SECTION 4

MONITORING

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

ENVIRONMENTAL MONITORING

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

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

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

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

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

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

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

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

PROGRAMMATIC MONITORING

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