Casco Bay Plan 2024

Casco Bay Estuary
PARTNERSHIP

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ACRONYMS AND ABBREVIATIONS

ACFHP Atlantic Coastal Fish Habitat Partnership

ACJV Atlantic Coast Joint Venture

ANEP Association of National Estuary Programs

BIL Bipartisan Infrastructure Law

BMP Best Management Practice

CBCA Casco Bay Coastal Academy

CBCOM Casco Bay Coastal Ocean Model

CBEP Casco Bay Estuary Partnership

CBRSWG Casco Bay Regional Shellfish Working Group

CCMP Comprehensive Conservation and Management Plan

CCSWCD Cumberland County Soil and Water Conservation District

COBALT Collaborative for Bioregional Action Learning and Transformation

CRP Community Resilience Partnership

CSO Combined Sewer Overflow

DACF Maine Department of Agriculture, Conservation and Forestry

DEIJ Diversity, Equity, Inclusion, and Justice

DEP Maine Department of Environmental Protection

DIFW Maine Department of Inland Fisheries and Wildlife

DMR Maine Department of Marine Resources

EBTJV Eastern Brook Trout Joint Venture

eDNA Environmental DNA

EPA Environmental Protection Agency

ESI Environmental Sensitivity Index

EVI Environmental Vulnerability Index

FEMA Federal Emergency Management Agency

FOCB Friends of Casco Bay

GIS Geographic Information System

GMRI Gulf of Maine Research Institute

GOPIF Governor’s Office for Policy Innovation and the Future

GPCOG Greater Portland Council of Governments

HPF Habitat Protection Fund

IIJA Infrastructure Investment and Jobs Act

ISMN Integrated Sentinel Monitoring Network

ISWG Interlocal Stormwater Working Group

KELT Kennebec Estuary Land Trust

LCWMD Long Creek Watershed Management District

LEA Lakes Environmental Association

LGBTQIA+ Lesbian, Gay, Bisexual, Transgender, Queer, Questioning, Intersex, Asexual, Plus

LiDAR Light Detection and Ranging

LOBO Land-Ocean Biogeochemical Observatory

LPA Limited Purpose Aquaculture

MCP Maine Coastal Program

MEEA Maine Environmental Education Association

MIMIC Marine Invader Monitoring and Information Collaborative

MNRCP Maine Natural Resources Conservation Program

MOCA Maine Ocean and Coastal Acidification Partnership

MS4 Municipal Separate Storm Sewer System

NAWCA North American Wetland Conservation Act

NECAN Northeast Coastal Acidification Network

NEEFC New England Environmental Finance Center

NEP National Estuary Program

NERACOOS Northeastern Regional Association of Coastal Ocean Observing Systems

NGO Nongovernmental organization

NOAA National Oceanic and Atmospheric Administration

NRCS Natural Resources Conservation Service

NSF National Science Foundation

PANG Portland Area Nitrogen Group

PCBs Polychlorinated biphenyls

PFAS Per- and Polyfluoroalkyl Substances

PREP Piscataqua Region Estuaries Partnership

PRLT Presumpscot Regional Land Trust

PWD Portland Water District

QAPP Quality Assurance Project Plan

RoPCs Risks of Primary Concern

rSETs Rod Surface Elevation Tables

SCW Sebago Clean Waters

SEP Supplemental Environmental Project

SMARTeams Salt Marsh Adaptation and Resiliency Teams

SWAP Maine State Wildlife Action Plan

SWAT Surface Water Ambient Toxics

SWiM Sustainable Winter Management

TAC Technical Advisory Committee

TMDL Total Maximum Daily Load

TNC The Nature Conservancy in Maine

TU Trout Unlimited

UNH University of New Hampshire

USFW GOMCP U.S. Fish and Wildlife Gulf of Maine Coastal Program

USGS U.S. Geological Survey

USM University of Southern Maine

VRMP Volunteer River Monitoring Program

WBP Watershed Based Plan

WWTF Wastewater Treatment Facility

INTRODUCTION

For three decades, the Casco Bay Estuary Partnership (CBEP) has guided efforts to sustain a healthy Bay and watershed: protecting key habitats, improving water quality, and encouraging sound stewardship. This collective work on behalf of the Bay has yielded many positive outcomes—like cleaner swimming beaches; more shellfish beds open to harvesting; and improved fish passage along our streams and rivers. But stressors on the Bay are changing in character and growing in number and magnitude. The work of CBEP is changing as well.

Today, CBEP brings together dozens of organizations and individuals in a collaborative network on behalf of Casco Bay. The Partnership's core staff, housed at the University of Southern Maine (USM), strives to anchor the network, strengthening the effectiveness of all members of the Partnership on behalf of Casco Bay, the watershed, and the people of the region. The organization is science-based, watershed focused, and collaborative.

The Bay and Its Importance

Casco Bay stretches from Cape Elizabeth in the south to Phippsburg to the east. The bay inshore of Halfway Rock totals about 160 square miles in area. It is a geographically complex place with 575 miles of shoreline, and 785 islands, islets, and ledges. It borders the Portland metropolitan area, Maine's largest urban center. Ferries service six year-round Casco Bay Island communities.

Figure 1: Map of Casco Bay showing numerous islands and complex shoreline.

The Bay's strong tides swirl in and out among all those islands and ledges, creating a mélange of coastal and marine habitats, from broad tidal flats to exposed rocky shores, tidal marshes to kelp beds. The typical daily tidal range in Portland is just under ten feet but spring tides approach 14 feet between low water and high water.

Casco Bay has abundant maritime trades, a strong lobster fishery, and more than 800 documented marine species. The region's residents enjoy the many recreational amenities it offers, including swimming, boating, fishing, clamming, and wildlife-watching.

According to NOAA, the marine economy in 2018 accounted for 10 percent of the total jobs in Cumberland County (which aligns closely with the Casco Bay watershed) and about one billion dollars of economic activity. That amounts to 4.4% of all economic activity in the county. 82% of marine-related jobs were in tourism and recreation and another 4% in marine resources, especially fishing and aquaculture.

Yet market measures rarely account for the worth of the ecological elements and systems that make life possible—such as the work of soils in filtering water, plants in generating oxygen, wetlands in nurturing juvenile fish and shellfish, salt marshes in buffering shorelines, and woodlands in limiting flooding. Economists and ecologists are only beginning to estimate the financial significance of the gifts that natural ecosystems offer. A 2012 study commissioned by Manomet Conservation Sciences estimated the annual value of the diverse ecosystem functions within Cumberland County to be between $800 million and $2 billion (in 2012 dollars).

The true value of Casco Bay to area residents and visitors extends further still. The Bay holds inestimable cultural, recreational, aesthetic, and spiritual importance to those who live or spend time along its shores. With its fisheries, shipping trade, summer colonies, maritime industries, military history, and famed Calendar islands, Casco Bay has left a large and indelible imprint on the region's literature, history, and way of life. The region is what it is because of the Bay.

Yet the Bay is far from pristine. Roadways, lawns, wastewater treatment plants and air pollution contribute excess nutrients and toxic chemicals to marine ecosystems. Development can fragment the landscape, reducing wildlife habitat. Species that once supported iconic Maine fisheries, such as cod and haddock, have experienced steep declines. CBEP's *State of the Bay*, Sixth Edition reveals status and trends evident in the region.

The Watershed

The Casco Bay watershed is 986 square miles in area. It forms an elongated triangle, extending from Cape Elizabeth in the south to Bethel in the northwest, and Phippsburg in the east. Sebago Lake, Maine's second largest and deepest lake, sits in the heart of the watershed. Forty-eight municipalities touch the watershed. Those forty-eight towns and cities include some of the most populous and prosperous in the state of Maine. These towns represent about 4.4% of Maine's total land area, but they house a quarter of Maine's population and one-third of all Maine jobs.

The Bay has two major tributaries, the Presumpscot and Royal Rivers. Together, these two rivers drain 82% of the Casco Bay watershed. The remainder of the watershed, including most coastal areas and the islands, contains some thirty smaller tributaries. The Bay is also influenced by the Kennebec River to our north. Coastal currents sweep the outflow of the Kennebec south and into the Bay, reducing salinity in the Eastern Bay.

The Portland metropolitan area, Maine's largest urban center, anchors the region's economic strength, but not all parts of the watershed share equally in this prosperity. Towns vary widely in population, wealth, basis of the local economy, and municipal capacity. Inland and island communities are often more dependent on tourism and natural resources industries, have smaller year-round populations, higher poverty rates and limited municipal personnel. Exurban communities (both along the Casco Bay shore and in the mid-watershed) have more resources, but face significant challenges regarding housing, transportation, stormwater management, flood risk reduction and environmental protection due to some of the region's highest growth rates and past underinvestment in water infrastructure.

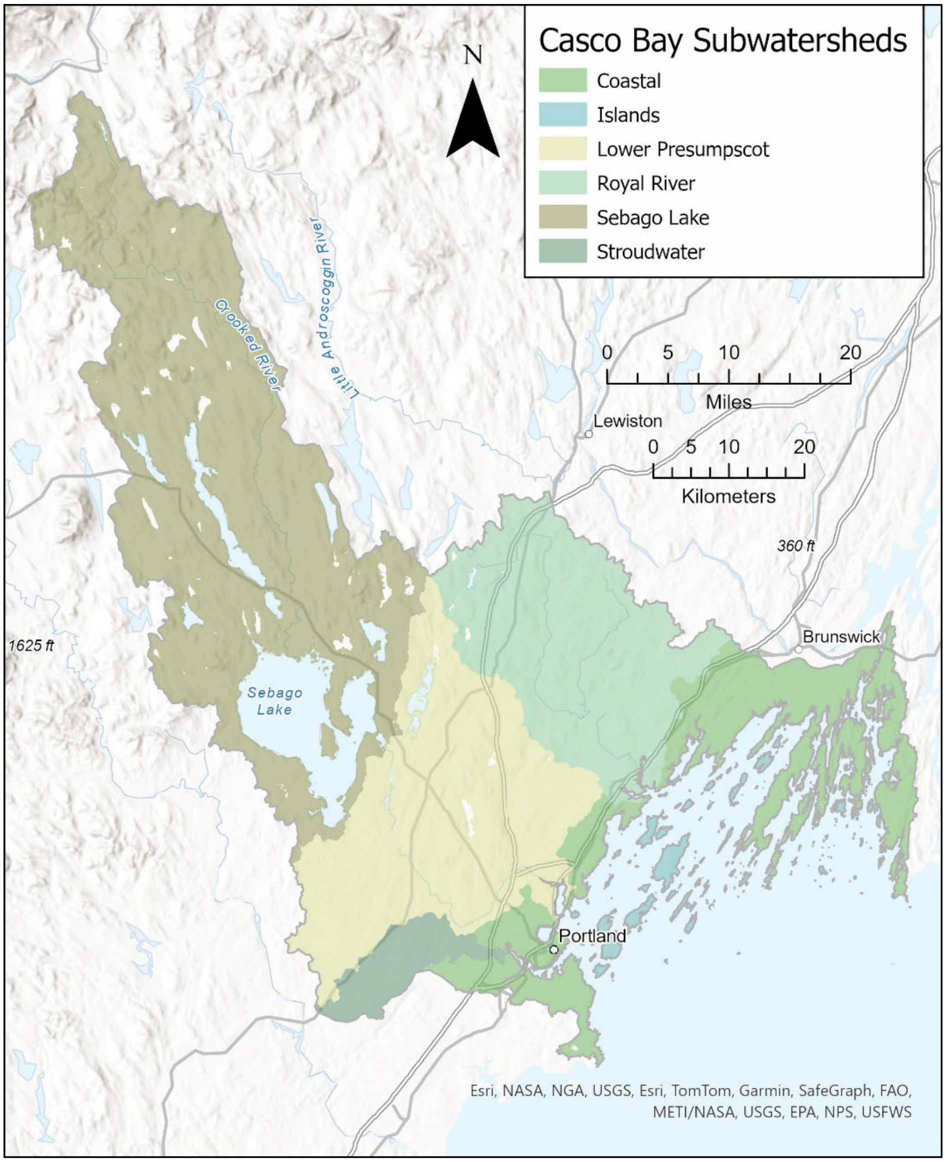

Figure 2: Major Subwatersheds of the Casco Bay watershed.

Changes and Challenges

Casco Bay is changing. Evidence of that change is all around us, from declining eelgrass and the disappearance of northern shrimp to more intense winter storms. While climate change alone does not cause all the changes we see in the Bay, it now forms the inescapable backdrop for the changes and challenges facing the Bay. Climate stressors exacerbate existing problems such as water pollution, habitat degradation and the proliferation of non-native species. They impose new costs on our communities, whether for climate adaptation and disaster preparedness or for recovery. Extensive damage from severe winter storms that struck the Maine Coast in 2022, 2023, and 2024 has ignited a growing sense of urgency regarding the need for proactive planning and implementation of strategies to protect community touchstones, from roads and boatyards to parks and private piers.

Regional Stressors

Development Pressures: The region's population is growing, with much of the new development dispersed in suburban and rural villages and towns – interrupting stream corridors, disrupting wildlife habitats, and contributing to runoff pollution. Development pressure on waterfront land drives up property values, makes conservation of shorelines expensive, and restricts public and commercial access to the water.

Urbanization and Stormwater: Human activity and urbanization threaten water quality, especially in Casco Bay's semi-enclosed bays and the watershed's lakes and streams. Human activity affects water quality when pollutants enter our waterways, but also when loss of forest and wetlands or construction of impervious surfaces like roads and parking lots alter how water moves through the landscape. While the region's population growth remains low compared to some U.S. areas (less than half a percent a year), the rate has increased to almost 1% a year in recent years, leading to land use changes that can put our waters at risk.

Combined Sewer Overflows: Despite decades of work eliminating combined sewer overflows (CSOs) and reducing frequency and magnitude of CSO discharge events, dozens of outfalls remain, discharging millions of gallons of largely untreated combined sewage and stormwater to the Bay. Fixes are costly and time-consuming.

Influx of Invasive Species: The number of harmful non-native species is increasing. "Rapid assessment" surveys by scientists of marine organisms in 2013 and 2018 at two Casco Bay locations found that between one-sixth and one-third of all identified marine species were not native. European Rock Shrimp, first seen in Maine less than a decade ago, are now widespread in Casco Bay, just one of several invaders first reported in recent years.

Climate Stressors

Rising Air Temperatures: Worldwide, 2022 was the sixth-warmest year on record based on NOAA data. The 10 warmest years have all occurred since 2010. Maine's annual temperature has increased by 3.2°F since 1895 (although the trend at the Portland Jetport since 1935 has been more gradual). An additional 2 to 4°F increase in Maine temperatures is forecast by 2050, with up to a 10°F increase by the end of the century.

Warming Ocean Temperatures: Between 2004 and 2013, the Gulf of Maine warmed faster than 99 percent of the global ocean. In the five-year period from 2015 to 2020, Gulf waters were warmer than any previous five-year period in the instrumental record. Summer water temperatures in Casco Bay have warmed more than 3° F in just 30 years.

Intensifying Precipitation: Maine is experiencing increases in both annual precipitation and extreme precipitation events, raising concerns about flooding and stormwater impacts. Stormwater runoff carries excess nitrogen and phosphorus into marine waters—

aggravating coastal acidification, lowering dissolved oxygen (leading to fish kills), stimulating harmful algal blooms, and altering ecological communities.

Rising Seas: The Maine Climate Council's Science and Technical Committee estimates that Maine is likely to experience a foot and a half of sea level rise by mid-century and 3.9 feet by 2100 (compared to a Year 2000 baseline based on intermediate assumptions). Because most of Casco Bay's coastal infrastructure was designed and built with a static sea level in mind, even a foot of sea level rise will lead to increases in the frequency of coastal flooding, erosion, and infrastructure damage. Rising seas also put valuable coastal wetlands at risk.

Acidifying Coastal Waters: When marine waters absorb carbon dioxide, they become more acidic, experiencing changes in water chemistry that make it more difficult for juvenile shellfish to build and maintain shells. Global CO_2 levels are important, but local processes play a role here in Casco Bay. The Bay's waters are especially vulnerable due to local geology and frequent rainfall. Runoff and water pollution, especially nutrient loads, also contribute.

Regional Challenges

Loss of Eelgrass Beds: Between 2001/2002 and 2013, Casco Bay lost more than half of its eelgrass beds—which provide essential habitat for waterfowl and many marine organisms and help protect water quality. A partial recovery between 2013 and 2018 offered hope, but eelgrass continued to decline between 2018 and 2022. By 2022, the area of eelgrass in Casco Bay was only 28% of 2001/2002 levels.

Changes in Fisheries: Aquaculture operations in Casco Bay (involving oysters, kelp, and blue mussels) are growing in number while once-abundant species like cod are increasingly rare. Heavy reliance on the lobster industry makes coastal economies vulnerable should something threaten Maine's iconic shellfish species. Harvesters of wild shellfish report soft shell clams in decline, while quahogs are on the rise. Blue crab and other mid-Atlantic species are now well established in Casco Bay.

Disruptions to the Marine Food Web: Marked declines in wild-caught fisheries (particularly large, predatory species) and in the population of clams and mussels may be causing shifts in the Bay's food web. Warming waters, influx of mid-Atlantic species and arrival of non-native species from distant shores exacerbate the problem.

Casco Bay Estuary Partnership

Casco Bay Estuary Partnership is one of twenty-eight national estuary programs around the country. The National Estuary Program (NEP) was created by Congress under Section 320 of the Clean Water Act as part of the 1987 Clean Water Act Amendments and is administered by the U.S. Environmental Protection Agency (EPA). The program establishes locally led, non-regulatory, collaborative programs to protect and restore the water quality and ecological integrity of Estuaries of National Significance.

In 1990, Governor McKernan submitted a request to EPA to designate Casco Bay as an Estuary of National Significance, CBEP was created the following year. The Casco Bay

Estuary Project, as it was known at the time, was (and still is) administered by EPA Region 1, which covers the six New England states, and hosted by the Maine Department of Environmental Protection (DEP). The group spent five years gathering information and building partnerships. The first Casco Bay Plan was released in 1996. That same year, the Estuary Project moved from DEP to the Marine Law Institute, part of Maine Law School, which was itself part of the University of Maine system. CBEP has been hosted by the University of Southern Maine (through the Marine Law Institute, the Muskie School of Public Service, and most recently, the Catherine Cutler Institute) ever since. The name of the organization was changed to the Casco Bay Estuary Partnership in 2006 to reflect the role of collaboration in our work.

CBEP Structure and Governance

CBEP consists of the Partnership, a Management Committee, Executive Committee, and the Staff.

The Partnership. The Partnership includes individuals and organizations working together to help achieve our mission or implement portions of the Comprehensive Conservation and Management Plan (CCMP, aka Casco Bay Plan). The Partnership welcomes participation by anyone with an interest in helping protect and restore coastal habitats; improve water quality in the Bay or the watershed, engage and work with communities on climate vulnerability or water resource challenges, or gather the information and understanding we need to better manage our waters.

Management Committee. The Management Committee is the most important oversight body for the work of CBEP. Most formal decision-making authority rests with the Management Committee. A Chair and Vice-Chair are selected to serve two-year terms. Decisions are ordinarily made by consensus. Members of the Management Committee represent individuals and organizations with a stake in the work of the Partnership, including citizens, federal and state agencies, local government, and nonprofit organizations. While some members of the Partnership serve on the Management Committee, others (such as land trusts and lake associations, and most local governments) are not directly represented. The Management Committee meets at least quarterly. Meetings are open to the public and publicized via our website.

Executive Committee. The Executive Committee meets monthly with the CBEP Director to provide advice and direction. Members of the Executive Committee are selected by the Management Committee from among their members. The Executive Committee is empowered to act on behalf of the full Management Committee when issues need to be addressed in a timely manner.

Staff. The CBEP Staff provides technical expertise, coordination, training, and leadership to implement projects, strengthen work on behalf of Casco Bay, and support the work of partners. The staff has expertise in environmental sciences, climate resilience planning, coastal restoration, community engagement, facilitation, and project management. Staff priorities are developed annually in coordination with the Management Committee.

Our Guiding Vision

1. **Enhance Casco Bay**: focus on actions that increase the Bay's well-being—improving marine ecosystems, economic vitality, and the region's quality of life.
2. **Drive innovation**: catalyze creative, cost-effective, and enduring environmental solutions that are grounded in good science and meet community needs.
3. **Work collaboratively**: build on the collective strength of diverse interests, including those of underserved or vulnerable communities, advancing a shared agenda for the Bay.
4. **Link people and place**: foster widespread appreciation of the Bay's ecological and economic values, and inspire residents, businesses, and municipalities to adopt practices that reduce their impact on Casco Bay.
5. **Build capacity and understanding** provide training and broadly disseminate information on Bay-related research, community initiatives, educational programs, and volunteer opportunities.
6. **Adapt as conditions change** foster regional resilience—the capacity for ecosystems, and economies to adapt as climate and other variables shift, and to bounce back from unexpected disruptions.

The Casco Bay Plan

The first Casco Bay Plan was adopted in 1996 and updated in 2006, reflecting ten years of progress addressing persistent challenges facing Casco Bay. The Casco Bay Plan was rewritten in 2016 to reflect changing conditions along the coast of Maine, especially growing concern about the impact of climate change on coastal ecosystems and coastal communities. The current Plan, issued in 2024, represents an update to the 2016 Plan. Its overall structure is like that of the 2016 Plan, but Goals, Strategies and Actions (below) have been updated to reflect changing circumstances.

Why This Update?

This update to the Casco Bay Plan was undertaken to reflect significant changes in regional needs, growing understanding of the impact of climate change on the region, the changed policy context, and expectation of availability of extraordinary resources.

- We have completed some Actions from the 2016 Plan and have come to recognize that other Actions are no longer priorities. In eight years, we have learned lessons about the Bay, and what works and what doesn't.
- We understand nutrient pollution in the Bay better than ever. Efforts are underway by Maine Department of Environmental Protection (DEP) to develop marine nutrient criteria for nitrogen pollution. While work remains to be done reducing nitrogen inputs to the Bay, a shift in focus back towards addressing principal sources of water pollution offers efficiencies for addressing nutrients in parallel with other water quality challenges.
- Our understanding of how a changing climate is affecting our region is growing. All work done on behalf of the Bay and our people needs to be forward-looking and inclusive. We must center our work on community and ecosystem resilience (not

just restoration or protection) and consider questions of equity as we ensure Casco Bay and the other waters of the region contribute to a prosperous future.

- The context in which we operate has changed and changed again. Maine's focus on climate change, especially through the work of the Maine Climate Council and the Governor's Office for Policy Innovation, and the Future (GOPIF), has altered the context of our work, shifting agency priorities, building new coalitions, and opening new opportunities.
- Increases in federal funding for infrastructure improvement, climate resilience and ecosystem restoration have created opportunities for large-scale projects (whether for habitat or community resilience) that were previously out of reach. Yet underserved and underrepresented communities across the region often lack capacity to access these funds. Smaller towns, especially inland and island communities lack planning capacity, while people dependent on natural resource industries (who are directly vulnerable to changes in our lands and waters) are busy making a living and caring for families.

An in-depth reevaluation of our work was needed to reflect these and other changes. It has become increasingly apparent that our work now occurs in the context of accelerating changes in the coastal ocean. The past is no longer an adequate guide to future conditions. Even short-range planning must address this inherent uncertainty. The Casco Bay Plan must be able to respond as circumstances change. Therefore, this CCMP Update is intended to be amended in response to changing circumstances.

The Plan has been drafted with a nominal ten-year planning horizon. It is unlikely to persist as long as that unchanged, but a ten-year vision helped shape priorities. Most Actions, targets and outputs were drafted with reference to a five-year period (through 2029).

How the Updated Casco Bay Plan was Developed

This update was developed over the course of 16 months by CBEP Staff with input from the Partnership and the Management Committee. The update was informed by effort over several prior years to map out priorities via four supporting documents: *Habitat Plan*, *Monitoring Plan*, *Finance Plan* and *Communication Strategy* (see the appendices). Each of these subsidiary documents was used to inform the Goals, Strategies and Actions in this updated Plan.

In late fall of 2022, we began by soliciting ideas for changes in the Casco Bay Plan. CoastWise Partners (led by Holly Greening and Rich Batiuk) conducted one-on-one interviews with Management Committee members. CoastWise Partners provided CBEP with detailed anonymous notes from the interviews, and a summary of their findings. Notes were shared with all Management Committee members. We held a Strategic Planning retreat in January of 2023, facilitated by CoastWise Partners. Participants included Management Committee members as well as several thought leaders from the Partnership who have not recently been represented on the Management Committee, such as representatives of The Nature Conservancy and local land trusts. CoastWise Partners prepared detailed notes and a meeting summary.

Following the retreat, we formed working groups drawn principally from Management Committee members to focus on selected portions of the Casco Bay Plan. This included groups focused on habitat, water quality, community, and coordination and collaboration priorities. Each group met several times to provide CBEP staff with high-level suggestions within their area of expertise. Staff collated responses and brought them back to the Committees for additional feedback and refinement.

Once top-line priorities were identified, staff drafted detailed descriptions of Goals, Strategies and Actions. All Draft Goals, Strategies and Actions were shared with the Management Committee. Management Committee members were assigned principal reviewer responsibility for a minimum of two and in many cases three draft Actions. This assured that each Action was reviewed in detail by at least two Management Committee Members.

Staff revised the Goals, Strategies and Actions in response to Management Committee comments. CBEP's Executive Committee authorized Staff to prepare a single draft of the Goals, Strategies and Actions and solicit initial feedback from EPA Region 1. Region 1 provided detailed comments regarding EPA requirements for the CCMP and suggested structural and content changes. Staff revised the document based on EPA's feedback and shared the penultimate draft with EPA Region 1 and the Management Committee in early February of 2024. This document reflects additional comments received on the February draft from both members of the Management Committee and EPA Region 1.

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GOAL 1: PROTECT, RESTORE, AND ENHANCE THE KEY HABITATS THAT SUSTAIN ECOSYSTEM HEALTH OF CASCO BAY AND ITS WATERSHED FOR NOW AND THE FUTURE

The long-term health of Casco Bay and the Casco Bay watershed depends on vital habitats that protect water quality and support native fish and wildlife, biodiversity, and commercial fisheries.

CBEP takes a landscape approach to habitat by focusing on geographic sub-regions and emphasizing connections between and among habitats rather than isolated species or habitat types. The health of the Bay (as well as of our lakes, rivers, and streams) depends on the forests and wetlands that protect natural hydrology and water quality. Connectivity among aquatic habitats is essential to help organisms migrate, withstand climatic extremes and sea level rise, and maintain their populations in the face of established and emerging stressors.

Habitat protection, aquatic connectivity, and the restoration of natural stream processes benefit human communities as well; supporting fisheries and tourism, providing recreational opportunities, decreasing flood impacts, and reducing infrastructure maintenance.

CBEP is committed to protecting, enhancing, and restoring critical coastal habitats (e.g., eelgrass beds, tidal wetlands, and mudflats), planning for future migration of intertidal habitats (as sea levels rise), and conserving the undeveloped forests, wetlands, floodplains and shorelines that protect water quality. Through these efforts, we strive to strengthen ecosystem functions and build climate resilience.

Strategy 1.1: Identify places and initiatives that are most important for the protection, restoration, and enhancement of key habitats

Human alterations of the landscape have left their mark on the Bay and its coastal habitats as well as rivers, streams, lakes, and freshwater wetlands throughout the watershed. These modifications have often resulted in habitat fragmentation and a loss of connectivity between habitat types. In aquatic ecosystems, alterations to natural hydrology have impacted the flow of surface and groundwater, transport of sediment, nutrients, organic matter, and wood; and the movement of organisms. These changes have altered the fabric and function of regional habitat networks, leaving habitats more vulnerable to stressors including climate change. Place-based habitat planning can serve as a framework for organizing collaborations at the scale of a subwatershed or embayment that accelerate habitat protection, restoration, and enhancement activities across multiple habitat types. Landscape-scale analysis can inform resource allocation to protect important ecosystem functions considering climate change and continuing land use changes.

Action 1.1.A Develop science-based regional plans that integrate aquatic habitat protection, restoration, continuity, and resilience priorities

Goal 1: Protect, restore, and enhance the key habitats that sustain ecosystem health of Casco Bay and its watershed for now and the future

Strategy 1.1: Identify places and initiatives that are most important for the protection, restoration, and enhancement of key habitats

Purpose

Define geographic habitat priorities, highlight key habitat needs, focus collaborative efforts, and make efficient use of resources in meeting habitat objectives.

Location

Regional plans may be developed for any subwatershed or region in Casco Bay or the watershed. Locations have not yet been selected.

Description

CBEP staff will work with the U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (USFWS GOMCP) and other agency partners to analyze priorities for aquatic habitat protection, habitat restoration and enhancement, and habitat resilience. Priorities will be informed by existing state and regional habitat plans, such as Maine Wildlife Action Plan, and the Atlantic Coast Joint Venture. Priorities will be integrated with CBEP's Habitat Plan (See Appendix 2) and used to evaluate proposals submitted to CBEP for funding under Habitat Protection Fund (Action 1.1.A) and Habitat Resilience (Actions 1.2.A and 1.2.B) grant programs. Priorities will also inform allocation of staff capacity for advancing the Strategies and Actions in Goal 1.

We will develop science-based priorities using available geospatial data analyzed at relevant ecological scales. Plans will be assembled for selected subwatersheds (e.g., lower Presumpscot watershed, Royal River watershed, and Stroudwater watershed) or embayments (e.g., Eastern Bay, Presumpscot Estuary, Royal River Estuary, Fore River Estuary). These subregional plans will collectively define regional habitat priorities for Casco Bay and its watershed.

Timeline: Begin in 2024

Lead Implementers

- U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (USFWS GOMCP; project co-lead with CBEP; mapping, technical assistance, and connection to Atlantic Coast Joint Venture)
- Casco Bay Estuary Partnership (project co-lead with USFWS GOMCP; process facilitation and document preparation)

Other Collaborators

- Maine Department of Inland Fisheries and Wildlife (connection to Maine Wildlife Action Plan)
- Maine Department of Marine Resources (relationship with Maine fisheries)
- The Nature Conservancy in Maine (regional and state-level priorities)
- Maine Coastal Program (coastal habitat plans, municipal connections)
- Maine Coast Heritage Trust (prioritization, connections to land trusts, awareness of potential habitat projects)
- National Oceanic and Atmospheric Administration Restoration Center (funding and knowledge of regional and national priorities)
- Greater Portland Council of Governments (planning expertise and connections to municipalities)
- Cumberland County Soil and Water Conservation District (connections with municipalities, watershed-based planning, perspective on implementation)
- Maine Department of Environmental Protection (watershed assessments, connections to stormwater and site development regulation, data)

Regional priorities will focus on priority habitats that sustain the ecological health of Casco Bay and its watershed. Therefore, the focus of the analysis, plans and priorities will be on aquatic resources and terrestrial habitats that contribute to water quality protection and ecosystem resilience. This approach reflects the need for technically-sound regional priorities that are independent of priorities of partners such as individual land trusts or towns and subregional collaborations like Sebago Clean Waters. Overlap with town, land trust, and regional collaboration priorities is both anticipated and desirable.

Resources

CBEP's existing Habitat program staff will coordinate and convene the habitat analyses with partner support. The task will require between 10% and 20% of a lead staff member's time annually to facilitate priority setting meetings, manage contracts and draft reports.

CBEP funds will be needed to contract for expert assistance assembling data, conducting analyses, producing high-quality graphics, and similar tasks. Most underlying data sets are available from public sources (e.g., National Wetland Inventory; State data on water quality attainment and at-risk watersheds), but some data may be proprietary, requiring additional CBEP funds. We anticipate spending less than $25,000 in such additional costs to develop each subwatershed plan. Additional funds up to $10,000 may be needed for graphic design and document preparation.

Outputs

- Geospatial priorities
- Subregional plans and maps
- Place-based planning documents comprised of maps and a summary narrative

Outcomes

Short-term

- Defined CBEP vision and habitat priorities for Casco Bay and selected Casco Bay watersheds

Medium-term

- Community stewardship, regional collaboration, and focused use of resources

Long-term

- Targeted improvements to the Bay's habitats, water quality, ecosystem function and integrity

Metrics and Targets

Metric	**Target**
Assemble geospatial data and tools to support development of priorities (geodatabase)	2025
Pilot subregional plan	One by end of 2025
Four subregional plans in priority regions	End of 2029

Strategy 1.2: Permanently protect habitats that support resilience of aquatic ecosystems and protect water quality

The integrity of Bay ecosystems rests in large part on the persistence of coastal habitats (such as tidal flats, rocky intertidal areas, salt marshes and coastal forests) as well as inland river and stream corridors, freshwater wetlands, and upland forests. Even as Casco Bay responds to climate impacts, the watershed will support fish, wildlife, and birds. Through conservation projects over a period of decades, land trusts and local governments have made significant progress, permanently protecting over 15% of the Casco Bay watershed via an extensive network of coastal and inland conservation areas that help preserve water quality and support a healthy Bay. CBEP will continue advancing these efforts in the face of increased development pressures, sea level rise and greater storm frequency and intensity.

Action 1.2.A Invest in habitat protection via the Casco Bay Estuary Partnership Habitat Protection Fund

Goal 1: Protect, restore, and enhance the key habitats that sustain ecosystem health of Casco Bay and its watershed for now and the future.

Strategy 1.2: Permanently protect habitats that support resilience of aquatic ecosystems and protect water quality.

Purpose

Provide grant funding in support of efforts to permanently protect 20% of the Casco Bay watershed by 2030 with a focus on areas that safeguard health and resilience of aquatic ecosystems.

Location

Throughout the Casco Bay watershed, with a focus on lands that protect water quality and habitats that benefit aquatic ecosystems.

Timeline: Ongoing

Lead Implementers

- Casco Bay Estuary Partnership (funder)
- Maine Department of Inland Fisheries and Wildlife (priorities and proposal review)
- U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (priorities and proposal review)

Other Collaborators

- Maine Coast Heritage Trust (knowledge of regional activities)
- Land trusts (grant recipient/project implementation)
- Local governments (grant recipient/project implementation)
- State agencies (grant recipient/project implementation)

Description

Casco Bay Estuary Partnership has provided strategic financial support for habitat protection since 2000, committing more than $950,000 to support permanent protection of 12,800 acres throughout the Casco Bay watershed (including coastal islands, tidal flats, wetlands, riparian areas, and forests). Most of the properties funded allow public access.

As of 2020, 14.2% of the land area of the Casco Bay watershed had been permanently protected by conservation ownership or protected by conservation easement. Subsequent conservation activity had likely pushed that total over 15% by the start of 2024.

Through the Habitat Protection Fund, CBEP will continue to provide grants up to $25,000 to land trusts, municipalities, and agencies to facilitate habitat protection through acquisition of fee title or conservation easements. Funds can be used to leverage local, federal, or state funding, help cover transaction costs; and support strategic “high risk, high reward” or time sensitive opportunities. Requests for funding will be reviewed by CBEP's staff and Habitat Protection Committee, with representatives drawn from the land trust community and federal and state agencies.

To be eligible, the proposed conservation acquisition must benefit aquatic ecosystems in the Casco Bay watershed. Areas of particular interest include the Bay's shoreline, intertidal habitats, and islands, river riparian areas and floodplains; freshwater wetlands; and forested areas near headwater streams. Natural areas that could accommodate tidal wetland migration (as sea levels rise) or that would protect or enhance sediment supply to tidal wetlands will be considered. CBEP is committed to improving equity in access to open space, fairness in distribution of Habitat Protection Fund grants, and supporting local communities and land trusts in identifying priorities and remediating inequities.

Resources

CBEP plans to coordinate two Habitat Protection Fund rounds per year, each fall and spring, allocating $80,000 - $100,000 in annual grant funding through a mix of BIL and core EPA Section 320 funds. Funding is anticipated to be commensurate with available BIL monies through 2027. Funding levels for these grant programs are likely to decline thereafter.

Limited CBEP staff time is needed to issue Requests for Proposals, convene the Habitat Protection Committee, administer grants, collect project data, and track program accomplishments.

Outputs

- Two Habitat Protection Fund requests for proposals annually
- Three to five Habitat Protection Fund grants annually

Outcomes

Short-term

- Acres acquired by partners through conservation easements or fee ownership

Medium-term

- Protection of priority habitats (coastal habitat, wetlands, forests, floodplains, and other areas that contribute to Bay water quality)

Long-term

- Resilience of Casco Bay's aquatic ecosystems and maintenance of habitat values, water quality, ecosystem function, and integrity

Metrics and Targets

Metric	Target
Percentage of land area within the Casco Bay watershed permanently protected by 2030 (a "twenty by thirty" goal)	20%
New permanently protected acres by 2034 (beyond 2021 SOTB)	31,500 acres
New acres of coastal habitat protected by 2034 (beyond 2021 SOTB)	250 acres
New wetland acres protected by 2034 (beyond 2021 SOTB)	400 acres
Number of projects funded per year	Four through 2029

Action 1.2.B Provide technical assistance and coordination to land trusts and local governments to support land conservation

Goal 1: Protect, restore, and enhance the key habitats that sustain ecosystem health of Casco Bay and its watershed for now and the future

Strategy 1.2: Permanently protect habitats that support resilience of aquatic ecosystems and protect water quality

Purpose

Provide technical assistance and capacity for local and regional initiatives that help to permanently protect 20% of the Casco Bay watershed by 2030, with a focus on areas that safeguard health and resilience of aquatic ecosystems.

Location

Throughout the Casco Bay watershed, with a focus on areas that safeguard health and resilience of aquatic ecosystems.

Timeline: Ongoing

Lead Implementers

- Casco Bay Estuary Partnership (technical assistance and coordination)
- U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (technical assistance)
- Sebago Clean Waters (regional coordination, implementation)

Other Collaborators

- Land trusts (beneficiaries, implementors)
- Local governments (beneficiaries, implementors)
- Maine Department of Inland Fisheries and Wildlife (state-level planning and assistance)
- Maine Land Trust Network (state-wide coordination)
- State and federal habitat programs (funding and assistance)

Description

Casco Bay Estuary Partnership will continue to support land conservation in partnership with organizations, such as the U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (USFWS GOMCP), and through regional collaborations, like Sebago Clean Waters. CBEP has partnered with USFWS GOMCP to provide GIS (Geographic Information Systems) services and other forms of technical support for land conservation for many years. While some conservation professionals and many consultants now have GIS expertise, there remains an ongoing need for GIS support as some land trusts have minimal staffing and lack funds to hire GIS consultants. This partnership provides habitat analysis for 8 to 12 land conservation projects each year and supports evaluation of Habitat Protection Fund proposals.

Multi-organizational collaboration has emerged as an important and strategic approach to regional land conservation. As a partner to Sebago Clean Waters and other regional collaborations, CBEP's capacity to provide technical assistance is helpful in the development and expansion of regional approaches to land protection. In a supporting role, CBEP staff members may help address ongoing training and technical assistance needs such as the mapping, habitat analysis, proposal drafting, grant management and reporting needed to secure federal and state habitat grants (e.g., Regional Conservation Partnership Program, North American Wetlands Conservation Act, Land for Maine's Future Program, Maine Outdoor Heritage Fund and Maine Natural Resource Conservation Program). Other types of technical assistance include coordination related to strategic planning, regional prioritization, and development of collaborative grant proposals.

CBEP also may provide direct financial support through its Habitat Protection Fund according to CBEP protection priorities (as articulated in Action 1.1.A).

Resources

Technical assistance on land conservation to towns and land trusts is provided by several members of the Partnership, including CBEP, U.S. Fish and Wildlife Gulf of Maine Coastal Program, CCSWCD, Sebago Clean Waters, Maine Coast Heritage Trust, and several federal and state agencies.

CBEP's existing habitat program staff provides dedicated staffing to nurture local initiatives and regional collaboration. Staff time may be used for a variety of tasks, including proposal development, or coordinating among partners. CBEP may also assist municipalities, land trusts and other organizations with specific projects.

Limited CBEP funding (less than $20,000) may be needed from time to time to cover planning costs such as data gathering, mapping, or facilitation. This Action relates to Actions 1.1.A, 2.2.A, 3.2.A, and 3.2.B, which also address using planning, assistance, or funding to address community needs.

Outputs

- Habitat protection projects initiated
- Collaborative grant proposals submitted, and grants secured
- Diversification of funding for habitat protection

Outcomes

Short-term

- Formation and continuation of local and regional initiatives advancing habitat protection

Medium-term

- Increased capacity, community support, and funding for developing and implementing local and regional protects that permanently protect habitat

Long-term

- Resilience of Casco Bay's aquatic ecosystems and maintenance of habitat values, water quality, ecosystem function, and integrity

Metrics and Targets

Metric	Target
Number of organizations accessing USFWS GOMCP GIS Service Center services	Six annually
Number of geospatial analyses provided in support of habitat protection efforts	Eight annually
Dollars secured (cash or equivalent, such as donated land) through local and regional collaboration on land conservation projects	An average of $1 million annually

Strategy 1.3: Enhance habitat resilience and restore connectivity of coastal wetlands, aquatic habitats, and shorelines

Human impacts have compromised the ability of many inland and coastal aquatic habitats to sustain functions critical to long-term ecosystem health. These challenges have become more severe because of climate change, coastal acidification, and sea level rise. Where feasible, habitat restoration and enhancement can counter cumulative human impacts and buffer the effects of climate change. Priority targets in Casco Bay include restoring aquatic continuity in both freshwater streams and tidal channels and restoring and managing tidal marshes to enhance their ability to respond to rising seas. Other priority coastal habitats include tidal mudflats and shellfish bars and reefs.

Action 1.3.A Lead efforts to restore and manage coastal habitats to enhance resilience

Goal 1: Protect, restore, and enhance the key habitats that sustain ecosystem health of Casco Bay and its watershed for now and the future

Strategy 1.3: Enhance habitat resilience and restore connectivity of coastal wetlands, aquatic habitats, and shorelines

Purpose

Protect and enhance the resilience of tidal marshes, tidal flats, and shellfish bars.

Location

Coastal habitats throughout Casco Bay, especially tidal wetlands, tidal flats, and shellfish beds.

Description

Coastal wetlands provide essential functions to human communities as well as habitat for a diverse array of species. The Bay's coastal wetlands have been impacted by centuries of human modification as well as the effects of climate change, pollution, invasive species, and other stressors. These impacts have compromised ecosystem functions and disrupted natural processes that are critical to long term ecosystem resilience. Where feasible and cost effective, CBEP will apply a process-based approach to increasing resilience of coastal wetlands.

Working with allied organizations through regionally focused committees, CBEP staff will provide strategic funding, technical assistance, grant writing, targeted outreach and training, and project coordination to

Timeline: Ongoing

Lead Implementers

- Casco Bay Estuary Partnership (funding, preliminary engineering, permitting and project development)
- U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (technical assistance, funding)
- Casco Bay Regional Shellfish Working Group (coordination with harvesters; implementation)
- Maine Coast Heritage Trust (regional coordination and implementation)
- Maine Coastal Program (funding, prioritization, coordination)
- Cumberland County Soil and Water Conservation District (project implementation)

Other Collaborators

- Ducks Unlimited (funding, regional coordination)
- Friends of Casco Bay (supplementary data collection supporting tidal flat projects)
- Land trusts (project implementation)
- Local governments (project implementation)
- Maine Department of Marine Resources (technical assistance, data access)

support tidal wetland restoration and enhancement efforts, particularly those focused on tidal marsh, mudflats, and shellfish beds. Projects are complex, typically requiring years to reach implementation.

Priorities under this Action reflect the Casco Bay Habitat Plan (Appendix 2), as well as other regional and state-level habitat plans and priorities, including Maine's State Wildlife Action Plan and the Atlantic Coast Joint Venture.

An established CBEP geographic priority is the *Maquoit and Middle Bay Focus Area of Statewide Ecological Significance*. This region includes tidal wetlands in the Cousins River, Harraseeket River, Maquoit Bay, and Middle Bay. Other geographic areas warrant consideration for focused protection and restoration activities as well (See Action 1.1.A).

Other Collaborators (cont'd)

- Manomet (green crab population assessments and tidal flat elevation studies; coordination with harvesters)
- Natural Resources Conservation Service (funding)
- National Oceanic and Atmospheric Administration Restoration Center (funding and technical assistance)
- The Nature Conservancy in Maine (prioritization, funding)
- Wells National Estuarine Research Reserve (regional coordination)

Habitat restoration and enhancement targets will be met by:

- Developing a portfolio of restoration and enhancement opportunities;
- Working with communities, landowners and organizations to identify opportunities where barriers to completion can most readily be overcome;
- Implementing habitat restoration and enhancement activities, including projects that rely on nature-based solutions to achieve combined habitat and community goals (See Action 3.2.A); and
- Tracking progress and monitoring tidal marsh change to learn from our actions and achieve restoration and enhancement goals.

Tidal Marshes

Tidal marshes exist in sheltered areas regularly flooded by the ebb and flow of the tides. They support coastal ecosystems by harboring juvenile fish, protecting water quality, and subsidizing nearshore food webs. Detritus exported from marshes is an important food source for nearby shellfish. Tidal marshes buffer coastal communities from storm surge and sea level rise. Maine's tidal marshes also sequester atmospheric carbon and slow the buildup of atmospheric CO_2. Conversely, loss of tidal marsh can release large quantities of CO_2 stored in tidal marsh sediments.

Tidal marshes are at risk due to accelerating sea level rise, a threat compounded by the impact of centuries of human use and modification. European settlers constructed networks of ditches and embankments to boost production of salt marsh hay or to grow agricultural products in wetland areas. Today, these alterations contribute to subsidence, pooling, and habitat loss that increase vulnerability to rising seas. Many tidal marshes were also dammed to power tide mills or support ice production. To this day, significant marshes lie submerged beneath impoundments, like those beneath New Meadows Lake. The Bay's remaining tidal marshes are often affected by road and railroad crossings, which alter tidal exchange and drainage of floodwaters. Collectively, these hydromodifications result in conversion of salt marsh to freshwater or brackish wetlands, colonization by invasive plants, or permanent loss of marsh area. Species dependent on salt marshes, such as saltmarsh sparrow (*Ammospiza caudacuta)*, which nests in high marsh habitats, are imperiled by these cumulative impacts. Remediation of hydrology can put marshes on a more resilient trajectory. CBEP will work with partners to develop a regional Salt Marsh Adaptation and Resilience Team (SMARTeam) to employ emerging methods for remediating historic ditching and diking.

The Maine Coastal Program, working closely with CBEP and incorporating data from previous CBEP efforts including the 2002 *Return The Tides* study, created the Maine Tidal Restriction Atlas that shows where roads, railroads, dams, and other structures cross tidal habitats and restrict tidal flow. The Atlas also shows crossings that are anticipated to become tidal as sea levels rise. We will continue to restore tidal functioning in these settings by replacing undersized culverts and removing coastal dams or dikes (following CoastWise best practices). These practices can increase aquatic connectivity and sediment transport, restore salt marsh habitat, and foster the capacity of wetlands to adapt as sea levels rise.

CBEP has previously supported several tidal restoration projects and will continue monitoring outcomes while pursuing new projects. CBEP will, in collaboration with partners, identify priority projects for protection, restoration, and enhancement of tidal marshes.

Tidal Mudflats

The Bay's tidal mudflats have been identified as important habitats since Casco Bay was designated an Estuary of National Significance in 1991. Extensive tidal mudflats are revealed at low tide within sheltered coves and embayments. Mudflats support the softshell clam, quahog, and bloodworm fisheries, and provide important feeding habitat for resident and migratory shorebirds.

Tidal flats have been heavily impacted by European green crabs, which prey upon softshell clams, blue mussels, and other invertebrates. Some flats show acidic conditions that reduce settlement of shellfish larvae and can even cause shells of young shellfish to erode. Many intertidal flats are visited multiple times each year for commercial harvests of marine worms, softshell clams and quahogs, and tidal flats are an increasingly common location for shellfish aquaculture. While less studied than tidal marshes, tidal flats are also vulnerable to sea level rise, which may change circulation patterns and deposition of marine sediments. Sediment supplies to tidal flats may also be reduced due to shoreline protection (riprap and other shoreline hardening methods) and impoundment behind dams on main stem rivers.

The impact of sea level rise on, and habitat restoration needs of tidal mudflats are not well understood. CBEP will work with partners to study the vulnerability of tidal flats to stressors, develop criteria for prioritizing protection, restoration, and enhancement of tidal flats, and evaluate methods to improve resilience through testing novel methods.

Shellfish Beds, Bars and Reefs

Shellfish beds bars and reefs are important ecological communities that provide water quality benefits and structural habitat for other marine species. In Casco Bay, mussel bars historically were abundant, but European green crabs are thought to have decimated blue mussels leading to widespread losses. Monitoring and historical data are sparse, so it is difficult to quantify what was lost.

Shellfish beds are a CBEP priority for both study and restoration, especially for developing and testing methods that address vulnerability to invasive species. Methods for creating or restoring shellfish reefs are largely untested in Maine, but experimental oyster enhancement projects suggest that it may be feasible to replace emergent habitat values of lost blue mussel bars with oyster reefs on a small scale. As waters warm in conjunction with climate change, improving over-winter survival and reproduction of American oysters, it may become increasingly feasible to establish oyster bars and reefs in Casco Bay. Research is needed to develop methods for restoring blue mussel bars.

Resources

Several CBEP partners dedicate significant resources towards restoration and resilience of coastal habitats, including U.S. Fish and Wildlife Service's Gulf of Maine Coastal Program Office, Maine Coastal Program, and Maine Coast Heritage Trust.

Significant staff time (30% of an FTE) will be involved with coordinating regional efforts, developing potential projects, drafting funding proposals and assisting organizations seeking implementation funds. Demand for assistance often exceeds CBEP and regional capacity. CBEP will seek targeted restoration and resilience grants and explore ways to tap BIL funds to expand staff and partner capacity.

Funding needs for coastal habitat restoration are significantly beyond the capacity of the National Estuary Program to fund directly, so implementation of coastal habitat restoration and resilience projects will continue to depend on dedicated fundraising.

BIL funding through the National Estuary Program is expected to be available to support habitat restoration and resilience projects through 2027. Our Bipartisan Infrastructure Law (BIL) Spending Plan forecasts spending about $120,000 annually (including staff costs) facilitating habitat restoration and resilience projects through 2027. On the order of $50,000 annually in NEP-related BIL funds will be used to support preliminary studies and analyses that help determine project scope, examine feasibility, and estimate costs.

Requests from partners for financial support for early project development costs have increased in recent years. To ensure these funds are available to all partners and community members in an equitable manner, approximately half of the BIL funds for habitat restoration and resilience projects will be awarded as grants via a competitive RFP.

Outputs

- Feasibility studies (e.g., topographic surveys, geotechnical assessments, hydrodynamic models, marsh surface analyses, engineering designs), research plans, supplies, and materials
- Site assessments, monitoring plans, monitoring data
- Grant proposals raising funds for implementation
- Permits, grant reports, landowner agreements
- Completed restoration and resilience projects

Outcomes

Short-term

- Project implementation and monitoring
- Restoration and enhancement of coastal habitat and habitat continuity

Medium-term

- Improvement of habitats, water quality, ecosystem function and integrity

Long-term

- Enhanced coastal resilience

Metrics and Targets

Metric	Target
Pilot tidal flat restoration in one or more embayments	One by 2029
Pilot shellfish bed restoration in one or more embayments	One by 2029
Number of outputs (e.g., feasibility studies or engineering designs) of tidal marsh restoration projects	Four by 2029, six by 2034
Number of coastal wetland restoration or enhancement projects implemented	Six by 2029
Area of coastal habitat (other than eelgrass) restored or enhanced	50 acres by 2029 75 acres by 2034

Action 1.3.B Lead efforts to restore aquatic connectivity through culvert replacement, dam removal, and other methods

Goal 1: Protect, restore, and enhance the key habitats that sustain ecosystem health of Casco Bay and its watershed for now and the future

Strategy 1.3: Enhance the resilience and connectivity of coastal wetlands, shorelines, and aquatic habitats

Purpose

Restore ecological continuity for aquatic ecosystems through reconnecting streams and rivers.

Location

Streams and rivers throughout the Casco Bay watershed, prioritizing locations that reconnect tributaries Casco Bay, main stem rivers, and lakes that provide habitat for migratory fish.

Description

As the region has developed, the rivers and streams that flow to Casco Bay have become fragmented and disconnected from the Bay through the construction of dams, roads, railroads, and other structures. Consequently, anadromous fish such as alewife, blueback herring, shad, and rainbow smelt that depend on freshwater habitats to spawn experienced widespread population declines. Restoring anadromous fish to rivers is important to reestablishing inshore populations of cod and other large predatory species. For decades, the lack of these predatory fish in Casco Bay has diminished local fisheries and reduced the Bay's health and resilience. Furthermore, the habitat requirements of wild brook trout and other native aquatic organisms vary seasonally and are highly dependent on continuity between habitat types, including access to cold water refugia.

Projects designed to restore aquatic organism passage benefit anadromous and native fish communities and can provide numerous other habitat benefits by enhancing river continuity (the river processes and functions that enable transport of woody debris, sediment and water downstream, store floodwaters, and facilitate movement of aquatic and terrestrial organisms upstream and downstream). Projects that support these aquatic system functions further enhance the resilience of Casco Bay and its tributaries.

Timeline: Ongoing

Lead Implementers

- Casco Bay Estuary Partnership (funding, preliminary engineering, permitting and project development)
- U.S. Fish and Wildlife Service, Gulf of Maine Coastal Program (funding, prioritization, technical assistance)
- Maine Department of Transportation (implementation of culvert replacement projects)
- Lakes Environmental Association (implementation)
- Sebago Clean Waters (regional coordination and priorities)
- Trout Unlimited (implementation)
- Cumberland County Soil and Water Conservation District (implementation)

Other Collaborators

- Local governments (implementation)
- Maine Audubon ("StreamSmart" education programs)
- Maine Department of Environmental Protection (funding)
- Maine Department of Marine Resources (prioritization, science)
- Maine Department of Inland Fisheries and Wildlife (prioritization)
- National Oceanic and Atmospheric Administration (funding, technical assistance)
- Natural Resources Conservation Service (funding)
- U.S. Army Corps of Engineers (Royal River studies)
- Maine Rivers and other NGOs (implementation)
- Maine Stream Connectivity Workgroup (prioritization)
- Governor's Office of Policy Innovation and the Future (GOPIF; climate vulnerability of community infrastructure)

CBEP worked with Trout Unlimited chapters and the U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (USFWS GOMCP) to create a *Casco Bay Fish Passage Atlas* to identify opportunities to increase habitat connectivity. The Atlas was incorporated into Maine's Stream Habitat Viewer, making the data widely available.

CBEP will extend this work in the coming years through continued efforts to restore fish passage at dam and culvert sites.

Major Dams

In the Casco Bay watershed, 104 mapped dams block movement of anadromous fishes to entire watersheds and subwatersheds, including hundreds of miles of streams and thousands of acres of lake habitat. Dams diminish water quality as well. The lower main stem of the Presumpscot River fails to meet water quality standards in part due to dams creating a series of reservoirs that are vulnerable to low oxygen conditions and can no longer support riverine fish and invertebrate communities.

CBEP will continue working with partners to facilitate provision of effective fish passage at key dams. Dam removal is effective at achieving fish passage and other ecological outcomes and is preferred to other strategies such as construction of fishways. Even the best fish passage facilities act as partial barriers to fish migration and do little to reestablish river continuity. Where dam removal is a practical alternative, CBEP will provide technical assistance, funding, and other types of support. Dam removal is not always feasible due to conflicts with hydroelectric power production or maintenance of drinking water supplies, warranting consideration of alternative means of providing fish passage if benefits justify the investment.

Highest priority dams are those on main stem rivers that lack functional fish passage and are at or near head of tide along rivers and streams home to historic spawning habitat for anadromous fish. These include Bridge Street Dam owned by the Town of Yarmouth, Elm Street Dam also of Yarmouth, and the Stroudwater Dam owned by the City of Portland. Mainstem dams on the Presumpscot are also a priority. After the successful restoration of anadromous fish past Saccarappa Falls, the Pleasant River constitutes the next major tributary that could provide substantial habitat for migratory fish, requiring fish passage at Mallison Falls Dam, Little Falls Dam, and Gambo Dam.

Culverts, Small Dams, and Other Barriers

USFWS GOMCP has twice analyzed Casco Bay fish passage data to produce lists of top fish passage restoration opportunities, sharing results that have helped catalyze fish passage improvement projects by Trout Unlimited, municipalities and others. Through its Stream Smart program, Maine Audubon offers training for landowners, contractors, and other professionals on constructing road stream crossings that maintain fish and wildlife habitat while protecting roads and public safety. These efforts provide a robust infrastructure that CBEP can help maintain and expand.

CBEP will continue to work with these organizations and others to facilitate replacement of undersized road crossing structures, giving priority to barriers on coastal streams and waterways in the lower watershed that block movement of diadromous species and that pose flooding risks. Barriers at or near the head of tide are of particular interest. The Partnership may also assist with high value opportunities elsewhere in the watershed, such as barriers to movement of brook trout to cold-water refugia like forested, spring-fed streams.)

Resources

Culvert replacement, construction of fishways at dams, and dam removal are time consuming and expensive efforts that typically require multiple organizations and significant external funding. Several CBEP partners are already working to improve fish passage and river continuity, including the USFWS GOMCP, Maine Department of Inland Fisheries and Wildlife, Maine Department of Marine Resources, Maine Department of Transportation, Trout Unlimited, and Cumberland County Soil and Water Conservation District (CCSWCD). Most regional fish passage improvement projects will advance under the leadership of CBEP partners, including land trusts, municipalities, watershed associations and state agencies.

Significant CBEP staff time (20% of an FTE) will be used to coordinate regional collaboration and facilitate project development and completion. Demand for assistance often exceeds regional capacity. CBEP will seek targeted grants to expand staff and partner capacity beyond current levels.

As with coastal restoration projects, upfront cash outlays (typically under $15,000) are often required to cover technical analyses or development of preliminary designs. Core CBEP funds (including BIL funds) will be used to leverage additional funding for project implementation. Our BIL Spending Plan envisions dedicating about $20,000 annually to these purposes beyond costs for staff. Spending under this Action often has close connections to flooding risk and community resilience (See Action 3.2.A).

Several partners have recently requested financial assistance with early project development costs. To address this growing need in an equitable manner, a portion of funds for fish passage improvements and river continuity will be made available as grants via a competitive RFP, with funding levels around $20,000 a year through 2027.

Outputs

- Feasibility studies, engineering designs, site assessments
- Grant proposals raising funds for implementation
- Permits, grant reports, landowner agreements, public meetings
- Completed projects

Outcomes

Short-term

- Project implementation and monitoring
- Restoration of stream connectivity and fish passage

Medium-term

- Improvement of habitats, water quality, ecosystem function and integrity

Long-term

- Enhanced community resilience

Metrics and Targets

Metric	Target
Number of studies or site assessments completed to support restoration	Three by 2029, eight by 2034
Number of fish passage grant proposals written or projects funded for the watershed, annual average	One
Number of watershed connectivity projects implemented	Three by 2029, eight by 2034
Miles of stream reconnected to the Bay	Five miles. By 2029
Miles of stream reconnected to lakes and large rivers	One- and one-half miles by 2029

Action 1.3.C Accelerate recovery of Casco Bay eelgrass to 2018 levels by reducing key stressors and conducting restoration

Goal 1: Protect, restore, and enhance the key habitats that sustain ecosystem health of Casco Bay and its watershed for now and the future

Strategy 1.3: Enhance habitat resilience and restore connectivity of coastal wetlands, aquatic habitats, and shorelines

Purpose

Facilitate recovery of eelgrass coverage in Casco Bay to a minimum of 5,000 acres by 2032.

Location

Casco Bay eelgrass beds and sites that have supported eelgrass beds in the past 20 years.

Description

Eelgrass is an essential and vulnerable resource. As a habitat, eelgrass provides food for migratory winter waterfowl and serves as nursery habitat for fish and shellfish. Eelgrass helps sustain and improve water quality, and beds remove carbon dioxide from the water and sequester organic carbon in marine sediments. Eelgrass thus both ameliorates coastal acidification and slows accumulation of CO_2 in the atmosphere. Eelgrass meadows help dampen wave energy and reduce sediment resuspension and shoreline erosion. They are also sensitive indicators of ecosystem health and because of their visibility and significance, offer opportunities for public outreach and engagement.

Historically, Casco Bay's sheltered inner embayments have hosted extensive eelgrass beds but in recent decades, eelgrass coverage has been highly variable. The most recent data from 2022 documented a 54 percent decline in eelgrass coverage from 2018 levels, with localized losses in some embayments close to 100 percent. Even where eelgrass remains, density has often declined. The *Maquoit and Middle Bay Focus Area of Statewide Ecological Significance* (an established CBEP geographic priority) includes documented eelgrass meadows in the Harraseeket River, Maquoit Bay, and Middle Bay that have seen significant losses, where solutions are urgently needed.

Eelgrass beds are threatened by multiple stressors including nutrient pollution; sediment loads, invasive species, warming waters, sea level rise, and direct impact from human activities such as

Timeline: Begin in 2024

Lead Implementers

- Casco Bay Estuary Partnership (funding, permitting and project development)
- Maine Department of Environmental Protection (Eelgrass surveys, long-term eelgrass monitoring)
- New England National Estuary Programs (regional coordination and resource sharing)
- U.S. Environmental Protection Agency (technical assistance)
- Friends of Casco Bay (water quality and light data; boat access)
- Manomet (green crab data)
- Team Zostera/COBALT (Phenology of seed set, seed collection, seeding trials)

Other Collaborators

- Casco Bay Eelgrass Consortium (regional coordination)
- Portland Harbor Commission (Conservation moorings and removing moorings from eelgrass beds)
- The Nature Conservancy in Maine (prioritization, funding, state-level coordination)
- U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (technical assistance)
- Local governments (implementation, cooperation and access to town lands and waters)
- Maine Blue Carbon Network (blue carbon science)
- Academic institutions (research assistance)

commercial fishing, aquaculture, and construction of docks and piers. The impacts of some stressors are not well understood. We lack consistent data on green crab distribution and abundance, making it difficult to know when eelgrass is at risk from green crab bioturbation. Our understanding of the tolerance of Maine's eelgrass populations to warming waters is limited. The relationship between eelgrass beds and aquaculture facilities is also poorly understood.

CBEP is committed to collaborating with key partners with the goal of returning eelgrass coverage to 2018 levels (about 5,000 acres) by 2032 (when another State round of eelgrass mapping is planned). Unfortunately, the path to achieving those goals is unclear. Restoration of eelgrass meadows has a mixed track record in New England, making it difficult to evaluate when and where active restoration would be beneficial. Control of green crabs offers a potential strategy for restoration, but few methods for green crab control have been shown to be effective except in semi-enclosed bays or other restricted waters. Research into methods for eelgrass protection, restoration and enhancement in Maine is needed to guide activities.

CBEP will convene the Casco Bay Eelgrass Consortium several times a year to serve as a hub for discussions about eelgrass monitoring and research. Together, we will conduct a regional effort to evaluate the relative importance of key eelgrass stressors, including temperature, nutrient pollution, light availability, and green crab impacts as contributors towards eelgrass decline. Better understanding of causes of declines is essential for ensuring long-term persistence of Casco Bay eelgrass. The Consortium will identify other research priorities, such as identification of resilient eelgrass beds or genotypes, developing methods to determine site suitability for eelgrass protection and restoration, and developing methods to evaluate the ability of beds to adapt to emerging conditions, among others. The Consortium will learn from and engage with wider east coast US and Canada eelgrass research and restoration networks on activities such as common garden and assisted migration efforts.

DEP plans to map eelgrass in Casco Bay in 2027 and 2032 and conduct more intensive monitoring at selected Casco Bay locations. DEP's monitoring activities are an essential foundation for understanding Casco Bay eelgrass and should be supplemented and expanded as resources allow.

CBEP will work with a coalition of New England National Estuary Programs, EPA Region 1, and Team Zostera/COBALT (Collaborative for Bioregional Action Learning and Transformation) to test methods for restoring eelgrass by harvesting seed to be released to boost eelgrass populations. We will work together to better understand the timing of eelgrass flowering and seed production. We will develop and evaluate strategies and develop new partnerships to harvest, handle, and store eelgrass seed to support seeding operations. When and if warranted, we will work to implement pilot studies to test restoration methods or implement proven approaches. Short-term tests and trials, however, will not prove sufficient, we must also build long-term institutions or coalitions able to support adaptive management and restoration of seagrass meadows in Casco Bay.

Resources

While eelgrass populations have shown significant declines in recent years, and several stressors have been linked to loss of eelgrass, the relative importance and cumulative effect of stressors is not yet entirely clear, making estimation of resources needs to achieve recovery and restoration impossible. A robust coalition already exists working together to accelerate eelgrass recovery.

CBEP's Staff Scientist will provide staff support for regional coordination, evaluate stressors, and test restoration methods.

CBEP may provide partial funding (up to $50,000) for research studies or demonstration projects that address priorities identified by the Casco Bay Eelgrass Consortium. However, external funding will be essential to this effort. External grants (as much as $500,000 over a period of 5 years) will be needed both to support ongoing activities like research, public engagement, and restoration and to fund scientific studies.

Outputs

- Report or reports documenting flowering and seed production in eelgrass beds in Casco Bay
- Data on flowering and seed set submitted to CBEP and regional eelgrass initiative leaders
- Communications and outreach products to inspire community engagement and stewardship
- Meetings of the Casco Bay Eelgrass Consortium
- Tests of restoration methods
- Data on location, extent, and density of eelgrass beds in Casco Bay (mapping expected in 2028 and 2032)

Outcomes

Short-term

- Understanding of local eelgrass seed availability
- Understanding of stressors to eelgrass beds to evaluate restoration potential
- Strengthened relationships with eelgrass restoration community in New England and surrounding states
- Increased public awareness of and engagement in seagrass conservation and restoration
- Tests of value of eelgrass seeding as a method for restoring or subsidizing eelgrass beds and populations in Casco Bay

Medium-term

- Restoration or enhancement of Casco Bay eelgrass using seeding methods
- Increased frequency of eelgrass mapping and monitoring in Casco Bay
- Opportunities for the public (residents and tourists) to engage with conservation and restoration of seagrass meadows

Long-term

- Enhanced resilience of Casco Bay's habitats, water quality, ecosystem function and integrity
- Better understanding of mechanisms of persistence and resilience of eelgrass meadows in the face of frequent disturbance and interacting stressors
- Integration with current and emerging sensor technologies, the Casco Bay Regional Ocean Model, and emerging coastal models to strengthen understanding of carbon dynamics in coastal waters

Metrics and Targets

Metric	Target
Meetings of the Casco Bay Eelgrass Consortium	Two meetings a year
Pilot studies on restoration methods	Two by 2029
Updated Casco Bay Eelgrass maps	Based on 2027 and 2032 flights
Acreage of eelgrass beds	3000 acres by 2027 5000 acres by 2032

GOAL 2: ADDRESS THE CUMULATIVE WATER QUALITY IMPACTS OF HUMAN ACTIVITY IN THE CASCO BAY WATERSHED

Casco Bay's still mostly forested watershed and the Bay's large tides help reduce the impacts of human activity on the Bay. But human activity and urbanization still threaten water quality, especially in Casco Bay's semi-enclosed embayments, and the watershed's lakes and streams.

Human activity affects water quality in many ways, most evidently when pollutants enter our waterways, but also when loss of forest, destruction of wetlands and construction of impervious surfaces like roads and parking lots alter how water moves through the landscape. What we do on land directly affects the health of our waters.

Certain pollutants are of specific concern. While nutrients like nitrogen and phosphorus are essential for plant growth, elevated levels can trigger a cascade of negative consequences in our waters—such as algal blooms, low dissolved oxygen, and even fish kills. Human health is put at risk when pathogens from human or animal wastes reach swimming or shellfish harvesting areas. Growing use of winter deicing products (road salt) harms fish and other aquatic organisms when chlorides and other salts enter our streams via snow melt, runoff, and groundwater.

CBEP will continue efforts to improve understanding of nutrient processes in Casco Bay, address key sources of water pollution like stormwater runoff, combined sewer overflows and septic tanks, and strengthen local efforts to address water quality challenges.

Strategy 2.1: Develop the scientific basis for managing nutrient pollution in Casco Bay

A fully validated, high-resolution forecast model of Casco Bay is expected to be available by mid-2024. CBEP will complete development of that model, coordinate preparation of data products and create interconnected models that strengthen understanding of the Bay, inform permitting decisions, and improve management of Casco Bay. The models and insights derived from them will also highlight data gaps, guide design of monitoring activities, and enable robust analysis of data on the condition of Casco Bay. Where feasible, these models will also be leveraged to address other community needs.

Action 2.1.A Develop Casco Bay model infrastructure

Goal 2: Address the cumulative water quality impacts of human activity in the Casco Bay watershed

Strategy 2.1: Develop the scientific basis for managing nutrient pollution in Casco Bay

Purpose

Create interconnected model infrastructure for Casco Bay by 2029 that informs permitting decisions and supports policy evaluation. Where feasible, leverage models to address other community needs. Improve understanding of physical and ecological processes that affect the health of Casco Bay.

Location

The model extends from Boothbay in the north and east to Saco Bay in the south and west and about 12 miles offshore. The broad geographic scope ensures forecasts of conditions in Casco Bay address the influence of the Kennebec River on Casco Bay hydrodynamics and links with the existing Saco Bay model for computational efficiency.

Description

In May 2011, CBEP hosted a workshop for coastal scientists and resource managers to identify key data collection and modeling actions that could enhance understanding of Casco Bay circulation patterns and improve coastal management. Workshop participants recommended development of a high-resolution hydrodynamic model of Casco Bay, but funding for model development was not available. Just over a decade later, in 2022, the Casco Bay Nutrient Council and the Casco Bay Monitoring Network also endorsed development of a Casco Bay hydrodynamic model.

Improved understanding of water movement can heighten understanding of Casco Bay and lead to better coastal policy. Models of severe events can help us understand community vulnerabilities and prepare for future storms. Understanding water movement in enclosed embayments could reveal which parts of the Bay are most vulnerable to pollution. Understanding Bay-wide water movement could reveal transport dynamics of lobster and clam larvae. Community members have identified dozens of other potential uses for high-resolution hydrodynamic data, from enhancing search and rescue operations to helping harvesters locate fish and shellfish.

Timeline: Underway. The Casco Bay Coastal Ocean Model (CBCOM) is under development. A validated model is expected by summer 2024. Development of model products to address permitting priorities will begin in mid-2024, with functional products expected in 2025.

Lead Implementers

- Casco Bay Estuary Partnership (funding, stakeholder engagement, product specification)
- University of Massachusetts-Dartmouth (model development)
- Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS; daily forecasts, long-term model operation)
- University of Maine (oversight of model extensions)
- Maine Department of Environmental Protection (key user of model output, nutrient loading models, water quality criteria)
- Portland Water District (key user of model output)

Other Collaborators

- Friends of Casco Bay (integration with water quality monitoring)
- Maine Coastal Program (coordination with state-wide efforts)
- Portland Waterfront Alliance (Connections to Portland Harbor community).
- Southern Maine Community College (educational uses of model products)
- University of Southern Maine (educational uses of model products)

In late 2022, CBEP tapped Bipartisan Infrastructure Law funds to assemble a high-resolution ocean model of Casco Bay. The model, which was subsequently developed by the University of Massachusetts-Dartmouth, provides forecasts of ocean conditions, including ocean height, wave state, current velocity, temperature, and salinity. Through a partnership with Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS), the model will be run daily to produce three-day hourly forecasts.

This new model is a key step, but addressing our needs will demand additional modeling, to be conducted over the next few years and beyond. Three-day forecasts can help prepare for tomorrow, but they are less useful for long-term planning. We also need to understand worst case scenarios like floods or droughts, estimate risks and describe typical conditions.

Casco Bay's "model infrastructure" will consist of interconnected models that inform Casco Bay science, monitoring, and policy. We envision not a static product, but a group of interlinked tools that will be updated as better data or tools become available. The core model infrastructure would include:

- A hydrodynamic model (How does water move in and around the Bay? How could that change as sea level rises?);
- A nutrient loading model (Where are nutrients coming from? How are loads changing? What can we do to reduce those loads?);
- An ecosystem model (What are the ecological implications of pollutant loads, especially nutrients? How might Casco Bay change with increased loads? Under climate change?).

The high-resolution hydrodynamic model enables ecosystem modeling. A coastal ecosystem model combines information on water movement with data on nutrient loads and understanding of ecological processes to evaluate water quality (and other) conditions. These models offer insight into nutrient processes, phytoplankton abundance, water clarity, dissolved oxygen, and carbonate chemistry. Spatially explicit ecosystem models can identify areas of Casco Bay most at risk for water quality problems or highlight areas that may become more vulnerable due to climate change and coastal acidification.

The models will provide the framework for future decisions regarding climate adaptation, permitting of wastewater and stormwater discharges, and design of monitoring programs. The process of developing models will test our understanding of the Bay, and point to information gaps, thus providing guidance for future monitoring and scientific studies. We will also work to improve access to model outputs such as short-term forecasts and characterization of risk to community users (see Action 4.1.A).

CBEP's modeling efforts will be overseen by a new Model Infrastructure Working Group. Membership will be drawn from users of model outputs (such as permitting agencies, wastewater dischargers, or aquaculture operators), coastal scientists, and interested community members.

Resources

NERACOOS has committed to hosting and running the Casco Bay Coastal Ocean Model once it is developed and validated. University of Maine and University of Southern Maine scientists will assist with developing additional add-on model products to address community needs.

Funding for development of the CBCOM was allocated from BIL funds in 2022. CBEP anticipates spending about $75,000 annually through 2029 to fund model applications and extensions.

In addition, we expect that as much as 30% of CBEP's staff scientist's time will go towards coordinating model development. We will continue to seek grant funds to develop methods for making model output more accessible to community members.

Outputs

- The Casco Bay Regional Ocean Model, a high resolution predictive hydrodynamic model of Casco Bay and the nearby coastal ocean
- Model outputs that address water quality concerns, such as model runs that simulate extreme events, or estimates of probability and risk
- Application of nutrient loading model or models to the Casco Bay watershed
- Ecosystem or water quality model of Casco Bay

Outcomes

Short-term

- Improved scientific and technical understanding of water movement in Casco Bay

Medium-term

- Greater understanding of how circulation patterns may affect transport of nutrients and other pollutants
- Improved ability to evaluate risks to water quality from increasing nutrient loads and changing climate

Long-term

- Improved science and decision-making pertaining to the Bay and watershed
- Improved water quality in Casco Bay

Metrics and Targets

Metric	Target
Completed and validated high resolution hydrodynamic model of Casco Bay and surrounding coastal ocean	By summer 2024
Initial model runs and other products that can help advance water quality permitting discussions for major dischargers in the Portland metropolitan area	By summer 2025
Casco Bay Ecosystem model completed	By 2029

Strategy 2.2: Work collaboratively to reduce key sources of water pollution throughout the watershed

We will work to strengthen policies to reduce cumulative impacts of urbanization and other land use changes, support ongoing regional efforts to reduce combined sewer overflows, and work to better understand and eventually reduce pollutants – especially bacteria, nitrogen, and phosphorus – entering our waters from septic tanks and other onsite wastewater treatment systems.

Action 2.2.A Strengthen planning policies, site design requirements, and land use practices that protect and restore natural hydrology and reduce pollution from stormwater

Goal 2: Address the cumulative water quality impacts of human activity in the Casco Bay watershed

Strategy 2.2: Work collaboratively to reduce key sources of water pollution throughout the watershed

Purpose

Encourage and implement state and local policies and practices that encourage use of planning, land use policies, and site design requirements and engineered structures to protect aquatic ecosystems from the impacts of urbanization and suburbanization.

Location

Municipalities in the Casco Bay watershed, especially those in the middle and lower watershed with more extensive urban and suburban areas.

Description

Certain land uses, especially urbanization, pose pervasive threats to water quality due to increased runoff containing non-point source pollutants from impervious surfaces and developed areas. Historically, Maine's low population and modest agricultural economy have limited the extent of problems, but that is changing. A growing population in the Portland area, as well as expanding suburban areas to the north and west of the City (likely to be exacerbated by construction of the Gorham Connector) put more lakes and streams at risk and could increase nutrient loads flowing to Casco Bay. These challenges are most acute in the Portland region; a

Timeline: This is an ongoing activity, but several opportunities to engage in development of relevant policies are expected in 2024. For example, the Maine Department of Environmental Protection (DEP) recently began revising the state's "Chapter 500" rules regarding stormwater requirements for new development. Communities subject to the Clean Water Act's Municipal Separate Storm Sewer System (MS4) permitting requirements are in the early phases of implementing Low Impact Development (LID) policies under Maine's MS4 General Permit. The final MS4 permit, however, has been appealed and remanded back to DEP for further consideration, likely leading to additional delays.

Lead Implementers

- Maine Department of Environmental Protection (updates on "Chapter 500" rules and oversight of MS4 permits)
- Cumberland County Soil and Water Conservation District (leadership of ISWG, staff for Long Creek Watershed Management District (LCWMD), relationships with municipalities)
- Friends of Casco Bay (legal and policy review and advocacy)
- Casco Bay Estuary Partnership (technical assistance, participation in State policy working groups, coordination)
- Local governments (implement MS4 permits, update comprehensive plans, ordinance review)

recent review by DEP of changes in impervious cover over a period of 20 years identified the Fore River watershed as the region with the largest increase in impervious cover in Maine.

Runoff can carry a variety of pollutants into our streams, lakes, and the Bay. As urbanization intensifies, wetlands are often filled or drained, riverbank forests are cut down, and road crossings block the movement of water, woods, sediment, and aquatic organisms. Instead of soaking into the ground and being intercepted by vegetation, rainfall falls on roofs, parking lots, driveways, and roadways, surging into nearby streams. Cumulatively, these effects reduce water quality, damage aquatic habitat, and eliminate all but the most pollution tolerant aquatic insects and fish.

Methods exist to reduce both pollutants and impacts, but they are underutilized. These tools have many names (Green Infrastructure, Low Impact Development, Best Management Practices, etc.). Regardless of what you call them, they aim to address a few important principles that together can protect watershed health and resilience of aquatic ecosystems, such as:

- Minimize disruption of hydrological processes (including infiltration and groundwater flows);
- Filter runoff and treat stormwater before it reaches rivers and streams;
- Minimize and reduce impervious surfaces;
- Minimize the use of deicing salts and prevent infiltration of high chloride meltwater;
- Protect natural wetlands and riparian (stream bank and lakeshore) areas and floodplains;
- Manage and maintain, and when necessary, replace poorly functioning devices and piped infrastructure intended to reduce water quality impacts and flooding;
- Implement water quality protection methods responsive to the needs of downstream waters and to the probable stressors affecting aquatic ecosystems.

Many towns in our region are taking steps to reduce water quality impacts of runoff, such as adopting local ordinances restricting use of synthetic pesticides and fertilizers, or conducting public outreach and education efforts around pet waste, landscaping practices, and more (see also Action 2.3.B)

While agriculture is not as widespread in the watershed as urban and suburban areas, it can have important water quality impacts. Agriculture can be an especially important source of water pollution, such as sediment (due to soil erosion), nutrients (from fertilizer and animal wastes), and bacteria (from animal waste). In our region, small-scale agriculture (both “hobby farms” and high value-added, small-acreage specialty producers) sometimes lack access to information about how to reduce water quality impacts. Reducing water quality impacts of agriculture therefore may require outreach and education efforts and development of local policies.

Other Collaborators

- Interlocal Stormwater Working Group (ISWG; coordinating implementation of MS4 permits)
- New England Environmental Finance Center (New England-wide connections, creative solutions, finance strategies)
- U.S. Environmental Protection Agency (oversight of delegated permitting programs, including MS4 permits)
- Maine Water Environment Association Stormwater Committee (coordination and policy development)
- Maine Department of Environmental Protection’s Nonpoint Source Training Center (training)
- Greater Portland Council of Governments (relationships with municipalities, planning expertise)

CBEP and allied organizations will work to strengthen state and local policies and educate policy makers, local officials, design professionals, and contractors about the relationship between land use and water quality and methods for reducing those impacts. Together, we will do this principally by:

- Engaging in stormwater-related policy development, like the upcoming revisions to Maine's "Chapter 500" rules addressing stormwater discharges from new construction (See Action 4.1.A);
- Providing information, assistance and training to local officials and state legislators, including through presentations, training events and other educational materials (see Action 3.2.B);
- Working with town councils and state legislatures to establish dedicated funding for stormwater infrastructure maintenance, repair, and replacement.

It has become increasingly clear that protecting water quality in urban and suburban landscapes requires protecting hydrology of entire watersheds. That links this Action with habitat conservation activities under Strategy 1.1 (Permanently protect habitats that support resilience of aquatic ecosystems and protect water quality). Protecting water quality has long been a principal aim of our habitat conservation programs. This Action can complement Goal 1 Actions by engaging with communities, local governments, and landowners to improve policies and practices that preserve important hydrologic features where fee acquisition or conservation easements are unlikely or impossible.

Resources

This Action builds on efforts already underway by several organizations, especially the Cumberland County Soil and Water Conservation District, the Interlocal Stormwater Working Group, and local governments.

The role of CBEP's existing staff will be to support partner-led initiatives by participating in policy discussions and coordinating among CBEP partners, and serving on advisory panels, Boards and Commissions.

When resources permit, CBEP may provide partial funding (between $5,000 and $20,000) for outreach and education activities.

Outputs

- Updates Maine stormwater rules
- Adoption of low impact development ordinances
- Delivery of technical assistance on stormwater and water infrastructure to communities
- Presentations to local government audiences; related outreach documents (See also, Action 3.2.B)
- Participation in state, regional and local working groups, stakeholder meetings and rulemaking processes to support policy development

Outcomes

Short-term

- Increased community awareness of methods to reduce water quality impacts of new construction and land use change

Medium-term

- Adoption of state and local policies (laws, ordinances, rules, etc.) to reduce water quality impacts of urbanization and protect water quality

Long-term

- Improved water quality due to decreases in stormwater runoff and related hydrologic changes
- Improved water quality in Casco Bay

Metrics and Targets

Metric	Target
Updated “Chapter 500” stormwater management and site development rules	2025
Adoption of local low-impact development ordinances	Ten towns in the region by 2029
Presentations to local leaders or civic groups by CBEP staff	Average of two per year through 2034
Provide tools and training to enable municipalities to make more informed decisions regarding stormwater and land use	Reach 50% of Casco Bay watershed municipalities annually by 2029
Teach municipal and legislative leaders about stormwater, the water quality impact of land use practices, and local policies that can help protect water quality	25% of Casco Bay watershed towns (about 12 towns) reached annually

Action 2.2.B Reduce combined sewer overflow discharges

Goal 2: Address the cumulative water quality impacts of human activity in the Casco Bay watershed.

Strategy 2.2: Work collaboratively to reduce key sources of water pollution throughout the watershed.

Purpose

Continue regional progress reducing Combined Sewer Overflow (CSO) discharges to reduce pathogens and nutrients loads entering the Presumpscot River and the Bay.

Location

Portland, South Portland, and Westbrook.

Description

Antiquated sewer systems with underground pipes that carry both sewage and stormwater can lead to the direct discharge of untreated sewage into Casco Bay during heavy rains. Portland, South Portland, and Cape Elizabeth still have combined stormwater/sewer infrastructure that discharges into Casco Bay, while Westbrook's discharges into the Presumpscot River. (A closely related issue occurs when raw sewage finds its way into storm sewers, through cross-connection, or due to leaks in aging underground infrastructure.)

All these communities have worked hard to eliminate Combined Sewer Overflow (CSO) discharge points (or outfalls). The number of active CSO discharge points has dropped from 80 in 1990 to 34 in 2022. Numerous projects are underway or have been completed that reduce discharges from remaining outfalls. Discharges have declined markedly both in absolute volume (cut by nearly ¾ since 2000), and in annual discharge per inch of rainfall.

Despite decades of work, 166.5 million gallons of combined sewer effluent was discharged to Casco Bay waters in 2022 during some 64 CSO discharge "events." (Illegal cross-connections and leakage of sewage from aging sewer lines into adjacent storm drains provides a less-well documented path for discharge of untreated human wastes to the Bay).

Reduction of CSO discharges is a priority for CBEP, but making progress requires continued leadership from CSO communities and regulatory agencies, often working in collaboration with Portland Water District, which by charter manages wastewater treatment plants, pump stations and interceptor sewers.

