Parker River/Essex Bay ACEC Resource Inventory

Massachusetts Coastal Zone Management

2000

TABLE OF CONTENTS

INTRODUCTION

The Parker River/Essex Bay Area of Critical Environmental Concern (ACEC) is recognized as a unique complex of ecosystems with environmental, economic, and recreational significance. The area is especially noted for the Plum Island Sound and Essex Bay estuaries, extensive salt marsh, barrier beach and dune ecosystems, shellfish beds, and abundant wildlife. Located on the North Shore of Massachusetts, the ACEC includes 25,500 acres in the towns of Essex, Gloucester, Ipswich, Newbury, and Rowley. Although the ACEC was designated in 1979, this is the first time since the designation that a summary of the natural resources has been compiled focusing specifically on the ACEC.

The resource inventory summarizes existing research and compiles expert field knowledge about natural resources in the Parker River/Essex Bay ACEC. Background information and data is summarized from state agency and conservation group research reports (*see Literature Cited*). Since research efforts generally focus on the two ecosystems of Plum Island Sound and Essex Bay, these regions will be highlighted throughout the inventory. In addition, local scientists and field experts were interviewed in the Fall, 1999 to gain further insight about the status and trends of ACEC resources including: 1) current and future resource trends, 2) gaps in existing research and data, 3) important resource threats or issues, and 4) opportunities for restoration. Their responses are documented in *Field Notes* at the end of the sections on salt marsh, wildlife, finfish, shellfish, and water quality. The interviews, along with information from existing reports, are combined in this report to summarize the condition of ACEC natural resources. Additional background on the area is provided in: 1) Appendix A which is an updated bibliography of ACEC research documents, 2) Appendix B which includes ACEC designation and regulatory fact sheets, and 3) Appendix C which is a contact list for ACEC partners.

Managers, scientists, and local officials who are working to protect ACEC resources can use information compiled in the inventory to: 1) assess local and regional research needs, 2) guide restoration/mitigation efforts, and 3) prioritize future workplans. At the local level, the inventory can be used as background information for writing grants or to update open space and master plans. The inventory is also a tool that can be used by scientists and resource mangers to prioritize and design technical assistance and research programs at local and regional levels.

The salt marsh is a predominant ecological and visual feature in the ACEC. Common marsh animals and plants as well as impacts and monitoring parameters are described in the inventory's **Salt Marsh** section. *Salt Marsh Field Notes* indicate the following topics of concern:

- standardized monitoring protocols,
- tidal restrictions,
- sea level rise,
- recreational boating, and
- increased development along the marsh edge.

Wildlife depends on salt marsh and upland to forage, breed, rest, and migrate to other seasonal habitats. Historical and current records of bird surveys are presented in the **Wildlife** section of the resource inventory. *Wildlife Field Notes* indicate the following topics of concern:

- human impacts on wildlife populations,
- inadequate shore and migratory bird population estimates,
- habitat fragmentation,
- loss of wildlife corridors, and
- recreational boating impacts on wildlife.

ACEC waters provide important spawning, nursery, and feeding areas for many finfish populations. A description of the major finfish species as well as data showing population changes from the 1960s to the 1990s are presented in the **Finfish** section of the inventory. *Finfish Field Notes* indicate the following topics of concern:

- long-term, quantifiable estimates of pelagic fish populations,
- change in large scale, oceanic conditions,
- fish spawning habitat degradation, and
- maintenance and upgrading of fish ladders and dams.

The ACEC continues to be an important shellfishing area on the coast of Massachusetts. The **Shellfish** section of the inventory describes the species being harvested and defines the Division of Marine Fisheries classification of shellfish beds. *Shellfish Field Notes* indicate the following topics of concern:

- qualitative and quantitative data needs,
- over harvesting,
- invasive species,
- aquaculture, and
- water quality and related shellfish management closures.

Physical, chemical, and biological results of water quality sampling as well as potential sources of pollution for Plum Island Sound and Essex Bay are described in the inventory's **Water Quality** section. *Water Quality Field Notes* indicate the following areas of concern:

- development and the associated increase in impervious surface and nutrient loading,
- nutrient sampling in tributaries,
- water quality remediation at identified hot spots,
- septic system failures, and
- agricultural runoff from upper watersheds.

In addition to these sections, the resource inventory describes the regional history, geology and soils, estuaries and tidal flats, land use, open space and recreation, and future ecosystem research in the Parker River/Essex Bay ACEC.

ACEC CHARACTERISTICS AND DESIGNATION

An Area of Critical Environmental Concern (ACEC) is a region with unique natural and human resource values that are worthy of concern and protection. The Parker River/Essex Bay Area of Critical Environmental Concern was designated in 1979 as the second coastal ACEC in Massachusetts. This ACEC includes 25,500 acres of estuarine, riverine, salt marsh, and barrier beach ecosystems and is located within the municipalities of Newbury, Rowley, Ipswich, Essex and Gloucester. Table 1 summarizes town areas based on their approximate acreage within the ACEC boundary and this acreage as a percentage of total ACEC area.

Table 1. Acreage and percentage of towns within the ACEC
Note: *These numbers were obtained through analysis of the MassGIS database*
ACEC area is calculated to be 25,500 acres

Town	Approximate acreage	Approximate percentage of ACEC
Newbury	7,387	29
Rowley	3,898	15
Ipswich	9,866	39
Essex	3,435	14
Gloucester	912	4

On the coast, the ACEC boundary (Figure 1) follows the mean low water line from the northern edge of the Parker River National Wildlife Refuge south to Gloucester. Inland, circling the Plum Island Sound and Essex Bay estuaries, the boundary is primarily defined by the 10-foot contour line. In addition to the important ecological functions that ACEC resources provide, they also contribute directly to local economies through commercial and recreational shellfishing, fishing, water sports, beach activities, and the scenic character that invites residents and ecotourism to the area.

The Massachusetts Department of Environmental Management (DEM) administers the ACEC Program and coordinates closely with the Massachusetts Coastal Zone Management (CZM) office regarding all coastal ACECs. A decision by the Secretary of Environmental Affairs to designate an area as an ACEC carries with it a requirement that all state environmental agencies acquire information about the resources of the ACEC; preserve, restore, or enhance the resources of the area; and ensure that activities within the ACEC minimize adverse effects on the natural and cultural values of the area. This designation highlights the importance and focuses attention on issues of resource values, function, degradation, restoration, and use (DEM 1993).

Projects within ACEC boundaries require higher environmental standards and review. However, rather than creating new regulations, the goals of an ACEC designation are implemented through the existing state environmental regulatory and review framework. Specific state regulatory requirements concerning ACECs include: Massachusetts Environmental Policy Act (MEPA), Waterways Regulations (Chapter 91), Wetlands Protection Act, Solid Waste Facilities Site Assignment Regulations, and CZM policies. The designation also encourages coordination of local, regional, state, and federal programs, plans, and activities to achieve designation goals.

The 1979 Parker River/Essex Bay ACEC designation document (Appendix B) identifies the following factors to support designation:

Threat to the Public Health. The use of the rivers and bays for shellfishing, water sports, and fishing is dependent upon maintaining the existing high water quality. Any pollutants discharged into these waters could adversely affect their users and consumers.

Quality of the Natural Characteristics. Because there has been minimum alteration of the natural features of this area, they are presently functioning at their maximum capacity; the scenic quality of the area contributes to the recreational enjoyment of its visitors.

Productivity. This area's productivity is nearly double that of the most productive agricultural lands and can be attributed to the overall health of the ecosystem.

Uniqueness. There are only 10 major barrier beach systems on the Massachusetts mainland that remain undeveloped. This ACEC contains two; Castle Neck and the southern end of Plum Island. The importance of the area to migratory birds, its extensive shellfish resources, and vast salt marshes also contribute to its uniqueness.

Irreversibility of Impact. Man's destruction of estuaries, salt marsh, and barrier beaches is irreversible. Alteration of barrier beaches will result in the loss of a natural storm barrier, the destruction of marshland will decrease the nutrient supply in adjacent rivers and bays, and inappropriate development can pollute ground and surface water.

Economic Benefits. The natural resources of this ACEC contribute directly to the financial well-being of the region. The region is famous for shellfish resources as well as recreational activities that contribute directly to local economies.

Supporting Factors. Strong public consensus on the intrinsic value of the area weighs heavily in favor of the ACEC designation. The Parker River National Wildlife Refuge, Sandy Point State Reservation, and the Crane Wildlife Refuge and Beach all lend importance to the area. Local wetlands zoning by-laws, shellfish management programs, and conservation restrictions further demonstrate local efforts to protect the area.

All of these factors combined demonstrate that the Parker River/Essex Bay region is unique. The ecological, economic, and recreational values identified in 1979 as reason for ACEC protection still stand today, over 20 years later.

