2005

2005 State of the Bay Report

Casco Bay Estuary Partnership

State of the Bay

2005

Casco Bay Estuary

PARTNERSHIP

The Casco Bay Estuary Partnership

The Casco Bay Estuary Partnership (CBEP, formerly the Casco Bay Estuary Project) is a collaborative effort to preserve and protect the bay's resources. The partners include local, state and federal government agencies and interested citizen groups. In 1990, the U.S. Environmental Protection Agency designated Casco Bay as "an estuary of national significance," leading to the formation of the CBEP. For the past 15 years, CBEP has received significant annual federal funding to develop and implement a plan for the bay's future. Since the *Casco Bay Plan* was adopted in 1996, the partners have been working together to meet the five goals stated in the plan:

- Minimize the loading of pathogens, toxics, nutrients, and sediments from stormwater and combined sewer overflows.
- Open and protect shellfish and swimming areas impacted by water quality.
- Minimize adverse environmental impacts to ecological communities from the use and development of land and marine resources.
- Reduce toxic pollution.
- Promote responsible stewardship on the part of the Casco Bay community members to protect Casco Bay and its watershed.

To learn more about CBEP and our work, please visit www.cascobayestuary.org.

Casco Bay Estuary PARTNERSHIP

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Front cover image: Landsat satellite image, 30 meter resolution, Spring 2001-2003.
Back cover photo: William Hubbell.

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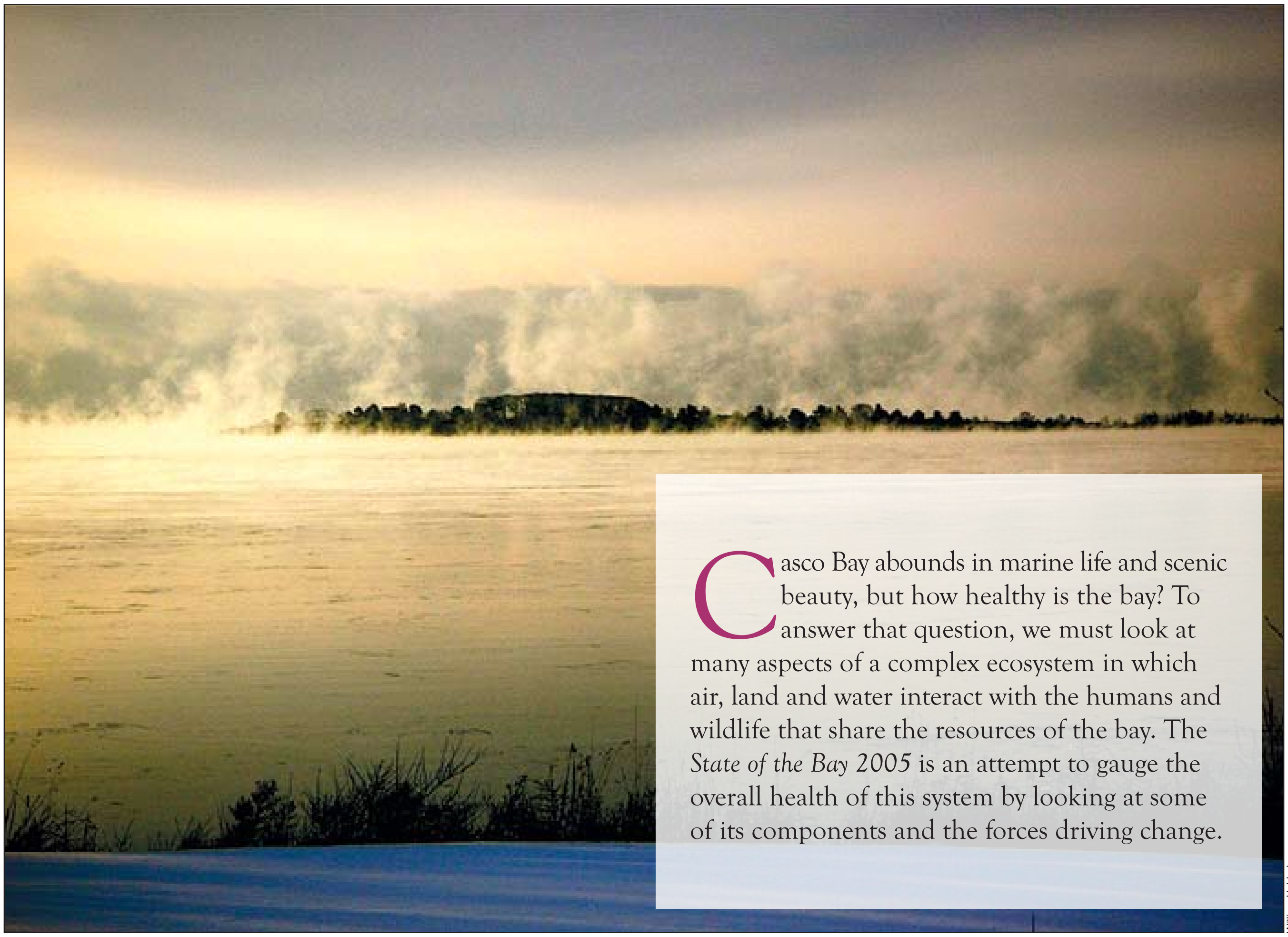
What Influences the State of Casco Bay and How is Casco Bay Estuary Partnership (CBEP) Measuring It?



Casco Bay abounds in marine life and scenic beauty, but how healthy is the bay? To answer that question, we must look at many aspects of a complex ecosystem in which air, land and water interact with the humans and wildlife that share the resources of the bay. The *State of the Bay 2005* is an attempt to gauge the overall health of this system by looking at some of its components and the forces driving change.

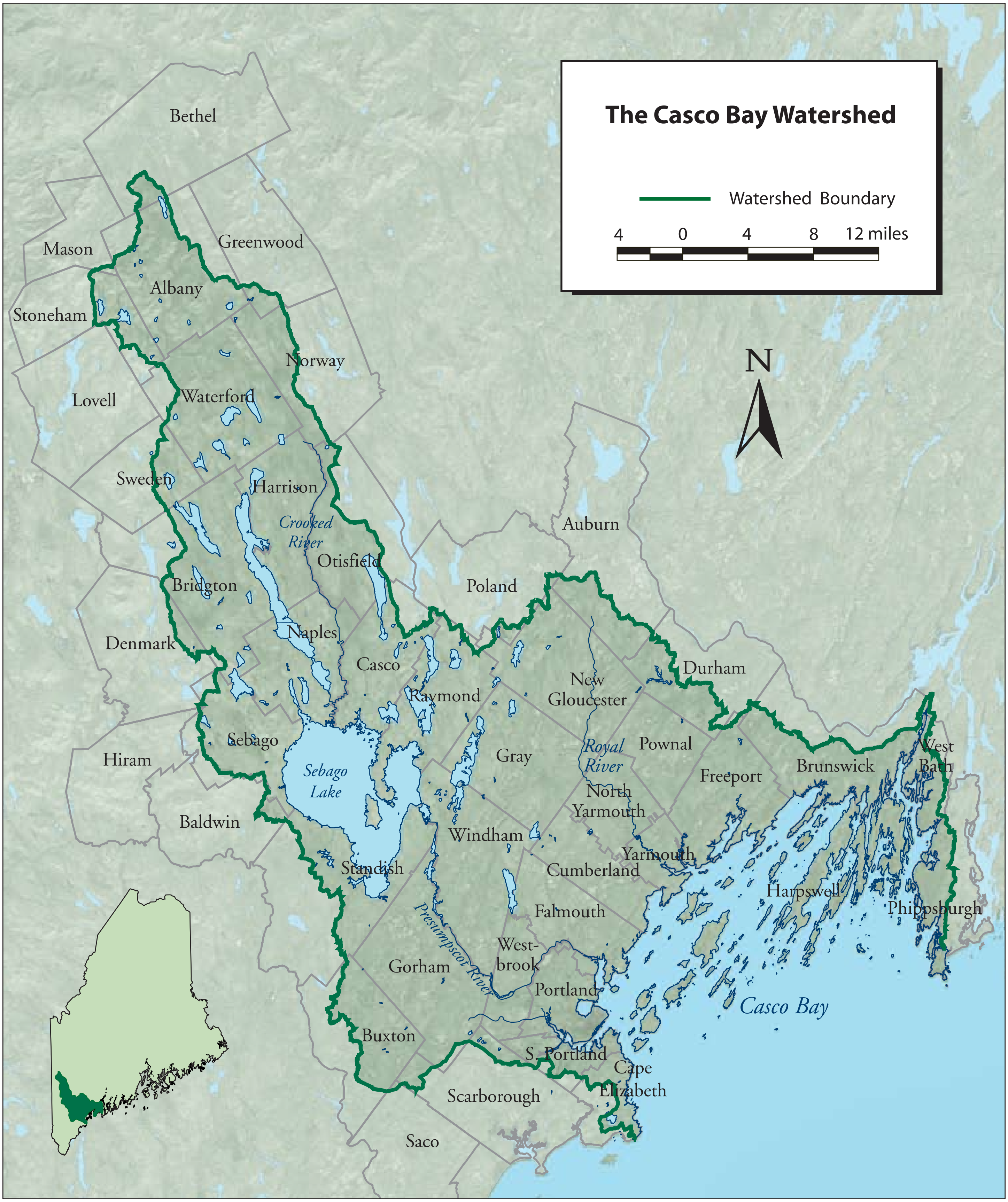
William Hubbel

Sea smoke on Casco Bay off the coast of Cumberland Foreside.

Casco Bay and Its Watershed

Casco Bay and its watershed (the 985 square miles of land that drain to the bay) is located at the heart of the most densely populated area in Maine. While the watershed represents only 3% of Maine's land area, its 41 municipalities include a quarter of the state's population. The watershed stretches from the coast at Cape Elizabeth east to Cape Small in Phippsburg, and northwest to Bethel in the western mountains of Maine. There are 578 miles of shoreline, including 785 islands, islets and exposed ledges in Casco Bay. The water surface covers nearly 200 square miles.

Twelve lake and river systems feed the bay, including Sebago Lake and the Presumpscot, Stroudwater, Royal and Fore Rivers. The bay supports a wealth of industries including shipping and petroleum transport, commercial fishing, tourism and recreation, and shellfish harvesting. Research done by the University of Southern Maine in 1988 estimated the value of the fisheries industry to Casco Bay at $120 million and the tourism and recreation industry at $250 million per year. A 1995 study estimated the overall value of the Casco Bay soft-shell clam industry at $11.6 to $15.7 million per year (Heinig *et al.* 1995).



The watershed for Casco Bay encompasses 985 square miles of land that drain into the bay. This land area represents approximately 3% of Maine's land area but is home to over a quarter of Maine's population. Forty-one municipalities from Bethel to the bay are located at least partially within the watershed. Twelve major lake and river systems flow to the bay including Sebago Lake and the Presumpscot, Stroudwater, Royal and Fore Rivers.

Human Impacts

Humans have a profound influence on the health of the bay's ecosystem, relying on the bay and its watershed for drinking water, recreation, food, transportation, industry, and waste disposal. Thirty years ago, because of pollution and habitat degradation resulting from human activities, significant portions of Casco Bay were closed to recreation, fishing and shellfishing. For example, the lower Presumpscot River was devoid of fish and both Back Cove and the Fore River were so polluted that human contact with the water was a health hazard.

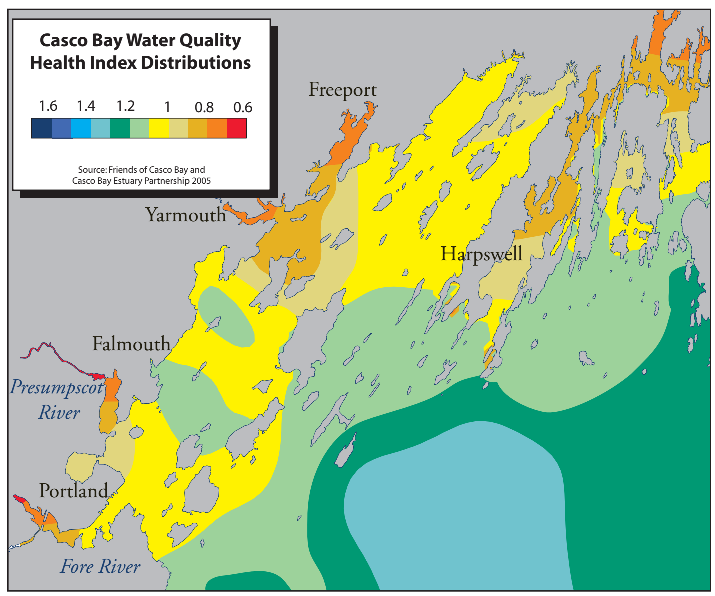
Today, there are measurable improvements in the health of the bay. State and federal clean water laws, the cooperation of business, industry and municipalities, and the implementation of the *Casco Bay Plan* are all helping to address the environmental impacts of human activities on the environment. Many formerly closed shellfishing areas are open. The lower Presumspcot River offers a banquet of fish for hungry coastal birds. East End Beach in Portland is open for swimming and sailboarders are enjoying the waters of Back Cove.

Not all the news is good, however. With a growing population and increasing development pressure there are still significant concerns. Stormwater runoff from paved areas, lawns and farms is carrying a cocktail of bacteria, oil and chemicals, many of them toxic, into the waterways that lead to the bay. Pollutants carried in wind and rain from both distant and nearby sources (incinerators, power plants and cars, for example) are deposited in the bay. These "nonpoint" sources of pollution are a challenge to control because they rely, in large part, on changes in individual behavior.

Measuring the State of the Bay

As we work together to preserve and protect the health of Casco Bay, environmental monitoring allows us to measure our progress. Monitoring data can be used to establish a baseline of information, assess trends over time, and gauge whether our actions are helping us to meet the five stated environmental goals in the *Casco Bay Plan*. Through the Casco Bay Monitoring Program, CBEP and our partners are tracking a series of key environmental indicators. An environmental indicator is a measure of environmental quality that can be reliably used to assess the current condition of the environment as well as trends over time.

In *State of the Bay 2005* we use fourteen indicators ranging from population change to the levels of toxics in blue mussels to address questions about the health of Casco Bay and to measure our progress towards meeting the goals of the Casco Bay Plan. The indicators used in this report are helping us to answer the question: "What is the state of Casco Bay and its watershed?" We hope that the indicators are meaningful and that they convey information on the status of environmental quality in Casco Bay in a simple, concise format through text and illustrative graphics.



Data such as the water quality health index, above, serve as important indicators for evaluating the watershed's health (see page 38 for full map and description of index).

References

Casco Bay Estuary Program. 1996. *Casco Bay Plan.*

Colgan, C. and F. Lake. 1988. *The Economic Value of Casco Bay.* University of Southern Maine. Maine Coastal Program/Maine State Planning Office.

Heinig, C., P. Moore, D. W. Newburg and L. R. Moore. 1995. *Economic Analysis of the Soft-Shell Clam Industry* (Mya arenaria) *in Casco Bay.* Casco Bay Estuary Program.

Is Population Changing Around Casco Bay?

Answer: The population of the watershed is increasing.

Why Are Changing Demographics Important?

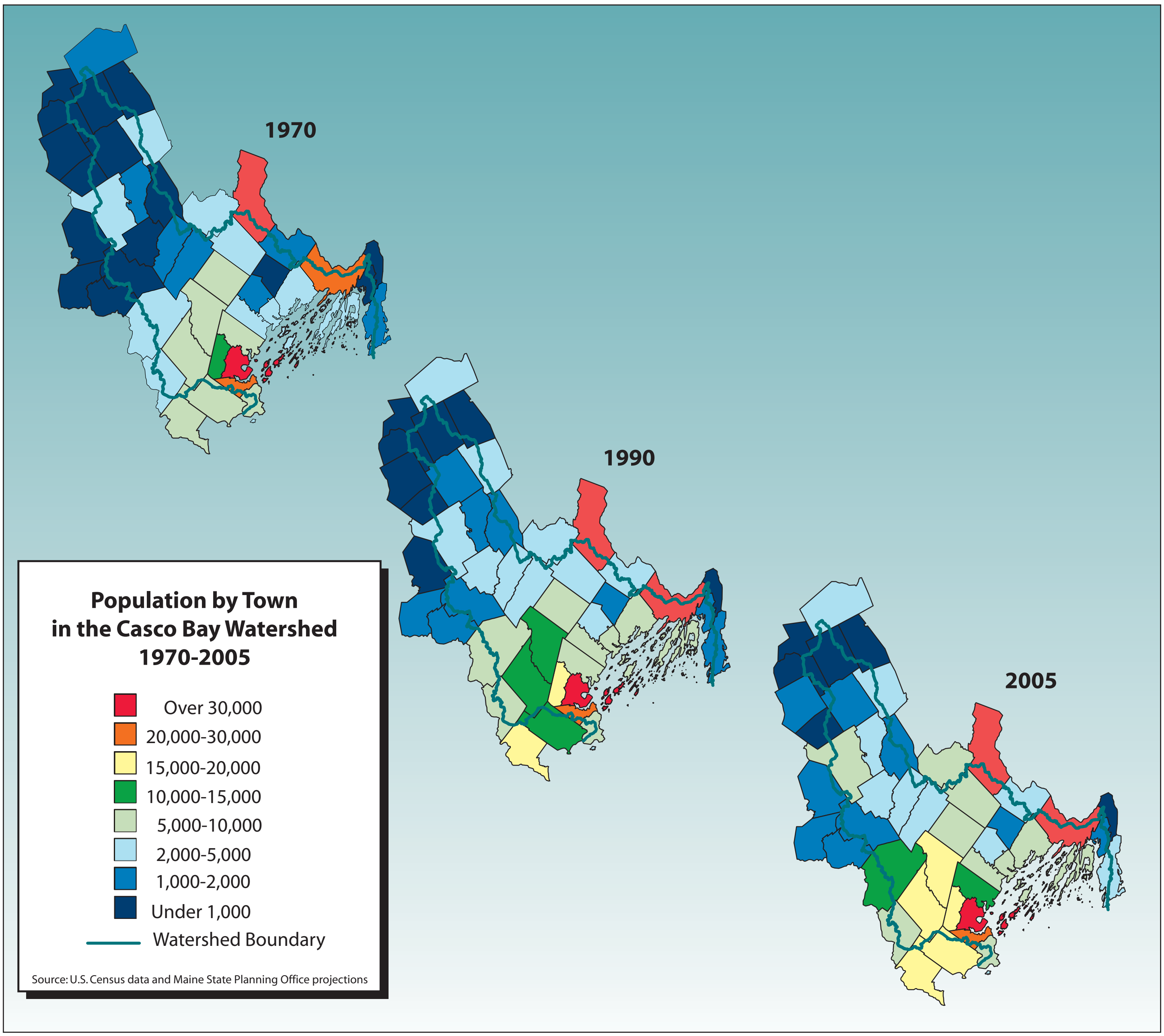
Assessing population change throughout the watershed provides insight about past and future patterns of economic growth, resource use, land development, and related pressures on ecosystems. Although demographic data describe only one facet of a complex socioeconomic system, tracking population change is important because population growth can be an underlying cause of ecosystem stress due to the expansion of transportation, housing, stormwater, sewer, and other built infrastructures needed to accommodate additional residents. Reviewing population information in conjunction with land use change and other indicators can explain changing demand for natural resources such as water, open space, or shellfish.

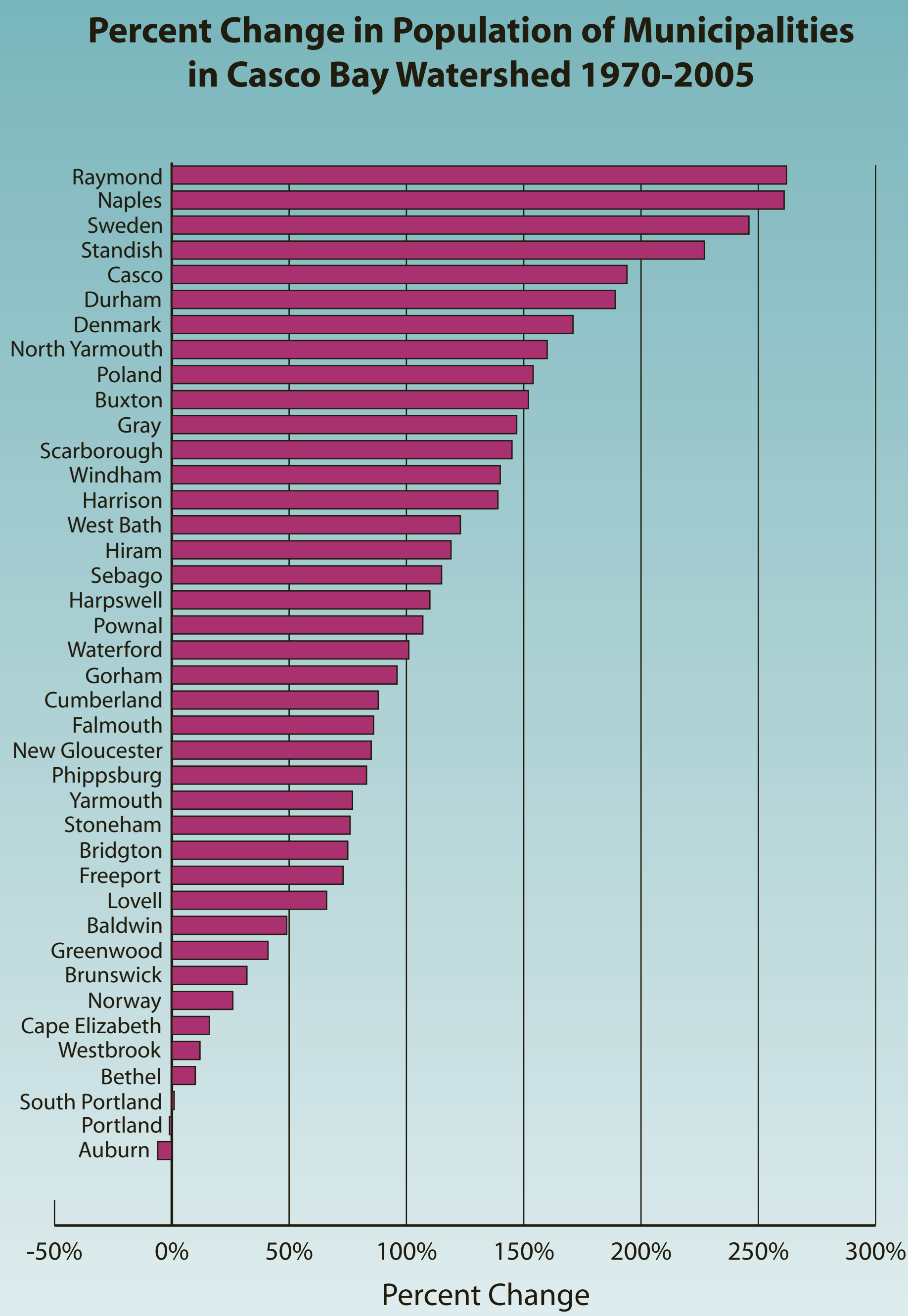
Population growth is projected to continue in the entire watershed, with a 6 percent increase over the next 10 years. Growing populations place development pressure on undeveloped lands and put more vehicles on local roads, driving sprawl-like development patterns, increasing impervious surface area, and compounding traffic congestion. For example, according to the Maine Bureau of Motor Vehicles website, vehicle registrations in Cumberland County increased from 215,141 to 283,943 between 1998 and 2003, an average annual increase of over 6%. In this way, population growth can be an indirect cause of air and water pollution in Casco Bay.

