

MEASURING PROGRESS:

THE CASCO BAY MONITORING PLAN

June 1996

Casco Bay Estuary Project

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Measuring Progress: The Casco Bay Monitoring Plan

Introduction

The *Casco Bay Plan* is committed to preventing pollution, improving water quality, and protecting and restoring important fish and wildlife habitat in Casco Bay. To accomplish these goals, the *Casco Bay Plan* outlines actions to be completed over the next five year period, and sets forth an implementation strategy that will continue protecting the bay into the future.

How will progress toward these goals be measured? Government officials and the public need information to judge progress in protecting and restoring Casco Bay and to document significant changes in the estuary over time. Emphasis is placed on accountability and outcomes with each action focused and cost-effective. To judge progress, the *Casco Bay Plan* has developed this monitoring component to define how progress will be measured, how change will be monitored, and to report these findings to interested parties. There are four separate pieces of the overall monitoring plan for Casco Bay:

- Environmental Monitoring
- Tracking the Progress of Local Governments
- Public Attitude and Action Survey
- Programmatic Monitoring

Taken together, these four pieces will be used to measure change over time.

Environmental Monitoring

Improvement in the environment is the key result sought. To determine if there has been actual change, either improvement or degradation in the environment, an Environmental Monitoring Plan has been developed and is presented as Section 1 of this document. This Environmental Monitoring Plan outlines what indicators will be used to specifically measure outcomes that relate to the goals and objectives of the *Casco Bay Plan*.

Tracking the Progress of Local Governments

Municipalities play a vital role in the protection of Casco Bay. In Maine, home-rule provides municipalities the authority to plan for and regulate land uses within their communities. Municipalities also have the ability to influence the behavior of citizens through the standards that govern land use activities, education in the schools and the types of activities provided in their communities.

Recognizing the vital role municipalities play in protecting Casco Bay, many actions outlined in the *Casco Bay Plan* were designed to assist municipalities in local environmental protection efforts. To track the progress of local efforts and whether or not the actions undertaken are meaningful, a "Municipal Action Checklist" was developed. The checklist covers key government activities affecting the *Casco Bay Plan's* five priority issues.

Section 2 provides a copy of the baseline information obtained from administering the checklist in 1996. This checklist will be administered biennially to measure changes by local communities. The checklist provides the added benefit of acting as a strong guide suggesting where technical assistance is needed by municipalities and in sharing across municipal boundary lines information important from a regional perspective.

Public Attitude and Actions Survey

Households and boaters play a major role in preventing pollution and protecting Casco Bay. Households affect water quality by their use of fertilizers and pesticides, disposal of contaminants, disturbing habitat, and upkeep of private septic systems. Boaters impact water quality by dumping waste, mishandling fuel, and damaging habitat.

Recognizing these issues, the *Casco Bay Plan* places emphasis on educating the public and boaters and encouraging them to act in ways beneficial to the bay. A key issue is the extent to which attitudes and behaviors change over time as a result of effort designed specifically for them.

A statistical survey of households and boats was conducted to provide baseline information on current attitudes and actions. This information will be used immediately to guide program design of current outreach efforts. The survey will be re-administered every five years to assess change over time and determine if the current programs were effective. Section 3 contains a copy of the first survey completed.

Programmatic Monitoring

Programmatic monitoring will be conducted by the Casco Bay Estuary Project for all actions outlined in the *Casco Bay Plan* and a report will be presented to the Implementation Board each July. The first report will be developed by July, 1997 to document progress in undertaking expected actions.

**Casco Bay Environmental Monitoring Program:
Proposed Plan, Estimated Costs and Implementation Schedule**

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Casco Bay Environmental Monitoring Program: Proposed Plan, Estimated Costs and Implementation Schedule

I. 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 proposed to address these objectives. Analysis of combined sewer overflow effluent and stormwater runoff will provide data on pollution loading from combined sewer overflows and stormwater. Testing for enterococcal bacteria will allow the status of swimming beaches to be characterized and data collected by the Maine Department of Marine Resources will be 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 will help to identify trends in the condition of the bay's ecological communities. Analysis of sediment and tissue contaminant levels and a larval bivalve bioassay will provide data on toxic contamination. In several cases, proposed monitoring activities build on monitoring already being conducted by state, federal, municipal or volunteer agencies.

Also included are recommendations for annual review and revision of the Casco Bay Environmental Monitoring Program, quality assurance and quality control protocols, and mechanisms for ensuring that data generated by the Casco Bay Environmental Monitoring Program is useful to managers and available to the public. A five-year schedule is outlined and priorities established for selecting monitoring activities should funding fluctuate.

II. 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, are established for each of these objectives. An 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 will provide quantitative assessments of the effects of management actions. In many cases, implementation of the proposed monitoring activities will require pilot studies to determine the number and placement of stations as well as the statistical analysis required to accept or reject the null hypothesis.

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 in 1996/1997² 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 show promise as indicators of the effectiveness of

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

²The 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.

management action or of ecosystem health.

The Casco Bay Environmental Monitoring Program will be reviewed on an annual basis by the Implementation Committee and revised as necessary. 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.

The Casco Bay Environmental Monitoring Program includes a provision that up to 10% of the funds allocated annually for the Casco Bay Environmental Monitoring Program may be dedicated to testing the application of new monitoring tools in the bay. The Implementation Committee will decide annually if and how these funds are to be expended.

The Casco Bay Environmental Monitoring Program will require a 35% time commitment on the part of the Casco Bay Estuary Project core staff. The time will be required for: issuing requests for proposals, selecting contractors and managing contracts; tracking shellfish closure and combined sewer overflow data, Maine Department of Environmental Protection (DEP) water quality assessments, and habitat alteration permits; and writing annual monitoring reports.

Where appropriate, the Casco Bay Environmental Monitoring Program will be coordinated with ongoing monitoring activities carried out by other organizations. These include but are not limited to: 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) 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, and Presumpscot Riverwatch.

The participation of other organizations is noted, as appropriate, in the Casco Bay Environmental Monitoring Program. Where the activities of other organizations are noted, no attempt has been made to estimate the cost of their monitoring activities in Casco Bay.

III. 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 stormwater and combined sewer overflows to Casco Bay

Casco Bay Plan objectives:

- Reduce loading from combined sewer overflows.
- Reduce loading from nonpoint sources of pollution.

Monitoring objective:

Assess changes in the volume of combined sewer overflow effluent and in the loading of pathogens, toxics, nutrients and sediments from combined sewer overflows to Casco Bay.

Null hypothesis:

The volume of combined sewer overflow effluent and the loading of pathogens, nutrients, toxic contaminants and sediment from combined sewer overflows to Casco Bay will not decline significantly ($p \leq 0.05$) with the implementation of combined sewer overflow plans.

Proposed monitoring activity #1:

Combined sewer overflow abatement assessment. Currently, there are 59 active combined sewer overflows discharging to Casco Bay; they are located in Portland, South Portland and Westbrook (see Figure 1). These communities have been 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 12 combined sewer overflows located in South Portland; the data is transmitted to DEP on a monthly basis. Portland and Westbrook are still finalizing their combined sewer overflow implementation plans. These cities have chosen to 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. Westbrook began submitting annual reports on estimated combined sewer overflow flows to DEP in 1994; Portland should do so in 1996.

In addition to measuring or estimating total flows, these three communities will also conduct limited monitoring of pollutant loads in combined sewer overflow flows. The parameters to be analyzed include: total suspended solids, E. Coli, 5-day biological oxygen demand, total Kjeldahl nitrogen, ammonia, nitrate/nitrite, total phosphorus, petroleum hydrocarbons, polycyclic aromatic hydrocarbons, polychlorinated biphenols, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, silver, zinc, pH, and temperature.

