PART II
A Chorus of Conservation

Who better to examine Cape Cod Bay than the men and women who devote professional hours to its study through marine science, policy, cultural heritage and history, and conservation?

The following essays reflect perspectives, opinions, reflections and concerns, along with a deep respect for the stewardship and sustainability of Cape Cod Bay, as well as a vision for the stewardship and sustainability of the natural resources of Cape Cod Bay.

Heritage & Culture

by Duncan Oliver, Historian, Past President, Historical Society of Old Yarmouth

Early Cape Codders relied on Cape Cod Bay for food, transportation, and items with which to improve their daily lives.

From almost the first day, from the Puritans, English colonists realized that travel on Cape Cod could be best accomplished by sea. Early settlers landed their small vessels at high tide and left them on the sand until they were ready to leave. Docks were built to help unload the vessels, but these were small by later standards of the packet docks to host 19th century schooners.

It wasn't until settlements had begun to grow that simple docks turned into industrious wharves. The shallow nature of docking areas limited the size of vessels that could visit the Cape.

In looking for food, early Cape Codders could collect shellfish from the sea, leaving little imprint on the shore. Middens, piles of clam and quahog shells, were found frequently around the Bay, evidence that Indians had used these waters for food.

Fishermen went out in small vessels, not too far from shore. Some seines and weirs were used as well, but the great age of weir fishing on Cape Cod was the late 18th and 19th century. These fishermen ran their vessels up creeks in winter to protect them during storms and ice. Few remains exist of areas where fishermen wintered over. In the winter time, a large proportion of Cape Cod men looked for whales. After the 1650s, they actually built houses out on the dunes to look for whales, and six men shared a house. Their wives and family remained in the village. Try yards for obtaining oil were established near the beach area. Four were located on Sandy Neck and names like Try Island in Wellfleet attest to try yards on the lower Cape.

Image courtesy of William R. Davis

The need to transport whale oil probably resulted in the first substantial piers and wharves. Most of the oil was taken to Boston as the port facilities in Plymouth weren't large enough to handle these hogsheads for trans-Atlantic voyages.

It is surprising that early colonists left such a little mark on the land and edge of the bay, but such a large mark on some of the mammals in the water. Within 100 years of man coming to Cape Cod, right whales were scarce, forcing men to look to deep water for their sources of oil.

A Walk Along Cape Cod Bay

Our Valuable Coastal Habitats

by Gilbert D. Newton, M.S.; Teacher, Sandwich High School; Professor, Cape Cod Community College

Cape Cod is characterized by a wide diversity of coastal marine habitats. If you walk along the shoreline and spend some time exploring the beaches, dunes, and marshes, you will discover an incredible assemblage of plants and animals. Many of these species are located in specific habitats or zones, such as barrier beaches or salt marshes, and are limited in their distribution based on the physical features of an area, as well as their interactions with other living things.

If we start at a sandy beach, such as those at the Cape Cod National Seashore in Wellfleet, the first thing to notice is that this is a dynamic system in which the sediment is in constant motion, particularly in the intertidal zone, the area between the high and low water marks. This is a hostile environment for most species, though several have adapted to the changes in tides, temperature, and oxygen concentration. Small mole crabs (Emerita talpoida) can sometimes be seen feeding on bits of detritus (decomposing plant material) up and down the beach. Large numbers of the common slipper snail (Crepidula fornicata) may wash up after strong waves or a storm. These animals are often attached to a hard object and even each other.

The shells of other mollusks can be seen here, including the popular and edible quahog (Mercenaria mercenaria) which can be easily identified by its thick shell and purple coloration on the inside. The presence of bay scallop shells (Aequipecten irradians) suggests the growth of eelgrass (Zostera marina) beds in deeper water. Eelgrass is a flowering plant, and supports large populations of fish and shellfish offshore.

In muddy, tidal flats, you may notice something squirting at you from the substrate or bottom. This is the soft-shelled clam (Mya arenaria), or steamer. Its filter-feeding siphon points upwards while the animal is attached with its strong foot. Cylindrical razor clams (Ensis directus) will burrow deeply in the mud. First Encounter Beach in Eastham is an excellent place for collecting razor clam shells. Crawling close to shore, but perfectly camouflaged is the common spider crab (Libinia emarginata). This harmless animal may be further concealed by a colony of algae, bryozoans, and sponges glued to its carapace.

Many small animals may be seen in the tangled mats of seaweed that make up the wrack line along the beach. The seaweeds are really macroalgae, and are divided by the different pigments in their cells. Common green algae include the sheets of sea lettuce (Ulva lactuca), and the introduced green fleece (Codium fragile). This alga is a major nuisance in that it can grow in large clumps on shellfish, particularly scallops, and weigh enough to prevent their movement.

Brown algae can photosynthesize, but the brown pigment, fucoxanthin, masks the chlorophyll. Common examples include gulfweed (Sargassum filipendula), identified by its toothed blades, and tiny air bladders. The largest is the strap-shaped kelp (Laminaria saccharina) which also has a strong root-like holdfast. Two of the most common species of brown algae are the rockweeds, Fucus vesiculosus and Ascophyllum nodosum, sometimes called the knotted wrack. These two algae have large air bladders, and are found attached to rocks or, in the case of Fucus the edges of salt marsh banks. The rockweeds retain moisture at low tide and so frequently they are homes for many small animals avoiding desiccation. A small tube worm, (Spirorbis borealis) will attach to the branches. Probably my favorite alga is the sea potato (Leathesia difformis) which looks like a lump of brown popcorn, and grows as an epiphyte on other seaweeds.

You will probably find the red algae to be the most attractive, particularly when seen underwater. The edible Irish moss (Chondrus crispus) with its forked branches is quite common, as is the tubular and filamentous Polysiphonia sp. An interesting find is the coral weed (Corallina officinalis) with its ability to precipitate lime on its surface, making it look more like a statue than a plant.

The most productive habitats are the estuaries and bays, and the salt marshes that surround them. These natural nurseries support large numbers of animals, including several commercially important shellfish and finfish species. Blue crabs (Callinectes sapidus) can be collected in this habitat, but be careful handling one. They can pinch. You can also explore the narrow tidal creeks, salt marsh panes, or rivers and streams that interconnect this vast system.

Tall cordgrass (Spartina alterniflora) grows along the outer edge of the marsh where it can be exposed to salt water inundation, and therefore has the ability to remove salt from its leaves. At its base is a zone of rockweed covering a group of ribbed mussels (Modiolus demissus) that lie embedded in the

mud. The cordgrass gives way to the dominant marsh hay (Spartina patens), giving a golden-brown hue to the marsh.

Small pockets of standing water called panes may be inhabited by stranded animals such as the horseshoe crab (Limulus polyphemus). This animal is not a true crab, but is more closely related to arachnids, such as spiders and ticks. An extract from its blue blood is used to detect bacterial endotoxins in medicines. Harmless to you, it feeds mainly on worms and clams.

When you walk through a marsh, you may see dozens of small holes constructed by one of the most common crustaceans, the fiddler crab (Uca sp.) Fiddler crabs aerate and fertilize the marsh sediments, and are a food source for animals visiting the marsh.

For the truly dedicated, your explorations can take you to several other specialized coastal habitats. There are tide pools at low tide where you can find sea stars (Asterias sp.), sea anemones (Metridium senile), and colorful encrusting algae. Rock jetties and groins are places of attachment for barnacles (Balanus balanoides), rockweed (Fucus sp.), and filamentous green algae (Enteromorpha sp.) And sand dunes represent transition communities between the terrestrial and marine systems displaying the dominant beach grass (Ammophila breviligulata) while providing habitat for the endangered piping plover (Charadrius melodus).

So head to the shore where the natural splendors are fascinating and diverse. Cape Cod Bay is home to many important species of plants and animals that are simply a field walk away.