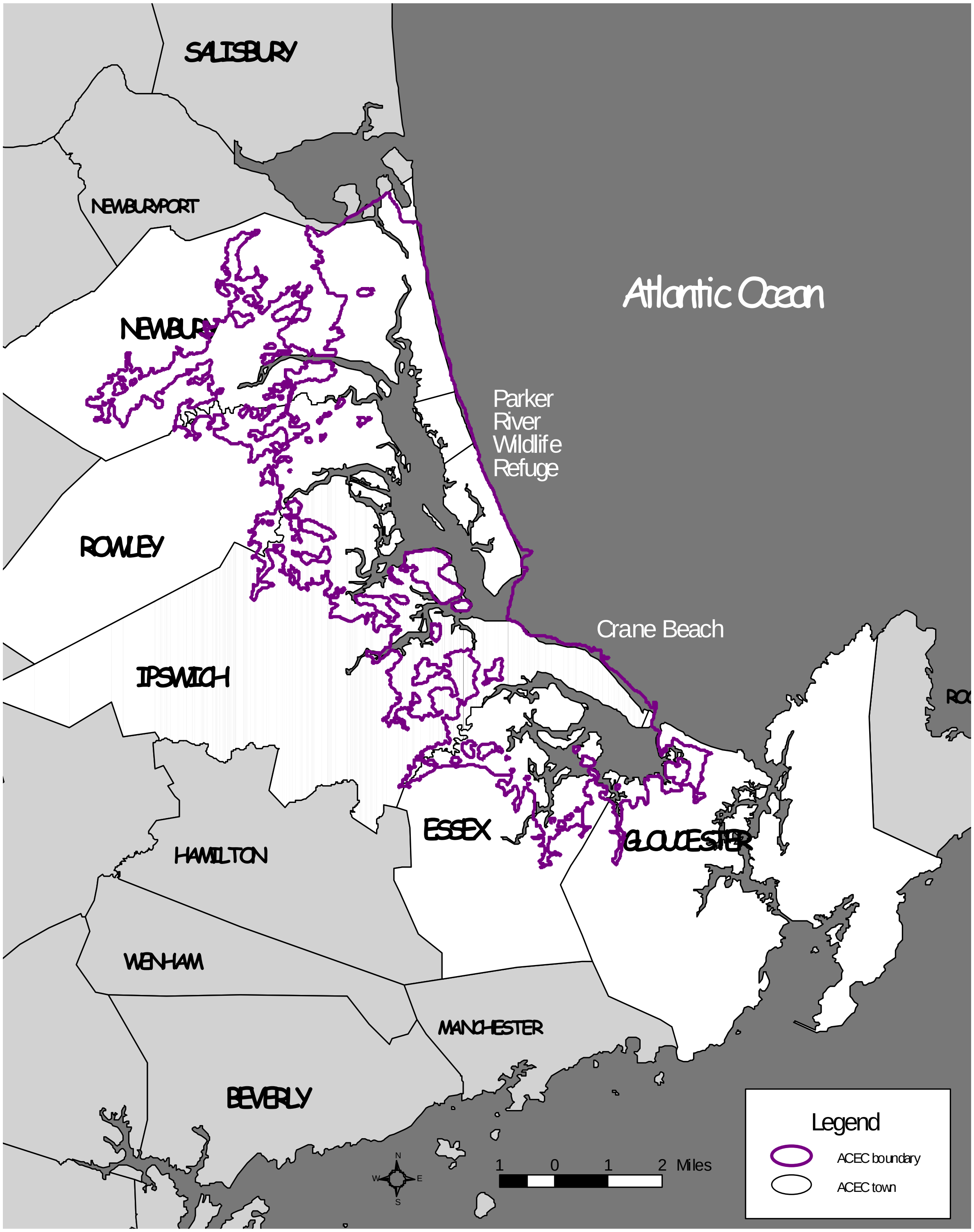

Figure 1. Parker River/Essex Bay ACEC boundary

REGIONAL HISTORY

Salt marshes in the ACEC were a tremendous asset to early settlers and colonists of the seventeenth century (USFWS 1992). Open meadows filled with acres of marsh grass provided hay for insulation, roofing, and livestock feed and bedding. “It was not uncommon for a farmer living many miles inland to own or lease the rights to a piece of island salt marsh, and what hay he did not require for his own use could be sold” (Weare 1993). Some farmers, who lived further away from the marsh lots, built barns or small camps to provide shelter for themselves, their crews, and their animals during the haying season. For inland farmers without land access, the hay was brought home in barges known as gundalows (Weare 1993). In the late 1800s, the invention of the bog shoe made it possible for horses to be brought onto the marsh, and mowing machines and horse rakes soon took over much of the work done by hand. Eventually, tractors pulling mechanical hay balers were used to harvest salt hay. However in the 1930s, cutting of the salt marsh dramatically declined as local dairy farms’ demand for salt hay diminished. In 1965, five individuals harvested hay from the salt marshes from the ACEC (Jerome et al. 1968) while today, only three people still regularly hay in the marsh around Plum Island Sound (Buchsbaum per comm 1999)

PLUM ISLAND SOUND

The barrier island with sand dunes and salt marsh recognized today as Plum Island is believed to have started as a sandspit over 6,000 years ago (Weare 1993). The first description of Plum Island and the Sound came from the explorer John Smith in 1614 who indicated the marsh grass was fit for pasture, with, “…pines, walnuts, and other woods to make this place an excellent habitation, being a good and safe harbour” (USFWS 1992). In 1649, the General Court divided Plum Island among the townships of Newbury, Rowley, and Ipswich. For the first 150 years of settlement in these towns, the marshes and meadows of Plum Island were treated primarily as a resource for grazing of hogs, cattle, horses, and sheep (USFWS 1992, Weare 1993). The salt hay was also used for bedding and mulching and as housing insulation. Eventually this unrestricted grazing took a toll on the marsh, and in 1739 the General Court passed an act declaring it unlawful for livestock to roam free on the island (USFWS 1992). During the 1800s and early 1900s, the southern portion of Plum Island contained cottages, farms, some hotels, waterfowl hunting camps, and fishing camps scattered throughout the salt marsh. In the early 1900s, Plum Island became a vacation destination as hotels, regularly scheduled ferries, and even a casino were established (Weare 1993). When development of the northern end of Plum Island threatened to spread south, the Massachusetts Audubon Society and the Federation of Bird Clubs of New England purchased approximately 1,600 acres on the central section of the island. In 1942, this land was purchased by the U.S. Fish and Wildlife Service to form the Parker River National Wildlife Refuge, which currently includes a total of 4,662 acres. Approximately 120 acres of privately owned land at the southern tip of the island was acquired by the Commonwealth of Massachusetts and became Sandy Point State Reservation managed by the Department of Environmental Management (USFWS 1992).

ESSEX BAY

In 1634, the area around Essex Bay was settled as Chebacco Parish by Europeans who made their living by farming and fishing. Although much of the land could not match England’s fertile soil, it could still support grains, vegetables, and the farming practices brought by colonists. Winters were more severe than settlers had previously known and livestock that were used to spending almost the entire year in pasture were now penned up four to five months. Fishermen were another group of Europeans drawn to the coast to make a living. Abundant cod and herring, which had long been popular in the European diet, were a profitable export commodity. Many men of Ipswich and the Chebacco Parish engaged in fishing on the eastern shore of Cape Ann until 1812, when impacts of the revolutionary war and falling prices caused a decline in the fishing industry (Vickers 1994).

Although farming and fishing have always been important parts of the regional economy, historic shipbuilding is what made the Essex area unique from other parts of the region. With growth of the local shipbuilding industry in the early 1800s, most fishermen left the sea for more comfortable work closer to home. In 1819, Ipswich's Chebacco Parish was incorporated as the town of Essex and shipbuilding replaced fishing as the town's primary maritime industry (Vickers 1994). Shipbuilding was so popular that most lumber was already harvested from the area by this time and had to be imported from Maine, New Brunswick, and the Carolinas to continue making Essex vessels (Ellis-Peckham 2000). In 1821, the Essex Canal was built to enable the rafting of ship timber as well as general lumber supplies down the Merrimack River, into Plum Island Sound, through the canal, and into the Essex River. Before the canal was built, transport of New Hampshire timber had to go out into Ipswich Bay to reach the mouth of the Essex River. To construct the canal, a section of salt marsh was cut through to create passage from the Ipswich River near Fox Creek to the Essex River (Story 1995). In 1876, the Essex Branch of the Boston and Maine railroad was built to support the shipbuilding industry. In addition to shipyard supplies, the train brought tourists to visit the area until 1942 when this branch was discontinued (Story 1975). In 1880-1890, the shipbuilding industry peaked in Essex with the majority of vessels being built to support the Gloucester fishery. However, when diesel engines were invented in the early 1900s and more efficient trawlers began replacing the traditional fishing dories, the shipbuilding industry began to decline. After World War II with the advance of factories and use of steel to make cheaper and faster boats, demand for fishing boats fell off completely. Today only recreational yachts and lobster boats are still built in Essex, although the Essex Shipbuilding Museum still tell of the history (Ellis-Peckham 2000).

GEOLOGY AND SOILS

Many landforms found within the ACEC result from the last period of glaciation. During final glacier recession when the ice mass began to thin, forward movement decreased until the glacier became a stagnant ice bloc. Melting of this bloc then exposed till and bedrock. Streams from the rapidly melting ice flowed through the network of glacial valleys and channels transporting vast amounts of debris. The glacial sediments, with variable texture and composition, were eventually reworked and formed into existing coastal features (USFWS 1992).

The geology in the area includes bedrock outcrops (ledge), glacial till (hardpan soils), glacial outwash (stratified sands and gravel), marine and estuarine deposits (sands, silt, and clay), swamp deposits (organic muck), alluvial deposits (flood plains), and beaches and sand dunes. Marine silts and clays that are now positioned relatively high on the landscape are unique to this coastal area. These sediments were first deposited within a salt-water environment shortly after the glacier receded from the area and were uplifted above present day sea level when the weight of the glacier was removed, allowing the Earth's crust to rebound. Currently, there are 44 different kinds of soils mapped within Northern Essex County; many of these soils are found within the ACEC watersheds (Fletcher per comm 1998).

Plum Island Sound was primarily formed during the last period of glacier advance and retreat. The Sound flows into Ipswich Bay and is bordered on the east by the long, narrow, barrier beach of Plum Island (Figure 2) (Massachusetts Audubon Society 1999). Ipswich and Westbrook soils are the peats found throughout the salt marsh and adjacent brackish wetlands of Plum Island Sound. A high percentage of organic material from decaying estuarine marsh plants compose these two soil compositions. Drumlins (hill-like features composed of glacial debris and sometimes bedrock that form under a flowing glacier) are the most prominent features of the landscape on the mainland side of the Sound (Massachusetts Audubon Society 1999).

