specific to Long Island Sound restoration. However, they provided examples of activities for which they expended about \$337

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million. The three activities for which officials provided examples of expenditures were to upgrade wastewater treatment plants.

From fiscal years 2012 through 2016, EPA reported expending about \$22 million to operate the Long Island Sound Study, including about \$19 million from the agency's Long Island Sound program and about \$3 million from the National Estuary Program. On average, EPA reported expending about \$4.5 million per year on Study operations, such as public outreach and education, monitoring, modeling, research, and activities to achieve the 1994 and 2015 plans. Of the \$4.5 million per year, the Study provided an average of \$1.3 million per year to the Long Island Sound Futures Fund. The Long Island Sound Futures Fund is a grant program that, according to the Study, funds activities in local communities that aim to protect and restore the Sound.<sup>62</sup> For example, the Long Island Sound Futures Fund awarded \$150,000 to the New York City Department of Parks and Recreation in 2016 to construct a living shoreline in Douglaston, New York. The purpose of this project was to stop the continued loss of urban salt marsh by reestablishing up to one acre of salt marsh and enhancing nearby forest, upland, and coastal grassland habitat.

A U.S. Fish and Wildlife Service official said that the agency expended about \$1 million in 39 activities from fiscal years 2012 through 2016. According to Long Island Sound Futures Fund documents, funds provided to the Long Island Sound Futures Fund are used to pay for restoration projects. For example, the U.S. Fish and Wildlife Service provided \$55,392 in fiscal year 2016 to a project to restore a 12-acre coastal forest in the Village of Mamaroneck, New York. The focus of the project is to reverse forest fragmentation and degradation by removing non-native plants and planting native trees, shrubs, and herbs.

In addition to the funds expended by the four Study members above, officials from three other Study members—the Natural Resources Conservation Service, the U.S. Geological Survey, and the U.S. Army Corps of Engineers—also said that they expended funds for restoration activities in the region around the Sound but do not isolate expenditures

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<sup>62</sup>The Long Island Futures Fund is managed by the National Fish and Wildlife Foundation, a nonprofit organization that was created by statute in 1984 to encourage, accept, and administer private gifts in connection with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration, to further the conservation and management of fish, wildlife, plants, and other natural resources, among other things.

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made specifically for the Sound. For example, officials from these Study members said that the agencies expended funds for activities in the region that contributed to restoration but were not intended solely to restore the Sound. They each provided examples of restoration expenditures or costs for fiscal years 2012 through 2016: the National Resource Conservation Service expended \$54 million through programs such as the Environmental Quality Incentives Program; the U.S. Geological Survey expended about \$3.8 million on data monitoring and other activities; and the U.S. Army Corps of Engineers expended \$27 million for 13 projects.

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**The 2015 Plan Estimated that Future Activities May Cost At Least \$18.9 Billion, but the Estimates Address Only Some of the Plan's Long-Term Targets**

Study members estimated in the 2015 plan that future restoration activities would cost at least \$18.9 billion over 20 years. Nearly all the amount was for activities addressing the goal to achieve clean waters and healthy watersheds. As shown in table 6, Study members estimated that activities under that goal could cost at least \$18.1 billion from 2015 through 2035. The cost estimate included \$5.5 billion specifically for work on wastewater treatment plants in New York, Connecticut, and the upper watershed states, which may include upgrading the plants with available technologies for nutrient removal. Study members also estimated that activities to reduce nitrogen by addressing CSOs and urban stormwater in Connecticut may cost at least \$4.4 billion and \$700 million. Finally, the cost estimate included \$12.4 billion to complete ongoing work in New York and Connecticut to reduce overflows from combined sewer systems as well as sewer systems that are not combined with stormwater systems.

**Table 6: Estimated Costs for Clean Waters and Healthy Watersheds Activities in Long Island Sound from 2015 through 2035**

Dollars in millions

<b>Activities</b>	<b>Location</b>	<b>Estimated cost</b>
Wastewater treatment plants	Connecticut	3,000
Wastewater treatment plants	New York	2,000
Wastewater treatment plant retrofits	Massachusetts, New Hampshire, and Vermont	5
Urban stormwater	Connecticut	700
Ongoing combined sewer overflow and separate sanitary system overflow abatement	New York	8,000
Ongoing combined sewer overflow and separate sanitary system overflow abatement	Connecticut	4,400
<b>Total</b>		<b>18,105</b>

Source: GAO analysis of Long Island Sound Study information. | GAO-18-410

The remainder of the \$18.9 billion was for activities related to goals to achieve thriving habitats and other restoration themes. As shown in table 7, Study members estimated that these other activities could cost \$778 million from 2015 through 2035. According to the 2015 plan, activities to address the goals to achieve thriving habitats and abundant wildlife, such as by protecting open space, may cost \$650 million—\$500 million in New York and \$150 million in Connecticut. These activities could include acquiring properties that the Study has identified as high priority for conservation to minimize coastal development in the future. Study members also estimated in the 2015 plan that Connecticut and New York would spend about \$4 million each on education activities. These activities could include volunteer and outreach efforts for the general public at the 33 Long Island Sound Stewardship Areas, such as how human disturbance can affect wildlife.



**Table 7: Estimated Costs for Species Management, Land and Open Space Protection, and Education Activities in Long Island Sound from 2015 through 2035**

Dollars in millions

Activities	Location	Estimated cost
Open space protection	New York	500
Open space protection	Connecticut	150
Species management	Connecticut	120
Education	Connecticut	4
Education	New York	4
<b>Total</b>		<b>778</b>

Source: GAO analysis of Long Island Sound Study information. | GAO-18-410

Economic guidance generally states that investment decisions should be informed by a consideration of both benefits and costs of relevant alternatives. For example, the Office of Management and Budget (OMB) has issued guidance on estimating costs and benefits to help federal agencies efficiently allocate resources through well-informed decision making about activities. This guidance includes OMB Circular A-94,<sup>63</sup> which we have previously identified as providing leading practices for economic analysis.<sup>64</sup> OMB Circular A-94 directs agencies to follow certain economic guidelines for estimating costs and conducting cost-effectiveness analyses of federal programs or policies to promote efficient resource allocation through well-informed decision making in certain circumstances.<sup>65</sup> The guidance applies to federal agencies and programs, but we have previously found that it provides leading practices for economic analysis of investment decisions. Under OMB Circular A-94, a cost estimate is to include a comprehensive assessment of the costs.

<sup>63</sup>Office of Management and Budget Circular A-94.

<sup>64</sup>GAO, *Climate Change: Information on Potential Economic Effects Could Help Guide Federal Efforts to Reduce Fiscal Exposure*, [GAO-17-720](#) (Washington, D.C.; Sept. 28, 2017).

<sup>65</sup>These guidelines apply, with limited exception, to any analysis used to support government decisions to initiate, renew, or expand programs or projects that would result in a series of measurable benefits or costs extending for 3 or more years into the future. The circular applies specifically to: (1) benefit-cost or cost-effectiveness analysis of federal programs or policies, (2) regulatory impact analysis, (3) analysis of decisions on whether to lease or purchase, and (4) asset valuation and sale analysis.

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By developing its \$18.9 billion estimate, the Long Island Sound Study has taken steps to assess the potential costs of future restoration activities. However, the 2015 plan includes 20-year cost estimates for activities related to 10 of the 20 long-term targets that the Study plans to achieve. These cost estimates focus primarily on activities to achieve clean waters and healthy watersheds and thriving habitats and abundant wildlife. These include restoration activities that address wastewater treatment plants to help achieve the long-term target nitrogen loading, and restoration activities to conserve open space to achieve the long-term target protected open spaces. However, the total does not include the cost of activities to achieve other long-term targets such as river miles restored for fish passage, tidal wetlands extent, marine debris, and public access to beaches and waterways.