Regulators require CSO remediation, but the costs—which are substantial—rest with our communities. The regional sewer system operated by the City of Portland and Portland Water District (PWD) accounts for over 90 percent of CSO discharges in the region. Through the end of

Timeline: Ongoing

Lead Implementers

- City of Portland (CSO permit applicant/implementor of sewer separation and CSO storage projects)
- City of South Portland (CSO permit applicant/implementor of sewer separation projects and CSO mitigation projects)
- Portland Water District (operator of sewer collection system and major Wastewater Treatment Facilities (WWTFs)
- Maine Department of Environmental Protection (CSO permits, state program, funding)
- U.S. Environmental Protection Agency (oversight of state permit programs)

Other Collaborators

- Friends of Casco Bay (legal and policy analysis, advocacy)
- Town of Cape Elizabeth (one remaining CSO outfall)
- City of Westbrook (several remaining CSO outfalls)
- Communities with Municipal Separate Storm Sewer System (MS4) Permits (dry weather monitoring, remediation of sanitary to storm sewer cross-connections)

2022, the City and PWD have spent over $235 million on CSO abatement. The ten-year Integrated Plan - Phase 1, currently being implemented, calls for an additional $110 million to be spent on CSO abatement. Inflation and changing engineering practice will increase actual costs substantially.

The need for prompt action on CSO control is becoming more acute as climate change triggers more extreme precipitation events. Work to control runoff volume and pollution in the face of more intense precipitation includes CSO abatement, increased use of green infrastructure and low impact development and innovative approaches to stormwater management (Action 2.2.A).

CBEP staff will support communities and regulators in efforts to solve financial and technical challenges, to educate area residents about what they can do to reduce combined sewer discharges (for example, by removing sump pumps and roof leaders), and to publicize regional efforts to address CSOs.

Resources

This Action will be implemented primarily by PWD and our CSO communities, especially Portland, South Portland, and Westbrook. Costs for remaining work addressing CSOs are substantial and growing.

CBEP staff will play a supporting role for CSO implementation, principally by helping communicate about community CSO abatement efforts and the importance of continued reductions in discharges.

Outputs

- CSO remediation projects
- Repair or lining of leaking sewer pipe, reducing flow of untreated sewage to stormwater conveyances
- CBEP staff continues to support regional efforts and highlight regional successes reducing discharges

Outcomes

Short-term

- Reduced volume of CSO discharges
- Reduced numbers of active CSOs

Medium-term

- Local improvements in water quality

Long-term

- Improved water quality in Casco Bay

Metrics and Targets

Metric	Target
Number of remaining active CSO discharge locations	Under 30 by 2029, with additional reductions by 2034
Volume of CSO discharges per inch of annual rainfall 2022 Baseline = 3,512,570 gallons per inch of rainfall	20% decline by 2029 from 2022 baseline with continued reductions through 2034
Total volume of CSO discharges per inch of annual rainfall 2019 Baseline = 4,878,400 gallons per inch of rainfall	2019 baseline exceeded no more than twice through 2034

Action 2.2.C Address pollution from on-site wastewater treatment systems like septic tanks

Goal 2: Address the cumulative water quality impacts of human activity in the Casco Bay watershed

Strategy 2.2: Work collaboratively to reduce key sources of water pollution throughout the watershed

Purpose

Develop plans and begin to implement projects to reduce nutrient and pathogen pollution entering our waters from on-site wastewater treatment systems like septic tanks and overboard discharges.

Location

Casco Bay watershed, especially coastal areas and lakeshores in rural and suburban communities that lack municipal sewer systems.

Description

Onsite wastewater systems can have significant impacts on water quality both in coastal waters and inland areas. Anecdotal evidence and results of water quality monitoring suggest that septic tanks and "overboard discharges" are sources of bacterial and nutrient contamination of Casco Bay, rivers and streams, and lakes.

Addressing pollution from inadequate or failing on-site wastewater systems could reduce bacterial contamination of lakes and coastal waters, allow reopening of some clam flats, and reduce nutrient loading to lakes and the Bay. However, we are only generally aware of the location and condition of onsite wastewater treatment systems in the region. Maine's Shellfish Advisory Council has recently flagged poorly maintained septic tanks and overboard discharges as a top statewide concern for the shellfish industry.

Most of our larger cities and towns are served by the Portland Water District's wastewater systems. Several mid-sized communities have dedicated municipal wastewater treatment systems. But most towns in the watershed lack sewers, so businesses and residents depend on on-site treatment, usually septic tanks. Even in towns and cities that do have wastewater systems, service often does not extend to all residents, especially those living further from town centers or in isolated areas.

Maine has among the oldest housing stock in the nation, so many on-site wastewater treatment systems are aging. Maintenance is often deferred. Most lakeshore "camps" and coastal "cottages" rely on septic tanks or other on-site wastewater treatment systems. While Maine law

Timeline: This Action will begin in 2024. A report on water quality impacts of on-site wastewater systems and recommended approaches to reduce them will be completed by the end of 2025. Further efforts will depend on findings from the first two years' work.

Lead Implementers

- Cumberland County Soil and Water Conservation District (studies and implementation)
- Maine Department of Environmental Protection (funding)
- Casco Bay Estuary Partnership (funding, coordination)
- Casco Bay Regional Shellfish Working Group (access to existing data and data tools)
- Greater Portland Council of Governments (connections with municipalities)
- Maine Department of Marine Resources (access to data on area closures)

Other Collaborators

- Friends of Casco Bay (legal and policy analysis)
- Subsurface Wastewater Program, Maine Department of Health and Human Services (technical assistance)
- Local governments (ordinance review and implementation)

requires septic tank inspections when property in the shoreland zone is transferred, septic systems on older homes may not have been inspected or maintained for decades. Many systems do not function as intended and may pose a threat to water quality. Even well-maintained septic systems have cumulative water quality impacts because septic tanks (and most other on-site wastewater systems) are not designed to reduce nitrogen pollution, a particular concern in marine waters. While numbers have been declining for years, just under one hundred permitted “overboard discharges” or “OBDs” remain that discharge lightly treated wastewater to Casco Bay waters. Simple outhouses are still found on some Casco Bay islands. When poorly maintained they also can result in shellfish closures.

Towns have records going back decades about septic systems, including information on when they were constructed, where they are located, and how many people they were designed for. (Older systems may be undocumented or incompletely documented). While some of these records have been scanned and are available online, many are available only in paper form. Transferring data to electronic formats for mapping and analysis often requires hand digitization. The Casco Bay Regional Shellfish Working Group’s “Community Intertidal Data Portal” includes a tool to help transfer, organize, and display data from either town records or on-site observations.

This multi-year Action will focus on understanding local and regional impacts of onsite wastewater treatment systems and developing strategies to address them. Over the next two years, we will gather data on the distribution, age, and condition of septic tanks and permitted overboard discharges. We will identify locations where aging or failing septic tanks are most likely to have significant effects on water quality (in both lakes and the Bay), assess strategies, and evaluate costs. This effort will culminate in a regional meeting (a “Septic Tank Summit”) to discuss the study’s findings, share ideas and information, and establish priorities for next steps.

Resources

CCSWCD will lead this Action, with funding and other assistance from CBEP.

CBEP will allocate about $50,000 in BIL funds annually to this Action from 2023-2024 through 2026-2027. Additional funds (under $5,000) may be used to help cover costs associated with planned events, such as a “Septic Tank Summit.” Allocations may increase in 2026 and 2027, if resources allow, as we shift towards implementation priority strategies to reduce pollution from septic tanks.

Outputs

- Data on location and age of septic tanks and other on-site wastewater systems
- Identification of locations most at risk from on-site wastewater systems
- Report on strategies to reduce impacts
- “Septic Tank Summit” meeting

Outcomes

Short-term
- Develop strategies for reducing pathogen and nutrient pollution from aging or failed septic tanks

Medium-term
- Reduce pathogen and nutrient pollution from aging or failed septic tanks and overboard discharges

Long-term
- Improved water quality in affected waters
- Prevention of further deterioration or improvement of water quality in impaired waters

Metrics and Targets

Metric	Target
Data on location and condition of septic tanks assembled	By end of 2024
Report on onsite wastewater treatment systems	By end of 2025
“Septic Tank Summit”	2025
Stakeholder groups attending Septic Tank Summit	Ten

Strategy 2.3: Develop and implement local efforts to address water quality challenges

While land use changes and a growing human population are common drivers of water quality problems, the way those causes play out varies from place to place. Water quality solutions need to reflect local sources and site-specific information. CBEP will address local and site-specific water quality challenges by facilitating development of watershed-based plans and working to improve water quality in impaired and urban streams.

Action 2.3.A Increase data gathering and stressor assessments to accelerate development of watershed management plans

Goal 2: Address the cumulative water quality impacts of human activity in the Casco Bay watershed

Strategy 2.3: Develop and implement local efforts to address water quality challenges

Purpose

Accelerate development of watershed management plans, create plans more likely to address water body impairments due to better access to data, and ensure eligibility for Section 319 funding.

Location

Watershed wide, with additional work in priority watersheds. Priority watersheds will be determined based on review of available information, and opportunities to improve water quality.

Description

DEP-approved Watershed-based Management Plans (WBPs) identify priorities for water quality improvement based on watershed surveys, stream stressor identification, geospatial analysis, and community priorities. In Maine, formal WBPs (either “Nine Element Watershed Based Plans” or “Lake Watershed Based Protection Plans”) are usually required to access EPA/DEP implementation funding for nonpoint source pollution protection and watershed restoration projects.

Funding for Watershed-based Management Plan development has been in short supply for a decade resulting in a decline in the number of approved WBPs. As of mid-2023, there were only three (3) active and approved Nine Element Plans, and six (6) Lake Plans, throughout the Casco Bay watershed. Other WBPs will expire in the next few years.

Timeline: This Action will kick off in 2024. The initial focus will be on a) identifying and addressing information bottlenecks that impede development of and updates to watershed management plans and b) identifying priority water bodies for stressor assessments and plan development. In subsequent years, the effort will emphasize data collection, stressor assessment, and plan development for priority waters.

Lead Implementers

- Cumberland County Soil and Water Conservation District (needs assessment, watershed plan development)
- Casco Bay Estuary Partnership (funding, oversight)
- Maine Department of Environmental Protection (funding through “Section 319” grants and State Revolving Fund, oversight of watershed planning, guidance on identification of key stressors, oversight of watershed planning and approval of completed Plans)

Other Collaborators

- Portland Water District (data on lake water quality and land use)
- Watershed groups (local knowledge and assistance)
- Local governments (local assistance, data access)
- Friends of Casco Bay (prioritization)
- Greater Portland Council of Governments (connections with municipalities)

Costs of developing WBPs have grown, due both to inflation and the need for more in-depth "stressor assessments" that evaluate causes of water quality impairment. Some recently completed WBPs have cost over $100,000, but most still cost less. Lack of available funding and rising costs have become a serious barrier to updating old or developing new WBPs. Opportunities may exist for cost reductions, especially by coordinating Plan development practices, gathering or collecting data needed for Plan development, and simplifying access to environmental data.

We will collaborate to develop a shared regional approach to developing WBPs that will:

- Assemble a working group (or other coordinating structure) to oversee the Action;
- Identify priority locations for updating or developing WBPs;
- Develop procedures and tools to streamline preparation of WBPs that meet EPA requirements;
- Accelerate data collection and development of stressor assessments;
- Work together to seek supplementary funds to prepare plans; and
- Complete priority plans.

Priorities for watershed plans will be based on local needs and community input, as well as by reference to lists of impaired and threatened waters, such as Maine's list of Priority Watersheds, Maine's Impervious Cover Total Maximum Daily Load (TMDL), and the most recent available "303(d)" list of impaired waters.

Resources

CCSWCD will lead implementation of this Action, with funding provided by CBEP.

We anticipate allocating about $50,000 in BIL funds to this Action annually from 2023-2024 through 2026-2027.

A key purpose of this Action is to seek efficiencies to reduce cost of watershed management plans. Available CBEP BIL funds are insufficient to fund all the watershed plans needed in our region. While costs vary depending on location and issues, typical Plans are likely to cost over $50,000. Therefore, significant external funds will be needed to advance next steps and develop priority watershed plans.

CBEP and CCSWCD will work in association with plan sponsors (often municipalities or lake associations) to seek additional funds to support plan development.

Outputs

- Report outlining steps to reduce regional costs of watershed plan development through economies of scale, simplifying data access, increasing data collection, or standardizing processes
- Tools, checklists, and data archives that help implement report recommendations
- List of priority locations for watershed planning that identifies for each watershed primary needs such as updated watershed surveys or better stressor assessment
- Plans for data collection and stream stressor assessment for priority watersheds
- Data collection to support stream stressor assessments
- Annual update report (2024 through 2028) on data collection, stressor assessments and watershed plan development for priority watersheds
- Completed stressor assessments
- Proposals submitted for funding of development of watershed plans

- Completion and approval of Watershed Management Plans

Outcomes

Short-term
- Establish priorities for Watershed Management Plan development

Medium-term
- Implement strategies to reduce cost of watershed plans
- Develop approved watershed plans
- Improved strategies for watershed protection based on detailed assessment of local conditions and needs

Long-term
- Additional Section 319 implementation grants awarded for projects based on new or updated WBPs
- Additional non-point source *projects* implemented to help improve water quality
- Improved water quality and resilience of aquatic ecosystems

Metrics and Targets

Metric	Target
Convene a working group to identify data collection needs and establish priorities for stressor assessments and watershed plan development within the Casco Bay region	By September of 2024
Completed plans for data collection and stream stressor assessment for priority watersheds	Minimum of one per year 2025 through 2028, with a goal of six total plans prepared by 2028
Data collection to support stressor assessment for priority watersheds	Data collection occurring in two watersheds each year 2025 through 2028
New or updated stressor assessments completed	Six watersheds by 2028
Grant proposals submitted to support creation of WBPs	One per year 2026 through 2028
Complete or update first new or updated Watershed Based Management	One by 2028

Action 2.3.B Improve water quality in impaired and urban streams

Goal 2: Address the cumulative water quality impacts of human activity in the Casco Bay watershed

Strategy 2.3: Develop and implement local efforts to address water quality challenges

Purpose

Focus regional effort on the challenges of managing water quality, especially in urban and suburban watersheds, to protect water quality, improve aquatic habitats, reduce nutrient and pathogen pollution, and ameliorate the impacts of road salt on streams.

Location

Urban and impaired streams in the Casco Bay watershed such as the urban stream of the lower watershed and tributaries to the Presumpscot River.

Description

This Action highlights ongoing efforts to address water quality challenges in our most impacted and vulnerable watersheds, in both urbanized and rural areas with persistent water quality problems.

Several long-standing regional efforts have been established to address the water quality challenges associated with urbanization. These ongoing initiatives will continue in coming years.

- The Interlocal Stormwater Working Group (ISWG) is a regional coalition of communities that work collaboratively to implement the MS4 permit in the Casco Bay region. The group acts as a clearinghouse on information and ideas and assists towns with permit compliance.
- The Long Creek Watershed Management District (LCWMD) works to protect water quality in the Long Creek Watershed on behalf of about 140 landowners. The effort is important not only as a novel public-private partnership, but also as a testbed for solutions to some of our most intractable water quality challenges. Extensive monitoring has helped highlight the importance of the impacts of chlorides (derived from winter deicing products), heat, and drought on the health of our streams. Urban stream restoration projects have demonstrated that it is possible to

Timeline: This Action continues and calls attention to existing activities that address water quality in some of our most impacted and vulnerable watersheds. These activities are already underway and will continue through 2034.

Lead Implementers

- Long Creek Watershed Management District (implementation in Long Creek Watershed Management Plan and SWiM program to reduce use of winter deicing products)
- Maine Department of Environmental Protection (funding, data collection, designation of impaired waters, Impervious Cover TMDL, oversight of MS4 programs, watershed programs)
- Interlocal Stormwater Working Group (ISWG; implement MS4 programs)
- Cumberland County Soil and Water Conservation District (leadership of ISWG, implementation, especially site visits, inspections, and engineering)

Other Collaborators

- Casco Bay Estuary Partnership (funding, coordination)
- Friends of Casco Bay (advocacy and assistance with monitoring)
- City of Portland (implementation in several urban impaired stream watersheds)
- City of South Portland (implementation in several urban impaired stream watersheds)
- Local governments (implement MS4 programs, comprehensive plans, local ordinances)
- Maine Department of Transportation (implement strategies to reduce use of winter deicing products)

improve habitat quality even in sites that no longer support natural hydrologic regimes. Investments in parcel inspections, street sweeping, and other ongoing activities have shown the benefits of robust operations and maintenance programs to address the impacts of urbanized areas and their negative impacts on watersheds and water quality.

- The Maine Stormwater Conference, held every two years, offers opportunities for Maine engineers, designers, local officials, and others to hear from each other and from national experts.
- Winter deicing products ("road salt") pose one of the most intractable challenges to the health of Maine streams. Dissolved salt finds its way to our streams via runoff and groundwater. In some streams, related exposure thresholds are exceeded for weeks or months at a time. Salt is toxic to many freshwater organisms, so elevated levels leave streams with degraded insect and fish communities. Unfortunately, it has proved difficult to remove salt from the water, so the primary way to reduce impacts of salt on our streams is to reduce use of salts in the first place. That poses legal, economic, and even cultural challenges that will require ongoing effort from many members of the Partnership to address. LCWMD is piloting efforts to reduce salt use through its Sustainable Winter Management (SWiM) program. Legislative outreach efforts are underway by several partners to support legislation to limit liability winter maintenance operators following approved methods.

Other problems remain and will require new and expanded efforts to address them. For example, tributaries to the Presumpscot River in the rural and urbanizing portions of its watershed show persistent water quality problems, such as low dissolved oxygen and elevated bacteria levels. Monitoring suggests these problems are getting more widespread and persistent. Elevated sediment loads on the Pleasant River may be harming the brook floater (a state Threatened freshwater mussel). Development activities in the Stroudwater watershed are pushing local land use past thresholds where water quality and ecological impacts are likely. Monitoring has been more limited than on the Presumpscot, but water quality on the river is already problematic. Bacteria levels regularly violate applicable water quality criteria.

Resources

These activities will continue to be led by partners, especially DEP, ISWG, CCSWCD, and local governments.

CBEP's existing staff has and will continue to support these and related efforts by participating on boards and working groups (CBEP Director) and offering technical assistance (Director and Staff Scientist). Time commitment varies year to year between about 10% and 20% of an FTE.

CBEP will also seek opportunities to play a catalytic role convening regional conversations around emerging issues (See Action 4.2.A) or funding demonstration projects via relevant grant programs (described elsewhere).

Outputs

- Bimonthly ISWG Meetings (6 per year)
- Implementation of MS4 permits by local communities
- Service of CBEP staff on the LCWMD Board of Directors
- Updated Long Creek General permit
- Completion of the “Hannaford Plaza” constructed wetland project in the Long Creek Watershed
- Implementation of the Long Creek Watershed Management Plan
- Biennial Stormwater Conferences
- Exploration of approaches to reducing impact of road salts on water quality
- Legislative outreach in support of limited liability legislation to reduce incentives for over application of salt by winter maintenance contractors

Outcomes

Short-term

- Better implementation of MS4 permits

Medium-term

- Improved water quality in Long Creek
- Innovative approaches to reducing impact of road salts on stream health

Long-term

- Improved water quality in urban streams
- Prevention of further deterioration or improvement of water quality in impaired waters

Metrics and Targets

Metric	Target
Long Creek General Permit	By 2026
Completion of the “Hannaford Plaza” constructed wetland project	By 2025
Maine Stormwater Conferences	Every two years

Strategy 2.4: Track emerging threats to water quality

We need to both address long-standing water quality challenges and remain alert for new and emerging threats to water quality. CBEP plays a key role gathering information on new, hypothesized, or emerging threats to water quality, and evaluating their impact on Casco Bay and the waters of the Casco Bay watershed.

Action 2.4.A Study the prevalence of PFAS in Casco Bay

Goal 2: Address the cumulative water quality impacts of human activity in the Casco Bay watershed

Strategy 2.4: Track emerging threats to water quality

Purpose

Coordinate with, and where necessary, supplement ongoing efforts to evaluate the presence and potential sources of PFAS in Casco Bay waters, sediments, fish, and shellfish.

Location

Casco Bay-wide. Specific sample locations will be selected based on requirements of state programs and evaluation of pathways for PFAS delivery to Casco Bay.

Timeline

Data collection by DEP, wastewater plant operators and FOCB has already begun.

Lead Implementers

- Friends of Casco Bay (implementor, boat access, coordination, and stakeholder engagement)
- Bigelow Center for Ocean Sciences (sample handling, laboratory analysis and science)
- Maine Department of Environmental Protection (collect data on PFAS, including concentrations in soils and sediment, shellfish tissue, wastewater treatment facility sludge and discharges)

Other Collaborators

- U.S. Environmental Protection Agency (regional context and support)
- Wastewater treatment plant operators (sample collection)

Description

PFAS (Per- and Polyfluorinated Substances) pollution is a significant and growing problem. For decades, PFAS compounds have been used in a wide range of consumer goods and industrial products. They are environmentally persistent and readily find their way into the environment. PFAS carried in wastewater poses challenges for wastewater treatment systems, which act as conduits of PFAS between consumer uses and the environment. Land-based disposal of sewage sludge, for example, has led some Maine agricultural lands to become contaminated with PFAS. This soil contamination has led to contaminated wells, a deer consumption advisory and agricultural lands taken out of production. Available alternatives for disposal of sludge have caused significant logistical challenges and increased costs for wastewater treatment.

In 2021, the Maine legislature passed several laws addressing PFAS contamination. These included a law, “An Act to Stop Perfluoroalkyl and Polyfluoroalkyl Substances Pollution” that effectively bans sale of all products containing “intentionally added” PFAS compounds by 2030. Another law requires manufacturers of pesticides registered in the state (beginning this year) to attest whether the formulation contains PFAS compounds or has ever been stored in a fluorinated HDPE container (a potential source of PFAS contamination).

The Biodiversity Research Institute, back in 2009, conducted a survey of toxic contaminants in sixteen osprey eggs from Casco Bay. Eleven of sixteen eggs showed PFOS (Perfluorooctane sulfonic acid) at levels above a published adverse effects threshold for chickens. One egg contained a concentration of PFOS over 2500 nanograms per gram, more than twenty times greater than the applicable levels of concern. At the time that was the highest recorded concentration from Maine wildlife. More recently (2021), DEP's Surface Water Ambient Toxics (SWAT) program found low levels of PFAS from some sites within Casco Bay, including from Portland Harbor. Early in 2023, Maine CDC issued fish consumption advisories for freshwater fish in portions of the Presumpscot River, where testing has shown elevated PFAS levels. PFAS are finding their way into aquatic organisms, and bioaccumulating and posing a risk to piscivorous birds, such as osprey, bald eagle, and kingfisher.

Unfortunately, we have, until recently, had little information to help determine how these compounds are entering the Casco Bay food webs. In 2022, the Maine legislature passed LD 1911, which required monthly PFAS testing of licensed discharges in 2022 and 2023. DEP also maintains a map of state PFAS investigations, showing sites where soils or groundwater have been tested for PFAS, as well as known locations of previous land disposal of potentially contaminated sewage sludge or septage. As these data accumulate, they can be leveraged to help focus PFAS monitoring efforts.

Measurement of the prevalence of these compounds in Casco Bay waters, sediments and biota can shed additional light on where PFAS are found and help infer how they found their way to the Bay. Data collected in the next few years can provide a baseline to allow us to evaluate the effectiveness of PFAS control strategies, including the effectiveness of Maine's first-of-its-kind law to ban most consumer goods containing PFAS compounds by 2030.

In 2023, Friends of Casco Bay and Bigelow Center for Ocean Sciences began sampling Casco Bay at established monitoring sites along the coast and extending to Broad Sound. This study will provide information regarding levels of PFAS compounds throughout the Bay, and hopefully set the stage for more detailed studies to identify sources of PFAS in the Bay. DEP's SWAT program has expanded efforts across the state to identify PFAS in fish and shellfish. Future studies (by these or other groups) may expand to search for PFAS in other organisms. But studying organic contaminants like PFAS is costly. Costs of sample collection and laboratory analyses can run into the many hundreds or even thousands of dollars per sample. Comprehensive studies are likely to run into the hundreds of thousands of dollars.

The Partnership will support these emerging efforts, especially by helping to identify funding sources and assisting with raising funds. CBEP staff can assist as well by participating in discussions about research priorities or study designs, by working with Friends of Casco Bay and Bigelow, and by engaging in their efforts to draw together stakeholders to identify and explore addressing coastal sources of PFAS contamination. All this work is contingent upon funding for this emerging science and policy issue.

Resources

PFAS studies will be led by Friends of Casco Bay, Bigelow Laboratory, and the Department of Environmental Protection. Ongoing state efforts to study PFAS will be a key component of the overall effort, while FOCB and Bigelow have already successfully raised funds for and begun field sampling, with a focus on collecting data complementary to the information collected by state agencies.

Comprehensive studies on PFAS in Casco Bay will likely cost hundreds of thousands of dollars, so CBEP staff and partners will continue efforts to raise dedicated funds to study PFAS in Casco Bay.

This Action will require limited time from existing CBEP staff (Director and Staff Scientist) to support the efforts of the partners by participating in stakeholder meetings and assisting with site selection and data analysis.

Outputs

- Studies of presence, prevalence, and concentration of PFAS compound in the waters and sediments of Casco Bay and its tributaries that will complement current studies focused on fish and shellfish tissue sampling to give a more complete picture of PFAS distribution
- Report on sources of PFAS contamination to Casco Bay
- Actions to help address PFAS loading and contamination in Casco Bay, as supported by improved understanding of prevalence and sources

Outcomes

Short-term

- Understanding of prevalence and distribution of PFAS in Casco Bay

Medium-term

- Evaluation of sources of PFAS entering coastal waters

Long Term

- Management actions and policies to reduce sources of PFAS to Casco Bay from PFAS
- Reduced prevalence and concentrations of PFAS in the living organisms of Casco Bay including shellfish, fish, birds, and marine mammals
- Analysis of PFAS trends following policy changes

Metrics and Targets

Metric	Target
Initial pilot-scale study of PFAS in Casco Bay sediments and waters, designed to inform design of future studies	By 2026
Additional follow-up studies	One more by 2029

GOAL 3: ENGAGE COMMUNITIES AND PROVIDE INFORMATION AND TOOLS TO SUPPORT DECISIONS TO PROTECT AND RESTORE CASCO BAY

Casco Bay is an anchor for the region's cultural identity and a valued national asset, yet the Casco Bay watershed continues to face some of Maine's more intense growth and development pressure as well as numerous impacts from climate change. Through community engagement activities, the Partnership can build relationships with partners, communities, and community leaders, and collaborate with them in the work of stewarding and protecting Casco Bay and its watershed. CBEP can play a significant role in increasing community pride and connection to the Bay through public outreach initiatives that illuminate the region's ecological assets, and help citizens and leaders prepare for climate disruptions. CBEP can also drive community engagement efforts that expand our reach to better reflect and serve the growing diversity of communities within the watershed.

Strategy 3.1: Engage residents and visitors with stewardship of our waters, by highlighting the watershed's importance and sharing information on how to protect it

Watershed residents who enjoy a sense of pride in place and understand Bay-related issues are more likely to adopt practices and actions that benefit the Bay and watershed. CBEP will work with partners to develop and deliver consistent and compelling messages that can help inspire and motivate bay residents, visitors, and other target audiences to care about and participate in protecting and restoring Casco Bay. CBEP will also support educational programming and community science programs that foster long-term connection and stewardship.

Action 3.1.A Provide information and outreach to target audiences in the Casco Bay region

Goal 3: Engage communities and provide information and tools to support decisions to protect and restore Casco Bay

Strategy 3.1: Engage residents and visitors with stewardship of our waters, by highlighting the watershed's importance and sharing information on how to protect it

Purpose

Communicate effectively and creatively to old and new audiences about the values of and issues facing Casco Bay, through updated branding and targeted messaging. Better-informed residents and visitors will become better Bay stewards and take steps to protect Casco Bay and its waters.

Location

Watershed- wide.

Description

Community engagement is central to CBEP's mission to protect and restore Casco Bay. Watershed residents and visitors who appreciate the many assets of Casco Bay and enjoy a strong sense of place are more likely to adopt practices that benefit the Bay and become good environmental stewards.

Timeline: Ongoing from 2023

Lead Implementers

- Casco Bay Estuary Partnership (coordination, outreach materials, events)
- Nongovernmental organizations (both target audience and outreach)

Other Collaborators

- Regional planning agencies (outreach implementation)
- State and federal agencies (outreach implementation)
- Higher educational institutions (outreach implementation)
- Local governments (target audience)
- K-12 educational institutions (target audience)
- Community leaders (target audience)
- New underserved and under-represented communities (target audience, see Strategy 3.3)
- Businesses (target audience, outreach partner)

CBEP will continue to work with partner organizations to update and deliver Bay and watershed related information via CBEP's website and e-newsletter as well as other publications and social media venues. Staff will also increase the use of these communication strategies to amplify the work of the staff and increase the reach and visibility of the work of our partners. Staff will produce a body of general (i.e., not time-sensitive) informational and educational content to be deployed on social media channels when there is less current project news to report on.

To strengthen CBEP's role as a communications hub, increase public awareness of the Partnership, and reach new underserved and underrepresented (UU) audiences, including inland and rural communities, CBEP will evaluate the effectiveness of various community engagement tools and messages in reaching new and target audiences. Once we have evaluated these tools and messages (by the end of 2024), CBEP will revise its brand with the aim of increasing public awareness of the Partnership, reaching new audiences, and strengthening CBEP's role as a communications hub.

On the surface, the branding exercise will update the look of CBEP outreach and communications materials, such as our logo, tag lines, web pages, and e-newsletter. But on a deeper level, the exercise will craft a relatable, compelling story that expresses who we are. The new story will express CBEP's purpose and values, align with partner messaging, and support efforts to engage new target audiences. Efforts to reach new audiences will include making information and messaging accessible to more people using well-established practices like expanding use of human stories, developing infographics to convey important ideas at a glance, and editing written materials to ensure readability for a wide audience.

Resources

Ongoing public education and outreach efforts will require significant CBEP staff capacity in coming years. Fully implementing this Action (along with other outreach and community engagement Actions) is likely to require additional staff capacity. We anticipate hiring additional staff to assist with this and other communications and outreach tasks. Long-term (more than three years) funding for a position, however, cannot be guaranteed. CBEP will continue to seek novel partnership and funding approaches that can support outreach, communications, and community engagement needs.

Core National Estuary Partnership (NEP) funding (up to $30,000) will be used in 2024 to work with a communications consultant on a rebranding effort. Annual expenses for communications products such as our website, newsletter, social media accounts and annual report are expected to run on the order of $5,000 to $10,000 per year, with additional costs required in some years for special publications.

Outputs

- Evaluate periodically and deliver CBEP outreach products, including e-newsletter, annual report, and other products, for relevancy to new audiences and organizational program changes
- Produce new creative and accessible outreach content disseminated primarily through digital and social media
- Collect data on and conduct evaluation of website, e-newsletter, and social media effectiveness and consumption
- Develop a new Casco Bay “brand” that includes a new mission statement, logo, and other design elements

Outcomes

Short-term

- Increased knowledge of Casco Bay resources and priority issues
- An increased personal connection to Casco Bay and its watershed

Medium-term

- Increased understanding of our audiences
- A wider audience for CBEP and partner communications

Long-term

- Community support for policies and decisions that protect and restore the Bay and Watershed

Metrics and Targets

Metric	Target
Evaluate and update e-newsletter and annual report content and format	Annually
Produce digital and social media educational content about the Bay and Watershed and highlighting work of CBEP and partners	Twice a week
Online communication metrics, including website visits, social media engagements, and email newsletter open rates	Evaluated twice a year
New branding and outreach materials	By end of 2024
New strategies for effective delivery to under-targeted audiences	2025

Action 3.1.B Promote and facilitate Bay and Watershed-focused community science activities

Goal 3: Engage communities and provide information and tools to support decisions to protect and restore Casco Bay

Strategy 3.1: Engage residents and visitors with stewardship of our waters, by highlighting their importance and by sharing information about how to protect them.

Purpose

Promote and support community science activities in Casco Bay by providing technical assistance and establishing a regional network.

Location

Watershed wide.

Description

Community engagement with the natural world is a continuum that often begins with a pivotal outdoor experience and culminates with environmental action. CBEP and partners can use a variety of tools and programs to help people along that continuum. Community science can be an effective way to improve awareness of the natural world, increase knowledge of our waters, and encourage people to take action to protect the Bay.

"Community science" refers to a growing practice in which community members collaborate with practicing scientists or others with relevant knowledge or skills (including local, historical, or Indigenous knowledge) to conduct studies to address community priorities. Community members have a voice in determining what questions to ask and participate in designing studies, gathering data, and interpreting results. Community science includes a wide range of different practices through which communities use scientific tools and methods to answer questions and see solutions to local challenges.

Several CBEP partners already manage programs that engage community members in science, observation, and data collection. Friends of Casco Bay runs the successful "Water Reporter" program that enlists volunteers to collect observational data about

Timeline: Ongoing starting in 2024; workshop and planning effort in 2025

Lead Implementers

- Friends of Casco Bay (volunteers, data access, outreach)
- Wells National Estuarine Research Reserve and the Marine Invader Monitoring and Information Collaborative (MIMIC)
- Presumpscot Regional Land Trust (Presumpscot and Stroudwater water quality data collection; fish counts at Highland Lake dam)
- Maine Healthy Beaches (community water sample collectors at select beaches)
- Maine Department of Marine Resources (volunteer phytoplankton observers)
- Maine Department of Environmental Protection (Volunteer River Monitoring Program)
- Lake Stewards of Maine (lake monitoring programs)
- Casco Bay Estuary Partnership (grants, coordination, data quality assurance)

Other Collaborators

- Lake and watershed associations (lake monitoring)
- Lakes Environmental Association (lake monitoring)
- K-12 educational institutions (classroom science projects)
- Maine Environmental Education Association (connections to educators and other assistance)
- Cumberland County Soil and Water Conservation District (watershed education programs)
- Land trusts (community engagement activities)
- Higher educational institutions (technical assistance, study design, data analysis and training)

how the Bay is changing. The Wells National Estuarine Research Reserve works with Casco Bay island residents to document the presence of invasive marine species. Presumpscot Regional Land Trust coordinates volunteers who monitor the Presumpscot and Stroudwater rivers. Maine's Department of Marine Resources engages volunteer observers to study the composition of the plankton and look for harmful algae species. Land trusts, towns and nonprofits enlist volunteers to take photographs or observe the timing of flowering of certain plants to show impacts of climate change and sea level rise. Many lake associations sponsor local water quality monitoring efforts. These ongoing monitoring programs are, and will continue to be, the backbone of volunteer-based monitoring of Casco Bay and the other waters of the watershed.

Proposals to CBEP's Community Engagement Grant program frequently include requests for funding for community science projects (often submitted by classroom teachers). These proposals demonstrate persistent interest in science that address community concerns. CBEP staff and other partners help with study design and development of data quality assurance practices when resources permit, but much more could be done to engage and empower communities through collaborative science.

Over the next few years, CBEP will work to expand support for community science (including volunteer monitoring) in our region. This effort will begin small, with targeted grants and increased technical assistance from CBEP staff (made possible by additional outreach and science staff capacity). This phase will include:

- Funding to support locally driven projects through Monitoring Infrastructure Grants (Action 4.3.A) and Community Engagement Grants (Action 3.1.D);
- Assistance with methods and research design, as resources permit; and
- Support (financial and technical) for and assistance with development of Quality Assurance Project Plans (QAPPs) (which are required whenever data collection is supported with NEP funds).

As the effort gets underway, CBEP staff will convene interested partners, evaluate community interest and capacity, and consider what further role CBEP can play in facilitating volunteer monitoring and community science initiatives. CBEP could, for example, offer a clearinghouse to connect community-based organizations with people and organizations with relevant expertise, help community science project leaders spread the word about their efforts, develop a list of ways to fund community science projects, or host periodic events for highlighting community science successes and challenges.

Special attention should be paid to prioritizing and/or making accessible community science opportunities and funding for underserved communities.

Resources

Multiple CBEP partners already support community-engaged science, such as volunteer monitoring programs and classroom science projects. This Action will be built on that foundation.

CBEP staff time will be allocated towards growing regional community science. CBEP outreach staff (approximately 10% to 20% of an FTE annually) will compile information on current community science programs, assess needs for a regional delivery framework, and establish a network or clearinghouse to support community science. CBEP Staff Scientist will allocate up to 10% of their time to assist with research planning and data quality assurance.

Proposed grant funding will initially be awarded through Monitoring Equipment and Community Grant programs described elsewhere. A dedicated Community Science grant fund (up to $25,000 annually) may be created in the future if interest in community science grows and resources allow.

Outputs

- Grants in support of community science projects
- Quality Assurance Project Plans (QAPPs) developed to support community science projects
- A planning meeting or workshop for community-based groups and existing CBEP partner organizations to explore the development of community science programs
- Community science needs assessment
- Events that provide an opportunity for community science participants to share lessons learned, share data, and inspire others

Outcomes

Short-term

- Broader support for community science initiatives
- Wider range of opportunities, attracting a larger pool of prospective volunteers

Medium-term

- Students, teachers, local board members, and community leaders are better connected to professional scientists and resources
- Better coordination of and support for community science programs on Bay related activities

Long-term

- Widespread community engagement and stewardship on behalf of the Bay and watershed

Metrics and Targets

Metric	**Target**
Grants supporting community science for community-based organizations, municipalities, schools, and other audiences	Three by 2029
QAPPs developed for community science efforts, on average	One per year through 2029
Number of participants involved with and collecting data through community science or citizen science efforts led by members of the Partnership	10% increase by 2029 compared to 2024
Number of attendees at a community science planning meeting or workshop	Five organizations attending
New community science programs or projects in the watershed, on average	Two programs or projects started every three years through 2034

Action 3.1.C Deliver Bay and Watershed-focused education programs to engage learners of all ages

Goal 3: Engage communities and provide information and tools to support decisions to protect and restore Casco Bay

Strategy 3.1: Engage residents and visitors with stewardship of our waters, by highlighting their importance and by sharing information about how to protect them

Purpose

Provide educational opportunities that inform students of all ages about the Bay and the Watershed and foster a sense of stewardship of our waters.

Location

Watershed-wide, but many programs focus on students in specific towns, such as our "MS4" communities, the Sebago Lake Watershed, or communities in the Portland Water District service area.

Description

Several partner organizations deliver educational opportunities focused on Bay and watershed topics. In-school and field programs for K-12 schools run by Cumberland County Soil and Water Conservation District and Portland Water District provide STEM-based lessons in compliance with Next Generation Science Standards (NGSS) and centered on student investigations. Maine Audubon delivers a variety of nature-themed programs for kindergarten through 12th grade, partnering with schools and community groups and specializing in outdoor/experiential learning, the NGSS, and multi-disciplinary curricula. They also offer a variety of educational walks, talks, and trips.

Gulf of Maine Research Institute offers middle school students from around the state a hands-on interactive investigation of the Gulf of Maine ecosystem in their Lab Venture program. Many local conservation organizations, such as land trusts and lake associations, provide Bay and Watershed focused experiential education programming as well. On a statewide level, Maine Environmental Education Association and Maine Mathematics and Science Alliance provide resources, support, and convening services to educators.

Implementation of this Action falls principally to the partner organizations who deliver educational content to students on an ongoing basis, but the value of educational efforts is widely recognized by members of the Partnership, so many of them contribute. CBEP assists educational programs through indirect means (funding partner programs and sponsoring conferences), direct means (CBEP Community Grants - see Action 3.3.A; and organization of teacher training events). Staff and other partners also support these programs by promoting

Timeline: Ongoing

Lead Implementers

- Cumberland County Soil and Water Conservation District (watershed education programs)
- Portland Water District (watershed education programs)
- Gulf of Maine Research Institute (marine education programs)
- Higher educational institutions (marine and coastal science and policy courses)

Other Collaborators

- K-12 school educational institutions (program recipient)
- Maine Environmental Education Association (outreach, coordination, and support)
- Maine Mathematics and Science Alliance (outreach, coordination, and support)
- Maine Audubon (school programs, summer activities, adult events)
- Land trusts and other community-based organizations (community engagement activities)
- Casco Bay Estuary Partnership (coordination and assistance)

them, connecting schools with educators, and sharing expertise. Many members of the partnership support education programs or provide occasional educational opportunities by visiting K-12 classes, offering presentations to college classes, engaging public audiences, and leading educational field trips.

CBEP will continue to play a supporting role in Bay/water quality related curriculum and programming and be available for providing educational presentations occasionally when requested.

Resources

This Action will be implemented primarily by partner organizations that provide educational programming, including Portland Water District, CCSWCD, Southern Maine Community College and the University of Southern Maine. Available funding to support classroom education, however, is limited, posing challenges for expanding program delivery.

All CBEP staff contribute informally to regional education efforts by offering presentations and sharing expertise. Outreach staff support workshops and training events and assist with regional coordination.

CBEP also supports local education efforts through the CBEP Community Grants program (Action 3.1.D). Additional resources (likely under $20,000 in any year) may be allocated from time to time through our annual workplan development process to address emerging needs, such as providing access to educational programs for underserved populations.

Outputs

- Cumberland County Soil and Water Conservation District educational programming to schools throughout the watershed
- Other educational programs and events
- CBEP staff continues to support partner organizations and deliver educational presentations

Outcomes

Short-term

- Greater understanding among students of all ages about Casco Bay and watershed ecosystems
- Better understanding by CBEP staff of regional environmental education activities
- Coordination among regional providers of environmental education

Medium-term

- Students of all ages develop an ethic of Bay stewardship

Long-term

- Stronger community support for actions that protect the Bay
- Bay focused learning in educational institutions of communities around Casco Bay

Metrics and Targets

Metric	Target
K-12 schools participating annually in Bay-focused units	Twelve per year
CBEP staff presentations to college and university classes	One per year
Number of Bay-focused presentations or events by CBEP staff for a general audience	Three per year

Action 3.1.D Offer small grants for community-based projects

Timeline: Ongoing

Lead Implementers

- Casco Bay Estuary Partnership (grant program)

Other Collaborators

- Schools (grant recipient)
- Community-based organizations (grant recipient)
- Nongovernmental and civic groups (grant recipient)
- Land trusts (grant recipient)
- Local governments (grant recipient)

Goal 3: Engage communities and provide information and tools to support decisions to protect and restore Casco Bay

Strategy 3.1: Engage residents and visitors with stewardship of our waters, by highlighting their importance and by sharing information about how to protect them

Purpose

Fund small community-based projects that engage communities and community members with Casco Bay and the waters of the Casco Bay watershed or foster local environmental stewardship.

Location

Grants will be available for projects that benefit the Casco Bay watershed.

Description

CBEP offers a Community Grants program to encourage new partnerships and an array of innovative projects designed to engage communities with Casco Bay. Past projects have included school-based marine education projects, community science and stewardship initiatives, storytelling, and art projects, and other activities that build greater public appreciation for Casco Bay.

Proposals are welcome from educators, local governments, land trusts and other non-profit organizations. Fund recipients must be legally recognized entities but partnerships with civic and community-based groups are strongly encouraged. In the next few years, CBEP will put a greater emphasis on encouraging applicants to partner with community-based organizations. We will also modify our grant announcements, criteria, management, and marketing to reach a broader audience and make the program more equitable and accessible. We have been generating a few news stories every year around the Community Grant program and will continue to seek media coverage to spread the word about the program.

Resources

Minimal CBEP staff time is required to develop the Request for Proposals, manage annual grants competitions, promote media coverage, and manage reporting requirements.

Core CBEP funds allocated to this Action are expected to be about $25,000 to $40,000 annually, depending on other funding needs. Some community grant proposals may address community science, so this Action is related to, and may provide grants in support of Action 3.2.B.

Outputs

- Annual RFP and grant awards
- Projects completed
- Community Grant RFP and related grant procedures modified to address equity and access in the application process and funding priorities

Outcomes

Short-term

- Local groups carry out creative approaches to engaging people in environmental projects
- Local groups implement projects that encourage people to be good stewards
- Support for local efforts to address environmental and community needs
- Media coverage of environmental stewardship projects

Medium-term

- Building new relationships and partnerships
- Cultivation of novel approaches to environmental stewardship

Long-term

- Community support for projects, policies and decisions that protect and restore the Bay and watershed

Metrics and Targets

Metric	Target
Number of grants funded per year	Five annually 2025-2029
Number of applicants per year who have not applied in previous years	One annually 2025- 2029
Number of grant-related media stories generated per year	Two annually 2025-2029

Strategy 3.2: Help coastal and watershed communities prepare for climate change and develop local policies and practices to protect our waters

Municipalities need assistance assembling and applying the best available science to become more resilient, and the additional support and capacity to develop, enact, and enforce ordinances that foster healthy water quality and ecosystems in Casco Bay. Sharing information, models, funding, and resources between communities and partners will help improve community planning for resilience.

Action 3.2.A Provide training, planning assistance and small grants to Casco Bay communities to protect aquatic ecosystems and support local resilience

Goal 3: Engage communities and provide information and tools to support decisions to protect and restore Casco Bay

Strategy 3.2: Help coastal and watershed communities prepare for climate change and develop local policies and practices to protect our waters

Purpose

Provide tools, training, and funding to help communities protect the health of streams, rivers, lakes and the Bay and adapt to water-related impacts of climate change.

Location

Watershed wide, especially communities disproportionately exposed to water-related hazards, including island, peninsula, coastal, and river communities. Online training events draw audience members from across the state and beyond.

Description

With the help of Bipartisan Infrastructure Law funding, the Partnership will expand engagement with communities, especially smaller inland and island communities, on water quality, habitat protection and community resilience. Local policies and programs in areas such as open space planning, stormwater management, road construction and maintenance, and shoreland zoning can profoundly affect both aquatic ecosystems and community resilience. Yet many communities are challenged to act, due to limited community capacity, rapid land use change, aging infrastructure, and impacts from climate change.

Timeline: Technical assistance is ongoing; A new grant program is to be started in 2024.

Lead Implementers

- Regional planning agencies (technical assistance, planning, relationships with municipalities; program delivery)
- Governor's Office of Policy Innovation and the Future (GOPIF; funding, regional coordination)
- Maine Coastal Program (funding, coordination)
- Maine Sea Grant (program delivery, technical assistance)
- Casco Bay Estuary Partnership (funding, coordination, technical assistance, grant program, ocean model)
- Gulf of Maine Research Institute (local data collection, program delivery)
- Island Institute (technical assistance and training)
- Sebago Clean Waters (trusted local relationships; program delivery)
- Maine Audubon (training programs like StreamSmart)
- National Oceanic and Atmospheric Administration Coastal Services Center (training and educational resources)
- Land trusts (local trusted relationships; grant recipient)

The Action, which builds on existing programs led by partners, will have several components, including:

- Assisting municipalities with identifying and addressing community needs related to flooding, water quality and aquatic ecosystems via community engagement, planning assistance and technical analysis;
- Working within the structure of GOPIF's Climate Resilience Partnership Program to fill in gaps in technical assistance and funding for community climate preparedness grant proposals and project implementation;
- Sharing expertise on interconnected resilience, water and habitat issues with communities, regional partners and local leaders through events, training, and coordination;
- Facilitating water-, habitat- and resilience-related outreach and education programs aimed at smaller communities (through venues such as Casco Bay Coastal Academy and GOPIF);
- Initiating a municipal grant program to assist local government with costs of water-related initiatives, including community engagement, planning, education, and design.

CBEP staff will support and enhance efforts at the local municipal level by offering scientific information, technical assistance, and funding so municipalities can make more informed decisions. The staff will partner with organizations like Community Resilience Partnership collaborators and regional planning agencies to organize workshops and training for municipal board members, staff, and volunteers. Staff will aid in community vulnerability assessments and open space and water resources planning. Staff will also connect communities with resource providers and deliver resources like case studies, model ordinances and examples from neighboring communities.

Efforts are well underway, in part due to leadership from GOPIF, to engage every community in Maine on climate resilience. The initial emphasis of this Action will be on smaller communities (islands, towns in the upper watershed) with limited planning and staff capacity, as well as municipalities in the Presumpscot and Stroudwater watersheds with impaired rivers and streams (See also Action 2.3.B).

Other Collaborators

- Academic institutions (maps and data products to support planning)
- Cumberland County Soil and Water Conservation District (program delivery, trusted relationships, technical assistance).
- Local governments (recipients of funding and assistance)
- Maine Department of Environmental Protection (education and training programs; grants)
- Maine Department of Transportation (coastal flood model, training and technical assistance, funding for infrastructure upgrade/repair)
- New England Environmental Finance Center (finance strategies)
- University of Southern Maine Muskie School (planning assistance)
- Watershed and nonprofit groups (local trusted relationships)
- Wells National Estuarine Research Reserve (program delivery)

Resources

Many partners already engage towns and cities with resilience- or water-related planning or offer related funding, training, or assistance. Important partners include GOPIF, Maine Sea Grant, the Maine Coastal Program, and Regional Planning organizations like GPCOG. Other state and federal programs offer training and grants for local efforts to address water quality and habitat protection.

Demand for services, however, exceeds available capacity, and is growing as communities respond to extreme storms and other events that increase the salience of these issues to local communities. CBEP will provide resources drawn largely from BIL funds to expand capacity to support local needs. That capacity may take the form of additional CBEP staff, shared staff positions with other organizations, or subawards to local partners who already have strong relationships with target communities. We anticipate spending approximately $100,000 to $150,000 annually to expand regional capacity while BIL funds are available. CBEP staff will also seek additional funds to address regional needs.

The small grant program described here will be funded through BIL, with total annual awards of about $50,000 through 2027. Limited CBEP funds may also cover some in-person meeting costs or provide stipends for members of underserved and underrepresented communities to attend events.

Outputs

- Direct engagement with two or more communities per year on climate resilience planning or implementation of local resilience projects
- Two climate resilience grant funded projects per year

Outcomes

Short-term

- Better municipal access to information, assistance, and funding to build water-related climate resilience

Medium-term

- Improved local decision-making and project implementation

Long-term

- More resilient coastal communities, particularly vulnerable populations
- Improved health of Casco Bay

Metrics and Targets

Metric	Target
Provide technical assistance and capacity building on climate resilience to towns	Assist five towns by 2029
Contracted climate resilience or water-planning support services provided to towns	Assist five towns by 2029
Provide training to municipalities, including associated guidance documents	Assist five towns by 2029

Strategy 3.3: Engage and empower new audiences and implement the CBEP Equity Strategy

CBEP and partner organizations' programming and engagement is not reaching or involving all communities in the watershed. In the next five years and beyond, CBEP will work with partners to ensure that we are inviting collaboration and providing equitable access to information and resources to a broader audience within our watershed.

Action 3.3.A Continue efforts to make the Partnership more inclusive and build mutually beneficial relationships with community-based organizations

Goal 3: Engage communities and provide information and tools to support decisions to protect and restore Casco Bay

Strategy 3.3: Engage and empower new audiences and implement the CBEP Equity Strategy

Purpose

Make CBEP more accessible to the communities we serve, strengthen equity and inclusion in program delivery, welcome new voices to the Partnership and strengthen connections with underserved and underrepresented communities.

Location

Programmatic action, so Bay and watershed wide.

Description

CBEP has been working with its Management Committee for the last several years to understand and address issues of equity in the Partnership. CBEP's Management Committee adopted a Diversity, Equity, Inclusion and Justice (DEIJ) statement in September of 2022 (See https://www.cascobayestuary.org/about-us/our-deij-commitment/).

That statement reflects a commitment by the organization to addressing environmental justice needs of marginalized groups in the watershed, including but not limited to people of color, the Wabanaki peoples of Maine, low-income communities, people with disabilities and the LGBTQIA+ community. It also calls on CBEP to evaluate and address inequities within our policies and practices to build a more welcoming organization and interact with new partners on the same basis of equality and respect we extend to our current partners.

Timeline: CBEP began work on environmental justice and equity in 2021. Outreach to underserved communities and other efforts to make our programs more accessible has begun. A formal equity review of CBEP programs and practices was completed in 2023. Recommendations from the review were shared with the Management Committee late in 2023.

Lead Implementers

- Casco Bay Estuary Partnership (implementation and continuous improvement)
- CBEP Management Committee (direction, oversight, and assistance)
- University of Southern Maine (host institution)

Other Collaborators

- Regional nonprofit organizations that work with underserved community members (e.g., RippleEffect and Sail Maine; connector organization)
- Organizations that serve smaller community-based organizations (e.g., Maine Initiatives and United Way; connector organization)
- Public health organizations (connector organization)
- Housing organizations (connector organization)
- Land trusts (connector organization)
- Municipalities and public entities (e.g., local libraries; connector organization)

In June 2023, we submitted a formal "Equity Strategy" to EPA, as required by President Biden's "Justice40" initiative under Executive Orders 14008 and 13985. The Strategy identifies underserved and underrepresented communities in our region and documents actions to work more effectively with those communities.

Our history, structure, policies, and procedures have shaped who we collaborate with, excluded voices from our discussions, and determined organizational priorities. Like most NEPs, CBEP's structure emphasizes relationships with organizations with ties to state and federal government, or with missions related to water quality or the Bay. That shapes who we speak with on a regular basis and how we think about coastal issues. We need to broaden our circle of communication to invite new voices to the Partnership and improve our ability to understand and serve our increasingly complex region and varied communities.

CBEP will work to expand our knowledge of and connections with underserved and underrepresented communities through outreach to community-based organizations. Each of these organizations (including many that are not part of Maine's environmental or conservation communities) is a potential starting point for listening and conversation, and thus broadening CBEP's understanding of issues affecting underserved and underrepresented communities. CBEP will also connect with adjacent organizations that work in intersecting disciplines, like housing, public health, social justice, and workforce development to learn about the populations they serve.

Over the next few years, this Action will require attention from CBEP staff and leadership to shift organizational culture, while remaining true to CBEP's core mission to protect and restore the health of Casco Bay. We will:

- Align CBEP hiring, contracting, grantmaking and recruitment processes to establish an inclusive workplace culture committed to environmental justice;
- Increase opportunities for meaningful engagement by underserved and under-represented communities on matters of importance to them;
- Actively encourage and invite communities of color and other marginalized groups to lend their voices and narratives to our planning efforts, work groups, and programs.

Facilitating meaningful engagement with CBEP activities, especially by underserved and underrepresented communities requires addressing practical and financial barriers to participation.

- CBEP will aim to adjust meeting times and locations to reduce barriers and enable equitable access to programming and information. This may include increasing opportunities for virtual participation.
- Using NEP funds to reduce barriers to participation in events, especially for people of limited financial means. This could include covering travel costs, providing meals at events or offering childcare. When actively seeking community input, we will evaluate whether to offer stipends to members of underserved or underrepresented communities for their participation.
- CBEP will explore use of translators at events and environmental education programs to improve access for people with limited English language proficiency.
- Beginning in the 2024-2025 Workplan, we will set aside funds to cover transportation and material costs if lack of those funds would otherwise prevent schools and other groups

from underserved and under-represented communities from participating in educational or field programs run by CBEP partners.

Resources

Implementing this Action involves both attention to governance and outreach to develop new relationships with organizations that serve underrepresented and underserved communities.

Significant CBEP staff time (about 25% to 35% of an FTE) will be needed to participate in events, attend community-based organization meetings and build new relationships. Additional capacity is likely to be needed to advance this Action. Funding is available for the next few years (through 2027) to address this and other communications needs, but no long-term model for funding increased capacity has yet been identified.

Modest funding will be required to help cover increased meeting costs (typically under $500 per event). Providing participant stipends could increase costs. We expect to request no more than $5,000 annually to help cover transportation and materials costs for Bay-related programs for underserved communities.

Outputs

- Develop methods for identifying organizations that engage with target underserved communities that already have relationships with CBEP or our partners
- New relationships with community-based organizations
- Meetings with leaders of community-based organizations that engage with underserved communities
- Support educational program transportation and materials costs for underserved communities
- Management Committee approval of governance changes to increase accessibility of CBEP activities and programs
- Update CBEP Operating Guidelines if necessary
- Implement University policies on access to online materials for people with visual or hearing impairments

Outcomes

Short-term

- CBEP learns more about community-based organizations in the watershed
- Community-based organizations learn more about CBEP
- CBEP policies and procedures are more welcoming to varied perspectives and interests

Medium-term

- Establishment of working relationships that broaden the network of people and organizations who participate in the Partnership
- Better representation of community perspectives in CBEP governance, as shown by more diverse participation in CBEP working groups, committees, and the Management Committee

Long-term

- A stronger organization that reflects the interests and addresses needs of a broader cross-section of people
- Greater community involvement, leadership in, and support for, policies and decisions that protect the Bay, its watershed, and its people
- A stronger Partnership that better reflects community priorities and needs

Metrics and Targets

Metric	Target
Community group meetings attended by CBEP Staff, on average	One per month through 2025
New connections and collaborations established	Two per year through 2029
New working relationships with underserved and underrepresented communities, as demonstrated by collaborative projects, shared activities, or participation in CBEP working groups, or committees	Five new relationships by 2029, developing one long-term partnership by 2034

Action 3.3.B: Engage with aquaculture operators and shellfish harvesters to support shellfish fisheries and encourage community stewardship of shellfish resources

Goal 3: Engage communities and provide information and tools to support decisions to protect and restore Casco Bay

Strategy 3.3: Engage and empower new audiences and implement the CBEP Equity Strategy

Purpose

Engage shellfish harvesters in protecting clean water and strengthen ties to Maine shellfish and aquaculture industries.

Location

Bay-wide. Waters near Portland and South Portland are closed to harvesting to protect public health. Aquaculture is concentrated in eastern and northern Casco Bay. Wild shellfish harvesting occurs principally in the towns of Yarmouth, Freeport, Brunswick, Harpswell and Phippsburg.

Description

The original 1996 Casco Bay Plan highlighted concerns about the impact of bacterial contamination on shellfish harvests. That issue remained of significant concern when the Plan was updated in 2006 and worries about red tides had increased. When the Plan was last revised, in 2016, the shellfish industry was slowly recovering from the impact of a boom in green crabs in 2012 and 2013, so concerns about invasive species were paramount. At that time, CBEP decided to step back from working with shellfish harvesters, but we also committed to reevaluating that decision when we next updated the Casco Bay Plan.

Shellfish harvesting has been an important cultural and economic activity in Casco Bay for millennia. Clams, quahogs, and mussels have been harvested from Casco Bay waters for generations. While wild American oysters are too sparse today to be widely harvested, shell middens on the shores of the Bay document that Indigenous people harvested them in abundance. Commercially viable shellfish harvests continue to be an important marker of the ecological health of Casco Bay.

Timeline: Beginning in 2024, but built on existing relationships

Lead Implementers

- Casco Bay Regional Shellfish Working Group (regional coordination, priorities, relationships with harvesters and town shellfish commissions))
- Downeast Institute (shellfish science, relationships with harvesters and shellfish commissions)
- Manomet (engagement with harvesters on science, gathering community knowledge)
- Maine Sea Grant (funding, community engagement, especially with aquaculture operators)

Other Collaborators

- Casco Bay Estuary Partnership (funding, technical assistance, coordination)
- Shellfish Harvesters (communications target)
- Aquaculture Operators (communications target)
- Maine Department of Marine Resources (regional biologists, relationships with harvesters, data access)
- Town Shellfish and Marine Resources Committees (implementation)
- Aquaculture Advisory Council (coordination and relationships with local growers)
- Harbormasters (coordination with local harvesters and other community members)
- Maine Shellfish Learning Network at the University of Maine (program delivery)
- Island Institute (community connections with island communities)
- Northeast Coastal Acidification Network (NECAN)

In recent years, the number of aquaculture operators in Casco Bay has climbed sharply. As of mid-2023, there were 49 full-scale aquaculture leases (33 growing shellfish), and 284 "Limited Purpose Aquaculture" (LPA) permits in Casco Bay (256 licensed to grow shellfish).

Both wild-harvest and aquaculture-based shellfish industries are dependent on clean water. Clams, oysters, mussels, and other bivalve shellfish are filter feeders. As they feed, they can concentrate toxic chemicals or pathogens from the environment. Thus, bacterial contamination or harmful algae blooms can make shellfish unsafe to eat.

These industries, especially the wild fishery, are affected by climate change and sea level rise. Warming waters have contributed to a shift in dominant shellfish on some tidal flats, with quahogs replacing softshell clams. All bivalves build their shells out of carbonate minerals, so they are vulnerable to coastal acidification. Warming conditions have made the Bay's waters more hospitable to invasive species like green crabs, which feed on commercial shellfish. Predation by invasives can all but eliminate recruitment of clams and has contributed to the disappearance of mussel bars and reefs from our waters. Most wild shellfish harvests in Casco Bay occur on our intertidal flats, but those habitats are vulnerable to rising seas. There may simply be less intertidal area to harvest in future years.

One response to these pervasive ecological changes is increased reliance on aquaculture to produce shellfish in commercially viable quantities. But coastal acidification and warming waters affect aquaculture as well. Some Maine aquaculture operations already test water quality on a regular basis so they can take steps to reduce the impact of acidification on operations.

CBEP will engage with harvesters and aquaculture operators via the Casco Bay Regional Shellfish Working Group (CBRSWG) and other organizations that already engage with shellfish and aquaculture industries. CBEP has been assisting the CBRSWG since 2019, principally by hosting an AmeriCorps Fellow for several years to support the organization's work, such as development of the "Community Intertidal Data Portal" (https://community-intertidal-data-portal-gpcog.hub.arcgis.com/). Other key relationships include the Downeast Institute, Manomet Center for Conservation Sciences, Maine Sea Grant, the University of Maine, and Running Tide (an aquaculture firm headquartered in Portland).

Resources

This effort will be led by CBEP partners, especially the CBRSWG and Friends of Casco Bay (FOCB), with the assistance of Manomet, Maine Sea Grant, and the Maine Department of Marine Resources.

CBEP staff provides a variety of assistance and support for these efforts, especially by participating in meetings and other events, assisting with planning and coordination, and with efforts to raise funds for program delivery. As CBRSWG is not an independent 501(C)(3) nonprofit, CBEP may act as a fiscal agent on their behalf from time to time, such as by sponsoring Greater Portland Council of Governments (GPCOG) Resilience Fellows to provide the organization with additional capacity.

CBRSWG has generally been successful at raising funds to support its operation. CBEP may from time to time provide funding of up to $25,000 in any given year to fill in short-term gaps in funding and support leadership of the working group.

Outputs

- Regular meetings of the CBRSWG
- Participate in CBRSWG events and meetings
- Sponsor an AmeriCorps Resilience Fellow to assist the Casco Bay Shellfish Working Group

Outcomes

Short-term

- Improve CBEP understanding of issues affecting shellfish populations, harvesters, regulators, and fisheries

Medium-term

- Strengthen ties to Maine shellfish industry and harvesters
- Support work by shellfish harvesters to protect coastal water quality and coastal ecosystem health

Long-term

- More resilient coastal communities and coastal economies
- Enhance climate resilience of Casco Bay wild mollusk harvests

Metrics and Targets

Metric	Target
Participating in CBRSWG meetings	One per year
Provide funding and technical support for CBRSWG event participation and initiatives	In 2024 and 2025; as funds allow through 2034

GOAL 4: MOBILIZE KNOWLEDGE AND RESOURCES TO SUPPORT REGIONAL COLLABORATION AND ACTION ON BEHALF OF CASCO BAY, THE WATERSHED, AND OUR COMMUNITIES

CBEP serves as a convener, helping regional entities launch and sustain collaborative Bay related initiatives. The Partnership coordinates an active "community of practice," leveraging support and maximizing resources so that residents throughout the watershed can better address the complex and evolving challenges facing Casco Bay.

Strategy 4.1: Serve as an information hub on Casco Bay issues and initiatives

CBEP mobilizes scientific, political, financial, and human resources to address the needs of Casco Bay and its watershed by gathering, organizing, and systematically sharing information.

Action 4.1.A Gather and share Casco Bay-related science

Goal 4: Mobilize knowledge and resources to support regional collaboration on behalf of Casco Bay, the watershed, and our communities

Strategy 4.1: Serve as an information hub on Casco Bay issues and initiatives

Purpose

Share what we know about Casco Bay and the Casco Bay watershed to strengthen Casco Bay science, inform policy development, and protect Casco Bay Estuary Partnership's role as a trusted source of information about the Bay.

Location

Programmatic Action, so Bay and watershed wide.

Description

Casco Bay Estuary Partnership has provided trusted information on Casco Bay for decades. We strive to be a source of credible knowledge about the Bay and its watershed. We provide technical information to many audiences, including the public, academic researchers, and policy makers.

This Action reaffirms our commitment to scientific rigor as we seek solutions to the Bay's environmental challenges. It complements Action 3.1.A, which describes our outreach practices, by focusing on our role as a source of local knowledge and technical expertise.

Timeline: Ongoing

Lead Implementers

- Casco Bay Monitoring Network (prioritization, data, and information sharing)
- Friends of Casco Bay (data collection, active website content)
- Maine Department of Marine Resources (ongoing monitoring and web content, including access to maps and data)
- Maine Department of Environmental Protection (ongoing monitoring, online access to data)
- Research community (ongoing research, access to recent scientific studies, scientific and technical advice)
- Casco Bay Estuary Partnership (coordination, information sharing)

Other Collaborators

- University of Southern Maine (collaboration with faculty and students)
- University of Maine System (collaboration with faculty and students)
- Bowdoin College Schiller Coastal Studies Center (collaboration with faculty and students)
- State and federal agencies (technical assistance and support)

Information Sharing

CBEP, through its Management Committee, Monitoring Network, and other working groups, offers a forum for exchange of information and ideas. The Partnership fosters an ethic of open communication by providing opportunities for participants to describe achievements, announce new initiatives, and share observations. CBEP strives to ensure that meetings and events are welcoming to all, and to build trust and respect among people and organizations with varied backgrounds and perspectives.

Supporting Sound Policies

CBEP is neither a regulator nor a regulated entity but works constructively with both groups. CBEP has long-standing relationships with federal and state agencies, local governments, and a wide range of nonprofit organizations. These connections enable CBEP to serve as a valued informational resource for decision makers. When CBEP engages in policy, we strive to provide accurate technical information, local knowledge, and regional context rather than advocate for particular outcomes. (CBEP takes policy positions rarely, and only when supported by consensus of the Partnership. See also Action 2.2.A.)

Data Access

Over the last several years, CBEP staff and members of the Partnership increased availability of scientific data and reports in many ways, including:

- CBEP scanned paper documents about Casco Bay going back to the early 1990s and posted electronic copies online in a searchable database of Casco Bay studies and reports;
- *State of the Bay* data (and related data analysis code) from our most recent *State of the Bay* report was released to the public via GitHub;
- Maine's Department of Marine Resources and Department of Environmental Protection have each made considerable progress releasing data collected by the agency to the public; and
- Friends of Casco Bay and Presumpscot Regional Land Trust each developed new web pages which share results of monitoring programs with public audiences.

We will continue efforts to make data and scientific information more accessible to everyone.

Historical Data

Climate change and technological advances have increased the potential value of archival data. CBEP staff will continue efforts to find, recover, and archive data collected by or on behalf of CBEP in the 1990s and early 2000s, before establishment of modern data archiving policies and practices.

Open Science

CBEP will work where possible to model "Open Science" practices that support equitable access to data and science and encourage our Partners to do the same. Open Science strives to make scientific research more accessible to everyone, by providing open (free, equitable) access to publications and data, engaging with communities through community-engaged science, and engaging with Indigenous and local knowledge. As one example, the "FAIR" data principles call for data to be Findable, Accessible, Interoperable, and Reusable with the aim of making data as accessible and reusable as possible.

Sharing Science with Students and the Public

CBEP will continue to offer public presentations, provide guest presentations in college and university classes, and lead field trips as time and resources allow. CBEP's online resources often appear among the top items in on-line searches for information regarding water-related topics in Casco Bay, offering an important entry point into understanding of Casco Bay for people without specialized training.

Resources

The tasks discussed in this Action are a part of good scientific practice and are an evolving part of ongoing activities conducted by many CBEP partners, including state and federal agencies and Friends of Casco Bay.

As part of CBEP's commitment to transparency and open science, all CBEP staff, especially the Director and Staff Scientist, play a role in implementing the Action as part of their regular duties. Time commitments vary year to year. The action is expected to require less than 10% time from any CBEP staff member in most years.

This Action is connected to Actions 3.1.A (Provide information and outreach to target audiences), Action 4.1.B (Report on the *State of the Bay*) and Action 4.3.A (Implement the Monitoring Plan).

Outputs

- Maintain CBEP's online publications library and continue to add relevant documents that become available
- Release new and historic data sets to the public
- Improve accessibility and usability of data about Casco Bay and the watershed
- Expand use of links on the CBEP website to partner data portals and offer suggestions about where users can find additional Casco Bay data and information
- Submit comments and testimony on proposed legislation, rules, or policies
- Give presentations to public audiences, classes, and professional audiences

Outcomes

Short-term

- Improved access for scientists, managers and the public to Bay related data and reports
- Readily accessible bibliography of CBEP-archived materials
- Improved topical knowledge among policy makers
- Higher visibility for CBEP among key policy makers

Medium-term

- Archived information is incorporated into future Bay related research and studies
- Improved local, state, and federal rules and policies
- Increased Bay related research

Long-term

- Improved research, management and decision making due to the availability of better information
- Improved water quality due to sound management of coastal waters

Metrics and Targets

Metric	Target
Expand use of online data archives to host CBEP data and encourage Partners to submit data to searchable archives	By 2029
Complete catalog of historic CBEP data, and connect data to related projects and reports	By end of 2025
Participate in policy discussions, stakeholder meetings or working groups	Three times by 2029 and five times by 2034
Draft testimony or offer formal public comment related to policy development at state and local levels	Twice by 2029 and four times by 2034

Action 4.1.B Report on the *State of the Bay*

Goal 4: Mobilize knowledge and resources to support regional collaboration on behalf of Casco Bay, the watershed, and our communities

Strategy 4.1: Serve as an information hub on Casco Bay issues and initiatives

Purpose

Provide regular updates on indicators of Casco Bay health to inform policy development. Encourage discussion of Bay science and management at periodic conferences.

Location

Casco Bay and watershed wide.

Description

The U.S. Environmental Protection Agency requires that each National Estuary Program provide periodic public reports (often based on a group of environmental indicators) summarizing conditions in its coastal waters. Casco Bay Estuary Partnership (CBEP) issues a *State of the Bay* report every five years.

Most *State of the Bay* indicators are based on data collected by partner organizations (especially state and federal agencies and Friends of Casco Bay). CBEP staff or contractors act as data aggregators and analysts and draft each *State of the Bay* report.

CBEP staff will work with the Monitoring Network to identify data that is likely to be collected over the long term. We will work to identify how often fully reviewed and corrected data becomes available, gather related metadata and data quality management documentation, and record data access procedures (which change often due to the availability of emerging technologies).

Community science is an increasingly valuable source of data and information on the condition of Casco Bay and the watershed. CBEP will work to incorporate local knowledge and findings from community science into *State of the Bay* (see Action 3.1.D).

CBEP developed data analysis procedures and related code for many *State of the Bay* environmental indicators when preparing the most recent (2021) *State of the Bay* report. CBEP staff will continue to automate data access and analysis wherever possible to streamline report preparation. For indicators based on data that are updated annually or more frequently, we will explore the feasibility of producing annual updates analyzing selected *State of the Bay* indicators.

Timeline:
The next State of the Bay report is due by 2026, with another expected in 2031.

Lead Implementers

- Casco Bay Estuary Partnership (preparation of *State of the Bay* reports, including gathering data, conducting analysis, and drafting report
- Casco Bay Monitoring Network (data access and strategic direction)
- Friends of Casco Bay (principal source of water quality data)
- Maine Department of Environmental Protection (source of multiple data sets)
- Maine Department of Marine Resources (access to data on bacteria levels at shellfish harvesting locations, abundance of key fisheries resources, shellfish area closures, and more)
- U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (technical assistance, especially on land use change, habitat condition and species of concern)

Other Collaborators

- Organizations that provide access to data
- Individuals who peer review each indicator
- Academic scientists who provide advice and insight
- Community voices providing local knowledge to supplement or complement technical and quantitative methods

Resources

The *State of the Bay* report requires a substantial time commitment from CBEP staff during the year when the report is being prepared. CBEP's Director and Staff Scientist will each spend as much as 30% of their time reaching out to coastal scientists, gathering data, conducting analyses, and drafting the report itself.

Preparation of the report also requires support from many CBEP partners, who provide advice, offer access to data, and provide chapter-by-chapter peer review. CBEP partners play an essential role in ensuring the quality of the Report and the underlying science.

Funding needs for preparation of maps and graphics, design and printing are significant. We estimate these services will cost between $25,000 to $40,000 for the next *State of the Bay* report. Funds will also be needed ($20,000 or so) for outreach and engagement around release of the Report, and to cover costs of *State of the Bay* events.

Outputs

- Streamlined data access and analysis procedures for select *State of the Bay* Indicators
- Incorporation of data from community science activities into *State of the Bay* reporting
- *State of the Bay* report

Outcomes

Short-term

- Greater consistency in reporting and more frequent updates of select *State of the Bay* indicators
- Sharing of data and findings from community science efforts with the broader community

Medium-term

- Stronger collaborations around data monitoring and analysis
- Increased public understanding of Bay status and trends

Long-term

- Improved science and decision-making pertaining to the Bay and watershed

Metrics and Targets

Metric	Target
State of the Bay reports completed	2026 and 2031
State of the Bay meeting or conference	2026 and 2031
Presentations based on *State of the Bay* analyses	Average of four per year, with more in years following each report

Strategy 4.2: Provide an organizational anchor for initiatives that benefit the Bay

CBEP has a long record of assisting groups and coalitions with organizing, project development, and grant seeking. It will continue traditional, grant-focused efforts to fund work that supports its mission and explore innovative funding mechanisms that align with CBEP priorities.

Action 4.2.A Host local and regional working groups on emerging issues

Goal 4: Mobilize knowledge and resources to support regional collaboration on behalf of Casco Bay, the watershed, and our communities

Strategy 4.2: Provide an organizational anchor for initiatives that benefit the Bay

Purpose

Foster formation of *ad hoc* working groups around emerging issues, shared interests, or geographic focus areas to encourage collaborative solutions.

Location

Programmatic Action, so Bay and watershed-wide.

Timeline: Ongoing

Lead Implementers

- Casco Bay Estuary Partnership (meeting organization and facilitation)

Other Collaborators

- Management Committee (prioritization, participants)
- State and federal natural resource agencies (prioritization, participants)
- Nongovernmental organizations (prioritization, participants)
- Researchers (participants)

Description

Working groups are short-term, *ad hoc* groups that form around shared interests or emerging issues. Whether place- or issue-focused, they provide a flexible way to share information, identify shared concerns, and develop regional priorities. Working groups may gather for a single event or work together over a period of months or longer. Working groups support CBEP's mission and emerge when multiple partners identify a need for greater coordination, especially in the absence of an existing organization able to address that need.

CBEP staff often plays a strategic role participating in, convening, or facilitating these working groups. Past examples have looked at eelgrass monitoring and restoration, regional land conservation priorities, and place-based conversations focused on the Presumpscot River, New Meadows watershed, Long Creek, and Crooked River.

The ability to act as a trusted convenor is central to CBEP's effectiveness and constitutes one of the National Estuary Program's most important regional roles. This role depends on the strength of the Partnership (especially strong relationships among members of the Management Committee) and the robust network of contacts it establishes.

CBEP will continue hosting or supporting *ad hoc* working groups to discuss and address emerging issues related to CBEP's mission in Casco Bay and throughout the watershed.

Working groups sometimes evolve into larger, ongoing efforts, like the Casco Bay Monitoring Network or the Casco Bay Nutrient Council.

Resources

Working groups always depend on the active engagement of CBEP partners.

Working groups require limited time from CBEP staff. Staff support working groups by scheduling meetings, preparing agenda, taking notes, and preparing documents. The workload varies but is typically low (5% time for lead staff). Total staff time required to support working groups depends on the number of active working groups. In recent years, CBEP has managed one or two such groups a year.

Limited CBEP funds may be tapped to support incidental meeting costs or cover travel costs or stipends to enable participation by members of underserved or under resourced communities.

Outputs

- Periodic meetings of local and regional working groups, such as the Model Infrastructure Working Group or the Casco Bay Eelgrass Network
- Project deliverables, such as reports or data
- New forums for collaboration between researchers and organizational representatives

Outcomes

Short-term

- Increased frequency and scale of collaboration on topics of shared interest
- Formation of place-based collaborations with shared goals and priorities
- Greater efficiency and more comprehensive information and results

Medium-term

- Expanded, scientific knowledge base of Casco Bay and its watershed

Long-term

- Improved decision-making on Bay-related activities and policies

Metrics and Targets

Metric	Target
Number of working groups active each year	Three annually 2025-2029
Number of working group meetings held each year	Six annually 20205-2029

Action 4.2.B Seek resources to support programs that benefit the Bay

Goal 4: Mobilize knowledge and resources to support regional collaboration on behalf of Casco Bay, the watershed, and our communities

Strategy 4.2: Provide an organizational anchor for initiatives that benefit the Bay

Purpose

Support the collaborative work of the Partnership by building organizational capacity to implement the Casco Bay Plan and increasing and diversifying funding sources.

Location

Programmatic Action, so Bay and watershed-wide.

Timeline: Ongoing

Lead Implementers

- Casco Bay Estuary Partnership (grant submissions, assistance with preparing proposals, letters of support)

Other Collaborators

- University of Southern Maine Research Service Center (support for proposal submission by CBEP)
- Management Committee (ideas, prioritization)

Description

EPA encourages National Estuary Programs to diversify and increase programmatic and leveraged funding by applying for grants from a variety of sources, including federal programs, state programs and foundations. Casco Bay Estuary Partnership (CBEP) has a long record of fundraising to support shared priorities.

CBEP core staff members also support other groups working on behalf of the Bay, ranging from local organizations to academic researchers, in their efforts to seek funds for specific projects. CBEP involvement may be significant (e.g., acting as fiscal agent) or minimal (e.g., a letter of support to accompany a grant proposal). Our designation as a National Estuary Program often carries extra weight when we or our partners are applying for federal or state funding.

The Bipartisan Infrastructure Law offers CBEP, like other National Estuary Programs, a significant short-term increase in federal funding. BIL and other recent federal legislation have also increased federal funds for infrastructure, climate resilience, and habitat restoration. However, these supplementary appropriations will run out in just a few years. The Partnership itself, as well as many partners, need to prepare for when federal dollars are less available. Diversifying funding sources now can soften the impact of future declines in federal funds.

In seeking alternative sources of funding to support implementation of the Casco Bay Plan, CBEP will:

- collaborate with allied organizations to identify opportunities for obtaining and diversifying revenue sources;
- leverage local networks to attract federal funds (by identifying local sources of match); and
- pursue external funding resources to support Plan Actions.

Resources

Many CBEP partners raise funds to support programs that implement portions of the Casco Bay Plan.

CBEP staff put substantial time towards raising funds for CCMP implementation beyond EPA cooperative agreements and BIL workplans. Staff submit multiple grant proposals to federal, state, and philanthropic funders (including EPA) through the University of Southern Maine (USM) every year. Staff work with the USM's Research Services Center to address reporting and other obligations. They also assist other organizations with proposal preparation and prepare letters of support endorsing proposals submitted by other organizations. These tasks cumulatively represent 10% to 15% of the time of the Director and the Program Manager, and under 5% of the time of other staff.

Outputs

- Pledged nonfederal match (cash and in kind)
- Completed and submitted grant proposals
- Funds raised for CBEP through our host organization
- Funds raised by partners to implement portions of the Casco Bay Plan

Outcomes

Short-term

- CBEP and others are better able to take advantage of suitable grant programs
- More numerous and competitive federal grant proposals submitted

Medium-term

- Increased local capacity for implementation; increased federal grant funding outside Section 320 U.S. Environmental Protection Agency funding

Long-term

- Improvements to Bay's habitats, water quality, ecosystem function and integrity

Metrics and Targets

Metric	Target
List of grant opportunities created in 2024 and updated annually	Annual updates
Number of grant proposals submitted to fund CBEP programs or activities	Four per year
Number of collaborative proposals submitted with significant CBEP staff input or participation	Two per year
Number of applications to the National Estuary Program Watershed Grant program administered by Restore America's Estuaries, on average	One per year
Number of letters of support for proposals submitted by CBEP partners	Six per year

Strategy 4.3: Coordinate and expand Bay-related science and monitoring

Numerous groups monitor Casco Bay or its watershed (e.g., tracking water quality, invasive species, freshwater systems, biota and ocean acidification impacts and community responses), but many efforts operate in isolation with little coordination. The region would benefit from greater coordination to discuss long-term monitoring needs, identify key environmental indicators, advance a regional sentinel monitoring network, and develop consistent ways to share data and results of studies.

Action 4.3.A Work with the Monitoring Network to implement the Monitoring Plan and improve availability of up-to-date data on the condition of Casco Bay

Goal 4: Mobilize knowledge and resources to support regional collaboration on behalf of Casco Bay, the watershed, and our communities

Strategy 4.3: Expand Bay-related science and monitoring

Purpose

Convene and lead a Casco Bay Monitoring Network that identifies shared priorities and works to advance priorities identified in the Casco Bay Monitoring Plan.

Location

Casco Bay and watershed-wide.

Description

CBEP established the Casco Bay Monitoring Network in 2016 to strengthen monitoring of Casco Bay. The group originally focused on ` monitoring Casco Bay itself but expanded to include freshwater monitoring in 2020. The group meets at least annually to share monitoring results, share monitoring plans, and discuss regional needs.

CBEP released our most recent Monitoring Plan (developed with input from the Monitoring Network) in 2020 (https://www.cascobayestuary.org/strategic-planning/casco-bay-monitoring-plan/). The Plan:

- Identifies three overarching research questions, focused on nutrients, habitat conditions and the Casco Bay food web;
- Highlights programmatic needs to support monitoring, including strengthening the monitoring network, seeking stable funding, simplifying ways to share data, and developing a hydrodynamic model of Casco Bay; and

Timeline: Ongoing

Lead Implementers

- Casco Bay Estuary Partnership (coordination, meeting facilitation)
- Friends of Casco Bay (anchor data source and member of the Network)
- Presumpscot Regional Land Trust (anchor data source and member of the Network)
- Wells National Estuarine Research Reserve (anchor data source and member of the Network)
- Maine Department of Environmental Protection (anchor data source and member of the Network)

Other Collaborators

- Lakes Environmental Association (data source and member of the Network)
- Lake Stewards of Maine (data source and member of the Network)
- Portland Water District (data source and member of the Network)
- Northeaster Regional Association of Coastal Ocean Observing Systems (NERACOOS; member of the network, source of ocean data, and data management and delivery)
- U.S. Geological Survey (Royal River gauge)
- Gulf of Maine Research Institute (data source and member of the Network)
- University of Southern Maine (member of the Network)

- Emphasizes the need to protect key monitoring programs, while filling information gaps in freshwater conditions, fish community composition, eelgrass populations, and impacts of aquaculture.

A growing number of entities are monitoring the waters of Casco Bay. Core data on conditions in Casco Bay are gathered by Friends of Casco Bay, Maine Department of Environmental Protection (DEP), Maine Healthy Beaches Program, and Maine Department of Marine Resources. Friends of Casco Bay has established three automated water quality monitoring stations, in Cundy's Harbor, Portland Harbor, and off Cousins Island, in the center of the Bay. The presence of marine invasives is being tracked through programs run by the Wells National Estuarine Research Reserve and Massachusetts Office of Coastal Zone Management. The Gulf of Maine Research Institute gathers data on the fish community of Casco Bay. The Maine Coastal Program monitors elevation change in one Casco Bay tidal wetland using sediment elevation tables (rSETs).

Other Collaborators (cont'd)

- Long Creek Watershed Management District (anchor source of data)
- U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (member of the Network)
- Massachusetts Office of Coastal Zone Management (manages data for MIMIC and regional marine invasive species rapid assessment surveys)

In 2020, the Network was expanded to include organizations collecting data on our rivers, lakes, and ponds. Water quality data is collected from more than thirty-five lakes and ponds in the watershed, often thanks to the efforts of DEP, Lakes Environmental Association, Lake Stewards of Maine, and dozens of volunteers. Portland Water District monitors conditions in Sebago Lake. Presumpscot Regional Land Trust now manages volunteer water quality monitoring throughout the lower Presumpscot River watershed and at several locations on the Stroudwater river (See Action 4.3.B). Regional interest in tracking stream temperatures has been growing for several years.

