2004

Casco Bay Environmental Monitoring Program

Casco Bay Estuary Partnership

Casco Bay Estuary Project

Casco Bay Environmental Monitoring Program

Revised August 2004

Executive Summary

The goals of the Casco Bay Environmental Monitoring Program are:

- ✉ to measure the effectiveness of management actions and programs implemented under the Casco Bay Plan, and
- ✉ to provide essential information that can be used to redirect and refocus the Casco Bay Plan.

The objectives of the Casco Bay Environmental Monitoring Program are to assess changes in Casco Bay in:

- ✉ loading of pathogens, toxics, nutrients and sediments from stormwater and combined sewer overflows,
- ✉ status of shellfish and swimming areas,
- ✉ impacts to ecological communities from the use and development of land and marine resources, and
- ✉ toxic pollution.

A range of monitoring activities is addressing these objectives. For example, testing for enterococcal bacteria allows us to track the status of swimming beaches and data collected by the Maine Department of Marine Resources is being used to assess trends in the harvesting status of shellfish flats. Several activities, including assessment of habitat loss, conducting a census of bird populations, tracking trends in eel grass coverage and measurement of water quality parameters such as dissolved oxygen are helping us to identify trends in the condition of the bay's ecological communities. Analyses of sediment and tissue contaminant levels are providing data on toxic contamination. In several cases, Casco Bay Estuary Project monitoring activities build on monitoring already being conducted by state, federal, municipal or volunteer agencies.

This document includes monitoring activities that have been ongoing for several years, as well as proposed new or revised monitoring activities that are currently under development.

Casco Bay Environmental Monitoring Program

I. Introduction

The goals of the Casco Bay Environmental Monitoring Program are:

- ✉ to measure the effectiveness of management actions and programs implemented under the Casco Bay Plan, and
- ✉ to provide essential information that can be used to redirect and refocus the Casco Bay Plan.[1]

The objectives of the Casco Bay Environmental Monitoring Program are to assess changes in Casco Bay in:

- ✉ loading of pathogens, toxics, nutrients and sediments from stormwater and combined sewer overflows,
- ✉ status of shellfish and swimming areas,
- ✉ impacts to ecological communities from the use and development of land and marine resources, and
- ✉ toxic pollution.

Testable questions, drafted in the form of null hypotheses, have been established for each of these objectives. A hypothesis is a statistical tool used in testing an assumption about changing environmental conditions. A null hypothesis tests the assumption that no changes in environmental health have occurred as a result of management actions. If the null hypothesis is disproved then changes have occurred. Null hypotheses are used to help ensure that the monitoring activities of the Casco Bay Environmental Monitoring Program are providing quantitative assessments of the effects of management actions. Several of the null hypotheses require assessment of trends over time. With some exceptions, where earlier data exists, the Casco Bay Environmental Monitoring Program will use data collected beginning in 1996/1997[2] as a baseline against which to measure change.

Monitoring activities have been chosen that fit one of the following three criteria:

- ✉ activities that will generate information crucial to assessing the effectiveness of actions listed in the Casco Bay Plan management actions,
- ✉ activities that will provide information relevant to the health of the Casco Bay ecosystem although not directly attributable to the Casco Bay Plan , and
- ✉ activities that serve as indicators of the effectiveness of management action or of ecosystem health.

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[1]EPA. 1991. Monitoring Guidance for the National Estuary Program.

[2]The Casco Bay Estuary Project fiscal year runs from July 1 - June 30. The split year notation refers not to a two-year period but to the summer sampling season that straddles the end of one fiscal year and the beginning of the next.

The Casco Bay Environmental Monitoring Program will be reviewed periodically by an Ad Hoc Advisory Committee and revised as necessary with the approval of the Board. The most recent review and revision was undertaken in spring and summer, 2004. Care will be taken to ensure that the appropriate parameters have been measured and that the null hypotheses have been tested. Modification can be expected as the result of several factors, including:

- ✉ development of new information regarding the health of the Casco Bay ecosystem,
- ✉ changes in the information needs of the Casco Bay Estuary Project as program goals and objectives are modified,
- ✉ development of new monitoring methodologies which are appropriate, and
- ✉ changes in funding which may alter the level of monitoring activity in any given year.

Where appropriate, the Casco Bay Environmental Monitoring Program is coordinated with ongoing monitoring activities carried out by other organizations. These include but are not limited to: the Maine Department of Environmental Protection's (DEP) biennial assessment of water quality classification attainment, waterbird surveys conducted by the Maine Department of Inland Fisheries and Wildlife (IF&W), the Maine Department of Marine Resources' (DMR) eelgrass monitoring program and sampling of shellfish harvesting areas for pathogens, mussel tissue analysis conducted by Gulfwatch, and lobster tissue analysis conducted by the Surface Waters Ambient Toxics Monitoring Program. Other organizations conducting monitoring in Casco Bay and its watershed include the Portland Water District, Friends of Casco Bay, The US Geological Survey, Friends of the Royal River, and Presumpscot Riverwatch. The participation of other organizations is noted, as appropriate, in the Casco Bay Environmental Monitoring Program.