A Study member said that the Study completed 20-year estimates for proposed restoration activities where feasible and included them in the 2015 plan. The Study member also said that EPA worked with Study members to develop cost estimates using costs for past restoration activities. However, the Study member said that the exact course of action, and therefore costs, for many of the long-term targets were not defined and were still uncertain. For example, the Study only recently invested funds to evaluate nitrogen reduction targets to attain water quality standards, which can be used to determine the scope of work needed and costs to inform a cost estimate associated with achieving the nitrogen loading target. OMB Circular A-94 recognizes that estimates of costs are typically uncertain because of imprecision in underlying data and assumptions and states that this uncertainty can and should be part of the analysis and estimate. According to the circular, because such uncertainty is basic to many analyses, its effects should be analyzed and reported. One way to handle such uncertainty in a cost estimate is to perform a sensitivity analysis, which will result in a range of possible cost estimates. By working with Study members to develop cost estimates that include analyses of uncertainties for each of the targets in the plan, EPA and the Study could better estimate the comprehensive costs for Long Island Sound restoration and could better allocate resources and make decisions about their financial investments in the Sound.

In addition to the 20-year cost estimates, the 2015 plan contained four supplemental documents that described the 139 implementation actions for carrying out the strategies for the plan's four themes in greater detail as well as estimated costs for carrying out those implementation actions for fiscal years 2015 through 2019. EPA's funding guidance for comprehensive conservation and management plans states that agencies

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should estimate the range of potential costs of all actions to implement the plan.<sup>66</sup> For the four 5-year supplemental documents that it developed, EPA worked with the Study to create four cost ranges: (1) \$0 to \$25,000; (2) \$25,000 to \$150,000; (3) \$150,000 to \$1 million; and (4) greater than \$1 million. The Study then assigned these ranges to the implementation actions in the four 5-year implementation plans for each theme. However, the Study only assigned 75 percent of the 139 implementation actions in the 2015 plan to these four ranges. Instead of a cost range, the Study identified the funding needs for more than a third of the remaining 25 percent of the actions as staff time or not applicable. A Study member said that the Study did not assign a range of costs for staff time and identified some action costs as not applicable because, for example, the work required would be intermittent or the associated costs were accounted for in other implementation actions. According to Circular A-94, uncertainty, such as staff time, should be included in a cost estimate.<sup>67</sup> In addition, implementation actions for which costs are accounted for elsewhere could be assigned to the Study's first cost range, \$0 to \$25,000. According to the Study member, estimates of potential cost ranges for the implementation actions could be included in future supplements to the 2015 plan. By working with the Study to estimate the range of potential costs for all the implementation actions and including the estimates in future supplements to the 2015 plan, EPA would have better assurance that Study members have complete information to guide resource allocation decisions about activities to achieve the goals of the 2015 plan.

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## Conclusions

By identifying six priority problems and associated goals in the 1994 plan and taking actions to achieve these goals, the Study, with EPA as director, has provided a long-standing focus on improving the water quality and other ecosystem functions in the Sound and its surrounding watershed. In its updated 2015 plan, the Study identifies further actions to be taken and has identified numerical goals for almost all of the 20 long-term targets in the 2015 plan, which unlike the 1994 plan, will enable the Study to do a comprehensive assessment of progress toward the numerical goals of the 2015 plan. As of June 2018, the Study has not yet fully incorporated leading practices for performance reporting, such as

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<sup>66</sup>EPA, *FY2017-FY2019 Clean Water Act §320 National Estuary Program Funding Guidance*. (Washington, D.C.: 2016.)

<sup>67</sup>Office of Management and Budget Circular A-94.

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evaluating actions for unmet goals, in the web pages the Study plans to use to report progress for the 20 long-term targets. By working with the Study as it finalizes its reporting format, EPA can ensure that the leading practices of performance reporting are fully incorporated, which in turn will help ensure that the Study is providing information to the public and Congress about its restoration progress.

In addition, the 2015 plan includes 20-year cost estimates for some, but not all the activities related to the 20 long-term targets that the Study plans to achieve. By working with Study members to develop cost estimates that include analyses of uncertainties for each of the targets in the plan, EPA and the Study could better estimate the comprehensive costs for Long Island Sound restoration and ensure better resource allocation decisions for the Sound. In addition, the Study has not estimated the range of potential costs of all 139 implementation actions in the 2015 plan. By working with the Study to estimate the range of potential costs for all the implementation actions and including the estimates in future supplements to the 2015 plan, EPA would have reasonable assurance that Study members have considered complete cost information when making resource allocation decisions about activities to achieve the goals of the 2015 plan.

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## Recommendations for Executive Action

We are making the following three recommendations to the Environmental Protection Agency in its capacity as the Director of the Long Island Sound Study, in coordination with Study members:

- The Director, working with the Study, should ensure that as the Study finalizes its reporting format, it fully incorporates leading practices of performance reporting. (Recommendation 1)
- The Director, working with the Study, should develop cost estimates that include analyses of uncertainties for each of the targets in the 2015 plan. (Recommendation 2)
- The Director, working with the Study, should estimate the range of potential costs for all implementation actions and include the estimates in future supplements to the 2015 plan. (Recommendation 3)

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## Agency Comments and Our Evaluation

We provided a draft of this report to EPA and the departments of Agriculture, Commerce, Defense, and the Interior for their review and comment. We also provided a draft of the report to the Connecticut Department of Energy and Environmental Protection and the New York State Department of Environmental Conservation for their review and comment. EPA provided written comments, which are reproduced in appendix V, and stated that it agreed with the conclusions and recommendations in our report. EPA also provided technical comments, which we incorporated as appropriate. The departments of Agriculture, Defense, and the Interior, and the Connecticut Department of Energy and Environmental Protection responded by email that they did not have comments on the draft report. The Department of Commerce and the New York State Department of Environmental Conservation provided technical comments, which we incorporated as appropriate.

In a letter signed by the Regional Administrators of EPA Region 1 and Region 2, EPA stated that the report is timely because the Study is working to transition from the 1994 plan to evaluating and reporting on the 2015 plan and highlighted steps the agency will take to meet our recommendations. EPA stated that working with the Study the agency: plans to further evaluate, develop, and apply leading practices of performance reporting as it finalizes its reporting format, estimating enhancements to the reporting format will be available on the Study's website by the end of 2019; will evaluate the range of costs needed to attain each of the targets and include cost estimates with uncertainty bounds in future updates of the plan, expecting the enhanced cost information will be available on the Study's website by the end of 2019; and will ensure that the planned update to implementation actions includes a range of costs for all implementation actions, estimating actions will be completed in 2020.

In its written comments, EPA suggested two specific revisions to our report. First, EPA stated that the Study has established more intermediate goals than we included in our report. In our report, we said that as of March 2018, the Study had established intermediate targets for 7 of the 20 long-term ecosystem targets. According to EPA's comments, applying the methodology that we used in the report to the 20 ecosystem targets results in 11 targets having intermediate goals. EPA also stated that the agency will work with the Study to better communicate these existing intermediate goals on the web pages reporting ecosystem progress. In response to this information, we analyzed the Study's web pages that were available in June 2018 and agreed that five additional ecosystem

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targets had intermediate goals as of that date. We revised the report to include this information.

Second, EPA stated that the report's statement that the 2015 plan estimates that future implementation activities may cost nearly \$21.9 billion is a misleading interpretation of the 2015 plan's implementation costs because the plan does not present that figure. EPA stated that table 6 in our report appeared to double count Connecticut's combined sewer overflow costs in the 2015 plan by including both the \$4.4 billion taken from text and \$3 billion taken from a table in the plan. Although we presented these data to EPA during our review, the error was not caught until the draft report was reviewed. EPA stated that the 2015 plan is admittedly unclear in attributing costs to specific categories and that the agency will work with the Study to clarify the estimated implementation costs in future updates. In response to EPA's comments, we reviewed the 2015 plan and removed the \$3 billion cost estimate for Connecticut's combined sewer overflow from table 6 and revised the total cost estimate for future restoration activities to \$18.9 billion.

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We are sending copies of this report to the appropriate congressional committees, Administrator of EPA, Secretary of Agriculture, Secretary of Commerce, Secretary of Defense, Secretary of the Interior, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or [gomezj@gao.gov](mailto:gomezj@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made significant contributions to this report are listed in appendix VI.



J. Alfredo Gómez  
Director, Natural Resources and Environment

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# Appendix I: Objectives, Scope, and Methodology

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This appendix provides information on the scope of work and the methodology used to examine (1) what is known about the progress made toward achieving the 1994 Long Island Sound *Comprehensive Conservation and Management Plan* (1994 plan);<sup>1</sup> (2) the goals of the 2015 Long Island Sound *Comprehensive Conservation and Management Plan* (2015 plan) and factors that may hinder progress according to Long Island Sound Study (the Study) members;<sup>2</sup> (3) how Study members plan to measure and report on progress toward the goals of the 2015 plan; and (4) what Study members expended on restoration activities in fiscal years 2012 through 2016 and cost estimates for future activities.