Under the Monitoring Plan, the Network provides a forum for communicating among individuals and organizations observing the Bay and the watershed and helps establish priorities for allocating CBEP resources (including both staff time and National Estuary Program funds) to support monitoring. CBEP staff supports the Network and implements the recommendations of the Network. In the next few years, the Network will meet at least twice a year, with increased staff support. While final priorities will be determined by the Monitoring Network, likely areas of focus include updating information cataloging monitoring programs, simplifying access to monitoring data, or organizing Casco Bay monitoring and science conferences or events.

A new subcommittee of the Network will meet at least annually to evaluate proposals requesting funding through the new Monitoring Infrastructure Grants program made possible by BIL. These grants will offer funding to expand monitoring in the region including such costs as purchasing new equipment, funding pilot studies, or developing data quality assurance documents. Because BIL funds will only be available for a few years, these grants will not be used to fund long-term monitoring expenses such as staff salaries, laboratory fees or consumables past an initial research or pilot phase.

Resources

The costs of comprehensive Casco Bay monitoring far exceed CBEP's available funding. Monitoring must be a shared responsibility of the individuals and organizations with a stake in understanding the Bay. Indeed, state and federal agencies and Friends of Casco Bay fund most long-term monitoring of Casco Bay.

CBEP will allocate significant staff time (estimated at 25% of the time of the Staff Scientist) to coordinating and staffing the Monitoring Network and implementing Monitoring Network priorities. CBEP habitat program and science staff, as well as summer interns and volunteers conduct data collection in support of Monitoring Network Priorities, especially understanding changes in coastal habitats like tidal wetlands. This work (which complements data collecting in support of habitat restoration projects) adds no more than a few days in the field annually.

CBEP provides direct financial support for monitoring of Bay Water Quality (currently about $30,000 per year to Friends of Casco Bay) and to support volunteer-based monitoring of marine invasive species (about $5,000 annually to the MIMIC program, managed by Wells Estuarine Research Reserve). CBEP occasionally provides funding (up to about $10,000) for other high-value data collection efforts, such as periodic Marine Invasive Species Rapid Assessments.

We anticipate allocating about $75,000 annually in Bipartisan Infrastructure Law funds through 2027 to support the Monitoring Infrastructure Grants program.

Outputs

- Meetings of the Casco Bay Monitoring Network
- Creation of a dedicated communications on-line platform to facilitate communication among members of the Casco Bay Monitoring Network
- Updated map and other data on ongoing monitoring programs
- Annual priorities for strengthening monitoring
- Annual Monitoring Infrastructure Grants awarded

Outcomes

Short-term

- Improved communication among individuals and organizations monitoring Casco Bay
- New monitoring programs or improvements to existing programs

Medium-term

- Expanded monitoring of Casco Bay and the waters of the watershed
- Greater efficacy of monitoring work and increased sharing of Bay-related monitoring data

Long-term

- Better early detection of changes in Bay water quality and habitats

Metrics and Targets

Metric	**Target**
Number of participants in Casco Bay Monitoring Network	Twenty organizations
Monitoring Network meetings	Two per year
Monitoring Infrastructure Grants awarded	One per year through 2027

Action 4.3.B Expand monitoring of Casco Bay tributaries

Goal 4: Mobilize knowledge and resources to support regional collaboration on behalf of Casco Bay, the watershed, and our communities

Strategy 4.3: Expand Bay-related science and monitoring

Purpose

Increase understanding of conditions in rivers and streams that may influence the health of Casco Bay.

Location

Casco Bay watershed, including Casco Bay's coastal tributaries and tributaries to the Presumpscot and Royal Rivers.

Description

The watershed's rivers and streams act as funnels, carrying not only water but stormwater runoff, nutrients, pesticides, road salt, fecal waste, eroded sediment, litter and other contaminants to Casco Bay. Rivers and streams are also important aquatic ecosystems, facing combined threats from climate change and shifting land use.

Lack of capacity has long limited monitoring of rivers and streams to a handful of ongoing programs, so our perspective on the watershed's rivers and streams is selective:

- Presumpscot Regional Land Trust manages volunteer-led monitoring of dissolved oxygen, specific conductance, temperature, and bacteria in the Presumpscot watershed (and along the main stem of the Stroudwater).
- The Long Creek Watershed Management District conducts detailed hydrologic and water quality monitoring along Long Creek, an urban stream near the Portland Jetport and Maine Mall.
- Lakes Environmental Association, Lake Stewards of Maine, DEP, the Portland Water District, and many lake associations gather data on conditions in our lakes and ponds.
- The U.S. Geological Survey reestablished a river gauge on the Royal River several years ago, thus providing local data on flow from a river whose flow is not actively regulated.

Timeline: Ongoing

Lead Implementers

- Maine Department of Environmental Protection (biomonitoring, Volunteer River Monitoring Program)
- Long Creek Watershed Management District (comprehensive monitoring conditions in Long Creek and its tributaries)
- Presumpscot Regional Land Trust (volunteer water quality monitoring of the Presumpscot and Stroudwater rivers and their tributaries.
- U.S. Geological Survey (Royal River gauge)
- Lake Stewards of Maine (volunteer water quality and invasive species monitoring of lakes and ponds)
- Portland Water District (Sebago Lake water quality monitoring)

Other Collaborators

- Cumberland County Soil and Water Conservation District (work with lake and watershed associations)
- Local governments (locally sponsored freshwater monitoring programs on lakes, rivers, and streams; monitoring of stormwater outfalls)
- University of Southern Maine (technical assistance)
- U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (stream temperature monitoring network)
- Lake and watershed associations (volunteer monitoring)
- Trout Unlimited (stream temperature monitoring network)

- The Maine Department of Environmental Protection conducts biological monitoring at selected locations every five years and collects complementary data in response to management concerns.
- A regional coalition (locally led by the U.S. Fish and Wildlife Service's Gulf of Maine Coastal Program and Trout Unlimited Chapters), has begun collecting steam temperature data using inexpensive data loggers.
- Maine's current MS4 General Permit requires limited monitoring of stormwater outfalls. Some MS4 towns are conducting additional freshwater monitoring.

To improve our understanding of our rivers and streams, including how they affect Casco Bay, monitoring needs to be expanded to cover more locations and provide better temporal coverage. Existing piecemeal monitoring should be better integrated. We need to collect more types of data to address emerging policy concerns. Stream temperature data helps us understand the effects of climate change. Data on conductivity or chloride concentrations reflects the impact of road salt.

Interest in freshwater monitoring has increased, but the longevity of related efforts remains uncertain. In 2022, volunteers with the Royal River Alliance monitored portions of the Royal River for the first time in several decades and documented persistent low dissolved oxygen conditions above the Elm Street dam. Efforts to change the water quality classification of portions of the lower Presumpscot River (from Class C to more protective Class B) have inspired several years of focused data collection. Several towns have shown interest in collecting water quality data to understand the impacts of local policies.

National Estuary Program (NEP) resources will be used to support more river and stream monitoring in several ways:

- CBEP's BIL Spending Plan allocates funds for monitoring infrastructure. Most funds will be available through a competitive Monitoring Infrastructure Grants program. Funds can cover costs for purchasing equipment, developing QAPPs, pilot studies, and other start-up costs (See Action 4.3.A).
- CBEP will work with the Town of Brunswick and other towns to develop a QAPP for municipal water quality monitoring. A standard QAPP (approved by EPA and Maine DEP) will lower barriers to other towns conducting local monitoring.
- CBEP staff will assist as appropriate for developing river and stream monitoring programs, including development of QAPPs.
- CBEP owns and maintains monitoring equipment that supports Presumpscot River Monitoring. CBEP also has limited equipment that can be loaned out to support pilot studies or to temporarily replace malfunctioning equipment (See Action 2.3.B).
- The Casco Bay Monitoring Network offers a venue for sharing best practices and discussing freshwater monitoring priorities (See Action 4.3.A)
- CBEP will assist with development of community science programs that support freshwater monitoring (See Action 3.1.B)
- CBEP will assist with raising grant funds (See Action 4.2.B)

Resources

This Actions hinges on commitments from CBEP partners to carry out monitoring. Monitoring of Casco Bay tributaries, however, remains less widespread and comprehensive than needed to guide management. But raising funds for long-term monitoring can be difficult, and available CBEP funds are insufficient to address all needs.

CBEP staff (especially the Director and the Staff Scientist) play supporting and catalytic roles assisting partners with freshwater monitoring. CBEP staff will assist with regional coordination, data sharing, data quality assurance planning, equipment purchases and repair, and fundraising. These supporting tasks should take no more than 10% of an FTE in most years.

CBEP provides funding (less than $20,000 a year) to support volunteer-based water quality monitoring along the Presumpscot and Stroudwater Rivers. Those costs could increase substantially if either the geographic scope or comprehensiveness of stream and river monitoring expands in coming years. For the moment, however, no reliable long-term source of funding for expansion has been identified.

Approximately $75,000 in BIL funds will be allocated annually to strengthening monitoring via Monitoring Infrastructure Grants (under Action 4.3.A), but only a portion of that will benefit freshwater programs.

Outputs

- Enhanced QAPP for municipal monitoring of local rivers and streams that complements the existing Maine Volunteer River Monitoring Program QAPP
- Monitoring Infrastructure Grants Program
- Equipment loaner program
- Water quality data
- Grant proposals

Outcomes

Short-term

- Coordination among monitoring organizations
- Strategic allocation of staff and funding resources toward expanded monitoring
- Grant funding
- Availability of freshwater monitoring data

Medium-term/Long-term

- Better understanding of water quality of rivers and streams in the Casco Bay watershed
- Better understanding of the impact of tributaries on the Bay's health
- Improvements to the Bay's habitats, water quality, ecosystem function and ecosystem integrity

Metrics and Targets

Metric	Target
Long Creek Watershed Management District water quality reports	Annual
Number of river and stream locations monitored	Increase in number of locations monitored by 2029 compared with 2024 levels
Number of river or stream monitoring programs	One new program by 2029 compared to 2024

Strategy 4.4: Strengthen the Partnership and our shared sense of purpose

The "P" in CBEP stands for Partnership. Collectively, we accomplish more on behalf of Casco Bay than we would by working separately. To ensure the continued health of the Partnership, we must invest in the strength of our organization. That involves formal attention to organizational governance, as well as nurturing ties among new and existing members of the Partnership.

Action 4.4.A Evaluate and implement governance changes to strengthen the Partnership

Goal 4: Mobilize knowledge and resources to support regional collaboration on behalf of Casco Bay, the watershed, and our communities

Strategy 4.4: Strengthen the Partnership and our shared sense of purpose

Purpose

Update governance practices by 2025 to reinforce the sense of common purpose among all members of the Partnership and make CBEP more accessible to the communities we serve.

Location

Programmatic Action, so Bay and watershed wide.

Description

Our "Operating Guidelines" (which function as our bylaws) have not been updated since 2017. During the January 2023 Management Committee retreat, a consensus emerged to conduct a review of CBEP's governance. The main issue identified at the time was that CBEP governance emphasizes the roles and activity of the core staff, rather than establishing a genuine collaborative partnership. Several other changes in practices have also been suggested. A 2023 diversity, equity, and inclusion review of CBEP operations highlighted potential changes in governance to help broaden participation in CBEP programs and leadership.

Over the next two years, CBEP will review and update our governance practices and amend our Operating Guidelines as necessary to formalize proposed changes. All Management Committee members will be invited to participate, but the review will be led by a working group that will share recommendations with the Management Committee. Any changes in our Operating Guidelines will be approved by the Management Committee. Changes in practices will be discussed by the Executive Committee or Management Committee, as appropriate.

Timeline: CBEP conducted a review of governance practices in the fall of 2023. Recommendations were discussed with the full Management Committee at the March 2024 Management Committee meetings. New practices will be implemented no later than 2025.

Lead Implementers

- CBEP Management Committee (oversight and direction)
- University of Southern Maine (host institution)

Other Collaborators

- Other members of the Partnership (suggestions and comments)
- Community members not currently included in CBEP governance practices (potential beneficiaries)

Resources

Governance changes will be led by CBEP's Executive Committee, and a working group drawn from the Management Committee. CBEP staff will provide logistical support and draft policies and any necessary changes to our Operating Guidelines.

The CBEP Director will serve as an ex officio member of the governance working groups. CBEP's Program Coordinator and Community Engagement staff will also allocate time to strengthen CBEP governance.

Outputs

- Governance review meeting or meetings
- Recommendations to CBEP's Management Committee
- Updated Operating Guidelines

Outcomes

Short-term

- CBEP policies and procedures are more welcoming to varied perspectives and interests

Medium-term

- Strengthened sense of common purpose among all members of the Partnership
- Better representation of community perspectives in CBEP governance

Long-term

- A stronger Partnership that better reflects community priorities and needs

Metrics and Targets

Metric	**Target**
Recommendations to the Management Committee	By September 2024
Updated Operating Guidelines adopted	By March 2025

Action 4.4.B Provide shared learning and networking opportunities for people that work on behalf of our waters

Goal 4: Mobilize knowledge and resources to support regional collaboration on behalf of Casco Bay, the watershed, and our communities

Strategy 4.4: Strengthen the Partnership and our shared sense of purpose

Timeline: Events will begin in 2024 and continue at least annually thereafter

Lead Implementers

- Casco Bay Estuary Partnership (event planning and implementation)
- CBEP Management Committee (event ideas and prioritization)

Other Collaborators

- Other members of the (extended) Partnership (participation and attendance)

Purpose

Strengthen the sense of community and shared purpose among members of the Partnership, especially people who are not represented on the Management Committee. Create connections among people in the region who work on water quality, aquatic habitat, or related Casco Bay issues.

Location

Programmatic Action, so Bay and watershed wide.

Description

The network of connections built by National Estuary Programs (including CBEP) has often been recognized as an important contribution to coastal management. Existing connections and trust among individuals can simplify negotiations, speed up project development, and improve response to unexpected or catastrophic events. Yet, restrictions on meeting in person that were in place from 2020 through 2022 and reliance on remote meeting technologies meant interpersonal connections among members of the Partnership suffered over the past few years.

CBEP will host events at least annually that bring together members of the Partnership and others to learn from each other, discuss their work, and get to know one another. Whenever possible, these Partnership events will be held at a venue that connects people directly to the Bay or our other waters.

We will also facilitate other, more frequent opportunities for colleagues to get together. Events may include training opportunities, field trips, celebrations of ongoing work or accomplishments, and scientific conferences, among others.

Events will be designed to broaden, as well as strengthen, relationships. We will invite people not part of CBEP's existing networks to attend, and welcome new voices and perspectives at long-standing gatherings. We will seek to create joint events with organizations not usually considered part of the environmental or conservation communities and reach out to underserved or underrepresented communities. As an example, we will organize showcase gatherings for Community Grants, and invite community-based organizations to learn about the grant program, hear about past projects and discuss emerging project ideas.

Resources

This Action will require CBEP staff time to organize events. We anticipate these tasks will be taken on by existing CBEP staff as part of their regular duties.

Some events will require CBEP funds to pay for meeting venues, coffee, or meals. Federal restrictions on use of National Estuary Program Funds mean some events may need to be funded from other sources. These events will cost less than $5,000 a year.

Outputs

- Events that offer opportunities for people to come together and learn about each other's work

Outcomes

Short-term

- A more interconnected network of communications among people who work on or are affected by issues related to Casco Bay

Medium-term

- A greater sense of shared purpose among members of the Partnership
- Innovative programs and projects that grow out of personal and professional connections

Long-term

- A stronger Partnership
- Improvements in health of Casco Bay

Metrics and Targets

Metric	Target
In-person Management Committee meetings or events	Once per year
Larger community events	One per year
Attendees at Partnership community events	Forty people

Appendices

2024

Casco Bay Estuary

PARTNERSHIP

APPENDIX A: CROSSWALK INFORMATION

From the 2016 CCMP to the Updated CCMP

Part 1: Goals

Goals Overview

Our four Goals remain essentially unchanged from the 2016 Caso Bay Plan. The updated Casco Bay Plan, focusing on the same four general areas: (1) Habitat, (2) Water Quality, (3) Community Engagement and (4) Collaboration and Science. The wording of each Goal has been altered to better reflect how we think and talk about our work, especially regarding the centrality of climate change in everything we do.

Goals Details

Old Goal 1: Protect, restore, and enhance key habitats that sustain ecological health

Updated Goal 1: Protect, restore, and enhance the key habitats that sustain ecosystem health of Casco Bay and its watershed for now and the future

Reworded to highlight waters throughout the Casco Bay watershed, and to emphasize the need to think about long-term ecological function in the context of climate change.

Old Goal 2: Reduce nutrient pollution and its impacts, including coastal acidification

Updated Goal 2: Address the cumulative water quality impacts of human activity in the Casco Bay watershed

Revised wording reflects a change in focus towards addressing cumulative impact of human activity on our waters. While nutrients are still a primary concern for Casco Bay, the updated goal reflects progress made since 2016 on understanding nutrient processes in Casco Bay, and emerging consensus that growing human populations and rapid land use change throughout the Casco Bay watershed pose a threat to aquatic ecosystems.

Old Goal 3: Foster resilient communities and their connections to Casco Bay

Updated Goal 3: Engage communities and provide information and tools to support decisions to protect and restore Casco Bay

The scope of our community engagement activities has broadened. The updated wording of Goal 3 better reflects current activities. The change in wording reflects both an interest in active engagement with a broader range of individuals and organizations and a commitment to assisting local governments with addressing environmental challenges.

Old Goal 4: Mobilize collective knowledge and resources to support Casco Bay

Updated Goal 4: Mobilize knowledge and resources to support regional collaboration and action on behalf of Casco Bay, the watershed, and our communities

Reworded to emphasize the collaborative structure of the Partnership and highlight the importance of all the waters of the Casco Bay watershed.

Part 2: Strategies

Strategies Overview

Most of the strategies from the 2016 Casco Bay Plan have been carried forward into the Updated Plan on a one-to-one basis. Strategies have been revised and updated to reflect changes in how we organize our shared work on behalf of Casco Bay. Several Strategies were merged based on experience about how Actions under different Strategies relate to one another. Five old Strategies were merged into two updated ones, for a loss of three Strategies. Five new Strategies were added, producing a net gain of two.

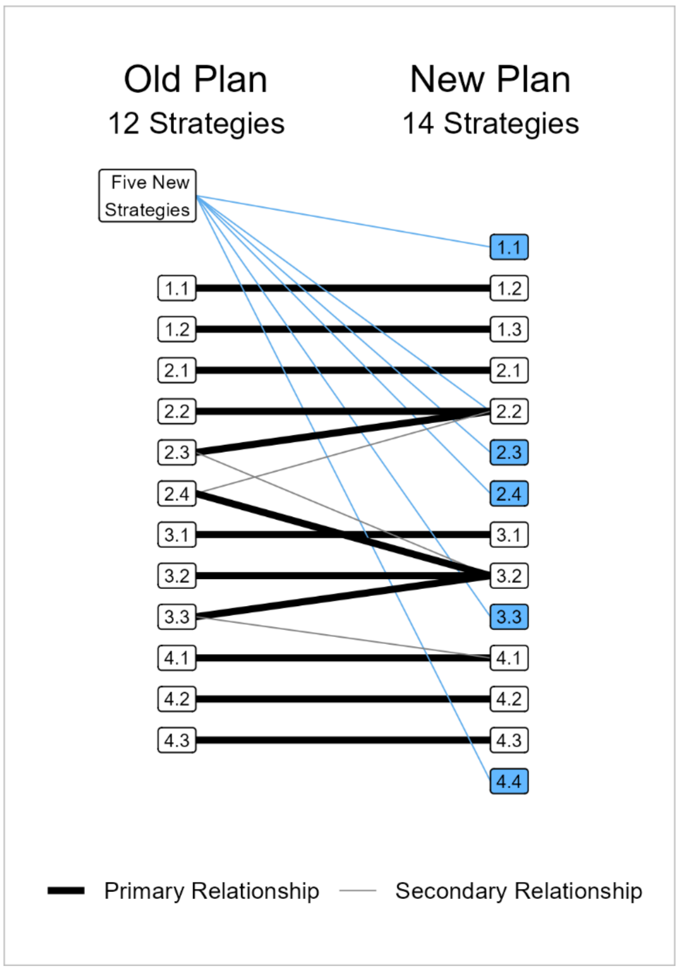

Figure A.1. Relationships between Strategies from the old and updated Plans. Every old Strategy is linked to one New Strategy, and most new Strategies have strong connections to one older Strategy.

Strategies Details

Old Goal 1: Protect, restore, and enhance key habitats that sustain ecological health

Old Strategy 1.1: Conserve significant coastal habitats and areas that protect water quality, such as riparian corridors, wetlands and forests adjoining headwater streams

New Strategy 1.2: Permanently protect habitats that support resilience of aquatic ecosystems and protect water quality

Rephrased to simplify language and emphasize watershed relationships.

Old Strategy 1.2: Restore and enhance coastal habitats and habitat connectivity that are important to sustaining the health of C

New Strategy 1.3: Enhance habitat resilience and restore connectivity of coastal wetlands, aquatic habitats, and shorelines

New language strengthens attention to long-term health of Casco Bay considering climate change and other long-term stressors.

Old Goal 2: Reduce nutrient pollution and its impacts, including coastal acidification

Old Strategy 2.1: Fill the gaps in scientific understanding of Casco Bay's nutrient sources, processes and impacts that are needed to guide policy and management decisions

New Strategy 2.1: Develop the scientific basis for managing nutrient pollution in Casco Bay

Updated to reflect progress made over the past five or six years on nutrient science. Our focus is shifting from filling gaps in understanding of nutrient processes towards developing robust tools, especially models and model output, to help guide management.

Old Strategy 2.2: Encourage use of green infrastructure to reduce nutrient pollution from runoff

New Strategy 2.2: Work collaboratively to reduce key sources of water pollution throughout the watershed

Related Actions and activities from old Strategy 2.2 have been incorporated into the new Strategies 2.2 (especially 2.2.A) and 2.3. This reflects the overall shift in focus under Goal 2 from a focus on nutrients towards broader water quality concerns.

Old Strategy 2.3: Advance policies and regulations that minimize nutrient pollution and coastal acidification

New Strategy 2.2: Work collaboratively to reduce key sources of water pollution throughout the watershed

Related Actions and activities from old Strategy 2.3 were incorporated into the new Strategies 2.2 (Especially 2.2.A), 3.2 and 4.1.

Additional connections to updated Strategies

New Strategy 3.2: Help coastal and watershed communities prepare for climate change and develop local policies and practices to protect our waters

Old Strategy 2.4: Seek long-term solutions for funding stormwater management and constructing stormwater infrastructure

New Strategy 3.2: Help coastal and watershed communities prepare for climate change and develop local policies and practices to protect our waters

Several Actions under the old CCMP Strategy 2.4 were completed, while progress on others is likely to be slow, so it no longer makes sense as a separate strategy. Remaining activities have been moved to Strategies 3.2 and 2.2.

Additional connections to updated Strategies

New Strategy 2.2: Work collaboratively to reduce key sources of water pollution throughout the watershed

Old Goal 3: Foster resilient communities and their connections to Casco Bay

Old Strategy 3.1: Strengthen appreciation for the cultural, ecological, and economic values of Casco Bay

New Strategy 3.1: Engage residents and visitors with stewardship of our waters, by highlighting the watershed's importance and sharing information on how to protect it

The old Strategy has been reworded to emphasize community engagement, behavior change, and new audiences, not just sharing information. The updated Strategy aims to foster connections to the Bay and build a sense of stewardship for our waters.

Old Strategy 3.2: Improve local policies and practices to better protect the Bay

New Strategy 3.2: Help coastal and watershed communities prepare for climate change and develop local policies and practices to protect our waters

In practice, technical assistance, and training activities under Old Strategy 3.3 on climate resilience often overlapped with similar activities related to policy development to protect water quality under Old Strategy 3.2. The Strategies have been combined into New Strategy 3.2, which emphasizes ongoing work providing technical assistance and training to towns.

Old Strategy 3.3: Help communities prepare for climate change impacts and resulting economic, cultural, and ecological disruption

New Strategy 3.2: Help coastal and watershed communities prepare for climate change and develop local policies and practices to protect our waters

In practice, technical assistance, and training activities under Old Strategy 3.3 on climate resilience often overlapped with similar activities related to policy development to protect water quality under Old Strategy 3.2. The Strategies have been combined into New Strategy 3.2, which emphasizes ongoing work providing technical assistance and training to towns.

Additional connections to updated Strategies

New Strategy 4.1: Serve as an information hub on Casco Bay issues and initiatives

Old Goal 4: Mobilize collective knowledge and resources to support Casco Bay

Old Strategy 4.1: Serve as an information hub on Casco Bay issues and initiatives

New Strategy 4.1: Serve as an information hub on Casco Bay issues and initiatives

No change in the Strategy title, but some activities previously under this Strategy have been moved to Goal 3 to emphasize their importance for community engagement.

Old Strategy 4.2: Provide an organizational anchor for initiatives that benefit the Bay

New Strategy 4.2: Provide an organizational anchor for initiatives that benefit the Bay

No change in the Strategy title, but the Strategy description has been updated.

Old Strategy 4.3: Expand the scope and coordination of Bay-related environmental monitoring

New Strategy 4.3: Coordinate and expand Bay-related science and monitoring

Updated Strategy emphasizes the importance of integrating monitoring with emerging science.

New Strategies

New Strategy 1.1: Identify places and initiatives that are most important for the protection, restoration, and enhancement of key habitats

We added a new Strategy to highlight the need to develop scientific and technical basis for geographic priorities for habitat protection, restoration, and enhancement of habitat resilience.

New Strategy 2.2: Work collaboratively to reduce key sources of water pollution throughout the watershed

New Strategy 2.2 groups efforts to address key sources of water pollution in our region: stormwater, combined sewer overflows, and on-site wastewater treatment systems like septic tanks and overboard discharges. It consolidates activities that previously fell under several Actions and Strategies from the old CCMP but is not a direct successor to any one previous Strategy.

New Strategy 2.3: Develop and implement local efforts to address water quality challenges

This new strategy addresses local watershed planning and water quality protection. It focuses on watershed planning and on urban streams, and partially absorbs spatially explicit activities that were included in multiple Strategies in the old Plan.

New Strategy 2.4: Track emerging threats to water quality

Our 2016 Plan suggested we should reevaluate what role the Partnership can play on toxics contaminants when we next updated our Plan. When we conducted that reevaluation, several Partners pointed to the need to understand PFAS contamination. While the only Action under this Strategy today involves PFAS, we selected a broader title to emphasize our role hosting conversations about (unknown) emerging concerns, and to facilitate future evolution of our work on emerging challenges.

New Strategy 3.3: Engage and empower new audiences and implement the CBEP Equity Strategy

This new Strategy responds both to Justice40 obligations for use of federal BIL funds, and to the work of CBEP's DEIJ Working Group. Related equity, environmental justice and access activities are included under other Strategies as well.

New Strategy 4.4: Strengthen the Partnership and our shared sense of purpose

We added a Strategy that focuses on the importance of building and maintaining the Partnership as an organization. This was implicit in the last CCMP. Here, we make it explicit.

Part 3: Actions

Actions Overview

At the Action level, most activities from the 2016 Casco Bay Plan are carried forward into the updated Plan, although sometimes with a change in emphasis. Direct successors to Actions from the 2016 Casco Bay Plan are indicated in the diagram by the dark black connecting lines. Less direct relationships between Actions from the 2016 Plan and Actions from the updated plan are indicated in lighter grey.

Overall, eight Actions from the old Casco Bay Plan were discontinued (Shown in darker blue). Most were Actions that were either completed or are no longer relevant. A few were dropped because the Management Committee determined that they are no longer priorities. Even when an Action was dropped, related work may continue as part of a different Action (indicated by the thinner grey connecting lines).

Eight new Actions have been added (in lighter blue). Several "New" Actions are related to Actions from the 2016 Plan but are not direct successors to them. Other "New" actions reflect new priority areas, such as work on PFAS or on environmental justice.

Once splits and mergers of different Actions are considered, the total number of Actions described in the Updated Casco Bay Plan has dropped from 32 to 28.

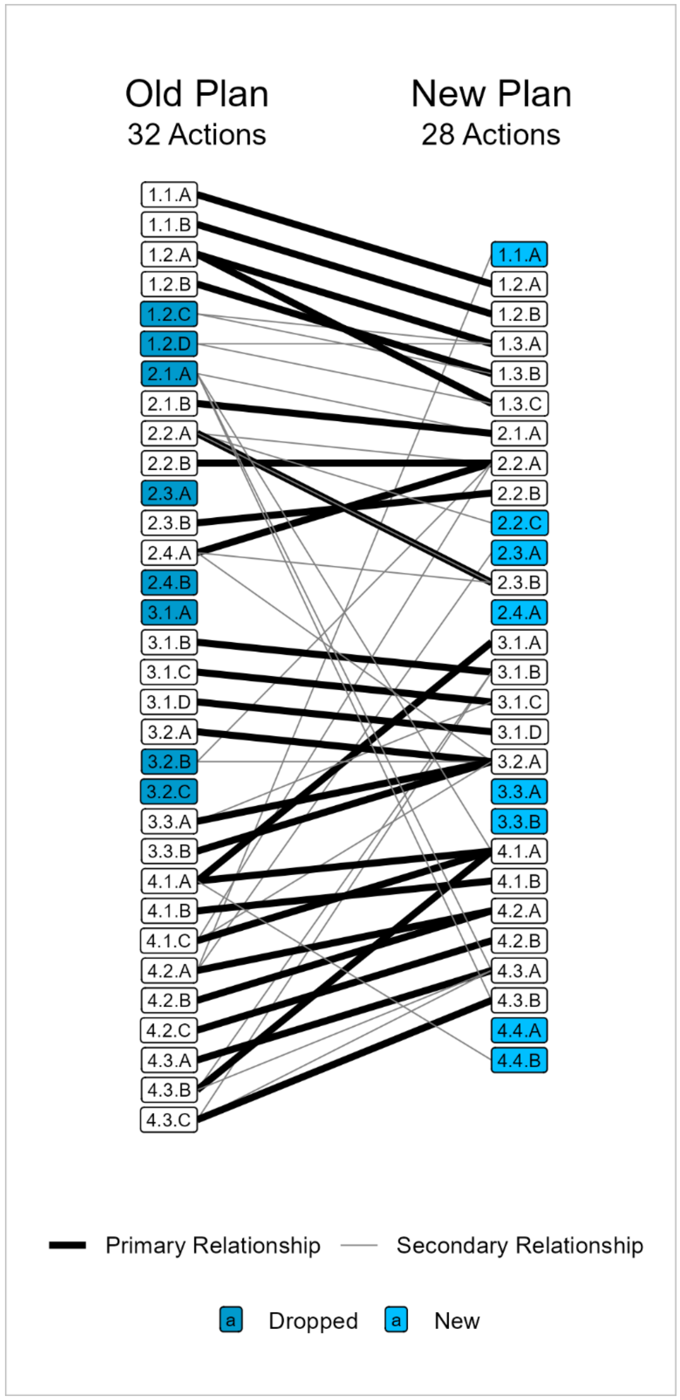

Figure A-2. Relationships between Actions from the old and updated Plans. Most Actions in the Updated Plan have a strong connection to one Action from the old Plan. Many also have secondary links to other Actions from the Old Plan.

Actions Details

Old Goal 1: Protect, restore, and enhance key habitats that sustain ecological health

Old Strategy 1.1: Conserve significant coastal habitats and areas that protect water quality, such as riparian corridors, wetlands and forests adjoining headwater streams

Old Action 1.1.A: Maintain the Casco Bay Estuary Partnership Habitat Protection Fund

New Action 1.2.A: Invest in habitat protection via the Casco Bay Estuary Partnership Habitat Protection Fund

Reworded and updated to emphasize investment in protected habitat.

Old Action 1.1.B: Assist habitat protection efforts

New Action 1.2.B: Provide technical assistance and coordination to land trusts and local governments to support land conservation

Change the wording to better reflect the kinds of assistance we offer.

Old Strategy 1.2: Restore and enhance coastal habitats and habitat connectivity that are important to sustaining the health of Casco Bay

Old Action 1.2.A: Lead coastal habitat restoration efforts

New Action 1.3.A: Lead efforts to restore and manage coastal habitats to enhance resilience

Rephrased and updated to emphasize resilience.

New Action 1.3.C: Accelerate recovery of Casco Bay eelgrass to 2018 levels by reducing key stressors and conducting restoration

Eelgrass populations in Casco Bay have dropped by more than two thirds in the past 15 years. This new Action focuses attention on addressing this alarming trend separate from our more general work on coastal restoration. Specifically, it identifies ambitious new eelgrass recovery goals.

Old Action 1.2.B: Coordinate efforts to restore aquatic habitat continuity.

New Action 1.3.B: Lead efforts to restore aquatic connectivity through culvert replacement, dam removal, and other methods

"Coordinate" language emphasized the role of CBEP staff rather than the entire Partnership. The new title reflects shared responsibility. It also clearly identifies methods for improving aquatic habitat continuity.

Old Action 1.2.C: Train habitat restoration practitioners

Action absorbed into other Actions

Activities included under the old Action 1.2.C have been folded into work leading related habitat projects (specially actions 1.3.A and 1.3.B). While capacity to implement restoration and other Actions remains in short supply, training alone cannot solve that. Some training, aimed principally at municipal partners, is also included under Strategy 3.2.

Secondary connections to other Actions

New Action 1.3.A: Lead efforts to restore and manage coastal habitats to enhance resilience

New Action 1.3.B: Lead efforts to restore aquatic connectivity through culvert replacement, dam removal, and other methods

Old Action 1.2.D: Study and test novel methods to enhance ecosystem functioning

Action dropped

Action has been dropped because it relies on an outdated concept of a distinction between habitat restoration and resilience projects. Innovative methods will now be included in all our habitat and resilience implementation activities, especially under new Actions 1.3.A, and 1.3.C.

Secondary connections to other Actions

New Action 1.3.A: Lead efforts to restore and manage coastal habitats to enhance resilience

New Action 1.3.C: Accelerate recovery of Casco Bay eelgrass to 2018 levels by reducing key stressors and conducting restoration

Old Goal 2: Reduce nutrient pollution and its impacts, including coastal acidification

Old Strategy 2.1: Fill the gaps in scientific understanding of Casco Bay's nutrient sources, processes and impacts that are needed to guide policy and management decisions

Old Action 2.1.A: Assess Casco Bay's nutrient sources, cycles, and impacts

Action dropped

The action is largely complete. Remaining activities are now included in modeling (New Action 2.1.A) Science (Action 4.1.A) and monitoring (Actions 4.3.A and 4.3.B). The Casco Bay Coastal Ocean Model and a potential successor ecosystem model are the key next steps for understanding Casco Bay nutrient dynamics.

Secondary connections to other Actions

New Action 2.1.A: Develop Casco Bay model infrastructure

New Action 4.1.A: Gather and share Casco Bay-related science

New Action 4.3.A: Work with the Monitoring Network to implement the Monitoring Plan and improve availability of up-to-date data

New Action 4.3.B: Expand monitoring of Casco Bay tributaries

Old Action 2.1.B: Improve understanding of water movement within Casco Bay

New Action 2.1.A: Develop Casco Bay model infrastructure

Renumbered and updated to focus on key next steps, such as finalizing a high-resolution model and developing model outputs that are directly applicable to addressing water quality permitting and other regional needs.

Old Strategy 2.2: Encourage use of green infrastructure to reduce nutrient pollution from runoff

Old Action 2.2.A: Work collaboratively to reduce nutrient pollution within a priority watershed

New Action 2.3.B: Improve water quality in impaired and urban streams

We continue to work in urban watersheds on nutrient pollution and other stressors, especially in Long Creek, but the focus has shifted to emphasize a more wholistic approach to urban stream health, principally under Action 2.3.B. Local efforts to reduce nutrient pollution will also occur under New Actions 2.2.A (on stormwater policy) and 2.2.C (on reducing pollution from onsite wastewater treatment systems).

Secondary connections to other Actions

New Action 2.2.A: Strengthen planning policies, site design requirements, and land use practices that protect and restore natural hydrology and reduce pollution from stormwater

New Action 2.2.C: Address pollution from on-site wastewater treatment systems like septic tanks

New Action 2.3.B: Improve water quality in impaired and urban streams

These three new Actions represent different aspects of the evolution of our thinking regarding how best to address nutrient challenges. We are focusing more on addressing specific pollution sources and less on nutrients as a separate water quality challenge.

Old Action 2.2.B: Share innovative stormwater solutions

New Action 2.2.A: Strengthen planning policies, site design requirements, and land use practices that protect and restore natural hydrology and reduce pollution from stormwater

Action renumbered and revised to clarify that the goal is better policies and practices. The region does not lack good examples or ideas, but most are still rarely implemented. Overall, stormwater efforts from the 2016 Plan have been reconfigured to focus on policy responses to land use change (Action 2.2.A) and specific challenges of urban and urbanizing streams (2.3.B).

Old Strategy 2.3: Advance policies and regulations that minimize nutrient pollution and coastal acidification

Old Action 2.3.A: Form a stakeholder-based group to study impacts of nutrients and costs of nutrient management

Action completed

Action completed via the Casco Bay Nutrient Council and the Portland Area Nitrogen Group.

Old Action 2.3.B: Reduce combined sewer overflow discharges

New Action 2.2.B: Reduce combined sewer overflow discharges

Action renumbered and updated. No change in title.

Old Strategy 2.4: Seek long-term solutions for funding stormwater management and constructing stormwater infrastructure

Old Action 2.4.A: Help address stormwater and water infrastructure finance challenges

New Action 2.2.A: Strengthen planning policies, site design requirements, and land use practices that protect and restore natural hydrology and reduce pollution from stormwater

Finance continues to be a challenge, but it is only one of a group of interconnected policy problems, and short-term progress appears unlikely. Our near-term stormwater priorities are tied to policy adoption (Action 2.2.A) and efforts to address chronic stressors of urban streams (Action 2.3.B).

Secondary connections to other Actions

New Action 2.3.B: Improve water quality in impaired and urban streams

New Action 3.2.A: Provide training, planning assistance and small grants to Casco Bay communities to protect aquatic ecosystems

Old Action 2.4.B: Monitor implementation of Portland's stormwater service charge

Action dropped

Action formally dropped by the Management Committee five years ago as no longer needed, and not an appropriate role for CBEP to lead because of potential perception of conflicts of interest.

Old Goal 3: Foster resilient communities and their connections to Casco Bay

Old Strategy 3.1: Strengthen appreciation for the cultural, ecological, and economic values of Casco Bay

Old Action 3.1.A: Highlight Casco Bay's economic importance

Action dropped or absorbed into other Actions

Action completed in 2016 and 2017. New Actions under Strategy 3.1 emphasize community engagement, behavior change, and new audiences, not just sharing information.

Old Action 3.1.B: Expand and publicize volunteer opportunities

New Action 3.1.B: Promote and facilitate Bay and watershed-focused community science activities

Refocuses CBEP work on volunteerism and stewardship towards community science. The realignment reflects lessons learned about how to leverage CBEP resources and expertise to support community engagement and stewardship.

Old Action 3.1.C: Encourage experiential learning programs to engage students with Casco Bay

New Action 3.1.C: Deliver Bay and Watershed-focused education programs to engage learners of all ages

Updated wording to reduce emphasis on experiential learning. While some CBEP partners are deeply engaged with experiential learning, partners take a variety of approaches to education. The revisions also emphasize the Partnership's commitment to education outside traditional K-12 classrooms.

Old Action 3.1.D: Offer small grants for community-based projects

New Action 3.1.D: Offer small grants for community-based projects

Action updated, no change in title.

Old Strategy 3.2: Improve local policies and practices to better protect the Bay

Old Action 3.2.A: Provide technical assistance to Casco Bay communities

New Action 3.2.A: Provide training, planning assistance and small grants to Casco Bay communities to protect aquatic ecosystems

The revised title adds specificity regarding the content and intent of providing technical assistance and education to municipalities. Related work is also included under Action 2.2.A.

Secondary connections to other Actions

New Action 2.2.A: Strengthen planning policies, site design requirements, and land use practices that protect and restore natural hydrology and reduce pollution from stormwater

Old Action 3.2.B: Create and promote a municipal self-assessment tool to encourage adoption of local policies that protect Casco Bay

Action dropped

Project completed via a report produced by GPCOG in 2017. Similar needs are now being addressed by planning assistance under Actions 2.2.A and 3.2.A.

Secondary connections to other Actions

New Action 2.2.A: Strengthen planning policies, site design requirements, and land use practices that protect and restore natural hydrology and reduce pollution from stormwater

New Action 3.2.A: Provide training, planning assistance and small grants to Casco Bay communities to protect aquatic ecosystems

Old Action 3.2.C: Help Portland create a solution for dredged material disposal

Action largely complete

Funding was secured for initial project implementation early in 2024. CBEP's role is not expected to be significant enough in coming years to retain this in the Plan as a separate Action. CBEP will continue to participate informally in discussion of implementation.

Old Strategy 3.3: Help communities prepare for climate change impacts and resulting economic, cultural, and ecological disruption

Old Action 3.3.A: Foster climate preparedness among local decision makers

New Action 3.2.A: Provide training, planning assistance and small grants to Casco Bay communities to protect aquatic ecosystems

Combined with Old Action 3.3.B under the new Actions 3.2.A. The updated plan has been reorganized to emphasize engagement with local governments across issue areas.

Secondary connections to other Actions

New Action 3.1.C: Deliver Bay and Watershed-focused education programs to engage learners of all ages

The Casco Bay Coastal Academy, a workshop series aimed principally at members of volunteer municipal boards and commissions, will continue under Action 3.2.A. it is also part of the larger effort to deliver education to "learners of all ages" called out under Action 3.1.C.

Old Action 3.3.B: Promote climate adaptation best practices that incorporate sound climate science

New Action 3.2.A: Provide training, planning assistance and small grants to Casco Bay communities to protect aquatic ecosystems

Combined with Old Action 3.3.A under the new Actions 3.2.A. The updated plan has been reorganized to emphasize engagement with local governments across issue areas

Old Goal 4: Mobilize collective knowledge and resources to support Casco Bay

Old Strategy 4.1: Serve as an information hub on Casco Bay issues and initiatives

Old Action 4.1.A: Gather and share Casco Bay information

New Action 3.1.A: Provide information and outreach to target audiences in the Casco Bay region

We split the old Action 4.1.A in two that focus respectively on outreach (Action 3.1.A) and communicating science (Action 4.1.A). The new Action 3.1.A includes general communication and outreach work that used to be included in Goal 4. This consolidates our community engagement work under Goal 3.

New Action 4.1.A: Gather and share Casco Bay-related science

The old Action combined sharing of technical information with outreach. The new Plan clarifies the distinction. This new Action clarifies CBEP ‘s role disseminating scientific and technical information.

Secondary connections to other Actions

New Action 4.4.B: Provide shared learning and networking opportunities for people that work on behalf our waters

Old Action 4.1.B: Report on the State of the Bay

New Action 4.1.B: Report on the State of the Bay

Action updated. No change in title.

Old Action 4.1.C: Share scientific and community information to inform relevant policy decisions

New Action 4.1.A: Gather and share Casco Bay-related science

Old Action 4.1.C was about sharing CBEP knowledge and expertise in the context of policy development. It has been folded into new Actions 4.1.A (Casco Bay science), 2.2.A (stormwater policies) and 3.2.A (community assistance).

Secondary connections to other Actions

New Action 2.2.A: Strengthen planning policies, site design requirements, and land use practices that protect and restore natural hydrology and reduce pollution from stormwater

New Action 3.2.A: Provide training, planning assistance and small grants to Casco Bay communities to protect aquatic ecosystems

Old Strategy 4.2: Provide an organizational anchor for initiatives that benefit the Bay

Old Action 4.2.A: Lead place-based planning to benefit habitat and water quality

New Action 4.2.A: Host local and regional working groups on emerging issues

Place-based planning and issue-focused working groups often overlap, and CBEP manages both types of groups similarly. This updated Action puts them together into one Action. Place-based planning and prioritization is part of several other new Actions, including 1.1.A (habitat priorities) and 2.3.A (watershed planning).

Secondary connections to other Actions

New Action 1.1.A: Develop science-based regional plans that integrate aquatic habitat protection, restoration, continuity, and resilience priorities

New Action 2.3.A: Increase data gathering and stressor assessments to accelerate development of watershed management plans

Old Action 4.2.B: Host technical working groups on emerging issues

New Action 4.2.A: Host local and regional working groups on emerging issues

Coordinating activities often blur the distinction between regional (geographic) focused work (Old Action 4.2.A) and programmatic or technical working groups (Old Action 4.2.B). The two are combined in the new Plan into Action 4.2.A.

Old Action 4.2.C: Seek funding to support programs that benefit the Bay

New Action 4.2.B: Seek resources to support programs that benefit the Bay

Action reworded to clarify that we often seek resources other than funding to support our mission, such as scientific research, staff time, or equipment.

Old Strategy 4.3: Expand the scope and coordination of Bay-related environmental monitoring

Old Action 4.3.A: Coordinate a Casco Bay Monitoring Network and Plan

New Action 4.3.A: Work with the Monitoring Network to implement the Monitoring Plan and improve availability of up-to-date data

The Monitoring Plan was completed in 2020. Action has been reworded to emphasize the role of the Monitoring network as the coordinating and leadership structure for Casco Bay monitoring. It also highlights the need to simplify access to data from monitoring programs run by a variety of state and federal agencies, and nonprofits.

Old Action 4.3.B: Facilitate improved research on changes in Casco Bay

New Action 4.1.A: Gather and share Casco Bay-related science

Climate change has become the inescapable background for all Casco Bay-related work. The old Action has been absorbed into the general need for tracking and sharing Casco Bay-related science. Interest in science for a changing Bay also influences community science (Action 3.1.B) and Monitoring (Action4.3.A) priorities.

Secondary connections to other Actions

New Action 3.1.B: Promote and facilitate Bay and watershed-focused community science activities

New Action 4.3.A: Work with the Monitoring Network to implement the Monitoring Plan and improve availability of up-to-date data

Old Action 4.3.C: Expand monitoring of Casco Bay tributaries

New Action 4.3.B: Expand monitoring of Casco Bay tributaries

Renumbered and updated. No change in the title.

Secondary connections to other Actions

New Action 3.1.B: Promote and facilitate Bay and watershed-focused community science activities

New Action 4.3.A: Work with the Monitoring Network to implement the Monitoring Plan and improve availability of up-to-date data

New Actions

New Action 1.1.A: Develop science-based regional plans that integrate aquatic habitat protection, restoration, continuity, and resilience priorities

> This new Action will help support conservation efforts, especially considering the changing funding landscape. Coordinated regional efforts are more likely to be funded via today's large federal grants through NOAA, FWS and NRCS.

New Action 2.2.C: Address pollution from on-site wastewater treatment systems like septic tanks

> New Action focuses attention on septic tanks and onsite wastewater disposal. While most of the population of the region lives in communities with municipal wastewater treatment systems, most of the Casco Bay watershed is not served. Septic tanks and overboard discharges are common, especially along lakeshores, on islands, and on the peninsulas of the eastern Bay. Given the age of Maine's housing stock, many systems are thought to no longer function as intended.

New Action 2.3.A: Increase data gathering and stressor assessments to accelerate development of watershed management plans

> New Action focuses on developing watershed plans.

New Action 2.4.A: Study the prevalence of PFAS in Casco Bay

> New Action reflects a commitment made in the 2016 Casco Bay Plan to reassess whether CBEP could play a role addressing toxic contaminants. Several CBEP partners are actively engaged in work on PFAS. This Action recognizes their leadership and incorporates that work into the CCMP.

New Action 3.3.A: Continue efforts to make the Partnership more inclusive and build mutually beneficial relationships with community-based organizations

> New Action implements CBEP's Equity Strategy, our DEIJ Statement, and the work of CBEP's DEIJ Working Group.

New Action 3.3.B: Engage with aquaculture operators and shellfish harvesters to support shellfish fisheries and encourage community stewardship of shellfish resources

> This Action addresses a commitment made in the 2016 Casco Bay Plan to revisit how CBEP works with shellfish harvesters. The Casco Bay Regional Shellfish Working Group and others are leading this work. This Action incorporates their work into the CCMP and commits us to seek similar working relationships with aquaculture operators.

New Action 4.4.A: Evaluate and implement governance changes to strengthen the Partnership

> CBEP will initiate a review of our governance practices, with the intention of both strengthening the Partnership and improving access to CBEP programs, planning and activities.

New Action 4.4.B: Provide shared learning and networking opportunities for people that work on behalf our waters

> We plan to increase efforts to build the sense of a shared community among CBEP Partners, especially by holding more watershed-wide events.

APPENDIX B: HABITAT PLAN 2022 AND HABITAT PLAN UPDATE

Casco Bay Habitat Plan Update

Plan Prepared in 2022; Update 2024

Introduction

Casco Bay Estuary Partnership (CBEP) prepared a draft Habitat Plan in 2022 and submitted it to EPA for initial review. At the time, we were hesitant to outline specific habitat priorities, as we felt they should be developed in the context of updating *The Casco Bay Plan* (the core document of our Comprehensive Conservation and Management Plan, or CCMP). CBEP came to an agreement with staff at EPA's Region 1 that we would update the draft Habitat Plan when we wrapped up the updated CCMP.

The purpose of this document is to provide an addendum to the 2022 Casco Bay Habitat Plan that documents CBEP's habitat and regional priorities. It complements the Casco Bay Habitat Plan. Refinements to habitat priorities were developed through a series of meetings with CBEP's Management Committee, CBEP subcommittees, and partner organizations between fall 2022 and spring 2023, which were convened as part of the Casco Bay Plan update process.

Habitat Prioritization

Habitat priorities reflect the importance of each habitat to the Bay's ecological health, assessment of habitat vulnerability, strategic priorities, and consideration of regional capacity, as well as regional expertise and practical constraints. Habitat management should anticipate and incorporate climate change into strategies and actions. Priority habitats include:

Eelgrass beds

The area of Casco Bay's eelgrass beds declined 54% between 2018 and 2022 with accompanying declines in bed density. This decrease mirrored similar large losses documented in 2013. Current (2022) eelgrass coverage is only about 27% of peak eelgrass abundance observed as recently as 2001.

Despite these alarming declines, there may be cause for cautious optimism, as the Bay's eelgrass beds have demonstrated an inherent capacity to rebound through natural recruitment and revegetation. This variability results from a complex but poorly understood interaction between the cumulative effect of multiple stressors and traits that make eelgrass naturally resilient.

Research is needed to understand the drivers of eelgrass loss, site suitability for eelgrass restoration, and the importance of genetic traits to resilience. Coalitions such as the Casco Bay Eelgrass Consortium are essential for building and expanding capacity to research drivers of eelgrass loss and building bed resilience through regenerative approaches such as seed harvest, seed dispersal, transplanting, and assisted migration.

Tidal marsh

Regional scientists and restoration practitioners have identified the current ebb phase of the 19-year Metonic tide cycle as a window of opportunity (through 2030) within which to enhance marsh resilience to rising sea levels. Detailed hydrological assessment of the Bay's marshes is needed to inform site-specific interventions aimed at restoring marsh elevation capital while avoiding harm to imperiled marsh obligate birds.

Land protection can also contribute to marsh resilience by: a) consolidating fragmented ownership of Spartina salt marsh to simplify management of whole marsh systems, b) preventing development of adjacent low-lying areas (migration areas) suitable for new tidal marsh to establish as sea levels rise, c) protecting ecotones and adjacent uplands that buffer marsh habitat from human activities, and d) protecting watersheds that drain to tidal marshes via groundwater and freshwater streams, supporting water quality and habitat values.

Restoration and resilience initiatives should focus on optimization of marsh hydrology through a combination of a) remediation of marsh surface hydrology and the impacts of agricultural modifications, and b) optimizing tidal hydrology for current and future sea levels beneath roads and other built structures. Guidelines for replacing tidal crossings are outlined in the CoastWise manual. The Salt Marsh Adaptation and Resiliency Teams (SMARTeams) model provides a framework for remediating marsh surface hydrology at a 'tideshed' scale.

Tidal mudflats

The Bay's sheltered embayments encompass extensive mudflats with ecological communities that provide values such as water quality protection and feeding habitat for resident and migratory shorebirds. The cumulative effect of potential stressors is poorly understood. Mudflats are heavily impacted by European green crabs and show acidic conditions that reduce settlement of shellfish larvae and contribute to shell erosion. A variety of commercial fisheries occur in tidal flats, and mudflats are vulnerable to sea level rise, which may change circulation and sediment distribution patterns.

Research on habitat vulnerability, and development of criteria for prioritizing protection, restoration, and enhancement is needed to evaluate methods to improve resilience through novel methods. Land protection adjacent to tidal mudflats contributes to resilience and preserves fisheries access. Protecting and restoring sediment supplies can occur through natural bluff erosion and restoration of stream connectivity where dams impede sediment transport to the estuary.

Shellfish beds, bars and reefs

Shellfish beds, bars and reefs provide water quality benefits and structural habitat for marine species. European green crabs have decimated mussel bars, but a lack of monitoring makes it difficult to quantify the extent of loss. Development and testing of methods to address shellfish bed vulnerabilities to invasive species is a priority. Experimental oyster enhancement projects show promise for replacing emergent mussel bar habitat values, particularly if American oysters can establish subtidal beds or reefs in suitable intertidal habitats. Research is needed to develop methods for restoring blue mussel bars.

Rivers and Streams

Aquatic habitat fragmentation through construction of dams and roads has disconnected the Bay from river and stream networks in the watershed. Restoration of continuity between Casco Bay and its watershed, and within river and stream networks, remains an ongoing priority. Barriers at or near head of tide are of particular interest due to impact on diadromous species. Anadromous fish such as alewife, blueback herring, shad and rainbow smelt depend on access to critical freshwater habitats to spawn, and native cold-water species require seasonal access to microhabitats moving between rivers, streams, and other surface water bodies.

Research shows that dam removal is the most effective method for restoring continuity and ecosystem function, and dam removal is particularly important on main stem rivers. Culverts priorities include barriers on coastal streams and waterways in the lower watershed that block movement of diadromous species and that pose flooding risks. Land conservation and land use policies that protect floodplains, wetlands, forested upland in headwater areas, and riparian shoreline contribute to resilience of river and stream habitats.

Geographic Prioritization

Science-based plans that integrate habitat protection, restoration, continuity and resilience needs are priorities at the scale of subwatersheds and embayments. Place-based planning serves as a foundation for place-based collaborations whose purpose is to accelerate habitat protection, restoration, and enhancement initiatives that strengthen habitat resilience.

The *Maquoit and Middle Bay Focus Area of Statewide Ecological Significance* is a geographic priority encompassing the Cousins River, Harraseeket River, Maquoit Bay, Middle Bay and associated islands and shorelines. Other geographic areas warrant consideration for focused protection and restoration activities, including selected subwatersheds (e.g., lower Presumpscot watershed, Royal River watershed, and Stroudwater watershed) or embayments (e.g., Eastern Bay, Presumpscot Estuary, Royal River Estuary, Fore River Estuary). These subregional plans will collectively define regional habitat priorities for Casco Bay and its watershed.

Dams at or near head of tide block access of anadromous fish to entire watersheds, and dams that block access of anadromous fish to significant watershed segments, remain priorities for restoration of river continuity, and include: Bridge Street Dam, and East Elm Street Dam, in Yarmouth; Mallison Falls Dam, and Little Falls Dam in Windham / Gorham; Stroudwater Dam, in Portland.

Objectives

The following objectives have been established for habitat protection, restoration, and resilience in the updated Casco Bay Plan.

Regional Habitat Plans (Action 1.1.A)

- Initial subregional plan prepared by end of 2025
- Four regional plans completed by the end of 2029

Habitat Protection (Action 1.2.A)

- Permanently protect 20% of the land area of the Casco Bay watershed by 2030, equivalent to 31,500 additional acres above the area mapped during the 2020 State of Casco Bay report
- Permanently protect 250 acres of coastal habitat, and 400 acres of wetland habitat, by 2034
- Provide partial funding to support four habitat protection projects annually through 2029

Habitat Resilience (Action 1.3.A)

- Pilot tidal flat restoration in one or more embayments by 2029
- Pilot shellfish bed restoration in one or more embayments by 2029
- Complete two coastal wetland restoration or enhancement projects every three years (for a target of 6 by 2029)
- Restore or enhance 50 acres of coastal habitat (other than eelgrass) by 2029 and 75 acres by 2034

Aquatic Habitat Connectivity (Action 1.3.B)

- Implement three watershed connectivity projects by 2029 and eight by 2034
- Reconnect five miles of river and stream to Casco Bay by 2029
- Reconnect one- and one-half miles of stream to lakes and large rivers by 2029

Eelgrass Beds (Action 1.3.C)

- Conduct two pilot studies on eelgrass restoration methods by 2029
- Recover eelgrass coverage in Casco Bay to 3,000 acres by 2027 and 5,000 acres (equivalent to 2018 levels) by 2032, as documented by updated Maine DEP Coastal mapping Initiative Eelgrass maps.

HABITAT PLAN 2022

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Executive Summary

Casco Bay was designated an Estuary of National Significance in 1990 in part because of the richness and diversity of marine habitats and its location at the border between north and mid-Atlantic species assemblages for marine species.

Casco Bay Estuary Partnership (CBEP) is scheduled to formally update our Comprehensive Conservation and Management Plan (CCMP) in 2022-2023. The core of the strategic thinking involved with that effort will occur when we update The *Casco Bay Plan*, which, once completed, will constitute a consensus statement of priorities for the Partnership for the next five years. Under EPA guidance, the full CCMP includes a number of subcomponents, including a Habitat Plan, Finance Plan, Monitoring Plan and Communications and Outreach Strategy. Each of these supporting documents takes a close look at one aspect of CBEP operations, developing information and priorities that inform the *Casco Bay Plan*. Each is influenced by the other supporting documents and will be revised as needed in light of the updated Plan.

This Habitat Plan takes close looks at habitat issues related to CBEP operations. The document reviews past CBEP habitat-related planning, evaluates priorities identified by CBEP Partners (including federal and state agencies), considers emerging issues like climate change, sea level rise and carbon sequestration, and identifies priorities regarding emerging needs and areas of focus for CBEP Habitat programs.

Geographic Scope

The *Casco Bay Plan* defines Casco Bay as the waters landward of a conceptual line drawn from Small Point in Phippsburg to Dyer Point in Cape Elizabeth. Several rivers and coastal streams empty directly to Casco Bay, most notably the Presumpscot River, the Royal River, and the Stroudwater River. These drainages together comprise the Casco Bay watershed. The union of Casco Bay and the watershed comprises CBEP's formal service area. The watershed-focus reflects movement of water and water-borne pollutants, but does not reflect the complexity of habitat connectivity, especially regarding large forest blocks and movement of marine organisms. This Habitat Plan, therefore, takes a flexible approach to functional boundaries. While watershed boundaries remain important, contiguous habitat blocks cross watershed boundaries, and marine organisms exist as part of regional populations, and metapopulations. Connections to Scarborough Marsh, Saco Bay, and the Kennebec River are especially important.

Study Approach

Historically, CBEP has not focused on habitat for specific species, but taken a broad approach to habitat protection and restoration, considering ecosystem or community types that provide habitat to a wide range of different species of interest, including harvested species and rare and endangered species. CBEP's habitat programs have included three primary areas of effort: habitat protection, coastal habitat restoration, and restoration of aquatic continuity. Those categories reflect how we work to improve habitat condition. Climate change and related stressors are motivating increased attention to habitat resilience, which blurs the distinction between habitat protection and restoration.

This report focuses on habitats, needs and capacities, rather than the increasingly uncertain distinction between restoration and protection. This Plan, while focused on coastal habitats, also considers inland aquatic habitats and upland forest because of their importance to protecting the integrity of aquatic ecosystems.

In developing the Habitat Plan, CBEP drew from several sources of information including:

- Past CBEP organizational and planning documents,
- Recent analysis conducted for the State of Casco Bay report,
- Related plans and priorities identified by other organizations, including climate vulnerability studies,
- An online questionnaire to partners, and
- Staff knowledge, skills, and experience.

Based on the information gathered, we analyzed the status of major habitat types, identified threats to those habitats and weighed priorities. We also evaluated capacity and roles of other organizations in our region to study, manage, protect, or restore each habitat type. The review included analysis of the following:

- Tidal Marsh
- Tidal Mudflat
- Eelgrass Beds
- Rocky Intertidal
- Shellfish Bars and Reefs
- Kelp Beds
- Islands
- Rivers and Streams
- Freshwater Wetlands and Riparian Areas
- Lakes and Ponds
- Upland Forests

Not coincidentally, this list aligns well with prior CBEP habitat priorities and with priorities identified in studies conducted by CBEP Partners.

Survey of Community Priorities

CBEP staff conducted an online survey of partners, topical experts, and agency representatives in the fall of 2021 to gauge community support for different habitat priorities. CBEP received over 30 replies from over 100 invited respondents. Respondents showed support for several CBEP habitat priorities, including tidal marshes, tidal flats, eelgrass beds and fish passage improvement. The groups showed significant interest in considering subtidal habitats, chiefly eelgrass beds, kelp beds, and shellfish reefs. The group was supportive of including inland habitats in the CBEP Habitat Plan, especially forests, but several respondents pointed out that other organizations (lake associations; land trusts) engage with inland habitats.

Status and Trends

Casco Bay harbors well documented concentrations of tidal wetlands, tidal flats, and eelgrass beds. The Bay's islands and ledges provide seal haul-outs and sea bird breeding islands; their importance shaping adjacent marine habitats is likely profound, but not well understood. Extent of shellfish reefs and kelp beds are poorly documented. Inland rivers and streams are blocked by dozens of dams and hundreds of road crossings, most of which act as partial or severe barriers to movement of aquatic organisms. Health of the region's wetlands, lakes, ponds and streams is closely linked to land use, with the greatest wetland loss and worst water quality in more urbanized or suburbanized regions.

We lack robust information on historical extent of most subtidal and intertidal marine habitats. Data is essentially absent prior to the 1970s. We evaluated historical changes based on physical evidence, historic maps, local histories and narrative information.

- Tidal wetland losses are relatively well documented, especially close to Portland, where tidal wetlands along the Fore River and adjacent to Back Cove have been extensively filled. Most tidal wetlands in the Bay show signs of human alteration for ice ponds, agriculture, navigation, or other purposes.
- Eelgrass abundance has fluctuated, but data is limited before the 1990s. Peak eelgrass cover of over 8,000 acres was observed in 2001-2002. Green crab disturbance cut that number in half by 2013. Eelgrass currently covers more than 5,000 acres of the Bay.
- Presence of oyster shell middens attest to abundant American oyster in Casco Bay thousands of years ago. Anecdotal and fisheries data suggests blue mussel reefs were more abundant in the Bay a generation ago, with recent declines often attributed to predation by invasive green crab.
- While the number of islands in Casco Bay has presumably changed little, their ecological condition has not been studied in recent years.

Flowing water was an attractive source of power to early settlers, so dams were constructed throughout the watershed by the early 17th century, falling out of repair as economic conditions changed. Dozens of dams remain, with outlet dams on most lakes and ponds. Very few allow movement of migratory or resident fish. Dams were constructed at head of tide on most Casco Bay tributaries decades or centuries ago, cutting anadromous fish off from freshwater breeding habitat. Road construction proliferated in the 20th century, further reducing stream continuity as road-stream crossings became more and more abundant.

Maine's peak deforestation occurred in the mid-19th century. Our forests have regrown significantly since, as agricultural lands have been abandoned. However, data shows the Casco Bay watershed lost on the order of 16 square miles of forest between 2001 and 2016. While a portion of that will recover, as harvested areas revert to forest, other losses, especially to urban and suburban lands, are more permanent.

Threats

The principal threats to coastal habitats across most habitat types include sea level rise, climate change, development of adjacent lands, reductions in water quality, and invasive species. Climate change and the loss of freshwater wetlands, riparian areas and forestlands constitute the dominant threats to freshwaters. Additional threats were identified for most habitat types. For example, tidal flats and tidal marshes are "depositional" environments that rely on marine-derived sediments to maintain themselves in the face of rising seas. Changes in sediment supply, therefore, may have unanticipated impacts on intertidal habitats.

Gap Analysis

Numerous federal and state agencies have roles to play managing habitats of concern. For certain habitat, non-profit organizations and academic scientists, marine harvesters or coastal businesses are also important. We formally evaluated regional management capacity (excluding CBEP) to address ten different management needs (from "Protection and conservation" to "Research") for each of our priority habitats. Significant gaps in capacity were identified for each habitat category.

Generally, tools for long-term protection and management of subtidal habitats, including eelgrass beds and shellfish beds, are severely limited. Agency responsibilities focus on permitting or harvests (more than habitat per se) and legal tools for permanent protection of subtidal lands are poorly developed. Few examples of subtidal restoration have been conducted in Casco Bay, leaving significant practical and design questions largely unanswered. Few CBEP Partners have significant experience with subtidal restoration.

Restoration and protection of tidal wetlands has been a statewide and national concern for years. Yet capacity, especially for project management, is insufficient to meet projected regional needs. These systems are directly threatened by sea level rise and climate change. Little capacity exists in Maine to study ecosystem response to climate change or develop strategies to address resulting impacts.

Years of effort on stream and river continuity mean that policies now favor replacement of undersized culverts with larger structures that protect aquatic connectivity. Many towns have received training regarding proper sizing of road crossings, and Maine DEP manages grants to help address increased costs of larger structures. Yet even here, capacity for regional analysis and prioritization remains scarce.

Across habitat types, the skills needed to manage restoration and resilience projects are in short supply. Project managers need everything from "soft" skills for building relationships with landowners to "hard" skills to manage technical contractors and permitting. Such skills take time to develop, and relatively few people in our region have direct experience managing resilience projects from beginning to end.

Thus, CBEP can help address capacity limitations by (a) providing technical assistance (b) testing innovative methods to enhance resilience or restore coastal habitat; resilience methods or restoration concepts. convening regional coalitions to establish shared priorities, (c) training project managers

Recommended Approach

CBEP will take a process-oriented approach to ecosystem restoration and resilience, aiming to protect the resilience not only of existing habitats, but the geophysical and biological processes that build and maintain habitat over time. Resilience of coastal ecosystems depends on the natural processes that sustain them, such as the ebb and flow of the tides, the free flow of floodwater and sediments, and the growth of biogenic structures (forests, reefs) that build habitats on which other organisms depend.

CBEP restoration priorities are focused on reestablishing aquatic habitat connectivity in support of the natural processes inherent to the free and uninhibited flow of tidal waters and freshwater. Particular focus is on restoration of natural hydrology and connectivity within and between tidal wetlands, between the Bay and the watershed, and within freshwater riverine networks.

Where appropriate, CBEP should consider potential carbon sequestration benefits of habitat restoration and protection efforts.

Priority Habitats

Habitat priorities reflect the importance of each habitat to the Bay's ecological health, assessment of habitat vulnerability, strategic priorities and consideration of regional capacity, as well as CBEP's existing expertise and practical constraints.

Priority habitats include:

- Tidal Marshes (ongoing priority),
- Tidal Mudflats (new priority),
- Eelgrass beds (ongoing priority),
- Shellfish bars and reefs (new priority),
- Rivers and Streams (specifically, river continuity and anadromous fish; ongoing priority),
- Inland habitats that protect water quality (including freshwater wetlands, riparian areas and upland forests; ongoing priority).

(We also considered rocky intertidal areas, kelp beds, islands, and lakes and ponds. Those habitats are important, but current understanding or institutional capacities make them lower priorities right now for CBEP.)

Priority Sites

CBEP was unable to conduct in-depth geospatial analyses to select priority sites. A principal recommendation that emerged from this analysis is the need to conduct such analyses in association with CBEP Partners to help coordinate and focus effort across organizations to achieve sub-watershed level goals.

Nevertheless, with regards to addressing river continuity, especially to benefit anadromous fish, one clear (if likely long-term) priority emerges even without detailed geospatial analysis. Dams at or near head of tide block access of anadromous fish to entire watersheds. Similarly, dams that block access of anadromous fish to significant watershed segments are a natural priority. This includes:

- The Stroudwater Dam, in Portland
- The Elm Street and Bridge Street Dams, in Yarmouth; and
- Mallison Dam, in Windham / Gorham

Removal of dams or provision of fish passage at dams is a complex undertaking that takes years. CBEP is unlikely to lead efforts to remediate fish passage at any of these sites but will facilitate conversation about the fate of these fish passage barriers and provide technical assistance developing and implementing solutions and offer funding (when possible) to address unanswered technical questions.

Introduction

Vision and Mission

The Casco Bay Estuary Partnership mission is defined in the *Casco Bay Plan* 2016-2021 as follows: "The Casco Bay Estuary Partnership (CBEP) mobilizes collective action to strengthen the Bay's ecological and economic vitality, fostering a shared commitment to Casco Bay. It focuses scientific expertise and financial resources on helping watershed communities address regional challenges such as water pollution, habitat degradation and adaptation to climate change." CBEP helps to conserve the ecological integrity of Casco Bay and its watershed through science, public stewardship, and effective management.

In the context of the Casco Bay Habitat Plan, CBEP's function is to catalyze work that protects the ecological integrity and resilience of the Bay. In fulfillment of this role, CBEP follows a core set of guiding principles for how it operates within the broader network of organizations, communities and people working on behalf of Casco Bay and the watershed:

- Enhance Casco Bay: focus on actions that increase the Bay's well-being – improving marine ecosystems, economic vitality, and the region's quality of life.
- Drive innovation: catalyze creative, cost-effective, and enduring environmental solutions that are grounded in good science and meet community needs.
- Work collaboratively: build on the collective strength of diverse interests, advancing a shared agenda for the Bay.
- Link people and place: foster widespread appreciation of the Bay's ecological and economic values, and inspire residents, businesses, and municipalities to adopt practices that reduce their impacts on Casco Bay.
- Build capacity and understanding: provide training and broadly disseminate information on Bay-related research, community initiatives, educational programs, and volunteer opportunities.
- Adapt as conditions change: foster regional resilience—the capacity for ecosystems and economies to adapt as climate and other variables shift, and to bounce back from unexpected disruption.

This vision informs CBEP's approach to developing the Casco Bay Habitat Plan.

CBEP's Traditional Habitat Focus

CBEP's habitat programs have, in recent years, focused on three primary areas of effort: habitat protection, coastal habitat restoration, and restoration of aquatic continuity. Those categories are reflected in four Actions under Goal 1 of the of the Casco Bay Plan:

- Action 1.1.B. Maintain the Casco Bay Estuary Partnership Habitat Protection Fund
- Action 1.1.B. Assist habitat protection efforts
- Action 1.2.A. Lead coastal habitat restoration efforts
- Action 1.2.B. Coordinate efforts to restore aquatic habitat continuity

CBEP's habitat protection funding and coordination efforts have emphasized protection that benefits coastal ecosystems or water quality. Our restoration focus has been on restoring tidal flow to coastal wetlands. Efforts to address river continuity have looked principally towards improving access of anadromous fish to freshwater breeding habitat. CBEP also works on other habitat protection, restoration, or resilience efforts that benefit the Bay.

Increasingly, climate change is leading to new thinking about habitat resilience, which is blurring the distinctions between habitat protection and restoration.

Institutional Context and Purpose

As one of 28 National Estuary Programs (NEPs) established under the Clean Water Act and funded through the U.S. Environmental Protection Agency (EPA), CBEP is focused on protecting and restoring the water quality and ecological integrity of Casco Bay. Casco Bay was designated an *Estuary of National Significance* in 1990 because of its richness and diversity of marine habitats, threats from pollution, hydromodification, and habitat loss. According to preliminary planning documents, "Casco Bay is at the northern edge of the breeding range for many southern marine invertebrates and birds, and at the southern edge of the breeding range for many northern or boreal birds and some invertebrates." An estimated 850 species of marine life were identified in Casco Bay at the time of the program's founding.

Like other NEPs, the work of CBEP is guided by a Comprehensive Conservation and Management Plan (CCMP), commonly referred to as the *Casco Bay Plan*. According to the Preliminary CCMP for the Casco Bay Estuary Project, published in 1992, Casco Bay was nominated for inclusion in the National Estuary Program in part due to its nationally significant living resources in need of protection.

Planning Context

This document, the Habitat Plan, summarizes habitat priorities, provides a comprehensive assessment of ecosystem threats, and puts these into contemporary context to inform strategic priorities for Casco Bay, clarifying priorities for habitat restoration and protection in the region for the coming decade. The Habitat Plan also incorporates new thinking on habitat vulnerability to coastal change and the resilience of natural ecosystems and processes.

The Habitat Plan aligns CBEP with EPA programmatic guidance[1], which states that NEPs must include a "habitat protection/restoration plan" as a part of their CCMP. The Habitat Plan should reflect the results of, and planned responses to, a risk-based vulnerability assessment. EPA now requires that CCMP strategies should "identify relevant habitat types and key species", while stating measurable objectives, and actions that reflect a climate change vulnerability assessment. In 2017, EPA conducted a Program Evaluation of

[1] FY 2021 – FY2024 Clean Water Act §320 National Estuary Program Funding Guidance. October 2020.

CBEP and noted that, “CBEP would benefit from a prioritized approach to habitat conservation at appropriate watershed scales, and dependent on engagement with partners.” The Habitat Plan aims to address those needs.

CBEP takes an ecosystem approach to protection and restoration. This document is referred to as the Habitat Plan and use of the word “habitat” derives from EPA programmatic guidance calling for NEPs to develop a habitat protection / restoration plan. With a handful of exceptions, such as alewife or saltmarsh sparrow, the Habitat Plan is not focused on protecting and restoring habitat for populations of individual species, *per se*. The Habitat Plan addresses the broader idea of protecting and restoring the ecological integrity of Casco Bay, including key habitats within it. Therefore, in this document “habitat” generally conveys its broadest meaning, e.g., a salt marsh is habitat for many different organisms, and the Bay and its watershed is comprised of multiple habitat types (intertidal, subtidal, etc.).

It is our hope that the Habitat Plan serves as a shared statement of priorities across organizations and our intent that the Habitat Plan reflect the priorities of key partner organizations working in Casco Bay.

Existing Expertise/Capacity

CBEP’s base funding, governance structure, and institutional arrangement at the University of Southern Maine (USM) allows for the organization to play unique and nimble roles in facilitating the protection, restoration and enhancement of the Bay’s priority habitats. CBEP’s organizational capacity; flexibility; willingness to take risks and learn through innovation; and ability to respond quickly to emerging issues stands alone in the Casco Bay region. CBEP’s base funding through the National Estuary Program enables decisions regarding the allocation of funding to be driven by strategic needs for Casco Bay.

Allocation of CBEP staff capacity is split between program administration and strategic implementation of CCMP and workplan priorities. CBEP core staff are a combination of systems-generalists and topical specialists, drawing from a range of technical and soft competencies in science, planning, communication, coalition building, financial management, tech-transfer and project management. CBEP staff have decades of experience working in the Bay, the watershed, and with area communities and organizations.

CBEP’s ability to directly implement habitat protection, restoration and enhancement work is limited by its institutional framework. CBEP staff can provide staff and financial support for this work and can allocate resources to partners to facilitate these activities, but CBEP cannot directly acquire land or directly administer construction contracts due to limitations imposed by our host institution, the University of Southern Maine.

Relationship to Other CBEP Planning Documents

Casco Bay Plan

The *Casco Bay Plan* is a statement of shared regional priorities for the Casco Bay Estuary Partnership. It reflects a consensus set of regional priorities, established with the input of

CBEP's Management Committee, CBEP Partners, and community members. It is an overarching strategic document that identifies goals, strategies, and actions for addressing the needs of Casco Bay and the communities of the Casco Bay region. The Casco Bay Plan directly informs development of the annual workplans CBEP submits to EPA, and drives allocation of resources, including funding and staff time.

According to EPA guidance, in addition to the *Casco Bay Plan*, our CCMP includes a number of supporting documents, including a Habitat Plan, Finance Plan, Monitoring Plan, and an Outreach and Communications Strategy.

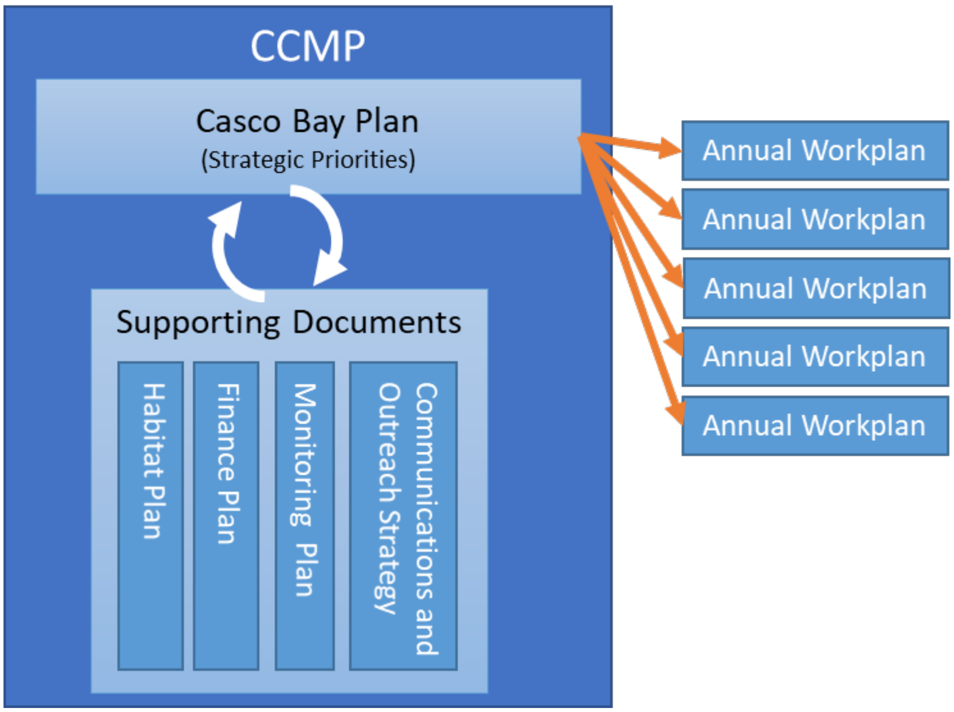

Figure 1. Conceptual model showing the relationship between major components of CBEP's "Comprehensive Conservation and Management Plan" and annual workplans.

Like the other supporting documents of our CCMP, the Habitat Plan both informs and is informed by the content of the *Casco Bay Plan*. The Habitat Plan provides background information and habitat-focused information and prioritization that provides a basis for strategic thinking about future restoration and conservation actions.

The *Casco Bay Plan*, the core document of our CCMP, is scheduled to be updated in 2022 and 2023. This Habitat Plan will play an important role informing that update. We anticipate revisiting the Habitat Plan and all supporting Plans and revising them as needed to reflect the new *Casco Bay Plan*. Like our other supporting documents, the Habitat Plan may be revisited on an as needed basis to support adaptive management.

Casco Bay Climate Change Vulnerability Report

CBEP published the *Casco Bay Climate Change Vulnerability Report* in 2017. The assessment analyzed the potential impacts of different climate change stressors - warmer summers, warmer winters, warmer water, increasing drought, increasing storminess, sea level rise, and ocean acidification – and identified risks to implementation of the *Casco Bay Plan* 2016-2021. Eight habitat-related short and medium-term "Risks of Primary Concern" (RoPCs) were identified (H1-H8, below). Additional RoPCs were identified for water quality and community resilience, many of which also relate indirectly to habitat.

H-1: Warmer waters in rivers and streams in summer exceed thermal tolerances for some native aquatic species, leading to population declines and local extinction.

H-2: Warmer ocean water temperatures cause shifts in species' geographic ranges and the community structure of Casco Bay's ecosystem, leading to declines in some existing fisheries resources and increases in some invasive species, pathogens, pests, and disease vectors.

H-3: Rising seas and increased storm intensities cause greater demand for protection of coastal properties via shoreline hardening (which would reduce habitat value and scope for wetland migration), and therefore the need to facilitate better solutions such as living shorelines.

H-4: More winter precipitation falling as rain, earlier snow melt and less predictable precipitation lead to a shorter and less predictable spring season of high river flows, affecting fish migration.

H-5: Acidification, both in the water column and in tidal flats, caused by global and local factors leads to reduced growth and survival of some species.

H-6: Higher temperatures increase respiration rates in eelgrass, reducing net productivity and increasing mortality. (Medium-term RoPC)

H-7: Climate change leads to changes in marine and coastal food webs, altering species composition, making coastal ecosystems less resilient to other stressors like invasive species, elevated nutrients, and habitat destruction, and raising chances of the ecosystem hitting a tipping point. (Medium-term RoPC)

H-8: Sea level rise and altered hydrology in tidal wetlands (due to multiple climate stressors) shifts species composition, causes both gains and losses of tidal wetland area, and makes the wetlands more susceptible to invasion by invasive plants. (Medium-term RoPC)

Appendix B of the Vulnerability Report lists peer-reviewed climate-related Risks of Primary Concern for specific habitats and certain species, summarized in Table 4, in Section 3 of this report.

Casco Bay Monitoring Plan[2]

The Monitoring Plan (2020) established a coordinated monitoring framework for providing data to assess the status and trends in the health of Casco Bay and its watershed, identifying gaps in existing monitoring, and highlighting priorities for improving or expanding monitoring. *Habitats* are a Priority Topic, with a focus on gauging the health and extent of priority habitats, including tidal marshes, tidal flats, eelgrass beds, and connected waterways for migratory fish. The Monitoring Plan also raises questions around rock ledges, rockweed, and kelp, which it addresses as subtidal habitats. A coastal habitats conceptual model was included in the Monitoring Plan, anchored around fish passage, salt marsh, tidal flats, and eelgrass. The Monitoring Plan identified the following guiding questions for habitats status:

- Are key coastal habitats changing in size or health status?
- How is sea level affecting extent and health of Casco Bay intertidal and shallow subtidal habitats?
- What proportion of the Casco Bay watershed is in permanently protected conservation status? What proportion of high value watershed lands (buffers, shorelines, migration corridors, etc.) are permanently protected by land protection or policy?

The Monitoring Plan stands independent of the Habitat Plan, but the two documents are both part of the CCMP, support the *Casco Bay Plan*, and influence each other indirectly through adaptive management. The Monitoring Plan has influenced thinking about existing information needs regarding habitats, and this Habitat Plan may influence thinking around monitoring priorities.

CBEP Finance Plan[3]

The CBEP Finance Plan describes financial mechanisms for implementation of habitat protection and restoration strategies and actions and ensuring the long-term financial viability of habitat related strategies in the *Casco Bay Plan*.

CBEP Community Engagement Strategy

Outreach needs and priorities as they pertain to habitat protection and restoration will be evaluated as part of future *Casco Bay Plan* updates.

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[2] CBEP and U.S. EPA, 2020. Casco Bay Monitoring Plan. https://www.cascobayestuary.org/publication/casco-bay-monitoring-plan/
[3] CBEP Finance Plan, 11/4/21 Draft

Scope and Terminology

Geographic Scope

For the purposes of the *Casco Bay Plan*, Casco Bay is defined as the waters landward of a conceptual line drawn from Small Point in Phippsburg to Dyer Point in Cape Elizabeth, including the Calendar Islands and excluding the waters seaward of Halfway Rock (Fig. 2). Several rivers and coastal streams empty directly to Casco Bay, most notably the Presumpscot River, the Royal River, and the Stroudwater River, and together with smaller coastal streams and their sub-watersheds, this drainage comprises the Casco Bay watershed. CBEP's service area is defined as Casco Bay and its watershed, and this area was formally adopted by CBEP's governing Management Committee and approved by EPA.

The concept of a basin (the Casco Bay watershed) draining to a receiving water body (Casco Bay) is a useful paradigm for CBEP's management purposes as an NEP, but at ecologically relevant scales, this service area oversimplifies inherently complex interactions amongst Casco Bay and its watershed; and adjacent aquatic and terrestrial ecosystems and political entities. The most obvious omission in CBEP's service area is the Kennebec River and its watershed. The Kennebec River influences the waters of eastern Casco Bay, but the Kennebec River watershed falls outside of CBEP's service area. Another fuzzy boundary occurs in the Outer Bay. The Inner Bay is well defined, being sheltered by the Calendar Islands, but the Outer Bay is open to the ocean and becomes indistinguishable from the Gulf of Maine. Ecological interactions between the Bay and adjacent coastal areas, such as Scarborough Marsh and the Kennebec Estuary (e.g., sturgeon movement between critical habitats), are vital to the ecological integrity of Casco Bay.

Any rigid boundary will suffer from similar problems, crossing important ecological or political boundaries that may affect ecological connections or affect project implementation. For example, large, intact forested habitat patches that may be critical targets for protection of water quality often cross both watershed and political boundaries. Accordingly, this Habitat Plan, while focused on habitats and activities that benefit the ecosystems within our defined service area, takes a flexible approach to thinking about the ecological boundaries that define the CBEP Service Area.