Locations of Combined Sewer Overflows in Casco Bay

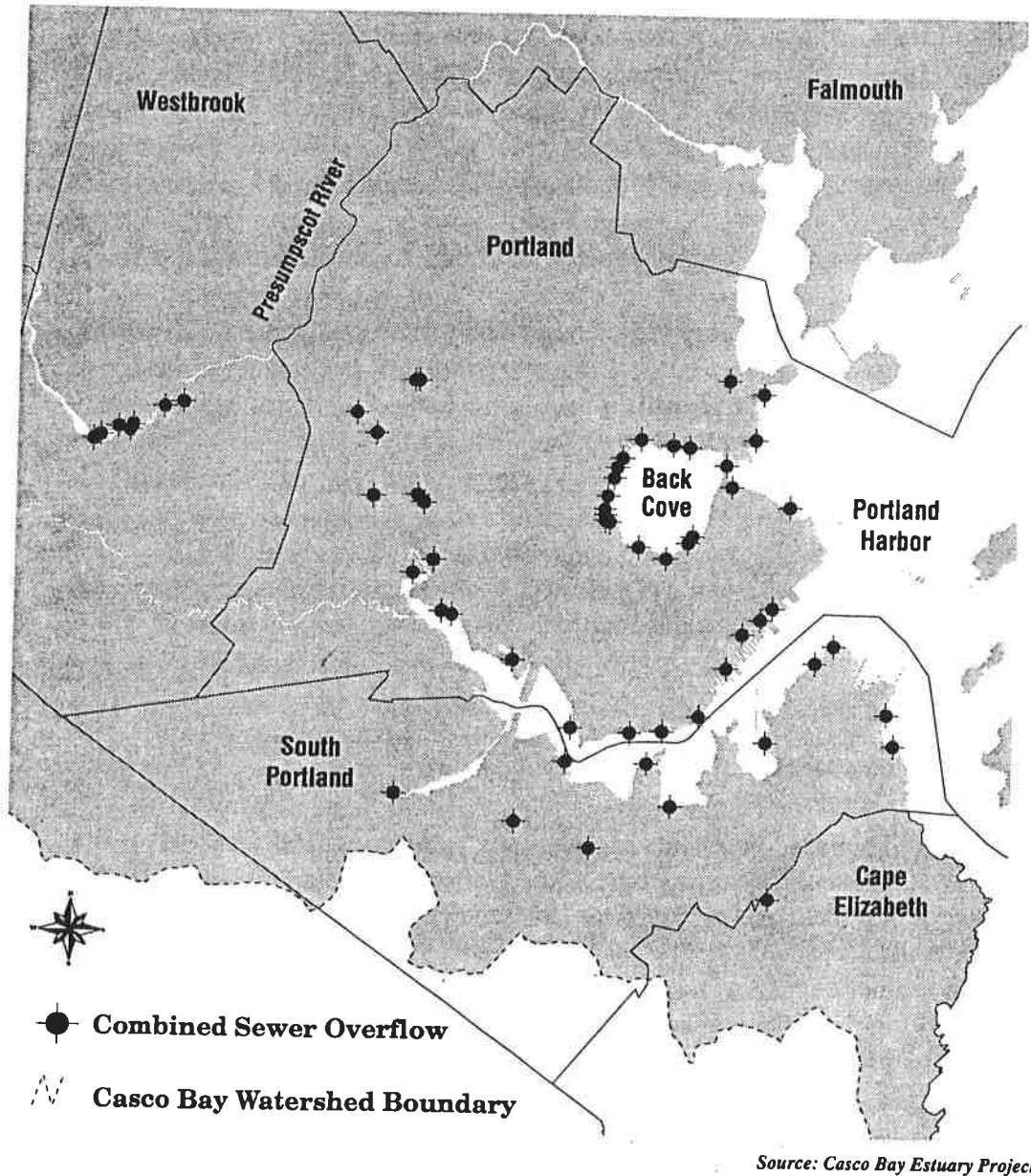


Figure 1. Combined sewer overflows actively discharging to Casco Bay

Data on flows and pollutant loads from South Portland, Portland and Westbrook will be collected annually from DEP's Division of Engineering and Technical Assistance. The data will be compiled to allow for annual comparisons of flow from individual combined sewer overflows as well as total combined sewer overflow flow to Casco Bay. Inferences on trends in pollutant load will be made, as appropriate, from pollutant loading data and from national studies of combined sewer overflow contaminant loads. Friends of Casco Bay will help track municipal efforts to implement combined sewer overflow plans.

Time interval: annual

Responsible organizations:

- The cities of Portland, South Portland and Westbrook will collect information on flows and loading within their jurisdictions and submit it to DEP.
- DEP will provide data on flows and loading to Casco Bay Estuary Project.
- Friends of Casco Bay will serve as a watchdog and prepare an annual assessment of compliance with monitoring program.

Outcome: Information will be 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

Status of data: The Casco Bay Estuary Project geographic information system currently has data describing the locations of 59 active combined sewer overflows discharging to Casco Bay. By July, 1996, recent data on flows and loading from combined sewer overflows in South Portland and Westbrook will be attached to the appropriate points in the geographic information system. Annual data collected thereafter will be attached as monitoring progresses as part of the Project's data management.

Monitoring objective:

Assess indicators of loading of pathogens, toxics, nutrients and sediments from stormwater to Casco Bay.

Null hypothesis:

The loading of pathogens, toxics, nutrients and sediments from stormwater will not increase significantly ($p \leq 0.05$) over time.

Proposed monitoring activity #2:

Stormwater control analysis. Indicators of pathogens, toxics, nutrients and sediments will be analyzed in a subwatershed of Casco Bay over a five year period, including both before and after implementation of best management practices (BMPs) designed to control surface water run off. A subwatershed will be selected which 1) has been channelized into a direct discharge into the lower watershed and not connected to a waste water treatment facility and 2) is scheduled for implementation of BMPs in the second phase of the study. Selection of an appropriate study site may be accomplished by project staff on the basis of interviews with staff of the Cumberland County Soil and Water Conservation District, DEP's Nonpoint Source Pollution Program and municipalities. Alternatively, selection of the site could be incorporated as a requirement in the Request for Proposals as written by project staff for this monitoring activity.

Within the selected subwatershed, flows during several rain events will be sampled: 1) for

at least one year prior to implementation of BMPs, 2) during implementation and 3) for at least two years following implementation. Automatic sampling devices will be used to estimate flow and to collect water samples for laboratory analysis. A minimum of four samples will be collected during each rain event. Individual samples will be composited to produce a sample that represents the entire rain event. The percentage of each sample mixed into the composite will be based on the relative proportion of runoff at the site at the time the sample is taken. The specific parameters to be analyzed will be determined based on the predominant land use in the subwatershed chosen for analysis. If a more rural subwatershed is selected, parameters to be analyzed may be limited to nitrogen, fecal coliform bacteria, and total suspended solids. Selection of a more developed subwatershed will require analysis of additional parameters such as biological and chemical oxygen demand, total nitrogen, ammonia, nitrate/nitrite, total phosphorus, polycyclic aromatic hydrocarbons, polychlorinated biphenols, and selected metals and pesticides.

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, quality assurance/quality control (QA/QC) protocols, statistical tests to be used and expected performance. In addition to the water quality analysis, changes in land use activities within the subwatershed will also be tracked.

Time interval: annual

Responsible organization: The Casco Bay Estuary Project will contract for this monitoring activity.

Outcome: Improved understanding of the efficacy of best management practices

Estimated cost to the Casco Bay Estuary Project: \$30,000³ in 1996/1997 and 1997/1998 and \$20,000 for each of the next three years

Status of data: With the exception of a subwatershed map, there is currently no data in the Casco Bay Estuary Project geographic information system that is relevant to this monitoring action. With implementation of this monitoring action, sampling points and associated data will be included in the geographic information system as part of the Project's data management.

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.

Proposed monitoring activity #3:

³Estimated costs reflect the cost of contracting for monitoring services and do not include Casco Bay Estuary Project personnel costs.

