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Addressing GAO's Recommendations

LISS Performance Reporting and Cost Estimating

Acknowledgements

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Addressing GAO's Recommendations

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Executive Summary

In 2018, the GAO released a report titled *Long Island Sound Restoration: Improved Reporting and Cost Estimates Could Help Guide Future Efforts (GAO-18-140)*. The report examined: what is known about the progress made toward achieving the 1994 CCMP; how the LISS intends to measure and report on progress toward achieving the 2015 CCMP; and the estimated costs of restoration. The GAO had three specific recommendations:

- Incorporate the following leading practices of performance reporting in LISS reporting, which are: i) Evaluating performance compared to goals set out by a plan; ii) Reviewing past performance toward meeting the goals, measured as baseline and trend data for ecological indicators; and iii) Evaluating actions for unachieved goals to understand how and why they haven't been met, and what management adjustments are needed.
- Develop cost estimates that include analysis of uncertainties for each of the ecosystem targets in the 2015 Plan; and
- Estimate the range of potential costs for all implementation actions and include the estimates in future supplements to the 2015 plan.

To assist EPA in addressing GAO's recommendations, this report summarizes findings from an evaluation of the LISS's current reporting framework through the lens of the GAO leading practices, research on reporting practices from other estuary programs, and a cost analysis to generate ecosystem target cost estimates. This report offers suggestions to help the LISS further address the GAO's reporting and cost estimating recommendations moving forward.

Performance Reporting

We reviewed the information provided for each ecosystem target on the LISS ecosystem target trends and status website. LISS focuses reporting on ecosystem targets (environmental outcomes) but does not report on the status of implementation actions (programmatic outputs), which makes it challenging to fully evaluate how the implementation of CCMP actions and management strategies relate to the achievement of ecosystem targets. We found that the LISS is in substantial compliance with GAO leading practices #1 and #2, and that most of the gaps observed are expected to be filled in the short-term. Full application of leading practice #3, however, will require the LISS to track implementation progress of management actions and critically assess how that progress relates to unmet goals. LISS is not alone in this challenge—we only identified two NEPs that are tracking and reporting progress at the implementation action level (Puget Sound and San Francisco Bay). Of the NEP programs, the Puget Sound is the closest to connecting implementation progress with environmental outcomes. The Chesapeake Bay Program is also tracking and connecting implementation progress with outcomes.

Table E1 summarizes gaps in performance reporting for each LISS ecosystem target. By our interpretation, until implementation progress is tracked at the level of CCMP strategies or implementation actions, LISS' reporting will only partially comply with GAO Leading Practice #3. Of the programs reviewed, we consider the LISS to be in the upper tier for incorporating GAO's leading practices, having indicators for most of its ecosystem targets, and having an advanced online reporting framework. Several programs are in the process of updating their reporting platforms and others offered innovative features that might inspire the LISS, such as more online performance reporting and less paper reporting; open portals/databases for more frequent, direct updates by partners; inclusion of social and economic indicators; and standalone websites with clean and engaging visualizations using infographics, compelling imagery, and interactive reporting elements).

Table E1. Ecosystem Target Information Incorporating GAO Leading Practices

Ecosystem Target	1. Performance toward plan goals	2. Baseline & trend data	3. Evaluation of actions for unmet goals
Extent of Hypoxia	●	●	◖
Nitrogen Loading	●	◖	◖
Water Clarity	●	●	○
Impervious Cover	○	○	◖
Riparian Buffer Extent	●	●	○
Approved Shellfish Areas	●	●	◖
Sediment Quality Improvement	○	○	◖
Coastal Habitat Extent	●	●	◖
Eelgrass Extent	○	●	◖
Tidal Wetland Extent	●	●	◖
River Miles Restored for Fish Passage	●	●	◖
Shellfish Harvested	●	●	◖
Habitat Connectivity	○	○	○
Protected Open Space	●	●	◖
Waterfront Community Resiliency & Sustainability	●	○	◖
Harbor and Bay Navigability	●	●	◖
Public Engagement and Knowledge	○	○	○
Public Beach Closures	●	●	○
Marine Debris	●	●	◖
Public Access to Beaches and Waterways	●	●	◖

○not applying practice ◖partial application ●full application

Cost Estimating

The 2015 CCMP and the 2018 GAO reports estimated a total implementation cost of $14 and $18 billion, respectively, over a 20-yr horizon. The LISS has partially addressed the costing recommendations of the GAO—specifically, by providing relative cost ranges for implementation actions in the supplemental documents to the CCMP. However, LISS has not generated cost estimates for each ecosystem target.

A cost analysis was conducted to estimate ecosystem target costs. The approach evaluated two sets of program cost estimates: core costs and implementation action (IA) costs. Core costs include the 20-yr state-level capital expenditures listed in Table 5 on page 49 of the 2015 CCMP. IA costs are the 5-yr ranges (min and max) for the 139 implementation actions published as supplements to the 2015 CCMP. Core costs and implementation action costs were distributed across relevant ecosystem targets (while accounting for overlaps and uncertainty) to arrive at ET-specific cost estimates. Cost information was primarily derived from existing estimates in the 2015 CCMP and the Supplemental Reports to the CCMP. Additional costs were derived for CSO and stormwater retrofitting in New York using data from the NYC Long-Term Control Plans and an impervious cover analysis of non-CSO portions of the NY contributing drainage area, respectively. **Table E2** summarizes results of the cost analysis, which estimated a total maximum 20-yr cost of $12.4 billion. Individual ecosystem target costs ranged widely from $33 million (the Navigability target) to $1.8 billion (Hypoxia target) over 20-yrs. Just under 70% of the total costs were associated with core costs for targets in the WW theme.

Table E2. Summary of 5- and 20-yr Ecosystem Target Costs (rounded costs in $ Millions)

Theme	Ecosystem Target	IA $ Range (5-yr)		Core $ (20-yr)	Total $ Range (5-yr)		Total $ Range (20-yr)	
		Min	Max		Min	Max	Min	Max
WW	Hypoxia	2	21	1,696	426	445	1,705	1,780
	Nitrogen Loading	2	21	1,696	426	445	1,705	1,779
	Water Clarity	2	21	1,696	426	445	1,705	1,780
	Impervious Cover	0	5	695	174	179	696	716
	Riparian Buffers	0	3	213	54	57	215	226
	Approved Shellfish Areas	1	12	695	175	186	699	744
	Sediment Quality	1	8	1,696	425	432	1,699	1,726
	Total	**9**	**92**	**8,386**	**2,106**	**2,188**	**8,423**	**8,752**
HW	Coastal Habitat Extent	1	8	60	16	23	64	91
	Eel grass extent	1	5	1,756	440	444	1,758	1,775
	Tidal wetland extent	0	5	60	15	20	62	80
	River Miles Fish Passage	0	2	96	24	26	97	102
	Shellfish Harvested	0	2	30	8	10	31	38
	Connectivity	1	5	279	70	75	282	299
	Open Space	1	17	213	54	70	217	281
	Total	**4**	**43**	**2,494**	**628**	**667**	**2,510**	**2,667**
SC	Shorelines	1	8	27	8	15	30	60
	Navigability	0	2	27	7	8	28	33
	Public Eng. & Knowledge	2	10	8	4	12	14	47
	Beach Closures	0	2	695	174	176	696	703
	Marine Debris	0	1	95	24	25	96	100
	Public Access	1	7	27	7	14	30	56
	Total	**4**	**30**	**878**	**223**	**250**	**893**	**998**
	TOTAL	**17**	**165**	**11,758**	**2,957**	**3,104**	**11,826**	**12,417**

Addressing GAO Recommendations

Based on our findings from the review of performance reporting practices and cost estimating efforts, the actions summarized in **Table E3** are for LISS consideration in order to fully address GAO recommendations and to advance reporting moving forward.

Table E3. Summary of Actions for Addressing GAO Recommendations

GAO Recommendation		**Actions**
#1 Leading Practices		1. Assess completion status of implementation actions and how progress relates to ecosystem target achievement. Determine if actions need to be modified in order to meet target.
		2. Work with partners to further develop innovative online performance reporting tools. Specifically, consider standalone performance web platform/branding, interactive mapping, real-time data portals, and searchable databases (see Puget Sound Info and ChesapeakeSTAT).
		3. Explore a reporting platform that allows direct data upload by Sound partners. LISS can reduce the burden of data compilation and synthesis by investing in a reporting platform that allows direct (and easy) data upload by partners (see Tahoe Info and Puget Sound Info).
		4. Reduce the # of printed publications and increase frequency of online reporting for ecosystem targets and indicators as data becomes available. The trend with most NEPs is to move towards reliance on online communications where updates can match the speed at which new data/analysis/information becomes available.
#2 Develop Costs Estimates for Ecosystem Targets		5. During next CCMP update, refine cost estimates generated for each implementation action. There is already a wealth of information provided for each action in the supplemental documents. Refining the cost estimates, understanding the uncertainties of that estimate, and linking actions directly to specific ecosystem targets/indicators is a valuable next step.
		6. Work with partners to further track & evaluate core costs. More effort on core costing may include assigning a cost range (uncertainty), adding other states to the current list, and potentially expanding the number of cost centers.
#3 Estimate Cost Ranges for Implementation Actions		7. Track $ spent and source of funding as part of performance reporting. Chesapeake Bay, Puget Sound, and Tahoe include information about project cost within performance reporting. If a similar approach was taken by LISS, the ability to estimate costs and track funding sources would be increased.
		8. Refine costing assumptions (e.g., yearly estimates, science & management, ET cross-links). The costing approach presented includes several assumptions that could (and likely should) be adjusted as more information becomes available.

Introduction

The Long Island Sound provides numerous economic and recreational benefits to the surrounding states. However, development, pollution, and rapid population growth have led to environmental degradation in the Sound which threatens those benefits. The impacts of environmental degradation prompted the creation of the Long Island Sound Study (LISS), which is a federal-state partnership formed in 1985 to restore the 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.

As required under the Clean Water Act, the LISS developed a Comprehensive Conservation and Management Plan (CCMP) recommending actions to restore and maintain the Sound's chemical, physical, and biological integrity. The original CCMP was released in 1994 and identified six priority problems: toxic substances, pathogen contamination, floatable debris, management and conservation of living resources and their habitats, land use and development, and low dissolved oxygen. A revised CCMP was released in 2015 that focused on four themes: (1) Clean Water and Healthy Watersheds (WW), (2) Thriving Habitats and Abundant Wildlife (HW), (3) Sustainable and Resilient Communities (SC), and (4) Sound Science and Inclusive Management (SM).[1]

At the request of the United States House of Representatives Committee on Transportation and Infrastructure, the Government Accounting Office (GAO) reviewed the LISS progress on restoring the Sound. In 2018, the GAO released a report titled *Long Island Sound Restoration: Improved Reporting and Cost Estimates Could Help Guide Future Efforts (GAO-18-140)*.[2] The report examined: (1) what is known about the progress made toward achieving the 1994 CCMP, (2) how the Study plans to measure and report on progress toward achieving the 2015 CCMP, and (3) estimated costs of restoration. Upon completing its evaluation, the GAO report recommended steps to improve the Study's progress reporting and cost estimation practices.

GAO's Recommendations

Specifically, the GAO report advanced three major recommendations related to evaluating performance of CCMP implementation and estimating the cost of ecosystem target achievement.

[1] The 2015 CCMP is available at http://longislandsoundstudy.net/our-vision-and-plan/
[2] The 2018 GAO report is available at https://www.gao.gov/products/GAO-18-410.

The GAO recommended that the LISS Director, working with partners, should:

1. Ensure that the LISS fully incorporate leading practices of performance reporting as it finalizes its reporting format. These leading practices include:
    - Evaluating performance compared to goals set out by a plan;
    - Reviewing past performance toward meeting the goals, measured as baseline and trend data for ecological indicators; and
    - Evaluating actions for unachieved goals (understanding how and why they haven't been met, and what needs to be done about it).
2. Develop cost estimates that include analysis of uncertainties for each of the ecosystem targets in the 2015 Plan; and
3. Estimate the range of potential costs for all implementation actions and include the estimates in future supplements to the 2015 plan.

By 2017, the LISS had created a new online reporting framework to help track and report progress on 20 ecosystem targets developed as part of the updated CCMP, which incorporates some, but not all, of the GAO leading performance reporting practices. In addition, the 2015 CCMP and supplemental documents contain 20-year implementation cost estimates for statewide capital expenditures and 5-year implementation action costs, respectively.

Purpose

To assist EPA in addressing GAO's recommendations, the Horsley Witten Group and FB Environmental evaluated the current reporting framework through the lens of the GAO leading practices. In addition, we revisited implementation cost estimates published in the 2015 CCMP and in the supplementary documents prepared for each of the four themes. This report offers suggestions from our evaluation to help the LISS further address the GAO's reporting and cost estimating recommendations moving forward.

Methods

To address GAO Recommendation 1: Leading Practices, we identified gaps in LISS's overall performance reporting framework and, more importantly, opportunities for improvement. Specifically, we conducted the following:

- An in-depth review of the Status and Trends LISS Ecosystem Targets and Supporting Indicators website to evaluate the extent of information presented on each of the 20 ecosystem targets;
- A review of LISS publications (e.g., 2015 CCMP and four supplemental documents, 2016 Sound Update, 2012 Sound Health, and 2011-2012 Biennial Report, 2015 Implementation Tracking Report);

- Monthly discussions and a working session with the LISS director, staff, and partners about (and capacity for) incorporating and addressing observed "gaps" in the application of GAO's Leading Practices for Performance Reporting; and
- Research on the reporting practices of other comparable estuary (and non-estuary) programs, including Puget Sound, San Francisco Bay, Chesapeake Bay, Tampa Bay, Piscataqua, Casco Bay, and others.

To address GAO Recommendation 2: Ecosystem Target Cost and Uncertainty and GAO Recommendation 3: Implementation Action Cost Ranges, we:

- Held monthly meetings and a working session with the LISS director, staff, and partners to develop an approach to estimating implementation costs for each ecosystem target that accounted for overlapping costs and an analysis of uncertainty;
- Reviewed the core costs presented in the 2015 CCMP and relative cost estimates (ranges in some cases) for each implementation action as presented in the supplementary documents;
- Created a cost matrix that links implementation actions and core cost centers with specific ecosystem targets to generate 5-yr and 20-yr cost estimates per target;
- Identified uncertainty factors related to IA and core cost estimates and applied a qualitative uncertainty analysis for the Water and Watershed theme; and
- Made observations on how other programs track implementation costs as part of the evaluation of performance reporting practices.

Findings from these efforts and options for incorporating GAO's recommendations in the 2020 CCMP update are presented in the remaining sections of this report and in the associated attachments.

Performance Reporting

What is the status of 2015 CCMP implementation? Are the management strategies resulting in the desired ecosystem improvements? If not, how do we adapt our strategies or indicators to more effectively achieve objectives or measure results? These are some of the questions that performance reporting is intended to answer and that the GAO's leading reporting practices, specifically, are intended to illuminate.

LISS Current Reporting Framework

In 2017, the LISS launched a well-organized and user-friendly website dedicated to reporting the status and trends of 20 ecosystem targets established during the 2015 CCMP update, as

well as 22 supporting indicators *(http://longislandsoundstudy.net/research-monitoring/liss-ecosystem-targets-and-supporting-indicators/)*. The targets and indicators are organized within the WW, HW, and SC themes (SM theme does not have associated ecosystem targets). Each of the 20 targets is a quantitative measure of a variable that integrates programmatic output and environmental outcome. Improvements to these ecosystem target pages have continued from 2017 to the present. As of 2019, each ecosystem target generally includes:

- A progress bar indicating progress towards meeting the target—this information meets the GAO leading practice for evaluating performance compared to goals set out by a plan;
- Data charts and graphs showing trends over time, where data is available, as well as a discussion of the trends and data collection methods—this information meets the GAO leading practice for reviewing past performance toward meeting the goals, measured as baseline and trend data for ecological indicators;
- A description of challenges in achieving unmet targets, such as difficulties in measuring progress, difficulties achieving full implementation, and outside factors affecting progress. The information partially addresses the GAO leading practice for evaluating actions for unachieved goals without an evaluation of how the implementation (or lack of implementation) of management actions/strategies influences achievement of the ecosystem target; and
- Links to related targets and supporting indicators, other monitoring resources, maps, technical references, reports, and partner information.

LISS indicated that webpages for ecosystem targets and supporting indicators will be updated annually or at the appropriate frequency for the data as they come in—a goal LISS shares with other estuary programs. Already in 2019, updates to the eelgrass coverage and coastal habitat restoration goals have been completed following the arrival of data on these two targets in late 2018.

Previously, LISS was reporting progress in two biennial hard-copy formats, in alternating years—the *Sound Health Report* and the *Protection and Progress Biennial Report*. In addition, LISS has the Sound Update newsletter, which provides annual progress updates, as well as the quarterly *Sound Bytes* e-newsletter. These documents all report on progress towards meeting goals, describe specific actions and accomplishments, and include maps and funding information.

LISS reporting methods are evolving. Program staff are currently deliberating whether to continue with past reporting methods (various hard copy reports) or to expand efforts on the web-based interface. LISS is well aware of the trend among EPA aquatic management programs towards more online reporting and less paper copies (a trend we document in the "Other Programs" section below). LISS partners also maintain Sound-related websites and produce written reports, such as the 2018 Long Island Sound Report Card from Save the Sound.

Reporting Gaps

The 20 ecosystem targets on the status and trends website were reviewed to determine if information was provided in accordance with the three GAO leading practices. We found that LISS, like most of the other estuary programs, is applying the GAO's leading reporting practices for measuring performance towards a goal and against a baseline but is falling short at evaluating actions for unmet targets. In addition, the website does not include information on which management actions have been completed for each ecosystem target, dollars spent, or activities under the Science and Management theme. We acknowledge that some of this information may be occasionally presented within some of the written reports published by the LISS.

Table 4 summarizes which practices are and are not being used for each target. **Attachment A** includes a detailed performance matrix summarizing how the leading practices are incorporated into each ecosystem target. Gaps were identified where no data was available to measure progress towards meeting the target (Leading Practice #1), or where a baseline was missing or the trend analysis was incomplete (Leading Practice #2). Compliance with the third leading practice—evaluation of actions for unmet goals—was based on a review of the information provided under the "challenges" section of the website. Because there is no reporting on the completion status or influence of implementation actions related to ecosystem targets, Leading Practice #3 is considered only partially applied across the board.

Table 4. Ecosystem Target Information Incorporating GAO Leading Practices

Ecosystem Target	1. Performance toward plan goals	2. Baseline & trend data	3. Evaluation of actions for unmet goals*
Extent of Hypoxia	●	●	◖
Nitrogen Loading	●	◖	◖
Water Clarity	●	●	○
Impervious Cover	○	○	◖
Riparian Buffer Extent	●	●	○
Approved Shellfish Areas	●	●	◖
Sediment Quality Improvement	○	○	◖
Coastal Habitat Extent	●	●	◖
Eelgrass Extent	○	●	◖
Tidal Wetland Extent	●	●	◖
River Miles Restored for Fish Passage	●	●	◖
Shellfish Harvested	●	●	◖
Habitat Connectivity	○	○	○
Protected Open Space	●	●	◖
Waterfront Community Resiliency & Sustainability	●	○	◖
Harbor and Bay Navigability	●	●	◖
Public Engagement and Knowledge	○	○	○
Public Beach Closures	●	●	○
Marine Debris	●	●	◖
Public Access to Beaches and Waterways	●	●	◖

○not applying practice ◖partial application ●full application

**By our interpretation, none of the ecosystem target reporting <u>fully</u> complies with GAO Leading Practice #3 without comprehensive reporting on action-level implementation progress.*

Targets related to nitrogen loading (partial), water clarity, impervious cover, riparian buffer extent, sediment quality, eelgrass extent, habitat connectivity, waterfront community resiliency, public education and knowledge, and beach closures had reporting gaps. Most of these gaps, however, are anticipated to be resolved once additional data collection efforts are completed. **Table 5** summarizes how the LISS is actively filling these gaps, where deficiencies remain, and examples of how programs report on similar targets/indicators. A database of status and trends and a summary of challenges for each target can also be found in **Attachment A**. More discussion on each leading practice evaluation is provided below.

Leading Practice 1: Performance according to a plan

A progress status bar is provided for each target showing status of progress towards meeting the goal in the CCMP ranging from "behind schedule" to "met goal" (**Figure 1**). Where the status bar indicates that data is unavailable, this was interpreted to mean that for this ecosystem target, GAO's leading practice #1 is not fully being met at this time.

Of the 20 targets LISS set in the 2015 CCMP, five do not have data to fully assess performance according to the goal in the CCMP (see Table 1): impervious cover, sediment quality improvement, eelgrass extent, habitat connectivity, and public engagement and knowledge. Only one of the targets—habitat connectivity—does not have an associated indicator. A quantitative measure of habitat connectivity has not yet been agreed upon by LISS and its monitoring partners, but it is in development. In addition, the LISS hasn't established a method to measure the non-point nitrogen loading from non-point sources, which is part of a 2025 goal under the nitrogen loading target, nor is there a method for deriving reductions in effective impervious cover.

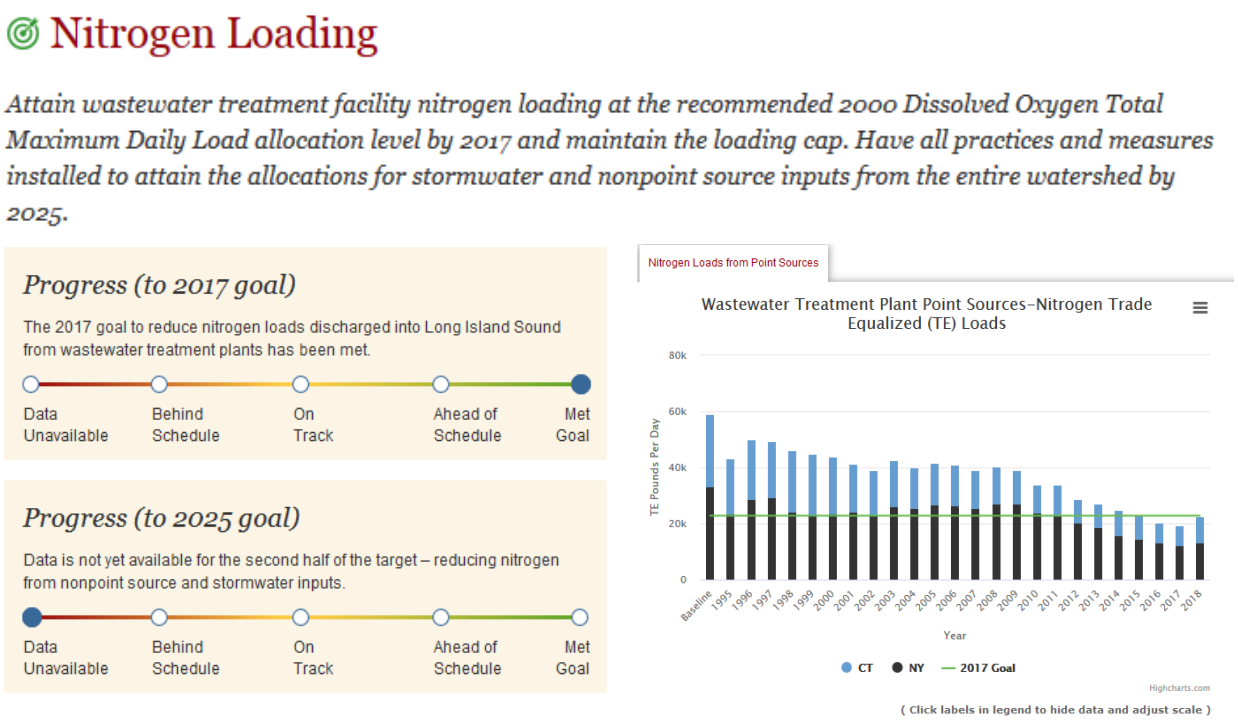

Figure 1. Example Progress Status Bar and Baseline/Trend Graphic from the Nitrogen Loading Target

Leading Practice 2: Baseline and trend data

The LISS relies on a decades-long, extensive record of scientific monitoring data upon which to determine baselines and understand trends. The 2014 scientific synthesis *Long Island Sound: Prospects for the Urban Sea* brings together many of the disparate lines of evidence and monitoring data streams to assess the state of the Sound's health in many respects and was in large part a basis for the 2015 CCMP revision. Most of the reporting on ecosystem targets includes interactive data charts and figures showing annual data, a defined baseline, and the CCMP target(s). Baselines differ across indicators based on available data sets (typically baseline years of 1994, 2006, 2010, or 2014). Trend data are displayed using a web data visualization service from highcharts.com and discussed in a section called "Status and Trends." In some cases, charts displaying indicator data for a given target have a clickthrough option to resize the scale on the x or y axis. Figure 1 shows a representative chart from the nitrogen loading target with a baseline established in 1994 and Trade Equalized lbs. per day from wastewater treatment plants in NY and CT for each year through 2018. The 2017 target set for point sources (green line) was met in 2015. Six ecosystem targets had incomplete or partially complete baseline and trend data: nitrogen loading (for 2025), impervious cover, sediment quality improvement, habitat connectivity, waterfront communities, and public education/knowledge.

Leading Practice 3: Evaluating practices for unachieved goals

GAO's third leading practice is to provide information on why targets have not been adequately met and what the management or monitoring challenges are that must be overcome to meet those targets. Each ecosystem target includes a section on "Challenges" that provides this information (**Figure 2**). The LISS makes a comprehensive effort to acknowledge the difficulties with meeting targets or compiling the data needed to determine indicator status and trends. For four targets (water clarity, habitat connectivity, public engagement and knowledge, and beach closures) the LISS could provide more discussion on what management or reporting actions need to be taken to meet/measure these goals. The LISS does not currently track progress on the 139 implementation actions or 84 strategies listed in the CCMP and detailed in the Supplemental Documents. Furthermore, at the outset of our work, actions were not directly linked to ecosystem targets. Without this information, it is difficult to evaluate if unmet targets are likely to be achieved when strategic actions are fully implemented or if the management strategies need to be adapted. Ultimately, to fully embrace GAO's recommendation, the LISS will need to improve tracking at the action or strategy level.