It may eventually be worthwhile to reassess CBEP's service area and formally consider altering the service area boundary or develop policies for deciding when it is appropriate to conduct work in adjacent areas that benefit the ecological integrity of Casco Bay.

Key Species

Per EPA requirements of CCMPs, which are summarized in Section 1.2.1, this Habitat Plan lists "key species" in association with relevant habitats. Characteristics of key species include their importance to the integrity of an ecological community (e.g., keystone or indicator species), their cultural or economic significance, or their status (of concern). Their importance often leads resource managers to monitor them. Generally, the species listed have previously been named in CBEP plans and documents or those of external partners.

The Casco Bay Estuary

Casco Bay is often referred to as the “Casco Bay estuary,” but estuarine conditions and salinity levels in the Bay are dynamic and vary at different spatial and temporal scales. Throughout most of the Bay, salinity levels are almost always comparable to those further out in the Gulf of Maine, except after major storms and runoff events. Rather than being a singular, monolithic “estuary,” Casco Bay is a complex marine-driven tidal body encompassing a series of smaller coves and estuarine sub- embayments, including the Presumpscot Estuary, the Royal River Estuary, and the Fore River Estuary. Seasonal Kennebec River flows influence salinity and stratification in the Eastern Bay, leading some to consider the Eastern Bay a “reverse estuary”, as lower salinity waters influenced by the Kennebec River discharge often lie “downstream” or “offshore” from higher salinity waters in the tidal embayments of eastern Casco Bay.

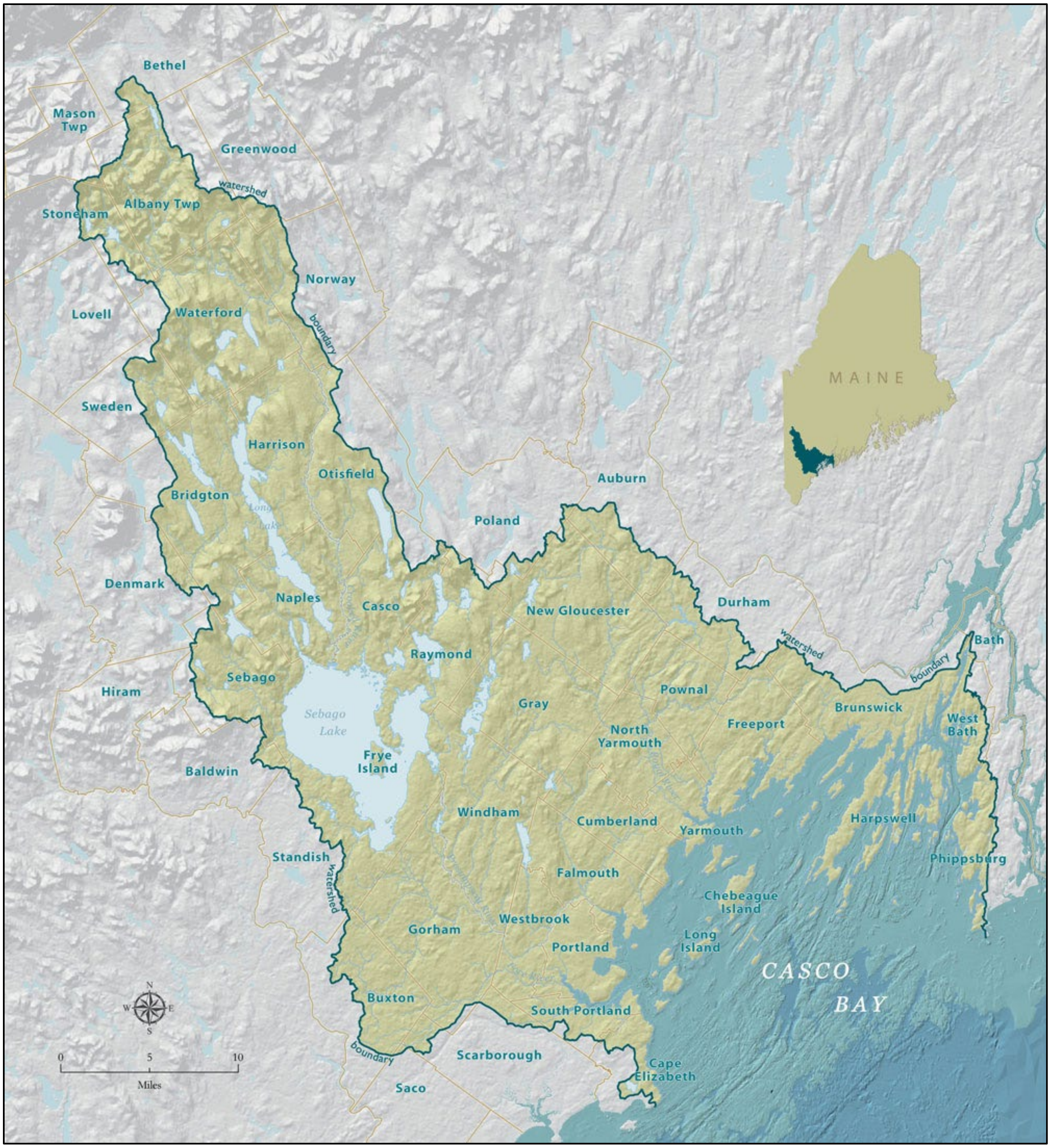

Figure 2. Map of Casco Bay and the Casco Bay Watershed

Water Column and Subtidal Habitats

The original *Casco Bay Plan* (1996) identified the marine and estuarine waters of Casco Bay as a priority habitat. The Bay's surface waters and water column continue to be important habitat. CBEP's primary interaction with the water column has historically been via consideration of water quality. For example, the 2016-2021 *Casco Bay Plan* established a stand-alone goal focused on water quality, but includes no Strategies or Actions focused on subtidal habitats other than eelgrass. *Casco Bay Plan*, Goal 2 – *Improve Casco Bay's water quality by reducing nutrient pollution and its impacts, including coastal acidification* – sets forth the strategies and actions to protect water quality.

The characteristics of pelagic upwelling zones, coarse gravel bottom, and other subtidal habitats reflect more than water quality. Underwater habitat conditions are dynamic and reflect the complex, generally unobserved, three-dimensional structure of the aquatic environment and interactions between bottom composition, tides and current velocities, light penetration, upwelling, wave energy, temperature gradients, stratification, and variation in salinity. Aquatic organisms in near-shore coastal environments live in an ever-changing three-dimensional matrix of microhabitats. These complex conditions help support the rich diversity of Casco Bay's biota.

CBEP has focused little on subtidal habitats other than eelgrass. Partly that reflects a lack of information about these ecosystems, and partly a lack of clear threats (other than degraded water quality) to the physical processes that structure nearshore habitats. Partly it reflects limited tools and opportunities to protect or restore these systems. Human activities that affect benthic habitat condition (like dredging) or hydrological microenvironments (like hydrological modification) have been considered via other portions of the *Casco Bay Plan* and have not been considered part of our habitat restoration or conservation portfolios. To some extent that is arbitrary.

This Habitat Plan is generally consistent with CBEP's established approach to subtidal pelagic and bottom habitats. It does not directly address protection and restoration of subtidal habitat and water quality, but eelgrass beds, rockweed, and kelp forests are considered as distinct habitat systems. The work of CBEP in subtidal habitat is likely to evolve through time, as Maine Coastal Program and others map the Bay's subtidal habitats and habitat protection and restoration needs become clearer. Climate change is expected to have significant effects on the submerged habitats via impacts on water depth, water temperature, salinity, and hydrodynamics. It may become necessary in the future to consider whether the changing distribution of aquatic habitats due to climate change justifies addressing submerged habitats more directly in prioritization of habitat restoration and conservation planning.

Approach

In developing the Habitat Plan, CBEP drew from several sources of information including:

1) Review of past versions of the *Casco Bay Plan* and other CBEP organizational and planning documents, including the Casco Bay Climate Change Vulnerability Report[4].
2) Recent analysis and reanalysis of conditions for the State of Casco Bay report.
3) Review of related plans at overlapping spatial scales.
4) An online questionnaire to partners, experts, and agency representatives in the fall of 2021.
5) Staff knowledge, skills, and experience.

Constraints on time, staff capacity and financial resources limited our ability at this time to conduct in-depth geospatial analysis of priority habitats or to comprehensively review scientific research pertaining to habitats and key species.

Prior Habitat Studies and Planning

Studies, Reports and Plans

Numerous habitat plans, studies of habitat needs for species of concern, and analyses of habitat priorities for specific regions have been conducted by CBEP and CBEP Partners over the years. CBEP staff reviewed numerous documents to inform development of the Habitat Plan.

Past habitat planning and analyses have occurred at multiple spatial and temporal scales, making it impossible to integrate information and priorities from prior work in a systematic way. Instead, these plans provide an implicit view of the habitat priorities and interests of organizations in the region that work closely on habitat issues. Appendices 1 and 2 provide summary tables and in-depth discussion of prior habitat-related documents.

The work of several state and federal agencies relates to CBEP's Habitat Program, including Maine DMR, Maine Division of Inland Fisheries and Wildlife (DIFW), Maine DEP, Maine Department of Agriculture, Conservation and Forestry (DACF), as well as nested programs within those agencies such as Maine Coastal Program, Maine Geological Survey, Maine Natural Areas Program and Beginning With Habitat. Federal agencies with direct responsibility for habitat include National Oceanic and Atmospheric Administration (NOAA) and U.S. Fish and Wildlife Service (USFWS). A variety of interagency groups and regional coalitions have prepared habitat plans or priorities. Agency priorities tend to emphasize the resources concerns and preferred analytic framework of each agency. Some agencies focus on individual species (such as harvested or endangered species), while others focus on habitats. Habitat classification varies.

[4] CBEP 2017. https://www.cascobayestuary.org/publication/casco-bay-climate-change-vulnerability-report/

CBEP has identified priority habitats, and habitat goals, strategies, and actions, in several officially accepted documents over the years. Prior Casco Bay plans were developed in consultation with agency partners, so CBEP priorities are generally aligned with agency plans. Overall, past CBEP habitat priorities have included:

- Salt marshes and tidal marshes
- Tidal flats
- Eelgrass beds
- Rocky shores
- Shellfish beds, bars and reefs
- Subtidal waters / estuarine and marine aquatic habitats
- Islands, especially bird breeding islands
- Freshwater wetlands (as habitat and for water quality protection)
- Rivers and streams (especially fish passage concerns)
- Freshwater wetlands
- Riparian areas, including the “edge zones” along Casco Bay shores and rivers and streams
- Upland forests near headwater streams

Upland forests, freshwater wetlands, and “riparian areas” have been included principally because of their importance to water quality. CBEP and our partners have long recognized the close link between land use (and thus condition of wetlands, upland forests, and riparian zones) and nutrient pollution, and the ecological integrity of rivers and streams; lakes; and coastal waters.

Survey of Community Priorities

CBEP staff conducted an online survey of partners, topical experts, and agency representatives in the fall of 2021 to gauge community support for different habitat priorities. CBEP received over 30 replies from over 100 invited respondents. A summary of responses is included in Appendix 3. In general, there was strong support for most historic CBEP habitat priorities, including tidal marshes, tidal flats, eelgrass beds and fish passage improvement. The groups showed significant interest in considering several subtidal habitats, chiefly eelgrass beds, kelp beds, and shellfish reefs. The group was supportive of including inland habitats in the CBEP Habitat Plan. Support was strongest for protecting upland forests (about 75%), but somewhat lower for other inland habitats, including lakes and ponds. Comments from respondents highlight that other organizations are already addressing inland habitats, so it may be appropriate for CBEP’s priorities to lie elsewhere. Responses to questions about possible geographic areas of focus were less informative, as most received some support.

Summary of Common Priorities

Perhaps unsurprisingly given the nature of CBEP’s past and current governance structure, there appears to be strong overlap between state, federal, and interagency priorities, previously identified CBEP priorities, and generally, with community priorities as captured in the 2021 survey. The survey was not structured so that terminology was consistent with this framework and beyond the top priorities, there was broad support for all habitats. Current CBEP expertise largely aligns with overlapping priority areas.

Table 1. Summary of past CBEP priorities, state, federal and interagency priorities, and community partner priorities.

Habitat Priorities	Historic CBEP	State / regional	Federal / interagency	Community Survey (top priority)	Overlap	Existing CBEP expertise
Salt marsh & tidal marshes	x	x	x	x	x	x
Tidal mudflats	x	x	x	x	x	x
Eelgrass beds	x	x	x	x	x	x
Rocky intertidal	x	x				
Sandy shorelines		x				
Shellfish reefs & bars	x	x	x			
Kelp beds		x	x			
Bay surface & water column			x	x		
Uninhabited islands	x		x			
Rivers, streams	x	x	x	x	x	x
Freshwater wetlands	x	x				x
Upland forests		x				
Lakes and ponds		x				
Terrestrial / aquatic edges	x			x		x

Status and Threats to Habitats in the Watershed

Climate Risks and Resilience

The *Casco Bay Climate Change Vulnerability Report*[5] evaluated seventy-nine potential risks to CBEP programs, marine resources, and coastal infrastructure based on seven principal climate stressors:

- Warmer Summers
- Warmer winter
- Warmer waters
- Increased drought
- Increased precipitation and greater storm intensity and frequency
- Sea Level Rise
- Ocean Acidification

[5] https://digitalcommons.usm.maine.edu/cbep-publications/23/

The report identified "Risks of Primary Concern", or "RoPCs", based on estimating the probability of each risk occurring and potential consequences. The report also highlighted that climate stressors will not act alone on coastal resources, but will interact with other stressors, like habitat loss, invasive species and changes in water quality. Impacts of climate change on habitats of concern to CBEP are pervasive.

The Bay's coastal and marine habitats are vulnerable to all seven climate stressors. In the short to intermediate term (to mid-century) warmer winters, warmer water, increased drought, increased precipitation, and sea level rise are linked to risks of primary concern.

Climate change impacts including warming temperatures and increasing precipitation have already altered distribution of aquatic species, changed salinity distributions in nearshore waters, and fostered the intrusion of invasives. Rising seas may have already affected rates of shoreline erosion and reduced resilience of tidal marshes. Future rising sea levels may reduce the harvestable area of tidal flats, inundate tidal marshes, and submerge eelgrass beds too deeply for them to persist. Where upslope migration is impossible, the area of these habitats may be substantially reduced.

Estuarine habitats, already impacted by land use development, hydromodification, high nutrient loads, and other anthropogenic stressors, are particularly vulnerable. A 2021 study commissioned by NOAA[6] convened experts representing NOAA, U.S. Fish and Wildlife Service, EPA and other institutions to evaluate the vulnerability of marine, estuarine, and riverine habitats in the Northeast. The authors specifically recommend that National Estuary Programs use the assessment findings to inform prioritization of habitat conservation activities in CCMPs. Estuarine habitats identified as having *very high vulnerability* include intertidal shellfish reefs, and native wetlands of New England, while water column, subtidal shellfish reefs, kelp beds, and submerged aquatic vegetation had *high vulnerability*.

The *Casco Bay Climate Change Vulnerability Report* identified multiple Risks of Primary Concern related to freshwater habitats due to increased intensity and duration of storm events and warming temperatures. Increased precipitation is expected to increase runoff and river discharge, causing erosion, straining infrastructure, and transporting more pollutants to downstream waters. Changes in winter snowfall and timing of snow melt may alter timing of high river flows, disrupting fish migrations. Higher water temperatures will stress cold water ecological communities, potentially leading to local extirpation of iconic species like brook trout and Atlantic salmon. Warmer waters will also accelerate algae growth and exacerbate thermal stratification in lakes and ponds, increasing water quality problems.

Upland forest, headwater streams, riparian areas and wetland ecosystems are vulnerable to several climate change stressors, including warmer temperatures, increases in precipitation and storm intensity, and increasing risk of drought. Rising summer air

[6] Farr et. al. 2021. https://doi.org/10.1371/journal.pone.0260654

temperature and changes in precipitation patterns, especially the increased risk of drought, will alter availability of soil moisture and groundwater. Hotter summers increase evapotranspiration, increasing probability of droughts at regional, local or even microhabitat scale. Climate change is likely to interact with other stressors, especially invasive pests and disease, leading to significant changes in the composition of Maine forests and wetlands and the species of plants, animals and birds they harbor.

Protecting, restoring and enhancing these habitats is important to their long-term regional resilience of natural ecosystems and human communities. Resilient tidal marshes; eelgrass beds; shellfish beds; rivers and streams; and forests, in turn contribute critical “green infrastructure” that supports resilience for human communities and the Bay through natural processes like carbon sequestration, wave attenuation, shoreline stabilization, and pollution mitigation. Strategic allocation of resources is warranted to ensure that the values associated with these habitats are sustained for the benefit, uses and enjoyment by human communities of today and of future generations.

That strategic allocation of resources should focus not only on protection and restoration of habitats but on the geophysical and biological processes that build and maintain habitat over time. Resilience of coastal ecosystems depends on the natural processes that sustain them, such as the ebb and flow of the tides, the free flow of floodwater and sediments, and the growth of biogenic structures (forests, reefs) that build habitats on which other organisms depend.

In a world with changing climate and increased uncertainty about future ecological conditions, habitat programs should eschew traditional ideas that treat habitat restoration and protection as separate activities, and instead consider how multiple activities work together to protect and restore site, ecosystem, and watershed-scale processes that can build and rebuild healthy ecosystems for generations to come.

Coastal and Marine Habitats

Threats to multiple coastal and marine habitats

Invasive Species

Invasive species are pervasive in the marine environment and widespread in intertidal habitats like tidal flats and rocky shores. Green crabs have disrupted clam flats and eelgrass beds. Certain invasive encrusting organisms known as ascidians (e.g., *Didemnum vexillum*) can dominate benthic habitats. Invasive species are exacerbated by human activities, as most invasives are introduced to new shorelines

Oil Spill Risk

Casco Bay’s coastal and marine habitats are also vulnerable to oil spills owing to the proximity to oil port facilities, storage tanks, pipelines, and the Wyman oil-fired power plant. A 1996 spill from the Julie N. oil tanker released over 179,000 gallons of heating oil into the Fore River on an incoming tide. Future vulnerability to spills depends on the evolution of the economics of the oil terminal, storage facilities, and pipeline in the Port of Portland, which is likely to be affected by any changes in the dominance of fossil fuels in

Maine's energy mix. While we anticipate petroleum will be a part of Portland Harbor for many years, changes in petroleum volume have indirect effects on funding for oil spill response.

Maine DEP maintains Environmental Vulnerability Index (EVI) maps[7] based on Environmental Sensitivity Index maps (ESIs) prepared by NOAA, last updated in 2016. EVI maps show the location and type of coastal resources at risk from oil spills, including habitat for threatened and endangered species and species of concern, shorebirds, seabird nesting islands, seasonal bird rafting areas, diadromous fish runs, shellfish bed and seed conservation areas, marine worm areas, eelgrass beds, and seal haul outs, as well as coastal marine geologic environments at risk from spills such as marshes, flats, and beaches.

Tidal marsh

CBEP has recognized tidal marsh as a priority habitat since establishment as an NEP. Tidal marshes provide nursery habitat for marine species, mitigation of flooding and storm surge, and filtration of water pollutants. Tidal marsh are highly productive ecosystems and provide important habitat for highly visible species like waterfowl and wading birds, as well as essential habitat for salt marsh sparrows and other marsh-dependent species. NOAA identifies tidal marsh as Essential Fish Habitat in commercial Fishery Management Plans.

Tidal marshes have among the highest primary productivity of any ecosystem in Maine. They sequester atmospheric carbon in organic-rich sediments, slowing increases in atmospheric CO_2. Tidal marsh productivity supports coastal ecosystems by harboring juvenile fish, protecting water quality and subsidizing nearshore food webs. The seaward edge of tidal marsh is often mudflat. Detritus exported from marshes is often an important food source for nearby shellfish.

In Maine, where property is owned to the low-tide line, tidal marshes are privately owned. State capacity to manage tidal marshes is limited.

Key Species and Communities

- *Spartina patens*; *Spartina* salt marsh / high marsh plant community
- Common reed (*Phragmites australis* -- Invasive of concern)
- Obligate marsh birds - Saltmarsh sparrow, Nelson's sparrow; wading birds (e.g., great blue heron); waterfowl (e.g., black duck)

Populations of saltmarsh sparrows are perilously low nationwide, and Casco Bay is near the northern end of their range. Saltmarsh sparrows also appear to hybridize with Nelson's sparrows in this region. Warming temperatures may result in range expansion northward, and Maine's tidal marshes may be more resilient than New England tidal marshes further

[7] Maine EVI Maps: https://www.maine.gov/dep/spills/emergspillresp/evi/

south[8]. USFWS and Maine DIFW have identified 17 marshes along Maine's coastal priorities for saltmarsh sparrow protection and restoration, including three in Casco Bay (Cousins River, Gamble Marsh in Maquoit Bay, and a marsh complex at the head of Middle Bay; Fig. 3).[9] Each of the three Casco Bay marshes has been partially protected, and each is an area of focus for additional protection by local and state conservation organizations.

Figure 3. Maine Priority Saltmarsh Sparrow Marshes. Source: Maine IFW & USFWS, 2021.

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[8] https://www.nerra.org/landscape-scale-marsh-resilience/
[9] Maine IFW & USFWS 2021.

Status

According to analysis of National Wetlands Inventory data, Casco Bay includes about 2,359 acres of tidal marsh consisting primarily of fluvial minor marsh and fringing marsh. Tidal marsh is located at the head of coves, along the perimeter of sheltered bays, and near the outlets of rivers and streams. Significant tidal marsh systems include the Cousins River, the upper Harraseeket River / Mast Landing, the upper Fore River, Long Marsh, and Mare Brook.

The distribution of tidal marsh today is difficult to put into historical context because of lack of good historic data. Extensive areas of former marsh were filled, especially in and around the Fore River, Back Cove, and the Presumpscot Estuary. Dams have impounded former tidal marsh in the Upper New Meadows and at several ice ponds in the Eastern Bay. Tidal restrictions have resulted in degradation and loss of salt marsh upstream of road crossings and other infrastructure. Some tidal wetlands were altered, and possibly expanded, by deposition of eroded soils due to poor agricultural practices in adjacent uplands. Many tidal marshes were modified to facilitate coastal industries, improve production of salt marsh hay, or convert wetlands for production of other agricultural commodities. Remnant dikes, tidal dams, roadbeds, ditching, and other modifications affect present-day marsh health. While remaining dams and other tidal restrictions are relatively well documented, secondary hydromodifications have generally not been evaluated.

Threats

Although the historic loss of tidal marsh due to human activity has not been quantified, extensive loss of tidal marsh occurred in Casco Bay as a result of filling. Comparison of early and contemporary maps illustrate that large wetland complexes around the Fore River and Back Cove were developed as industry, commerce and population grew in and around Portland. Tidal marsh around the Presumpscot Estuary was filled resulting from shipbuilding, brickmaking, and other industries. Each of these embayments received fill from the Great Fire at Portland in 1866. Shipbuilding, timber, and other industries were also prevalent in other coves around Casco Bay, and it is reasonable to assume that extensive tidal marsh fill occurred. Some fill is obvious today – such as the Route 1 and I-295 crossings of the Cousins River, and marinas along the banks of the Royal River.

The long, narrow, irregular shoreline of Casco Bay also resulted in fill of tidal marsh for construction of causeways and railroads, to shorten travel times. Many marshes have been impacted by utility infrastructure (water, sewer, etc.), with pipelines that traverse the marsh, filling remnant marsh and impeding natural hydrology.

Tidal marsh was also impacted from damming, diking, and other modifications to the natural ebb and flow of tidal and freshwater. Numerous tidal mills and ice ponds existed on tidal marshes around the Bay, and most have names or structures that are still in evidence today, such as the mill building and dam at Stroudwater Village, “Mill Creek” in South Portland, and dozens of remnant ice pond dams around Harpswell and Phippsburg.

Tidal marsh grasses were a convenient source of fodder for the livestock of early European settlers, and agricultural modifications from ditching and diking that facilitates production of salt marsh hay or other agricultural commodities are still in evidence today. The legacy of these modifications is difficult to remediate fully, and in some cases, may not be visible to the naked eye.

Although the rate of destruction of wetlands has slowed due to regulatory programs, it still occurs today. Wetland mitigation activities, now largely implemented through in-lieu wetland impact fees redistributed through the Maine Natural Resource Conservation Program, are unlikely to compensate fully for impacts to wetlands in coastal regions, where property values are especially high.

Tidal marshes are vulnerable to excess nutrients, as well invasive species, and land use change, which exacerbates non-point sources of pollution while also altering hydrology around tidal marshes.

Tidal marsh, and high marsh habitat for obligate bird species, are threatened by sea level rise. While tidal marshes are natural depositional environments and can keep up with moderate sea level rise via sediment accretion, there are limits to that natural resilience. Loss of tidal marsh due to rising seas has been well documented in the mid-Atlantic and along the shores of the Gulf of Mexico. Moreover, marshes need a supply of sediment if they are to persist, so they are at increased risk where fundamental sediment transport processes are altered by shoreline hardening or dams on rivers and streams.

Table 2. Summary of threats to tidal marsh habitat in Casco Bay.

Threat	Description
Hydromodification - primary	Current and historic restriction of tidal and freshwater flows at bridges, culverts, causeways, railways, dikes, dams, levees
Hydromodification - secondary	Historic impacts to hydrology through ditching, filling, berms, draining, fords
Subsidence	Low marsh surface elevation relative to tidal datums; results from historic tidal restriction, impoundment, hydromodification, soil chemistry changes
Sea level rise	Increases severity of current tidal restrictions; converts marsh to mudflat or pool/panne; converts high marsh community to low marsh; loss of saltmarsh sparrow nesting habitat
Saltwater intrusion	Conversion of nontidal wetlands to tidal; conversion of tidal freshwater to salt marsh
Development	Land use development in adjacent low-lying areas suitable for development of new marsh and inland marsh migration in response to sea level rise
Buffer loss	Loss of forested and vegetated buffers and edge habitat degrading habitat quality, especially for mammals and migratory birds
Stormwater	Alterations to freshwater inputs, including increases in flows due to impervious surfaces; non-point sources of pollution from septic systems, runoff
Pollution	Excess nutrients and other pollution in surface water transported by tides
Invasive species	Colonization and monoculture stands of *Phragmites australis*; bioturbation by European green crab

Impeded sediment movement	Disruption of natural sediment transport processes through shoreline hardening at bluffs and construction of dams, causeways, jetties, and other structures
Fill and disturbance	Direct disturbance or fill associated with construction and development
Contamination	Risks of spills or leaks from utilities and other infrastructure, including sewer mains, water mains, stormwater system, natural gas or oil pipelines and storage tanks, shipping and transport

Tidal mudflat

The Bay's tidal mudflats have been identified as important habitats since Casco Bay was designated an Estuary of National Significance. Extensive tidal mudflats are revealed at low tide within sheltered coves and embayments in calm, depositional areas, often abutting tidal marsh and patches or beds of eelgrass.

Mudflats support the softshell clam, quahog, and bloodworm fisheries, and provide important feeding habitat for shorebirds, including semipalmated sandpipers and other 'peeps,' waterfowl, and wading birds. The Bay is an important feeding stop for migratory shorebirds due to the extensive tidal flats. Tidal flats associated with the Fore River, Back Cove, Maquoit Bay and Middle Bay are particularly important. Tidal flats help reduce wave energy, especially at low to mid tide, thus reducing shoreline erosion.

Key Species

- Shellfish - soft-shell clam (*Mya arenaria*), quahog (*Mercenaria mercenaria*);
- Invasive species, especially the European green crab (*Carcinus maenas*);
- Shorebirds/peeps (e.g., lesser yellowlegs, *Tringa flavipes*); sea ducks (common eider, *Somateria mollisima* and black duck, *Anas rubripes*)

Status

According to analysis of National Wetlands Inventory data, Casco Bay includes 11,055 acres of tidal flats and beaches. Mudflats are located in coves, behind islands and peninsulas, and near river outlets throughout the Inner Bay. Extensive tidal mudflats are present in Fore River, Back Cove, Presumpscot Estuary, Royal River Estuary, Harraseeket River, Maquoit and Middle Bay, Winnegance Bay, and other sheltered areas. Casco Bay's mudflats are important to Maine's softshell clam, quahog, and marine worm industries.

Threats

Tidal flats have been heavily impacted by green crab, which prey upon softshell clams and other bivalves. Warming waters have likely reduced overwinter mortality of green crabs while increasing the distribution and abundance of quahogs. Warming waters may also be a factor in the increased abundance of quahogs in some Casco Bay embayments. Some flats show acidic conditions that reduce settlement of shellfish larvae and can even cause shells of young shellfish to erode.

Many intertidal flats are visited multiple times each year for commercial harvests of marine worms, softshell clams and quahogs. Shellfish harvesting from tidal flats is often restricted because of water quality concerns, including bacterial contamination, or presence of toxic marine phytoplankton. Impacts of physical disturbance associated with harvests on populations of non-target species and habitat value for migratory shorebirds have been little studied. Tidal flats are an increasingly common location for shellfish aquaculture.

While less studied in this respect than tidal marshes, tidal flats are also vulnerable to rising seas. Sea level rise may drown intertidal flats, reducing harvest ability and shifting species composition. Like tidal marshes, the ability of tidal flats to keep up with sea level rise is likely to depend on sediment supply.

- Shellfish predators, such as invasive green crabs, as well as abundant native predators, such as milky ribbon worms
- Invasive species
- Declining pH / Coastal acidification (directly on sediment pH and indirectly via impact on shellfish larvae)
- Sea level rise
- Reduced sediment supply. Shoreline hardening or dams and other aquatic barriers can trap sediments, reduce sediment supply and disrupt sediment transport processes.
- Water pollution, especially bacteria contamination
- Toxic contaminants
- Loss of adjacent forested and vegetated buffers and edge habitat
- Overharvesting
- Direct disturbance / fill
- Derelict fishing gear
- Oil spills

Eelgrass beds

Eelgrass beds have been recognized as priority habitats for CBEP since it was formed. At present, most of Casco Bay's eelgrass is subtidal, although low-intertidal eelgrass may have been more abundant in the past.

Eelgrass is a valuable and vulnerable resource. As a habitat, it provides food for migratory winter waterfowl and serves as nursery habitat for fish and shellfish. It helps sustain and improve water quality by stabilizing sediments and filtering nutrients and suspended particles. Productive eelgrass beds remove carbon dioxide from the water and sequester organic carbon in marine sediments. They thus both ameliorate coastal acidification and slow accumulation of CO_2 in the atmosphere. Eelgrass beds help dampen wave energy and reduce sediment resuspension and shoreline erosion.

Key Species

- Eelgrass (Zostera marina)
- European green crab (*Carcinus maenas*)

Status

Casco Bay supports some of the most extensive contiguous eelgrass beds in Maine, but mapping has been limited, making it difficult to assess changes in status prior to the mid-

1990's. Barry Timson of Maine Geological Survey mapped Maine's coastal geology in the 1970's and developed maps that included eelgrass[10], but Casco Bay's eelgrass beds are thought to have been only partially mapped through this effort. Eelgrass distribution in the Bay was not thoroughly mapped until USFWS did so in 1995[11] based on data developed by Maine DMR based on data collected in 1993-94. The distribution and extent of Casco Bay's eelgrass beds has been mapped regularly since that time, over which the total area of eelgrass has ranged from a high of 8,199 acres in 2001-02 to a low of 3,652 acres in 2013 following a rapid increase in green crabs. Most recently, in 2018, Maine DEP mapped 5,033 acres of eelgrass. The distribution and abundance of eelgrass has increased over 2013 lows, and beds are denser. Maine DEP intends to map Casco Bay's eelgrass beds next in 2023.

Widespread declines in bed area and density in 2013 are believed to have been driven primarily by green crab disturbance. Intensive monitoring of eelgrass beds near Portland indicates that recent efforts to reduce nitrogen loads from nearby wastewater treatment facilities have likely benefited nearby eelgrass.

The *Casco Bay Plan* 2016-2021 directed CBEP to lead efforts to pilot eelgrass restoration, following a successful experimental project to test different methods for transplanting eelgrass. Observations over the next year of natural eelgrass recruitment in areas of recent loss tempered community concerns and led to reduced interest in active restoration. Funding entities became reluctant to fund larger-scale restoration efforts.

Threats

Eelgrass generally grows subtidally in Casco Bay and requires sufficient light penetration through the water column to reach its slender leaves. Eelgrass is therefore vulnerable to plankton blooms, high turbidity water, smothering by sediments, and other stressors that reduce light availability, such as docks, piers, and moorings.

Exploding populations of European green crab around 2012 are implicated in widespread losses of eelgrass cover documented in Maquoit Bay, Middle Bay, and adjacent areas. While eelgrass has recently recovered somewhat from those losses, warming water temperatures are ever more hospitable to green crabs, which cannot survive extended periods of cold typical of winters of the past. Warming waters may also increase the vulnerability of eelgrass to low light conditions, epiphytic growth by invasive tunicates, and eelgrass wasting disease.

Eelgrass is also vulnerable to sea level rise, with deeper waters reducing light to the deep edge of eelgrass beds, as well as other climate stressors such as increased intensity and frequency of storms, which accelerate delivery of pollutants to coastal waters, shoreline erosion, and physical damage to eelgrass.

[10] Maine State Planning Office 1983.

[11] Banner and Libby 1995

Eelgrass beds can be directly impacted by dredging, although it is difficult to evaluate the historic impacts of dredging, since dredging predated eelgrass mapping. Altered bathymetry of active harbors reduced the extent of intertidal and shallow subtidal habitat suitable for eelgrass due to dredging, filling of shorelines, construction of piers. Direct impact from scarring, resulting from commercial shellfish dragging, mooring chains, or propellers, is also a threat to local beds.

Eelgrass may also be impacted by the boom in commercial aquaculture around Casco Bay, but the impacts of aquaculture on eelgrass beds are not well understood and warrant investigation.

- Water pollution – excess nutrients and sediments
- Invasive species – green crabs (disturbance); tunicates (fouling)
- Scarring from dragging, trawling, moorings and propellors
- Shading from docks, piers, moorings
- Conflicts with aquaculture and other commercial fisheries
- Dredging
- Sea level rise
- Warming waters

Rocky intertidal

Rocky intertidal habitat is an iconic element of the Maine coast, serving as the foreground of imagery from Nubble Light to Acadia National Park.

Rocky intertidal areas form on wave-swept shores and provide habitat for a wide range of fish and wildlife. Rocky shorelines with exposed intertidal bedrock host specialized ecological communities comprised of organisms that require a hard substrate for attachment, such as rockweeds, barnacles and blue mussels, and other organisms that shelter within the three-dimensional canopies formed by seaweed. Rocky shores also provide recreational opportunities such as picnicking, birdwatching, tide pooling, and swimming. They are thus an important and much-loved component of Casco Bay's coastal tourism economy.

Rockweed, like other marine algae, takes up carbon dioxide and nutrients from the water, locally remediating coastal acidification and improving water quality.

Key Species

- Rockweed (Ascophyllum nodosum);
- blue mussel (*Mytilus edulis*);
- European green crab (*Carcinus maenas*)

Status

According to analysis of National Wetlands Inventory data, Casco Bay includes 3,241 acres of rocky intertidal habitat. The Bay's rocky intertidal habitat is prevalent along the most exposed shorelines in the outer bay as well as the seaward side of inner islands and peninsulas. The coast from Willard Beach in South Portland seaward to Two Lights State Park in Cape Elizabeth is predominantly rocky intertidal.

Threats

A commercial fishery exists for rockweed, which is a standard material for packing live lobsters and bloodworms for shipping. Rockweed is also used in a range of products ranging from fertilizer to cosmetics. While current harvests are thought to be small in Casco Bay, data is limited.

Rocky intertidal habitats have been impacted by invasive species, particularly green crab, Asian shore crab, and invasive ascidians.

- Invasive species – green crab, Asian shore crab, tunicates
- Water pollution
- Loss of habitat due to docks and piers
- Overharvesting – seaweed (rockweed, dulce)
- Sea level rise
- Warming waters

Shellfish bars and Reefs

Certain shellfish species form dense aggregates known as shellfish bars or reefs with emergent habitat values. Shellfish reefs create three-dimensional structure that improves water quality, affects local hydrodynamics, alters habitat conditions, and hosts a diversity of other animals. Under suitable circumstances, these reefs or bars can reduce wave energy, or protect shorelines from erosion. Blue mussels (*Mytelus edulis*) can form clustered beds in intertidal and subtidal areas with higher salinity. In recent centuries, blue mussels have been the principal bed or reef-forming bivalve in Casco Bay. Mussels were described as "particularly abundant … in areas which have good circulation of water" in 1989, when the Bay was nominated for the NEP. These "ephemeral" mussel bars were also recognized as particularly important as food resources for eiders and black ducks. Today, blue mussel "bars" are considered to be relatively scarce, likely due to green crab predation, but the extent of loss hasn't been measured.

Although Eastern oyster shells are common in shell middens on Casco Bay islands, and oysters were reportedly in evidence in the Fore River and Quahog Bay 150 years ago[12], Eastern oyster (*Crassostrea virginica*) are relatively uncommon in Casco Bay today, and are not believed to form reefs, although that could change with warming water. Clusters of *European* oysters (*Ostrea edulis*), thought to have been introduced to Casco Bay in the early 20th century, are common. European oysters are known to form reefs in their native waters, but the presence of European oyster reefs in Casco Bay has not been documented.

Key Species

- Blue mussel (*Mytilus edulis*),
- Eastern oyster (Crassostrea virginica),

[12] Verrill 1873 in CBEP 1992.

- European oyster (*Ostrea edulis*),
- European green crab (*Carcinus maenas*)

Status

The distribution, abundance, and composition of Casco Bay's shellfish beds may have experienced dramatic shifts over the last decade, but there is insufficient information available to quantify those changes and fully understand the implications of these changes for the Bay's estuarine and marine ecosystems.

Between 2008 and 2010, Maine Department of Maine Resources (DMR) coarsely mapped the distribution of blue mussels, Eastern oysters, European oysters and other shellfish in communities with municipal shellfish programs, based on reports from local harvesters. Unfortunately, little information is available regarding emergent habitat values, and available maps are not regularly updated, making it difficult to ascertain the location of reefs or to track changes over time. Prior maps of Casco Bay's shellfish harvest areas were prepared in 1995 based on data developed by Maine DMR[13] but did not differentiate between blue mussels, soft shelled clam, northern quahog and sea scallop beds.

Historically, the Bay has supported a robust commercial harvest of blue mussels, which were so abundant they were perhaps taken for granted. Presently most harvest of blue mussels is via aquaculture and blue mussels are thought to be less abundant than in decades past[14]. Most mussel aquaculture is dependent on settlement of wild mussel larvae, linking aquaculture harvests to wild populations.

Threats

Reef-forming shellfish face several threats including predation by European green crab, coastal acidification resulting from higher atmospheric carbon and high nitrogen levels, and commercial harvest. Blue mussels are particularly vulnerable to green crab predation, and the explosion in European green crab populations circa 2012 coincided with anecdotal reports of widespread losses. The extent of losses, however, is undocumented, making it difficult to quantify the resulting impacts to water quality and habitat.

Warming waters enable green crabs to survive Maine's winters. Warming waters may also be a factor in the reported increases in abundance of quahogs and European oysters. If waters continue to warm, Eastern oysters may further expand in Casco Bay.

Shellfish beds may also be impacted by the boom in commercial aquaculture around Casco Bay, but the impacts of aquaculture on shellfish beds are not well understood and warrant investigation.

- Invasive species – green crab; invasive tunicates
- Water pollution – excess nutrients; bacterial contamination; phytotoxins

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[13] Banner and Libby 1995.
[14] Sorte *et al*. 2013

- Dredging
- Overharvesting
- Trawling
- Warming waters
- Sea level rise
- Coastal acidification
- Oil spills

Kelp beds

Kelp are brown macroalgae that grow in shallow subtidal areas on hard substrates including bedrock and coarse gravel.

Kelp beds, also referred to as kelp forests, are important marine ecosystems that provide habitat to fish and wildlife through floating three-dimensional leaf structures. Kelp beds support a wild kelp fishery during the winter. The extent of the wild harvest in Casco Bay is thought to be relatively small. Kelp takes up nitrogen and sequesters carbon, helping to protect water quality, and reducing the impact of coastal acidification. Kelp may also be susceptible to reduced light availability from suspended sediments, algal blooms, and other types of shading. Kelp aquaculture is a growing industry along Maine's coast. Kelp is susceptible to increased abundance of sea urchins and may be threatened by warming waters, but little is known about urchin populations.

Key Species

- Sugar kelp (Saccharina latissima)
- Bladder wrack (Fucus vesiculosus)

Status

The distribution of Casco Bay's kelp beds is not well documented, but modeling efforts are underway. Kelp aquaculture, principally based on growing sugar kelp during the winter month, has been growing in Maine waters and in Casco Bay. As of fall of 2020, there were eight licensed full aquaculture leases and thirty-six limited purpose aquaculture licenses active in Casco Bay growing sugar kelp or other marine algae.

Threats

- Marine invasive species, including invasive tunicates and bryozoans
- Commercial fishing
- Warming waters

Islands

Casco Bay includes over 750 islands, islets, and exposed ledges at mean high tide. The Bay's islands provide nesting and roosting habitat for seabirds, wading birds, osprey and eagles and serve as seal haul-outs and wintering habitat for waterfowl.

The Bay's islands, particularly uninhabited seabird nesting islands, have been identified as priority habitats for CBEP since it was founded, although islands were not explicitly identified as priorities in the 2016-2021 Plan. Earlier planning documents typically focused on islands as nesting habitat for seabirds or as seal haulouts.

Some inner Casco Bay islands are important habitat for colonial nesting seabirds (e.g., the common eider, double-crested cormorant, herring gull, great black-backed gulls). Uninhabited outer islands often provide prime nesting sites for other species, including common tern, roseate tern, artic tern, black guillemot, and common eider, in part because they are inaccessible to common terrestrial predators.

Islands and ledges provide other important habitat values. Casco Bay's islands are ringed by rocky intertidal habitat beneath exposed bedrock, and the sheltered sides of islands host eelgrass beds, tidal flats, shellfish beds and fringing salt marsh. Islands interact with tidal currents, driving upwelling and mixing of surface and deeper waters and contributing to the productivity of marine ecosystems. Smaller islands and ledges are important locations for seal haulouts. Many islands are important recreational destinations; the Maine Island Trail, managed by the Maine Island Trail Association in partnership with landowners, provides recreational access to boaters.

Key Species

- Nesting seabirds: Common tern (*Sterna hirundo*), roseate tern (*Sterna dougallii*), artic tern (*Sterna paradisaea*), black guillemot (*Cepphus grylie*), common eider (*Somateria mollisima*)
- Marine mammals: Harbor seals (*Phoca vitulina*), gray seals (*Halichoerus grypus*)
- Striped bass (*Morone saxatilis*), Atlantic mackerel (*Scomber scombrus*)

Status

Several organizations focus on a handful of islands in Casco Bay in various capacities, with emphasis on either 1) socio-economic resilience of inhabited islands; 2) recreational access where permitted; or 3) conservation and management of seabird nesting islands. Beyond the handful of islands where focused work on these issues is underway, there are extensive knowledge gaps about the Bay's island habitat. No single organization or entity systematically monitors Casco Bay's island habitats.

The best available information on island habitats is provided in the Maine DEP's Environmental Vulnerability Index (EVI) Maps. The EVI maps for Casco Bay were partially updated in 2016 and document threatened resources in tidal and marine waters, providing information on the location of seabird nesting islands, seal haul-outs, and essential habitat for bald eagles, harlequin ducks, and other plants and animals of concern.

When the 1996 *Casco Bay Plan* was published, 50 seabird nesting islands were documented in the Bay, of which 17 supported nationally significant populations of nesting birds. Collectively, these were inhabited by an estimated 15% of the state's nesting seabird population. The Bay's islands are also important habitat for several wading birds, including great blue herons, black-crowned night herons, glossy ibises, and snowy egrets. Active or historic tern nesting islands in Casco Bay include Jenny Island, Clapboard Island Ledge, The Nubbin, Sister Island Ledge, Grassy Ledge, and Outer Green Island. CBEP's allocation of resources toward islands shifted over the last decade, following several successful island protection and seabird nesting restoration projects, reflecting shifts in CBEP strategic priorities and partner capacity.

Threats

Direct human disturbance is likely the most significant threat to island habitats. Seals and nesting birds are readily disturbed and abandon sites with substantial human use. Impacts can be substantial even on uninhabited islands. Several uninhabited Casco Bay islands are visited by hundreds of visitors each summer. In addition to disturbing birds and animals at rest, human visitors destroy native vegetation, introduce Invasive species, and leave behind trash and other debris.

Changing ocean conditions will also affect islands. Warming of the Gulf of Maine has resulted in well documented changes in abundance of many marine species that provide food for island-nesting birds. Rising seas will drown some smaller islands and ledges.

- Human inhabitance and development; recreation
- Invasive species, including invasive terrestrial plants
- Introduced predators, feral pets
- Warming waters
- Sea level rise

Freshwater Habitats

Rivers and streams; freshwater wetlands and riparian areas; and lakes and ponds are important freshwater habitats in the Casco Bay watershed. Freshwater habitats have been impacted by centuries of human activity that altered hydrology, morphology, connectivity, location, water quality and natural processes, compromising the ability of many freshwater habitats to sustain functions essential to long-term ecosystem health.

Rivers and streams

Rivers and streams deliver fresh water, sediments, nutrients, dissolved oxygen, detritus and wood to coastal ecosystems and provide critical links between Casco Bay and upstream aquatic and terrestrial habitats. Healthy streams offer other values, including recreational opportunities (fishing, boating, swimming), flood flow regulation, hydroelectric power, and drinking water supply.

Rivers and stream habitats in the Casco Bay watershed have been impacted by centuries of direct hydromodification, by past forestry and agricultural practices, and by suburban and urban development. Direct hydromodifications resulted from construction of mills, roads, railroads, dams, canals, towpaths and other structures. Throughout Maine, stream channels were historically modified to accommodate timber harvest and transport, and the entire watershed has been logged two or three times over.

Stream continuity is critical to aquatic organisms such as invertebrates, fish, amphibians, reptiles and mammals. Dams and poorly designed culverts beneath road and rail crossings fragment aquatic habitat, degrade stream and river habitat and interrupt the exchange of organisms and nutrients between freshwater and marine ecosystems.

Loss of forest and other land use changes like urbanization degrades both stream habitat and water quality. Conversion of forested areas to agriculture and development has increased runoff, driving erosion of stream banks to accommodate higher flows and depositing sediments into stream beds and altering stream bed habitat. High sediment loads tied to bank erosion or poor agricultural practices can adversely affect habitat structure and affect species of concern like freshwater mussels. Stream ecosystems depend on the stream side ("riparian") forest to ameliorate summer water temperatures and provide the leaf litter that forms the base of stream food webs. Habitat quality, as revealed by stream invertebrate communities, tends to be lower in urban and suburban areas. Rates of residential and commercial construction are accelerating. For example, annual residential building permit applications increasing from 722 in 2011 to 1,784 in 2018[15]. In high growth areas, this rapidly increases levels of impervious surface area to critical thresholds associated with water quality degradation.

Casco Bay is directly fed by numerous coastal streams and three main stem rivers (the Presumpscot, Royal, and Stroudwater) whose fresh waters mix with seawater to form estuarine sub-embayments.[16] These three drainages comprise most of Casco Bay's watershed and historically, supported diadromous species including shad, blueback herring, alewives, American eel, rainbow smelt and Atlantic salmon, as well as striped bass and sturgeon. Coastal streams support rainbow smelt, tomcod, and sea-run brook trout among other anadromous species. Together with American eel, these diadromous species are integral to both healthy freshwater and marine ecosystems, transporting essential nutrients and serving as prey for cod, haddock and striped bass and supporting marine fisheries.

In the Casco Bay watershed, each main stem river was dammed at or near head of tide decades or centuries ago for industrial and hydroelectric purposes. Construction of main stem dams severed connections between the Bay and spawning habitats for anadromous fish, resulting in the local extirpation of these species. Focused efforts to restore stream connectivity and fish passage have resulted in partial restoration of anadromous fish to spawning habitat in the Presumpscot River and its tributaries, but much work remains to

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[15] CBEP 2021. State of Casco Bay.
[16] Other so-called "rivers", including the New Meadows River, Harraseeket River, and Fore River are principally tidal embayments. The Outer Bay is influenced by freshwater flows from the Kennebec River, but because the Kennebec River watershed is outside of CBEP's service area, habitat considerations in the Kennebec are omitted from this plan.

restore connectivity in the Presumpscot, Royal, and Stroudwater Rivers as well as coastal streams.

American eel elvers (glass eels), which are netted below head of tide on the Bay's rivers and coastal streams, support a lucrative seasonal commercial fishery. Alewife and river herring are harvested elsewhere in Maine. While populations of river herring on the Presumpscot are now increasing, diadromous fish in the Casco Bay watershed do not yet support commercial harvesting.

Key Species

- River herring: Alewife (*Alosa pseudoharengus)*, blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*),
- Rainbow smelt (*Osmerus mordax*),
- Eastern brook trout (*Salvelinus fontinalis*),
- landlocked salmon (*Salmo salar*),
- Brook floater (Alasmidonta varicose; a freshwater mussel)

Status

There are over 1,300 miles of rivers and streams in the Casco Bay watershed. Although Maine DIFW, Maine DEP, and other agencies and organizations have conducted a variety of habitat and water quality surveys, no go-to resource provides ready access to mapped habitat characteristics. Some individual streams, particularly impaired water bodies surveyed as part of preparation of watershed plans, have completed geomorphic assessments and in-stream habitat surveys, but such surveys are scattered and scarce.

A survey of the Casco Bay watershed conducted in 2008-2010 found 573 severe (or assumed severe) barriers to fish passage and 551 potential barriers to fish passage, comprised primarily of dams and problem culverts beneath roads and railways[17]. Concerted efforts over the last two decades to restore anadromous fish passage to spawning habitat in the Presumpscot watershed are paying off in increased returns of alewife, blueback herring, and shad, but much work remains. On the Royal River and Stroudwater River, efforts to restore anadromous fish access to spawning habitats have yet to produce any results. On small coastal streams, and on freshwater tributary streams, inadequate, undersized, and poorly built culverts are a nearly ubiquitous barrier to aquatic connectivity and fish passage, although some dams degrade and disrupt habitat as well.

Threats

- Loss of riparian forest and other vegetation within riparian zones; erosion
- Changes in land use, especially those related to loss of wetlands, riparian forests, or changes in stream hydrology
- Fragmentation and loss of aquatic habitat connectivity, including:

[17] CBEP 2015, State of the Bay Report.

    - Disrupted stream processes including transport of flood waters, sediments, wood, nutrients and aquatic organisms
    - Conversion of free-flowing riverine habitat to impoundments
    - Flow obstructions & modifications including dams, inadequate culverts and remnant stream alterations
- Non-point source and point-source pollution, including impact of winter deicing products ("road salt"), toxic contaminants in urban runoff, and high sediment loads, which blanket stream bottoms and degrade benthic habitat conditions
- Warming water temperatures
- Increased frequency and severity of storms

Threats to Migratory Fish

In many ways, Casco Bay is cut off from the freshwater rivers and streams that flow into it throughout the watershed. Continuity of aquatic habitats has been heavily fragmented by construction of dams, roads, rail lines, and pipelines. These structures have interrupted natural riverine processes such as the transport of cold water, flood water, sediments, and wood while severely constraining the seasonal movement of aquatic organisms such as anadromous fish and eastern brook trout into critical habitats. These structures also directly alter riverine habitat, converting coldwater rivers and streams to warm-water impoundments, resulting in degraded water quality and a shift in ecological communities towards generalist, stress-tolerant species assemblages.

Anadromous fish are critical to both estuarine and riverine ecosystems, and are important prey for cod, haddock, and other marine finfish. Today, the distribution, abundance and composition of anadromous fish in the Bay and its watershed is greatly diminished from levels of the past. Anadromous fish used to have access to all of the primary freshwater rivers flowing to the Bay, including the Presumpscot River, the Royal River, and the Stroudwater River, as well as their major tributaries, but today, access to historic habitat is limited to a portion of the Presumpscot River, and to a few tributaries including East and West Branch Piscataqua River, Mill Brook, and Little River. Restoring anadromous fish requires addressing dams, inadequate culverts, and other barriers to passage into critical habitat.

Rivers and streams are also threatened by the conversion of forested areas to developed areas, particularly construction of roads, buildings, houses and other impervious surfaces, which alter the surface and subsurface hydrology while accelerating delivery of non-point source pollution to water bodies. The loss of forested and vegetated riparian buffers along rivers and streams exacerbates the impacts of development while also impacting habitat values for terrestrial species that move along the corridors.

Rivers and streams are vulnerable to climate change, especially warmer water, warmer winters, and increased intensity and frequency of storms.

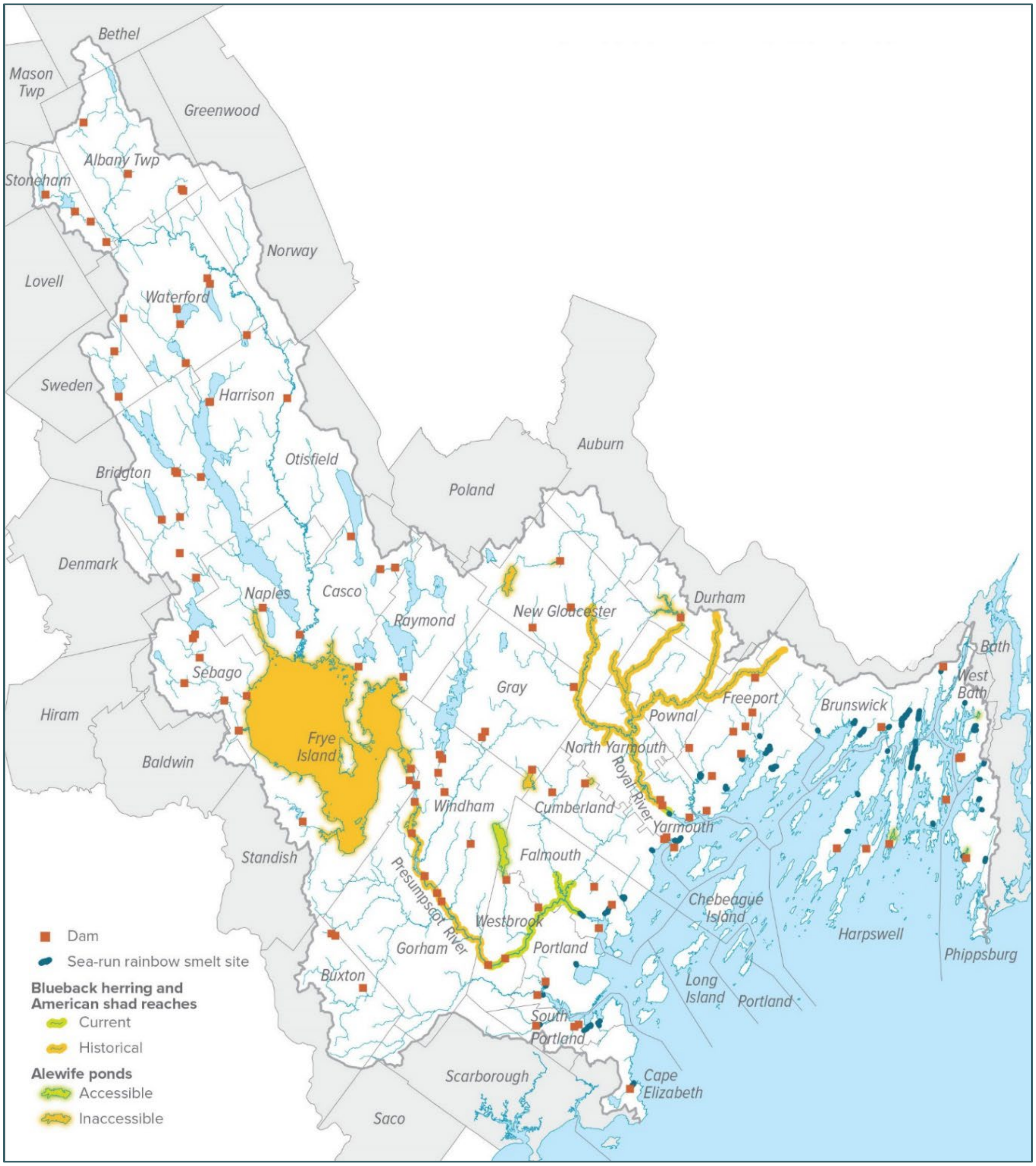

Figure 4: Present and historic habitat for migratory fish in the Casco Bay watershed

Freshwater wetlands and riparian areas

Freshwater wetlands in the watershed include bogs, fens, marshes, lake margins, wooded swamps, and vernal pools. Many wetlands provide storage of floodwaters during high flow events, reducing downstream flooding. They are sites of both groundwater recharge and discharge, and thus play an outsized role in hydrological processes. Wetlands reduce water velocities, trap sediment, and remove nutrients from ground and surface water.

Riparian areas (the shores of streams, rivers, lakes and ponds) are important links between terrestrial ecosystems and the surface waters and wetlands. Riparian areas often include floodplains, freshwater wetlands, vernal pools and other important habitats. Many animals use these areas for shelter, feeding, nesting, and movement. Riparian areas buffer aquatic habitats from adjacent land uses and filter runoff, reducing non-point source pollution. Because they often form continuous or near continuous forested corridors across otherwise developed urban or agricultural landscapes, riparian areas provide long-distance movement corridors utilized by many forest-loving birds and mammals, from racoon to moose and bear.

Wetlands and riparian areas are important habitats for shorebirds, wading birds and waterfowl. They provide essential habitat for a wide variety of insects, mammals, and birds, from dragonflies to wood duck. Riparian areas are also important refugia from high current velocities for fish and other aquatic organisms during floods. Development too close to wetlands and riparian areas can significantly degrade habitat values.

Key Species

None specified

Status

National Wetlands inventory data suggest there are more than 45,000 acres of “palustrine” wetlands in the Casco Bay watershed. That figure includes most wetlands, excluding lakes and rivers. Recent data on changes in wetlands in the Casco Bay watershed is limited. Available watershed-wide land cover data is not high enough resolution to allow accurate evaluation of condition of riparian buffers. Buffers in forested landscapes are often largely intact, while in agricultural or suburban areas, they are more degraded. Loss of riparian forest, destruction of stream-side vegetation, filling of floodplains, and other direct impacts are most common in urban areas.

Freshwater wetlands are protected through Maine’s Natural Resources Protection Act, and by Section 404 of the Federal Water Pollution Control Act but permitted fill and alteration to wetlands remain possible via permitting programs. Permitting programs often require “mitigation” for unavoidable impacts to wetlands. Today, mitigation is often accomplished through payment of in-lieu wetland impact fees via Maine Natural Resources Conservation Program (MNRCP).

Riparian areas receive limited protection through Maine’s Shoreland Zoning program, which is implemented principally at the municipal level. Construction and clearing of vegetation are generally limited within 75 feet of protected waters, although details and implementation vary from town to town.

Threats

- Direct impacts due to development, hydromodification, and other human activities such as filling and draining

- State-minimum guidelines for stream setbacks are not sufficient to maintain all habitat values nor fully to buffer streams from adjacent land use impacts. Most municipalities adopt state-minimum guidelines in local ordinances.
- Mowing and cutting of riparian areas can significantly reduce water quality and habitat values.
- Changes in groundwater and surface water hydrology due to changes in land use in adjacent uplands or climate change (increased frequency or severity of storms; increased risk of drought)
- Water pollution – non-point and point source
- Invasive species

Lakes and ponds

The Casco Bay watershed encompasses several large inland water bodies including Sebago Lake – the drinking water supply for much of Greater Portland – and numerous smaller lakes and ponds. Nevertheless, the initial *Casco Bay Plan* (1996) expressly excluded lakes and ponds as priority habitats because they were “less directly linked to Casco Bay.”

Lakes and ponds are important habitat for fish and wildlife as well as important drivers of regional tourism, supporting fishing, boating, hunting and other water sports. Connectivity between Casco Bay and freshwater lakes and ponds occurs through watershed rivers and streams and provides important exchange of aquatic organisms and nutrients between Casco Bay and inland water bodies. Many lakes and ponds are artificially impounded by outlet dams that regulate water levels and constrain downstream flows movement of water, sediment, wood, and nutrients, and act as barriers to fish migration. State and federal resource managers have identified a few lakes and ponds as historic or current spawning habitat for alewives. Sebago Lake provides important habitat for land-locked Atlantic salmon.

The fish community of many Maine lakes and ponds has been significantly altered by introductions and relocations (official, unofficial, or accidental) of gamefish, baitfish, and other non-native species. Many non-native gamefish are now well established, and important recreational resources. Some populations of species that are native to Maine are also the result of introduction by humans. These introductions and relocations have had a significant effect on native fish communities.

Key Species

- Common Loon (*Gavia immer*)
- Alewife (Alosa pseudoharengus)
- White sucker (Catostomus commersonii)
- Yellow perch (Perca flavescens)
- Chain pickerel (*Esox niger*)
- Eastern brook trout (*Salvelinus fontinalis*)
- Lake trout (Salvelinus namaycush)

- Landlocked Atlantic salmon (*Salmo salar*)
- Smallmouth bass (*Micropterus dolomieu*; introduced)

Status

The presence of dams, natural waterfalls and barriers, and problem culverts has severed nearly all the connections between Casco Bay and inland lakes and ponds. Currently, just two freshwater lakes and ponds are known to support annual alewife runs in the Casco Bay watershed: 1) Highland Lake in Falmouth, Westbrook and Windham, and 2) Great Pond in Cape Elizabeth, and in each case migrating fish must pass above a dam to reach spawning habitat. Historically, Sebago Lake also supported alewife runs, but it is currently inaccessible due to the presence of six dams along the main stem of the Presumpscot River. A few other lakes and ponds may have the potential to support alewives following dam removal or construction of fishways.

Invasive aquatic plants can significantly alter aquatic habitat structure in Maine lakes. Variable-leaved water milfoil (*Myriophyllum heterophyllum*) is already established in several lakes in the Casco Bay watershed, including Sebago Lake and Long Lake, as well as in the impoundments along the Presumpscot River.

Threats

Lakes and ponds are threatened by poor water quality and destruction of riparian habitat. Both factors are exacerbated by shoreline development driven by recreational value of inland waters. Invasive species are a particular concern. Invasive species are usually introduced to lake watersheds inadvertently, but anglers sometimes introduce game or bait fish on purpose. Aquatic plants and other invasives can be transported from one lake to another inadvertently by boaters.

- Development and changes in land use can affect input of nutrients and other pollutants to lakes and can degrade riparian forests and degrade quality of shoreline habitat for fish, invertebrates, waterfowl and wading birds.
- Water pollution, especially enrichment of lakes with excess phosphorous leading to "eutrophication"
- Increased frequency and intensity of storms may increase input of pollutants, especially phosphorus.
- Warming waters may harm cold-water fish communities. Warmer temperatures are also expected to increase duration and strength of thermal stratification, with negative effects on water quality, especially nutrient cycling, algae blooms and dissolved oxygen.
- Mercury deposition, derived principally from air pollution from powerplants to our west can accumulate in freshwater fish, leading to fish consumption advisories, and negative effects on fish-eating birds like loon, osprey, and eagle.
- Dams block movement of aquatic organisms between lakes and ponds and downstream water bodies
- Lake associations sometimes have concerns about impacts of restoration of anadromous fish runs, especially alewife, on other fish and on lake water quality.

- Invasive species, including invasive aquatic plants, can have a profound effect on lake and pond ecosystems. Invasive fish, cladocerans and mollusks, while not yet documented in Maine lakes, also put Maine lakes at risk.

Upland Forests

Upland forests have seldom been identified as a priority habitat in their own right by CBEP, but CBEP has highlighted their importance for protecting water quality, maintaining watershed hydrologic processes, and supporting aquatic ecosystems.

Upland forest protects water quality by regulating the volume, timing, and rate of surface water runoff and groundwater discharge to downstream receiving waters. The rivers and streams that empty to Casco Bay are fed by headwater streams that emerge from forested uplands and wetlands. Maintaining forest cover protects headwater streams at their source. Forests shade these small streams, maintaining cool water temperatures and dissolved oxygen levels critical to cold water macroinvertebrate and fish communities. Because of complex microtopography and permeable soils, forests are critical locations for groundwater recharge. Clean, cold, oxygen rich groundwater enters nearby waters, further cooling waters, and providing thermal refugia for cold water species during the warmest parts of the summer. Forests also provide leaf litter that anchors the food web of small to mid-sized streams. The Class AA Crooked River, the primary tributary to Sebago Lake, is fed by several forested headwater streams. Statewide, stream macroinvertebrate communities associated with forested watersheds are more diverse than those found in watersheds with even moderate levels of forest loss.

Forests help protect water quality by capturing and retaining sediments, nutrients and other pollutants. Levels of many pollutants tend to be higher in waterbodies found in watersheds with a lower proportion of forest. Export of nutrients like phosphorus and nitrogen is exceptionally low from intact forest as compared with urban or agricultural lands. Health of both lakes and coastal waters in the Northeast is generally correlated with higher percentages of forest in source watersheds. Loss of upland forest can increase runoff, and thus risk of downstream flooding.

Large tracts of unfragmented forest also provide other benefits. They provide interior forest habitat that supports forest-dependent birds and wildlife. Forestlands support timber harvesting and timber-related industries. Forests trails are widely used for recreation, including hiking, biking, and snowmobiling. Forests trees capture large quantities of carbon dioxide as they grow. A portion of that carbon is sequestered for decades in living trees and for centuries in forest soils.

Key Species

- Eastern brook trout (*Salvelinus fontinalis*)
- Landlocked Atlantic salmon (*Salmo salar*)
- Wood thrush (Hylocichla mustelina)
- Canada Lynx (Lynx canadensis)

Status

National Land Cover data collected at five-year intervals show a net loss of forest cover between 2001-2016 of about 16 square miles, but the rate of loss appeared to slow in each successive five-year period between 2001-2005, 2006-2010, and 2011-2016. The overall rapid loss of forest cover was noted by a U.S. Forest Service report that ranked the Casco Bay watershed first among 33 threatened Eastern and Midwestern watersheds at risk of development of private forests near drinking water supply areas[18]. Current trends (since 2016) are unclear and may have changed because of development pressures associated with the Covid-19 pandemic, which have dramatically increased property values.

It is difficult to quantify, but much of the watershed's forested land is actively managed for periodic timber harvest. The extent of protected forest land in the watershed has also increased over the last twenty years.

[18] Barnes et al 2009

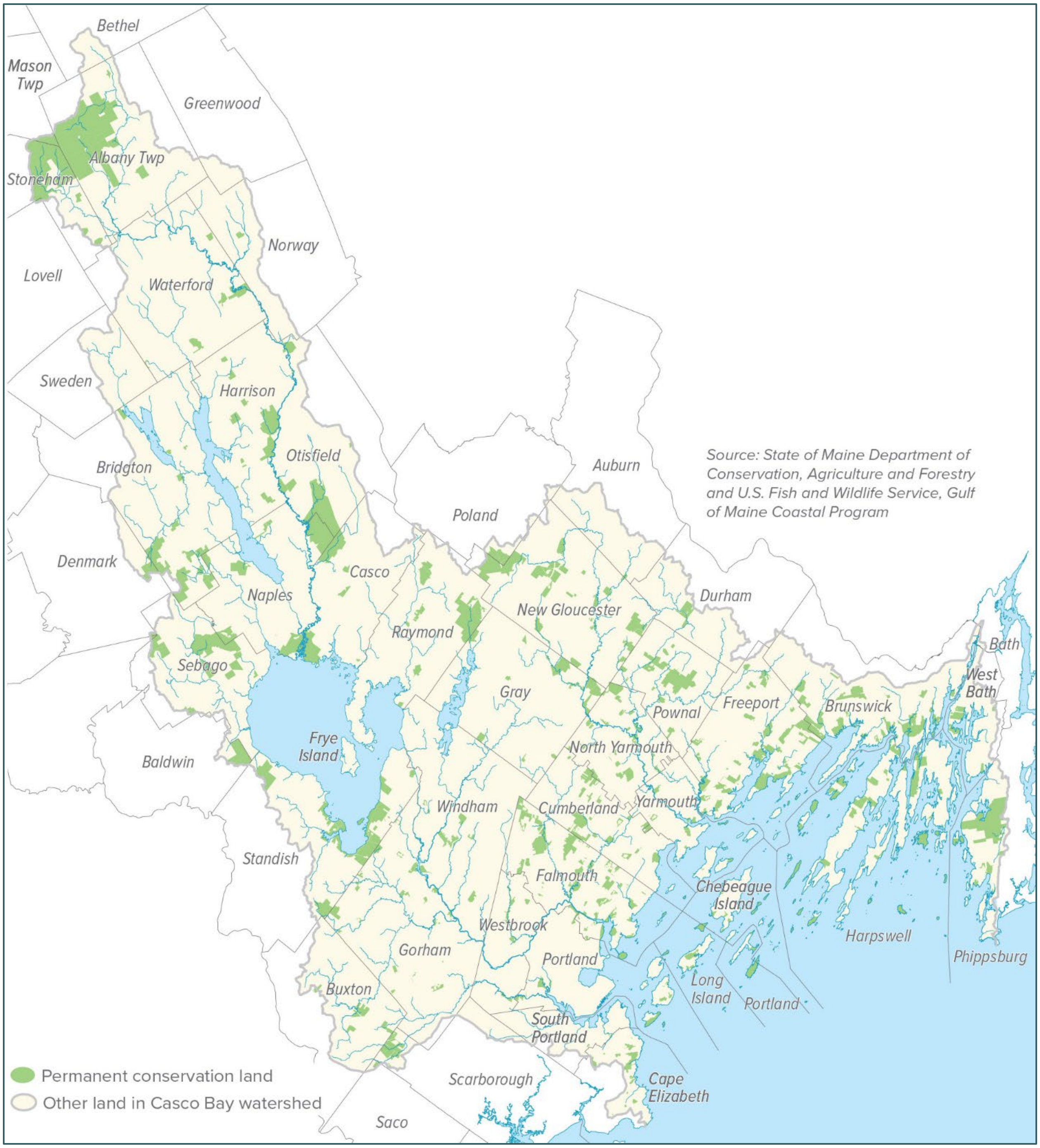

Figure 5: Permanently protected conservation lands in the Casco Bay watershed

Threats

Upland forests, along with freshwater wetlands, riparian areas and are important to CBEP's mission principally because of their importance for sequestering nutrients and other pollutants and thus protecting water quality in downstream waters.

All three are threatened directly by similar processes, including land use change and climate change. As the region grows and new residential housing and commercial buildings are constructed to accommodate growing populations, natural areas are converted to development and impervious surfaces, threatening both interior forest habitat values and water quality, especially of headwater streams. Road construction further fragments remaining habitat.

More than 16 square miles of forest were lost in the Casco Bay watershed from 2001 through 2016. Loss of riparian vegetation, including riparian forest cover, is likely substantial, but low-resolution land cover data precludes detailed analysis. Forest area was lost to shrublands and agricultural lands, but principally to developed lands, which suggests most of these losses are permanent, and are likely associated with substantial secondary effects on health of streams and rivers.

While as much as 60% of the Casco Bay watershed is currently forested, only 14% is in some form of permanent protection, thus most forest lands are subject to potential conversion. While data is scarce, loss of forests is thought to be accelerating due to high demand for real estate.

- Construction of new residential housing or expansion of commercial areas to serve a growing human population
- Land use conversion from forested to agricultural land use, solar farms, etc.
- Construction and expansion of roads and other impervious surfaces, as well as new and expanded utility & infrastructure corridors
- Climate change, especially warming temperatures, drought, and changes in soil moisture resulting from shifting precipitation patterns and warmer temperatures
- Invasive species and disease, exacerbated by climate change
- Poor forestry practices such as clearcutting and badly built logging roads

Management Capacity and Gap Analysis

This section summarizes existing capacity and broadly guides the collective goals and strategies of CBEP and the collaborative network of communities, organizations, businesses, agencies, and people working to sustain the ecological health and resilience of the Bay and its watershed for the future.

Existing Resources and Capacity

Tidal marsh

Organizations

Numerous federal, state, and local agencies have interests in tidal wetlands, yet capacity to develop on-the-ground restoration projects in Casco Bay is limited. Tidal marshes around the state and the Gulf of Maine face similar threats to those in Casco Bay, so state and federal agency attention is spread thin. Local entities like towns and land trusts often lack the technical skills to evaluate potential tidal wetland restoration sites, implement restoration projects, or manage tidal wetlands.

- Coastal land trusts, which typically work at a town scale, actively work to conserve tidal marsh habitat, adjacent uplands, and low-lying marsh migration corridors, but these small organizations generally lack the expertise and capacity for restoration and enhancement activities. An exception is the Kennebec Estuary Land Trust (KELT), which works in West Bath and Phippsburg, but KELT is for the most part focused on tidal marshes along the Kennebec Estuary, and less active on the Casco Bay side of Phippsburg or West Bath. Portland Trails manages invasive *Phragmites* in the Fore River Sanctuary. Maine Coast Heritage Trust is actively protecting tidal marsh in Casco Bay and building experience and expertise for marsh restoration and enhancement, but to date has not embraced these activities in Casco Bay.
- Municipalities seldom actively pursue conservation of tidal marsh but may already own parcels with tidal marsh present, as well as infrastructure such as roads or utilities that cross tidal marsh. Municipalities face similar constraints as land trusts for direct management and stewardship of marshes, but municipalities have been directly involved in some tidal marsh restoration projects where replacement of tidal culverts occurred on Town roads.
- State resource agencies have expertise for assessment, monitoring, and management of tidal marshes, as well as expertise for tidal marsh restoration and enhancement. However, the capacity of Maine's state agencies is insufficient for the size of Maine's coast and the extent and distribution of tidal marshes. Consequently, the state's level of activity on the Bay's tidal marshes is low, and generally limited to site-specific monitoring.
- State agencies own tidal marsh in Maquoit Bay, Brunswick (Maquoit Bay Conservation Lands and Gamble Marsh), and at the Austin Cary Lot adjacent to Doughty Cove and Long Marsh in Harpswell, as well as fringing marsh adjacent to Mackworth Island, Little Chebeague Island, and other island properties. State-owned marshes generally lack an active management presence.
- Maine DOT has replaced tidal culverts for tidal marsh restoration efforts in Casco Bay, in one case on a private road, but Maine DOT generally does not actively develop their own mitigation projects anymore, instead opting to pay in-lieu wetland impact fees through the Maine Natural Resource Conservation Program.
- U.S. Fish and Wildlife, Gulf of Maine Coastal Program has expertise in tidal marsh assessment, restoration, and monitoring of tidal marsh ecosystems, protection and management of obligate marsh bird species including the saltmarsh sparrow, and protection and management of other fish and wildlife that utilize tidal marsh habitat. USFWS GOMCP also has experience with managing tidal marsh restoration projects but has not done so in Casco Bay. USFWS GOMCP does not directly protect tidal marsh but supports conservation of tidal marsh by providing technical assistance to land trusts for grant proposals seeking funding from key funding mechanisms such as North American Wetland Conservation Act (NAWCA) grants. The geographic focus of the Gulf of Maine Coastal Program extends throughout the Gulf of Maine, which limits the availability to apply capacity in Casco Bay, particularly when larger tidal marsh systems have similar needs and vulnerabilities further up the Maine coast.

- Academic institutions in the region, including USM, Bates, Bowdoin, and UNE host scientists with expertise in tidal marsh ecology who occasionally conduct research which takes place on Casco Bay's tidal marshes.
- CCSWCD administers construction work and has staff expertise in culvert replacement and design, erosion control, and general contracting activities for construction. CCSWCD serves the communities of Cumberland County, which along the Bay's coast includes the municipalities from Cape Elizabeth to Harpswell.
- Specialized skills are needed to model and design tidal crossings and to optimize their hydrological and hydraulic performance. There are currently few Maine firms with this skill set, including among coastal towns with road engineering firms on retainer.
- Consulting firms may implement tidal marsh restoration and enhancement projects as part of mitigation for impacts to tidal marsh elsewhere as a contractor to another entity such as a town.

Other Resources

- Tidal marsh mapping - Several resources are available for identifying tidal marsh habitat protection needs and opportunities in additional to the standard National Wetlands Inventory.[19] Maine Natural Areas Program developed a Current Tidal Marsh database as well as a Tidal Marsh Migration Database[20], the latter of which is being updated in 2022. In 2007, Wells NERR mapped fringing marsh around Casco Bay[21] and CBEP retains this geospatial data. The Nature Conservancy in Maine developed a Future Habitat viewer in their Coastal Resilience online platform[22], and included municipal parcel data to help identify properties with marsh migration potential.
- Maine Tidal Restriction Database[23] - In 2020, Maine Coastal Program pulled together information from several sources to create an initial geo-spatial database of built infrastructure such as roads, railways and dams that are currently tidal or predicted to become tidal under sea level rise scenarios. A cursory analysis of sites found that over 80% of currently tidal crossings restrict the free exchange of tidal flows to varying degrees. Although the database is not sufficiently populated to conduct a robust analysis, the database serves as a starting point for tidal restoration prioritization.

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[19] https://www.fws.gov/program/national-wetlands-inventory/wetlands-mapper
[20] https://www.maine.gov/dacf/mnap/assistance/marsh_migration.htm
[21] Hayes et. al. 2007.
[22] https://maps.coastalresilience.org/maine/#
[23] Bartow-Gillies et. al. 2020.

- The CoastWise Approach[24] – New tidal restoration methods are in development. Maine Coastal Program, working with a technical team including InterFluve and Woods Hole Group, is developing guidance for towns, engineers, and habitat restoration practitioners for designing coastal road and rail crossings where built infrastructure crosses tidal marsh, mudflats, and other tidal wetlands. CoastWise provides extensive detail on how to locate, design, and implement tidal restoration projects, taking in site specific information informing socio-economic and ecological resilience considerations. A related initiative, "Farmers in the Marsh", in development by wetland ecologists at Rachel Carson National Wildlife Refuge, UNH, and other institutions, for documenting and remediating historical agricultural modifications to tidal marshes prior to, and in preparation for, subsequent tidal restoration.

Capacity

Table 3. Summary of capacity for protection and restoration of tidal marsh in Casco Bay.

Entity	Funds	Technical assistance	Project Management	Construction	Description
Maine Coastal Program	Limited	Limited			P/T staff; coordination of assessment and restoration; supports feasibility studies for restoration. Develops tools (Tidal Restriction Atlas, CoastWise). Installed rSET tables in Maquoit Bay and monitors annually in partnership with MNAP.
USFWS, Gulf of Maine Coastal Program		Limited			Technical assistance for restoration projects; coordinated development of plans for protection and restoration of saltmarsh sparrow populations and habitat.
Maine Natural Areas Program		Limited			Identifies and documents important plant communities and wetlands including in Casco Bay. Reports on community types & values, incidences of rare and threatened species, and threats and impacts.
Maine DOT		Very limited	Very Limited	Very Limited	Hydrology and wetland expertise; manage projects at State assets
Municipal	Very limited			Very Limited	Several towns have been partners on tidal restoration projects and feasibility studies. Many support protection of tidal marshes and adjacent properties.
CCSWCD		Contractual		Contractual	Capacity to administer construction work with funding support; very limited capacity for restoration engineering & design process.

[24] https://www.wellsreserve.org/project/coastwise

External partners		Very limited	Contractual	Contractual / very limited	Rachel Carson NWR, Wells NERR, UNH, KELT and MCHT restore marshes through collaborations outside Casco Bay.
Other land trusts					Coastal land trusts protect tidal marshes and adjacent properties and steward holdings.
Casco Bay Estuary Partnership	Limited	Limited	Limited		Restoration capacity with roles including partial funding, assessment/ monitoring, technical assistance, project management. Habitat protection grant funds.

Gap Analysis

Knowledge Gaps

- Lack of spatially explicit data on the historic distribution of tidal marsh in Casco Bay, particularly around the Fore River, Back Cove, and Presumpscot Estuary. Tidal marshes in these regions were extensively filled.
- No procedures to track permitted fill or loss of tidal marsh over time.
- Infrequent, irregular data on the distribution and abundance of tidal marsh obligate birds and critical high marsh habitat.
- Lack of documentation on the distribution and abundance of invasive *Phragmites*.
- Limited quantification of fish production from existing tidal marsh, a NOAA priority.
- Insufficient understanding of marsh surface elevations relative to local tidal datums (e.g., elevation capital), and level of risk to and resilience of marshes to sea level rise; 2020 low-tide Lidar data, with a nominal vertical accuracy <5cm, will help address this gap, as will long term monitoring of rSET stations along the Maine coast.
- Lack of information on sediment dynamics and budgets in Casco Bay tidal marshes.
- Understanding is limited of the long-term impact of tidal restoration on sediment supplies, distribution and abundance of tidal wetlands, and wetland habitat quality.
- Few comparative studies have looked at tidal restoration outcomes on carbon sequestration and methane emissions.
- Need to assess tidal marsh in need of protection at the seaward/scarp edge to slow shoreline erosion and conversion of marsh to mudflat.

Methods Development

- Need to evaluate intervention strategies to address lack of “elevation capital” in Caso Bay tidal wetlands, such as thin-layer deposition
- Test “living shoreline” methods to protect eroding marsh scarps and protect tidal marsh margins under rising seas
- Need for experimental projects to create and protect obligate marsh bird habitat
- Need for pilot projects to restore ditch plugs using novel methods
- Refine and standardize methodology for assessing tidal marshes and tidal road crossings for “restoration” as well as for improvement of marsh resilience.

Implementation Challenges

- Tidal marshes are often privately owned, typically by multiple parties, creating management challenges, complicating restoration and enhancement implementation, and constraining stewardship, monitoring and long-term management activities.
- Low-lying houses, commercial buildings or businesses, and other land uses were often enabled by past hydromodification. Restoration of tidal flow can put infrastructure at increased risk of flooding.
- Tidal marsh “restoration” projects often alter ecosystem composition, converting one type of wetland or aquatic habitat to another, thus requiring assessment of tradeoffs exchanging existing wetland services, functions and values for “restored” services, functions, and values.
- Presence of water, sewer, gas, oil and other utility infrastructure at tidal road crossings greatly increases the complexity of restoration projects.
- Uncertainty about the future ability of tidal marshes to keep pace with sea level rise places emphasis on the importance of protecting low-lying undeveloped areas suitable for marshes to expand.
- Effects of tidal restoration projects often play out over the span of several years. Long-term monitoring is necessary for adaptive management purposes. Permitting agencies and funders often require multi-year monitoring commitments. Yet capacity for long-term monitoring is limited. Funders are reluctant to cover the full, long-term costs, and institutional constraints make it difficult to provide stable long-term funding and staffing. CBEP should continue long term monitoring at past and future tidal restoration sites.

Tidal mudflats

Tidal flats are principally managed by state agencies and municipalities, with an eye towards commercial harvests especially of clams, quahogs, bloodworms and sandworms. Attention to the role of shellfish in protecting water quality or in creating habitat is seldom a primary concern. Both harvesters of wild shellfish and aquaculture operators have shown willingness to consider creative approaches to managing shellfish resources.

Municipalities survey shellfish areas, allocate harvest permits, and coordinate shellfish conservation activities, such as seeding and distribution of crushed shell to balance the pH of mudflats. A subset of municipalities has shellfish resource management and enforcement capacity. Towns are required to have shellfish committees if an active (intertidal) shellfish harvest occurs within their jurisdiction.

Gaps in capacity to work on tidal flats are exacerbated where State-designated shellfish growing area is classified Prohibited. In Prohibited areas, harvests are not allowed, so state and municipal agencies do not manage shellfish resources. Geographically, Prohibited areas of the Bay primarily occur in more urbanized areas and areas with permitted wastewater discharges. Thus, gaps in information and capacity to manage or to restore shellfish resources are particularly severe in and adjacent to the Fore River, Back Cove, and Presumpscot Estuary.

Capacity

- Maine DMR and its associated advisory committees (e.g., Shellfish Advisory Council) oversees management of shellfish and aquaculture industry in the state and provides municipalities with technical assistance for management of shellfish resources.
- Municipal shellfish management programs exist in ten Casco Bay municipalities. Municipal shellfish programs focus on intertidal harvests of softshell clam and quahog. Municipalities conduct population surveys, manage permit allocation, and enforce shellfish regulations. The capacity for shellfish management varies widely by town.
- NGO groups such as Maine Clammers Association and Downeast Institute advocate for shellfish harvesters and communicate regarding threats to shellfish. Informal associations (e.g., Independent Maine Marine Worm Harvesters Association) advocate for the marine worming industry.
- Casco Bay Regional Shellfish Working Group is a regional network of harvesters and municipal shellfish programs working collaboratively to support management of shellfish resources.
- Maine Shellfish Learning Network focuses on collaborative communication around wild clam and mussel fisheries, especially declining landings.
- Researchers investigate scientific questions related to shellfish populations, tidal flat ecology and resilience.