II. The Casco Bay Environmental Monitoring Program

The organization of the Casco Bay Environmental Monitoring Program is based on the goals and objectives of the Casco Bay Plan. Each set of goals and objectives is followed by one or more monitoring objectives, null hypotheses, and monitoring activities designed to test these hypotheses.

Casco Bay Plan goal:

Minimize the loading of pathogens, toxics, nutrients and sediments from combined sewer overflows to Casco Bay

Casco Bay Plan objectives:

- ✉ Reduce loading from combined sewer overflows.
- ✉ Reduce loading from existing and new nonpoint sources.

Monitoring objective:
Assess changes in the volume of combined sewer overflow effluent and the frequency of overflow events from combined sewer overflows to Casco Bay.

Null hypothesis:
The volume of combined sewer overflow effluent and the frequency of overflow events will not decline significantly ($p \leq 0.05$) with the implementation of combined sewer overflow plans.

Ongoing monitoring activity #1:

Combined sewer overflow abatement assessment. In 1996 there were 59 active combined sewer overflows discharging to Casco Bay, located in Portland, South Portland and Westbrook. These communities were required by DEP and EPA to establish implementation plans for reducing combined sewer overflows and must monitor progress towards the goals of these plans. South Portland is nearing completion of the stormwater-sewer separation projects identified in its combined sewer overflow implementation plan. Flows are measured continuously in all combined sewer overflows located in South Portland; the data is transmitted to DEP on a monthly basis. Portland and Westbrook model flows based on data from selected combined sewer overflows rather than measuring actual flow in all combined sewer overflows. The models predict the frequency, volume and duration of combined sewer overflow activity. In addition to measuring or estimating total flows, the communities also record the frequency of combined sewer overflow events.

Data on flows are collected annually from DEP's Division of Engineering and Technical Assistance. The data is compiled to allow for annual comparisons of flow from individual combined sewer overflows as well as total combined sewer overflow flow to Casco Bay. As of 2003, there were 34 CSOs remaining in Portland, 8 in South Portland and 5 in Westbrook.

Time interval: annual
Responsible organization:

- The cities of Portland and South Portland collect information on past, current and projected flows within their jurisdictions and submit it to DEP.
- DEP provides data on flows to Casco Bay Estuary Project

Outcome: Information is used to track compliance of municipalities with their combined sewer overflow implementation plans.
Estimated cost to the Casco Bay Estuary Project: Staff time for collecting data from DEP.

Monitoring objective:
Assess indicators of loading of toxics from stormwater to Casco Bay.
Null hypothesis:
The loading of toxics from stormwater will not increase significantly ($p \leq 0.05$) over time.

Proposed/Under development monitoring activity #2:
Stormwater control analysis. There is currently little data available in the Casco Bay watershed on the contribution of toxic contaminants to the Bay from nonpoint source runoff.
Levels of toxic contamination (metals and organic contaminants) will be analyzed in stormwater collected by the cities of Portland and South Portland at sites where stormwater has been separated as a result of the combined sewer overflow program. Samples will be collected and analyzed beginning in 2004/2005 and repeated over multiple years. Maine DEP will request assistance from the Region 1 EPA laboratory for analysis and interpretation of the levels of toxics in the stormwater.
A sampling design will be completed before initiation of the study that will include details of the procedures to be employed in analysis of the samples, QA/QC protocols, statistical tests to be used and expected performance.
Time interval: annual
Responsible organization: The cities of Portland and South Portland will collect the samples and Maine DEP will request the assistance of the US EPA Region 1 Laboratory for analysis of the samples and interpretation of the results.
Outcome: Improved understanding of the loading of toxics to Casco Bay via stormwater runoff.
Estimated cost to the Casco Bay Estuary Project: Staff time to collect data from USEPA Region 1 Laboratory.

Casco Bay Plan goal:

Open and protect shellfish and swimming areas impacted by water quality

Casco Bay Plan objectives:

- ✉ Increase open shellfish acreage currently impacted by poor water quality.
- ✉ Swimming areas of Casco Bay shall meet bacterial standards.

Monitoring objective:
Assess changes in the status of shellfish harvesting areas.
Null hypothesis:
The acreage of open shellfish habitat will not change over time.

***Ongoing monitoring activity #3*:**
Tracking shellfish harvesting areas. Changes in the acreage of closed and open flats will be tracked using data collected by DMR as part of the National Shellfish Sanitation Program. DMR's benchmark map of shellfish harvesting areas was updated with assistance from the CBEP in 1999-2000 and will be used as the basis for assessing changes in the status of these areas. CBEP has worked with DMR to and others to ensure that the reason for shellfish closures is identified on DMR base maps. The Maine DMR website makes maps of the open/closed status available to the public. In addition, since 1998, the CBEP project *Expanding and Sustaining the Shellfisheries of Casco Bay, Maine* has mapped softshell clam habitat, assessed productivity and opened 300 acres of beds closed due to pollution impacts.
Time interval: annual
Responsible organization:

- Municipalities will coordinate collection of water samples by certified volunteers.
- DMR will implement the National Shellfish Sanitation Program by analyzing water samples and conducting shoreline surveys.
- Casco Bay Estuary Project will compile data provided by DMR and will identify and illustrate trends in the status of shellfish harvesting areas in Casco Bay.

