State of the Bay

Casco Bay Plan

STATE OF THE BAY

Casco Bay provides a major link between open ocean, fresh water, and the land. Past and present human activities impact its health today.

History of Pollution in Casco Bay

The arrival of European settlers in the late 18th century brought unprecedented changes to the Casco Bay region. Soils from cleared lands resulted in erosion that filled former harbors, such as Mast Landing in Freeport, and dams blocked the passage of fish to spawning areas.

By the middle of the 19th century, Portland had become a major commercial port, with industries (*e.g.,* railroad yards, tanneries, metal foundries, canneries, and paint manufacturers) that emitted airborne pollution and discharged untreated waste, heavy metals, and other pollutants into the bay.

As the population and industrial base around Portland grew, pollution intensified. The early half of this century was marked by growth in manufacturing of glass, paper, textiles, metals, and

photo by Christopher Ayres

shoes, as well as the start of tourism and construction of seasonal shorefront homes. Increased use of automobiles added to marine pollution through airborne emissions, roadway runoff, improper disposal of oil and fluids, and leaking underground fuel storage tanks.

There was little understanding of pollution's ecological consequences during this era, and hence no regulation. When links were established between disease and water quality, laws were enacted as early as 1903 to protect Sebago Lake, the region's water supply. To prevent consumption of clams from contaminated areas, the Interstate Shellfish Sanitation Conference adopted the National Shellfish Sanitation Program in 1925. Little action was taken to reduce pollution entering marine or estuarine waters.

By the middle of this century, portions of Casco Bay were an open sewer — toxic to wildlife and humans alike. The Presumpscot River, one of the sub-watersheds that feed Casco Bay, received human waste from 11,000 residents and untreated industrial discharges from textile, pulp, and paper mills. According to reports from Presumpscot River Watch, pollution was so severe that by 1965 there was "no measurable oxygen" in the river, which resembled a "root beer float" with brown bark chips a foot deep, topped by foaming chemicals. A state report that year declared the lower river "dead" and conditions for nearby residents "intolerable."

While attempts had been made to enact federal and state water quality laws in the late 1940s and 1950s, these initial efforts failed to keep pace with water pollution. Being underfunded and understaffed, state agencies could not adequately regulate the activities of municipalities and industries.

Relief finally came in the early 1970s with passage of the federal Clean Water Act, which mandated sewage treatment and industrial treatment of wastes and provided funds to help municipalities install the necessary equipment. This legislation led to construction of sewage treatment plants in municipalities along Casco Bay.

Reduction of these "point sources" of pollution had a dramatic impact on the bay, permitting the return of many wildlife species, and recreational use of the bay increased. Because the bay no longer looked dirty, most people began to consider it a healthy body of water.

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These assumptions were challenged in articles appearing in the *Portland Press Herald* and with the publication in 1988 of a report entitled *Troubled Waters — A Report on the Environmental Health of Casco Bay*. Produced by the Conservation Law Foundation and the Island Institute, this report examined impacts of bacterial contamination and levels and sources of toxic pollution. It was proposed in the report that the bay's ecosystem was more polluted than had previously been thought, with toxic contamination levels rivaling those of the country's worst urban harbors. As media reports spread this information, the public image of a pristine bay was shattered. Residents of the watershed were disturbed by the news and sought prompt governmental action.

The Maine Department of Environmental Protection prepared an Agenda for Action, spelling out measures to clean up the bay, and nominated Casco Bay to a U.S. Environmental Protection Agency program designed to help restore and protect the health of significant estuaries. Admission to the National Estuary Program would provide the federal funds and technical guidance necessary to begin studying the bay, with support administered through a federal/state partnership working at the local level.