Gap Analysis

Knowledge Gaps

- Scarce “low tide” data on elevations of tidal flats limits our ability to determine how distribution of tidal mudflats will change under sea level rise and how such changes will affect shellfish harvests. Recently acquires LIDAR data can be analyzed to provide greater insight.
- Tidal flats are natural “depositional” environments, yet we have only limited understanding of sediment budgets, and how sea level rise will affect sediment transport and deposition.
- Preliminary studies suggest coastal acidification and specifically acidification of intertidal muds may have significant effects on shellfish communities.
- We lack high quality data on distribution of green crabs, as well as other invasive and native predators on shellfish in soft-bottomed sediment communities. Current monitoring and research efforts by Manomet will help provide additional information.
- We know little about the ecological impacts of aquaculture on mudflat communities.

Methods Development

- Restoration needs of tidal mudflats are not well understood. Methods for restoration are largely non-existent.

- Effective interventions to manage green crab populations at either local or regional scale are scarce and poorly understood.

Implementation Challenges

- State and municipal management structure manages tidal flats principally for shellfish harvests. Capacity to address other values of tidal flats, such as their importance for migratory birds, is limited.

Eelgrass beds

Capacity

- Maine DEP monitors eelgrass bed distribution and abundance every five years and maintains long-term eelgrass sentinel monitoring at sites in Casco Bay.
- State agencies also oversee permitting regarding piers, wharves, aquaculture, dredging and moorings that may impact eelgrass beds and trigger eelgrass mitigation requirements.
- The Casco Bay Eelgrass Consortium is an ad hoc network of agencies and organizations with an interest in the health of the Bay's eelgrass beds. In the past, the Consortium successfully tested four methods for hand-planting transplanted eelgrass to seed revegetation in a recently denuded eelgrass bed. CBEP has coordinated this group.
- Maine Department of Environmental Protection, Maine Coastal Program, and others are collaborating on efforts to develop or refine existing site suitability models for eelgrass restoration.
- A couple of individual towns actively coordinate with shellfish harvesters to trap European green crabs, but benefits to eelgrass beds, if any, are unknown.
- Eelgrass protection is a priority for many agencies and organizations, but none have the capacity to lead eelgrass protection and restoration efforts outside of existing regulatory mechanisms. No one in our region works predominately on eelgrass.
- Researchers investigate scientific questions pertaining to eelgrass
- Consulting firms may implement eelgrass restoration and enhancement projects as part of mitigation for impacts to subtidal wetlands elsewhere, as a contractor to another entity such as a town.

Gap analysis

Knowledge gaps

- Insufficient data on historic eelgrass distribution and abundance makes it difficult to determine appropriate eelgrass targets.
- Although site suitability models for planting eelgrass have been developed for the northeastern U.S.[25], it is not clear how applicable these are to Casco Bay. Maine DEP

[25] Short *et. al.* 2002

and others anticipate developing new models for eelgrass restoration, beginning in 2022.
- Lack of data on green crab distribution and abundance makes it difficult to anticipate or detect when eelgrass may face elevated threat from green crab bioturbation.
- Significance of private septic systems as a source of nutrients (and therefore a threat to eelgrass beds) is poorly understood.
- Impacts of commercial aquaculture operations on eelgrass beds are little studied and likely complex as both positive (water quality) and negative (disturbance; shading) interactions are likely.
- Understanding of tolerance of Maine's eelgrass populations to warming waters is limited.
- The role that genetic variability plays in enhancing resilience of eelgrass beds at multiple scales is just beginning to receive focused attention from researchers.

Methods Development

- Restoration of eelgrass has a mixed track record in most of New England, making it difficult to evaluate when and where eelgrass planting, or other active restoration techniques would be beneficial. Research into the feasibility of eelgrass protection and restoration in Maine is needed to guide activities.
- Indirect approaches to eelgrass protection, such as conservation of shoreline and watersheds, or water quality remediation have also been little studied in the Casco Bay context.
- Conservation moorings have been proposed as an alternative strategy for mitigating for unavoidable eelgrass loss, but little is known yet about either public acceptance or effectiveness for restoring eelgrass in Maine.

Implementation Challenges

- Restoration of eelgrass habitat is limited by lack of dedicated leadership, staff and funding, as well as by regulatory barriers.
- A significant lag in eelgrass management responses arises due to relatively low frequency of regional aerial surveys (5 years).
- Existing regulatory tools do little to protect eelgrass beds from dragging and trawling.
- While submerged lands are technically owned by the Stat, no mechanisms exist to directly protect eelgrass beds in Maine.
- A primary strategy for protection of eelgrass beds would entail control of green crab, yet no active program exists for green crab population management at local or regional scale, and few methods have been shown to be effective except in semi-enclosed bays or other restricted waters.
- Until 2021, MNRCP's wetland mitigation policies made it difficult to utilize wetland mitigation funds for eelgrass restoration, but as of 2022, MNRCP has signaled interest in supporting projects focused on eelgrass protection and restoration, including a pilot project to use "conservation moorings" to reduce impacts from mooring fields.

Rocky intertidal

Capacity

- Maine DMR regulates rockweed fisheries in rocky intertidal habitat, but there is little data on harvesting activity in Casco Bay

Gap analysis

- We have limited information on the condition, especially species composition, of rocky intertidal habitats in Casco Bay. Elsewhere, spatial variability in community composition is tied to differences in water chemistry, wave exposure, and other environmental factors. Casco Bay likely harbors similar diversity.
- Data on rockweed harvest activity in Casco Bay is unavailable.
- Information on invasive species, particularly green crabs and tunicates, within rocky intertidal habitat is only available from a handful of sites in Casco Bay. We have little understanding of the impacts of these invasives on rocky shore communities.
- The impact of rockweed harvests on rockweed, and on the marine invertebrates and fishes that inhabit rockweed gardens is scattered. While harvests alter structure of the rockweed canopy, the ecological relevance of those changes is little studied.
- We do not understand how water pollution (excess nutrients, toxic contaminants, etc.) affects rocky intertidal habitats and rockweed as a keystone species that provides the physical structure of these ecosystems.
- Green crab control is likely to be exceptionally difficult in these relatively open communities.

Shellfish bars and reefs

Capacity to evaluate biogenic shellfish habitat like oyster reefs or mussel bars is limited, as blue mussels, historically an important wild fishery and the most important molluscan ecosystem engineer in Caso Bay, are depleted, reducing attention from fisheries managers.

Towns are required to have shellfish committees if an active (intertidal) shellfish harvest occurs within their jurisdiction. Municipalities survey shellfish areas, allocate harvest permits, and coordinate shellfish conservation activities.

The Nature Conservancy in Maine (TNC) developed a small-scale shellfish enhancement project in Phippsburg using American oysters, which it monitored then subsequently handed off to the Town to manage. The project was a collaboration with Maine DEP, the Town, CBEP and others. TNC has active shellfish restoration programs in other New England states but is not actively working on shellfish enhancement in Casco Bay at present.

Capacity

- Existing local and state focus is largely on shellfish harvest, especially dominant wild harvests of softshell clam and quahog, both of which inhabit soft-bottomed tidal flats. The structural characteristics of shellfish reefs or bars and the importance of certain shellfish species as ecosystem engineers receive little attention.
- Maine DMR mapped molluscan shellfish in Casco Bay in 2010, and oversees management of commercial shellfish harvesting activities, tracking landings. Maps are not updated regularly.
- Maine DMR and its associated advisory committees (e.g., Shellfish Advisory Council) oversees management of shellfish and aquaculture industry in the state and provides municipalities with technical assistance for management of shellfish resources.
- Municipal shellfish management programs exist in ten Casco Bay municipalities. These programs are responsible for co-management of intertidal shellfish harvests, principally softshell clam and quahog, but also blue mussels, where a wild harvest remains. Municipalities conduct population surveys, manage permit allocation, and enforce shellfish regulations. The capacity for shellfish management varies widely by town.
- State agencies provide municipalities with technical assistance and expertise for management of intertidal shellfish resources, including blue mussels, but there are only three shellfish biologists responsible for the entire Maine coast.
- Nongovernmental organizations (NGOs) (e.g., Maine Clammers Association) advocate for shellfish harvesters and communicate regarding threats to shellfish.
- Casco Bay Regional Shellfish Working Group is a regional network of harvesters and municipal shellfish programs working collaboratively to support management of shellfish resources.
- Maine Shellfish Learning Network focuses on collaborative communication around shellfish and reduced landings.
- Researchers investigate scientific questions related to shellfish ecology, with most research focused on softshell clams and species important in Maine aquaculture, including blue mussels and eastern oyster.
- Companies such as Running Tide are exploring the potential for innovative coastal enhancement projects involving shellfish and kelp aquaculture to enhance water quality through grant-funded pilot projects.
- The Quahog Bay Conservancy is a non-governmental organization working around Quahog Bay in Harpswell to revitalize the ecosystem of Quahog Bay, with a particular focus on shellfish aquaculture.

Gap analysis:

- We have limited documentation of historic distribution and abundance of shellfish beds / reefs.

Data on locations and abundance of shellfish in Casco Bay is fragmented and incomplete. Recent data on blue mussels is almost nonexistent.

- Restoration needs of shellfish beds / reefs is not well understood, in part because we lack historic information in prevalence of bivalve filter feeders.
- Bacterial contamination is a major cause of permanent and episodic closure of shellfish beds to harvest. Yet we do not have good data on location or condition of septic systems, or robust understanding of the water quality impacts of outdated or poorly maintained on-site wastewater treatment systems.
- The impact of warming seas, sea level rise, and coastal acidification on Casco Bay shellfish resources is poorly understood. Changes in habitat extent, species composition, and structure of biogenic habitats are possible.
- Despite significant public concern, information on green crab distribution and abundance is still fragmentary. We lack tested methods of interventions to manage green crab populations.
- Aquaculture operations may have direct (physical disturbance / displacement) and indirect (food supply) impact on wild shellfish resources, but the impacts are just beginning to be studied.

Kelp beds

Capacity

- Bigelow Laboratory for Ocean Sciences is developing maps of kelp forests in coastal Maine based on habitat models.
- Maine DMR regulates kelp aquaculture as well as wild harvests.
- Maine Sea Grant provides training and resources to support development of kelp aquaculture.
- Researchers from the University of Maine and Bigelow Laboratory have studied the effects of kelp (principally in aquaculture) on carbonate chemistry and wave attenuation.

Gap analysis:

- Distribution and abundance of kelp beds in Casco Bay has not been studied in detail. We do not know the extent of this habitat type, nor can we track long-term changes in abundance or distribution. It is not clear whether kelp beds should be considered a habitat of concern in need of restoration or protection.
- Kelp beds have not previously been a focus of concern in Maine. Therefore, studies of the ecosystem services and habitat values provided by kelp “forests” have been little studied locally.
- Strategies to protect and restore kelp beds are not well developed. It may be possible to adapt methods originally developed for aquaculture for restoration purposes.

Islands

Capacity

- US Fish and Wildlife Service GOMP historically has supported restoration and management of island habitats and maintained a database of nesting island activity throughout the Gulf of Maine.
- The Gulf of Maine Seabird Working Group is a partnership between public and private organizations dedicated to restoring and protecting seabirds in the Gulf of Maine.
- Audubon Society (national) – restores seabird habitat and manages seabirds in conjunction with government partners.
- Maine Coast Heritage Trust engages in conservation planning for islands along Maine coast and actively protects and manages individual islands, often permitting public use.
- Local land trusts own and manage parcels on several of Casco Bay's inhabited and uninhabited islands for public access or conservation purposes.
- Island Institute focuses on coastal and socio-economic resilience of inhabited island communities.

Gap Analysis

- Organizational capacity for protection and restoration of island habitats is both limited and fragmented. Organizations that focus on Casco Bay's islands have specific missions that limit geographic overlap, information sharing and development of consensus management goals.
- The abundance, access limitations and ownership patterns of islands make it difficult to identify gaps and needs related to island habitat.
- We lack a clear understanding of changes in island ecosystems over the past half century, because no systematic monitoring of Casco Bay island habitats has been conducted. Data on habitat condition and abundance of key indicator species is infrequent or incomplete.
- Studies on the impact of sea level rise, warming waters and coastal acidification on island habitats are scarce, in part because of lack of institutions that focus on islands as habitat from a wholistic perspective.

Rivers and streams

Anadromous Species

Migratory fish and river continuity have been a focus of interest in Maine for decades, driven in part by the importance of Atlantic salmon Downeast, and in part by the potential for large anadromous fish runs in Maine's rivers and streams because of their cool waters and (today) relatively good water quality. Considerable capacity and expertise for working on these issues exists within the state. Most restoration activity, however, occurs at the local, usually municipal, level, where capacity for analyzing and remediating fish passage barriers is limited.

Municipalities must replace culverts beneath town-owned roads periodically, but municipalities vary in their emphasis on stream connectivity. The "Stream Smart" initiative provides education and training programs targeted to road managers on culvert replacements. Stream Smart training encourages towns to follow best practices that promote natural riverine processes, including passage for aquatic organisms. Most municipalities in our region have participated in training on “Stream Smart” structures. Municipalities are eligible for designated State funding for culvert replacements that address habitat and flood risk concerns

DOT replaces culverts and bridges on state roads as needs dictate, generally when infrastructure reaches a state of disrepair and needs replacement. If other State agencies such as Maine DIFW or Maine DMR identify habitat or species values for a river or stream, Maine DOT will generally work within financial means to optimize fish passage. A recent example is along Mill Brook, where Maine DOT replaced three road crossings and improved passage for migrating alewives.

Efforts to remove dams or provide effective fish passage at dams take years to come to fruition. Projects tend to involve multi-organization coalitions working over a period of years to build local support, address legal issues, solve technical challenges, and fund implementation. Most lakes and ponds in the Casco Bay watershed have outlet dams that both control water level and restrict movement of resident and migratory fish. Dams on the Presumpscot River main stem are licensed by the Federal Energy Regulatory Commission. Legal obligations to provide fish passage at these dams are tied to license conditions and other legal agreements negotiated years ago by dam owners, advocacy organizations and state and federal agencies.

Capacity

- U.S. Fish and Wildlife, Gulf of Maine Coastal Program has expertise in river and stream habitat restoration through culvert replacement, dam removal, and in-stream habitat enhancement. GOMCP also has expertise in assessment and monitoring of rivers and streams and restoration project outcomes. The geographic focus of the Gulf of Maine Coastal Program extends throughout the Gulf of Maine, which limits the availability to apply capacity in Casco Bay.
- Maine DOT’s environment office has engineering and hydrology expertise on culvert replacement.
- Maine DMR has generally been the lead entity advancing restoration and management of diadromous species in the watershed. Priorities have included FERC licensed dams in the Presumpscot River, the Highland Lake alewife run and commercially harvested species including American eel.
- Maine IFW focuses on wild Eastern brook trout, landlocked salmon, and preventing expansion of invasive fish. Focus areas include Crooked River, native brook trout streams and lakes, and sea-run brook trout and the Pleasant River as one of four documented populations of endangered brook floater freshwater mussel.
- Towns often lack the in-house expertise to manage dam removal or culvert replacement process and must rely on outside assistance. Municipal work on stream restoration is often conducted in partnership with and at the request of partnering organizations.

- CCSWCD administers construction work and has staff expertise in culvert replacement and design, erosion control, and general contracting activities for construction. CCSWCD serves the communities of Cumberland County, and CCSWCD has been increasingly involved in culvert replacement in recent years. CCSWCD also works on in-stream restoration and restoration of riparian buffers through 319 watershed projects, Long Creek Watershed Management District, and other efforts.
- Local Trout Unlimited (TU) chapters have worked with USFWS GOMCP to identify culvert replacement and dam removal priorities to benefit wild Eastern brook trout and land-locked Atlantic salmon in the Casco Bay watershed. National TU staff are present in Maine and are working on restoring connectivity for sea-run brook trout in Eastern Bay coastal streams. TU has developed, funded and implemented several dam removal and culvert replacement projects in the watershed.
- Sebago Clean Waters is a robust watershed-scale collaboration aiming to protect and restore aquatic resources in the Sebago Lake watershed. Several land trusts are focused on conserving land that has been prioritized for its value in protecting water quality.
- Lakes Environmental Association is developing capacity for restoring river and stream connectivity in the Sebago Lake watershed, in partnership with the Sebago Clean Waters collaborative.
- Friends of the Presumpscot River, Maine Rivers, and Friends of Sebago Lake advocate for restoration of anadromous fish to historic spawning habitat in the Presumpscot River.
- The Royal River Alliance has a narrow focus to address fish passage at two Yarmouth dams on the Royal River.

Monitoring

- Sappi monitors annual use of fishways on Presumpscot main stem designed for anadromous fish migration as part of permit obligations.
- USM and Presumpscot Regional Land Trust monitor annual alewife returns to Highland Lake.
- Maine DMR coordinates a volunteer monitoring program for anadromous smelt and tomcod.
- Maine IFW (Gray office) periodically conducts habitat assessments and maintains records on habitat values.
- Maine’s Department of Environmental Protection conducts biological assessment of stream health, focusing largely on composition of stream invertebrates and periphytic algae.
- DEP also manages the Maine Volunteer River Monitoring Program (VRMP), that provides training and technical assistance to support citizen scientists collecting local water quality data.

Gap Analysis

Knowledge Gaps

- Information about the distribution and abundance of anadromous species like smelt, tomcod, sea run brook trout (salters") in, as well as information on habitat and water quality of, coastal streams is needed to inform protection and restoration efforts.
- Lack of knowledge of historic spawning areas and habitats for anadromous fish, particularly in 1) Presumpscot River tributaries, 2) Stroudwater River watershed, and 3) coastal streams impedes our ability to identify restoration opportunities and establish regional restoration goals.
- Available high-resolution data on land use and land cover and impervious surfaces is outdated. National land cover data is not of high enough resolution to allow robust analysis of land cover, riparian buffer condition and impervious cover at a scale suitable for stream protection, habitat evaluation or watershed-wide restoration planning.

Implementation Challenges

- Restoration activities typically occur without comprehensive geomorphic assessment; agencies lack geomorphology skills and expertise.
- Limited capacity within the Casco Bay region to plan, coordinate and implement restoration efforts at the scale of the problem results in slow progress.
- Data on the location, condition, and impacts of remnant dams and other modifications remains incomplete, especially in smaller streams, impeding prioritization and restoration.
- Maine's standard model for watershed planning through the 319 program has not integrated stream fragmentation as a stressor, implying to stakeholders that restoring stream connectivity is not important.
- The region lacks a shared set of species and subwatershed-specific restoration goals, resulting in an opportunistic rather than proactive approach to implementation. There is a need for a systematic anadromous fish and stream continuity restoration plan for Casco Bay.

Freshwater wetlands and riparian areas

Capacity

- Maine's Beginning with Habitat program offers interpreted wetlands maps aimed principally at planners and other municipal officials. GIS data depicting wetlands at 1:24,000 scale is available through the National Wetlands Inventory.
- Maine Natural Areas Program inventories lands that support rare and endangered plants, rare natural communities and ecosystems, and outstanding examples of more common ecosystems. Many occur in freshwater wetlands.
- Funding for wetland protection and restoration is available through the Maine Natural Resource Conservation Program, Maine's In-Lieu fee program for wetland impacts

- Land trusts and collaborators incorporate freshwater wetlands and adjacent buffers into strategic land acquisition activities
- CCSWCD, Maine DEP and collaborators emphasize the importance of vegetated riparian corridors in Section 319 watershed assessment, planning and implementation projects

Gap analysis

- No organizations actively working within the Casco Bay watershed have a strategic focus on restoration and enhancement of freshwater wetlands.
- Successful MNRCP funded projects in the watershed are typically for protection of wetlands and adjacent buffers. Few freshwater wetland enhancement and restoration projects are implemented with MNRCP resources in the watershed, resulting in a net loss of wetlands as permitted impacts occur but are not remediated in kind.
- Structural barriers to freshwater wetland mitigation through MNRCP include the lack of effectiveness of wetland creation, restoration and enhancement, private ownership of suitable sites, high cost of project implementation, requirements for permanent protection, and long-term monitoring and stewardship costs.
- Capacity for long-term stewardship and monitoring at wetland mitigation sites, which must be permanently protected according to MNRCP guidelines, is limited or nonexistent.
- Outside of targeted systems (e.g., Section 319-funded watershed efforts), there is limited information on the condition of vegetated buffers. Analysis of high-resolution land cover data in the Casco Bay watershed is outdated, and spatial resolution of more recent land cover data is too low to support analysis of buffer condition.
- Available data on land use and land cover is not of high enough resolution to allow analysis of riparian buffer condition.

Lakes and ponds

Capacity

- Many lakes and ponds have dues-paying lake associations that communicate and coordinate with shorefront property owners and pool resources for shared needs, such as road maintenance.
- Regional organizations actively working to protect and restore lakes in the Casco Bay watershed include Lakes Environmental Association (LEA), Lake Stewards of Maine, Portland Water District, and CCSWCD.
- Scientists at St. Josephs College, Bates College, and USM conduct research in area lakes.
- Organizations working on restoration of stream connectivity in lakes and adjacent tributaries include Trout Unlimited, LEA, and Maine IFW.

- The Sebago Clean Waters collaborative, which includes area land trusts, is focused on maintaining water quality in Sebago Lake through protecting forested land in the watershed.
- Maine IFW is particularly focused on protecting land-locked Atlantic salmon, which are present in Sebago Lake, and ensuring salmon have access to spawning habitat in the Crooked River watershed.
- Maine DMR is focused on restoration of anadromous fish into historic spawning habitats, including lakes and ponds that are suitable for alewife spawning.
- Maine DEP has a dedicated staff focused on the health of Maine lakes, including water quality and prevalence of invasive species.

Gap analysis

- Despite interest from state agencies and advocacy organizations, progress on restoration of fish passage between lakes and ponds and downstream water bodies has been slow, in part because responsibility for these efforts is diffuse, and no organization has taken on a leadership role coordinating or leading related efforts.
- Robust information is lacking about the potential of several lakes and ponds as alewife spawning habitat. Examples include Little Sebago Lake, Forest Lake, Knight's Pond, Crystal Lake, Sabbathday Lake, and Runaround Pond.

Upland forests

Capacity

- Several organizations are focused on protecting, managing and maintaining forests in the watershed, and owners of privately owned forests have strong financial incentives to maintain working forests through the State tax code's current use exemptions, which serves as a mechanism of temporary land protection.
- Maine Woodland Owners and Small Woodlot Owners of Maine, support private woodlot owners and maintenance of small-scale working forests.
- Maine DACF, U.S. NRCS and local soil and water conservation districts promote best practices in forestry and management of pests, including invasive insects.
- Local land trusts are actively involved in protected forested lands through the Casco Bay watershed. In the Sebago Lake watershed, several local land trusts, the Portland Water District, and conservation organizations have long worked to protect forested land. In recent years, these groups formed the Sebago Clean Waters collaborative, building new capacity for forest protection, which has resulted in a rapid increase in the rate of conservation of forested land above Sebago Lake.

Gap analysis:

- Funding to protect and manage forested lands is not sufficient to address rapidly increasing property values.

- State and local regulations afford greater protection via setbacks to great ponds and rivers than to headwater streams and intermittent water bodies, thus placing tributaries at risk.
- Many rural areas, where forested land is more prevalent, lack municipal capacity for land use planning.
- Monitoring of invasive insects and diseases of forest trees may not be adequate for the type of rapid-response interventions needed to contain outbreaks
- Some may perceive tradeoffs associated with large scale land protection. Municipalities may be concerned about loss of economic development potential or reduced property tax revenue as land is shifted from current-use taxation (reduced taxes; potential for future shift to full taxation) to permanently protected (usually tax exempt) status.
- The prevalence and location of woodlots in "current use" tax status is largely unknown at watershed scale.

Gap Analysis Summary

A "Gap Analysis" is a review of needs and capacity, used to identify "gaps" or potential gaps in ability to address habitat restoration and protection needs. Areas where existing capacity to protect or restore at-risk habitats is limited may be strategic priorities for CBEP.

Table 4: Gap Analysis (Intertidal Habitats). Assessment of Existing Habitat Restoration and Protection Capacity. Regional capacity (omitting CBEP contributions)

Intertidal Habitats	Site Assessment, Planning, Prioritization	Habitat Protection	Restoration and Resilience	Research, Testing and Monitoring
Tidal marsh	State and Federal agency resources spread thin.	Conservation organizations have multiple interests, and limited capacity, but work to protect tidal marshes and migration areas	Very limited project management capacity. Limited local engineering capacity (costly). Project monitoring and adaptive management under resourced.	Robust regional research on restoration and resilience. Researchers also interested in climate change, sea level rise and carbon sequestration
Tidal Mudflats	Town shellfish programs evaluate flats principally for intertidal shellfish harvests	Intertidal flats are privately owned, with limited protection as wading bird habitat. Federal and state permits required for some activities.	Limited efforts to manage flats for shellfish harvest	Researchers study tidal flats and test methods for protecting harvests
Rocky Intertidal	Regional attention to the rocky intertidal is very limited. Extent of habitat and scope of threats is largely unknown.	Rocky intertidal is privately owned. Rockweed harvests a threat. Some areas protected because adjacent lands are protected.	No restoration efforts known from our region.	Very limited assessment of condition. Some regional research on impacts. No relevant work on restoration.

Table 5: Gap Analysis (Subtidal and Marine Habitats). Assessment of Existing Habitat Restoration and Protection Capacity. Regional capacity (omitting CBEP contributions)

Subtidal and Marine Habitats	Site Assessment, Planning, Prioritization	Habitat Protection	Restoration and Resilience	Research, Testing and Monitoring
Eelgrass beds	Aerial photography every five years. Limited capacity for site assessment, project planning or prioritization.	Subtidal lands are state owned. Some activities require state approvals and state and federal permits. Other activities are unregulated.	Limited capacity for analysis to develop priorities. Capacity for project management very limited, with almost no local capacity and agency resources spread thin.	Significant regional research network. Some ongoing research in Maine. Significant gaps understanding restoration needs and methods, and evaluating threats from climate change, sea level rise, and invasive species.
Shellfish bars & reefs	Limited data available on present or historic distribution. Historic assessments mostly in terms of harvestable species. Growing interest in water quality and habitat values may lead to increased capacity.	Subtidal lands are state owned. Management tends to focus on commercial harvests. Some activities affecting shellfish reefs require federal or state permits.	Small number of test projects are underway, but technical uncertainty blocks prioritization and planning. Capacity for project management and implementation very limited.	Small commercial harvests in recent years have reduced data collection and research. Lessons about restoration methods available from outside of Maine, but little capacity for testing them here.
Kelp Beds	Very limited information is available about distribution, abundance or condition. No regional assessment.	Subtidal lands are state owned. No specific efforts known to protect kelp habitats.	No known projects or project planning in our region	Limited research underway to better understand kelp forest habitats.
Islands	No regional organization takes a wholistic view of islands as habitat, which limits effective planning, coordination, and prioritization.	Conservation organizations have put significant resources towards protection of islands both as habitat and for public access. Cost of island protection are high.	"Restoration" of island habitat is very limited, mostly addressing invasive plant species. Other "restoration and resilience" concepts are not well developed.	Capacity to track ecological condition of islands is very limited. Research on sea birds is ongoing. Other island habitat values have received less recent attention.

Table 6: Gap Analysis (Inland Habitats). Assessment of Existing Habitat Restoration and Protection Capacity. Regional capacity (omitting CBEP contributions).

Inland Habitats	Site Assessment, Planning, Prioritization	Habitat Protection	Restoration and Resilience	Research, Testing and Monitoring
Rivers and Streams (Anadromous species)	Maps of fish passage barriers are available, but capacity to analyze them at landscape scale is very limited. Capacity for site assessment is very limited. Regional priorities have not been articulated.	Direct disturbance to rivers and streams is limited by section 404 of the Clean Water Act and Maine's Natural Resources Protection Act. Partial protection is afforded by permanent protection of adjacent lands.	Capacity for project development, fundraising and management is extremely limited. Engineering design expertise is available (but costly). Post project assessment is severely limited by lack of capacity and funding.	Research on impacts of anadromous fish on inland waters is limited but growing. Studies that assess effectiveness of interventions are scarce.
Freshwater Wetlands and Riparian Areas	No organization has taken a watershed-scale approach to prioritization of freshwater wetlands. Consulting firms often have site assessment capabilities, but lack of funding remains a barrier for effective planning.	Freshwater wetlands are protected by federal and state laws. Conservation organizations often prioritize riparian and wetland areas for their ecological values.	Capacity for project management is limited. Wetland mitigation funds provide both funding and incentive for certain wetland restoration activities, so expertise on wetland restoration is available via contractors, but costs are high.	Research on freshwater wetlands and wetland restoration is abundant, but few examples occur in our region.
Lakes and Ponds	State agencies, lake associations and statewide nonprofits offer capacity to evaluate needs. Maine DEP and Portland Water District maintain lists of vulnerable lakes, based on multiple criteria.	Lake associations and state agencies take a proactive approach to protecting lakes, with a focus on water quality and invasive plant control. Federal and state laws limit direct impacts.	"Restoration" of lakes focuses on water quality and thus management of pollution sources, especially soil erosion, agricultural runoff and septic tank leachates.	A robust community of scientists studies Maine lakes, including lakes in the Casco Bay watershed. Long-term monitoring of Maine lakes is ongoing and well-coordinated.
Upland Forests	Multiple local, regional and state entities have identified priorities for forest protection. Land trusts have become proficient at finding funding.	While many land trusts, state agencies and towns work to protect forest for conservation, timber harvesting and recreation, the need is great, so protection is limited by lack of funding.	"Restoration" of forest lands is usually conducted as part of forestry rotations or via passive land management. Active efforts to "restore" forests for conservation are uncommon in our region. Professional foresters offer expertise for designing and implementing forest projects.	Research on Maine's forests is sustained, looking at watershed processes, forestry practices, biodiversity support, and climate resilience.

Few organizations aside from CBEP are strategically focused on tidal marshes, eelgrass beds, shellfish beds and rivers and streams in Casco Bay and the Casco Bay watershed. What capacity is allocated is generally specific to the constraints of organizational missions and mandates, geographic coverage, and organizational knowledge, skills, and expertise.

Land trusts and other conservation entities in the Casco Bay region have limited capacity for protection of tidal marshes, tidal mudflats and rivers and streams through direct acquisition of conservation easements and fee ownership. Subtidal habitats are owned by the State and cannot be protected through easement or fee ownership but are subject to State management and certain types of impacts are restricted under federal and state permit programs. While land trusts sometimes incorporate subtidal and intertidal habitats into strategic planning, effectiveness is limited by organizational capacity, fund availability, and the high cost of shorefront property.

Capacity for restoration and enhancement of estuarine and marine habitats is very limited outside of CBEP. State and federal entities can aid local partners when projects are already in development, but government entities are not able to directly coordinate, develop and implement projects in tidal marsh, shellfish beds, and eelgrass beds in Casco Bay, in part due to limited agency capacity to work throughout the State's large coastline.

Capacity has increased in recent years for restoration of river and stream connectivity through culvert replacement, however, most efforts are opportunistic based on infrastructure needs for replacement or repair. In a few cases, Trout Unlimited and LEA are fostering fish passage projects with restoration goals, but the projects prioritize Eastern brook trout and land-locked Atlantic salmon. There is a significant gap in community capacity to prioritize and implement restoration projects aimed at restoring connectivity and habitat for anadromous species.

Priorities and Recommendations

Basis for Priorities and Recommendations

All these coastal, marine, freshwater and inland habitats are important to the ecological health of Casco Bay. CBEP staff capacity, and the capacity of the members of the Partnership, however, are limited. Thus, it is essential to define priorities among habitat types and recommendations for actions within each habitat type.

Identification of priorities is based both on the review of habitat condition, threats and vulnerabilities in Chapter 3 and the review of institutional context and gap analysis presented in Chapter 4. In addition, the Partnership's mission and historic priorities have led to development of significant organizational expertise addressing threats to, and coordinating restoration of, coastal habitats. That expertise and the relationships built over years of work are important intangible assets on which to build future opportunities.

Priorities and recommendations for habitat protection and restoration reflect

a) The importance of each habitat type to Bay's ecological health and integrity,
b) Vulnerability assessments,

c) Availability of information and science to guide prioritization or project implementation
d) Strategic priorities of agencies and other partners
e) CBEP's past habitat restoration and protection priorities,
f) Current capacity in the region, and
g) Expert guidance, such as through the 2021 survey.

Priorities inherently also reflect constraints on CBEP, such as University of Southern Maine restrictions on CBEP activities, lack of marine safety and scientific diver safety resources at USM, lack of regular access to a boat, and federal funding requirements.

Resilient tidal marshes, eelgrass beds, shellfish beds and rivers and streams contribute critical "green infrastructure" that forms the basis of community resilience to climate change through carbon sequestration, wave attenuation and shoreline stabilization, and pollution mitigation, with additional benefits to commercial fisheries and recreational uses and enjoyment.

The resilience of tidal marsh, eelgrass beds, tidal mudflats and rivers and streams depends upon the restoration of natural processes that sustain them, such as the ebb and flow of the tides, the free flow of floodwater and sediments. Process-based approaches to restoration (e.g., tidal restoration) can be enhanced with innovative habitat enhancement efforts like remediating ditches, dikes and other marsh surface alterations to restore sheet flow across the marsh surface, improve drainage, and promote sediment deposition. To the extent practicable, restoration warrants remediation of historic structures, modifications and impacts, and mitigation against degradation linked to development. Enhancing connectivity within the full spectrum of aquatic habitats strengthens the resilience of Casco Bay ecosystems and their ability to accommodate a changing climate and the growth of our region.

CBEP restoration priorities are generally focused on reestablishing aquatic habitat connectivity in support of the natural processes inherent to the free and uninhibited flow of tidal waters and freshwater. Particular focus is on restoration of natural hydrology and connectivity within and between tidal wetlands, between the Bay and the watershed, and within freshwater riverine networks.

Specific restoration and enhancement strategies are described as they pertain to each habitat type.

Habitat by Habitat Discussion

Tidal marsh

Recommendation

Continue to prioritize tidal wetlands for protection, restoration, and study. Effort is needed to address information gaps, test methods for marsh restoration and management of marsh resilience in the Casco Bay context and provide capacity to implement projects. Dozens of locations around Casco Bay offer opportunities for restoration. While some restoration priorities are obvious, CBEP should conduct a formal priority-setting process to priorities for restoration and resilience efforts of a stronger technical footing.

Resources

Geospatial data – In addition to the National Wetlands Inventory,[26] Maine Natural Areas Program developed a Current Tidal Marsh database as well as a Tidal Marsh Migration Database[27], the latter of which is being updated in 2022. In 2007, Wells NERR mapped fringing marsh around Casco Bay[28] and CBEP retains this geospatial data. The Nature Conservancy in Maine developed a Future Habitat viewer in their Coastal Resilience online platform[29], and included municipal parcel data to help identify properties with marsh migration potential.

Marsh Condition – At a subset of tidal marshes in Casco Bay (generally, larger marshes), MNAP has conducted site assessments and developed reports documenting marsh conditions, the presence of rare plants, anthropogenic impacts, and other information.

Maine Tidal Restriction Database[30] - In 2020, Maine Coastal Program pulled together information from several sources to create an initial geo-spatial database of built infrastructure such as roads, railways and dams that are currently tidal or predicted to become tidal under sea level rise scenarios. A cursory analysis of sites found that over 80% of currently tidal crossings restrict the free exchange of tidal flows to varying degrees. Although the database is not sufficiently populated to conduct a robust analysis, the database serves as a starting point for tidal restoration prioritization.

The CoastWise Approach[31] – New tidal restoration methods are in development. Maine Coastal Program, working with a technical team including InterFluve and Woods Hole Group, is developing guidance for towns, engineers, and habitat restoration practitioners for designing coastal road and rail crossings where built infrastructure crosses tidal marsh, mudflats, and other tidal wetlands. CoastWise provides extensive detail on how to locate, design, and implement tidal restoration projects, taking in site specific information informing socio-economic and ecological resilience considerations.

Farmers In The Marsh. A method in development by Dr. Susan Adamovicz of Rachel Carson National Wildlife Refuge, Dr. David Burdick of University of New Hampshire (UNH), and others, Farmers in the Marsh aims to enhance a tidal marsh ecosystem's resilience to sea

[26] https://www.fws.gov/program/national-wetlands-inventory/wetlands-mapper
[27] https://www.maine.gov/dacf/mnap/assistance/marsh_migration.htm
[28] Hayes et. al. 2007.
[29] https://maps.coastalresilience.org/maine/#
[30] Bartow-Gillies et. al. 2020.
[31] https://www.wellsreserve.org/project/coastwise

level rise and tidal restoration. The method involves detailed documentation of secondary hydrological and marsh surface alterations from historic agricultural uses, and remediation of impacts and marsh hydrology through management of berms, ditches, mega-pools and other legacy features.

Prioritization

CBEP developed a working database of tidal restoration sites that crosswalks site-specific identifiers (IDs) including a) MCP tidal crossings IDs, b) USFWS stream barrier site IDs, c) CBEP tidal restriction IDs, d) Maine DOT asset IDs, and e) Return The Tides site IDs. In spring 2022, CBEP used this dataset to develop initial restoration priorities based on a manual, site by site review of available criteria (below), using best professional judgement to score the sites based on staff knowledge. Refinement of priorities would benefit local and regional partners in identifying areas to focus limited resources. CBEP should work with partners to further develop priorities for tidal marsh conservation, restoration, and enhancement.

Establishment and revision of criteria for protecting and restoring tidal marshes should be an iterative process that integrates current science, information, and monitoring of outcomes. A robust prioritization of tidal marsh priorities could draw from criteria such as:

- Degree of current tidal influence
- Degree of tidal restriction
- Size of wetland
- Condition of wetland
- Connectivity to other wetland types
- Marsh migration potential
- Habitat values for rare and threatened species and SGCN
- Community resilience
- Risk assessment
- Land use
- Ownership and conservation status
- Feasibility and cost
- Predicted tidal influence under SLR scenarios

Some of this information is currently available publicly, for some sites, but additional work is needed to develop consistent information across all sites. CBEP should explore opportunities to develop these data, as well as opportunities to partner in setting regional restoration priorities.

Prioritization has limited purpose and utility, serving primarily to focus limited resources and optimize cost/benefit opportunities. Ultimately, restoration must happen synergistically with local conditions and needs, and in cooperation with partners and property owners. Restoration decisions should be driven by site specific information, which is extensively detailed in the forthcoming CoastWise manual.

Habitat Protection - In habitat protection strategies, it is a CBEP priority to support land trusts, agencies, and municipalities in permanently protecting tidal marsh and connected tidal and freshwater wetlands through fee ownership or acquisition of conservation easements, as well as adjacent uplands and shorelines, and coastal streams that empty to tidal marsh.

An established CBEP geographic priority is the *Maquoit and Middle Bay Focus Area of Statewide Ecological Significance*[32]. This region includes tidal marshes in the Cousins River, Harraseeket River, Maquoit Bay, and Middle Bay. Other geographic areas warrant consideration for focused protection and restoration activities as well.

Tidal mudflats

Recommendation

Tidal flats may be especially vulnerable to sea level rise, indirect impacts of shoreline stabilization on sediment supply and invasive species. CBEP should study vulnerability of tidal flats to these and other emerging stressors. CBEP should evaluate methods to improve resilience of tidal flats and consider pilot-scale tests of novel methods where appropriate. CBEP should work with partners to develop criteria for prioritizing protection, restoration and enhancement of tidal flats.

Generally, resources allocated to manage Casco Bay's mudflats have been focused on commercial fisheries values. Mitigation activities have focused on remediation of pollution sources, particularly sources of fecal bacteria contamination, to improve water quality and enable commercial shellfish harvests. While this work is important and should continue, the habitat restoration needs of tidal mudflats are not well understood and need to be developed.

Casco Bay's tidal flats are extensive and played an important role in establishing the Bay as an *Estuary of National Significance*. Research is warranted to identify habitat protection, restoration and enhancement needs and opportunities for the Bay's tidal flats for the myriad of species that directly or indirectly depend upon and utilize these resources. Fundamental questions about the vulnerability of tidal flats to sea level rise remain unaddressed. The proliferation of aquaculture on and adjacent to tidal flats is another area in need of additional research. Coastal acidification is threatening the Bay's tidal flats, and further work is needed to explore the value of remedial activities such as the use of shell hash to improve pH.

Resources

Geospatial data – The primary source of geospatial data on tidal flats is the National Wetlands Inventory (NWI). Efforts are underway to develop new maps of tidal flats using recently acquired low-tide LIDAR data. Maps of habitat values (e.g., use by migratory birds and commercially harvested shellfish) are less detailed.

[32] https://www.maine.gov/dacf/mnap/focusarea/maquoit_middle_bay_focus_area.pdf

Prioritization

CBEP should work with partners to develop criteria for prioritizing protection, restoration and enhancement work in the Bay's tidal flats. Criteria for evaluating and prioritizing flat protection, restoration, and enhancement could include:

- Size of flats
- Condition of flats
- Presence of commercially important intertidal shellfish or worms, and access of harvesters to the intertidal from adjacent uplands
- Connectivity to other wetland types
- Habitat values for rare and threatened species and SGCN
- Adjacent land use and conservation status
- Climate vulnerability, especially vulnerability to rising seas

Habitat Protection - In habitat protection strategies, it is a CBEP priority to support land trusts, agencies, and municipalities in permanently protecting tidal mudflats through fee ownership or acquisition of conservation easements, as well as the adjacent uplands and shorelines, connected wetlands, and coastal streams that empty to tidal flats.

The *Maquoit and Middle Bay Focus Area of Statewide Ecological Significance*[33] is an established CBEP geographic priority. This region includes tidal flats in the Royal River Estuary, Harraseeket River, Maquoit Bay, and Middle Bay.

Rocky intertidal

Recommendation

Wait and watch. Rocky intertidal areas remain abundant in Casco Bay, and threats are limited (although that could change if there are increases in harvest pressure). While there is room for better science regarding the role of rockweed gardens as habitat for marine species, CBEP has limited capacity to lead the types of detailed research needed to inform future management.

Eelgrass beds

Recommendation

CBEP should continue to work on restoration and protection of eelgrass in Casco Bay, and support eelgrass monitoring and science through collaborative institutions such as the Casco Bay Eelgrass Consortium. Real-world performance of eelgrass restoration and even some protection strategies, like conservation moorings are poorly understood, so projects should be treated as experiments, and incorporate monitoring to learn from experience.

Resources

[33] https://www.maine.gov/dacf/mnap/focusarea/maquoit_middle_bay_focus_area.pdf

Geospatial data - Casco Bay's eelgrass beds are regularly mapped and monitored, so the current and historic location and extent of beds is well documented. Maine's *Historical Eelgrass Coverage Viewer*[34] enables users to slide between historic data sets at different spatial scales and analyze changes in bed area, extent and density through time.

Site suitability for restoration – Work by UNH scientists [35] pioneered the development of site selection models for eelgrass transplants in restoration and mitigation activities. Nearby New England regions have utilized and refined the tool for location of eelgrass restoration activities.

Prioritization

Restoration – Experimental transplant studies in Casco Bay suggest that eelgrass restoration through transplant is feasible in Maine, but outcomes are difficult to predict and sustain, in part due to the difficulty in controlling green crabs. Development of a site suitability tool for eelgrass restoration and mitigation is needed. CBEP should support opportunities to develop and test tools for locating eelgrass transplant projects. Green crab trapping and management strategies may support eelgrass restoration at the scale of subestuarine embayments.

Habitat Protection - In habitat protection strategies, it is a CBEP priority to support land trusts, agencies, and municipalities in permanently protecting intertidal and subtidal eelgrass beds through fee ownership or acquisition of conservation easements of adjacent uplands and shorelines, connected wetlands, and coastal streams.

CBEP strategies aimed at reducing nutrient pollution and managing stormwater support eelgrass by improving and protecting water quality.

The *Maquoit and Middle Bay Focus Area of Statewide Ecological Significance*[36] is an established CBEP geographic priority. This region includes current and historic eelgrass beds mapped in the Royal River Estuary, Harraseeket River, Maquoit Bay, and Middle Bay.

Shellfish bars and reefs

Recommendation

Shellfish reefs provide both structural habitat for other marine species and important water quality benefits thus supporting resilience of nearby marine ecosystems. Shellfish reefs should be adopted as a priority for both study and restoration, especially for developing and testing methods that address vulnerability to invasive species.

Shellfish reefs are identified by State and Federal agency partners as important and vulnerable habitat. In Casco Bay, mussel bars have historically been abundant. Although

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[34] https://www.arcgis.com/apps/MapSeries/index.html?appid=ac2f7b3d29b34268a230a060d6b78b25
[35] Short et. al. 2002
[36] https://www.maine.gov/dacf/mnap/focusarea/maquoit_middle_bay_focus_area.pdf

the causal link is poorly established, it is generally believed that European green crabs decimated blue mussel bars throughout the Bay circa 2012, leading to widespread loss of mussel bars. Monitoring of mussel bars is lacking, therefore documentation of change over time is minimal and it is difficult to quantify what was lost.

Resources

Geospatial data – Maine DMR 2010 maps of molluscan shellfish include blue mussels and American oysters, the two native shellfish species with potential to form emergent reefs and bars, but this data set is assumed to underrepresent the distribution and abundance of blue mussels and does not specify whether either species forms aggregate reefs or bars. Maine DEP Environmental Vulnerability Index includes maps of shellfish resources including mussel seed areas, but these may draw from the same underlying data set.

Prioritization

Methods for creating or restoring shellfish reefs are largely untested in Maine, but experimental oyster enhancement projects suggest that it may be feasible to replace emergent habitat values of lost blue mussel bars with oyster reefs on a small scale. As waters warm in conjunction with climate change, improving over-winter survival and reproduction of American oysters, it may become increasingly feasible to establish oyster bars and reefs in Casco Bay. Research is needed to develop methods for restoring blue mussel bars.

Habitat Protection - In habitat protection strategies, it is a CBEP priority to support land trusts, agencies, and municipalities in permanently protecting shellfish reefs and bars through fee ownership or acquisition of conservation easements, as well as the adjacent uplands and shorelines, connected wetlands, and coastal streams that empty to shellfish reefs.

Kelp beds

Recommendation

Limited information on status of kelp beds in Casco Bay reduces our ability to evaluate benefits of habitat restoration or protection. CBEP has limited capacity to conduct or facilitate either research on or assessment of kelp beds, so they should be treated as a lower priority for the time being. CBEP should be supportive of efforts to improve our understanding of the ecological value and historic distribution of kelp resources in the Bay.

Islands

CBEP will continue to assist with permanent protection of island habitats by continuing to fund acquisition of easements and fee ownership via the Habitat Protection Fund. CBEP has a strong interest, but limited capacity to understand the ecological condition of Casco Bay's many islands. CBEP could play a productive role in bringing together the many organizations directly involved with island management, CBEP has limited capacity to do so. Thus island habitats should be a low priority for the time being. CCBEP should remain open to playing a convening role to assist with emerging regional initiatives.

Rivers and streams - anadromous fish

Recommendation

The focus of CBEP's Habitat work on streams should remain on restoring aquatic ecosystem continuity, especially access of anadromous fishes to freshwater spawning habitat. Work to protect freshwater mussels in the Presumpscot watershed offers an opportunity to tie together fish passage, sediment loading, riparian protection and other issues around a coherent narrative to protect a threatened species. CBEP should also work with Partners to establish aquatic barrier restoration priorities for the Casco Bay watershed. Additional work in flowing waters should address water quality concerns principally through water quality programs, or riparian habitat protection.

Resources

Geospatial data – Extensive data on surveyed culverts, stream barriers, and dams are available in Maine, and have been used to create tools and resources supporting barrier removal, restoration of aquatic organism passage, and freshwater habitat connectivity. Geospatial data on public and private stream barriers in the Casco Bay watershed are available from CBEP.

Casco Bay Watershed Fish Barrier Priorities Atlas[37] – USFWS, Gulf of Maine Coastal Program used stream barrier data to develop town atlases showing stream barriers and flood prone sites in 2012. Identified freshwater public and private road crossings in need of culvert replacement for flood resilience, aquatic organism passage, and restoration of natural stream processes, and maps priority streams. Municipal atlases were delivered to 42 watershed municipalities and are available online.

Maine Stream Habitat Viewer[38] – Maine Coastal Program developed this online tool displaying publicly owned road/stream crossings with stream barriers, potential barriers, and non-barriers, as well as dams. Private sites are not shown. Enables users to locate barriers and access summaries of barrier data and photos. Priority habitat data are available for Atlantic salmon, alewife, sea-run smelt, wild brook trout, and tidal marshes.

Maine Aquatic Barrier Prioritization Tool[39] – Within their Coastal Resilience online mapping platform, TNC developed an online screening tool, with funding from NRCS, designed to support river restoration practioners in prioritizing stream barriers for removal or fish passage improvements. TNC convened technical committees and experts to guide development and weights for metrics and consensus prioritization scenarios for: a) coastal

[37] https://www.cascobayestuary.org/publication/casco-bay-watershed-fish-barrier-priorities-atlas-complete/
[38] https://webapps2.cgis-solutions.com/MaineStreamViewer/#
[39] https://maps.coastalresilience.org/maine/#

anadromous fish, b) inland brook trout, c) Atlantic salmon, d) alewife, and e) shad and blueback herring. CBEP participated in development of these scenarios, which use best available information on habitat suitability.

Maine Stream Connectivity Working Group[40] – A network of river restoration practitioners and planners currently convened by Maine DMR and Maine Rivers, the working group meets twice annually and provides opportunities for technical experts to work with partners on specific projects and sites.

Stream Smart[41] - The Maine Stream Connectivity Working Group developed the *Stream Smart* program to guide the approach to designing and replacing freshwater culverts. Stream Smart, based on the Stream Simulation ecological design approach developed by the U.S. Forest Service in the Pacific Northwest,[42] trains road owners, landowners, contractors, and other professionals responsible for road-stream crossings to design and install culverts that support natural stream processes, including floodwaters and movement of aquatic organisms. Training workshops are coordinated by Maine Audubon, which maintains an extensive resource library. Stream barrier restoration projects are expected to follow Stream Smart principles.

Prioritization

Habitat restoration - CBEP prioritizes barrier remediation and restoration of aquatic habitat connectivity and fish passage for diadromous species including rainbow smelt, alewife, blueback herring, tomcod, sea-run brook trout, sea lamprey, American shad, striped bass, Atlantic salmon, shortnose sturgeon, Atlantic sturgeon, and American eel.

Information on the presence, abundance, current habitat suitability and historic presence of diadromous species throughout the watershed is quite limited. It is generally assumed that eels, which can travel for short periods over land, as well as up steep gradients including the face of dams, are able to access rivers, streams, lakes, and ponds in the lower Casco Bay watershed (e.g., downstream of Sebago Lake). State and federal resource agencies also assume that Atlantic salmon cannot be restored to the Casco Bay watershed. Large fish such as striped bass and sturgeon have been documented in the lower Presumpscot River, as well as throughout the Bay's estuarine waters, but otherwise are not presumed to use the Casco Bay watershed for spawning. Information on tomcod and sea lamprey are largely unavailable. Therefore, CBEP's prioritization focuses on representative species for which there is available information on historic or current spawning habitat for smelt, alewife, blueback herring, and shad. Other diadromous species such as brook trout, tomcod, lamprey, and eels are likely to be co-beneficiaries for restoration activities in coastal streams and rivers.

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[40] https://www.maine.gov/dmr/science-research/searun/programs/streamconnectivity.html
[41] https://maineaudubon.org/projects/stream-smart/resource-library/
[42] https://www.fs.fed.us/eng/pubs/pdf/StreamSimulation/hi_res/%20FullDoc.pdf

Generally, CBEP prioritizes restoration of stream barriers in proximity to Casco Bay, so that barriers nearer to the Bay are higher priorities than those further from the Bay. Additionally, CBEP prioritizes barriers on larger rivers and streams than on smaller headwater streams and intermittent water bodies. Dams are generally higher priorities than culverts, and freshwater bodies that with habitat values for priority diadromous species are highest priorities.

Highest priority dams are those on main stem rivers that lack functional fish passage and are at or near head of tide. There are three that stand out as particularly important barriers to address: Bridge Street Dam in Yarmouth, Elm Street Dam in Yarmouth, and the Stroudwater Dam in Portland. Each of these structures impedes movement of priority species, is in close proximity to tidal waters, severs habitat connectivity between the Bay and large freshwater riverine networks upstream, and has fundamentally altered critical riverine habitat for CBEP priority species, converting riverine habitat to impoundments. Thus, these three dams stand out as highest priority barriers to address.

Mainstem dams on the Presumpscot are also a priority. After the success of restoring anadromous fish access past the old site of the Sacarappa Dam, the Pleasant River constitutes the next major tributary that could provide substantial habitat for migratory fish. Anadromous fish access to the Pleasant would require fish passage at three dams (Mallison, Little Falls, and Gambo), and so is a long-term , not short-term priority.

To develop fish passage priorities beyond mainstem dams near head of tide, CBEP should use geospatial analysis, such as the Aquatic Barrier Prioritization tool for Maine, or a barrier analysis tool developed by Maine DOT. The following scenarios, criteria, and scales are recommended for this analysis:

- Conduct separate analyses to identify aquatic barrier priorities for each subwatershed including the Presumpscot River watershed, the Royal River watershed, the Stroudwater River watershed, and coastal subwatersheds.
- Subwatershed priorities should utilize existing consensus scenarios for 1) alewife, 2) shad and blueback herring, and 3) coastal anadromous species.
- Highest priority barriers within each subwatershed will be based on 1) location on main stem rivers, b) distance from head of tide, and c) dams over culverts. The highest priority barriers will be: 1) main stem rivers > tributaries, 2) distance from head of tide, 3) dams > culverts, 4) severe barriers > partial or potential barriers.

CBEP should develop maps for each subwatershed identifying barrier priorities, as well as a single map and analysis of top 20 freshwater barrier restoration priorities for the Casco Bay watershed as a whole.

Habitat Protection - In habitat protection strategies, it is a CBEP priority to support land trusts, agencies, and municipalities in permanently protecting freshwater rivers and streams through fee ownership or acquisition of conservation easements for riparian corridors, floodplains, connected wetlands, groundwater recharge areas, aquifers, and other important water resource features.

CBEP has generally not evaluated watershed-wide priorities for protection of freshwater bodies. During the Presumpscot Land Conservation: Vision, Values and Priorities process, priority aquatic habitats for protection were identified including East Branch Piscataqua River, West Branch Piscataqua River, Mill Brook, Pleasant River, and upper Little River watershed. CBEP is a member of Sebago Clean Waters, which prioritizes conservation of land for water resource protection of Sebago Lake and its tributaries.

Freshwater wetlands and riparian areas

Recommendation

CBEP should focus on protection of freshwater wetlands and riparian areas principally because of their effects on water quality and resilience of downstream aquatic habitats. CBEP should continue to invite applications for funding through the Habitat Protection Fund. These areas should be high priorities for protection, but low priorities for habitat restoration. Where restoration does occur, it should be part of an integrated resilience plan that incorporates habitat protection, aquatic ecosystem continuity improvements, and freshwater wetland enhancement.

Lakes and ponds

Recommendation

Lakes and ponds are among the most iconic components of the Casco Bay watershed and inland Maine. Many provide recreational opportunities, draw tourists to the state, and are important economic engines for inland communities. Nevertheless, lakes and ponds should be of lower priority for CBEP's habitat programs. State agencies, nonprofits and local governments have substantial capacity to address lake habitat issues, such as habitat loss or invasive species. CBEP has an abiding interest in lake water quality and ecosystem health, so CBEP should consider playing a supporting role on lake issues on a case-by-case basis, especially when lake concerns overlap with water quality or anadromous fish restoration activities.

Upland forests and inland habitats that protect water quality

Recommendation

Upland forests, especially those forests adjacent to headwater streams are crucial for protecting water quality in lakes, rivers, streams and the Bay. Forests are also important for forest-dependent birds and wildlife, public recreation and carbon sequestration. Forest areas should be an intermediate to high priority for habitat protection, depending on water quality value of protection, public access and health of receiving waters. CBEP will work with other partners both through regional Partnerships, like Sebago Clean Waters and by providing partial funding for forest protection through the Habitat Protection Fund

Priority Habitats

CBEP will continue to focus here on marine and coastal habitats and rivers and streams as habitat for migratory fish that spend a portion of their lives in coastal waters. This reflects CBEP's historic focus on coastal habitats, not that coastal habitats are more at risk than inland habitats. Climate change and accelerating land use change in our region are likely to place most habitats at risk in coming decades.

CBEP will partner with other organizations to protect inland habitats that protect water quality throughout the Casco Bay watershed, Freshwater wetlands, riparian areas and upland forest are of critical importance to the health of the Bay. CBEP's interest in these habitats focuses not on their intrinsic habitat values for fish and wildlife, but on their role supporting healthy aquatic ecosystems and maintaining water quality.

- Tidal Marshes (ongoing priority)
    - Full engagement with regional restoration efforts, including research, prioritization and implementation
- Tidal Mudflats (new priority)
    - Focus on increasing understanding of issues and problems, especially vulnerability to invasive species, climate change and sea level rise. Advance understanding of managing tidal flats for multiple habitat values and resilience.
- Eelgrass beds (ongoing priority)
    - Facilitate regional understanding of methods for restoration and protection.
- Shellfish bars and reefs (new priority)
    - Gain understanding of present and historic abundance and ecosystem services provided by shellfish reefs. Pilot restoration techniques and approaches, including control of green grab and other invasive predators.
- Rivers and Streams (specifically, river continuity and anadromous fish; ongoing priority)
    - Continue work to increase access of anadromous fish to historic habitat in the Casco Bay Watershed
- Inland habitats that protect water quality (including freshwater wetlands, riparian areas and upland forests; ongoing priority).
    - Provide funding to support habitat protection efforts, and work with Partners to expand regional conservation.

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Habitat Plan Appendix B1: Prior CBEP Habitat Planning and Analysis

Summary Table

Table 7. Summary of past Casco Bay Estuary Partnership Habitat Evaluation, Studies, and Priorities

Year	Document	Priorities / Findings
1992	Casco Bay Estuary Project. 1992. Preliminary Comprehensive Conservation and Management Plan.	• Subtidal waters (ocean floor, surface of ocean, and water column) • Islands – uninhabited islands, seabird breeding areas, importance of endangered roseate tern. Importance of unvegetated small islands and “half-tide” ledges as seal haulouts • Flats – Importance for migratory shorebirds: Fore River Estuary, Back Cove, Maquoit Bay, Middle Bay. • Eelgrass beds • Mussel bars – important for eiders, black ducks. Considered at the time to be ephemeral but abundant. • Salt marshes • Freshwater wetlands • Rivers and streams – resident and anadromous fish (alewife, smelt, shad, and possibly salmon); landlocked salmon • “Edge zones” along water bodies (riparian corridors, shorelines)
1995	Banner, A. and J. Libby. 1995. Identification of Important Habitats in the Lower Casco Bay Watershed. U.S. Fish and Wildlife Service Gulf of Maine Project.	Mapped important habitats through a GIS analysis, based on habitat scarcity and importance of certain species, including saltmarsh cordgrass, eelgrass, shellfish, marine worms, resident and migratory fishes, endangered species, waterbirds, seabirds and wading birds. This tends to focus attention on tidal wetlands, tidal flats, and stream corridors. Study did not consider upland habitats like forests or riparian corridors.
1996	Banner, A. and M. Gormley. 1996. Identification of Important Casco Bay Fish and Wildlife Habitats at Risk from Future Development. U.S. Fish and Wildlife Service Gulf of Maine Project and Casco Bay Estuary Project.	Conducted a build-out analysis based on contemporary regulations (zoning, etc.) of important habitats mapped in the 1995 USFWS study.
1996	Casco Bay Estuary Project. 1996. *Casco Bay Plan* – Protect the	• Subtidal areas – sea bottom i.e., mud, sand, gravel, cobble, boulders, and rock; eelgrass beds • Intertidal areas – salt marshes, flats, eelgrass beds, rocky shore

	health and integrity of our bay for the future.	• Islands – seabird nesting islands • Rivers, Streams, and Freshwater Wetlands • Rivers and Streams, with a focus on habitat for fish and wildlife, especially anadromous fish. • Riparian zones, including streambanks and edge habitat along the Casco Bay shoreline • Freshwater wetlands - habitat and role purifying polluted water and reducing flood damage. Also identified certain "degraded habitats", many of which have not yet been addressed: • New Meadows "Lake" • Long Creek • Lower Presumpscot River I295 crossing • Four dams on the Royal River main stem • Capisic Brook "... an American eel run but is now impassable due to a dam and reduced water flows."
2000	Bonebakker, E., P. Shelley. Casco Bay Return The Tides Action Plan. Conservation Law Foundation. NOAA funded, CBEP commissioned.	• Identified 102 sites (roads, dams, rail, berms) to assess for tidal restriction and marsh degradation • Implemented volunteer field assessments in 1999-2000 • Created database of assessed sites with unique identifiers • Identified >12 sites where structures significantly restricted tides at tidal wetlands • Recommended CBEP develop a restoration program and capacity for feasibility studies
2003	Presumpscot River Management Plan Steering Committee. A Plan for Future of the Presumpscot River	• Restoring, preserving, or enhancing riverine habitat from Gambo Dam to Casco Bay. • Restoring self-sustaining populations of native resident fish, and sea-run fisheries. • Providing access to the entire river (up to the dam at Sebago Lake) for sea-run fish. • Protecting open space along the main stem and tributaries to preserve or improve wildlife habitat and provide healthy riparian buffers.
2005	Habitat Restoration Inventory for the Lower Presumpscot River Watershed (Northern Ecological Associates)	Produced a report and database of potential habitat restoration sites with photos, field data, and location. Although commissioned by CBEP and funded by a grant from NOAA, results were little used directly owing to a lack of CBEP oversight; significant gaps and omissions; complexity, cost, and scale of significant restoration needs; and ownership constraints. Some smaller sites became projects for Youth Conservation Corps.

2005	Habitat Restoration Inventory for the Royal River, Spruce Creek and Lower Kennebec River Estuary (Northern Ecological Associates)	Like the previous study, produced an Access database of potential habitat restoration sites. Funded principally by the Maine Coastal Program. Informed Youth Conservation Corps programs.
2008	Recommendations for Future Restoration and Management Efforts for Mill Brook (J. Varricchione, Maine DEP; CBEP)	Focused study of Mill Brook. Many recommendations have been partially or wholly implemented. • Address barriers to fish passage beneath road crossings (largely accomplished) • Protect the stream corridor through conservation easements and fee ownership (Significant progress)
2008	Fringing Marsh Mapping & Restoration Inventory (Hayes *et al.*)	Study of "fringing marshes around Casco Bay, including an early examination of vulnerability to sea level rise. • Address non-point sources of freshwater runoff and pollution such as fertilizer • Plant, expand or enhance vegetated buffers ("Riparian buffers") • Control invasive Phragmites • Restore tidal flow
2012	Casco Bay Watershed Fish Barrier Priorities Atlas. (U.S. Fish and Wildlife Service, Gulf of Maine Coastal Program and CBEP)	• Analyzed 2009-10 road/stream barrier survey data, State dams data, CCEMA flood sites, CBEP flood modeling, and stream habitat values to prioritize public and private crossings for restoration of natural stream processes, fish passage and flood resilience • Delivered town atlases with priority barriers and summary data to 42 municipalities
2013	Land Conservation in the Lower Presumpscot River Watershed: Vision, Values, Priorities (Levesque *et. al*.)	The study produced aquatic habitat conservation priority areas around the following tributaries to the main stem of the Presumpscot: • Mill Brook • East Branch Piscataqua River • West Branch Piscataqua River • Upper Little River • Pleasant River
2016	*Casco Bay Plan*, 2016-2021 (CBEP)	• Action 1.1.A identifies shoreline, intertidal habitats, and islands; river riparian areas and floodplains; freshwater wetlands; and forested areas near headwater streams as priorities for conservation. • Action 1.2.A tidal wetlands (especially tidal restrictions) and eelgrass beds as priorities for restoration. • Action 1.2.B highlights need for fish passage improvements, especially at major dams and culverts.

Detailed Review

1992 – Preliminary CCMP

Reviewed historical documents that documented diversity and habitat values of Casco Bay and identified information needed to inform development of the *Casco Bay Plan*. Listed resources needing protection included:

- Subtidal waters (ocean floor [rock, sediment], surface of ocean, and water column).
- Islands – uninhabited islands, seabird breeding areas, importance of endangered roseate tern. Importance of unvegetated small islands and "half-tide" ledges as seal haulouts.
- Flats – Importance of flats for migratory shorebirds: "...locations in Casco Bay where large numbers of migratory shorebirds congregate to feed…" include Fore River Estuary, Back Cove, Maquoit Bay, Middle Bay.
- Eelgrass beds
- Mussel bars – important for eiders, black ducks. Ephemeral. "Mussels are abundant throughout Casco Bay." (p. 19)
- Salt marshes
- Freshwater wetlands
- Rivers and streams – resident and anadromous fish (alewife, smelt, shad, and possibly salmon), landlocked salmon
- "Edge zones" along water bodies (riparian corridors, shorelines)

1995 – Identification of Important Habitats in the Lower Casco Bay Watershed.

- Led by USFWS Gulf of Maine Project and funded by CBEP. Accepted as a CBEP publication.
- Mapped important habitats through a GIS analysis. Aggregated species values and adjusted scores for relative scarcity of habitats and species' rank on Gulf of Maine Council's list. "The final map scores were the products of the scores for habitat quality, habitat abundance, and species rating."
- "In accordance with the National Estuary Program, evaluation species were those predominantly associated with wetland and coastal features."
- "Species for which habitats were identified included saltmarsh cordgrass, eelgrass, shellfish, marine worms, resident and migration fishes, endangered species, waterbirds, seabirds and wading birds."

1996 – Identification of Important Casco Bay Fish and Wildlife Habitats at Risk from Future Development (Banner and Gormley)

- Conducted a build-out analysis based on contemporary regulations (zoning, etc.) of important habitats mapped in the 1995 USFWS study

1996 – Casco Bay Plan

- "Priority habitats identified by CBEP include the waters and islands of Casco Bay, and the rivers, streams, and freshwater wetlands of the watershed. While lakes, ponds, and certain terrestrial features provide important habitats, these are less directly linked to Casco Bay and therefore are not discussed in the Plan." (p. 54)

- Subtidal areas – sea bottom i.e., mud, sand, gravel, cobble, boulders, and rock; eelgrass beds
- Intertidal areas – salt marshes, flats, eelgrass beds, rocky shore
- Islands – seabird nesting islands
- Rivers, Streams, and Freshwater Wetlands
    - Rivers - Presumpscot, Royal, Stroudwater, Fore; "vast network of streams"
        - "…habitat to muskrat, beaver, river otter, belted kingfisher, black duck, spotted sandpiper, shad, trout, bass, perch, pickerel, and salmon."
        - "Streams provide important habitats for juvenile fish and for anadromous fish like alewife and smelt…"
        - "The landlocked salmon, a prized recreational fish, lives in Sebago Lake and spawns in the upper Casco Bay watershed."
    - Riparian zone / streambank; edge habitat along Casco Bay shoreline
    - "Like coastal salt marshes, freshwater wetlands afford critical habitat…" and "…play an important role in purifying polluted water and reducing flood damage."
- "Some ecological features – such as islands, tidal flats, and salt marshes – are especially important sources of food and shelter…"
- Named degraded habitats:
    - New Meadows "Lake"
    - Long Creek
    - Lower Presumpscot River I295 crossing
    - Four dams on the Royal River main stem
    - Capisic Brook "used to be an American eel run but is now impassable due to a dam and reduced water flows."
- P. 66: Map of "Important Habitats for All Evaluation Species" – lower 15 towns

2000 – Casco Bay Return The Tides Action Plan (Bonebakker et. al.)

The Conservation Law Foundation collaborated with CBEP on the Return The Tides study in 1999-2000. CLF, under the leadership of Erno Bonebakker and with funding provided by NOAA, trained and coordinated volunteers to collect field data as part of a comprehensive survey of known or suspected tidal crossings around Casco Bay. This was the first concerted effort to locate tidal restrictions in Casco Bay. The study purposes were: 1) to develop protocols and training materials to build volunteer capacity to assess tidal marshes and promote restoration activities, 2) Identify and assess tidal marsh crossings to inform future restoration actions, 3) build a prototype database for a future statewide effort, and 4) assess the potential for promoting long-term stewardship of marshes and other habitats.

Study findings were that 12 roads and dams out of 102 potential crossings were significantly restricting tides and impacting adjacent tidal marsh. Some of these sites have been the focus of subsequent CBEP tidal restoration activity. A key study recommendation was for CBEP to develop a program to further evaluate impacts of hydromodifications on tidal marshes and develop conceptual alternatives for restoring natural hydrology. The ”Return The Tides” project, as it has come to be known, began in Casco Bay in 1999, and subsequently expanded statewide in 2001-2002. Data sheets, photos, and other materials from this effort are on file at Maine Coastal Program but much of the information collected from this effort was never digitized, including photos.

Note: In 2020, Maine Coastal Program NOAA Coastal Management Fellow Ellen Bartow-Gillies used the Return The Tides database to create a new statewide database of current and future tidal crossings under different sea level rise scenarios. MCP's database is available through the Maine Tidal Restriction Atlas[43], and the original Return The Tides site identification has been replaced with a new system.

2003 – A Plan for Future of the Presumpscot River (Presumpscot River Management Plan Steering Committee)

CBEP coordinated a multi-year stakeholder process to establish shared management objectives for the Presumpscot River. The Plan was partially funded, and officially accepted, by CBEP, and CBEP was a member of the Steering Committee which authored the document. The Plan served to launch the Presumpscot River Watershed Coalition and guided collaborative efforts on overarching objectives to restore fisheries, protect open space, enhance recreation and protect and improve water quality among other objectives. The Plan recommended removal of specific dams on the Presumpscot main stem and provision of fish passage at others, as well as specifying actions to protect open space and improve the riparian habitat corridors. Management objectives included:

- Restoring, preserving, or enhancing riverine habitat from Gambo Dam to Casco Bay.
- Restoring self-sustaining populations of native resident fish, and sea-run fisheries.
- Providing access to the entire river (up to the dam at Sebago Lake) for sea-run fish.
- Protecting open space along the main stem and tributaries to preserve or improve wildlife habitat and provide healthy riparian buffers.

2005 – Habitat Restoration Inventory for the Lower Presumpscot River Watershed (Northern Ecological Associates)

In 2003, CBEP received NOAA grant funds and commissioned a study to “Identify, evaluate, document potential habitat restoration opportunities in, and directly adjacent to, waterbodies in the lower portion of the Presumpscot River Watershed.” Intended to serve as a restoration compendium. Geographic focus - subset of the Presumpscot River watershed, including the main stem downstream of Cumberland Mills Dam, the Mill Brook watershed, the East and West Branch Piscataqua watersheds, and the Presumpscot Estuary. Omitted Little River and Pleasant River. Produced an Access database of sites

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[43] https://www.maine.gov/dmr/mcp/environment/tr-atlas/

including photos, field data, and location. This document was generally not utilized by CBEP. Informed work of youth conservation corps.

2005 – Habitat Restoration Inventory for the Royal River, Spruce Creek and Lower Kennebec River Estuary (Northern Ecological Associates).

Inventory similar to the Presumpscot inventory in methods and outputs, focused on Royal River. Study was funded and commissioned by the Maine Coastal Program. CBEP participated in surveys but did not have a formal role in the study. The report was not officially accepted by CBEP. Informed work of youth conservation corps.

2008 – Recommendations for Future Restoration and Management Efforts for Mill Brook (J. Varricchione, Maine DEP; CBEP)

A collaborative effort of the CBEP Habitat Restoration Committee and led by Jeff Varricchione of Maine DEP, which focused on the stream due to its documented habitat values for anadromous fish species including and accessibility to Casco Bay following removal of the Smelt Hill Dam on the Presumpscot main stem. Incorporated input from numerous state and federal agencies, as well as NGO partners, to recommend priority restoration and management activities in and adjacent to Mill Brook in Westbrook and the Mill Brook watershed to ensure long-term ecological health and values. Key recommendations were to address barriers to fish passage beneath road crossings and to protect the stream corridor through conservation easements and fee ownership.

2008 – Fringing Marsh Mapping & Restoration Inventory (Hayes et al 2008)

In 2007, CBEP commissioned Wells NERR to map fringing salt marsh, rapidly assess marsh characteristics and condition, and recommend restoration actions to protect, restore and enhance degraded marsh habitat. Restoration actions generally identified the need for a) addressing non-point sources of freshwater runoff and pollution such as fertilizer; b) planting or increasing vegetated buffers; c) controlling invasive *Phragmites*; and d) restoring tidal flow.

2012 – Casco Bay Watershed Fish Barriers Priorities Atlas

Alex Abbott, contractor with U.S. Fish and Wildlife Service, Gulf of Maine Coastal Program, and CBEP staff collaborated on an effort to develop town atlases with mapped priorities for road/stream crossings in need of replacement for restoration of natural stream processes, fish passage and flood resilience. Atlases include public and private road/stream crossing field data collected in 2009-2010, flood prone sites or sites with documented flood hazards, and priority stream habitat, and were mailed to 42 municipalities.

2013 – Land Conservation in the Lower Presumpscot River Watershed: Vision, Values, Priorities (Levesque et. al.)

CBEP coordinated an effort by the Presumpscot River Watershed Coalition to establish shared regional priorities for land protection in the lower Presumpscot watershed, which was an action recommended in the 2003 Presumpscot Plan. The VVP report focused on core conservation values including aquatic habitat, terrestrial habitat, natural communities of special concern, water quality, recreation & access, working woodlands, agriculture, and historic resources. The effort produced aquatic habitat conservation priority areas around the following tributaries to the main stem:

- Mill Brook
- East Branch Piscataqua River
- West Branch Piscataqua River
- Upper Little River
- Pleasant River

2016 – Casco Bay Plan, 2016-2021 (CBEP 2016)

The 2016 *Casco Bay Plan* updates strategic goals, strategies and actions for CBEP over the five-year period from 2016-2021. Goal 1, and nested strategies and actions, focus CBEP efforts on habitat protection, enhancement, and restoration. Current CBEP strategic priorities for habitat are detailed in Section V, below.

Action 1.1.A identifies the Bay's shoreline, intertidal habitats, and islands; river riparian areas and floodplains; freshwater wetlands; and forested areas near headwater streams as priorities for conservation.

Action 1.2.A calls out tidal wetlands (especially tidal restrictions) and eelgrass beds as priorities for restoration.

Action 1.2.B highlights fish passage improvements, especially at major dams and culverts.

Habitat Plan Appendix B2: Complementary Habitat Planning Documents

Summary Tables

Table 8. Summary of related federal and state agency plans and documents

Year	Source	
State		
2000	Beginning With Habitat - Focus Areas of Statewide Ecological Significance. Maine Natural Areas Program/Maine DACF.	Landscapes that contain exceptional concentrations of at-risk species and natural communities and high quality common natural communities, significant wildlife habitats, and their intersection with large blocks of undeveloped habitat. Focus areas partly or entirely within the Casco Bay watershed include: • Jugtown Plains –Terrestrial habitat complex abuts the Crooked River, Pitch Pine and Heath Barren. • Kennebec Estuary – Centered on the tidal portion of the Kennebec River but includes small areas of Phippsburg which lie in the Casco Bay watershed, as well as the whole of Small Point in Phippsburg. • Maquoit and Middle Bay – Includes Maquoit Bay, Middle Bay, the Harraseeket River, and the Royal/Cousins River estuary, as well as several islands, points of land, and undeveloped upland areas. • Perley Pond Peatland – This freshwater wetland complex lies within the Sebago Lake watershed. • White Mountains – Headwater streams and forested upland areas in the Sebago Lake watershed.
2015	Maine State Wildlife Action Plan 2015-2025. Maine DIFW.	• Identifies Species of Greatest Conservation Need (SGCN) in Maine, including low and declining populations that are indicative of the diversity and health of the state's fish and wildlife, and key SGCN habitats, stressors, and strategies • Incorporates coastal and marine ecosystems as key habitats: tidal marsh; rocky coast; intertidal mudflat, sandy shore, mollusk reefs, bedrock, and gravel shore; subtidal mud bottom, sand bottom, mollusk reefs, bedrock bottom, and gravel bottom; and intertidal and subtidal water column. • Lists 165 marine/coastal actions, and 54 freshwater aquatic actions, to benefit SGCN
2017	Maine Wetland Program Plan. Maine DEP.	The 2017-2022 plan lays out goals for wetland protection, monitoring, research, restoration, stewardship, and tracking. Includes call-out for work on analysis of tidal barriers in coastal wetlands.
2020	Maine Won't Wait – A Four Year Plan for Climate Action. Maine Climate Council.	• Protect Maine's Environment and Working Lands and Waters • Promote Natural Climate Solutions and Increase Carbon Sequestration • Potential for coastal ecosystems, especially tidal wetlands and eelgrass beds, to sequester carbon

		• Calls for significant increases in habitat protection (statewide goal of 30% protected area by 2030), and restoration, especially of “high biodiversity areas to support land and water connectivity and ecosystem health”
Federal		
2022	USFWS, Gulf of Maine Coastal Program (5-year plan)	Priority habitats: • Saltmarshes, especially with respect to conservation of tidal marsh-dependent species of concern, including the saltmarsh sparrow • Watershed restoration and diadromous fish conservation, including stream continuity for river herring.
	Essential Fish Habitat. NOAA Fisheries.	• Atlantic Salmon Essential Fish Habitat (EFH) in Casco Bay watershed: Presumpscot River main stem approximately to Gambo Dam, West Branch of Piscataqua River to Forest Lake dam, and Mill Brook to Highland Lake dam. Casco Bay is outside the Distinct Population Segment (DPS) area subject to Threatened Species Protections. The DPS begins at Small Point and includes the Kennebec Estuary. • Highly Migratory Species: Most Casco Bay’s marine waters are EFH for adult bluefin tuna • New England/Mid-Atlantic Species: Most Casco Bay waters are EFH for juvenile Atlantic Butterfish • In 2017, NOAA established the Gulf of Maine Distinct Population Segment (DPS) for Atlantic Sturgeon that includes the Kennebec River, but Casco Bay and its watershed falls outside of the formal DPS.
Interagency		
2004	Gulf of Maine Habitat Restoration Strategy. Gulf of Maine Council on the Marine Environment.	• Rivers – Major threats include dams and passage barriers for anadromous fish prioritized dam removal and culvert replacement, which are important for improving riverine habitat and restoring fish passage. • Tidal marsh -- include altered hydrology and tidal restrictions caused by roads, causeways, dikes, tide gates, and dams and ditching and filling of salt marsh. • Shellfish habitat –invasive species (green crab, *Phragmites australis*), tidal restrictions and poor water quality. • Subtidal habitats – The value of eelgrass beds and kelp beds is noted, but restoration is uncommon. • Islands -- Noted the value of uninhabited islands and the importance of terns as indicators of ecosystem health. Major threats: development and sea level rise. • Recommended restoration of seabird islands, tidal hydrology, dike removal, and invasive species management.
2017	Conservation Strategic Plan 2017-2021. Atlantic	• Sets priority habitats for the North Atlantic Subregion: riverine bottom, submerged aquatic vegetation and marine and estuarine shellfish beds • Identifies major threats to North Atlantic priority habitats, sets conservation strategies & objectives

	Coastal Fish Habitat Partnership.	• Lists science and data objectives as well as outreach and communication objectives
2019, 2020	Atlantic Coast Joint Venture	• Salt Marsh Bird Conservation Plan – identifies threats, prioritizes species for conservation action, and lays out conservation strategies. Priority (tier A) species includes saltmarsh sparrow (*Ammospiza caudacuta*), and tier B includes Nelson's sparrow (*Ammospiza nelson subvirgatus*) • Saltmarsh Sparrow Conservation Plan – Provides population and habitat objectives for saltmarsh sparrow and identifies additional species-specific conservation strategies. • Saltmarsh sparrow habitat tool – prioritizes saltmarsh sparrow habitat including patches in Casco Bay
	Eastern Brook Trout Joint Venture	• Mapped Maine wild brook trout (*Salvelinus fontinalis*) patches including Casco Bay subwatersheds • Identifies threats and challenges for the Northern Region including increased water temperatures, population fragmentation, and exotic species, as well as management strategies including reducing habitat fragmentation and improving water quality
Regional / collaborative landscape planning		
2010	Conservation Blueprint, A Guidebook for Protecting Place and Prosperity. Sagadahoc Region Rural Resource Initiative	• Established conservation objectives for the region, including protecting water resources and riparian areas • Identified significant rivers and bays to protect, including several in Casco Bay: The Basin, Harpswell Sound, Long Reach, Maquoit Bay, Merepoint Bay, Middle Bay, New Meadows River, Quahog Bay, Winnegance Bay • Identified significant great ponds to protect, including several in Casco Bay: Big Pond, Phippsburg; Blaisdell Pond, Phippsburg; Campbell Pond, West Bath; Houghton Pond, West Bath; Sprague Pond, Phippsburg;
2013	Presumpscot Vision, Values and Priorities. Presumpscot River Watershed Coalition / Levesque *et. al*.	• Established shared conservation values and priorities for the lower Presumpscot watershed, including focus areas for aquatic habitat and water quality protection. Aquatic habitat priority areas included the following: • Mill Brook • East Branch Piscataqua River • West Branch Piscataqua River • Upper Little River • Pleasant River
2020	Sebago Clean Waters	• Collaborative (but non-public) prioritization of parcels for protection based on evaluation of geospatial features and values, with the objective of maintaining Sebago Lake water quality • Goal to protect 25% of the Sebago Lake watershed by 2035

State Habitat Plans and Documents

Beginning with Habitat Focus Areas

Maine's Beginning with Habitat program established statewide Focus Areas of Statewide Ecological Significance, which are landscape scale areas that include concentrations of at-risk species and natural communities and high quality common natural communities, significant wildlife habitats, and large blocks of undeveloped habitat. They are intended to serve as planning tools for conservation organizations, towns, and landowners to inform land protection in a voluntary, non-regulatory manner. The following Focus Areas partially or wholly fall within Casco Bay or the Casco Bay watershed:

- Jugtown Plains – This terrestrial habitat complex abuts the Crooked River and consists of Pitch Pine and Heath Barren.
- Kennebec Estuary – Centered on the tidal portion of the Kennebec River but includes small areas of Phippsburg which lie in the Casco Bay watershed, as well as the whole of Small Point in Phippsburg.
- Maquoit and Middle Bay – Includes the whole of Maquoit Bay, Middle Bay, the Harraseeket River, and the Royal/Cousins River estuary, as well as several islands, points of land, and undeveloped upland areas.
- Perley Pond Peatland – This freshwater wetland complex lies within the Sebago Lake watershed.
- White Mountains – Includes headwater streams and forested upland areas in the upper Sebago Lake watershed.

Maine State Wildlife Action Plan (Maine DIFW)

The Maine State Wildlife Action Plan (SWAP) identifies Species of Greatest Conservation Need (SGCN) in Maine, their key habitats, stressors and problems affected SGCN, as well as identifying specific conservation actions to take and monitoring needs. SWAP recommendations align well with CBEP's Habitat Program. Maine DIFW and numerous organizational partners rewrote the SWAP in 2015 through an extensive public process, and CBEP staff participated in sessions that had a focus on marine and estuarine habitats and species. Maine DIFW provides limited funds to implement conservation actions and address monitoring needs, so the SWAP is intended to be a shared collaborative document informing conservation work across a broad range of organizations. Several SWAP conservation actions and monitoring needs are relevant to freshwater and marine and estuarine habitats in Casco Bay and the Casco Bay watershed. An updated SWAP is due in 2025.

Maine Won't Wait – A Four-Year Plan for Climate Action (Maine Climate Council)

Maine Won't Wait serves as the State's climate plan. CBEP participates in the Coastal and Marine Working Group. Several strategies touch on coastal and marine habitats, coastal resilience, and freshwater ecosystems. Strategy E: Protect Maine's Environment and Working Lands and Waters, Promote Natural Climate Solutions and Increase Carbon Sequestration, directly relates to CBEP habitat programs. Strategy E calls for significant increases in habitat protection (setting a statewide goal of 30% protected area by 2030), and restoration, especially of “high biodiversity areas to support land and water connectivity and ecosystem health” and for carbon storage.