Outcome: Assessment of effectiveness of actions designed to reduce discharge of pathogens to Casco Bay.
Estimated cost to the Casco Bay Estuary Project: Staff time to collect data from DMR

Monitoring objective:
Assess changes in the public health status of swimming beaches.
Null hypothesis:
Pathogen concentrations at swimming beaches do not meet public health standards for water contact.

***Ongoing monitoring activity #4*:**
Monitoring swimming beaches. In response to growing concern about public health risks posed by polluted coastal swimming beaches, a state task force, which includes the Casco Bay Estuary Project, is working to implement the federal Beaches Environmental Assessment, Closure and Health (BEACH) Act of 2000. The Maine Healthy Beaches Program (MHBP) is a voluntary program, which includes public education and water quality assessment components. Its activities include gathering water quality monitoring information from participating town and state beaches, providing technical assistance, and encouraging additional communities and volunteer groups to participate in the program. During the first two years of the program (2002

and 2003), two beaches in the Casco Bay watershed participated in the program, Willard Beach in South Portland and East End Beach in Portland. While there were no closures in 2003, there was an advisory posted on June 10th at Willard Beach, which was lifted on June 11th, and two precautionary advisories at East End Beach due to rainfall. So far in the 2004 sampling season, there have been rainfall closures at Willard Beach, possibly linked to pet waste pollution.
The MHBP is working to recruit additional communities in the Casco Bay watershed. CBEP will assist with the recruitment effort. Data on beach pollution was collected by the Maine DEP in summer 1996 at several Casco Bay swimming areas: Thomas Point Beach in Brunswick, Fort Williams Park in Cape Elizabeth, Mackworth Island and Town Landing in Falmouth, Winslow Park in Freeport and Head Beach in Phippsburg. Several of these beaches showed elevations in levels of Enterococcus bacteria following rainfall events, particularly Fort Williams, Mackworth Isalnd, Town Landing and Winslow Park, where levels exceeded the instantaneous standard for Class SB waters (54/100 ml). If these beaches participate in the MHBP in the future, it may be possible to assess any change in the water quality following swimming events since the 1996 sampling season.

Time interval: as required to test compliance with state water quality classification standards
Responsible organization: DEP and communities participating in the MHBP.
Outcome: Assessment of effectiveness of actions designed to reduce discharge of pathogens to Casco Bay
Estimated cost to the Casco Bay Estuary Project: Staff time to collect data from DEP, MHBP.

Casco Bay Plan goal:

Minimize adverse environmental impacts to ecological communities from the use and development of land and marine resources within Casco Bay and its watershed

Casco Bay Plan objectives:

- ✉ No net loss of aquatic and island habitats living aquatic resource habitat and associated buffers will occur over time.
- ✉ Habitat in Casco Bay shall be of a quality that does not have an adverse effect on the structure and function of the biological community.
- ✉ The miles of rivers, streams and coastal waters meeting water quality classification shall increase annually.
- ✉ The acreage of protected coastal habitat shall increase annually.

Monitoring objective:
Assess loss of living aquatic resource habitat and associated buffers due to the use and development of land and marine resources**.**
Null hypothesis:
No net loss of living aquatic resource habitat and associated buffers will occur over time.

Proposed/Under development monitoring activity #5:

Tracking regulated activities. The loss of different types of living aquatic resource habitat and associated buffers due to development activities has been tracked since 1994 using permit data collected by DEP under the Natural Resources Protection Act, Permit-by-Rule and other state regulations. These activities include, for example, boat ramps, dredging, fill, construction of docks and piers, soil disturbance, and movement of rocks and vegetation. DEP has developed a digital, georeferenced database which is being used to create an annual 1:24,000 scale map of NRPA-permitted activities. Where appropriate, data collected will be cross-referenced with important habitats identified by U.S. Fish and Wildlife Service and the Beginning with Habitat program and compared to State Planning Office data collected on docks and piers. In the period from 1994-1998, the southern Maine region, which includes the Casco Bay, had the highest number of permitted activities coastwide. In addition, the number of Permit-by-Rule activities more than doubled during that period in the region. CBEP will work with DEP to analyze overall trends in permitted coastal development activities during that last ten years.
Time interval: annual
Responsible organization: DEP will compile permit data by municipality and, when possible, attach this data to a geographic information system parcel map. CBEP will analyze long-term trends.
Outcome: Assessment of the effectiveness of actions designed to eliminate net habitat loss and analysis of trends in coastal development and habitat loss.
***Estimated cost to the Casco Bay Estuary Project*:** Staff time to collect and summarize data from DEP for municipalities in the Casco Bay watershed.