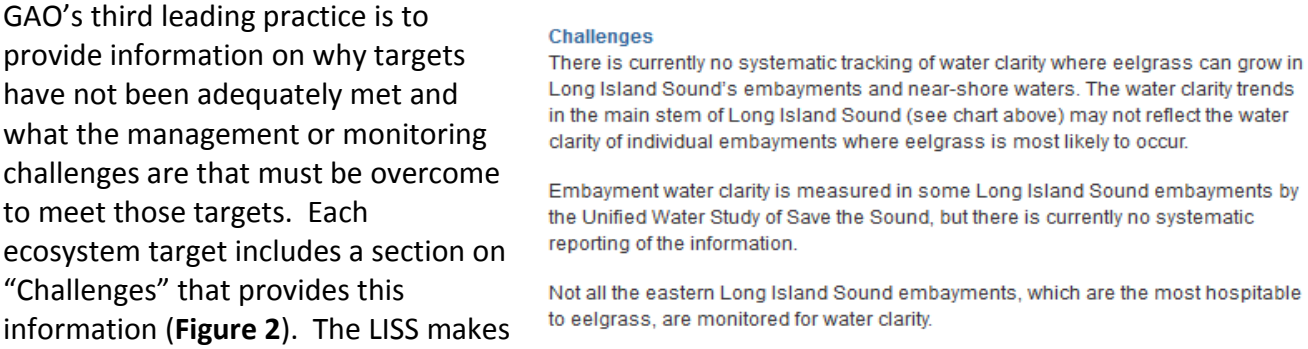

Figure 2. Example of the "Challenges" narrative for Eelgrass Extent target

In a similar evaluation by GAO of the Puget Sound Partnership, the GAO recommended that an indicator should only be tracked if a target has been set; however, most programs agree that there is value in including indicators even if data is not yet available.

Table 5. Addressing Reporting Gaps by LISS and Other Programs' Efforts

Deficient Eco Target	LISS Status	Similar Targets/Indicator Reporting by Other Programs
Nitrogen Loading: *Attain WWTF nitrogen loading limits at the 2000 Dissolved Oxygen TMDL allocation level by 2017 and maintain the loading cap. Have practices and measures instituted to attain allocations for stormwater and NPS inputs from the entire watershed by 2025.*	Have WWTP portion but need means to assess nonpoint source limits by 2025 goal.	• Chesapeake Bay- N loads simulated using Watershed Model and jurisdiction-reported data on wastewater discharges and Agricultural and Urban BMPs for non-point source load reductions. • PREP- nitrogen concentrations and loads from point and non-point sources (by tributary) • Puget Sound- Marine Water Condition Index has multiple parameters relevant to eutrophication against a baseline reference. Reporting focus is on change rather than an absolute quality. They have a separate freshwater quality metric that quantifies impaired listings.
Water Clarity: *Improve water clarity by 2035 to support healthy eelgrass communities and attainment of the eelgrass extent target.*	Currently no systematic tracking of water clarity where eelgrass can grow in LIS's embayments and near-shore waters. Began to collect data in near shore areas in 2018.	• Did not find example of water clarity for specific habitat areas • Tahoe--Water Clarity target-Secchi depth transparency; also have a Lake clarity tracker that reports BMPs at parcel level • Chesapeake Bay- under a WQ Standard target that combines DO/Water Clarity/Chlorophyll a; reported annually by trib. • Tampa Bay- clarity indicated by chlorophyll a concentration; unknown if specific seagrass areas are evaluated
Impervious Cover: *Through green infrastructure, LID, and stormwater disconnections, decrease by 10 % the area of effective impervious cover in the CT and NY portions of the watershed by 2035 relative to a 2010 baseline.*	Should have IC data from 2010-2015 soon. Need method to determine effective impervious cover. Would need to combine with LID data to adjust for "effective" IC.	• Others are tracking IC, but no one is tracking effective cover at this level. If adopting a BMP tracking or other project tracking platform, may be able to estimate effective cover reductions. • PREP- higher resolution imagery and different processing methodology to measure changes in IC; not looking at decreases in effective IC • Chesapeake Bay--Assessing rate of impervious surface change every 2-5 years. CB struggling with this (see "Progress" section). • Casco has an impervious cover indicator
Riparian Buffer Extent: *Increase the % area of natural vegetation within 300 ft of any stream or lake in the CT and NY portions of the Long Island Sound watershed to 75% by 2035 from the 2010 baseline of 65%.*	Should have data needed by 2019.	• Puget Sound- Riparian restoration measured by length or area of restoration projects completed • Chesapeake Bay- Acres of forest buffers were measured directly and obtained from annual state reports to the Chesapeake Bay Model. Average width is reported annually directly to Bay Program staff so that miles of buffer can be calculated.

Deficient Eco Target	LISS Status	Similar Targets/Indicator Reporting by Other Programs
Approved Shellfish Areas: *Upgrade 5% of the acreage restricted or closed for shellfishing in 2014 by 2035.*	Identify how to address in 2020 CCMP update: Target is behind schedule due to the states downgrading of shellfish acreage in 2015	• PREP tracks the % of possible acre-days a year (i.e. the # of open acres multiplied by the # of days those acres were open for harvest); reports acres by harvest category • Chesapeake only reporting on acres of restored oyster beds • Casco is tracking change in acres of harvesting classification status
Sediment Quality Improvement: *Reduce the area of impaired sediment in Long Island Sound by 20% by 2035 from a 2006 baseline.*	Need to identify when 2015 NCA update will be available. Standardization of 2010 data will help. Unclear how to manage contaminated sediment.	• Puget Sound reports on Marine Sediment Quality (Vital Sign) and three indicators -Exceedance of Sediment Quality Standards, Sediment Chemistry Index, and the Sediment Quality Triad Index
Eelgrass Extent*: Restore and maintain 2,000 additional acres of eelgrass by 2035 from a 2012 baseline of 2,061 acres.*	2017 data was unavailable - is now available.	• Puget Sound reports sound-wide eelgrass coverage • Chesapeake Bay- Submerged Aquatic Veg. estimated and observed; acres and % coverage from photointerpretation from annual aerials. • PREP and Casco both include eelgrass indicators • Tampa Bay (seagrass)
Habitat Connectivity: *Increase connectivity of coastal habitat by 2035 by restoring and/or protecting habitat patches that increase biodiversity and support migratory pathways.*	Methodology not yet decided. Proposal being drafted related to Stewardship Sites. Challenging to accomplish at LIS scale. Once tool developed, metrics will be set.	• No examples of this type of target where found. • Casco Bay has mapped interior forest acres, unclear if this is an indicator they are tracking and method • Stream miles opened to fish passage (Chesapeake and Puget).
Waterfront Community Resilience: *All coastal municipalities have prepared plans for resiliency and sustainability by 2025, future development compliant by 2035.*	Baseline data starting 2018; assume baseline of zero.	• The Chesapeake Bay Program is considering the development or adoption of up to 9 indicators to track progress toward building climate resiliency. • San Francisco Bay has one action and 3 tasks related to coastal resiliency and community planning
Public Engagement and Knowledge: *Increase the knowledge/engagement of public in the protection and/or restoration of LIS compared to 2006 public survey.*	Need follow-up to 2006 survey. Next round of data collection should fill gap.	Chesapeake Bay--Stewardship: 13 minute-phone survey of 5,200 residents capturing measures of 19 individual stewardship behaviors, likelihood to perform those behaviors in the future, volunteerism, civic engagement, and attitudes and perceptions that impact personal stewardship.
Public Beach Closures: *Reduce by 50% the # of beaches reporting at least one closure day or the total # of beach-day closures per monitored beach due to water quality impairments by 2035, compared to a five-year rolling average from 2014.*	Closures are not always due to water quality issues; new test introduced in 2006 for bacterial pathogens in NYC marine waters; how do we address these challenges?	Casco Bay reports on swimming beach closures using public data collected by Maine Healthy Beaches, a partnership of the Maine Department of Environmental Protection and University of Maine Cooperative Extension.

Other Programs

To assist LISS in filling reporting gaps and—more importantly—to provide recommendations for improvement in reporting structure, we reviewed the current reporting methods of several other estuary programs (NEP and non-NEP), including: the Chesapeake Bay, Tampa Bay, Puget Sound, Casco Bay, San Francisco Bay, Piscataqua, and Lake Tahoe programs. We first reviewed the program's website to determine how its performance reporting was structured, and then followed up with six of the programs by phone and/or email to better understand the goals and relative capacity of these programs.

Specifically, we asked program representatives to discuss the following elements of their performance reporting process:

- Timeframe/schedule for the next update to the CCMP or principle plan (for non-NEPs);
- Anticipated changes to tracking and reporting methods;
- Annual budgets ($ or %) allocated to reporting performance;
- Number of staff devoted to tracking and reporting;
- Source of monitoring data or implementation information used for reporting purposes;
- Frequency of performance reporting updates; and
- Measures to link performance metrics with $ spent.

Program Representatives

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March 27th, 2019

Chesapeake Bay Program
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Table 6 summarizes key elements of reporting across the main programs. While these programs differ in estuary/watershed size, targets and indicators used, capacity for reporting, and in how performance and progress is communicated, many share similar challenges in reporting as the LISS (e.g., reliance on others to provide data, limited in-house capacity). We compared the reporting formats, frequency, and capacity of the other programs to determine if there were lessons and/or innovations that might be of interest to the LISS. Specifically, we tried to identify what was unique about their reporting, what updates are they considering, and are there examples for how to address gaps in LISS reporting.

A brief description of each program's reporting approach is provided below. Each description incudes links to the program's website, information on how the program evaluates performance on environmental outcomes and implementation progress (outputs), reporting capacity, unique or innovative features, and planned updates to reporting methods. Screenshots of different elements of their reporting platforms are also provided.

Of the programs reviewed, we would consider the LISS in the upper tier for incorporating GAO's leading practices, having indicators for most of its ecosystem targets, and having an advanced reporting program. LISS focuses reporting on ecosystem targets (environmental outcomes) but does not report on the status of implementation actions (programmatic outputs), which makes it challenging to fully evaluate how the implementation of CCMP actions and management strategies relate to the achievement of ecosystem targets. LISS is not alone—we only identified two NEPs that are tracking and reporting progress at the implementation action level (see discussion in next section).

Several programs are in the process of updating their reporting platforms and others offered innovative features that might inspire an updated LISS approach. In general, the trend is towards:

- More online presentation of performance and progress tracking and less static paper reporting;
- Open portals/databases for more frequent, direct updates by partners;
- Inclusion of social and economic indicators; and
- Evolution of online platforms into standalone websites with clean and engaging visualizations using infographics, compelling imagery, and interactive reporting elements.

Attachment B includes notes from our discussions with other program representatives.

Table 6. Program comparison table showing key components of performance reporting practices among LISS and the six other aquatic programs reviewed.

Program	Performance Reporting Component: Format website & reports	Frequency of Reporting	Level of Reporting	Staff or Budget	Notable Features/Innovations
Casco Bay Estuary Partnership	Hard-copy status and trends and implementation progress www.cascobayestuary.org/about-casco-bay/state-bay/	5-year State of the Bay; CCMP TBD	18 indicators	1 FTE	• Metrics for implementation actions clearly defined and presented in CCMP • Working towards a WQ dashboard with real-time data links
Chesapeake Bay Program	Web-based status and trends and implementation progress www.chesapeakeprogress.com/ www.chesapeakestats.com	Continuous; biennial Bay Barometer Report, quarterly Newsletter	10 goals 30 outcomes (indicators)	<1/3 of budget	• Independent web platform/branding • Simple graphics indicating trends • climate resiliency and Healthy watersheds indicators • Funding stats
Piscataqua Region Estuaries Partnership	Web-based status and trends https://www.stateofourestuaries.org/ Hard-copy implementation progress	5-year State of Our Estuaries; 10-year CCMP	23 indicators	$90k /year	• User-friendly web platform • Easy to find more detailed info on indicators and implementation
Puget Sound Partnership	Web-based status and trends and implementation progress https://www.pugetsoundinfo.wa.gov/	Every 2 years State of the Sound; 2/yr for NTAs; vital signs?	6 goals; 25 Vital Signs; 600+ actions; interim progress	4 FTE	• Independent web platform/branding • Project level costs and funding gaps • Healthy Humans & Quality of Life indicators • Moved to Lake Tahoe platform
San Francisco Estuary Partnership	Hard-copy status and trends Web-based implementation progress www.sfestuary.org/progress-tracking/	5-year State of the Estuary; 6-year CCMP	33 indicators; 32 actions and 112 tasks	$300k /5-yr cycle	• Web-based Progress Tracker • focused and strategic revision process that results in < 50 priority actions. • Include measurements to track progress for all actions and develop a tracking tool.
Tahoe Regional Planning Agency	Web-based https://laketahoeinfo.org	Continuous	246 indicators tracked	No data	• Project Tracker, mapping and database of projects, includes $ spent and gaps • Sustainability Dashboard • Direct data upload • continuous update notifications
Tampa Bay Estuary Program	Hard-copy status & trends and implementation progress www.tbep.org/about_the_tampa_bay_estuary_program-state_of_the_bay.html	Instantaneous, weekly, to every 5 yrs; annual technical reports	21 goals, 39 actions; 22 indicators	1/3 of salary & fringe	• Tampa Bay Water Atlas • 2017 addition of climate change goal/indicators

Casco Bay Estuary Partnership

CBEP was founded in 1990 and oversees efforts to restore Casco Bay, whose shores are home to the city of Portland and the surrounding metropolitan area, as well as significant fisheries and wildlife habitat. Casco Bay was designated an estuary of national significance under the jurisdiction of the NEP. Curtis Bohlen, PhD, serves as the director of CBEP and oversees a staff of three full time, with numerous contributions from partners including Maine state agencies, local municipalities such as the Cities of Portland and South Portland, and the University of Maine. CBEP is a small program without a legislative mandate (as a legacy of when it was created, in the second round of NEP sites), and does not host a major research university in its watershed. As such, CBEP doesn't have the funds or the infrastructure to give out grants for data collection or collect data under its own auspices, so making use of existing data streams is a necessity. 1996 saw the publication of the first Casco Bay Plan, which was updated in 2006. The current revision, the 2016-2021 Casco Bay Plan, was begun in 2014 and completed in 2016. The next revision is currently scheduled for 2022, but CBEP is potentially moving to a 10-year cycle.

Reporting Environmental Outcomes

The 2015 State of the Bay Report assesses environmental outcomes based on 16 indicators. Each indicator discussion in the report is a general assessment of a given issue that is then supported with several lines of numerical evidence. For example, the assessment of inland water quality relies on biomonitoring data in freshwater bodies and impervious surface cover in the Casco Bay watershed. CBEP has an EPA requirement to produce interim progress reports on their CCMP, which the State of the Bay report on a five-year cycle satisfies. The State of the Bay report is available as a pdf download from the CBEP website but is not an interactive webpage with interactive features like LISS (**Figure 3**).

Reporting Implementation Progress

The 2016-2021 plan sets out four overarching management goals, and an implementation structure to achieve them that includes 12 strategies and 32 actions. Each goal contains one to four strategies, each strategy has one to four actions, and each action is measured by one to four metrics with associated targets. CBEP does not track implementation progress at the level of the metrics they set out for each action. Instead, they produce an annual report that is loosely tied to the CCMP and provides a high-level summary of progress for the public. In addition, for the last two years they have produced an annual internal CCMP implementation update for the CBEP management committee meetings at the end of the year. This document is intended to be a thorough review of where CBEP is making progress and where it is not, as a way of determining priorities for the next workplan.

Capacity for Reporting

CBEP is the smallest program we spoke with, having only one full-time equivalent for tracking and reporting indicators. Out of a total staff of four, that equates to a quarter of total staff time annually, on average.

Notable Features/Innovations/Challenges

As a result of its limited staffing and budget for grantmaking to monitoring partners, CBEP has to be creative in using the data that are available, whether or not they were created for CBEP's purposes. Much like LISS's webpage for the hypoxia ecosystem target, CBEP's website links to NERACOOS's site where a web user can find continuously updated data for the Casco Bay buoy. NERACOOS states on their website that they are advancing efforts to monitor water quality data in addition to the physical oceanography data that they currently host from their network of NOAA, state, NGO, and academic data partners. This will be a key effort for many of the northeastern NEP sites to engage with. Curtis Bohlen envisions a Casco Bay Dashboard, a web interface that displays frequently updated data on dissolved oxygen, water temperature, bacteria levels during summer months, beach closures, and potentially more variables that make sense to be updated automatically (e.g. turbidity, salinity). Another notable feature of CBEP's reporting structure is their attention to the evaluation of unmet goals. The 2015 State of the Bay Report discusses a sudden decline of eelgrass, due to green crab invasion. The suggested approach is to invest in eelgrass restoration, which may or may not be successful in the face of continued green crab pressure.

Updates to Reporting Methods

For the upcoming 2020 State of the Bay Report, CBEP says that many of the indicators will be changed or replaced depending on the availability of new data. Curtis Bohlen provided the example of their tracking and reporting of land use and land cover (LULC). In previous years the state was able to rely on land use/land cover mapping at 5-meter resolution. The old maps are now in need of an update and Maine does not have current LULC at 5-meter resolution. so CBEP is moving to using 30m NOAA's C-CAP Land Cover Atlas.

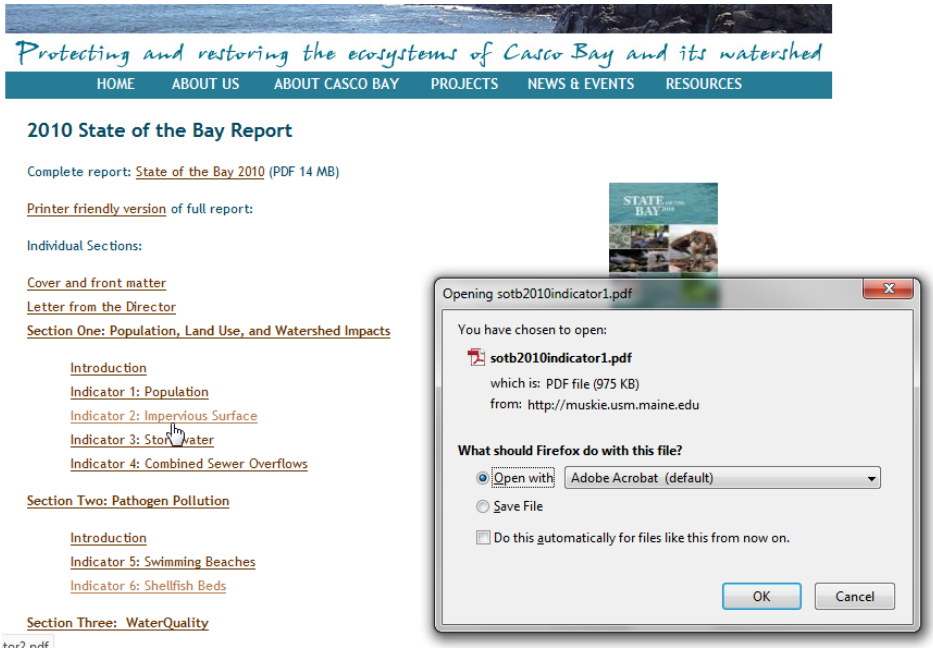


Figure 3. The Casco State of the Bay report is accessible on line in PDF, but performance reporting is not provided in an interactive, web-based format

The Chesapeake Bay Program

CBP was founded in 1983 to reduce pollution in the Chesapeake Bay and represents the first Congressional effort in national estuarine restoration, thus predating the NEP, LISS, and the other programs reviewed here. The first plan outlining measurable goals and incorporating deadlines towards recovery was the *1987 Chesapeake Bay Agreement*, which was most recently replaced by the 2014 Chesapeake Bay Watershed Agreement. The Chesapeake Bay Program is under the direction of the Chesapeake Executive Council. Members include representatives from six states in the Chesapeake Watershed, and the U.S. Environmental Protection Agency. Chesapeake Bay Program partners include federal agencies, state agencies, local governments, academic institutions and non-governmental organizations. The Chesapeake Bay Accountability and Recovery Act requires the Office of Management and Budget to submit an annual report on federal and state funding toward environmental restoration in the Chesapeake Bay watershed. There is an emphasis on states and local governments to tracking restoration projects in order to comply with watershed TMDLs.

Reporting Environmental Outcomes

The CBP provides data describing the status of ecological indicators via multiple web-based platforms including the primary clearing house –the ChesapeakeProgress website, an independent platform for reporting progress towards the 10 goals in the Agreement. Performance towards meeting each goal is assessed using 1-8 desired outcomes/indicators per goal. ChesapeakeProgress provides a variety of materials describing the progress of each outcome as compared to baseline and trend data, including interactive charts and downloadable materials (**Figure 4**). For example, a specific outcome for the black duck aims to support a wintering population of 100,000. According to survey results, an average of 51,332 black ducks were observed in Chesapeake Bay watershed states between 2013 and 2015. This marks a five percent increase from the average number of black ducks observed in the region between 2012 and 2014 and 51 % of the 100,000 bird goal. This is followed by an interactive chart illustrating the average abundance of black ducks between 2009 and 2015, and options to download the data/methods. A Progress section is also provided for each Outcome describing whether the progress towards each outcome has or has not improved or is getting worse.

In addition to background information and interactive materials for each indictor, there is an option to learn about the factors influencing progress. For example, the Toxic Contaminants Policy and Prevention Outcome indicates a high cost associated with remedies for toxic contaminants, and that the extent of these contaminants is geographically broad.

A central component of the Chesapeake Bay Program performance evaluation is the Biennial Strategy Review System. Over the course of two years, multiple teams, including a Management Board and Goal Implementation Teams, meet regularly (i.e., monthly, quarterly, and annually) to establish work plans and management strategies. A retrospective evaluation takes place every two years to review, evaluate, and update strategies based on progress towards the goals and outcomes established in the 2014 Agreement.

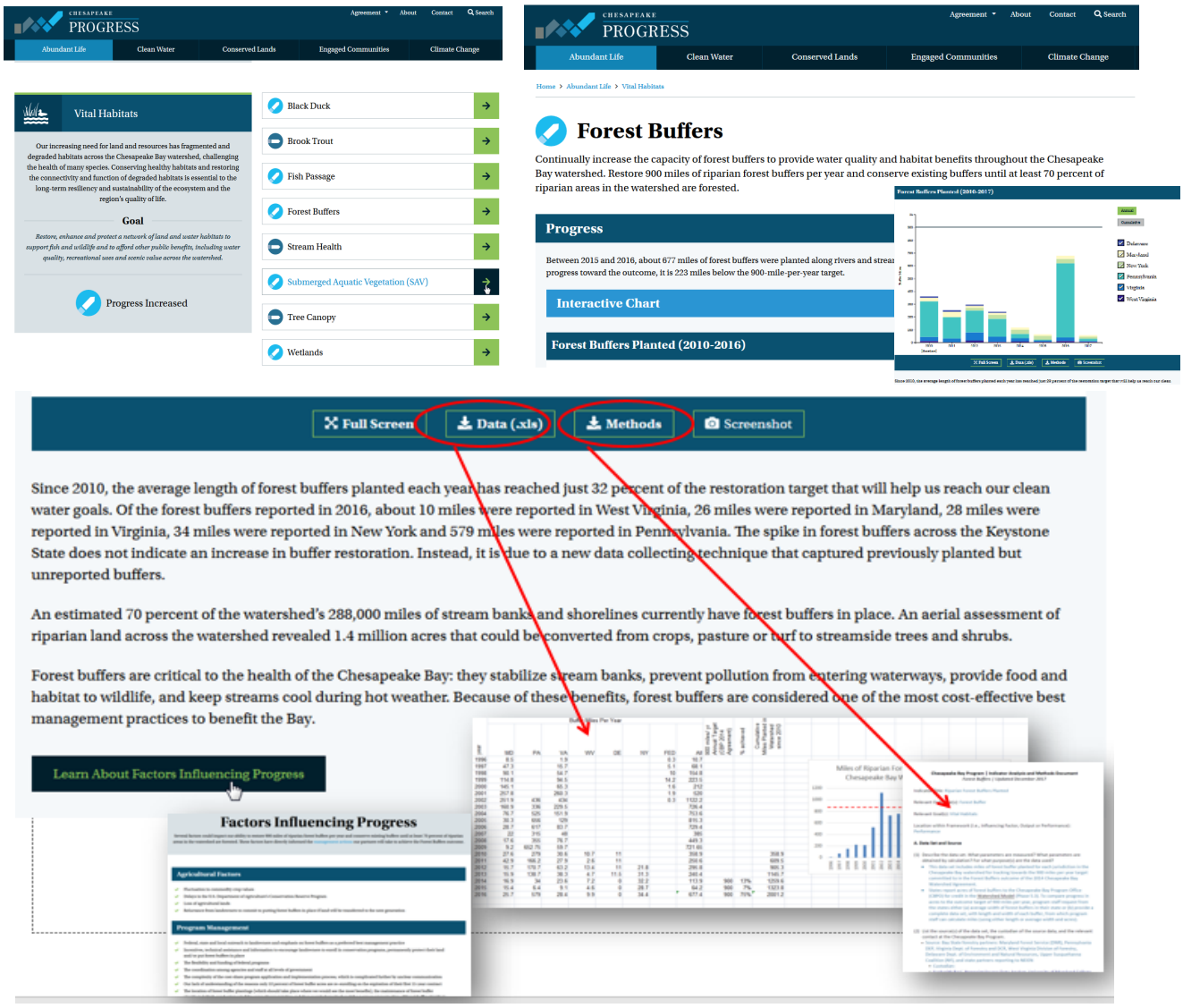
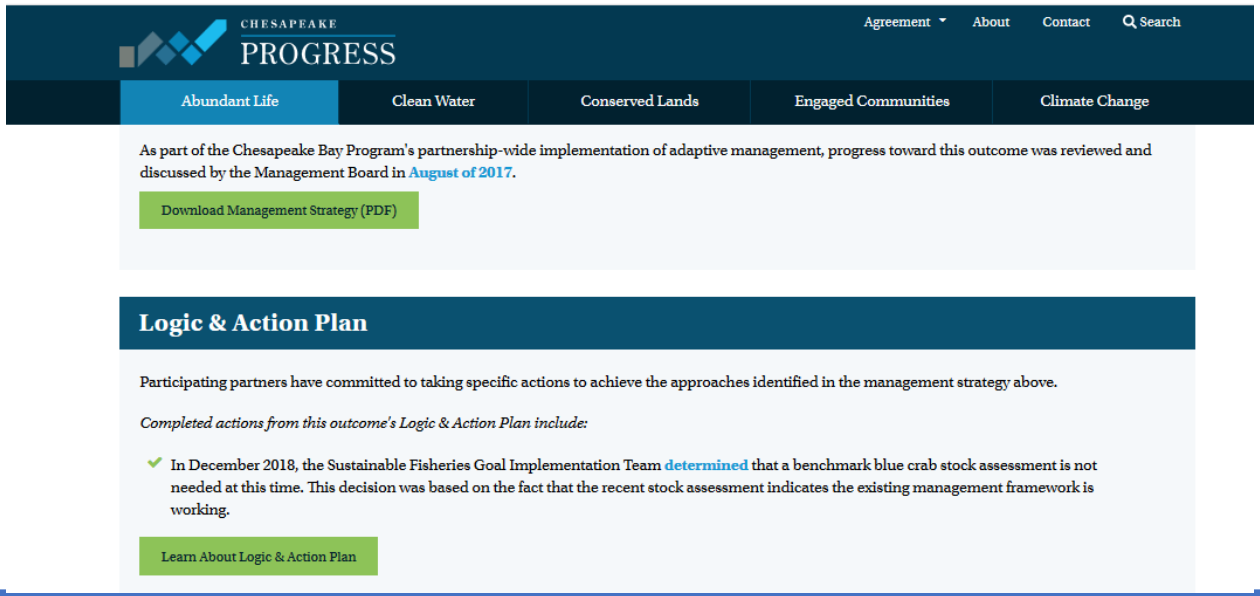


Figure 4. Screenshots illustrating information available for each indicator (Forest Buffer example)

Metrics for performance are established at the Outcome level. Each Outcome includes a target date and quantifiable data. For example, the *Tree Canopy Outcome* aims to expand the urban tree canopy 2,400 acres by 2025. Outcomes are determined by the Management Board and assigned to the Goal Implementation Teams. Goal Implementation Teams are responsible, among other duties, for identifying indicators and developing performance metrics. Progress towards individual Outcomes is reviewed by the Management Board during Quarterly Progress Meetings. Implementation Workgroups are a critical piece of determining the metrics for performance assessment.