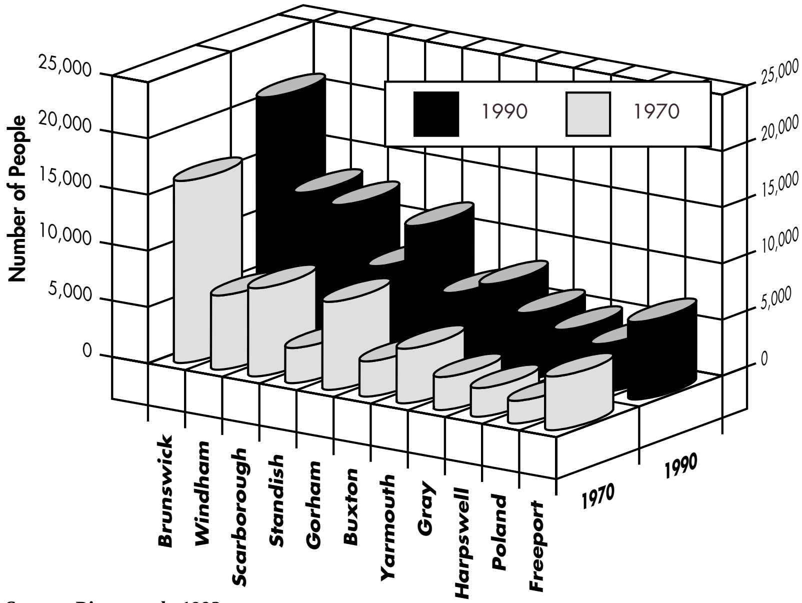
In 1990, Casco Bay was selected as an estuary of national significance, and the Casco Bay Estuary Project office was established in Portland to coordinate local efforts. *(For more information on the National Estuary Program, see Appendix A; for more information on the process undertaken in preparing this* Plan, *see Chapter 11,* Developing the Casco Bay Plan.*)*

Changing Demographics Around Casco Bay

The concern that surfaced in the late 1980s over the fate of Casco Bay was prompted by demographic factors as well. Growth in population and housing development within the watershed, which had risen steadily for decades, jumped sharply during the "building boom" of the 1980s.

Prior to this period, the region had experienced only modest growth. During the first major influx of European settlers, between the American Revolution and the Civil War, the population of the Casco Bay watershed grew from 30,000 to nearly 80,000, but the growth was evenly distributed. Land grants to veterans helped settle the interior and new industries prompted development in coastal towns.

Figure 1-1 **Population Change from 1970 to 1990 in Towns with Greatest Growth**



Source: Risser et al., 1992

Growth slowed considerably in the latter half of the 19th century as people migrated out of Maine to find work in other urban areas or to settle in the West. Of the 33 main cities and towns in the Casco Bay watershed, 24 lost population between 1850 and 1900, while Portland grew from 20,000 to 50,000, accounting for nearly all the region's net growth.

Population began climbing again early in this century, with a rise in manufacturing around Portland, the growth of tourism, and construction of seasonal homes. Beginning around 1950, improved transportation and the lure of cheaper land and taxes prompted the process of "suburbanization." Widespread construction of single-family homes, on large 2- to 5-acre lots, contributed to rural sprawl and fragmentation of fields and woodlands.

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, Poland, and Freeport *(see Figure 1-1).* Many of these towns are now bedroom communities, with residents driving to work in larger communities. This lifestyle has led to a proliferation of cars and accompanying environmental problems. While the population of the lower watershed increased by 50,000 people between 1970 and 1990, the number of registered vehicles in Cumberland County during that period increased by roughly 70,000.

Population growth is projected to continue in the lower watershed, with a 9 percent increase over 1990 census figures expected by the year 2000.

Water Quality in Casco Bay

The health of bay waters is determined, in large measure, by levels of dissolved oxygen, nutrients, bacteria, and toxic pollutants, as well as habitat quality and the health of the biological community. Assessments of these parameters help to determine whether waters can support a full and diverse range of marine life and uses.

When dissolved oxygen levels fall below a certain threshold (which varies for each plant and animal species), marine life must move or perish. A number of

Table 1-1 **Rivers and Brooks Failing to Meet Water Quality Standards Due to Agricultural Practices**

River, Brook	Water Quality Standards *(See Appendix B)*	Watershed	Town(s)
Chandler River	Class B	Royal River	North Yarmouth, Pownal
Unnamed Brook	Class C	Royal River	North Yarmouth, Yarmouth
Thayer Brook	Class B	Presumpscot, Pleasant	Gray
Otter Brook	Class B	Presumpscot River	Windham
Black Brook	Class B	Presumpscot River	Windham
Colley Wright Brook	Class B	Presumpscot River	Windham
Mosher Brook	Class B	Presumpscot River	Windham
Inkhorn Brook	Class B	Presumpscot River	Windham
Hobbs Brook	Class B	Presumpscot River	Cumberland
E. Branch Piscataqua	Class B	Presumpscot River	Falmouth
Alewife Brook	Class A	Coastal	Cape Elizabeth