What Patterns of Population Change Are Occurring in the Watershed?

A review of population data throughout the watershed reveals two clear patterns. First, similar to national trends, Casco Bay's coastal communities are in the midst of a surge in population growth. Proximity to quality of life factors, employment opportunities, and primary transportation corridors contributes to coastal population growth. Second, formerly rural communities adjacent to the coastline are becoming suburban "bedroom" communities. Although population growth has shifted away from Portland and South Portland, whose populations have remained relatively constant, the populations of adjacent "bedroom" communities have grown rapidly over the last 30 years.

During the period between 1970 and 1990, almost 80 percent of total growth in the lower watershed took place in 11 suburban and rural communities: Brunswick, Windham, Scarborough, Standish, Gorham, Buxton, Yarmouth, Gray, Harpswell, Portland, and Freeport. To the south of Casco Bay, the combined populations of Saco and Scarborough have nearly tripled over the last 35 years from 13,535 in 1970 to an estimated 36,750 in 2005. Upper watershed communities adjacent to Sebago Lake and other freshwater bodies are experiencing a similar surge of population growth. The combined population of Naples, New Gloucester, Raymond and Standish has nearly tripled from 8,217 in 1970 to an estimated 23,675 in 2005.





Note: Historical population data are not available for Long Island, incorporated as a town in 1993.

Source: U.S. Census data, Maine State Planning Office projections

How Can This Information Be Used to Prepare for Future Growth?

Land use and transportation planners at the local, regional, state, and national scales are developing innovative ways to accommodate population growth while minimizing the impact of associated development on ecosystems. CBEP is working with state agencies and local municipalities to promote Low Impact Development (LID) which helps to minimize the impact of development on water resources. Examples of LID strategies are rain gardens, pervious pavement and green roofs (roofs which limit stormwater runoff by using plants to take up rain water). Smart growth promotes integration of centralized downtown development patterns with land conservation and alternative transportation. Using a third approach, conservation subdivision design, communities can maximize open space protection while maintaining development by allowing builders to cluster houses, leaving large areas of open land. All of these strategies contribute creative solutions to ecological impacts driven by rapid population growth.

Indicator 2: Impervious Surface

How Much of the Casco Bay Watershed Is Covered by Impervious Surface?

Answer: Overall, impervious surfaces cover approximately 5.9% of the Casco Bay watershed, with the highest levels occurring along coastal areas.

Why Is it Important to Monitor Percent Impervious Surface Coverage?

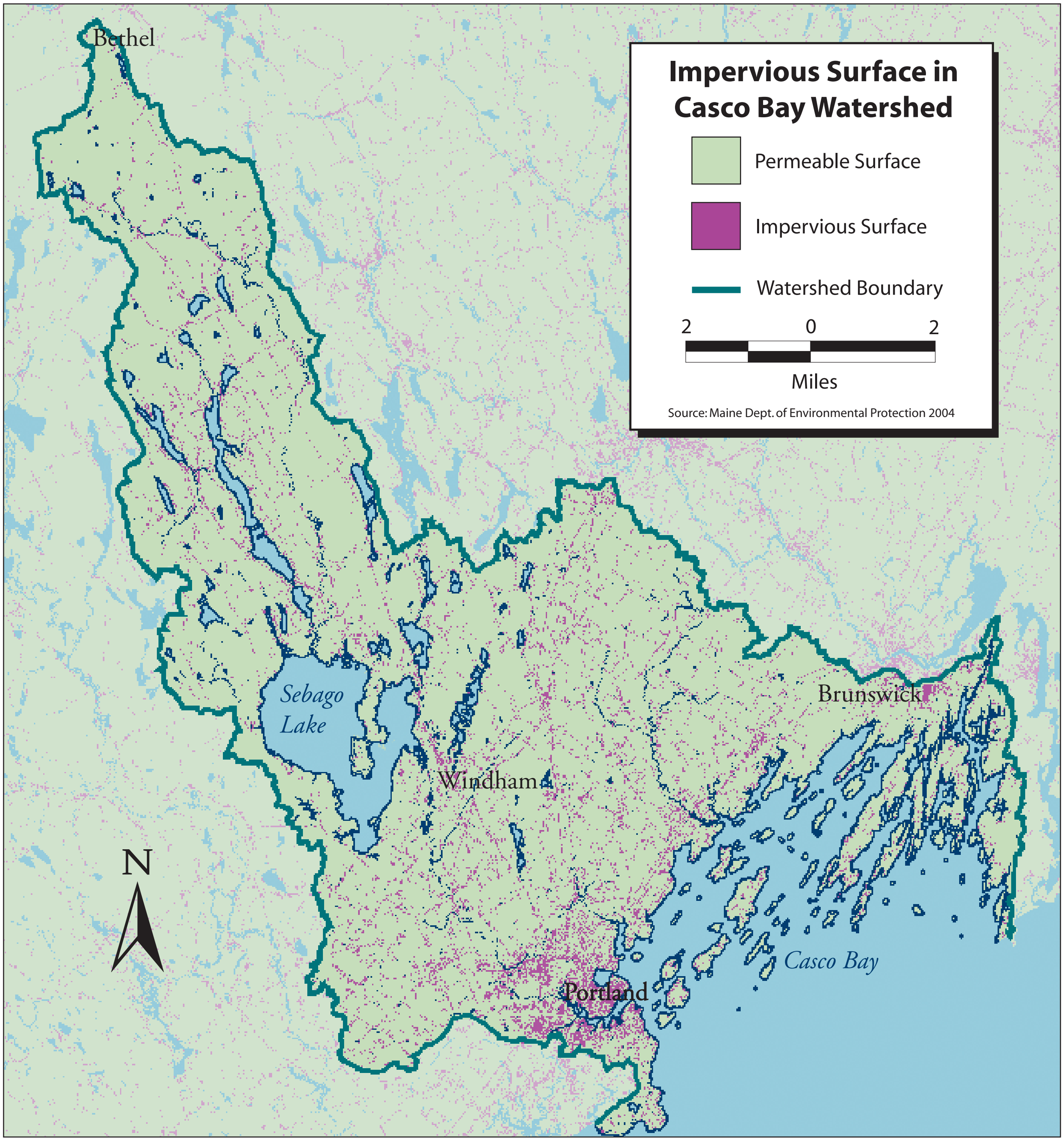
Impervious surfaces such as roads, parking lots, rooftops and compacted soils alter natural hydrological flow by preventing infiltration of rain water and snow melt into the ground. Instead, impervious surfaces direct runoff into stormwater drainage systems and their receiving water bodies. Streams, rivers, lakes and estuaries with watersheds that contain a high percentage of impervious surface area are likely to show poor water quality, degraded aquatic habitat, and reduced biological diversity. High impervious surface levels can also lead to increased flooding, erosion, stream channel alteration, and reduced groundwater recharge. Currently, impervious surfaces cover approximately 5.9% of the Casco Bay watershed, with the highest levels occurring in subwatersheds close to the coast, and the lowest levels occurring in the upper Sebago Lake watershed.

Impervious surface coverage can be a useful indicator in predicting stream degradation. Recent studies suggest that the ability of Maine's streams to support aquatic ecological communities becomes degraded when the amount of impervious surface area exceeds 6%-10% of the overall watershed area (Morse 2001). Research by the Maine Department of Environmental Protection (DEP) supports this conclusion. In a study of the impact of urbanization on two Casco Bay watershed streams, Long Creek and Red Brook, sampling sites located in regions having impervious surface area coverage less than 7.0% had good water quality and biological community (*e.g.,* fish, aquatic insects, crustaceans, etc.) conditions, while sites located in regions having coverage greater than 7.0% had poor to fair water quality and biological community conditions and, in some cases, failed to meet even state minimum water quality standards. Furthermore, sites with high impervious surface areas had high pollutant loads (*e.g.,* metals, total suspended solids) compared with the reference site, Red Brook (Varricchione 2002). Additional DEP studies have found similar conditions within other streams in the Casco Bay watershed (Meidel *et al.* 2005)

Impervious surfaces channel pollutants such as gasoline and oil into stormwater systems, which discharge into the rivers and streams flowing into Casco Bay.

Interlocal Stormwater Working Group

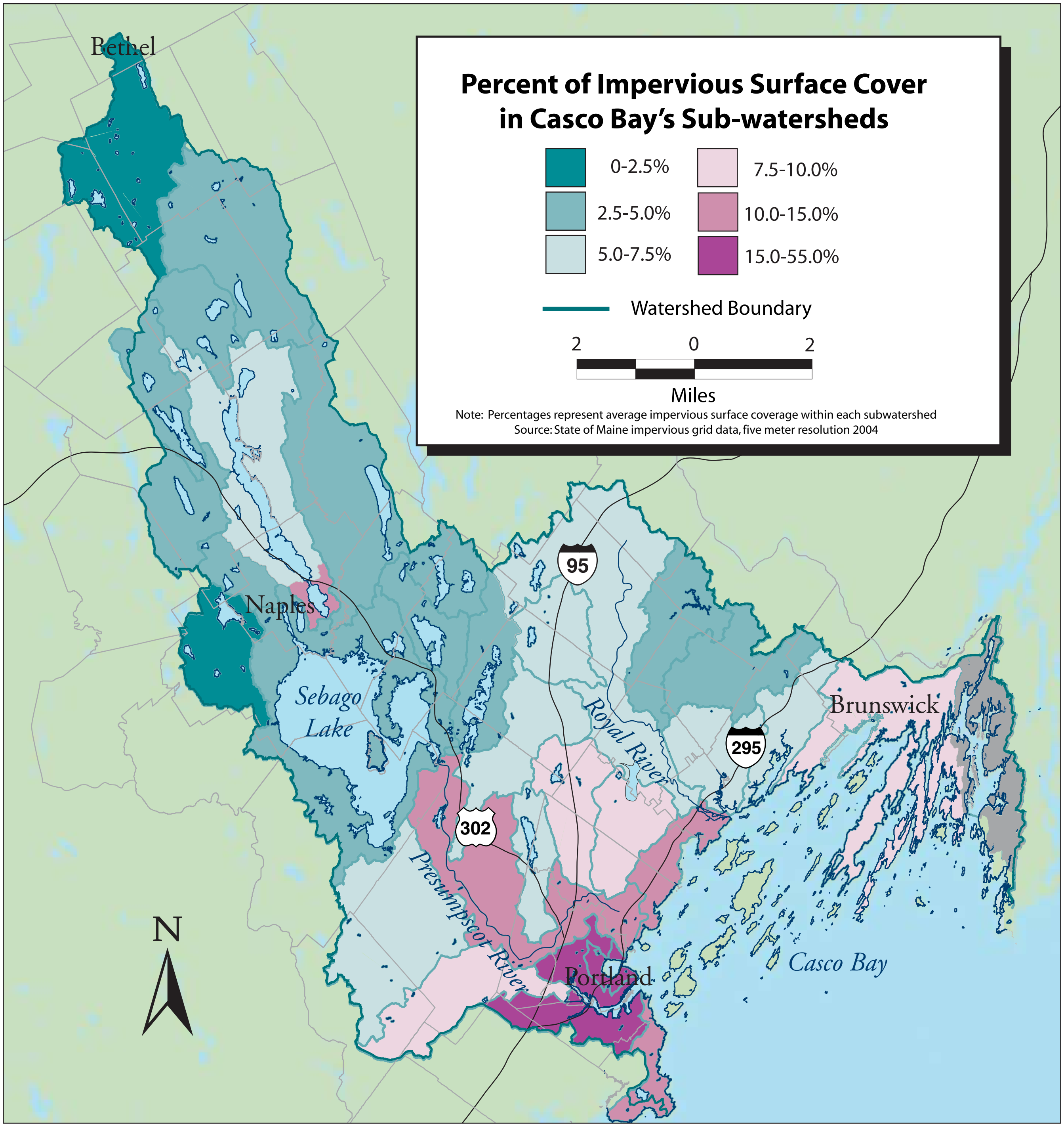
In 2002, fourteen municipalities within the Casco Bay watershed joined to form a partnership, the Interlocal Stormwater Working Group (ISWG), to meet federal and State stormwater regulations mandated by Congress under the Clean Water Act. By taking a regional approach to addressing stormwater pollution, ISWG can both maximize the limited financial and staff resources available and work on a geographic scale that is more appropriate to managing stormwater. Both CBEP and the Cumberland County Soil and Water Conservation District have provided significant support to facilitate the formation of the group and, in the case of CBEP, funding for implementation of education and outreach, training, and demonstration projects. The ISWG is successfully collaborating to reduce nonpoint source pollution from stormwater runoff and improve water quality throughout the Casco Bay watershed and has been held up as a model for municipal collaboration in the state.



How Does Impervious Surface Affect Water Quality and Aquatic Habitat?

Impervious surfaces accelerate the movement of runoff and thus the delivery of pollutants from throughout the watershed into Casco Bay. On its way to receiving water bodies, stormwater runoff accumulates pollutants such as oil, gas, and other hydrocarbons, heavy metals, de-icers, pesticides, fine sediment, fertilizers, and bacteria, all of which can impair water quality. For example, runoff from fertilized lawns contributes excess nutrients to water bodies, which can lead to algal blooms and in extreme cases, fish kill events. Other stormwater pollutants of concern are toxic contaminants, such as heavy metals and pesticides, which originate from vehicles and businesses or from homeowner activities.

Impervious surfaces alter natural hydrology patterns and lead to more frequent and extreme hydrologic conditions in streams and rivers. By accelerating flood conditions, impervious surfaces can lead to property damage, erosion, channel alteration, and habitat degradation. Increased stormwater runoff erodes stream and river banks and deposits sediments



downstream, degrading high value habitat such as spawning beds and riparian shoreline and altering natural stream channels. During summer months, impervious surfaces can also lead to higher stream temperatures. As rainfall warmed by the pavement flows into water bodies, stream habitat becomes less suitable for trout and other temperature-sensitive aquatic species. Studies by the Maine Department of Environmental Protection have found that increasing percentage impervious surface coverage is associated with reduced biological diversity and a shift in aquatic community structure from insect communities toward non-insect, pollution-tolerant species.

References

Meidel, S. and Maine DEP. 2005. *Urban Streams Nonpoint Source Assessments in Maine*. Maine Department of Environmental Protection, Augusta, ME.

Morse, C. 2001. *The Response of First and Second-Order Streams to Urban Land-Use in Maine.* MS thesis, Ecology and Environmental Science Program, University of Maine (98 p).

Varricchione, J. 2002. *A Biological, Physical, and Chemical Assessment of Two Urban Streams in Southern Maine: Long Creek & Red Brook.* Volumes I and II, Maine Department of Environmental Protection, Portland, ME.

Are the Volume and Frequency of Combined Sewer Overflows Changing Over Time?

Answer: Yes. They have decreased since 1996.

CSO outfall at Back Cove, Portland.

Why Is Combined Sewer Overflow Abatement Important?

Stormwater drainage systems can convey stormwater alone or stormwater mixed with sanitary waste (a combined sewer). In the 1970's, networks of underground pipes that used to direct stormwater and untreated wastes directly into rivers and the Bay were "intercepted" and directed to sewage treatment plants before discharge. When heavy rains overwhelm the capacity of the treatment plants or the conveyance system, a portion of the combined sewage and stormwater flow is diverted without treatment through relief points known as combined sewer overflows (CSOs). These overflows result in the introduction of millions of gallons of polluted water to rivers and the Bay annually, including bacteria and viruses from sewage. These pathogens can lead to human health threats, beach and shellfish bed closures and aesthetic impacts. Reducing this source of polluted water is an important goal of the Casco Bay Plan. The United States Environmental Protection Agency (EPA) 1994 CSO Control Policy requires communities to establish a set of minimum controls and to develop long-term plans for achieving compliance with the Clean Water Act.

Where Are There Combined Sewer Overflows in the Casco Bay Watershed?

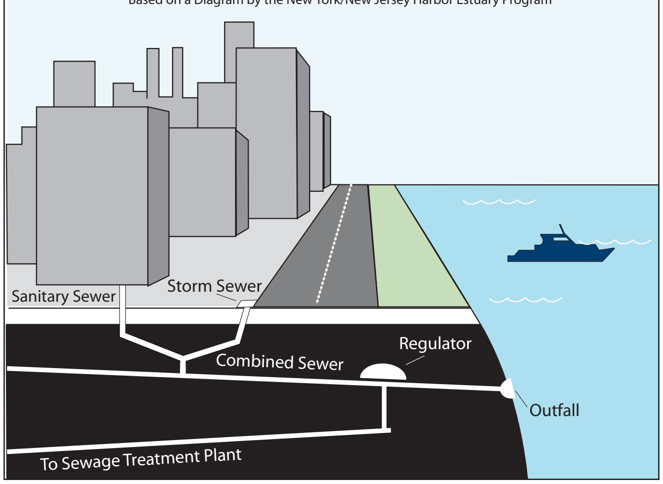
Forty-one communities in Maine currently have CSOs. In the Casco Bay watershed, active CSOs are found in Portland, South Portland and Westbrook. Portland's CSO flows comprised 42% of the total flows for the state in 2004 (Maine DEP). Over the last decade, each of these cities has made major strides towards reducing the number, volume and frequency of combined sewer overflow events.

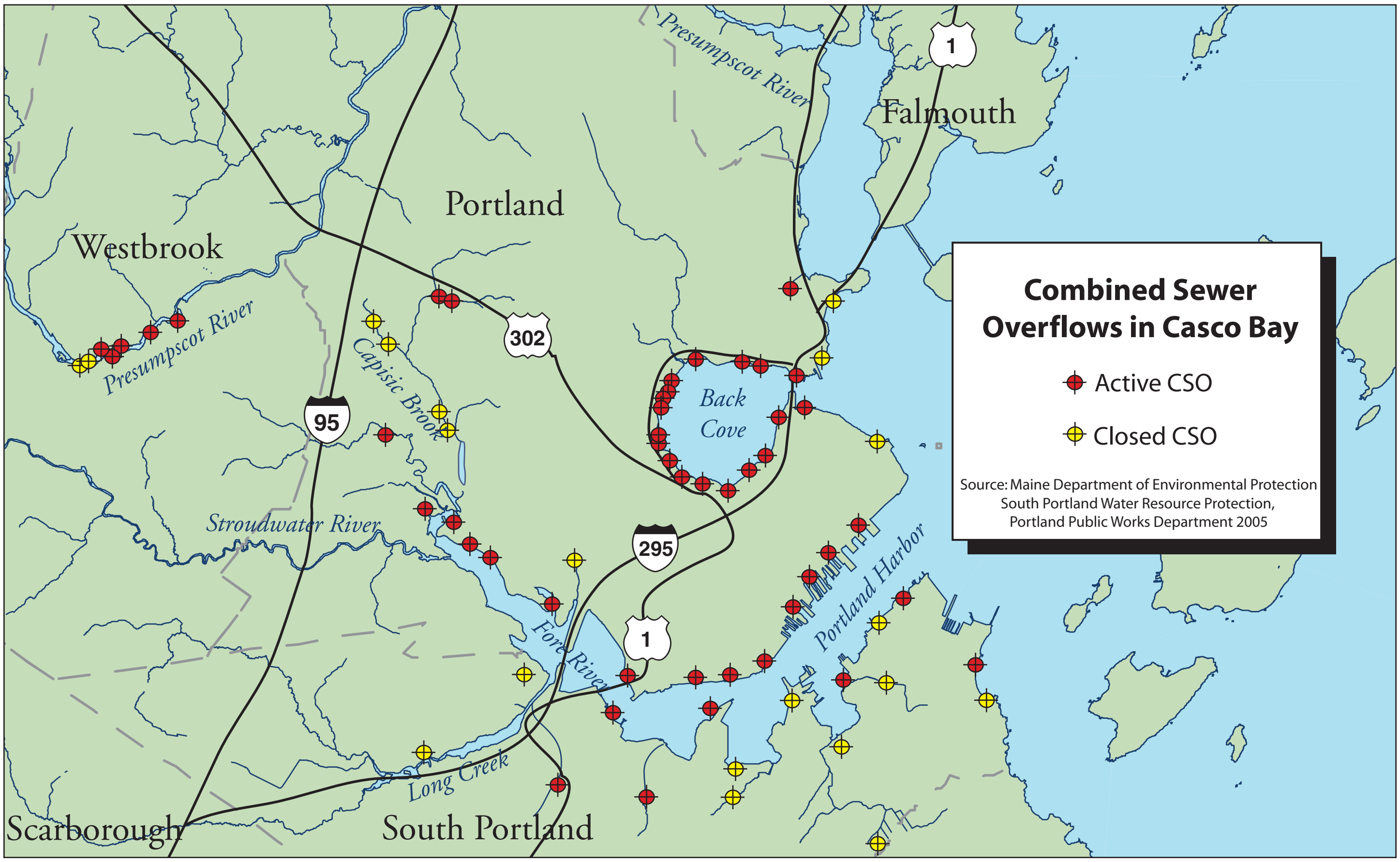
What Progress Has Been Made Towards Elimination of CSOs?