Gil Newton, far right, leads a community nature walk in Sandwich for the Cape Cod Bay Ocean Sanctuary Program

Areas of Critical Environmental Concern

by Lisa G. Berry Engler, ACEC Coastal Coordinator;
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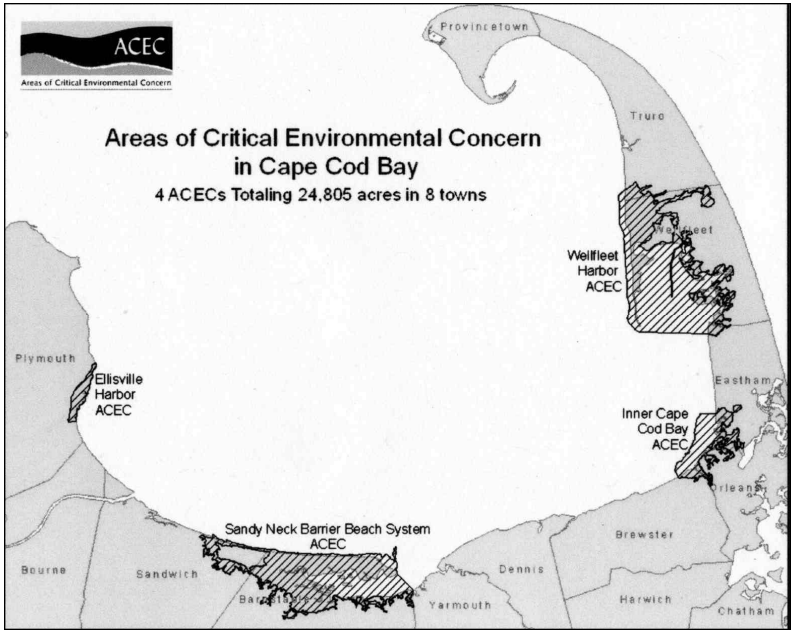

Areas of Critical Environmental Concern (ACECs) are places in Massachusetts that receive special recognition because of the quality, uniqueness and significance of their natural and cultural resources. These areas are identified and nominated at the community level and are reviewed and designated by the state's Secretary of Energy and Environmental Affairs. ACEC designation creates a framework for local and regional stewardship of critical resources and ecosystems. Please visit the ACEC Program's website to learn more: www.mass.gov/dcr/stewardship/acec.

There are four ACECs that border Cape Cod Bay: Ellisville Harbor ACEC in Plymouth; Inner Cape Cod Bay ACEC in Brewster, Eastham, and Orleans; Sandy Neck Barrier Beach System ACEC in Barnstable and Sandwich; and Wellfleet Harbor ACEC in Eastham and Truro. These ACECs total approximately 24,805 acres and include salt marshes, estuaries, barrier beaches, coastal dunes, tidal flats, coastal flood plains, salt ponds, and tidal creeks and rivers. The critical resources within these ACECs provide feeding and breeding grounds for many aquatic birds, habitat for shellfish and finfish, improved water quality, recreational opportunities for the public, as well as storm damage protection and flood storage capacity for neighboring communities. Stewardship activities within the ACECs that are accomplished by local and state partners help raise awareness for the critical resources, their value to the community, and how to provide protection from threats such as development, water quality degradation, overuse, and mismanagement. Stewardship activities include drafting management documents such as barrier beach management plans or harbor management plans, educating users through signage, pamphlets or guided walks, supporting scientific research, and holding annual conferences.

Estuarine Habitat Restoration at Cape Cod National Seashore

by J. W. Portnoy, Ecologist, Cape Cod National Seashore

The Seashore's Tide-Restricted Marshes

Cape Cod, like much of the eastern U.S. seaboard, has a 350-year history of coastal wetland loss due to diking, drainage and filling, with an estimated 1400-hectare (ha) of original salt marsh estuaries that are still diked today. Outer Cape Cod was not excepted; in fact, the four largest estuaries diked on Cape Cod occur on the bayside of Wellfleet, Truro and Provincetown. With Cape Cod National Seashore establishment in 1960, the National Park Service inherited over 850-ha of diked coastal systems representing a 42% loss of the native salt marsh habitat present at the time of European settlement. Diked marshes within the Seashore account for more than half of the total diked wetland area over all of Cape Cod.

Salt marshes were diked for various reasons: to ease foot, wagon and later automobile and train passage across the many salt marshes that wove throughout the outer Cape's upland farms and villages; to favor salt hay farming by reducing tidal flooding and thereby encouraging the growth of high-marsh grasses (Spartina patens); to allow the cultivation of salt-sensitive crops in the organic-rich wetland soils; and to eliminate, through drainage, habitat for floodwater-breeding mosquitoes. Typically an earthen dike was built across an inlet or narrow reach of tidal creek and/or marsh to an elevation that blocked all but the highest storm tides. These structures effectively blocked seawater flow into upstream wetlands, but also tended to impound freshwater that normally discharged to the sea during low tides. Thus, to allow discharge, all dikes were fitted with culverts, albeit with one-way valves on their seaward ends to prevent saltwater inflow during flood tides. To further wetland drainage, diked salt marshes were subsequently ditched and creeks channelized to expedite freshwater discharge. Virtually all of the Seashore's diked marshes have been treated in this way.

Although salt marsh diking has caused serious estuarine water quality problems on Cape Cod and throughout the world, the most noticeable effects of diking are changes in vegetation. Cattails (Typha spp.) and, in particular, the common and exotic reed, Phragmites australis, characteristically spread onto tide-restricted marshes in the northeastern U.S., shading out and displacing native halophytic grasses. At higher elevations that are consequently more deeply drained by diking, a large variety of freshwater wetland and even upland plants may invade diked flood plains once the stresses of salt and waterlogging are removed. Thus, hundreds of hectares of original salt marsh habitat have been converted to freshwater wetlands or upland habitat types within four of the Seashore's five largest tidal marshes, described below.

Importantly, with establishment of the National Seashore, the NPS received stewardship responsibility for most of the marshlands, both diked and natural, within the Park boundary; however, ownership and control of the structures (dikes, culverts, tide gates and weirs) that profoundly affect the salinity, hydroperiod and estuarine ecology of the extensive tidally restricted marshes was retained by the local towns and the State. Progress in addressing NPS concerns about water management has been slow, but recently successful in East Harbor and Hatches Harbor.

East Harbor, Truro and Provincetown

Before diking in 1868 East Harbor (currently mapped as "Pilgrim Lake") comprised a 129-ha tidal lagoon and 162-ha salt marsh receiving semi-diurnal tidal exchange from Cape Cod Bay through a 300-m wide inlet. Presently, tidal exchange is limited to a 1.2-m-diameter culvert. Modern salinity has ranged 3-4 ppt in the harbor proper and < 2 ppt in surrounding wetlands. *Typha angustifolia* and *Phragmites australis* dominate the lowest-elevation wetlands probably first vegetated with *Spartina alterniflora*, whereas diverse wetland shrubs occupy slightly higher elevations replacing the original high-marsh halophytes (e.g. *S. patens, Juncus gerardii*). The lagoon is shallow (< 2 m), highly eutrophic and therefore subject to chronic hypoxia and summertime fish kills.

Since December 2001, the Seashore and the Town of Truro have attempted to improve tidal flushing and water quality by opening valves in the 1.2-m culvert that normally allows only freshwater discharge to Cape Cod Bay. Results have been profound, in terms of the recovery of salinity, to two-thirds that of seawater, and an abundance of estuarine animals, including shellfish, finfish, crustaceans and waterfowl. However, eutrophication and summertime oxygen stress remains a problem. To improve tidal exchange and water quality further, funding is sought by both the National Park Service and the US Army Corp of Engineers to perform a comprehensive study of more complete tidal restoration alternatives.

Pamet River, Truro

This tidal river's extensive wetlands occupy an outwash valley that extends completely across outer Cape Cod from a barrier beach on the Atlantic Ocean shore to a large inlet in the west where the system receives daily tidal exchange from Cape Cod Bay. After thousands of years of salt marsh development much of the flood plain has been isolated by solid-fill roads and tide gates from tidal seawater for 130 years, allowing the establishment of a diverse freshwater wetland plant community. Despite the freshwater wetland cover, the upper Pamet is separated from the Atlantic Ocean by only a narrow dune system and remains, geologically, a back-barrier wetland subject to episodic seawater overwash. Indeed, in just the last few decades several severe storms have overwashed the barrier and filled the diked Pamet basin with seawater. Extensive mortality of salt-sensitive vegetation was averted only because overwash occurred during the dormant season; a summer hurricane, in contrast, could decimate present vegetation communities.

A joint Corp of Engineers and Cape Cod Commission study, funded by both the Town and the Seashore, studied the hydrodynamics and groundwater hydrology of the upper Pamet to identify alternatives for proactively managing the diked system in view of likely future overwash. The study determined that installation of large culverts could restore tidal excursion to re-establish salt marshes in the upper Pamet while providing for the rapid discharge of overwashed seawater from the Atlantic. In addition the study found that nearby domestic drinking-water wells, septic systems and other structures would not be affected by restored seawater flow and estuarine restoration; however, no action has yet been taken.

East Harbor

Photo courtesy of Cape Cod National Seashore

Herring River

Photo courtesy of
Cape Cod National Seashore

Herring River, Wellfleet

The originally extensive Herring River salt marsh system occupied another outwash valley descending from east to west on the outer Cape peninsula with three inlets along the Cape Cod Bay shoreline. Early 20th century photographs show the flood plain covered by extensive tidal salt marshes; historic salt marsh cover over most of the flood plain has been corroborated by peat core analysis. After closure of the two northernmost inlets in the 18th and 19th centuries by natural sediment deposition, the main river mouth was diked in 1909 eliminating nearly all seawater inflow. Decreased salinity caused freshwater wetland species, especially exotic cattails and common reed, to increase at the expense of Spartina spp. and other halophytes. At higher elevations, the lowered water table due to diking and subsequent ditching and stream channelization allowed upland plants (e.g. *Prunus serotina, Rubus* spp.) to spread across the flood plain; today this same 125-hectare "upland" area is characterized by acid sulfate soils, formed by the oxidation of naturally sulfidic salt marsh sediment, that leach acidity and toxic aluminum into surface waters.