Defined as a drowned River Valley, Essex Bay is also a coastal enclosure formed by the large Castle Neck Sand Spit (Figure 2). The spit and dunes consist of fine sand derived from deposits of late glacial marine clays. These deposits underlie the offshore, salt marshes, and coastal lowlands. The South side of Essex Bay consists largely of granite hills, rimmed by salt marsh. Late glacial marine clays underlie the extensive salt marsh areas found on the west side of the bay (Chesmore et al. 1973, Roach 1992).

Figure 2. Aerial photo of Plum Island Sound and Essex Bay

More comprehensive morphometric data and geologic background for Plum Island Sound and Essex Bay can be found can be found in the Division of Marine Fisheries (DMF) Monograph series (DMF 1968, 1973).

WATERSHED CHARACTERISTICS

Resources in the Parker River/Essex Bay ACEC are connected by river networks in the Parker, Ipswich, and North Coastal Watersheds (Figure 3). The Parker River Watershed encompasses 83 square miles and is bordered by the Merrimack River Watershed to the north and the Ipswich River Watershed to the south. The Parker River begins as a series of headwater ponds that are typical alewife spawning grounds. The fresh water portion of the river is about 8 miles while the remainder of the river is tidal and surrounded by extensive ACEC salt marsh (Stevenson 1998). After traveling 21.3 miles, the river empties into Plum Island Sound at the Parker River Wildlife Refuge. Water flow over the river's six dams is reduced to a trickle during the summer and may cease completely in certain segments of the river in years of low precipitation. Communities in the Parker River Watershed are mostly rural in character with low density housing and many farms in the upper watershed. Most industrial activity is clustered along the Little River in Newbury, which flows into the Parker River. However, land use is changing as the population in the watershed increases each year. With increased urban and suburban development comes greater concern for water quality problems and loss of open space (EOEA 1999b).

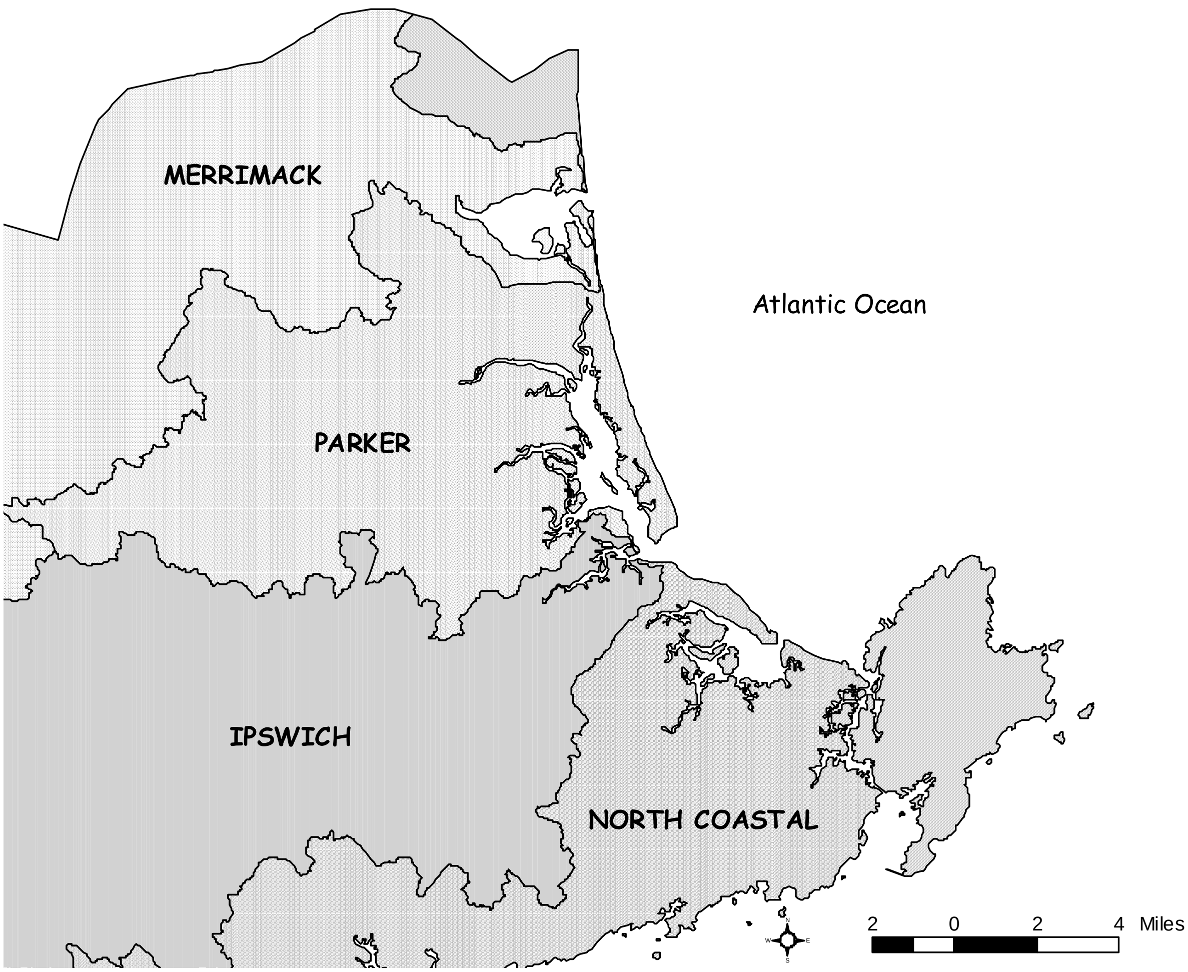

Figure 3. Parker River/Essex Bay ACEC watersheds

The Ipswich River Watershed encompasses 155 square miles. The Ipswich River begins in Wilmington and flows northeasterly into Ipswich and Plum Island Sound. Four functioning dams are located in Reading, Middleton, and Ipswich with remnants of other smaller dams found in the river and its tributaries. Along its course, the river and tributaries flow through wetlands that help maintain good water quality. These wetlands and the watershed's groundwater provide much of the river's flow during drier times of the year. Most of the watershed is forested with residential, industrial, and commercial development being the other types of land use. Water efficiency and conservation is a great concern in the region since portions of the river run dry in the summer and several communities rely on the river to meet their water supply needs. Shellfish and anadromous fish runs in the tidal portions of the river also rely on adequate water supply and quality. More efficient use of water and improved water conservation practices would greatly benefit the river and its watershed (EOEA 1999a).

The 168 square-mile North Coastal Watershed has an estimated population of 500,000 within portions of 27 communities. Many of the watershed's rural communities have retained their scenic and environmental character but are increasingly faced with the threat of suburban sprawl. The dominant resource industries in the upper North Shore ACEC communities of Essex and Gloucester include commercial fishing for finfish, lobsters, and shellfish harvesting. Historically, numerous shellfish beds in this region have been closed from pollution but recent years have seen an increase in restoration efforts (EOEA 1999c).

HABITATS OF THE ACEC

BARRIER BEACH

A barrier beach is a narrow strip of beach and dune separated from the mainland by a wetland or water body. Beaches are formed when waves transport and deposit sand on the shore; dunes are defined as hills or ridges of sand, pebble, and/or cobble deposited by wind and wave action and are often covered by beachgrass. All dunes extending from the beach to the marsh or bay are part of the barrier beach. Together the beach, dunes, tidal flats, and associated water bodies comprise the dynamic barrier beach system. Forces of nature constantly reconfigure these areas; sand is moved by storms, currents, waves, and wind. The strength of the barrier beach system lies in its dynamic nature and its ability to move and reshape. While these areas provide storm protection for property and natural resources land-ward of the barrier, they also serve as habitat for a variety of plant and animal species. Equally important are the recreational and aesthetic qualities provided by barrier beaches (CZM 1994).

Both Plum Island and Crane Beach are some of the few natural barrier beach/dune and salt marsh complexes left in the Northeast. Longshore currents have historically extended Plum Island south while rising sea levels, combined with wind and wave action have displaced the island westward to the point where its northern end is separated from the mainland only by the narrow Plum Island River. The Castle Neck Sand Spit (commonly known as Crane Beach) stretches for more than four miles along Ipswich Bay and consists of fine sand derived from deposits of late glacial marine clays. These deposits underlie the offshore, salt marshes, and coastal lowlands. Sands from these deposits are carried by storm and wave action toward shore, forming the beaches. Both Plum Island and Crane Beach are home for many wildlife species, including the endangered piping plover and least tern.

ESTUARINE WATERS

Located within the ACEC boundary are Plum Island Sound and Essex Bay, which are some of the most undisturbed estuarine habitats in the Northeastern United States. These bodies of water serve as nurseries for fish and shellfish and provide habitat and food for birds and other wildlife. Open waters of these estuaries change with the seasons. In the spring, large amounts of fresh water runoff from melting snow and spring rains dilute the salt content. During dry weather in the summer, inputs of fresh surface water are reduced and cause estuarine salinity to increase close to levels of offshore waters (Buchsbaum et al. 1996).

Plum Island Sound

Plum Island Sound is known for its extensive salt marsh and tidal flats, rich shellfish beds, and abundant fish and wildlife. The Sound is a relatively narrow body of water, oriented primarily in a north-south direction from its mouth at Ipswich Bay to its northern and western extensions in the Parker and Plum Island rivers (Figure 4). The Sound is an estuary encompassing 4,470 acres over an 8 mile reach (Table 2). The salinities of the tidal waters range from 22.3 to 30.8 ppt (Buchsbaum and Purinton 2000). The primary sources of fresh water are the Ipswich and Parker rivers that drain into the Sound. Smaller rivers include the Mill and Little Rivers which run into the Parker River, Rowley-Egypt River, Plum Island River, Mud Creek, and Eagle Hill River. The latter three are completely tidal throughout their length.