Source: Maine Department of Environmental Protection, 1994 Water Quality Assessment

tributaries that feed Casco Bay fail to meet minimum standards for dissolved oxygen, according to an assessment made by the Maine Department of Environmental Protection in 1994 *(see Appendix B for information on water quality standards).*

The lack of dissolved oxygen in these rivers is attributed to agricultural practices that allow manure and fertilizers to run off into streams. Additional tributaries fail to meet standards for dissolved oxygen due to loadings from urban runoff.

Table 1-2 **Rivers, Brooks, and Creeks Failing to Meet Water Quality Standards Due to Urban Runoff**

River, Brook	Water Quality Standards *(See Appendix B)*	Watershed	Town(s)
Frost Gully Brook	Class A	Harraseeket River	Freeport
Capisic Brook	Class C	Fore River	Portland
Clark Brook	Class C	Fore River	Westbrook
Stroudwater River	Class B	Fore River	Gorham
Long Creek	Class C	Fore River	South Portland, Westbrook

Source: Maine Department of Environmental Protection, 1994 Water Quality Assessment

Preliminary results of Friends of Casco Bay volunteer water quality monitoring in Casco Bay itself show that there were seven violations out of 320 samples for dissolved oxygen in SC waters. In SB water, 79 samples out of 1,209 showed dissolved oxygen violations.

Nutrients such as nitrogen can overstimulate the growth of aquatic plants, causing "algal blooms" that then die, depleting oxygen levels and killing off other species. While Casco Bay does not appear to have major nutrient enrichment problems at present, the potential for problems will increase as population and development grows.

Bacteria are a natural component of estuarine and marine food chains, but human sewage can contain pathogenic (*i.e.,* disease-causing) bacteria and viruses that pose a risk to public health from water contact or consumption of shellfish. Fecal coliform, a benign form of bacteria that resides in the intestines of humans and other mammals, is used as an "indicator" species because it may be accompanied by pathogenic bacte-

Table 1-3 **Closed Clam Flats in Casco Bay in 1994**

Town	Total Flat Acreage	Closed Acreage	% Closed
Brunswick	1,986	479	24
Cumberland	509	163	32
Falmouth	874	874	100
Freeport	2,089	277	13
Long Island	98	89	91
Phippsburg	222*	36*	16*
Portland	613	613	100
Harpswell	3,464	1,160	33
Yarmouth	1,399	564	40
West Bath	328	268	82

*Includes only that portion of the flats within Casco Bay.
Source: Maine Department of Marine Resources, December 1994

ria.

Many areas of the bay currently fail to meet water quality standards for bacteria, and bacteria-laden stormwater has prompted closure of clam flats *(see Chapter 3 for further details).* Bacterial contamination has also caused periodic closure of public swimming areas at East End Beach and Peaks Island (the only two swimming beaches that are routinely monitored).

Streams and rivers that feed Casco Bay carry far more than fresh water; they contain polluted sediments and organic matter that react chemically with salt water and settle to the bottom of the bay. Toxic contamination from "point sources" such as industrial and sewage treatment plant discharges has declined in the past two decades, but Casco Bay continues to receive extensive contamination from "nonpoint" sources such as stormwater runoff *(see Chapter 2).* The National Oceanic and Atmospheric Administration is currently modeling sources of nonpoint pollution entering the Gulf of Maine (including Casco Bay), which will help determine the relative pollutant loads.

A waste load allocation study was conducted on the Presumpscot River by the Maine Department of Environmental Protection with S.D. Warren Company, Portland Water District, the Town of Windham, and Friends of the Presumpscot. The study found that during low-flow conditions, the river does not attain Class B *(see Appendix B)* dissolved oxygen standards for a 2.4-mile segment of the upper Presumpscot in the Windham area. In the lower river, below the point-source discharges in Windham and Westbrook, a 0.3-mile segment above the most seaward dam in the river (Smelt Hill dam) and a 1.5-mile segment in the estuary below the dam do not meet minimum dissolved oxygen standards for Class C or Class SC, respectively *(see Appendix B).* The model also predicted that a 1-mile segment in the lower river (above Smelt Hill dam) would not meet monthly average dissolved oxygen levels (of 6.5 parts per million) needed to sustain cold water fish (*e.g.*, trout). In addition, the study reported that the structure and function of the biologic community (based on bottom-dwelling macroinvertebrates) does not meet Class C standards *(see Appendix B)* downstream of the paper mill outfall in Westbrook.

