THE NOMINATION OF CASCO BAY TO THE NATIONAL ESTUARY PROGRAM

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LIKELIHOOD OF SUCCESS

EXECUTIVE SUMMARY

- Casco Bay, Maine, is an especially precious resource. It contains a high diversity of habitats which support an abundance of living resources, both commercial and non-commercial, and includes endangered and threatened species.

- Nearly one quarter of the Maine's population live in Casco Bay's watershed. Direct pressure on Casco Bay is increasing as this region of the eastern seaboard experiences rapid economic growth.

- Once considered pristine, toxic materials are present in elevated levels in Casco Bay's sediments and living resources. Safe swimming standards are routinely violated in some of the more heavily used areas of the bay. About 11% of the bay's shellfish areas are closed due to pollution and nutrient loading to the eastern end of Casco Bay is thought to have been partly responsible for a massive shellfish die off in 1988.

- Environmental problems in and threats to Casco Bay are faced by many other estuaries along the east coast. Lessons learned by confronting Casco Bay's environmental problems could be useful to many other communities in the country. Casco Bay is located in the National Estuary Program's Biogeographic Province A where no representation exists.

- Prevention of further degradation and improvement of existing conditions is the primary purpose of nominating Casco Bay to the National Estuary Program. Through integrating a sound scientific understanding with public participation, protection of Casco Bay will be assured.

- Formation of a Comprehensive Conservation and Management Conference would enable development and implementation of a comprehensive protection and management plan for Casco Bay. Public interest in Casco Bay is high. The timing is perfect to ensure success. Local and state government commitments are strong. Although much has already been done to correct problems in Casco Bay, still more needs to be done. Inclusion of Casco Bay in the National Estuary Program would further advance ongoing initiatives.

NATIONAL ESTUARY PROGRAM

THE NOMINATION OF CASCO BAY

INTRODUCTION

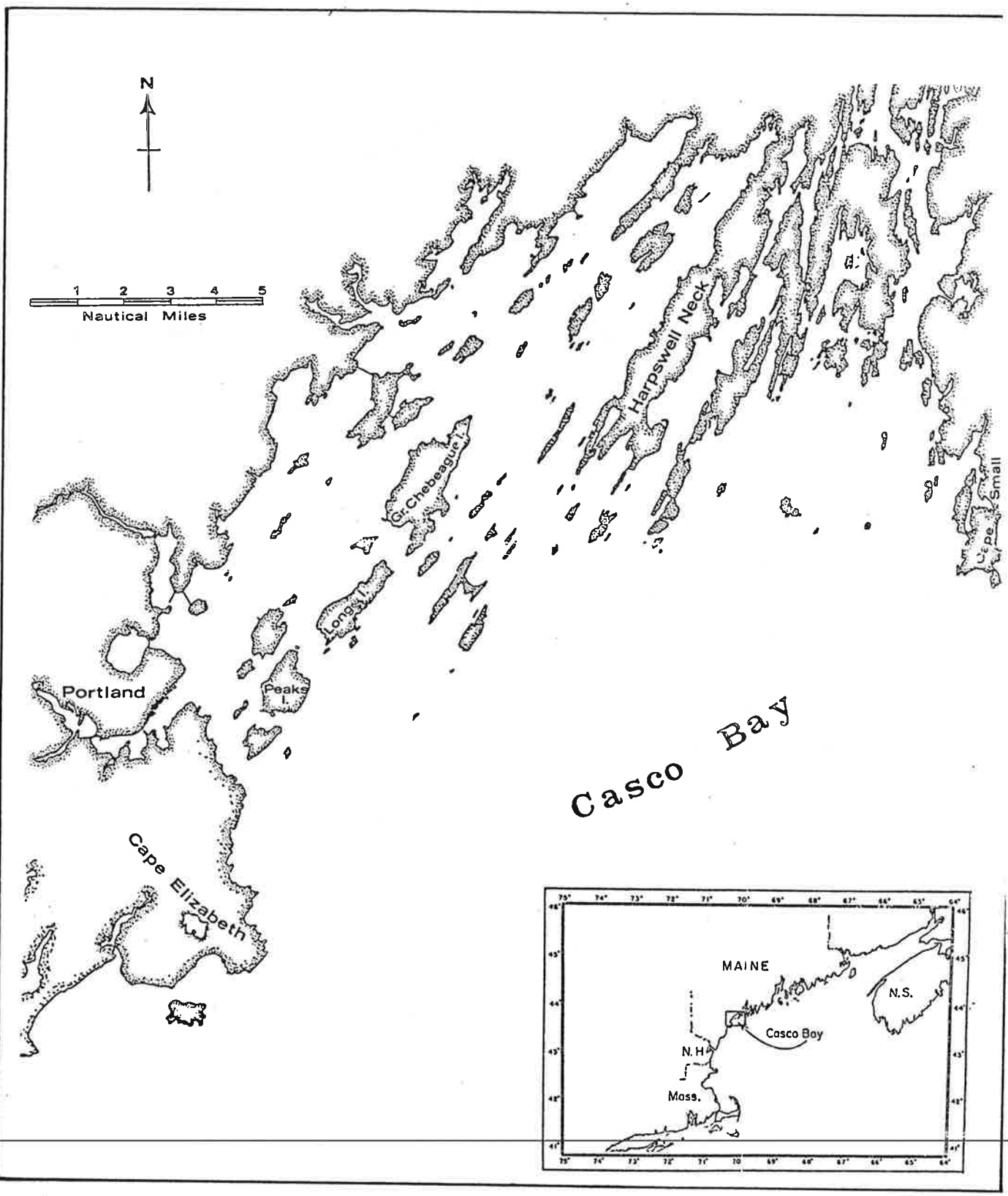
Casco Bay, Maine (Figure 1) is abutted by the largest population center north of Boston in the United States. The bay itself has been of strategic importance for commerce since colonial times due to its deep water and protection from the open ocean and continues to be a significant resource to the people of Maine and the northeast. Until recently, pressure on the bay has been light in terms of use and demands on it, but in the late 1970's and early 1980's, the Casco Bay region of Maine's coast became one of the more rapidly growing areas in the State. With its deep water, over 400 islands, rich fishery and high biological diversity, apparent clean water, and ample space for its many water oriented activities, Casco Bay continues to draw people to its shores for their residences, business, and industry.

Maine's largest city, Portland, is the largest fishing port north of Gloucester, Massachusetts. A deep port, Portland is also Maine's most important cargo port. Until about 1976, it was the second largest oil handling facility on the east coast, it being the end point of the Portland to Montreal oil pipeline. Over the last 15 years, the waterfront areas of Portland and South Portland have received an infusion of millions of dollars of capital from public and private sources. The recent (since 1985) addition of the Portland Fish Auction, Bath Iron Works dry dock facility, Merrill Industries cargo facilities and the expansion of international ferry service to the Maritimes are indicative of just a few of the pressures now being put on Casco Bay. It is these demands on the bay from an increased population which threaten the very qualities of Casco Bay which drew people to it in the first place.

In fact there is documented evidence that the environmental quality and uses of Casco Bay have suffered. The health of Casco Bay is in question and positive steps are necessary if it is to be protected. It is with this concern that Casco Bay is being nominated to the National Estuary Program, to prevent further degradation of a precious natural and economic resource.

Figure 1

CASCO BAY, MAINE



In January, 1989, the Honorable John McKernan, Governor of the State of Maine, released ***AGENDA FOR ACTION*** (M.D.E.P., 1989), a report describing documented pollution problems in Casco Bay, Maine. The Governor announced a series of eight actions to be taken during 1989 and eight actions which would continue beyond 1989. The purpose of that report and the announced actions was to assure the people of Maine that their government was sufficiently concerned about environmental threats to Casco Bay to make that water body a Statewide priority and more importantly that steps were being initiated to correct problems and protect a valuable natural resource.

Action #1 of ***AGENDA FOR ACTION*** was to nominate Casco Bay to the National Estuary Program. In fact this is the last of the short-term actions which remains to be initiated. If successful, and Casco Bay becomes a part of the National Estuary Program, not only will Casco Bay benefit, the entire coasts of Maine and the two other states (New Hampshire and Massachusetts) in this biogeographic region will benefit through the stimulation of research and expansion of our understanding of marine ecology in this part of the Northwest Atlantic.

NATIONAL SIGNIFICANCE

Designation of Casco Bay as a Nationally Significant Estuary is warranted for several reasons. The uniqueness of the biological community, geographic location, economic value to the region, nature of the identified problems and the proposed plan to address the problems make Casco Bay's protection plan instructional to many other areas of the country, especially along the built up portion of the east coast.

How can the lessons learned from Casco Bay be applied to other coastal areas or within the State or to other States?

Casco Bay contains a diversity of marine habitats and environmental conditions which represent conditions found elsewhere on the east coast between Cape Cod and the St. Croix River on the Canadian Border. Within Casco Bay are sand beaches, tidal mud and sand flats, rocky shores, saltmarshes, soft and hard bottoms, gravel, cobble, and boulder habitats, areas with low and high tidal and freshwater flushing, and large protected intertidal areas. By emphasizing Casco Bay as an ecological unit, lessons may be learned which apply to many other areas of the nation, especially the northeast region and the States of Massachusetts, New Hampshire and Maine. The study of Casco Bay is therefore multipurpose.

Probably the most important characteristic of Casco Bay is that it offers an opportunity to emphasize protection instead of restoration. Although problems have been identified in Casco Bay, they are not yet as serious in terms of geographic extent as those problems associated with other estuaries in the country. The State of Maine is committed to do everything possible to avoid further degradation of Casco Bay.

Another value of adding Casco Bay to the National Estuary Program lies in the actual process of convening a management conference. While preparing ***AGENDA FOR ACTION,*** many programmatic problems were uncovered through the coordination of the many interested parties of Casco Bay. Users, dischargers, planners, and managers each had a different perspective. Conflicts and inadequacies within our own State programs were uncovered which has given us the opportunity to correct them. Continuation of this process will directly benefit Maine's management of environmental protection, but it should also benefit other states and areas with similar situations. For example, in order to estimate annual pollutant loads to

Casco Bay, it was discovered that no standard reporting method existed for license monitoring data. Therefore no good estimate of pollutant loads could be made to estimate present day contributions to the problem. This highlighted the value and utility of a good internal quality assurance/ quality control program. It was also determined that the specific pollutants identified as a problem in Casco Bay were not consistently included in waste discharge license monitoring requirements. In municipal plants, which receive a complex mix of wastes, this appears to have been an important omission. Lessons such as these will continue to emerge as the study of Casco Bay continues. Through inclusion of Casco Bay in the National Estuary Program, these lessons may be more readily passed on to others.

Additionally, because Casco Bay and the communities and land uses within its watershed are more typical of coastal areas in this region, the lessons from Casco Bay should be more applicable to other areas. Casco Bay contains within it problems relating to urbanization and small scale industrialization, agricultural activities, and residential development.

Why is Casco Bay important to the Nation?

The primary goal of the National Estuary Program is to preserve and protect the ecological integrity of our nations estuaries. Since no one program can realistically accomplish this for all estuaries in the country, the National Estuary Program's approach is to select a small set of estuaries representing a variety of biogeographic zones and a variety of problems to act as models for other areas of the country. Casco Bay will fill this need in several ways:

- Although the economic importance of Casco Bay is clearly less than that of any other estuary in the National Estuary Program, it is that very fact that makes its inclusion in the National Estuary Program of such importance. Casco Bay's problems tend to be smaller in geographic extent and less dramatic ecologically. They are, therefore, probably more typical of the problems being experienced by a large number of the nation's coastal systems. Results from Casco Bay may indeed be more applicable to other areas of the country than those developed from the larger and more heavily populated estuaries now in the program because the results would be based on a scale more closely resembling those of a large number of estuaries.
- Casco Bay would be the only estuary represented in National Estuary Program Region A, that biogeographic region north of Cape Cod.

- Casco Bay's pollution problems are unique in that hydrodynamically there are two distinct halves to the bay with two distinct sets of problems. In the western half of Casco Bay, urbanization and industrialization pose toxic and pathogen pollution threats, whereas in the eastern half of the bay, eutrophication is the primary concern. Because of this separation, cause and effect relationships may be more successfully determined thereby enhancing the likelihood of success.
- Casco Bay is itself an important ecological resource. For decades, marine biologists have specifically selected Casco Bay as a study area due to its biological richness and diversity of habitats. Inclusion in the National Estuary Program would further the efforts of marine biologists in this biogeographic region. Furthermore, the Casco Bay area is an important link in the life cycle of many species migrating between North and South America. As stopover and wintering habitat for these migratory species declines in both quality and quantity, the protection of these areas transcends national importance to global importance.
- Casco Bay presents an opportunity to develop biological community standards as a management tool, the concept of which may be modified and improved upon by other states in the nation.

LIVING RESOURCES

Casco Bay is nationally significant because:

1) it has a highly productive invertebrate population which supports large numbers of fish,seals and birds.

2) it supports a diverse assemblage of invertebrates and birds.

3) it provides nesting areas for the endangered least terns, roseate terns, and

4) it provides nesting areas for two species of special concern, the common and arctic terns.

The wide variety of habitats available in Casco Bay, both on land and underwater, results in a high species diversity for both birds and invertebrates. Also, Casco Bay is at the northern edge of the range for breeding for many invertebrates and birds and at the southern range for northern or boreal birds and some invertebrates. Therefore, a high number of species are found at this zoogeographic transition zone.

Marine Invertebrates

The specific information on invertebrates given below is from Verrill (1874), Kingsley (1901), US Fish and Wildlife Service (1980) and Larsen et al. (1983a).

In the mid 1800's, Casco Bay was a popular place to collect marine invertebrates for museum collections. The collections were placed in the Museum of the Portland Society of Natural History (which burned to the ground in the "great fire" of 1866) and the Museum of Comparative Anatomy in Boston. The famous marine biologist, A.E. Verrill, collected marine invertebrates in numerous locations in North America and in 1873, he located a collecting party on Peaks Island in Casco Bay.

Verrill collected 260 species from hard bottoms in Casco Bay, 173 species from muddy bottoms and 92 species from the intertidal zones of the islands and Cape Elizabeth. The following are excerpts from Verrill's description of Casco Bay in relation to marine invertebrates:

> "There is great diversity in the character of the bottom and here a large amount of profitable dredging has been done" (i.e. earlier collectors found a large variety of species).
>
> "Most of the species are decidedly boreal and arctic forms, which we had previously dredged in the Bay of Fundy and further north."
>
> "There is considerable diversity in the character of the fauna in different parts" (of the bay).
>
> "The deeper localities have a very northern fauna, similar in many respects to that of the deeper outer water; while the shallow localities, especially in the inner harbor of Portland and in Back Cove, have a less northern fauna and even yield a few decidedly southern forms."
>
> "The shores of the islands and of Cape Elizabeth afford excellent collecting grounds at low-water owing to their diversified character"

Around Peaks Island Verrill noted that the intertidal animals were numerous and interesting because of the diversity of the shores and the purity of the water. One of the localities which Verrill collected in Casco Bay was Quahog Bay in Harpswell. He found the area to be interesting zoologically because of the number of southern species present in this shallow sheltered cove. He considered these species to have a remarkable distribution because they are completely isolated from their co-species of the southern coast of New England and surrounded on both sides by more northern forms. Of the 62 species collected in Quahog Bay, 20 were considered by Verrill to be southern species.

In the early 1900's, Dr. Kingsley and colleagues located at a biological laboratory established in South Harpswell collected marine invertebrates in Casco Bay. Dr. Kingsley noted that conditions in Casco Bay "are favorable for the development of marine life" and that "Casco Bay is nearly as rich in species as is the southern coast (i.e. Vineyard Sound, Massachusetts) while in individuals it is vastly richer, as has been noticed by everyone who has collected in the two regions." Kingsley found 517 species in the Casco Bay area, 431 of them were in waters less than 50 fathoms. In 1902, Kingsley published an addendum in which he added 13 species to the list of marine invertebrates found in Casco Bay.