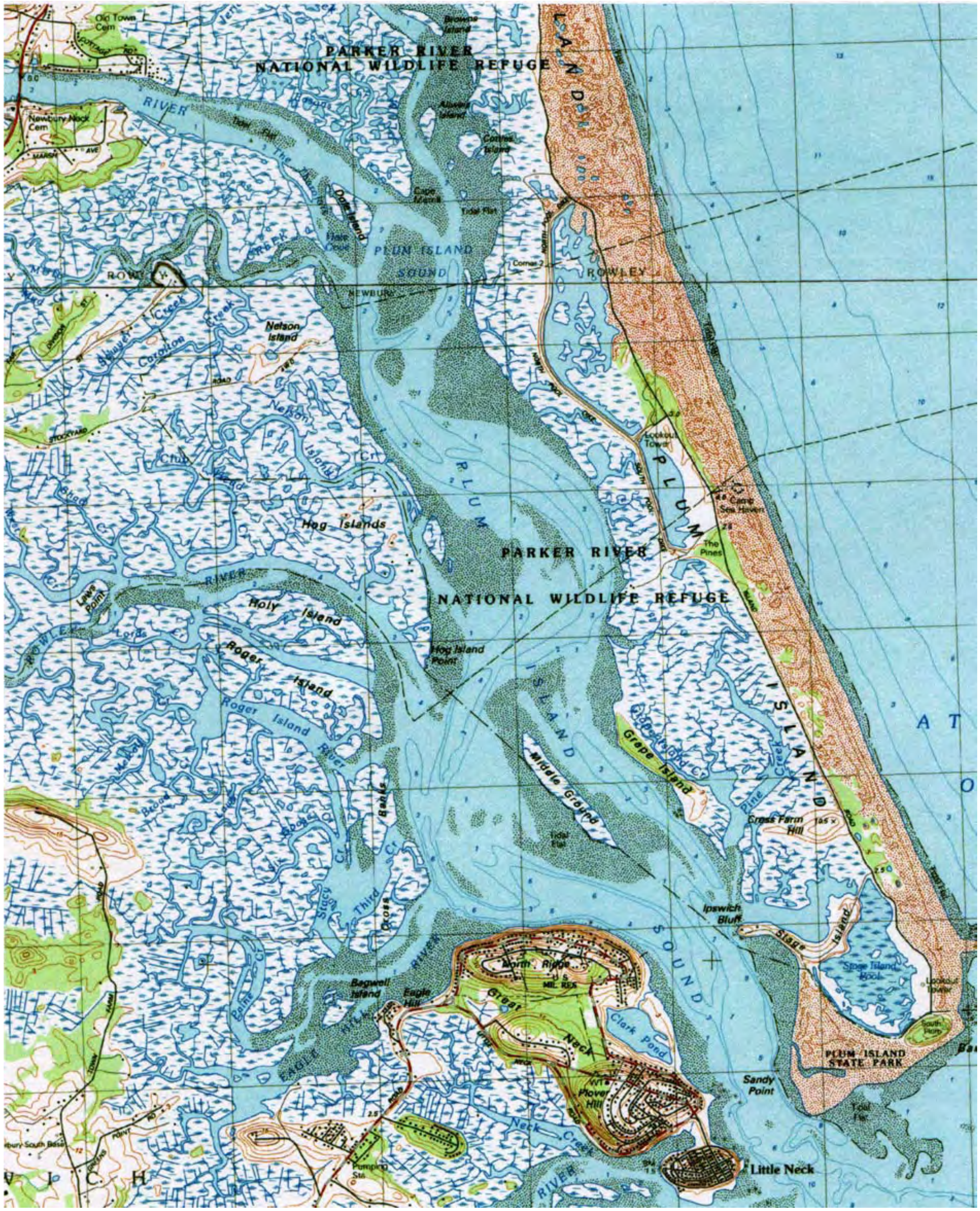

Figure 4. USGS Map of Plum Island Sound

Table 2. Morphometric measurements of Plum Island Sound (Buchsbaum and Purinton 2000)	
Description	**Units**
Maximum Length	8.17 miles
Maximum Width	1.86 miles (Mean High Water) [MHW]
Maximum Depth	50.0 feet (MHW)
Mean Depth	9.9 feet (MHW)
Total Surface Area	4,470 acres
Length of Shoreline	162.2 miles (MHW)
Volume	1,933,236,360 cubic feet (MHW)
Mean Tidal Amplitude	8.6 feet (Ipswich River mouth)
Salt Marsh Area	8,140 acres

Essex Bay

Essex Bay is bordered on the north and west by the town of Ipswich, south and west by Essex, and east by Gloucester (Figure 5). This estuary encompasses 1,909 acres of tidal waters (Table 3) and is composed of the bay proper and the following rivers and tributaries: Castle Neck River, Essex River, Ebben Creek, Farm Creek, Lanes Creek, Lufkin Creek, Walker Creek, and Soginese Creek. The Essex River, which is the main tributary, enters the Bay at Conomo Point and provides a constant flow of fresh water. Bay salinity ranges between 20.5 to 32.0 ppt (Chesmore et al. 1973). Approximately 70 percent of the total surface area of the Bay is intertidal (Roach 1992).

Table 3. Morphometric measurements of Essex Bay (Chesmore et al. 1973)	
Description	**Units**
Maximum Length	3.59 miles
Maximum Width	2.92 miles (MHW)
Maximum Depth	47.0 feet (MHW)
Mean Depth	7.3 feet (MHW)
Total Surface Area	1,909 acres
Length of Shoreline	59.3 miles
Volume	606,730,687 cubic feet (MHW)
Mean Tidal Amplitude	8.6 feet
Salt Marsh Area	2,321 acres

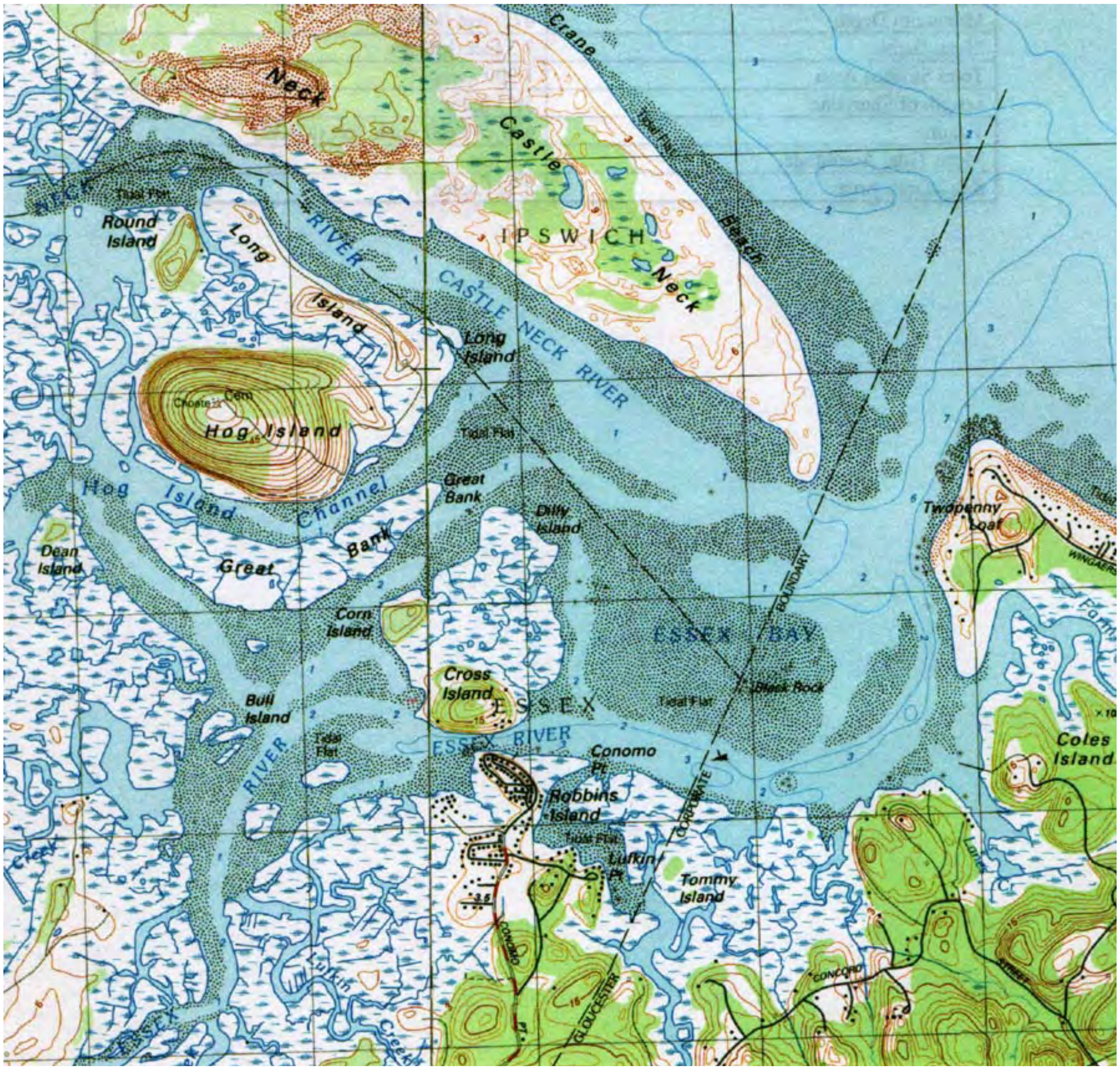

Figure 5. USGS map of Essex Bay

TIDAL FLATS

The Massachusetts Wetlands Protection Act defines tidal flats as “those nearly level portions of coastal beaches extending from mean low water landward to the more steeply sloping face of the beach” (Geist 1996). Tidal flats have substrate composed of materials ranging from very fine silt to clay and coarse sands and are found along the sea shore, in estuaries, behind barrier beaches, and in salt ponds. It is the combination of this salinity, substrate quality, and the character of water movement that determine plant and animal species composition in tidal flats. Large plants are not found on the flats because of the harsh sand-mud environment and daily tidal fluctuations. Instead, plants are mostly algae that tolerate exposure and do not need a physically stable surface for growing (Table 4) (Jerome et al. 1968). Although the importance of this plant life is often overlooked because it seldom provides a direct source of revenue, algae are vitally important to the marine environment in the ACEC because they provide food and cover for many forms of life such as snails, fish, and crustacea.