When the Casco Bay Plan was written in 1996, Portland had 42 CSOs contributing an estimated 720 million gallons of combined sewage and stormwater overflowing each year. Portland currently has a population of 64,249. The City covers 20 square miles, of which 4,200 acres drain to combined sewers. The City's Master Plan for CSO elimination aims to reduce the total number of active CSOs to 10, to reduce CSO volumes from 720 million gallons per year to 87 million gallons per year, and to demonstrate an 85% reduction in CSO events.

Diagram of a Combined Sewer Overflow (CSO)

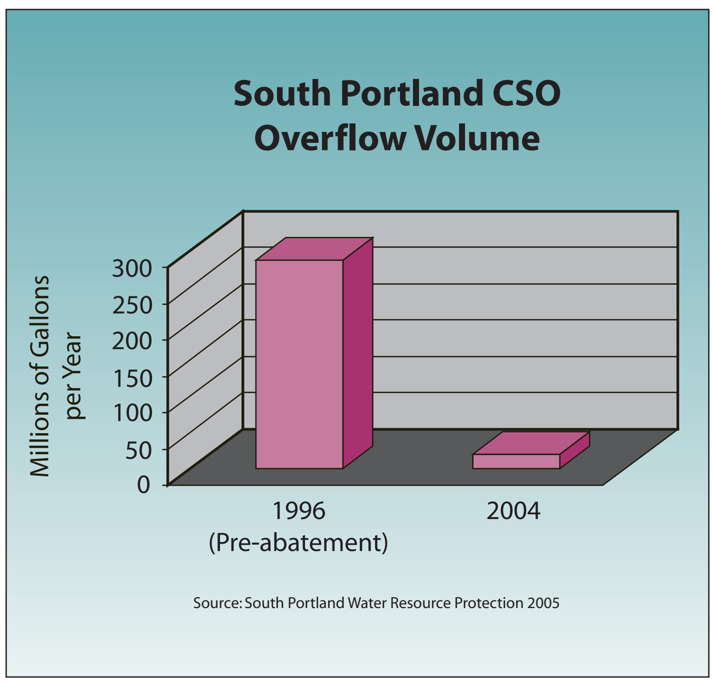
Based on a Diagram by the New York/New Jersey Harbor Estuary Program





Locations of active and closed Combined Sewer Overflows in Casco Bay communities. A total of 20 CSOs have been eliminated since the early 1990s.

To date, Portland has spent $36 million dollars implementing Phase 1 of their three phase CSO abatement plan, with a total of 8 active CSOs eliminated to date. The City expects to spend $59 million implementing Phase 2 and additional funding on Phase 3. In 2004, a very rainy year, the total volume from all combined sewer overflow events in Portland was estimated at approximately 607 million gallons (Portland Department of Public Works).



In the early 1990s, the City of South Portland had 15 active combined sewer overflows, discharging as much as 280 million gallons per year. There were two additional combined sewer overflows in South Portland owned by the State. Since that time, a total of ten active CSOs have been eliminated, one by the State and nine by the City. These include CSOs impacting Willard Beach and Trout Brook. Of the City of South Portland's six remaining CSOs, two are expected to be eliminated this year. In 2004, measured overflows were about 20 million gallons per year (South Portland Water Resource Protection).

The City of Westbrook had seven combined sewer overflows, discharging up to 49 million gallons a year into the Presumpscot River. As of 2004, 2 of these active CSOs have been eliminated and the CSO overflows reduced to under one million gallons per year (Maine Department of Environmental Protection).

Has the Acreage of Open Shellfish Beds in Casco Bay Changed Over Time?

Answer: Acreage of open beds has increased significantly since 1994.

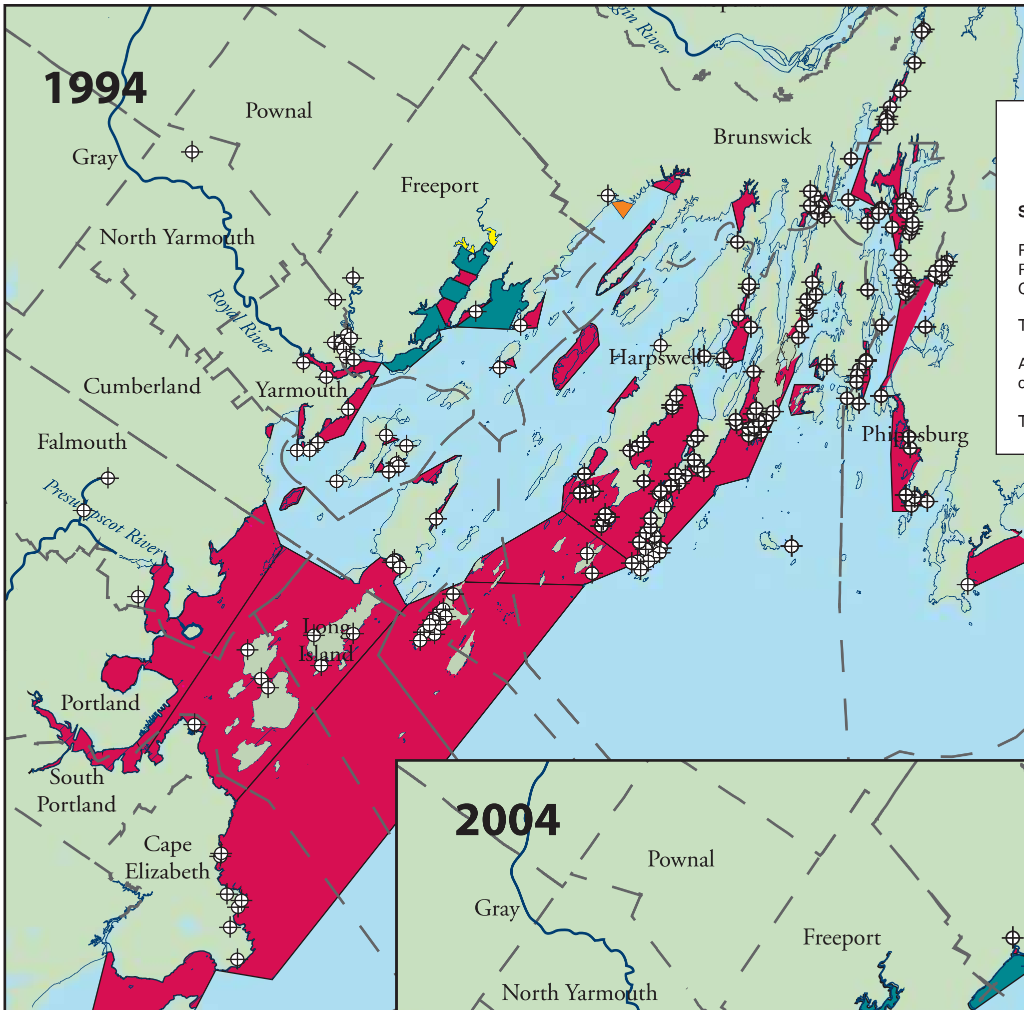
Bill Silliker, Jr.

Why is Open Shellfish Bed Acreage Important?

The status of our shellfish beds serves as a significant indicator of water quality in Casco Bay. In addition, shellfishing represents an important tradition, as well as a livelihood for many residents. The economic value of the soft-shell clam industry in Casco Bay has been estimated at between $11.6 and $15.7 million annually. The closure of shellfishing areas because of pollution limits the economic value of the resource. By working to sustain the health of the shellfish beds and expand open acreage, we are promoting economic and ecological well-being and maintaining an important part of our coastal heritage.

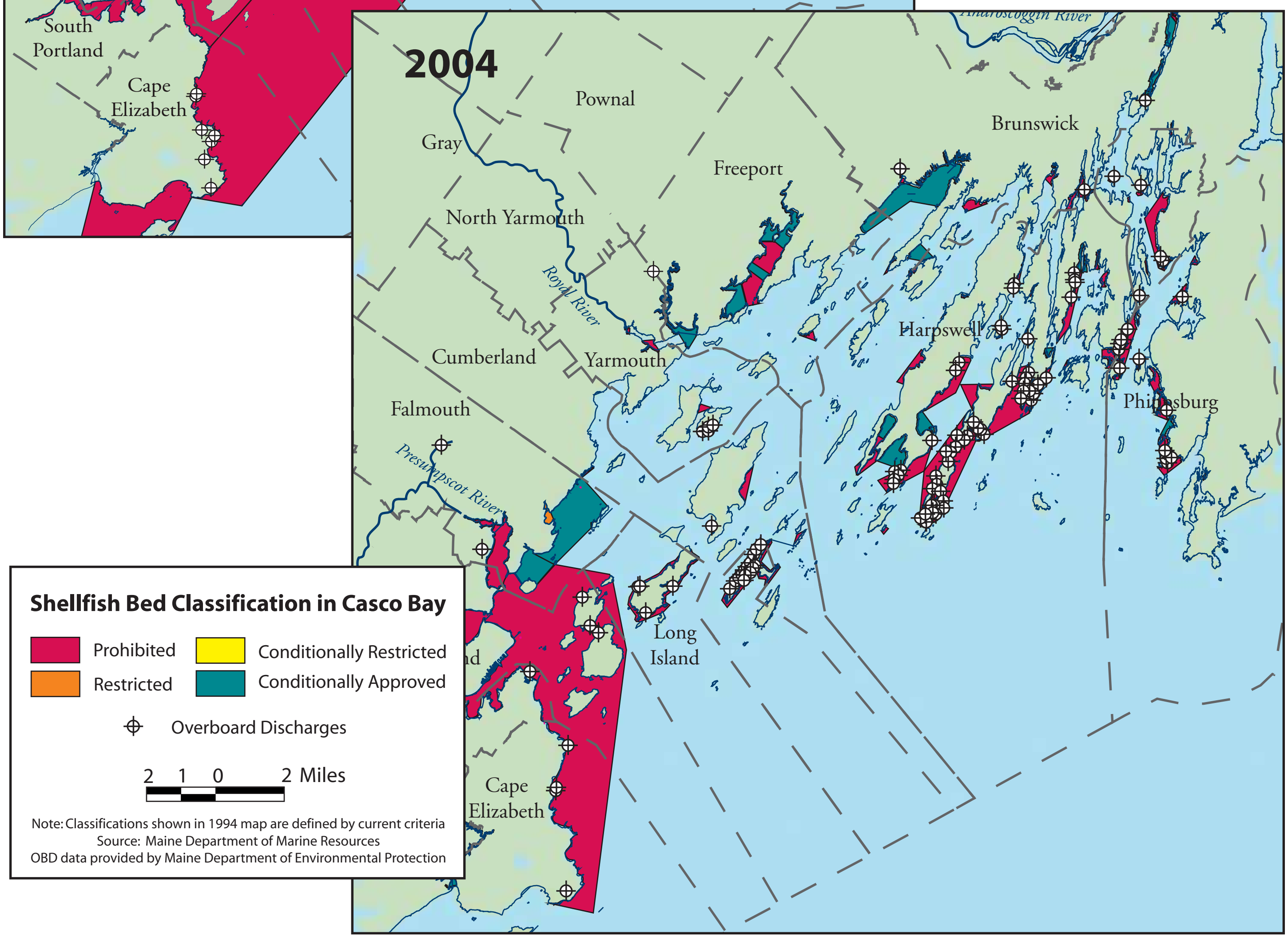
Contamination and Closure

Consumption of shellfish contaminated by fecal waste can cause illness. Shellfish flats are closed by the state when water quality monitoring indicates the presence of animal or human fecal waste or when there is a threat of fecal contamination. Bacterial contamination from malfunctioning septic systems, overboard discharge systems, boat discharges, combined sewer overflows and nonpoint source pollution led to the closure of 37% of the bay's shellfish flats ten years ago. Over the past decade, progress has been made to eliminate many of the sources of bacterial contamination in Casco Bay, leading to the reopening of thousands of acres of formerly closed flats.



Change in Casco Bay Clam Flat Harvesting Status 1994-2004

Status of Clam Flats	1994	2004
Prohibited	57,019.7	19,173.6
Restricted	224.2	57.4
Conditionally restricted	100.8	173.3
Total prohibited or restricted	57,344.7	19,404.3
Approved or conditionally approved	140,014.1	177,954.5
Total acreage	197,358.8	197,358.8



The acreage where shellfishing is prohibited or restricted in Casco Bay has declined dramatically in the last decade.

An Effective Partnership: Overboard Discharge System Elimination

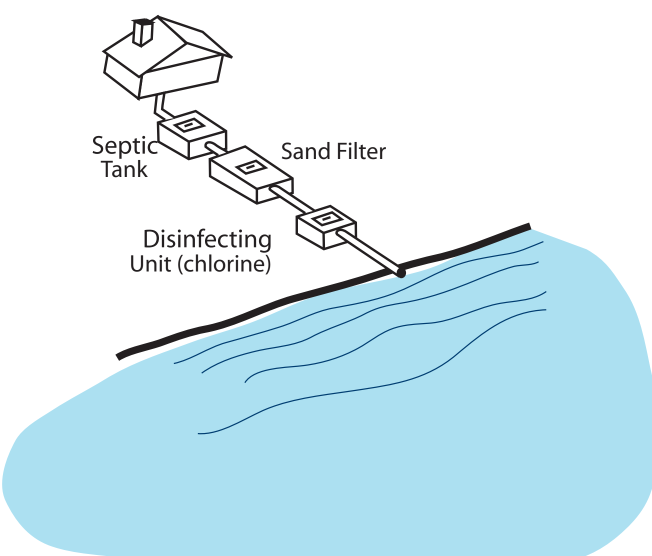
A typical overboard discharge system is similar to a household septic system except that the leaching field is replaced by a combination of a sand filter or mechanical aerobic tank and a chlorination unit to disinfect the effluent before it is discharged into a water body (see illustration). Because the proper maintenance of a household system cannot be guaranteed, the Maine Department of Marine Resources considers each overboard discharge system as a potential source of bacteria and permanently closes nearby shellfish flats.

In 1987, Maine enacted the Overboard Discharge Law, which prohibited new systems and established a procedure for replacing existing systems with alternative treatment methods. Since that time, the state has worked with towns and homeowners, providing grant funding to help eliminate overboard discharge systems. In 1999, CBEP began working with Maine Department of Environmental Protection, Maine Department of Marine Resources, municipalities and homeowners to provide the technical and financial assistance needed to replace overboard discharges located near productive shellfish resource areas. To date, CBEP has helped to open over 300 acres of flats.

Reference

Heinig, C., P. Moore, D.W. Newburg and L. R. Moore. 1995. *Economic Analysis of the Soft-Shell Clam* (Mya arenaria) *in Casco Bay.* Casco Bay Estuary Program.

Diagram of an Overboard Discharge System (OBD)



Maine Department of Environmental Protection and
Maine Department of Community and Economic Development, 1993,
Treat it Right: Alternative Wastewater Systems that Protect Water Quality

Guy Watson, Yarmouth Shellfish Committee and Marcia Bowen, Normandeau Associates furrow one of the test soft-shell clam "farm" plots with clam forks.

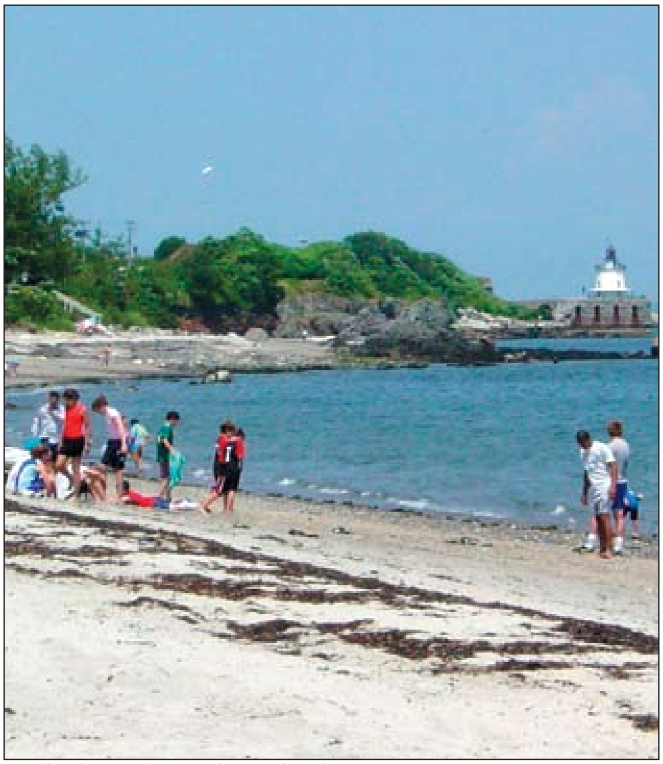
Expanding and Sustaining the Shellfisheries of Casco Bay

CBEP is working with a team of shellfish stakeholders and consultants to identify and eliminate fecal pollution sources, re-open soft-shell clam flats and develop tools for sustainable management of shellfish resources. For example, in October of 2001, CBEP led an effort to test the value of soft-shell clam farming options by seeding clams in three saltwater "farm" locations along the Bay.

A sampling area in one of the soft-shell clam flat plots studied to investigate the success of clam seeding.

What is the Status of Swimming Beach Monitoring in Casco Bay?

Answer: Two Casco Bay beaches are routinely monitored for water quality.



Willard Beach, South Portland

Which Casco Bay Beaches are Routinely Monitored?

There are two areas in Casco Bay that are monitored regularly for bacterial contamination. East End Beach in Portland is monitored by the City of Portland three times per week during the summer. Since 1996, Willard Beach in South Portland has been monitored twice per week, from May to September. Three beaches on Peaks Island have been permanently closed due to sewage pollution since 1991. There is currently no monitoring program in place for Peaks Island and the other beaches in Casco Bay. See the map identifying the locations of Casco Bay swimming beaches.

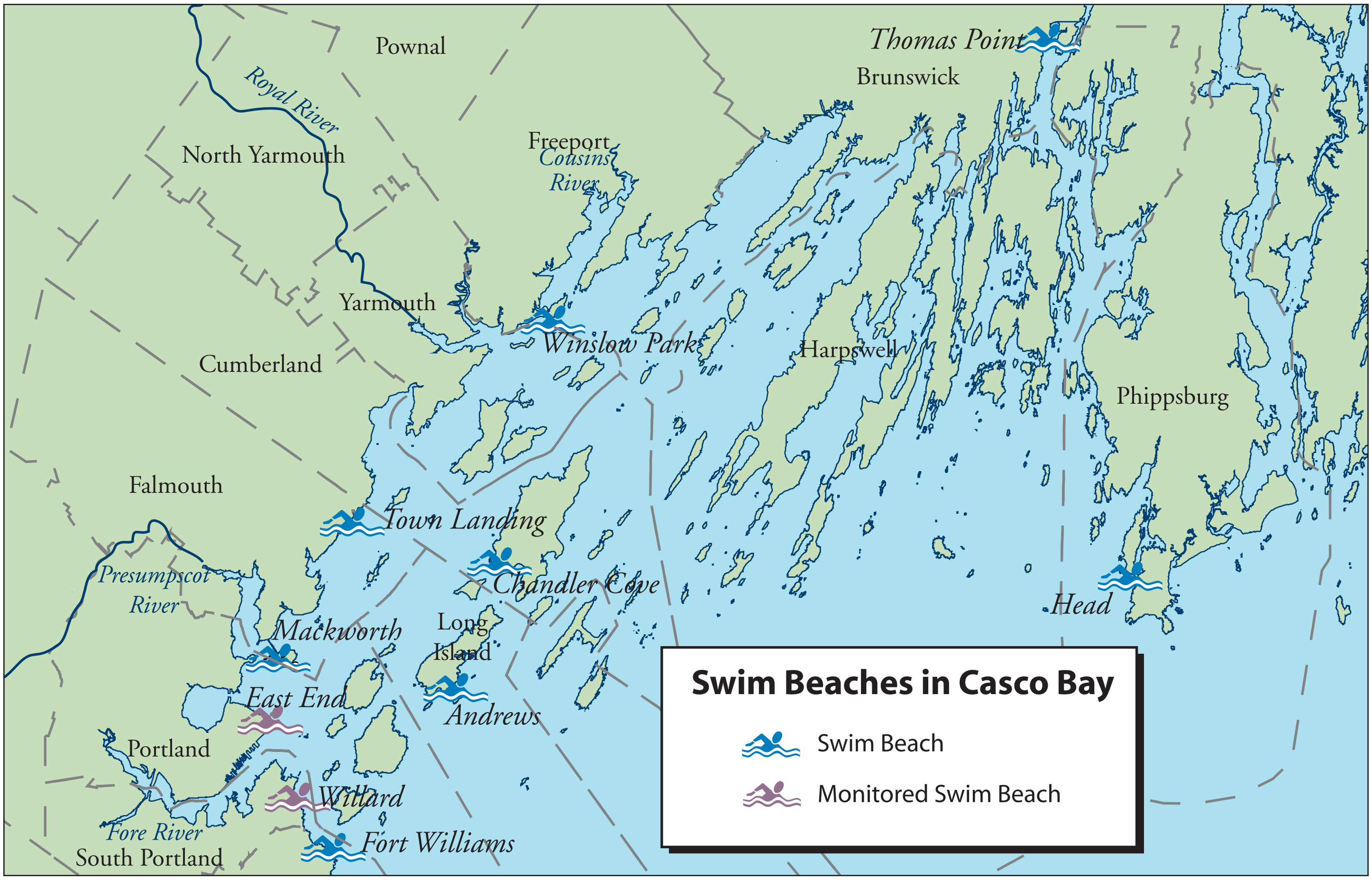
Why is Beach Monitoring Important?

Bathers are at risk when water is contaminated by fecal matter from nearby poorly functioning septic systems, boat moorings and marinas, stormwater runoff, combined sewer overflows, animals or poor practices by recreational water users. Regularly monitoring the water quality during the summer for the presence of indicator organisms such as *Enterococcus* bacteria helps to protect bathers from health problems caused by waterborne bacteria and viruses. These can include ear and eye infections, sore throats and gastric illness. Recreational bathers are often surprised to learn that many beaches are not routinely monitored for safe water quality. In Maine, the decision to monitor and/or issue swimming beach advisories or closures is left to the discretion of municipal health departments and State Park officials.