Proposed/Under development monitoring activity #6:
Assessing habitat loss. CBEP has worked with NOAA and a task force convened by the State Planning Office(SPO) for the Coastwatch Change Analysis Program (C-CAP) to conduct a "change analysis" using satellite imagery. In addition, CBEP proposes to work with the State Planning Office (SPO), which is developing data on impervious surface in Casco Bay communities, to assess changes over time. The SPO database will be available in late 2005. The NEMO program (Nonpoint Education for Municipal Officials) is also developing GIS coverages of impervious surface in Casco Bay watershed communities. Where appropriate, data collected will be cross-referenced with important habitats identified by the U.S. Fish and Wildlife Service and the Beginning with Habitat program. As the impervious surface data becomes available next year, CBEP will evaluate the overall health of the watershed based on impervious surface and will begin to assess changes over time over the next five years.
Time interval: 2005 and every 5 years
Responsible organization: CBEP will work with SPO and NEMO.
Outcome: Assessment of the effectiveness of actions designed to eliminate net habitat loss.
***Estimated cost to the Casco Bay Estuary Project*:** To be determined

***Proposed/Under development monitoring activity #7*:**

Tracking wetland loss. Since 1995, DEP has been tracking wetland losses based on permits. and can compile wetland loss numbers for activities that impact at least 4,300 square feet. (Activities that impact wetlands but fall under Permit-by-Rule are not tracked by site location by DEP). The information is stored in an ORACLE database and can be sorted by town and wetland type. Loss of wetland functionality is another important consideration in assessing wetland habitat loss. The State Planning Office (SPO) is working towards an assessment of land use around wetlands. Land cover data at a fine scale (5 meter pixels) is expected to be available in 2005. In addition, Wells National Estuarine Research Reserve (WNERR) is developing an Index of Biological Integrity for coastal fringing marshes and has included marshes in Casco Bay in a research study of fish as indicators of wetland health. Over the next five years, CBEP will work with WNERR and other partners to refine wetland health indices for the Casco Bay watershed.

Time interval: five to ten years

Responsible organization:

- Casco Bay Estuary Project proposes to work with DEP to estimate wetland losses over time.
- SPO will assess changes in wetland function due to activities surrounding wetlands.

Outcome: Assessment of the effectiveness of actions designed to eliminate net habitat loss.

***Estimated cost to the Casco Bay Estuary Project*:** Staff time to collect data from DEP and SPO.

***Ongoing monitoring activity #8*:**

Evaluating changes in eel grass. Changes in the acreage of eelgrass beds in the bay are being tracked using DMR's 1:12,000 scale color photography from 1993 as a baseline. Metric quality aerial photography with a scale of 1:12,000 was obtained for Casco Bay in 2001 and 2002. Acquisition of Photography followed guidelines specified in the *NOAA Coastal Change Analysis Program (C-CAP): Guidance for Regional Implementation.* Seth Barker from DMR has recently assessed trends in eelgrass distribution in Casco Bay during the 1993 – 2002 period. He has noted an increase in eelgrass bed acreage in Maquoit Bay. In at least one portion of Maquoit Bay, the increase may be due to a decrease in impacts from mussel dragging. Decreases in eelgrass acreage were noted in other parts of Casco Bay (Board Cove, north of Cousins Island and west of upper Great Chebeague Island.)[3]

Time interval: ten years

Responsible organization:

- DMR conducts the surveys of eelgrass beds and has conducted trends analysis.

Outcome: assessment of the effectiveness of actions designed to eliminate net habitat loss.

***Estimated cost to the Casco Bay Estuary Project*:** Staff time to coordinate with Seth Barker at DMR.

[3]*Eelgrass Distribution and Change Analysis, Casco and Saco Bays*, Seth Barker, Maine Department of Marine Resources, 2004

Monitoring objective:
Assess indices of habitat quality in Casco Bay.
Null hypothesis:
Populations of several species of birds will exhibit no significant downward trend over five years.

Proposed/Under development monitoring activity #9:
Waterbird survey. A periodic survey of sea birds and wading birds is conducted by Maine Inland Fish and Wildlife (IF& W) in collaboration with US Fish and Wildlife in order to characterize changes in sea bird populations in the Bay and elsewhere along the coast. The survey includes species that depend upon Casco Bay for at least some portion of their life cycle. Survey data will be compared to habitat loss data compiled above as well as important habitats identified by the U.S. Fish and Wildlife Service and the Beginning with Habitat program. The survey was conducted in spring and summer of 2000 and will be conducted again in 2005. CBEP and the Maine DEP will ask IF & W to compare the 2000 survey data to an existing 1980 database in order to assess trends over the last twenty years in sea and wading bird populations.
Time interval: 5 years
Responsible organization: IF&W conducts the surveys of waterbirds; US Fish and Wildlife has agreed to assist with development of a bird population indicator.
Outcome: Assessment of the impact of habitat on the structure and function of the biological community; seabird population trends over the past twenty years.
Estimated cost to the Casco Bay Estuary Project: Staff time to collect data from IF&W

Null hypothesis:
The number of occurrences of depleted dissolved oxygen will not vary significantly over time.