Table 4. Common algae in Plum Island Sound and Essex Bay (Jerome et al. 1968, Chesmore et al. 1973)	
Green Algae (Class Chlorophyceae) *Enteromorpha* spp. *Ulva lactuca* (sea lettuce) **Red Algae (Class Rhodophyceae)** *Chondrus crispus* (Irish moss)	**Brown Algae (Class Phaeophyceae)** *Ascophyllum nodosum* (rock weed) *Fucus vesiculosus* (rock weed) *Laminaria saccharina* (kelp) *Chorda filum* (devil’s whip)

Most of the animals found in tidal flats have also adapted to daily environmental stress or burrow beneath the exposed surface during low tide (Myers 1996) (Table 5). In addition to being habitat for many invertebrates, tidal flats are also a feeding area for large numbers of shorebirds that migrate through the region. Birds search the tidal flats for clams, snails, sand shrimp, amphipods, and worms that live just below the surface. At high tide, these same invertebrates are food for foraging fish, such as winter flounder and striped bass (Massachusetts Audubon Society 1999).

Table 5. Dominant organisms associated with different tidal habitats (Buchsbaum and Purinton 2000)	
Open water with sandy substrate	Atlantic silversides Mummichogs Sand shrimp
Muddy salt marsh habitats	Atlantic silversides Mummichogs Sand shrimp Shore shrimp
Brackish riverine habitats	White perch Smelt River herring White-fingered mud crab

SALT MARSH

Salt marshes are a predominant ecological and visual feature and make up over 50 percent of the Parker River/Essex Bay ACEC. With approximately 12,800 salt marsh acres , the ACEC contains the largest contiguous area of marsh north of Long Island, New York and is locally known as part of the “Great Marsh,” which runs from West Gloucester to Salisbury (Figure 6). ACEC salt marshes are well protected under the Massachusetts Wetlands Protection Act and through ownership or control by municipalities and conservation agencies and groups such as the U.S. Fish and Wildlife Service, Massachusetts Department of Fisheries and Wildlife, Essex County Greenbelt Association, and The Trustees of Reservations.

Salt marshes are a major source of nutrients for the marine food chain, provide flood control and protection of uplands from storm damage, and serve as efficient filters for contaminants from upland discharge and urban runoff. In addition, salt marshes provide habitat for diverse plants and wildlife (Table 6) (Jerome et al. 1968, Chesmore et al. 1973, Myers 1996).

> “Many tidal creeks and salt pannes (shallow, temporary ponds on the marsh surface) are interspersed within the extensive open grassland of the marsh surface. These habitats are home to millions of small invertebrates that serve as food for salt marsh killifish and sticklebacks. These, in turn, are eaten by larger fish and birds. Small, upland islands within the marsh serve as resting and nesting areas for birds and animals that occasionally need some dry land” (Massachusetts Audubon Society 1999).

Table 6. Common salt marsh animals found in the ACEC (Buchsbaum et al. 1996)

Mollusks:	Coffee bean snail
Dragonflies:	Salt marsh skimmer
Grasshoppers:	Dusky-faced meadow grasshopper, salt meadow grasshopper
True flies:	Salt marsh mosquito, greenhead fly, chironomid midges, biting midges
Butterflies:	Broad winged skipper
Crustaceans:	Grass shrimp, isopod *Philoscia viltata*, several amphipod species
Fish:	Mummichog, nine-spined stickleback
Birds:	Clapper Rail, Willet, Wilson’s Phalarope, Seaside Sparrow, Salt Marsh Sharp-tailed sparrow

Marshes are divided into two general vegetation zones and contain a number of plant species that tolerate or live only in seawater (Table 7). The low marsh is flooded twice daily by the incoming tide and is dominated by *Spartina alterniflora*, while the high marsh is flooded sporadically and is dominated by *Spartina patens*.

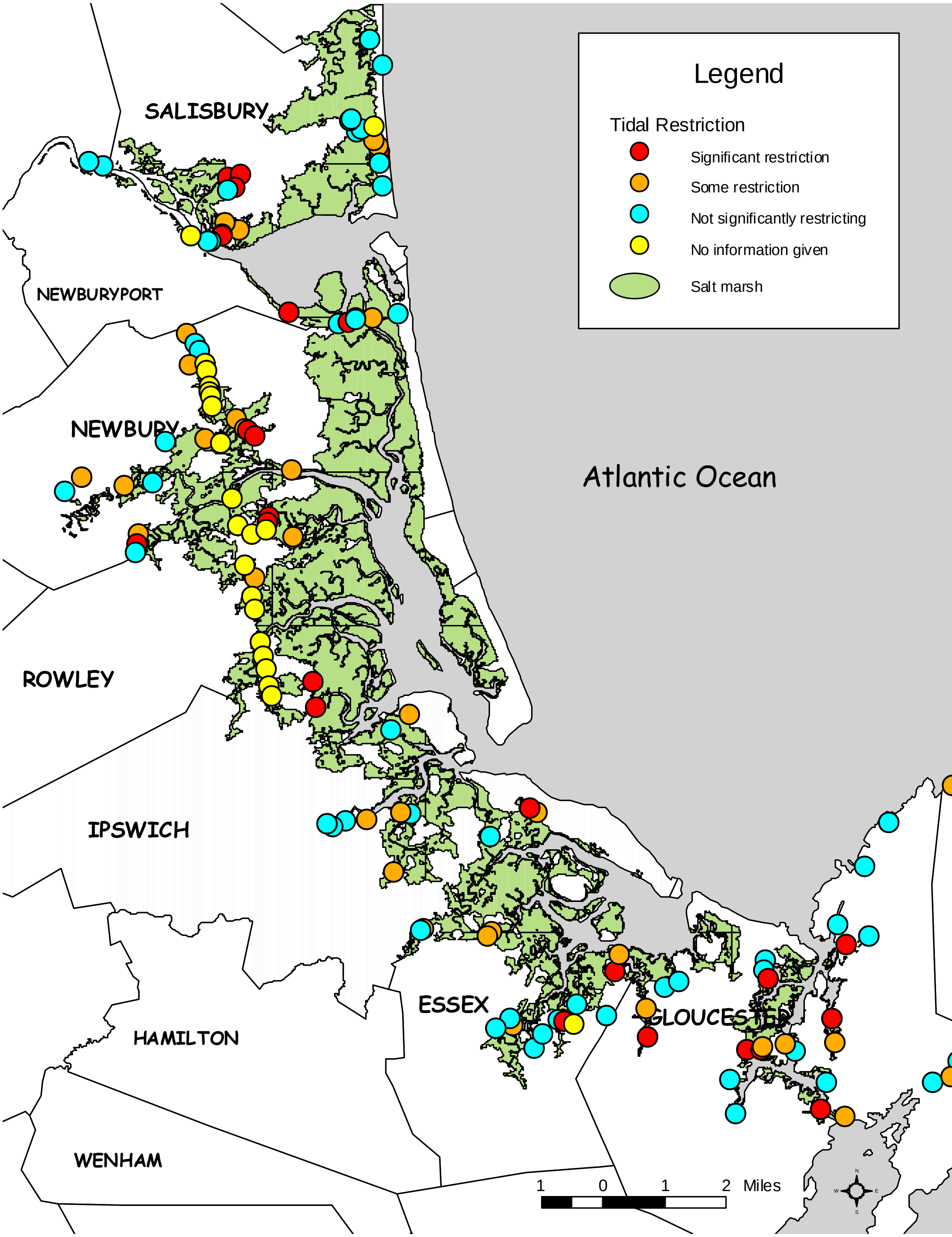

Figure 6. Great Marsh and ACEC salt marsh and tidal restriction sites

Table 7. Common salt marsh plants of the Parker River/Essex Bay ACEC (Massachusetts Audubon Society 1999)	
Shrubs	**Other Nonwoody Plants and Wildflowers**
Marsh elder (*Iva frutescens*)	Seaside goldenrod (*Solidago sempervirens*)
	Sea lavender (*Limonium carolinianum*)
Grasses, Sedges, and Rushes	Seaside plaintain (*Plantago oliganthos*)
Salt marsh cordgrass (*Spartina alterniflora*)	Sea milkwort (*Glaux maritima*)
Salt marsh hay (*Spartina patens*)	Marsh orach (*Atriplex patula*)
Common reed (*Phragmites australis*)	Glasswort (*Salicornia spp.*)
Spikegrass (*Distichlis spicata*)	Tall sea blite (*Suaeda lineraris*)
Black grass (*Juncus gerardi*)	Silverweed (*Potentilla anserina*)
Salt marsh bulrush (*Scirpus maritimus*)	Seaside arrowgrass (*Triglochin maritima*)
Salt marsh three square (*Scirpus robustus*)	Annual salt marsh aster (*Aster subulatus*)
Salt marsh sedge (*Carex hormathodes*)	Salt marsh water hemp (*Acnida cannabina*)

Historically, salt hay was used by early settlers for thatching roofs and cattle feed. From June to September, crews cut and stacked two types of hay: black grass growing at the highest points on the marsh was cut early in the season and hauled home by wagon; salt marsh hay or cordgrass growing on the lower marsh was stored on circles of posts called staddles and brought home during the winter months when the frozen marsh could safely bear the weight of the loaded sleds led by horses (Weare 1993). Since the 1960s, tractors pulling mechanical hay balers have been used to harvest salt hay. Only a few people still regularly hay to any extent in the ACEC marsh (Buchsbaum per comm 1999). Thus, the bulk of this marsh organic matter eventually contributes to the overall productivity of surrounding waters (Jerome et al. 1968). Studies on how haying affects the marsh ecosystem are currently underway by the Massachusetts Audubon Society and the Woods Hole Marine Biological Laboratory (MBL).