Hydrodynamic modeling, along with extensive multidisciplinary ecological research, indicates that extensive tidal and estuarine-habitat restoration is possible in Herring River without affecting adjacent roads, well-water quality and most structures. A major planning effort for this 1100-ha project, the largest so far for the entire Gulf of Maine, is under way by town, state and federal managers.

Hatches River

Photo courtesy of
Cape Cod National Seashore

Hatches Harbor, Provincetown

Because this salt marsh developed relatively recently behind the prograding northwestern tip of outer Cape Cod, peat is sandier and peat depths shallower than in the much older marsh systems to the south. A 1-km-long dike constructed in 1930 for mosquito control essentially bisected the flood plain completely blocking tidal exchange and reducing salinity in the landward half of the wetland. As a result, native salt marsh grasses were replaced by many species of salt-sensitive plants, including 8-10 ha of the somewhat salt-tolerant *Phragmites* by the 1990s; relict *Spartina* cover in the diked marsh amounted to only about 5 ha at lowest elevations nearest the tidal creeks. The Provincetown Airport was constructed within the flood plain in the 1940s, i.e. long before Park establishment, using the pre-existing dike as protection against tidal flooding.

The need for dike repair in 1986 prompted interagency discussions about the actual flood-protection needs of the airport and the possibility of tidal restoration. Federal Aviation Administration engineers determined critical flooding elevations for airport structures, while NPS scientists and cooperators developed a numerical hydrodynamic model of the estuarine system. The model showed that a wide, low culvert cross-section should provide sufficient seawater flooding to restore 25 – 35 ha of salt marsh and, at the same time, dampen storm tides that may otherwise affect the airport's instrument landing system. This culvert configuration and a general restoration plan were finally approved by a planning and regulatory team representing 10 local, state and federal agencies in 1997. Pre-restoration monitoring began in summer 1997, with the new culverts installed in the winter of 1998-1999.

Despite model predictions, the new culverts were not fully opened after construction. Opening has been done in small increments to build confidence among cooperators, especially airport officials, in the reliability of the model, and because of concerns for extensive plant death due to waterlogging should the marsh fail to drain during each low tide. Experience since 1999 has allayed both concerns.

The culverts were fully open by 2005. As a result of restored tidal range and salinity, exotic common reed and shrubs are being eliminated from the flood plain, and being replaced by an expansive area of native salt-marsh grasses and forbs. At the same time, the new culverts have performed as designed and as the model predicted, filtering out storm tides and protecting Provincetown Airport operations.

Conclusions

Salt marsh ecosystems are defined most fundamentally by tidal range and salinity. In recognition of this dependency and of the degrading effects of human-made tidal restrictions, Cape Cod National Seashore and cooperating local, state and federal agencies have been working for 20 years to restore tidal flow to Cape Cod's many diked salt marshes. This work will continue, restoring both ecological and social values and providing excellent case studies for application to estuarine restoration elsewhere.

Stormwater Runoff and Bacterial Pollution

by Jo Ann Muramoto, Ph.D., Senior Scientist, Association to Preserve Cape Cod; Massachusetts Bays Program Regional Coordinator for Cape Cod

I'll tell a true story about stormwater runoff. When I was a freshman at a science and engineering college in Pasadena, California, there was a student who was a chemical engineering major. Not only was he smart (he aced his courses while inhaling), but he was cool, hip (this was the early 70's), and a child of nature. So I was awed when he announced that he drank stormwater runoff from the street because runoff was pure and clean. But there was a seed of doubt in me. Who hasn't seen oily iridescent sheens on road surfaces after rain? What about the dirt and debris and worse, that collects in storm drains between storms? These were city streets, after all, not pristine nature.

Now we know better. Between the 1970's and the 1990's, we have learned a lot about water pollution and its many causes. By the early 1990's, watershed planners, engineers and scientists realized that untreated stormwater runoff from developed land areas can pollute our ponds, lakes, streams, rivers and coastal waters. We know that untreated stormwater run-off from roads, parking lots, buildings, and landscaped areas frequently contains bacteria, nutrients, metals, pesticides, oil, sediments, road de-icing compounds, or other pollutants. We know that allowing untreated polluted runoff to enter our coastal and fresh water bodies can cause water pollution.

Stormwater runoff from naturally vegetated and undisturbed land is usually cleaner. Why is this so? The answer is that rain and snowmelt in naturally vegetated areas soaks into the soil, where any pollutants that are present can stick to soil particles or be taken up by plants and beneficial soil bacteria. This natural treatment of stormwater runoff now forms the basis for new, green approaches to treating stormwater runoff using rain gardens, vegetated bioretention basins, and vegetated swales.

We also know that allowing stormwater to run off from impervious surfaces without managing the runoff can increase downstream flooding, erosion and sedimentation.

Impervious surfaces such as pavement and buildings prevent rainwater and snowmelt from soaking into the soil beneath these surfaces. As a result, water flows more quickly off imper-vious surfaces and builds up volume faster than precipitation that falls onto vegetation and soil. You can see this for yourself on any day following a heavy rain by going to the nearest body of water – the water will be brown and cloudy, the result of runoff. Generally, the more impervious surfaces and unmanaged runoff there is, the more erosion and sedimentation there will be.

This article focuses on storm-water runoff as one important source of bacterial pollution in Cape Cod Bay. It is important to remember, however, that stormwater can carry many pollutants, depending on land uses in the watershed, and that stormwater is only one of several sources of bacterial pollution.

Shellfish closure in Brewster, 2006.
Photo courtesy of Jo Ann Muramoto, APCC.

Both fecal coliform bacteria and Enterococcus bacteria are indicators of the presence of fecal matter. Fecal coliform bacteria can originate from both humans and animals (e.g., wildlife and domestic animals), while Enterococcus bacteria originates from humans. To help protect public health, there are state and federal water quality standards for swimming beaches and shellfishing areas. Shellfishing areas must be closed to shellfishing when the concentration of fecal coliform bacteria exceeds 14 per 100 milliliters. Swimming beaches must be closed when the concentrations of Enterococcus bacteria exceed 35 per 100 milliliters (mL) based on samples collected over several successive days (or 104 per 100 mL based on a single sample). In untreated stormwater, concentrations of fecal coliform bacteria can range from several hundred per 100 mLs to several thousand or several tens of thousands of bacteria per 100 mLs, or higher.

Watershed	Embayment or Estuary leading to Cape Cod Bay	Town	Cause of Impairment
Cape Cod	Provincetown Harbor	Provincetown/Truro	Pathogens
	Pamet River	Truro	Pathogens
	Duck Creek	Wellfleet	Pathogens
	Herring River	Wellfleet	Pathogens
	Wellfleet Harbor	Wellfleet	Pathogens
	Boat Meadow River	Eastham	Pathogens
	Little Namskaket Creek	Orleans	Pathogens
	Rock Harbor Creek	Orleans	Pathogens
	Namskaket Creek	Brewster/Orleans	Pathogens
	Quivett Creek	Brewster/Dennis	Pathogens
	Sesuit Creek	Dennis	Pathogens
	Chase Garden Creek	Dennis/Yarmouth	Pathogens
	Mill Creek	Barnstable/Yarmouth	Pathogens
	Barnstable Harbor	Barnstable	Pathogens
	Maraspin Creek	Barnstable	Pathogens
	Scorton Creek	Sandwich	Pathogens
South Shore	Ellisville Harbor	Plymouth	Pathogens
	Plymouth Harbor	Plymouth	Pathogens, other
	Duxbury Bay	Kingston/Plymouth	Pathogens
	Jones River	Kingston	Pathogens
	Green Harbor	Marshfield	Pathogens
	Bluefish River	Duxbury	Pathogens

Table 1. Cape Cod Bay embayments and estuaries classified as Category 5 (most impaired) for pathogenic bacteria.

Massachusetts 2006 List of Impaired Waters, MA DEP 2006.

In Cape Cod Bay, stormwater is one important source of bacterial pollution, though not the only source. Following storms, public beaches and shellfishing areas are often closed due to high concentrations of potentially harmful bacteria. For example, shellfishing areas throughout New England and Cape Cod were closed in June 2006, following exceptionally heavy rains, due to high counts of fecal coliform bacteria. Many swimming beaches were also closed due to high counts of human Enterococcus bacteria.