Much of the present-day Casco Bay is similar in diversity and richness of marine invertebrate individuals as it was in the late 1800's and early 1900's. A survey of unconsolidated sediments (Verrill's "muddy bottoms") in Casco Bay by Larsen and colleagues in 1980, yielded 264 species compared to the 173 species found by Verrill in the same type of habitat. In fact in a single one foot square grab sample, there were 86 species. To date, approximately 850 species have been found in the waters Casco Bay. Based on the densities encountered in the 1980 survey when compared to other studies using similar methods (Table 1), it appears that much of Casco Bay remains the highly productive region described by Kingsley in 1901.

Table 1

Location	Mean Density/Square Meter
Casco Bay, Maine	8,743
Sheepscot Estuary, Maine	
Gradient Study	4,928
Shallow Water Study	771
Mystic River, Massachusetts	3,000
Moriches Bay, New York	1,300
Delaware Bay	722
False Bay, South Africa	2,200
Gullmars Fjord, Sweden	4,198
Lambert Bay, South Africa	1,153

However, there are signs of man's impact on Casco Bay. An area off the mouth of the Presumpscot River has deposits of sawdust where species numbers of individuals are greatly reduced. Other areas such as the shipping channel and the Fore River had reduced numbers of individuals which could not be explained by natural causes. One station, a former Peaks Island dump had high levels of metals. The animals adapted to living in and among soles of shoes and other debris are quite different from the surrounding stations and there is some indication that the animals at the innermost station in the Fore River may be adapting to their oily environment.

Although, southern species probably still occur in the upper reaches of shallow bays such as Quahog Bay, we no longer find evidence of southern species in Portland Harbor or Back Bay. However, after the algae bloom in Maquoit Bay last fall (1988) which killed clams and worms, the southern species living at the extreme of their range may have been affected also. If algae blooms become a recurrent problem in these shallow poorly flushed bays in northern Casco Bay, this "outpost" of southern species may not survive.

Marine Birds and Mammals

The specific information on marine birds and mammals described below is from *Casco Bay Coastal Resources Inventory* (Hutchinson and Ferrero, 1981), the *Ecological Characterization of Coastal Maine* (US Fish and Wildlife Service, 1980) and the Maine Audubon Society (personal communication).

The *Ecological Characterization of Coastal Maine* states that:

> "the abundance and quality of the intertidal habitat make the marine and estuarine environment of this region (i.e. Casco Bay) important. The presence of many large shallow bays with intertidal flats, mussel reefs and eelgrass beds provide large acreages of many habitats. Similarly, the occurrence of many nearshore islands (approximately 400) provide additional intertidal areas as well as island habitats for nesting waterbirds and rocky ledges for seals."

Waterbirds

Waterbirds include seabirds, shorebirds, wading birds and waterfowl. Cape Elizabeth in Casco Bay is the boundary for two zoogeographic regions for waterbirds: the boreal zone and the northern temperate zone. The result is that a wide variety and unusual aggregation of marine birds occur in Casco Bay. There are an estimated 150 species of waterbirds in the Casco Bay area, 100 of which are regularly occurring (Appendix 1). Numbers of birds in Casco Bay varies seasonally from approximately 4,600 to 32,000. There are three peaks: in October during fall migration, during January when an estimated 32,000 birds are wintering in Casco Bay and in February and March during spring migration. Nesting locations of seabirds in Casco Bay are shown on Figure 2. One hundred and forty seven areas of concentrated use by waterbirds and seals were identified and mapped in the *Casco Bay Coastal Resources Inventory* (Figure 3).

Seabirds

The uninhabited islands of Casco Bay and other uninhabited islands along the coast of Maine support the largest breeding populations of double-crested cormorants, common eiders and black guillemots on the east coast of the United States. Seabirds which live and breed in the Casco Bay area include: double-crested cormorants, great black-backed gulls, herring gulls, common eiders, least terns, roseate terns, arctic terns, common terns and black guillemots

which is on the southern extent of its breeding range. The endangered roseate tern nests on Clapboard and the Nubbin Island in Casco Bay. The endangered least tern nests on a beach near Richmond Island in Cape Elizabeth. Least terns also nest on other beaches north and south of Casco Bay and use the bay for feeding. There are 17 major seabird nesting islands in Casco Bay (Figure 4 ; two islands #17 and #19 are wading bird breeding areas). Numbers of colonies and nesting pairs of seabirds counted in aerial surveys conducted in 1979 and 1980 are listed in Table 2:

Table 2
Nesting Seabirds in Casco Bay

Species	No. of Colonies	No. of Nesting Pairs
Eider	45	2,941
Herring gull	56	5,383
Great black-backed gull	37	2,127
Double-crested cormorant	15	3,968
Common tern	9	561
Black guillemot	2	7

Common eiders, herring gulls, great black-backed gulls and black guillemots are year round residents of Casco Bay.

Two species of loon and three species of grebe are winter residents in Casco Bay, and a few non-breeding loons remain in the bay year round. The horned grebe and the common loon are the most common of the five species wintering in the bay. The maximum number of wintering loons is estimated to be 200 individuals, and the maximum number of grebes is probably 400 individuals. Loons and grebes are distributed singly and in small groups throughout Casco Bay. Areas of consistent use are shown on Figure 5 .

Bonaparte's gull and the ringbilled gull are the principal migratory seabirds found in Casco Bay. Flocks of a few hundred ringbilled gulls are found in the Fore River and Back Bay year-round. Bonaparte's gulls are also found year round, although their numbers are lower than the ringbilled gulls. Laughing gulls are occasionally found in Casco Bay in the summer.

Figures 2, 3, and 4

FIGURE 2
MARINE BIRD NESTING AREAS

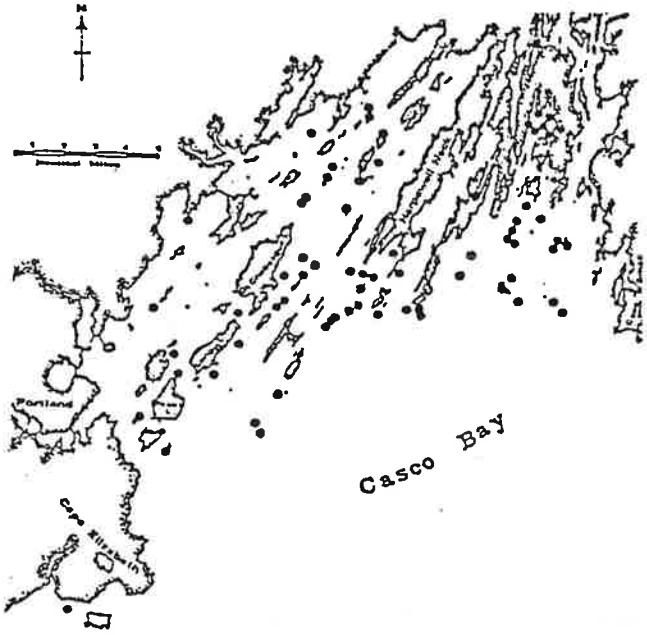


FIGURE 3
AREAS OF CONCENTRATED USE BY MARINE BIRDS AND/OR SEALS

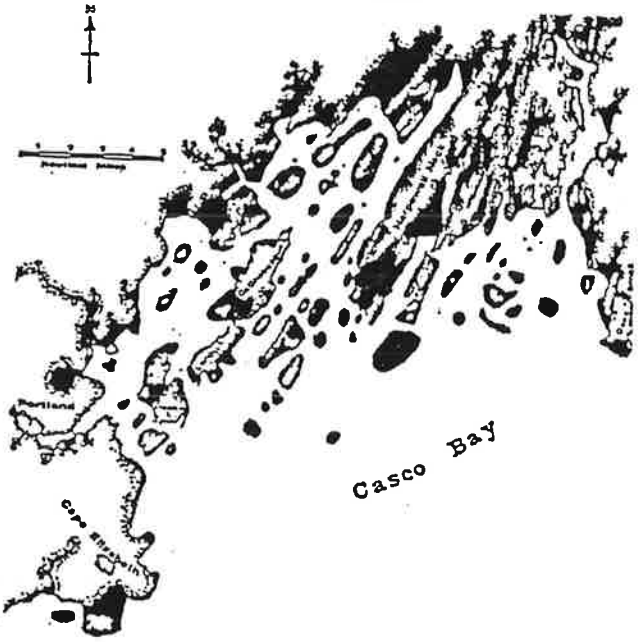
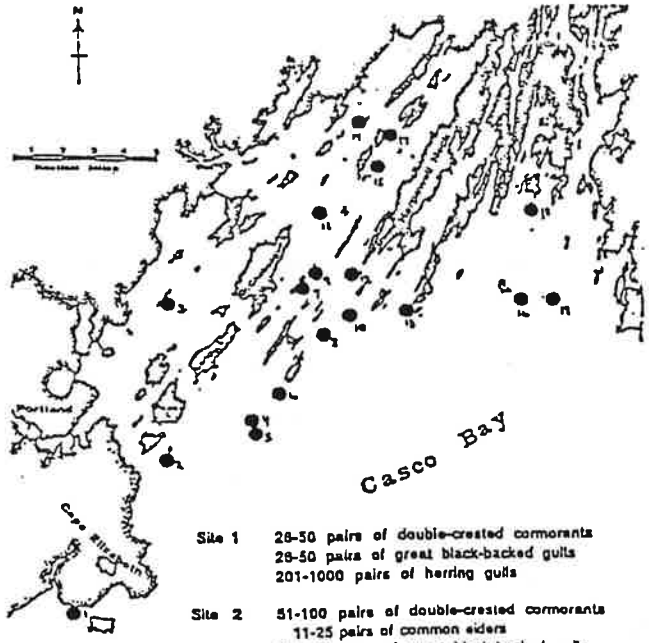


FIGURE 4
MAJOR NESTING ISLANDS FOR MARINE BIRDS



Site 1
- 26-50 pairs of double-crested cormorants
- 26-50 pairs of great black-backed gulls
- 201-1000 pairs of herring gulls

Site 2
- 51-100 pairs of double-crested cormorants
- 11-25 pairs of common eiders
- 51-100 pairs of great black-backed gulls
- 201-1000 pairs of herring gulls
- 1-10 pairs of black guillemots

Site 3
- 26-50 pairs of common terns

Site 4
- 101-200 pairs of double-crested cormorants
- 11-25 pairs of great black-backed gulls
- 11-25 pairs of herring gulls

Site 5
- 201-1000 pairs of double-crested cormorants
- 51-100 pairs of common eiders
- 101-200 pairs of herring gulls
- 1-10 pairs of black guillemots

Site 6
- 101-200 pairs of double-crested cormorants
- 51-100 pairs of common eiders
- 26-50 pairs of great black-backed gulls
- 101-200 pairs of herring gulls

Site 7
- 201-1000 pairs of common eiders
- 11-25 pairs of great black-backed gulls
- 51-100 pairs of herring gulls

Site 8
- 201-1000 pairs of double-crested cormorants
- 11-25 pairs of great black-backed gulls
- 11-25 pairs of herring gulls

Site 9
- 201-1000 pairs of common eiders
- 51-100 pairs of great black-backed gulls
- 201-1000 pairs of herring gulls

Site 10
- 201-1000 pairs of common eiders
- 101-200 pairs of great black-backed gulls
- 1-10 pairs of herring gulls
- 11-25 pairs of black-crowned night herons

Site 11
- 101-200 pairs of double-crested cormorants
- 1-10 pairs of great black-backed gulls
- 101-200 pairs of herring gulls

Site 12
- 201-1000 pairs of common eiders
- 11-25 pairs of great black-backed gulls
- 101-200 pairs of herring gulls

Site 13
- 1-10 pairs of common eiders
- 1-10 pairs of great black-backed gulls
- 26-50 pairs of herring gulls
- 11-25 pairs of common terns

Site 14
- 26-50 pairs of common terns

Site 15
- 51-100 pairs of common terns

Site 16
- 201-1000 pairs of double-crested cormorants
- 1-10 pairs of great black-backed gulls
- 26-50 pairs of herring gulls
- 1-10 pairs of black guillemots

Site 17
- 175 pairs of great blue herons

Site 18
- 11-25 pairs of common eiders
- 1-10 pairs of great black-backed gulls
- 26-50 pairs of herring gulls
- 11-25 pairs of common terns

Site 19
- 11-25 pairs of great blue herons
- 11-25 pairs of black-crowned night herons
- 1-10 pairs of snowy egrets

Seabirds were not always as abundant in Casco Bay as they are today. In the late 1800's, human exploitation and disturbance of the nesting colonies resulted in dramatic declines in seabird colonies in the bay. Breeding populations of double-crested cormorants, common eiders, great black-backed gulls and black guillemots were eliminated from Casco Bay and the rest of the Maine coast. Herring gull colonies also were eliminated from Casco Bay and the remaining few inhabited off-shore islands. Common terns were reduced in numbers but not to the extent of the other seabirds. In fact, the numbers of common terns are reduced today but this time because they are outcompeted by great black-backed and herring gulls.

Shorebirds

The Maine coast is an important resting and feeding area for migrating shorebirds including sandpipers, plovers, turnstones, godwits, curlews, dowichers and phalaropes. Thirty three species of shorebirds are found commonly along the Maine coast. As many as 500,000 semipalmated sandpipers, which is approximately 10% of the total population of semipalmated sandpipers, migrate along the coast of Maine. The Maine coast is also used by tens of thousands of migrating semipalmated plovers, short-billed dowitchers, black-bellied plovers and ruddy turnstones.

Intertidal mudflats are required for feeding while nearshore ledges and sand and gravel beaches or spits are important roosting areas. Casco Bay has numerous locations which are appropriate for both feeding and roosting. The principal feeding areas are illustrated on Figure 6. There are five locations in Casco Bay where large numbers of migrating shorebirds congregate to feed (Figure 7). Three locations are near downtown Portland, two in the Fore River Estuary and one in Back Bay (also known as Back Cove). The two other feeding locations are in the upper reaches of Casco Bay, Maquoit and Middle Bays in Brunswick. The most popular feeding area is Back Bay where up to 5000 semipalmated plovers, black-bellied plovers, ruddy turnstones, yellowlegs, least sandpipers, dunlins, short-billed dowichers and semipalmated sandpipers congregate to feed. The other four locations attract fewer birds (500-2500) and represent fewer of the species found in Back Bay.

A few species of shorebirds such as dunlins, sanderlings and ruddy turnstones may sometimes winter along the southern Maine coast, which includes Casco Bay. The purple sandpiper regularly winters along the Maine coast; however, its principal wintering grounds are in eastern coastal Maine.