To examine what is known about the progress toward achieving the 1994 plan, we analyzed the plan to gain a better understanding of it and identify any goals associated with the six priority problems.<sup>3</sup> We also analyzed data from the Study's website in November 2017, the Study's most recent progress reports, and the book *Long Island Sound: Prospects for the Urban Sea*—a summary of available science and environmental data for the Long Island Sound (the Sound).<sup>4</sup> We analyzed the Study's most

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<sup>1</sup>Long Island Sound Study, *The Comprehensive Conservation and Management Plan*, (Stamford, CT: March 1994).

<sup>2</sup>Long Island Sound Study, *Long Island Sound Comprehensive Conservation and Management Plan 2015: Returning the Urban Sea to Abundance*, (Stamford, CT: September 2015).

<sup>3</sup>The Study is a partnership consisting of federal and state agencies, concerned organizations, and individuals dedicated to restoring and protecting Long Island Sound. Members of the Study include officials from the Department of Agriculture's Natural Resources Conservation Service, the Department of Commerce's National Marine Fisheries Service, the Department of Defense's U.S. Army Corps of Engineers, the Department of the Interior's U.S. Fish and Wildlife Service and U.S. Geological Survey, the Environmental Protection Agency (EPA), the Connecticut and New York College Sea Grant Programs, the Connecticut Department of Energy and Environmental Protection, the Massachusetts Department of Environmental Protection, the New York State Department of Environmental Conservation, the New York Department of State, the New York City Department of Environmental Protection, and the New England Interstate Water Pollution Control Commission—a nonprofit interstate agency established by statute in 1947 that uses a variety of strategies to meet the water-related needs of its member states, Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

<sup>4</sup>James S. Latimer, Mark A. Tedesco, R. Lawrence Swanson, Charles Yarish, Paul E. Stacy, Corey Garza, eds. *Long Island Sound: Prospects for the Urban Sea*, 1<sup>st</sup> ed. (New York: Springer-Verlag, 2014).

recent progress reports—*Protection and Progress* and *Sound Health*.<sup>5</sup> We analyzed data that were on the Study’s website in November 2017 because the time frame coincided with the time frames of our review. These data, reports, and the book included examples of progress but did not assess performance toward the goals associated with the priority problems in the 1994 plan. Therefore, we asked Study members for their responses on progress and the data that supported their responses. To do so, we interviewed Study members to obtain their views about progress toward the 1994 plan.

For our interviews with Study members, we contacted all 16 members of the Study and representatives of the 5 Study work groups that were active at the time of this review. Of the 16 Study members, 14 agreed to participate in this review:<sup>6</sup> (1) Department of Agriculture’s Natural Resources Conservation Service; (2) Department of Commerce’s National Marine Fisheries Service; (3) Department of Defense’s U.S. Army Corps of Engineers; the Department of the Interior’s (4) U.S. Fish and Wildlife Service and (5) U.S. Geological Survey; (6) Environmental Protection Agency (EPA); (7) Connecticut Sea Grant; (8) Connecticut Department of Energy and Environmental Protection; (9) New York State Department of Environmental Conservation; (10) New York Department of State; (11) New York City Department of Environmental Protection; (12) the New England Interstate Water Pollution Control Commission; (13) the Study’s Citizens Advisory Committee; and (14) the Study’s Science and Technical Advisory Committee.<sup>7</sup>

The 5 Study work groups are (1) Climate Change and Sentinel Monitoring Work Group, (2) Habitat Restoration and Stewardship Work Group, (3)

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<sup>5</sup>Long Island Sound Study, *Protection & Progress 2011-2012 Long Island Sound Study Biennial Report* (Stamford, CT: 2013); and Long Island Sound Study, *Sound Health 2012: Status and Trends in the Health of Long Island Sound* (Stamford, CT: 2012).

<sup>6</sup>The Study members who did not participate were the Massachusetts Department of Environmental Protection and the New York College Sea Grant Program.

<sup>7</sup>The Study’s Citizens Advisory Committee is a volunteer organization that provides ongoing advice to Study members. Membership on the committee is open to representatives of environmental organizations, businesses, industries, local governments, and other public and private organizations in Connecticut and New York with a demonstrable interest in the restoration and protection of the Sound and its ecosystems. The Study’s Science and Technical Advisory Committee is made up of engineers, scientists, and representatives from government agencies, academia, industry, and private organizations, and is responsible for providing objective scientific and technical guidance for the restoration and protection of the Sound.



Public Involvement and Education Work Group, (4) Water Quality Monitoring Work Group, and (5) Watersheds and Embayment Work Group. Representatives from all 5 work group agreed to participate in this review.

We asked the following question for each priority problem: “Since 1994, how much progress has been made addressing the priority problem in Long Island Sound: no progress, little progress, moderate progress, or goal has been met?” For purposes of reporting responses to this question, we refer to Study members and work group representatives collectively as Study members. The New York State Departments of Environmental Conservation and State provided their responses together, and therefore we counted the two agencies as one Study member. The New England Interstate Water Pollution Control Commission did not provide a response to this question. As a result, 17 Study members provided responses to this question.

As part of the interviews, we also asked Study members, “What evidence are you basing your response on?” We did not independently assess the reliability of the data they cited for the purpose of evaluating if the data showed progress toward addressing the priority problems. Instead, we noted the limitations the Study associated with the data to better interpret Study members’ views. For some priority problems, Study members said that they were unable to provide a response because they did not have sufficient knowledge or data about progress toward the associated goals. As a result, the total number of Study members who answered these questions varied by priority problem and, for each priority problem, we identified the total who provided a response. In addition, we visited two Long Island Sound restoration projects to observe restoration activities and learn how these activities may contribute to progress toward the goals of the 1994 plan.

To examine the goals of the 2015 plan and factors that may hinder progress according to Study members, we analyzed the 2015 plan to obtain information about the goals to achieve four themes in the plan. In the interviews with the 17 Study members described above, we asked them “What factors, if any, may hinder achievement of the 2015 plan’s goals.” More than one Study member representative was present in many of the interviews and each representative in the interviews could identify as many factors as they thought necessary. As a result, the number of times a factor was identified—54—was greater than number of Study members. We narrowed the number of responses to 11 categories by grouping together factors that were the same or were similar. In those

cases that more than one representative of the same Study member identified the same factor, we counted that factor only once for that Study member in order to generate the statements we used in the report. See appendix II for a complete list of all the factors that were identified, the number of Study members who identified each factor, and how we grouped those factors into the 11 categories.

To examine how Study members plan to measure and report on progress toward achieving the 2015 plan, we analyzed sections of the plan that contained goals associated with four themes and relevant web pages that the Study issued in March 2018 and then analyzed them again in June 2018. We also conducted interviews with subject matter experts to obtain their views on the sections of the 2015 plan that contained the themes and goals, and with Study members to learn how they planned to report on progress toward the 2015 plan. As a result of our analysis of the 2015 plan and interviews with Study members, we identified the 20 long-term targets and associated indicators that Study members plan to use to measure progress toward the 2015 plan, and determined that the Study plans to report on progress using the web pages.

For our interviews with subject matter experts, we identified individuals with expertise on the 20-long term targets and their associated indicators. We identified 73 experts by asking Study members to recommend experts and identifying the contributors to *Long Island Sound: Prospects for the Urban Sea*. We removed from this list those individuals whom we had already interviewed, those who represented a Study member, those who were involved with the development of the 2015 plan, and those whose contact information we were unable to obtain from the Study member or an Internet search. We invited by email the remaining 47 experts to participate in interviews to obtain their views about the 20 long-term targets and their associated indicators. We also provided the experts with a list of the 20 targets and indicators and asked them to review the targets and to “select those that you would be comfortable speaking about based on your knowledge and expertise.” Of the 34 experts who responded, we interviewed 19 about the targets they had expertise in and could discuss. The remaining 15 experts chose not to participate or said that they were ineligible because they were either involved with the development of the 2015 plan or affiliated with a Study member.