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 will be used as the basis for assessing changes in the status of these areas. Testing of this hypothesis will require that the data upon which closures or openings are based be supplied to the Casco Bay Estuary Project so that openings due to reversal of administrative closures can be distinguished from those achieved due to pollution reduction.

Time interval: annual

Responsible organizations:

- 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 to 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

Status of data: The Casco Bay Estuary Project geographic information system currently contains information on the status of shellfish harvesting areas in Casco Bay. By July, 1996 sampling stations and associated data will also be attached. Data collected after July, 1996 will be attached as part of the Project's data management.

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.

Proposed monitoring activity #4:

Monitoring swimming beaches. Water samples will be collected at swimming beaches in the bay judged to be at risk from pathogens. An inventory of swimming beaches is currently being prepared by the Casco Bay Estuary Project and the Cumberland County Soil and Water Conservation District; it will be the basis for establishing sampling locations. Samples will be collected after rain events and will be analyzed for enterococcal bacteria. Sufficient samples will be collected in order to determine the geometric mean. The geometric mean, as well as instantaneous levels, will be compared to state water quality classification standards. This activity will build on monitoring that the City of Portland conducts at East End Beach and Sandy, Front and Centennial Beaches on Peaks Island and will be further aided by volunteer activities on the part of Friends of Casco Bay.

A sampling design will be completed before initiation of the study that will include details of sampling locations, the procedures to be employed in analysis of the samples, QA/QC protocols, statistical tests to be used and expected performance.

Time interval: as required to test compliance with state water quality classification standards

Responsible organizations:

- DEP and the City of Portland will collect and analyze water samples.
- Friends of Casco Bay will coordinate volunteers to help with water sampling.

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 and the City of Portland.

Status of data: There is currently no data in the Casco Bay Estuary Project geographic information system relevant to this monitoring activity. With implementation of this monitoring action, sampling points and associated data will be included in the geographic information system as part of the Project's data management.

Casco Bay Plan goal:

Minimize adverse environmental impacts to ecological communities from the use and development of land and marine resources

Casco Bay Plan objectives:

- No net loss of aquatic and island habitats.
- Habitat in Casco Bay should 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 monitoring activity #5:

Tracking regulated activities. The loss of different types of living aquatic resource habitat and associated buffers due to development activities will be tracked using permit data collected by DEP under the Site Location of Development Law, the Natural Resources Protection Act and other state regulations. The type and quantity of permitted activities will be summarized by municipality within the Casco Bay watershed. If permit data representative of the total of permitted activities is geo-referenced, they will be used to create an annual map of permitted activities. Where appropriate, data collected will be cross-referenced with important habitats identified by the U.S. Fish and Wildlife Service.⁴

Time interval: annual

⁴"Identification of Important Habitats in the Lower Casco Bay Watershed", Arnold Banner and John Libby, U.S. Fish and Wildlife Service Gulf of Maine Project, December 11, 1995.

Responsible organization: DEP will compile permit data by municipality and, when possible, attach this data to a geographic information system parcel map.

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 and summarize data from DEP for municipalities in the Casco Bay watershed

Status of data: The Casco Bay Estuary Project geographic information system currently includes municipal boundaries as well as parcel maps for several of the municipalities in the watershed. As part of the Project's data management, permit data will be displayed on a parcel-by-parcel basis where such data is geo-referenced. In addition, data will be summarized by municipality.

Proposed monitoring activity #6:

Assessing habitat loss. Remotely sensed data, in the form of "SPOT" images, will be used to track changes in land use cover in a portion of the lower watershed. A plan will be developed for estimating habitat loss based on changes in land cover. The plan will include a mechanism for assessing patch size, buffer strips, wildlife corridors and other factors affecting the value of habitat. A "SPOT" image from 1995 will form the baseline for this monitoring activity. Costs for acquisition and groundtruthing of the "SPOT" image to be acquired in 2005 are not included in this budget. Changes in land cover between 1995 and 2005 will be assessed for their significance in terms of habitat loss. Where appropriate, data collected will be cross-referenced with important habitats identified by the U.S. Fish and Wildlife Service.

Time interval: every 10 years

Responsible organization: Casco Bay Estuary Project will contract for this monitoring activity.

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

Estimated cost to the Casco Bay Estuary Project: \$5,000 in 1996/1997 and \$5,000 in 1997/1998

Status of data: A 1995 "SPOT" image has been incorporated into the Casco Bay Estuary Project geographic information system. Updating of the image as a result of groundtruthing will be completed by July, 1996. The new image will be attached as part of the Project's data management.

Proposed monitoring activity #7:

Tracking wetland loss. The loss of wetlands will be tracked using data supplied by the National Wetlands Inventory. Maps will next be available in 1997. Funds are earmarked in that year for digitizing the maps. The analysis of wetland loss will include assessment of loss of important habitats as identified by the U.S. Fish and Wildlife Service.

Time interval: ten years

Responsible organizations:

- National Wetlands Inventory will collect data on wetlands in the Casco Bay area.
- Casco Bay Estuary Project will contract to have this data digitized.

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

Estimated cost to the Casco Bay Estuary Project: \$5,000 in 1997/1998

Status of data: The most recent wetlands inventory (1987) is in the Casco Bay Estuary Project geographic information system. New inventory information will also be included as available as part of the Project's data management.

Proposed monitoring activity #8:

Evaluating changes in eel grass. Changes in the acreage of eel grass beds in the bay will be tracked using DMR's recently completed inventory as a baseline. Eel grass beds in the bay will be surveyed in 1999/2000 using aerial photography. Protocols developed by the National Oceanic and Atmospheric Administration's (NOAA) Coastwatch Change Analysis Program will be used to interpret the photographs and to assess trends in eel grass distribution. The analysis of trends in the distribution of eelgrass will include assessment of loss of important habitats as identified by the U.S. Fish and Wildlife Service.

Time interval: five years

Responsible organizations:

- DMR will conduct the survey of eelgrass beds.
- Casco Bay Estuary Project will provide partial funding to DMR for this monitoring activity.

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

Estimated cost to the Casco Bay Estuary Project: \$10,000 in 1999/2000

Status of data: The Casco Bay portion of DMR's 1993 eelgrass inventory has been attached to the Casco Bay Estuary Project geographic information system. The updated inventory will also be attached as part of the Project's data management.

Monitoring objective:

Assess indices of habitat quality in Casco Bay.

Null hypothesis:

Populations of several species of birds will exhibit no significant upward trend over five years.

Proposed monitoring activity #9:

Waterbird survey. A periodic survey of sea birds and wading birds is conducted by IF&W in order to characterize changes in sea bird populations in the Bay and elsewhere along the coast. The survey includes species which 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 as identified by the U.S. Fish and Wildlife Service.

Time interval: periodic

Responsible organization: IF&W will conduct the surveys of waterbirds.

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 IF&W

Status of data: There is currently no data in the Casco Bay Estuary Project geographic information system relevant to this monitoring activity. Sampling sites and survey data will be attached as part of the Project's data management as the data becomes available.

Null hypothesis:

The number of occurrences of depleted dissolved oxygen will not decrease significantly over time.

Proposed monitoring activity #10:

Dissolved oxygen monitoring. Dissolved oxygen will be monitored at 29 stations in Casco Bay, including several characterized by restricted flushing. These stations are clustered in the Fore River, Back Cove, the Harraseeket River, Maquoit Bay, Mere Point Bay, Middle Bay, Quahog Bay and the New Meadows River. Sampling will be conducted predawn, at low tide, and during the summer months to increase the likelihood of encountering annual lows in dissolved oxygen. In 1995, these same stations were sampled for dissolved oxygen 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. The data collected in 1995 may provide a context for the data to be collected in 1996/1997 and later years.