Figures 5, 6, 7, and 8

FIGURE 5
AREAS OF CONSISTENT USE BY LOONS AND GREBES

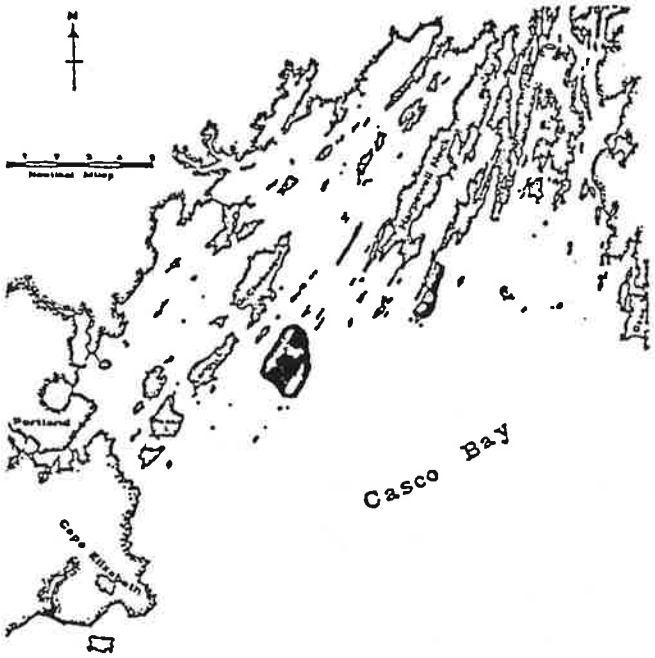


FIGURE 6
SHOREBIRD FEEDING AREAS

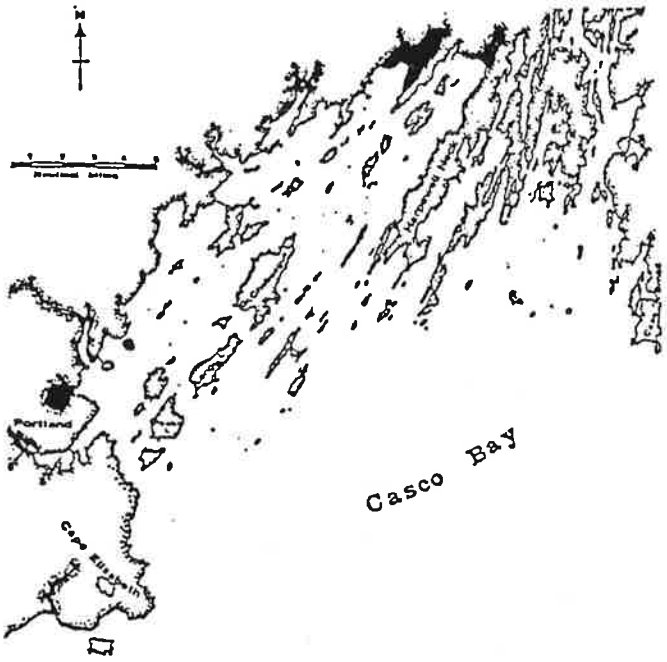
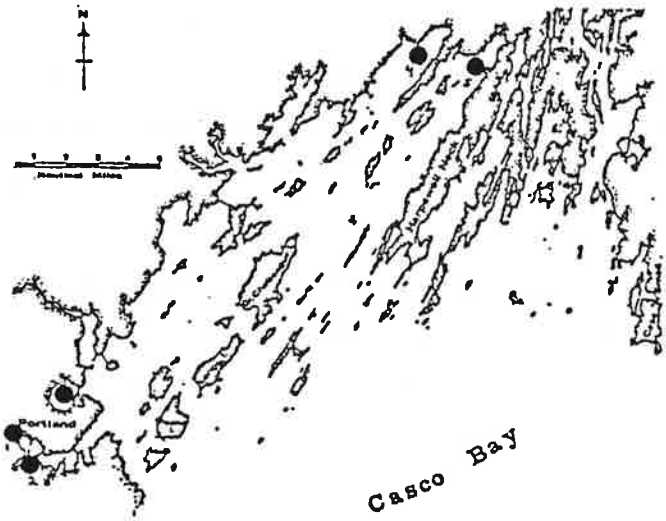


FIGURE 7
AREAS OF CONCENTRATED USE BY MIGRATING SHOREBIRDS



Site 1 1001-2500 black-bellied plovers and semipalmated sandpipers

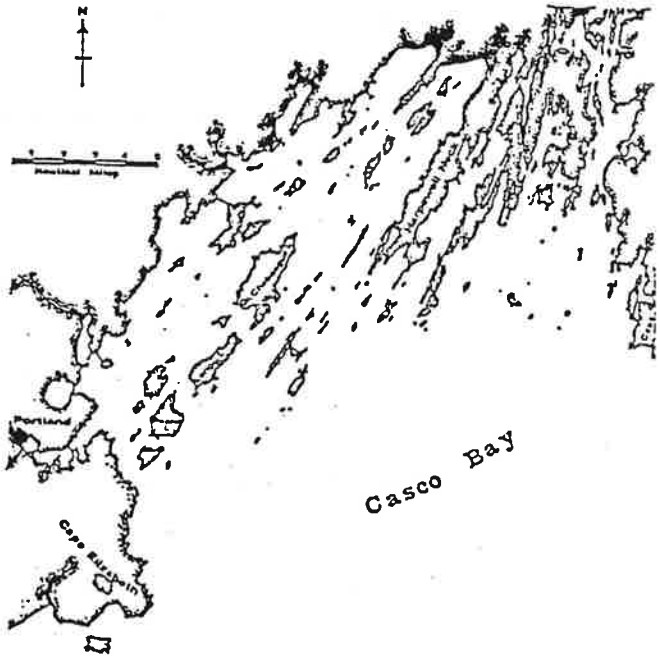
Site 2 501-1000 black-bellied plovers, yellowlegs and short-billed dowitchers

Site 3 2501-5000 semipalmated plovers, black-bellied plovers, ruddy turnstones, yellowlegs, least sandpipers, dunlins, short-billed dowitchers and semipalmated sandpipers

Site 4 1001-2500 semipalmated plovers, black-bellied plovers, and yellowlegs

Site 5 501-1000 semipalmated plovers and black-bellied plovers

FIGURE 8
PRINCIPAL HERON FEEDING AREAS



Wading Birds

Wading birds include the herons, egrets, bitterns and ibises. Four species of wading birds are commonly found in Casco Bay in the summer. They include the great blue heron, the snowy egret, the black-crowned night heron and the glossy ibis. Three islands in Casco Bay are used by breeding colonies of wading birds (Figure 4). One of these, Upper Goose Island, contains the largest number of nesting great blue herons in Maine. A 1975 coastal wading bird survey found that Maine has the only great blue heron nests in New England.

One island just south of Casco Bay is used by 300 pairs of snowy egrets, glossy ibises and black-crowned night herons. Southern Maine, south of Casco Bay, is the northern limit for the little blue heron, Louisiana heron and the glossy ibis; however, their limit of breeding is extending northward. Maine is also the northern limit for breeding by snowy egrets.

The wetlands and numerous intertidal and shallow subtidal flats found in Casco Bay provide excellent feeding habitats for the wading birds. Areas which are heavily used for feeding by wading birds are shown in Figure 8.

Waterfowl

Casco Bay supports one of the most important winter waterfowl populations on the Maine coast. American and king eiders; black ducks; mallards; common and Barrow's goldeneyes; buffle-heads; greater scaups; white-wing, surf and black scoters; old squaws; red-breasted and common mergansers; harlequin ducks; brant; green-winged and blue-winged teal and Canada and snow geese are found commonly in Casco Bay. American eiders are the most common waterfowl in the bay. Larger numbers of eiders, goldeneyes, black ducks and buffle-heads winter in Casco Bay than in other regions of coastal Maine because of the abundance of waterfowl food present. Back Cove in Portland is an important winter feeding area for black ducks. The extensive tidal flats (Figure 9), mussel bars and eelgrass beds provide the winter food supply for these birds. The ledges and bars around and near the outer islands provide important ice-free wintering areas for eiders, scoters and old squaws. These areas also are used by migratory brant in the spring.

Forty five islands support an estimated 3000 pairs of breeding eiders. A number of islands are considered significant for breeding because of the numbers of breeding pairs (Figure 4). Black ducks, mallards and teal also may nest in small numbers in the Casco Bay area.

Raptors

Until the 1960's, the endangered bald eagle nested in Casco Bay (Map 10). No nesting has been observed in the bay since that time. In the winter, bald eagles have been reported in Casco Bay. An estimated 50 pair of ospreys nest in Casco Bay, principally in the northern part of the bay (Figure 10). The endangered Peregrine falcon has been sighted during migration in Casco Bay. Peregrine falcons were hacked on a building in Portland for two years in an attempt to establish nesting in the area. To date the young have not returned to their nesting location; however, the possibility of return still exists.

Marine Mammals

The harbor seal is the principal seal found in Casco Bay. However, there have been sitings of gray seals in the bay. An estimated 400-500 seals live year round in Casco Bay where numerous areas are suitable as seal haulouts. Suitable haulouts are either small islands without terrestrial vegetation which have some areas exposed at high tide or half-tide ledges which are under water at high tide. Other factors which make sites suitable for haulouts include gentle slopes to the ledge, dense seaweed cover and deep water around the site for a quick escape, even at low tide. Haulouts are critical to the life of seals because they are used for resting, sunning, feeding, breeding, bearing their young and socializing. Seals tend to use haulouts exposed to wind and wave action for feeding and socializing and more sheltered haulouts during moulting, mating and bearing their young. The numerous ledges in Casco Bay provide both types of haulouts. The seal haulouts located in Casco Bay are shown on Figure 11. The group size at the haulouts varied from one to greater than 100, with a mean of 31 seals.

Whales are principally found migrating through the waters off Casco Bay. Sitings in the Casco Bay area include the endangered humpbacked whale, the killer whale, the beluga and a sperm whale. Harbor porpoises migrate into Casco Bay in the summer. The common dolphin and the striped dolphin also have been found in Casco Bay.

Seals and most whales eat large amounts of fish. It has been estimated that seals consume 2500-3000 pounds of fish each year. The basic diet for most of the year for seals is flounder and hake, two common fish found in Casco Bay.

Figures 9, 10, and 11

WINTERING WATERFOWL INVENTORY RESULTS
FOR CASCO BAY, 1976-1980
(Spencer, et al., 1980)

Year	Black Duck	Mallard	Goldeneye	Bufflehead	Scaup	Scoters	Eiders	Old Squaw	Merganser	Unid. Ducks	Geese	Total
1976	3,282	34	2,928	573	265	284	7,815	239	3,111	1,043	241	19,617
1977	2,279	27	2,080	896	325	67	12,772	256	1,687	586	90	21,045
1978	4,219	39	2,409	1,055	253	395	12,846	569	2,345	648	180	25,080
1979	2,435	8	862	782	60	35	13,841	51	1,931	494	155	20,654
1980	1,906	175	3,199	1,137	105	315	14,986	632	2,376	494	218	25,435

FIGURE 9
TIDAL FLATS IMPORTANT TO WATERFOWL

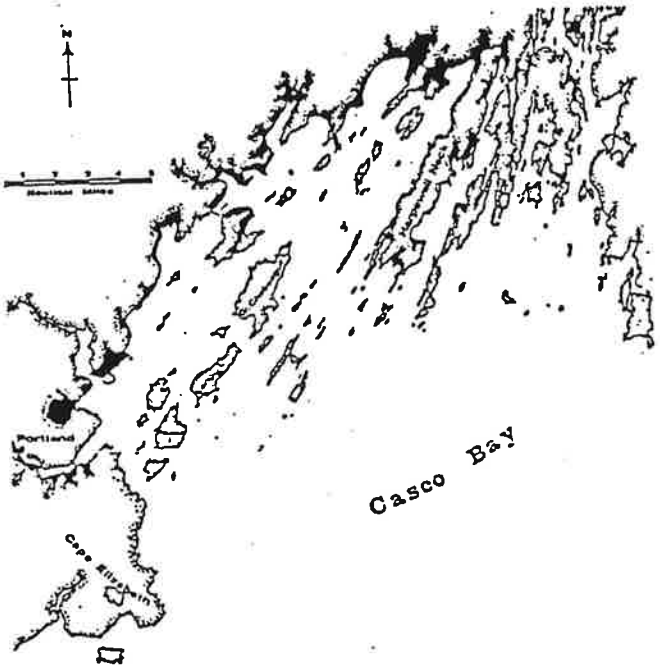


FIGURE 10
OSPREY NESTING TERRITORY (DOTS) AND
FORMER EAGLE NESTING TERRITORY
(TRIANGLE)

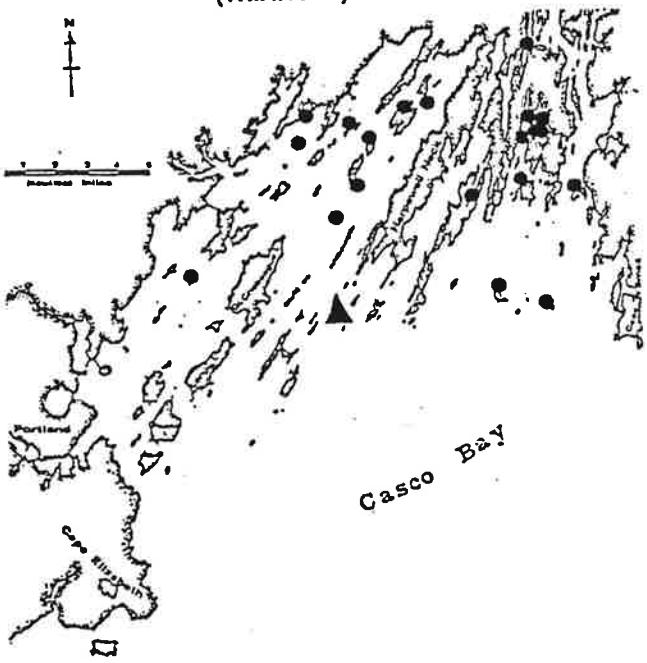
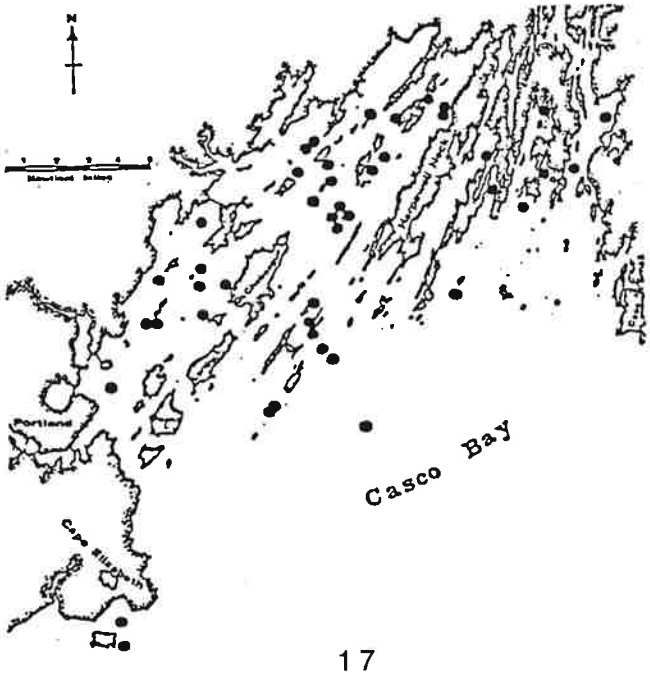


FIGURE 11
SEAL HAULOUTS



What is geographic scope of Casco Bay?

Casco Bay, Maine lies within the Gulf of Maine in the National Estuary Program's Biogeographic Province A, North of Cape Cod (Figure 1). It encompasses about 150 square miles of water between Cape Elizabeth on the west to Small Point on the east and 250 miles of shoreline (Table 3). Casco Bay contains a rich assortment of natural resources and physical features which make this body of water one of the most widely used areas north of Boston. Almost 150,000 people live year round in the towns immediately abutting Casco Bay (Table 4), and at least 250,000 people live in its upland watershed.

Table 3

CHARACTERISTICS OF CASCO BAY

AREA	152	Square Miles
TIDAL VOLUME	41	Million Cubic Feet
TOTAL VOLUME OF BAY	191	Million Cubic Feet
DRAINAGE AREA	979	Square Miles
LAND USE		
Urban	140	Square Miles
Agriculture	102	Square Miles
Forest	710	Square Miles
Wetland	19	Square Miles
Other	8	Square Miles
POPULATION IN DRAINAGE	251,000	

Table 4
MUNICIPALITIES ABUTTING CASCO BAY

MUNICIPALITY	1986 POPULATION
BRUNSWICK	18701
CAPE ELIZABETH	8094
CUMBERLAND	5267
FALMOUTH	6661
FREEPORT	6332
HARPSWELL	4066
PHIPPSBURG	1672
PORTLAND	61919
SO. PORTLAND	22782
YARMOUTH	7472
BATH	10100
WEST BATH	1449
TOTAL	**154,515**

Three major rivers drain into Casco Bay, the Presumpscot, Royal, and Fore. The largest river is the Presumpscot which has a drainage area of 647 square miles. The Presumpscot receives the municipal wastes of the city of Westbrook (pop. 15,543) as well as industrial wastes from S.D. Warren Paper Company, a kraft process pulp and paper mill. The Royal, draining 143 square miles, drains mostly forest and agricultural lands. Recently, however, development pressure has increased significantly within its drainage and especially along its shores. With that development, siltation and bacterial contamination has resulted. The Fore River (drainage area 54 square miles) is actually a short reach formed by the confluence of the Stroudwater River and several smaller streams draining th urban portion of Portland and South Portland. In addition to receiving the city of South Portland's wastes, it receives virtually all the stormwater from Portland, South Portland, and parts of Scarboro, Buxton, Gorham, and Westbrook. The Stroudwater has also historically received an illegal heavy metal discharge.