Closures of shellfish beds directly impact the Cape's economic well-being. Cape Cod Bay is home to some of the Commonwealth's most important shellfish aquaculture and shellfish resources. The total area of shellfish resources in Cape Cod Bay between Provincetown and the Back River in Hull is over 412,880 acres. On Cape Cod, there are 38 shellfish areas associated with Cape Cod Bay alone, totalling 145,082 acres (Figure 1). Of this vast area, 54.55 acres are restricted to shellfishing, 1,125.8 acres are prohibited, 1,905.5 acres are conditionally approved, and the remainder (141,996 acres) is approved for shellfishing (David Whittaker, Massachusetts Division of Marine Fisheries). Each closure results in the loss of revenue to those who depend upon shellfishing for income and also impacts recreational shellfishing and consumers.

Beach closures impact the Cape's tourist economy. There are at least 71 swimming beaches in Cape Cod towns on Cape Cod Bay where beach water quality testing for Enterococcus bacteria is performed. In 2006, there were 50 beach closures in Cape Cod towns on the Bay; of these 50 beach closures, 25 (or 50%) occurred during or after rain events, pointing to stormwater runoff as the mechanism.

Many coastal embayments on Cape Cod Bay are suffering from chronic bacterial pollution. The Massachusetts Department of Environmental Protection lists 22 coastal embayments and estuaries on Cape Cod Bay in the most impaired category of water quality due to chronically high concentrations of pathogenic bacteria (Table 1; Massachusetts Department of Environmental Protection, 2006).

While untreated stormwater runoff represents a major cause of closures of beaches and shellfish areas, it is not the sole cause. Other nonpoint sources of human sewage bacteria include discharges of boat sewage, improperly sited or malfunctioning septic systems, and illicit discharges.

What can be done to address stormwater pollution? Reducing pollutant use in the watershed helps to ensure that stormwater runoff carries fewer pollutants. Treating stormwater runoff before it enters a water body is important for minimizing or preventing water pollution. Stormwater treatment methods include stormwater catch basins, leaching trenches, infiltration galleys, vegetated bioretention basins, vegetated swales, and others that are designed to treat different pollutants. Low-impact development approaches now incorporate stormwater Best Management Practices (BMPs) that minimize impervious area and maximize stormwater infiltration.

Massachusetts is a leader in stormwater management and regulation. Many government agencies, organizations, and businesses are working to address stormwater pollution throughout the nation, the Commonwealth and Cape Cod. Some efforts in which Cape Cod Bay towns are involved include:

- **National Pollutant Discharge Elimination System (NPDES) Stormwater Permitting:** Under the federal Clean Water Act and the NPDES program, discharge of pollutants into water bodies is regulated. The NPDES stormwater program requires communities, industries, businesses, developers and others to manage and treat their stormwater runoff to prevent water pollution. The U.S. Environmental Protection Agency (EPA) administers this program, requiring communities to prepare and implement a stormwater management plan and obtain a permit for

discharging stormwater. Cape Cod Bay communities that are required to provide NPDES stormwater plans include Eastham, Orleans, Brewster, Dennis, Yarmouth, Barnstable, Sandwich and Bourne. Annual progress reports are posted on the Internet.

- **Draft Pathogen TMDL for the Cape Cod Watershed:** This draft document, prepared by EPA and DEP, describes bacterial pollution in Cape Cod waters and proposes a Total Maximum Daily Loading (TMDL) approach to regulating and controlling bacterial pollution. A TMDL works by controlling pollution sources in the watershed so that pollutant concentrations in the water body do not exceed levels that cause harm to ecosystems or public health.

- **State and regional stormwater programs:** The Massachusetts Office of Coastal Zone Management (CZM), a division of the Executive Office of Energy and Environmental Affairs (EOEEA), maintains a grant program and provides technical assistance to help communities with stormwater management and stormwater treatment. The Department of Environmental Protection provides grants for nonpoint source pollution prevention through the 319 grant program, which is funded by the EPA. EPA and DEP are working to implement bacterial water quality standards for state waters. DEP has published a stormwater manual and requires stormwater management for projects that require wetland permits. State transportation funds are available to help communities with stormwater treatment. Regional organizations, such as the Cape Cod Commission, Massachusetts Bays Program and Massachusetts Bays Estuary Association, provide technical assistance and outreach in stormwater management to Cape Cod towns. Certain non-governmental organizations also provide assistance to help communities with stormwater management, and outreach programs such as Think Blue Massachusetts help to educate citizens about the sources and impacts of stormwater pollution.

- **Cape Cod Water Resources Restoration Project:** The USDA Natural Resources Conservation Service has proposed this Cape-wide program to restore shellfish beds, salt marshes and fish runs. Shellfish beds would be restored by treating approximately 24 of the most important stormwater outfalls on Cape Cod, including several on Cape Cod Bay. This proposed project represents one of the most significant long-term restoration projects in the Northeast, and requires federal approval by Congress and the Administration.

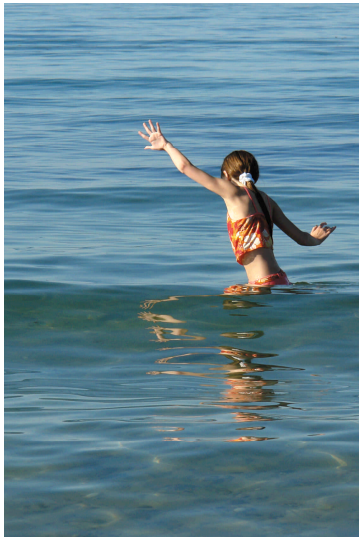

Photo courtesy of Nancy Viall Shoemaker

Despite these excellent programs, the Cape needs help to clean up its stormwater discharges. Cape Cod towns face significant financial challenges like many other small and medium-sized communities. Grants are highly competitive and can only pay for a small fraction of all needs throughout the Commonwealth. Stormwater treatment devices require appropriate siting and ongoing maintenance to ensure that they continue to protect water quality. The challenge for Cape Cod is to first ensure that all stormwater discharges are treated and, secondly, to ensure that all stormwater treatment continues, whatever the technology used. Innovative stormwater financing approaches such as stormwater utilities may provide the necessary resources for maintenance needs and may be appropriate for some Cape Cod communities that have sizeable impervious areas. The Association to Preserve Cape Cod (APCC), host of the Massachusetts Bays Program on Cape Cod, has received a grant from the Massachusetts Environmental Trust to provide a stormwater utility outreach program to Cape Cod communities. This outreach program will provide workshops, invited speakers and other outreach venues to raise public awareness of the need for stormwater management to protect and improve our waters.

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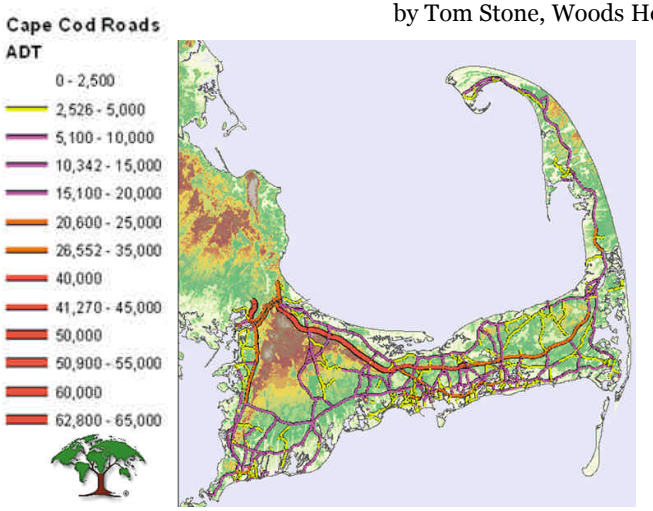
Think Blue Massachusetts website at: www.ThinkBlueMA.org

The Importance of Vehicular Traffic Sources of Nitrogen for Coastal Lagoons of Mass Bay

by Tom Stone, Woods Hole Research Center



Average Cape Daily Traffic Volumes

Courtesy of Woods Hole Research Center

Excess nitrogen input represent the largest pollution problem in the nation's coastal waters and one of the greatest threats to the ecological integrity of these ecosystems. A variety of deleterious changes in a coastal ecosystem are associated with eutrophication, including alterations in community structure, degradation of habitat quality, and increased incidences and duration of harmful algal blooms. Reversing the effects of coastal N pollution requires information on the magnitude of nitrogen sources, which vary in importance from estuary to estuary and from region to region. Important sources include wastewater treatment plants, septic-tank discharge through groundwater, runoff of fertilizer from lawns and agricultural fields, animal feedlot operations, and atmospheric deposition. Some of the nitrogen deposited onto land and water surfaces from the atmosphere is derived from upwind industrial and metropolitan areas. But, an important fraction may also come from local traffic, especially in areas like Cape Cod, where high traffic volumes are experienced year round and especially during the tourist season. Nitrogen from vehicle exhaust enters the nearby environment through deposition directly onto road surfaces and through deposition of N gases on nearby leaf and land surfaces. Much of this nitrogen is then washed into nearby water bodies during rains.