The parameters to be analyzed include: temperature, salinity, conductivity, dissolved oxygen concentration, per cent saturation, particulate total nitrogen, dissolved total nitrogen, particulate inorganic nitrogen, and depth. Box and whisker plots will be used to determine the appropriate dissolved oxygen metrics (if different from those identified by the 1995 study). Both parametric and non-parametric methods will be used to make comparisons. The data will be transformed to stabilize the variance or used in power series. Results of analysis of variance will be described as significant at the 95% level. 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: Casco Bay Estuary Project will contract 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: \$15,000 annually

Status of data: Sampling stations and associated data from 1995 will be attached to the Casco Bay Estuary Project geographic information system by July, 1996. Data from 1996 will be attached as part of the Project's data management.

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.

Proposed monitoring activity #11:

Temperature, pH, salinity, dissolved oxygen and clarity monitoring. These parameters will be monitored by Friends of Casco Bay on a monthly basis at several stations in Casco Bay. Testing of this hypothesis will require establishment of levels for each parameter

which signify anthropogenic effects. This activity will build on nearly three years' worth of data collected by Friends of Casco Bay for the Casco Bay Estuary Project to date. Station locations are identified in Figure 2. 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.

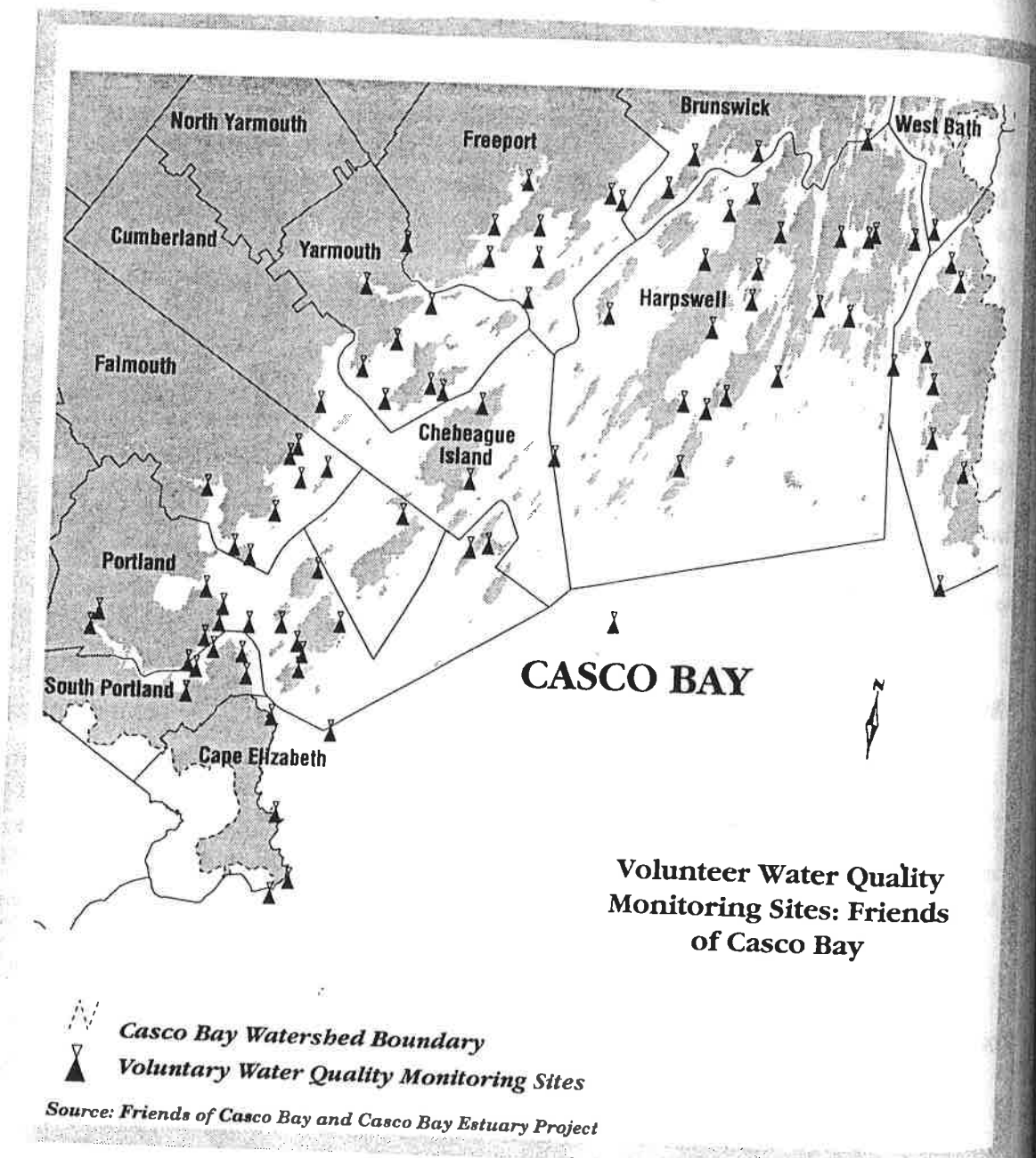


Figure 2. Map of Friends of Casco Bay station locations for monitoring temperature, pH, salinity, dissolved oxygen, and clarity.

Water temperature and salinity are measured electrometrically using a YSI Model 33 Salinity-Conductivity-Temperature meter. The pH will be measured using narrow-range and wide-range pH octet comparators. Dissolved oxygen will be measured electrometrically using a YSI Model 58 Dissolved Oxygen meter. Clarity will be 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.⁵

Time interval: annual

Responsible organization: Friends of Casco Bay

Outcome: Assessment of the impact of habitat on the structure and function of the biological community.

Estimated cost to the Casco Bay Estuary Project: \$15,000 in 1996/1997 and \$25,000 annually thereafter⁶

Status of data: Data collected by the Friends of Casco Bay to date will be attached to the Casco Bay Estuary Project geographic information system by July, 1996. New data will be attached as part of the Project's data management.

Monitoring objective:

Assess the miles of rivers, streams and coastal waters meeting their water quality classification.

Null hypothesis:

The miles of rivers, streams and marine waters meeting water quality classification will not increase biennially.

Proposed monitoring activity #12:

Water quality assessment. The mileage of rivers, streams and coastal waters meeting water quality standards will be tracked using water quality assessments provided by DEP (305(b) reports). Data collected by volunteer water quality monitoring groups will be considered by DEP in making water quality assessments. 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 organizations:

- DEP will identify 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.

⁵Quality Assurance Project Plan for Friends of Casco Bay's Citizens' Water Quality Monitoring Program. Friends of Casco Bay, South Portland, Maine. March 1, 1993.

⁶Friends of Casco Bay is funded for nearly one half of fiscal year 1996/1997 with funds from a previous Casco Bay Estuary Project grant. Additional funds for Friends of Casco Bay volunteer monitoring activities will be provided as an action in the Stewardship component of the *Casco Bay Plan*.

Estimated cost to the Casco Bay Estuary Project: Staff time to collect data on attainment of water quality classification from DEP.

Status of data: Data on the classification of the waters of Casco Bay and its watershed are currently attached to the Casco Bay Estuary Project geographic information system. Information on attainment status will be attached as part of the Project's data management.

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 annually.

Proposed monitoring activity #13:

Identifying protected habitat. The acreage of coastal habitat protected by easement or acquisition will be tracked in collaboration with the Maine Coast Heritage Trust by annually surveying the land trusts in the lower watershed. The survey will include questions regarding the type of habitat being protected as well as other values (open space, access to shoreline, etc.). In addition to tracking land trust activity, specific areas showing changes in municipal zoning for open space, resource protection or coastal protection will also be tracked. Government-owned property will also be identified. The habitat value of protected parcels will be estimated using information on important habitats collected by U.S. Fish and Wildlife Service, analysis of "SPOT" images and professional judgment. Costs incurred in this monitoring activity are for data acquisition, digitizing and assessment of habitat value.

Time interval: annual

Responsible organization: Casco Bay Estuary Project will contract for this monitoring activity.