Number of Beach Days with Closures or Advisories

Year	Willard Beach, South Portland	East End Beach, Portland
1997	6	14
1998	2	10
1999	2	4
2000	1	5
2001	0	3
2002	7	4
2003	0	1
2004	6	2

Source: South Portland Parks and Recreation Department, Portland Water District, Portland Parks and Recreation Department



Willard Beach and East End Beach (highlighted) are monitored regularly. The University of Maine Cooperative Extension/Sea Gant staff conducted Sanitary Shoreline Surveys on East End Beach in 2003 and Willard Beach in 2005, providing technical support and oversight. Both Portland and South Portland are committed to remediating pollution problems and notifying the public of health risks at these beaches.

Maine Healthy Beaches Program

With the help of U.S. EPA funding, administered by the Maine State Planning Office (SPO), the state is implementing the Maine Healthy Beaches program (MHB). MHB has established a unified coastal water quality monitoring program for 18 towns and State Parks representing 38 of the state's beaches. SPO, the University of Maine Cooperative Extension and Sea Grant along with an Advisory Committee of state agencies and organizations, including Casco Bay Estuary Partnership, are working together to educate the public about healthy beach use and to encourage towns to participate in the MHB program. The MHB program provides towns with training and technical resources including permanent signs with a changeable color-coded plate. Beach administrators determine whether to close a beach or issue an advisory using a risk based approach in conjunction with bacterial samples on a single sample basis.

The MHB program uses an on-line database for managers and has launched a new segment of their website which allows members of the public to view the status and data generated for each beach participating in the program. To learn more, visit the website: http://www.mainehealthybeaches.org/index.html.

Maine Healthy Beaches program signs have signs with changeable color-coded plates. Green indicates the beach is open. Orange warns that swimming and other water contact activities are not advised. Red indicates the beach is closed.

Inidicator 6: Protected Land

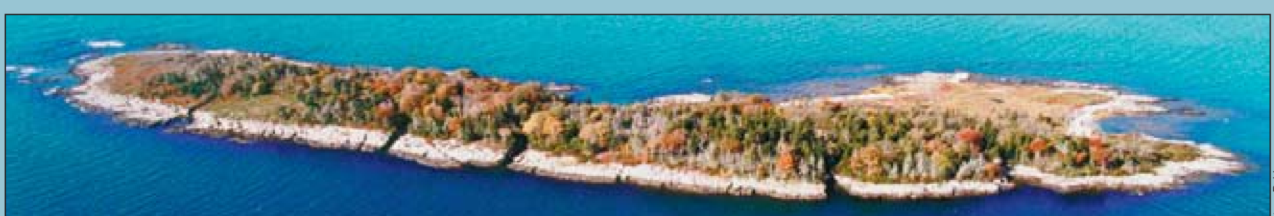
How Much Land Is Protected in the Lower 15 Towns In the Casco Bay Watershed?

Answer: Protected land has increased by nearly 50% since 1997.

Why Is it Important to Protect Critical Habitat in Casco Bay?

The Casco Bay watershed supports a diverse assemblage of migratory birds, fish and other wildlife, but habitat is threatened with residential and commercial development throughout the watershed. A Brookings Institution report released in July, 2001 documented that Greater Portland is consuming more acreage per person than any other city in the Northeast. Between 1982 and 1997, the Greater Portland population increased 17%, but farmland and forestland conversion to urban uses increased by 108%. Only eight other metropolitan areas in the nation sprawled at a faster rate. As sprawl escalates, the natural resource values of the Casco Bay watershed decline.

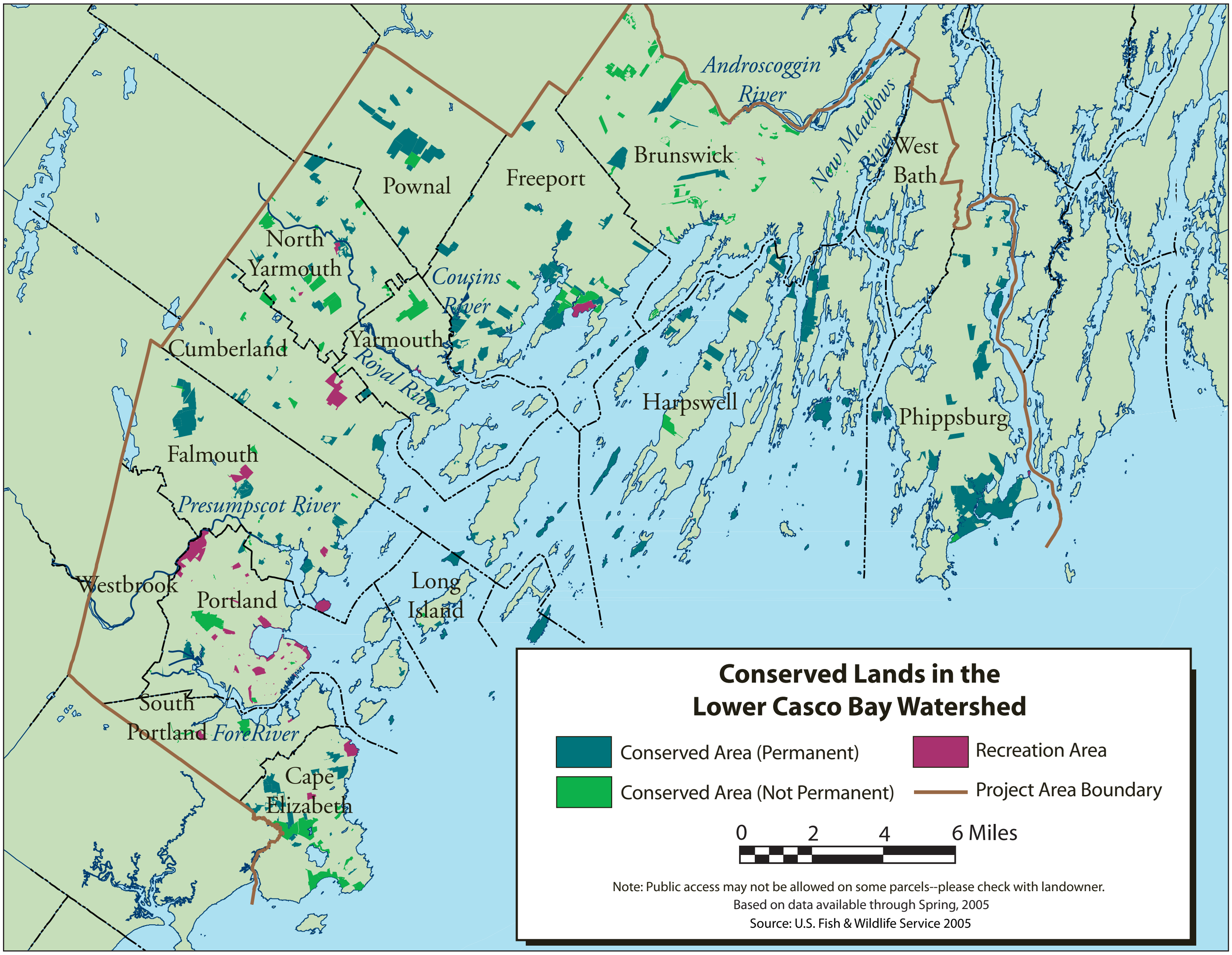
In 1997, in order to track the effectiveness of protecting important habitat and open space, CBEP, with significant technical support from the U.S. Fish and Wildlife Service Gulf of Maine Coastal Program and the cooperation of land trusts in the region, compiled a detailed geographic information system database and map to document the extent of protected lands in the lower 15 towns of the watershed. In 2005, CBEP enlisted the support of the U.S. Fish and Wildlife Service Gulf of Maine Coastal Program and land trusts once again to update the protected lands coverage. In 1997, 7,300 acres of protected lands at 246 sites were documented, and in 2005, 3,600 additional acres of protected lands at 95 new sites were identified. This represents nearly a 50% increase in protected lands.



Flag Island

Flag Island, a 41.6 acre island in Casco Bay, was permanently protected in 2002 by the cooperative efforts of a unique array of federal, state and private partners, including CBEP. Flag Island is one of Maine's premier coastal nesting islands for common eiders: with more than 600 nesting pairs, Flag Island ranks as the eighth highest value island for nesting eiders statewide. The island is particularly significant for its high concentration of nesting eiders near the southern end of their breeding range. Flag Island also supports other nesting birds, including gulls, great blue herons, osprey and woodcock.

Federal and state agencies and non-government conservation partners have been instrumental in permanently protecting this island. A federal National Coastal Wetland Grant prepared by the U.S. Fish and Wildlife Service Gulf of Maine Coastal Program provided half of the $1 million purchase price. In addition, several hundred thousand dollars were provided by the Natural Resource Trustees for the Rhode Island North Cape Oil Spill Fund as compensation for the wintering eiders killed in the North Cape spill. Remaining funds were provided by the Land for Maine's Future Program, the Maine Outdoor Heritage Program, the *Julie N* Oil Spill Fund and the CBEP Habitat Protection Fund. Additional funds from the North Cape spill are being used to monitor and manage the nesting eiders.



Definitions: Conserved Area (Permanent): Land protected from development through permanent conservation easements, restrictions, or ownership; Conserved Area (Not Permanent): Land protected from development through term conservation easements, restrictions, or current use. Status may change when land is transferred or taken out of current use. Includes land primarily used for undeveloped recreation, water supply protection, or education; Recreation Area: Land which is primarily used for developed recreation (e.g. ballfields), with remaining open areas providing conservation.

What Are-And Are Not-Protected Lands?

Not all land that community members think is protected from development actually is. Therefore, in developing a database of protected lands, it is important to clarify the multiple forms of land ownership that provide varying levels of protection for natural resource values. For example, natural areas such as town forests and parks are often assumed to be permanently protected. However, local residents have sometimes been dismayed to learn that their town forest or park has been slated for conversion to a municipal facility, or even sold for development. In addition, a conservation easement owned by a local land trust may or may not provide for permanent protection of fish and wildlife habitat values or for public access. All conservation easements are personalized to meet the needs of the landowner and the willingness of the conservation partner to accept and then enforce the terms of the easement. Conservation easements may preclude any development, or they may permit any number of uses—including timber harvest, farming, and sometimes, limited residential or commercial development.

Documenting an increase in protected lands over time is only one measure of success in conserving fish and wildlife habitat. It is equally important to document the changing landscape matrix, increasing sprawl and the loss of habitat over time. If we truly hope to assess the changing value of the Casco Bay watershed for fish and wildlife over time, we need not only to document lands we have permanently protected—but also, the lands that we have permanently lost to residential and commercial sprawl.

References

Brookings Institution. 2001. *Who Sprawls Most? How Growth Patterns Differ Across the U.S.* Washington DC. http://www.brookings.edu/es/urban/publications/fulton.pdf

Inidicator 7: Undeveloped Land

Are There Large, Undeveloped Blocks of Land in the Casco Bay Watershed?

Answer: Yes. Large areas of unfragmented, natural land still remain in the watershed, but they are becoming scarcer as development progresses.

Why Are Large, Undeveloped Blocks of Land Important?

Larger blocks of natural habitat, including forests, grasslands, and freshwater wetlands, play a vital role in the health of the Casco Bay watershed:

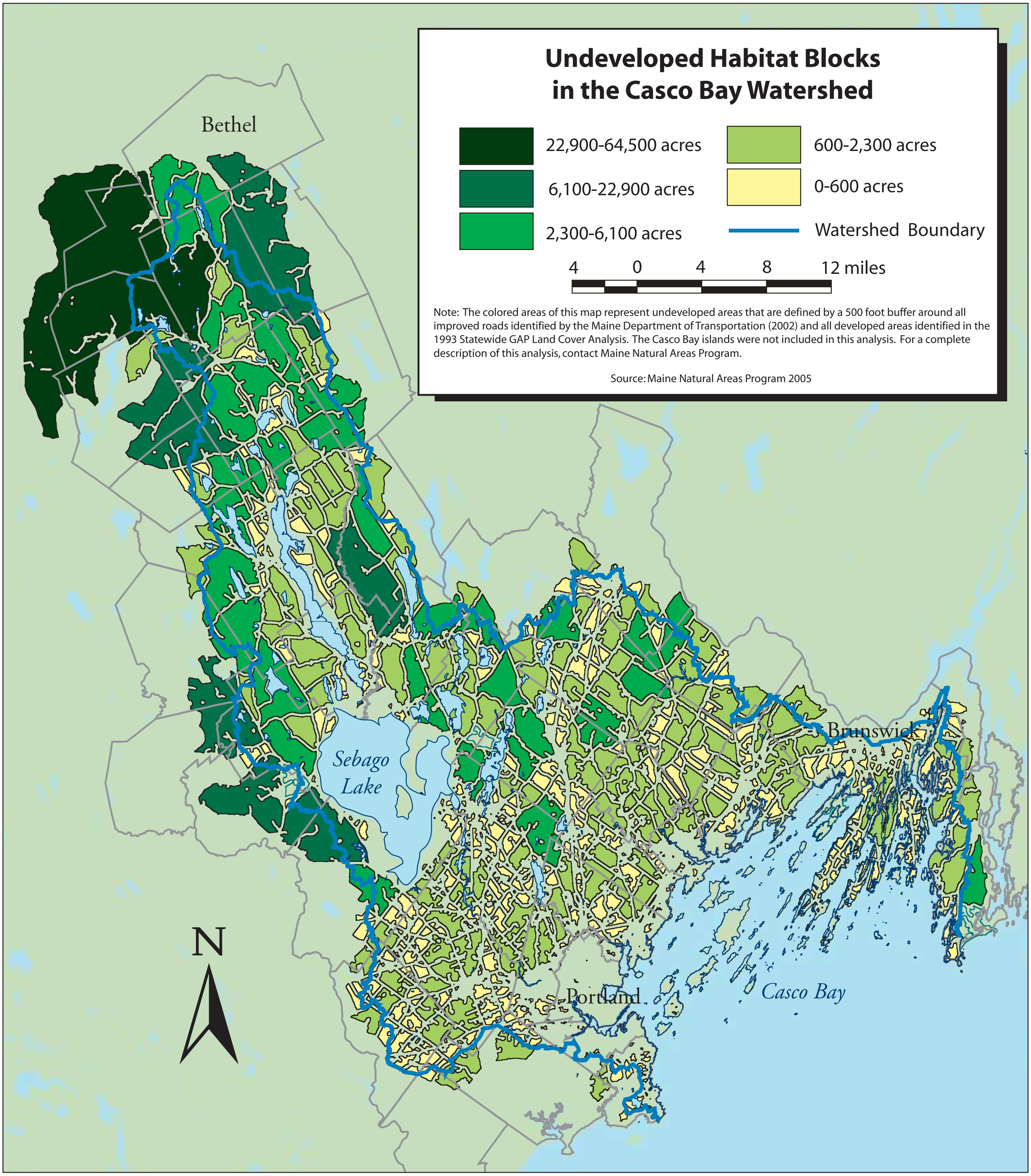
- **For Wildlife:** Larger habitat blocks are more likely to support healthy, genetically diverse populations of many plant and wildlife species. Examples of species that require larger areas of habitat uninterrupted by roads and development include mammals like fisher and bobcat, birds of prey like the Northern Goshawk, and songbirds like the Wood Thrush. Large habitat blocks can provide refuges of higher quality habitat that is buffered from the degrading influences of surrounding development, known as "edge effects," including reduced opportunity for plants and animals to move across the landscape, road kill, pollution, changes in light and moisture regimes, and increased threats from invasive species. Research has shown that maintaining large habitat blocks and connecting corridors between those blocks is essential to maintaining all of our native wildlife species into the future.
- **For Healthy Ecosystems:** Larger natural areas provide important ecosystem services that protect the quality of our air, surface water, and ground water. Healthy upland and freshwater wetland ecosystems protect lakes, rivers, and streams by minimizing erosion and sedimentation and maintaining natural nutrient cycles.

USF&WS

The Wood Thrush requires large areas of unfragmented habitat.

Ed Geis/Headwaters

- **For Quality of Life:** Larger unfragmented natural areas can provide opportunities for outdoor recreation such as hiking, cross-country skiing, hunting, and fishing. These areas enhance the scenic and rural character of the landscape. Traditional land uses such as farming and forestry depend on these larger areas of open space. In turn, working farms and forestlands provide valuable habitat for a variety of plants and wildlife.



Large blocks of undeveloped natural land play a critical role in supporting healthy native wildlife populations and diverse and functioning ecosystems. In the Casco Bay watershed, the largest blocks of undeveloped land are located in the northwestern portion of the watershed. Some of the less densely developed municipalities such as Bridgton and Waterford have large blocks (>2,000 acres) of land that remain unfragmented by development.

What Can Be Done to Maintain Large Undeveloped Blocks of Land?

As development progresses in the Casco Bay watershed, larger unfragmented natural areas are becoming scarcer. The map on page 23 shows the undeveloped blocks remaining in the Casco Bay watershed, as mapped by the state's Beginning with Habitat program. The table provides data on undeveloped blocks by town. Although most of the largest blocks are in the upper part of the watershed, some substantial blocks remain in Windham, Gray, New Gloucester, and other towns. The Maine Beginning with Habitat program provides each town with local maps of undeveloped blocks, valuable habitat, public and conservation lands, wetlands and impervious surface coverage. The program also makes presentations to the towns which include suggested conservation strategies to help towns grow wisely. Good land use planning is the key to maintaining these larger blocks and all of their values for people and wildlife into the future.

Large habitat blocks are essential to the bobcat.

Land Area in Unfragmented Blocks by Town in Casco Bay Watershed

Town	Net land in 250+ acre blocks (acres)	Net land in 2000+ acre blocks (acres)	Total Non-water Acres	% land in 250+ acre blocks	% land in 2000+ acre blocks
Auburn	14,316	3,864	37,877	38%	10%
Baldwin	15,800	9,945	22,627	70%	44%
Bethel	31,711	29,572	41,093	77%	72%
Bridgton	23,182	15,979	36,211	64%	44%
Brunswick	10,375	2,166	29,739	35%	7%
Buxton	11,494	0	25,813	45%	0%
Cape Elizabeth	1,092	0	9,004	12%	0%
Casco	12,380	11,343	19,842	62%	57%
Cumberland	6,106	1,057	14,496	42%	7%
Denmark	21,536	17,702	29,421	73%	60%
Durham	15,565	6,252	24,424	64%	26%
Falmouth	5,668	579	18,607	30%	3%
Freeport	9,011	434	22,014	41%	2%
Gorham	13,662	0	32,387	42%	0%
Gray	15,192	6,929	27,611	55%	25%
Greenwood	20,963	20,059	26,590	79%	75%
Harpswell	1,423	0	5,498	26%	0%
Harrison	12,809	2,442	21,052	61%	12%
Hiram	17,628	1,256	23,939	74%	5%
Naples	12,332	3,374	20,187	61%	17%
New Gloucester	17,930	6,841	30,111	60%	23%
North Yarmouth	7,279	1,083	13,540	54%	8%
Norway	17,816	12,011	28,534	62%	42%
Otisfield	18,994	14,388	25,395	75%	57%
Phippsburg	9,984	2,886	17,818	56%	16%
Poland	15,932	2,730	27,056	59%	10%
Portland	64	0	11,552	1%	0%
Pownal	8,142	251	14,524	56%	2%
Raymond	13,452	7,873	21,142	64%	37%
Scarborough	10,479	1,760	30,056	35%	6%
Sebago	14,117	10,056	20,865	68%	48%
South Portland	104	0	7,664	1%	0%
Standish	22,076	13,789	37,530	59%	37%
Stoneham	19,210	19,105	21,484	89%	89%
Sweden	14,175	10,527	18,409	77%	57%
Waterford	21,964	19,060	32,059	69%	59%
West Bath	3,709	0	7,526	49%	0%
Westbrook	3,394	0	10,920	31%	0%
Windham	11,219	4,227	29,688	38%	14%
Yarmouth	1,827	0	7,458	24%	0%

Note: Total area of each town was calculated by subtracting the area of surface water features (in MEGIS layer "HYD24POL") from the total area within the town boundaries (from MEGIS layer "METWP24"). Block sizes exclude surface water, although water was not considered a fragmenting feature for the blocks analysis. Long Island was not included in this analysis.

Source: Beginning With Habitat Program 2005.

What is the Status of the Waterbird Populations of Casco Bay?

Answer: Baseline data collected in 2000 will allow us to identify habitats and evaluate population trends in coastal waterbirds in the future.

Why Is it Important to Understand the Status of Waterbird Populations in Casco Bay?

A baseline understanding of the areas where waterbirds congregate can help us to permanently protect high priority habitat. Further, the number of waterbirds in Casco Bay is an important indicator of environmental quality. While Maine's waterbirds are migratory, they return to the same habitat locations during migration, wintering and breeding. Studying population trends over time can help us to assess environmental impacts on the birds. If Casco Bay waterbird populations decline while those of Maine and New England are stable or increasing, it could indicate a problem with the health of the habitat in Casco Bay. For example, toxins, oil spills, loss of habitat or other localized factors could result in a decline in the numbers of waterbirds. A local population decline that is also observed throughout New England could indicate habitat threats elsewhere in the birds' range.