Reporting Implementation Progress

Management strategies are clearly outlined for each outcome, indicating what actions have been completed, and actions that partners have committed to. In the case of Toxic Contaminants Policy and Prevention, the management strategy includes commitment, for example, in "developing a guidance document for the control and reduction of PCBs in regulated stormwater and wastewater." CBP has initiated a system to track completion of management actions in order to assess how the actions influence the desired environmental outcomes. For each outcome, a logic table and work plan are developed that identify specific actions, metrics, and completion status (among others). These tables are updated as part of the biennial strategy review. Ongoing and completed actions are listed under the Logic and Actions section for each outcome (**Figure 5**). In some cases, the list of activities is grouped by state.



WORK PLAN ACTIONS

Green - action has been completed or is moving forward as planned Yellow - action has encountered minor obstacles
Red - action has not been taken or has encountered a serious barrier

Action #	Description	Performance Target(s)	Responsible Party (or Parties)	Geographic Location	Expected Timeline
1.1	Continue planning stock assessment update with selected terms of reference	Report progress on stock assessment update at Winter 2018 Chesapeake Bay Stock Assessment Committee meeting. • Resolve issues with catchability / relative abundance of juveniles and adults. • Review life history parameters (e.g. -variable M –by age, sex) Incorporate commercial CPUE as tuning index (Co-op dataset: 14 years // CPUE by gear, region, size, sex)	CBSAC	Baywide	January 2018
		Conduct stock assessment update on above selected terms of reference.	CBSAC	Baywide	February 2019
1.2	Evaluate timing, planning, and funding for the next benchmark stock assessment (full analysis and review of the stock	Revisit terms of reference and evaluate when the next benchmark stock assessment is needed.	CBSAC, GIT Executive Committee	Baywide	January 2019
		Develop options for funding a benchmark stock assessment in coordination with the CBP Budget and Finance Workgroup.	CBSAC, Budget and Finance Workgroup, GIT Executive	Baywide	February 2019

Figure 5. Logic and action plan and list of completed actions.

Capacity for Reporting

CBP estimates that over two thirds of the program budget is for implementation (state, local, etc.), and one third goes to monitoring, implementation tracking, analysis and reporting. A significant portion of the overall monitoring effort in the Chesapeake Bay is provided by the states, and there are other types of support included in that third of CBP's budget. CBP has always had a monitoring and reporting program, so they have never had to carve into the implementation budget. If the emphasis is on adaptive management, the monitoring is more important. From the ChesapeakeProgress webpage, it appears that there are at least seven staff dedicated to administering the performance reporting website.

Notable Features/Innovations/Challenges

The simple, clean look and independent nature of ChesapeakeProgress website is impressive. There are relatively few indicators being tracked compared to many other programs, despite the size and complexity of the watershed. Interactive graphs, maps, and active links to additional data and management documents are a bonus. The CBP reports annually on funding spent by state and federal agencies, but caveats that an estimate of the total funding directed toward the ***Chesapeake Bay Watershed Agreement*** is not readily available (**Figure 6**). Much of the information is provided by the OMB per the Chesapeake Bay Accountability and Recovery Act. CBP also tracks dollars spent at the project level (information provided on the CBP's flagship website).

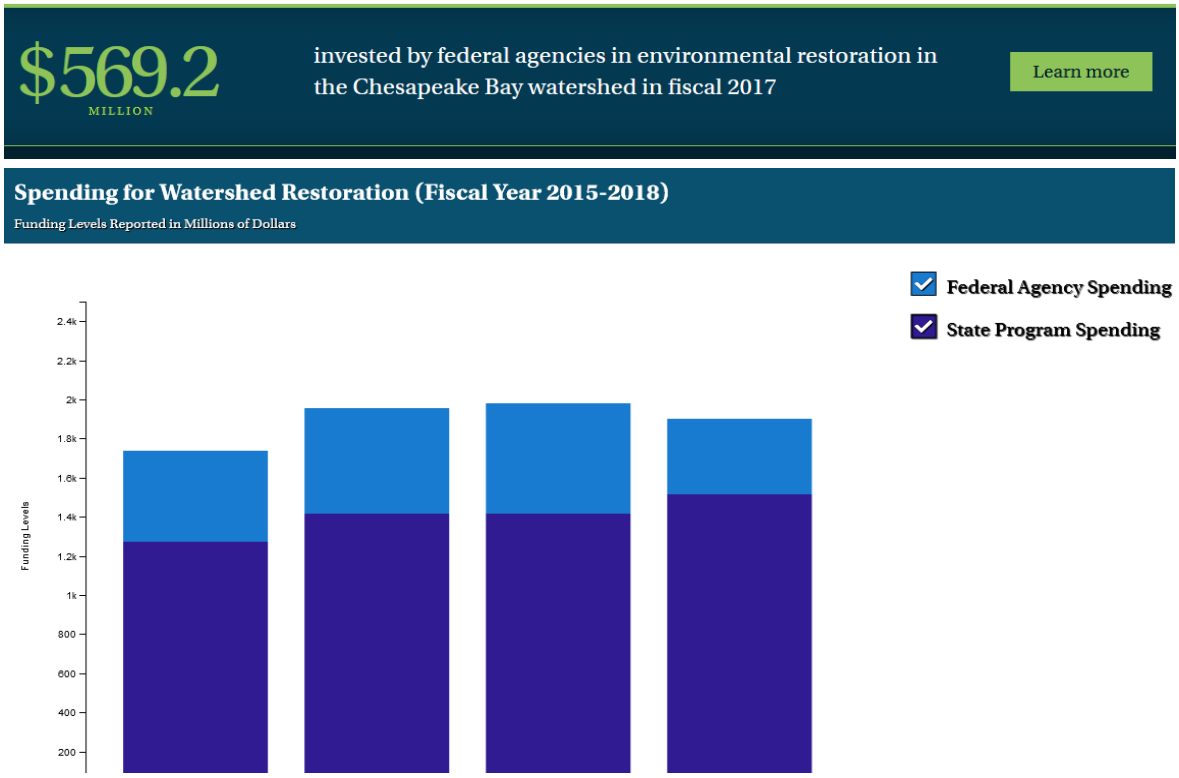


Figure 6. Reporting to CBP of federal and state expenditures on watershed restoration efforts >$300k is required under the CBARA

The Chesapeake Bay Program is committed to make management decisions on monitoring and performance reporting highly transparent. Access to information guiding indicator selection, data collection methods, and a process for the addition or removal of indicators is clearly described. When an indicator no long meets a monitoring need because the goal has been achieved or the data is no longer relevant, then that indicator is archived (see www.chesapeakebay.net/channel_files/23821/approved_cbp_indicators_framework_and_management_process.pdf).

Updates to Reporting Methods

The Chesapeake Bay Program has been reporting progress and updating regularly on their Chesapeake Progress website (chesapeakeprogress.com). This site is the home of progress tracking for 10 goals under five categories. The same goals will be continually assessed until 2025, when the current Watershed Agreement's targets and goals are set to be reached. The success of this platform is evident based on the recent unveiling of a larger umbrella site called ChesapeakeStat, which houses ChesapeakeProgress and two other portals for management decisions and data (**Figure 7**). Chesapeake Decisions will support adaptive management and will facilitate collaboration between work groups focusing on each of the 10 goals as they prepare for biennial strategy reviews. Chesapeake Data will be a data portal that makes the Bay Program's extensive data resources more accessible and transparent.
These sites are independent from the CBP's flagship website.

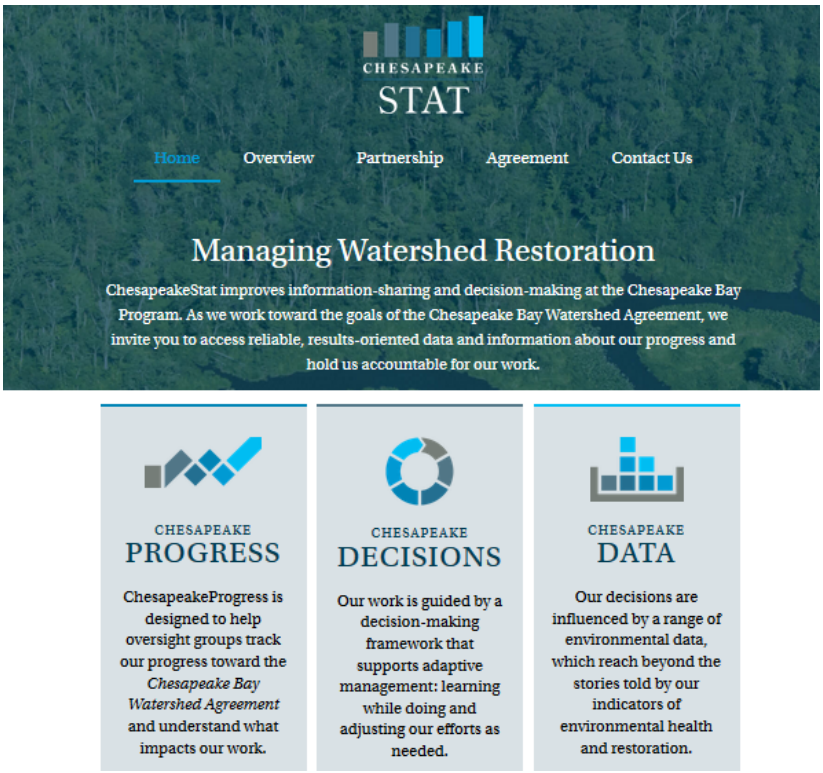


Figure 7. ChesapeakeStat is an umbrella platform for performance reporting, management information, and data collection.

Piscataqua Region Estuaries Partnership (PREP)

PREP serves New Hampshire's estuaries, the Great Bay-Little Bay-Portsmouth Harbor estuarine system and the Hampton-Seabrook estuary. Three staff members are responsible for all performance reporting, out of a total staff of four. PREP is supported in part by an EPA matching grant and is housed by the University of New Hampshire School of Marine Science and Ocean Engineering in Durham, on the northwest edge of Great Bay and Little Bay. Operating under the 2010 CCMP, PREP is on a 10-year cycle with the next CCMP revision coming in 2020.

Reporting Environmental Outcomes

Every five years PREP reports the status and trends of 23 environmental indicators in the State of Our Estuaries Report, with the most recent conference and Report having taken place in late 2017 and early 2018, respectively. This report is hard copy, but PREP has made an effort to replicate information in a more interactive web-based format (www.stateofourestuaries.org) and to provide updated information as it becomes available. The next report is due out in 2023. Indicators are classified as pressure, condition, response, and social indicators (**Figures 8** and **9**). The PREP website has examples of how to present links to detailed scientific information, including technical reports and external scientific reviews of certain indicators they track, all contained within their indicator pages.

Reporting Implementation Progress

PREP's 2010 CCMP set out five themes, seven goals, 33 objectives, and 82 action plans. Each action plan is a complex grouping of:

- "activities" – approximately 3 to 10 specific tasks to complete
- "outputs" – approximately 3 to 10 tangible products or services resulting from the action plan
- "outcomes" – approximately 1 to 4 changes to characteristics, conditions, or behavior resulting from the action plan
- "implementation metrics" –roughly 1 to 4 tangible measures of the progress of the action plan. In many cases, implementation metrics are linked to environmental indicators from the PREP monitoring plan that are reported in the State of Our Estuaries using unique IDs for each action plan.

PREP does not track implementation progress at the level of individual action plans. Instead, annual workplans submitted to EPA provide a high-level summary of progress in the previous year. Tracking and reporting of performance is carried out every 6 months for EPA and annually for NEPORT. PREP's annual NEPORT reporting for habitat conservation does make an effort to link performance metrics to amounts spent.

Capacity for Reporting

PREP reports that its annual budget for performance reporting is approximately $90,000 out of a total EPA award of $600,000. For its staff of four, this equates to roughly one full time equivalent. Approximately 70% of indicator data is collected by partners and 30% in-house, depending on the type of data. All of the water quality and biological monitoring is collected by their academic, state, and federal partners, though PREP staff serve as project managers on EPA-required quality assurance project plans (QAPPs) and as fiscal agents for grants and contracts (Rachel Rouillard, pers. comm.).

Notable Features/Innovations/Challenges

PREP is doing an excellent job with limited resources to provide information in a clear, readable format that flows easily as a user clicks through, and they don't shy away from evaluating unmet goals. The State of Our Estuaries Report website includes a wealth of information in a streamlined, user-friendly interface. Two such examples are eelgrass coverage (one of PREP's condition indicators), and oyster restoration (one of PREP's response indicators).

To take oyster restoration as an example of a goal (analogous to an LISS target) that is not being met, PREP provides detailed evaluation of why this goal is lagging. Oyster restoration is a difficult, expensive undertaking that nevertheless could yield an important class of filter-feeding organisms that improve light penetration and sequester nutrients, providing important water quality benefits. As of 2016, 26 acres of estuary had undergone restoration for oyster resettling (the PREP goal is/was 20 acres), but these restoration areas do not typically see successful continuation of viability, leading to decreases in shell coverage and eventual loss of the restored area. Sedimentation in the estuary is an ongoing problem that decreases the likelihood of restoration success, but as the report explains, reef-building can help elevate restoration areas higher in the water column to avoid settling of some sediment. In addition, siting restoration beds near native oyster beds has a tremendous positive impact on the likelihood of survival, with new oyster larvae recruitment greatly increasing at smaller distances.

Any discussion of goals in the Great Bay-Little Bay-Portsmouth Harbor estuarine system would be incomplete without mention of the long-term trend of declining eelgrass coverage. This trend is troubling for an estuary that used to be dominated by eelgrass. Data from the entire estuary beginning in 1996 and Great Bay alone beginning in 1981 both show a significant decline, and the causes are difficult to tease out.

Water clarity, sedimentation, large storms, and wasting disease all come into play, and the best scientific understanding currently is that long-term nutrient loading has applied enough pressure to eelgrass that it is not resilient to large storms and outbreaks of wasting disease. As a result of the declining trend, eelgrass coverage in 2016 (most recent data) was only 54% of the PREP goal of 2,900 acres by 2020. The PREP website-based State of Our Estuaries Report materials provide good coverage of this vexing problem and links to a more detailed "Environmental Data Report" complete with Technical Advisory Committee findings and outside expert reviews on the state of the science.

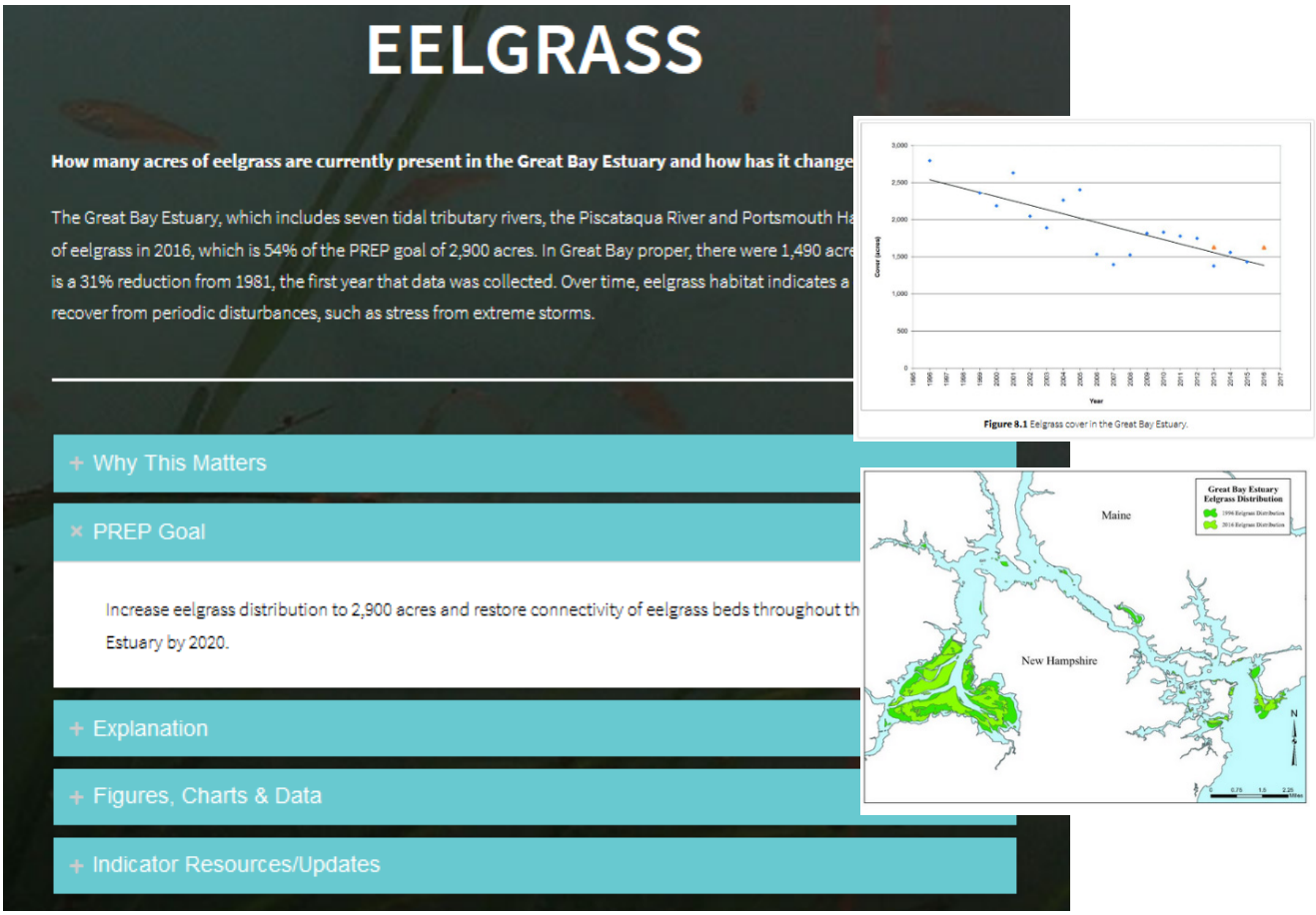
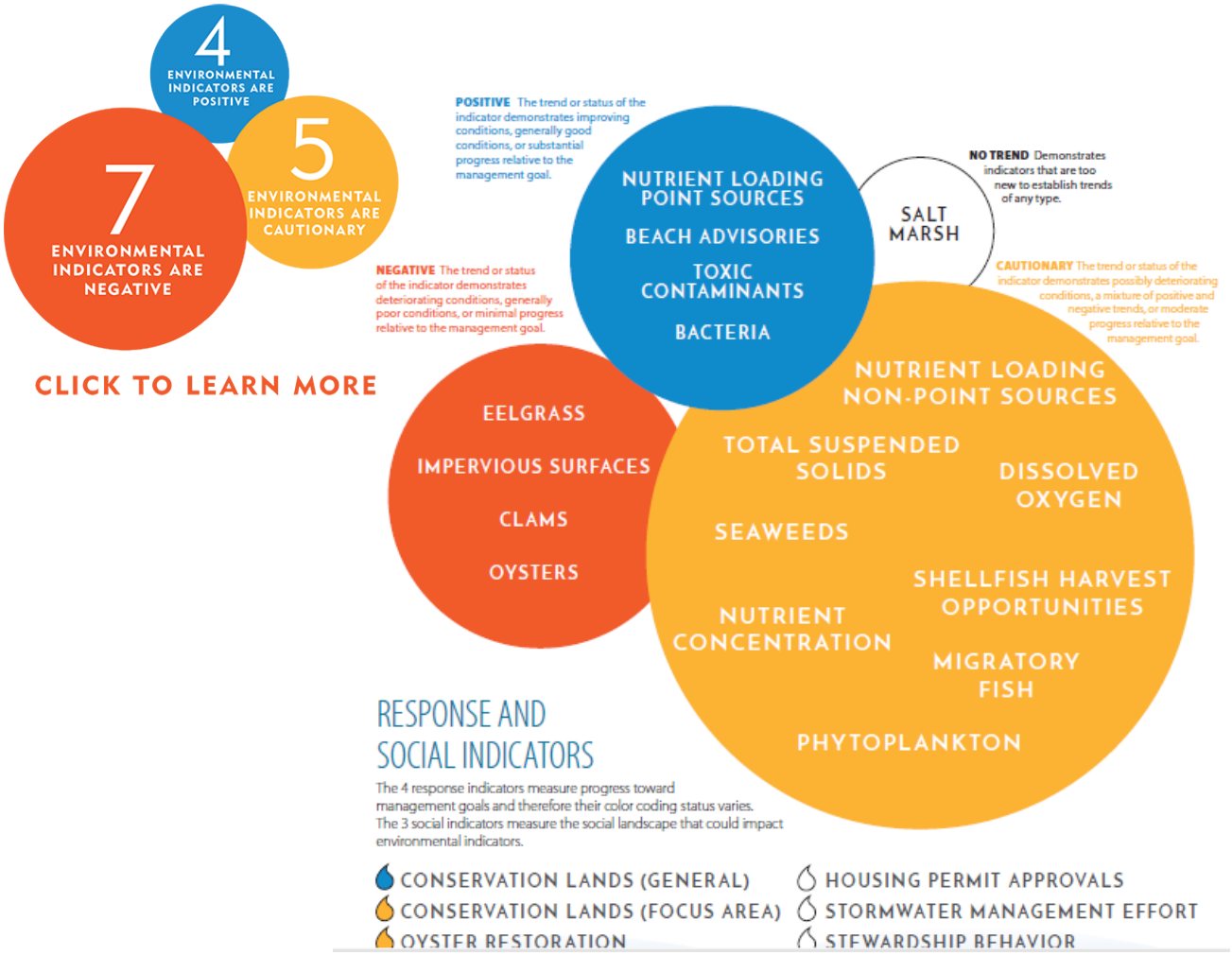


Figure 8. PREP's website provides a quick link to indicator information

Updates to Reporting Methods

PREP does not plan on making changes to the way they report progress in advance of their next CCMP revision, which is understandable given that the 2020 CCMP is in currently in development in 2019. That being said, PREP did build their website in order to provide more frequent updates in the interim between the 2018 State of Our Estuaries Report and the upcoming 2023 conference and report. They are still in the process of determining the right frequency to update the website with current information, how much effort should be budgeted, etc.



INDICATOR	STATUS	STATE OF THE INDICATOR	PAGE
Impervious Surfaces		In 2015, 5.6% of the land area of the Piscataqua Region watershed was covered by impervious surfaces. This is an increase of 1,257 acres of impervious cover or 0.2% of the land area since 2010.	14
Total Suspended Solids		Suspended solids at Adams Point have increased since 1989, but they have decreased at the Great Bay Station since 2002.	
Nutrient Loading (Point-Sources)		Significant reductions in point treatment facilities.	
Nutrient Loading (Non-Point Sources)		Non-point source loading has de	
Nutrient Concentration		Total nitrogen decreased at Ada creased at the Oyster River and	
Phytoplankton		Based on monthly sampling at (>20 ug/L) levels for chlorophyl	
Seaweeds		At limited intertidal sampling 1980 and 2016. Two new invasi	
Dissolved Oxygen		In 2015, at the Great Bay and Coa dissolved oxygen events occur i	
Eelgrass		Eelgrass acreage in the Great Ba	
Salt Marsh		Between the early 1900s and 2010, over a thousand acres of salt marsh area was lost in the Piscataqua Region watershed.	25

The trend or status of the indicator demonstrates improving conditions, generally good conditions, or substantial progress relative to the management goal. — POSITIVE

The trend or status of the indicator demonstrates possibly deteriorating conditions, a mixture of positive and negative trends, or moderate progress relative to the management goal. — CAUTIONARY

The trend or status of the indicator demonstrates deteriorating conditions, generally poor conditions, or minimal progress relative to the management goal. — NEGATIVE

Demonstrates indicators that are too new to establish trends of any kind. — NO TREND

Figure 9. PREP's 2018 State of the Estuaries Report includes summaries of indicator progress that are not easily found on the website.