Outcome: Assessment of actions designed to increase the acreage of protected habitat

Estimated cost to the Casco Bay Estuary Project: \$5,000 annually

Status of data: Some protected lands are currently attached to the Casco Bay Estuary Project geographic information system. All known protected lands will be attached by July, 1996. Newly protected lands will be attached as part of the Project's data management.

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 acceptable for consumption.
- 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.

Proposed monitoring activity #14:

Sediment contaminant analysis. Samples of surface sediments will be collected from sites sampled in previous studies in order to detect trends in sediment contamination. Analysis will include, at a minimum, contaminants included in previous studies as well as an assessment of sediment organic carbon content and grain size. Comprehensive sediment contaminant analysis was conducted in 1991 (station locations are shown in Figure 3). In 1994, sediments were analyzed for dioxins and furans (PCDD-PCDF), planar PCBs and butyltins (station locations are shown in Figure 4).

Sediment will be 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 will be those of the NOAA National Status and Trends Program, EPA's Environmental Monitoring and Assessment Program - Estuarine (EMAP-E), and the U.S. Fish and Wildlife Service trace organic analytical program. QA/QC procedures will include analyses of matrix spikes, duplicates and laboratory blanks with each batch of samples. In addition, marine reference sediments from the National Research Council of Canada and the National Institute of Standards and Technology will be analyzed as laboratory reference materials.

A sampling design will be completed before initiation of the study that will describe 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. Cost for sediment contaminant analysis will be spread over a three year period prior to sampling.

Time interval: ten years

Responsible organization: Casco Bay Estuary Project will contract 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: \$120,000

Status of data: Sampling stations and associated data from earlier sediment contamination analysis is attached to the Casco Bay Estuary Project geographic information system.

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.

Proposed monitoring activity #15:

Mussel tissue analysis. Twenty stations were sampled in Casco Bay in 1988 for analysis of contaminant levels in blue mussel tissues by DEP's Marine Environmental Monitoring Program. These twenty stations will be sampled again using the methodologies of DEP's Marine Environmental Monitoring Program, Gulfwatch and the NOAA National Status and Trends Program. Effort will be made to avoid periods of high turbidity to minimize gut sediment. Soft tissues of twenty standard length animals (50-60 mm shell length) will comprise a single composite sample. Four replicate composites will be collected at each station. Lipid content will be analyzed in order to allow for normalization.