These sources of nitrogen are being measured in a study carried out jointly by scientists from The Woods Hole Research Center and Cornell University. Preliminary results show that total N deposition, both in rainfall and as dry aerosols, is over 3 mg N m-2 d-1 within about 150 feet of sampling sites along Woods Hole Road and Route 28 in the summer. This estimate is twice as high as previously believed. These estimates are being refined and will be applied to maps of high-traffic volume roads that are near coastal ponds, wetlands, and estuaries to estimate the inputs of nitrogen to these sensitive aquatic ecosystems.

Provincetown

Photo courtesy of Paul M. Shoemaker

Boston Harbor Outfall

by Bruce Berman
Communications Director, Save the Harbor/Save the Bay

One of the common concerns that Save the Harbor/Save the Bay shares with organizations like the Provincetown Center for Coastal Studies and other groups from Cape Cod to Cape Ann is that the Boston Harbor clean-up not come at the expense of Massachusetts Bay or Cape Cod Bay.

In the early phases of the project we were all particularly concerned about the potential impacts of the 9.5 mile long Mass Bay Outfall, which discharges treated effluent into Massachusetts Bay.

To address these concerns, we required strict limits on what could – and could not – be discharged into our marine environment, and began monitoring the site for potential impacts even before the plant went on line.

The results of that monitoring are regularly reviewed by a panel of independent scientists known as the Outfall Monitoring Science Advisory Panel (OMSAP) working in partnership with citizens and organizations around the bay through OMSAP's Public Interest Advisory Committee, which we chair.

Based on what we have learned so far from the extensive monitoring in place, we are pleased to report that the outfall appears to have had no negative or dramatic impacts on either Massachusetts Bay or Cape Cod Bay. Though there have been glitches from time to time, both the monitoring program, and the Deer Island sewage treatment facility and the Mass Bay outfall appear to working quite well.

In fact, the area adjacent to the diffusers at the end of the pipe is now home to a rock crab, brown and white sea anemones, and orange or bone white "sea peach" tunicates.

Photo courtesy of MWRA

If you would like to attend the next meeting of OMSAP and PIAC scheduled for early December, contact Ben Lasley at SH/SB by email at lasley@savetheharbor.org.

You can learn more about the outfall and its impacts on the environment at www.mwra.state.ma.us/harbor/html/outfall_update.htm

Cape Cod Bay No Discharge Area

by Steve McKenna,
Massachusetts Office of Coastal Zone Management

A No Discharge Area, or NDA, is a designated body of water in which the discharge of ALL boat sewage, even if it is treated, is prohibited. A body of water can become an NDA if a community or state believes that the waters are ecologically and recreationally important enough to deserve further protection than that provided by current Federal and State laws.

NDAs are important because they prevent the discharge of boat sewage in sensitive areas. Sewage wastes discharged from boats can contain microorganisms (bacteria, viruses, and protozoans), nutrients, and chemical products. All of these can have harmful effects upon aquatic life directly or by degrading water quality.

The effort to designate Cape Cod Bay as No Discharge Area began in the spring of 2006 with the formation of the Cape Cod Bay NDA workgroup. Representatives from Coastal Zone Management, the Town of Barnstable, Provincetown Center for Coastal Studies, the Association to Preserve Cape Cod, Mass Bays Program and Nantucket Sound Keeper agreed that a creation of a Cape Cod Bay NDA was a sound resource management goal, and began working to designate all of the waters of Cape Cod Bay, from Provincetown to Plymouth, as a Federal No Discharge Area. The geographic boundary follows the state territorial water line, and includes 11 Cape Cod towns.

Beginning in the spring of 2007, members of the workgroup began meeting with individual towns to gathering the necessary background information on existing vessel use within Cape Cod Bay, and existing pumpout facilities. At the same time, the work group began developing public outreach material to educate town officials and the general public about what an NDA is, what it means for towns, what it means for boaters, and about the water quality benefits associated with an NDA.

In the summer of 2007, the work group members began meeting with the Selectmen of all eleven Cape Towns to provide them with information about the Cape Cod NDA project, and to ask for their formal support. Our goal is to have letters of support for all 11 Cape communities by the end of October. The majority of data on vessel use and pumpout facilities has been collected through the efforts of the work group members and from Regina Lyons, an EPA intern assisting with the project. The workgroup is currently analyzing the data to determine what additional pumpout facilities may be needed to meet the requirements of EPA for NDA designation.

Over the winter, the work group will be working with those towns where additional pumpout needs have been identified to help them secure grant funding for this equipment. A formal application is expected to be submitted for EPA approval in early 2008, with formal designation expected in the fall of 2008 or spring 2009.

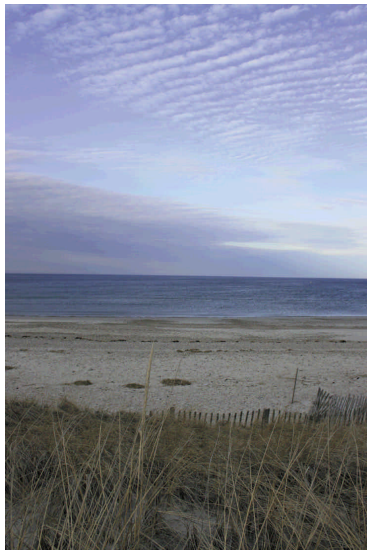
Left to right: Regina Lyons, EPA; Steve McKenna, MA CZM; Dale Saad, Town of Barnstable; Jo Ann Muramoto, APCC/Mass Bays; and Theresa Barbo, PCCS
Missing: HeatherRockwell, Nantucket Soundkeeper Program Officer

Coastal Zone Management on Cape Cod

by Steve McKenna,
Massachusetts Office of Coastal Zone Management

The mission of the Massachusetts Office of Coastal Zone Management is to balance the impact of human activities with the protection of coastal and marine resources through planning, public involvement, education, research, and sound resource management. To accomplish this mission, CZM works closely with local communities to ensure that local decision-making is based on sound coastal management principles. To directly serve the coastal communities throughout the state, CZM established its regional technical assistance program and maintains five regional offices.

The CZM Regional Office for Cape Cod & Islands serves the 26 towns throughout Cape Cod, Martha's Vineyard, Nantucket, and the Elizabeth Islands. These communities are within the Cape Cod Bay, Cape Cod, and Buzzards Bay watersheds. The region is a very diverse geographically, ecologically and politically. Ecologically, the Cape separates the cold deep waters of habitats of Cape Cod Bay from the warm shallow water habitats of Nantucket and Vineyard Sounds, Geographically, the region encompasses all of the Cape, and the islands of Nantucket, Martha's Vineyard, Monomoy, Tuckernut, Muskeget, Nomans and the 15 named islands of the Elizabeth Island chain. Politically, the region encompasses 26 municipalities, three county governments; Barnstable, Dukes and Nantucket counties; two regional planning agencies; two federally recognized tribal nations; Cape Cod National Seashore; Camp Edwards and Otis Air Force Base, and a large marine academic community centered in Woods Hole.



The Cape & Islands Regional Coordinator serves as a liaison between federal and state programs and municipal authorities on key initiatives within the coastal zone. The regional coordinator facilitates local initiatives that are consistent with CZM program goals, such as resource management and watershed and port/harbor planning efforts. The Cape Cod Bay NDA project is an example of this type of facilitation effort.

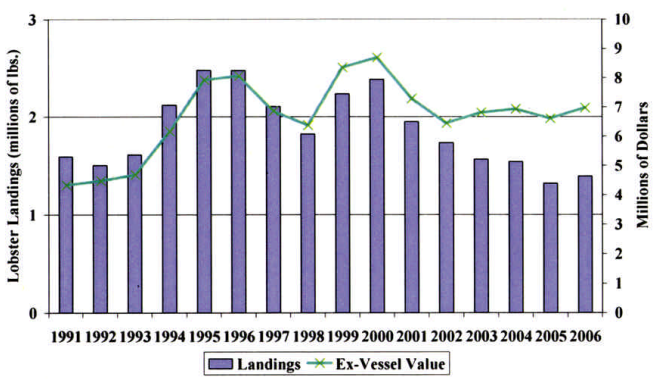
The CZM regional Coordinator responds to technical assistance requests on a variety of coastal issues, including: Coastal landform protection, natural resource assessment and mapping, stormwater management and remediation, water quality protections and harbor planning efforts. CZM works to provide ongoing training opportunities to coastal resource managers throughout the Cape & Islands, and helps coordinate workshops on a variety of emerging coastal issues.

Cape Cod Bay Lobster Fishery

by Robert Glenn, Senior Marine Fisheries Biologist, MA DMS

American lobsters are one of the most commercially important natural resources in Cape Cod Bay. Lobsters have been commercially harvested in the bay since the 1830's, and today have an ex-vessel value of between $5,000,000 and $8,000,000 annually.