We then interviewed the 19 experts about each of the targets and associated indicators that they said they had identified. The experts we interviewed included members of academia, as well as one state official and one county official. Not all of the 19 experts were able to address

each of 20 targets and associated indicators. As a result, the total number of expert responses varied for each target and associated indicator and we identified the total number of experts who responded to questions about each target and associated indicator. Because we used a nonprobability sample, the information obtained from these interviews is not generalizable to other individuals with expertise on the 20 long-term targets and their associated indicators but provides illustrative information.

For our analysis of the web pages the Study published in March 2018, we used GAO's prior work on performance management reporting, which identified leading practices that have the potential for enhancing the general usefulness of performance reports as vehicles for providing decision makers and the public with information to assess progress.<sup>8</sup> We then analyzed the web pages to determine the extent to which they incorporated these leading practices.

To examine what Study members expended on restoration activities in fiscal years 2012 through 2016 and cost estimates for future activities, we took the following steps: we analyzed EPA's *Justification of Appropriation Estimates for Committee on Appropriations* for fiscal years 2014 through 2018 to obtain the relevant EPA expenditure data; we obtained and analyzed expenditure data from other Study members; and we analyzed the cost estimate information in the 2015 plan. We chose this time period because it was the most recent period for which expenditure data were available during the time frames for our review. Of the 12 Study members described above, 7 provided at least some expenditure data, 4 said that they do not fund restoration activities, and 1 did not reply to our request for expenditure data.<sup>9</sup> We were unable to compare expenditure data across Study members because three Study members said that they spend funds for restoration activities in the region around Long Island Sound but do not isolate expenditures made specifically for it. We assessed the reliability of these data through interviews with Study members who were familiar with these data. We found these data to be

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<sup>8</sup>GAO, *Results-Oriented Government: GPRAs Have Established a Solid Foundation for Achieving Greater Results*, [GAO-04-38](#) (Washington, D.C.: Mar. 10, 2004); and *GPRAs Performance Reports*, [GAO/GGD-96-66R](#) (Washington, D.C.: Feb. 14, 1996).

<sup>9</sup>The four Study members who said they do not fund restoration activities are the National Marine Fisheries Service, Connecticut Sea Grant, the Citizens Advisory Committee, and the Science and Technical Advisory Committee. The New York City Department of Environmental Protection did not reply to our request for expenditure data.

sufficiently reliable for the purpose of this reporting objective with the limitation that they represent the minimum amount of Study member expenditures on restoration activities in fiscal years 2012 through 2016. Further, we attended two Study meetings (on April 12, 2017, by phone, and May 11, 2017, in person) to obtain information about how Study members make expenditure decisions for restoration activities.

For our analysis of cost estimate information in the 2015 plan, we consulted the Office of Management and Budget Circular A-94, which provides general guidance for estimating costs,<sup>10</sup> and analyzed EPA's funding guidance for comprehensive conservation and management plans.<sup>11</sup> We then analyzed the cost estimates in the 2015 plan to determine the extent to which they followed the Office of Management and Budget and EPA guidance. In our interviews with Study members and subject matter experts described above, we determined that Study members had not developed other cost estimates for restoring Long Island Sound, and experts were unaware of other such estimates. We also interviewed relevant officials from EPA, the Connecticut Department of Energy and Environmental Protection, and the New York State Department of Environmental Conservation to obtain information about how the cost estimates in the 2015 plan were created.

We conducted this performance audit from January 2017 to July 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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<sup>10</sup>Office of Management and Budget Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (Oct. 29, 1992). The guidance applies to federal agencies and programs, but we have previously found that it provides leading practices for economic analysis of investment decisions.

<sup>11</sup>EPA, *FY2017-FY2019 Clean Water Act §320 National Estuary Program Funding Guidance*. (Washington, D.C.: 2016.)

# Appendix II: Factors Identified by Members of the Long Island Sound Study

In our review of the Long Island Sound restoration efforts, we asked Long Island Sound Study (the Study) members to identify factors that may hinder Long Island Sound restoration progress. Specifically, we asked the following question to all 17 Study members we interviewed: “What factors, if any, may hinder achievement of the goals of the 2015 Long Island Sound *Comprehensive and Conservation Management Plan*.” More than one Study member representative was present in many of the interviews and each representative could identify one or more factors. As a result, the number of factors identified—54—was greater than number of Study members who identified the factor. Table 8 shows the 11 categories of factors, the number of times factors in those categories were identified, and the number of Study members who identified each factor.

**Table 8: Long Island Sound Study (Study) Members Identified Factors that May Hinder Long Island Sound Restoration Progress**

Factor category	Number of times the factor was identified	Number of Study members who identified the factor
Insufficient funding	14	14
Climate change	15	9
Data related factors	6	3
Public appreciation of and education about the Sound	5	3
Development and population growth	5	3
Scientific understanding	3	2
Changing modes of communication	1	1
Infrastructure	1	1
Relaxing regulations	1	1
Coordination	2	2
Insufficient support	1	1
<b>Total</b>	<b>54</b>	<b>40</b>

Source: GAO. | GAO-18-410

Note: Several Study member representatives participated in nearly each interview. As a result, the number of times a factor was identified may be greater than the number of Study members who identified the factor.

We narrowed the number of responses to 11 factor categories by grouping together factors that were the same or were similar. Table 9 shows each factor category, each of the original factors that Study members identified, and the number of times the factor was identified by Study members.

**Appendix II: Factors Identified by Members of  
the Long Island Sound Study**

**Table 9: Long Island Sound Study Members Identified Different Factors that May Hinder Long Island Sound Restoration Progress Grouped Under 11 Different Factor Categories**

<b>Factor Category</b>	<b>Original Factor Stated by Study Member</b>	<b>Number of times the factor was identified</b>
Insufficient funding	Funding	8
	Lack of funding	2
	Staffing	1
	Funding for project design, project implementation, and land protection	1
	Money, lack of State and Federal funding (and other funding sources)	1
	Money	1
Climate change	Climate change	4
	Increases in water temperature	1
	Rising sea levels	1
	Increases in storm activity	1
	Climate change impacts (sea level rise, warming temperatures, increased storms)	1
	Sea level rise	1
	Continued regional climate warming	1
	Increased precipitation and significant storm events	2
	Continued sea level rise	2
	Climate warming	1
Data related factors	Difficulty measuring indicators	1
	Variability of data collected	1
	Variability of data	1
	Incomplete data	1
	Data availability	1
	Interannual variables	1
Public appreciation of and education about the Sound	Low appreciation of the Sound's value within communities	1
	Individuals do not have access to the Sound	1
	The public's understanding of how their actions impact the Sound	1
	Public access to Sound	1
	Public understanding of issues affecting the Sound	1
Development and population growth	Development pressure	1
	Population growth	2

**Appendix II: Factors Identified by Members of  
the Long Island Sound Study**

<b>Factor Category</b>	<b>Original Factor Stated by Study Member</b>	<b>Number of times the factor was identified</b>
	Balance between public use and species restoration	1
	High population levels	1
Scientific understanding	Better understanding of the cause and effect of water quality and ecological issues	1
	Model uncertainty	1
	Issues with conducting science	1
Coordination	Continued coordination	1
	Process	1
Changing modes of communication	Changing modes of communication	1
Infrastructure	Infrastructure	1
Relaxing regulations	Regulatory requirements	1
Insufficient support	Lack of enough groups or organizations to develop and implement projects that would work toward the goals	1

Source: GAO. | GAO-18-410

# Appendix III: The 20 Long-Term Targets and Associated Indicators

The 2015 Long Island Sound *Comprehensive Conservation and Management Plan* has four broad themes—clean water and healthy watersheds, thriving habitats and abundant wildlife, sustainable and resilient communities, and sound science and inclusive management—and associated goals. It also has 20 long-term targets with associated indicators (see table 10).