Although much of the salt marsh is still relatively pristine, there are concerns of human alterations and impacts to these habitats. For example, little is known about salt marsh alterations and impacts caused by mosquito ditching and tidal restrictions. Historically, much of the ACEC salt marsh was influenced by mosquito control activities, which can be seen from the extensive network of marsh ditches. Studies suggest that mosquito ditching reduces salt panne acreage and shorebird use of the marsh (Buchsbaum et al. 1996). Fortunately, current mosquito management practices through Open Marsh Water Management (OMWM) are more environmentally sensitive. OMWM is being used to restore marsh habitats by plugging old ditches in hopes of reducing drainage, maintaining and enhancing salt pannes, and channeling fresh water from uplands away from the salt marsh. Since OMWM incorporates existing ditches and natural features into their design, these practices have much less impact than past ditching activities (Buchsbaum and Purinton 2000).

Another major threat to salt marsh habitats of the ACEC is the invasion of the non-native plant *Phragmites australis.* Typically the invasive *Phragmites* grows where water is brackish at the edge or the transition zone of a salt marsh; growth might also be enhanced where higher nutrient levels from septic system leaching fields interact with groundwater tables. Occasionally, these plants will grow in the middle of the marsh where elevations are slightly higher or where there is a source of fresh water (Buchsbaum et al. 1996).
Phragmites encroachment into salt marsh habitats increases where tidal restrictions formed by the construction of roads, railroads, dikes, and tide gates impedes the natural flow of saline tidewater (Buchsbaum et al. 1996). Throughout the ACEC and Great Marsh, sites where the natural flow

of seawater is restricted by culverts or dikes were identified in a report by the Parker River Clean Water Association entitled *Tidal Crossings Inventory and Assessment* (PRCWA 1996) (Figure 6). As the vegetation changes and water flow is restricted, native plants are displaced, habitat is lost, and biodiversity decreases with a shift in species composition. *Phragmites* density was analyzed for the Plum Island Sound region as part of the Massachusetts Audubon Society's 1996 Minibay Project. Results of this study indicate that the invasive plant has not taken over a large percentage of the region so far, but it is widespread and occurs in stands ranging from a few plants to several acres (Buchsbaum et al. 1996). Since *Phragmites* is considered of less value to wildlife than native salt marsh species, these sites are being targeted by resource managers for restoration and monitoring efforts (Figure 7).

It is widely accepted that monitoring is an essential component of salt marsh management (Burdick et al. 1999). Monitoring is required to identify problems, modify management practices, track projects, evaluate success, help predict potential benefits, and increase our understanding of how salt marshes function. In June, 1998 the Massachusetts Audubon Society and the Gulf of Maine Council on the Marine Environment organized a meeting of managers, scientists, students, and policy makers at Castle Hill in Ipswich to discuss regional monitoring approaches, needs, and methods. A report compiled from meeting presentations and related studies is entitled, *Monitoring Restored and Created Salt Marshes in the Gulf of Maine* (1999). This report indicates that information gained by monitoring salt marsh restoration projects will "improve our understanding of salt marshes and their interactions with tidal waters and will benefit future marsh management programs" (Burdick et al. 1999).

Argilla Road in Ipswich is a tidally restricted restoration site where multiple parameters including vegetation, fish and crustacea, macroinvertebrates, salinity, and surface and groundwater hydrology are being monitored. In the fall of 1998, a unique collaboration of federal, state, and local officials, and conservation groups worked to restore approximately 20 acres of tidally restricted salt marsh at Argilla Road by replacing a 32" culvert with an 8' wide by 5' high box culvert. Tide gauges indicate that the previous restriction of 18" has improved to a 2.5-3" restriction. It also appears that much of the invasive *Phragmites* growth is stunted or dead with native *Salicornia* sprouting up underneath the stressed *Phragmites*. Large salt panne complexes have also been restored and are providing habitat for marsh fish (Hutchins et al. 1999). In addition to being a model for salt marsh monitoring throughout the region, this project provides an opportunity to educate the public about restoration and offers techniques to local communities wanting to sponsor similar projects (Catena 1998).

Two pro-active volunteer restoration programs managed by state agencies are also underway in the ACEC. The state Wetlands Restoration and Banking Program (WRBP) is working with volunteer professional scientists to monitor salt marsh restoration sites at Little Neck in Ipswich and Conomo Point in Essex. Over 60 scientists are part of this program which monitors vegetation, fish, macroinvertebrates, hydrology, and salinity both before and after restoration takes place. Citizen volunteers are also monitoring these two restoration sites through the Wetlands Health Assessment Toolbox (WHAT) program. CZM, the University of Massachusetts

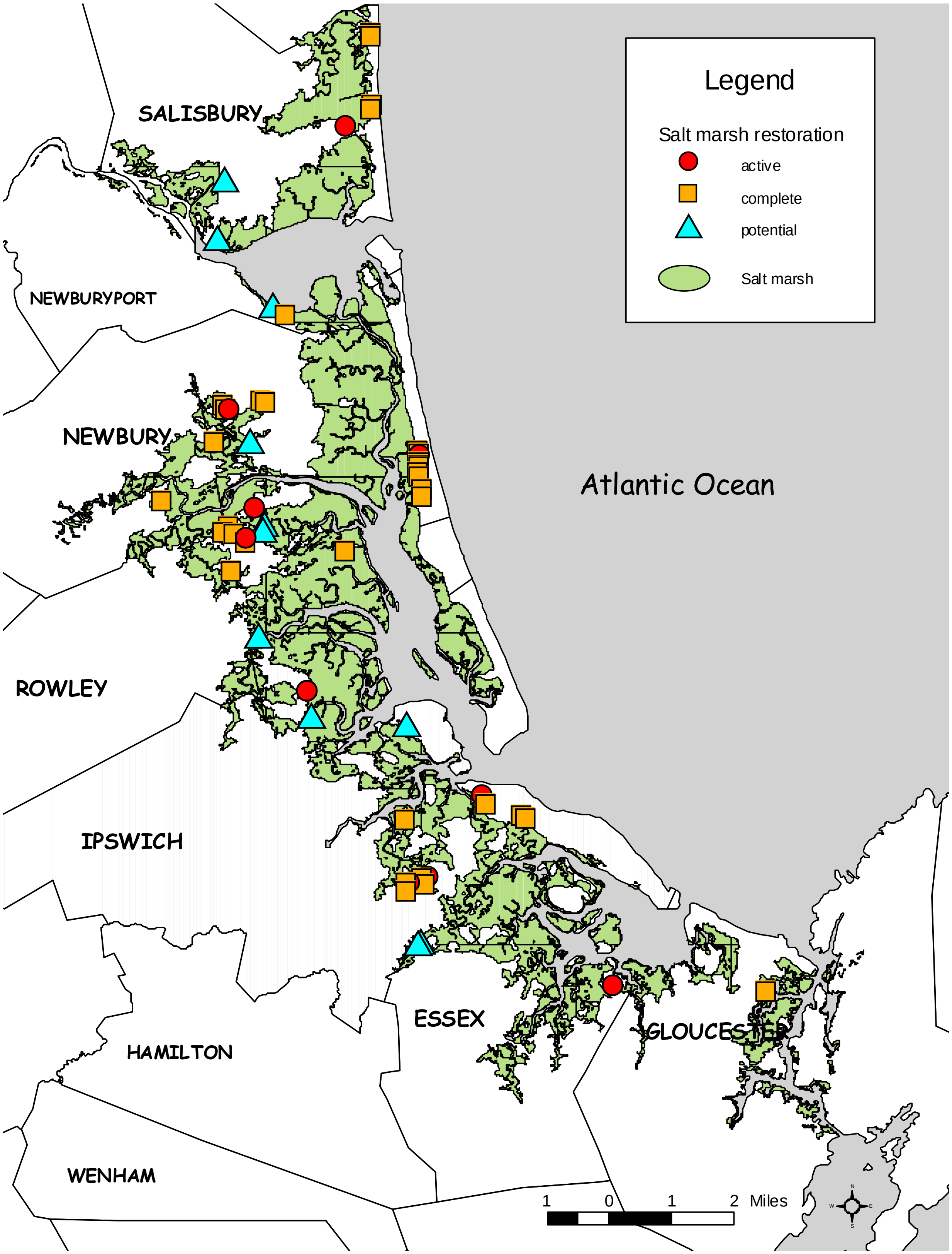

Figure 7. Great Marsh and ACEC salt marsh restoration sites

Cooperative Extension Program, and the Massachusetts Bays National Estuary Program have developed the WHAT approach to assessing wetland quality or ecological health through volunteer monitoring at four sites in the ACEC region. Each of the study sites, all having been adversely affected by tidal restrictions, stormwater discharges, and nonpoint source pollution from urban development, have a corresponding reference site that represented the best obtainable condition for the area. Parameters monitored at each site include: avifauna, vegetation, aquatic macroinvertebrates, water chemistry, tidal influence, and land use. Monitoring results indicate that shifts in plant and invertebrate community structure and indicator species richness and abundance are strongly associated with sources of nonpoint pollution and direct habitat impacts (Smith 1999). From data collected, CZM wetland specialists have developed a land use index which quantifies the degree and intensity of human land use within 100 meters of the salt marsh study site (Carlisle per comm 2000). By engaging citizens, WHAT partners hope to foster stewardship of wetlands and further educate communities about complicated issues surrounding wetland values and functions.