Puget Sound Partnership

The Puget Sound encompasses inland marine waters and shoreline from Olympia, Washington north to the Canadian border, and east of the Pacific Ocean. The Puget Sound Partnership (PSP) is a state agency funded by the National Estuary Program and founded in 2007 by the Washington State Legislature to address anthropogenic degradation of the ecosystem. At the outset, the goal of the PSP was to restore Puget Sound by 2020. The first Action Agenda, published in 2008, was last updated in 2018. Program partners include local government, tribes, businesses, and nonprofits. Puget Sound has recently updated their performance reporting website, now called Puget Sound Info (www.pugetsoundinfo.wa.gov/) based on the platform used by Tahoe Info. Puget Sound Info is organized into three main reporting categories: the environmental outcomes reporting called Vital Signs; the action agenda tracker, and an atlas for NEP specific activities (**Figure 10**). Partners can log in the website and upload data. The data center (upper right) serves as a repository for data across the Puget Sound Info programs and includes direct links to vital signs and interim progress measures.

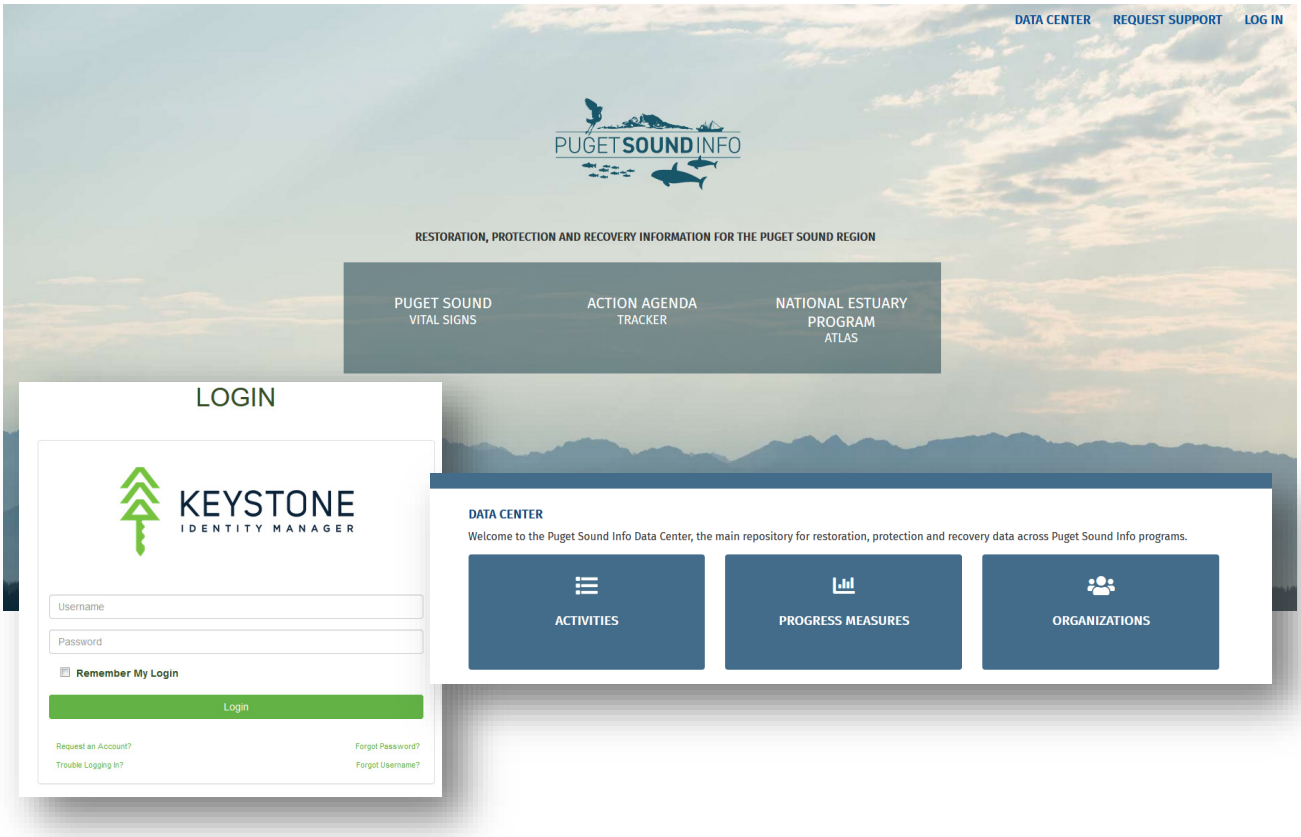


Figure 10. Home page for Puget Sound Info

Reporting Environmental Outcomes

The [2018-2022 Action Agenda for Puget Sound] is divided into two components: The Comprehensive Plan and the Implementation Plan. The Comprehensive Plan outlines the framework for the recovery including 6 ecosystem recovery goals for which there are 25 Vital Signs and 50 indicators to measure progress. For example, the "Healthy Water Quality" recovery goal contains 4 metrics/indicators. The new Vital Signs reporting webpage (https://vitalsigns.pugetsoundinfo.wa.gov/) provides background information, key messages about the status/progress for each indicator, management strategies, as well as supporting documents outlining the basis for evaluating progress (**Figure 11**).

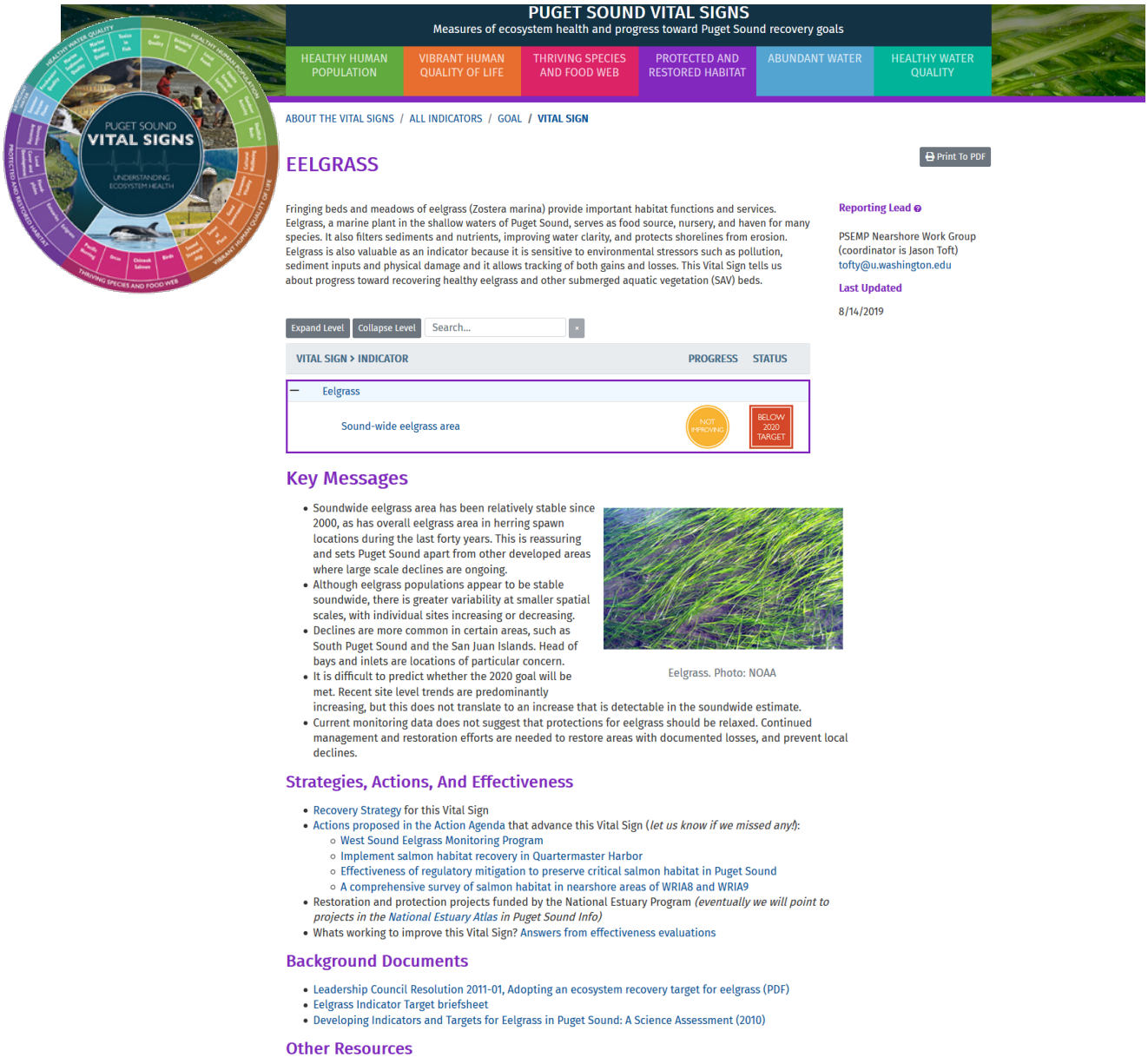


Figure 11. Screen capture from new Vital Signs indicator reporting webpage

A biennial State of the Sound Report is published, the most recent report was published in 2017 and included a progress review of each vital sign, indicating whether progress was Getting Better, having Mixed Results, Not Improving, Getting Worse, or missing data. The 2017 State of the Sound includes a Table that attaches progress categories to Vital Sign indicators. The categories note the status of the indicator in reference to a baseline. The 2017 State of the Sound references Vital Sign indicators as the metric for measuring performance in the Puget Sound recovery effort. Specific Vital Signs are called out in the report with a brief description of the indicator, the target, and a description of the progress. For example, the indicator for *Shellfish Beds* (page 30 of the 2017 State of the Sound) is acres of harvestable shellfish beds. The stated target is: "Between 2007 and 2020, a net increase of 10,800 acres of harvestable shellfish beds should occur, including 7,000 acres where harvest had been prohibited." The section describing the progress of this Vital Sign describes an increase in harvestable shellfish beds over the last ten years, stating that this increase is 44% of the 2020 target.

The 2018 Action Agenda includes a section (page 16) in which three specific barriers to recovery are addressed (e.g., conflicting government programs and incentives), followed by a list of commitments that would enhance the progress towards full recovery. In addition, the 2017 State of the Sound report addresses unmet targets under each Vital Sign. For example, the Vital Sign *Floodplains* specifically cites a lack of funding for the failure to implement actions, and indicates the need to complete field inventories assessing bank hardening. In 2014, the Puget Sound Ecosystem Monitoring Program published the Puget Sound Ecosystem Monitoring Gaps, which presented the gaps in Vital Sign indicator tracking as well as the costs required to address those gaps. The Key Messaging section of the website includes a discussion on challenges and gaps.

Reporting Implementation Progress

There are over 360 Near Term Actions (NTAs) that were being tracked within the original Action Agenda Report Card, but the new reporting format now includes an Action Agenda Tracker with an interactive map and a searchable tracking database for over 600 actions, including the NTAs (**Figure 12**). The database for each action includes information on costs, implementation status, and relevance to climate change, and links each action to specific Vital Signs. Through the data center, PSP is also evaluating performance using interim measures. Each measure is included in a searchable database (**Figure 13**). When you click on a measure, it takes you to a separate webpage where the measure is described, guidance is provided on how to evaluate the measure, and how this measure informs adaptive management (**Figure 14**). There is extensive overlap between information provided in the data center, the vital signs, and action tracker.

Capacity for Reporting

PSP has an interesting strategy toward performance reporting capacity. Two staff are devoted to effectiveness assessments, one person handles collecting monitoring data on Vital Sign indicators, and a fourth staff member gathers implementation progress data.

Welcome to the new Action Agenda Tracker!

The Action Agenda Tracker was created to allow implementers, funders, decisionmakers, and the public to track Puget Sound recovery actions. The Tracker also helps us tell stories about the work and accomplishments of the broad community of organizations and individuals dedicated to Puget Sound recovery.

The actions in this tracker are all included in the **Action Agenda for Puget Sound**, a regional plan developed through the collaborative work of government agencies, tribes, and other organizations committed to improving the health and resilience of the Puget Sound ecosystem. The Action Agenda for Puget Sound outlines strategies and priority actions to improve the health of human communities, species and habitats, and the quality and quantity of water resources.

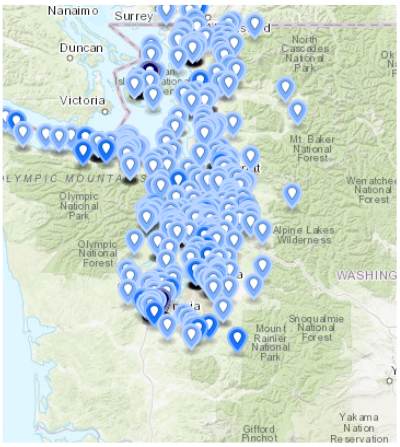
Learn more about the Action Agenda.

***** Support materials for NTA reporting *****

NTA managers, please see the **Training resources** under the Help menu in the upper right for guidance on how to update your NTA, including materials from the training sessions in April. If you have questions about NTA reporting, please contact **Alex.Mitchell@psp.wa.gov.**

Near Term Action Map

Click on the map for a full screen view of all 2018 NTAs.



Stage

Planning/Design Implementation

Post-Implementation Completed

ACTIVITIES

Activities listed here include Near Term Actions from the 2018-2022 Action Agenda and a limited set of National Estuary Program (NEP) investments. Please check back in the coming months as more projects, programs and NEP investments are added to the platform.

Currently viewing 636 of 636 Activities Reset Download Table

Activity Name	Owner Organization	Primary Contact	Activity Class	Activity Stage	Implementation Start Year	Completion Year	Regional Priority Approach	Activity Type
30% Design of Priority Estuary Restoration Projects in th	Kitsap County	Christina Kereki	Action Agenda NTA	Planning/Design	2020	2022	CHIN7.1: Protect and	Ecological Restc
A comprehensive survey of salmon habitat in nearshore	Washington State De	Bart Christiaen	Action Agenda NTA	Implementation	2018	2022	CHIN1.3: Develop a	Enabling Condit
A framework and guidance for sub-tidal habitat monitor	U.S. Geological Surve	Stephen Rubin	Action Agenda NTA	Planning/Design	2020	2022	EST1.1: Gain a bette	Enabling Condit
A Guide to Streamside Living	Hood Canal Salmon E	Mendy Harlow	Action Agenda NTA	Planning/Design	2020	2022	BIBI3.1: Facilitate in	Behavior Chang
A Multi-Benefit Restoration of the Lower Duckabush Rive	Hood Canal Salmon E	Mendy Harlow	Action Agenda NTA	Planning/Design	2020	2022	CHIN7.1: Protect and	Ecological Restc
A Regional Outreach Model for Privately Managed Storm	Snohomish Conserva	Kate Riley	Action Agenda NTA	Planning/Design	2020	2022	BIBI1.1: Increase loc	Behavior Chang
Accelerate development and implementation of innovat	PureBlue	Ryan Vogel	Action Agenda NTA	Planning/Design	2020	2022	TIF2.1: Address stor	Enabling Condit
Accelerating Riparian Restoration in Thurston County	Thurston County	Amber Stonik	Action Agenda NTA	Planning/Design	2019	2021	BIBI2.1: Provide edu	Ecological Restc
Accelerating shoreline protection and recovery - incentiv	Washington Environm	Martin Tiernan	Action Agenda NTA	Planning/Design	2020	2022	SA3.1: Develop and	Behavior Chang
Acceleration of shoreline armoring removal in Central Pu	Mid Sound Fisheries	Jeanette Dorner	Action Agenda NTA	Planning/Design	2020	2022	CHIN7.1: Protect and	Ecological Restc
Acquisition and restoration of priorities identified in the	North Olympic Land	Michele Canale	Action Agenda NTA	Implementation	2019	2022	CHIN7.1: Protect and	Enabling Condit
Acquisition of Priorities identified in the Western Strait	North Olympic Land	Michele Canale	Action Agenda NTA	Planning/Design	2018	2022	CHIN7.1: Protect and	Enabling Condit
Addressing Ocean Acidification in Washington: Monitorir	University of Washing	Jan Newton	Action Agenda NTA	Planning/Design	2020	2022	SHELL1.16: Embrace	Enabling Condit
Advanced distillation treatment - optimizing a new appr	Snohomish Conserva	Cindy Dittbrenner	Action Agenda NTA	Planning/Design	2020	2022	SHELL1.9: Improve v	Ecological Restc
Advancing Sea Level Rise Adaptation: Developing Multi-	Friends of the San Ju	Tina Whitman	Action Agenda NTA	Planning/Design	2020	2022	SA3.3: Implement p	Ecological Restc

Regional Priority Approach	Activity Type	Vital Sign	Lead Entity Management Area	Total Cost	Secured Funding	Unfunded Need	NEP Funding	Non-NEP Funding	Does This Address Climate Change?

Figure 12. The Action Agenda Tracker includes a searchable database and interactive map of over 600 activities and NTAs. The database includes cost information, implementation status, and links activities to vital signs.

Notable Features/Innovations/Challenges

Vital Signs includes both human health/wellbeing and environmental indicators. The Vital Signs webpage was and is structured to provide not only indicator status and trend data but also implementation progress data. This ambitious undertaking succeeds at housing a wealth of project-specific reporting of cost information and gaps in funding needed. PSP is one of the only programs we reviewed expending a high level of effort to link cost, implementation actions, and indicator progress. Actions are tagged for relevance to climate adaptation.

PSP also devotes a high level of effort to assessing the essential question of whether implementation is achieving the desired environmental outcomes. Two PSP staff are dedicated to developing what they call "effectiveness assessments," quantitative measures of indicator change with correlation to CCMP actions. Interviewee Scott Redman (PSP Science & Evaluation Program Director) describes these as imperfect experimental designs that nevertheless yield some statistical power - not the classic experimental design of a before-after-control-impact (BACI) study but meta-analysis techniques that yield a change detection statistic. This statistic then provides a reasonably reliable answer to the question of whether PSP's indicator status and trend data explain the observed change detection.

Updates to Reporting Methods

Scott Redman explained that PSP was currently undergoing a complete overhaul of their Vital Sign indicators, which he qualified with a reminder that this is a never-ending task. The Vital Sign website and reporting approach had not been updated to any significant degree since 2010 and while the new framework has been launched, there are still placeholders.

The GAO told PSP in their 2018 report that no indicator should be tracked without a numerical target or goal to reach, and there are several indicators that remain TBD. PSP is leading that effort to achieve targets for all Vital Sign indicators by 2020. They are engaged with the project's partners and the public in a series of outreach conversations about making changes by 2020. Scott anticipates moving away from the hard-copy model and toward a web-based interface as their primary reporting platform. The online model that they followed is the web platform used by the Lake Tahoe Regional Planning agency (https://laketahoeinfo.org/), whose philosophy is that if you build the system correctly, the partners will be engaged to take ownership of the platform and enthusiastically participate in data-sharing and the collaborative management process.

PROGRESS MEASURES

NOTE: All Activity Progress Measures currently included in the system are DRAFT. Final versions will be available in November 2019.

Three types of progress measures are used to track ecosystem recovery activities and progress toward a healthy and resilient Puget Sound:

- **Vital Sign Indicators** - Measures of ecosystem health and progress toward Puget Sound recovery goals.
- **Intermediate Progress Measures (COMING SOON)** - Establish a common understanding of natural and social processes (aka pressures) causing changes to the Vital Signs and the collective impact of multiple activities toward reducing or mitigating the impact of those pressures.
- **Activity Progress Measures (DRAFT)** - Demonstrate direct contributions of Action Agenda Near Term Actions (NTAs) to Puget Sound recovery. These often focus on enabling conditions (e.g. Outreach, Incentives) or direct restoration and protection accomplishments.

Activity and intermediate progress measures are currently under development and are expected to change over time as needed to support continual improvement of Puget Sound recovery strategies.

Currently viewing 81 of 81 Progress Measures

Reset Download Table

Progress Measure	Measurement Unit	Progress Measure Type	Vital Sign	Indicator Lead	Lead Organization	Contributing Partners	# of Subcategories	Description
(PLACEHOLDER) Amount of Funding Available Through Finar	Dollar ($)	Intermediate	N/A				0	This progress m
(PLACEHOLDER) Number of Incentive Programs Enhanced o	Each Unit (number)	Activity	N/A				4	This progress m
(PLACEHOLDER) Number of Incentive Programs in Puget So	Each Unit (count)	Intermediate	N/A				0	This progress m
(PLACEHOLDER) Number of Incentives Used or Rebates Red	Each Unit (number)	Activity	N/A				3	This progress m
(PLACEHOLDER) Number of Sites Referred for Further Invest	Each Unit (number)	Activity	N/A				0	This progress m
Acres of harvestable shellfish beds	Acre (acres)	Vital Sign Indicator	Shellfish Beds	Scott Berbells	Washington State D	Washington State D	1	This indicator tr
Air quality indicator	Percent (%)	Vital Sign Indicator	Air Quality	Jill Schulte	Washington State D	Washington State D	0	Th
Area of estuarine wetlands restored to tidal flooding	Acre (acres)	Vital Sign Indicator	Estuaries	Tish Conway-Crano	Washington Depart	Washington Depart	1	Th
Armor on feeder bluffs	Mile (miles)	Vital Sign Indicator	Shoreline Armoring	Hugh Shipman	Washington State D	Washington State D	1	Th

This indicator tracks the area of harvestable shellfish beds in Puget Sound. The Washington State Department of Health classifies 108 shellfish growing areas in Pu Sound to assure that harvested shellfish are safe to consume. The data collected fo classification process represent the conditions that dictate shellfish harvest and the trends provide information on marine water quality in Puget Sound.

Figure 13. Progress is reported for Vital Signs, Intermediate Measures, and Activities

PROGRESS MEASURES (PLACEHOLDER) AMOUNT OF FUNDING AVAILABLE THROUGH FINANCIAL INCENTIVE PROGRAMS

Overview

BASICS

Name (PLACEHOLDER) Amount of Funding Available Through Financial Incentive Programs

Progress Measure Type Intermediate

Measurement Unit Dollar ($)

Description
This progress measure represents the total amount of funds available annually to project owners to implement activities that will advance Puget Sound recovery.

ACCOMPLISHMENTS

(PLACEHOLDER) Amount of Funding Available Through Financial Incentive Programs

No reported data available

IMPORTANCE

This measure would track efforts to increase funds available through incentive programs to support activities in line with Puget Sound recovery priorities. It would track fund availabily by topic area.

ADDITIONAL INFORMATION

REPORTING GUIDANCE

Critical Definitions

Figure 14. Progress Measures Example

San Francisco Estuary Partnership

SFEP serves the San Francisco Bay, its associated smaller bays, and the inland estuary known as the San Francisco Bay Delta. In all, this large estuary system covers a geographic area in northern California that stretches from Sacramento in the northeastern-most portion of the study area to San Francisco at the mouth of the estuary where it meets the Pacific Ocean. According to SFEP, this is the largest estuary in western North America, and the study area includes numerous municipalities and counties. In addition to SFEP's full time staff of 13, numerous partners at the federal, state, and municipal levels of government, as well as NGOs, partner with the organization to manage the estuary and implement the CCMP. The first SFEP CCMP was produced in 1993, and following 14 years of implementation a revised CCMP was produced in 2007 and again in 2016.

Reporting Environmental Outcomes

SFEP reports on the status and trends of 33 indicators in the State of the Bay Report on a five-year cycle. As with many other NEP-affiliated programs, the report and associated conference are timed to take place during the revision process of the CCMP. The State of the Bay Report is available in pdf form on the SFEP website at www.sfestuary.org.

Reporting Implementation Progress

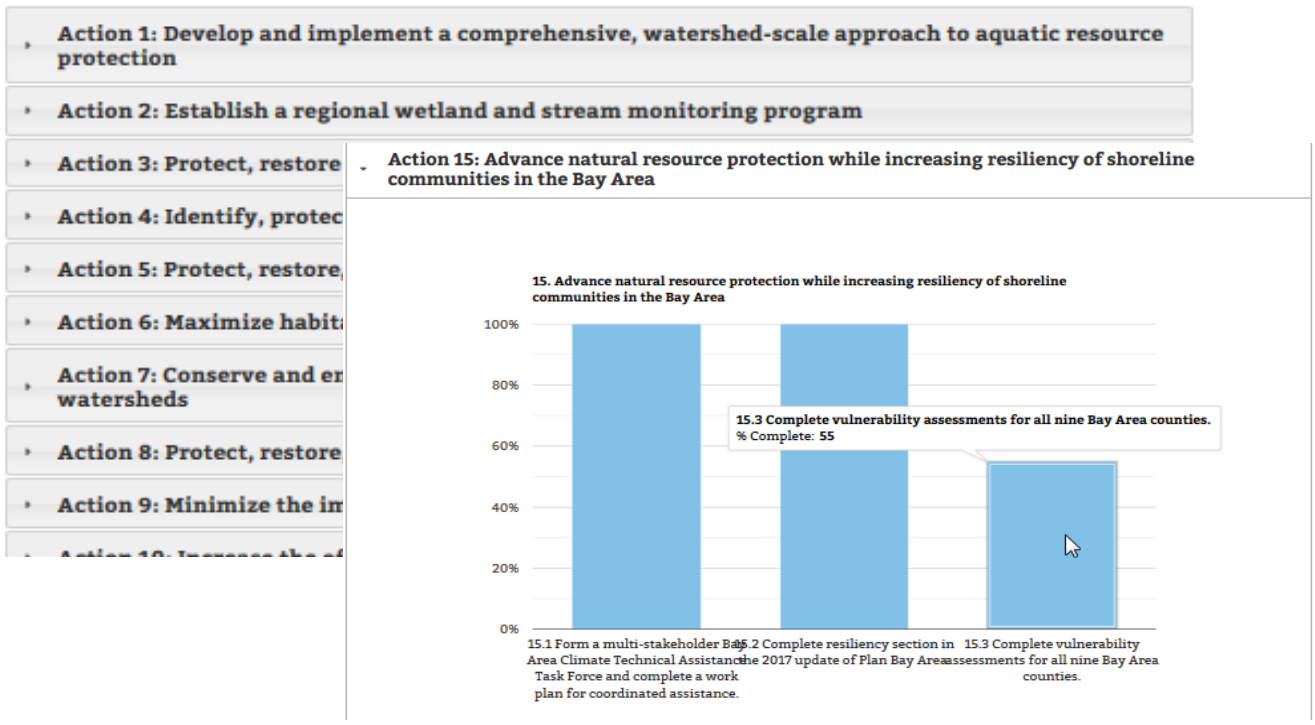
SFEP reports implementation progress based on the 2016 CCMP, which lays out four implementation goals, 12 objectives, 32 actions, and 112 tasks. The CCMP contains detailed information on activities involved in each of the 112 tasks, including measures for performance tracking. The SFEP website has a page devoted to progress tracking where information on the implementation status of the 32 actions at the level of the 112 tasks is displayed (www.sfestuary.org/progress-tracking/). On this webpage, each action has a dropdown under which all the associated tasks are shown with progress represented by bar charts displaying percent completed (**Figure 15**). In addition, the viewer can scroll down to the bottom of the page to a sortable online database called the "Progress Tracker," which contains columns for the source data for the bar charts, the owner" or leading partner, any notes on progress to date, and the date last updated.