Figure 1. Commercial landings and ex-vessel value of American Lobster in Cape Cod Bay.



The lobster fishery in Cape Cod Bay is primarily conducted with traps fished from small, 28 to 42 ft "lobster-style" boats. These boats make day trips during which they typically haul between 150 and 400 traps per day. The primary lobster fishing ports in the bay are Plymouth Harbor, Sandwich Basin, and Provincetown Harbor, which typically account for approximately 50%, 23%, and 21% of the commercial lobster landings respectively. Barnstable Harbor and Sesuit Harbor account for the remainder of the bay-wide lobster landings. Fishing occurs all year, however, the majority of the commercial landings and fishing effort occurs between June and October.

Table 1. Cape Cod Bay lobster fishery statistics.

Year	*# of active lobstermen*	*# of Traps*
1991	244	63,466
1992	253	70,717
1993	264	77,258
1994	309	89,977
1995	305	95,176
1996	334	107,872
1997	331	105,754
1998	321	107,520
1999	316	105,817
2000	333	111,484
2001	336	114,462
2002	311	110,095
2003	312	108,521
2004	278	100,259
2005	278	90,997
2006	258	98,039
Average	**299**	**97,338**

Between 1991 and 2006 commercial lobster landings in the bay have ranged from 1.3 to 2.5 million pounds, with peaks in 1995, 1996, and 2000 (Figure 1). The commercial landings, number of active fishermen, and number of traps fished in the Cape Cod Bay lobster fishery increased substantially from 1991 to 1996, remained fairly stable between 1997 and 2001, and have declined substantially from 2002 to 2006 (Table 1 & Figure 1). Despite the decline in lobster landings since 2000, the ex-vessel value of lobster during this time period has remained fairly stable at approximately $7,000,000. This is due to an increase in the ex-vessel per pound price of lobster in recent years.

The decline in lobster landings in recent years appears to be related to extremely poor young-of-year (YOY) recruitment in the middle to late 1990's (Figure 2). Lobsters in this region typically take between 6 and 8 years to reach minimum legal size (3 1/4" carapace length). As such YOY lobsters that settled out between 1995 and 1999 would be reaching the fishery between 2001 and 2007, which happens to be the time period when commercial landings have declined. While it is difficult to predict whether the relationship between larval settlement and future landings in the fishery will continue, the increased settlement observed between 2002 and 2004 may be an indicator of improvements in the lobster fishery in Cape Cod Bay between 2008 and 2012.

Red Tide in Massachusetts and Cape Cod Bay

Compiled by Mass. Division of Marine Fisheries (MA DMF) Staff

Monitoring Program

Red tide is a naturally-occurring dinoflegellate Alexandriun fundyense phytoplankton bloom that produces a condition in shellfish known as Paralytic Shellfish Poisoning (PSP) and has occurred somewhere in coastal Massachusetts every year, except 2004, since 1972 prompting the closing of many designated shellfish growing areas (DSGA) throughout the state.

MA DMF initiates its annual Paralytic Shellfish Poisoning (PSP) monitoring program in March in the Nauset estuarine system in Orleans and Eastham closely followed by the coastwide shellfish sampling regimen from the New Hampshire border to the south side of Cape Cod commencing in early April and continuing on a weekly basis through November. Shellfish sampling initially involves collecting the Blue mussel, Mytilus edulis, from 16 primary stations (4 in Cape Cod Bay) and processing them at the DMF Gloucester Biotoxin lab. If biotoxin levels begin to rise or exceed 80ug/100g in shellfish tissue, the official level mandating closure, sampling is conducted more frequently at affected primary sites and may be extended into selected secondary locations. Very rarely, over the last 35 years, have coastal blooms extended beyond the northern portions of Cape Cod Bay.

The 2005 bloom migrated southward through southern Maine and New Hampshire and into the Commonwealth eventually setting an all-time record for the distribution of Alexandrium cells and subsequent DSGA closures. On its passage southward, the intensity of the bloom with its exceptional numbers of cells (40,000 per liter recorded in Cape Cod Bay) was exacerbated by the extremely heavy rain and northeast winds from two back-to-back northeast storms that pressed the bloom tightly up against the shoreline into Cape Cod Bay thus creating a Perfect Storm scenario. A total of 1,351,265 acres, or 77.4% of the Commonwealth's marine waters were eventually closed to shellfishing with 476,159 of those being in the lower portions of Massachusetts Bay (Cohasset to Duxbury) and Cape Cod Bay (35%).

Not only did the 2005 event dramatically impact that year, but effects were carried well into 2006 in the form of shellfish harvesting closures for selected species. No biotoxin events occurred in Cape Cod Bay in 2007.

Cape Cod Bay Finfisheries

Commercial Finfisheries Regulatory measures enacted to rebuild regional groundfish populations (Atlantic cod, yellowtail flounder, winter flounder, etc.) have restrained fishing operations using gear capable of catching groundfish. In addition, directed fisheries for spiny dogfish have also been limited by strict catch quotas and closed seasons.

A fleet of approximately three dozen otter trawl vessels continues to fish Cape Cod Bay on a limited basis in Provincetown, Sandwich, and Plymouth harbors as well as numerous more distant Massachusetts ports. A small fleet of approximately 10 vessels deploys gillnets in Cape Cod Bay on a limited basis. Five vessels reported setting fish pots in Cape Cod Bay during 2006.

Recreational Finfisheries Recreational anglers pursue striped bass, fluke, winter flounder, mackerel, bluefin tuna, bluefish, and Atlantic cod. Shore anglers fish the surf and harbors while a ubiquitous fleet of private boats and an extensive fleet of party boats carry a host of anglers to all reaches of Cape Cod Bay.

Fishery Survey Trends The Massachusetts Division of Marine Fisheries has conducted a trawl survey every spring and fall since 1978 throughout state waters including Cape Cod Bay. The survey is useful in monitoring population trends in many fish species which reside on or near the seafloor of Cape Cod Bay, including species of little commercial or recreational interest.

Shellfish Harvesting in Cape Cod Bay The Division of Marine Fisheries (DMF) has a multi-faceted responsibility for the management of shellfish throughout the Commonwealth, including disciplines such as water quality monitoring and analysis, resource and habitat assessment, selected fisheries management and aquaculture.

Shellfish Sanitation and Water Quality Since 1988, when the Department of Environmental Quality Engineering (DEQE), now the Department of Environmental Protection (DEP) transferred shellfish water quality responsibilities to DMF, the Division's Shellfish Project has focused most of their energies toward this activity. Primarily, it deals with protecting the public health by classifying marine waters into five major categories; Approved, Conditionally Approved, Restricted, Conditionally Restricted and Prohibited.

Visit the DMF website for further information on growing areas and the shellfish program:

www.mass.gov/dfwele/dmf/programsandprojects/dsga.htm#ccb

www.mass.gov/dfwele/dmf/programsandprojects/dsga.htm#ccb

Canal Station Vessels
Photo courtesy of USCG

United States Coast Guard Presence

The United States Coast Guard maintains a strong presence on Cape Cod Bay at three locations: Stations Sandwich and Provincetown, and at Air Station Cape Cod at Otis Air Force Base located slightly inland at the Massachusetts Military Reservation.

Executive Petty Officer Mark Coady from Station Sandwich, which is a 'heavy weather station,' says crews are "out on the water every day, either in the Cape Cod Canal or the bay." Crews are busy, he clarified, "especially around the southern coast, near Barnstable Harbor and Sesuit, not to mention commercial traffic in-bound to the canal itself." Station Sandwich is responsible for the southwestern half of Cape Cod Bay, while Station Provincetown covers the Northeast section.

From the air, Commander Stephen Torpey, operations officer at the Air Station, says "Cape Cod Bay is our backdoor and we fly over it often to get to places" during exercises and while on Search and Rescue missions, either in the bay or in nearby waters.

The Cape Cod Canal

by Samantha Mirabella, Park Ranger,
US Army Corps of Engineers, Cape Cod Canal

The Cape Cod Canal is a sea level 17.4-mile Federal navigation project located in southeastern Massachusetts. The waterway extends from Cleveland Ledge Light in Buzzards Bay on its southwest to approximately 1.6 statue miles seaward of the Canal Breakwater Light in Cape Cod Bay on its northeast making Cape Cod an island. This 480-foot wide by 32-foot deep canal provides a mileage savings of 65 to 166 miles for vessels that would otherwise have to travel around the historically treacherous outer shores of Cape Cod.

Since 1928, the US Army Corps of Engineers has been responsible for the operation and maintenance of the Cape Cod Canal. The Corps responsibilities along the canal include: operation and maintenance of the navigable waterway as well as the two highway bridges and one vertical lift railroad bridge that span the Canal; monitoring all vessel traffic and direct all vessels over 65 feet through the canal; and managing the natural resources and recreational opportunities on the nearly 1,100 acres of Federal land that surround the canal.