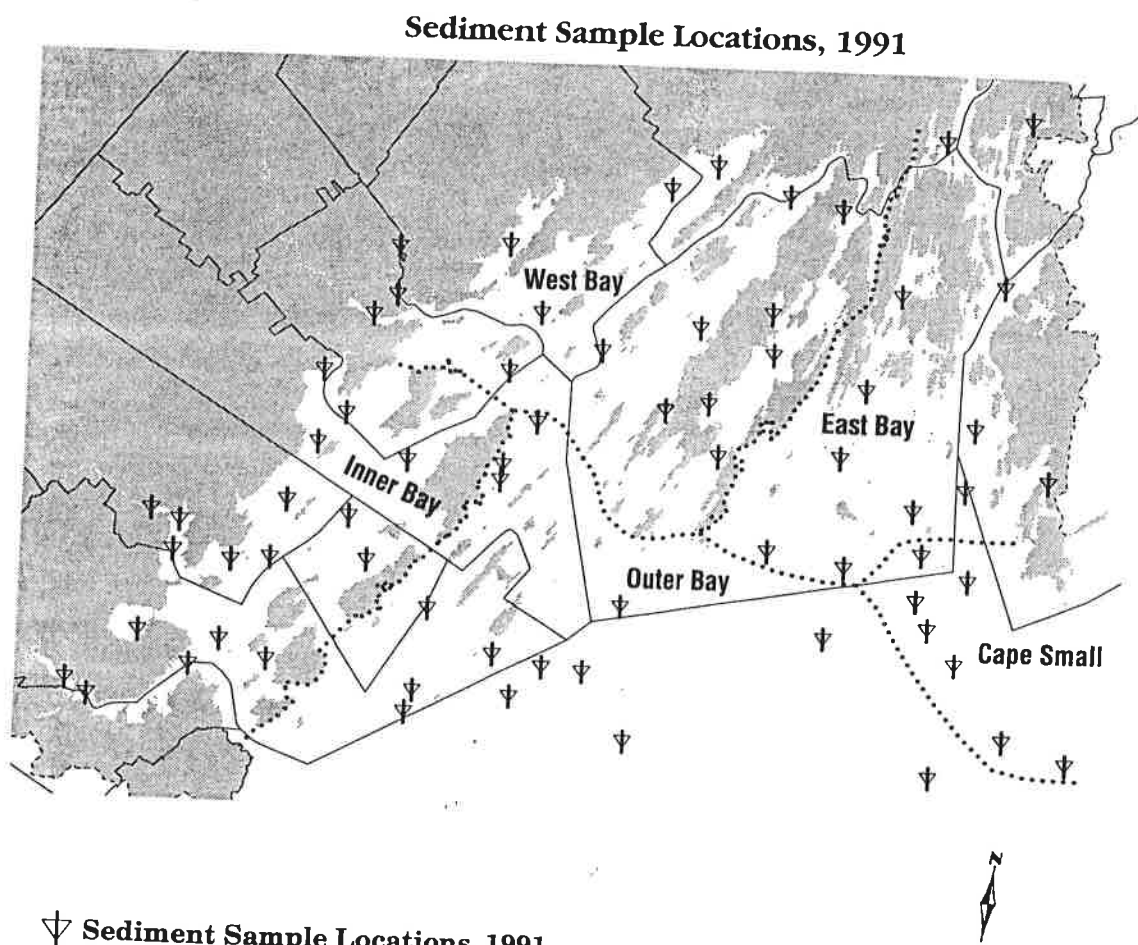


Figure 3. Map of stations sampled for sediment contaminant analysis in 1991

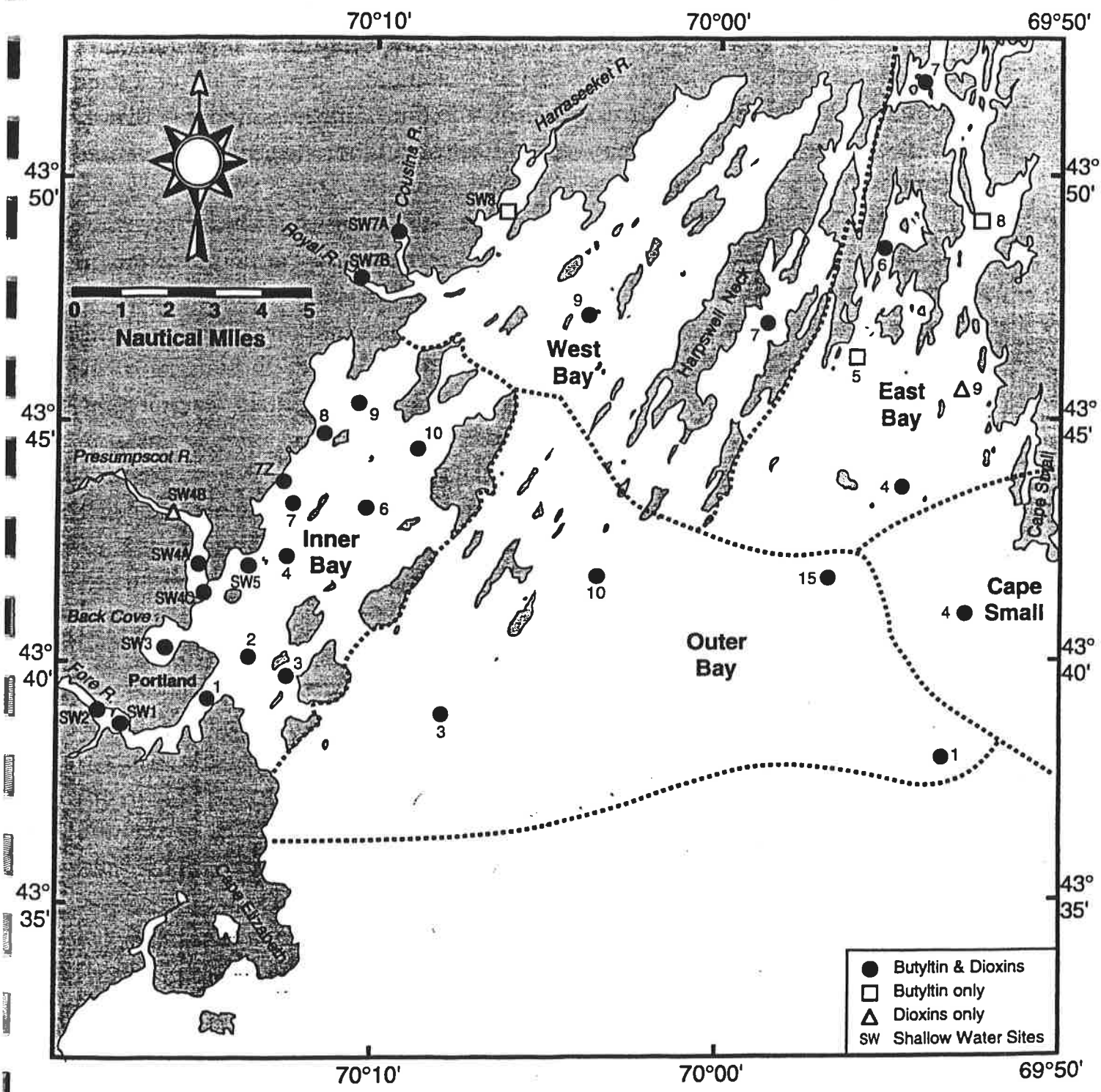


Figure 4. Map of station locations sampled for sediment contaminant analysis in 1994.

The number of stations sampled in future monitoring may be reduced if the data indicate that fewer stations are needed to demonstrate contaminant gradients. The number of samples to be analyzed may be reduced for those years when samples are collected in Casco Bay for Gulfwatch. Casco Bay is scheduled for Gulfwatch sampling 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 will provide a larger context for data collected by the Casco Bay Environmental Monitoring Program.

In the first year of mussel tissue analysis (1996/1997), replicate samples will be collected at selected stations for analysis of seafood contamination. Mussels of food size and quality will be cooked before analysis. Results will be compared to that from mussels of similar size and quality which are analyzed without cooking. The data will be analyzed to determine if a relationship exists between contaminant levels in cooked and uncooked animals.

Data collected from mussels, cooked and uncooked, will be forwarded to the Department of Human Services, Bureau of Health and the Department of Agriculture, Food and Rural Resources for assessment of risk to public health. Interpretation of the data should distinguish between the threat posed by mussels harvested from Casco Bay and those purchased from area seafood markets or restaurants.

A sampling design will be completed before initiation of the study that will describe the parameters to be analyzed, the details of the procedures to be employed in analysis of the sample QA/QC protocols, statistical tests to be used and expected performance.

Time interval: biennial

Responsible organizations:

- Casco Bay Estuary Project will contract for most of this monitoring activity.
- Gulfwatch will carry out this monitoring activity at some sites in Casco Bay.

Outcome: Assessment of the impact of habitat on the structure and function of the biological community

Estimated cost to the Casco Bay Estuary Project: \$35,000 in 1996/1997 and \$30,000 in 1998/1999 and 2000/2001

Status of data: There is currently no data in the Casco Bay Estuary Project geographic information system relevant to this monitoring activity. Incorporation of sampling stations and associated data will be accomplished as part of the Project's data management.

Proposed monitoring activity #16:

Lobster tissue analysis. Lobsters will be collected and the meat and tomalley analyzed separately for contaminants using the methodology employed by DEP's Surface Waters Ambient Toxics Monitoring Program. Twenty lobsters just recruiting to the fishery (1 - 1.25 pounds) will be collected from the sample areas as they are 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 will be recorded. Because the residence time of lobsters in any given area is unknown, samples will initially be collected from three distinct areas of the bay: Portland Harbor and vicinity, the upper bay, and the outer bay. If no significant differences are found among these three areas, composite samples will be collected in future sampling for assessment of temporal changes only. The number of stations required for lobster tissue analysis may be reduced if

Surface Waters Ambient Toxics Monitoring Program continues to sample lobster tissue in the Casco Bay area. Lobster tissue data has been analyzed at three stations in Casco Bay (Fore River, Presumpscot River and Harpswell) in 1994 and 1995 and several other stations along the coast from Kittery to Cobscook Bay. This data set may provide a context for data collected by the Casco Bay Environmental Monitoring Program.

In the first year of lobster tissue analysis (1997/1998), additional replicate samples will be collected at selected stations for analysis of seafood contamination. Legal-sized lobsters will be cooked before analysis. Results will be compared to that from lobsters of similar size and quality which are analyzed without cooking. The data will be analyzed to determine if a relationship exists between contaminant levels in cooked and uncooked animals.

Data collected from lobsters, cooked and uncooked, will be forwarded to the Department of Human Services, Bureau of Health and Department of Agriculture, Food and Rural Resources for assessment of risk to public health. Interpretation of the data should distinguish between the threat posed by mussels harvested from Casco Bay and those purchased from area seafood markets or restaurants. Interpretation of the data should distinguish between the threat posed by lobsters harvested from Casco Bay and those purchased from area seafood markets or restaurants.

A sampling design will be completed before initiation of the study that will describe 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 organizations:

- Casco Bay Estuary Project will contract for most of this monitoring activity
- Surface Waters Ambient Toxics Monitoring Program will analyze lobster tissues at 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: \$35,000 in 1997/1998 and \$30,000 in 1999/2000

Status of data: There is currently no data in the Casco Bay Estuary Project geographic information system relevant to this monitoring activity. Incorporation of sampling stations and associated data will be accomplished as part of the Project's data management.

Proposed monitoring activity #17:

Cormorant tissue analysis. Cormorant chicks will be collected from three, geographically distinct rookeries in the bay; adipose and liver tissue will be analyzed for contaminants. If no significant differences are found among these three areas, composite samples will be collected in future sampling for assessment of temporal changes only.

A sampling design will be completed before initiation of the study that will describe 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 organizations:

- Casco Bay Estuary Project will contract for most of this monitoring activity

- Surface Waters Ambient Toxics Monitoring Program will analyze cormorant tissues at 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: \$30,000

Status of data: There is currently no data in the Casco Bay Estuary Project geographic information system relevant to this monitoring activity. Incorporation of sampling stations and associated data will be accomplished as part of the Project's data management.

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 monitoring activity #18:

Sediment toxicity bioassay. A sediment bioassay using larval bivalves, worms or amphipods will be conducted annually on sediments from twenty sites in the bay, corresponding to stations sampled for sediment contaminant analysis. Stations will be chosen to cover the range of contaminant concentrations identified by the sediment contaminant analysis. Sediment will be collected and pore water extracted. Invertebrate eggs will be incubated in the pore water for 24 hours. The percentage of normal and deformed larvae will then be counted. An initial analysis will be conducted to ensure that the invertebrate larvae sediment bioassay is sensitive to the range of contamination found in Casco Bay.

A sampling design will be completed before initiation of the study that will describe 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.

The sediment toxicity bioassay will be carried out for two years in order to establish an effective monitoring strategy. In the third and fourth years of this activity, sediment will be collected from station locations for contaminant analysis and comparison with the bioassay results. The fifth year of the program will coincide with comprehensive sediment contaminant analysis as described above.

The sediment bioassay is a new monitoring method and, therefore, satisfies the provision in the Casco Bay Environmental Monitoring Program recommending testing of new monitoring methods. Its effectiveness as a monitoring tool will be evaluated on an annual basis.