Back Bay (Back Cove) is a shallow cove adjacent to downtown Portland. Refuse has been placed on its shores for decades; to the extent that the original cove is mostly filled in. The cove has been the recipient of much of Portland's sewage until the late 1970's. Eighteen combined

sewer overflows or CSOs still discharge into its waters. The snow dump for Portland is on its shores. The cove is circled by roads including Interstate 295. Leaching from old dumps, CSOs, runoff from the snow dump and the highways surrounding its shores make this cove a potential candidate for toxic pollutant accumulation. Increases in toxic pollutants in this cove are a particular problem because hundreds of migrating gulls and thousands of migrating shorebirds use the cove as a feeding area. Also, Back Bay is an important winter feeding area for black ducks.

NEED FOR A CONFERENCE

A management conference on Casco Bay is needed because of the diversity and complicated nature of the bay's environmental problems and the necessity of coordinating the interested parties affected by management of those problems. Based on the level of interest and public participation experienced thus far, it is clear that developing and then implementing a protection plan for the bay will require further extensive public education and participation.

What is the importance of Casco Bay on a local scale?

QUALITY OF LIFE

In *The People of Maine, A Study in Values* (Market Decisions, Inc., 1989), polling results revealed that 81.1% of Maine people agreed with the following statement.

"The natural beauty of Maine should be preserved even if it means spending more public money or interfering with private investment decisions."

Maine people have sent a strong and clear statement that economics is not their only measure of "quality of life." Attempting to place a dollar figure on access to open space, clean water, and opportunity to observe wildlife is probably not only an impossible task but an undesirable one.

The presence of a healthy Casco Bay determines in large part the quality of life for the people in Maine. Large corporations have selected this part of Maine in part due to its environmental setting. Although much of this business activity is not directly dependent on clean water (ie. shipping and industry), the quality of life which attracts professionals, business development, and tourism is. From there, economic opportunities arise.

ECONOMIC RESOURCES

Not only is the economy of the Casco Bay area heavily dependent on the bay as a resource, but much of the economy of Maine is dependent on the Casco Bay region. It contains the State's largest city and center of business and industry, the State's largest shipping port, and the

Portland Fish Exchange (only fish auction north of Boston). While dollar figures present only a small picture of the value of a clean Casco Bay, they nevertheless provide a piece.

Recreation and Tourism

The economy of the Casco Bay region is more service based than industry based. An especially important component of the service sector is recreation and tourism. During the summer, Casco Bay is both a destination resort and stopover point for both land and water based tourism. Sportfishing party boats, sightseeing tours, a tuna fishing tournament, yacht races, whale watching cruises, swimming and boating draw people from away as well as from the local population. According to the Maine State Planning Office, about 22% of total tourist expenditures is on lodging which may be used to arrive at an estimate of the total economic activity generated by tourism in the area. In 1988, lodging sales were almost $52 million which translates into about $236 million in total sales generated by tourists.

ESTIMATED VALUE OF TOURISM IN THE CASCO BAY REGION

Portland Lodging Sales	$34,663,000
Suburban Portland Lodging Sales	$8,721,000
Brunswick Lodging Sales	$8,563,000
Total Lodging Sales	$51,947,000
Total Tourist Sales (Total / 0.22)	**$236,122,727**

Source: Maine State Planning Office

Commercial and Recreational Fisheries

The commercial fisheries of Casco Bay remains an important resource to the local economy. Not only does it provide the livelihood for many families in the area it also provides recreational value. Table 5 shows the distribution of license types and landings reported in the Casco Bay area.

Table 5

LICENSED HARVESTERS IN CASCO BAY

1988

Type	Number
Lobster	6,811
Shellfish	2,508
Worm	795
Mussels	120
Commercial	1,386
Scallop	1,762
Sea Weed	107
Total	13,489

1988 LANDINGS* VIA CASCO BAY

Groundfish

Pounds	32,840,223
Landed Value	$18,967,931
Estimated Market Value	$56,093,793

Shellfish (including lobsters)

Pounds	16,484,171
Landed Value	$21,821,006
Estimated Market Value	$65,463,018

Total

Pounds	49,324,394
Landed Value	$40,788,937
Estimated Market Value	$122,366,811

Source: Maine Department of Marine Resources

*Landings via Casco Bay actually reflect catches from all over the Gulf of Maine and not solely from Casco Bay. Groundfish are primarily caught offshore, not within the bounds of Casco Bay and landed some distance from where they were caught the principal finfish fishery in Casco Bay is herring. Shellfish, on the other hand, are landed closer to their point of harvest so that the landings reported here may be a more accurate reflection of the Casco Bay shellfish resource.

The specific information on commercial and recreational marine resources described below is from Card et al. (1981) and the US Fish and Wildlife Service (1980).

Lobsters

Nationally, lobsters are associated with Maine. Casco Bay has ideal habitat for this most important commercially fished species. During the summer months, lobsters prefer ledge and rocky bottoms near rocky shores and islands. They also prefer high salinity waters. Casco Bay; with its hundreds of islands, rocky bottoms and shores, and high salinity waters; provides all the preferred habitat requirements for lobsters. Thousands and thousands of lobster traps are found throughout Casco Bay. An estimated 20% of Maine lobsters are landed in Cumberland County (the county surrounding Casco Bay). The lobster season is from April to November, with the peak fishing from August to October.

Clams and Marine Worms

Casco Bay also provides perfect habitat for clams (Figure 12) and marine worms (Figure 13). In Maine, clams live in intertidal mud flats. Worms live both intertidally and subtidally; however, commercial sizes and quantities are intertidal. Commercially harvested marine worms include sandworms and bloodworms. Sandworms are the principal marine worm found in Casco Bay and are sold for bait along the east coast of the United States.

Because clams are eaten by man, Maine's Department of Marine Resources monitors the flats for fecal coliform and buildup of biological toxins such as those induced by red tides. Eleven percent of the flats in Casco Bay are closed because of bacterial contamination (Table 6). Also, flats are often temporarily closed due to unacceptable levels of biological toxins.

Table 6

SHELLFISH ACREAGE 1988

Total Acreage	138,783
Acres Closed	15,557
Acres Open	123,226
Percent Closed	11

Source: Maine Department of Marine Resources

Figures 12 and 13

FIGURE 12
COMMERCIAL CLAM FLATS

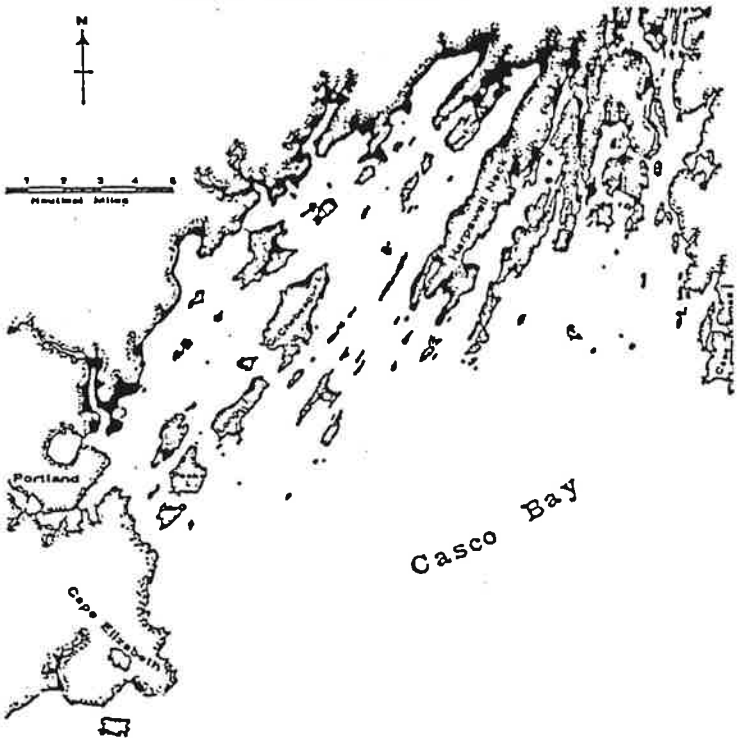
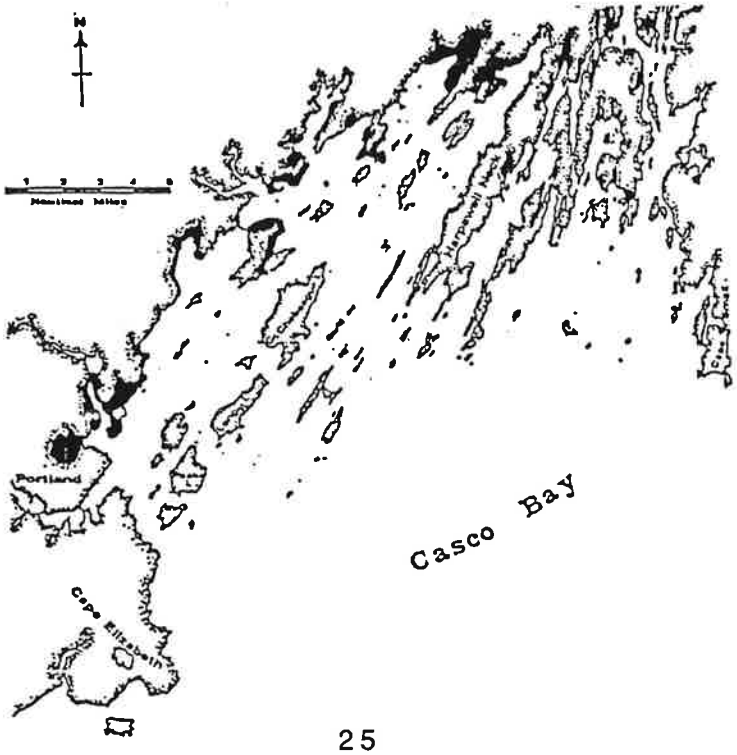


FIGURE 13
COMMERCIAL WORM HARVESTING AREAS



The most recent inventory on Casco Bay softshelled clam flats was in 1979 (Card et al. 1981). At that time there were about 1,700 acres of commercially productive softshell clam flats open to digging. Average production was 79 bushels per acre. At today's restaurant value of $150/bu., the Casco Bay softshell clam industry is valued at over $20 million dollars.

The large expanses of mud flats in the numerous coves in northern Casco Bay are ideal for clam and worm growth and development. However, to keep a sustained harvest, seed or juvenile clams are transplanted from flats where they are over-abundant to flats where the clam densities are low. Seed clams taken from around Crow Island in Casco Bay has provided the bulk of clams for the Regional Shellfish Commission's softshell clam transplanting program.

Clam and worm harvesting activities can be disruptive to other intertidal invertebrates. Also, these activities may destroy eelgrass beds on which waterfowl, particularly black ducks, feed.

Crabs

One-quarter of Maine's crab landings are from the Casco Bay area. Primary crabbing areas in Casco Bay are shown on Figure 14. Crabs are fished from mid-April through October, with a peak in May and a secondary but smaller peak from September through October. Most of the crabs are caught incidentally to lobsters; however, there are four to six full time crabbers.

Mussels

Mussels are abundant throughout Casco Bay in the intertidal and shallow subtidal areas. They are particularly abundant and grow to marketable size quickly in areas which have good circulation of water. The mussel harvest is principally in the winter, from October through April, when the threat of contamination by biological toxins is low. Mussels are harvested either by dragging with a modified scallop drag or by pitching them into skiffs by hand. Dragging is the principal method used in Casco Bay. In the northern reaches of Casco Bay, an estimated 200,000 bushels of mussels have been harvested by dragging. Dragging and washing activities stir up the sediments and have the potential to reintroduce buried contaminants and nutrients into the water column where they are then available to the food chain. Excessive sedimentation also has the potential to destroy the eelgrass beds present in the coves of upper Casco Bay.

Figures 14 and 15

FIGURE 14
PRIMARY CRABBING AREAS

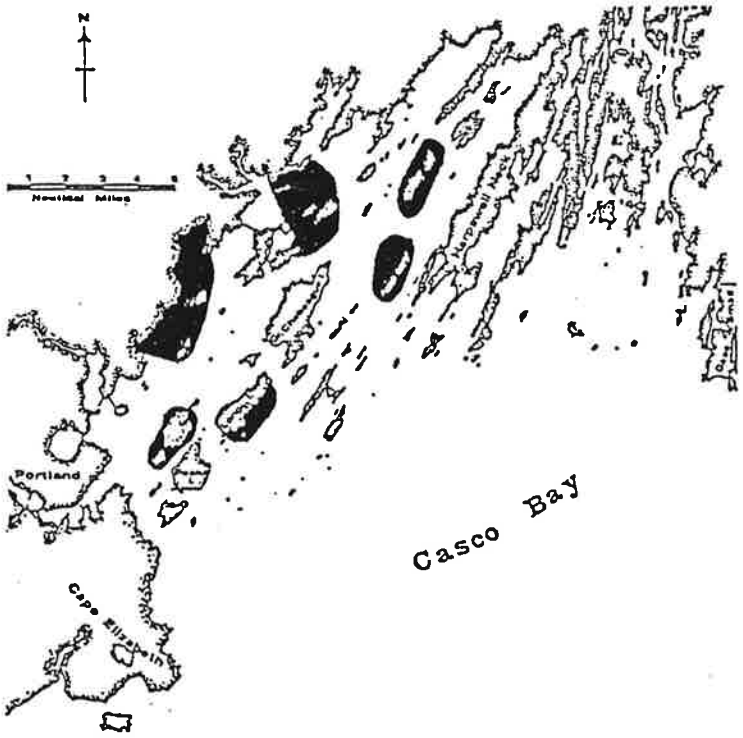
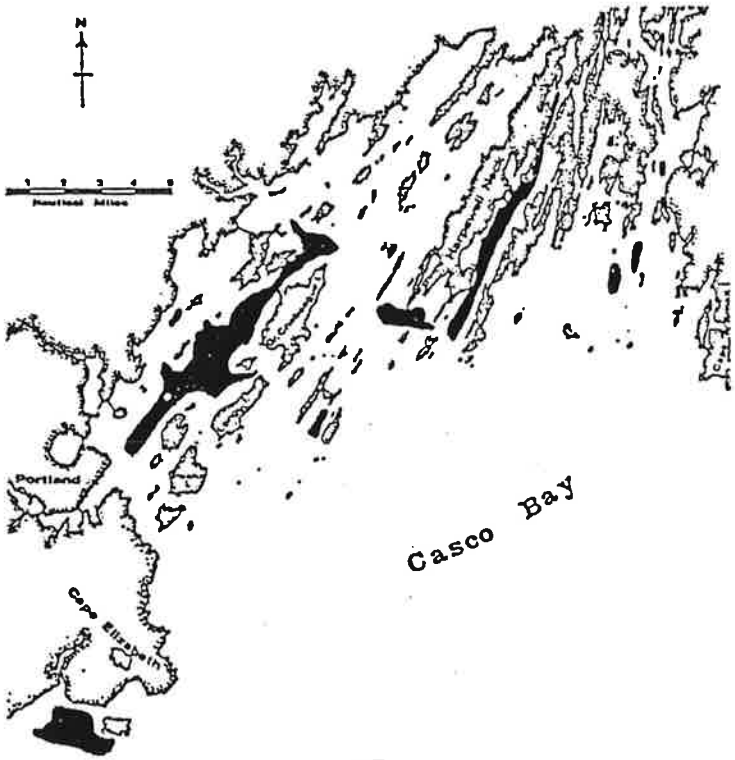


FIGURE 15
SCALLOP BEDS



Mussels have been used as indicators of toxic pollution. Results of recent tissue testing in Casco Bay indicate that there exists isolated areas of heavy metal (lead, mercury, and zinc) build up in blue mussels. These areas lie within the 11% of Casco Bay already closed to harvest due to bacterial pollution.