The study concluded that no additional point-source loading should be allowed and that increasing river flow, in relation to temperature, would be the most effective solution to the dissolved oxygen problems that exist periodically. In extreme drought conditions, which probably occur once every 10 years, there should be increased dissolved oxygen monitoring, adjusted flows, and reduced loading from the paper mill in Westbrook. Also at low-flow conditions in the sum-

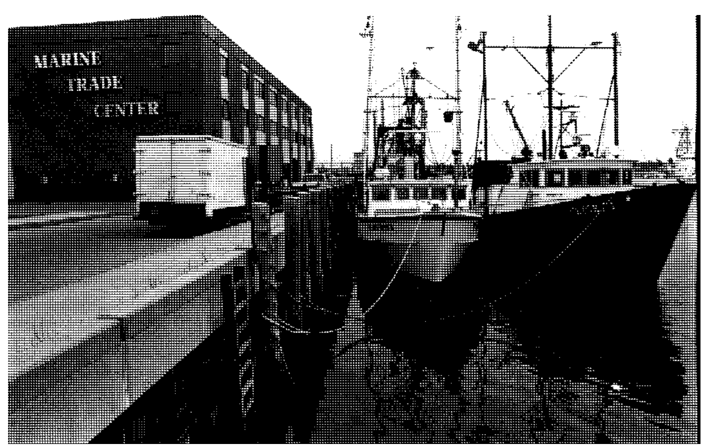


photo by Christopher Ayres

mer, the heat of the discharge from the paper mill results in an increase in water temperature in the river that is above the level considered detrimental to the biologic community (based on Maine Department of Environmental Protection rules).

The Value of Casco Bay

The value of Casco Bay is evident to anyone living in its watershed, but hard to capture by any single measure. Economic figures reveal only one dimension of the bay's diverse array of values. While the costs of environmental protection are traditionally seen as detracting from economic gains, it is now clear that Casco Bay will provide economic returns only so long as its ecological health is sustained.

The bay's economic worth is evident in the wealth of industries it supports: from shipping and petroleum transport to commercial fish and shellfish harvesting, tourism, and recreation. The Port of Portland alone provides 3,700 jobs, $314 million in sales, $70 million in wages, and $9 million in taxes per year from these sectors.

As the third largest oil-handling port on the East Coast, Portland ships and stores 80 percent of Maine's petroleum. In 1990, 209 tankers and 260 barges delivered nearly 72 million barrels of oil to the port's nine major oil-transfer facilities. The port also handles other cargo products, including lumber and coal.

Casco Bay provides abundant recreational opportunities for residents and visitors alike. Tourism-related expenditures exceed $145 million per year in Portland and $250 million in the region.

Portland is also Maine's largest fishing port, and its fish auction is one of the leading fish-handling facilities in New England (handling more than 30 million pounds of fish in 1994). While most of the fish landed in Portland come from the Gulf of Maine, Casco Bay is thought to be an important nursery for many juvenile finfish.

Lobster landings in Cumberland County represent approximately 20 percent of Maine's total landings (which in 1994 were 37 million pounds, worth $100 million). Sea-urchin harvesting has increased dramatically, from next to nothing in 1987 to the No. 2 fishery, after lobsters, today. Soft-shell clams represent a resource for bay residents that has not yet been fully realized. Currently, the industry generates between $11.6 and $15.7 million for the local economy, drawn from approximately two-thirds of the bay's clam flats; the remainder are closed due to actual or potential contamination. If water quality in the bay improves, further flats could be reopened and additional jobs generated. Crabs, mussels, scallops, and marine worms are also harvested commercially in Casco Bay.