**Table 10: The 20 Long-Term Targets and Associated Indicators in the 2015 Long Island Sound *Comprehensive Conservation and Management Plan***

Target name	Description of target	Indicator
<b>Clean water and healthy watersheds theme</b>		
Extent of hypoxia	Measurably reduce the area of hypoxia in Long Island Sound from pre-2000 Dissolved Oxygen Total Maximum Daily Load (TMDL) averages to increase attainment of water quality standards for dissolved oxygen by 2035, as measured by the 5-year running average size of the zone.	The average size of the maximum summertime extent of hypoxia (dissolved oxygen $\leq$ 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 analysis of variance) that a change has occurred with 95 percent confidence after 20 years (in 2035). We chose areal extent from the available hypoxia metrics tracked by the Long Island Sound Study (the Study)—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 wastewater treatment facility nitrogen loading at the recommended 2000 Dissolved Oxygen TMDL allocation level by 2017 and maintain the loading cap. Have all practices and measures installed to attain the allocations for stormwater and nonpoint source inputs from the entire watershed by 2025.	Discharges from wastewater treatment facilities are tracked for compliance with permit limits consistent with the Long Island Sound Dissolved Oxygen TMDL for nitrogen. <sup>1</sup> This target is to attain the TMDL allocation for wastewater treatment facilities (in trade equalized pounds per day) by 2017 and maintain compliance with that cap into the future. The allocations for nonpoint sources in the Long Island Sound TMDL require implementation of a variety of best management practices to control nonpoint source pollution. This target is to have all the necessary practices to attain the TMDL nonpoint source allocation in place by 2025. Because it is difficult to directly monitor nonpoint source nutrient loads, a best management practice tracking and modeling approach will be used to assess attainment of the TMDL stormwater and nonpoint source allocations. This approach will produce quantitative estimates of nitrogen load controlled as a result of those practices. The estimation of nitrogen load controlled will be used to measure attainment of the TMDL targets to reduce nitrogen loading from stormwater and nonpoint sources.

<sup>1</sup>New York State Department of Environmental Conservation, Connecticut Department of Energy and Environmental Protection, 2000. *A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound* (Albany, NY, and Hartford, CT: 2000).



**Appendix III: The 20 Long-Term Targets and Associated Indicators**

<b>Target name</b>	<b>Description of target</b>	<b>Indicator</b>
<b>Clean water and healthy watersheds theme</b>		
Water clarity	Improve water clarity by 2035 to support healthy eelgrass communities and attainment of the eelgrass extent target.	Water clarity is one of the major factors affecting eelgrass health and therefore extent. For most of Long Island Sound water clarity is correlated with phytoplankton levels and measured using standard light penetration techniques (for example, Secchi disk, photosynthetically active radiation sensors). For the purposes of this goal, "improved" is defined as an increase in the overall numeric criterion for water clarity in the Long Island Sound water quality report card (under development) by at least half letter grade (for example, B to B+) between the initial 2015 report card evaluation and the evaluation conducted in 2035.
Impervious cover	Through green infrastructure, low impact development, and stormwater disconnections, decrease by 10 percent the effective area of impervious cover in the Connecticut and New York portions of the watershed by 2035 relative to 2010 baseline.	The degree of impervious cover, particularly near waterbodies, has been shown to be associated with degradation of water quality in rivers and streams. The analysis is based on University of Connecticut Center for Land Use Education And Research Land use data ( <a href="http://clear.uconn.edu/publications/research/Statewide_riparian_final.pdf">http://clear.uconn.edu/publications/research/Statewide_riparian_final.pdf</a> ) <sup>2</sup> and can be tracked using the Center for Land Use Education and Research Land estimate of impervious cover. Low impact development projects (for example, green roofs, permeable parking lots) logged in the Center for Land Use Education And Research Land Low Impact Development Atlas would be considered pervious for the purpose of this analysis. The 2010 baseline is 296,000 acres (463 square miles) of impervious cover in the Study area. The study area is defined by the TMDL, and the study area boundary can be found here: <a href="http://longislandsoundstudy.net/wp-content/uploads/2010/01/LISSHabMap02.pdf">http://longislandsoundstudy.net/wp-content/uploads/2010/01/LISSHabMap02.pdf</a> .
Riparian buffer extent	Increase the percent area of natural vegetation within 300 feet of any stream or lake in the Connecticut and New York portions of the Long Island Sound watershed to 75 percent by 2035 from 2010 baseline of 65 percent.	Naturally vegetated zones around the shorelines of all waterbodies provide a buffer that has been shown to be effective in removing contaminants from groundwater before it enters into receiving waters. The target is to have 75 percent of areas within 300 feet of a stream or lake within the Connecticut and New York portions of the Long Island Sound watershed naturally vegetated by 2035, based on University of Connecticut Center for Land Use Education and Research land use data ( <a href="http://clear.uconn.edu/projects/riparian_buffer/results/CLEAR_%20Summary_021508.pdf">http://clear.uconn.edu/projects/riparian_buffer/results/CLEAR_%20Summary_021508.pdf</a> ). Naturally vegetated includes forest, grassland, shrub, and wetland land use categories, but not turf grass or agriculture field classes. This target is based on analysis of land use and water quality in Connecticut. <sup>3</sup>
Approved shellfish areas	Upgrade 5 percent of the acreage currently restricted or closed for shellfishing by 2035 from 2014 baseline.	Each state has designated areas for safe shellfishing; the "growing waters" designation is common to both Connecticut and New York. Currently Connecticut has approximately 128,000 approved acres, 248,000 acres of conditionally approved or restricted beds, and 23,500 acres prohibited, while New York has 412,000 acres certified 1,613 acres seasonally certified (restricted), and 75,500 acres uncertified. Thus, to meet this target, 17,400 of the 349,000 closed or conditionally closed acres would need to be upgraded. This metric is reported by the states and tracked by the Study Indicators program.

<sup>2</sup>Wilson E, Arnold C. *The Status of Connecticut's Coastal Riparian Corridors*, Center for Land Use Education and Research (CLEAR) (2008).

<sup>3</sup>Goetz SJ, Wright RK, Smith AJ, Zinecker E, Schaub E. 2003. "IKONOS Imagery For Resource Management: Tree Cover, Impervious Surfaces, and Riparian Buffer Analyses In the Mid-Atlantic Region," *Remote Sensing of Environment* 88(1-2), 195-208 (2003). Wilson E, Arnold C. *The Status of Connecticut's Coastal Riparian Corridors*, Center for Land Use Education and Research (CLEAR) (2008).

**Appendix III: The 20 Long-Term Targets and Associated Indicators**

<b>Target name</b>	<b>Description of target</b>	<b>Indicator</b>
<b>Clean water and healthy watersheds theme</b>		
Sediment quality improvement	Reduce the area of impaired sediment in Long Island Sound by 20 percent by 2035 from 2006 baseline.	<p>Sediment quality is determined by the Environmental Protection Agency's National Coastal Assessment Sediment Quality Index. This index is based on concentrations of 28 contaminants, characterized as "good," "fair," or "poor" for each station based on the number and severity of exceedances, and weighted by the portion of the Sound represented by each station. Our target is to reduce the net area that is impaired (rated as fair or poor) in Long Island Sound by 20 percent.</p> <p>In 2006, 34 stations had data sufficient to establish a rating, and of those, 15 scored good, 11 fair, and 8 poor. Spatially weighted (because sampling density is higher further west in Long Island Sound), 51.5 percent of Long Island Sound scores "good," 30 percent "fair," and 18.5 percent "poor." By this definition, 48.5 percent of Long Island Sound is considered impaired. To accomplish the goal of reducing this impairment by 20 percent we need to see net improvement in 10 percent (<math>48\% \times 0.2 = 9.6\%</math>) of the area weighted stations.</p> <p>We define "improvement" to be upgrading from "poor" to "fair" or from "fair" to "good," and net improvement to be the area of stations improving minus the area of stations regressing (from "good" to "fair" or "fair" to "poor"). By this definition, our goal can be accomplished by reducing the percentage of Long Island Sound scoring poor from 18.5 percent to less than 8.5 percent (as long as the percentage scoring "fair" does not increase to more than 40 percent) or by increasing the percentage scoring "good" from 51.5 percent to more than 61.5 percent, or a combination of both (for example, 57% good, 33% fair, 10% poor = 5.5% increase in good + 8.5% decrease in poor = 13.5% of Long Island Sound area improved = 27% decrease in impairment).</p>
<b>Thriving habitats and abundant wildlife theme</b>		
Coastal habitat extent	Restore 350 acres of coastal habitat by 2020 and a total of 3,000 acres by 2035 from a 2014 baseline.	From 1998 to 2014, Study partners have restored 1,650 acres of coastal habitat. The interim goal is to restore an additional 350 acres by 2020, for a cumulative total of 2,000 acres. The final goal is to restore an additional 2,550 acres between 2021 and 2035, bringing the cumulative total of acres restored since 1998 to 4,550 acres. The target for the coastal habitat extent includes restoration in any of the 12 targeted habitat types, including eelgrass and tidal wetlands. While separate and specific restoration targets are set for these two habitat types, gains in these two areas can be used to reach the total coastal habitat restoration targets. The Habitat Restoration Work Group tracks coastal habitat restoration projects that are in progress within the watershed by various partners and reports the total acres restored annually.
Eelgrass extent	Restore and maintain an additional 2,000 acres of eelgrass by 2035 from a 2012 baseline of 2,061 acres.	<p>The 2012 eelgrass baseline comes from a 2012 U.S. Fish and Wildlife Service survey that found 2,061 acres of eelgrass in the Eastern Basin of the Long Island Sound. While the survey was only conducted in the Eastern Basin, eelgrass experts believe that eelgrass beds in the Central Basin are small or nonexistent while beds are absent from the Western Basin. Therefore we use 2,061 acres as an estimate of total eelgrass coverage in the Sound, and the goal is to increase this to 4,061 acres of areal eelgrass extent as measured by aerial imagery.</p> <p>This target will be achieved through the successful implementation of additional water quality protections and associated reductions in land based inputs of nutrients, as well as restoration (replanting) efforts led by academic, government, and nonprofit agencies and partners. The Habitat Restoration Work Group tracks eelgrass restoration projects that are in progress within the watershed by various partners and reports the total acres restored annually. However, this ecosystem target is influenced by habitat restoration projects as well as natural gains and losses in eelgrass extent.</p>