Report recommendations align fairly well with existing CBEP habitat priorities. CBEP Habitat Protection Fund (HPF) priorities already target biodiversity, ecosystem health and upland forests that protect water quality. HPF reviewers consider climate-related opportunities, including acres of upland forest protected and potential for carbon sequestration in coastal wetlands.

The Report explicitly identifies the potential for coastal ecosystems (especially tidal wetlands and eelgrass beds; but also seaweed) to sequester carbon, and thus help the state achieve its long term “net zero” emissions targets. These habitats are already CBEP restoration priorities.

Maine Won’t Wait encourages use of “Nature Based Solutions” to facilitate resilience in the face of climate change, which aligns with CBEP’s habitat restoration efforts. For example, the tidal culverts technical assistance we offer, and related CoastWise training, address both environmental and infrastructure resilience.

Maine Wetland Program Plan 2017-2022

Maine DEP updated the interagency Maine Wetland Program Plan in 2017. The Plan lays out goals for wetland protection, monitoring, research, restoration, stewardship, and tracking. CBEP is listed as an implementing partner developing methodology for analysis of barriers on tidal streams under Objective 1, Acton C of the Plan.

Federal Habitat Plans and Documents

The work of several federal agencies relates to CBEP’s Habitat Program including U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, Natural Resource Conservation Service, U.S. Environmental Protection Agency and others.

U.S. Fish and Wildlife Service Gulf of Maine Coastal Program

National Oceanic and Atmospheric Administration – Essential Fish Habitat

Essential Fish Habitat includes all types of aquatic habitat where fish spawn, breed, feed or grow to maturity and includes kelp forests, bays, wetlands, rivers, and some areas of the deep ocean. NOAA identifies Habitat Area of Particular Concern and Essential Fish Habitat in Casco Bay, and the watershed as follows:

Habitat Area of Particular Concern – Inshore areas are important to juvenile Atlantic cod. NOAA maps the inshore areas of Casco Bay between 0m and 20m depth relative to Mean Lower Low Water as critical habitat and includes almost all of Casco Bay’s tidal and marine waters.

Essential Fish Habitat – NOAA identifies Essential Fish Habitat in Casco Bay as follows:

- Atlantic Salmon Essential Fish Habitat in Casco Bay watershed: Presumpscot River main stem approximately to Gambo Dam, West Branch of Piscataqua River to Forest Lake dam, and Mill Brook to Highland Lake dam. But, not in Distinct Population Segment area, which begins east of Small Point and includes Kennebec Estuary
- Highly Migratory Species: Almost all of Casco Bay's intertidal and marine waters are Essential Fish Habitat for adult bluefin tuna
- New England / Mid-Atlantic EFH Species: All of Casco Bays tidal and marine waters are Essential Fish Habitat for juvenile Atlantic Butterfish

Interagency Habitat Plans and Documents

Gulf of Maine Council on the Marine Environment

The Gulf of Maine Council on the Marine Environment works to foster environmental health and community well-being throughout the Gulf of Maine watershed. Partners include Maine DMR, NOAA, U.S. EPA, the U.S. Department of the Interior. The Council has guided coastal habitat restoration activities for decades and has directly funded several Casco Bay and CBEP habitat restoration and enhancement efforts over the years. The Council has been less active in recent years due to shifting agency priorities and bureaucracies, but core planning documents remain relevant to CBEP's Habitat Program, particularly the 2004 Gulf of Maine Habitat Restoration Strategy, which established shared objectives for habitat restoration throughout the Gulf of Maine. Language has changed about resilience of key habitats, but Council recommendations are generally aligned with CBEP's Habitat Program.

Rivers – Major threats include dams and passage barriers for anadromous fish. Restoration recommendations focus on dam removal and culvert replacement, which are important for improving riverine habitat and restoring fish passage to critical habitat.

Intertidal habitats – Major threats to tidal marsh include altered hydrology and tidal restrictions caused by roads, causeways, dikes, tide gates, and dams and ditching and filling of salt marsh. Threats to shellfish habitat include invasive species (European green crab and *Phragmites australis*), tidal restrictions and poor water quality. Restoration recommendations include tidal hydrology, dike removal, and management of invasive species.

Subtidal habitats – The value of eelgrass beds and kelp beds is noted, but restoration is uncommon.

Islands, beaches and dunes - Noted the value of uninhabited islands and the importance of terns as indicators of ecosystem health due to their sensitivity to habitat condition and fish communities. Major threats identified include development and sea level rise. Restoration of seabird nesting islands is a recommendation.

Atlantic Coastal Fish Habitat Partnership – Northeast Region

The Atlantic Coastal Fish Habitat Partnership (ACFHP) is one of 20 Fish Habitat Partnerships in the United States. Its mission is "to accelerate the conservation, protection, restoration, and enhancement of habitat for native Atlantic coastal, estuarine-dependent, and diadromous fishes through partnerships between federal, tribal, state, local, and other entities." The entirety of Maine is within the ACFHP North Atlantic Subregion, and Maine DMR, NOAA, US Fish and Wildlife Service, and Wells NERR are formal ACFHP partners.

ACFHP priority habitats and major threats for the North Atlantic Subregion were laid out in the ACFHP Conservation Strategic Plan 2017-2021.

Priority habitat: Submerged aquatic vegetation

Major Threats

- Dredging and coastal maintenance
- Water quality degradation and eutrophication
- Vessel operations impacts
- Sedimentation

Priority habitat: Riverine bottom

Major Threats

- Obstruction to fish passage / habitat connectivity
- Dredging and coastal maintenance
- Water quality degradation and eutrophication
- Consumptive water withdrawal
- Sedimentation

Priority habitat: Marine and estuarine shellfish beds (oyster reefs, scallop beds, hard clam beds, shell accumulations)

Major threats:

- Water quality degradation and eutrophication
- Sedimentation

ACFHP Conservation objectives

- Protect, restore or maintain resilient subregional priority habitats to optimize ecosystem functions and services to benefit fish and wildlife.
- Support the maintenance of water quality and hydrology standards for functional priority habitats and improvement of water quality in degraded priority habitat areas.
- Restore, enhance, and maintain adequate and effective fish passage to ensure connectivity within and among required subregional priority habitats.

Atlantic Coast Joint Venture

The Atlantic Coast Joint Venture (ACJV) is a regional partnership that collaborates to protect, restore and enhance coastal marshes to benefit birds, other wildlife, and people throughout the ACJV area. Maine DIFW is an ACJV partner, as are several federal agencies. ACJV staff are employed by U.S. Fish and Wildlife Service. ACJV focuses conservation work on coastal marshes and imperiled species including Saltmarsh sparrow and black duck.

ACJV has published the Salt Marsh Bird Conservation Plan and the Saltmarsh Sparrow Conservation Plan to establish priority strategies for conservation of salt marsh habitat and obligate birds.

ACJV has developed an online Saltmarsh Sparrow Habitat Prioritization Tool that ranks habitat patches along the Atlantic coast and includes several marshes in and adjacent to Casco Bay. The tool also includes a marsh migration data layer for three-foot and six-foot sea-level rise scenarios, developed by The Nature Conservancy.

ACJV Salt Marsh Bird Conservation Plan (2019)[44] - identifies habitat values of tidal marsh, priority species and habitats (imperiled tidal marshes and marsh-obligate birds), habitat threats, conservation strategies, monitoring needs and funding needs. The Plan also includes a Maine summary of habitat status, species status, threats, priority management actions, and priorities for future research, which was prepared by the Maine Natural Areas Program.

ACJV Saltmarsh Sparrow Conservation Plan (2020)[45] - A regional conservation plan for Saltmarsh Sparrow, which builds upon the Salt Marsh Bird Conservation Plan by providing species-specific population and habitat objectives, genetic considerations, and describing additional conservation strategies to enhance populations and address seasonal conservation needs.

Maine Saltmarsh Sparrow Prioritization

In 2021, Maine IFW and USFWS GOMCP convened a working group to develop geographic priorities to guide Saltmarsh sparrow protection, enhancement and restoration work in the state. As of the end of 2021, the document remains a draft. Preliminary priority areas mapped include marshes in Casco Bay.

Eastern Brook Trout Joint Venture

The Eastern Brook Trout Joint Venture (EBTJV) is a collaborative Fish Habitat Partnership bringing together agencies, local governments, NGOs and other partners using non-regulatory approaches to protect, restore and enhance aquatic habitat throughout the range of Eastern brook trout.

Maine DIFW and other state agencies, U.S. Fish and Wildlife, municipalities, Trout Unlimited, and several other organizations are Maine-based EBTJV partners. EBTJV provides grant funding to achieve conservation goals including restoring populations that have been impacted by habitat modification and invasive species, and actions to reconnect suitable habitats adjacent to wild populations.

Regional Landscape Planning

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[44] https://www.acjv.org/documents/salt_marsh_bird_plan_final_web.pdf
[45] https://www.acjv.org/documents/SALS_plan_final.pdf

Multi-party, regional (e.g., sub-Casco Bay watershed) conservation planning and cooperation occurs in subregions of the watershed but has never occurred at a scale of the entire Casco Bay watershed. Most conservation planning occurs at the local level – i.e., at the level of a town or single land trust. Land trust conservation plans are not shared publicly, but several municipalities have created open space plans. Notable regional scale landscape planning efforts in the Casco Bay watershed include:

Presumpscot Vision, Values and Priorities (2013) –CBEP coordinated an effort by the Presumpscot River Watershed Coalition to establish shared regional priorities for land protection in the lower Presumpscot watershed, which was an action recommended in the 2003 Presumpscot Plan. The VVP report focused on core conservation values including aquatic habitat, terrestrial habitat, natural communities of special concern, water quality, recreation & access, working woodlands, agriculture, and historic resources. The effort produced aquatic habitat conservation priority areas around the following tributaries to the main stem:

- Mill Brook
- East Branch Piscataqua River
- West Branch Piscataqua River
- Upper Little River
- Pleasant River

Sagadahoc Region Rural Resource Initiative Conservation Blueprint (2010) –This was a collaborative effort between the Beginning With Habitat program and the MidCoast Council of Governments and prepared a set of maps guiding land protection priorities that were largely based on BWH map layers. The Blueprint was envisioned to serve as a guide for land conservation in a portion of the Eastern Bay including Bath, Brunswick, Harpswell, Phippsburg and West Bath.

Sebago Clean Waters – SCW is an active coalition working to protect the water quality of Sebago Lake through conservation of land in the Sebago Lake watershed. SCW is a formal collaboration that includes several local land trusts, regional conservation organizations, the Portland Water District, and CBEP. SCW tracks progress toward quantified land conservation goals and has developed an online tool for evaluating water quality protection values of prospective conservation projects at a parcel-specific scale.

Habitat Plan Appendix B3: Summary of Responses to Survey

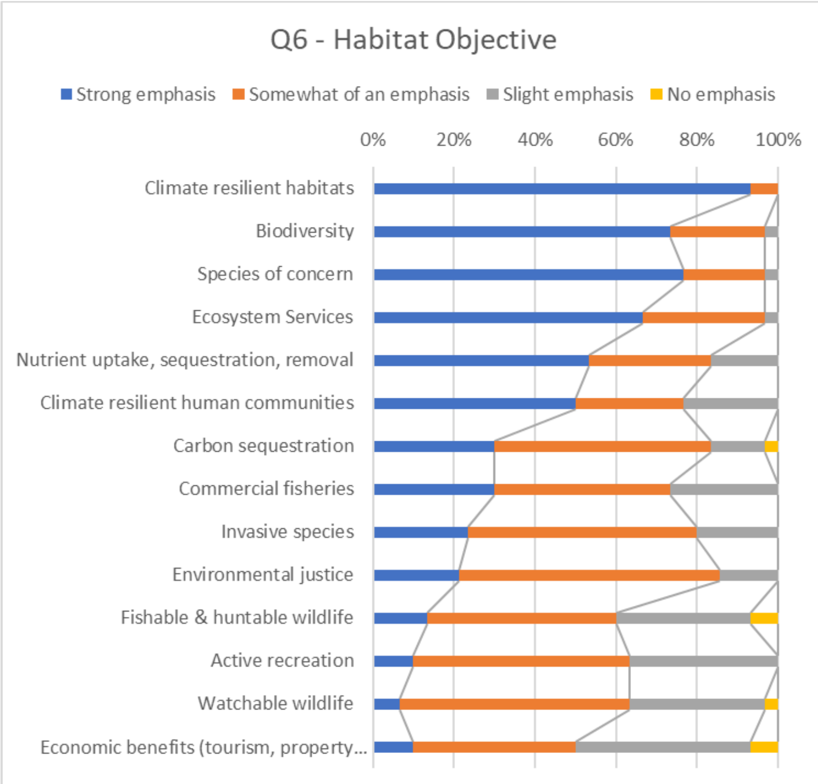

Figure 6. Responses to survey question 6, "Developing habitat-related priorities involves balancing multiple, potentially conflicting, goals and objectives. To what degree should each of the following objectives be emphasized in the CBEP Habitat Plan?

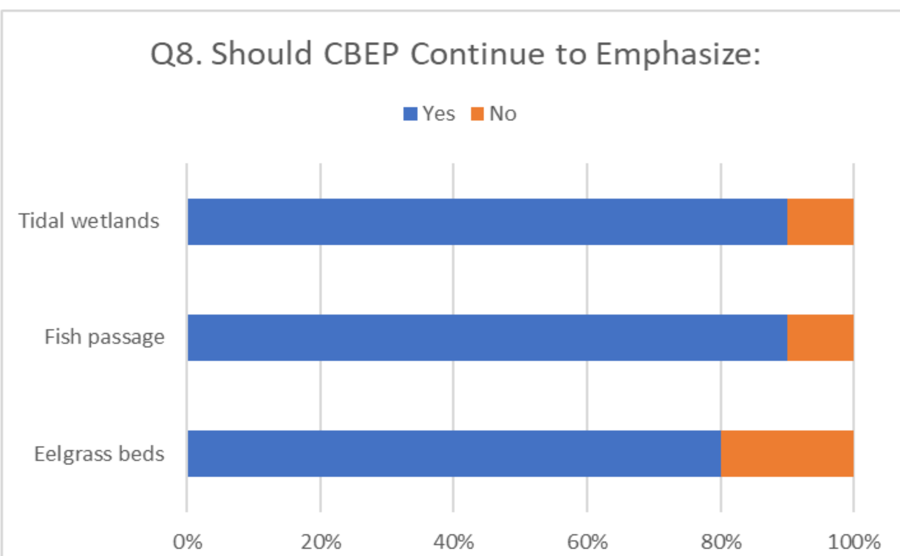

Figure 7. Responses to question 8, "Over the last decade, CBEP's Habitat Program focused on tidal wetlands, eelgrass beds, and fish passage. Weighing each focus against alternatives, should each of them continue to be emphasized in the Habitat Plan?"

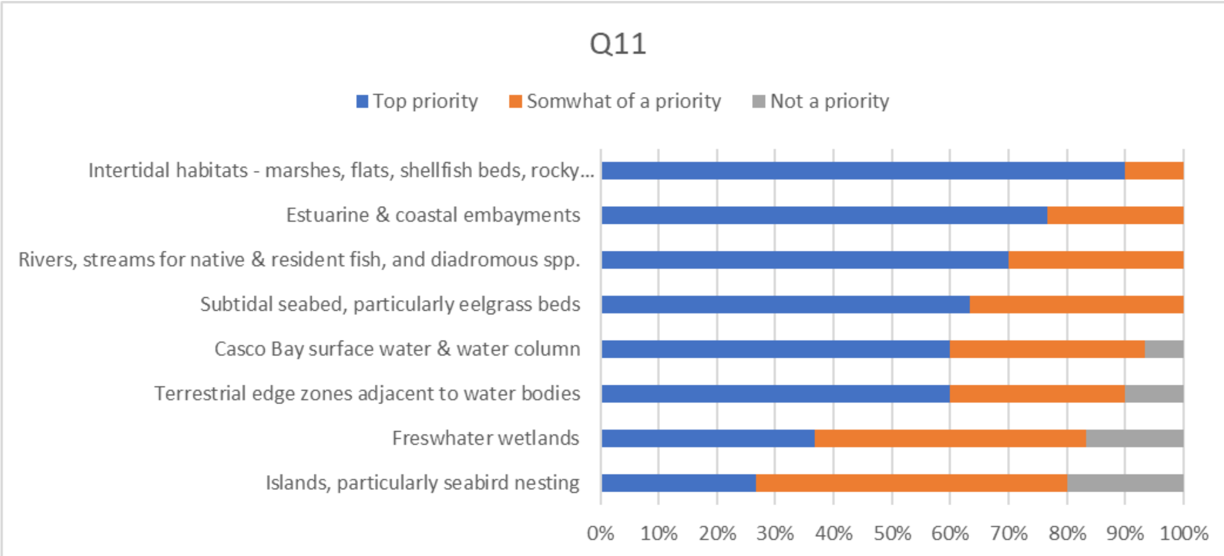

Figure 8. Survey responses to question 11, "A review of CBEP's previous planning documents found that the Partnership has consistently identified the following coastal resources as important habitats (in no particular order). To what degree should these habitat

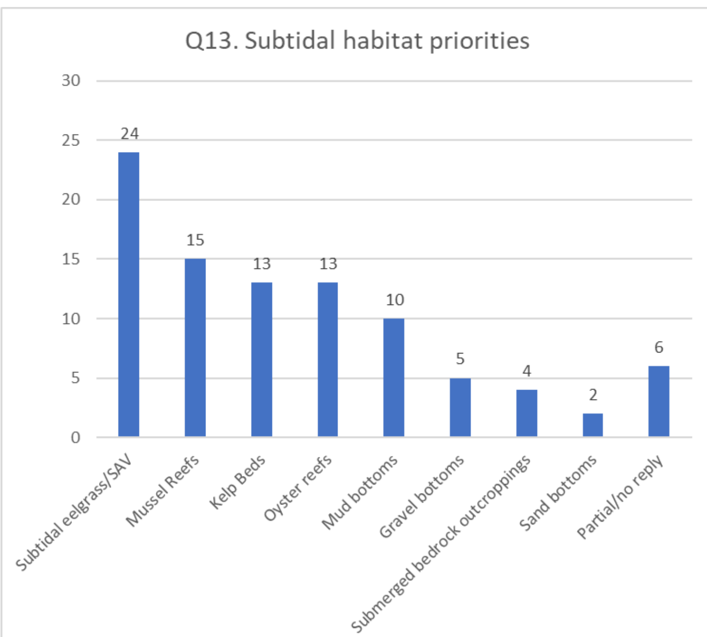

Figure 6. Responses to survey question 13, "Which subtidal habitats should be prioritized, if any?"

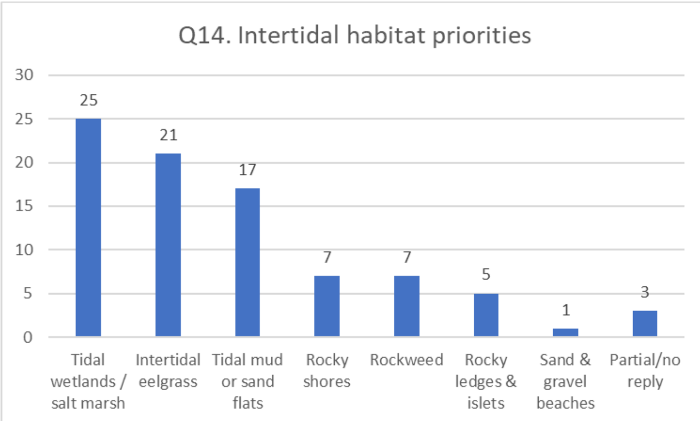

Figure 9. Responses to survey question 14, "Which intertidal habitats should be prioritized, if any?"

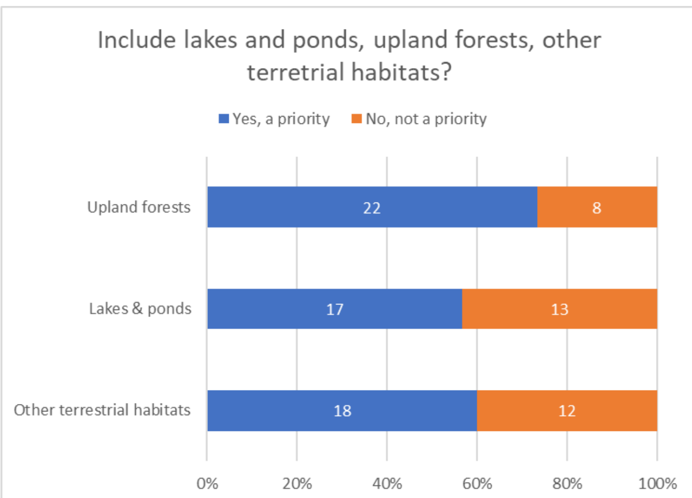

Figure 10. Responses to survey question 16, "Should the Habitat Plan identify lakes and ponds, upland forests, or other terrestrial habitats as a priority?

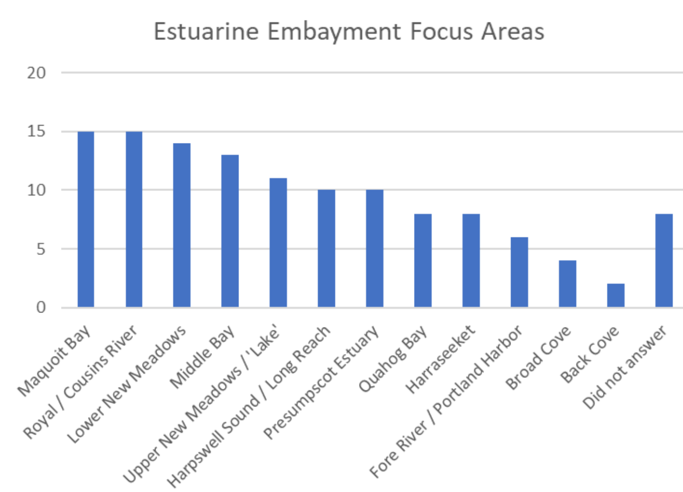

Figure 11. Responses to survey question 20, "Another way to prioritize work on coastal habitat is to focus attention by location. Are there certain Casco Bay coastal embayments that should be identified as habitat focus areas?"

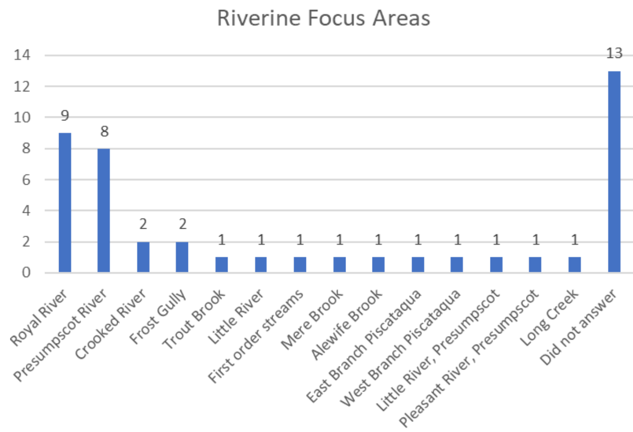

Figure 12. Responses to survey question 21, "Are there certain river or stream systems that should be identified as habitat focus areas?"

APPENDIX C: COMMUNITY ENGAGEMENT STRATEGY

Community Engagement Strategy

April 2024

Section I. INTRODUCTION

Background and Purpose

Casco Bay Estuary Partnership (CBEP), one in a network of 28 EPA-funded National Estuary Programs (NEPs), is a collaborative, non-regulatory effort of people and organizations interested in protecting and restoring Casco Bay. Our partners include local, state, and federal government organizations; non-profits; local businesses; citizens; academic institutions and more. The program works under a Comprehensive Conservation and Management Plan (CCMP) under EPA rules, known as the *Casco Bay Plan*. The Casco Bay Plan outlines priorities for the estuary and watershed, as well as the Partnership's goals, and identifies action plans to address these priority issues. The current CCMP was adopted in 2016 with extensive input from the community and project partners to ensure that the most relevant goals, actions, and issues were the focus of the organization's work moving forward. The CCMP is being updated in 2024.

EPA programmatic guidance calls for NEPs to develop a few documents that support the CCMP, including one that identifies "education/outreach, and public involvement strategies." The Community Engagement Strategy (hereafter, "Strategy") is formally a supplement to the 2023 CCMP update. Accordingly, the document lays the groundwork for community consideration of outreach and communications priorities under the update and provides a blueprint for public engagement initiatives for the 2022-2027 period and beyond.

This Strategy document will be adopted as a part of the CCMP, along with other supporting planning documents including the Monitoring Plan, Finance Plan, Habitat Plan and a new Diversity, Equity, Inclusion, and Justice (DEIJ) strategy. Links between these initiatives will be identified and discussed during the Plan update process in 2022-24.

This Strategy is not structured around the Goals of our existing CCMP. The reason is that community engagement and communications can and should support all our CCMP Goals and be integrated into many of our programmatic activities. Thus, the document focuses on actions that support CBEP's Community Engagement programs generally. This document presents a framework to assist CBEP staff and partners in allocating program resources effectively. Specific implementation details were developed as part of the 2024 CCMP update, and via details included in our annual workplans.

Working as a Partnership

The Casco Bay region is fortunate to have many active organizations that carry out a variety of education and outreach activities aimed at engaging the public in protecting and restoring the Bay. Historically, these organizations have formed successful working partnerships to provide various programs and activities. Those partnerships, however, are too often of limited scope or short-lived, sometimes falling victim to changes in policy or funding priorities. As a "backbone organization," CBEP can play an important role as a convener and catalyst, working with outreach partners to support collaborative initiatives and increase public involvement, and help residents and visitors understand and address the challenges facing Casco Bay.

As a convening organization, there are two primary roles that CBEP plays in protecting and restoring Casco Bay. In the first role, CBEP's staff carries out independent projects, often funded by core EPA funds and often implemented in concert with other partners. In our second, convening role (exemplified recently by the Nutrient Council and the Monitoring Network), CBEP gathers partners around a specific topic or mission, providing coordination, funding, information, and facilitation to develop shared priorities and support work largely conducted by Partner organizations.

CBEP's community engagement program also serves in both roles, carrying out independent projects related to CBEP's mission, and supporting partner organizations that can benefit from coordination, funding, outreach, technical assistance, and other types of support.

The Strategy incorporates feedback from key public outreach partners gathered through a digital needs assessment. Members of CBEP's Executive Committee were involved with revising and reviewing it, and the final document was approved by CBEP's Management Committee on March 23, 2022.

Past Outreach and Education Staffing & Planning Efforts

Casco Bay Estuary Partnership (then *Project*) developed a 4-page Outreach Strategy document in 2004, with the help of an Outreach Committee, which outlined some objectives and accompanying strategies. In 2014, the part-time CBEP Communications Coordinator formed an Outreach Committee that drafted a one-page *Communications Strategy for Website, Email and Social Media,* as well as a status document that catalogued current outreach and communications activities and listed some "next steps" for CBEP to consider. The document was never formally adopted by CBEP's Management Committee but did inform internal thinking about CBEP's outreach and communications program.

In 2016, a new full-time Community Engagement Coordinator position was created to develop, coordinate, and implement CBEP's activities to "...raise awareness and engage communities with Casco Bay." This position coordinates the development, implementation, and evaluation of community engagement efforts of CBEP, as described in the Casco Bay Plan 2016-2021. The Coordinator builds relationships and coordinates with numerous collaborators, including local governments, non-profits, schools, and businesses to develop and implement projects and programs to achieve the Goals of the Plan.

Vision & Priorities

The Vision of the Community Engagement Strategy is to have an informed, engaged public taking actions that increase protection and restoration of the Casco Bay Watershed. The goal of this Community Engagement Strategy is to identify ways to strengthen CBEP's community engagement and communications activities for the next three to five years[46].

To achieve this goal, CBEP has established the following strategic Community Engagement priorities:

- Strengthen CBEP's role as an information hub and reinforce brand recognition through consistent, coordinated communication strategies.
- Improve communication and coordination among Casco Bay partner organizations, particularly through education and outreach colleagues, to leverage resources and funding and to minimize duplication.
- Expand community engagement through developing new, mutually beneficial partnerships and wider audiences.

Concepts Guiding CBEP Community Engagement

Framing this work as "community engagement" rather than just "communication and outreach" is a subtle but helpful distinction, as *engaging* implies more involved commitment and a sense of ownership by stakeholders.

A few core concepts guiding CBEP's community engagement program are:

- *Harness Existing Relationships*: Harnessing our existing relationships with agencies and organizations is necessary to promote the Partnership's collective work and to identify supporters and champions.
- *Foster and Support Peer-to-Peer Networks*: Peer exchange allows partners to learn from one another's challenges and opportunities and collectively be more effective in our work. CBEP is in a good position to convene networks so that we can work together more efficiently and support each other in our work.
- *Make It Convenient for People to Engage*: Providing convenient opportunities for participation – whether online or offline – is critical to engaging a broad array of audiences. Successful programs are the result of a diverse mix of engagement strategies and opportunities.
- *Reach New Audiences Where They Are*: CBEP is spending more time communicating but still only reaching and hearing from a small segment of the Casco Bay region's population. How do CBEP and our partners level the playing field to engage the broader community, and do so in a way that doesn't require huge marketing budgets or overworked staff?
- *Inform/Engage/Empower/Collaborate*: Consider the goals for reaching each audience; are we intending to inform, engage, or empower and collaborate? The

[46] Outreach needs change rapidly, so looking out further than three to five years would be impractical. The Strategy has no formal "end date", as it will be revisited regularly, looking forward three to five years each time.

communication and outreach strategies we use will depend upon which goal we are aiming for. Are we looking for action of any kind, or just intending to inform?

To Inform	To Engage	To Empower/Collaborate
Social media	Workshops	Trainings
Email/listserv	Surveys	Capacity-building
Website	Presentations	Providing tools
Presentation materials	Training sessions	Citizen science
Printed materials	Field visits	Meetings and workshops where audience is (existing venues)
Press stories/op-eds	Meetings	Listening sessions
Storytelling	Volunteer opportunities	Interactive event activities
	Storytelling	Polling and surveys
	Exhibiting at events	“Boots in the mud” activities

Section II. EXISTING COMMUNITY ENGAGEMENT PROGRAM

Engagement with Organizational Partners

CBEP engages with core organizational partners (primarily organizations represented on CBEP Management Committee) through:

- The communication channels/tools referenced above
- CBEP Management Committee: quarterly meetings
- Collaboration on projects and research
- Financial and logistical support for projects
- Participation in external or *ad hoc* workgroups and committees, such as Habitat Protection Fund Committee, Community Grants Committee, Nutrient Council, Monitoring Network
- Facilitating and convening collaborations among partners, such as Sebago Clean Waters, Long Creek Watershed Management District, Greater Portland Conservation & Trails Initiative
- Promotion of partner activities that support CCMP implementation
- Collaboration on grant opportunities
- Letters of support for grant proposals
- CBEP’s two grant programs: Habitat Protection Fund and Community Grants
- Hosting or sponsoring workshops and conferences

The quarterly Management Committee and monthly Executive Committee meetings are the primary vehicle for CBEP to engage with its partner organizations. In the past, the CBEP governance structure has included a variety of active committees to further engage members.

Engagement with Students and Volunteers

CBEP Community Grants Program

On an annual basis, at a minimum, CBEP engages with education partners and community organizations through our Community Grants Program. The intent of this program is to encourage new partnerships and innovative projects that engage communities with Casco Bay and its watershed. During the Covid pandemic, CBEP encouraged more grant proposals that integrate outdoor and/or distance learning, providing educators with additional tools and resources for shifting their programming toward more digital and distance learning.

Community grant projects have included support for expeditionary learning schools, field-based projects, storytelling and art projects, citizen science and stewardship, and marine education. Eligible entities include educators, land trusts and other non-profit organizations, civic groups, municipal committees and boards, churches, clubs, school groups and neighborhood associations. Fund recipients must be legally recognized entities, not-for-profit, and projects must occur in Casco Bay or its watershed.

From 2016 to 2021 CBEP's Community Grant Program awarded 33 grants for projects like the following:

- Chebeague Island Community Association, for an aquaculture festival
- Harpswell Heritage Land Trust, for a junior ranger program
- Kennebec Estuary Land Trust, for community clam conservation
- Friends of Pope Preserve, for informational signs
- Lakes Environmental Association for pivoting curriculum to a digital format
- Yarmouth School District for shareable art lesson for high school

It is unclear how many organizations are aware of this program, beyond the roughly one thousand e-newsletter recipients. A targeted effort involving partners sharing the announcement with smaller community-based organizations, and even better, partnering with those organizations to apply, would help this program develop a broader reach.

School- and Field-Based Education

CBEP's main role to date has been to support partner organizations in their work to engage with students in the classroom, in the field, and through service learning. CBEP supports partner organizations in this work through indirect means (funding partner programs and conferences), direct means (CBEP grant programs), and promotion and referral.

Cumberland County Soil and Water Conservation District's (CCSWCD) education program reaches over 2,000 K-12 students with their STEM-based lessons that are developed in consideration of the Next Generation Science Standards and led by student investigations. CCSWCD staff provides lessons on topics such as the water cycle, "source to sea," ocean currents, salt marsh habitat, and stormwater. Their staff offers lessons in the classroom, in the field, and through service-learning activities.

Portland Water District's (PWD) "WaterWays" program provides students with four weeks of water-related lessons, and reaches over 1,000 students, seven months a year, in multiple schools. Those lessons are focused on freshwater. PWD's "TroutKids" program and summer camp programs also provide general freshwater education.

Friends of Casco Bay's (FOCB) Casco Bay Curriculum "A Changing Estuary" was developed to help teachers connect the classroom with coastal waters and to help students become good stewards of Casco Bay.

Many organizations in the Casco Bay region work in partnership to deliver marine science education programs. The University of Maine's Sustainable Ecological Aquaculture Network (SEANET) has worked with 4-H programs to develop marine science and aquaculture education content and delivered it in Cumberland County via "Summer of Science" programs. The Island Institute collaborates with Hurricane Island Center for Science and Leadership and Herring Gut Learning Center to provide aquaculture education workshops for K-12 teachers from across the coast of Maine.

Many schools in our region, particularly those focused on expeditionary learning, tackle marine or freshwater quality independently or in cooperation with regional leaders.

Southern Maine Community College (marine science) and University of Southern Maine (water quality) offer related college level courses. University of New England recently announced that they are expanding their presence in Portland; expanding marine science offerings in Portland will follow. (Roux Institute?) CBEP has also provided educational support and resources to environmental courses at the Maine College of Art & Design.

Southern Maine Water Festival: This free, full-day festival is historically held each May at the University of Southern Maine's Portland Campus. Environmental organizations provide classroom and exhibit hall activities, a stage show and water trivia competitions. The festival is for fifth and sixth grade students and teachers conducting water-related classroom activities prior to the festival. CBEP has historically provided sponsorship and funding support for the festival.

CBEP has sponsored the Maine Environmental Education Alliance's annual conference that aims to share strategies and ideas to implement outdoor and environmental education more effectively in schools and communities across the state.

Land trusts in the Casco Bay Watershed provide a myriad of educational programs including summer and vacation weekday camps, nature walks and "nature explorer" events, and other family activities focused on Casco Bay natural areas and resources.

Volunteer/Community Science programs

In recent years, CBEP has had AmeriCorps regional resilience members that are hosted by Greater Portland Council of Governments and staff has also been engaged with discussions at the state level regarding a Maine Climate Corps. Improving organizational capacity with AmeriCorps members is a potential avenue for enlisting more community science volunteers.

CBEP's many partner organizations coordinate a variety of programs to engage volunteers in meaningful science and stewardship to enhance local research and monitoring efforts.

Friends of Casco Bay's Water Reporter program: Volunteer Water Reporters use their smartphones to photograph algal blooms, coastal erosion, sea level rise, pollution, eelgrass, sightings of coastal and marine wildlife, and other changes they are seeing on and around Casco Bay.

CBEP provides funding and staff support to the WELLS Reserve's Marine Invader Monitoring and Information Collaborative (MIMIC) program. MIMIC is a network of trained volunteers and scientists who monitor marine invasive species along the Gulf of Maine.

CBEP provides funding to Presumpscot Regional Land Trust (PRLT) to provide a volunteer-based monitoring program that enhances public awareness of river water quality in the watershed. Data generated from the monitoring program is submitted to Maine Department of Environmental Protection.

Presumpscot Regional Land Trust, in collaboration with the University of Southern Maine and the Department of Marine Resources, supports ongoing research on alewife migration from Casco Bay and engage volunteers to count fish as they enter Highland Lake in Westbrook. In a new fish migration ambassador program, volunteers engage with visitors at fish viewing pools.

Regional and local land trusts in the Casco Bay watershed also engage volunteers in a variety of science and stewardship efforts such as programs in which volunteers collect photographic data to show the impact of long-term climate change trends, engage in aquatic invasive plant control, and other initiatives.

Engagement with Municipal Staff, Board Members & Community Leaders

Increasing CBEP's role in providing information and assistance to municipal and community leaders, particularly with climate resilience, was identified in the 2016 Casco Bay Plan. To that end, CBEP staff has been ramping up our work with partners to engage that audience through providing workshops, training programs, and technical assistance.

Casco Bay Coastal Academy (CBCA). Created by CBEP in 2019, CBCA is a formal partnership with Cumberland County Soil & Water Conservation District, Greater Portland Council of Governments, and New England Environmental Finance Center, and informal partnership with other organizations.

The goal of the quarterly CBCA workshop series is to build the knowledge base of municipal board members about critical coastal issues and provide skills training to support their project planning and implementation.

Climate Resilience Planning and Financing. In collaboration with New England Environmental Finance Center (NEEFC), Maine DEP, and Resilience Works LLC, CBEP carried out a workshop series focused on crafting successful proposals toward sustainable financing of climate resilience and stormwater-related projects. The Climate

Resilience Bootcamp Series for Municipalities offers knowledge sharing, idea exchange, and real-world advice.

Continuing that work, CBEP and NE-EFC received a State of Maine Governor's Office of Policy Innovation and the Future (GOPIF) award for a Community Resilience Pilot Project. CBEP and NEEFC worked with a cohort of three coastal communities (Harpswell, Phippsburg, West Bath) on a series of workshops to guide local climate resilience planning, to help the communities prepare for effects of climate change and develop climate planning models for towns and cities in Maine. The methods and outcomes from this project informed the State's Community Resilience Partnership Program (CRP). CBEP, working with NEEFC and Kennebec Estuary Land Trust, subsequently became Service Providers in the CRP, assisting five southern Midcoast communities with enrolling in the Program and engaging their communities on climate mitigation and adaptation.

CBEP staff participated in The Social Resilience Project, a pilot partnership with Maine Sea Grant, Wells National Estuarine Research Reserve (Wells NERR), Bowdoin College, Blue Sky Planning Solutions, The Nature Conservancy of Maine, and Kennebec Estuary Land Trust, as well as coastal communities including Brunswick, Harpswell, Phippsburg, and West Bath, on increasing social resilience in Midcoast Maine. The goal is to build a socially diverse regional network of practitioners, and determine the highest priority actions the region can take to increase the resilience of those identified as the region's populations most vulnerable to storm impacts.

CBEP is a member of the Interlocal Stormwater Working Group (ISWG), a regional collaboration of municipalities coordinated by Cumberland County Soil and Water Conservation District. ISWG meets monthly to address technical and practical challenges of municipal stormwater management, including implementation of the Municipal Separated Storm Sewer System (MS4) stormwater general permit and associated Minimum Control Measures.

Engagement with Other Community Members

As of this writing, CBEP is embarking on a Diversity, Equity, Inclusion and Justice (DEIJ) process to broaden our community partnerships and ensure that CBEP better addresses environmental concerns that disproportionately impact vulnerable people and communities.

Evaluation of CBEP Community Engagement Program

Community Engagement Strengths, Weaknesses, Opportunities, Threats (SWOT)

Strengths	**Weaknesses**
• A plan to guide the work • Core funding from EPA • Many active, collaborative partners	• Small staff size to carry out programs • Limited organizational capacity • Communicating scientific concepts in a way that resonates with audiences
Opportunities	**Threats**
• Reaching out to new audiences and working outside of our silos • Assessment of our messaging so that we can reach a wider audience	• Many different organizations with overlapping messages result in CBEP communication being “drowned out” • We (Partnership) often work in a silo/echo chamber

School- and Field-Based Education Gaps

While there are many organizations engaged in providing some level of Bay-focused environmental educational programming, interviews with education professionals and needs assessment responses indicate there are clear gaps or needs for improvement.

On a statewide level, Maine Environmental Education Association and Maine Mathematics and Science Alliance provide resources, support, and convening services to educators. On a regional level, however, there seems to be a need for a more cohesive system to track these efforts and identify gaps in services and resources.

There also appears to be a more sizable programming gap for high school students than other age groups.

Volunteer/Community Science Program Gaps

With limited staff to operate independent volunteer and community-based science programs, CBEP primarily supports partner organization efforts through funding, resource/referral, and promotion.

Local Government Outreach Gaps

There are many local government challenges right now related to coastal protection and climate resilience that could be filled by a more coordinated, efficient delivery system of planning and technical assistance. There are also opportunities for education through workshops, “lunch and learns,” field visits, and other venues.

Section III. EXISTING COMMUNICATION CHANNELS

The narrow goal of CBEP’s communications strategy is to increase the visibility of CBEP and our partners, and to communicate the value and role of the Partnership to facilitate implementation of CBEP’s mission and the CCMP. CBEP uses multiple methods and “channels” to communicate with target audiences. CBEP communication strategies will vary by audience and project and are tied to the levels of partner engagement described earlier.

Website:

CBEP keeps its website up to date with regular news and announcements, linked to social media, and a digital resource library that includes publications, maps, and other materials. The website was updated in 2021.

Social Media Channels:

Facebook: CBEP has maintained an active Facebook page since 2016. The posts with the most traffic are ones that tag multiple partners, as well as ones that include short video clips and engaging photos. This is anecdotal and could be verified by metrics analysis.

Instagram: CBEP has maintained an Instagram page since 2019, which we post to less frequently than Facebook, but which seems to have a more active, engaged following. This may be due to IG attracting a younger crowd that is more digitally focused. This is anecdotal and could be verified by metrics analysis.

LinkedIn: CBEP has a page on LinkedIn where we cross-post announcements, releases, etc. This appears to engage more for-profit partners or potential partners, like consulting firms, than other social media channels. This is anecdotal and could be verified by metrics analysis.

YouTube channel: CBEP uploads educational videos and workshop recordings to this channel, which we created in 2021.

Digital & Print Publications:

E-News: CBEP distributes a quarterly electronic newsletter, *Casco Bay Currents*, which keeps its partner organizations and other audiences up to date with CBEP and partner projects, funding and volunteer opportunities, and events. The newsletter is created through the MailChimp platform, which is simple to use and integrates nicely with Eventbrite and other platforms. Staff also use MailChimp to create and distribute periodic flyers, announcing grants programs, events, and other timely news that falls outside of the quarterly e-news cycle.

A print newsletter, *Currents*, was printed quarterly and discontinued after 1995.

Several fact sheets have been distributed over the years, some of which are still in circulation. New print fact sheets are developed on an ad hoc basis, such as for State of Casco Bay and other events.

Signage at Bell Buoy Park on Portland Harbor and Back Cove (until recent construction work), as well as adapted signage in the East Bay and at the Pope Preserve in South Portland. Educational signage is also a tool for education and community engagement.

Annual Report (Public): CBEP produces an annual report for partners and the public, which is also shared on the CBEP website and on CBEP's Facebook and Instagram pages. The print version is distributed on a limited basis, primarily to key partners, and is also posted on our website, sometimes in “Flipbook” format, usually in PDF format.

Workshops and Conferences:

State of the Bay: Every five years CBEP takes a step back and updates a scientific assessment of the health of Casco Bay, producing a report that is shared with its many audiences and in some instances, a summary report and related documents. In past years, CBEP has hosted a State of the Bay conference that includes topical presentations, poster sessions, and related activities.

Speaking Engagements: CBEP staff present periodically on Casco Bay topics to a variety of audiences, including rotary clubs, utility departments, universities, schools, and other venues.

Training & Workshops: CBEP staff organize and facilitate a variety of workshops and training on different topics.

Other Media:

Casco Bay Stories: This program is a series of multimedia stories that illustrate people’s connection to Casco Bay (cascobaystories.org).

Traditional Media Outlets: There is a list of media contacts that is in constant revision; press releases are sent out on an ad hoc basis. We do keep a clipping library of Casco Bay (CBEP and other) news stories.

Direct Program Work:

CBEP staff work closely with many individuals and organizations in the course of our regular work. While not always considered part of “outreach and communications” the relationships we establish with individuals and organizations by working together are an important part of our identity, help build people’s trust in us as an honest and trustworthy source of information and help build our brand as hands-on problem solvers.

Existing Communication Messages

CBEP Branding:

CBEP adopted new logos in 2006 as part of the CCMP revision; they are still in use today. A *Style Guide* was developed in 2014 but is not being used with any consistency. The Style Guide included a mission statement (below), a branding statement and tagline, and fonts and colors to use in communication materials. The “Style Guide” was used very briefly, but it was too limited to have much influence. For example, we lacked standard PowerPoint and Word document templates that ensured consistent styles and style usage through our most common tools. Another influence has been the lack of a consistent designer behind the scenes on many of our products, and lack of consistent rules for which documents go to a designer, and which do not.

Integration with University of Southern Maine and Cutler Institute Branding:

We follow the University of Southern Maine Brand Guidelines and include the logo when appropriate on written and digital publications.

CBEP Messaging:

- Formal Mission Statement adopted in 2014:
    - The Casco Bay Estuary Partnership is devoted to protecting and restoring the water quality, and fish and wildlife habitat of the Casco Bay ecosystem, while ensuring compatible human uses.
- Informal Mission Statement, never adopted, but which is now used on our digital and print materials:
    - The mission of Casco Bay Estuary Partnership is to help conserve the ecological integrity of Casco Bay and its watershed through science, public stewardship and effective management.

Association of National Estuary Programs (ANEP) Messaging (via website and email communications):

- NEPs are Non-Regulatory and Locally Driven
- NEPs Promote Efficient Public-Private Partnerships
- NEPs Support EPA's Clean Water Act
- NEPs Are Results-Oriented and Successful

Evaluation of CBEP Communications

CBEP Branding and Messaging

Branding and messaging should constantly evolve to reflect the organization, and CBEP should revamp its branding and communication with a consistent and recognizable look, to create a more distinctive and on-point brand. The branding would include an updated mission statement, logo, colors, font, tagline, PowerPoint template, email signature, letterhead, etc. A branding update might require additional updates to our website, social media accounts, letterhead, and other existing materials. The products should be easy for staff to integrate into its program content and communication channels.

However, a branding effort is about more than developing a "look"; more importantly, it is creating a core story that expresses CBEP's purpose and values that is relatable, compelling, and engaging, and that can be adapted and shared with multiple audiences. A logical time to do this work is after updating the CCMP.

To communicate in an engaging way, CBEP should continue to update our photo bank with timely photos with the use of professional photographers.

Evaluation of Communication Strategies

Using a "one size fits all" approach to communications may not be particularly effective in reaching many audiences. For this reason, this Community Engagement Strategy aims to identify potential audiences and use more targeted messaging to communicate in ways that appeal to different identities, priorities, and cultural frameworks. This may include employing communication strategies that address the different languages, literacy, and abilities of target audiences.

CBEP staff does a poor job of monitoring metrics of communications performance, such as social media followers/reach and website traffic. These metrics are available through Google Analytics and integrated social media monitoring tools. Staff does monitor e-newsletter subscriptions more frequently due to the ease of doing so using the MailChimp platform. The use of metrics could be useful as a way of tracking what communication channels are most effective at engaging audiences, and to some degree which audiences are most engaged.

We have traditionally not been effective at engaging traditional media outlets, like the Portland Press Herald. Perhaps CBEP should convene a meeting or workshop with partners to discuss how to effectively engage the media as well as communicate about the issues in a more unified manner.

Our e-newsletter appears to be a good way to reach people, but there are two areas of improvement that we should address. The first is to develop a more visually appealing format that is updated with re-branding and is consistent with other forms of communication. The second is to explore and address the quality of its content, considering more “guest posts” from partners and spotlights on Bay champions, to name a couple of examples.

Section IV. EXPANSION OF FUTURE ENGAGEMENT AUDIENCES

Serving and Expanding Existing Audiences

CBEP Organization

The “organization” refers to CBEP staff, Management Committee (including our partner organizations and EPA Region 1 staff) and Executive Committee, which is a subgroup of the Management Committee. Our primary outreach goal for this sector is to keep the group informed of our respective activities and keep everyone working together. A secondary goal is to help share emerging information about the Bay and about work going on in the region that may affect their work. Our primary communication channels for this sector are weekly staff meetings, monthly Executive Committee meetings, and quarterly Management Committee meetings. With our most active partners, we principally engage directly, and it is through shared work that we maintain ties. A key role of the Partnership is to ENGAGE these folks in shared priorities and EMPOWER these groups to be more effective.

Federal & State Government

We work with many state and federal agencies on a regular basis, so they may more clearly fall within other categories, but there are other agencies – like Natural Resources Conservation Service NRCS and Federal Emergency Management Agency (FEMA) -- with whom we could work more effectively. A primary goal is to provide science-based information to inform policy.

Local Government

Our main goals for this audience are to ensure local governments are knowledgeable about Bay issues by sharing the latest scientific findings, and to provide tools and technical assistance to address priority issues.

National Audiences

Our primary interests are to maintain strong relationships with our national partners and share best practices with our colleagues. We also want to burnish our reputation with national audiences -- especially EPA and national lawmakers -- because they oversee our work, control future policies, and influence future budgets. We can do this by showcasing successes and providing science-based information to inform policy.

Business Sectors

Fishers and others in the working waterfront sector are important allies in our work because their work is completely dependent on healthy waters and habitats. Likewise, tourism leaders such as hotel and marina owners are important advocates because their businesses depend on a healthy ecosystem. And many of the Greater Portland Region's largest businesses are significant resource users. We made this audience a focus in the 2016 Casco Bay Plan but did not make huge strides in engaging this sector.

Students/Youth

Students and youth audiences represent future constituencies for Casco Bay. We may want or need to think about ways to engage this audience beyond the "education" mission that has been the dominant way our Partners have engaged. How can we build that future constituency, especially via direct experiences of the Bay and its resources?

Traditional Media

The media is principally a conduit for information to others, but we could also consider whether we want to try to educate members of the media about issues of concern to us. Cultivating relationships with environmental and other reporters at local newspapers, radio, and TV stations not only increases their literacy about environmental issues, but positions CBEP as a trusted local expert to consult. Other goals for this audience are to share accomplishments through the lens of engaging stories and to increase visibility of CBEP.

Casco Bay Education & Outreach Practitioners

With this audience, which are key partners, we aim to foster coordination and collaboration, ensure that communication messages are reasonably consistent, and when possible, use shared messaging.

Nonprofit Resource Managers (land trusts, other nonprofits)

This sector is made up of staff from land trusts, state agencies, and others that work primarily with CBEP’s Habitat Program Manager to allocates resources toward projects that result in the protection, restoration, and enhancement of aquatic habitats that sustain the Bay's health.

Educators – Traditional and Non-Traditional

We primarily reach this sector by supporting our community partners, which have strong volunteer stewardship, education, and technical assistance programs.

Academic Institutions (including University of Southern Maine)

Our goal with academic institutions is to engage through partnering on research programs, education, and service-learning opportunities, and through our host institution, collaborating with our Cutler Institute organizations when possible.

Landowners/residents

The engagement goal with "the general public" is to provide easy-to-understand information and empowering ("what you can do") messages in a language people can understand.

Serving or Expanding New or Under-Engaged Audiences

One of the primary goals of this Community Engagement Strategy is to explore possibilities for new relationships with non-traditional partners. Every audience responds to different messages and different messengers. Who or what are they most likely to relate to? What audiences are we not reaching? This list is not in any particular order.

Funders

We have not previously identified funders as a distinct outreach target. Our goal here is to increase our visibility. We may also want to think about how we could influence the way foundations, donors, and funders think about issues of concern to us, especially land use, coastal water quality, and climate resilience.

Community-Based Groups

A goal for this audience would be communicating the link between other community issues, such as public health, working waterfront, etc. and Bay environmental issues. To this end, we want to build relationships and support community initiatives that can integrate with environmental messaging (e.g., arts, public health, faith) to engage with people who may become ambassadors for CBEP priorities within their community networks.

Tourists & Visitors

With this audience, we want to raise awareness of the resources and challenges of Casco Bay, which includes summer residents and regional, national, and international tourists.

DEIJ/Under-represented target communities (Including but not limited to communities of color, Indigenous communities, people for whom English is a second language, people with physical and mental disabilities, low-income communities, and New Mainers)

Our work is richer and more meaningful when it includes the voices and lived experiences of many different community members. Many communities are disproportionately harmed or burdened by environmental pollution and the impacts of climate change; others are historically or unintentionally left out of important conversations and scientific findings about places where they live. Our goal with these communities is to help address environmental and information-delivery inequities, as well as capture the wisdom and lived experiences of all kinds of people who live in the watershed.

Inland communities

CBEP has historically been more focused on coastal communities and issues, partially because of limited staff capacity. Casco Bay's nearly 200 square mile watershed and the communities of people living in it are key audiences, as their activities and actions greatly impact the health of the Bay.

The creative and arts community

The creative and arts communities can help the Partnership tell stories and illustrate resources and challenges in a more engaging way and help us reach other new audiences.

Section V: Community Engagement Priority Actions

Our community engagement priorities address three key needs. These include:

1. **Broadening our reach**, building new collaborations, and engaging new partners;
2. **Helping towns and communities** throughout the Casco Bay watershed address climate resilience and water quality challenges; and
3. **Updating CBEP's brand** and communication practices to better address the first two needs and to strengthen our identity as a Partnership.

Provide information and outreach to target audiences in the Casco Bay region (CCMP Action 3.1.A)

Priorities: Broadening our Reach and Updating CBEP's Brand

In fall of 2023, CBEP will evaluate the effectiveness of various community engagement tools and messages in reaching new and existing target audiences. This effort will lead to a formal process in 2024 to update CBEP's brand identity. The brand update will include development of updated brand statements, along with revision as necessary of CBEP's messaging tools, such as our mission statement, tag lines, key message statements and logo. The purpose of this rebranding effort is to update our key marketing materials with the aim of increasing public awareness of the Partnership, reaching new audiences and strengthening CBEP's role as a communications hub.

On the surface, the branding exercise will update the look of CBEP outreach and communications materials. But on a deeper level, the exercise will craft a relatable, compelling story that expresses who we are. The new story will express CBEP's purpose and values, align with partner messaging, and support efforts to engage new target audiences.

Efforts to reach new audiences will include making information and messaging accessible to more people using well-established practices like expanding use of human stories, developing infographics to convey important ideas at a glance, and editing written materials to ensure readability for a wide audience.

Promote and facilitate Bay and Watershed-focused community science activities (CCMP Action 3.1.B)

Priority: Broadening our Reach and Helping Towns and Communities

Over the next few years, CBEP will work to expand support for community science (including volunteer monitoring) in our region. This effort will begin small, with targeted grants and increased technical assistance from CBEP staff (made possible by additional outreach and science staff capacity). This phase will include:

- Funding to support locally driven projects through Monitoring Infrastructure Grants (Action 4.3.A) and Community Engagement Grants (Action 3.1.D).
- Offering assistance and training to community groups interested in community science with study methods and research design, as resources permit.
- Support for and assistance with development of Quality Assurance Project Plans (QAPPs) (which are required whenever data collection is supported with NEP funds).

Special attention will be paid to prioritizing and/or making accessible community science opportunities and funding for underserved communities.

Continue efforts to make the Partnership more inclusive and build mutually beneficial relationships with community-based organizations (CCMP Action 3.3.A)

Priority: Broadening our Reach

CBEP will work to expand our knowledge of and connections with underserved and underrepresented communities in the Casco Bay Watershed through expanded outreach to community-based organizations. Each of these organizations (including many that are not part of Maine's environmental or conservation communities) offers a potential starting point for listening and conversation, and thus broadening CBEP's understanding of issues affecting underserved and underrepresented communities. CBEP will also connect with adjacent organizations that work in intersecting disciplines, like housing, public health, social justice and workforce development to learn about community-based organizations and the populations they serve.

CBEP will also seek ways to make our events (as well as any events sponsored by existing CBEP Partners) more welcoming and accessible to more communities and individuals. This effort will involve considering the impact of many of our existing practices on accessibility, and becoming more aware of how moderate changes in CBEP practices can make it easier for more people to participate in the Partnership.

Provide technical assistance and small grants to Casco Bay communities (CCMP Action 3.2.A, as well as portions of 2.2.A)

Priority: Helping towns and communities

With the help of Bipartisan Infrastructure Law (BIL) funding, CBEP plans to engage with communities, especially smaller inland and island communities, on community resilience, water quality and habitat protection issues. These communities face numerous challenges addressing interlinked water and resilience needs, including lack of community capacity, rapid land use change, aging infrastructure, and emerging impacts from climate change. Local policies and programs in areas such as open space planning, natural resource inventories, stormwater planning, road construction and maintenance, and shoreland zoning can profoundly affect both local water quality and community vulnerability to storms, drought, and other climate-related threats.

These interrelated Actions will help local leaders make connections and better decisions toward implementing Bay and Watershed friendly municipal policies and practices and build resilience to climate impacts.

CBEP will work at the community level in association with regional Partners, especially local governments, the Governor's Office for Planning Innovation and the Future (GOPIF), regional planning agencies and other local and other service providers, to address climate resilience and water resource challenges. The Program will have several components, including:

- Expanding direct relationships with municipal governments.
- Assisting municipalities with identifying and addressing community resilience needs (especially those related to water resources) via community engagement, planning assistance and technical analysis.
- Sharing CBEP expertise on interconnected resilience, water and habitat issues with communities, regional partners and local leaders through events, direct technical assistance, and coordination.
- Delivering resources like case studies, model ordinances, examples from neighboring communities and connections to resource providers.
- Initiating grant programs to assist local government with water-related initiatives, including community engagement, planning, education and design (that can be leveraged to ease access to state and federal grant programs.
- Facilitating outreach and education programs aimed at smaller communities (through venues such as Casco Bay Coastal Academy and GOPIF).

Work with smaller communities (islands and towns in the upper watershed) will be a priority.

Resilient Communities Planning and Assistance Program (From BIL Five Year Spending Plan)

Priority: Helping towns and communities

The Resilient Communities Planning and Assistance Program leverages BIL Funds to help implement CCMP Actions 2.2.A, and 3.2.B, and to help towns with small staffs or limited planning capacity access federal and state grants to address water quality and resilience needs. A parallel grant program will offer funds to assist with implementation of community or habitat resilience projects.

APPENDIX D: MONITORING PLAN AND UPDATE

Casco Bay Monitoring Plan Update

Plan Adopted October 15, 2020; Update 2024

Introduction

The Casco Bay Monitoring Plan (Plan) represents the work of the Casco Bay Monitoring Network (Network), a community of more than 20 scientists and organizations that routinely monitor conditions in Casco Bay and will continue their work in the future. The Plan was developed by the Network in 2019 and 2020 and was adopted and approved by EPA and the Management Committee in October of 2020.

Casco Bay Estuary Partnership (CBEP), through the Monitoring Network, the Monitoring Plan, and periodic State of Casco Bay reports, improves monitoring and enhances understanding of the Bay by setting priorities, sharing information among scientists, providing funding, reducing redundancies, filling gaps in data collection, and pulling together data from multiple sources.

The Network meets regularly to discuss recent observations, evolving and emerging monitoring needs, changes in monitoring plans and practices, developing technologies, and collaborative opportunities. The Monitoring Plan was developed by and largely for members of the Network. As such, the Network has a key role to play as the stewards of the Plan.

This document provides an update on status of priorities identified in the existing Monitoring Plan and identifies emerging priorities based on community input and discussion by members of the Monitoring Network during the process of updating *The Casco Bay Plan*, our primary CCMP document.

STATUS OF 2020 PLAN RECOMMENDATIONS

Programmatic (from Plan Executive Summary)

- Strengthen the Monitoring Network. Link to emerging monitoring frameworks and programs. Facilitate sharing of data and information.

<u>Status:</u> The Network has been expanded to include more organizations, especially those collecting data on the fresh waters of the Casco Bay watershed. Members would like to meet more regularly.

- Identify and advocate for long-term stable funding mechanisms for monitoring programs. Seek funding to track impacts of climate change and address other emerging needs.

<u>Status</u>: The Maine legislature passed legislation and appropriations in 2022 to support periodic collection of data on extent of eelgrass beds and tidal wetlands, via a new Marine Vegetation Mapping Program. Maine's Climate Council advocated for more extensive monitoring of the Maine coast, leading to some expansion of data collection by state agencies. Nevertheless, funding continues to be a challenge for many members of the Network, especially non-profit members. Supply chain challenges and equipment shortages have increased some monitoring costs, exacerbating the situation. Availability of Bipartisan Infrastructure Bill (BIL) funding will help address short-term funding needs, especially for monitoring equipment and infrastructure.

- Develop a Casco Bay circulation model to provide context for interpretation of monitoring data.

Status: CBEP contracted with NERACOOS and the University of Massachusetts-Dartmouth in 2022 to develop a high-resolution hydrodynamic model of Casco Bay and the nearby coastal ocean. The modeling effort, supported principally with BIL funds, is well underway. A final draft model grid has been prepared and initial model runs are complete. We expect a fully validated model to be in operation by late summer of 2024. The model will be run as part of NERACOOS's coastal forecasting programs, generating daily three-day forecasts.

Monitoring (from Plan Executive Summary)

- Maintain core of existing monitoring programs.

Status: Several programs have expanded in recent years to add programs, locations, or parameters. No programs have been discontinued.

- Expand emerging monitoring areas, including:
  - tracking freshwater conditions (especially nutrients in rivers and streams);
  - sampling fish communities and other components of the food web;
  - extending eelgrass monitoring;
  - studying impacts of aquaculture on water quality, flora, and fauna.

Status: Significant progress, although work understanding impacts of aquaculture has not advanced. The Monitoring Network has expanded to increase participation by groups collecting data on fresh waters. Several new freshwater monitoring programs have been initiated or are in late planning stages, including a regional effort to track stream temperatures and expanded municipal monitoring in Brunswick and Windham. The Gulf of Maine Research Institute has been successful in raising funding to continue the CBASS monitoring program, which tracks coastal fish communities. A new eelgrass monitoring program began in 2023 to track phenology of flowering and seed production in Casco Bay eelgrass.

- Track marine habitat extent and condition, emphasizing long term impacts of climate change.

Status: CBEP continues to monitor multiple tidal marshes to track and evaluate long-term change. Maine DEP's Marine Vegetation Mapping Program will gather data on eelgrass and tidal wetlands. Recent LiDAR (Light Detection and Ranging) data was collected synchronized to low tide, providing improved mapping of intertidal and shallow subtidal flats.

Programs to expand (from page 50 of Plan)

- PRLT Presumpscot and Stroudwater River freshwater monitoring - add nitrogen.

Status: Monitoring program continues and has expanded to more locations. Nitrogen sampling has not yet been added, due to costs and logistical challenges of managing chain of custody for samples collected by volunteers.

- Gulf of Maine Research Institute (GMRI) CBASS - clarify priority components for long-term, expand locations as funding is available.

Status: After a couple of lean years with limited sampling, GMRI has succeeded in raising funding to support several more years of data collection. The program now focuses on a handful of well-defined locations, allowing these sites to act as "sentinel" sites for tracking changes in the Casco Bay fish community.

- Friends of Casco Bay (FOCB) Bay water quality and acidification, continuous monitoring - add stations in Portland Harbor and Eastern Bay.

Status: FOCB now manages three continuous monitoring stations year-round. FOCB is a regional leader in efforts to strengthen monitoring of coastal acidification.

- Marsh monitoring – incorporate sentinel monitoring sites, which should be the same as DMR rSET sites.

Status: CBEP led an effort in 2022 to assess Casco Bay's larger tidal marshes that are in public or conservation ownership to evaluate their suitability as long-term "sentinel" monitoring locations. Three locations (Cousins Marsh, Gambel Marsh, and Mare Brook Marsh) appear especially suitable. (Gambel marsh is DMR's only rSET location in Casco Bay). All three are also sites with potential for projects addressing historic impacts to marsh surface hydrology, which may complicate their use as "sentinel" sites.

- DMR phytoplankton – expand monitoring to track additional species and locations.

Status: DMR has gradually expanded both the number of volunteers involved and number of locations studied. The focus of the program remains on identifying species likely to produce phytotoxins.

- DMR rSETS - add sites; integrate with vegetation, hydrologic, and other sentinel monitoring.

Status: Only one group of rSETs has been installed in Casco Bay, at Gambel Marsh, in Brunswick. DMR protocols include limited monitoring of other environmental variables, including vegetation, in proximity to their rSETs. CBEP has conducted rapid site assessment surveys at Gambel Marsh but has not established long-term monitoring there. State-wide conversations have recently begun with CBEP participation regarding greater coordination of tidal marsh restoration and monitoring.

- DEP eelgrass aerial surveys - expand.

Status: A new Maine DEP program, the Marine Vegetation Mapping Program, will collect data on the extent of eelgrass in Casco Bay every five years.

- University of Maine Land/Ocean Biogeochemical Observatory (LOBO) buoy continuous monitoring.

Status: LOBO buoys remain underutilized, but deployment costs are substantial, principally due to the need for periodic maintenance by scientific dive teams.

- New England marine invasive species Rapid Assessment Survey: survey is conducted every three to four years; CBEP has provided partial funding for almost a decade - continue to fund.

Status: A Rapid Assessment Survey took place in early August 2023 and included two sites in Casco Bay.

- DEP GulfWatch program - restore consistency of sampling.

Status: DEP has been able to continue sampling of Casco Bay shellfish for a suite of persistent toxins (now including PFAS), but sampling is infrequent. The GulfWatch program itself is no longer active under that name.

- Inshore continuous nitrogen monitoring (CBEP NuLAB or similar) - re-activate.

Status: Technical challenges with high frequency monitoring have proven significant and will require significant staff time and resources to address. Equipment has been upgraded and repaired, but not deployed recently.

Monitoring Prioritization

Related Programs funded by CBEP under the Bipartisan Infrastructure Law

Casco Bay Estuary Partnership has filed a five-year spending plan for BIL funding that calls for funding to address several monitoring priorities. These represent long-standing shared priorities for which we have a solid plan for progress over the next few years:

- Casco Bay Model Infrastructure. CBEP will continue to work with NERACOOS, UMASS-Dartmouth and University of Maine researchers to develop and expand on the Casco Bay Coastal Ocean Model (CBCOM), as we seek to develop integrated ocean, watershed and ecosystem models to inform management of Casco Bay. The Monitoring Network will be involved with model development to evaluate how the CBCOM can help improve monitoring, and how expanded monitoring can support model development.
- Monitoring Infrastructure Grants Program. The Monitoring Infrastructure Grants Program will offer grants to cover a portion of the costs of expanded monitoring capacity in the region. Allowable costs might include:
    - Purchase of automated field monitoring equipment such as buoys, data sondes or data loggers;
    - Purchase of laboratory equipment to process field-collected samples;
    - Establishing new monitoring collaborations, including building long-term “sentinel” monitoring programs;
    - Developing (and documenting) data quality assurance practices (including writing “SOPs” and “QAPPs” or upgrading laboratory practices to meet certification requirements).
- Onsite Wastewater Initiative. Among other tasks, the Onsite Wastewater Initiative will establish methods for tracking number, location and condition of septic tanks, especially in shoreline areas.

Programs being discussed by Monitoring Network

The Monitoring Network meets annually in the spring to present results of the prior season's monitoring efforts. These presentations, beginning in 2019, are available on Casco Bay Estuary Partnership's website at https://www.cascobayestuary.org/casco-bay/monitoring/. The Network is planning a separate meeting to discuss future priorities. The following efforts are currently under consideration by the Network.

Programmatic Needs

- Update the inventory of Casco Bay monitoring and data collection programs (the most recent survey, from 2016 is provided in Appendix A of the 2020 Monitoring Plan) and expand the inventory to include freshwater monitoring.
- Evaluate the extent to which existing monitoring programs will be able to document ecosystem and other changes resulting from climate change and sea level rise.
- Simplify sharing of data and coordination of monitoring activities. A number of ideas have been floated about how to achieve improved coordination, including via creation of dedicated Slack groups and hosting a regularly updated web page with links to available online sources of Casco Bay-related data.
- Hold more frequent meetings of the Monitoring Network and consider hosting periodic Casco Bay Science gatherings.

Monitoring Needs

- High resolution impervious cover data on a regular schedule.
- Marine habitat extent and condition to track shifting system-wide abundance of important intertidal and subtidal habitat types.
- Impacts of aquaculture operations on water quality, flora, and fauna (a priority identified in the existing Plan, but not yet successfully implemented).
- Monitoring of sediment nutrient fluxes.
- Establishing freshwater monitoring of harmful algae blooms (HABs).

Research Needs

- Evaluate methods and study designs for sampling emerging contaminants such as PFAS and microplastics. (PFAS studies are now well underway under the leadership of Friends of Casco Bay, Bigelow Labs, and the Department of Environmental Protection).
- Explore expanded use of eDNA to track presence / abundance / location of selected aquatic species like anadromous fishes or invasive species.
- Evaluate cost and feasibility of using stable isotopes (in indicator species) to document trophic relationships in the Bay.

Casco Bay Monitoring Plan

October 15, 2020

Prepared by Casco Bay Estuary Partnership, Casco Bay Monitoring Network, and U.S. Environmental Protection Agency

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EXECUTIVE SUMMARY

Background

People enjoy Casco Bay because of its clear water, inviting island landscapes, and the marine life, such as fish, seals and cultured oysters that call the Bay home. Yet the Bay is changing. The water is warming, becoming more acidic, and sea level is rising. How do we know this, and why is this important?

We know this because Friends of Casco Bay monitors nutrients and pH in the water. We know this because the Maine Department of Marine Resources has been tracking presence of harmful algal blooms that may pose threats to consuming shellfish like clams and mussels. And we know this because Casco Bay Estuary Partnership (CBEP) has set out a plan that presents an approach for collaborative and adaptive monitoring in Casco Bay.

U.S. Environmental Protection Agency's National Estuary Program (NEP) requires each NEP, including CBEP, to develop a monitoring plan. The partnership has written two previous plans, in 1996, and 2004. This 2020 Casco Bay Monitoring Plan (Plan) represents a significant update, incorporating up-to-date information on monitoring programs, available data, and management priorities.

The environmental monitoring landscape in Casco Bay and regionally has changed dramatically in the past decade. Use of automated water quality sensors has grown as costs of automation have dropped, and scientists, regulatory agencies, and environmental organizations have grown more proficient in their use. Data collected by national and state agencies are increasingly available online. Technical tools and standard practices for data sharing are more widely available, making regional data collaborations and public-facing data dashboards possible, if not yet simple to implement.

But perhaps the largest change in coastal monitoring has been the evolution of overlapping local- and state-level monitoring collaborations. These programs provide both purpose and context, and sometimes data, to inform Casco Bay monitoring. The region-wide "Integrated Sentinel Monitoring Network (ISMN)" has identified monitoring methods to use to track changes in coastal ecosystems throughout the Northeastern U.S. The City of Portland is finalizing the "Blue Portland" integrated water quality plan, which will include recommendations both for monitoring and for providing synoptic information on City actions to protect water quality and on ambient conditions in the Bay through on-line dashboards. The Maine Ocean and Coastal Acidification Network (MOCA) has built a robust network of scientists, organizations and volunteers working together to understand acidification in Maine waters. The Maine Climate Council has identified monitoring and communication of environmental data to inform decisions by individuals, business, and groups as a priority for protecting Maine's coastal economy.

The Casco Bay Monitoring Plan has been informed by and in some cases helped inform these interrelated monitoring contexts.

The Plan represents the work of the Casco Bay Monitoring Network (Network), a community of more than 20 scientists and organizations that routinely monitor conditions in Casco Bay and will continue their work in the future. The Network meets regularly to discuss recent observations, changes in monitoring plans and practices, and emerging monitoring needs. This Plan envisions a long-term role for the Network as the stewards of the Plan.

CBEP, through the Monitoring Network, the Monitoring Plan, and periodic State of Casco Bay reports, improves monitoring and enhances understanding of the Bay by setting priorities, sharing information among scientists, providing funding, reducing redundancies, filling gaps in data collection, and pulling together data from multiple sources.

After the first meeting of the Network in December of 2016, we inventoried the state of monitoring in Casco Bay and found an extensive network of scientists, managers and citizens collecting water, seining for fish, analyzing contaminants in shellfish, tracking vegetation changes in salt marshes, and collecting other data. We also cataloged related national and state-level data.

The Monitoring Network worked with CBEP's Management Committee to set monitoring priorities and develop conceptual models of how the Casco Bay ecosystem works. The Plan sets out three overarching questions, embodied in three conceptual models that address public and scientific questions about the health of the Bay, and provide structure to future monitoring:

(1) Are anthropogenic nutrients making the Bay less healthy?

The concentration and distribution of nutrients in the Bay is central to understanding status and trends of water quality in the Bay. Eutrophication and eelgrass were selected as starting points for this model because they are both key regulatory endpoints for managing impact of nutrients in coastal waters. Acidification was selected as well because of its close relationship to primary production and significant uncertainties about the impact of acidification on Maine's coastal waters. Causal relationships identified in this conceptual model highlight the need for data on nutrient concentrations in the Bay, nutrient loads entering the Bay, and nutrient sources on land.

(2) Are coastal habitats of Casco Bay both healthy and abundant enough to support ecosystem processes and protect the vitality of the Bay?

The habitats conceptual model was anchored on the following four focal habitats: fish passage, salt marsh, tidal flats, and eelgrass. The model highlights ways to strengthen existing data collection and make more efficient use of existing data to assess condition of the Bay's coastal habitats.

(3) Is the food web of Casco Bay changing and does it support marine biodiversity, food production and key ecosystem services?

The food web underlies the ability of a clean and productive Bay to produce seafood and support charismatic megafauna like seals, osprey, and shorebirds. Thus, the food web, in loose terms, relates directly to public perceptions of the health of the Bay. This conceptual model was built out from four major categories of a pelagic marine food web: phytoplankton to zooplankton to forage fish to larger fish. We extended the conceptual model to add other important components of the food web, and to reflect public interest in the food web, which focuses on marine harvests and watchable wildlife. Building out the food web conceptual model pointed out significant historic monitoring gaps, especially the lack of long-term consistent monitoring of most organisms inhabiting the Bay. Equally important, it identified data already collected - principally in support of fisheries management - that can provide insight into Casco Bay's ability to support marine harvests.

Plan Priorities

The Casco Bay Monitoring Plan provides a coordinated framework for monitoring Casco Bay and its watershed. The framework leverages existing data collection programs, identifies emerging information needs, and highlights data gaps. The Plan also identifies ideas for improving monitoring in the next five to ten years. Recommendations prioritized by the Network are summarized here as Programmatic and Monitoring Priorities. Additional recommendations are provided in the full report.

Programmatic Priorities

- Strengthen the Monitoring Network. Link to emerging monitoring frameworks and programs. Facilitate sharing of data and information.
- Identify and advocate for long-term stable funding mechanisms for monitoring programs. Seek funding to track impacts of climate change and address other emerging needs.
- Develop a Casco Bay circulation model to provide context for interpretation of monitoring data.

Monitoring Priorities

- Maintain core of existing monitoring programs.
- Expand emerging monitoring areas, including:
    - tracking freshwater conditions (especially nutrients in rivers and streams);
    - sampling fish communities and other components of the food web;
    - extending eelgrass monitoring;
    - studying impacts of aquaculture on water quality, flora, and fauna.
- Track marine habitat extent and condition, emphasizing long term impacts of climate change.

Conclusion

Data collected under the Casco Bay Monitoring Plan has many uses, including:

- Inform the public regarding the health of Casco Bay and provide a foundation for periodic State of Casco Bay reports.
- Provide the Monitoring Network with information to assess status and trends in the health of Casco Bay and its watershed.

- Inform decisions for adapting monitoring priorities in response to changing coastal conditions or emerging issues.
- Measure the effectiveness of policies, management actions, and programs implemented under CBEP's Comprehensive Conservation and Management Plan, the Casco Bay Plan.
- Ensure that updates to the Casco Bay Plan are based on the best available data and science.

While completing the Plan, a common refrain was that coastal managers are looking for "sentinel" indicators of change, such as trends in nutrient enrichment, or in fish communities. The role of the Network and CBEP is to see the bigger picture; to look at impacts Bay-wide instead of town-by-town, or program-by-program. How does nutrient enrichment impact habitats such as eelgrass? Is lower pH in bottom water of Casco Bay related to offshore changes or to coastal processes such as river runoff? Will aquaculture result in additional algal growth in the upper Bay? Will changes in temperature yield changes in fisheries?

The 2020 Casco Bay Monitoring Plan will guide the Monitoring Network and Casco Bay Estuary Partnership in addressing these and other emerging questions, in evaluating management actions, in collaborating for funding opportunities, and in communicating to the public about changes to the Bay. These organizations have come together to create a dynamic Plan to ensure the future health and vitality of the critical resource that is Casco Bay.

Section I. INTRODUCTION

The volume and diversity of data available about conditions in Casco Bay is substantial. More than a dozen organizations regularly collect data about the Bay, while numerous state, regional and national data sources shed light on local conditions. Despite the quantity of data available, it can still be difficult to answer important questions about status and trends in Bay and its watershed. A central challenge is that most data collected in and about Casco Bay is collected to address specific institutional or programmatic missions, rather than to fill Bay-wide information needs.

The Casco Bay Monitoring Plan provides a coordinated framework for monitoring Casco Bay and its watershed. The framework leverages existing data collection programs, identifies emerging information needs, and highlights data gaps.

The need for coordinated monitoring of conditions in Casco Bay has never been greater. Climate change (and its impact on coastal communities, fisheries, and ecosystems) poses significant challenges for public and private actors in the region. Ocean and coastal acidification has raised new questions not addressed by historic monitoring. Innovative approaches to protecting clean water (like Portland's "Blue Portland" integrated water quality planning process) are more dependent than traditional approaches on data to identify cost-effective solutions and demonstrate effectiveness of actions.

The Plan has been written with the assistance of, and on behalf of, the Casco Bay Monitoring Network. The Network is an informal community of individuals, organizations, and agencies involved with monitoring conditions in Casco Bay. It meets on a roughly semi-annual schedule to discuss recent observations, changes in monitoring plans and practices, and emerging monitoring needs. This Plan envisions a long-term role for the Network as the stewards of the Plan. In an era of ongoing changes in Maine's coastal ocean, the Plan needs to be responsive to changing environmental conditions as well as changes in priorities and information needs. The Network provides the institutional mechanism to allow monitoring in Casco Bay to be better coordinated and adaptive to changing circumstances.

A. Purposes

The Casco Bay Monitoring Plan has the following primary purposes:

1) Establish a coordinated monitoring program that will provide data to assess status and trends in the health of Casco Bay and its watershed.
2) Identify gaps in existing monitoring and highlight priorities for improving or expanding monitoring.
3) Delineate a mechanism for adapting monitoring priorities in response to changing coastal conditions or emerging issues without jeopardizing important long-term data series and coordination.
4) Provide a consensus regional context for monitoring that facilitates funding of monitoring programs.

5) Facilitate efforts to share information on the health of the Bay with multiple audiences, including educators, policy makers, the business community, and the public.

Data collected under this monitoring plan has many uses, including:

1) Inform policy and management decisions.
2) Measure the effectiveness of management actions.
3) Inform the public regarding the health of Casco Bay.
4) Provide a foundation for periodic State of the Bay reports.
5) Evaluate effectiveness of programs implemented under the *Casco Bay Plan*.
6) Update the *Casco Bay Plan* based on best available data and science.

B. Definition of Monitoring

For purposes of this Monitoring Plan, “Monitoring” consists of ongoing data collection efforts undertaken to provide information about status or trends of natural, social, or economic systems over time.

Monitoring overlaps with research, however, research (including social science research) answers specific questions and produces generalizable knowledge, while monitoring collects actionable data about local processes that are used for multiple purposes. The line between research and monitoring is porous. Some short-term monitoring programs answer specific questions about local conditions. Research projects sometimes generate data that is of value outside the context of the original research questions. Research informs monitoring, and vice versa. The individuals engaging in research and conducting monitoring overlap and regularly communicate.

This Plan principally addresses monitoring. It is not a research agenda for Casco Bay.

C. Adaptive Management

This Casco Bay Monitoring Plan is intended to guide monitoring for a period of at least five years but may well be in force longer.

The history of prior monitoring plans is instructive. The first Casco Bay monitoring plan, “Measuring Progress: The Casco Bay Monitoring Plan,” was developed in 1996 by the Casco Bay Estuary Project and was not updated until eight years later (2004), when “Casco Bay Environmental Monitoring Program,” was released. The 2004 document had limited influence on monitoring practice yet has not been superseded 16 years later. The two prior plans did not address climate change, invasive species, nutrient pollution, coastal acidification, sea level rise, nor emerging contaminants.

Adaptive management may be especially important over the next few years. Other organizations are engaged in developing monitoring programs and plans that can and should influence and be influenced by the Casco Bay Monitoring Plan. Portland is preparing a plan (“Blue Portland”) for integrated water quality management that aims to address multiple Clean Water Act permit obligations. Portland’s plan will include recommendations for monitoring water quality protection and water quality. The cities of

Portland and South Portland are developing a joint climate action and adaptation plan, "One Climate Future," which may include monitoring of climate change, climate vulnerabilities, and adaptation and mitigation actions. The Maine Climate Council, coordinated by the Governor's Office of Policy Innovation and the Future, is considering recommendations for enhanced data collection and data sharing, regarding fisheries, climate change, and coastal water quality, among others. The Northeast Coastal and Acidification Network (NECAN) and Maine Ocean and Coastal Acidification Partnership (MOCA) continue to discuss ways to optimize monitoring of acidification and coastal carbonate chemistry. The Northeast Regional Ocean Council (NROC) and the Northeastern Regional Association of Coastal Observing Systems (NERACOOS) are collaborating to create an Integrated Sentinel Monitoring Network for the Northeast. Casco Bay monitoring, through the Monitoring Network, should both inform these discussions of coastal monitoring, and be responsive to the evolving priorities these efforts will identify in coming months and years.

A decade from now, we will look back on this document and wonder that some new concern was not reflected here. New issues will come to the fore, but we cannot be certain what those topics will be. If this document is to play a constructive role guiding regional monitoring for more than a year or two, it must be adaptive. It must incorporate ongoing communication with individuals and organizations involved with monitoring and incorporate insight into the evolving needs of decision makers.

The Plan must be the basis for ongoing discussion, prioritization and collaboration. The Casco Bay Monitoring Network provides the institutional structure to ensure long-term relevance and support adaptive management. The Monitoring Network can also identify projects that will engage undergraduate and graduate students while addressing emerging monitoring needs.

D. Existing Monitoring

CBEP worked with the Monitoring Network and the Casco Bay Nutrient Council to identify Casco Bay monitoring programs and data sources. We began by reviewing the 2004 and 1996 Casco Bay Monitoring Plans, and the contents of our State of the Bay Reports, to identify data used in the past to characterize conditions in Casco Bay. Working with the Monitoring Network, we developed a map and a catalog of present-day monitoring programs. We compiled a list of other relevant data sources, using multiple sources ranging from the U.S. Census to Google Earth.

At least ten organizations located in Maine are engaged in significant ongoing monitoring of conditions in Casco Bay. These organizations conduct dozens of separate monitoring programs. These organizations include:

- Bowdoin College;
- Casco Bay Estuary Partnership;
- Department of Environmental Protection, Maine;
- Department of Marine Resources, Maine;
- Friends of Casco Bay;

- Gulf of Maine Research Institute;
- Southern Maine Community College;
- University of Maine;
- University of New Hampshire;
- Wells National Estuarine Research Reserve.

At least seven organizations are engaged in regular monitoring of conditions in fresh water within the Casco Bay watershed. They include:

- Department of Environmental Protection, Maine;
- Lakes Environmental Association;
- Lake Stewards of Maine;
- Long Creek Watershed Management District;
- Portland Water District;
- Presumpscot Regional Land Trust;
- University of Southern Maine.

In addition, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, and U.S. Geological Survey regularly collect information on weather, tides, river flow and more that are essential to understanding the health of the Casco Bay ecosystem.