Ongoing monitoring activity #10:
Dissolved oxygen monitoring. In 1995, dissolved oxygen was monitored at 29 stations in Casco Bay, including several characterized by restricted flushing as part of a coastwide inventory of areas at risk for low dissolved oxygen and as well as those thought not to be susceptible to the problem. These stations were clustered in the Fore River, Back Cove, the Harraseeket River, Maquoit Bay, Mere Point Bay, Middle Bay, Quahog Bay and the New Meadows River. In 1996, 12 of the sites located in the Harraseekett River, Maquoit Bay, and Quahog Bay were resampled, and 2 new sites in the Cousins River were added. Since1999, CBEP has supported synoptic dissolved oxygen profile monitoring during summer early morning low tides in "hot spots" identified through Friends of Casco Bay's monitoring program. Target areas have included the Harraseeket River, Maquoit Bay, Mere Point Bay, Middle Bay, Quahog Bay and the New Meadows River. The parameters analyzed include: temperature, salinity, conductivity, dissolved oxygen concentration, per cent saturation and depth. Starting in 2001, dissolved inorganic nutrients was added as a measured parameters. In addition, in 2001, we began developing a method for quantitative measurement of chlorophyll. Each summer, the sites and study design are modified to reflect what has been learned from the previous seasons. In

summer 2003, profile monitoring was done exclusively in Quahog Bay, and Total Organic Carbon Samples were collected in the sediments at each site. Summer of 2004, the program will revisit the eight sites monitored in 2001 (four sites each in Quahog Bay and New Meadows) and will compare the data from the two years. The null hypothesis (no significant change in water quality from 2001 to 2004) will be tested for significance at the 95% level. A sampling design is developed before initiation of each study that includes details of the procedures employed in analysis of the samples, QA/QC protocols, statistical tests to be used and expected performance. FOCB provides CBEP with a data report that includes summary statistics.
Time interval: annual
Responsible organization: Casco Bay Estuary Project contracts with FOCB for this monitoring activity.
Outcome: Assessment of the impact of habitat on the structure and function of the biological community.
Estimated cost to the Casco Bay Estuary Project: $10,000 annually

Null hypothesis:
Variation in water temperature, pH, salinity, dissolved oxygen and water clarity in Casco Bay attributable to anthropogenic effects does not vary significantly over time.

***Ongoing monitoring activity #11*:**
Temperature, pH, salinity, dissolved oxygen and clarity monitoring. These parameters are monitored by Friends of Casco Bay citizen volunteers monthly during April through October or monthly throughout the year by BayKeeper boat at 80 stations in Casco Bay. Samples for dissolved inorganic nutrient analysis are collected at the BayKeeper boat sites.
Water temperature, Salinity, Dissolved Oxygen, and pH are measured with a YSI model 6600 DataSonde from the BayKeeper boat. These same parameters are measured by the citizen volunteers using a thermometer, hydrometer, winkler titration, and narrow-range and wide-range pH octet comparators, respectively. Dissolved oxygen is measured by this activity at random times of the day, tide and month; the resulting data does not therefore duplicate data collected by the previous activity. Clarity is measured using a Secchi disc. A Quality Assurance Project Plan for this monitoring activity has been developed by Friends of Casco Bay and accepted by EPA and the Casco Bay Estuary Project.[4] Testing of the null hypothesis will require establishment of levels for each parameter, which signify anthropogenic effects. Analysis of the past eleven years of data and of the new 2004 data will be undertaken in fall/winter 2004/2005.

[4]*Quality Assurance Project Plan for Friends of Casco Bay's Citizen's Water Quality Monitoring Program*, Friends of Casco Bay, South Portland, Maine, 2001.

In addition, since 2000, the CBEP has participated in the National Coastal Assessment (NCA) monitoring program. Water quality samples were collected from a total of 33 sites in Casco Bay in 2000 and 2001 and additional samples will be collected in 2004. NCA measurements include

the following water quality parameters: dissolved oxygen, salinity, temperature, pH, nutrients and
chlorophyll. NCA sampling and analysis follows an EPA-approved QAPP and the Coastal 2000 Field Operations Manual. The NCA data is made available to CBEP after final QA review.

Time interval: annual
Responsible organization: Friends of Casco Bay, CBEP and NCA
Outcome: Assessment of the impact of habitat on the structure and function of the biological community; analysis of trends in water quality in Casco Bay
Estimated cost to the Casco Bay Estuary Project: $40,000 to FOCB; funding for NCA sampling and analysis is provided by the NCA program.