**Appendix III: The 20 Long-Term Targets and Associated Indicators**

<b>Target name</b>	<b>Description of target</b>	<b>Indicator</b>
<b>Thriving habitats and abundant wildlife theme</b>		
Tidal wetland extent	Restore an additional 515 acres of tidal wetlands by 2035 from a 2014 baseline.	As of 2014, 985 acres of tidal wetland habitat have been restored in the Study area since 1998. The 2035 target is to restore an additional 515 acres, bringing the cumulative total of restored tidal wetland acres since 1998 to 1,500. For the purposes of this metric, a wetland is considered "restored" after a successful effort to restore tidal flow (for example, culvert enlargement, fill removal). The Habitat Restoration Work Group tracks tidal wetland restoration projects that are in progress within the watershed by various partners and reports the total acres restored annually.
River miles restored for fish passage	Open 200 additional miles of fish riverine migratory corridors in the Connecticut and New York portions of the watershed by 2035 from a 2014 baseline.	This target will be attained by reopening, either through dam removal or fish passage projects, an additional 200 riverine migratory corridor miles. The 2014 baseline is 317 open riverine migratory corridor miles in Connecticut and three open riverine migratory corridor miles in NY. For context, there are an estimated 1,850 total riverine migratory corridor miles in Connecticut, more than half of which are dammed or otherwise not passable for fish. The length of New York total riverine migratory corridor miles has not been estimated, but is much smaller. The Habitat Restoration Work Group tracks fish passage projects that are in progress within the watershed by various partners and reports the total miles restored annually.
Shellfish harvested	Increase the harvest of oysters, clams, and scallops in the Sound through a combination of habitat management and shellfish aquaculture.	This is defined as the total harvest, by weight, of oysters, clams, and scallops harvested commercially or recreationally from open areas and/or shellfish leases. These data are collected by the states, and reported by the Study's Indicators program. Specific targets and timeframes will be developed after considering shellfish management plans under development such as the Connecticut statewide plan.
Habitat connectivity	Increase connectivity of coastal habitat by 2035 by restoring or protecting habitat patches that increase biodiversity and support migratory pathways.	Research shows that improving habitat connectivity allows for genetic and ecological flow. Corridors provide fish and wildlife with greater ability to move for the purposes of feeding, breeding, and resting. Promoting restoration and protection projects which increase aquatic and terrestrial connectivity, is an important component of ecosystem resilience, or the ability of an ecosystem and the fish and wildlife it supports to maintain function in the face of change. Connectivity gains can be both targeted and monitored by mapping restoration and protection projects in a Geographic Information System database and using decision support tools like the Stewardship Site Identification Geographic Information System Tool and Landscape Conservation Cooperative Connecticut River Pilot Landscape Design Tool which highlights the best areas of intact, resilient and connected habitat and identifies corridors between these areas of high quality patches. Using decision support tools like these will help to guide land protection decisions by highlighting areas on the landscape that have the greatest ecological value and identifying corridors between them. Efforts to refine these decision support tools are still underway as part of the implementation action "to develop or apply habitat connectivity models to provide metrics for all restoration and protection projects." Once these tools are complete, they will be used to establish a quantitative metric which will be used to estimate a baseline and set a more specific quantitative goal to be accomplished by 2035.

**Appendix III: The 20 Long-Term Targets and Associated Indicators**

<b>Target name</b>	<b>Description of target</b>	<b>Indicator</b>
<b>Thriving habitats and abundant wildlife theme</b>		
Protected open space	Conserve an additional 4,000 acres of Connecticut land and 3,000 acres of New York land within the Long Island Sound coastal boundary by 2035, while maintaining or increasing the total area of protected land.	Connecticut's goal is to conserve an average of 200 acres per year within the Long Island Sound coastal boundary over the next 20 years, resulting in a total of 4,000 acres. New York State is currently working on the latest version of their New York Open Space Conservation Plan. The Plan serves as the blueprint for the State's land conservation efforts and is required by law to be revised every three years. The most recent revision will be released in 2015. In the Plan, open space is considered an area of land that is either publicly or privately owned that will remain in its natural state or is used for agriculture, free from intensive development for residential, commercial, industrial or institutional use. The Plan identifies conservation projects and objectives for all counties found within the Long Island Sound watershed. These projects and objectives were determined by Regional Advisory Committees composed of county and state, land conservation organizations, and community interest group representatives, along with public comments received through the Plan review process. This Plan will help guide land acquisition in New York State for the coming years. The target number of acres to be acquired each year within the Long Island Sound watershed for New York is 150 acres per year. This number was determined by reviewing and averaging the total number of acres acquired each year and reported to the National Estuary Program Online Reporting Tool (NEPORT). The total number of acres acquired each year (includes acres acquired by all possible land acquisition entities: state, municipal, and land conservation organizations) for the last eight years (2007-2014), within the Long Island Sound watershed in New York State, was analyzed. Thus, the target is to preserve 3,000 acres of New York land within the Long Island Sound watershed by 2035. There is, however, a need for an accurate, complete inventory of protected land statewide in Connecticut and in the coastal area of Connecticut and New York to assess progress toward these goals.
<b>Sustainable and resilient communities theme</b>		
Waterfront community resiliency and sustainability	All coastal municipalities have prepared plans for shoreline resiliency and infrastructure sustainability and resiliency by 2025, with all future development compliant with those plans by 2035.	Sustainable development and redevelopment as well as the protection of urban and suburban infrastructure from the effects of climate change are two of the main principles driving the revision of the comprehensive conservation and management plan. This target will encourage municipalities, within the coastal zone, to develop and implement comprehensive plans, which will have long lasting benefits to their residents. The implementation of these plans should not sacrifice ecosystem integrity. The Sound-wide enumeration of coastal municipalities will be quantified and tracked by the Study (in Connecticut there are 36 coastal municipalities, in New York there are 96).
Harbor and bay navigability	Maintain all federal navigation channels in harbors and bays and manage dredged material in a cost-effective and environmentally sound manner, consistent with a bi-state Dredged Material Management Plan, by 2035.	Maintenance of navigational channels is essential to sustain both recreational and commercial activities in harbors and embayments along the Connecticut and New York shorelines. This target ensures that dredging and dredged material disposal operations are accomplished in a sustainable manner, consistent with the Marine Protection, Research, and Sanctuaries Act, Clean Water Act, National Environmental Policy Act, and the Long Island Sound Dredged Material Management Plan so that future generations can enjoy boating in Long Island Sound and be assured that environmental degradation does not occur from the maintenance of harbors and embayments. The Long Island Sound Dredged Material Management Plan is presently under development. Project lists and dredge material amounts can be found at <a href="http://www.epa.gov/region1/eco/lisdreg/index.html">http://www.epa.gov/region1/eco/lisdreg/index.html</a> .