Any such list is necessarily incomplete and contingent. Local programs are sometimes not widely publicized, and new programs come into being regularly. We invite organizations that regularly collect data about Casco Bay or its watershed to contact Casco Bay Estuary Partnership and participate in the Monitoring Network.

State-level data is becoming increasingly available on-line through centralized archives like the Maine Office of GIS/ Geolibrary and individual departments. Commercial entities such as Google and ESRI now make important geographic data, such as historical aerial photographs, available, often free of charge.

Section II. SETTING PRIORITIES

Casco Bay is a complex interconnected system. Hundreds of types of information could be incorporated into this Monitoring Plan. But without priorities, a Plan can devolve into little more than a list of existing programs, or worse, a wish list of programs that do not exist and are unlikely to be funded.

A primary purpose of this Plan is to highlight ways that we could be improving monitoring in Casco Bay.

CBEP worked with the Monitoring Network and CBEP's Management Committee on an approach for setting priorities. The process hinged on identifying three Priority Topic areas and developing graphical Conceptual Models to highlight existing monitoring and identify information gaps. These Priority Topics are:

1) ***Nutrients and Water Quality*** - Track changes in nutrients and related water quality issues in fresh water and in the Bay.
2) ***Habitats*** - Gauge the health and extent of priority habitats, including salt marshes, tidal flats, eelgrass beds, and connected waterways for migratory fish.
3) ***Food Web*** - Monitor how the Casco Bay ecosystem links primary producers like phytoplankton and marine algae to fish and wildlife, charismatic species, and marine harvests.

We used a variation of "Stressor – State – Response" logic to identify how priority areas are interrelated, and what data might inform understanding of each Priority Topic.

For each Priority Topic, we identified a collection of core items (State) we wanted to understand and, using graphical conceptual models, identified upstream (causal, often Stressor) and downstream (consequence, usually Response) metrics. This was an iterative process, with each additional metric generating identification of more upstream and downstream metrics. The resulting Conceptual Models were shared, critiqued, and simplified in conjunction with the Monitoring Network. These Conceptual Models are heuristic devices, not intended to be accurate scientific statements of all cause-and-effect relationships.

The final Conceptual Models contain dozens of boxes representing potential metrics for each Priority Topic, with considerable overlap. To clarify dominant relationships among our three Priority Topics, we produced a simplified top-level Conceptual Model.

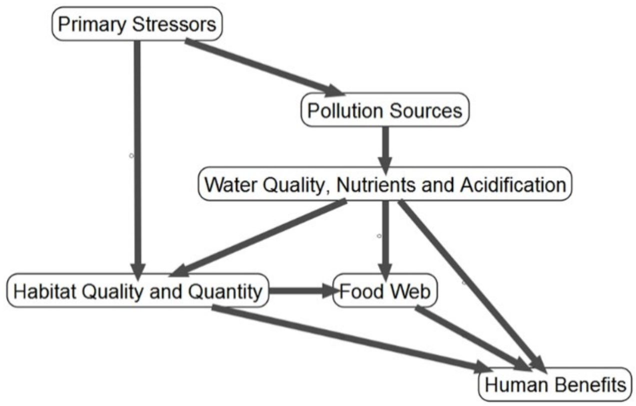

Figure 1: Simplified causal diagram showing relationships among Priority Topics

In this simplified framework, primary (anthropogenic) stressors like population and land use affect Casco Bay indirectly through two main pathways. The first is via effects on coastal and marine habitat, such as loss of wetlands or construction of fish passage barriers. The second is through changes to pollutant loadings to the Bay, which affect water quality. Water quality and habitat condition have ripple effects on each other, the marine food web, and human benefits derived from the Bay.

Human Benefits goes beyond the biophysical responses that are the focus of monitoring Nutrients, Habitats, or the Food Web. The heart of tracking Human Benefits lies in understanding how the Bay provides benefits to the people living along its shores and in its watershed and especially how coastal communities and economies depend on and connect to the Bay. While this Plan does not include Human Benefits as a Priority Topic, it does include a list of data sources that inform our understanding of people's relationship with the Bay. None of these data sources derives from local monitoring programs, but they are used in State of the Bay and Economic Status reporting.

We mapped existing data collection programs onto the Conceptual Models, to evaluate strengths and weaknesses of existing monitoring. As expected, we lack data to address many potential metrics. We lack data entirely for certain topics. In other areas, we are collecting limited data infrequently or from just a few locations. For still other subjects, we have limited historical data from past studies, but no ongoing monitoring.

The results of this exercise are presented in Section III. Each Priority Topic and related Conceptual Model and monitoring programs are discussed, following the framework of Figure 1. This highlights how existing monitoring and available data sources address Priority Topics, but also reveals data gaps and offers the opportunity to evaluate importance of those data.

The Priority Topics segments each conclude with a discussion of Strengths and Drawbacks, which leads to Section IV., Recommendations for Monitoring Priorities 2020-25. Appendix A contains detailed descriptions of 34 monitoring programs, organized into a Catalog. Appendix B lists related reports that are available on Casco Bay Estuary Partnership's website. Taken together, the Casco Bay Monitoring Plan presents a compilation of monitoring programs, information, and plans as of the 2020 monitoring season.

Section III. PRIORITY TOPICS

A. Nutrients and Water Quality

"Are anthropogenic nutrients making the Bay less healthy?"

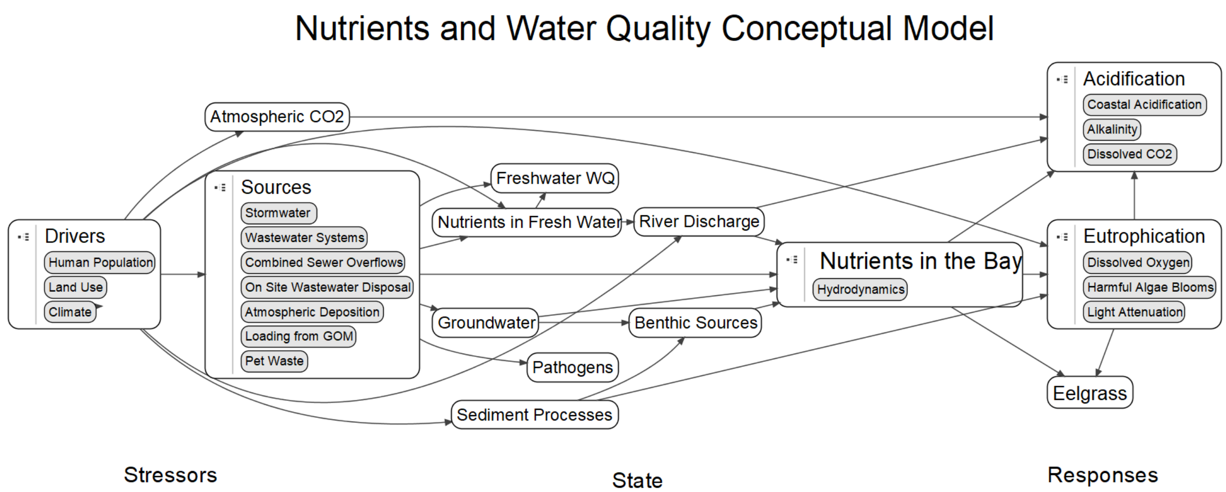

Figure 2: Nutrients and Water Quality Conceptual Model

The conceptual model for this Priority Topic originates from four focal points:

- Nutrients in the Bay;
- Eutrophication;
- Eelgrass;
- Acidification.

The concentration and distribution of nutrients in the Bay is central to understanding status and trends of water quality in the Bay. Eutrophication and eelgrass were selected as starting points for this model because they are both key regulatory endpoints for managing impact of nutrients in coastal waters. Acidification was selected because of its close relationship to primary production and significant uncertainties about the impact of acidification on Maine's coastal waters.

The conceptual model traces those starting concerns upstream to identify dominant sources of nutrients entering the Bay. The sources of nutrients included here are thought to be most important for Casco Bay but are not comprehensive. As we learn more about nutrient dynamics in Casco Bay, we may want to target monitoring to better understand other nutrient sources.

Additional water quality issues affect both marine and fresh water. Elevated levels of pathogens can put public health at risk. Managing ice and snow on roadways and parking areas through application of sand and salt (de-icing practices), can degrade freshwater ecosystems.

Significant complexity is buried within the conceptual model, which was substantially simplified to facilitate communication. Ecosystem response to nutrient enrichment has been incorporated implicitly as part of Acidification and Eutrophication. Nutrients and water quality also appear as drivers in both the Habitats and Food Web conceptual models, and eelgrass is included in Habitats as well.

1. Nutrients and Water Quality Stressors

Guiding Questions

What are the most important sources of nutrients entering Casco Bay?

What proportion of nutrients entering the Bay are controllable by policy or management interventions?

Are annual nitrogen and phosphorus loads to Casco Bay changing?

Are freshwater inputs to the Bay changing?

Are changes in river flow affecting nutrient delivery to aquatic ecosystems?

How do freshwater inflows affect susceptibility of the Bay to nutrients and acidification?

Population growth directly impacts water quality because more people produce additional waste that must be managed and treated.

Land use, in a broad sense, is also an important driver of nutrient pollution. Urbanization spurs increases in runoff via growth in impervious cover, construction of drainage systems, and changes in vegetation and topography. Suburbanization increases vehicle miles traveled, contributing to both atmospheric deposition of nitrogen and local deposition of nitrogen compounds that contribute to nutrients in runoff. Development also reduces nutrient assimilative capacity (and other ecosystem functions) of the watershed through destruction of wetlands, forests and flood plains. While thought to be less significant than urbanization in the Casco Bay watershed, agriculture may be a locally important source of nutrients and other pollutants including bacteria and sediments.

Climate change both increases nutrient loads entering the Bay and increases susceptibility of coastal ecosystems to nutrient loads. Increased precipitation is expected to increase runoff, and river discharge, transporting more pollutants to downstream waters. Higher temperatures accelerate growth of phytoplankton, speed decomposition, and exacerbate thermal stratification, all of which may increase susceptibility of receiving waters to nutrients.

Primary sources of nutrients entering Casco Bay include human waste (entering the Bay principally via sewage), urban and suburban runoff, and atmospheric deposition. Agricultural runoff is not widespread in the Casco Bay watershed, but may be a factor locally, especially in fresh water. On-site (mostly private) wastewater treatment systems are another source of nutrients reaching the Bay. Septic tanks are the most common on-site wastewater treatment systems in our region, and a few hundred overboard discharges ("OBDs"), located principally on the Casco Bay islands, release wastes directly to receiving waters.

Related State of the Bay Indicators

Nutrients and Water Quality Stressors are reported on in the following 2020 State of Casco Bay Report Indicators:

- Population and Land Use;
- Wastewater Disposal;
- Stormwater;
- Combined Sewer Overflows;
- Climate Change.

Throughout this document, monitoring programs and reports are referenced in the following ways:

(C) indicates that a program is described in detail in the Catalog of Monitoring Programs in Appendix A. In the Monitoring Plan, these program descriptions are indicated by their Appendix A listing (C-number), for example (C-1) refers to Bowdoin College Coastal Studies Center Acidification.

Programs with a (W) are the subject of one or more reports that are available on CBEP's Website (https://www.cascobayestuary.org/resources/publications/) and more fully referenced in Appendix B. In the Monitoring Plan, references to these reports are indicated by their Appendix B location (W-capital letter.number.lower case letter), for example (W-B.1.a.) refers to B. Habitats 1. Clam flats a. Friends of Casco Bay 2013 Casco Bay clam flat pH study.

Not all reports listed in Appendix B are specifically mentioned in the Plan, but each is deemed to be related to monitoring in Casco Bay.

Data Sources and Monitoring Programs

Table 1: Data Sources for monitoring nutrients and water quality stressors. Local monitoring efforts are in italics.

Nutrients Stressors	Data Source or Monitoring Program	Comments
Population	U.S. Census American Community Survey	
Climate	National Oceanic and Atmospheric Administration (NOAA), Portland Jetport weather station	Data accessible through the NOAA Climate Data Center.
Bay water temperature	Friends of Casco Bay, water quality monitoring programs (C-16, C-17)	
Bay water temperature	Gulf of Maine Research Institute, CBASS (C-23)	Program includes dissolved oxygen.
Bay water temperature	Maine Department of Marine Resources, (DMR) Shellfish Sanitation Program, Bacteria (C-11)	Shallow water / intertidal temperatures.
Bay water temperature	Bowdoin College Coastal Studies Center (C-1, C-2)	Temperature data is collected both at the Bowdoin buoy and at the Coastal Studies Center as part of Acidification monitoring.
Bay water temperature	Maine DEP (C-6, C-9)	
Land Use	Coastal Change Analysis Program (CCAP) National Land Cover Dataset (NLCD) Cropland Data Layer	National land cover datasets using consistent methods and categorization. Resolution varies; historic data mostly uses a 30 m pixel.
Land development patterns	Building Permit Data	Provides data only on residential building permits.
Wetland status	National Wetland Inventory	Low resolution characterization of extant wetlands; updated periodically.
Impervious surfaces	Maine Department of Inland Fisheries and Wildlife	High-resolution data layer derived from 2007 aerial imagery.
Permitted discharges	Maine DEP	Data available on permitted discharges, including wastewater treatment facilities, CSOs and OBDs.

River flow	U.S. Geological Survey river gages on the Royal and Presumpscot Rivers	Royal River gage re-installed in 2019.
Wastewater treatment plant discharges	Portland Water District (PWD) Other treatment plant operators Maine DEP	All major wastewater treatment plants discharging to Casco Bay or major tributaries now collect periodic data on discharge volume and concentration of nitrogen.
Combined Sewer Overflows (CSO)	Portland Water District City of Portland City of South Portland Maine DEP	PWD monitors CSO volumes continually. Cities provide storm event discharge totals. DEP provides annual summaries by municipalities.
Stormwater	Long Creek Watershed Management District (LCWMD) (C-26)	LCWMD collects significant data on water quality in Long Creek, a stream affected by suburban runoff.
Atmospheric Deposition	Maine DEP Wolfe's Neck Atmospheric Deposition Monitoring Station (W-C.3.f.,h.,n.,o.,s.,t.,u.)	Maine DEP managed monitoring station. Data available through National Atmospheric Deposition Program (NADP).

Additional Data or Reports:

- Climate change - EcoSystem Indicator Partnership Gulf of Maine Council on the Marine Environment (W-A.3.a.)
- Climate change - University of New Hampshire (W-A-3.c.)
- Climate change vulnerabilities - Waterview Consulting (W-A.3.e.)
- Bay water temperature, salinity - Northeast Coastal Acidification Network, Shell Day
- Impact of development on surface waters, South Portland - Mitchell Center for Environmental and Watershed Research, University of Maine, (W-A.4.k.)
- River flow, Presumpscot River - U.S. Environmental Protection Agency, dye study (W-A.4.o.)
- Watershed survey reports - Cumberland County Soil & Water Conservation District (W-A.5.a.,b.,c.,d.,e.,f.,g.,h.,i.,j.,k.,l.,m.,n.,o.)
- Watershed survey report - Forest Lake Association (W-A.5.p.)
- Watershed survey reports - Friends of the Royal River (W-A.5.q.r.)
- Watershed survey report - Thompson Lake Environmental Association (W-A.5.v.)

2. Nutrients and Water Quality Status

Guiding Questions

What are typical concentrations of major nutrients in Casco Bay?

Are concentrations of major nutrients in the Bay changing?

Are there locations within Casco Bay where elevated nutrient levels are likely to cause water quality problems?

Do winter de-icing practices affect water quality in Casco Bay tributaries?

Do pathogens in the Bay threaten health of swimmers or those eating shellfish?

Efforts to monitor concentration of major nutrients in Casco Bay and in waters within the Casco Bay watershed go back decades. Friends of Casco Bay (FOCB) has managed multiple nitrogen monitoring programs in the Bay for many years, building up what is probably the most comprehensive long-term data on nitrogen concentrations available anywhere in Maine’s coastal waters (Cadmus and Saquish Scientific, 2009).[47] U.S. Environmental Protection Agency, Maine DEP, and others have contributed to our

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[47] Cadmus Group and Saquish Scientific. 2009. Nutrient criteria development in Maine coastal waters: Review of existing data and preliminary statistical analyses. Report to Maine DEP. Available at: https://www.maine.gov/dep/water/nutrient-criteria/091104_cadmus_saquish_nutrient_criteria_report.pdf

understanding of nutrient status of Casco Bay waters through a variety of monitoring programs, often coordinated with the FOCB data collection programs. Maine DEP maintains a dataset that includes data drawn from these and other sources.

Fresh water monitoring in the watershed is limited but robust. Presumpscot Regional Land Trust (PRLT) has continued the long-running volunteer monitoring of water quality in the Presumpscot River that was begun by Presumpscot River Watch. In recent years, PRLT has added sites on the Stroudwater River to its program. Lakes Environmental Association and Lake Stewards of Maine have established volunteer monitoring programs in Casco Bay watershed lakes and ponds and conduct complementary continuous monitoring at selected locations. Portland Water District monitors water quality in Sebago Lake and its tributaries, the area’s drinking source. Since 2010, the Long Creek Watershed Management District has refined monitoring of this urban stream, which discharges to the Fore River. For several years under the leadership of Professor Karen Wilson, Environmental Science students at the University of Southern Maine have collected winter and early spring data on chlorides (salts) and conductivity in various streams in the watershed.

Related State of the Bay Indicators

Nutrients and Water Quality Status is reported on in the following 2020 State of Casco Bay Report Indicators:

- Inland Water Quality;
- Bay Water Quality;
- Nutrients;
- Swimming Beaches and Shellfish Beds.

Data Sources and Monitoring Programs

Table 2: Data Sources for monitoring status of nutrients & water quality in Casco Bay and other waters in the watershed. Local monitoring efforts are in italics.

Nutrients Status	Data Source or Monitoring Program	Comments
Marine Waters		
Nitrogen concentration in marine waters	Maine DEP (C-9) Friends of Casco Bay (C-17)	Long-term data records from grab samples.
High frequency nitrogen data	Casco Bay Estuary Partnership, nutrient sensor (C-4)	Nitrate and ammonium data, with temperature and conductivity. Future deployments uncertain.
High frequency nitrogen data & Nutrients in fresh water	University of Maine, Land/Ocean Biochemical Observatory (LOBO) buoy (C-30) Nutrients point samples in association with LOBO buoy (C-31)	Nutrients in fresh water sampled at Presumpscot River, Royal River, Nason's Brook.
Nutrients	U.S. Environmental Protection Agency, National Coastal Condition Assessment	Periodic assessment, relatively few sample locations every three to five years.
Pathogens in marine waters	Maine DMR, Shellfish Sanitation Program, Biotoxins in shellfish (C-12)	Hundreds of locations, mostly in the Eastern Bay.
Pathogens at swimming beaches	Maine DEP, Maine Healthy Beaches Program (C-8)	Both freshwater and saltwater beaches included.
Nitrogen stable isotopes in mussels	Gulf of Maine Research Institute	
Lakes and Ponds		
Fresh water quality, Sebago Lake	Portland Water District (C-27)	
Fresh water quality, selected lakes & ponds	Lakes Environmental Association (C-25)	

Fresh water quality, selected lakes	Lake Stewards of Maine, Volunteer Lake Monitoring Program	Maine DEP aggregates lake water quality data from many sources and makes it available on-line, including phosphorus data, where available.
Rivers and Streams		
Fresh water quality, two rivers	Presumpscot Regional Land Trust, Presumpscot and Stroudwater Rivers (C-29)	Emphasis on bacteria, dissolved oxygen, and temperature. No nutrient data currently collected.
Fresh water quality, Sebago Lake tributaries	Portland Water District (C-28)	Includes phosphorus and bacteria.
Macroinvertebrates and Algae, rivers and streams	Maine DEP, Biological Monitoring	Includes wetlands.
Chlorides and Conductivity, stream	Long Creek Watershed Management District (C-26)	Chloride and conductivity data ~ 9 months a year.
Chlorides and Conductivity	University of Southern Maine Department of Environmental Science and Policy	Student-collected data, mostly winter/spring.

Additional Data or Reports:

- Nutrient pollution in Casco Bay - Nutrient Council (W-A.1.a.)
- Nutrients, Nitrogen Nab - Friends of Casco Bay
- Hydrodynamics, circulation modeling - Applied Science Associates (W-A.2.a.); and Norwich University (W-A.2.b.); and University of Maine (W-A.2.c.)
- Fresh water quality, Presumpscot River - FB Environmental Associates (W-A.4.a.); and Presumpscot River Watershed Coalition (W-A.4.j.)
- Fresh water quality, Royal River - Friends of the Royal River (W-A.4.b.)
- Fresh water quality, Capisic Brook - Partnership for Environmental Technology (W-A.4.e.f.)
- Nitrogen loading in tributaries, Presumpscot River, Royal River, Capisic Brook - University of Maine, Gray (W-A.4.l.)

3. Nutrients and Water Quality Responses

Guiding Questions

Are nutrients entering Casco Bay having negative effects on water quality?

Are nutrient loads, including phosphorus loads, harming water quality in Casco Bay watershed lakes?

Is water quality in Casco Bay changing?

Is water quality in Casco Bay watershed lakes and rivers changing?

Are salts affecting the invertebrate communities in Casco Bay tributaries?

The Bay is experiencing preliminary ecological effects of excess nutrients including coastal acidification, damage to eelgrass beds, impacts on water quality, shifts in algae communities, and increase in harmful algae blooms. Climate change causes waters to warm which exacerbates certain effects. This combination heightens concern about Casco Bay's long-term ability to provide habitat for commercially fished/farmed species and to provide a clean, healthy environment for recreation and tourism.

Conditions in fresh water are more difficult to summarize, since conditions are highly variable from location to location, depending on local watershed conditions, land use, and geochemistry. Observations on freshwater conditions include:

- Water quality in Casco Bay watershed lakes and ponds is often good, but some, like Highland Lake, in Falmouth and Westbrook, have shown signs of stress. While local land use plays a big role in determining water quality, some lakes are more susceptible to problems than others because of their bathymetry or geochemistry.
- While data is limited for streams and rivers in the watershed, water quality in urban streams tends to be poor. Agricultural runoff stresses a handful of streams in our region.
- Certain tributaries of the Presumpscot, and even certain sampling locations, show elevated levels of *E. coli* bacteria, and thus elevated risk of exposure to pathogens.

- Data from Long Creek is showing the importance of winter salt in degrading the health of our freshwater streams. Streams draining forested areas tend to support healthy invertebrate and fish communities.

Related State of the Bay Indicators

Nutrients and Water Quality Responses are reported on in the following 2020 State of Casco Bay Report Indicators:

- Inland Water Quality;
- Bay Water Quality;
- Nutrients;
- Coastal Acidification.

Data Sources and Monitoring Programs

Table 3: Data Sources for monitoring responses of nutrients and water quality in Casco Bay and other waters in the watershed. Local monitoring efforts are in italics.

Nutrients Responses	Data Source or Monitoring Program	Comments
	Acidification	
CO_2	NOAA, University of New Hampshire Gulf of Maine buoy D	
Ocean acidification, Continuous	Bowdoin College Coastal Studies Center, LOBO buoy (C-1)	Land/Ocean Biogeochemical Observatory (LOBO) buoy.
Ocean acidification, Continuous	Friends of Casco Bay, Cousins Island (C-16)	Part of FOCB continuous water quality monitoring suite.
	Eutrophication	
Bay water quality, Seasonal	Friends of Casco Bay (C-17)	Long history of monitoring water quality parameters, such as dissolved oxygen turbidity, temperature, pH and salinity. Current program involves “shore” and “sea” monitoring locations.
Bay water quality, Continuous	Friends of Casco Bay (C-16)	Part of FOCB continuous water quality monitoring suite.
Bay water quality	Maine DEP, Marine water quality(C-9)	Program collecting data in Casco Bay in 2020, but future deployments are uncertain.
Bay water quality	Bowdoin College Coastal Studies Center, Bowdoin buoy (C-2)	LOBO buoy.
Fresh water quality, lakes, ponds, and streams	Lakes Environmental Association (C-25) LCWMD (C-26) Portland Water District (C-27, C-28) Lake Stewards of Maine	See above, under “Status.” Lake and stream monitoring programs often track both nutrients and ecological responses to nutrients, like Chlorophyll-A, and water clarity.
Biotoxins	Maine DMR, Shellfish Sanitation Program, Biotoxins in shellfish (C-12)	See description under Food Web.

Phytoplankton	Maine DMR, Volunteer phytoplankton monitoring	See description under Food Web.
	Ecosystem Health	
Impaired streams	Maine DEP, Waters not meeting state water quality criteria (W-A-4.c.)	“305b” and “302D” lists.
Eelgrass	Maine DEP (C-6) (W-B.3.a.,b.,c.)	Analysis of aerial imagery, dive surveys at selected locations.

Additional Data or Reports:

- Bay water quality, Citizen Scientists - Friends of Casco Bay (W-A.1.c.,d.,e.,f.,g.,h.)
- Ocean acidification, Continuous (2015-2020) - University of New Hampshire, Southern Maine Community College Pier (C-32; W-A.3.d.)
- Coastal water quality, New Meadows River - MER Assessment Corporation (W-D.2.h.)

4. Strengths and Drawbacks of Nutrients and Water Quality Monitoring

Strengths or Opportunities

- We now have high quality river discharge data for the Bay's two largest tributaries, the Presumpscot River at Westbrook (2016 to present) and Royal River at Yarmouth (1990-2004 and 2019 to present).
- Casco Bay's water quality monitoring programs are approaching thirty years old; which has produced one of the best and most extensive data sets on water quality anywhere in the state or the country. Water quality monitoring in the Bay has a lot on which to build, and robust monitoring programs continue Bay-wide.
- Casco Bay has a long history of nutrient monitoring, led by Friends of Casco Bay and Maine DEP. This has produced deep institutional experience and increasing sophistication about nutrient monitoring.
- In recent years, several organizations have expanded the use of "continuous" (really, high frequency) monitoring technologies, greatly improving our ability to understand how ecological processes and episodic events affect the Bay.
- Some of the first high frequency, multi-year ocean acidification monitoring in the region occurred in Casco Bay, under the leadership of Friends of Casco Bay, Casco Bay Estuary Partnership, University of New Hampshire, and U.S. Environmental Protection Agency. That has provided a robust foundation for clarifying monitoring needs.
- The Maine Climate Council, and its Coastal and Marine Working Group, have drawn attention to the importance of monitoring for adapting to climate change. This attention may identify new priorities and funding sources for monitoring.

Drawbacks or Vulnerabilities

- Until recently, high resolution land cover data for our region was sporadic, and used changing methodologies, making trend analysis difficult. Federal data sources like CCAP and NLCD use consistent methods, but spatial resolution of older data remains poor.
- Maine produced high resolution (1 meter pixel size) impervious cover data nearly a decade ago, but that is too old to be of much use in understanding present-day water quality conditions. No schedule nor funding mechanism exists for producing updates for high quality impervious cover data. Alternative (national) data sources are much lower resolution.
- Monitoring of alkalinity, which has significant impact on ocean and coastal acidification chemistry, remains limited, both in the Bay and in major tributaries.

- No program collects consistent data on concentrations of nutrients in Casco Bay tributaries, blunting our ability to understand loading of nutrients to the Bay.
- No data provides information on the number, spatial distribution, and current condition of on-site wastewater treatment systems (especially septic tanks).
- Sediment nutrient processes, and especially release of nutrients from Casco Bay sediments, have not been studied in Casco Bay, limiting our ability to understand whether, when, and where the sediments act as sources or sinks for nutrients entering the water column.
- DEP monitoring of nutrients in Casco Bay is scheduled to scale back in 2021. There is currently no clear plan for replacing DEP effort with some sort of long-term monitoring program.
- Management needs in the urbanizing Portland Harbor, especially under a Portland Integrated Water Quality Plan, are likely to require additional monitoring infrastructure to increase both geographic and temporal resolution.
- While nitrogen data is relatively common in Casco Bay, phosphorus data is somewhat less common. Data on other macronutrients and micronutrients are essentially absent. Understanding of nutrient processes in the Bay requires information on prevalence of multiple nutrients.
- Data on health of Casco Bay tributaries is limited principally to periodic biological monitoring, which limits ability to identify relative importance of specific stressors.
- Robust, up-to-date hydrodynamic models of Casco Bay could enhance use of nutrient and water quality data, by connecting observations with explicit causal hypotheses.
- Policy interpretation of data would be further improved with linked watershed, water quality and ecosystem models, providing insight into processes and consequences that are difficult to monitor directly.
- Minimal data available regarding nutrient input to the Bay from the Gulf of Maine and by extension from the currents entering the Gulf of Maine.
- Many existing monitoring programs lack sufficient and secure funding.

B. Habitats

"Are coastal habitats of Casco Bay both healthy and abundant enough to support ecosystem processes and protect the vitality of the Bay?"

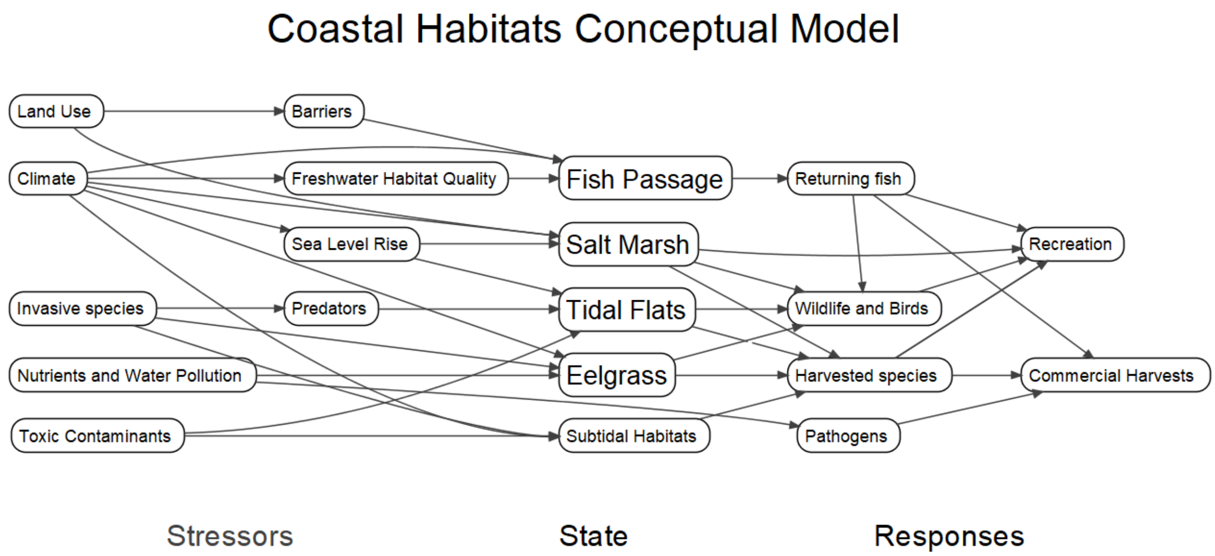


Figure 3: Coastal Habitats Conceptual Model

The Habitats conceptual model was anchored on the following four focal points:

- Fish Passage;
- Salt Marsh;
- Tidal Flats;
- Eelgrass.

These focal points represent three habitat types and a habitat-related issue (fish passage) that have long been areas of concern for the Estuary Partnership and are explicitly called out in the *Casco Bay Plan 2016-2021*. As the Conceptual Model evolved, the Monitoring Network as a group noted concern about other habitats, including areas of importance to local fisheries like rock ledges, rockweed, and kelp. While these habitats receive little monitoring effort in Casco Bay today, we did not want them to go unrepresented. We have represented them in the model as "Subtidal Habitats." These categories are a reminder that data on less-studied habitats may be important for understanding ecosystem change.

While land use change, road construction, and similar human activities directly threaten some tidal marshes, climate change, sea level rise, poor water quality and invasive species threaten either the extent or the health of all coastal habitats, including those not explicitly identified here.

Responses to changes in habitat include impact on fish populations, fisheries, wildlife, recreation, and water quality.

1. Habitats Stressors

Guiding Questions

How are human activities affecting the health or extent of coastal ecosystems?

How is climate change affecting the health of coastal habitats?

Are sea levels changing in Casco Bay?

How prevalent are invasive species in Casco Bay and how are they affecting the health or extent of coastal ecosystems?

Are toxic chemicals present in Casco Bay at levels of concern?

Centuries of human impacts have compromised the ability of many coastal habitats to sustain functions essential to long-term ecosystem health. Dams and undersized culverts have degraded tidal wetlands and hindered migration of diadromous fish like smelt and alewives. Shellfish dragging and marine moorings have scarred eelgrass beds.

Toxic chemicals from industrial facilities, roadways, and urban lands have deposited contaminants like PCBs (polychlorinated biphenyls), pesticides, and heavy metals into sediments. Toxic contaminants are represented here as a stressor that degrades habitat quality, especially in soft bottom intertidal and subtidal habitats. They are also incorporated in the Food Web Priority Topic as a stressor that affects health of marine organisms and has the potential to biomagnify within marine ecosystems.

Climate change impacts including warming temperatures and increasing precipitation have altered distribution patterns of aquatic species, changed salinity distributions in nearshore waters, and fostered the intrusion of invasives. Rising seas may have already affected rates of shoreline erosion and reduced resilience of tidal marshes. Future rising sea levels may reduce the harvestable area of tidal flats, inundate tidal marshes, and submerge eelgrass beds too deeply for them to persist. Where upslope migration is impossible, area of these habitats may be substantially reduced.

Invasive species are pervasive in Casco Bay's marine environment. Invasives like green crabs have disrupted clam flats and eelgrass beds. Invasives are widespread in intertidal habitats like tidal flats and rocky shores. Certain invasive encrusting organisms like *Didemnum vexillum* (an invasive ascidian) can dominate benthic habitats.

Related State of the Bay Indicators

Habitats Stressors are reported on in the following 2020 State of Casco Bay Report Indicators:

- Invasive Species;
- Bay Water Quality;
- Toxics;
- Coastal Habitats.

Data Sources and Monitoring Programs

Table 4: Data Sources for monitoring stressors affecting health or extent of coastal habitats. Local monitoring efforts are in italics.

Habitats Stressors	Data Source or Monitoring Program	Comments
Land use	See land use data sources described under Nutrients and Water Quality	
Climate	See data sources on climate change identified under Nutrients and Water Quality	
Sea Level Rise	NOAA Portland Tide Gage	
Marine invasives, Casco Bay islands	Wells National Estuarine Research Reserve, Marine Invaders Monitoring & Information Collaborative (MIMIC) (C-34)	Volunteer-based monitoring program looking for common invasives.
Marine invasives, New England Rapid Assessment Survey (RAS)	Massachusetts Institute of Technology (W-B.3.d.,e.) Massachusetts Office of Coastal Zone Management, (W-B.3.f.,g.)	Periodic surveys by professional biologists looking for invasives, including cryptic or difficult to identify species.
Toxics in sediments	U.S. Environmental Protection Agency, National Coastal Condition Assessment	Limited locations in Casco Bay; probability-based sampling.

Additional Data or Reports

- *Julie N* oil spill - Industrial Economics, Inc. (W-A.1.j.)
- Predators in clam flats - University of Maine-Machias (W-B.1.b.,c.,d.)
- Barriers, Kennebec - Kennebec Estuary Land Trust (W-B.2.e.)
- Diadromous fish surveys, Presumpscot River - Normandeau Associates (W-B.2.f.)
- Stream crossings water quality and flow - Presumpscot River Watershed Coalition (W-B.2.h.)
- Road and stream crossings - Maine Coastal Program, Maine Stream Habitat Viewer
- Aquatic connectivity - U.S. Fish and Wildlife Service Gulf of Maine Coastal program, Stream-Smart
- Tidal restrictions - Maine Coastal Program, Tidal Restriction Atlas (available in fall 2020)
- Damage to eelgrass beds - U.S. Geological Survey (W-B.3.j.)
- Sea Level Rise in wetlands - Casco Bay Estuary Partnership (W-B.4.a.,b.,c.,d.,e.,f.,g.,h., i.,j.,k.)
- Sea Level Affecting Marshes Model (SLAMM) - Casco Bay Estuary Partnership, Warren Pinnacle
- Toxic pollution, Casco Bay - Casco Bay Estuary Partnership (W-B.5.b.)
- Toxics in sediments - Friends of Casco Bay (W-B.5.c.)
- Toxics in sediments - Casco Bay Estuary Partnership (C-5); and Geochemical and Environmental Research Group (W-B.5.d.,e.,f.,g.,h.); and Ramboll Environ (W-B.5.m)
- Toxics in sediments, Portland Harbor Dredge sites - City of Portland/Portland Harbor Commission
- Toxics in sediments, Pesticides - Maine Board of Pesticides Control (W-B.5.j.,k.)
- Tidal restrictions - Conservation Law Foundation, Return the Tides (W-B.6.e.)
- Tidal culverts - Maine Department of Transportation

2. Habitats Status

Guiding Questions

Are key coastal habitats changing in size or health status?

How is sea level rise affecting extent and health of Casco Bay intertidal and shallow subtidal habitats?

What proportion of the Casco Bay watershed is in permanently protected conservation status?

What proportion of high value watershed lands (buffers, shorelines, migration corridors, etc.) are permanently protected by land protection or policy?

Priority habitats including salt marshes, tidal flats, eelgrass beds, and connected waterways are facing challenges, with both extent and health of these habitat types under threat, from multiple stressors.

Tidal marshes provide important habitats for highly visible species like waterfowl and wading birds, as well as essential habitat for salt marsh sparrows and other marsh-dependent species. Tidal marshes have among the highest primary productivity of any ecosystem in Maine. They sequester atmospheric carbon in organic-rich sediments, reducing excess atmospheric CO_2. Tidal marsh productivity also supports coastal ecosystems by harboring juvenile fish, protecting water quality and subsidizing nearshore food webs. Tidal marshes are at risk because of direct disturbance, hydrological alteration (often due to roads or railroads crossing the marsh), declining water quality, and destruction of adjacent forests and other habitats. Tidal marshes in southern New England are already showing signs of stress due to rising seas.

Tidal flats support the softshell clam, quahog, and bloodworm fisheries, and provide important habitat for wading birds, from little "peeps" (small sandpipers) to large waders. Tidal flats are plagued by invasive species such as green crab and milky ribbon worm. Some flats show acidic conditions that reduce settlement of shellfish larvae and can even cause shells of young shellfish to erode. Sea level rise may drown intertidal flats, reducing harvest ability and shifting species composition.

Eelgrass is a valuable and vulnerable resource. As a habitat, it provides food for migratory winter waterfowl and serves as nursery habitat for fish and shellfish. It helps sustain water quality by stabilizing sediments and filtering nutrients and suspended particles. Eelgrass is threatened by poor water quality, especially elevated nutrients or poor water clarity and can also be lost or damaged by physical disruption, due either to human activity (moorings, dredging) or invasive species (green crabs).

Connected waterways directly support migratory fish, such as eels, smelt and alewives, but they also support dozens of terrestrial and marine species, from cod to bald eagles, that feed upon the migrating fish. They form an essential connection between marine ecosystems and inland streams, lakes, and rivers. Fish migrating from the Bay to upstream habitats face a gauntlet of passage barriers, like culverts, dams, rock ledges, and beaver dams.

Related State of the Bay Indicators

Habitats Status is reported on in the following 2020 State of Casco Bay Report Indicators:

- Aquatic Connectivity;
- Eelgrass;
- Conserved Lands;
- Coastal Habitats.

Data Sources and Monitoring Programs

Table 5: Data Sources for monitoring status (health and extent) of coastal habitats. Local monitoring efforts are in italics.

Habitats Status	Data Source or Monitoring Program	Comments
Wetlands	U.S. Fish and Wildlife Service, National Wetlands Inventory	Infrequent updates, low resolution (¼ acre). Not designed for tracking of local trends.
Salt marshes	Casco Bay Estuary Partnership (C-3) (W-B.6.b.,c.,d.)	Habitat and stream channel assessments, principally of actual or potential habitat restoration sites.
Tidal wetland elevation and sedimentation	Maine DMR, Maine Coastal Program, rSET tables	Only one marsh in Casco Bay.
Eelgrass extent	Maine DEP (C-6) (W-B.3.a.,b.,c.)	Interpretation of aerial photographs.
Eelgrass health	Maine DEP (C-6) (W-B.3.a.,b.,c.)	Permanent diver transects at three study sites.
Seafloor and ocean	Maine DMR, Maine Coastal Mapping Initiative (C-13)	Includes benthic epifauna and infauna data, also monitored certain invasives.
Conserved lands	Maine Department of Agriculture, Conservation, and Forestry, Natural Areas Program, Maine Conserved Lands Data	Updated frequently, but not designed principally to track changes in total conserved land over time.

Additional Data or Reports

- Habitats - Maine Department of Agriculture, Conservation and Forestry, Maine Natural Areas Program, Beginning with Habitat
- Conserved lands - U.S. Fish and Wildlife Service
- Eelgrass at Merepoint - MER Assessment Corporation (W-B.3.h.)
- Fringing Salt Marshes - University of New England (W-B.6.g.,h.); and Wells National Estuarine Research Reserve (W-B.6.j.)
- Wetlands, "Blue Carbon" studies - Bates College

3. Habitats Responses

Guiding Questions

Are impacts to habitats affecting populations of selected species of interest, such as species at risk, harvested species, migratory species, or indicator species?

Are habitat changes affecting fisheries and harvests?

How are conservation and management choices (restoration, enhancement, protection) affecting the health or extent of aquatic ecosystems?

The effects of changes in Casco Bay coastal habitats may be reflected in declines in abundance and health of species. Historically, local data collection has focused on a small number of indicator species, including shorebirds, ospreys, salt marsh birds, horseshoe crabs, alewives, and rainbow smelt. However, few programs have persisted. An alternative approach is to rely on fisheries-related data to understand changes in Bay ecosystems. These programs are likely to continue in the long term but provide data on a narrow group of species.

Related State of the Bay Indicators

Habitats Responses are reported on in the following 2020 State of Casco Bay Report Indicators:

- Aquatic Connectivity;
- Coastal Habitats.

Data Sources and Monitoring Programs

Table 6: Data Sources for monitoring responses to changes in coastal habitat health or extent. Local monitoring efforts are in italics.

Habitats Responses	Data Source or Monitoring Program	Comments
Alewives, Highland Lake	University of Southern Maine Department of Environmental Science and Policy (C-33)	Volunteer-based fish count.
Alewives, Presumpscot River	Gulf of Maine Research Institute, CBASS, River alewife sampling (C-19)	
Diadromous Fish, Presumpscot River	Maine DMR, Cumberland Mills Dam	Fish count data collected by Sappi paper mill.
Salt marsh birds	University of Maine, Saltmarsh Habitat and Avian Research Program (SHARP)	Regional data collection throughout the Northeastern U.S., following standard protocols. No recent data from Casco Bay.
Marine fish communities	Maine DMR, Annual trawl surveys	See discussion under Food Web.
Marine harvests	Maine DMR, Annual catch reporting	Many catch statistics are not available at Casco Bay- relevant spatial scales. See discussion under Food Web.

Additional Data or Reports

- Rainbow smelt monitoring - Maine Department of Marine Resources (C-14)
- Rainbow smelt presence/absence - Maine Department of Marine Resources (C-15)
- Salter brook trout - Trout Unlimited

4. Strengths and Drawbacks of Habitats Monitoring

Strengths or Opportunities

- After a significant gap following 2001-2002 eelgrass mapping, eelgrass in Casco Bay was mapped in both 2013 and 2018. DEP's recent efforts to track eelgrass condition at selected sites by collecting detailed data several times a year are providing deeper insight into interacting processes affecting eelgrass in the Bay.
- CBEP monitoring of restored tidal wetlands provides a strong methodological foundation for tracking hydrologic and ecosystem change. Future efforts could emphasize long-term change at sentinel sites rather than tracking restoration.
- The Integrated Sentinel Monitoring Network has led efforts to define sentinel monitoring needs and methods.
- There is great interest in tracking the conditions of coastal habitats, and in particular, the species that use them, both on the part of state agencies and the public. Habitat monitoring priorities overlap with resource agency plans and programs, such as the Maine State Wildlife Action Plan.

Drawbacks or Vulnerabilities

- State agency capacity to monitor Maine's coastal habitats and associated species is low, particularly relative to the length of its coastline.
- The state of Maine has no mechanism for funding or conducting regular updates to maps of coastal and marine habitats. Some habitats, like wetlands, are tracked by a national program, but data are not optimized for trend analysis and smaller spatial scales. Little mapping of subtidal habitats (except for eelgrass) occurs.
- No structure is in place for monitoring changes in health of key coastal habitats in Casco Bay. Few long-term monitoring sites have been established in Casco Bay, and the institutional and funding structures to ensure long-term data collection have not yet been established.
- High resolution monitoring of sea level rise and sediment deposition using modern state-of-the-art rod sediment elevation tables (rSETs) is currently occurring at only one field site in Casco Bay.
- Maine Department of Environmental Protection collects limited data on anthropogenic toxics, including emerging contaminants such as endocrine disrupters and PFAS (perfluoroalkyl and polyfluoroalkyl substances), however, resources are limited, and long-term trends are difficult to discern.
- No program is currently monitoring salt marsh sparrows in Casco Bay tidal wetlands.
- Private ownership extends to mean low water along Maine's coast, which complicates monitoring in intertidal habitats.

- No reliable data exists on presence of remnant dams (or other fish passage barriers except culverts) in Casco Bay tributaries.

C. Food Web

"Is the food web of Casco Bay changing and does it support marine biodiversity, food production and key ecosystem services?"

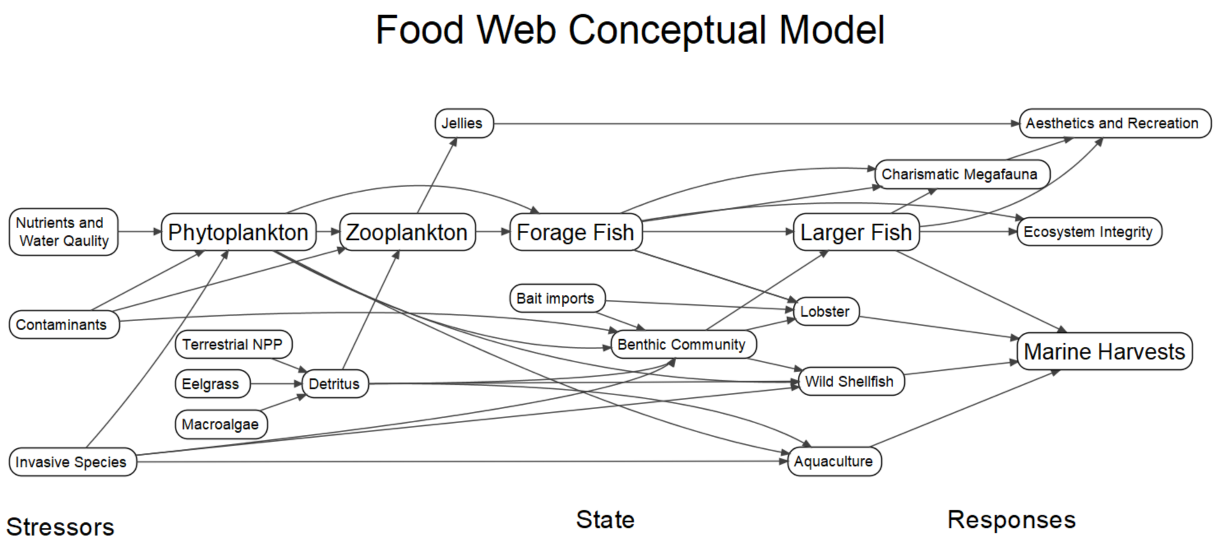


Figure 4: Food Web Conceptual Model

The food web underlies the ability of a clean and productive Bay to produce seafood and support charismatic megafauna like seals, osprey, and shorebirds. Thus the "food web," in loose terms, relates directly to public perceptions of the health of the Bay.

This conceptual model was built out from four major categories of a pelagic marine food web: phytoplankton to zooplankton to forage fish to larger fish. We extended the conceptual model principally to add significant components of the food web, and to reflect public interest in the food web, which focuses on marine harvests and watchable wildlife. Contaminants are incorporated here principally because of their effect on living organisms in the Bay, and widespread appreciation of the potential for biomagnification to exacerbate problems with toxic contaminants at higher trophic levels. Contaminants here complement Toxics in Sediments, which are included under the Habitats Priority Topic.

Nutrient loads and invasive species (each addressed principally in other conceptual models) are incorporated here because of their influence on food web structure and dynamics.

Climate change was not depicted here directly to simplify the graphical model. Climate change will profoundly alter every aspect of the food web, directly or indirectly. It is already incorporated in the water quality and habitat conceptual models, both of which themselves influence the food web. Climate is considered here as a pervasive background process that imposes gradual changes to boundary conditions to which the food web will respond.

A further simplification in this model is that we include marine harvests here solely as a response. We also recognize that harvests have a profound effect on the Bay food web.

1. Food Web Stressors

Guiding Questions

Are water quality challenges affecting the Casco Bay food web?

Are invasive species affecting the Casco Bay food web?

Are changes in climate affecting the Casco Bay food web?

Are stressors cumulatively likely to affect Casco Bay marine harvests?

How are contaminants like persistent toxics, emerging contaminants, or microplastics affecting the health of organisms in the Bay?

The biota in the marine food web is threatened by changes in water temperature, increase in invasive species, declining water quality, and a variety of contaminants. Climate change will lead to range shifts for many marine organisms, including harvested species. Cumulative effects may significantly alter species composition with implications not only for ecosystem health and harvesters, but also for shore-side processing and support industries.

Marine organisms are exposed to a range of contaminants, including persistent toxics, like metals, PCBs and organochlorine pesticides. Less persistent contaminants, like perfluorinated compounds, are found both in the marine environment and in tissue of marine organisms. The role of microplastics in the marine environment is an area of active research, regarding not only their prevalence and distribution, but also their effects. Ingestion of microplastics by zooplankton, a crucial food source for many secondary consumers, may provide a pathway for transfer up trophic levels. Biotoxins derived from harmful algae can affect marine organisms directly, but they are also of high importance for marine harvests because they contaminate shellfish, posing significant public health risks.

Related State of the Bay Indicators

Food Web Stressors are reported on in the following 2020 State of Casco Bay Report Indicators:

- Bay Water Quality;
- Living Resources;
- Swimming Beaches and Shellfish Beds.

Data Sources and Monitoring Programs

Table 7: Data Sources for monitoring stressors that affect the food web or food production in Casco Bay. Local monitoring programs are in italics.

Food Web Stressors	Data Source or Monitoring Program	Comments
Climate change	See discussion of climate change and sea level rise tracking in prior sections	
Water quality	See discussion under Nutrients and Water Quality	
Invasive species	See discussion under Habitats	
Mercury deposition	Maine DEP, Wolfe's Neck Atmospheric Deposition Monitoring Station (W-C.3.f.,h.,n.,o.,s.,t.,u.)	Local data, but part of national air deposition monitoring programs.
Toxics in sediments	U.S. Environmental Protection Agency, National Coastal Condition Assessment	Limited locations in Casco Bay; probability-based sampling.
Toxics in shellfish, soft shell clams, mussels, lobsters	Maine DEP, Surface water ambient toxics (SWAT) (C-10) (W-C.3.j.,k.,l.)	
Toxics in shellfish, mussels	National Oceanic and Atmospheric Administration, Mussel Watch	Infrequent samples from a handful of locations only.
Toxics in shellfish, mussels	Maine DEP, GulfWatch (C-7)	No new samples collected recently. Program was discontinued but future collaboration with NOAA may be possible.
Bacteria in marine waters	Maine DMR (C-11)	Hundreds of locations, mostly in the Eastern Bay. See discussion under Nutrients and water quality.

Additional Data or Reports

- Bacteria in clam flats - Normandeau Associates, Inc. (W-C.1.h.,i.,j.,k.)
- Toxics in osprey eggs - Biodiversity Research Institute (W-C.3.c.,d.,e.)
- Toxics in mussel tissue - Ecosystem Indicator Partnership GulfWatch (W-C.3.g.); and Maine Bureau of Health (W-C.3.i.); and Maine Department of Environmental Protection (W-C.3.m.)
- Human exposure to toxics - Menzie-Cura & Associates (W-C.3.q.)
- Microplastics - Friends of Casco Bay

2. Food Web Status

The primary indicators of food web status are the health, abundance, and distribution of plant and animal life throughout the Bay and the watershed. (Many of these are also "response" indicators in the Habitats conceptual model.) Conceptually, studying the food web involves determining who eats whom. Direct studies of diet of marine organisms are labor intensive and are usually considered beyond the scope of monitoring. Stable isotope methods offer an alternative not previously considered in Casco Bay monitoring plans.

At the bottom of the marine/fish food web are phytoplankton, but also other primary producers like eelgrass and macroalgae, as well as terrestrial net primary production (NPP) inputs (included in the conceptual model via the "detritus" category). Phytoplankton and detritus are consumed principally by zooplankton, shellfish, and small fish. Moving up the food chain, forage fish serve as food for larger fish and megafauna; and are directly harvested by humans (often for bait). Larger fish, in turn, provide harvesting opportunities for humans and food for marine mammals and birds.

The primary method of tracking the status of the Casco Bay food web will be to document the dominant species present in the Bay at different trophic levels. This provides information that informs understanding of how the Bay functions today, and provides baseline information for understanding how the Bay is changing in the face of climate change and other stressors. Traditional biological sampling tends to be labor intensive. It is based on capturing and identifying organisms from the marine environment. That requires boats, specialized gear, time, and trained specialists able to identify marine species.

In recent years, significant advances have been made using environmental DNA (eDNA) and related technologies to document presence, and in some cases, relative abundance of certain species in the coastal environment. The potential exists for eDNA, in the next few years, to provide cost-effective alternatives for monitoring presence, distribution and abundance of marine organisms, from invasive species to commercially important species like cod. Demonstration studies in Casco Bay have already shown the value of eDNA for detecting presence of migratory fish.

Guiding Questions

What are the major components of the Casco Bay food web?

Are the dominant species at different trophic levels in Casco Bay changing?

Are dominant pathways in the Casco Bay food web – who eats whom – changing over time?

How does the Casco Bay food web support species of interest like charismatic species, and harvested marine organisms?

Related State of the Bay Indicators

Food Web Status is reported on in the following 2020 State of Casco Bay Report Indicators:

- Living Resources;
- Swimming Beaches and Shellfish Beds.

Data Sources and Monitoring Programs

Table 8: Data Sources for monitoring status of the Casco Bay food web. Local monitoring programs are in italics.

Food Web Status	Data Source or Monitoring Program	Comments
Biotoxins, Harmful algae blooms (HABs)	Maine DMR, Shellfish Sanitation Program, Biotoxins in shellfish (C-12)	Phytotoxin monitoring program.
Harmful algae blooms	Woods Hole, Casco Bay Red Tide/Paralytic Shellfish Poisoning (PSP) Monitoring Buoys	Not clear whether data are available, nor what the future deployment plans are.
Phytoplankton	Maine DMR	Volunteer phytoplankton monitoring and identification program supporting Biotoxins monitoring.
Chlorophyll-A	Bowdoin College (C-2) Maine DEP (C-9) Friends of Casco Bay (C-16) University of Maine (C-30)	Chlorophyll-A is monitored by several automated sensor systems in Casco Bay, managed by Bowdoin College, DEP, FOCB, and UMaine.
Marine biota	Gulf of Maine Research Institute, CBASS programs: • Acoustic fish survey (C-18) • Beach seine fish survey (C-20) • Jig groundfish survey (C-21) • Zooplankton via Oceanographic survey (C-22) • Trap survey (C-24)	The CBASS program is our only local, targeted program looking at most food web components.
Marine fish communities	Maine DMR	Annual trawl surveys provide regional data on finfish in Maine and New Hampshire. Surveys include data from a small number of locations within Casco Bay. Locations are based on a probability sample each year, prioritizing regional population estimation over detection of trends.
Lobster settlement	University of Maine, Wahle Lab (W-C.1.l.)	Annual survey of abundance of juvenile lobsters in near-shore habitats, including locations in Casco Bay.

Additional Data or Reports

- Horseshoe crab populations - Bar Mills Ecological (W-C.1.a.)
- Horseshoe crab spawning - Bar Mills Ecological (W-C.1.b.,c.,d.)
- Brook floater (freshwater mussel) - biodrawversity LLC (W-C.1.e.)
- Lobsters - MER Assessment Corporation (W-C.1.g.)
- eDNA, rainbow smelt - Wells National Estuarine Research Reserve (W-C.1.m.)
- Osprey nest abundance and reproductive success - Biodiversity Research Institute (W-C.2.a.,b.,c.)
- Shorebirds - Biological Conservation, LLC (W-C.2.d.,e.,f.)
- Terns on Jenny Island - Gulf of Maine Seabird Working Group (W-C.2.g.)
- Common eiders on Flag Island - Maine Department of Inland Fisheries and Wildlife (W-C.2.h.)
- Terns on Outer Green Island - National Audubon (W-C.2.i.,j.)
- Beach seine subtidal species - Southern Maine Community College
- Red Tide/PSP - Battelle (W-C.3.a.,b.); and MER Assessment Corporation (W-C.3.r.)
- Seals - Marine Environmental Research Institute (W-C.3.p.)
- IF&W waterfowl surveys (reported in State of the Bay reports, W-D.2.a.,c.,d.,e.)
- Water Reporter photographs - Friends of Casco Bay

3. Food Web Responses

Guiding Questions

Are Casco Bay marine harvests changing in biomass, value, or composition?

About how many people work as marine harvesters in the largest Casco Bay fisheries?

Is abundance of “watchable wildlife” in the Bay changing?

Do changes in species composition of Casco Bay marine ecosystems suggest declines in ecosystem health, integrity or resilience? Are there other direct measures of ecosystem health and integrity?

Here, we track “Responses” to the marine food web of Casco Bay principally in terms of human benefits. There is a certain symmetry to that, as ability of the Bay to provide a sustainable environment for aesthetics and recreation, resilient ecosystems, and marine harvests is partially dependent on human behavior. Reducing the inflow of nutrients and contaminants to the Bay will resonate through the food chain and produce more robust populations of harvestable species. Equally important, it will result in a coastal marine food web better able to respond to climate change, invasive species, and other stressors while continuing to produce harvestable protein (even if the mix of harvested species may change in coming decades). System resilience will also depend on responsible harvesting in terms of both species composition and total biomass. Additional details on ways of tracking human benefits derived from the Bay are discussed below.

Related State of the Bay Indicators

Food Web Responses are reported on in the following 2020 State of Casco Bay Report Indicator:

- Living Resources.

Data Sources and Monitoring Programs

Table 9: Data Sources for monitoring responses to the condition of the Casco Bay food web. Local data collection programs are in italics.

Food Web Responses	Data Source or Monitoring Program	Comments
Lobster harvests	Maine DMR	
Shellfish harvests	Maine DMR	
Aquaculture harvests	Maine DMR	
Other marine harvests	Maine DMR	DMR tracks information on harvests of finfish species, as well as other marine resources. While value of harvest of other species in 2019 was small compared to lobster or shellfish, they are cumulatively important, and long-term trends may be important to document.
Lobster licenses	Maine DMR	
Softshell clam licenses	Southern Maine Conservation Collaborative, Casco Bay Regional Shellfish Working Group	Numbers collected from municipal governments.
Aquaculture licenses	Maine DMR	

Additional Data or Reports

- Harvests - Island Institute, Waypoints report, 2018

4. Strengths and Drawbacks of Food Web Monitoring

Strengths or Opportunities

- Historic and present-day water quality monitoring in Casco Bay has largely been designed to provide summary information on eutrophication, which is directly tied to system metabolism. Core monitoring infrastructure therefore provides information that can be used as synoptic indicators of net primary production and respiration. The quality and broader utility of these data has only been improved by expansion of efforts to monitor coastal acidification.
- The design of GMRI's Casco Bay Aquatic System Survey (CBASS) program was intended to link food webs to fisheries. If adequately funded and expanded to address other species and other portions of the Bay, it would provide a structured starting place for understanding Casco Bay's marine food web.
- The Maine EPSCOR eDNA program could provide an avenue to expand use of eDNA techniques to characterize presence and abundance of selected marine species in Casco Bay.
- GMRI and Bates College have used stable isotope analysis to characterize nutrient sources in different parts of Casco Bay (See the Nutrients and Water Quality Priority Topic). Stable isotope analyses of selected sentinel species might provide a way to track long-term change in marine food webs.

Drawbacks or Vulnerabilities

- While numerous studies over the years have looked at components of the marine food web in Casco Bay, we are unaware of any effort at systematic data collection to facilitate understanding of ecosystem structure or detect long-term change.
- Estuary and Bay faunal communities haven't been recently characterized to understand how the resident community is changing over time and with proximity to pollution sources.
- While coastal birds have been monitored repeatedly over the past 25 years, methods, and even target species, have changed repeatedly, making long-term comparisons impossible.
- We have uncovered no programs monitoring numbers of marine mammals in Casco Bay that are designed to provide reliable estimates at the Bay or local scale.
- DMR monitoring of HABs is thorough, but narrowly focused. Data provides only limited information about primary producers generally. This data alone cannot document shifts in relative abundance of major groups during seasonal events like the spring phytoplankton bloom.
- Zooplankton data is very rare in Casco Bay.

- Monitoring of fish communities in Casco Bay samples few locations, thus obscuring spatial patterns and variation.
- Benthic communities, both intertidal and subtidal, are not regularly studied, despite their importance for commercial fisheries in the region. Monitoring, itself often opportunistic, tends to focus on harvestable species, not community structure.
- DMR data on fisheries and marine harvests is comprehensive, but data collection and reporting are often not designed for analysis at Casco Bay scale.
- No program in Casco Bay is tracking changing abundance of jellies, including ctenophores, hydromedusae and scyphomedusae.
- Monitoring for persistent contaminants is expensive and has declined in recent years.

D. Human Benefits

"How do humans derive material and cultural benefits from the Bay?"

The Monitoring Plan provides no separate graphical conceptual model of human benefits derived from the Bay, as these benefits are direct outcomes of the health and productivity of the Bay. Thus, the three previous conceptual models provide the analytic structure for understanding how the Bay provides benefits to the people living along its shores and in its watershed. The challenge with developing indicators of human benefit derived from the Bay lies principally in the difficulty of capturing the many different ways that humans receive benefit from living in a coastal area.

Previous CBEP Monitoring Plans made no effort to evaluate human benefits derived from Casco Bay. This plan highlights the need to understand, track, and report on such benefits. This is a new area for Casco Bay monitoring, and one that will continue to evolve as we gain more experience with related metrics.

Human Benefits include both market and non-market values. Thus, metrics describing human benefits derived from the Bay should incorporate both analyses of the Casco Bay economy, and other measures of the importance of the Bay to our communities. Econometric "input-output" tools can readily capture the size of market transactions (price times quantity) and number of jobs supported by Bay-related commercial activities, such as fisheries, boat yards, and marine construction (See CBEP's 2017 Economic Analysis, W-D.1.i.). Such analyses should be complemented with metrics that speak more directly to people's experience of the Bay, and the social, existence, heritage, and aesthetic values that it supports.

Areas of interest include, but are not limited to:

- The coastal economy;
- Commercial fisheries;
- Aquaculture;
- Recreation;
- Property values;
- Heritage values;
- Educational values.

Guiding Questions

How large is Casco Bay's Marine Economy? What are its most important components?

How many people fish, hunt, boat and play on the Bay?

How many people work harvesting the bounty of the Bay?

How many people travel to the Bay's islands seasonally?

How do people learn about and teach about Casco Bay and its watershed?

Related State of the Bay Indicators

Human Benefits are reported on in the following 2020 State of Casco Bay Report Indicators:

- Economics;
- Education;
- Stewardship;
- Climate Preparedness.

Data Sources and Monitoring Programs

The following data sources are not the subject of regular monitoring programs but are used in State of the Bay and Economic Status reporting.

Table 10: Data Sources for information on human benefits

Benefit	Data Source	Comments
Bay economics	USM Maine Center for Business and Economic Research, Economic Modeling Specialists International economic analyses (W-D.1.i.)	Including gross regional product, employment, average earnings, in selected coastal and marine business sectors.
Ocean economy	Middlebury Institute Center for the Blue Economy, National Ocean Economics Program	County estimates of gross regional product, employment, average earnings, in selected coastal and marine business sectors.
Ferry ridership	Casco Bay Lines	CBEP analysis of data.
Casco Bay boat launches	Maine Department of Agriculture, Conservation and Forestry	Includes "official" state boat launches only, not local, commercial, and informal facilities.
Recreational fishing licenses	Maine Department of Inland Fisheries and Wildlife	Allocation to fishing location is not possible.
Marine harvests	Maine DMR	Data currently reported by landing port.
Marine harvesting and aquaculture licenses	Maine DMR	Difficult to assign harvests or landings to specific locations.
Casco Bay marine moorings	Harbormasters	CBEP analysis of data.
Educational programs	Selected educational providers	CBEP analysis of data.
Stewardship activities	Selected organizations	CBEP analysis of data on citizen science, bay cleanup events, etc.

Additional Data or Reports

- Population trends - Maine State Office of Policy and Management
- Economic impact of clam industry - MER Assessment Corporation (W-D.1.e.)
- Economic value of Casco Bay - University of Southern Maine (W-D.1.h.)
- Ocean uses - Northeast Regional Ocean Council, Northeast Ocean Data Portal
- Economic impact of tourism - Maine Office of Tourism Partners
- State of the Bay - Casco Bay Estuary Partnership (W-D.2.a.,b.,c.,d.,e.)
- State of the Bay - Friends of Casco Bay (W-D.2.f.)
- State of the Gulf of Maine - Gulf of Maine Council on the Marine Environment (W-D.2.g.)

2. Strengths and Drawbacks of Data Sources for Human Benefits

Strengths or Opportunities

- The 2017 econometric analysis of Casco Bay economy has shown tracking of the economic importance of the Bay can be conducted cost-effectively based on available data and following standard protocols.

Drawbacks or Vulnerabilities

- We need continued identification and development of solid, cost-effective Human Benefits metrics.
- Many fisheries statistics are not readily available at Casco Bay scale.
- Human Benefits metrics outside those directly tracked for fisheries regulation are difficult and expensive to gather or access.

Section IV. RECOMMENDATIONS FOR MONITORING PRIORITIES 2020-25

A. Programmatic recommendations - in order of priority rankings by Monitoring Network

1. The Casco Bay Monitoring Network provides the core adaptive management structure for ongoing monitoring of Casco Bay. The Monitoring Network will meet regularly to share data; and to discuss our understanding of the Bay, evolving monitoring needs, developing technologies, and collaborative opportunities.
2. The Casco Bay Monitoring Network needs to strengthen both formal and informal connections with Casco Bay monitoring programs and other local and regional monitoring efforts. Possible linkages include the following:
    a. Blue Portland;
    b. One Climate Future;
    c. Maine Climate Council;
    d. MOCA;

e. NECAN;
f. NERACOOS;
g. Northeast Integrated Sentinel Monitoring Network.

Coordination can align Casco Bay monitoring with priorities these other groups identify, and leverage outside resources to address (ideally, fund) Casco Bay monitoring needs.

3. Stable and adequate funding is essential for sustained monitoring. The Monitoring Network should work together to identify and advocate for long-term funding mechanisms.
4. The Monitoring Network and CBEP staff should facilitate sharing of data among Monitoring Network participants. This includes encouraging state agencies to make their data more readily available.
5. CBEP and partners need to continue to reach out to groups involved with or beginning to get involved with monitoring, including monitoring of fresh water, and invite their participation in the Monitoring Network.
6. Geographic Priorities - monitoring should emphasize collection of data in and around specific focus areas, including Eastern Bay.

B. Programs to continue on current basis

These programs form the core of Casco Bay monitoring. Their current structure addresses Casco Bay needs well. Loss of these programs would leave a significant hole in our ability to track conditions in Casco Bay. While programs can always continue to improve, these programs are already an essential long-term part of Casco Bay monitoring.

1. Nutrients and Water Quality

    C-1. Bowdoin College acidification

    C-2. Bowdoin College buoy

    C-6. DEP eelgrass monitoring

    C-8. DEP Maine Healthy Beaches

    C-9. DEP marine water quality monitoring

    C-17. FOCB Bay water quality and nutrients, seasonal monitoring

    Lake Stewards of Maine lakes water quality monitoring

    C-25. LEA lakes and ponds water quality monitoring

    C-26. Long Creek WMD stream monitoring

    C-27. PWD Sebago Lake water quality monitoring

    C-28. PWD Sebago Lake tributaries monitoring

    DEP biomonitoring of streams and rivers

2. Habitats

    C-6. DEP Eelgrass

C-13. DMR Maine Coastal Mapping Initiative

C-33. USM Alewives in Highland Lake

C-34. Wells National Estuarine Research Reserve “MIMIC” marine invasive species monitoring

3. Food Web

C-10. DEP Surface Water Ambient Toxics

C-11. DMR bacteria in marine waters

C-12. DMR biotoxins in shellfish and phytoplankton monitoring

DMR fisheries landings and licenses

DMR trawl survey

C. Program to discontinue

1. UNH ocean acidification (superseded by expanded FOCB ocean acidification monitoring); C-32.

D. Programs to expand - in order of priority rankings by Monitoring Network

These are monitoring programs that are an important part of Casco Bay monitoring, and for which the Monitoring Network has identified value in expanding or refining the existing programs. The Monitoring Network should provide support for expansion of these programs.

1. PRLT Presumpscot and Stroudwater River freshwater monitoring - add nitrogen; C-29.
2. GMRI CBASS - clarify priority components for long-term, expand locations as funding is available; C-18, 19, 20, 21, 22, 23, 24.
3. FOCB Bay water quality and acidification, continuous monitoring - add stations in Portland Harbor and Eastern Bay; C-16.
4. Marsh monitoring – incorporate sentinel monitoring sites, which should be the same as DMR rSET sites; C-3.
5. DMR phytoplankton – expand monitoring to track additional species and locations.
6. DMR rSETS - add sites; integrate with vegetation, hydrologic, and other sentinel monitoring.

These are programs with the potential to fill important data gaps, but for which we have not identified stable funding sources. The Monitoring Network should advocate for funding.

1. DEP eelgrass aerial surveys - expand.
2. University of Maine LOBO buoy continuous monitoring - continue; C-30.
3. New England marine invasive species Rapid Assessment Survey: survey is conducted every three to four years; CBEP has provided partial funding for almost a decade - continue to fund.
4. DEP GulfWatch program - restore consistency of sampling; C-7.

5. Inshore continuous nitrogen monitoring (CBEP NuLAB or similar) - re-activate; C-4.

E. Programs to consider - in order of priority rankings by Monitoring Network

These are programs that could provide data of high value but for which existing efforts are absent or lacking. The Monitoring Network should consider how to initiate these programs.

1. Monitor nutrients in freshwater and delivery of nutrients to coastal waters via rivers and streams.
2. Establish sentinel monitoring of selected coastal and nearshore habitats to track impacts of climate change; for example, include species that might not typically be monitored.
3. Monitor impacts of aquaculture operations on water quality, flora, and fauna.
4. Track marine habitat extent and condition.
5. Develop a Casco Bay circulation model to provide context for interpretation of monitoring data.
6. Use eDNA to track presence / abundance / location of selected aquatic species like anadromous fishes or invasive species.
7. Collect high resolution impervious cover data on a regular schedule.
8. Monitor sediment nutrient fluxes.
9. Establish methods for tracking number, location and condition of septic tanks, especially in shoreline areas.
10. Supplement existing acidification monitoring by adding: (a) additional locations; and (b) additional parameters.
11. Establish a microplastics monitoring effort.
12. Establish freshwater monitoring of harmful algae blooms (HABs).
13. Use stable isotopes in indicator species to enhance understanding of trophic relationships in the Bay.

F. Cost estimates for addressing data gaps

Develop circulation model including loading of nutrients to Casco Bay

The goal to develop a modern circulation model for Casco Bay was identified in Casco Bay Estuary Partnership's (CBEP) 2016 Casco Bay Plan, yet we have made only limited progress, as the level of funding necessary to accomplish this goal is substantial. CBEP staff have worked with partners, including Portland Water District and University of Maine, in an effort to raise funds to address this need.

Estimated cost – $125,000 to $250,000

Monitor nutrients in fresh water

Robust estimates of costs of freshwater monitoring are not yet available, as we do not have the data to determine sampling frequency to address management needs. It is not clear whether monitoring can be conducted with volunteers, or whether high frequency monitoring using automated equipment will be needed.

Estimated Cost – Pilot Study: $15,000 to $25,000. Annual Monitoring: $20,000 if managed with volunteers. $50,000 to $100,000 if using contractors or high frequency monitoring equipment.

Track food web components

Gulf of Maine Research Institute's (GMRI) CBASS is a program that tracks zooplankton, planktivorous fish, pelagic fish, groundfish, and anadromous fish (both entering and leaving the Presumpscot River system). It is the only program in Casco Bay currently looking at multiple components of the Casco Bay food web. It complements several general monitoring programs conducted by Maine's Department of Marine Resources.

The program is currently funded at a scaled-back level by GMRI via a National Science Foundation (NSF) EPSCOR grant that focuses on use of eDNA for monitoring coastal conditions. The current focus is on tracking anadromous and inshore fish populations. The EPSCOR grant has an expected five-year duration. At the end of that grant, CBASS would be unfunded.

Estimated Cost – $50,000 to $150,000 annually, depending on design.

Extend eelgrass monitoring

DEP managed collection of eelgrass data in Casco Bay based on aerial photography in 2013 and 2018. The goal for our region is collection of eelgrass data bay-wide approximately every five years. DEP has no long-term funding for eelgrass monitoring, and had to assemble resources from multiple partners, including CBEP, in both 2013 and 2018. Legislation has been introduced in the Maine State Legislature in both the last legislative session and this year (2021) to provide funding for a state-wide eelgrass monitoring program.

Estimated cost – $125,000 to $200,000 every five years for Casco Bay alone. A state-wide program is estimated to cost $250,000 or more annually for a combination of staff time and contracting costs.

Conduct sentinel monitoring of marine habitats to track climate change

CBEP conducts monitoring of coastal habitat, especially salt marshes today. The monitoring program, however, is designed principally to trace short-term changes following restoration, not long-term change in response to climate change and sea level rise. Maine's Coastal Program has established one tidal marsh monitoring site, equipped with an rSET, in Casco Bay.

Estimated Cost – Developing new monitoring protocols: $10,000 to $20,000. Increased cost of annual monitoring: $10,000 to $15,000, if conducted by CBEP staff, principally for seasonal field staff and consumables. Cost if contractors conduct the monitoring: $50,000 annually.

APPENDIX E: FINANCE PLAN AND UPDATE

Casco Bay Finance Plan Update

Plan Adopted October 15, 2020; Update 2024

Introduction

The Casco Bay Finance Plan ("Plan") was adopted by our Management Committee in March of 2022. EPA Region 1 reviewed it the same year and accepted provisionally as support for development of the complete CCMP in 2023 and 2024.

This document provides an update on priorities in the existing Finance Plan and identifies emerging priorities based on changes in the funding landscape and discussions held during the process of updating *The Casco Bay Plan*, our primary CCMP document.

The structure of our approved Finance Plan was built on top of the version of *The Casco Bay Plan* that was in place at the time it was drafted. The structure of the Plan was tied, in part, to the four Goals and twelve Strategies outlined in that version of our CCMP. Our updated (draft) CCMP, prepared in 2023, includes four very similar goals, and fourteen Strategies, most of which are directly related to strategies in the older CCMP.

This update focuses on the top-level priorities identified in the Plan, which are tied to overall programmatic needs or to one of the four primary Goals identified in the Casco Bay Plan which (while reworded slightly) are largely unchanged. Because overall programmatic needs have not changed, and our top four Goals have only been lightly modified, we do not address other structural changes in our CCMP in detail here. Each Action in our core CCMP includes a discussion of the resources needed to complete the Action.

STATUS OF 2022 PLAN RECOMMENDATIONS

Status of Programmatic Recommendations (from Plan Executive Summary)

The Plan was developed while our management Committee was discussing how we would use short-term increases in funds from the Bipartisan Infrastructure Law (BIL). That was reflected in the funding priorities identified in the Plan and reviewed here.

Fund CBEP staff capacity

Availability of BIL funds offers a short-term opportunity to increase CBEP staff capacity. Other federal funding, available through BIL and other short-term appropriations may offer additional opportunity in months to come. Reliance on BIL and other short-term federal funding to support staff, however, will create problems down the road, when those funding sources dry up. Longer term, we face challenges identifying long-term funding streams to support staff capacity.

Increase Habitat Protection Fund (HPF) grant program funding.

BIL funds have allowed us to increase HPF funding to $100,00 a year for the next several years.

Expand CBEP capacity to “cue up” habitat restoration and community resilience projects by hiring an additional staff member

Funding for staff able to assist with local project development has been included in recent BIL funding requests. One position, a joint position with Maine Sea Grant with responsibilities regarding climate resilience for coastal communities, has been filled. The University of Southern Maine, our Fiscal Host, has given approval for us to initiate searches for other staff.

Engage temporary staff or a contractor to develop an operational hydrodynamic model for Casco Bay and to document the status of septic tanks in the region

CBEP tapped BIL funds to fund development of a hydrodynamic model by NERACOOS and University of Massachusetts-Dartmouth. A search for a Staff Scientist who will oversee further development of the model (among other duties) is underway.

Designate funds for assisting local partners, especially municipalities, in accessing state and federal funds to address stormwater, water quality and climate resilience needs.

Provide funds to enhance regional monitoring capabilities, under the guidance of the Monitoring Network.

Several new grant programs have been funded using BIL funds. We anticipate releasing a consolidated RFP for the new grant programs in October, with the goal of awarding new grants before the end of the year.

Fund development of formal watershed plans to facilitate access to federal funding for watershed protection.

We are tapping BIL funds to support a review of watershed planning priorities by the Cumberland County Soil and Water Conservation District, with the intent that additional funds will be available in future years to fund Plan development.

Grow the Community Grants program and add a citizen science component.

As we moved some grant programs off our Core EPA funding and onto BIL funds, we have been able to increase funding for the Community Grants Program. Our updated CCMP anticipates increased support for Community Science, both via grants and staff technical assistance.

Status of Goal 1 Recommendations

(Language from the Updated Casco Bay Plan: Protect, restore and enhance the key habitats that sustain ecosystem health of Casco Bay and its watershed for now and the future)

The Plan highlighted the need for staff capacity to develop habitat protection, restoration and resilience projects. We have since allocated BIL funds for that purpose. The Plan also called for cooperative fund-raising with Partners around regional habitat priorities. Multiple conversations are underway about regional initiatives that could support not only project implementation, but also project planning, permitting and design.

Status of Goal 2 Recommendations

(Language from the Updated Casco Bay Plan: Address the cumulative water quality impacts of human activity in the Casco Bay Watershed)

Recommendations for Goal 2 highlighted the need to develop a hydrodynamic model of Casco Bay, hire a Staff Scientist and seek external funds from grants to strengthen the modelling effort. We are funding model development and the Staff Scientist using BIL funds. We brought in a nearly $50,000 grant from the National Science Foundation to identify modelling needs and priorities.

Status of Goal 3 Recommendations

(Language from the Updated Casco Bay Plan: Engage communities and provide information and tools to support decisions to protect and restore Casco Bay)

The Plan recommended we fund new staff to strengthen CBEP's ability to provide technical support to municipalities, especially smaller towns.

- We have funded a new, Joint position with Maine Sea Grant, to specialize in coastal resilience.
- We are in discussion with the Greater Portland Council of Governments (GPCOG) about the possibility of hiring a shared environmental or water planner to deliver services to municipalities, thus reducing costs to CBEP and improving coordination with GPCOG.
- We will soon be hiring a Community Engagement Specialist to assist with our outreach efforts, especially efforts to connect with new audiences.

Funding for community grants has more than doubled, and the community science program has been incorporated into our updated CCMP.

We have been able to raise significant funds through two grants from the Governor's Office of Policy Innovation and the Future (GOPIF) to assist communities with climate vulnerability assessment and resilience planning.

Status of Goal 4 Recommendations

(Language from the Updated Casco Bay Plan: Mobilize knowledge and resources to support regional collaboration on behalf of Casco Bay, the watershed, and our communities)

The Plan highlighted the need to ensure ongoing support for core Monitoring Partners, and the importance of capacity (in the form of a Staff Scientist) to staff the Casco Bay Monitoring Network. We continue to provide partial support for key monitoring programs and will roll out a new Monitoring Infrastructure Grants Program this fall to assist with developing new monitoring programs or expanding existing efforts. A search for the Staff Scientist is underway.

Recent CBEP Grant Successes

- **Cutler Institute Administrative Support**: 5% of Director Bohlen's time is now covered by the University in order to cover time spent on University and Cutler Institute leadership.
- **Coastal Watersheds Grant:** $224,975. In Partnership with the New England Environmental Finance Center, we are testing the feasibility of using aquaculture to remediate elevated nutrient levels in waters near Portland's East End Wastewater Treatment Facility.
- **Governor's Office of Policy Innovation and the Future (GOPIF)**: $62,000. In Partnership with the New England Environmental Finance Center, we acted as local technical service providers assisting municipalities with climate resilience planning.
- **Governor's Office of Policy Innovation and the Future (GOPIF)**: $15,000. In Partnership with the New England Environmental Finance Center, we led a regional pilot project on working with communities to assess climate vulnerabilities.
- **National Science Foundation Civic Innovation Challenge Grant**: $46,862. We developed a regional collaboration and held workshops to better understand how members of the Portland Harbor community might make use of hydrodynamic information from the Casco Bay Coastal Ocean Model.

Finance Prioritization 2024

Availability of BIL funds has dramatically changed the funding landscape for the time being, as was anticipated when the 2022 Finance Plan was drafted. BIL funds will, however, dry up in just a few years. That creates a significant "funding cliff" in 2027 or 2028, near the end of the current five-year planning horizon.

The top finance priority for the next few years, therefore, is to develop alternative sources of funding that can lessen the impact of that fiscal cliff on CBEP programs and staff. There are serious structural challenges to building stable local funding sufficient to make up for the loss of both BIL funding for the NEPs and the more or less simultaneous decline in federal funds for project implementation. (Those structural challenges are discussed in more detail in the full 2022 Finance Plan).

CBEP is likely to need to develop a new business model to reliably bring in funds from contracts and grants to address future need. In the interim, this will require increased allocation of staff time for fundraising, especially for development of grants and contracts. It will also require initiating discussions with the Management Committee and other Partners about finding new ways to support CBEP, preferably without cutting into the fundraising opportunities of our most important Partners.

Finance Plan

March 23, 2022

Executive Summary

The Casco Bay Estuary Partnership (CBEP) Finance Plan provides a framework for strategic thinking to ensure the long-term financial viability of implementation of key elements of the *Casco Bay Plan*, CBEP's Comprehensive Conservation and Management Plan (CCMP).

The Finance Plan (Plan) focuses on three interrelated financial issues to be considered for long-term success implementing the *Casco Bay Plan*:

1. Funding of CBEP operations (core staff, CCMP Updates, State of the Bay reporting, long-term monitoring partnerships, etc.);
2. Funding for implementation of the CCMP, including funds used by municipalities, conservation organizations and other Partners;
3. Generation of adequate "non-federal match" to enable continued access to NEP funds that require a minimum 1:1 non-federal match.

The document is organized around the twelve core "Strategies" of the *Casco Bay Plan*. For each Strategy, the document provides an overview of emerging funding needs and funding sources. Information on how CBEP has funded work under each Strategy over the past 15 years is reviewed in Appendix A.

We evaluated priorities and prospects for raising funds for CBEP's work and implementation of the *Casco Bay Plan* from multiple sources, including:

- "Core" National Estuary Program funding;
- New funding to the National Estuary Programs provided under the "Infrastructure Investment and Jobs Act" (IIJA), also known as the "Bipartisan Infrastructure Law" (BIL);
- Other funding though EPA and the National Estuary Program, especially Coastal Watersheds Grants;
- Other federal and state grants, including anticipated funds provided to federal agencies under the IIJA;
- Foundations and philanthropic funders;
- Fee-for-service models such as contracts, fee for service, public-private partnerships or conference fees.

CBEP's "core" EPA funding has grown over the years, but when adjusted for inflation, the purchasing power of core NEP funding has remained essentially flat for two decades. A majority of CBEP's "core" funding covers personnel costs that enable the staff to manage the NEP, implement the CCMP, and fulfill our role as a convenor and source of trusted information about the Bay. Much of the rest goes towards long term monitoring and Habitat Protection Fund grants. Without diversifying funding sources, the "core" budget is tight.