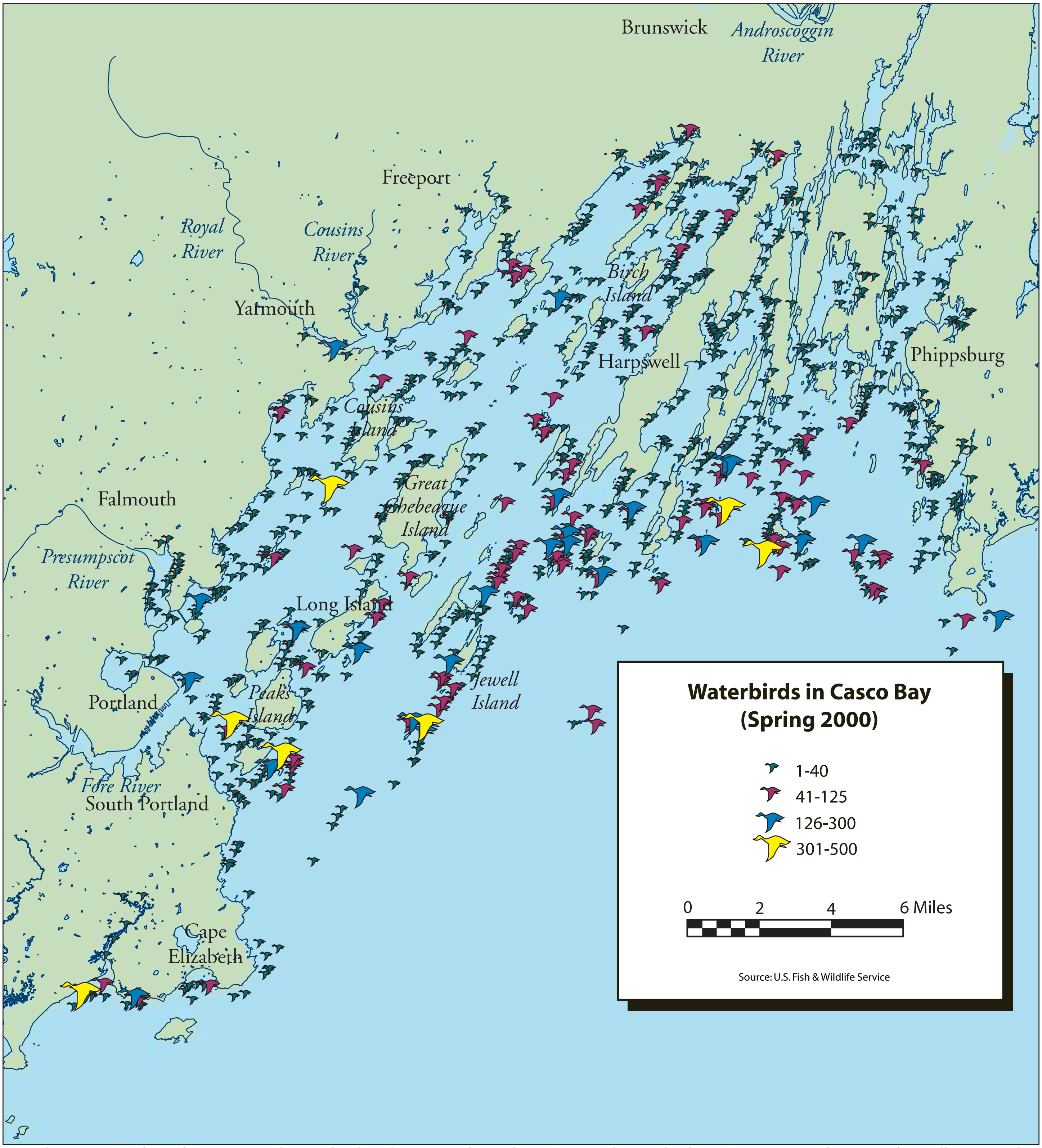
Key Studies to Date

In 2000, with the assistance of funds from CBEP, the Maine Department of Inland Fisheries and Wildlife and the U.S. Fish and Wildlife Service conducted a series of aerial waterbird bird surveys in Casco Bay. The surveys were timed to occur within the spring migration (February 16 to April 30), nesting (May 1 to June 30) and fall (September 1 to November 30) migration seasons for the birds. Seasonal surveys are necessary to observe the diversity of waterbird species that use the bay during these various periods. The results for the spring migration season are indicated in the map and the table. This data will serve as a baseline to which future surveys can be compared.

Aerial Bird Survey Data for Casco Bay (Spring Migration Period 2000)

Species	Count
American Black Duck	270
American Crow	11
American Green-winged Teal	50
Atlantic Brant	175
Bald Eagle	3
Bald Eagle Nest	1
Black Scoter	710
Black-headed Gull	0
Bufflehead	439
Canada Goose	146
Common Eider	14,175
Common Loon	1
Common Tern	0
Double-crested Cormorant	1,427
Goldeneye	10
Great Black-backed Gull	115
Great Blue Heron	13
Grebe	2
Gull	1,751
Herring Gull	3,227
Hooded Merganser	2
Mallard	18
Merganser	1,171
Northern Harrier	1
Oldsquaw	0
Osprey	23
Raven	0
Red-breasted Merganser	4
Ring-billed Gull	0
Ring-necked Duck	45
Sandpiper	58
Scoter	815
Snowy Egret	0
Surf Scoter	29
White-winged Scoter	8
Total	**24,700**

Note: Data from April 29 and 30, 2000
Source: Maine Department of Inland Fisheries and Wildlife



Aerial surveys conducted in 2000 indicate the distribution and numbers of coastal waterbirds in Casco Bay. The map above illustrates the results of the spring survey.

Preparing for Oil Spills

Understanding the distribution and numbers of coastal waterbirds is critical in the event of oil spills, for both spill response and damage assessment. This is especially true for Casco Bay, which has the largest volume of oil transport in New England. Knowledge of the location of waterbird concentration areas is important in oil spill response planning. For example, it may be necessary to haze birds from a threatened site, to boom sites in order to avoid oiling, or to avoid using bird colony locations as staging areas during oil cleanup. Coastal waterbird surveys conducted during the 1980's were used to help determine the number of birds impacted by the *Julie N* oil spill in the Fore River in 1996. As a result, the settlement for damage relating to this spill was aimed at helping to increase the waterbird population in Casco Bay. The settlement included partial funding for the enhancement of 130 acres of coastal wetlands in Scarborough Marsh and the acquisition and permanent protection of Flag Island, a coastal waterbird nesting site that was threatened with development.

In 1996 The Julie N *oil tanker spilled 179,634 gallons of fuel oil into the Fore River after striking the former Million Dollar Bridge while entering the harbor.*

Reference

Maine Department of Inland Fisheries and Wildlife. 2000. John Kenney. *Casco Bay Aerial Survey Report*.

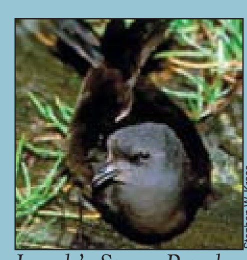
Outer Green Island with observation blind.

Outer Green Island Tern Restoration Project

In 2002, the National Audubon Society's Seabird Restoration Program in cooperation with the Maine Department of Inland Fisheries and Wildlife and U.S. Fish and Wildlife Service Gulf of Maine Coastal Program initiated a tern restoration program on Outer Green Island in Casco Bay. CBEP provided funding to assist with this program. Outer Green Island is a 5.5-acre island located 5 miles east of Portland. Historically, the island served as a tern colony until 1914. Outer Green was selected because of its rich seabird nesting history and because of its remote location (hopefully reducing predator visits).

During the first season, in order to attract the target species, a resident field camp was established and 100 decoys and a solar powered CD sound system broadcasting tern colony calls were placed on the southeast corner of the island. In just three years, the colony has grown to over 650 pairs of Common Terns and 13 pairs of Roseate Terns (a federally listed endangered species)! In 2004, Audubon also initiated a Leach's Storm-Petrel attraction program on Outer Green Island; storm-petrels nested on the island until approximately 1918, but no longer nest in Casco Bay. The goal of this project is to re-establish a breeding site in Casco Bay.

Roseate Tern



Leach's Storm-Petrel

Inidicator 9: Eelgrass

Has Eelgrass Habitat in Casco Bay Changed Over Time?

Answer: Yes. The overall amount of eelgrass has increased over the past decade.

Why is Eelgrass Habitat Important?

Eelgrass (*Zostera marina L.*) is a flowering plant that grows rooted in the sediment in low intertidal and shallow subtidal environments. In areas such as Casco Bay that are protected from severe wave action, eelgrass often forms extensive, dense meadows that provide critical ecological functions and values, including habitat for fish and wildlife. Many commercially and recreationally valuable species of fish and shellfish depend on eelgrass beds as feeding and nursery areas. Eelgrass is also important waterfowl habitat. Brant, in particular, rely on eelgrass for food. In addition, eelgrass beds help to protect shorelines by stabilizing the substrate and baffling waves and currents, and help to improve water quality by filtering sediments and absorbing nutrients. The leading cause of widespread eelgrass loss throughout New England is reduced water quality due to coastal watershed development, but local habitat damage or destruction has also been attributed to dredge and fill operations, boat propellers, docks, anchors and mooring chains, and fishing gear.


Hillary Neckles

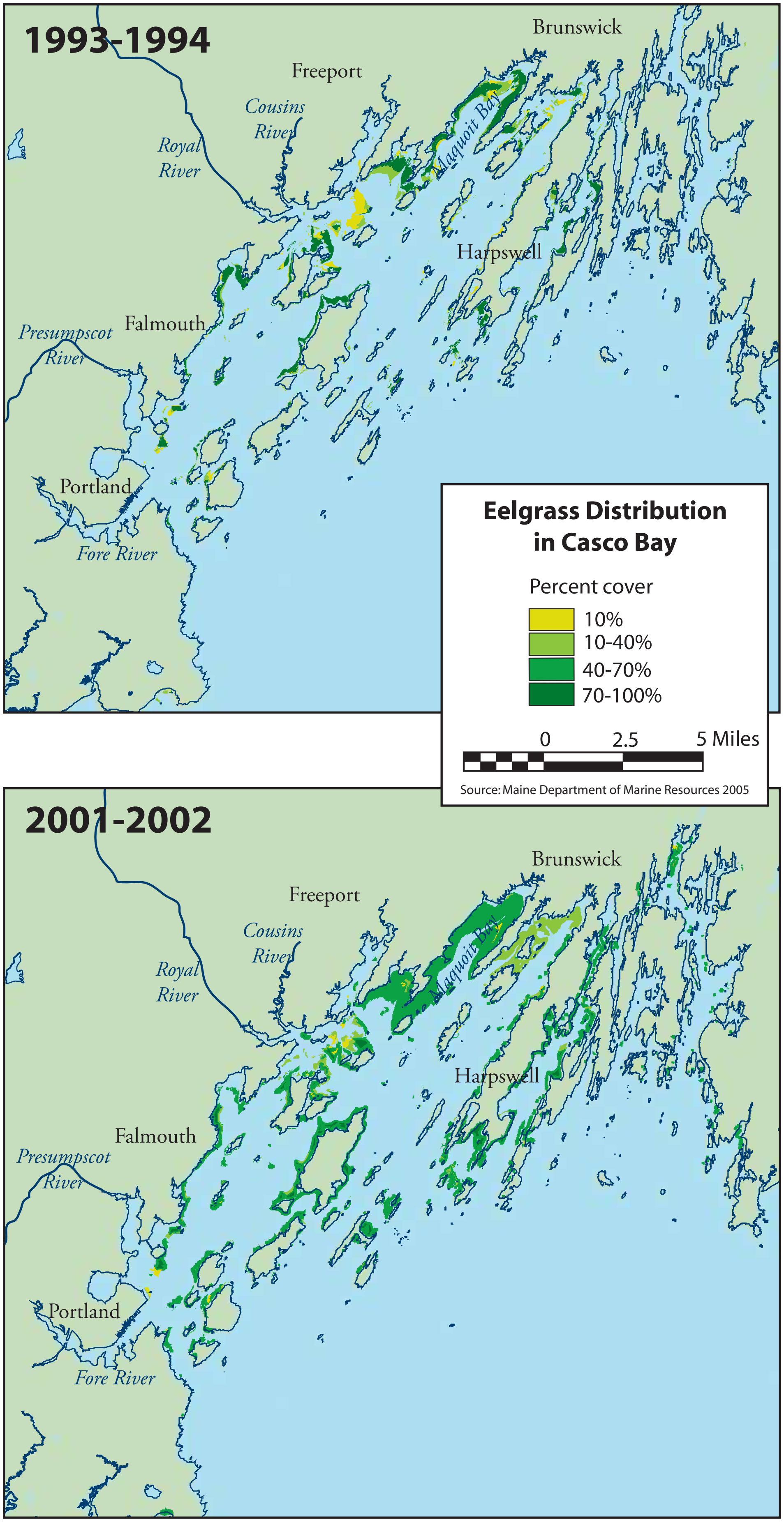
Eelgrass serves many important ecological functions, such as providing habitat for fish and wildlife.


Hilary Neckles

Intertidal eelgrass bed in Maquoit Bay.

Key Findings

Eelgrass beds in Casco Bay were mapped from aerial photographs (1:12,000 scale) by the Maine Department of Marine Resources in 1993-1994 and again in 2001-2002. Photographs were acquired and interpreted following the NOAA Coastal Change Analysis Program protocol for seagrass mapping. The overall amount of eelgrass habitat has increased in Casco Bay over the past decade. In 1993-1994, 7,056 acres of eelgrass were present in Casco Bay and in 2001-2002, 8,248 acres were present. Areas of increase are largely restricted to the northeastern end of the bay; in particular, eelgrass beds in Maquoit Bay increased considerably in extent and density during this period (Barker 2005). However, decreases in coverage occurred in Broad Cove, north of Cousins Island, west of upper Great Chebeague Island, and in the vicinity of Upper and Lower Goose Islands (Barker 2005).



In the last decade, eelgrass habitat overall increased by 1,192 acres in Casco Bay.

Why Has Eelgrass Habitat Declined in a Few Areas?

Eelgrass declined in portions of the middle section of Casco Bay. The causes of eelgrass loss have not been determined. The majority of extensive habitat loss is associated with the end of Casco Bay that is most populated, suggesting that influences of activities in the watershed on water quality may have played a role. Losses due to direct physical disturbance are also documented throughout the bay. A recent study identified 132.5 acres of eelgrass habitat in Maquoit Bay that had been degraded by mussel dragging, and drag marks in the vicinity of Little Mosier Island suggest additional local dragging impacts (Barker 2005). Scientific evidence indicates that eelgrass beds that are damaged by intensive dragging activity will take a mean of 10-11 years to revegetate under good growth conditions (Neckles *et al.* 2005).

A dragging scar (circled in yellow) created in June 1999 in a Maquoit Bay eelgrass bed covers 78.6 acres (Neckles et al. 2005).

References

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Neckles, H. A., F. T. Short, S. Barker, and B. S. Kopp. 2005. "Disturbance of Eelgrass *Zostera marina* by Commercial Mussel *Mytilus edulis* Harvesting in Maine: Dragging Impacts and Habitat Recovery." *Marine Ecology Progress Series* 285. 57-73.

Are the Levels of Toxic Chemicals in Casco Bay Sediments Changing Over Time?

Answer: Generally, the levels of toxic chemicals have declined or remained unchanged over the past decade.

Why Is it Important to Measure the Levels of Toxic Chemicals in Casco Bay Sediments?

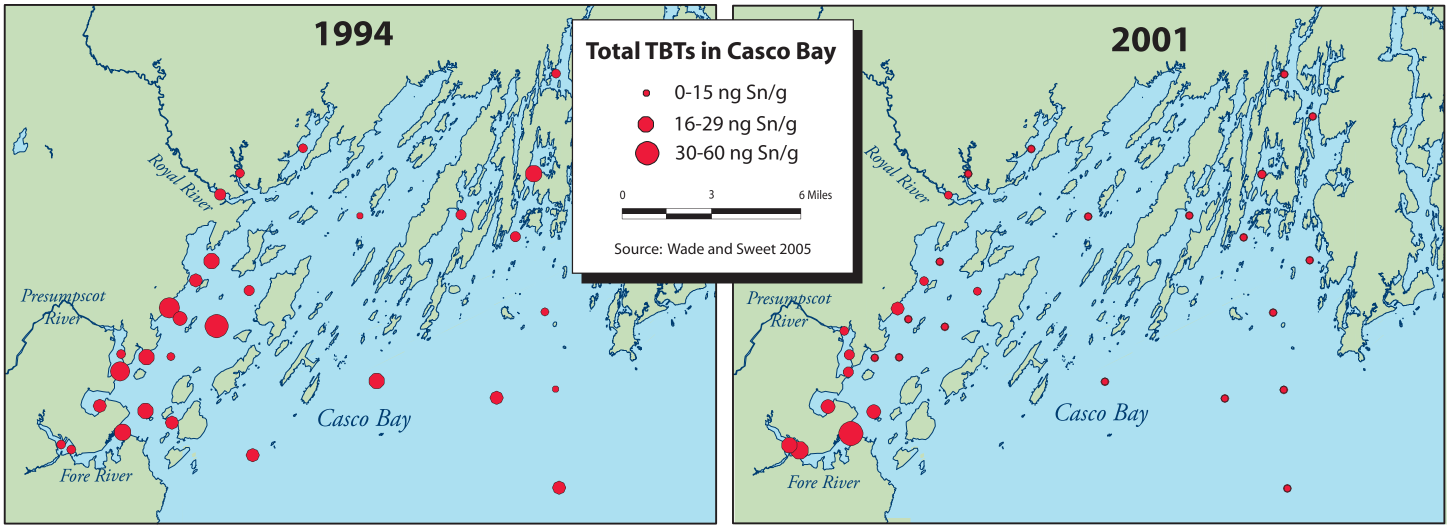
The presence of toxic chemicals in the sediments of Casco Bay serves as an indicator of overall contamination of the marine ecosystem. When toxic chemicals are introduced to the Bay via rivers, stormwater runoff, pipes and the atmosphere, many do not readily dissolve or disperse. They can become attached to sediment particles and settle to the bottom where they may take a long time to break down. Even when clean sediments are deposited on top of contaminated deposits, dredging and biological activity can bring them back to the surface. Bottom-dwelling (benthic) animals that are exposed to contaminated sediments can suffer adverse effects. These benthic organisms play an important role in the food chain, recycling organic matter and serving as a food source for groundfish (*e.g.*, flounder, cod, and haddock), lobsters and crabs. By eating benthic organisms that live and feed on contaminated sediments, fish and large crustaceans may experience inhibited growth and reproduction, disease vulnerability and even death. Humans who eat seafood contaminated by toxic chemicals can also be at risk. For example, the presence of dioxins in Casco Bay, largely a byproduct of paper mills, has resulted in elevated concentrations in the liver (tomalley) of lobsters. A public health advisory against eating lobster tomalley has been in effect in Maine since 1992 (Maine DEP 2004). The Maine Department of Health and Human Services has also issued guidelines for the consumption of saltwater fish species contaminated by mercury and organic chemicals.

Lee Doggett

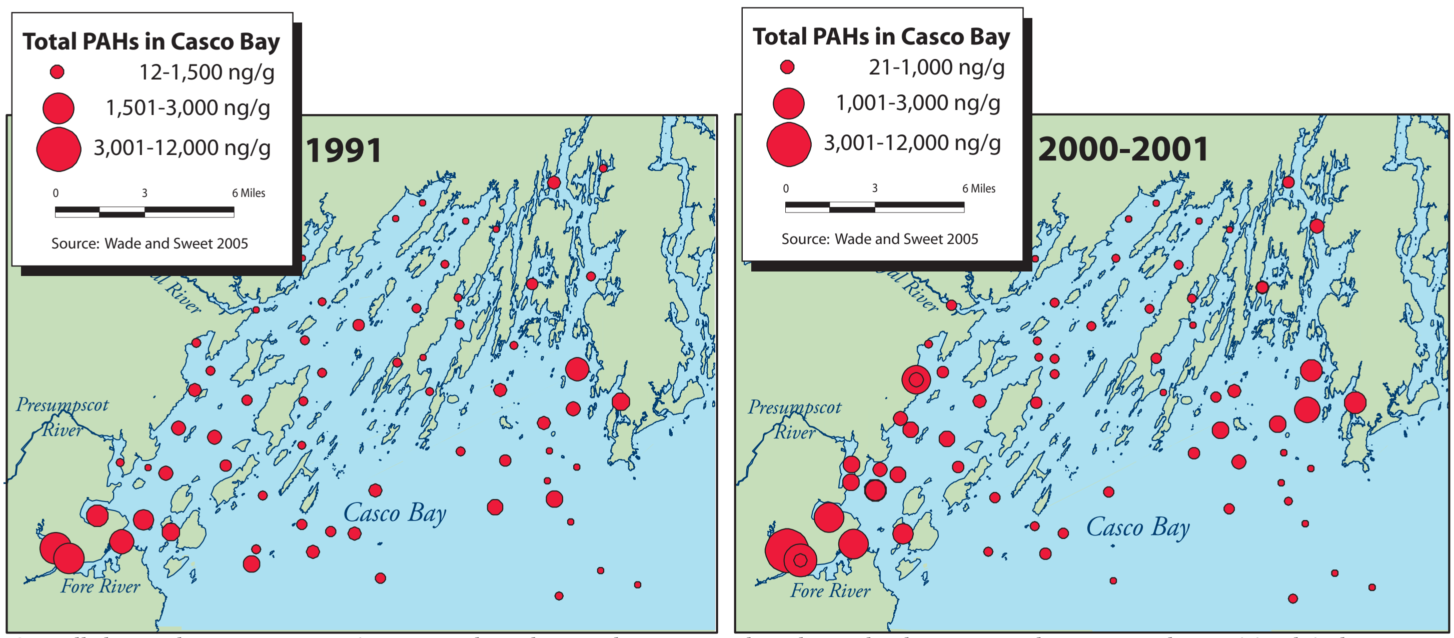
In some heavily polluted areas, such as the flats of the Fore River, mollusks, small crustaceans and other expected benthic species were absent during in a 1989 sampling. Some of the hardy worms that were found had oil on their "feet' (parapodia), probably from petroleum-related contaminants (Doggett 2005).

Key Findings

When scientists first took a close look at the sediments of Casco Bay in 1980, they were surprised to find a wide array of toxic contaminants present, including heavy metals and organic chemicals. In 1991, CBEP commissioned a baseline study to assess sediment contamination levels at 65 sites in the Bay, using state-of-the art analytical methods. Sampling sites were selected based on depth, circulation, sediment type and historical data, *i.e.*, areas where there was a known "dirty history" such as industrial facilities and point discharges. The samples were analyzed for heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and pesticides (Kennicutt *et al.* 1992). In 1994, 28 of the original sites and 5 new sites were analyzed for butyltins, dioxins/furans and coplanar PCBs (Wade *et al.* 1995). In 2000 and 2001, in partnership with EPA's National Coastal Assessment, CBEP resampled the sediments at the original locations. Scientists from Texas A & M University compared the results of the 1991/1994 sampling to the 2000/2001 studies. They concluded that most toxic chemicals have decreased or stayed the same over time, indicating that pollution control strategies are working in Casco Bay (Wade and Sweet 2005).