Salt Marsh Field Notes

The following responses are individual opinions rather than a consensus reached by those interviewed. Field note information can be used by local and regional resource managers to assess research needs, guide restoration efforts, prioritize future workplans, and design technical assistance programs.

The following people were interviewed about salt marsh resources:

Robert Buchsbaum	Massachusetts Audubon Society
Dave Burdick	University of New Hampshire
Wayne Castonguay	The Trustees of Reservations
Chuck Hopkinson	Woods Hole Marine Biological Laboratory
Chuck Katuska	Massachusetts Wetlands Restoration and Banking Program
Walter Montgomery	Northeast Massachusetts Mosquito Control and Wetlands Management
Tim Purinton	Massachusetts Audubon Society

1. Based on information gathered through existing research, have salt marsh habitats improved or declined in the past 20 years? Where is this trend going in the next 20 years?

- Assessment of the past 20 years greatly varies:
  - Although salt marshes have been protected through regulations since the 1970s, there have been significant impacts from tidal restrictions, disturbance of edge habitat, and increased stormwater inputs from development. Although tidal restrictions are being addressed throughout the region, impacts from invasive species and stormwater runoff have caused an overall decline in the acreage and function of marsh habitat in the past 20 years.
  - Overall, the ACEC salt marsh has remained relatively well protected and changes have been small over the last 20 years compared to similar ecosystems throughout the state.
  - There is not enough baseline historic monitoring to determine whether or not the marsh area and function has changed in the last 20 years.
- There is consensus that pressures on salt marsh resources will increase in the next 20 years:
  - Development on land surrounding the salt marsh will increase nonpoint source pollution, eutrophication, and invasive species, which will further degrade marsh transition zones.
  - Salt marsh habitat and function will decline from: 1) sea level rising more rapidly than natural salt marsh accretionary processes, and 2) human development on the upland marsh edge, which will prevent natural marsh transgression to inland areas.
  - Increased recreational boating will cause greater erosion and slumping of the salt marsh.
- Other views of future salt marsh trends include:
  - Salt marsh area and function will remain status quo as people’s perceptions, appreciation, and respect improves with environmental education.
  - Marsh trends will depend on the economy…if economic growth continues, restoration project money will continue to be available for improving marsh habitat.

2. What additional research and monitoring is needed to improve our assessment of salt marsh habitats?

- All monitoring programs need to include, at a minimum, some indication of vegetation and hydrology with additional parameters of birds, fish, and biodiversity as needed on a project basis. The monitoring for each project should be scientifically rigorous, contain quantifiable measures of success, and be carried out over a sufficient period of time to provide meaningful results.

- Site specific monitoring is adequate, but a larger scale/systems approach is needed to monitor: 1) growth of invasive species, 2) erosion rates, 3) bank slumping, 4) nutrient loading, 5) impacts of mosquito pesticide (BTI) on the food web, and 6) potential long-term vegetation and habitat change as a result of sea-level rise.
- Long-term monitoring is needed to track vegetation change after restoration projects are complete.
- Fish and birds need to be sampled frequently to relate population change to restoration activities.
- Reference marshes that serve as controls for natural year to year variation need to be included in the design of a monitoring program.
- Academic involvement in salt marsh research needs to be strengthened. Currently, the Woods Hole Marine Biological Laboratory and the University of New Hampshire are the primary academic institutions doing comprehensive studies in the marsh. One way to increase academic research is to promote the salt marsh ecosystem as a site for graduate student studies.
- Although volunteers need supervision and clear monitoring goals, they are a valuable way to collect salt marsh restoration data.

3. What are threats or issues that need to be addressed in salt marsh habitats?

- Development and associated water quality problems around the marsh transition zone.
- Increased recreational boat use and issues of no wake zone enforcement, bank erosion and slumping, and jet ski impacts on tidal creeks.
- Tidal restrictions and impacts of invasive species growth, altered wildlife habitat, sedimentation, and elevation of the marsh.
- Sea level rise and associated shifts in vegetation.

4. What are opportunities for improvement or restoration of salt marsh habitats?

- Create a regional, salt marsh restoration site plan to help direct future actions and funding opportunities for restoration projects.
- Develop a clearinghouse of information learned from restoration activities that a variety of audiences can access when a new restoration project is started.
- Create a monitoring program for salt marsh sites that are actively and passively managed. Monitoring needs to be made a component of restoration grants and funding.
- Require the same monitoring protocols for mitigation projects as required of proactive restoration.
- Focus *Phragmites* management on control rather than elimination. Total elimination is not likely and perhaps not even desirable from a wildlife management perspective. The best way to control this invasive species is to eliminate tidal restrictions; the need to periodically repair bridges and culverts provides an opportunity to make incremental changes over time.
- Increase education and outreach about salt marsh resources, impacts, and benefits to a variety of targeted audiences…schools, business communities, local officials, etc. Existing restoration sites such as Argilla Road can be used for educational viewing.
- Improve coordination of restoration partners for permit review, enforcement, monitoring, and translation of monitoring results to local officials. The relationship between restoration partners and regulators can be improved by better articulating project expectations and outcomes.
- Promote using circuit riders to support restoration efforts and provide technical assistance.
- Improve enforcement and education of the “no wake zone” to reduce recreational boating impacts. Enforcement efforts can be implemented and improved by advocating for a full time harbormaster and staff in each town while an educational brochure would increase the public’s awareness and understanding of this designated area.

BIOLOGICAL RESOURCES

WILDLIFE

A large number of animals depend on the ACEC salt marsh and upland to forage, breed, rest, and migrate to other seasonal habitats. Much of the Plum Island Sound region is part of the U.S. Fish and Wildlife Service's (USFWS) Parker River National Wildlife Refuge. In addition to the federal refuge, there are also a number of state wildlife management areas and a number of properties owned by nonprofit conservation organizations that help protect wildlife throughout the ACEC. Barrier beaches of Plum Island and Crane Beach along with surrounding salt marsh habitats are especially attractive to birds and other wildlife.

Despite the recognized importance of the ACEC to wildlife habitat, little data exists on biodiversity and historic wildlife population estimates. The majority of wildlife data is collected for bird populations since the area is a well-known habitat along the Atlantic Fly-way Migration route. Over 300 species of birds have been sighted at the National Wildlife Refuge, including 75 rare species (DEM 1993). Numerous shorebirds use the barrier beaches and coastal salt marshes as important stopovers on their spring journeys to breeding grounds in Canada and on their fall journeys to tropical wintering grounds.

As part of the Plum Island Sound Minibay project, historic records of birds in the region were evaluated and compared to current surveys of water birds, waterfowl, shorebirds, gulls, and terns. Historical data was taken from journals of a state ornithologist who kept notes on birds he observed during the 1930s, 1940s, and 1950s. For comparison, results from the early 1990s were analyzed from refuge bird surveys conducted by members of the Brookline Bird Club (Buchsbaum et al. 1996). The analysis (Table 8) examines long term trends and synthesizes baseline data about birds currently using Plum Island Sound for breeding, feeding, and resting.

Table 8. A comparison of historical and present bird numbers on Plum Island (Buchsbaum et al. 1996).

Species	Comparison trends from 1930-1950s to 1990s
Common Loon (*Gavia immer*)	Has shown no consistent trend. The peak number of common loons recorded has varied from a low of 7 in the 1940s to a high of 49 in the 1950s.
Green-winged Teal (*Anas crecca*)	Has increased since the 1940s from 20 to 462.
American Black Duck (*Anas rubripes*)	Has steadily declined since the 1940s when a peak of 1,800 was observed.
Mallard (*Anas platyrhynchos*)	Has increased dramatically between the 1930s and the 1990s from vritually none to 133
Red-breasted Merganser (*Mergus serrator*)	Has steadily increased since the 1930s.
White-winged Scoter (*Melanitta fusca*)	Has dropped sharply from 1,400 during the 1930s to 267 during the 1950s. Peak numbers in the 1990s are similar to those of the 1950s.
Black-bellied Plover (*Pluvialis squatarola*)	Reached a peak of 1,183 in the 1940s and is at 174 in the 1990s.

Semipalmated Plover (*Charadrius semipalmatus*)	Has been relatively stable since the 1930s.
Greater Yellowlegs (*Tringa melanoleuca*)	Reached a peak of 310 during the 1940s then dropped to only 22 during the 1950s. Numbers at 93 in the 1990s.
Semipalmated Sandpiper (*Calidris pusilla*)	Has declined from about 4,500 during the 1930s to approximately 1,180 in the 1990s.
Bonaparte's Gull (*Larus philadelphia*)	Was slightly lower in the 1990s compared to 1930-1950.
Common Tern (*Sterna hirundo*)	Has decreased from 600 in the 1930s to 38 during the 1990s.

> "It is difficult to attribute population trends for birds measured in this report to specific local changes since most of these birds are migratory. In general, there is little evidence that Plum Island Sound as a habitat for birds has changed significantly between the 1930s and today. We do know that ditches, which have been dug throughout the marshes to reduce mosquito breeding habitat, have reduced the number of salt pannes available to birds, and that humans have affected mallard populations by feeding them. We suggest that the changes in the average peak numbers of birds in Plum Island may be related to regional and global factors such as the following.
>
> - Changes in the adequacy of breeding habitat in other regions may impact the bird species that come to Plum Island Sound during the non-breeding season.
> - Shifts in the number and type of fish found in Plum Island Sound caused by overfishing in the Gulf of Maine and other factors may have increased some of the food species available to birds in the Sound.
> - Migratory birds often shift their migration patterns in response to weather conditions and the availability of food" (Buchsbaum et al. 1996).