**Appendix III: The 20 Long-Term Targets and Associated Indicators**

<b>Target name</b>	<b>Description of target</b>	<b>Indicator</b>
<b>Sustainable and resilient communities theme</b>		
Public engagement and knowledge	Increase the knowledge and engagement of the public in the protection or restoration of Long Island Sound.	A 2006 public perception survey supported by the Study was conducted to gauge the knowledge of residents in the watershed. The survey correlated environmental knowledge with behaviors contributing to environmental stewardship. However, achieving positive behavior changes requires understanding and addressing the specific barriers preventing individuals and communities from their adoption. This target will require the development of baseline and trends metrics through best available research methods or review of existing social data that assess the degree to which the public understands its role in the protection of Long Island Sound and acts on that knowledge.
Public beach closures	Reduce by 50 percent the number of beaches reporting at least one closure day or the total number of beach-day closures per monitored beach due to water quality impairments by 2035 compared to a 5-year rolling average from 2014.	The Study presently tracks closure days at 648 Connecticut and New York beaches using the Environmental Protection Agency Beach Advisory and Closing Online Notification system ( <a href="http://watersgeo.epa.gov/beacon2/reports.html">http://watersgeo.epa.gov/beacon2/reports.html</a> ). The 5-year rolling average is 1,317 closure or advisory days, which translates to almost exactly two closure days per monitored beach. Of the 648 beaches reporting, 132 (20.5 percent) had at least one closure day. The target therefore is to reduce the 5-year rolling average to about one closure day per monitored beach per year (658 total closure days assuming constant number of beaches sampled), or to reduce the total number of beaches reporting a closure to less than 10.25 percent of the total number of tracked beaches (66 at present sampling level).
Marine debris	Decrease the mass of marine debris in Long Island Sound by 2035.	While the Study tracks several measures of marine debris, including boom or skimmer data, debris collected by vessels, and various annual beach cleanup statistics, the currently tracked indicator of pounds of debris removed per mile of beach cleanup performed is the best "effort independent" metric of the presence of debris in Long Island Sound. The data are obtained from Long Island Sound coastal cleanup days conducted as part of the International Coastal Cleanup coordinated by the Ocean Conservancy. The target is to reduce the 5-year rolling average of this indicator, compared to the 2013 baseline (5-year rolling average from 2009 to 2013) of 313 pounds of debris removed per mile surveyed.
Public access to beaches and waterway	Increase the number of public access points accessible by the public to the Sound and its rivers by at least 10 percent by 2035.	Public access to the shore for all members of the Long Island Sound community is an important design principle for the comprehensive conservation and management plan. There is not much undeveloped waterfront left along the coast. The comprehensive conservation and management plan includes an action to undertake a Sound-wide evaluation of coastal public access needs including a re-evaluation of existing public access for state or municipal sites that would most benefit for improvements to existing facilities. Such a plan would include the following steps: identify the current number of points and miles accessible; identify specific potential public access sites that could be re-developed in the future, as well as areas and stretches requiring additional attention; describe planning challenges to be considered in adding new access sites; summarize findings and set out steps for implementing the plan and increasing access. Measurement methods for shoreline accessibility will be based on this Sound-wide public access plan. The current suggested metric for this is the quantity of public access points. Currently in Connecticut, there are 328 access points, so a 10 percent increase would require 33 new access points. New York does not currently track this metric, but would begin doing so as part of the implementation action "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." Additional measurement methods and numeric targets for shoreline accessibility (for example, the Americans with Disabilities Act compliant access points) may arise upon completion this Sound-wide public access plan.

Source: GAO analysis of Long Island Sound Study information. | GAO-18-410

# Appendix IV: Expert Responses on Whether Indicators Are Accurate, Valid, and Reliable

We interviewed a nonprobability sample of 19 individuals with expertise on Long Island Sound to obtain their views on the 20 long-term targets and their associated indicators that the Long Island Sound Study said they plan to use to measure progress toward the goals of the 2015 Long Island Sound *Comprehensive Conservation and Management Plan*. We asked each expert to review the targets and associated indicators and to “select those that you would be comfortable speaking about based on your knowledge and expertise.” We then conducted interviews with each expert, and asked “is the indicator a valid, accurate, and reliable way to measure progress to achieve the target?” Table 11 shows the expert’s responses for each target.

**Table 11: Expert Responses on Whether Indicators Associated with 20 Targets in the 2015 Long Island Sound *Comprehensive Conservation and Management Plan* Are a Valid, Accurate, and Reliable Way to Measure Progress to Achieve the Targets**

Target name	Yes	No	Total number of responses
Extent of Hypoxia	12	0	12
Water clarity	9	0	9
Coastal habitat	8	0	8
Sediment quality improvement	6	0	6
Eelgrass extent	6	0	6
Protected open space	5	0	5
Riparian buffer effect	4	0	4
Marine debris	4	0	4
Public access to beaches	3	0	3
River miles restored for fish passage	2	0	2
Harbor and bay navigability	2	0	2
Habitat connectivity	1	0	1
Tidal wetland	8	1	9
Nitrogen loading	7	1	8
Shellfish harvested	6	1	7
Impervious cover	4	1	5
Waterfront community resiliency and sustainability	4	1	5
Public engagement and knowledge	4	1	5
Approved shellfish area	6	2	8
Public beach closures	3	1	4
<b>Total</b>	<b>104</b>	<b>9</b>	<b>113</b>

Source: GAO. | GAO-18-410

# Appendix V: Comments from the Environmental Protection Agency



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION 1  
Boston, Massachusetts

REGION 2  
New York, NY

JUN 25 2018

OFFICE OF THE  
REGIONAL ADMINISTRATORS

Mr. Alfredo Gomez  
Director  
Natural Resources and Environment  
U.S. Government Accountability Office  
Washington, DC 20548

RE: GAO Draft Report, *Long Island Sound Restoration: Improved Reporting and Cost Estimates Could Help Guide Future Efforts* (GAO-18-410)

Dear Mr. Gomez:

Thank you for the opportunity to review and comment on the GAO Draft Report, *Long Island Sound Restoration: Improved Reporting and Cost Estimates Could Help Guide Future Efforts* (the report). The purpose of this letter is to provide the U.S. Environmental Protection Agency's response to the Draft Report's findings, conclusions, and recommendations.

The EPA is proud of the accomplishments of the Long Island Sound Study (Study), achieved through partnership with the Connecticut Department of Energy and Environmental Protection and the New York State Department of Environmental Conservation. Working cooperatively across federal and state programs and involving stakeholder communities and organizations to solve problems, the Study has been a national leader in aquatic restoration.

- When approved in 2001 by EPA, the Total Maximum Daily Load (TMDL) for nitrogen developed by Connecticut and New York was the most complex and comprehensive in the nation. The 106 New York and Connecticut wastewater treatment plants have reduced the annual discharge of nitrogen to Long Island Sound by 45 million pounds compared to baseline levels established in the TMDL and are meeting TMDL targets. Innovative permits and pollutant trading have reduced implementation costs while accelerating progress. Connecticut's Nitrogen Credit Exchange program, for example, won a 2007 EPA Blue Ribbon Water Quality Trading Award.
- Between 1998 and 2017, Study partners have restored 1,964 acres of coastal habitat and reconnected 386 river miles for fish migration.

The EPA appreciates the effort of your staff to engage with the many federal, state, and other partners that contribute to the Study. Using strong science, shared ecosystem goals, and cross-jurisdictional management, the Study is poised to further our strong progress toward clean water, thriving habitats and wildlife, and resilient, engaged communities. The EPA agrees with the conclusions and recommendations contained in the report. This letter also highlights steps already taken consistent with GAO's recommendations and specific suggested revisions to the report are outlined in the enclosure.

GAO organized its findings on federal efforts to restore Long Island Sound in three areas:

- **Progress toward 1994 Plan:** While Study members interviewed by GAO generally agreed that moderate progress has been made toward achieving the goals of the 1994 Comprehensive

Conservation and Management Plan (CCMP), without a comprehensive assessment it was not possible to determine the extent these views reflect actual progress;

- **Reporting Progress for the Plan:** The 2015 update to the CCMP includes twenty long-term ecosystem targets and associated numerical indicators that will be used to measure future progress, but leading practices for performance reporting still need to be implemented; and,
- **Estimating Costs of Restoration:** The 2015 CCMP includes cost estimates for implementation, but future revisions of implementation actions should include costs for all actions and uncertainty ranges.