Ongoing monitoring activity #12:
Water quality assessment. The mileage of rivers and streams meeting water quality standards (as defined in MRSA Title 38) is tracked using water quality assessments provided by DEP (305(b) reports). The attainment status is reported as miles of rivers and streams, numbers and acres of lakes, acres of estuaries and coastal waters that do not meet water quality standards (including DMR clam flat closures). Data collected by volunteer water quality monitoring groups is considered by DEP in making water quality assessments. CBEP receives copies of the 305(b) reports from DEP. In addition, EPA has provided CBEP with GIS coverages of water bodies in the watershed not meeting water quality standards. Data on attainment of water quality standards will be compared to important habitats as identified by the U.S. Fish and Wildlife Service.
Time interval: biennial
Responsible organization:

- DEP identifies those waters in the Casco Bay watershed which do not meet their water quality classifications.
- Volunteer water quality monitoring groups will contribute data to aid in this assessment.

Outcome: Assessment of the impact of habitat on the structure and function of the biological community.
Estimated cost to the Casco Bay Estuary Project: Staff time to collect data on attainment of water quality classification from DEP

Monitoring objective:
Assess the acreage of coastal habitat protected by conservation easement or other means.
Null hypothesis:
The acreage of protected coastal habitat will not increase over time.

Proposed/Under development monitoring activity#13:
Identifying protected habitat. The acreage of coastal habitat protected by easement, municipal open space zoning, resource protection zones, government ownership or acquisition has been mapped by the CBEP for 15 towns in the watershed through a partnership with land conservation organizations, U.S. Fish and Wildlife Service and municipalities. The U.S. Fish and Wildlife Service continues to work with local officials and land trusts to utilize the maps to protect land. The maps are currently being updated. CBEP will work with US Fish and Wildlife to assess changes in the acreage protected over time. ***Time interval:*** five years
Responsible organization: US Fish and Wildlife Service
Outcome: Assessment of actions designed to increase the acreage of protected habitat; analysis of trends in protected lands in Casco Bay watershed..
Estimated cost to the Casco Bay Estuary Project: CBEP staff time to obtain information from US Fish and Wildlife Service.

Casco Bay Plan Goal: Reduce toxic pollution in Casco Bay

Casco Bay Plan objectives:
- ⊠ The accumulation of toxics in sediments and biota shall be reduced.
- ⊠ Seafood harvested from Casco Bay shall be safe to eat.
- ⊠ Contamination in Casco Bay shall not have an adverse impact on the biological community.

Monitoring objective:
Assess changes in sediment levels of toxic contaminants**.**
Null hypothesis:
Sediment contaminant levels will not decline significantly ($p \leq 0.05$) over a ten-year period.

Ongoing monitoring activity #14:
Sediment contaminant analysis. Samples of surface sediments are collected every ten years from sites sampled in previous studies in order to detect trends in sediment contamination. Analysis includes, at a minimum, contaminants included in previous studies (metals, PAHs, pesticides and PCBs) as well as an assessment of sediment organic carbon content and grain size. Comprehensive sediment contaminant analysis was conducted in 1991. In 1994, sediments were analyzed for dioxins and furans (PCDD-PCDF), planar PCBs and butyltins. Building on the NCA sampling program, sediment samples were collected in Casco Bay during 2000-2002 from a total of 61 of the 70 original sampling stations. In addition, the NCA partnership funded sampling for 18 additional sites for sediment chemistry and toxicity. Sampling followed protocols used in1991/1994. The NCA program is managed by the CBEP in Maine. Sediment was collected with a Smith-McIntyre grab sampler and the top 2 cm removed, placed in clean glass jars, frozen and shipped to a laboratory for analysis.

The analytical procedures utilized were those of the NOAA National Status and Trends Program, EPA's National Coastal Assessment program, and the U.S. Fish and Wildlife Service trace organic analytical program. QA/QC procedures included analyses of matrix spikes, duplicates and laboratory blanks with each batch of samples. A sampling design was completed before initiation of the study, that described the parameters to be analyzed, the details of the procedures to be employed in analysis of the samples, QA/QC protocols, statistical tests to be used and expected performance. CBEP has contracted with Texas A&M to assess trends/changes in the level of sediment toxics between the 1991/1994 sampling and the 2000-2002 sampling. It is anticipated that this major sediment sampling will be repeated in 2010. In addition, NCA will collect and analyze additional sediment samples in Casco Bay in summer 2004 and, if funding continues, will collect samples every 3 years.
Time interval: ten years (additional samples may be collected every 3 years as part of the NCA monitoring program).
Responsible organization: Casco Bay Estuary Project contracts for this monitoring activity. NCA also contracts for sediment monitoring.
Outcome: Assessment of the impact of habitat on the structure and function of the biological community.
Estimated cost to the Casco Bay Estuary Project: $120,000. NCA also provides funding for sediment sampling.