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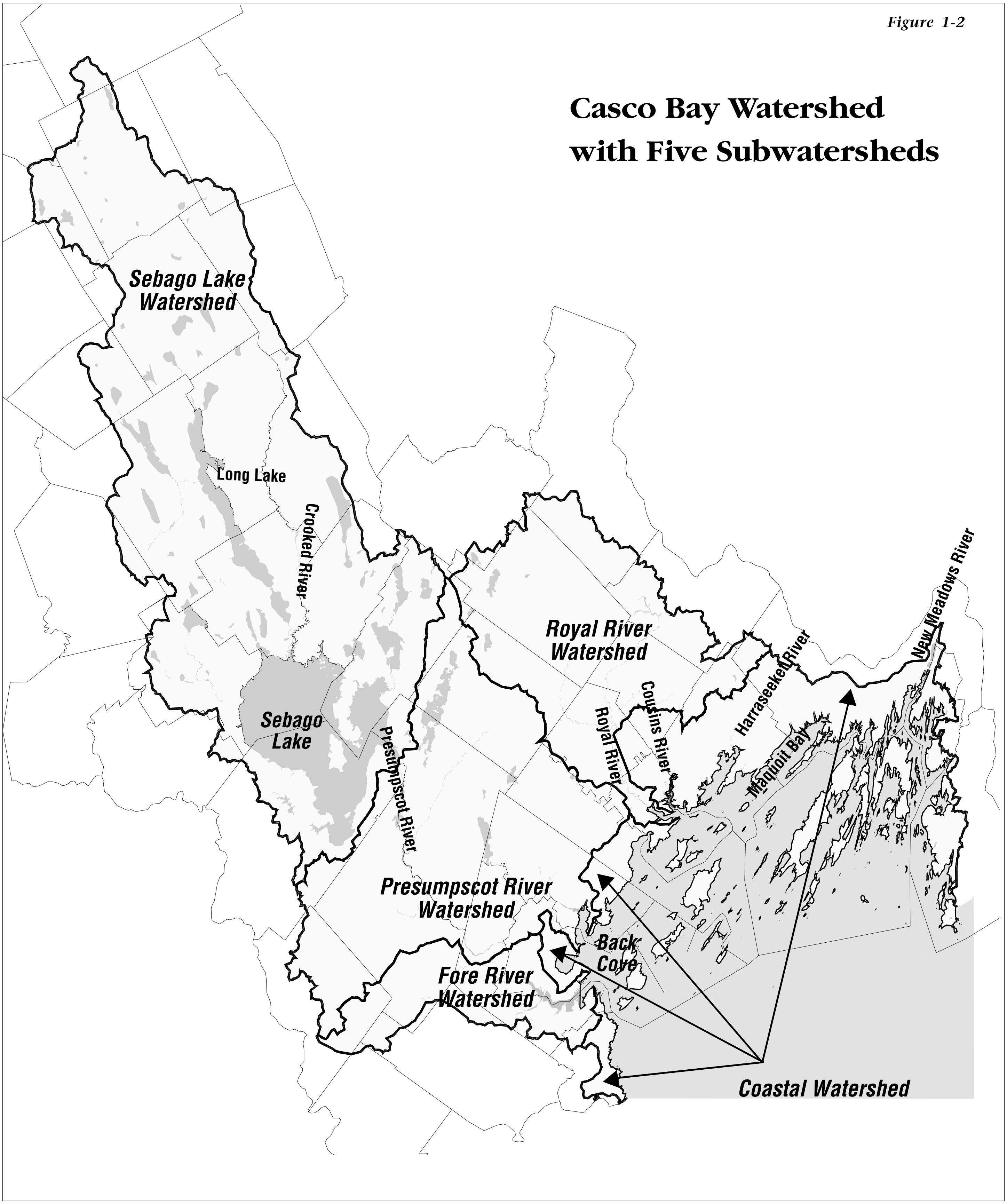
Figure 1-2


Casco Bay Watershed with Five Subwatersheds
Sebago Lake Watershed
Long Lake
Crooked River
Sebago Lake
Presumpscot River
Royal River Watershed
Royal River
Cousins River
Harraseeket River
Maquoit Bay
New Meadows River
Presumpscot River Watershed
Back Cove
Fore River Watershed
Coastal Watershed

gion. More than 12,000 sailboats and power boats are registered in towns in the watershed (providing $268,000 in excise taxes, $90,000 in mooring fees, and more than $60,000 in registration fees). In addition to recreational boating, residents and tourists use Casco Bay for wildlife viewing, sightseeing, sailboarding, sea kayaking, and recreational fishing and hunting. Cruise ships also contribute to the local economy, with estimated sales from each visit in excess of $1 million.