Though the Cape Cod Canal did not become a reality until July of 1914, proposals for a canal in this location date back to Plimoth Colony in the 1620s. Historically, two tidal rivers flowed through the isthmus; the Scusset River from Cape Cod Bay and the Monument River from Buzzards Bay. Less than 1 mile of land no more than 30 feet above sea level separated these waters. Nearly 300 years of studies, proposals and charters would pass before August Belmont's Boston, Cape Cod and New York Canal Company opened the canal to vessel traffic. This privately-run canal was a toll waterway. But, its narrow channel, tricky currents and resulting mishaps led to lower than expected use and revenues.

The failing canal was purchased by the Federal Government on March 31, 1928. The US Army Corps of Engineers was placed in charge of transforming the Canal into a safe and viable waterway. Major reconstruction occurred during the Great Depression years of the 1930s. Work included construction of all three bridges, widening and deepening the channel, straitening the approach channel in Buzzards Bay, improving the lighting system and placement of bank revetment. Approximately 54,000,000 cubic yards of excavation were involved with the construction of the canal, including 15 million cubic yards in Belmont's canal.

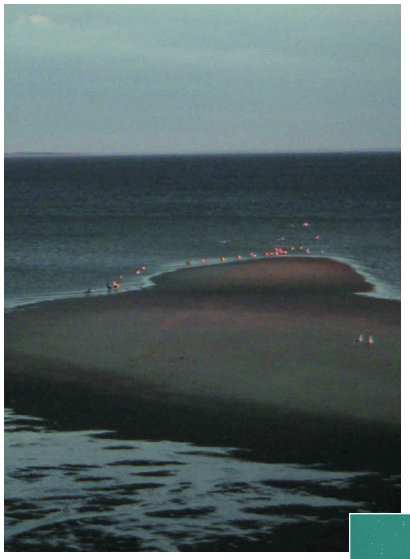
Today, the US Army Corps of Engineer's Centralized Marine Traffic Control Center with the assistance of their patrol and tug boats, ensure safe movement of all transiting vessels. Last year nearly 13,883 vessels, of which 6,569 were over 65 feet in length, transited the Cape Cod Canal transporting 7,769,584 tons of cargo.

Canal Station Rigid Hull, photo courtesy of USCG

NOAA Fisheries

by Todd Nickerson, Special Agent, NOAA Law Enforcement

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service Office of Law Enforcement (OLE) is responsible for protecting our nation's living marine resources in the Federal waters of the United States. In the northeast, the majority of efforts are placed on federal fishery regulations including such species as cod, haddock, monkfish, scallops, lobster, squid, and many others. Additional areas of responsibility include investigations regarding marine mammals and endangered marine species. The Special Agents in the northeast work very closely with the Massachusetts Environmental Police Officers on issues regarding Cape Cod Bay. Specifically, both agencies work closely on matters regarding the endangered right whales that frequent Cape Cod Bay. Major enforcement concerns include the harassment of surfacing large whales by recreational vessels. Agents and officers also closely monitor set fishing gear (pots and gill net) to ensure they comply with federal large whale take reduction plans. Besides matters with large whales, agents also investigate the Marine Mammal Protection Act in Cape Cod Bay. Agents investigate seal harassment and shootings as well as any human interaction cases involving marine mammals.



"Right whale image taken by Cynthia Browning (PCCS) under NOAA Fisheries permit 633-1763, under the authority of the U.S. Endangered Species and Marine Mammal Protection Acts"

Massachusetts Environmental Police

by Matt Bass, Officer, Massachusetts Environmental Police

The Environmental Police is primary enforcement agency for the Commonwealth Massachusetts to enforce all inland hunting and fishing laws, recreational vehicle regulations, boating safety and enforcement, commercial and recreational marine fisheries laws as well as boat and recreational vehicle theft. Environmental police officers area authorized to enforce all state laws as well as being deputized with the National Marine Fisheries Service and the U.S. Fish and Wildlife.

Coastal communities are divided into regions with officers assigned to districts within each region. A district may encompass anywhere from one to several towns. Coastal officers in the area of Cape Cod Bay have multiple vessels at there disposal including: jet skis for near shore areas, two 27' Safeboats located in Sandwich and Scituate, a 25' Parker center console in Plymouth, a 38' lobster boat located in Sandwich, and the offshore patrol boat "Jesse" primarily based out of Boston.

Officers' primary duties in Cape Cod Bay are to enforce boating laws, i.e. registration, proper number of life jackets and other safety equipment, commercial and recreational fisheries regulations, marine mammal protection and oil spills or other pollution.

East End of Cape Cod Canal

The Environmental Police have an excellent working relationship with local harbormasters, the National Marine Fisheries Service Office of Law Enforcement, the U.S. Coast Guard small boat stations as well as Air Station Cape Cod.

Current concerns for the bay are enforcement of mobile gear regulations concerning spawning area closures and the harvesting of surf clams as well as continuing efforts with the Atlantic Large Whale Take Reduction Plan by maintaining compliance with lobster and gillnet gear.

Unlike many watershed areas and ecosystems, Cape Cod Bay is not heavily industrialized as, say, areas along the Hudson River in New York. We do, however, have two energy plants along the Bay: the Pilgrim Nuclear Power Plant in Plymouth, and the Canal Power Plant in Sandwich, known by locals as 'the Mirant Plant.'

Two collaborators, Pine Dubois and Chris Powicki, weigh in on the ecological challenges Pilgrim and Mirant, respectively, pose, for Cape Cod Bay.

Jones River

Jones River and Pilgrim Nuclear Power Plant

by Pine Dubois, Executive Director, Jones River Watershed Assoc.

Jones River Landing Environmental Heritage Center has become fairly well established in the Jones River estuary and is rooted in its mission to improve the ecosystem functions of the Jones River and Cape Cod Bay. Purchased in 2003, Jones River Landing is a non-profit organization which houses several groups that working to develop public programs around ecology, recreation and boatbuilding. The Landing is the site of the oldest continuously operating boatyard in the country, and the Jones is the largest river draining to Cape Cod Bay. The Mass Bay Maritime Artisans ensure that the skills and crafts associated with the traditions of wooden boatbuilding are kept alive and energized, while the Jones River Watershed Association (JRWA) is making strides to improve water quality and overcome the politics of diminished flows - all in an effort to restore the historic and diadromous fish habitats.The headwater of the Jones River is Silver Lake, a deep coldwater glacier lake - the group intends to reinstate the habitat connection between Silver Lake and Cape Cod Bay.

In the late winter and spring this year the JRWA commented on the re-licensing of Pilgrim Station. The group has concerns that during the process of once-through cooling, the plant kills off significant populations of Jones River rainbow smelt and river herring along with impacts to dozens of other fish species. Pilgrim plant has an intake structure that juts out into the bay to suck in a half a billion gallons each day of water to cool the reactor. This water is then discharged back to the bay at high temperatures and questionable quality. The intake structure has screens and mechanisms to prevent too many organisms from being sucked in that would clog the pumps. Nevertheless, hundreds of thousands of fish, larvae and eggs are killed every year as a result of this system.

JRWA is urging a more advanced, environmentally benign upgrade to the plant if re-licensing is considered. A dry cooling tower would eliminate the intake structure and mechanisms. This type of system is being required in newer power plants and may be required in older plants as well. Currently the issue is before federal courts and EPA rules are being reworked. The present technology has been proven to have unacceptable adverse impacts on aquatic organisms.

JRWA is cooperating with the Division of Marine Fisheries [DMF] to study the population of rainbow smelt in the Jones River, which is reduced substantially from former high levels; and is monitoring river herring as part of the river restoration and fish passage plans. This summer DMF also enlisted Jones River Landing to assist in tagging the sand tiger sharks that have migrated to Kingston/Duxbury/Plymouth Bays. Other work includes data collection from the permanent water sampling station at JRL and planning a feasibility study for expanded fish passage in the river. Check out www.jonesriver.org for additional information and updates.

The Canal Power Plant

by Chris Powicki, Principal, Water Energy & Ecology Information Services; President, Cape & Islands Renewable Energy Collaborative

The Canal Power Plant is the largest steam-electric generating station within the Cape Cod Bay's drainage basin. Located on the eastern side of the Cape Cod Canal in Sandwich, it also is a very visible sign of our current energy economy, which is largely dependent on fossil fuels. Not only is the plant imposing adverse impacts on the bay's water quality, habitats and species, and coastal communities, but also its mode of operations is indicative of larger problems that could irrevocably alter Cape Cod Bay as we know it.

The Canal Plant has a total nameplate generating capacity of 1120 megawatts. One of the plant's two units has the capability to burn natural gas, but the facility is predominantly fueled by oil shipped from overseas and then barged through Buzzards Bay and Cape Cod Canal. The national security issues associated with securing foreign oil are all too evident these days, while the threat of another spill is omnipresent.