Scallops

There is a limited scallop fishery in Casco Bay. Scallops live in beds (Figure 15) or groups and their populations vary dramatically from year to year. Four percent of Maine's landings come from the Casco Bay area. The majority of scalloping is done by lobstermen who convert to scallop dragging in winter during the slack time for lobster fishing . The scalloping season is regulated by state law and extends from November 1 to April 15. Recreational scallopers also harvest scallops by diving for them in Casco Bay. The process of harvesting for scallops with a dredge is very disruptive to the marine benthic invertebrates. However, disturbing the coarser sediments on which scallops live would introduce less contamination than disturbing the fine-grained sediments on which mussels live.

Fish

Herring and menhaden (pogies) are schooling fish which are fished commercially in Casco Bay. Herring catches in the bay have varied annually from none to over 100,000 bushels. Menhaden catches have also been variable. Schools of herring also are followed and heavily preyed upon by seals and whales. Menhaden are heavily preyed upon by bluefish, which is a recreational sportfish.

Thirty-six species of finfish are commonly found in Casco Bay. The most common species found year round in the bay is the winter flounder. Atlantic herring is a common summer resident in the bay. Anadromous species include the alewife, blueback herring, American eel, rainbow smelt. Striped bass, bluefish, mackerel, flounder, cod, haddock, pollock and bluefin tuna are fished recreationally in Casco Bay.

The numerous shallow protected coves in Casco Bay provide perfect spawning areas for fish (e.g. sculpins, winter flounder, rock gunnel, tomcod and skates) which deposit eggs on the bottom.

Demersal fish sampled in Casco Bay by Department of Marine Resources are listed in Table 7. A finfish study by Central Maine Power Company also reported: Atlantic menhaden, Atlantic herring, blueback herring, spiny dogfish, rainbow smelt, bluefish, wrymouth, Atlantic tom cod, lumpfish, cunner and spotted hake.

Table 7
DEMERSAL FISH IN CASCO BAY

Flounder	Skates
Windowpane	Winter Skate
Yellowtail flounder	Thorny skate
Winter flounder (Blackback)	Little skate
American plaice (Dab)	Prickly skate
Witch flounder (Gray sole)	
	Sculpins
Gadids	Shorthorn sculpin
Atlantic cod	Longhorn sculpin
Haddock	Sea Raven
Silver hake (Whiting)	
White hake	Others
Red hake	Ocean pout
Pollock	Snake blenny
Four beard rockling	Goosefish
	Alewife
	Butterfish

In Casco Bay, recreational fishing is another important aspect of the recreational value of the bay. Species such as mackerel, pollock, flounder, haddock, cod, bluefish, stripped bass, and bluefin tuna are commonly sought. An estimate of this clean water dependent use is present below.

RECREATIONAL FISHING

Estimated Number of Recreational Fishermen (1985)	78,150
Estimated Value of Industry	$5,000,000

Source: Maine Department of Marine Resources

What are the major environmental problems facing Casco Bay and what are their most likely causes?

ENVIRONMENTAL PROBLEMS AND PROBABLE CAUSES

Until the mid-1980's, the general perception of Casco Bay was that it was pristine. Its location, remote from the rest of the industrialized east coast, appeared to assure its protection. In 1984, however, Larsen et al. (1983a) reported that sediments in Casco Bay were laden with various pollutants, including heavy metals, PCBs, and PAHs. Then in 1988, NOAA released results from their Long Term Status and Trends Program (NOAA, 1988). In several categories, Casco Bay ranked among the most polluted sites in NOAA's nationwide program. A listing of those pollutants of concern is presented in Table 8 below.

Table 8
POLLUTANTS IDENTIFIED
IN DIFFERENT MATRICES OF CASCO BAY

WATER COLUMN	SEDIMENTS	MUSSELS	WINTER FLOUNDER LIVERS
BACTERIA	CHROMIUM	LEAD	COPPER
	COPPER	PAHs	LEAD
	LEAD		SILVER
	NICKEL		ZINC
	ZINC		PCBs
	PAHs		
	PCBs		
	PESTICIDES		

Of these, several contaminants have potential serious ecological and/or human implications and emanate from both point and non-point sources. The following discussion of these pollutants is excerpted from ***AGENDA FOR ACTION*** (M.D.E.P., 1989) A more detailed report on the environmental health is included in ***TROUBLED WATERS*** (Hauge, 1988) (Appendix 2).

BACTERIA

The Problem

Bacterial pollution is probably the form of pollution in Casco Bay evoking most public response yet ironically has one of the least significant ecological impacts. Presence of human bacterial pollution is important, however, in that it is an indication that human pathogens, including viruses, could be present. Contact with pathogens through ingestion of water, food, or swimming may result in illness. Detecting pathogens in water is far less likely than detecting other more abundant bacteria associated with those pathogens. For this reason, the Food and Drug Administration and the State of Maine have water quality standards based on indicator organisms which are not generally considered pathogenic. When the standards are exceeded, uses such as shellfish harvesting or swimming, are either banned completely or greatly restricted. In either case, the result is an impairment of that water body and loss of use to the population.

Frequently associated with that impairment is the cost to former users as well as a loss of revenues by the fishing and tourism related industries. Although Maine law expressly prohibits discharges which results in closure of shellfish areas or cause unacceptable risks to swimmers, closures and violations of standards are in fact common. The Maine Department of Marine Resources estimates that 11% of the area of shellfish flats in Casco Bay is closed due to pollution.

During the summer of 1988, the Maine Department of Environmental Protection monitored 8 areas around Greater Portland for Enterococci, the swimming standard indicator organism, and found that 7 of the 8 areas exceeded swimming standards at least once during the summer. Included in this sampling was East End Beach, Portland's single public beach.

Probable Causes

Assessment of bacterial pollution is extremely complicated since it derives from many sources, both man made and natural, and the indicator organisms are less than ideal. For example, Klebsiella sp. is a bacterium which digests cellulose. It is abundant in pulp and paper wastewater treatment plants and considered part of the treatment process. Klebsiella sp.is also one of the organisms included in the total and fecal coliform test used for shellfish testing yet closures do not take this into account. The policy is one of erring on the side of safety which is appropriate but at the same time somewhat misleading in terms of describing environmental quality.

1-Sewage Treatment Plants

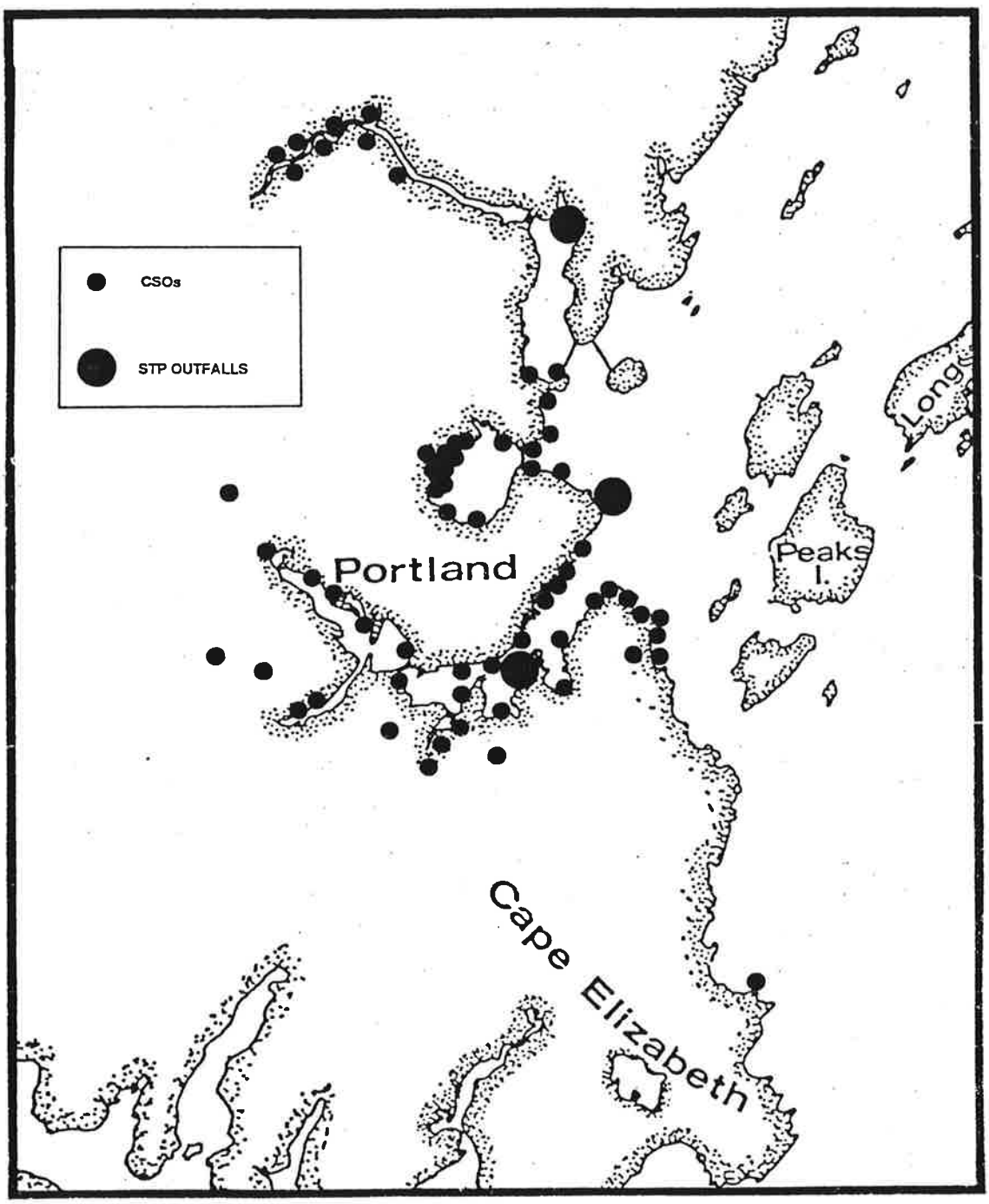
Within Casco Bay are 7 municipal sewage treatment plants licensed to discharge a cumulative volume of 35 million gallons/day (Figure 16). To date, about $100 million has been spent for treatment plant construction and another $6 million is projected to be spent in the near future. Performance of these, and for that matter any treatment plant, is less than perfect. For example, the City of Portland's treatment plant exceeded its license limit about 50% of the time it was sampled during 1987 and 1988. In some areas, such as Boston, this is a result of the user population outgrowing the plant's capacity. In Casco Bay, this is not the case. All sewage treatment plants have been recently built or rebuilt to meet the demands of the population served. While the normal daily discharge quality can be greatly improved through enforcement of license conditions, improvements in Casco Bay will probably not be noticed until the many other sources of bacteria are controlled. Several of these sources follow.

2-Combined Sewer Overflows

Before sewage treatment plants, Greater Portland's waste stream ran directly into storm sewers and then directly into Casco Bay. To reduce construction costs, those sewers were intercepted and directed to the new treatment facilities. Since sewage treatment plants are "sized" to efficiently treat waste flows from a certain size population, an increase in flow beyond design capacity results in an overloading or flushing out of the plant. To avoid this, combined sewer and storm water systems are engineered to bypass excess water around the treatment plant to preserve design flows. The result is a release of untreated wastewater into downstream waters, in this case Casco Bay. Each time it rains and when snow is melting, an unknown quantity of street runoff and raw sewage flows into Casco Bay through some or all of the 75 combined sewer overflows located around the bay (Figure16). With the overflow water is the domestic waste of a large part of Greater Portland. Combined sewer overflows are very likely the largest source of bacteria to Casco Bay since untreated sewage contains many orders of magnitude greater numbers of bacteria than those found in routine discharge violations. Combined sewer overflows probably explain the violations of bacteria standards in most of the 7 areas tested in 1988, including East End Beach which is immediately adjacent to a combined sewer overflow discharge point.

Figure 16

COMBINED SEWER OVERFLOW AND MUNICIPAL SEWAGE TREATMENT PLANT OUTFALLS IN INNER CASCO BAY



3-Single Family Overboard Discharges

Around Casco Bay are about 350 single family sewage systems each licensed to discharge about 300 gallons of sewage per day. Single family overboard discharges were allowed in the past (principally in the upper bay) due to the impracticality of connecting to a distant sewer and with the understanding that the discharge would be adequately disinfected. Maine Department of Environmental Protection data indicate that most private systems are not properly maintained and result in a discharge of human bacteria to state waters resulting in the closure of shellfish beds and localized violations of swimming standards. In 1987, the Maine Legislature prohibited the construction and use of new overboard discharge systems and required the gradual phaseout of some existing systems. The exact contribution of overboard discharges to the overall problem is not known, however, it is likely that they result in an expansion of the zone of impact due to their wide spread distribution.

4-Boating

Casco Bay is home to about 5000 boats (Table 9). Only three pumpout facilities exist to serve them. The impact of these boats has never been quantified, however, the potential for localized contamination and ecosystem effect is real. While federal law requires that holding tanks be used, it is generally accepted that few boaters actually use them. In areas where boats are concentrated near shellfish areas such as in the Harraseekett and Royal River, boating may well be the source of sufficient bacteria to at least partially explain closure of those shellfish harvest areas.

Table 9

RECREATIONAL BOAT USE OF WESTERN CASCO BAY

	NO. MOORINGS	NO. SLIPS	LAUNCH USE (weekly)	PUMPOUTS
SOUTH PORTLAND and PORTLAND	1000	1500	≈220	≈1
FALMOUTH	1000	No Data	≈100	0
YARMOUTH	160	334	≈200	1
FREEPORT	485	95	No Data	2

5-Stormwater Runoff

Storm and melt water runoff contain bacteria from many different sources. Malfunctioning and illegal domestic waste systems, spills of sanitary wastes, animal feces, and sewer backups all contribute to bacterial contamination. Portland Harbor is particularly susceptible to runoff pollution because of the concentration of human activities within the watershed and great abundance of pavement that prevents runoff from soaking into soils where the bacteria are held. Some studies (Field, R. and A. Tafuri, 1973) suggest that the bacteria concentration in storm water runoff is equivalent to that found in raw sewage.

TOXICS

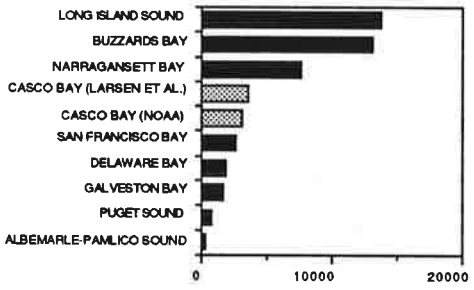
The Problem

Of a more serious ecological nature than bacteria is the threat of pollution by toxic materials such as heavy metals, chlorine, PCBs, PAHs, pesticides, dioxin and other organic compounds. Heavy metal concentrations in Casco Bay sediments are relatively high compared to those in other National Estuary Program estuaries (Figure 17). **Lead** is now known to be far more dangerous to human health than formerly thought. In the human, for example, it causes brain damage and nervous disorders. EPA recently lowered the lead standard in drinking water from 50 to 20 µg/l in recognition of its toxicity. While Casco Bay's water is not used for drinking, lead has been found in the food chain. In fact, flounder livers collected from Casco Bay contained the highest level of lead of any in a national survey (NOAA,1987a). **PAHs** (polynuclear aromatic hydrocarbons) are a group of fossil fuel compounds which include the known carcinogen benzo-a-pyrene. Larsen's work showed that levels in Casco Bay sediments were high, primarily around oil handling facilities (Figure 18). **PCBs** (polychlorinated biphenyls), known to be carcinogenic, were also found by Larsen and NOAA in Portland Harbor sediments and NOAA found that flounder livers collected in outer Casco Bay were also contaminated with PCBs. **Copper, zinc, and silver** also were found in relatively high concentrations in NOAA's flounder liver survey (Figure 19). While at levels below those of human health concern, these materials can nevertheless be extremely toxic to marine life causing ecological stress in the form of community structure disturbance and reduction in growth and reproduction at the species level. Unlike man, waterfowl, gulls, seals and whales feeding on fish eat the whole fish including the liver.