Work done for the Casco Bay Estuary Project, over the past five years, has helped demonstrate the economic returns that can be derived from sound environmental protection. A report entitled *The Economic Analysis of the Soft-shell Clam,* Mya arenaria, *Industry in Casco Bay*, prepared by MER Assessment Corporation, determined that the soft-shell clam industry could provide significantly greater revenues if water quality was high enough to permit harvesting from all the commercially viable clam flats.

A focused study of one "redeemable" clam flat enabled Brunswick to invest $90,915 (with 90 percent funded by the state) to replace overboard discharge systems and reopen a flat that is expected to yield $55,000 in the first year of harvesting alone. Over 20 years, the income to clam diggers of that flat could be more than $1 million.

Progress in Understanding Casco Bay

When the Casco Bay Estuary Project began in 1990, few scientific studies had assessed the human impact on the pollutant levels of Casco Bay. Little was known about the pollutants in the benthic (*i.e.,* bottom) sediments of the bay, its water circulation patterns, or its historic sources of pollution. Several studies had been conducted during the 1980s, but these provided incomplete snapshots of the bay's health. To gain a better scientific basis for making policy decisions, the Casco Bay Estuary Project commissioned several major studies.

Studies of Sediment Contamination

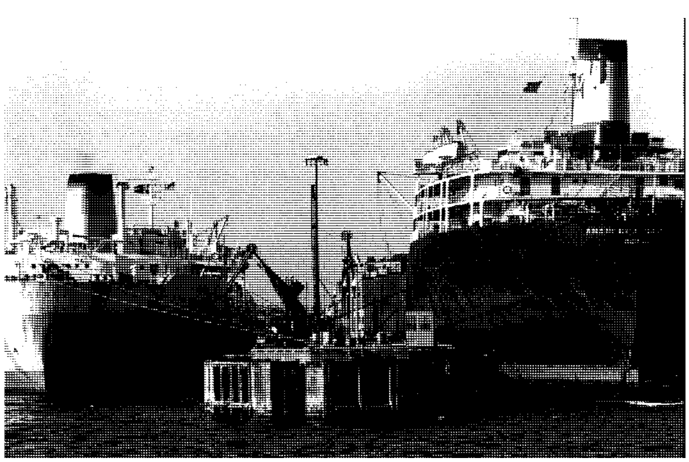


photo by Christopher Ayres

Research done in the early 1980s had revealed high levels of toxic contamination in sediments taken from certain parts of the bay. The presence of toxic pollution in sediment samples reflects both historic and contemporary sources of pollution — from petroleum products, industrialization, and agricultural practices. To better document the types and distribution of contaminants, the Casco Bay Estuary Project commissioned two studies, conducted in 1991 and 1994 by Texas A&M University.

Its studies indicated that toxic contaminants including PAHs (polynuclear aromatic hydrocarbons), heavy metals, pesticides, PCBs (polychlorinated biphenyls), planar PCBs, butyltins, dioxins, and furans are found throughout the bay. The levels and areas of heavy contamination are not as widespread as initially thought. Five metals (*i.e.,* lead, mercury, cadmium, silver, and zinc) did appear at elevated levels in parts of the bay, but pesticides had very low concentrations. The level of PCBs was high at one location, while PAHs (a by-product of fossil fuel combustion) had the most consistently high levels of toxic pollution. Coming predominantly from urban and industrial activities and automobile exhaust, PAHs enter the bay through stormwater runoff. Dioxins and furans were highest near urban sources in Portland, downstream from a paper mill source, and in the eastern bay where sources could be paper mills on the Androscoggin and Kennebec rivers or combustion sources (both local and distant). Butyltins were highest near potential sources, including marinas and boat anchorages.

These sediment studies form a baseline against which future research can be measured. *(Further information on toxic contamination studies to date is in Chapter 5 of this* Plan.*)*

Historic Sources of Contamination

GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Land use planning in the Casco Bay watershed has been greatly enhanced by computer technologies that can store, retrieve, integrate, analyze, and display environmental information. The Casco Bay Estuary Project began employing GIS at the outset of its work in order to gather and map information on existing conditions (*e.g.,* soils, topography, wetlands, hydrography, and roads) in the watershed. Later applications have involved build-out analyses, systems for identifying threats to natural resources, and three-dimensional visualizations of development uses. GIS technologies have been shared with local municipalities throughout the watershed to enhance their capacity for informed decision-making.