The plant employs conventional boiler, steam turbine, generator, and once-through cooling systems to convert fuel into useful electricity and wasted heat while creating aqueous discharges, air emissions, and solid wastes. Its operations are permitted under a variety of environmental policy frameworks, with significant upgrades to its emissions control systems performed in recent years to meet tightening standards. Nonetheless, for each hour that the plant runs at full capacity, it withdraws millions of gallons of ambient-temperature water from the canal; it emits tons of air pollution, hundreds of tons of greenhouse gases, and trace amounts of mercury and other air toxics; and it discharges millions of gallons of heated water, blended with wastewater streams containing various pollutants, to the canal. These practices harm Cape Cod Bay ecosystems in several ways.

According to studies commissioned by the plant, its cooling water intake system results in the entrainment of billions of eggs and hundreds of millions of juveniles and the impingement of tens of thousands of adults. Because most individuals die or suffer serious injury, this system is impacting localized populations of river herring and other important forage species, and it is disrupting the flow of energy through the ecosystem. The plant's heated discharges are somewhat less problematic: The tidal currents coursing through the canal promote rapid mixing, which minimizes the effects of thermal pollution. The pollutants contained in these discharges are also rapidly dispersed, but they represent an additional stressor among many, and some may bioaccumulate in marine species.

Among air emissions, releases of nitrogen oxides (NOx), mercury (Hg), and carbon dioxide (CO_2) are of the greatest concern for aquatic ecosystems, with the plant's releases joining those from countless other sources. NOx emissions deposit directly on the surface of Cape Cod Bay, and they can enter the bay as runoff if deposited within its drainage basin. This augments nutrient loading and increases the potential for eutrophication. Similarly, even trace releases of Hg are problematic, in that they can enter aquatic food chains and reach potentially toxic concentrations at higher trophic levels. The plant's CO_2 emissions do not have direct and immediate ecological impacts, but they are contributing to the unprecedented atmospheric accumulation of this greenhouse gas. This is changing global climate and ocean chemistry, with potentially severe implications for the future of Cape Cod Bay.


The Canal Power Plant

One good thing may be said about the skyrocketing price of oil: it has made power from the Canal Plant extremely expensive, to the extent that the plant operates at a nominal level most of the time, generates hundreds of megawatts only during peak power demand periods, and runs near full capacity very rarely if at all. As a result, its total pollutant and greenhouse gas emissions have dropped substantially over the past couple years, but its once-through cooling system continues to operate at full bore all the time, and the plant can still live up to its reputation as one of the dirtiest facilities in New England.

Organizations and agencies are working at many scales to mitigate the adverse impacts of the Canal Plant and our present-day energy system on the bay and its environs by advocating for and implementing more stringent policies, encouraging energy conservation and efficiency, and promoting renewable energy. In local communities, Cape Clean Air has led efforts to reduce air emissions from the plant, while the Cape & Islands Renewable Energy Collaborative is bringing together diverse stakeholders to accelerate progress toward a sustainable energy future at the individual, organizational, municipal, and regional levels. For more information,visit: www.cirenew.org, www.cirenew.info, and www.cigogreen.org.

Marine Resources

by Steve Tucker, who served as the Marine and Coastal Program Manager for the Cape Cod Commission from 1999 to early 2007.

Quiescent Cape Cod Bay doesn't demand our attention in the way that other adjacent coastal waters do.

Erosion is a chronic concern along the fringe of the Bay, especially on the North coast near the Corps of Engineers' Jetty and within Wellfleet Harbor. Aside from the occasional fall or winter tantrum, the waters of Cape Cod Bay generally behave better than the more boisterous Atlantic Ocean against the Cape's outer shore, making its presence known by punching through coastal landforms and relocate navigation channels. Cape Cod Bay's colder waters also mix freely with Massachusetts Bay and the Gulf of Maine and are less susceptible (in the aggregate) to the effects nutrients released from ocean and land-based sources that exacerbate episodic fits of vegetative growth, anoxia and overgrowth of algae and accompanying odors along Nantucket Sound and

Buzzards Bay. The same complexity that produces the highly reactive coastal ponds and small embayments on the south side of the Cape is not evident on the North side, and the graceful curve and more abrupt nature of the Northern shore has been spared from the proliferation of docks and piers that interrupt the banks, beaches and submerged habitat on the south coast. Cape Cod Bay and the North coast of the Cape have thus been the beneficiary of a certain serendipity, a pleasant accident of glacial morphology that left sufficient deposits to delineate the western edge of the Acadian and Virginian maritime provinces.

Are the natural defenses - we must ask ourselves - enough to stave against environmental degradation? The Bay has subsequently been adorned with designations that identify some of its special characteristics. Cape Cod Bay has been designated by Commonwealth as an Ocean Sanctuary. Subsets within this area have been called out as Areas of Critical Environmental Concern, some shallow regions harbor swatches of verdant seagrass and other locations have been designated by local officials as leasehold areas for aquaculture production. Underlying these geopolitical boundaries, sandy shoals continue to slip around rocky stretches that are, in turn, peppered with muddy slathers of silt.

Despite all we that we do know about Cape Cod Bay and local, state and federal efforts to identify key areas of the ecosystem and manage them appropriately, we are currently left with an inefficient patchwork-quilt of interests addressed in a partitioned manner and managed in isolation.

So too, we have focused the bulk of our ability to guide human interaction with the environment by focusing on this narrow strip of land, once forested, subsequently stripped to open cobbly farmland and provide wood that fueled human enterprise. The vistas that prevail throughout the daily lives of many Cape Codders are now dominated by the thick glens of human habitation, linked by sinewy veins of asphalt and bordered by stubbled grass lawns rather than sweeping seascapes where waves attenuate with distance to meet the flat horizon. The Cape's culture has shifted its focus from a seaward facing, resource-based orientation to the development of businesses and residence on our poor soils, and we have largely ignored the great waterbody to our North.

Fortunately, human society has a rich legacy of creating public systems to meet perceived threats, even after decades of lethargy.

Cape Cod may be facing several such threats, each of sufficient scale and scope to draw our attention back to the shore and the cold waters of Cape Cod Bay. As global climate change progresses, the cumulative effect of shoreline structures that sequester sand on particular properties, depriving the communal littoral system of material will become clearer as fringing beaches are starved and lost. So too, the Cape's teeming salt marshes that have been confined and constrained in place by roads and other infrastructure will be unable to respond to rising seas and portions will be drowned. Changes of a grander scale, affecting the temperature and salinity of bay waters may lead to sweeping shifts in the distribution and composition communities at the base of the food web. These changes could foster the establishment of species previously uncommon or unknown our part of the Gulf of Maine, or render Cape Cod Bay unsuitable for species that are now emblematic of New England's maritime character. One might even wonder whether our nearshore waters will come to host a more abundant and prolific, local source of red tide spores rather than suffering the more episodic invasion from the North.

There are indications that we are entering a time when threats to Cape Cod Bay are indeed universal enough to prompt our genuine engagement with the system once defined life on Cape Cod. A regional effort to limit the amount sewage released into the waters around the Cape has been launched, and is engendering a broader regional discussion about the importance of our coastal margins. The Commonwealth of Massachusetts and the United States Geologic Survey have been mapping the floor of Cape Cod Bay, generating new data and information that will improve our understanding of the relations between different habitat types and geographic areas. And perhaps most importantly, the Provincetown Center for Coastal Studies continues work to document the current composition of our coastal waters, our best measure of the "State of the Bay". This body of work represents some of the most forward thinking and vigilant work that the Cape has to offer. Staying vigilant, choosing to monitor the way that things are absent looming threats, is both the most daunting and the most valuable work that can ensue. Daunting, because generating support for and interest in the status quo can be difficult. Significant, because without an adequately honed baseline to measure from, it is impossible to accurately assess changes in the environment.

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Nancy Viall Shoemaker

Perhaps now, the stage is set for a more enlightened, cognizant approach to the management of our interaction with the marine environment; to take a more thoughtful and deliberate approach to the myriad uses and values of Cape Cod Bay. We have grassroots efforts afoot such as the nascent Cape Cod Bay Council, and legislative mandates that may soon be delivered to state agencies. We have a body of baseline science that needs continued attention and support, and looming questions about the future of our coastal landforms, salt marshes and marine waters all deserving of further exploration. The time to reclaim and in some instances, reshape our ties to the sea is now. If willing indifference prevails and absent redoubled efforts to monitor and safeguard the quality and key characteristics of Cape Cod Bay and the Cape's dynamic shoreline, we remain at risk of sailing into a tempest, blindly.

Cape Cod Bay doesn't demand much attention. But it does deserve further exploration, care and management if we are to safeguard its standing as a gem of the New England coast, and a touchstone of Cape Cod's history, lifestyle and ethic.