Monitoring objective:
Assess variation in toxic contaminants in tissues over time and throughout the bay.
Null hypothesis:
Tissue contaminant levels will not vary significantly ($p \leq 0.05$) over time or throughout the bay.

Ongoing monitoring activity #15:
Mussel tissue analysis. Data on blue mussel tissue toxics is available for selected sites in Casco Bay from 1987 onward. The DEP's ongoing Surface Water Ambient Toxics Monitoring Program continues to collect samples along the Maine Coast, including Casco Bay for aluminum, chromium, copper, iron, nickel, zinc, silver, lead, mercury, arsenic, cadmium, pesticides, PAHs, PCBs, coplanar PCBs, dioxins and furans. In addition, in 1996, 1998 and 2001, the CBEP sampled mussels at multiple sites in Casco Bay for the same suite of contaminants. The DEP's Marine Environmental Monitoring Program has established normal baseline reference concentrations (State Benchmark) for metals in mussels, with the exception of arsenic, which is compared to NOAA elevated levels. Organics are compared to elevated levels reported in the National Oceanic and Atmospheric Administration (NOAA) 1998 *Chemical Contaminants in Oysters and Mussels* by Tom O'Connor in NOAA's *State of the Coast Report*. The results of state and CBEP sampling are compared among sites, over time to the State Benchmark levels and to State or national "high" levels. Results are forwarded to the State Toxicologist at the Maine Department of Human Services, Bureau of Health for assessment of risk to human health. Casco Bay was also sampled as part of Gulfwatch in 1997 (Fore River, Presumpscot River and

Royal River), 1998 (Broad Cove), 2000 (Fore River, Presumpscot River and Royal River), and 2001 (Broad Cove). The Gulf watch data set provides a larger context for data collected by the Casco Bay Environmental Monitoring Program. The CBEP is developing a report on *Toxic Pollution in Casco Bay* to be completed in 2005. This document will include an analysis of trends in mussel tissue contamination in the Bay.
A sampling design was completed before initiation of the CBEP and SWAT studies that described the parameters to be analyzed, the details of the procedures to be employed in analysis of the samples, QA/QC protocols, statistical tests to be used and expected performance.
Time interval: biennial
Responsible organization:

- Casco Bay Estuary Project contracts for this monitoring activity through DEP; DEP SWAT Program.
- Gulfwatch carries out this monitoring activity at some sites in Casco Bay.
- Trends analysis is being undertaken by DEP and USEPA.

Outcome: Assessment of the impact of habitat on the structure and function of the biological community.
Estimated cost to the Casco Bay Estuary Project: $10,000 per station.

Ongoing monitoring activity #16:
Lobster tissue analysis. The DEP's Surface Water Toxics Monitoring (SWAT) Program collected lobsters from the Fore River, Presumpscot River and Harpswell in Casco Bay in 1994 and 1995 and had the meat and tomalley analyzed separately for contaminants (metals, PAHs, PCBs, dioxins/furans, pesticides). In 1996 and 1999, CBEP collected lobsters from the bay and analyzed the meat and tomalley according to the SWAT methodology. Twenty lobsters just recruiting to the fishery (1 - 1.25 pounds) were be collected from the sample areas as they were thought to be less mobile than larger, older lobsters and therefore more representative of the area where they are caught. The length or the weight of the lobsters collected was recorded. Because the residence time of lobsters in any given area is unknown, samples were collected from three distinct areas of the bay: Outer Casco Bay, Quahog Bay and New Meadows.
All CBEP lobster analyses were forwarded to the State Toxicologist,Maine Department of Human Services, Bureau of Health for assessment of risk to human health. Results for 1999 were similar to the results found in 1996: levels in meats were acceptable, while levels of dioxin were elevated in Quahog Bay samples. Maine DEP will collect lobster samples at sites in Luckse Sound near Long Island and from the Fore River in 2004. Brominated flame retardants in meat and tomalley will be added to the list of analytes. Through the ongoing National Coastal Assessment program, lobster samples were collected each summer from 2000 to the present along the Maine Coast (including Casco Bay in 2000-2001 and 2004). If the NCA program continues, lobsters will be collected by the NCA in Casco Bay every 3 years. At the request of the DEP and CBEP, the meat and tomalley will be analyzed separately so that the samples will be comparable to other sampling done in Maine. The NCA data may prove helpful in establishing spatial and temporal trends in contamination. A sampling design was be completed

before initiation of the CBEP, NCA and SWAT studies that described the parameters to be analyzed, the details of the procedures to be employed in analysis of the samples, QA/QC protocols, statistical tests to be used and expected performance.
Time interval: DEP annually; NCA every 3 years
Responsible organization:

- NCA
- DEP's SWAT Program will analyze lobster tissues from some Casco Bay sites.

Outcome: Assessment of the impact of habitat on the structure and function of the biological community.
Estimated cost to the Casco Bay Estuary Project: Staff time to collect data from DEP and NCA.