EPA agrees that the 1994 CCMP had few quantitative targets, which limited the degree to which comprehensive assessments could quantify progress. As noted in the report, the Study did evaluate and publish numerous qualitative assessments of progress. To enhance the ability to track and report on progress, the Study developed twenty quantitative ecosystem targets that were incorporated into the updated 2015 CCMP. GAO notes correctly that the utility of long term targets is enhanced when there are intermediate goals that can be continually assessed, with the results applied to adapt management as needed. In response to dialogue with GAO during the engagement, the Study has established a methodology to assess progress against intermediate goals for many of the ecosystem targets. For example, the ecosystem target to reduce effective impervious cover by ten percent in twenty years would assume a pace of 0.5 percent per year. Progress at any point in time would be assessed against the rate needed to attain the long-term target. On page 35, GAO states that the Study has now established intermediate goals for five of the ecosystem targets. However, applying the methodology to the twenty Ecosystem Targets results in eleven having intermediate goals (Impervious Cover, Riparian Buffer Extent, Approved Shellfish Areas, Sediment Quality Index, Coastal Habitat Extent, Eelgrass Extent, Tidal Wetlands Extent, River Miles Restored for Fish Passage, Protected Open Space, Public Beach Closures, and Public Access to Beaches and Waterways). EPA will work with the Study to better communicate these existing intermediate goals on the webpages reporting the ecosystem progress. Since ecosystems do not always respond immediately or linearly to management, the Study will evaluate and provide context to observed changes.

The report states that the 2015 CCMP estimates that future implementation activities may cost nearly \$21.9 billion. However, the 2015 CCMP does not present that figure and it is a misleading interpretation of the CCMP implementation costs. The Project Implementation Funding section of the 2015 CCMP (page 48-49), presents information on past costs related to implementation of the 1994 CCMP and expected future needs to implement ongoing commitments related to combined sewer overflow (CSO) and separate sanitary system overflow abatement programs. The future needs to implement ongoing commitment costs were provided to put into context the costs added from new actions identified in the CCMP. Table 6 in the GAO report appears to double count Connecticut CSO costs in the 2015 CCMP by including both the \$4.4 billion taken from the text and the \$3 billion taken from Table 5. The 2015 CCMP is admittedly unclear in attributing costs to specific categories. EPA will work with the Study to clarify the estimated CCMP implementation costs in future updates. These numbers will be of critical consideration as we collectively work to rationalize the pace of meeting environmental targets with the availability of state, federal, and local resources required to provide effective mitigation and ecosystem restoration.

GAO makes three specific recommendations for action. Those recommendations and EPA's response are provided below.



**Recommendation #1: The Director, working with the Study, should ensure that as the Study finalizes its reporting format, it fully incorporates leading practices of performance reporting.**

EPA agrees with this recommendation. As noted in the report, the Study has partially incorporated the practice of reporting progress data on ecosystem targets for a preceding period of time. Some ecosystem targets in the 2015 CCMP, however, do not have historical data upon which to compare. Some ecosystem targets will require new data collection to establish a baseline and compare changes over time.

EPA, working with the Study, is planning to further evaluate, develop, and apply leading practices of performance reporting. This work will commence in FY 2018 and will supplement the work on ecosystem targets, providing information on the degree to which the strategies and actions in the 2015 CCMP are being implemented and interpret those activities in the context of ecosystem target progress. This information will be posted on the Study website and used to revise the implementation actions every five years. We estimate that enhancements to the reporting format will be completed by mid-calendar year 2019 and made publicly available through the Study website by the end of 2019. We will work with the Study to continue enhancing the reporting format in calendar year 2020, to support the planned update to the CCMP's Implementation Actions in 2020. EPA is also continually working with the Study to collect new and ongoing data necessary to report on all the ecosystem targets.

**Recommendation #2: The Director, working with the Study, should develop cost estimates that include analyses of uncertainties for each of the targets in the 2015 plan.**

EPA agrees with this recommendation. EPA will take into consideration, when developing cost estimates, to not double count contributions for individual actions that can contribute to the attainment of multiple ecosystem targets. For example, reducing nitrogen pollution can contribute to reducing the extent of hypoxia, improving water clarity, and increasing eelgrass. The costs for attaining ecosystem targets for these three examples should not be double counted as actions that contribute to multiple ecosystem outcomes.

EPA, working with the Study and in close collaboration with our state partners and other stake holders, will evaluate the range of costs needed to attain each of the targets, while identifying areas of overlap so as not to exaggerate the cumulative costs. This work will commence later in FY 2018. We expect that enhanced cost information will be completed by mid-2019 and posted on the Study website by the end of 2019. We will work with the Study to continue to enhance the cost information in 2020; this will also support the planned update to the CCMP's Implementation Actions in 2020.

As noted by GAO, the Study is still working to develop the specific requirements and actions needed to meet ecosystem targets. As a result, the exact course of action and associated costs are still to be defined, reflecting the underlying uncertainty. Therefore, EPA agrees that future updates of the plan will include cost estimates with uncertainty bounds. EPA and the Study are continuing to assess progress in reducing nitrogen pollution and the resulting water quality improvements. Over the past two years, the Study has targeted \$2.6 million, matched by \$2.6 million from the New York City Department of Environmental Protection, to develop a refined water quality model that will include management options and costs in scenario planning. This initiative is strongly supported by the Region 1 and 2 Administrators and the state counterpart commissioners for CT and NY as a powerful tool for guiding needed investments to fully restore Long Island Sound.

**Recommendation #3: The Director, working with the Study, should estimate the range of potential costs for all implementation actions and include estimates in future supplements to the 2015 plan.**

EPA agrees with this recommendation. We note that the implementation actions in the 2015 CCMP that did not have costs associated with them were often low cost, requiring mostly staff time already committed to and accounted for in other actions. EPA will work with the Study to ensure that the planned update to implementation actions includes a range of costs for all implementation actions. The first update to the 2015 CCMP Implementation Actions will be completed in 2020.

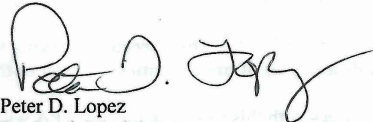
The GAO report is timely, as the Study is working to transition from the 1994 CCMP to evaluating and reporting on the 2015 CCMP. We believe the Study has benefited from the GAO engagement, already adjusting how the ecosystem targets are presented. The Study has specifically delayed finalizing approaches for CCMP assessment and reporting while the GAO engagement was ongoing. EPA is committed to working with the Study to act on GAO's recommendations.

If you have questions regarding this letter or the enclosed technical comments, please contact us or Mark Tedesco, Director of the Long Island Sound Office, at (203) 977-1542 or [tedesco.mark@epa.gov](mailto:tedesco.mark@epa.gov).

Sincerely,



Alexandra Dapolito Dunn  
Regional Administrator  
U.S. Environmental Protection Agency  
Region 1



Peter D. Lopez  
Regional Administrator  
U.S. Environmental Protection Agency  
Region 2

Enclosure: Specific Technical Comments

cc: EPA GAO Liaison Team

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# Appendix VI: GAO Contact and Staff Acknowledgments

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## GAO Contact

J. Alfredo Gómez, (202) 512-3841 or [gomezj@gao.gov](mailto:gomezj@gao.gov)

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## Staff Acknowledgments

In addition to the contact named above, Susan Iott (Assistant Director), Michelle K. Treistman (Analyst-in-Charge), Chuck Bausell, Mark Braza, Ellen Fried, Benjamin T. Licht, James I. McCully, Katya E. Rodriguez, and Sara Sullivan made key contributions to this report.

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# Related GAO Products

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*Great Lakes Restoration Initiative: Improved Data Collection and Reporting Would Enhance Oversight.* [GAO-15-526](#). Washington, D.C.: July 21, 2015.

*Great Lakes Restoration Initiative: Further Actions Would Result in More Useful Assessments and Help Address Factors That Limit Progress.* [GAO-13-797](#). Washington, D.C.: September 27, 2013.

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*Recent Actions by the Chesapeake Bay Program Are Positive Steps Toward More Effectively Guiding the Restoration Effort, but Additional Steps Are Needed.* [GAO-08-1131R](#). Washington, D.C.: August 28, 2008.

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