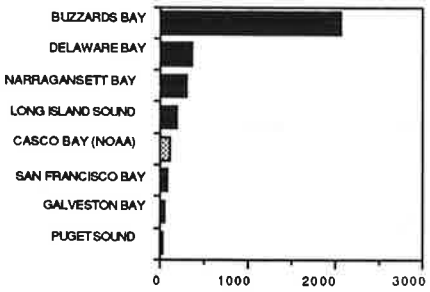
Figure 17

CONCENTRATIONS OF VARIOUS POLLUTANTS IN CASCO BAY SEDIMENTS IN RELATION TO OTHER ESTUARIES

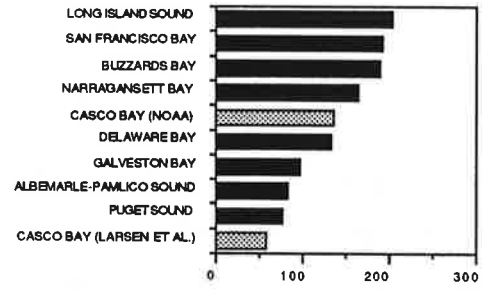
TOTAL PAHs REPORTED IN SEDIMENTS FROM VARIOUS NEP ESTUARIES



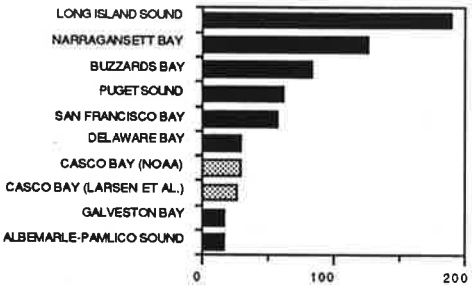
TOTAL PCBs REPORTED IN SEDIMENTS FROM VARIOUS NEP ESTUARIES



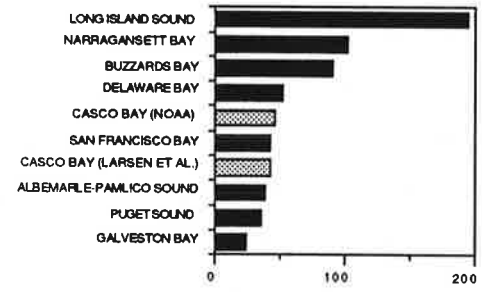
TOTAL Cr REPORTED IN SEDIMENTS FROM VARIOUS NEP ESTUARIES



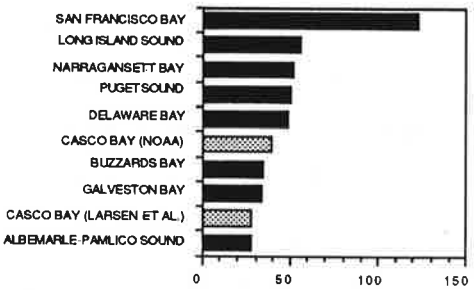
TOTAL Cu REPORTED IN SEDIMENTS FROM VARIOUS NEP ESTUARIES



TOTAL Pb REPORTED IN SEDIMENTS FROM VARIOUS NEP ESTUARIES



TOTAL Ni REPORTED IN SEDIMENTS FROM VARIOUS NEP ESTUARIES



TOTAL Zn REPORTED IN SEDIMENTS FROM VARIOUS NEP ESTUARIES

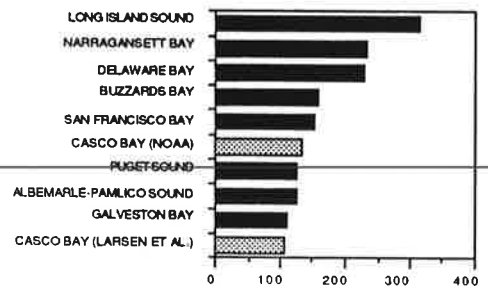


Figure 18

POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATIONS IN CASCO BAY SEDIMENTS AND OIL TRANSFER FACILITIES

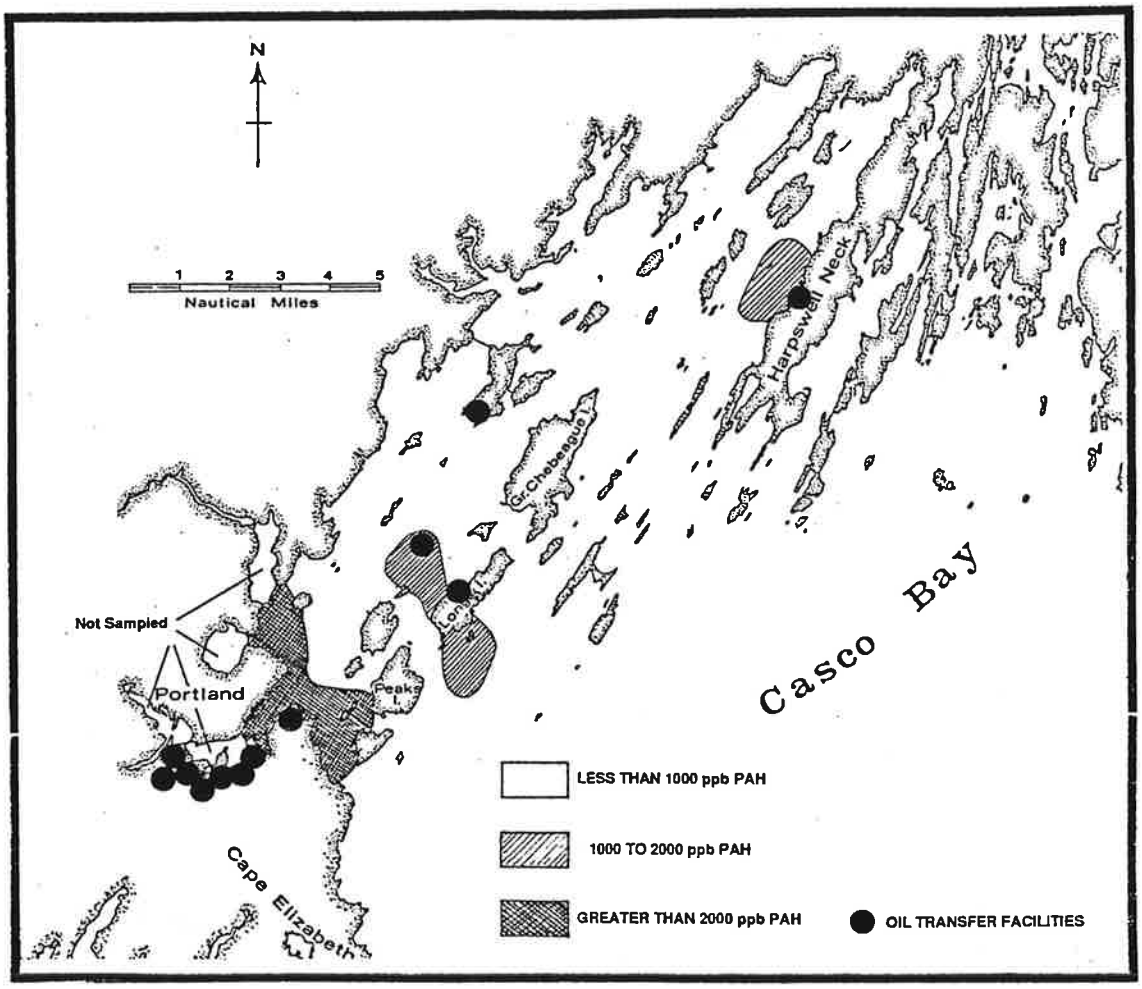
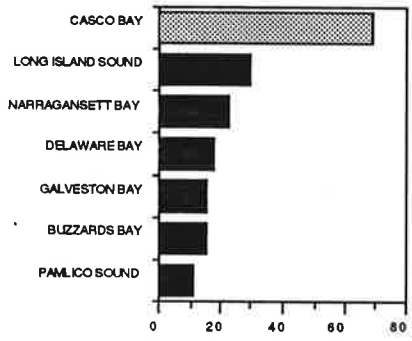


Figure 19

CONCENTRATION OF VARIOUS HEAVY METALS IN CASCO BAY FISH LIVERS IN COMPARISON TO OTHER N.E.P. ESTUARIES

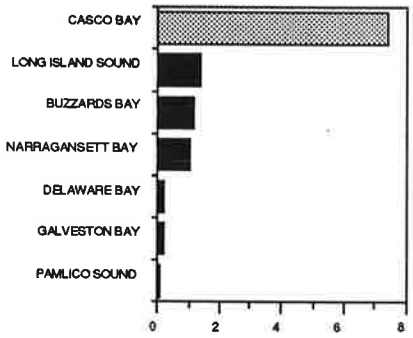
CONCENTRATIONS OF COPPER IN FISH LIVER

FROM VARIOUS NEP ESTUARIES



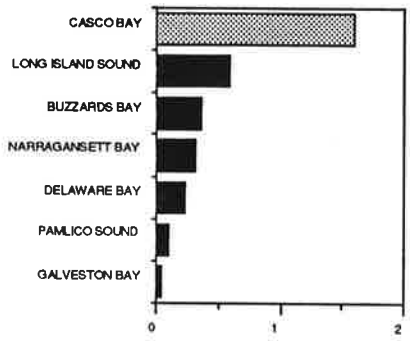
CONCENTRATION OF LEAD IN FISH LIVERS

FROM VARIOUS NEP ESTUARIES



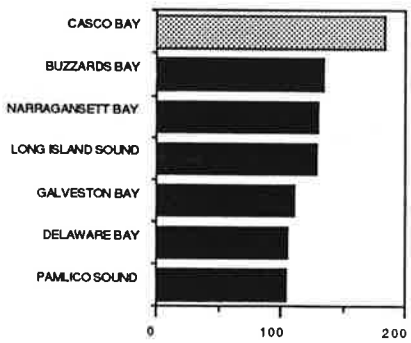
CONCENTRATION OF SILVER IN FISH LIVERS

FROM VARIOUS NEP ESTUARIES



CONCENTRATION OF ZINC IN FISH LIVERS

FROM VARIOUS NEP ESTUARIES



Eagles are high level consumers and already have felt the impact of toxic pollution. The accumulation of DDT in these birds resulted in egg shell thinning and reduced reproductive success. Five heavy metals and 13 organochlorines including dieldrin, DDT and its metabolic by products (DDE and DDD) were found in Maine eagles and their eggs. Levels were higher than reported at other locations such as Florida, Wisconsin, Alaska and Minnesota. Residues of DDE, DDD, DDT, dieldrin, and PCBs in eagle eggs sampled along the coast of Maine showed higher levels in western coastal regions (i.e. southern Maine) than in eastern coastal regions. Coastal residues also were higher than the levels found inland. Also, herring gull carcasses sampled in Maine contained elevated levels of DDE, PCBs and mercury. Residues of DDE, PCBs and mercury in merganser tissues were found to be significantly higher than in black ducks. Mergansers principally feed on fish, while black ducks feed on invertebrates. This is an example where bioaccumulation of toxics in the relatively long lived fish have been passed on to waterfowl. Toxic pollution has the potential to concentrate in high enough levels to reduce reproductive success in all waterbirds. Any loss in reproductive success could have disastrous effects on the seabird colonies which have spent years re-establishing themselves since the turn of the century.

Shorebirds are particularly susceptible to toxic pollution and habitat destruction because they concentrate in small areas which have the potential to be contaminated with toxic pollutants such as Back Bay and the Fore River in Portland. Also, stress from their long migration from their Arctic breeding areas to their South American wintering areas, makes the quality of their food and the lack of disturbance of utmost importance.

The presence of toxic materials in fish and bird tissues is of concern because it means that the material is biologically available. While the direct threat to human health through the food chain may be obvious to most people, the ecological consequences are less clear. Assessment of the seriousness of the problem is difficult, however. Few toxic materials have had "maximum safe levels" established for matrices (ie. sediments and tissues) other than water. The mere presence of lead in sediments, for example, means very little unless it can be related to biological activity. In order to place the information in any meaningful perspective, knowledge of sediment type, chemistry of overlying water, chemical form, and metabolic breakdown processes and products of the pollutant must be known. Without this understanding, one knows very little of a material's toxicity.

Probable Causes

1-Industrial Discharges

Around Casco Bay and within its watershed are several industrial discharges. The largest, S.D. Warren Company of Westbrook discharges 21.6 million gallons per day of treated pulp and paper process waste. The primary pollutant found in this discharge is carbonaceous organic matter which by itself is non-toxic. Toxic materials such as heavy metals, however, are found in the effluent. Although the concentration of toxic materials is low enough to avoid problems in the river water, because of the large volume of wastewater, the actual load delivered to Casco Bay may be significant.

Similarly, Central Maine Power Company's electric power generating facility on Cousins Island is licensed to discharge approximately 35 million gallons of cooling water each day. The concentrations of heavy metals such as copper is relatively low, however, the load may again be significant. Chlorine, a material generally accepted as beneficial because of its disinfectant qualities, is extremely toxic to aquatic and marine life.

On the Stroudwater River in Gorham, Silvex Incorporated, formerly operated a metal finishing business which contaminated groundwater. Analyses of water column chemistry in the Stroudwater above and below the site show elevated levels of heavy metals. Biological community measurements in the river also reflect a stressed environment. Prior to the State's knowledge of a problem, Larsen et al. (1983b) reported unexplained high levels of heavy metals in the estuarine portion of the Stroudwater and hypothesized an upstream anthropogenic source. Other uncontrolled industrial sources in the watershed of Casco Bay may exist.

In addition to the large industries which discharge directly to State waters, there are about 130 others which discharge indirectly through a municipal sewage treatment plant. Seven of these have wastes of sufficient quality to require pre-treatment before they are passed on to the sewage treatment plant.

Sewage treatment plants in the Casco Bay watershed are designed to remove solids, bio-chemical oxygen demand and bacteria. They are not designed to eliminate toxic materials. While much of the metals and some of the organic pollutants are removed coincidentally in the sewage treatment process, an unknown quantity passes through the facilities to Casco Bay. Monitoring of these materials has not normally been required in the dischargers license.

2-Boating

Of the 5,000 boats berthed in Casco Bay and the 500 large transient vessels per year passing through Casco Bay, virtually all use toxic materials. Bottom paints to prevent the growth of fouling organisms, sacrificial zinc anodes, red lead paints to prevent corrosion, disinfectants for holding tanks and bilges, and motor oil and gasoline or diesel fuel for motors are inadvertently released into the water. Tri-butyl tin (TBT), an effective anti-fouling ingredient of bottom paints, has been found to have severely toxic effects. In France, TBT based bottom paints were found to be directly linked to the decline of the lucrative oyster industry. France subsequently banned the use of TBT. Although TBT has recently been restricted in Maine, the effectiveness of the law is uncertain since sales continue in neighboring states. Monitoring and enforcement is virtually non-existent.

Bilge water, often contaminated with fuel, oils, and chemical cargoes, and cleansers spilled on and washed off the deck are regularly pumped into the water. No information is available on the quantity of such materials introduced into Casco Bay.

3-Petroleum Conveyance

About 80% of all petroleum products handled in Maine are handled through Casco Bay . Twelve facilities exist in the bay (Figure 18), most of which are adjacent to the Fore River. Larsen et al. (1983c) showed that PAH contaminated sediments corresponded closely with oil terminals and shipping lanes. While spill prevention and recovery procedures have improved greatly since the 1970's, spills continue to occur. The Maine Department of Environmental Protection Bureau of Oil and Hazardous Materials report that many areas of filled land adjacent to the Fore River are severely contaminated with fuel oil and coal tar due to abandoned underground storage tanks and improper closure of lagoons. Oil continues to visibly seep from ground adjacent to terminal facilities into the Fore River and Casco Bay.

4-Stormwater Runoff

Bacteria is not the only pollutant in stormwater runoff. Pesticides, heavy metals, motor oil, solvents, and other toxic compounds are abundant, especially in stormwater off urban areas such as Greater Portland. Lead in crankcase oil and burned and unburned automotive fuels, and zinc from galvanized culverts and rubber tire wear washes off highways, roads, and parking lots into storm drains and ditches leading to Casco Bay. Insecticides, herbicides, and fungicides wash off residential lawns, golf courses, and parks. Household chemicals improperly disposed of in streets or yards include a variety of toxic materials such as old paints, thinners, disinfectants, cleansers, and degreasers to name but a few. Little information exists, however, to permit environmental managers to know the relative importance of each of these non-point

sources although data from other areas of the country suggest that the contribution of pollutants through such sources equals or exceeds that from point sources.