The toxic contamination in bay sediments has accumulated over time, some from industrial sources dating back to the mid-1800s. Historic sources of pollution were studied by an environmental historian, through research involving maps, directories, and local history. Highlights are discussed in Chapter 5. The study documented a much more industrialized waterfront than currently exists.

Water Circulation Modeling

To better understand how water circulation in Casco Bay affects the transport of pollutants, the Casco Bay Estuary Project commissioned a study by researchers from the University of Maine's Department of Civil and Environmental Engineering. Circulation patterns, which are determined primarily by tidal exchange, wind, freshwater flows, and topography, influence both the distribution of flora and fauna, as well as of nutrients and pollution. Knowledge of water circulation can contribute to understanding a range of management issues — from identifying sources of pollution, to predicting where young clams may settle, to what impact an oil spill might have. The model indicates that water from the Kennebec River may, at times, enter the eastern parts of the bay.

Nitrogen and Bacteria Modeling

Many communities along Casco Bay are struggling to find a balance between human development and water quality. To help them predict how different land uses affect water quality, the Casco Bay Estuary Project commissioned a report from Horsley & Witten, Inc., to develop water quality loading models to predict present and future loadings of nitrogen and bacteria.

Maquoit Bay, which experienced an algal bloom in 1988 that killed off much marine life, afforded a good test case because it is relatively small, shallow, free from point sources of pollution and extensive urban development, and subject to excess concentrations of fecal coliform bacteria (which indicate the presence of disease-causing viruses or bacteria). Marine algal blooms are often triggered by excess nitrogen, so a model was developed to assess Maquoit Bay's potential sources of nitrogen (*i.e.*, agriculture, residential runoff, sewage, and air deposition). The study assumed that septic systems, particularly failing ones, and manure or fertilizer were the largest sources of nitrogen and bacteria entering the bay. This work begins to provide a basis for developing measures to reduce pollutant loading.

Habitat

As Chapter 4 of the *Plan* demonstrates, Casco Bay has a rich diversity of flora and fauna. Like many areas facing rapid growth, however, the watershed could lose important habitats with increased development. Working in cooperation with the Casco Bay Estuary Project, the U.S. Fish and Wildlife Service's Gulf of Maine Project gathered existing data, much of it from the State Department of Inland Fisheries and Wildlife, to determine the location of these important habitats and the potential effect on fish and wildlife habitat if coastal towns in the lower watershed were to develop to the maximum extent permitted by current zoning. This "build-out analysis" provides an innovative way to determine how land uses in the future could affect important habitats.

Where Are We Going?

The health of the bay is dynamic, always in the process of change, and its future is certainly in our hands. Casco Bay has had a varied history from which it has rebounded in part. Much has been accomplished by regulating point sources of pollution. Now the focus is directed at controlling and reducing pollutants that enter Casco Bay through nonpoint sources. As we have come to better understand the complex nature of the ecosystem, it is clear that federal and state regulations and funding have played a vital role in cleaning up Casco Bay. However, the straightforward solutions — building sewage treatment plants and stopping "end-of-the-pipe" discharges — have largely been done. Now a more demanding personal form of change is required.

To protect the health of Casco Bay during the next 30 years, we need to rethink many facets of our lives — choices in transportation, development, agricultural practices, home maintenance, consumption, and waste disposal. Roughly 60 percent of pollution comes from diffuse sources — oil and chemicals from roadway run-off, pesticides applied by homeowners, improperly maintained septic systems, and fertilizer from stream-side farm fields. Each of us living in the watershed contributes to this collective pollution and can play a role in reducing it.

This *Casco Bay Plan* represents an important cooperative environmental initiative to focus attention and action on continuing threats from water pollution, habitat loss, and human development. Improvements can be made, but only by working together to achieve a balance between human users and the health of Casco Bay. Where we are going is up to all of us.

Our scientific understanding of the bay is far from adequate. There is a continuing need for marine research focused on the Casco Bay ecosystem and how it functions. Such research represents investments whose returns will provide the basis for more informed management of this precious resource over time.

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NOTES