Capacity for Reporting

SFEP divides their performance reporting into two tracks, implementation progress and environmental outcomes. They track continuously and report quarterly on programmatic success. Caitlin Sweeney estimates that approximately 20% of SFEP's FTE goes to tracking and reporting out. The ballpark estimate for updating the CCMP, which includes a report on implementation progress as well as new goal-setting, is $200,000. For environmental outcomes under the auspices of the State of the Estuary Report, SFEP relies on its partners to collect data and then synthesizes everything in the report. Every reporting cycle of four to six years costs approximately $300,000 to update the report, not including partner spending for data collection.

VIEW ACTION STATUS BELOW:

The following charts record progress toward the completion of very specific actions which are enumerated and described in the Estuary Blueprint. These charts will be routinely updated over time as we collectively fulfill the attendant goals.



PROGRESS TRACKER:

	Action	Action Name	Task	Task Action	Task Owner	Milestone	% Complete	Progress Made To Date
		and enhance tidal marsh and tidal flat habitat		habitat in the Estuary.	Venture	acres of tidal habitat in SF Bay.		habitat within Estuary (not coastal). New total is 370 acres fo 2017 and 2018. May not capture projects completed in late 201
10	3	Protect, restore and enhance tidal marsh and tidal flat habitat		Restore tidal habitat in the Estuary.	SF Bay Joint Venture	Restore 8,000 acres of tidal habitat in the Delta.	40	According to website (http://resources.ca.gov/ecorestore/), 15 acres constructed, 2,020 under construction, 6,367 in permittin phase, and 995 in planning stages.
11	3	Protect, restore and enhance tidal marsh and tidal flat habitat	3.2	Protect land to support preservation and enhancement of tidal habitats.	SF Bay Joint Venture	Acquire and protect 500 acres through various mechanisms including transfer	5	Petes Landing - Bair Island (7 acres) in 2017

Figure 15. Action Status and Progress Tracker on the SFEP website

Notable Features/Innovations/Challenges

Regarding the tracking of implementation progress, SFEP has a number of innovative strategies and tools built into their hard copy and web interface that LISS can learn from. The *Estuary Blueprint* includes a chapter on tracking progress. For the CCMP revision published in 2016, special effort and attention were devoted to making the linkages between indicators, which are

measures of ecological progress, and CCMP components (goals, objectives, and actions), results of which are tracked as measures of CCMP implementation progress. The CCMP chapter includes what they call a Nexus (essentially an organizational table) which organizes implementation actions into specific goals and objectives (**Figure 16**). In addition, they have a clickable graphic showing which goals, indicators, and actions are linked (**Figure 17**).

NEXUS OF GOALS, OBJECTIVES, AND ACTIONS

		GOAL 1: Sustain and improve the Estuary's habitats and living resources.			GOAL 2: Bolster the resilience of Estuary ecosystems, shorelines, and communities to climate change.			GOAL 3: Improve water quality and increase the quantity of fresh water available to the Estuary.			GOAL 4: Champion the Estuary.		
	OBJECTIVE	A	B	C	D	E	F	G	H	I	J	K	L
ACTION													
1	Develop and implement a comprehensive, watershed-based approach to aquatic resource protection	●		●	●	●	●		●	●	●	●	●
2	Establish a regional wetland and stream monitoring program	●		●									●
3	Protect, restore, and enhance tidal marsh and tidal flat habitat	●			●	●							
4	Identify, protect, and create transition zones around the Estuary	●	●		●	●							
5	Protect, restore, and enhance intertidal and subtidal habitats	●	●		●	●							
6	Maximize habitat benefits of managed wetlands and ponds	●	●	●	●								
7	Conserve and enhance riparian and in-stream habitats throughout the Estuary's watersheds	●	●		●	●							
8	Protect, restore, and enhance seasonal wetlands	●	●										
9	Minimize the impact of invasive species		●	●									
10	Increase the efficacy of terrestrial predator management		●	●									
11	Develop processes for increasing carbon sequestration through wetland restoration, creation, and management	●		●	●		●						

OBJECTIVES

a. Protect, restore, and enhance ecological conditions and processes that support self-sustaining natural communities
b. Eliminate or reduce threats to natural communities
c. Conduct scientific research and monitoring to measure the status of natural communities, develop and refine management actions, and track progress towards management targets
d. Increase resilience of tidal habitats and tributaries to climate change
e. Increase resilience of communities at risk from climate change impacts while promoting and protecting natural resources
f. Promote integrated, coordinated, multi-benefit approaches to increasing resiliency
g. Increase drought resistance and water efficiency and reduce reliance on imported water
h. Improve freshwater flow patterns, quantity, and timing to better support natural resources
i. Reduce contaminants entering the system and improve water quality
j. Build public support for the protection and restoration of the Estuary
k. Strengthen regional leadership in support of Estuary health
l. Promote efficient and coordinated regional governance

Figure 16. Crosswalk showing relation between goals, actions, and objectives

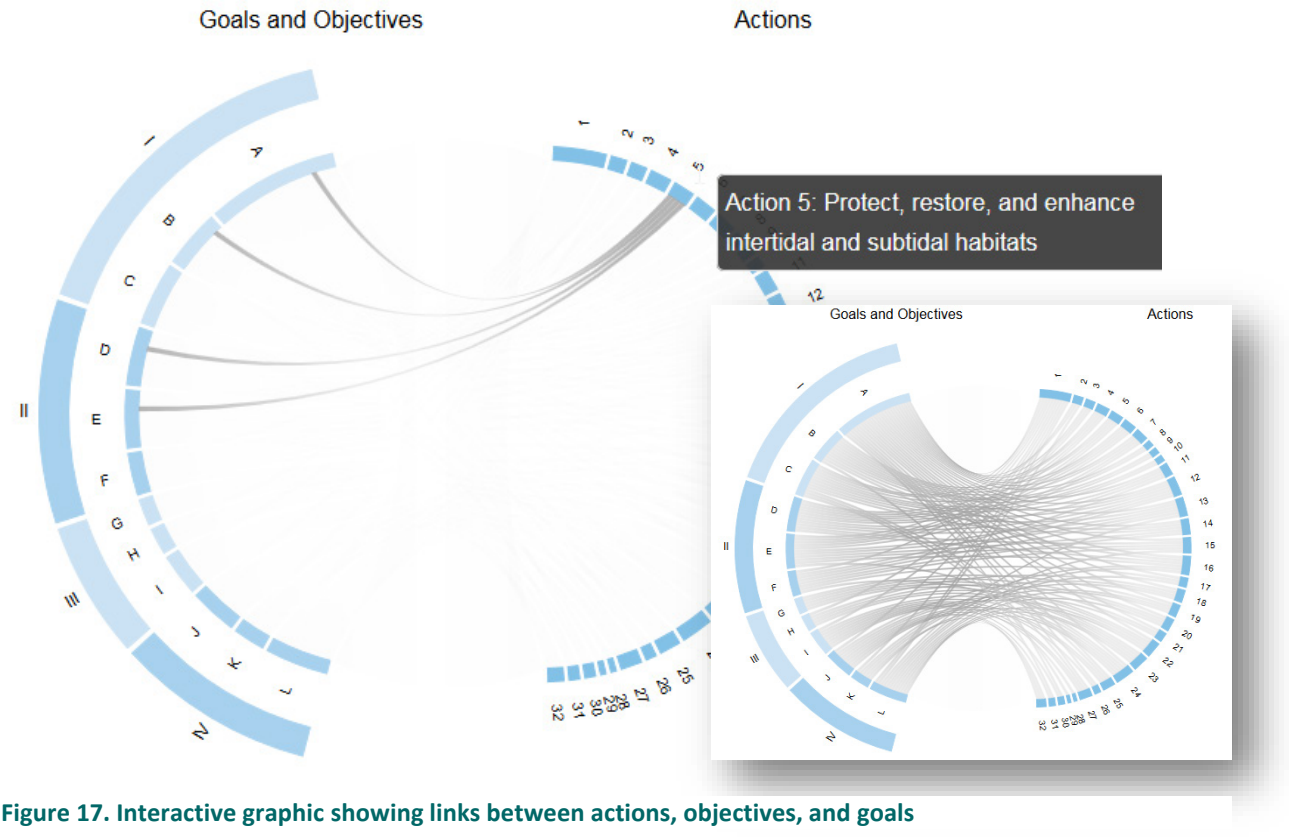


Figure 17. Interactive graphic showing links between actions, objectives, and goals

Updates to Reporting Methods

SFEP's last reporting cycle featured a State of the Estuary in 2015 and an Estuary Blueprint (CCMP revision) in 2016. Caitlin Sweeney envisions more engagement with principles of adaptive management in the next cycle, so that the State of the Estuary 2020 elicits a response from the community, SFEP adapts, and builds those adaptations into the next Estuary Blueprint revision in 2022 or 2023. SFEP sees adaptive management principles structuring their work (**Figure 18**) . In the "Assess" quadrant of the cycle, they are assessing implementation performance and environmental outcomes simultaneously on two separate but related tracks, with the latter formally published in the State of the Estuary. Next, in the "Plan" quadrant, they apply lessons learned to their revision of goals and actions, as well as implementation performance measures and indicators of environmental progress.

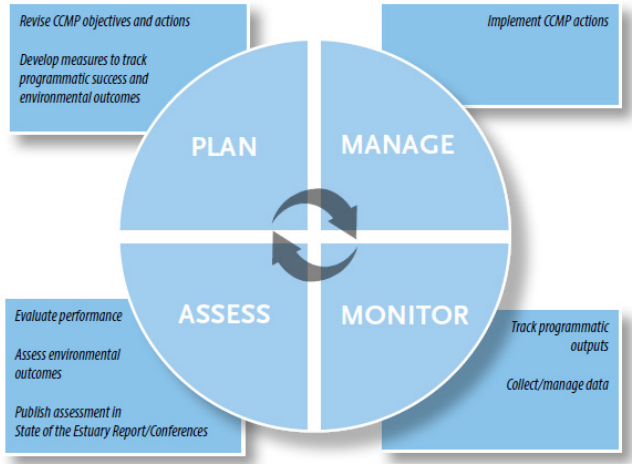


Figure 18. The adaptive management cycle of SFEP's 2016 CCMP. Available online at www.sfestuary.org/ccmp/

Tampa Bay Estuaries Program (TBEP)

TBEP oversees implementation of Charting the Course, a 2017 revised CCMP that covers implementation actions over a large (400-square-mile) geographic area on Florida's Gulf Coast. The program was established as a NEP estuary of national significance in 1991, with the first plan and implementation activities beginning in 1996, and the first plan revision published in 2006. In 2018, TBEP Senior Scientist Ed Sherwood succeeded long-serving director Holly Greening. Like Florida's other NEP sites, TBEP is an Independent Special District of the State of Florida, meaning that it is a governing body akin to a municipality or a county, authorized by Florida to work toward the goals of water quality improvement and habitat restoration. The rollout of the revised CCMP in 2017 allowed TBEP to report impressive successes in achieving the environmental goals that the program had set in 1996 and 2006. Between 2006 and 2017, TBEP and partners achieved a widespread recovery of seagrass in the bay, exceeding the recovery goal of 38,000 acres. 2006 marked the first year that all bay segments met the CCMP's nutrient management targets.

Reporting Environmental Outcomes

TBEP is monitoring the status and trends of 22 indicators that are laid out in the 2017 Monitoring and Indicators Plan, a supplement to the 2017 CCMP. The Monitoring and Indicators Plan includes information on linkages between indicators and related action plans. Both of these documents are available through the TBEP website, though the easiest way to find the Monitoring and Indicators Plan is by clicking the link in the CCMP Table of Contents. The 2017 CCMP provides a comprehensive look at status and trends for many of the indicators integrated into each action plan, though the indicators are not explicitly identified within the main CCMP document. TBEP is overhauling its website to move toward providing updates on indicators online.

Reporting Implementation Progress

The 2017 CCMP sets out ten goal themes and 39 actions. Each action has a strategy laid out with approximately two to five activities supporting the action. For each activity, a timeframe and cost range are identified, and a list of "benefits/performance measures," "results," and "deliverables" is provided. The deliverables are the most likely/practical programmatic outputs to be tracked. Implementation progress is reported in high-level summaries in annual workplans, not at the level of activities and the deliverables identified for them.

Capacity for Reporting

Ed Sherwood estimates that 20% of salary/fringe is currently dedicated to some sort of program reporting. The new work plan starting in October 2019 will see an increase to 33% of salary/fringe because TBEP is anticipating a new hire to develop new tools as part of a general overhaul of TBEP's website and online reporting format. TBEP has six employees, and all are responsible for some program reporting to varying degrees.

Notable Features/Innovations/Challenges

TBEP and its partners collect and synthesize a monumental amount of data in Tampa Bay and the watershed. One of their most notable successes in presenting data and turning it into usable information is in their mapping partnership with the University of South Florida Water Institute, the Tampa Bay Water Atlas (www.tampabay.wateratlas.usf.edu). This application hosts real-time data from buoys, sondes and weather stations, water quality sampling data, habitat and wildlife data, and the Tampa Bay Restoration database, all displayed in an ESRI-powered online GIS viewer (**Figure 19**). This interface is built for a technical/regulatory audience, as most of what is available is raw data or minimally processed data. In other words, this is not the home of public-facing, neatly packaged indicator status and trends. Rather, it is a GIS clearinghouse for data used to track and report all TBEP's indicators and restoration projects, providing all the functionality of the LISS Habitat Restoration Database (http://lisshabitatrestoration.com/) and the NERACOOS Long Island Sound Coastal Observatory (http://lisicos.uconn.edu/) with a that of full environmental database like New Hampshire's OneStop Datamapper (www4.des.state.nh.us/onestopdatamapper/onestopmapper.aspx).

Also of note is the 2017 CCMP's inclusion of effective descriptions of unmet goals. For example, the goal of restoring sea scallop populations has not been met despite great improvements in seagrass cover, which provides scallop habitat. Water clarity issues caused by nitrogen loading have been singled out as the most likely cause, whereas lack of habitat was once thought to be the limiting factor. Heavy harvesting pressure in the "Big Bend" region of Florida's Gulf Coast, an important nursery for sea scallops that can then disperse to Tampa Bay, is thought to be an important cofactor in the Tampa Bay sea scallop population's success.

Updates to Reporting Methods

In 2019 TBEP is overhauling the website to make it more progressive in reporting status and trends of environmental indicators. Ed Sherwood expressed that he would like TBEP to be more in-line with other estuary programs in what they report online. The State of the Bay is moving forward in real time, periodic, public-friendly assessments. The 2017 CCMP format (online interactive PDF, but static content that does not get updated) may be continued into the next programmatic report cycle after 2019.

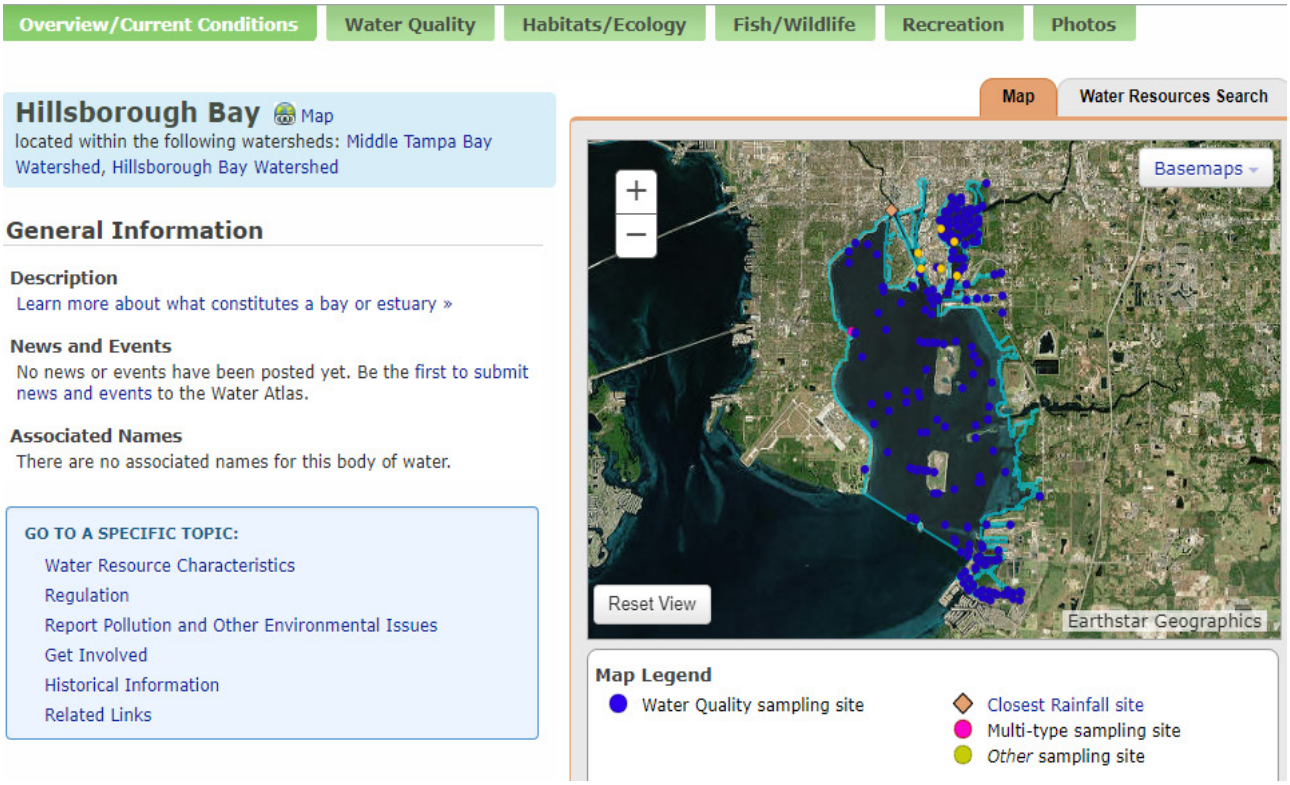


Figure 19. While the current website for Tampa Bay's progress reporting is not very progressive, the Water Atlas offers a glimpse into where TBEP is heading

Tahoe Regional Planning Agency

While decidedly not an estuary, Lake Tahoe offers one of the most modern approaches to performance reporting of the programs we reviewed. We were directed to the Lake Tahoe INFO website at https://laketahoeinfo.org/ by the Puget Sound Program as a model reporting platform that they are interested in adapting during the Vital Signs update. There are a number of interesting features about this program, including a heavy focus on implementation action/project tracking, reporting on over 240 indicators, and inclusion of economic and social indicators related to sustainable communities. The home page is organized into seven separate tracking portals or dashboards (**Figure 20**).

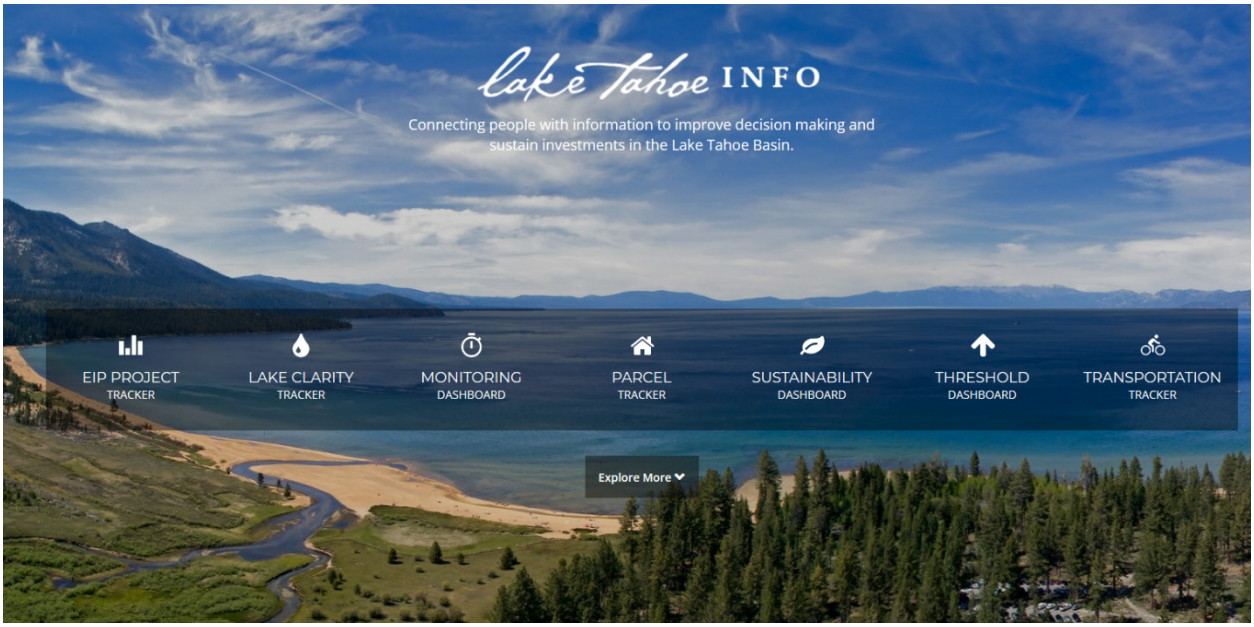


Figure 19. Homepage of the Lake Tahoe INFO website

The thresholds dashboard provides a summary of status and trends of environmental indicators for the Lake Tahoe Basin that evaluate the capacity of the Region to accommodate additional land development (**Figure 21**). Each indicator has its own page that provides more information on that indicator, including charts, links to data resources, etc.

The Environmental Implementation Project Tracker (EIP Tracker) includes interactive mapping, a searchable database of over 1000 projects, and information on $ spent and gaps on individual projects such as stormwater best management practices (**Figure 22**). The LT's investment in a webservice platform that allows for direct data upload by project partners (login required) and public download of certain data is unique. This feature allows for continuous updates to the data displayed on the website and is documented by live update notifications (**Figure 23**).

Development of the Lake Tahoe Info platform were funded by EPA, Southern Nevada Public Land Management Act, California's Strategic Growth Council, and the TRPA General Fund. Some of the platform can be freely modified and redistributed; other elements are available via commercial licensing through the Tahoe Regional Planning Agency (trpa@trpa.org). The open source version of the EIP Project Tracker is available as ProjectFirma on GitHub. The source code for the Stormwater Tools can be made available upon request.

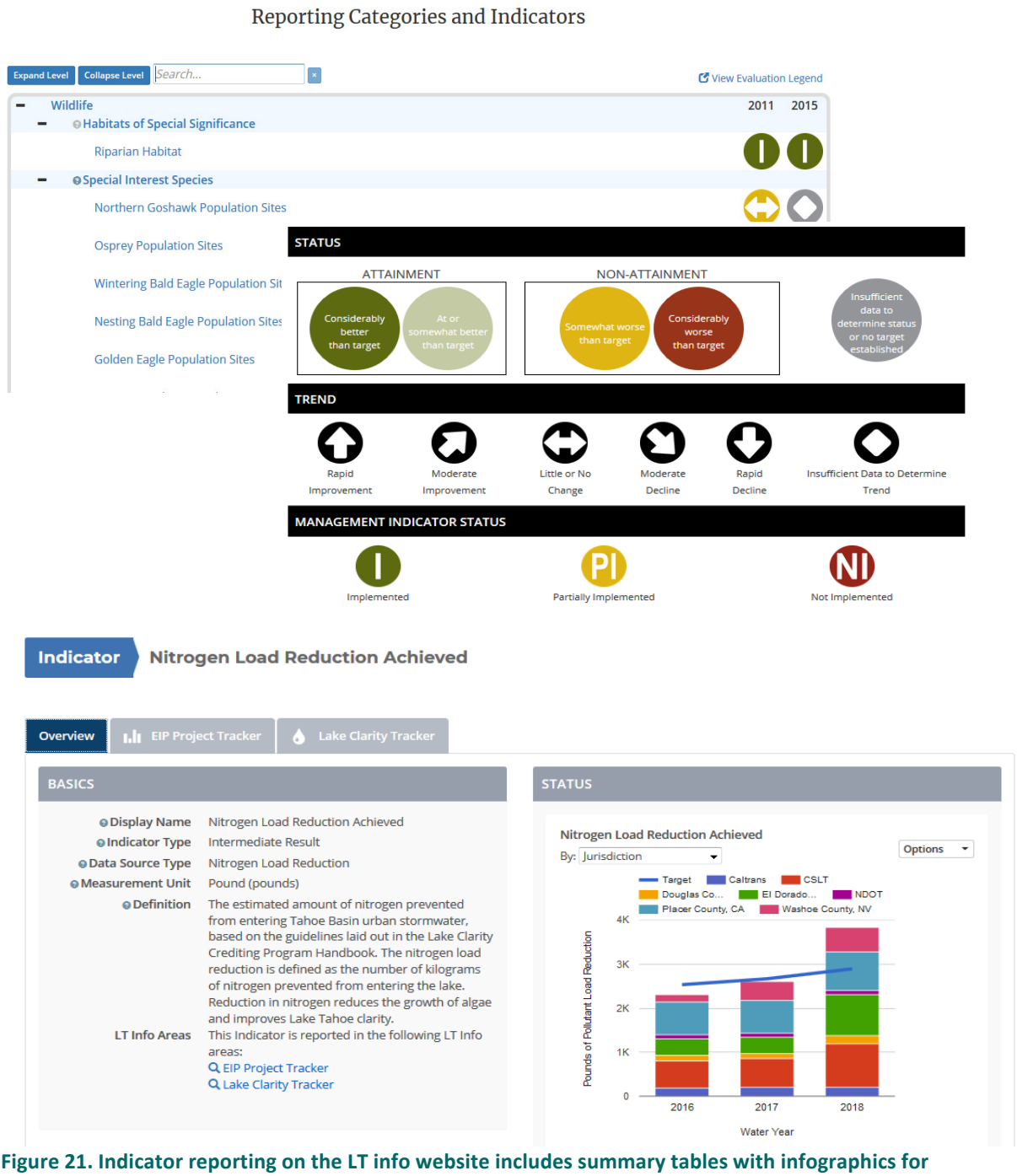


Figure 21. Indicator reporting on the LT info website includes summary tables with infographics for trends and status as well as more detailed information on each indicator.