Analysis of dredge spoils collected adjacent to activities such as boat yards, shipping terminals, and industry located on the water indicates accumulation of lead, chromium, cadmium, zinc, hydrocarbons, and other organic pollutants. Sanded and sandblasted paints, composites, and metals such as zinc, chromium, copper, and lead are presumed to contribute to local sediment pollution.

Snow dumps, such as the one on Portland's Back Bay are in effect concentrating winter stormwater in one small area. Preliminary sampling of the pile during 1988 indicates that as much as 1500 pounds of lead may be included in the pile, virtually all of which washes into Back Bay in melt water. Further investigation is needed to determine the environmental impacts of this method of snow disposal, not only in Casco Bay but state wide.

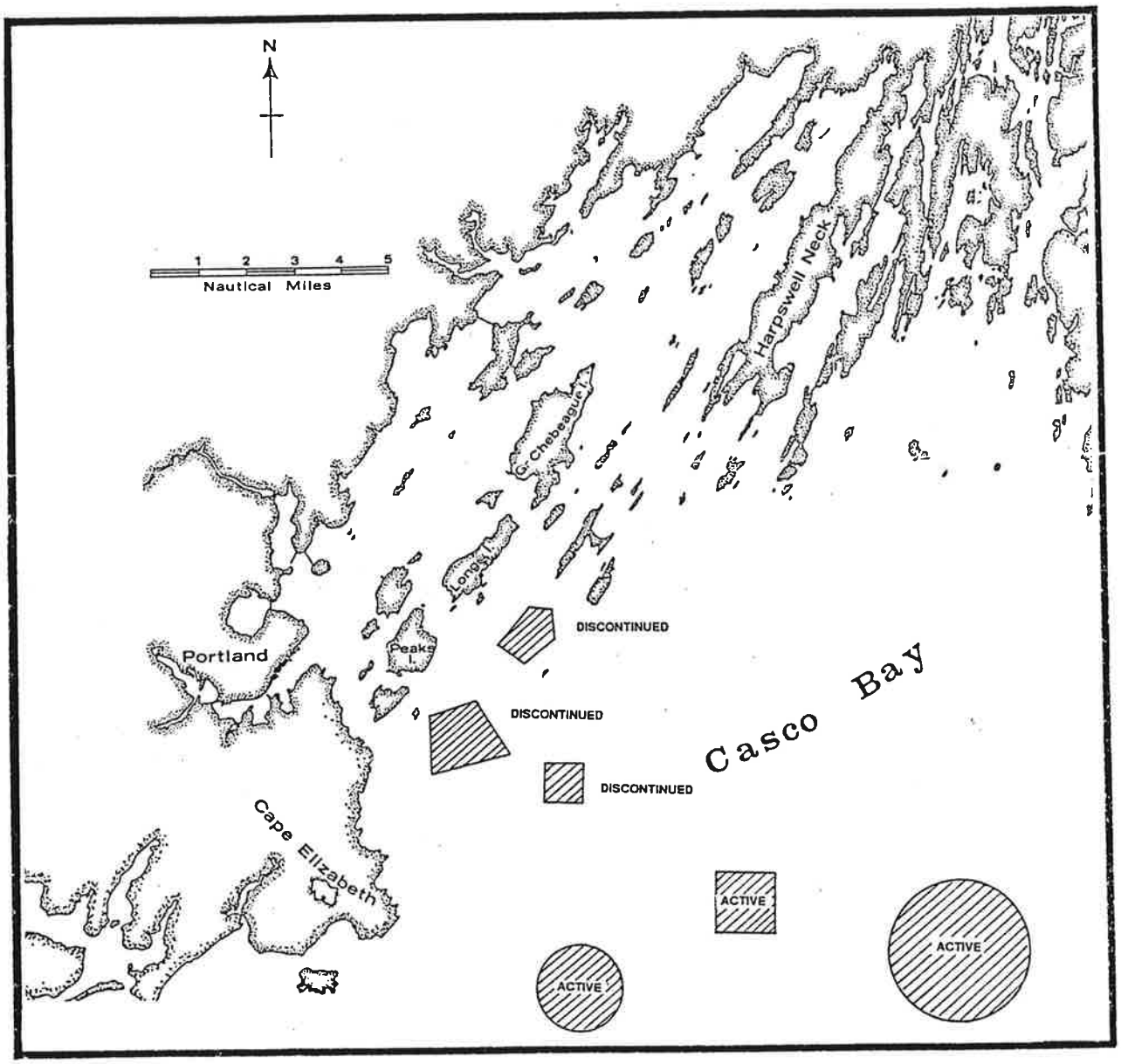
Atmospheric deposition is included in this category although some of it falls directly into Casco Bay. Very little local data exists to assess the contribution of pollutants to Casco Bay from the atmosphere, although for some parameters, such as lead, it appears that improvements are in hand. For example, Maine Department of Environmental Protection (1987) data show a reduction in the annual arithmetic mean concentrations of atmospheric lead in Portland from 0.29 µg per cubic meter in 1982 to 0.07 µg per cubic meter in 1987. Total suspended particulates over that period remained unchanged, however, indicating that lead may be an exception.

5-Ocean Disposal of Dredge Materials

Six ocean disposal areas exist within Casco Bay relatively close to shore. Three sites located in shallow water have been discontinued while three in deeper water (100 ft.) are active (Figure 20). No information exists on the contribution of these disposal areas to Casco Bay's pollution problem although it is known that polluted sediments can be a significant source to surrounding areas through resuspension and transport and biological uptake and transfer through the food chain. Problems can therefore extend beyond the limits of the disposal areas. In fact, NOAA's outer Casco Bay "control" station is very close to the Bigelow Bight Industrial Disposal Area which contains dredge spoils from at least Portland Harbor. The elevated PAH and metal levels encountered may likely be "echos" of Portland Harbor.

Figure 20

OCEAN DISPOSAL AREAS IN CASCO BAY



NUTRIENTS

The Problem

Nutrient enrichment is of concern in Casco Bay. In other estuaries such as Narragansett Bay, Chesapeake Bay, and Long Island Sound, eutrophication has resulted in several serious problems including shifts of phytoplankton species to toxin producing forms causing "red tides", oxygen depletions resulting in fishkills, and aesthetic impairment similar to that produced by algae blooms on several Maine lakes. There exists some opinion that the 1988 shellfish mortalities in Maquoit Bay at the western end of Casco Bay may have been related to localized nutrient enrichment leading to blooms of a phytoplankton species known elsewhere to be associated with pollution. In marine systems, availability of nitrogen is generally the factor limiting plant growth. NOAA (1988) estimates that about 1400 tons of nitrogen are discharged each year to Casco Bay's watershed. The quantity actually delivered to the bay is uncertain, however, since natural denitrification processes occur between the points of discharge and the bay itself. As the population of the Casco Bay region grows and forest cover declines as urbanization and development increases, it becomes important to know more of the effects of nutrient enrichment in Casco Bay.

Probable Causes

1-Domestic wastewater from sewage treatment plants, faulty septic systems, and overboard discharges are a major contributor of nutrients in general and nitrogen in particular. While some treatment plants are designed to remove nitrogen it is extremely expensive and no plant in Maine does so. The NOAA Northeast Case Study (1988) estimates that about 408 tons of nitrogen per year is discharged to Casco Bay from sewage treatment plants.

2-Industrial Discharges are estimated to account for about 343 tons of nitrogen discharged per year (NOAA, 1988). In Casco Bay this is mostly from S.D. Warren Paper Company, about 6 river miles upstream or about one day's time of travel to head of tide in Casco Bay (Mitnik, 1980).

3-Non-Point Sources include agriculture and forestry operations that are estimated to contribute about 393 tons of nitrogen per year to Casco Bay's watershed. Not included in NOAA's estimate is the amount of nitrogen fertilizer applied to and lost from residential areas and golf courses.

4-Atmospheric Deposition has been implicated in the eutrophication of Chesapeake Bay. Fisher et al. (1988) estimate that one quarter of all nitrogen inputs into the Chesapeake and other Atlantic Ocean coastal waters is from atmospheric nitrate deposition.

How does Maine propose to identify the cause of each problem?

Identification of causes requires a detailed diagnostic study. The first step, planning has already begun. Revisions now being made to discharge licenses will enable Maine to better estimate the total loading of pollutants to a specific waterbody. The revisions include requiring concurrent flow and concentration information on more than conventional pollutants. The list of pollutants is based on their potential to exist as well as ambient monitoring information which indicates they exist.

What are the institutional arrangements for Casco Bay and how are they working?

The U.S. Environmental Protection Agency is the principal federal agency with responsibility for water quality management. Other federal agencies which are involved include: U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service, the Federal Office of Ocean and Coastal Resource Management, U.S. Army Corps of Engineers and the U.S. Coast Guard.

The Maine Department of Environmental Protection is the primary state agency responsible for water quality monitoring, licensing and enforcement. The Department of Marine Resources is responsible for determining water quality problems (e.g. bacteria, biotoxins) as they relate to commercially important marine resources. Other state agencies which have responsibilities related to Casco Bay resources include: State Planning Office (Critical Areas Program and the Maine Coastal Program), Department of Economic and Community Development (growth management and local administration of the Maine Coastal Program), Department of Conservation (geology and submerged lands), Department of Health Services (public health), Department of Inland Fisheries and Wildlife (wildlife), Department of Transportation (ports and marine transportation) and Historic Preservation Commission (archaeological sites). Locally, responsibility includes the municipalities which surround Casco Bay and the Greater Portland Council of Governments, the regional planning agency which serves all surrounding communities except, at present, Brunswick and Harpswell.

There is general coordination among the agencies in relation to policy and regulation; however, the coordination would be greatly strengthened by a management conference which

would identify the "players" and define their roles and responsibilities. Also, the management conference will resolve some of the confusion which the general public has about the responsibilities of the various regulatory and planning agencies.

LIKELIHOOD OF SUCCESS

What are Maine, local governments, and public and private institutions already doing for the estuary?

Implementation of *Agenda for Action*

A strong positive first step and commitment toward protecting Casco Bay was taken in January when Governor McKernan released his report, ***Agenda For Action***. Sixteen specific steps were outlined as top priority for the State. Of those steps, eight were actions to be taken immediately and eight were actions to continue into the future. Since January, with the exception of recommendation #1 which is to nominate Casco Bay for inclusion in the National Estuaries Program, all immediate actions have been initiated or completed and many of the continuing actions have begun.

RECOMMENDATIONS	STATUS
IMMEDIATE ACTIONS - 1989	
1. **The Governor** shall **nominate the Gulf of Maine**, of which Casco Bay is a valuable part, to be designated **a Nationally Significant Estuary.**	**Initiated**
2. Declare **Casco Bay a Priority Waterbody** for comprehensive **action by all State Agencies.**	**Complete**
3. Strictly **enforce of all waste discharge licenses** held in Casco Bay through use of **penalties and corrective action.**	**Complete**
4. **Review and revise municipal and industrial discharge license** monitoring requirements to reflect concerns of Casco Bay.	**Initiated**
5. Require municipal **monitoring of stormwater and combined sewer overflows.**	**Complete**
6. **Report violations of water quality standards** immediately to municipalities.	**Initiated**
7. **Assess present and potential economic value of uses** within Casco Bay.	**Initiated**
8. Prepare legislation requiring all marinas to **provide for adequate pumpout facilities.**	**Complete**

CONTINUING ACTIONS FOR THE 1990's

1. **Identify, prioritize** and adequately **treat stormwater and combined sewer overflows.**

2. **Quantify** inputs of **toxics, nutrients, and bacteria** into Casco Bay.

3. **Remove discharges conflicting with designated uses.**

4. Prepare a **Comprehensive Casco Bay Watershed Plan.**

5. Develop a **public education program on Casco Bay's** environmental issues.

6. Review and **coordinate inter-agency management goals** for Casco Bay.

7. **Expand and improve** the State's environmental **data management** system.

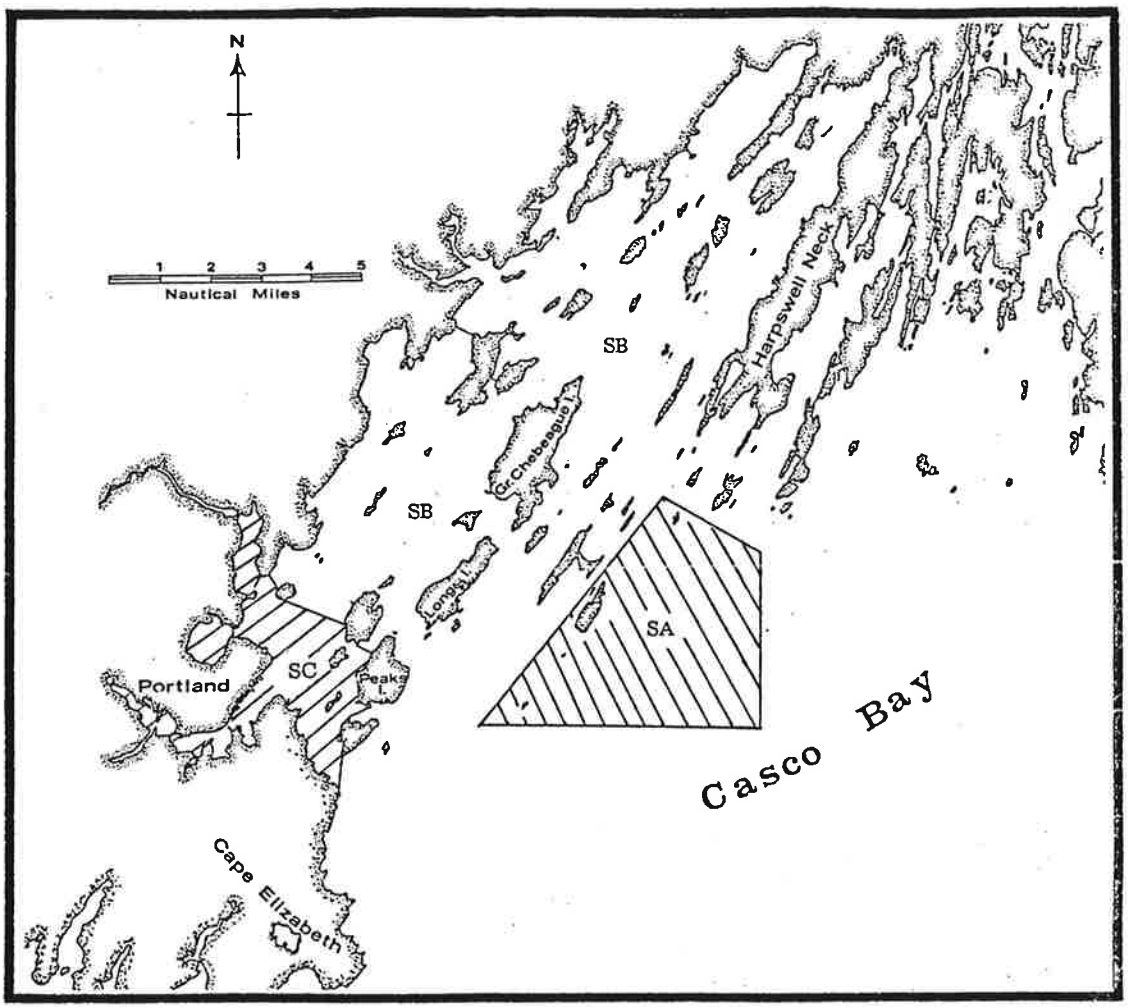
8. **Review and revise** as necessary State **policy** on the location of **snow dumps** and the **ocean disposal** of dredge spoils.

State of Maine Water Quality Standards

The State of Maine manages its surface water through the Water Classification Program (MRSA Title 38 Article 4-A). Marine waters are divided into three classes; SA, SB, and SC (Figure 21). SA waters are those outstanding marine waters which should be preserved in their natural condition. In Casco Bay, the water around State public lands such as Jewell and Eagle Islands are SA. SB waters are marine waters of truly general multiple use and comprise 95% of Casco Bay. The third class of water, SC, is considered to be more oriented toward commercial and industrial activities such as those found in Portland Harbor. SC waters nevertheless must meet the minimum criteria of "fishable/swimmable" according to State law and the federal Clean Water Act. Attainment of classification is largely achieved through the regulation of waste discharges and land use activities. For example, all waste discharge licenses and Board Orders permitting land use changes are written to protect or restore the legislated classification of downstream receiving waters. How well the permittee complies with conditions of the license largely determines how well a receiving water's classification is maintained. Even then, however, attainment may not exist due to a number of uncontrolled problems such as non-point source pollution, accidents and illegal dumping.