Proposed/Under development monitoring activity #17
Seal tissue analysis. Two years of data (2001-2003) on toxics in the tissues of free-ranging and stranded seals in the Gulf of Maine have been collected by scientists from the Marine Environmental Research Institute, Center for Marine Studies, Blue Hill Bay. The data includes samples from multiple stranded seals in Casco Bay. Tissues were analyzed for PCBs, dioxins, furans, pesticides and heavy metals including mercury. The resulting data will enable us to establish a 2001-2003 baseline for levels of toxics in seal tissues in Casco Bay as well as the ability to compare the Casco Bay to seal data from the rest of the Gulf of Maine. MERI is seeking funding to establish a long-term seal monitoring program in the Gulf of Maine which will establish seals as a high trophic level sentinel species for toxic contaminant accumulation, complimenting the Gulfwatch blue mussel program. The MERI seal sampling program has completed a sampling design, QA/QC protocols and established statistical tests to be used as part of the program.
Time interval: As MERI funding allows.
Responsible organization: MERI
Outcome: Assessment of the impact of habitat on the structure and function of the biological community.
Estimated cost to the Casco Bay Estuary Project: Staff time to collect and evaluate data from MERI

Monitoring objective:
Assess changes in biological indicators in response to variable levels of toxic contamination.
Null hypothesis:
The incidence of invertebrate larvae mortality or developmental abnormalities when exposed to elutriate from Casco Bay sediments will not decline significantly ($p \leq 0.05$) over time.

Proposed/Under development monitoring activity #18:
Sediment toxicity bioassay. .

Sediment samples for toxicity analysis are being collected as part of the National Coastal Assessment monitoring program. CBEP manages the NCA program in Maine. In 2000 and 2001 a total of 30 sediment samples were collected in Casco Bay for toxicity assessment based on *Ampelisca* toxicity significance. NCA sampling and analysis follows an EPA-approved QAPP and the Coastal 2000 Field Operations Manual. Additional sampling will take place in summer 2004 and is expected to take place in Casco Bay every 3 years in the future as NCA funding permits.
Time interval: 2000, 2001, 2004; and as NCA funding permits, every 3 years.
Responsible organization: CBEP, NCA
Outcome: Assessment of the impact of habitat on the structure and function of the biological community.
Estimated cost to the Casco Bay Estuary Project: Funding provided by the NCA

Null hypothesis:
The alteration of benthic community composition attributable to toxic contamination will not decline significantly ($p \leq 0.05$) over time.

Proposed/Under development monitoring activity #19:
Benthic community analysis. Sediment samples for benthic community analysis are being collected as part of the National Coastal Assessment monitoring program. CBEP manages the NCA program in Maine. In 2000 and 2001 a total of 30 sediment samples were collected in Casco Bay for benthic community analysis. NCA sampling and analysis follows an EPA-approved QAPP and the Coastal 2000 Field Operations Manual. Additional sampling will take place in summer 2004 and is expected to take place in Casco Bay every 3 years in the future as NCA funding permits.
Time interval: 2000, 2001, 2004; and every 3 years, as NCA funding permits
Responsible organization: CBEP,
Outcome: Assessment of the impact of habitat on the structure and function of the biological community.
Estimated cost to the Casco Bay Estuary Project: Funding provided by the NCA.

III.QA/QC

QA/QC protocols have been developed for all ongoing monitoring activities originating with the Casco Bay Environmental Monitoring Program. Where Casco Bay Environmental Monitoring Program activities are coordinated with other monitoring programs such as the Surface Waters Ambient Toxics Monitoring Program or Gulfwatch, care is taken to ensure that identical methodologies are used. In many cases, the Casco Bay Monitoring Program is relying on data collected by other organizations and will ensure that QA/QC meets EPA requirements.

IV.Data Management and Distribution

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The Casco Bay data management strategy relies upon a decentralized approach to data management, by forming a network among data collectors so that data users can have ready access to usable information about Casco Bay. The raw monitoring data and database management are the responsibility of the agency or entity that collects it. Every attempt is made to link existing databases to a geographic information system map format. Quality assurance plans are developed in order to ensure that the data collected meets basic quality assurance standards. Data from monitoring sponsored by the Casco Bay Environmental Monitoring Program is analyzed, transformed as necessary, and provided in a standard database format. Sampling stations and other important reference points are geographically referenced so that all monitoring data can be included in a geographic information system database. The data are rigorously reviewed to determine whether or not they are sufficient to test the various null hypotheses. The results of these tests are applied to analyze the effectiveness of the Casco Bay Plan and to assess the overall health of the bay.

The usefulness of the Casco Bay Environmental Monitoring Program depends in part on the extent to which the information generated is communicated to those charged with implementing management actions and, conversely, the extent to which the information requirements of these same managers are incorporated into future iterations of the Casco Bay Environmental Monitoring Program. Casco Bay Estuary Project makes the results of monitoring available through its website, through links to the websites of partner organizations, through scientific reports and fact sheets, and through public presentations.