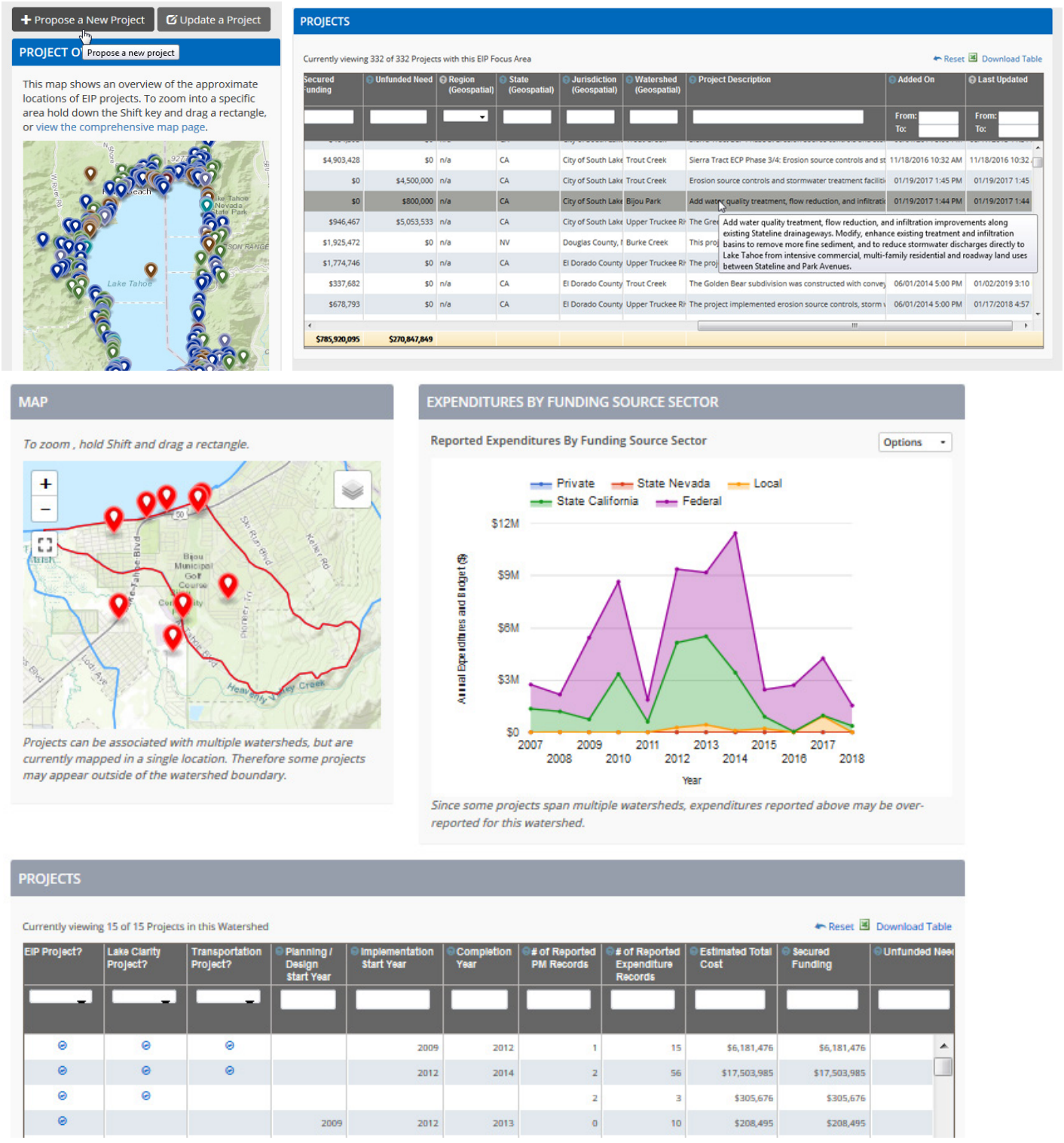


Figure 22. Environmental Implementation Project (EIP) Tracking includes maps, funding information, and searchable databases.

Figure 23. Partners with login credentials can update database directly. LT Info platform generates live update notification system visible on the website.

Program Comparison: Evaluation of Implementation Progress Reporting

We took a closer look at the aspect of performance reporting specific to tracking CCMP or other plan implementation progress. Of the other programs we reviewed, only San Francisco and Puget Sound are doing extensive tracking of their CCMP implementation progress in a more comprehensive way than high-level summaries in CCMP chapters, annual EPA workplans, and program evaluations. In order to gain a broader perspective on the cutting edge of online implementation progress tracking, we undertook a brief review of the other 23 NEP program websites. All programs provided a pdf version of their current CCMP for view or download, but only a handful of programs provided more information specific to CCMP tracking. These NEP programs provide documentation of work done under their CCMP but lack clear implementation progress tracking.

- **Barnegat Bay Partnership** provides four-year strategic plans which are shaped by commitment priorities under their CCMP but does not provide details on what actions or tasks have been achieved under the plan.
- **Buzzards Bay NEP** makes their program review submission and evaluation documents available which includes performance and progress towards their goals under the CCMP. They also provide an Interactive Map that reports environmental outcomes of their CCMP implementation work.
- The **Indian River Lagoon NEP** provides extensive information on projects underway in their annual reports, including implementation status and cost. This information is not explicitly linked to CCMP implementation actions.
- **Mobile Bay NEP** provides annual workplans under their CCMP goals outlining activities that will be undertaken in the following 12 months to implement the CCMP but does not provide details on what progress has been made.
- The **Partnership for the Delaware Estuary** posts CCMP revision documents, including technical reports and summary reports.

This broad review confirmed that most NEP programs are going to considerable lengths in the CCMP revision process to detail how to track their implementation actions, but only two NEP programs are actually tracking at the level that their CCMPs specify (or if they are collecting this information, they are not making it publicly available on their websites). San Francisco is providing detailed tracking information in their Progress Tracker, but the CCMP implementation tracking is not linked to their indicator status and trends monitoring. Only Puget Sound is attempting to use CCMP implementation tracking data to inform their analysis of the status and trends of indicators or unmet goals, through their Effectiveness Monitoring program (www.psp.wa.gov/evaluating-effective-action.php) and now, through their progress and action trackers. Chesapeake Bay Program is also doing this through the logic and action planning process.

Representatives from both the San Francisco and Puget Sound programs told us they were going to this level of detailed tracking in order to facilitate better adaptive management. It is too early to evaluate the utility of their approaches to implementation tracking, but it is reasonable to expect that they will be able to better evaluate how their actions are contributing to better environmental outcomes and progress toward targets and CCMP goals. Full attainment of the leading practice of evaluating unmet goals requires knowing exactly what the program has done in comparison to what the CCMP said it was going to do.

There are examples where other aquatic ecosystem management programs have elevated climate change indicators to the same level of reporting as other ecosystem indicators. PREP categorizes environmental indicators (pressure on ecosystem and others as response indicators). The Chesapeake Bay Program is considering the development or adoption of up to nine indicators to track progress toward building climate resiliency. Similarly, some (but not all) of other programs include a broader set of sustainability measures beyond environmental factors. The Chesapeake Bay Program includes sustainability goals and outcomes for sustainable schools and environmental literacy programs. Puget Sound tracks healthy human and quality of life indicators (cultural wellbeing, overall life satisfaction, sense of place, good governance) and has added a "relates to climate adaptation" category to its action tracker database. In addition to environmental indicators, Lake Tahoe Info includes a sustainability tracker with community and economic indicators (e.g., lifestyle, housing, health services, transportation, employment).

Addressing GAO's Comments

While the LISS is in the top tier of performance reporting of the NEP programs we reviewed, opportunities for improvement exist. After evaluating performance reporting for ecosystem targets, findings suggest that the LISS has generally incorporated the best practices recommended by GAO, with a few notable exceptions noted in the "Reporting Gaps" section above. Many of the observed deficiencies are anticipated to be resolved shortly (or are currently being resolved). For unmet goals, GAO encourages the LISS to evaluate the challenges and potential solutions to meeting targets, even when the science is not yet certain. Furthermore, GAO suggests that the LISS should better understand how ecosystem target achievement is tied to management activities (or implementation actions) of the CCMP. LISS doesn't currently track implementation action progress or assess how those actions influence ecosystem target achievement. There are many layers of accountability built into each target (scientific, managerial, congressional, etc.) that, if transparent, can be used to communicate challenges and to adapt management activities to find solutions to unmet or unmeasured targets.

The following recommendations are provided to support LISS in addressing GAO's performance reporting recommendations and identify opportunities for improvement and innovation:

1. Assess completion status of implementation actions and how progress relates to ecosystem target achievement.

2. Work with partners to further develop innovative online performance reporting tools (e.g. standalone progress web site/branding, interactive mapping, real-time data portals, and searchable databases).

3. Explore a reporting platform that allows direct data upload by Sound partners.

4. Reduce the # of printed publications and increase frequency of online reporting for ecosystem targets and indicators as data becomes available.

1. Assess completion status of implementation actions and how progress relates to ecosystem target achievement. Where ecosystem targets are unmet or are behind schedule, GAO Leading Practice #3 involves an evaluation of whether CCMP implementation is adequate to achieve the target. We interpret this evaluation to be necessary at the level of implementation actions or strategies. To carry out an evaluation at one of these levels of detail, LISS must first track completion status of implementation activities, determine how the actions influence ecosystem target attainment, and then determine if new or modified actions are needed – in short, to carry out an adaptive management cycle.

Currently, the LISS reporting website provides a wealth of information on the 20 ecosystem targets and 22 supplemental indicators, but it does not provide easily accessible information on progress implementing the actions identified in the supplemental reports. Some of this information is presented in the hard copy reports, including programmatic actions that may have historically been included in the implementation. As noted above, other program reporting websites are including implementation actions and project level tracking information (e.g., Puget Sound, San Francisco Bay, Chesapeake Bay, and Lake Tahoe). Chesapeake and Puget are going one step further and linking action tracking with the vital signs and environmental outcomes.

To address this, we linked each action from the supplemental reports to one or more ecosystem targets as part of our evaluation of GAO's recommendations related to cost estimating. We suggest tracking management activities either at the implementation action (IA) or strategy level. Finally, we offer a number of options for how progress on implementation actions could be organized on the LISS website; a tracking database seems the simplest approach.

Tracking Implementation Action Progress

The 2015 CCMP includes four Supplemental Documents that present a total of 139 implementation actions (IAs) across the four themes. The IAs are intended to carry out the specific strategies within each theme, while the 20 ecosystem targets (ETs) are set with the underlying assumption that implementation of these actions will result in measurable progress toward meeting the ETs.

For each IA, the supplemental documents include a description, a list of partners involved, funding sources and needs, and expected outputs and performance metrics. Therefore, the road map to tracking implementation progress has already been created and could be applied using the following approach:

1. Identify which actions are linked to specific ecosystem targets. This has been initially completed by HW/FBE as part of the costing analysis, but it should be reviewed and modified by LISS during the 2020 CCMP update (**Figure 24).** The Ecosystem Target Cost Matrix spreadsheet in **Attachment C** includes crosslinks between IAs and ETs. The Science and Management IAs should be also be linked to specific targets wherever possible.

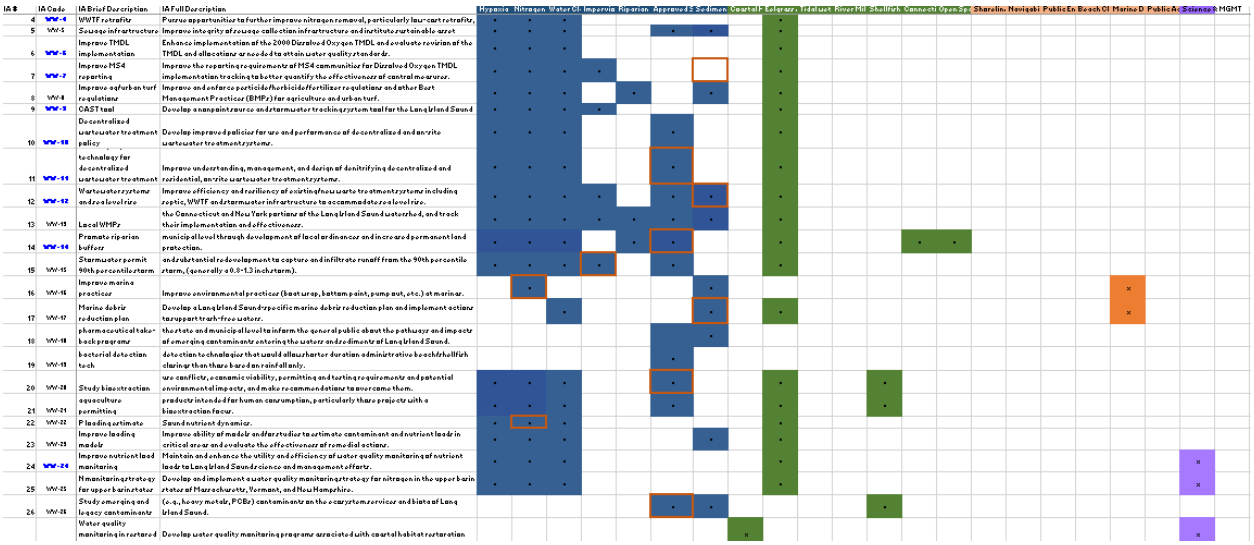
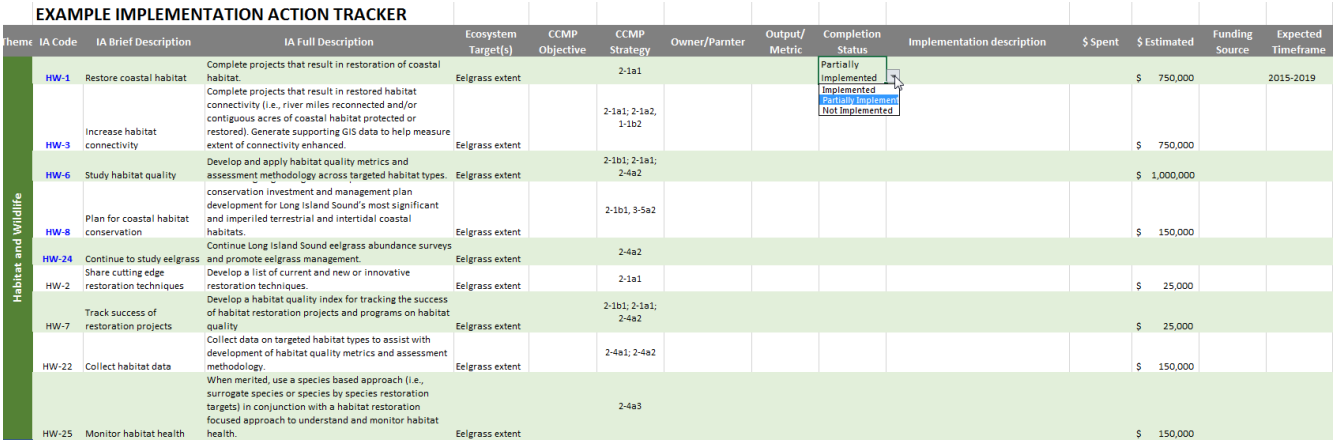


Figure 24. Target-Action Matrix Spreadsheet (see Attachment C)

2. Create an Implementation Action (IA) Tracking database for all IAs and all ETs. This could be done for all 139 actions in a consolidated Microsoft Access database (or a similar program) that would allow for flexibility in sorting and reporting of information. If 139 actions are too many to track, consider starting with only the actions that are within the primary theme or were identified as priorities in the supplemental documents. Eliminating the Science and Management IAs from tracking would also reduce the total number and tracking burden, as they are less directly connected to achieving ETs. For each action, the database should include the following data fields:

- the number/name of action and a short descriptor
- the relevant ecosystem target(s) and potentially the goals, objectives, strategies
- partners or owner
- funding source, $ spent, and remaining $ needed (or total estimated)
- status of completion (fully, partially, or not implemented), expected output or metric
- expected timeframe, completion date, and date of update.

This is essentially identical to the San Francisco Estuary Program Progress Tracker, but it adds in cost information (similar to the Puget Sound and Lake Tahoe progress trackers) and groups IAs by the ETs to which they contribute. Status of completion should be assessed based on the performance metrics provided in the CCMP supplements. Much of the other information needed can also be pulled directly from the supplemental documents. **Appendix D** includes a sample database template, illustrated in **Figure 25**; however, in order to link each action with multiple ETs, the database would need to be more robust than a simple spreadsheet database (e.g. Microsoft Excel).



EXAMPLE IMPLEMENTATION ACTION TRACKER

Theme	IA Code	IA Brief Description	IA Full Description	Ecosystem Target(s)	CCMP Objective	CCMP Strategy	Owner/Parnter	Output/ Metric	Completion Status	Implementation description	$ Spent	$ Estimated	Funding Source	Expected Timeframe
Habitat and Wildlife	HW-1	Restore coastal habitat	Complete projects that result in restoration of coastal habitat.	Eelgrass extent		2-1a1			Partially Implemented			$ 750,000		2015-2019
	HW-3	Increase habitat connectivity	Complete projects that result in restored habitat connectivity (i.e., river miles reconnected and/or contiguous acres of coastal habitat protected or restored). Generate supporting GIS data to help measure extent of connectivity enhanced.	Eelgrass extent		2-1a1; 2-1a2, 1-1b2			Implemented / Partially Implemen / Not Implemented			$ 750,000		
	HW-6	Study habitat quality	Develop and apply habitat quality metrics and assessment methodology across targeted habitat types.	Eelgrass extent		2-1b1; 2-1a1; 2-4a2						$ 1,000,000		
	HW-8	Plan for coastal habitat conservation	conservation investment and management plan development for Long Island Sound's most significant and imperiled terrestrial and intertidal coastal habitats.	Eelgrass extent		2-1b1, 3-5a2						$ 150,000		
	HW-24	Continue to study eelgrass	Continue Long Island Sound eelgrass abundance surveys and promote eelgrass management.	Eelgrass extent		2-4a2								
	HW-2	Share cutting edge restoration techniques	Develop a list of current and new or innovative restoration techniques.	Eelgrass extent		2-1a1						$ 25,000		
	HW-7	Track success of restoration projects	Develop a habitat quality index for tracking the success of habitat restoration projects and programs on habitat quality	Eelgrass extent		2-1b1; 2-1a1; 2-4a2						$ 25,000		
	HW-22	Collect habitat data	Collect data on targeted habitat types to assist with development of habitat quality metrics and assessment methodology.	Eelgrass extent		2-4a1; 2-4a2						$ 150,000		
	HW-25	Monitor habitat health	When merited, use a species based approach (i.e., surrogate species or species by species restoration targets) in conjunction with a habitat restoration focused approach to understand and monitor habitat health.	Eelgrass extent		2-4a3						$ 150,000		

Figure 25. Example IA Tracker Spreadsheet for Eelgrass Extent Target

3. For each Ecosystem Target (ET), include a condensed "IA Tracker" table or searchable database. ET-specific IA Trackers could simply show the implementation status of each relevant IA using icons. **Figure 26** provides an example of what this may look like for the Eelgrass Extent ET in the most condensed form. There are 33 implementation actions related to eelgrass, 24 from the water quality theme and 9 from the habitat theme. For simplicity (or to start out), we recommend showing only priority actions from the primary theme to which the ET belongs (e.g., only IAs from the Habitats & Wildlife theme for the eelgrass ET), and other related ETs that must be reached in order to support the ET in question (e.g., the water clarity ET must be met to support achievement of the eelgrass ET). Alternatively, a single IA Tracker (e.g., online searchable/filterable version of the tracking database) could be used covering all 20 ETs.

The LISS Habitat Protection and Restoration database (http://lisshabitatrestoration.com/) provides an example of a searchable database with sort and filter functions that could be followed.

4. Update the implementation status of all actions as soon as data becomes available – at least annually. If this information is gathered and synthesized at an annual or sub-annual frequency, LIS could collate this information into a two-year glossy summary publication to coincide with the biennial reporting requirement. At the 5-year evaluation, decisions should be made if IA implementation status is a factor in ecosystem target attainment and strategies and IAs could be reshaped accordingly in classic adaptive management fashion.
5. During the next CCMP update cycle, develop the new list of IAs with a strong focus on achieving progress toward meeting ETs. Design the metrics for implementation tracking accordingly, with adaptive management in mind. If the output for an IA is a tangible improvement (such as an infrastructure upgrade, retrofit, or restoration site), the connection to the appropriate ET is straightforward. If the output is not a tangible improvement (i.e., a study, a data product, or a public outreach project), spell out how the results will be incorporated into adaptive management to better achieve ETs. This focus on the ETs will clarify what is most important to track in implementation progress, and may reduce the total number of IAs to track.

Tracking Implementation Progress at the Strategy Level

Tracking 84 strategies instead of 139 actions would reduce the number of components to track; however, it is uncertain if the ultimate level of effort to track at this level will be less than at the IA level. In contrast to the IAs, the strategies currently do not have predefined metrics or expected outputs that can be used to evaluate implementation progress. If measures or milestones were established for each strategy during the 2020 CCMP update, then progress towards completing the strategy could be determined. In the meantime, measures could consist of the key outputs/metrics for IAs related to that strategy, or some subset.

Some examples using Strategy 2-1a1 are shown below. **Table 7** illustrates a single evaluation factor based on a combination of existing metrics/outputs from key IAs under strategy 2-1a1. **Table 8** illustrates a more complex approach that evaluates a few key IAs individually to generate an overall composite score and % complete value. The descriptions under both examples are generated from the existing IA metrics/outputs provided in the Supplementary Documents. Using this approach, you would:

1. Select the most appropriate level of implementation based on the status description that most closely matches;
2. Pick a number within the range of that category to fine tune within the broader category;
3. Add up each column; and
4. Divide by the number of IAs or factors evaluated, and 5) multiply that value by 100 to generate a percent complete value.

Eelgrass Extent		
Action	Description	Status
HW-1	Fund targeted coastal habitat restoration projects	P
HW-3	Direct restoration resources toward habitat connectivity	P
HW-6	Standardize methods for evaluating habitat quality	P
HW-8	Direct conservation resources to priority sites	P
HW-24	Continue collecting eelgrass coverage data	I
WW-Various	Work toward the water clarity ecosystem target	P
Key to Status Icons:		
Implemented	Partially Implemented	Not Implemented
I	P	N

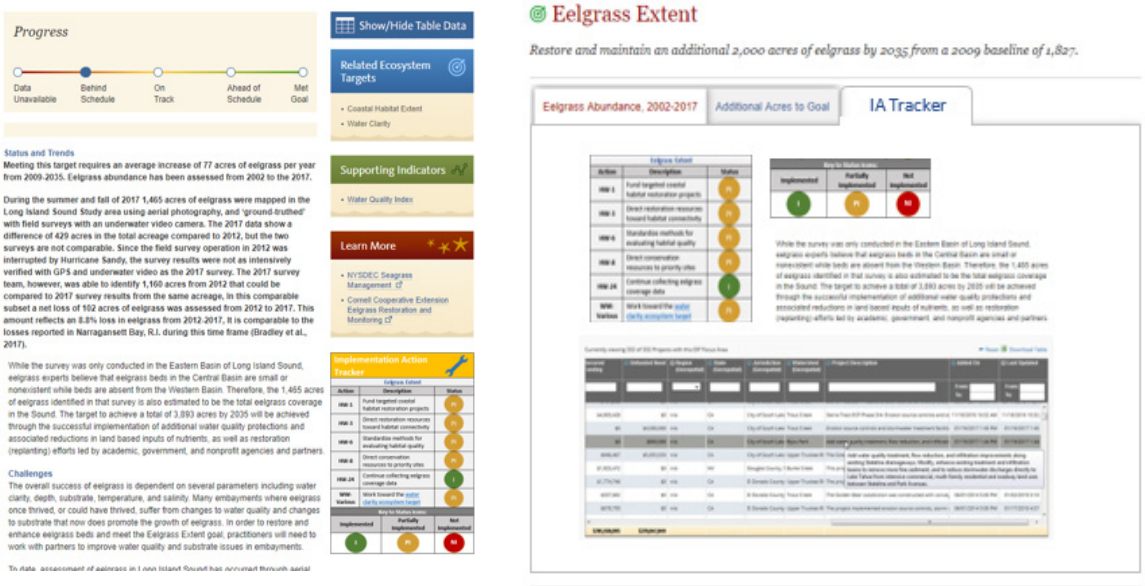


Figure 26. Example Eelgrass Extent Action Tracker. Options for where to include in the information on each Target include in the righthand column or as an added tab in the data window.