Time interval: annual

Responsible organization: Casco Bay Estuary Project

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 in 1996/1997, 1997/1998 and in 2000/2001; \$25,000 in 1998/1999 and 1999/2000

Status of data: There is currently no data in the Casco Bay Estuary Project geographic information system relevant to this monitoring activity. Incorporation of sampling stations and

associated data will be accomplished as part of the Project's data management.

Null hypothesis:

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

Proposed monitoring activity #19:

Benthic community analysis. Samples of the benthos will be collected from the same sites where sediment is collected for the sediment bioassay described above. Sediment will be collected using a Smith-McIntyre grab. The samples will be sieved on nested 0.5 and 1.0 mm screens and fixed in 5% buffered formalin. In the laboratory, all organisms will be removed and counted after identification to the lowest taxonomic level possible. The biomass (wet weight) of each sample will be estimated. Subsamples of sediment will be analyzed for grain size and organic content and an assessment of the history of dragging in the area of each station will be made using side scan sonar. Multivariate analysis will be used to correlate changes in benthic community composition with contaminant and physical factors and with the results of the sediment bioassay. Methodologies employed in previous benthic community studies in Casco Bay will be used to allow for comparison with these earlier data sets. The cost will depend upon the number of stations sampled and the number of replicates collected.

A sampling design will be completed before initiation of the study that will describe 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: five years

Responsible organization: Casco Bay Estuary Project will contract 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: \$100,000-300,000

Status of data: There is currently no data in the Casco Bay Estuary Project geographic information system relevant to this monitoring activity. Incorporation of sampling stations and associated data will be accomplished as part of the Project's data management.

IV. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) protocols will be developed for all monitoring activities originating with the Casco Bay Environmental Monitoring Program. Where Casco Bay Environmental Monitoring Program activities are to be coordinated with other monitoring programs such as the Surface Waters Ambient Toxics Monitoring Program or Gulfwatch, care will be taken to ensure that identical methodologies are used. In many cases, the Casco Bay Monitoring Program is relying on data collected by other organizations. An assessment of the QA/QC protocols used by these organizations in collecting their data will be included with the data in the annual reporting of monitoring activity. Where the QA/QC protocols are not sufficiently rigorous, project staff will negotiate with the appropriate parties in order to improve the quality of the monitoring activity.

V. Data Management and Distribution

The Casco Bay data management strategy calls for forming a network among data collectors so that data users can have ready access to usable information about Casco Bay. Information and data are critical for good planning and program implementation. Raw data must be synthesized into information in order to be useful to resource managers and the public. A goal of the Casco Bay data management strategy is to develop understandable information out of numerous individual data measurements.

Monitoring data will be organized by attaching it spatially to a geographic information system. The most important use of the geographic information system will be to store, analyze and make available information obtained through the Casco Bay Environmental Monitoring Program in order to assess the effectiveness of management actions in improving the environmental quality of Casco Bay. Therefore, the focus is on managing specific environmental monitoring data and not on building a regional system for computerized archiving of general program data.

The Casco Bay data management strategy will rely upon a decentralized approach to data management. The goal of this approach is to avoid burdening primary data collectors with additional tasks while at the same time providing information that is useful, accessible, and of reliable quality. Therefore, the primary data collectors will be asked to provide data that they currently collect to the Casco Bay Estuary Project on an agreed upon schedule. The raw monitoring data and database management will be the responsibility of the agency or entity that collects it. Every attempt will be made to link existing databases to geographic information system.

Quality assurance plans must be 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 should be analyzed, transformed as necessary, and provided in a standard database format. Sampling stations and other important reference points must be geographically referenced so that all monitoring data can be included in the geographic information system database. Requests for proposals should specify all parameters to be included in the database.

Summaries of the data collected by the Casco Bay Environmental Monitoring Program will be organized in the framework of EPA's National Environmental Indicators Project so that:

- monitoring information can be successfully reported to the public,
- annual comparisons of monitoring parameters can be easily made, and
- environmental progress in Casco Bay can be compared nationally.

The monitoring activities of the Casco Bay Environmental Monitoring Program will be classified according to the hierarchy of indicators developed by the National Environmental Indicators Project. This process will allow for the development of an annual Environmental Report Card for Casco Bay that will report on the status of each indicator, support program evaluation, and aid in program planning and resource targeting. Hard copies of the Environmental Report Card described above will be published annually and distributed.

The usefulness of the Casco Bay Environmental Monitoring Program will depend 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. The data must be rigorously reviewed to determine whether or not they are sufficient to test the various null hypotheses. The results of these tests should in turn be applied primarily to the overall goal of analyzing the effectiveness of the *Casco Bay Plan*. Secondary uses of the data include assessment of the overall health of the bay.

VI. Casco Bay Environmental Monitoring Program Schedule and Priorities

A schedule for the Casco Bay Environmental Monitoring Program is outlined in Table 1 and is based on 1) initiating monitoring activities in 1996/1997 and 2) an initial budget of \$115,000 (excluding Casco Bay Estuary Project personnel expenses) for 1996/1997. Because the proposed monitoring actions exceeded \$115,000 in first year costs, they were prioritized by the Technical Advisory Committee. Benthic community analysis and cormorant tissue analysis were determined to be of lower priority and, therefore, do not appear in Table 1 or subsequent tables. The schedule and budgets for later years, as described in Table 1, are a function of the time interval described for each monitoring activity. The actual costs will vary depending on the number of stations and replicates required to test null hypotheses.

Tables 2, 3, and 4 represent priorities for monitoring should less than \$115,000 be available to initiate monitoring activity. The priorities were established by the Management Committee based on the following criteria:

- relevance to the actions of the Casco Bay Plan,
- representativeness of the four goals (stormwater and combined sewer overflows, shellfish and swimming areas, ecological communities and toxic pollution),
- likely effectiveness of indicator,
- tie to previous sampling efforts (e.g., dissolved oxygen, eelgrass, mussels, etc.),
- application of new monitoring tools, and
- cost.

Table 1. Casco Bay Environmental Monitoring Program schedule and priorities based on \$115,000 in first year funding.

	1996/97	1997/98	1998/99	1999/00	2000/01
<u>Stormwater and combined sewer overflows</u>					
1. Combined sewer overflow abatement assessment (Pg. 4)	✓ ⁷	✓	✓	✓	✓
2. Stormwater control analysis (Pg. 6)	\$30,000	\$30,000	\$20,000	\$20,000	\$20,000
<u>Shellfish and swimming areas</u>					
3. Tracking shellfish harvesting areas (Pg. 7)	✓	✓	✓	✓	✓
4. Monitoring swimming beaches (Pg. 8)	✓	✓	✓	✓	✓
<u>Ecological communities</u>					
5. Tracking regulated activities (Pg. 9)	✓	✓	✓	✓	✓
6. Assessing habitat loss (Pg. 10)	\$5,000	\$5,000			
7. Tracking wetland loss (Pg. 10)		\$5,000			
8. Evaluating changes in eel grass (Pg. 11)				\$10,000	
9. Waterbird survey (Pg. 11)	✓		✓		✓
10. Dissolved oxygen monitoring (Pg. 12)	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000
11. Temperature, pH, dissolved oxygen and clarity monitoring (Pg. 12)	\$15,000	\$25,000	\$25,000	\$25,000	\$25,000
12. Water quality assessment (Pg. 15)	✓		✓		✓
13. Identifying protected habitat (Pg. 16)	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000
<u>Toxic pollution</u>					
14. Sediment contaminant analysis (Pg. 16)			\$40,000	\$40,000	\$40,000
15. Mussel tissue analysis (Pg. 20)	\$35,000		\$30,000		\$30,000
16. Lobster tissue analysis (Pg. 21)		\$35,000		\$30,000	
18. Sediment toxicity bioassay (Pg. 22)	\$10,000	\$10,000	\$25,000	\$25,000	\$10,000
Grand total:	\$115,000	\$130,000	\$160,000	\$170,000	\$145,000

⁷Check mark denotes activity that will occur but will not require expenditure of Casco Bay Estuary Project funds except for personnel costs.