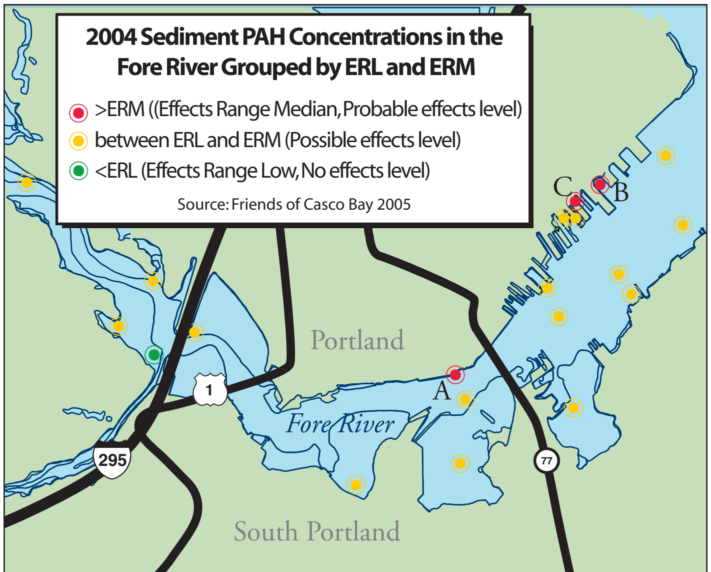
Tributyl tin (TBT) is an ingredient in marine anti-fouling paints. The overall decline of TBT concentrations in the Bay's sediments reflects the effectiveness of the federal and Maine laws which now ban the use of paints with TBT for all uses except for vessels longer than 25 meters or those having aluminum hulls (Maine DEP 1999). The continued use of TBT paints on large commercial vessels may explain the presence of elevated concentrations of TBT in the sediments of inner bay sites.



Overall the total concentration of PAHs in the sediments has remained unchanged. This suggests that increased use of fossil fuels is balanced by environmental controls that lower the PAH inputs to the Bay (Wade and Sweet, 2005).

How Toxic Are Casco Bay Sediments?

The concentrations of metals in Casco Bay are lower than levels known to cause harmful effects to organisms. Even the elevated levels of metals seen in Casco Bay are lower than the highly contaminated sediments in urban areas like Long Island Sound and Boston Harbor. While highly elevated above natural background levels, the PAH concentrations seen in the sediments of the inner part of the Bay were between the levels identified by the National Status and Trends Program as Effects Range Low (possible biological effects) and Effects Range Median (probable biological effects) (Long *et al.* 1995). The majority of PAHs detected in the Bay are high molecular weight, combustion related and sequestered in fine particles, which may reduce toxicity. PCB concentrations at almost all sites were below the toxic response threshold. Concentrations of pesticides were low compared to concentrations considered toxic. Butyltins, dioxins/furans, and planar PCBs were not present at toxic concentrations. In general, the highest concentrations of toxic chemicals were found near known sources. For example, elevated butyltin concentrations (a constituent of marine anti-fouling paints) were found near boat anchorages and marinas, while dioxins and furans were found in elevated concentrations downstream of paper mills (Wade and Sweet 2005).



Fore River

In 2004, sediments at 20 sites in Portland Harbor and the Fore River were sampled for toxic chemicals, supported by a Natural Resource Damage Assessment grant and funds from the CBEP. Sites were selected based on the need for future dredging as well as past "dirty history," including the *Julie N* oil spill, industrial uses, proximity to combined sewer overflows (CSOs), and drainage from the Jetport and Maine Mall. Total PAH concentrations at all but one of the sites were elevated beyond the Effects Range Low concentration (possible biological effects), while the Gas Works/China Clay Docks (A) and two sites near large CSOs, the Maine State Pier (B) and the Casco Bay Ferry Terminal (C), exceeded the Effects Range Median concentration (probable biological effects) established by the NOAA Status and Trends program (Long *et al.* 1995). The ratio of low molecular weight PAHs to high molecular weight PAHs can be used as a way to "fingerprint" the likely source of pollution. Low molecular weight PAHs are generally from pre-combustion sources such as oil spills, while high molecular weight PAHs are associated with post-combustion products, entering the marine environment via stormwater runoff and atmospheric deposition. The Casco Bay Ferry Terminal site, for example, had a "fingerprint" suggesting primarily post-combustion sources, likely from the CSO at the site. This sampling study provides valuable baseline data on the current status of the Harbor and Fore River sediments and identifies hot spots which merit further attention (FOCB 2005).

Change in Concentration of Toxic Chemicals From 1991/1994 to 2000/2001 in Casco Bay Sediments

Decreased	Increased	No Overall Change
Cadmium	Silver	Arsenic
Chromium		Copper
Mercury		Lead
Nickel		Zinc
Selenium		
Total pesticides, 4,4-DDE, 4-4-DDD and total DDTs		
Tributyl Tin and Total Butyl Tin		
Total PCBs		
Planar PCB 126		Planar PCB 77
		Dioxins/Furans
Low Molecular Weight PAHs	High Molecular Weight PAHs	Total PAHs

Source: Wade and Sweet 2005

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Wade, T. L. and S.T. Sweet. 2005. Texas A & M University. *Assessment of Sediment Contamination in Casco Bay.* Casco Bay Estuary Project.

Are There Toxic Chemicals in the Tissues of Casco Bay Blue Mussels?

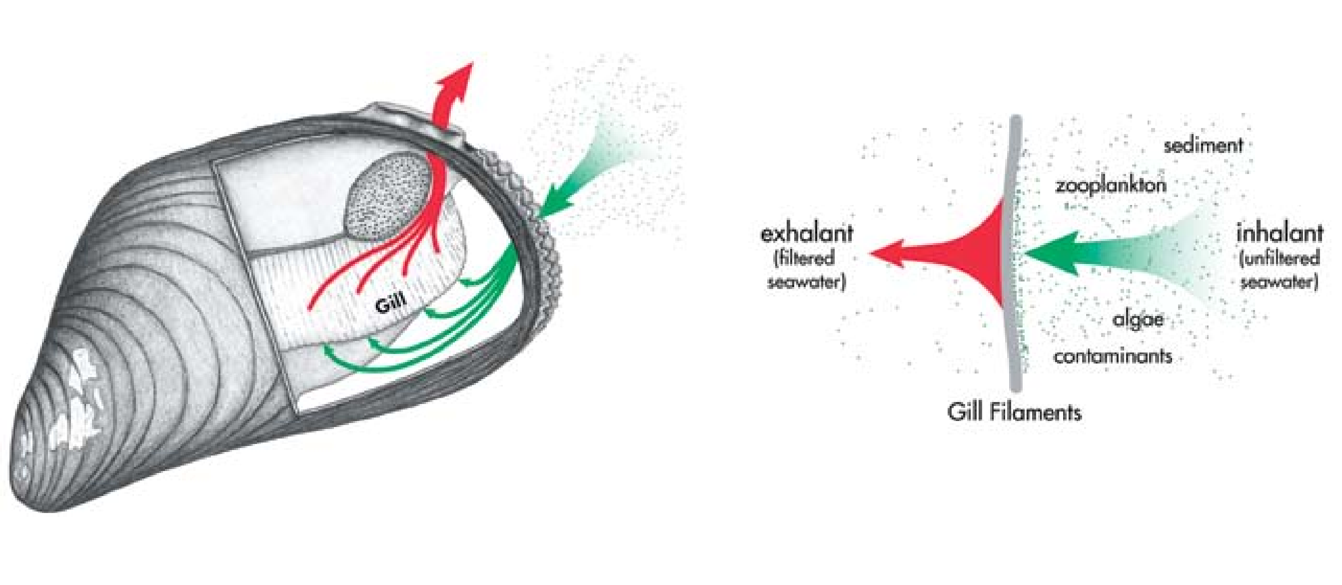
Answer: Yes. While mussels from most sites in the bay do not have elevated levels of toxics, there are some sites where metals and organics are elevated above the Maine coastal norm.

Why Is it Important to Monitor the Levels of Toxic Chemicals in Blue Mussels in Casco Bay?

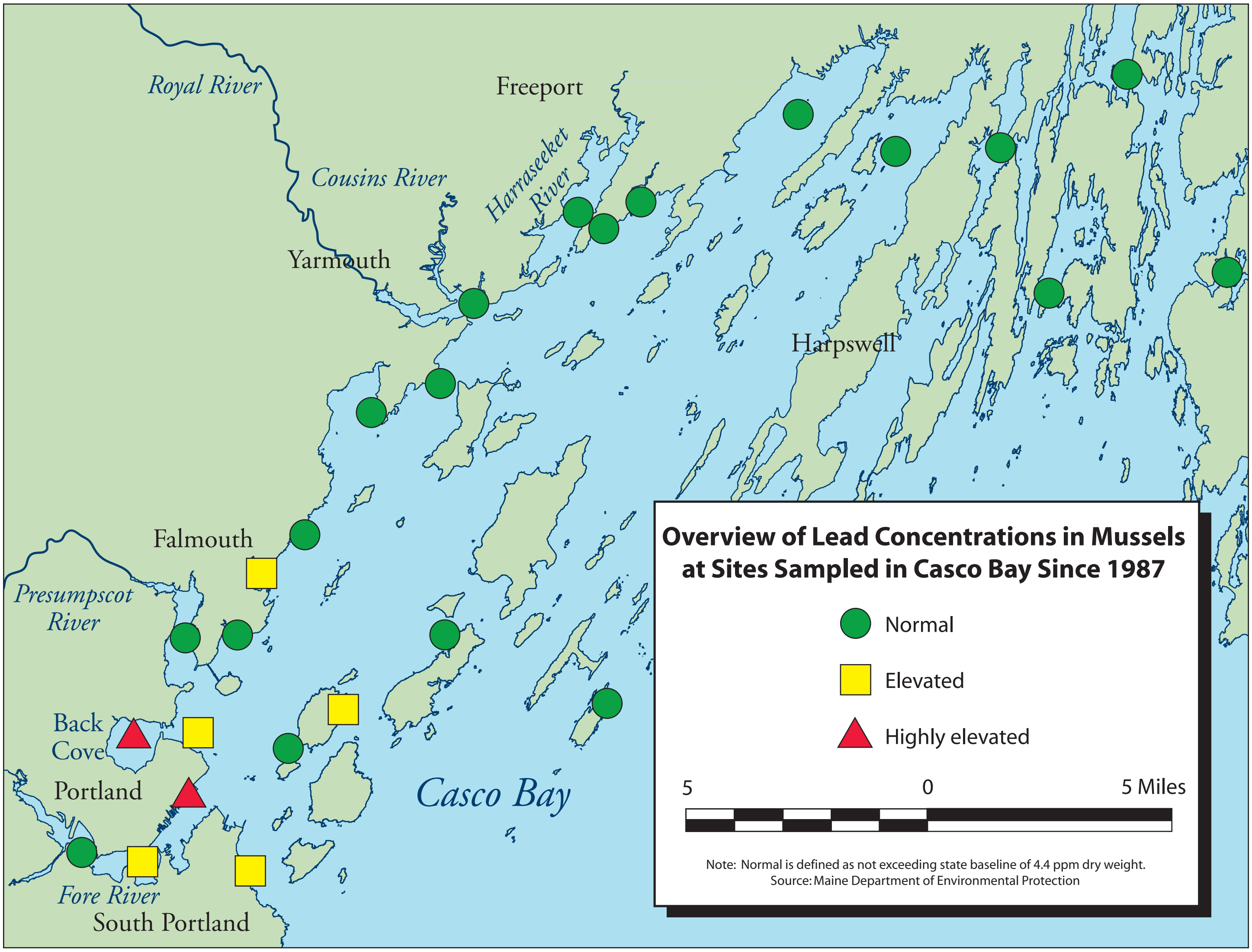
The common blue mussel, *Mytilus edulis,* is an ideal species to indicate the contaminant levels in an ecosystem. It is sendentary as an adult and is long-lived, accumulating local contaminants through feeding and surface contact. It is common throughout Gulf of Maine coastal areas and is thus useful as a "sentinel" species for Casco Bay and the broader Gulf. In Maine, blue mussels are found in densely populated beds in the intertidal zone (the zone between high and low tide). Casco Bay is one of the most productive areas in Maine for wild mussels. Because blue mussels are primary consumers at the base of the food chain, elevated levels of contaminants in mussel tissues suggest that top level consumers, including fish and humans, may be at risk from contaminants in the ecosystem.

Monitoring Blue Mussels in Maine's Coastal Waters

In 1987, Maine Department of Environmental Protection (DEP) began a major long-term monitoring program to assess the levels and locations of toxic contaminants along the coast, using the common blue mussel *Mytilus edulis* as the indicator species. The goals of DEP's blue mussel sampling program included defining background or baseline levels of toxic chemicals in Maine mussels (based on "reference sites" thought to be relatively free of pollution) and determining what levels pose a health risk to humans and/or marine life. Blue mussel soft tissue has now been analyzed from approximately 65 sites along the Maine coast over the past 18 years. Since 1996, CBEP has supplemented the DEP blue mussel monitoring program by periodically collecting samples at additional sites in Casco Bay. Selection of sites for testing takes into consideration the results of sediment contamination studies, the intensity of local land use, and past history of pollution, focusing on areas where the mussels might be exposed to elevated concentrations of toxics.



The common blue mussel serves as an excellent indicator of environmental contamination. As the mussel breathes and feeds, its gill filters out and retains particles, including contaminants, which can be digested and assimilated into its tissues.



Long-term monitoring of mussels in Casco Bay indicates that elevated levels of metals (such as lead) tend to be found in areas where human activity is concentrated.

Key Findings

DEP and CBEP have sampled blue mussels for the metals aluminum (Al), arsenic (As), cadmium (Cd), copper (Cu), iron (Fe), nickel (Ni), lead (Pb), zinc (Zn), silver (Ag) and mercury (Hg) as well as pesticides, dioxins and furans, PAHs and PCBs at multiple sites in Casco Bay. The map above provides an overview of the results of lead sampling at sites in the bay.

CBEP sampling in 1996 and 1998 indicated elevated toxic chemicals at the following sites:

- Lead levels were elevated in Back Cove mussels while dioxins and furans were elevated at sites in Freeport, New Meadows, Jewell Island, Back Cove and the Harraseeket River; total PCBs were elevated in samples from Back Cove, Quahog Bay and somewhat elevated in samples from Falmouth;
- Arsenic was elevated at Falmouth and Jewell Island.

For samples collected by CBEP and DEP from 2001 to 2003, the table on page 35 indicates sites where metals were elevated above the state norm. For other toxic chemicals, areas where elevated levels were detected are summarized as follows:

- PAHs were at baseline levels or below at all sites except the inner Fore River where they were highly elevated.
- PCBs and pesticides were at baseline or below at all other sites except the inner Fore River site, where PCBs were approaching elevated.

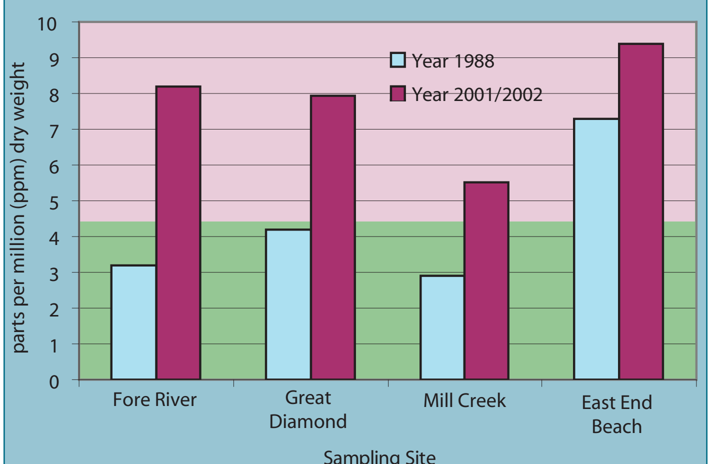
Field studies conducted by CBEP in 2001 indicate that recreational mussel harvesting is taking place in beds where pollutant levels are elevated in mussel tissue. Further studies will be needed to determine whether local harvesters and their families are consuming mussels frequently enough to face a health risk.

Metals Elevated Above Maine Normal Baseline Values Found in Mussels from Sampling Sites in Casco Bay 2001-2003

	Al	Cd	Cr	Cu	Ni	Pb	Zn	Ag	Hg
Great Diamond Island (Cocktail Cove)	X					X		X	
Long Island					X				
Mare Brook	X								
Inner Fore River						X	X		X
Maquoit Bay	X								
East End Beach						X	X		
Spring Point						X	X		
Mill Creek						X			
Outer Fore River						X			

Source: Maine Department of Environmental Protection

Changes in Lead Concentrations in Mussels from Casco Bay Sampling Sites Over Time



Note: Concentrations above 4.4 ppm dry weight are considered to be elevated based on reference conditions for Maine

Sampling at the same locations several years apart allows us to look at the way concentrations of contaminants are changing over time. Six of the sites noted in the table were also sampled for metals in 1988. Increases in lead levels were seen at four of the sites (Inner Fore River, Great Diamond Island, Mill Creek and East End Beach in Portland). The increases are all likely related to increased development and impervious surface.

What Can We Conclude From Our Study of Blue Mussels in Maine and Casco Bay?

Most areas in Maine and Casco Bay that are away from human activity, past and present, contain background/baseline concentrations of toxic chemicals. Based on the blue mussel as an indicator, elevated levels of toxic contaminants tend to be present in areas with a "dirty history" (*e.g.*, past manufacturing), in harbors, commercial ports, the mouths of river watersheds and in locations adjacent to population centers. This is also confirmed by regional mussel sampling conducted by the Gulf of Maine Council on the Marine Environment Gulfwatch program (see website in Reference below). The geographic distribution of sediment contamination in the bay (Indicator 10) is generally confirmed by the analysis of mussel tissue by the DEP, CBEP and Gulfwatch monitoring programs. Increases in concentrations of toxic chemicals in Casco Bay over time have been seen in areas with increased development and expansion of impervious surface, leading to increased loading of pollutants.

Reference

Gulf of Maine Council on the Marine Environment, *Gulfwatch Contaminants Monitoring Program,* May 2005, http://www.gulfofmaine.org/gulfwatch/mussels.asp (May 18, 2005).

What is the Quality of the Waters of Casco Bay?

Answer: Overall, water quality is good. There are a few areas where low dissolved oxygen is a concern.

Why Is it Important to Monitor the Water Quality of Casco Bay?

The water quality of Casco Bay is an important indicator of the overall health of the bay's ecosystem. The levels of dissolved oxygen and nutrients, for example, have a major impact on the health of the biological community. Assessments of these parameters help us to determine whether the bay can support a full and diverse range of marine life and uses. Friends of Casco Bay (FOCB), with support from CBEP, has successfully conducted the ongoing Citizens Water Quality Monitoring Program in the bay for the past twelve years. The program is carried out with the aid of more than 100 citizen volunteers who sample surface waters at 80 shore-based stations. They also assist FOCB professional staff with sampling at 10 profile stations located throughout Casco Bay. Measurements include temperature, salinity, pH, water clarity, and dissolved oxygen. In the last 4 years, the program was expanded to include measurements for chlorophyll fluorescence and dissolved inorganic nutrient concentrations.

Overall Findings

Evaluations of the twelve years of water quality data (1993 to 2004) indicate that overall water quality in Casco Bay is generally good. Dissolved oxygen (DO) is usually well above State standards and not close to levels that would impair biological processes. DO concentration in coastal waters is a dynamic property that varies spatially and temporally depending on physical, seasonal, biotic, and anthropogenic influences. A few areas of concern were found in locations with potentially heavy nutrient loading either directly from point sources (Portland Harbor) or indirectly from riverine and other non-point sources (Royal River, Presumpscot River, and Harraseeket River) and also in waters where restricted circulation may exacerbate DO conditions (New Meadows River and Quahog Bay). Nevertheless, low DO events tend to be exceptions rather than the rule in Casco Bay waters (FOCB and CBEP 2005).

Summary Statistics for All Casco Bay Surface Data

	Water Depth (m)	Temp (°C)	Salinity (ppt)	DO (mg/l)	DO (% saturation)	pH pH	Secchi Depth* (m)
Mean	7.25	12.95	29.03	9.20	103.5	7.94	2.98
SD	7.68	5.36	4.48	1.48	12.1	0.19	1.42
Minimum	0.1	-3.0	0.0	2.6	33.9	6.0	0.2
Maximum	55.0	30.0	34.0	14.9	177.5	8.6	15.3
Count	7022	8408	8329	8214	8126	7966	3808

*Secchi depth is a measure of water clarity. For Secchi depth, the summary statistics were calculated from 40 selected sites.

Source: Friends of Casco Bay and Casco Bay Estuary Partnership 2005

Data Summary

Summary statistics for all Casco Bay surface data are presented in the table above. The minimum and maximum values for each of the parameters provide a good representation of the variability among sites, across the bay, and over time. Overall, the monitoring data indicate the following:

- The shallowest water depth was measured in Anthoine Creek and the deepest depth was consistently measured at Halfway Rock.
- The coolest temperatures were measured at the sites that are sampled year-round, while the warmest single water temperature was found at the Cousins River site in front of the Muddy Rudder Restaurant during the summer of 1995.
- During the summer, the warmest waters were consistently observed at the Presumpscot River site. For swimming, Wolf Neck State Park offered some of the most inviting waters with an August mean temperature of 20˚C (68˚F).
- Willard Beach in South Portland had one of the lower August mean temperatures at 16.5˚C (62˚F).
- Sites near Custom House Wharf and in the upper New Meadows River consistently had some of the lowest DO levels and these low levels are likely associated with point or non-point source nutrient inputs and associated eutrophication effects.
- Water clarity was at a minimum at a number of shallow, inshore sites while the clearest water was found at Halfway Rock.