Figure 21

SURFACE WATER CLASSIFICATION OF CASCO BAY, MAINE



Clean Water Strategy and Public Participation

The Maine Department of Environmental Protection's Bureau of Water Quality Control is sponsoring the Clean Water Strategy process during the summer of 1989, in cooperation with the Maine Land and Water Resources Council. Staff from the Department of Environmental Protection and other key environmental agencies will be presenting the Strategy at a series of public hearings and informational meetings, one of which is to be held in Portland. The meetings will address current coastal water quality issues such as overboard discharges, combined sewer overflows, sediment contamination, shellfish closures, and general water quality management goals. The public input received at these meetings will be used to revise our programs and to refine the water quality classifications proposal as it pertains to Maine's coastal waters. The public participation process inherent in this effort is crucial to the success of the strategy.

Maine Coastal Program

The Maine Coastal Program, funded by the Federal Office of Ocean and Coastal Resource Management, is administered by the Maine State Planning Office. In 1986, the Maine Coastal Program developed a legislative initiative which resulted in the Coastal Management Act. The Act states that activities conducted in the coastal area will be consistent with nine coastal management policies including restoration and maintenance of water quality and natural areas protection. The regulatory part of the Coastal Management Act is implemented by the Maine departments of Marine Resources, Conservation and Environmental Protection. The Department of Economic and Community Development, Office of Community Planning administers the local grants program. One recently completed local study, "Review and Recommendations Report for the Town of Brunswick" in northern Casco Bay, suggests changes to the town's comprehensive plan in order to preserve coastal water quality.

The Maine Coastal Program also funded a one year grant for laboratory analysis for toxic pollutants in mussels in Casco Bay. Other Coastal Program initiatives include sponsorship of Coastweek and the development of technical assistance tools for local officials. Also, the Coastal Program funds a coastal coordinator in each regional planning agency which serves coastal communities to help coastal municipalities with coastal issues and conflicts. The coastal coordinator serving Casco Bay is located at Greater Portland Council of Governments.

Non-Point Source Pollution Control Program

Maine's Non-Point Source Pollution Control Program is a relatively new addition to Maine's water quality management tools. Casco Bay has been included as a high priority in all phases of this program. The Work Plan, which has been submitted to and approved by EPA Region I, lists Casco Bay as a priority waterbody, due primarily to the issue of stormwater management. In the Assessment Report to EPA, Casco Bay is again included as a priority. In the Non-Point Source Management Strategy, which is now being developed, Casco Bay is targeted. Inclusion of Casco Bay in both the National Estuary Program and EPA's Non-Point Source Control Program will greatly assist in the implementation of Continuing Action #4 in ***Agenda for Action***; preparing a comprehensive watershed plan for Casco Bay.

Compliance Monitoring and Enforcement

The Department's compliance monitoring and enforcement program have already begun placing increased emphasis on the marine environment. Casco Bay is the top priority. In 1989, all municipal and significant industrial wastewater treatment facilities will be inspected at least four (4) times each year. Those inspections will evaluate the operation, maintenance, and management of the facilities and all deficiencies noted during the inspections will be required to be corrected as soon as possible. Department staff will complete detailed evaluations of disinfection technologies used at municipal treatment facilities. Treatment plants with poorly operating disinfection systems will be required to upgrade their facilities. Many municipalities have excessive infiltration and inflow from groundwater or rainwater resulting in decreased efficiencies of the treatment process or the discharge of untreated wastewater from combined sewer overflows. Those municipalities will be required to study their wastewater collection systems and implement plans to eliminate the excessive infiltration and inflow.

The Department's enforcement program will put increased emphasis in resolving problems at wastewater treatment facilities that discharge to Maine's marine waters, especially Casco Bay. Consent Agreement and Enforcement Orders will be used to resolve detected problems. Casco Bay enforcement actions will have the Bureau of Water Quality Control's top priority.

NPDES Program

Maine is not a delegated NPDES state and issues its own permits in addition to those issued by EPA. The State does coordinate closely with EPA and one agency or the other takes the lead in issuance of individual licenses. The Department has recently reviewed the license

conditions to assure they properly reflect water quality concerns. Some municipalities are being asked to monitor for non-conventional pollutants in addition to their traditional monitoring requirements. Currently, licenses use fecal coliform bacteria as indicator organisms in treated effluents. The State's water laws have recently been amended to use Enterococcus bacteria for marine ambient water testing. Future licenses may contain an effluent Enterococcus standard.

State discharge licenses also regulate the addition of septage into sewage systems and require certified treatment plant operators. Also, license requirements for evaluations and abatement of combined sewer overflows are receiving far greater attention than in the past.

Toxic Pollution Control Strategy

Maine's Toxic Pollution Control Strategy is currently being revised with close cooperation of EPA Region I. The new strategy is due to be completed and go through rulemaking in 1989. Two components of the strategy will directly affect Casco Bay. First is the requirement that all municipal wastewater treatment facilities conduct chronic toxicity tests 9 times per year. Yarmouth, on the Royal River is the first town to be required to conduct chronic toxicity tests. This requirement will be incorporated into the licenses of all other municipalities as their licenses are renewed before 1994. Second, all pulp and paper mills on the 401L list will be required to conduct toxicity tests and complete Form 2-C, EPA's Priority Pollutant Screen. In addition, the State of Maine is proposing to require that all peaks exceeding 100µg/l be identified. S.D. Warren, a bleached kraft pulp and paper mill on the Presumpscot River, will be one of the first mills in Maine required to meet these license conditions. Additionally, the company is required to monitor pollutants in downstream estuarine sediments.

Combined Sewer Overflow Plan

A joint effort between the State, licensed dischargers, and municipalities surrounding Casco Bay, the Combined Sewer Overflow Control Plan was initially developed specifically for Casco Bay because of the recommendations contained in *Agenda for Action*. The plan has now been adopted state-wide. Beginning the summer of 1989, a study will be conducted to assess the impacts of combined sewer overflows (bacteria from the bypassed domestic wastewater and toxics from stormwater runoff) to Casco Bay in the cities of South Portland, Portland, Westbrook, and Falmouth. Storm flows will be characterized both qualitatively and quantitatively in order to prioritize remedial actions for specific outfalls. An ambient monitoring component will be included to assess the extent of impacts caused by the CSOs. The

final part of the plan is to develop a sewer system master plan which will describe steps and timetables for abatement of those CSOs which have been identified as causing unacceptable impacts.

Construction Grants

Maine's Municipal Construction Grants Program has already addressed the principal point sources of pollution to Casco Bay. Nevertheless, there remain about 75 combined sewer overflows. Corrective steps may be funded through the Revolving Fund Loan Program recently authorized by the Maine Legislature. The State-funded Small Community Grants Facilities Program has replaced a number of untreated wastewater discharges from individual and small groups of homes and businesses and will continue to do so on a priority basis.

Growth Management Law

In 1988, Maine passed a growth management law which requires all municipalities in Maine to develop comprehensive plans and implementation programs. Municipalities with high growth rates (>10%), including many towns in the Casco Bay watershed, are required to submit comprehensive plans to the state for review by January, 1991. Other municipalities have deadlines of January, 1993 and January 1996, depending on their growth rate. Financial assistance is provided by the state of Maine to municipalities and regional planning commissions to help them complete the required tasks. Nine coastal management policies (see Maine Coastal Program above) must be addressed by the coastal communities in their comprehensive plans. Also, training and certification of code enforcement officers is required by 1993. The state is responsible for developing the training and certification program for code enforcement officers.

What goals and objectives does Maine propose to set for Casco Bay and how does Maine propose to meet them?

The primary goal for Casco Bay is **to prevent its further degradation** and reverse, where possible, degradation which has already occurred. Full restoration of uses such as swimming, fishing, the harvest of shellfish and as a habitat for estuarine and marine life will require a comprehensive set of actions. **Prevention is the key to Maine's marine environmental program** and already the State of Maine is well along in implementing the recommendations called for in ***Agenda for Action.***

Four primary goals for Casco Bay are as follows:

- **Prevention of further degradation**
- **Attain Water Quality Classifications**
- **Eliminate discharges of pollutants causing use impairment**
- **Develop a comprehensive master plan for Casco Bay which considers living resources, and use in addition to economics.**

Five tasks which must be accomplished if Maine is to proactively manage and protect its waters, including Casco Bay, follow:

MONITORING AND RESEARCH is critical to obtaining accurate information upon which decisions are made. Most information on Casco Bay's pollution load is based on models developed from other areas of the country. While models are useful in pointing out general areas of concern, they are not adequate for effective expenditure of millions of dollars to solve problems. Neither do models account for natural inputs of materials. Monitoring information should properly include both anthropogenic as well as natural sources.

Monitoring in Casco Bay should not focus solely on chemistry but include physical, biological and cultural parameters. A physical understanding of Casco Bay's hydrodynamics is necessary for modelers to determine flushing rates, currents, pollutant trajectories. And a knowledge of biological communities existing in Casco Bay is necessary if we are to determine whether application of models, discharge requirements, and regulations are effective.
Specific research questions which must be addressed in the course of any program to protect Casco Bay include the following:

- What is the hydrography of Casco Bay?
- What is the mass balance of pollutants in Casco Bay?
- What biological monitoring protocols are appropriate for Casco Bay?
- What are "safe" levels of pollutants in sediments?
- What are "safe" levels of pollutants in tissues?

ENFORCEMENT of waste discharge licenses is necessary to predict and properly manage pollutants in Casco Bay. Licenses are written to avoid use impairment through consideration of the capacity of any downstream water to assimilate the wastes. Compliance with these license limits in large part determines how well water quality management goals are attained.

LICENSING waste discharges has changed dramatically over the past several years. So-called "conventional pollutants" like dissolved oxygen, pH, bacteria, and solids have been the focus of most discharge licenses. Today, other parameters are of equal or greater concern; especially those materials known to have toxic effects. New licenses and renewals should be written with more attention directed toward the ultimate receiving water; in this case Casco Bay.

REGULATION is the State's tool to manage resources belonging to its citizens. As has been shown in this case study of Casco Bay, there remain many uncontrolled sources of significant pollution. In some instances, no regulation exists at all and in other cases the regulations are ineffective. Dredge spoil disposal, stormwater management, and atmospheric deposition are but a few examples.

EDUCATION surely is the ultimate solution. The invisible nature of Casco Bay's pollution promotes the impression that no problems exist. While poisons are invisible, their effects are not. In Casco Bay there is still time to prevent impacts from becoming obvious. At present not only is the public uninformed, but many responsible for making the management decisions directly impacting Casco Bay are equally uninformed. A solid and continuing environmental education campaign must begin if Casco Bay is to be saved from a fate similar to waters to our south. Such a campaign clearly extends beyond the limits of Casco Bay and should be considered statewide.

Who will participate in the Management Conference and how will it be organized?

Should Casco Bay be accepted into the National Estuary Program, a management conference aimed at providing full representation of all interests of Casco Bay will be convened. Although the exact structure of this management conference is not yet fully developed, it is intended to include local, municipal, State, Federal, environmental, industry, technical, and user groups.

In order to balance full representation of the different groups with management efficiency, the State proposes to form a Casco Bay Steering Committee which may be comprised of members from various functional groups. A Technical Advisory Committee may represent scientific and engineering aspects. A Public Advisory Committee may represent the user population, and a Management Advisory Committee may represent public policy and assist with recommending actions to implement the management plan.

Already, the D.E.P. has participated in several public meeting concerning Casco Bay and the Governor has held two press conferences on Casco Bay.

Is there public and political will, as well as financial capability, to support implementation of the CCMP?

Public Commitment

At all levels, from the individual citizen through State government, it is clear that support and commitment exists to implement the CCMP or any other measure necessary to protect Casco Bay. Over the last two years, one of the major media issues in the State has been the health of Casco Bay. All the local newspapers and television news programs have covered Casco Bay many times. An incomplete compilation of articles on Casco Bay from the Portland Press Herald, included in Appendix 3, attests to the bay's local importance.

Educational, Extension and Research Organizations

University of Maine
- Sea Grant College Program (joint with University of New Hampshire)
- Cooperative Extension Service
- Ira C. Darling Canter
- Institute fo Quaternary Studies
- Land and Water Resources Center
- Marine Law Institute
- Center for Marine Studies
- Northeast Marine Education Project

University of Southern Maine, Gulf of Maine Course
Southern Maine Vocational Technical Institute, Marine Science Program
Bowdoin College Environmental Studies Program
Bigelow Laboratory for Ocean Sciences
Association for Research on the Gulf of Maine
Gulf of Maine Marine Education Association
Mr. and Mrs. Fish

Environmental Associations

Maine Audubon Society
Natural Resources Council of Maine
Conservation Law Foundation
Island Institute
Portland Waterfront Alliance
Waterfront Advisory Committee
Munjoy Hill Neighborhood Association
Baywatch
Friends of Casco Bay
Casco Bay Island Development Association
Casco Bay Greens
Maine Coast Heritage Trust
Maine Association of Conservation Commissions
Sierra Club Maine Chapter
The Nature Conservancy
New England Interstate Water Pollution Control Commission
Save Our Environment

Marine Trade Organizations

Maine Aquaculture Association
Maine Fisherman's Cooperative
Maine Harbormasters Association
Maine Import*Export Lobster Dealer's Association
Maine Lobstermen's Association
Maine Marine Alliance
Maine Marine Trades Association
Maine Recreational Boaters Association
Maine Sardine Council
Maine Science and Technology Board
Pound Keeper's Association

State Agencies
Maine Department of Environmental Protection
Maine Department of Marine Resources
Maine State Planning Office
    Critical Areas Program
    Maine Coastal Program
Maine Department of Economic and Community Development
    Office of Community Planning
Maine Department of Conservation
    Bureau of Public Lands
    Geological Survey
Maine Department of Health Services
    Health and Engineering Division
Maine Department of Inland Fisheries and Wildlife
Maine Department of Transportation
    Ports and Marine Transportation Division
Maine Historic Preservation Commission

Planning and Municipal Assistance
Greater Portland Council of Governments
Cumberland County Soil and Water Conservation District
Maine Municipal Association
Maine Association of Planners

Political Commitment

The Governor of Maine, who proposed to nominate Casco Bay to the National Estuaries Program, both Maine's Senators and district Congressman, have pledged strong support to the protection of Casco Bay (Appendix 4). Following the Governor's announcement of his intentions, Congressman Joseph E. Brennan introduced H.R. 1189, a bill to add Casco Bay, Maine, to the list of estuaries that receive priority consideration under the Federal Water Pollution Control Act. Such bipartisan support clearly indicates the sincerity of Maine's commitment.

Financial Capability

The 25% financial match required by the Clean Water Act for inclusion in the National Estuary Program will be provided at a minimum by committing personnel and in-kind services from the Maine Department of Environmental Protection. As the Management Conference is formed, local and municipal matches will also be secured. Already, the Maine Department of Environmental Protection has devoted at least one staff person full time to Casco Bay.

Within the State's master plan for marine protection (***Maine's Marine***

Environment, A Plan for Protection , M.D.E.P., 1989), Casco Bay was singled out as the highest priority for diagnostic monitoring. The anticipated cost of this study is in excess of $350,000 over two years and will attempt to determine which pollutants now present in the bay are due to present or historical activities in order to develop a remedial action plan.

On the local level, the municipalities of South Portland, Portland, Westbrook, and Falmouth have agreed to actively participate in the Casco Bay's protection via the Combined Sewer Overflow Plan. The City of Portland, for example, has demonstrated its commitment to Casco Bay by dedicating at least $113,000 in engineering services to conduct a preliminary assessment of its combined sewer overflow problems. The results of this study will lead to a larger and more comprehensive remedial program.

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