Table 2. Casco Bay Environmental Monitoring Program schedule and priorities based on \$85,000 in first year funding.

	96/97	97/98	98/99	99/00	00/01
<u>Stormwater and combined sewer overflows</u>					
1. Combined sewer overflow abatement assessment (Pg. 4)	✓	✓	✓	✓	✓
2. Stormwater control analysis (Pg. 6)	\$30,000	\$30,000	\$20,000	\$20,000	\$20,000
<u>Shellfish and swimming areas</u>					
3. Tracking shellfish harvesting areas (Pg. 7)	✓	✓	✓	✓	✓
4. Monitoring swimming beaches (Pg. 8)	✓	✓	✓	✓	✓
<u>Ecological communities</u>					
5. Tracking regulated activities (Pg. 9)	✓	✓	✓	✓	✓
6. Assessing habitat loss (Pg. 10)	\$5,000	\$5,000			
7. Tracking wetland loss (Pg. 10)		\$5,000			
8. Evaluating changes in eel grass (Pg. 11)				\$10,000	
9. Waterbird survey (Pg. 11)	✓		✓		✓
10. Dissolved oxygen monitoring (Pg. 12)	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000
11. Temperature, pH, dissolved oxygen and clarity monitoring (Pg. 12)	\$15,000	\$25,000	\$25,000	\$25,000	\$25,000
12. Water quality assessment (Pg. 15)	✓		✓		✓
13. Identifying protected habitat (Pg. 16)	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000
<u>Toxic pollution</u>					
14. Sediment contaminant analysis (Pg. 16)			\$40,000	\$40,000	\$40,000
15. Mussel tissue analysis (Pg. 20)	\$35,000		\$30,000		\$30,000
16. Lobster tissue analysis (Pg. 21)		\$35,000		\$30,000	
18. Sediment toxicity bioassay (Pg. 22)	\$10,000	\$10,000	\$25,000	\$25,000	\$10,000
Total:	\$85,000	\$100,000	\$140,000	\$150,000	\$125,000

Note: Under this and remaining scenarios, there would be no monitoring of stormwater other than that associated with combined sewer overflows.

Table 3. Casco Bay Environmental Monitoring Program schedule and priorities based on \$75,000 in first year funding.

	96/97	97/98	98/99	99/00	00/01
<u>Stormwater and combined sewer overflows</u>					
1. Combined sewer overflow abatement assessment (Pg. 4)	✓	✓	✓	✓	✓
2. Stormwater control analysis (Pg. 6)	-\$30,000	-\$30,000	-\$20,000	-\$20,000	-\$20,000
<u>Shellfish and swimming areas</u>					
3. Tracking shellfish harvesting areas (Pg. 7)	✓	✓	✓	✓	✓
4. Monitoring swimming beaches (Pg. 8)	✓	✓	✓	✓	✓
<u>Ecological communities</u>					
5. Tracking regulated activities (Pg. 9)	✓	✓	✓	✓	✓
6. Assessing habitat loss (Pg. 10)	-\$5,000	-\$5,000			
7. Tracking wetland loss (Pg. 10)		\$5,000			
8. Evaluating changes in eel grass (Pg. 11)				\$10,000	
9. Waterbird survey (Pg. 11)	✓		✓		✓
10. Dissolved oxygen monitoring (Pg. 12)	\$15,000	\$15,000	-\$15,000	\$15,000	-\$15,000
11. Temperature, pH, dissolved oxygen and clarity monitoring (Pg. 12)	\$15,000	-\$25,000 \$15,000	\$25,000 \$15,000	\$25,000 \$15,000	-\$25,000 \$15,000
12. Water quality assessment (Pg. 15)	✓		✓		✓
13. Identifying protected habitat (Pg. 16)	-\$5,000	-\$5,000	-\$5,000	-\$5,000	-\$5,000
<u>Toxic pollution</u>					
14. Sediment contaminant analysis (Pg. 16)			\$40,000	\$40,000	\$40,000
15. Mussel tissue analysis (Pg. 20)	\$35,000		\$30,000		\$30,000
16. Lobster tissue analysis (Pg. 21)		\$35,000		\$30,000	
18. Sediment toxicity bioassay (Pg. 22)	\$10,000	\$10,000	\$25,000	-\$25,000 \$10,000	\$10,000
Total:	\$75,000	\$80,000	\$110,000	\$120,000	\$95,000

Note: In this scenario and the following one, costs associated with the assessment of habitat loss are postponed until the next SPOT image is purchased (2005) rather than eliminated altogether. Analysis of protected habitat is eliminated. Dissolved oxygen monitoring is changed to an every-other-year schedule after the first two years. Funding for monitoring of temperature, pH, dissolved oxygen and clarity is reduced from \$25,000 to \$15,000 per year. Associated contaminant monitoring is dropped from the sediment bioassay for one year.

Table 4. Casco Bay Environmental Monitoring Program schedule and priorities based on \$55,000 in first year funding.

	96/97	97/98	98/99	99/00	00/01
<u>Stormwater and combined sewer overflows</u>					
1. Combined sewer overflow abatement assessment (Pg. 4)	✓	✓	✓	✓	✓
2. Stormwater control analysis (Pg. 6)	-\$30,000	-\$30,000	-\$20,000	-\$20,000	-\$20,000
<u>Shellfish and swimming areas</u>					
3. Tracking shellfish harvesting areas (Pg. 7)	✓	✓	✓	✓	✓
4. Monitoring swimming beaches (Pg. 8)	✓	✓	✓	✓	✓
<u>Ecological communities</u>					
5. Tracking regulated activities (Pg. 9)	✓	✓	✓	✓	✓
6. Assessing habitat loss (Pg. 10)	-\$5,000	-\$5,000			
7. Tracking wetland loss (Pg. 10)		\$5,000			
8. Evaluating changes in eel grass (Pg. 11)				\$10,000	
9. Waterbird survey (Pg. 11)	✓		✓		✓
10. Dissolved oxygen monitoring (Pg. 12)	\$15,000	-\$15,000	-\$15,000	-\$15,000	-\$15,000
11. Temperature, pH, dissolved oxygen and clarity monitoring (Pg. 12)	-\$15,000 \$5,000	\$25,000 \$10,000	-\$25,000 \$10,000	\$25,000 \$10,000	\$25,000 \$10,000
12. Water quality assessment (Pg. 15)	✓		✓		✓
13. Identifying protected habitat (Pg. 16)	-\$5,000	-\$5,000	-\$5,000	-\$5,000	-\$5,000
<u>Toxic pollution</u>					
14. Sediment contaminant analysis (Pg. 16)			\$40,000	\$40,000	\$40,000
15. Mussel tissue analysis (Pg. 20)	\$35,000		\$30,000		\$30,000
16. Lobster tissue analysis (Pg. 21)		\$35,000		\$30,000	
18. Sediment toxicity bioassay (Pg. 22)	-\$10,000	\$10,000	-\$25,000 \$10,000	\$25,000	\$10,000
Total:	\$55,000	\$60,000	\$90,000	\$115,000	\$90,000

Note: In this scenario dissolved oxygen monitoring is dropped after a one year follow up to last year's monitoring. Funding for monitoring of temperature, pH, dissolved oxygen and clarity is reduced from \$15,000 to \$5,000 in the first year of the program and from \$25,000 to \$10,000 thereafter. Initiation of the sediment bioassay is postponed from the first year of the program to the second.

**BASELINE INFORMATION FOR MEASURING
MUNICIPAL PROGRESS IN IMPLEMENTING
THE CASCO BAY PLAN**

**Prepared by the
GREATER PORTLAND COUNCIL OF GOVERNMENTS
for the
Casco Bay Estuary Project
JUNE 1996**



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