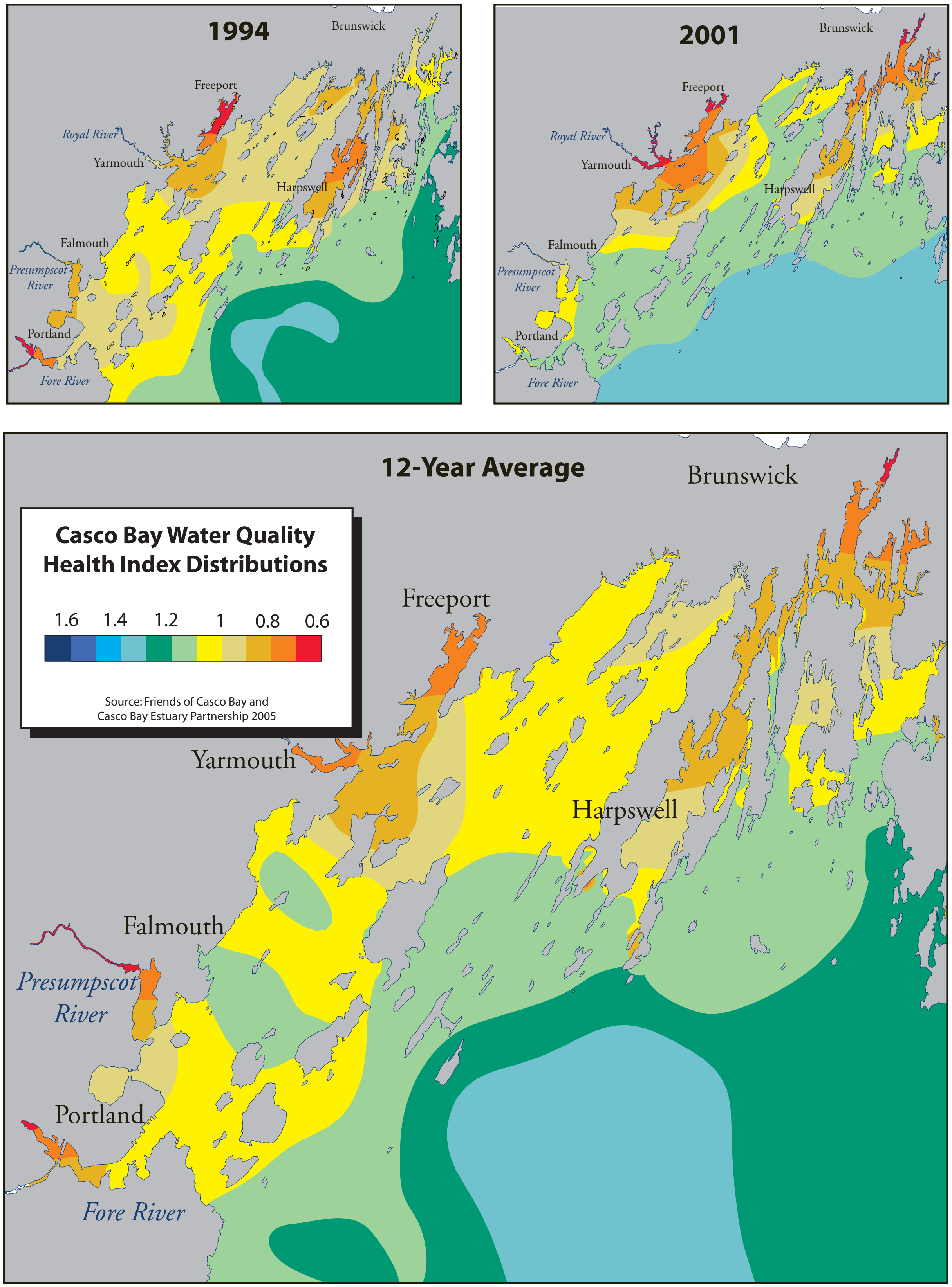
New Parameters: Chlorophyll and Nutrients

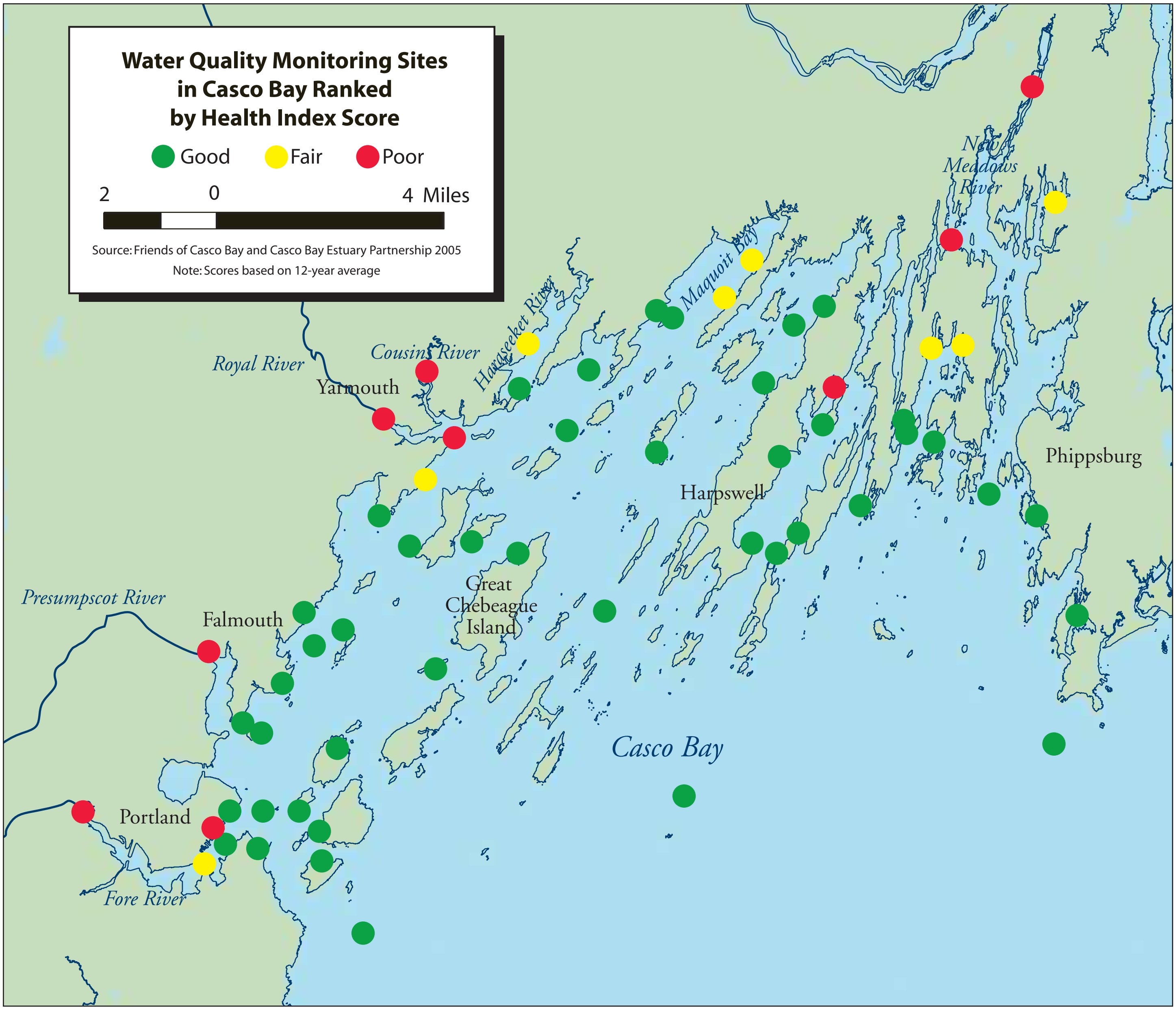
Fluorescence of chlorophyll (a plant pigment) and dissolved inorganic nutrient measurements were added to the FOCB monitoring program in 2001. Chlorophyll fluorescence is a measure of chlorophyll concentrations and an indirect estimate of the amount of phytoplankton (single celled plants) in the water column. Dissolved inorganic nutrients are crucial ingredients in the biogeochemical functioning of an estuarine system. However, too much of a good thing, in this case nutrient inputs related to human activities, could drive the system towards excessive growth of phytoplankton (eutrophication) which can lower bottom water dissolved oxygen levels. The mean nutrient concentrations for nitrate plus nitrite (NO_3+NO_2), ammonia (NH_4), silicate (SiO_4), and phosphate (PO_4) are typical of northeastern coastal waters, but the highest values measured suggest anthropogenic and riverine inputs. The addition of these critical parameters to the monitoring program will allow environmental managers to make more informed planning decisions.

Casco Bay Health Index

The twelve years of monitoring data have been used to develop the Casco Bay Water Quality Health Index (see figure on following page). The index combines several of the water quality parameters to provide a reliable, uncomplicated indicator of the bay's overall quality. The index is calculated based on DO (as percent saturation) and the clarity of the water. Both of these parameters are strong measures of water quality and the impacts of eutrophication. For each monitoring site, the summer means of these two parameters are scored based on their relative position between conservatively set low and high thresholds (65 to 95% and 0.5 to 3.5 m). The mean of these two values is the final index score. By summarizing these environmental parameters into one score, sites can be ranked, areas of concern identified, and trends in water quality may become more apparent over time. FOCB has used the Casco Bay Water Quality Health Index to rank each of the sampling sites in the Citizens Water Quality Monitoring Program as Good, Fair or Poor (see map on page 39).

Casco Bay Water Quality Health Index distributions. The poorest water quality is indicated by a score of 0.6 (red), the best by a score of 1.6 (blue). On average, the lowest scores are found in Portland Harbor, in the vicinity of the Presumpscot and Royal Rivers, and in the restricted embayments in northeastern Casco Bay. There is a clear inshore to offshore increase in the index with the highest scores consistently calculated for the site near Halfway Rock. This is due to both higher DO levels and greater water clarity the further a site is removed from anthropogenic and riverine inputs. Year-to-year variability is evident in the distribution of the index as indicated by the plots for 1994 and 2001. In 1994, low DO concentrations were observed at numerous sites along the northeastern coastline and are depicted here as lower scores being seen further offshore. In 2001, water quality was better throughout much of Casco Bay, though low scores were still seen at a few of the areas of concern. Note that most of the sites score ≥1 indicating that even when using relatively conservative low and high thresholds, water quality appears to be good throughout most of Casco Bay (FOCB and CBEP 2005).





A water quality rank has been assigned to each of the Friends of Casco Bay monitoring sites based on the Casco Bay Water Quality Health Index.

Reference

Friends of Casco Bay and Casco Bay Estuary Partnership. 2005. *Twelve-Year Water Quality Data Analysis for Casco Bay: 1993 - 2004.*

Do the Rivers, Streams and Estuaries in the Casco Bay Watershed Meet State Water Quality Standards?

Answer: Overall, yes, waters in the Casco Bay watershed meet State water quality standards. There are some areas that do not meet State water quality standards.

Why Are State Water Quality Standards Important?

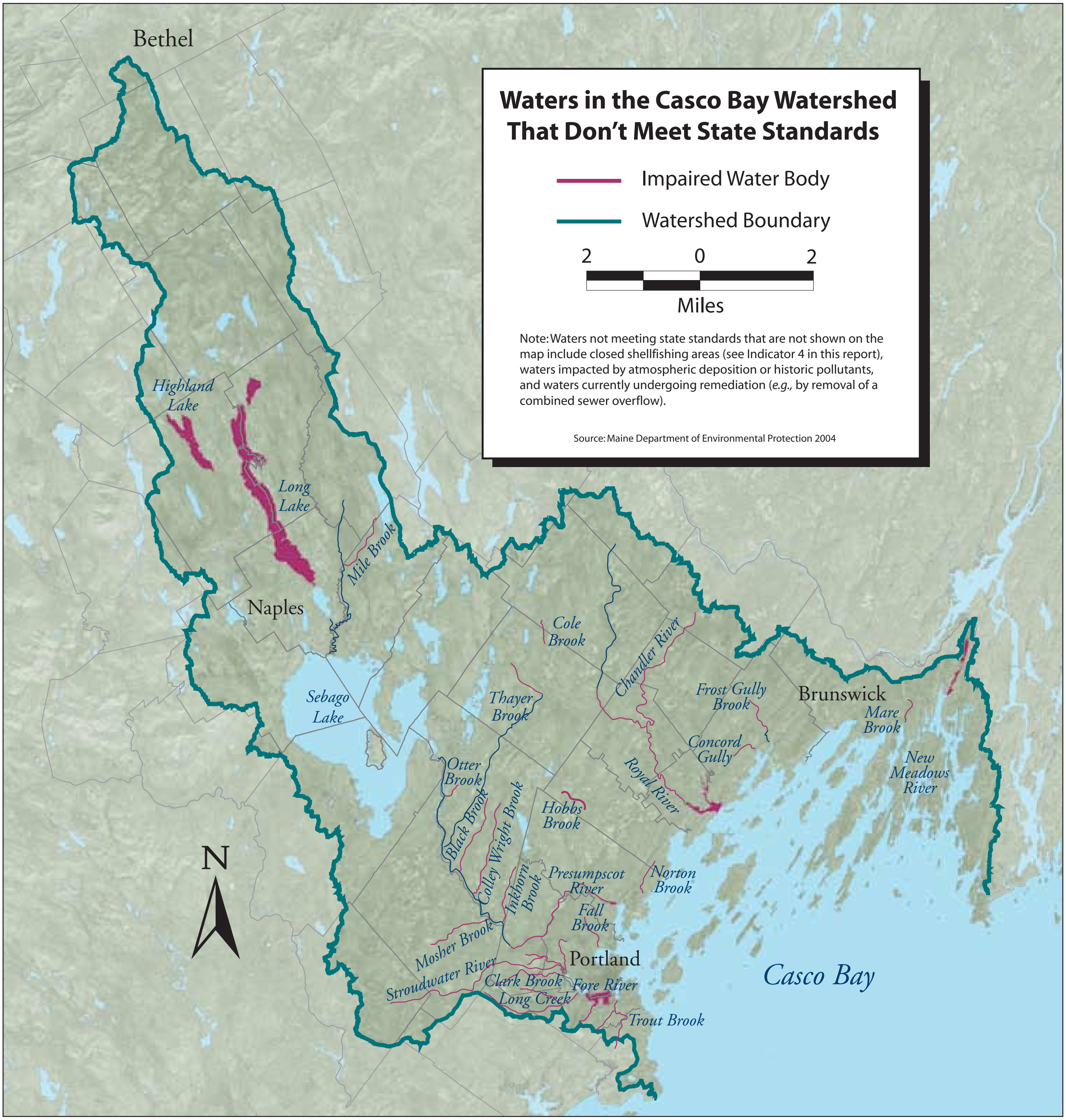
Water quality standards help the State manage its waters. The State of Maine enacted laws to comply with the Federal Clean Water Act of 1972 to manage its waters for specified "designated uses" such as swimming, fishing, boating, habitat for aquatic life, drinking water supply, navigation, agriculture, hydropower, industrial process and cooling water. Different classes of water allow different uses ranging from no discharges to permitted discharges. There are three classes for marine waters (SA, SB and SC), four for rivers and streams (AA, A, B, and C) and one for lakes (GPA). Standards are specified for each of these classes with A having the highest level of protection, B considered general purpose high quality water and C having a lower level of protection but still fishable and swimmable. The classes are management goals, not attainment levels. Every two years the Maine Department of Environmental Protection (DEP) assesses the status of its waters and produces an *Integrated Water Quality Monitoring and Assessment Report* ("305b") report that provides attainment levels. The latest report was produced in 2004 and is available on the Maine DEP website (see references on page 44).

Which Waters Do Not Meet Water Quality Standards?

The table on page 42 lists the waters in the Casco Bay watershed that do not meet water quality standards and are required to have an improvement plan produced (known as a Total Maximum Daily Load or TMDL) by the Maine DEP. The Presumpscot River and Highland Lake (Duck Pond) in Windham, Falmouth and Westbrook also do not reach water quality standards but have completed TMDL plans. The New Meadows Lake and the Upper New Meadows estuary do not meet water quality standards. Studies are being conducted with the coordination of the CBEP to determine if the source of the problem is from flow restrictions or nonpoint pollution sources. The map on the opposite page illustrates the waters that do not meet state standards, including the Presumpscot, Highland Lake (Duck Pond) and the New Meadows.

What Are the Trends?

Overall the water quality in the watershed is good and has remained so over time. More urbanization in the lower watershed may change that trend in the future unless care is taken. The greatest improvement in water quality is in the Presumpscot River (see sidebar on page 42). DEP expects that when it samples the river again it will meet water quality standards. While a few streams have been removed from the nonattainment list in the past ten years others have been added. Most of the streams that were added are small urban streams. DEP has recently emphasized the monitoring of these streams because of concerns about the impacts from urban land use. Many lakes have changed categories because of changes in assessment methodologies, so trends are not available.



While water quality in Casco Bay watershed is good overall, some lakes, rivers and streams, particularly in urbanized areas, have impaired water quality.

References

Maine DEP. 2004. *Integrated Water Quality Monitoring and Assessment Report* ("305b"). (http://www.maine.gov/dep/blwq/docmonitoring/305b/index.htm#2004) (June 1, 2005)

Presumpscot River Management Plan Steering Committee. 2003. *A Plan for the Future of the Presumpscot River* (http://www.cascobay.usm.maine.edu/Presumpscot.html) (June 1, 2005)

Waters That Don't Meet Water Quality Standards

(Maine Department of Environmental Protection is required to develop an Improvement Plan for these waters.)

Location	Impaired Use	Causes	Potential Source(s)
Mile Brook (Casco)	Aquatic life	Aquatic life criteria	Aquaculture Point Source
Royal River below Collyer Brook	Drinking water	Ambient Water Quality Criteria	Hazardous waste
Chandler River incl. East Branch	Aquatic life	Dissolved oxygen	NPS (nonpoint source) (unspecified)
Cole Brook (Gray)	Aquatic life	Aquatic life criteria	Agricultural NPS
Black Brook (Windham)	Aquatic life	Dissolved oxygen	General Development NPS
Colley Wright Brook (Windham)	Aquatic life, Recreation	Dissolved oxygen,Bacteria	General Development NPS
Hobbs Brook (Cumberland)	Aquatic life, Recreation	Dissolved oxygen, Bacteria	General Development NPS
Inkhorn Brook (Westbrook)	Aquatic life, Recreation	Dissolved oxygen, Bacteria	General Development NPS
Mosher Brook (Gorham)	Aquatic life, Recreation	Dissolved oxygen,	General Development NPS
Otter Brook (Windham)	Aquatic life, Recreation	Dissolved oxygen, Bacteria	General Development NPS
Thayer Brook (Gray)	Aquatic life	Dissolved oxygen	Agricultural NPS
Nasons Brook (Portland)	Aquatic life	Aquatic life criteria	Urban NPS
Norton Brook (Falmouth)	Aquatic life	Aquatic life criteria	General Development NPS
Capisic Brook (Portland)	Aquatic life	Aquatic life criteria	Urban NPS, Habitat, CSO
Clark Brook (Westbrook)	Aquatic life	Dissolved oxygen	General Development NPS, Habitat
Long Creek (South Portland)	Aquatic life	Aquatic life criteria	Urban NPS, Habitat
Stroudwater River (S. Portland, Westbrook)	Aquatic life	Dissolved oxygen	General Development NPS
Trout Brook (South Portland)	Aquatic life	Aquatic life criteria	Urban NPS
Kimball Brook (South Portland)	Aquatic life	Aquatic life criteria	Urban NPS
Red Brook (Scarborough, S. Portland)	Aquatic life, Fish consumption	Aquatic life criteria , PCBs	Urban NPS, Waste disposal
Fall Brook (Portland)	Aquatic life	Aquatic life criteria	Urban NPS, Habitat
Barberry Creek (South Portland)	Aquatic life	Aquatic life criteria	Urban NPS
Frost Gully Brook (Freeport)	Aquatic life	Dissolved oxygen, Bacteria	Urban NPS
Mare Brook (Brunswick)	Aquatic life	Aquatic life criteria	Indus (military) NPS, Urban NPS
Concord Gully (Freeport)	Aquatic life	Aquatic life criteria	Urban NPS
Highland Lake (Bridgton)	Aquatic life	Dissolved oxygen	General development NPS
Long Lake (Naples)	Aquatic life	Dissolved oxygen	General development NPS
Fore River Estuary	Aquatic life	Toxics, Elevated Fecals	Municipal point source, NPS, Historic sources
Royal & Cousins River Estuaries	Aquatic life	Dissolved oxygen, Elevated Fecals	Municipal point source, Nonpoint source, Sediment Oxygen Demand

Presumpscot River Watershed

The Presumpscot River, the largest freshwater source to Casco Bay, flows for 27 miles from Sebago Lake to the Casco Bay estuary, draining a 205 square mile watershed that includes 12 municipalities in Cumberland and York Counties. The Presumpscot River is a river in recovery. In 1999, pulp mill discharges to the Presumpscot ceased and water quality has dramatically improved on the river, prompting a movement to upgrade State water body classification. In 2002, the Smelt Hill Dam, the lowest of nine dams on the river, was removed so that the lower seven miles of the Presumpscot and its tributaries now flow freely to the estuary allowing unrestricted access for anadromous fish. Seven of the other dams are undergoing relicensing that will lead to opportunities to restore anadromous fish passage further upstream.

Despite recent improvements, water quality in the Presumpscot River remains degraded. As the river is cleaned up, development pressure along the relatively undeveloped shorelands continues to increase and the river is facing growing non-point source pollution loads. Nine Presumpscot River tributaries are on Maine's 303(d) list for non-attainment of class B water quality standards. Presumpscot River Watch monitoring data indicate that, since 1999, nearly all of the monitored tributaries do not meet class B standards for dissolved oxygen during the summer months. Sedimentation via runoff and erosion has altered stream channels and degraded fisheries habitat. Additionally, inputs from nutrients and toxics and the thermal impacts of lost riparian vegetation further degrade water quality for the sensitive cold water fisheries targeted for restoration. According to extensive assessment work initiated by the Presumpscot River Watershed Coalition (PRWC) partners, these impairments result from non-point source pollution loading, lack of riparian buffers, and poor land management practices. CBEP participates in the PRWC and has provided significant funding and technical assistance toward the development of *A Plan for the Future of the Presumpscot River*, completed in 2003.