Table 7. Example illustrating how to combine IA metrics into the status description for a CCMP strategy.

Strategies	Substantially complete	Partial implementation	No significant progress	Don't Know
Strategy 2-1a1*	Extensive (acres/miles/# of passages, connectivity) successfully restored; Good GIS tracking and analysis; habitat restoration techniques distributed	Need more restoration projects to meet ETs and connectivity, working on GIS and restoration practice guidance	Only just now starting, some plans but few implemented; a long way to go with GIS	

**Strategy 2-1a1: Develop and implement innovative and effective habitat restoration plans and projects including restoring quality and quantity of coastal habitat and fish passage (relevant actions HW-1, HW-2, HW-3; supporting actions HW-6, HW-7, HW-27).*

Table 8. Example strategy progress tracker displaying completion assessments for multiple IAs.

Factors (IAs) in Strategy 2-1a1	Substantially complete	Partial implementation	No significant progress	Don't Know
HW-1 Complete projects that result in restoration of coastal habitat.	Extensive (acres/miles/# of passages) successfully restored; restoration projects have met ETs; monitoring stage mostly; not supporting new plans	Need more restoration projects to meet ETs, # plans completed; % of projects installed; only a few target habitats types restored	Only just now starting, some plans but very few implemented; a long way to go	
	10 9 8	7 6 5 4	3 2 1	0
HW-2 Develop a list of current and new or innovative restoration techniques.	Annotated list of habitat restoration techniques is developed and posted; updates have occurred; actively shared with partners	Annotated list of habitat restoration techniques is mostly completed; not widely distributed yet	This hasn't been started; grant issued, but no real progress yet	
	10 9 8	7 6 5 4	3 2 1	0
HW-3. Complete projects that result in restored habitat connectivity. Generate supporting GIS data to help measure extent of connectivity.	Extensive river miles reconnected and/or contiguous acres of coastal habitat protected or restored; updated GIS data and connectivity analysis tool. Meet ET target	Less than half of connectivity enhancement opportunities realized; GIS database has a lot of holes	Some progress; no way to measure progress	
	10 9 8	7 6 5 4	3 2 1	0
Subtotal	8	6	3	=17/3
Strategy-Level Status				5.6
Percent Complete				56%

For either of these methods to be meaningful or practical, some effort will need to go into aligning IAs, strategies, and ETs and in identifying the metrics needed to appropriately bin status categories. Arguably, the process of selecting the most important aspects of each strategy requires tracking IA-level implementation, but it could be done in a way that is less onerous than systematically evaluating every action related to that strategy. Regardless of the

approach, the strategies would still need to be linked directly to relevant ecosystem targets, similarly to how the IAs were linked.

For each ET, create a progress tracker table that displays the strategies and implementation statuses that can be replicated on the LISS website. Create a strategy tracking database to store information about strategy implementation progress.

Pros and Cons of Tracking Implementation Progress at the Action or Strategy-level

Implementation Actions

- Lots of them (139)
- Based on existing outputs and metrics described in Supplemental Documents
- Could be a focus of next CCMP update
  - Reduce total number of IAs
  - Generate clear progress measures
  - Link directly to ET and indicators

Strategies

- Fewer number (84)
- No pre-defined metrics for measuring implementation progress
- Need to cross-link with ETs and indicators
- Could be focus of next CCMP update
  - Generate clear progress measures
  - Method to evaluate how implementation of strategy affects achievement of ET

Listing Completed and Ongoing Actions

Instead of providing a tracking database for actions or strategies, another option would be to simply provide a bulleted list of completed and ongoing actions, key accomplishments, and areas for improvement under each ecosystem target—similar to the Chesapeake Bay Program's Logic and Action reporting. This list could be organized by states or could be watershed-wide; LISS could include a link to a workplan or other hard copy action plan that indicates completion status (updated on an annual or biannual basis); or be a more detailed version of Appendix A from the 2015 CCMP that provided a brief discussion of key program and partner accomplishments for the period 1994-2014. This narrative of implementation progress would provide in-depth information for each strategy on what has been accomplished and what remains to be done.

As part of this effort, LISS should discuss the process governing the removal of targets that have already been met to strengthen focus on the still-active targets. For targets that have been achieved or indicators are no longer considered relevant, what is the plan for continued tracking or archiving of that indicator? The Chesapeake Bay Program has a guidance document that outlines a process for the addition or removal of indicators

(www.chesapeakebay.net/channel_files/23821/approved_cbp_indicators_framework_and_management_process.pdf).

Finally, for each Ecosystem Target, LISS should rewrite the existing "Challenges" section to incorporate implementation progress information. These "Challenges" sections can be used as the places to attain Leading Practice #3, where met or unmet ETs are evaluated based on what management actions have been taken and to suggest new management approaches.

2. Work with partners to further develop innovative online performance reporting tools. Consolidate performance reporting information and data links from LISS and others into an independent webpage that elevates the Sound partnerships and unifies status and trend reporting. Performance reporting is trending to more online publishing and less hard copy, although statutory requirements in many cases may require submission of reports. Some programs have a standalone website (and identity) for performance reporting that is separate—at least visually—from the program's flagship website (see ChesapeakeSTAT, Puget Sound Info). This creates the appearance of a more collaborative "ownership" of reporting by other partners in the estuary.

The existing website for LISS is effective and more advanced than many other NEPs (e.g., Tampa and Casco), but is buried in the program's website. Giving it some level of "independence" with a catchy name may encourage more active state and local engagement in reporting and access to estuary-wide data. For example, LISS could adapt the Chesapeake model of an overarching website "SoundStats" that has three main portals: "SoundHealth" (goes to reporting on ecosystem targets and other indicators); "SoundActions" (tracks programmatic measures and implementation actions/projects); and "SoundBytes" (with links to live and other data sources from partners and where folks can upload data). An independent site could offer a location for project partners who also have reporting websites to consolidate information or share web design resources. For example, Save the Sound's Report Card could be included with the information under SoundHealth, and CTDEEP water quality monitoring site could provide a framework for the data portal.

Continue to collaborate with partners to provide interactive mapping, real-time data portals, searchable databases or other technical components that go beyond the LISS's current capacity. ChesapeakeProgress, Tahoe Info, and others have interactive mapping elements in portions of performance reporting. Tampa Bay has the Atlas that has been successful. LISS has indicated that they don't have the capacity for this, but perhaps some of their partners might. Look for more opportunities to rely on partner products such as the CTDEEP LIS Water Quality Monitoring Program, UConn real-time sensors, and IEC's sampling stations. There is a link currently, for example to a clickable map of buoys and monitoring sites administered by others. This could be more prominent, and there are other ecosystem targets that could benefit from a similar set up.

Regardless, some small changes the LISS existing website could lead to a more user-friendly platform with more visually compelling imagery and infographics for communication of progress to general audiences. One such user-friendly strategy (following the example of Puget Sound) is to include an at-a-glance chart of all targets and supporting indicators that summarizes progress in one location using infographics to display indicator status and trends. A draft of such an indicators at-a-glance chart for LISS is provided in **Attachment E**. Continue to improve the functionality of the interactive graphs and maps (e.g., on the eelgrass extent graph, the link to hide data and adjust scales is not useful when only one data series is on display). Links and more detailed information can be provided for more targeted or sophisticated audiences without compromising the clean, streamlined look that the target pages currently have.

LISS is currently tracking supplemental indicators and linking them to relevant ecosystem targets, where feasible. LISS could enhance the visibility of climate change indicators on the website and consider the addition of other social and economic sustainability targets/indicators, similarly to Chesapeake Bay, Puget Sound, and Tahoe).

LISS could better clarify how the climate indicators inform the study of the targets (e.g. the effects of changing water temperature on dissolved oxygen and the hypoxia ecosystem target). LISS has a theme that may be a natural fit for some of these topics – Sustainable and Resilient Communities.

3. Where feasible, provide partners the opportunity to upload data directly to the performance reporting platform. Reduce the data compilation burden by exploring a reporting platform that allows direct data upload by Sound partners. Where raw data is provided to LISS, automate data QA/QC wherever feasible. Like LISS, many programs have limited staff dedicated to performance reporting and rely heavily on partners to conduct monitoring/data collection needed to measure performance. It can be a full-time job tracking information down. Puget Sound, which has four staff responsible for some aspect of performance monitoring recently upgraded to an online system based on Tahoe Info, that allows for direct upload of data by partners for project/action level implementation reporting. Choose creative (and easy) ways to get the project partners engaged in the data sharing/data upload process.

For most programs, data quality assurance and documentation remain the primary responsibility of the individual contributors. For data that can and should be updated at high frequency (e.g. dissolved oxygen sensor data), there are highly effective methods to automate the data management tasks of flagging suspect data, gap-filling missing data, correcting for sensor drift or fouling, etc. Many types of data can be managed effectively with XML (Extensible Markup Language), a coding language that can aid with QA/QC automation when used with a commercial or open source statistical software such as R (open source). Casco Bay talked about this extensively in having a water quality dashboard, for example. For LISS, public beach closures, water temperature, DO, etc. are the types of data that may require QA/QC.

4. Streamline progress tracking publications and reporting formats. Reduce the number of printed publications and embrace a frequency of online reporting for ecosystem targets and indicators that matches the speed at which new data/analysis/information becomes available. Within the past decade there have been various reporting mechanisms each with their own frequency of publication (online reporting, Sound Update, Sound Health, Protection & Progress Biennial Report, Implementation Report, etc.). LISS is in the process of deciding how many reports they are committed to moving forward. We recommend a 10-year CCMP revision with a 5-year update on implementation actions, a summary publication every 2 years, and a guideline of annual online updates on ecosystem targets and indicators, with the understanding that new data becomes available at a faster or slower pace for different ecosystem targets and indicators. A consolidated online platform may allow for more frequent tracking of some measures. Identify measures where real-time display or daily makes sense, such as the buoy data (already being done) or beach closures. Other indicators could also be updated on a continuous basis if there was a more automated process for project data uploads, especially where no data processing is required (e.g. the number of communities with resiliency plans or habitat acres restored). Lastly, metadata could be added to each reported measure to describe when the data was last updated and/or quality assured.

Ecosystem Target Costs

The 2015 CCMP and the 2018 GAO report estimated a total implementation cost of $14 to $18 billion, respectively, over a 20-yr horizon. The 2015 GAO recommended that LISS: 1) develop cost estimates that include analysis of uncertainties for each of the ecosystem targets; and 2) estimate the range of potential costs for all implementation actions and include the estimates in future supplements to the 2015 CCMP. The LISS has partially addressed these recommendations—the Supplemental documents contain relative cost estimates for each implementation action (ranging from $-$$$$, roughly $25,000 - $10M), for example—but LISS has not used this information to estimate costs for each ecosystem target.

Approach to Estimating Costs

An approach to estimating costs for each ecosystem target was devised by LIS and HW/FB using the information available in the 2015 CCMP, NYC 2017 LCTP work plan, and the Supplemental Reports. The approach divides costs into two camps: core costs (large statewide capital expenditures) and LISS implementation action (IA) costs. Core costs are generally estimated on a 20-yr timeframe and are dominated by capital costs of wastewater treatment plant upgrades, remediation of combined sewer overflows, land acquisition for conservation, urban stormwater management, and species management. Estimates for 5-year IA cost were completed by LISS for nearly all of the 139 IAs, with certain exceptions for IAs for which the scope of work had not yet been decided. This information was published as 2015 CCMP supplemental documents with

supporting descriptions of the IAs, deliverables, and performance measures. These IAs cover a large variety of programmatic activities and are referred to below as "IA costs."

The costing approach is described below in more detail. **Attachment C** includes the Ecosystem Target Cost Matrix.

1. Establish core costs and assign to ecosystem targets.

The core costs presented in the 2015 CCMP (see Section 5 and Table 5 on page 49) were used to set the floor for core spending to achieve all ecosystem targets. Several costs were unassigned at the time of the 2015 CCMP, notably combined sewer overflow remediation and urban stormwater management in New York State. Additional costs for upstream states beyond the WWTF upgrades were not included. We developed estimates for the two missing costs through the following means:

NY CSO Abatement Costs-- The total cost for CSO abatement in the LIS portion of New York was determined as the sum of costs for East River, Flushing Creek, Flushing Bay, Alley Creek, Hutchinson River, Bronx River and Westchester Creek provided in the New York City LTCP 2017 Summary Report (https://www1.nyc.gov/html/dep/pdf/green_infrastructure/improving-water-quality-by-reducing-the-impacts-of-csos-fall-2017.pdf. See Table on page 18). We assumed that the cost would be spread over the 20-year timeframe.

Urban Stormwater Retrofitting in NY—We used GIS and the CT-based stormwater retrofit cost listed in the CCMP to generate an equivalent cost for the non-CSO portion of NY draining to LIS. We divided the retrofit core cost for CT by the area of impervious cover in the CT portion of the watershed to generate a $/impervious acre ratio of $2,900/acre. We then calculated the area of impervious cover in the NY state portion of the LIS watershed, subtracted out the CSO sewershed areas, and multiplied the CT $/impervious acre ratio by the impervious acres in the non-CSO portion of the NY contributing drainage area (**Figure 27** and **Table 9**). We double checked the impervious estimates against CLEAR's impervious estimates from 2002 and they were very close (CLEAR's estimate was 7.46% impervious area in CT, and our estimate was 7.63%).

The GIS data sources used were:

- LIS watershed boundary from UConn CLEAR (http://clear.uconn.edu/projects/landscapeLIS/v2/summary/index.htm) doublechecked against USGS (www.usgs.gov/core-science-systems/ngp/national-hydrography/watershed-boundary-dataset?qt-science_support_page_related_con=4#qt-science_support_page_related_con);
- NYCSO sewershed boundaries (https://openseweratlas.tumblr.com/data were double checked against DEC boundaries (http://www.dec.ny.gov/maps/nyscsos.kmz); and
- Impervious cover from the MRLC database (https://www.mrlc.gov/data?f%5B0%5D=category%3Aurban%20imperviousness&f%5B1

%5D=region%3Aconus, which appears analogous to the UConn CLEAR's data. The UConn data is in the process of being updated.

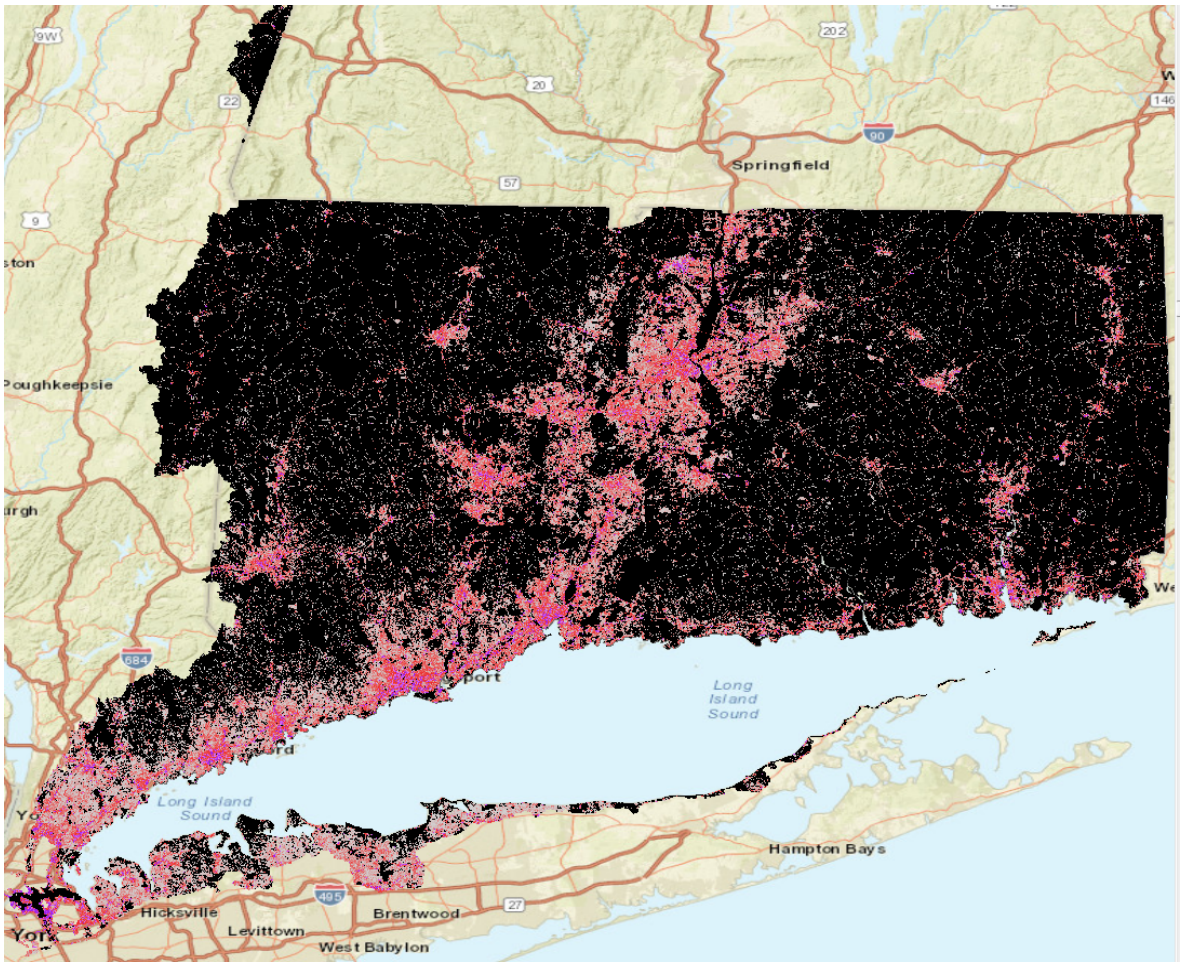


Figure 27. Impervious Cover in the CT and NY's non-CSO portions of the Long Island Sound Watershed

Table 9. Impervious Cover Calculations

	Area (ac)	Impervious Area (ac)	%	$	$/acre
LIS Watershed in CT	3158274	241060	8%	$ 700,000,000.00	$ 2,903.84
LIS Watershed NY (not CSO)	409840	52458	13%	$ 152,331,049.36	
LIS Watershed NY (CSO)	31049	23157	75%	$ 67,243,950.94	
LIS NY (CSO +Non-CSO)	440890	75615	17%	$ 219,575,000.30	

Next, for the purpose of calculating cost estimates for ecosystem targets, we assigned each core cost component to the ecosystem target(s) to which it directly contributed. For example, the WWTF Retrofits core cost contributes to five ETs (Hypoxia, Nitrogen Loading, Water Clarity, Sediment Quality, and Coastal Habitat Extent, while the Education core contributes to one ET (Public Engagement and Knowledge). We then divided the core costs by the number of ETs and

assigned equal fractions of the total to each ET. This procedure was done for all core costs to arrive at a total core cost for each ET.

Table 10 shows the core costs of approximately $11.8 Billion over 20-yrs and the allocation of these costs across relevant ecosystem targets. These costs are displayed in the "Core tab" of the Cost Matrix in Attachment C.

Table 10. Excerpts of Core Costs showing amounts and distribution by Ecosystem Target (not all ETs shown here)

Theme	Element	NY (20-yr)	CT (20-yr)	Upstream States (20 yr)	Total (20 yr)	# of ecosystem targets	Cost per target
WW	WWTFs retrofits	$ 2,000,000,000	$ 3,000,000,000	$ 5,000,000	$ 5,005,000,000	5	$ 1,001,000,000
WW	Urban stormwater	$ 152,330,000	$ 700,000,000		$ 852,330,000	9	$ 94,703,333
WW	CSOs	$ 1,801,000,000	$ 3,000,000,000		$ 4,801,000,000	8	$ 600,125,000
HW	Habitat restoration				$ 180,000,000	6	$ 30,000,000
HW	Riverine migratory corridors	$ 12,000,000	$ 60,000,000		$ 72,000,000	2	$ 36,000,000
HW	Species management		$ 120,000,000		$ 120,000,000	4	$ 30,000,000
HW	open space protection	$ 500,000,000	$ 140,000,000		$ 640,000,000	3	$ 213,333,333
SC	education	$ 4,000,000	$ 4,000,000		$ 8,000,000	1	$ 8,000,000
SC	climate prepardness, resiliency, sustainability		$ 80,000,000		$ 80,000,000	3	$ 26,666,667
	Total	**$ 4,469,330,000**	**$ 7,104,000,000**	**$ 5,000,000**	**$11,758,330,000**		

Theme	Element	Hypoxia	Nitrogen Loading	Water Clarity	Impervious Cover	Riparian Buffers	Approved Shellfish Areas	Sediment Quality
WW	WWTFs retrofits	x	x	x				x
WW	Urban stormwater	x	x	x	x		x	x
WW	CSOs	x	x	x	x		x	x
HW	Habitat restoration							
HW	Riverine migratory corridors							
HW	Species management							
HW	open space protection					x		
SC	education							
SC	climate prepardness, resiliency, sustainability							
	Total	$ 1,695,828,333	$1,695,828,333	$ 1,695,828,333	$ 694,828,333	$ 213,333,333	$ 694,828,333	$ 1,695,828,333

2. Link Implementation Actions (IA) under each theme to relevant ETs

Next, we considered the costs for specific implementation actions separately from the core costs. As with the core cost components, we took each of the 98 IAs in the first three themes and assigned it to the ET(s) to which it directly contributed. In many cases, an IA in one theme would contribute directly to an ET from a different theme. For example, riparian buffer-related actions in the Waters and Watersheds theme may also be reflected in Habitats and Wildlife ETs such as coastal habitat expansion. The identification of these overlaps is important to avoid double counting of costs between targets.

These linkages can be viewed in the "Water &Watersheds," "Habitat&Wildlife," and "Sustainable Community" tabs in the Cost Matrix spreadsheet in Appendix C.

3. Identify the cost range of each IA

The cost estimates of IAs were taken from the Supplemental documents to the 2015 CCMP and assigned to cost ranges using the following system of symbols outlined in the CCMP: $<$25K; $$=$25k-$150k; $$$=$150k-$1M; and $$$$ > $1M. We capped the range of the $$$$ IAs at $10,000,000, as the IAs are revised every five years and spending beyond $10,000,000 in that timeframe would be exceedingly unlikely. Because many costs were provided as a range, a minimum and maximum cost was estimated for each action. IA costs are applied over a 5-yr timeframe, not on a yearly basis.

4. Calculate total IA costs for each ET

The total cost of each IA was evenly split across all the applicable ETs (including in ETS within the same theme and in other themes). For example, if the minimum cost for an action was $125,000 and that action applied to 5 ecosystem targets, then $25,000 was added to each of the respective ETs' total minimum costs.

5. Add Science and Inclusive Management costs

The Science and Management theme has 41 IAs but no ETs. Some of these 41 IAs can be identified as contributing directly to ETs, particularly certain research and monitoring IAs that are required to effectively measure ETs. We carried out this exercise for all IAs in this theme, the result of which can be seen in the "WW$," "HW$," and "SC$" tabs in the Cost Matrix in Attachment C.

Not all 41 IAs could be reasonably attributed to specific ETs; however, for the purpose of cost assignment we divided the total cost of all 41 Science and Management IAs evenly into the 20 ETs. This was done for minimum and maximum costs to represent the entire range of potential costs. The cost per ET is tallied separately in the Cost Matrix at the bottom of the WW$, HW$, and SC$ tabs in a row entitled "SM allocations."

6. Generate total cost estimates and ranges for ETs

Total cost estimates and ranges of costs for all 20 ETs were created by multiplying the minimum and maximum IA costs by four (i.e., IA costs are 5-yr and the Core costs are 20-yr) and adding each total to the core costs to calculate a 20-year cost range for each ET. Similarly, a five-year cost range was calculated by dividing the core costs by four and adding the minimum and maximum IA costs. These results are presented in the "Summary" tab of the Cost Matrix and in **Table 11**.

The total 20-yr estimate for all the ecosystem targets is $12.4 billion; over $8.7 billion of that total is allocated to achieving the ecosystem targets in the Clean Water and Watersheds theme. The individual ecosystem targets show a wide range in maximum 20-yr costs, with $33 million for the Navigability target (SC) to $1.8 million for three of the WW targets—Hypoxia, Nitrogen Loading, and Water Clarity.

Table 11. Summary of 5 and 20-year ecosystem target costs (rounded costs in $Millions).

Theme	Ecosystem Target	IA $ Range (5-yr)		Core $ (20-yr)	Total $ Range (5-yr)		Total $ Range (20-yr)	
		Min	Max		Min	Max	Min	Max
WW	Hypoxia	2	21	1,696	426	445	1,705	1,780
	Nitrogen Loading	2	21	1,696	426	445	1,705	1,779
	Water Clarity	2	21	1,696	426	445	1,705	1,780
	Impervious Cover	0	5	695	174	179	696	716
	Riparian Buffers	0	3	213	54	57	215	226
	Approved Shellfish Areas	1	12	695	175	186	699	744
	Sediment Quality	1	8	1,696	425	432	1,699	1,726
	Total	**9**	**92**	**8,386**	**2,106**	**2,188**	**8,423**	**8,752**
HW	Coastal Habitat Extent	1	8	60	16	23	64	91
	Eel grass extent	1	5	1,756	440	444	1,758	1,775
	Tidal wetland extent	0	5	60	15	20	62	80
	River Miles Fish Passage	0	2	96	24	26	97	102
	Shellfish Harvested	0	2	30	8	10	31	38
	Connectivity	1	5	279	70	75	282	299
	Open Space	1	17	213	54	70	217	281
	Total	**4**	**43**	**2,494**	**628**	**667**	**2,510**	**2,667**
SC	Shorelines	1	8	27	8	15	30	60
	Navigability	0	2	27	7	8	28	33
	Public Engagement & Knowledge	2	10	8	4	12	14	47
	Beach Closures	0	2	695	174	176	696	703
	Marine Debris	0	1	95	24	25	96	100
	Public Access	1	7	27	7	14	30	56
	Total	**4**	**30**	**878**	**223**	**250**	**893**	**998**
	TOTAL	**17**	**165**	**11,758**	**2,957**	**3,104**	**11,826**	**12,417**

Cost per Ecosystem Target

Using our costing approach, the total 20-year cost range for all activities to achieve ETs was estimated at $11.8-12.4 billion. This value is significantly lower than the $18.9 billion figure cited in the GAO report, but relatively close to the $14Billion estimated in the CCMP. The principle reason for this difference is that the refinement of the cost estimate for abatement of CSOs has led to a greatly reduced figure for this core element in New York. As before, the largest share of the estimated cost goes toward achieving the ETs in the WW theme in the form of WWTF retrofits and CSO remediation.