Funding under the IIJA provides room over the next few years for new initiatives. That funding, however, is limited in duration, so a key need is to use IIJA funds to raise additional funds (both for CBEP and for CCMP implementation) and to establish programs that can persist without ongoing support through the NEP.

Many activities identified under the *Casco Bay Plan* are implemented principally by CBEP Partners. The Finance Plan considers both direct funding for CBEP activities and broader funding needed to address CCMP priorities. The Plan identifies several areas where CBEP funds or staff capacity could be leveraged to raise funds for CCMP implementation by strengthening collaboration with Partners. Several of these areas emerge as priorities for the use of IIJA funds.

The Finance Plan includes a Recommendations section for each Goal, many of which address long-term needs. The following eight recommendations represent current priorities:

(1) Fund CBEP staff capacity.
(2) Increase Habitat Protection Fund grant program funding.
(3) Expand CBEP capacity to "cue up" habitat restoration and community resilience projects by hiring an additional staff member.
(4) Engage temporary staff or a contractor to develop an operational hydrodynamic model for Casco Bay and to document the status of septic tanks in the region.
(5) Designate funds for assisting local partners, especially municipalities, in accessing state and federal funds to address stormwater, water quality and climate resilience needs.
(6) Fund development of formal watershed plans to facilitate access to federal funding for watershed protection.
(7) Grow the Community Grants program and add a citizen science component.
(8) Provide funds to enhance regional monitoring capabilities, under the guidance of the Monitoring Network.

These priorities will be reviewed and updated as part of the upcoming update to the *Casco Bay Plan*.

Section I. INTRODUCTION

A. Purpose

"The Casco Bay Estuary Partnership (CBEP) mobilizes collective action to strengthen the Bay's ecological and economic vitality, fostering a shared commitment to Casco Bay. It focuses scientific expertise and financial resources on helping watershed communities address regional challenges such as water pollution, habitat degradation and adaptation to climate change."

from CBEP's Casco Bay Plan 2016-2021

The Casco Bay Estuary Partnership Finance Plan provides a framework for strategic thinking to ensure the long-term financial viability of key elements of the *Casco Bay Plan*, CBEP's Comprehensive Conservation and Management Plan. Those key elements, as detailed in the four Goals of the CCMP, are: Habitats; Nutrients and Water Quality; Community Engagement; and Collaboration and Science. EPA Funding Guidance requires a Finance Plan "that will establish long-term financial sustainability to implement the CCMP through diverse resources and partners." This Finance Plan supports both the current CCMP and the in-depth strategic thinking necessary to update the *Casco Bay Plan* in 2022 and 2023.

To emphasize connection to our CCMP, and support its update, this Finance Plan reflects the structure of the CCMP, and is itself organized around the four Goals and related Strategies of the *Casco Bay Plan*. Strategy by strategy, this document identifies key considerations for addressing each strategy, and lists potential ideas for future funding.

The Finance Plan builds on prior CBEP successes identifying and raising funds to implement the CCMP. Those successes provide a foundation on which to launch future initiatives. CBEP staff reviewed data on prior funding received by CBEP and principal uses of those funds. That historical information is presented in Appendix A. CBEP also evaluated sources of funding tapped by CBEP Partners that implement portions of the Casco Bay Plan, for activities such as such as wastewater treatment plant updates, combined sewer overflow reductions, stormwater management and land conservation. Those additional sources of funds are discussed in relevant portions of the body of this Plan. Appendix B describes three prior financial planning efforts.

Three separate but interrelated strategic financial needs are considered in this document:

1. Direct funding for CBEP operations;
2. Funding for implementation of the CCMP, whether by CBEP or by Partners;
3. Generation of adequate "non-federal match" to enable continued access to NEP funds that require a minimum 1:1 non-federal match.

The Finance Plan has been developed in conjunction with the U.S. Environmental Protection Agency (EPA), which manages the National Estuary Program by providing funding guidance, resources, and technical assistance. CBEP is one of 28 National Estuary Programs around the nation. Members of CBEP's Executive Committee were involved with revising and reviewing it, and the final document was approved by CBEP's Management Committee on March 23, 2022.

B. Planning Context

The marine-related economy of the Casco Bay region was about $704 million in 2016, supporting some 18,000 jobs. That represents about 4% of the total regional economy, but the impact of marine jobs in smaller coastal and inland towns is much greater than that overall figure would suggest. Seventy percent of economic value, and eighty percent of marine-related jobs, are related to tourism. Casco Bay and the inland lakes of the Casco Bay watershed are significant drivers of local economies throughout the region.

This Finance Plan was drafted as CBEP was headed toward a formal EPA Program Evaluation (spring of 2022), and toward a planned update of the *Casco Bay Plan* (fall 2022 through 2023). The Plan aims to gather and organize strategic information about funding needs and opportunities to inform the upcoming planning process.

Because this Plan is intended principally as a supporting document for the *Casco Bay Plan*, strategic decisions that might be included in an organizational Finance Plan have been left unresolved. Strategic choices about allocation of funds to program areas, and allocation of staff resources to raising funds for program areas, have not yet been made. Those decisions are appropriately made in the context of the larger strategic priorities identified during the *Casco Bay Plan* update and after review of all supporting planning documents, including CBEP's Monitoring, Habitat, and Community Engagement Plans.

Soon after a draft of this Plan was presented to CBEP's Executive Committee, the Infrastructure Investment and Jobs Act (IIJA) was passed by Congress and signed into law by President Biden. The law includes a significant increase in federal funding for the National Estuary Program. That is expected to increase federal funds available for program implementation. The Plan identifies areas underfunded in recent years, and areas where CBEP activities have historically been difficult to fund via other sources. That information will help establish potential spending priorities for the new federal funds.

Sharp increases in available federal funds, updated strategic Plans, and shifting priorities mean that this Plan will need to be revised and updated as new strategic priorities become clear. We anticipate that the Finance Plan will be updated, or a supplement to the Plan will be adopted, soon after the update to the *Casco Bay Plan* is complete. Indeed, this plan will need to be updated every few years to keep it current with CBEP's evolving strategic priorities.

C. Adaptive Management

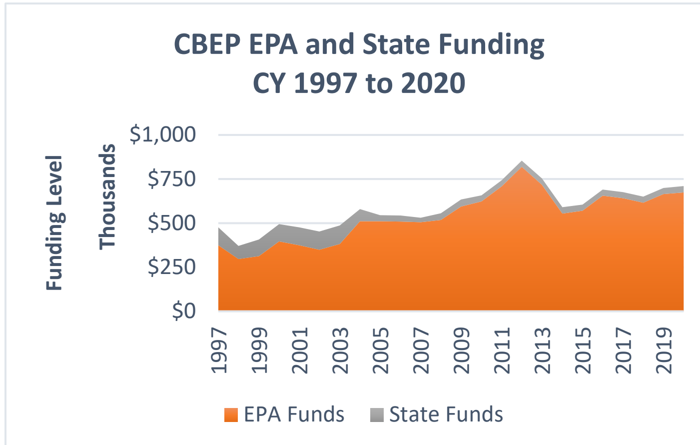
Changes that affect the Bay, the state, and the region are accelerating, and no Plan can be static. Updates to the CCMP and its associated Monitoring Plan, Habitat Plan, and Community Engagement Strategy will mean that the Finance Plan also must adapt to changing conditions and emerging priorities. This Finance Plan is intended to provide a framework and reference information to support thinking critically about how the goals of the *Casco Bay Plan* can best be achieved. CBEP staff will work with the Executive and

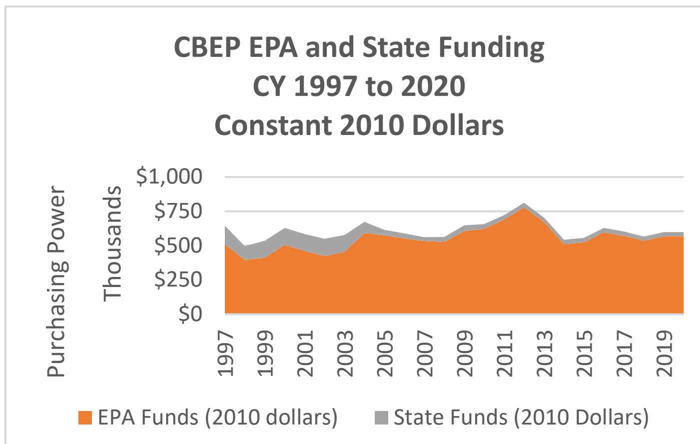
Management Committees as needed to review and modify the Finance Plan to keep it responsive to evolving needs and priorities.

D. Overview of Sources of Funding

Core Federal Funds

Casco Bay was deemed an "estuary of national significance" in 1990. The Casco Bay Estuary "Project" was initially managed by Maine's Department of Environmental Protection, with funding routed through New England Interstate Water Pollution Control Commission (NEIWPCC). The "Project" released the first *Casco Bay Plan* in 1996, the same year it moved institutional hosts to the University of Southern Maine (USM). The organization's name was changed to the Casco Bay Estuary Partnership in 1996, as part of adoption of an updated *Casco Bay Plan*.





Since 1996 CBEP, through USM, has been the recipient of Clean Water Act Section 320 funding from EPA. These funds represent the "core" federal funding for the Partnership. Annual budgets have varied over time, following changes in EPA funding allocations and congressional appropriations. For Workplan Year 26, July 1, 2021, to June 30, 2022, the core federal funding amount is $700,000. While total federal funding for CBEP under the National Estuary Program (including supplementary funds – see below) has increased, purchasing power has remained essentially flat since the 1990s.

Infrastructure Investment and Jobs Act

The Infrastructure Investment and Jobs Act (IIJA), signed into law in November of 2021, provides for a significant increase in funding to the National Estuary Programs. The additional funding will add on the order of $900,000 annually to CBEP's budget for five years (Federal Fiscal years 2022 through FY 2026; to be expended by CBEP roughly from mid-2022 through fall of 2027). Like Core EPA funds, these funds have the potential to support projects and activities that are difficult to fund via other grants and contracts.

Additional EPA Funding

CBEP is from time to time the recipient of supplementary EPA funding through the National Estuary Program for projects mandated or sponsored by EPA. Sources include Climate Ready Estuaries, Coastal Watershed Grants, and other EPA National Estuary Programs supplemental funding.

Core State Funds

CBEP receives both direct financial and other support from the state of Maine. Throughout the 1990s, CBEP received both direct financial contributions from the state (principally via DEP) and substantial in-kind support. A DEP staff member worked essentially full time on behalf of the Partnership, including as Director for a time. Both direct state financial contributions and in-kind support for the Partnership declined in the 2000s. Since about 2008, the Partnership has received a state appropriation annually from the Maine state legislature in the amount of $35,000. CBEP receives substantial in-kind support from several state agencies that collaborate with CBEP on multiple projects.

University Match

As a condition of its funding, EPA requires CBEP to obtain matching funds each budget year in a 1-to-1 ratio, meaning for FY22 the required match amount is $700,000. CBEP's host, the University of Southern Maine, provides a portion of our required match funds by charging CBEP significantly reduced indirect fees on the funds received from EPA. In addition, USM waives all indirect fees on the state appropriation.

Grants and Contracts

CBEP applies for and is awarded grants and contracts to work on projects of interest to a variety of funders, including federal agencies, state agencies, and private foundations. CBEP submits several proposals annually through USM to such funders to implement specific CCMP priorities, often in association with partner organizations. Proposals have been submitted to organizations like the National Oceanic and Atmospheric Administration (NOAA), Maine Department of Transportation (Maine DOT), Maine Coastal Program (MCP), Island Institute, and the Governor's Office of Policy Innovation and Future (GOPIF), among others. Details of these grants are provided in the appropriate strategy section, below.

CBEP staff also supports efforts by our Partners to raise funds for projects that implement portions of the *Casco Bay Plan,* even if funds will not accrue directly to CBEP's budget. Recent examples of proposals where CBEP played a supporting role but will not receive direct funds include proposals by the Portland Harbor Commission to fund dredging of private piers in Portland Harbor and safely dispose of dredged material in a CAD cell, and several proposals by academics to fund scientific studies of interest to CBEP.

Fee-For-Service

CBEP has never implemented a fee-for-service model for raising funds that accrue to CBEP's budget, however, CBEP helped found the Long Creek Watershed Management District (LCWMD), which is fee-based. LCWMD is a public-private partnership that implements stormwater management, water quality protection, and stream restoration on behalf of about 130 landowners in the Long Creek Watershed. The organization has an annual budget close to $1.5 million. LCWMD continues to be a significant source of non-federal match for CBEP. The Interlocal Stormwater Working Group, which CBEP also helped establish, is managed by the Cumberland County Soil and Water Conservation District, and supported principally via payments from communities that face MS4 permit obligations.

Gifts and Donations

CBEP has no formal structure for soliciting gifts or donations. Nevertheless, CBEP occasionally receives gift funds or donations from supportive individuals and organizations. Some of these are received directly and some through 1% for the Planet. In 2021, CBEP received $1,000 via 1% for the Planet.

Match

Maintaining adequate match to permit access to federal Section 320 funds, with their 1:1 non-federal match requirement, is a strategic necessity. Matching funds are provided to CBEP by our Partners, typically by organizations to which the Partnership provides direct funding or technical assistance and expertise. Details about these projects are provided in the appropriate strategy section.

E. Overview of Uses of Funding

EPA's annual award is used as core funding, covering most CBEP personnel costs, university indirect costs, operating expenses like computer fees, travel, land conservation and community engagement grants, habitat projects, new initiatives, pilot studies, and general administration. Where relevant, details are provided in the appropriate strategy section.

The state appropriation is used to fund a portion of the Executive Director's salary and related costs, and to pay dues to the Association of National Estuary Programs (ANEP), currently $4,500 annually. Since funding for ANEP is disallowed under EPA's funding guidance, the portion of state funding used for ANEP dues does not count as non-federal match.

Grant money, including supplementary funding from EPA, is used for work on the projects specified in the grant application or contract. Details on these uses are provided in the appropriate strategy section.

Gift funds provide limited, but unrestricted funds that enhance flexibility of CBEP's programs. Gift funds have been tapped to provide non-federal match for federal grants to CBEP or other organizations. Gift funds are also used to pay costs not permitted by EPA funding guidance, like subscription costs for the local newspaper.

Matching funds are reported to EPA via two annual reports: NEPORT National Estuary Program reporting system, and SF425 Federal Financial Report. Details are provided in the appropriate strategy section.

Section II. GOAL 1 Protect, restore, and enhance key habitats that sustain ecological health

A. Strategy 1.1. Conserve significant coastal habitats and areas that protect water quality, such as riparian corridors, wetlands and forests adjoining headwater streams

Funding needs and prospects for Strategy 1.1

Rising property values, a greater emphasis on fee acquisitions rather than conservation easements, and growing complexity of land conservation projects have steadily increased costs of land conservation, especially in our coastal towns. In addition, growing recreational use of conserved lands, especially those readily accessible from urban areas, has increased costs of property stewardship, such as monitoring of easements, control of invasive plants, maintenance of trails, and construction of parking facilities.

Most funders that support acquisitions of easements or fee ownership of habitat are likely to continue to invest in habitat protection in the future. Priorities of funders, however, will evolve as new ways of thinking about conservation take hold. Trends likely to influence future funding include an increased focus on climate change, emerging interest in responding to sea level rise, and greater consideration of the social justice, environmental justice and community impact of conservation decisions.

Increases in government funding for conservation are likely over the next several years but will be subject to changes in political leadership. Federal and State "Thirty by Thirty" initiatives demonstrate political support for accelerated land conservation. State funding, largely through the Land for Maine's Future Program, has increased under the administration of Governor Mills, but future funding is uncertain. Several federal programs that support conservation received a boost in funding via the Infrastructure Investment and Jobs Act.

Few habitat protection projects in our region have been funded based on their carbon sequestration benefits. That is likely to change. Maine's forests and tidal wetlands both offer opportunities for increased carbon sequestration. Documentation of carbon sequestration benefits for carbon offset markets is complex and requires commitments that constrain future land management decisions. That can make carbon markets a less attractive source of funding for small conservation organizations. However, government agencies and philanthropic funders are likely to prioritize projects based in part on perceived carbon sequestration benefits. We already see that at work, with increasing interest in protecting tidal marshes based on "blue carbon" stored in marsh sediments.

Historically, CBEP's role with regards to habitat protection has been to support and enhance the work of land trusts, principally through the HPF grants, but also via community engagement grants and support for mapping, geospatial analysis, coordination and strategic planning. Funding for those efforts has come from core CBEP funds, or from project-specific grants aimed at regional coordination and priority setting. CBEP's HPF grants usually represent a small fraction of total project costs. Even significant increases in the size of HPF grants would not change that.

Use of CBEP core funds or the new IIJA funds for land conservation should focus on leveraging conservation and fundraising capacity of CBEP Partners. Staff time could be used to facilitate or lead strategic discussions about priorities or to assist with regional fundraising initiatives. Direct investments through the Habitat Protection Fund should focus on grants that enable projects. Options might include:

- Contributions towards conservation easements, which often provide greater return in terms of acre protected per dollar invested;
- "High risk high reward" investments early in project development, facilitating later fundraising;
- Funds that cover hard-to-finance components of projects, such as surveys, deed research, legal fees or long-term stewardship;
- Late funding to bring a project to closing.

B. Strategy 1.2. Restore and enhance coastal habitats and habitat connectivity that are important to sustaining the health of Casco Bay

Funding needs and prospects for Strategy 1.2

Habitat restoration at the community level takes many steps, including establishing regional habitat priorities, identifying restoration opportunities, conducting site assessments, developing relationships with town staff, landowners and other partners, developing project designs, permitting, and finally implementation.

Grant funding is often available for the later stages of this process, once a specific project has been identified, and community buy-in secured. But it is difficult to raise funds for the early stages of project development, including identifying regional priorities, cataloging potential projects, and developing the relationships needed to move towards implementation. It is similarly difficult to raise funds to support post-project monitoring to meet permitting requirements and ensure that we learn as much as possible from each restoration project.

Ensuring availability of stable funding for CBEP staff to work on these less visible, but vital parts of the process should be a priority. These activities leverage CBEP resources to generate funding (for CBEP and our Partners) from state and federal funds for project implementation.

CBEP can maintain current efforts supporting habitat restoration based on CBEP core funds (for staff time). Expanding the Partnership's catalytic role on habitat restoration would require additional funds. Because of the difficulty of raising funds to cover the full costs of developing restoration projects, this may be an appropriate area for investment of IIJA funds. Alternatively, CBEP needs to identify new funders and new ways of conceptualizing and selling regional coordination to funders. For example, it may be beneficial to develop regional or state-wide restoration partnerships to create entities of sufficient scale to interest funders in covering costs of coordination and preliminary site assessment. Such partnerships might extend to work in Scarborough Marsh, Spurwink Marsh, or the Lower Kennebec.

Another priority should be developing new and deeper partnerships to implement activities under this Strategy. Cumberland County Soil and Water Conservation District has a history of successfully implementing restoration and water quality projects, often based on "Section 319" funding. The Maine Coastal Program leverages state and federal funding to work closely with municipalities.

Habitat restoration now occurs in the unavoidable context of climate change and sea level rise. In the next decade, that reality will shape the availability of funds. Restoration priorities are shifting. There is growing interest in the role of habitat restoration to enhance carbon sequestration and avoid release of stored carbon ("blue carbon"). New stressors (like coastal acidification and sea level rise) are becoming key targets for projects. Funders, including state and federal agencies, are interested in funding projects that combine habitat restoration with community resilience. "Maine Won't Wait", the state's recently published climate action plan, envisions expanding investments in both habitat restoration and coastal resilience.

CBEP's recent work plans have already been influenced by these trends. CBEP is developing an updated Habitat Plan, which includes explicit links to these new ways of thinking.

Existing federal and state habitat restoration funders are likely to continue to be important sources for implementing restoration projects for the foreseeable future. The growing recognition of the links between habitat and community resilience, however, open the potential for new sources of funding, including:

- Federal and state Emergency Management Agencies;
- Federal infrastructure funding (roads, culverts, bridges and resilience);
- Regional foundations with an interest in community resilience;
- Municipal budgets;
- Individual donors (e.g., via 1% for the Planet).

C. Goal 1 Recommendations

Core Funds

Continue to support core CBEP staff capacity to lead regional habitat restoration efforts. If / as Core funding levels increase, consider expanding staff capacity to develop, permit, and design restoration projects by funding a portion of another position with Core funds, with the remainder to be supported via habitat restoration implementation grants, as described below.

IIJA Funds

Consider two new multi-year "Infrastructure" initiatives, one focused on habitat restoration, and one on habitat conservation. Each program should have dedicated staff, and substantially increased budgets for contracts (e.g., to support engineering and permitting) and grants (to towns and land trusts). A principal goal of each initiative should be to leverage CBEP Core and IIJA funds to accelerate restoration and protection in part by raising funds for implementation from federal, state, and philanthropic sources.

Grant Funding

Dedicate significant staff capacity on raising funds in association with our Partners for implementation of habitat restoration and protection projects. Likely funding sources include NOAA, MCP, Maine DOT, and the many new and expanded federal funding sources appropriated under the IIJA.

Ensure that as funds are raised for implementation of restoration projects, CBEP staff time dedicated to those projects (e.g., for grant management, contract management, permitting, construction oversight, coordination report preparation, and monitoring) is as fully covered by grants as possible, thus freeing up Core and IIJA funds for other priorities.

Explore whether larger-scale, multi-project initiatives (e.g., a subwatershed effort; or Bay-wide effort aimed at specific habitat types) can provide a structure that allows grant funds to cover up-front development and coordination costs of CBEP habitat programs.

Fee-For-Service

Evaluate opportunities to receive direct funding from municipalities (and other landowners) as partial support for technical assistance on fish passage and habitat restoration efforts.

Section III. GOAL 2 Reduce nutrient pollution and its impact, including coastal acidification

A. Strategy 2.1 Fill the gaps in scientific understanding of Casco Bay's nutrient sources, processes and impacts that are needed to guide policy and management decisions

Funding needs and prospects for Strategy 2.1

A five-year focus on nutrients under the most recent *Casco Bay Plan* has greatly improved our understanding of nutrient sources entering Casco Bay. We now have a better idea of the magnitude of major nutrient sources than ever before. We have been identifying likely processes shaping nutrient concentrations and impacts throughout the Bay, but several years of effort have also uncovered additional information needs.

Needs for further studies (many identified by the Casco Bay Nutrient Council) include:

- Understanding the hydrodynamics of the Bay, especially in and around Portland Harbor, to better evaluate impacts of changes in nitrogen loads;
- Documentation of the magnitude of nitrogen loads associated with direct stormwater discharges to the Bay, especially in Portland, South Portland, and the Foresides;
- Quantification of nitrogen loads from CSO discharges as well as the "Bypass Flows" at the East End Wastewater Treatment Facility;

- Quantifying the potential nutrient removal benefits and cost effectiveness of widespread investment in stormwater “retrofits”, fertilizer ordinances, and other local strategies to reduce nitrogen loading to the Bay via urban stormwater;
- Evaluation of the impact of septic tanks and other on-site wastewater treatment on nutrient loads, especially in the eastern Bay;
- Developing an ecosystem or process model of Casco Bay to clarify vulnerabilities to nutrient loading, including assessment of links between nutrient loads and coastal acidification / changes in aragonite saturation;
- Understanding remobilization of nitrogen from the shallow sediments, and thus potential for indirect effects of winter nitrogen discharges on summer water quality.

Costs of those investigations are highly variable, depending on the study extent, methods, and desired precision and products. Cumulatively, they are likely to cost between half a million and two million dollars.

The cost of developing and validating a hydrodynamic model is likely to be about $200,000 to $350,000. That is too great a cost to be borne readily out of CBEP’s core funding. Portland Water District (PWD) worked with other wastewater treatment plant operators to try to raise money for an updated circulation model for Casco Bay. CBEP pledged funding to the effort, but not enough funds were raised to make it work.

Over the last few years, we have worked with University of Maine researchers to try and raise funds for related projects, principally by supporting UMaine applications for grants though federal science funders, especially National Science Foundation (NSF) and SeaGrant. We have not been successful. NSF, and to a lesser extent, SeaGrant, prioritize projects that advance scientific thinking or principles, not that address local management needs. UMaine fundraising effort has focused on projects that would advance understanding of oceanographic processes along the coast of Maine, and especially the influence of the Kennebec plume on marine currents. CBEP’s interests in hydrodynamics, however, focus on more restricted waters, including Portland Harbor, the Presumpscot Estuary, and the Royal and Cousins River Estuary. Strategically, therefore, it may be important for CBEP to fund development of a hydrodynamic model directly so that the resulting model addresses management needs.

If we want to complete these studies, we will need additional sources of funds. Some possible sources may include:

- Applying in partnership with academics for grant funding via state and federal research funders that we have not approached recently;
- EPA Coastal Watersheds Grants, although this program is not an ideal fit because the RFP focuses on demonstrating water quality improvement, not establishing the infrastructure to improve management;
- EPA Climate Ready Estuaries funding, although the connection to climate change for some related studies is at best indirect;
- Special EPA funding requests - CBEP, for example, was able to monitor coastal acidification via supplemental funds;
- The new IIJA funding to the National Estuary Programs.

- Collaboration with USM, University of Maine, or other academic partners to hire a scientist for a joint appointment that would have the capacity to advance additional grants through national scientific funders.

B. Strategy 2.2. Encourage use of green infrastructure to reduce nutrient pollution from runoff

Funding needs and prospects for Strategy 2.2

The Actions identified under Strategy 2.2 include "Work collaboratively to reduce nutrient pollution within a priority watershed" and "Share innovative stormwater solutions".

Organizations implementing these Actions include private landowners, municipalities, the Interlocal Stormwater Working Group (ISWG), LCWMD, Think Blue Maine, and CCSWCD.

Municipalities fund ISWG and implementation of their MS4 permit programs, including education and outreach, usually from general fund budgets. LCWMD is funded directly by about 130 landowners to implement stormwater management in the Long Creek Watershed. Landowners and developers who build new commercial properties fund stormwater management to comply with state and municipal regulatory requirements. CCSWCD organizes the Maine Stormwater Conference every two years, with funding from a combination of sources, including conference attendees, vendors, ISWG communities, and CBEP.

Regionally, the funds to implement this Strategy are principally directed towards addressing regulatory obligations. Thus, despite significant private and municipal spending on stormwater, gaps remain. Existing rules impose strict obligations on new construction, but much of the urban and suburban landscape of our region was built out before water quality-related regulatory programs were in force, so existing stormwater infrastructure is inadequate to protect water quality. Limited monitoring makes it difficult to evaluate cost-effectiveness of real-world stormwater control efforts, especially as facilities age. Currently, Maine's regulatory programs do not directly encourage reduction of nitrogen pollution from urban and suburban lands. Towns may underinvest in stormwater if they perceive water quality as of lower importance than other municipal costs like roads, schools, or public safety.

CBEP is not likely to be permitted by our fiscal host, the University of Southern Maine, to lead construction of stormwater infrastructure, because of concerns about long-term liability. Thus, CBEP funds (e.g., grants for pollution reduction projects, research, project implementation) are most likely to be used to:

- Coordinate actions on a watershed basis;
- Leverage municipal programs to achieve greater pollution reduction (incentivize technologies like green infrastructure);
- Implement nitrogen reduction strategies on a pilot scale;
- Develop and share information on cost effectiveness of nutrient reduction practices (site-level) and strategies (watershed-level);

- Study or monitor performance of real-world stormwater reduction practices and evaluate nutrient loads from target watersheds (e.g., Long Creek or the Fore River Estuary).

LCWMD has become an important source of non-federal match for CBEP programs. That provides strong incentives for CBEP to continue to provide technical assistance to LCWMD. Funding for staff time to provide that assistance will be provided principally from CBEP core funds.

Raising additional funds for stormwater-related efforts can be challenging. Many federal grant programs are not able to fund activities required under environmental permits (including MS4 permits), but the line between "required" activities and "add-ons" is not always clear-cut. Many funders are reluctant to fund work on private property, or work that directly benefits private interests. Yet in developed landscapes, "stormwater retrofits" often must be implemented on private property. In some cases, restrictions on use of federal funds are eased for actions identified in National Estuary Program CCMPs. CBEP may be able to act as an intermediary to facilitate funding.

Municipalities and CCSWD have successfully applied for state funding through several DEP / EPA programs (Section 319 and 604B grants, and SEPs) and Maine Coastal Program (Shore and Harbor Planning Grants and Coastal Communities Grants; CBEP is not directly eligible for Coastal Program funds) for stormwater-related work. LCWMD successfully applied for State Revolving Loan Funds for early project implementation.

The City of Portland funds stormwater-related work through their Stormwater User Fee. Other towns in our region have not picked up on that idea. The transaction costs of establishing a Stormwater Utility are substantial, placing development of a similar program at the municipal level beyond all but the largest municipalities. While there has been some discussion of establishing a regional utility, no substantive steps have been taken in that direction in recent years.

Future sources of funding to implement this strategy (whether through CBEP or Partners) could include:

- Stormwater Utilities (Portland stormwater fee and any new programs developed);
- Section 319 and Section 604B Grants administered by DEP;
- MCP's Shore and Harbor Planning Grants and Coastal Communities Grants
- Supplemental Environmental Projects;
- EPA, including supplemental NEP funding, Coastal Watersheds Grants, and STAR grants.

C. Strategy 2.3. Advance policies and regulations that minimize nutrient pollution and coastal acidification

Funding needs and prospects for Strategy 2.3

One basis for considering important strategic directions for our work under this Strategy is to revisit the Policy recommendations of the Casco Bay Nutrient Council. They include:

Recommendation #1: Encourage integrated planning and adaptive management across permits and municipalities.

Recommendation #2: Establish numerical nutrient criteria for marine waters.

Recommendation #3: Revise state rules and guidance for stormwater and site design to highlight stormwater controls (e.g., green infrastructure, gravel wetlands) that meet existing rules and remove nitrogen from stormwater.

Recommendation #4: Create a forum to discuss ways to harmonize state and local policies and provide input on specific policy recommendations. Such a group needs to be broad based and invite participation not only from urban and suburban communities, but rural Maine towns as well.

Recommendation #5: Develop tools and incentives to encourage the private sector to reduce nutrient loads through stormwater facility maintenance and good housekeeping. Enforce the rules that already exist.

Recommendation #6: Encourage municipalities to think and act in terms of watersheds when developing local policy, through preparation (and funding) of watershed management plans and building community awareness of watershed impacts.

Recommendation #7: Consider adoption of "Smart Growth" policies and strategies to reduce nutrient pollution (such as: incorporate watershed impacts during site design and planning reviews; create stronger incentives for implementation of Best Management Practices (BMPs); require BMPs on projects below state thresholds; protect forests and wetlands; develop ordinances that encourage green infrastructure in new development; increase density, redevelopment, and infill appropriate areas; manage and restrict fertilizer use).

Recommendation #8: Incorporate water quality/nutrient goals into municipal comprehensive plans.

CBEP leadership would be called for in many of these areas. While several Partner organizations have related interests and expertise (CCSWCD, Greater Portland Council of Governments-GPCOG, MEWEA, ISWG, DEP), CBEP's role as trusted convenor and source of information will be key to making progress. Thus, we see four key strategic funding needs under this Strategy:

(1) Funding CBEP staff time to not only participate but lead regional and even state-wide conversations on key policy issues;
(2) Funding studies or reports to address specific information needs;
(3) Funding for meeting facilitation and direct meeting costs to advance constructive policy discussions;
(4) Grants or contracts to key Partners (CCSWCD, GPCOG, NEEFC, MEWEA) or contractors to advance policy conversations.

Ideally, CBEP (or a closely allied organization) should have a dedicated staff member (full time or nearly full time) to lead this effort and build partnerships with other organizations with related interests. The program would need sufficient funds to hold meetings, contract for needed services, and print /publish findings and results. Such a program might cost between $100,000 and $200,000 annually, for a period of several years, and is well beyond what can be funded under current core CBEP funds. This vision could be implemented by leaning on new IIJA funding, or by tapping external grants. There are relatively few sources for such funds, but they may include the following:

- EPA, including supplemental NEP funding, Coastal Watersheds Grants, and STAR grants;
- MCP's Shore and Harbor Planning Grants (although CBEP is not directly eligible);
- Foundation grants;
- Section 319 Grants administered by DEP;
- Municipal budgets – if towns see the potential for long-term benefits.

None of these sources of potential funds have been easy to tap for strategic or policy discussions, so new approaches or new funders are likely necessary.

D. Strategy 2.4. Seek long-term solutions for funding stormwater management and constructing stormwater infrastructure

Funding needs and prospects for Strategy 2.4

Towns throughout the region continue to face challenges funding stormwater and water quality infrastructure. Maine towns are small organizations, with limited budgets. Funding stormwater management (infrastructure, maintenance and operations) out of general funds places water quality in direct competition with other local priorities. This dynamic has not changed since this Strategy was included in the *Casco Bay Plan* in 2016.

The City of Portland's Stormwater User Fee program has been in force since 2016. It has demonstrated that a user fee or stormwater utility is feasible and can generate dedicated revenue.

The number of towns facing significant stormwater infrastructure funding challenges will increase in the next year. The MS4 permit requirements are directly related to whether portions of a community fall within an "urbanized area" as designated by the U.S. Census. The 2020 Census is expected to bring several more towns in our region into the MS4 program. These communities are likely to face increased stormwater management costs as they come into compliance with permit requirements.

Over the past few years, attention of ISWG has focused principally on the process of developing the revised MS4 permit, now slated to go into effect July 1, 2022, so little attention has been spent on identifying stormwater funding strategies. As the new permit finally goes into effect in 2022, timing may be right for reviving conversations about regional stormwater and water quality financing. The transaction costs for establishing a stormwater utility are substantial, likely placing such a financing strategy beyond the reach of towns working separately. If alternative financing strategies are going to emerge in our region, they may need to develop out of regional conversations. Initially, towns are unlikely to fund that discussion themselves, so seed funding, whether through CBEP core funds, IIJA funds, or grant funds would be necessary.

A second strategic possibility relates to priorities under Strategy 2.3, specifically consideration of policy innovation that might foster new avenues of funding for stormwater remediation. Chief among these would be consideration of local, regional, or state-level pollution trading schemes. A pollution trading scheme might allow one discharger with a high marginal cost for additional nutrient removal from their discharges to fund work by another discharger with lower marginal costs. That kind of policy innovation would principally require dedicated staff at CBEP or an allied organization like NEEFC or CCSWCD to focus on related state and national policy.

Finally, we continue to lack city-wide, region-wide, or watershed-wide evaluation of relative costs and cost-effectiveness of alternative strategies for reducing nutrient discharges to the Bay. The Casco Bay Nutrient Council recommended an engineering study to evaluate magnitude and cost of nitrogen removal via enhanced stormwater management practices. We have not yet been able to fund such an effort.

We see the following funding needs under this Strategy:

- Staff time (at CBEP or with a Partner organization) to:
    - coordinate or lead regional stormwater finance discussions;
    - lead implementation of nutrient trading schemes;
    - address policy innovations.
- Funding for a study of effectiveness and cost-effectiveness of alternative nutrient controls.

Possible funding sources include:

- EPA funding, including supplemental NEP funding, IIJA funds, Coastal Watersheds Grants, and STAR grants;
- MCP's Shore and Harbor Planning Grants (for implementation at the municipal level);
- Foundation funding (would require a large enough initiative to interest major funders);
- Section 319 Grants administered by Maine DEP;
- Municipal budgets.

E. Goal 2 Recommendations

Core Funds

Continue to support core CBEP staff capacity to work on water quality related issues. If additional Core funds become available, hire a staff scientist to expand existing capacity to address stormwater, water quality, and ocean acidification science (and monitoring, discussed below).

IIJA Funds

Fund development of an "operational" hydrodynamic model of Casco Bay. Once that model is complete, consider funding further components of Casco Bay Science and Model

Infrastructure, including an updated watershed loading model and a Casco Bay ecosystem model.

Contract with a consultant to implement key recommendations of the Nutrient Council, including engineering study of effectiveness and cost-effectiveness of enhanced stormwater management practices.

Support development of Watershed Plans for impaired watersheds in the lower Casco Bay watershed.

Grant Funds

Work with University of Maine, University of Southern Maine, Gulf of Maine Research Institute, and other academic Partners to raise funds for model development and enhanced monitoring to address information needs uncovered by model development.

Provide technical assistance to municipalities applying for stormwater implementation funds, via Section 319, Section 604B, Coastal Watershed, and other funding sources.

Section IV. GOAL 3 Foster resilient communities and their connections to Casco Bay

A. Strategy 3.1. Strengthen appreciation for the cultural, ecological & economic values of Casco Bay

Funding needs and prospects for Strategy 3.1

The Actions under this Strategy are likely to change as we update the *Casco Bay Plan* and the Community Engagement Strategy, which makes it difficult to predict future uses of funds. We anticipate continued focus on support for experiential learning at multiple different educational levels and continuation of our successful Community Grants program. New strategic education and communications initiatives are possible.

Possible uses of funds include:

- Updating the 2016 assessment of Casco Bay's economic value, especially by developing town-level estimates of the importance of marine and coastal economic sectors or evaluating the value of ecosystem services provided by Casco Bay. Costs of such a study could range from $50,000 for a simple update of the 2016 study to over $200,000 for an ecosystem services assessment.
- Increasing grants for Community Engagement projects. CBEP has been allocating about $10,000 annually to the Community Grants program. Most grants have been for a few thousand dollars, leveraging significant local energy around a wide range of education, communication and outreach efforts. An expanded grant program (say, $20,000) could allow more numerous grants, larger grants, or grants that are more strategically targeted.
- Specific collaboration with or allocation of CBEP funds to work with our new or existing education partners (e.g., CCSWCD, PWD, USM, the Roux Institute) to

expand educational programs addressing specific strategic areas of interest to the Partnership, such as nutrients, as discussed in the Nutrient Council's report.

Possible sources of staffing include:

- Casco Bay Island Fellow through Island Institute;
- Resilience Corps Fellow through GPCOG AmeriCorps program.

B. Strategy 3.2. Improve local policies and practices to better protect the Bay

Funding needs and prospects for Strategy 3.2

Over the past few years, CBEP has worked closely with CCSWCD, GPCOG, and NEEFC to develop robust partnerships around educating municipal leaders about coastal and environmental issues. For example, the Casco Bay Coastal Academy offers quarterly education and training events for municipal leaders and interested citizens on matters such as climate change, the health of Casco Bay, habitat restoration, and financing water quality protection. The program has grown in scope and reach, with more than 50 participants attending recent events. CBEP staff helps bring these groups together, thus improving coordination, reducing duplication, and improving program delivery.

These established partnerships are likely to remain the core mechanism for addressing this strategy. All three partner organizations provide related services within their respective organizational priorities, which overlap, but are not identical with CBEP interests in this area. These services range from developing model ordinances to providing direct technical assistance on implementing state stormwater rules.

Currently, the ability of these organizations to implement Partnership priorities is limited as much or more by lack of resources than by lack of shared interests. All three Partner organizations rely principally on project-specific grants to implement their programs, and so their ability to support the *Casco Bay Plan* depends on their ability to raise related grant funding. If available, CBEP funds could directly fund implementation, or strategically facilitate growth and establishment of new programs.

Actions under this Strategy are likely to change as we update the CCMP, largely because of the strengths of these partnerships and the lessons we have learned over the past few years. We will probably continue or expand the Casco Bay Coastal Academy. We will continue to prioritize technical assistance to communities, but both the focus and mechanisms of that technical assistance may shift. New and updated Actions will be developed in communication with Partner organizations but may include developing model ordinances around emerging issues or providing direct technical assistance to municipalities on specific areas of focus. An emerging need, especially for our smaller towns, is to address lack of capacity of smaller communities to access "Infrastructure" and "resilience" funding sources recently made available in the IIJA.

The primary funding need will be to increase capacity at CBEP and at our Partner organizations to step up this kind of work, once shared priorities have been identified. Use of funds is likely to include increasing CBEP staff capacity or providing grants to facilitate growth of specific programs at Partner organizations and municipalities.

Another option may be to develop a grant program to fund municipal efforts to develop or update ordinances; or to fund implementation of local practices that help protect water quality and Casco Bay.

Funding this work via grants may be challenging, as there are relatively few sources for grants supporting policy development at the municipal level. Grant funds are more likely to be available if programs can be framed around emerging priority areas, including climate change, infrastructure investments, or social justice. Federal agencies not historically focused on water or habitat issues are looking for ways to invest in climate resilience as they seek to implement the Biden administration's Executive Order on climate change. This might open new sources of funds to address CBEP priorities, such as through public health, housing, transportation, and infrastructure agencies.

Several programs under this Strategy have the potential to be funded in whole or in part via a fee-for-service model. Individuals benefit from training and education under the Casco Bay Coastal Academy, and they may be willing to pay a nominal fee to participate. Municipalities benefit from direct technical assistance. Both GPCOG and CCSWCD have used fee-for-service models to support program delivery in the past. This model is more viable if the potential pool of customers is larger, thus this source of funding may be more sustainable if the "service area" is larger than the Casco Bay watershed.

Possible sources of funding for implementing this strategy include:

(1) Maine Coastal Program's Coastal Communities Grant program;
(2) Federal grants, especially as new sources of funds become available via growing focus on climate resilience;
(3) Foundation grants;
(4) Expanded NEP funding under the IIJA;
(5) Fee-for-service.

C. Strategy 3.3 Help communities prepare for climate change impacts and resulting economic, cultural and ecological disruptions

Funding needs and prospects for Strategy 3.3

Climate Preparedness / Resilience Planning

Many Actions under this Strategy overlap substantially with Actions under Strategy 3.2. As a matter of practice, CBEP and several of our Partners now integrate climate considerations with all our work. For towns interested in water quality issues, a discussion of stormwater naturally includes discussion of increasing storm intensities, sea level rise, and infrastructure vulnerability. Conversely, towns addressing climate vulnerabilities need to consider the intersection between a changing climate, environmental assets, and water-related infrastructure, including culverts, stormwater management structures, and wastewater treatment facilities.

CBEP, working with NEEFC, Wells Reserve, CCSWCD, and other Partners has developed substantial expertise in supporting municipal-level conversations on local climate and sea level vulnerabilities. The CBEP-NEEFC team offers a well-developed climate risk assessment framework, linked with specific expertise around financing of resilience projects and understanding of the intersection between infrastructure vulnerabilities and habitat and water quality. Other groups in our region, notably GPCOG, provide similar services, targeting different communities, and with complementary strengths.

From a strategic point of view, we expect direct assistance to municipalities with assessing and addressing climate vulnerabilities to be an area of growing demand as well as funding. The need for technical assistance to Maine towns (especially smaller Maine communities) on climate vulnerability was identified in the "Maine Won't Wait" report from the Maine Climate Council. GOPIF is already providing limited funding to CBEP and our Partners for just this sort of assistance. Funding, through GOPIF, as well as other state funding mechanisms, is likely to increase.

Much of the state funding is likely to be narrowly targeted to direct technical assistance. Funding offered by GOPIF so far has not met the full costs of providing related services, amounting to a few thousand dollars per town. It is not yet clear whether funding levels will increase as the true costs of providing these services are better understood, or if other sources of funding (such as direct payments from municipalities) will become available.

CBEP is working with AmeriCorps Fellows through GPCOG in 2021-2022 to increase our capacity in this area. AmeriCorps Fellows are available essentially full time for a period of 11 months, for less than the cost of hiring a graduate student for 10 hours per week for the academic year.

Moreover, the "market" for the technical assistance CBEP offers on climate vulnerability assessments is limited in the Casco Bay region, as we have only thirteen coastal towns, and several have already completed vulnerability assessments. Demand for these services is likely to remain robust with inland communities, statewide and throughout New England.

This situation poses strategic funding challenges for CBEP supporting local climate resilience:

- In the short term, we need additional staff capacity (either at CBEP or at NEEFC) to deliver services and meet existing demand, but external funding may be inadequate to support full staff positions. CBEP will need to decide the extent to which we want to subsidize these efforts using core CPEP funds, as we do now, or emerging NEP funding under the IIJA.
- CBEP will soon need to consider what the future of our work on this issue will be, once the first round of vulnerability assessments has been completed. We may want to consider whether our strategic interest in maintaining and expanding our expertise in this area justifies an expansion of our potential "customer base" to include inland communities, or towns outside our region.

Future funding needs for providing this technical assistance are primarily for staff capacity. The budget implications therefore depend on the scope of CBEP activities, which conversely can be scaled somewhat to available resources. At the moment, we anticipate a program that will take up perhaps 1/3 of our Community Engagement Coordinator's time, with additional costs scaling with program delivery and available funding, principally from state grants or municipal budgets.

Climate Science

Regional and state-level information on climate change and climate change impacts has perhaps never been so readily available. The Fourth National Climate Assessment (published in 2018) includes a regional summary for the Northeast that provides insight into how climate change will affect the region. Both the University of Maine's Climate Institute and the Maine Climate Council's Scientific & Technical Subcommittee produced Maine-focused summaries of climate science in 2020. These reports, however, are long and technically dense, and often appear remote to the types of decisions made at the local level by municipal staff, elected officials, business leaders, and private individuals.

The "Maine Won't Wait" report recognized this need by suggesting development of a Marine Information Exchange that would aggregate climate-related data with relevant non-climate information, and package it in ways that would help inform business decisions, government action, and climate response. During development of the most recent State of Casco Bay report, CBEP developed as good an understanding of available local, regional, and national data on the condition of Maine's coastal waters as anyone in the region. CBEP staff have been supporting a pilot-scale effort to develop an information exchange focused on data relevant to shellfish harvesting in Casco Bay (led by the Casco Bay Shellfish Working Group). CBEP also provides education and outreach regarding climate change science via public presentations, fact sheets, web content, and social media. Local climate science is incorporated into State of Casco Bay presentations and outreach materials.

CBEP has funded this work out of core CBEP funds, largely through allocation of staff time. This pattern is unlikely to change, unless we identify significant new funding sources. If this area is identified as a priority in upcoming strategic planning, possible areas to expand this work might include developing an updated library of materials to communicate with local leaders about climate; expanding outreach, training and education programs; or supporting development of the Marine Information Exchange.

Funding for such data-intensive activities has so far been scarce but is expected to increase. Funding may be directed primarily towards "big" players, like the University of Maine that can mobilize for large-scale data infrastructure, but state-level groups may lack local relationships to make data products relevant to local audiences. It remains to be seen how this tension will be resolved, what role CBEP will play, and whether CBEP can leverage our local knowledge and relationships to access related funds.

Finally, coming years will see an increase in the need for local-scale technical analysis, for example, to understand impact of climate change and sea level rise on tidal wetlands (e.g., SLAMM models of wetland fate under sea level rise), or evaluate impact of sea level rise on specific coastal infrastructure. CBEP already plays a role in these matters, when projects have significant coastal habitat benefits, as discussed under Goal 1. We are already evolving habitat programs to have more of a community resilience focus, thus blurring the distinction between these two areas of CBEP practice. Future expenditures in this area might include development of a local resilience technical assistance fund.

Potential sources of funding include:

- State grant funds, especially via GOPIF, MCP's Coastal Communities Grants, and new grant programs;
- Island Institute ShoreUp grants;
- Maine Community Foundation place-based or community-based grant funds;
- Fee-for-service arrangements with local communities;
- EPA Climate Ready Estuaries funds;
- Federal grant sources, including emerging infrastructure funds;
- AmeriCorps Fellows.

D. Goal 3 Recommendations

Core Funds

Continue to fund Core CBEP staff capacity on outreach, education, and municipal engagement.

Continue to fund Greater Portland Council of Governments (GPCOG) Resilience Fellows to support outreach and municipal engagement programs.

IIJA Funds

Fund a new staff position to strengthen CBEP's ability to provide technical support to municipalities, especially smaller towns to address water quality, habitat protection, and resilience needs. This position should be able to assist small towns with accessing newly available federal funds.

Expand and potentially refocus Community Grants program.

Consider creating a new Citizen Science initiative grounded in a combination of technical assistance and direct grant funding of community-based, school-based, and engaged science.

Define, implement, and expand CBEP's work on Environmental Justice and related DEIJ concerns.

Grant Funds

In association with the New England Environmental Finance Center and other Partners, continue to seek grant funding from both Federal and State sources for work supporting CBEP's work with communities on climate resilience.

Fee-for-Service

Consider "charging" a subsidized rate for providing certain technical assistance services to municipalities, whether by requiring formal cash payments, or dedicated in-kind "match".

Section V. GOAL 4 Mobilize collective knowledge and resources to support Casco Bay

A. Strategy 4.1 Serve as an information hub on Casco Bay issues and initiatives

Funding needs and prospects for Strategy 4.1

Most of the work conducted under this Strategy has historically been funded out of core NEP Funds, and that is unlikely to change.

The primary activities under this Strategy include maintaining a library of Casco-Bay related publications and reports, making the majority of those reports available on-line via the CBEP website, and producing periodic State of Casco Bay reports. More recently, this Strategy has begun to incorporate other types of coordination among CBEP Partners, such as providing Diversity, Equity, Inclusion and Justice (DEIJ) training.

Some National Estuary Programs (in California or Florida) have been able to raise significant grant funds to support specific activities that CBEP includes under this Strategy, such as preparation of "State of the Bay" reports or holding related scientific and technical meetings. Few foundations in Maine are likely to provide significant grants on the scale needed to fully cover costs of such activities, and it appears unlikely that state or local funds will be available for such purposes. Smaller grants could be used to offset a portion of costs, if "fundable" subparts of larger activities can be identified.

Several National Estuary Programs (NEPs) fund scientific meetings principally or entirely out of attendance fees. CCSWCD uses the biennial Maine Stormwater Conference to raise funds for their stormwater-related work, making a small profit from the event in most years. CBEP has not previously used State of Casco Bay events or smaller scientific meetings as opportunities to generate revenue. Instead, we have subsidized those events to a greater or lesser degree to encourage participation.

CBEP is just beginning to focus on environmental justice and DEIJ work. Costs so far have been modest, but this is an area of emerging interest from funders, so resources may be available to expand our efforts in this area, either through EPA's Environmental Justice programs, or from local foundations.

Possible sources of funding for this Strategy include:

- Meeting attendance fees;
- Small grants from Maine Community Foundation or other Maine foundations;
- EPA Environmental Justice Programs.

B. Strategy 4.2 Provide an organizational anchor for initiatives that benefit the Bay

Funding needs and prospects for Strategy 4.2

Currently, most work under this Strategy is funded by CBEP core funds, via support for CBEP staff time. But that is misleading, since CBEP staff raises additional funds for implementing the *Caso Bay Plan* and assists our Partners with funding implementation of portions of the CCMP.

As part of this Strategy, CBEP is charged to lead "place-based planning" on behalf of the Bay. Previous discussions have considered creation of a Fore River initiative, or development of a multi-year intensive stormwater management program in a smaller suburban watershed. In the past, CBEP's place-based planning efforts (e.g., on the Presumpscot or in the New Meadows) have succeeded in large measure because of availability of significant supplemental funds to pay for long-term (1-3 year) collaboration, such as meeting facilitation, and production of documents. If a clear place-based focus emerges during strategic planning, significant funds (~ $100,000 to $200,000) will need to be raised to push regional plans forward. Several federal funding programs and some Maine foundations have previously shown interest in supporting watershed-scale planning.

Formal watershed-based plans have been developed for a moderate number of subwatersheds within the Casco Bay region, principally for lake watersheds. Funding for development of watershed plans all but dried up in 2014, with revisions to federal policy for the "319" grant programs. As a result, many watershed plans in our region are outdated or soon will be. Most plans in our region have been developed by, or with the close involvement of, CCSWCD. Watershed-based plans are required to access certain federal and state grant funds that can jump-start local water quality protection efforts. While those sources of funding are themselves limited, increases are likely under federal Infrastructure funding. An effort to develop watershed-based plans for suburban areas in the lower Casco Bay watershed could pay dividends, by facilitating access to funds. Cost of individual watershed plans can range from a low of perhaps $20,000 to over $100,000. Considering economies of scale and the large number of watersheds involved, an effort like this could take a decade, and probably cost well over $1 million.

Existing levels of effort under this Strategy can continue based largely on core NEP Funds. Expansion of these efforts would require identifying additional funding, perhaps:

- New NEP funding from the IIJA;
- EPA Coastal Watersheds Grants;
- MCP's Coastal Communities Grants;
- Section 319 grants.

C. Strategy 4.3 Expand the scope and coordination of Bay-related environmental monitoring

Funding needs and prospects for Strategy 4.3

Long-term monitoring is both essential for managing coastal waters, and an exceptionally difficult activity to fund from grant-based sources. Grant funders typically want to fund innovation and projects with short-term payoffs. The value of monitoring data grows not as much due to innovation as by consistency of data collection over a period of years.

Currently, about fifteen organizations collect monitoring data in Casco Bay on a regular basis. While CBEP coordinates with these organizations, most are independently funded, and the Partnership has limited influence over monitoring practices or goals.

Friends of Casco Bay now manages three continuous monitoring stations and ten "profile" monitoring stations in Casco Bay, providing the backbone of the Bay's water quality monitoring framework. CBEP provides partial funding for the FOCB monitoring programs, but the bulk of the organization's data collection is funded independently.

CBEP also supports freshwater monitoring (principally in the Presumpscot watershed), invasive species monitoring, and monitoring of alewife returns to Highland Lake. Periodically, CBEP provides funding for monitoring equipment, or to expand existing monitoring programs.

Most other monitoring data is collected to address regulatory or public health concerns, although academic partners are collecting increasingly diverse data on living organisms.

The Casco Bay Monitoring Network (via the Casco Bay Monitoring Plan) has identified significant gaps in Casco Bay monitoring. We lack data on major portions of the Casco Bay food web. Freshwater monitoring is restricted mostly to lakes or to portions of the Presumpscot watershed. We collect little data on nutrients entering Casco Bay from stormwater, CSOs, or river discharge. Long-term "sentinel" monitoring of habitats to detect gradual shifts in the face of climate change remains very limited. Emerging technologies like satellite monitoring of water quality and use of "environmental DNA" offer new insights into coastal processes and potential cost savings for collecting certain kinds of information.

CBEP could invest significantly more in monitoring and not exhaust opportunities to sharpen our understanding of the Bay and how it is changing. We are likely to face difficult choices about which investments are most important for improving our understanding of the Bay and improving management of the Bay.

Because of the difficulty of funding monitoring from short-term grant sources, CBEP funding can be of great strategic importance to regional monitoring. Direct CBEP funding of monitoring, however, can be problematic from an institutional point of view. Most monitoring funding should represent a long-term commitment to data collection. Yet monitoring needs tend to grow over time, and thus monitoring could come to take over a larger and larger share of the CBEP budget. In recent years, CBEP monitoring funding has represented between $55,000 and $100,000 a year. Under current levels of core CBEP funding, that amount cannot increase appreciably without cutting into other program areas.

Thus, a central financing challenge is to identify long-term, stable sources of funding for monitoring. Funding mechanisms for monitoring used by other NEPs vary greatly. Some NEPs play little or no role in monitoring. Others have long-standing partnerships with federal agencies or academic organizations that are responsible both for monitoring and for funding all or most of the monitoring program. The original enabling legislation for the National Estuary Program assigned responsibility for monitoring NEP waters to NOAA, but that has never been implemented, except where NOAA programs overlap with NEP waters. An extensive monitoring program in San Francisco Bay is funded mostly by fees paid by dischargers, principally wastewater treatment plants.

The Casco Bay Monitoring Network helps people and partners coordinate monitoring efforts and learn from each other. CBEP currently staffs the Monitoring Network, with assistance from our EPA Region 1 Manager. The Network would benefit from additional staff capacity to organize more frequent meetings, develop shared information (e.g., on monitoring plans), coordinate data sharing, and otherwise strengthen the work of organizations collecting data on Casco Bay. CBEP has been exploring ways to provide that capacity at moderate cost, by working with UMaine graduate students, or AmeriCorps fellows. The Network, however, would best be supported by a long-term staff member with at least a master's degree level of training putting perhaps 15 % or 20% of their time towards the Network. That suggests this task might require about $15,000. In practice, however, we would need to find a way to support a full-time staff member working on this as well as other scientific projects.

Finally, Casco Bay currently lacks the modeling infrastructure needed to place monitoring data into context. Better understanding of the Bay's hydrodynamics and pollutant loads would go a long way to optimizing deployment of monitoring assets and help clarify implications of the data we already collect. Such models were discussed in detail under Strategy 2.1.

It is unlikely that available funding will meet Casco Bay monitoring needs without significant rethinking of how monitoring is conducted, and how it is funded. Possible sources of funding, monitoring services, and other resources could include:

- Grant funds, for pilot programs, purchases of initial equipment;
- Independent fund-raising by CBEP Partners;
- New partnerships with academic partners, including Gulf of Maine Research Institute, Bigelow Laboratory for Ocean Sciences, and Bowdoin College;
- New partnerships with commercial businesses, especially aquaculture operators;
- Direct funding via municipal budgets or stormwater fees;
- Funding from dischargers, required as a condition of discharge permits;
- AmeriCorps Fellows.

D. Goal 4 Recommendations

Core Funds

Fully support staff time working on Casco Bay report and data archives, and scientific and technical coordination. Continue to support development of technically sound State of Casco Bay Reporting. If Core funding increases, consider hiring a Staff Scientist to lead related programs.

Support a revitalized CBEP Technical Advisory Committee (TAC). The TAC would support development of the expanded hydrodynamic and ecosystem models described above and provide the structure to ensure they address clearly articulated scientific and management needs, including potential impacts of climate change on Casco Bay.

Continue to fund monitoring organizations including Friends of Casco Bay (marine water quality), Presumpscot Regional Land Trust (freshwater quality), and Wells National Estuarine Research Reserve (marine invasives).

IIJA Funds

Most actions under Goal 4 are aimed at building and maintaining relationships and information infrastructure for CBEP, and as such are appropriately supported principally via Core CBEP funds. However, Goal 4 Actions are woven into all CBEP activities, thus as CBEP capacity increases based on hiring using IIJA Funds, a portion of the expanded staff capacity will address Goal 4 needs. IIJA funds could productively be used to establish new monitoring programs (via funding equipment or program development) or developing watershed plans.

Grant Funds

Maine's Climate Council released the "Maine Won't Wait" Report in 2020, outlining a muti-year strategy for reducing greenhouse gas emissions and enhancing the climate resilience of Maine's communities and economy. CBEP was represented on the Council's Coastal and Marine Working Group. CBEP's experience with periodic State of Casco Bay reports provides us with valuable expertise gathering and analyzing data on changes in Maine's Coastal Ocean. CBEP should continue to seek dedicated funding from state and federal sources to support tracking and monitoring of climate change impacts and sharing of related expertise with statewide audiences.

Continue to engage with Gulf of Maine Research Institute, University of Maine, the Roux Institute, and other academic Partners to seek funding and long-term mechanisms to expand monitoring of Casco Bay and Portland Harbor.

Additional State Funding

Given the important role of CBEP shaping state-wide It would benefit the program if a case were made that the state should fund the program at the levels in the 1990s.

FINANCE PLAN APPENDIX 1 – HISTORICAL SOURCES AND USES OF FUNDS

GOAL 1 Protect, restore, and enhance key habitats that sustain ecological health

A. Strategy 1.1. Conserve significant coastal habitats and areas that protect water quality, such as riparian corridors, wetlands and forests adjoining headwater streams

Sources and uses of funds

EPA core funding supports the position of Habitat Program Manager. Core EPA funds also cover a portion of the Director's time that supports CBEP's habitat-related work, including preparing grant proposals, assisting with monitoring of restoration sites, facilitating stakeholder groups, and overseeing and assisting with other tasks. EPA core funds also provide annual funding allotments for the Habitat Protection Fund (HPF).

In the past fifteen years, CBEP has raised grant funding from state, federal, and philanthropic sources to support work related to habitat protection. These funds supported regional coordination of land conservation priorities, collection of data on habitat values, and conservation of protected areas.

Grants received and utilized by CBEP for Habitat Protection projects:

Source	Project	Dates
EPA	Targeted Watershed Initiative for Presumpscot River	2007-2010
NEIWPCC	Fringing Marsh Mapping	2007
MCP	Shorebird population monitoring collaboration	2009-2011
Maine Community Foundation Environmental Funders Network	Presumpscot Vision, Values and Priorities	2009- 2015

The bulk of the money needed for habitat protection has been raised by CBEP Partners, especially land trusts. The Casco Bay region is blessed with an active land trust community. Cumulatively, the fraction of the Casco Bay watershed lands under permanent protection had grown to 14.2% by 2020, principally under land trust leadership. Local and regional land trusts have been highly successful raising funds to support habitat protection. Sources include public donations, foundations, service clubs, municipal budgets, state grants, and federal grants, among others.

Key sources include:

- Maine-based foundations, including the Maine Community Foundation;
- Land for Maine's Future Fund;
- Maine Natural Resources Compensation Program (MNRCP);
- National Wetlands Grants;
- NOAA's Coastal and Estuarine Land Protection (CELP) program;
- Natural Resources Conservation Service;
- Direct donations;
- Municipal funding.

The HPF provides financial support for local efforts to permanently protect habitat in the Casco Bay watershed that benefit water quality or the Bay. HPF grants were typically about $25,000 in 2010, but recent grants have been smaller, more often $5,000 to $10,000.

Since 2000, the HPF has awarded grants to support 56 habitat protection efforts, working with 27 Partners (including land trusts, municipalities and state agencies), protecting land in 27 municipalities. Cumulatively, the projects have permanently protected 10,429 acres, leveraging the investment of National Estuary Program funds about 39:1. Organizations to which funds have been provided usually dedicate match to CBEP for reporting to EPA. A decade ago, habitat protection projects provided a significant fraction of CBEP's total non-federal match in some years.

B. Strategy 1.2. Restore and enhance coastal habitats and habitat connectivity that are important to sustaining the health of Casco Bay

Sources and uses of funds

EPA core funding supports the position of Habitat Program Manager and Executive Director/Chief Scientist and provides annual funding allotments for both habitat restoration and aquatic connectivity. Annual budget allocations for contracts and grants to support this Strategy vary but are typically about $10,000 to $20,000 annually. In addition, most of the Habitat Program Manager's time is spent implementing this strategy.

In the past fifteen years, CBEP has directly received grant funds to support several fish passage and habitat improvement projects. Although the Harpswell and Maine DOT projects are presented as grants here, in each case, CBEP provided specified services regarding tidal marsh monitoring and assessment. These projects are thus examples of CBEP providing services to "customers" on a "fee-for-service" basis.

Source	Project	Dates
Gulf of Maine Council on the Marine Environment (GOMC)	Smelt Hill dam riparian buffer restoration	2005-2006
Maine Community Foundation	Habitat collaboration	2020
GOMC/NOAA	Engineering design at Thomas Bay Marsh/Adams Road	2011-2012
Maine DOT	Restoration monitoring at Long Marsh/Doughty Cove	2013-2019
Maine Natural Resource Conservation Program	Restoration monitoring at Appletree Marsh/Wallace Shore Road	2014-2015
Town of Harpswell and Maine Coastal Program (MCP)	Restoration feasibility study at Basin Point Road	2017-2018
MCP/NOAA	Site mapping at Long Marsh and Skitterygusset Brook	2018-2020
EPA	Greater Research Opportunities Fellow	2015
MCP/NOAA/The Nature Conservancy (TNC)	Living Shoreline	2018-2020
EPA Climate Ready Estuaries	Oyster shell recycling	2018-2021

However, most habitat restoration projects that CBEP facilitates are not represented among the grants in the table, as most restoration funding travels through our Partner organizations. Few habitat restoration projects can be directly implemented by CBEP, as our fiscal host, the University of Southern Maine, is reluctant to take on related long-term potential liability. Thus, just as for habitat protection efforts under Strategy 1.1, much of the funding for habitat restoration under the CCMP flows through other organizations, including conservation organizations, municipalities, and the Cumberland County Soil and Water Conservation District.

Considering both CBEP grants and grants to other organizations for habitat restoration, the following sources have been particularly important over the last few years:

- EPA, especially supplementary funds through the National Estuary Program;
- Maine's Natural Resources Conservation Program (MNRCP);
- NOAA Habitat Restoration Grants;
- Maine Municipal Stream Crossing Upgrade Grant Program;
- Section 319 Nonpoint Source Watershed Protection Grants;
- TNC;
- MCP.

Prior to 2014, habitat restoration and connectivity funding directly paid for or subsidized small habitat restoration projects via CBEP's Community-Based Habitat Enhancement Grant Program. The program was discontinued, as costs of suitable projects continued to climb, and other state-level funding avenues became more available. The program supported projects like the following:

- Town of Falmouth for East Branch habitat enhancement;
- Cumberland County Soil and Water Conservation District (CCSWCD) for Youth Conservation Corps Smelt Hill habitat enhancement;
- City of South Portland for Trout Brook habitat improvements;
- Town of Yarmouth for Rolling Stones project to remove granite blocks and open fish passage on the Royal River;
- Western Foothills Land Trust for Moon Valley tree planting along the Crooked River.

Grantees provided match to CBEP for reporting to EPA.

Largely because of the increasing costs of habitat restoration projects, the Community-Based Habitat Enhancement Grant Program was discontinued, and our focus shifted to providing technical assistance and funding for preliminary site investigations and monitoring. The goal is to queue up projects and facilitate applications to raise primary project funds, from other federal or state sources.

In conjunction with its Partners, from 2015 to 2021, CBEP supported more than thirty aquatic connectivity, tidal restoration, and ecosystem restoration projects through a combination of direct funding and technical assistance.

Aquatic Connectivity

- TNC for fish passage assessment on the Royal River;
- Royal River Alliance (RRA) for World Fish Migration Day event;
- USM for improving and monitoring alewife passage on Mill Brook;

- Trout Unlimited (TU) for engineering study on removal of dams on Frost Gully Brook;
- MCP for Casco Bay stream restoration assessment;
- Wells National Estuarine Research Reserve (Wells Reserve) for utilization of environmental DNA methods for detecting presence of rainbow smelt in streams;
- CCSWCD for restoration projects on Trout, Baker, and Mill Brooks, and Totten Road Stream;
- Town of New Gloucester, U.S. Fish and Wildlife Service Gulf of Maine Coastal Program, TNC, and TU for replacement of a perched culvert on Brandy Brook;
- Town of Yarmouth for culvert replacement study on Pratts Brook;
- Cape Elizabeth Land Trust, Town of Cape Elizabeth, and TNC for monitoring river herring run at Alewife Brook;
- RRA for monitoring migratory fish below Bridge Street Dam on Royal River;
- Town of Brunswick for culvert assessment on Mare Brook;
- MCP for Maine Stream Connectivity Work Group;
- Friends of the Presumpscot River for implementation of fish passage at Saccarappa Dam;
- Lakes Environmental Association for restoration projects on the Crooked River.

Tidal Restoration

- MCP and Wells Reserve for CoastWise;
- Town of Phippsburg and Kennebec Estuary Land Trust for restoration feasibility study at Small Point Marsh;
- Town of Cape Elizabeth for culvert assessment and prioritization study;
- City of South Portland for restoration design alternatives at Mildred Street Pond;
- Bates College for study of methane emissions from restored tidal wetlands;
- Town of Harpswell for tidal restoration at Mill Cove;
- Town of Falmouth for site assessment at Mill Creek;
- Town of Freeport for monitoring at the Cousins River.

Enhancing Ecosystem Functioning

- MCP and Goodwill of Northern New England for shell recycling pilot project;
- Bigelow Laboratory for Ocean Sciences for study of use of shell in aquaculture;
- Downeast Institute for study of use of shell in ocean acidification remediation;
- MCP for study of Living Shorelines infrastructure practices;
- TNC for artificial oyster bed creation;
- U.S. Geological Survey (USGS) and Eelgrass Consortium for eelgrass transplanting;
- University of New Hampshire (UNH) for study of eelgrass restoration success;
- EPA for study of measurement of ecosystem services in salt marshes.

Organizations to which funds were provided gave match to CBEP for reporting to EPA.

GOAL 2 Reduce nutrient pollution and its impact, including coastal acidification

A. Strategy 2.1 Fill the gaps in scientific understanding of Casco Bay's nutrient sources, processes and impacts that are needed to guide policy and management decisions

Sources and uses of funds

EPA core funding and the Maine state appropriation support the position of Executive Director/Chief Scientist, and EPA core funding provides allotments for specific projects included in the annual Workplan.

In the past fifteen years, the following grant has been received and utilized by CBEP for Nutrient Sources projects:

Source	Project	Dates
EPA / Interagency Nutrient Sensor Challenge	Deployment of high frequency nitrogen analyzer in Portland Harbor	2017-2019

In conjunction with its partners, CBEP supported the following projects that improved our understanding of nutrient science for Casco Bay with financial and technical assistance from 2015 to 2021:

- University of Maine (UMaine) and USM for deployment of GreenEyes NuLAB land-based autonomous nutrient monitor and deployment of National Oceanography Centre submersible sensor and analysis of nutrient samples;
- UMaine for deployment of LOBO monitoring buoy near Portland's East End;
- UMaine for improving nitrogen loading estimates from three rivers;
- UMaine for development of FVCOM circulation model;
- New England Environmental Finance Center (NEEFC) for review of nitrogen removal technologies for urban areas stormwater management.

B. Strategy 2.2. Encourage use of green infrastructure to reduce nutrient pollution from runoff

Sources and uses of funds

EPA core funding and the Maine state appropriation support the position of Executive Director/Chief Scientist, and EPA core funding provides allotments for specific projects included in the annual Workplan.

In the past fifteen years, the following annual gift has been received and utilized by CBEP for Pollution Reduction projects:

Source	Project	Dates
PWD	PWD pumpout boat contribution	Annually

In conjunction with its partners, CBEP supported the following Pollution Reduction projects with financial and technical assistance from 2015 to 2021:

- Friends of Casco Bay (FOCB) and PWD for recreational vessel pumpout program;`
- LCWMD for meeting water quality goals of Long Creek;
- CCSWCD for biannual Stormwater Conference.

Organizations to which funds or technical assistance were provided gave match to CBEP for reporting to EPA.

C. Strategy 2.3. Advance policies and regulations that minimize nutrient pollution and coastal acidification

Sources and uses of funds

EPA core funding and the Maine state appropriation support the position of Executive Director/Chief Scientist, and EPA core funding provides allotments for specific projects included in the annual Workplan.

In conjunction with its partners, CBEP supported the following Policy-related projects with financial and technical assistance from 2015 to 2021:

- CCSWCD, FOCB, DEP, City of Portland, City of South Portland, PWD, UMaine, Maine Water Environment Association (MEWEA) and others for Casco Bay Nutrient Council;
- DEP and EPA for Portland Area Nitrogen Group (PANG) to identify nitrogen thresholds for coastal waters of the Portland metropolitan area;
- Consensus Building Institute for facilitation services for PANG;
- New England Environmental Finance Center (NEEFC) for study of Low Impact Development approaches to controlling nitrogen pollution;
- City of Portland for "Tier 3" Combined Sewer Overflow remediation program;
- Organizations to which funds were provided gave match to CBEP for reporting to EPA.

D. Strategy 2.4. Seek long-term solutions for funding stormwater management and constructing stormwater infrastructure

Sources and uses of funds

EPA core funding and the Maine state appropriation support the position of Executive Director, and EPA core funding provides allotments for specific projects included in the annual Workplan.

In the past fifteen years, the following grants have been received and utilized by CBEP for Stormwater Financing projects:

Source	Project	Dates
MCP and City of Portland	Support for public outreach regarding stormwater fee implementation	2012
EPA	New England Environmental Finance Center (CBEP's Director was initial Principal Investigator)	2016-2021

In conjunction with its partners, CBEP supported the following Stormwater Financing projects with financial and technical assistance from 2015 to 2021:

- City of Portland for Water Quality Stakeholders Group;
- City of Portland for Integrated Planning Process;
- CCSWCD for Interlocal Stormwater Working Group;
- City of Portland for stormwater fee implementation and evaluation.

Organizations to which funds were provided gave match to CBEP for reporting to EPA.

GOAL 3 Foster resilient communities and their connections to Casco Bay

A. Strategy 3.1. Strengthen appreciation for the cultural, ecological & economic values of Casco Bay

Sources and uses of funds

EPA core funding supports the position of Community Engagement Coordinator, provides annual funding allotments for the Community Grant program, and provides funding allotments for specific projects included in the annual Workplan.

In the past fifteen years, the following support has been received and utilized by CBEP for Community Engagement projects:

Source	Project	Dates
Island Institute	Island Fellow	2014-2016
GPCOG	Resilience Corps Fellow	2021

From 2016 to 2021 CBEP's Community Grant Program awarded 33 grants for projects like the following:

- Chebeague Island Community Association for an aquaculture festival;
- Harpswell Heritage Land Trust for a junior ranger program;
- Kennebec Estuary Land Trust for community clam conservation;
- Friends of Pope Preserve for informational signs;
- Lakes Environmental Association for shifting Living Connections curriculum to online format;
- Falmouth Land Trust for Millcreek bioblitz;
- Yarmouth School District for shareable art lessons for high school.

Grantees provided match to CBEP for reporting to EPA.

In addition to the community grants program, and in conjunction with its partners, CBEP supported the following Community Engagement projects with financial and technical assistance from 2015 to 2021:

- PWD for education programs including TroutKids;
- CCSWCD for education programs including CONNECT and Children's Water Festival;

- Waterfront Alliance for outreach and the One Climate Future initiative of Portland and South Portland;
- Maine Environmental Education Association (MEEA) for digital learning programs;
- Maine Center for Business and Economic Research and Institute for the Blue Economy for study of economic contribution of Casco Bay;
- Island Institute for island naturalist to deliver education programs on Long Island;
- Island Institute for educator to establish experimental seaweed aquaculture program on Long Island;
- Stewardship Network of New England/Nature Groupie Network for promoting volunteer opportunities;
- Tidelands Coalition for Marine Science and Next Generation Science workshops for Brunswick educators;
- King Middle School in Portland for development of Public Service Announcements on water quality challenges.

Organizations to which funds were provided gave match to CBEP for reporting to EPA.

B. Strategy 3.2. Improve local policies and practices to better protect the Bay

Sources and uses of funds

EPA core funding supports the position of Community Engagement Coordinator, provides annual funding allotments for the Casco Bay Coastal Academy program, and provides funding allotments for specific projects included in the annual Workplan.

In the past fifteen years, the following grant has been received and utilized by CBEP for Local Practices projects:

Source	Project	Dates
MCP/NOAA	Coastal Academy	2018-2020

In conjunction with its partners, CBEP supported the following Local Practices projects with financial and technical assistance from 2015 to 2021:

- GPCOG, CCSWCD, and NEEFC for Coastal Academy workshops for municipal officials;
- City of Portland for Harbor Non-Federal Dredge Working Group;
- GPCOG for Casco Bay Community Guidebook.

C. Strategy 3.3 Help communities prepare for climate change impacts and resulting economic, cultural and ecological disruptions

Sources and uses of funds

Climate Preparedness

EPA core funding supports the position of Community Engagement Coordinator and provides funding allotments for specific projects included in the annual Workplan.

In the past fifteen years, the following grants have been received and utilized by CBEP for Climate Preparedness projects:

Source	Project	Dates
Wells Reserve and Island Institute	Social Resilience Maine	2020-2021
GOPIF	Community Resilience Pilot Project	2021-2022

In conjunction with its partners, CBEP supported the following Climate Preparedness projects with financial and technical assistance from 2015 to 2021:

- Wells Reserve and Towns of Brunswick, Harpswell, Phippsburg, and West Bath on Social Resilience Project;
- NEEFC and DEP for climate resilience financing series for municipalities;
- Wells Reserve and Island Institute for coastal hazard event exercise;
- GOPIF and NEEFC for resilience project in Harpswell, Phippsburg, and West Bath;
- Island Institute, MCP and NEEFC for ShoreUp Maine conference.

Organizations to which funds were provided gave match to CBEP for reporting to EPA.

Climate Science

EPA core funding and the Maine state appropriation support the position of Executive Director/Chief Scientist, and EPA core funding provides allotments for specific projects included in the annual Workplan.

In the past fifteen years, the following grants have been received and utilized by CBEP for Climate Science projects:

Source	Project	Dates
EPA Climate Ready Estuaries	Sea level rise tool	2004-2005 & 2011-2014
MCP/NOAA	Sea level rise and Casco Bay's wetlands	2012-2013
EPA Climate Ready Estuaries	Climate vulnerability assessment	2016-2017
EPA Climate Ready Estuaries	Sea Level Affecting Marshes Model (SLAMM)	2017-2018

In conjunction with its partners, CBEP supported the following Climate Science projects with financial and technical assistance from 2015 to 2021:

- GOPIF and MCP for Maine Climate Council;
- EPA for risk-based assessment of climate change vulnerabilities of CBEP programs;
- Warren Pinnacle for SLAMM;
- EPA, Piscataqua Region Estuaries Partnership (PREP), and NEEFC for Coastal Adaptation to Sea Level Rise Tool;
- MCP for study of sea level rise in ten coastal communities.

GOAL 4 Mobilize collective knowledge and resources to support Casco Bay

A. Strategy 4.1 Serve as an information hub on Casco Bay issues and initiatives

Sources and uses of funds

EPA core funding supports the positions of Executive Director, CBEP Program Manager, and Community Engagement Coordinator, and provides funding allotments for specific projects included in the annual Workplan.

In conjunction with its Partners, CBEP supported the following Information and Issues projects with financial and technical assistance from 2015 to 2021:

- FOCB for Baykeeper to serve as Maine Ocean and Coastal Acidification Partnership (MOCA) Coordinator;
- Maine Coast Fishermen's Association for Casco Bay Stories;
- Maine Board of Pesticides Control for pesticides sampling of pyrethroid pesticide residues in Casco Bay sediment;
- City of Portland Water Resources for Environmental Justice Workgroup;
- Kelly Chadbourne for regional watershed and informational maps;
- Waterview Consulting for State of Casco Bay report and fact sheets.

Organizations to which funds were provided gave match to CBEP for reporting to EPA.

B. Strategy 4.2 Provide an organizational anchor for initiatives that benefit the Bay

Sources and uses of funds

EPA core funding supports the positions of Executive Director, Habitat Program Manager, and Community Engagement Coordinator, and provides funding allotments for specific projects included in the annual Workplan.

In the past fifteen years, the following grants have been received and utilized by CBEP for Initiatives projects:

Source	Project	Dates
GOMC	Feasibility study for the New Meadows River	2005-2006
Maine Outdoor Heritage Fund	Presumpscot River Paddling Map and Guide	2014-2015

In conjunction with its partners, CBEP supported the following Initiatives projects with financial and technical assistance from 2015 to 2021:

- Sebago Clean Waters for protecting water quality in Sebago Lake;
- GPCOG for Casco Bay Shellfish Working Group;
- Community Works for New Meadows Watershed Partnership;
- CCSWCD for LCWMD;
- RRA for restoring natural processes of the Royal River;
- Friends of the Presumpscot River for Presumpscot River Watershed Coalition;

- CCSWCD for Concord Gully Brook Watershed Management Plan.

Organizations to which funds were provided gave match to CBEP for reporting to EPA.

C. Strategy 4.3 Expand the scope and coordination of Bay-related environmental monitoring

Sources and uses of funds

EPA core funding supports the positions of Executive Director and CBEP Program Manager and provides funding allotments for specific projects included in the annual Workplan.

In the past fifteen years, the following special funding awards have been received and utilized by CBEP for Monitoring projects:

Source	Project	Dates
EPA	National Coastal Condition Assessment	2006-2011
EPA	Ocean acidification (OA) monitoring station	2014-2017
EPA	OA data management	2020-2021

and the following gift has been received and utilized:

Long Island Community Land Operating Company	Removal of invasive plants	2016

In conjunction with its partners, CBEP supported the following Monitoring projects with financial and technical assistance from 2015 to 2021:

- FOCB for water quality monitoring and continuous stations;
- Wells Reserve for Marine Invader Monitoring and Information Collaborative (MIMIC);
- Presumpscot Regional Land Trust (PRLT)/Presumpscot River Watch for freshwater monitoring;
- USM for alewife monitoring;
- Massachusetts Office of Coastal Zone Management (CZM) for Rapid Assessment Survey of marine invasives;
- EPA for Monitoring Network;
- Northeastern Regional Association of Coastal Observing Systems for OA data management;
- MCP for installation of rod surface elevation tables (rSETs);
- USGS for reinstallation of stream gage on Royal River;
- UNH for continuous OA station;
- Ramboll Environ for assessment of toxics in Casco Bay sediment.

Organizations to which funds were provided gave match to CBEP for reporting to EPA.

FINANCE PLAN APPENDIX 2 – SUMMARY OF PRIOR FINANCE PLANS AND STUDIES

A. Casco Bay Estuary Program Finance Plan, June 1996

The “Casco Bay Estuary Program Finance Plan June 1996” is apparently the only Finance Plan of Casco Bay Estuary Partnership that has been formally adopted by the Board or Management Committee. Financial strategies were developed with the help of external contractors in 2002 and 2008. A brief financial opportunities analysis was included as an addendum to the *Casco Bay Plan 2016-2021*.

Workplans and associated budgets filed in conjunction with CBEP's funding request to EPA contain significant financial details. They function as complementary short-term finance planning documents. Currently CBEP submits workplans annually.

The 1996 Finance Plan was created in conjunction with the first CCMP and was formally adopted in fall of 1996. That plan anticipated receiving continued funding from EPA and from Maine Department of Environmental Protection (DEP). It planned to use those core funds for three purposes:

a. Staff support for the Casco Bay Implementation Committee's CCMP implementation efforts;
b. Actions outlined in the *Casco Bay Plan*;
c. Priority components of a Monitoring Program that assesses changes in toxic pollution, stormwater and combined sewer overflow loading, clam-flat and swimming area status, and development impacts on the Casco Bay ecosystem.

The 1996 Plan envisioned fundraising and new financing mechanisms to replace projected declines in EPA funding. In fact, EPA funding dropped substantially around 1996, as CBEP transitioned from developing to implementing our initial CCMP.

B. Chapman Consulting Study, 2002

In 2002, Chapman Consulting reported the results of a study of CBEP's financing in *"Sustainable Financial Strategy for Casco Bay Estuary Project."* They suggested developing new funding sources through partnerships, municipalities, USM, and water utility fees.

CBEP has been successful in leveraging partnerships, including those with municipalities and wastewater treatment facilities, to implement the CCMP. Municipalities directly implement municipal stormwater management programs and fund the work of the Interlocal Stormwater Working Group (administered by the Cumberland County Soil and Water Conservation District). CBEP strongly supported establishment of Portland's stormwater service charge, which now generates millions of dollars annually for stormwater management and CSO remediation. Towns have also contributed essential non-federal funds towards several CBEP-led restoration projects. Local partnerships, however, have not evolved into a long-term source of funds for CBEP operations. They are unlikely to do so unless CBEP can offer a clear value proposition to elected officials regarding a suite of services CBEP would offer in return for consistent funding.

USM continues to support CBEP via reduced indirect costs, significant assistance with grants management, and small amounts of supplementary funding, but it has never been a significant source of cash.

C. Varn Associates Report, 2008

Varn Associates presented their *"Recommended Strategy for Funding Diversification 2008-2011"* to Casco Bay Estuary Partnership in 2008. Their report noted "the inherent vulnerability of high dependence on federal dollars" and provided the following list of possible novel funding mechanisms:

- Fees like mooring and boat registration;
- Abutter donations;
- Saltwater fishing licenses;
- Fines.

None of these concepts for additional funds have proven very successful.

Strict limits on use of EPA funds for direct fundraising make development of an effective structure for soliciting donations challenging. Moreover, donations are a critical component of the financial strategy of Friends of Casco Bay (FOCB), which directly implements important components of the CCMP, especially monitoring. Ideally, efforts by CBEP to solicit donations should complement, not compete with FOCB.

In principle it would be possible for CBEP to receive a portion of the funds generated by mooring fees, saltwater fishing licenses, and other coastal user fees. In Maine, however, such funds are typically already dedicated to support local and state agencies working in the coastal zone. Allocating a portion of these funds to CBEP would likely require legislative action and would spur opposition from entities already reliant on these funds. While not impossible, developing these funding sources would take a significant investment of time and political capital, and thus the strong support of the Management Committee.

Maine DEP has invited CBEP several times to propose projects to be funded as "Supplemental Environmental Projects" (SEPs). SEPs are "environmentally beneficial projects that a violator agrees to undertake as part of a settlement but is not otherwise legally obligated to perform." In effect, SEPs redirect money that might otherwise be dispersed as fines towards environmentally beneficial actions. CBEP now maintains an informal list of potential projects that may be suitable for a SEP. While no projects implemented by CBEP have been funded this way, a number of projects conducted by Partners have been. This is a viable, if unpredictable, source of funds.