How are CBEP and our Partners Promoting Stewardship in the Watershed?

Answer: Through volunteer groups, educational programs, grants and technical assistance.

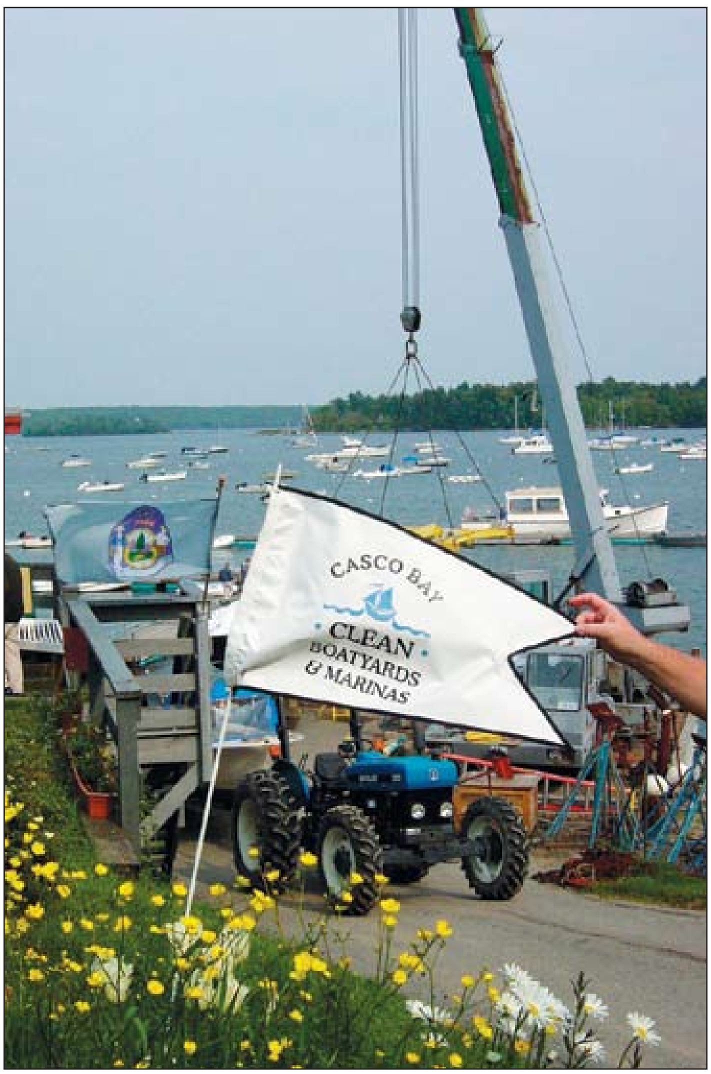
Environmental professionals and golf course superintendents attend a CBEP-sponsored training on sustainable practices for golf courses.

Why is Stewardship of Casco Bay and its Watershed Important?

One quarter of Maine's population lives in the Casco Bay watershed. As watershed residents, we are each intimately connected to the environment around us in both visible and invisible ways. A dramatic oil spill clearly sends the message that we are damaging our resources. When we leave pet wastes on sidewalks and beaches or pour waste oil down a storm drain, it is less obvious that these pollutants will flow eventually to streams and the bay. Damage to the environment from human activities is evident in the closure of shellfish beds and beaches, the presence of toxic chemicals in the sediments and animals of the bay, in the decline in oxygen levels in parts of the bay and in the failure of some of our rivers and streams to meet water quality standards. If all members of the Casco Bay community act as responsible stewards, we can preserve and protect the resources of the watershed and the bay for future generations. We can accomplish this by changing individual behaviors that are detrimental to the bay and by raising awareness of the importance of protecting the bay and its watershed.

What Are Some of the Stewardship Activities Taking Place in the Casco Bay Watershed?

All over the watershed, volunteer groups are collecting water quality samples, sponsoring clean-up days, protecting sensitive habitats through voluntary land conservation, advocating for environmental protection, helping to prevent erosion and sedimentation, and educating the public about sound stewardship. Local businesses and industry are promoting stewardship through, for example, reduced reliance on hazardous chemicals and responsible practices in site development and farming. The stewardship efforts of municipal officials include eliminating combined sewer overflows, reducing stormwater pollution, managing shellfishing areas, promoting waste recycling and protecting open space. The following projects are a few examples of the activities that CBEP and our partner organizations are supporting.



The Casco Bay Clean Boatyards & Marinas pilot project has expanded statewide.

The "Keep Casco Bay Clean" message goes on the road at Paul's Marina, one of the first Clean Marinas in Maine.

Maine Clean Boatyards & Marinas Program

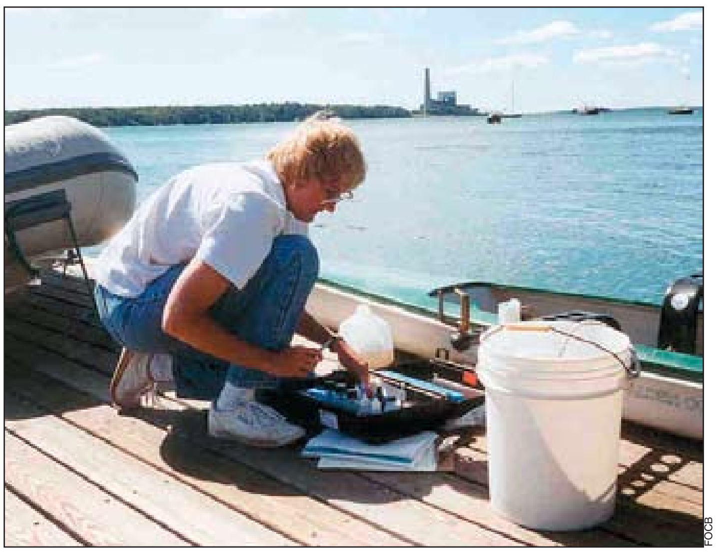
Originally piloted in the Casco Bay region, the Maine Clean Boatyards & Marinas Program is a collaborative partnership among industry, state and federal agencies, and environmental organizations dedicated to promoting best management practices in boatyards and marinas. The program has now expanded its focus to the mid-coast and Penobscot Bay regions and is also working in Southern Maine while continuing its efforts in Casco Bay. Participation in the program is voluntary and requires facility operators to sign a pledge and complete a self-assessment checklist prior to scheduling a verification visit. Technical assistance is available throughout the process and has helped many companies improve their environmental compliance. Upon successful completion of the verification visit a "Clean Marinas" award is presented and the facility is recognized publicly via a media event, news releases and advertisements.

Maine now has ten designated Clean Marina facilities, including six in the Casco Bay watershed: DiMillo's Old Port Marina and Yacht Sales, Portland; Portland Yacht Services, Portland; Great Island Boatyard, Harpswell; Paul's Marina, Brunswick; Yankee Marina and Boatyard, Inc.; Yarmouth; and Panther Run Marina, Raymond.

There are several facilities in the pipeline working towards designation and it is expected that as many as ten more will be certified statewide this year. In addition to working with businesses, the Program will also make its first formal attempts to reach the boating public. The purpose of this outreach will be to make boat owners aware of their role in keeping Maine's waters clean. The Maine Clean Boatyards & Marinas Program is sponsored by the Maine Marine Trade Association with funding from the State Planning Office/ Maine Coastal Program. In addition to participating on the Steering Committee for the Casco Bay pilot project, CBEP provided a graduate assistant to support the program.

Friends of Casco Bay Citizen Stewards Water Quality Monitoring Program

Since 1992, Friends of Casco Bay (FOCB) has been collecting scientifically-credible data on the water quality of Casco Bay. Research conducted by staff and volunteers has added to the fundamental understanding of the health and dynamics of Casco Bay. The data has been used to promote pollution reduction efforts, restore marine habitats, identify sensitive areas in need of protection or further study, and to inform state regulatory actions. For example, FOCB data was instrumental in the State reclassification of waters off Peaks and Little Diamond Islands, Two Lights in Cape Elizabeth and Willard Beach from class SC to SB, a higher standard for water quality.


FOCB

Friends of Casco Bay citizen water quality monitor.

The Water Quality Monitoring Program is not just about collecting data; it also entails recruiting, training, and supporting a valued corps of volunteer "citizen scientists." Since the programs inception, more than 400 Citizen Scientists have been trained in U.S. EPA-approved sampling techniques. Rigorous review of the monitors' techniques and data ensure that the Program accrues reliable information on the water quality of Casco Bay. Shoreside sampling by volunteers complements the monitoring done by FOCB staff members Peter Milholland and Mike Doan aboard their Baykeeper boats. They conduct monthly profiles of the water column at ten offshore stations, year-round, at times coping with stormy weather, rolling seas, and frozen bays. CBEP provides funding to support this Water Quality Monitoring Program.

2004 Royal River YCC team

Royal River Watershed Youth Conservation Corps

The Royal River Youth Conservation Corps began in summer of 2004. In just seven weeks, a team of five local high school students, working with a crew leader and a technical director, successfully completed over 20 erosion and pollution control projects in the Royal River watershed. They planted 149 trees and shrubs, moved 45 cubic yards of mulch, hand-placed 25 cubic yards of rock, dug 126 feet of ditches, removed 22 cubic yards of sediments from traps and kept over 18 tons of soil out of the water! They also stenciled 281 storm drains with the message "Protect Your Water... Don't Dump" or "No Dumping...Leads to Stream."

The Royal River YCC is making an important contribution to stewardship in the Royal River watershed, where polluted runoff is harming the scenic beauty, fish, recreational values, clam flats and other critical features of the system. A steering committee of state, local and federal partners including Sabbathday Lake Association, Maine DEP, CBEP, Friends of the Royal River, Cumberland County Soil and Water Conservation District and U.S. EPA guides the Royal River YCC. CBEP also provides funding to support the Royal River YCC. In Maine and elsewhere, the YCC model has proven to be an effective tool for raising awareness, energizing communities and inspiring local youth to become environmental leaders.

Volunteer assisting with New Meadows watershed survey.

New Meadows River Watershed Project

The New Meadows River is, in reality, not a river at all but a drowned river valley that is an embayment of the ocean. The river provides recreational resources and supports extensive finfish, shellfish and lobster fisheries. Maine DEP has classified the New Meadows River as a "Coastal Wetland Most at Risk from New Development."

Initiated in 1999, the New Meadows River Watershed Project is guided by a committee of municipal representatives from Brunswick, West Bath, Harpswell, Phippsburg and Bath, state and federal officials, representatives from non-governmental organizations, and area citizens. They meet regularly to explore ways to meet their goal of protecting, improving and maintaining the vitality of the ecological and economic resources of the New Meadows River and its watershed. The Project has conducted upper and lower watershed surveys and produced a State of the River report. In 2004, the Project completed the New Meadows River Watershed Management Plan which recommends actions to reduce sources of polluted stormwater runoff, improve the productivity of shellfish harvests, conduct research on the ecology and economics of the watershed system, build public awareness and stewardship and maintain and promote the effectiveness of the Project partnership. CBEP is an active partner in the Project and provides funding to support implementation of the Plan. In 2005, CBEP received a grant from NOAA and the Gulf of Maine Council on the Marine Environment to study ways to improve water quality through improved tidal exchange in the New Meadows Lake, an impounded portion of the river.

Presumpscot River Watch

The Presumspcot River is the largest freshwater source to Casco Bay. It flows for 26 miles from Sebago Lake to Casco Bay, through one of the most developed and fastest growing watersheds in Maine. Since 1989, Presumpscot River Watch (PRW) has been helping to preserve and improve the health of the Presumpscot River and its watershed. Volunteer-driven and agency supported, the group conducts scientific monitoring and shares data to increase public awareness. In addition, PRW serves as steward for the river through participation in legislative, community, and individual efforts.

Water quality monitoring volunteers sample the river twice a month from May through August, measuring dissolved oxygen, temperature, and levels of *Escherichia coli* (bacteria) at 30 sampling stations distributed along the mainstem and tributaries of the river. Citizen volunteers are also trained to assist with laboratory analysis of water samples, following a Maine DEP-approved Quality Assurance Project Plan. CBEP supports the PRW monitoring program by providing annual funding.

Presumpscot River Watch

Training Presumpscot River Watch volunteers

The Highland Lake-Mill Brook Project

Historically, sea-run fish species like the river herring and alewife swam from Casco Bay upstream into the Presumpscot River watershed to reproduce, before returning back to the ocean. With the removal of the Smelt Hill dam from the mouth of the Presumpscot in 2002, over 72 miles of streams and tributaries in the lower Presumpscot watershed were reopened to the migration sea-run fish. To improve fish passage and stream habitat at the Highland Lake dam on Mill Brook in Westbrook, Maine Department of Marine Resources has initiated a collaborative effort with the U.S. Fish and Wildlife Service, Casco Bay Estuary Partnership,

Natural Resources Conservation Service, City of Westbrook, Highland Lake Association, Corporate Wetlands Restoration Partnership, Maine Department of Inland Fisheries and Wildlife, National Fish and Wildlife Foundation and local landowners. Project partners plan to make several repairs to the fishway at the dam which will improve upstream migration. They will also install a fish weir along the top of the dam spillway which will improve the downstream passage of the sea-run fish past the dam, as they make their migration back to the ocean each fall. In addition, the project will work to restore the natural Mill Brook stream channel, located downstream of the Highland Lake dam, to make it more hospitable to native sea-run and freshwater fish.

Alewives, river herring species and American eel play an important role in the food web and in maintaining the health of coastal watersheds. In the inland freshwater and coastal marine environments they provide forage for bass, brown trout, salmonids, ospreys, eagles, kingfishers, blue heron, and aquatic furbearing mammals. Alewives are a host to native freshwater mussels, which they carry up- and down rivers in their gills. Spawning alewives heading upriver give cover to out-migrating salmon smolts in the spring. In the marine environment, they are eaten by a variety of predators, such as bluefish, weakfish, striped bass, cod, pollock and silver hake. This project provides an important step toward the restoration of these fisheries to the Presumpscot River watershed, Casco Bay estuary and Gulf of Maine.

Crest of Highland Lake Dam and fishway with sediment bar obstructing attraction flow at fishway entrance. These improvements will help to restore runs of river herring and American eel.

Reference

New Meadows River Watershed Steering Committee, *New Meadows River Watershed Management Plan,* February 2004,

Maine Volunteer Horseshoe Crab Spawning Surveys

Horseshoe crabs *(Limulus polyphemus)* are among the world's oldest living organisms, estimated to be more than 420 million years old. Ecologically their eggs are a critical food resource to migratory shorebirds enroute to their nesting grounds, and to fish which also prey on them. People have use horseshoe crabs for centuries for fertilizer, bait, and animal feed. Commercial harvesting of horseshoe crabs continues for bait, but they have been more valuable as a research subject, leading to significant gains in human medicine, and their blood is collected to test medical products for bacterial contamination.

A horseshoe crab monitoring volunteer holds two molted shells.

The Maine Horseshoe Crab Surveys were initiated in 2001 in response to anecdotal reports that populations were declining. This project involves collaboration between Maine DMR, Bar Mills Ecological, Maine Coastal Program, and many other organizations to establish quantitative baseline population data to determine whether horseshoe crab populations are stable or declining. Each year some 50-70 volunteers collect data at sites ranging from Casco Bay to Frenchman's Bay. Volunteers measure water temperature and survey the number, clustering and location of horseshoe crabs along a pre-established transect during predicted dates of peak spawning activity. The actual dates change each year but typically associated with the new moon and full moon lunar phases of late May and June.

Data reveal that horseshoe crabs in Maine appear to exist in isolated populations. Although spawning sites in Casco Bay are scarce given the available habitat suitable for spawning, two of the most important horseshoe crab spawning sites statewide are located at Middle Bay and Thomas Point Beach in the Bay. CBEP provided project funding to expand monitoring in Casco Bay and to develop a volunteer training handbook.

What Is the Overall State of Casco Bay?

William Hubbell

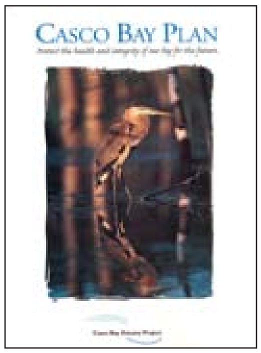
Based on the fourteen indicators presented in this report, significant changes have taken place over the last decade in the Casco Bay watershed. Indicator 1, population growth, is at the heart of many of the other changes observed in this report. The Casco Bay watershed, home to approximately 25% of the state's population, has seen a soaring growth in population and an outward expansion of population density from the greater Portland area to the suburban and rural areas to the west. This growth in population has had an impact on the environment that can be measured using several of the other indicators. The development of new homes, commercial centers, roads and other manmade structures is evident all around us. As illustrated in Indicator 2, impervious surface, the percentage of land covered by impervious surfaces exceeds the threshold for impacts to streams in many of the Casco Bay subwatersheds. The pattern of areas with less development also generally follows the distribution of large areas of undisturbed habitat remaining available for wildlife. Indicator 7, unfragmented blocks of habitat, reveals that nine of the forty-one municipalities in the Casco Bay watershed have no unfragmented blocks of habitat larger than 2,000 acres left and thirteen other towns have less than 5,000 acres of land left in blocks this size. Many of these municipalities are the same ones with the highest percentage of impervious surface and the greatest rate of population growth. These changes generally reflect trends in the growing population centers and coastal areas of Maine, New England and the nation. However, rapid growth and development is a relatively new phenomenon in Maine. There is still time to reverse many of the adverse impacts associated with growth and to plan wisely to minimize the environmental impacts of future development.

Several indicators in this report reveal a mixture of "good news" and "bad news" for the bay. Levels of toxic chemicals found in both sediments and blue mussels in Casco Bay (Indicators 10 and 11, respectively) either decreased or stayed the same for the majority of chemicals analyzed. Toxic chemicals are elevated at some sites in the bay. For example, polycyclic aromatic hydrocarbons (PAHs) are highly elevated in both the sediments and the tissues of mussels from the Fore River. As discussed in Indicator 5, with the initiation of the new Maine Healthy Beaches program, public education about the importance of beach water quality is reaching a broad audience; however, only two of Casco Bay's beaches are currently monitored for the safety of their waters for swimming. Finally, Indicator 13 reveals that, while the majority of rivers, streams, and coastal areas in the Casco Bay watershed meet the water quality standards expected for their use (*e.g.* fishing, swimming, shellfish harvest), there are some areas that have degraded water quality and do not meet the minimum state standards.

There is a significant amount of positive news in the *State of the Bay 2005*. Our knowledge and management of environmental impacts has increased and numerous entities from municipalities to school teachers are working to mitigate their impact through on-the-ground action, policy, and education, among other means. Indicator 3 shows that municipalities have dramatically reduced the volume of combined sewer overflows (CSOs) to the bay. These and other improvements to water quality are reflected in indicators 4 and 9 with the increased acreage of soft-shell clam flats open to harvest and the increase in acreage of eelgrass beds. The broader view of water quality in the bay (Indicator 12) reveals that, overall, water quality in the bay is good with some trouble spots where there is low dissolved oxygen. In the watershed, while the number of large unfragmented blocks of habitat (Indicator 7) is declining, much pristine and undisturbed habitat remains, providing a home for a wealth of species. Land conservation organizations, citizens, municipalities, and the state are working hard to protect the most important of these parcels for habitat values, recreation, and aesthetics and the acreage of protected land has increased by 50% since 1997 (Indicator 6). Finally, we find hope and commitment to protecting the environment in the active citizens around the bay. Stewardship (Indicator 14) opportunities abound and hundreds of dedicated volunteers are working to protect Casco Bay and its watershed. To learn more about volunteer opportunities and how to get involved, visit www.cascobayestuary.org.

How will CBEP Continue to Protect and Assess the Health of the Bay?

Casco Bay Estuary Partnership's Commitment



The results of this *State of the Bay 2005* "checkup" are generally good—but keeping the bay on the path to improvement will require responsible stewardship from everyone who uses the resources of the bay and its watershed. The state, federal, local and citizen partners that make up the CBEP will continue to work towards realization of our goals for a healthy Casco Bay. We are committed to implementing the recommended actions in the *Casco Bay Plan* and to continuing our environmental monitoring program.

CBEP will continue to utilize new technologies and techniques as they evolve, in conjunction with the latest science, to make progress in our five priority areas. In addition, we recognize that new issues will come to light as our knowledge of the environment grows and will develop new indicators to track these as appropriate (see sidebar). We plan to hold periodic State of the Bay conferences and to produce future *State of the Bay* reports, which will track changes and improvements in the bay over time.

New Indicators

The fourteen indicators presented in this report are helping CBEP to assess the health of Casco Bay and its watershed. In addition to this set of indicators, we are working on new indicators that will enhance our ability to assess the impacts of human uses on the bay's ecosystem. As data becomes available, we hope to develop indicators based on: the concentration of toxic chemicals in stormwater; loss of wetland acreage; the composition of the bottom-dwelling (benthic) animal community in the bay; and on non-native invading marine organisms.


Judith Pederson

Invasive tunicate.

CBEP and Invasive Species

In August 2003, CBEP brought a team of scientists to marinas in Portland, South Portland and South Freeport to search for signs of invading marine organisms. These "invasive species" are marine animals and plants that are not native to Maine's coast and which may spread into, or 'invade,' the existing ecosystem, overtaking native species and their habitat. The scientists were part of a team assembled by the northeast National Estuary Programs and MIT Sea Grant to search floating docks and piers in bays from New York Harbor to Maine. Among the non-native species encountered in Casco Bay were exotic species of tunicates, commonly known as sea squirts. These harmless looking organisms can potentially smother shellfish if they grow too abundantly. As a follow up to the field study, CBEP hosted *Maine's Marine Invasion: A Forum on the Impact of Non-native and Other Invasive Species on Maine's Coastal Ecosystems* in May, 2004. Currently, CBEP is working with a stakeholder committee to identify tools and resources that will help address the impacts of invasive species in Maine. As more information becomes available, CBEP will develop and indicator of the impact of invasive species.

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