Looking more closely at the 5-yr cost estimates is likely more practical given the CCMP 5-yr review cycle and program budgeting process. **Figure 28** shows the total $3.1Billion divided across the three themes as core costs, with an additional pie slice indicating the IA costs (only 7% or $165M). Almost 70% of the total CCMP costs are in the WW theme. The chart on the right shows a breakdown of the IA costs over 5-yr period. While most of the program costs are still within the WW theme, it appears that SC and HW themes are garnering almost half of the IA funds collectively.

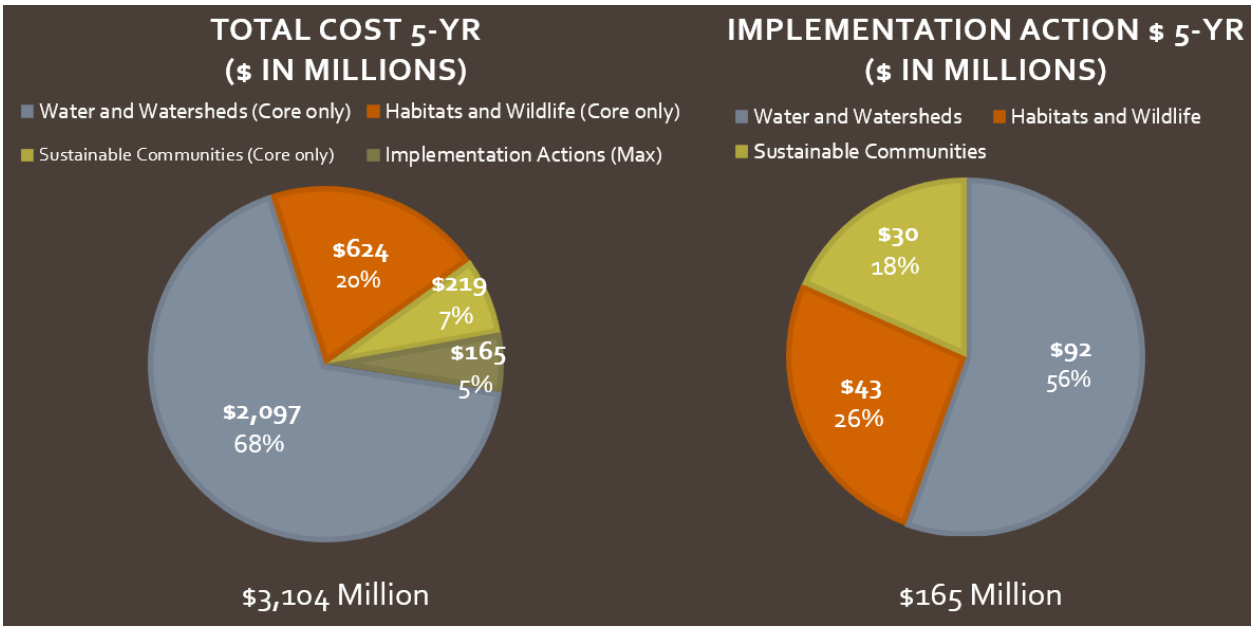


Figure 28. 5-yr Cost Breakdown by Theme

Figure 29 shows a breakdown by ecosystem target of the 20-yr maximum estimate of $12.4 billion dollars. This chart provides a quick comparison of which ecosystem targets account for a larger portion of the total costs.

Figure 30 provides a closer look at the 5-yr and 20-yr costs attributed to each ecosystem target within a given theme.

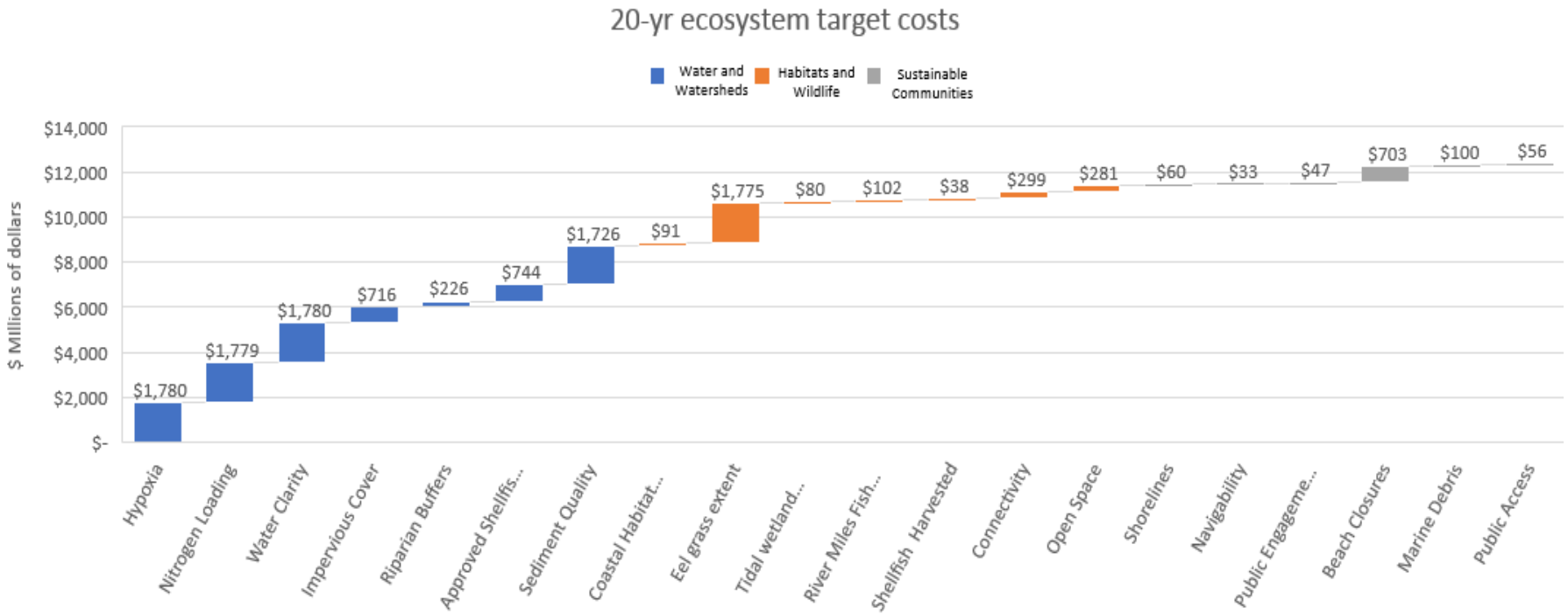


Figure 29. 20-yr Cost Breakdown by Ecosystem Target

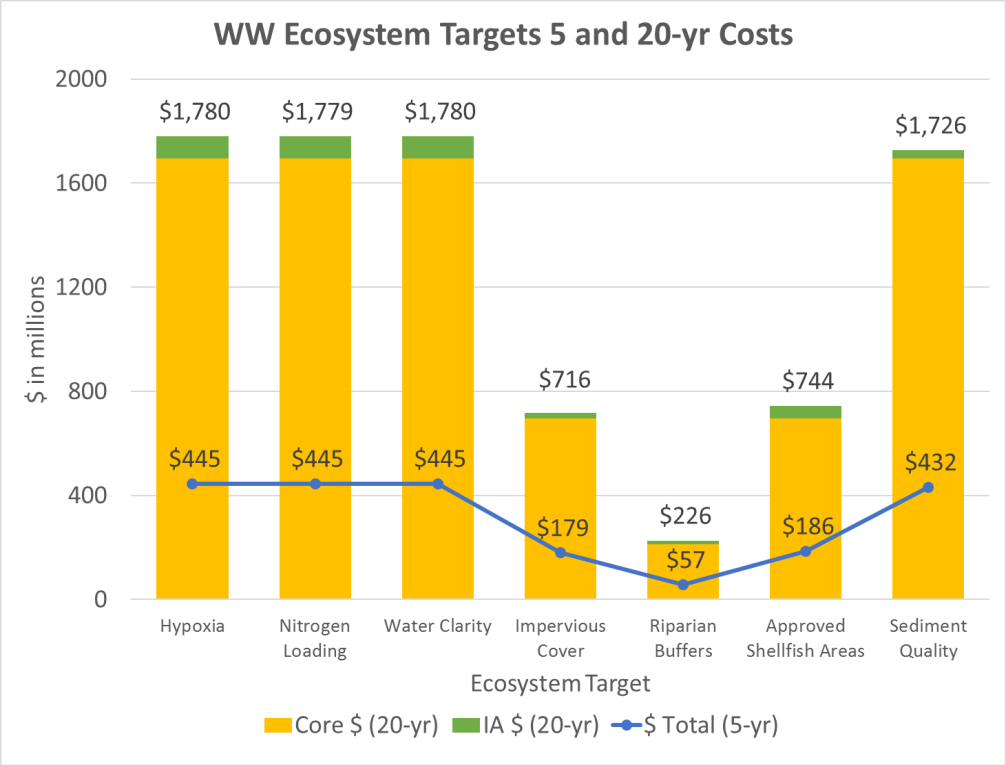


Figure 30. 5-yr and 20-yr Ecosystem Target Costs for Clean Waters and Healthy Watersheds theme

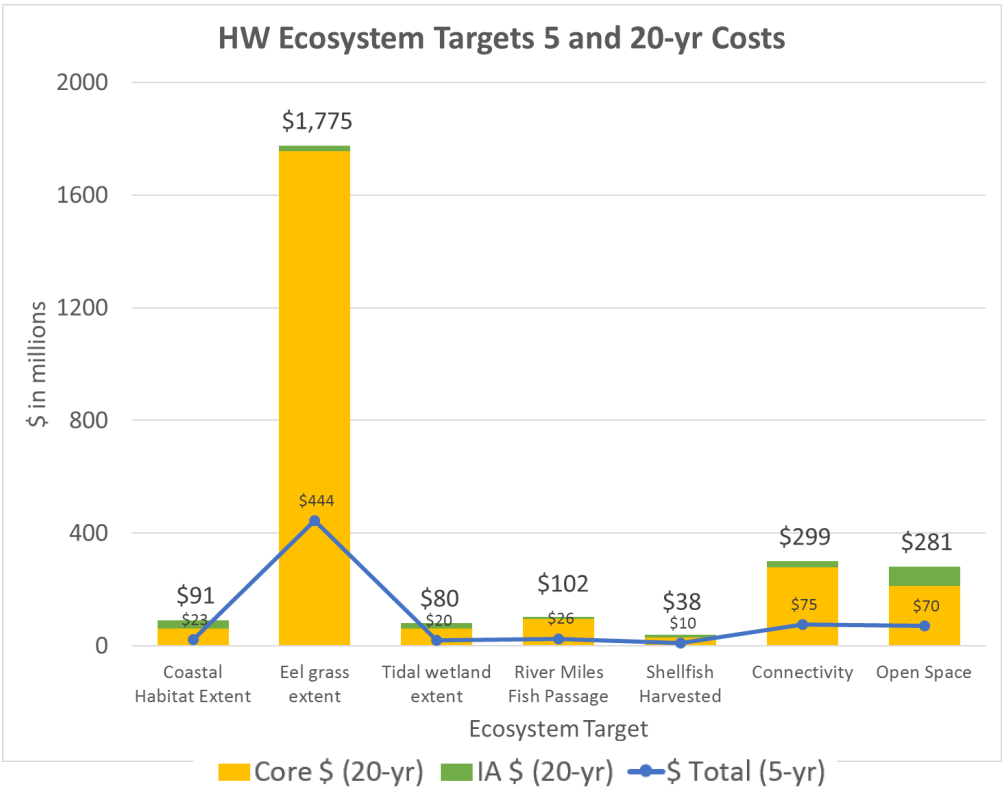


Figure 31. 5-yr and 20-yr Ecosystem Target Costs for Thriving Habitats and Abundant Wildlife theme

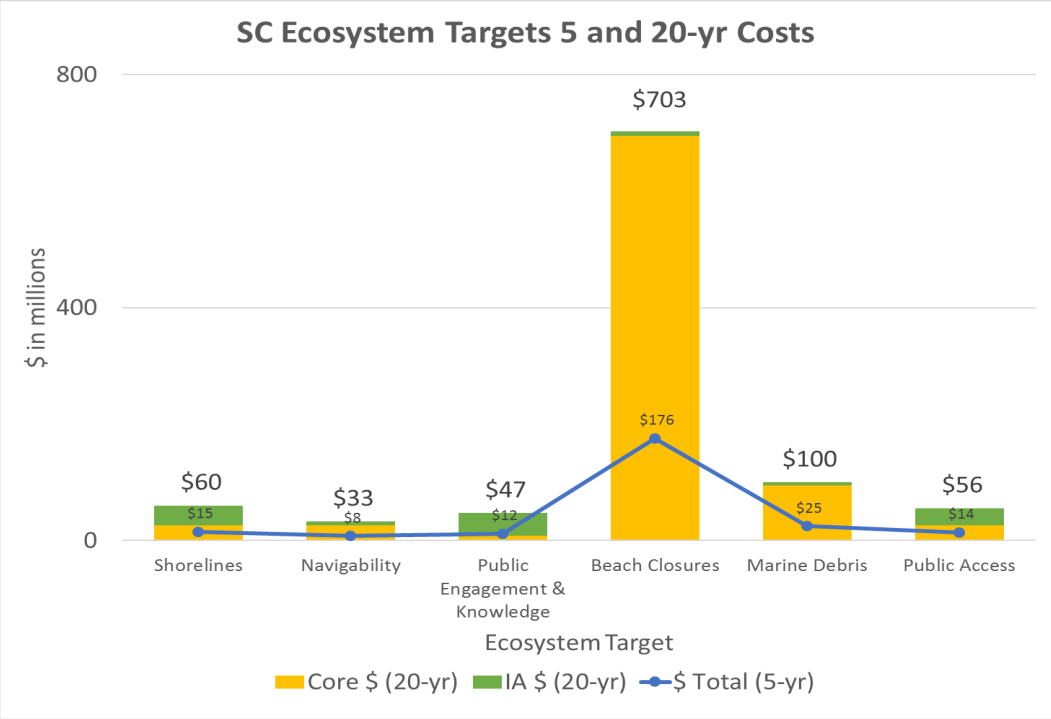


Figure 32. 5-yr and 20-yr Ecosystem Target Costs for Sustainable and Resilient Communities theme

Uncertainty in Cost Estimates

We recognize that there is much uncertainty in the cost estimating for ecosystem target achievement, including broader environmental and regulatory conditions that may change ecosystem targets (i.e., dissolved oxygen targets may become more stringent in response to rising temperatures); factors that influence program funding levels and priorities; and action implementation factors that contribute to uncertainty. In addition, there are a number of areas where uncertainty has already crept into the ecosystem cost estimates. For example, the pre-designated cost ranges assigned to the IAs ($-$$$$) represent uncertainty in the estimates. The $$$$ estimate could be any value >$1M and was artificially capped at $10M. On the other hand, only the minimum cost of the core requirements has been estimated to date, meaning that the uncertainty in core costs is not yet quantified.

Estimating the cost of core management plan components and implementation actions carries risk and uncertainty attached to each project. Risk is the probability that a negative outcome will occur, in a situation where the likelihood of best-case and worst-case scenarios can at least be estimated. Uncertainty, in contrast, is a situation in which there are more outcomes than can be identified. There are two types of uncertainty to consider: *requirements* and *cost-estimating*. *Requirements uncertainty* refers to the disparity in costs stemming either from a misunderstanding of the components necessary to complete a project, or from a change in those components as the project develops. *Cost-estimating uncertainty* arises from various

sources: difference between individual cost estimates, errors in extrapolating, etc. The IA cost estimates exhibit both types of uncertainty that are combined in the cost ranges. Extrapolating the 20-year costs from the five-year costs undoubtedly increases both types of uncertainty.

In an ideal world, each project would be broken down into its various cost components. Each cost component would then be given a minimum cost (best case scenario), a maximum cost (worst case scenario), and an estimate of the probability of the each of these scenarios occurring. These cost ranges and probabilities can then be used to construct a Monte Carlo simulation, which can give the decision maker a range of estimates and the probability of each occurring. Such an exercise for a project of this magnitude would likely be expensive and time-consuming. It is typical of ecological restoration projects to be subject to considerable uncertainty in construction costs that create a large range in the overall cost estimate. Most of that large uncertainty is due to *requirements uncertainty*, rather than *cost-estimation uncertainty*. With more information specific to the project, the *requirements uncertainty* can be reduced. *Cost-estimation uncertainty* can likewise be reduced by looking at ranges of estimates for other, similar projects.

To address GAO's recommendation to include uncertainty in ecosystem target cost estimates, we conducted a simple, qualitative uncertainty analysis. Our assumption is that all the cost estimates covered in the CCMP and supplemental documents are subject to uncertainty and our approach was to describe the sources of uncertainty as factors, and then categorize core components and implementation actions as either high, medium, or low level of uncertainty based on the number of factors that apply to each.

We identified 10 key uncertainty factors (**Table 12**) and assigned relevant ones to each of the implementation actions and core cost for the targets in the WW theme. In our ranking method, an IA or core cost with 0-3 uncertainty factors was ranked Low; 4-6 factors, Medium, and 7-10 factors, High. **Figure 33** provides a screen capture of the spreadsheet where uncertainty factors were assigned to each IA (see hidden "WWUncertainty" tab in Attachment C Cost Matrix).

Once levels of uncertainty were assigned to each IA, we compared the % of IAs that ranked as high, medium, or low uncertainty, as well as the % of the total cost associated with the IAs in those uncertainty categories (**Table 13**). Interestingly, most of the IAs were considered to have a relatively low uncertainty; however, most of the costs are associated with the IAs with the highest level of uncertainty. This is not surprising giving that the highest costs are with IAs that are linked to bigger scale activities.

Each ET was then assigned a level of uncertainty based simply on the most prevalent uncertainty category across all relevant IAs and core cost centers in that respective ET.

While interesting, we ultimately determined the exercise was not particularly useful other than in acknowledging the complex universe of uncertainties associated with these cost estimates. Perhaps the best means of incorporating uncertainty into ecosystem cost estimates is to more carefully estimate the cost ranges for IAs and core costs, be aware of the uncertainty factors at

play, and ensure that any update to the CCMP or supplementary documents includes a discussion of how those factors of uncertainty may influence ecosystem target costs and achievement.

Table 12. Narrative Description of Uncertainty Factors

	Factor	Descriptor
1	Construction costs	Costs estimated by contractor construction bids based on future rates for labor, materials, etc.
2	Implementation costs	Costs estimated for projects focused on feasibility, windows of opportunity, planning, research, outreach, advocacy, etc.
3	Duration	Length of time that a project is expected to last. A longer project schedule compounds the uncertainty of construction costs, implementation costs, and climate/environmental risk.
4	Range	The geographic area/extent covered by the project
5	Management decisions not yet made	The decisions on laws, regulations, policies, permitting decisions, local ordinances, etc. that affect the scope and timing of project activities
6	Available technology evolution	Gap between existing infrastructure, tools, techniques, etc. and the best or most cost-effective technology, including technologies that may become available during the course of the project (we don't currently have, but something may come up that is cheaper or more effective).
7	Risk (climate, environmental, etc.)	Risk that an unfavorable climate event (flood, drought, change in ocean temperature, etc.) or environmental event (exotic species invasion, pest outbreak, etc.) may increase the cost of the project or erase progress
8	Data validity	Uncertainty inherent in models of the future based on past/current conditions (growth projections, sea level rise, land use change, etc.)
9	BMP performance	The unknown difference between a modeled, expected capacity for performance of a BMP and what actually happens over the BMP's lifespan (e.g., under or over performance)
10	Funding availability	Degree to which the funding source is identified. A delay in starting a shovel-ready project compounds the uncertainty of first three factors

IA Number	Implementation Action	Cost	Cost Min	Cost Max	# of Uncertainty factors	Level of Uncertainty	Applicable Uncertainty factors
			$ <$25K; $$=$25k-$150k; $$$=$150k-$1M; $$$$ > $1M		1-10 factors assigned by committee	H=7-10; M=4-6; L=0-3	list of factors (by number)
WW-1	Evaluate the impact of increasing human population, climate change and land use trends in the Long Island Sound watershed to determine nutrient and contaminant stressors on sewage loads from Wastewater Treatment Facilities (WWTFs)/Combined Sewer Overflows (CSOs) and decentralized/on-site wastewater treatment systems (OSWTS).	$$	$ 25,000	$ 150,000	2	L	4,8
WW-2	Strategically plan for and implement capital improvements, BMPs, and improved operation and maintenance to mitigate CSO, stormwater, and nonpoint source loadings, taking into account the analysis of potential future changes in loading (WW- 1).	$$$$	$ 1,000,000	$ 10,000,000	10	H	all
	Explore expansion of point source and nonpoint source nutrient trading programs						

Figure 33. Screen Capture of Uncertainty Factor Assignments

Table 13. Uncertainty Analysis break down from IAs in the WW theme

ECOSYSTEM TARGET		Hypoxia	Nitrogen Loading	Water Clarity	Impervious Cover	Riparian Buffers	Approved Shellfish Areas	Sediment Quality
COUNT of Factors per ET	TOTAL	**29**	**29**	**30**	**6**	**9**	**21**	**16**
	H	4	4	4	1	0	2	2
	M	9	8	10	1	3	6	5
	L	15	16	15	4	6	12	9
UNCERTAINTY RATING (% of Count)	H	14%	14%	13%	17%	0%	10%	13%
	M	31%	28%	33%	17%	33%	29%	31%
	L	55%	59%	53%	67%	67%	62%	56%
UNCERTAINTY RATING (% of ET Cost Max)	COST MAX	$ 19,707,708	$ 19,257,708	$ 19,807,708	$ 3,751,190	$ 1,247,708	$10,619,375	$6,264,524
	H	52%	54%	52%	44%	0%	35%	59%
	M	21%	19%	21%	44%	82%	28%	32%
	L	27%	28%	27%	11%	18%	37%	9%

Addressing GAO's Comments

GAO recommended that the LISS estimate costs for each of the ecosystem targets in the 2015 CCMP and provide cost ranges for implementation actions in the updated CCMP supplements. LISS has already generated cost ranges for individual implementation actions but has not taken the next step to estimating costs at the ecosystem target level. Our cost estimating method described above generated individual ecosystem target cost estimates ranging from $33 million (Navigability target) to $1.8 billion (Hypoxia target) over 20-yrs. Just under 70% of the total costs was associated with core costs for targets in the WW theme. We recommend LISS take the following actions to improve its cost estimating and address GAO's recommendations:

1. During next CCMP update, look closely at cost estimates generated for each Implementation Action

2. Work with partners to further track & evaluate core costs

3. Track $ spent and source of funding as part of performance reporting

4. Refine costing assumptions (e.g. time, science & management, ET assignments)

1. Refine cost estimates for implementation actions as part of the 2020 CCMP revisions. Since the ecosystem target cost estimates are based on the costs of full implementation of management activities, having confidence in the cost ranges for the implementation actions is important. Regardless of the uncertainty surrounding these estimates (or the logic behind assigning costs to ecosystem targets), from a program budgeting perspective, there is value in understanding what funding support is needed and where funds

should be distributed for CCMP implementation. There is already a lot of good information provided for each action item in the supplemental documents, refining the cost estimates, understanding the uncertainties of that estimate, and linking actions with ecosystem targets and indicators is a valuable next step.

2. Work with partners to further track and evaluate core costs. Core costs may be more difficult to tease out given the multitude of communities, state and federal agencies, organizations, and the private sector that are expending (or anticipating to spend) dollars on watershed restoration and conservation actions that are never reported to the LISS or key partners. The core costs used likely represent the low end of anticipated cost range. Given the magnitude of these core costs compared to the IA costs and the presumed impact of these core elements on achieving ecosystem targets, it makes it even more critical to more accurately capture those costs. Expending more effort on core costs may include assigning a cost range to better account for uncertainties, adding expenditures from other states to the current list, and potentially expanding the number of cost centers could result in a significant increase in estimated costs for each target. Moving towards a standalone online platform where partners can upload data directly (and painlessly) may help broaden the cost estimating net.

3. Track dollars spent and funding source as part of performance reporting. LISS reports funding in several of its hard copy reports and could include information on the website at the project scale or implementation action level. Tahoe Info, Chesapeake Bay, and Puget Sound all include information about project funding, either as separate portals or within project progress reports. Chesapeake Bay has legislative support that requires federal agencies to report on funds spent on watershed restoration work, which trickles down to state spending through grant programs. The Puget Sound and TRPA both track dollars spent and needed at the project/action item level, as well as the source of funds (state, private, etc.). If organized properly, LISS partners could categorize project spending into the various themes or targets needed for performance reporting, which will help with estimating ecosystem target costs.

4. Refine assumptions in the cost estimating approach (e.g. time, science & management, ET assignments). The costing approach presented makes a number of assumptions that could (and likely should) be adjusted as more information becomes available. For example, core and IA costs for the three themes are currently distributed evenly across all relevant ecosystem targets. The total cost for the science and management IAs is divided evenly across 20 ecosystem targets. The IA costs are assumed across a 5-yr window and the core costs over a 20-yr window, and there is no front or back loaded of these costs overtime. In addition, the crosslinks between IAs, core cost centers, and ecosystem targets could be revised based on team discussions during the 2020 CCMP revisions.

Attachments

A. Performance Reporting Practices Matrix (.xls)

B. Interview Notes

C. Ecosystem Target Cost Matrix (.xls)

D. Implementation Action Tracker (.xls)

E. Targets and Indicators At-a-Glance