From the summer of 2000 through the fall breeding season of 2001, the USFWS Parker River Wildlife Refuge along with 15 other refuges are part of a region-wide study to determine shorebird use of impounded wetlands. This study will help determine the varying degree of importance that Refuges contribute to shorebird populations based on geographic location, habitat, and management actions relative to shorebird migration. Four habitat variables are expected to influence shorebird use of impounded wetlands: 1) abundance of an invertebrate food source, 2) mudflat to shallow water depths (since shorebirds are small and need to feed off benthic invertebrates at low tide), 3) slow water draw-downs during the migration period, and 4) sparse vegetation cover within the wetland. Sampling will include shorebird surveys, invertebrate sampling, vegetation density, and water depth. Based on this study, shorebird management plans for the USFWS Parker River Wildlife Refuge will be developed (Drauszewski per comm 2000).

Scientists at the Massachusetts Audubon Society are studying the correlation of salt marsh plant communities with bird species including the Red-Winged Blackbird, Song Sparrow, Sharp-Tailed Sparrow, Common Yellowthroat, Virginia Rail, and Marsh Wren. From vegetation analysis and visual observations of birds at Argilla Road in Ipswich, initial results show: 1) *Phragmites* has no negative impact on bird abundance or density; 2) *Phragmites* has a positive impact on the abundance on Red-Winged Blackbirds; 3) variables other than plant communities have a role in determining the distribution of most species detected; and 4) behaviors may indicate habitat preference where abundance alone does not (Holt per comm 2000).

For additional information on Essex County bird species, occurrences, and habitat see the Passport to Essex County Greenbelt: A Naturalist Guide to Essex County *(1990).*

Rare Species

The Massachusetts Natural Heritage and Endangered Species Program (NHESP), which is part of the Massachusetts Division of Fisheries & Wildlife, is responsible for the conservation and protection of wildlife and plants that are considered rare, threatened, or endangered in the state. Information on the abundance, distribution, and conservation needs of rare species and significant natural communities is collected through field surveys and literature searches by staff biologists and cooperators around the state. Figure 8 illustrates areas that represent the most important natural communities, state-listed rare species habitats, and vernal pools in the ACEC region; Appendix E is a list from the NHESP documenting the rare species found in these areas. For more information from NHESP about rare species lists, reports, and surveys visit their website at *http://www.heritage.tnc.org/nhp/us/ma/*.

The USFWS closes most of the ocean beach side of the Parker River National Wildlife Refuge during the breeding season of piping plovers (April through August). The need to close large sections of the beach during much of the summer to protect these birds is likely to continue for a number of years. Unlike the Wildlife Refuge, The Trustees of Reservation's management of Crane Beach keeps the beach open to the public but ropes or fences off all breeding areas each summer. Both public education and fencing are used as management practices on this beach. Table 9 shows recent trends in piping plover breeding estimates at both beaches.

Table 9. Piping plover breeding estimates (1995-99)

Location	**Crane Beach**		**Parker River National Wildlife Refuge**	
Year	***# pairs***	***# fledge***	***# pairs***	***# fledge***
1995	28	63	21	44
1996	36	33	17	20
1997	27	59	16	20
1998	35	71	15	11
1999	44	89	15	13

Due to consistently high productivity, Crane Beach has long been considered the most important breeding site for piping plovers in New England. In 1999, Crane Beach broke all previous state records for both breeding pairs and numbers of fledglings produced (Castonguay per comm 2000). The productivity decrease of piping plovers on the Parker River National Wildlife Refuge is estimated to be caused by abandonment, predation, washovers, and other weather related incidents (Melvin per comm 2000).

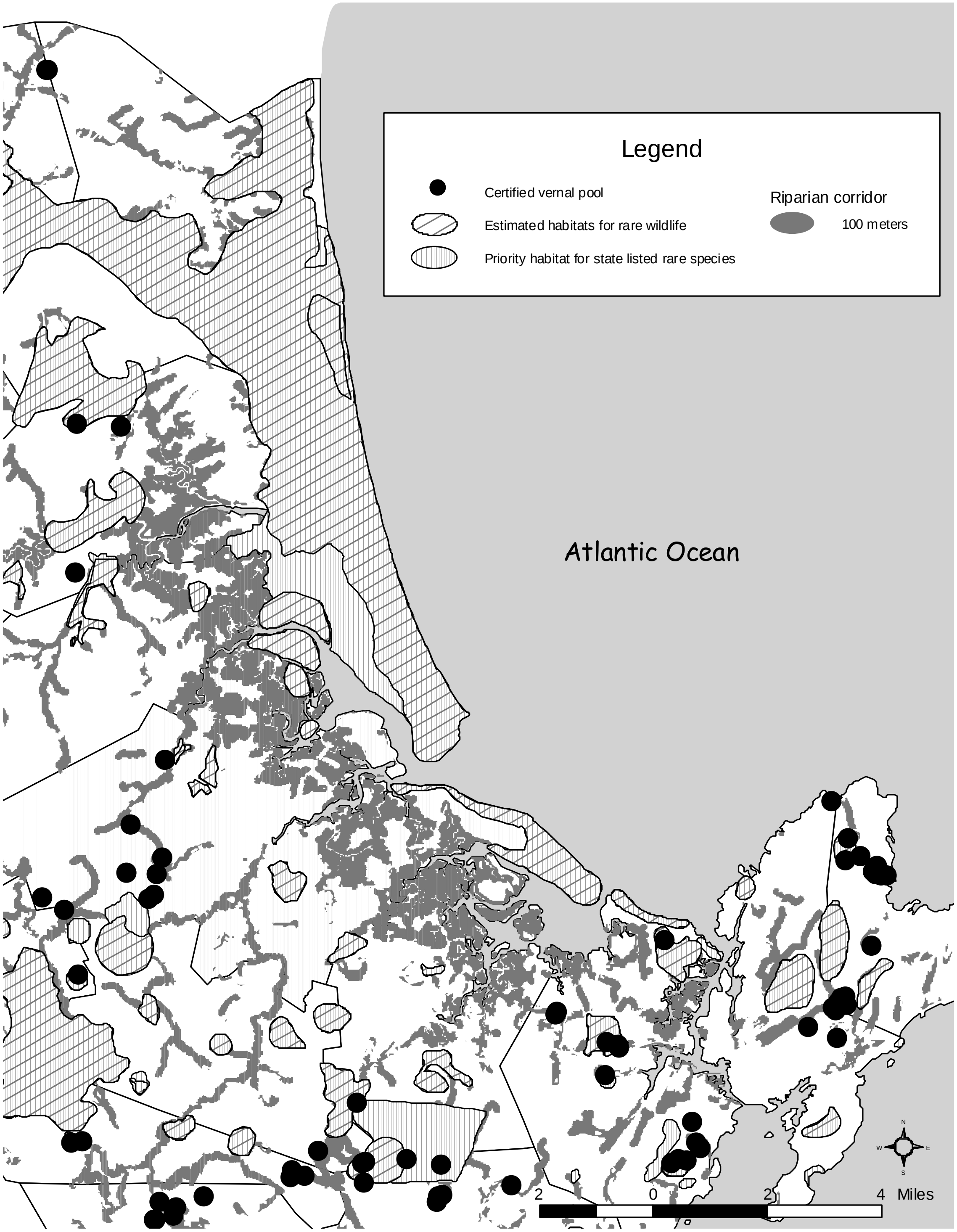

Figure 8. Wildlife habitat: Natural Heritage, vernal pool, and riparian corridor sites

Datalayer Descriptions (source = MassGIS database)

- *Certified vernal pool* = sites are certified by the Natural Heritage and Endangered Species Program.
- *Estimated habitats for rare wildlife* = estimations of resource area habitats of state listed rare wildlife populations in Massachusetts.
- *Priority habitat for state listed rare species* = estimations of the most important natural communities and state listed rare species habitats in Massachusetts.
- *Riparian corridor* = 100-meter corridor encompassing perennial stream and river features.

Wildlife Threats and Habitat Degradation

Much of the ACEC wildlife habitat is either protected under the Massachusetts Wetlands Protection Regulations or is owned by conservation agencies and nongovernmental organizations. However, there is still potential for increased growth and development to impact the upland marsh edge. Research shows that maintaining 300 foot coastal wetland buffers will protect the marsh and enhance habitat values by reducing the amount of wildlife disturbance (Buchsbaum and Purinton 2000). Because much of the ACEC is undeveloped and contains a great deal of conservation land, maintaining wide buffers is still possible in many places. Wildlife corridors along rivers where long stretches of undeveloped, naturally vegetated shorelines still exist and are illustrated in Figure 8. It is important to protect these areas since they provide unfragmented corridors for animal movement (Buchsbaum and Purinton 2000).

Although the ACEC is relatively undeveloped, there are still a number of habitat issues that the region is likely to face in the future, especially as growth and development pressures increase in surrounding communities: decline in water quality and eutrophication, marsh degradation and the continued invasion of *Phragmites*, loss of anadromous fish habitat, fragmentation and loss of wetland buffers and wildlife corridors, vulnerability of barrier beach wildlife, and rising sea level. “Some of these habitat issues are interrelated and are reflections of other regional or even global changes. Others will need to be addressed at the local level” (Massachusetts Audubon Society 1999).

Wildlife Field Notes

The following responses are individual opinions rather than a consensus reached by those interviewed. Field note information can be used by local and regional resource managers to assess research needs, guide restoration efforts, prioritize future workplans, and design technical assistance programs

The following people were interviewed about wildlife populations:

Robert Buchsbaum	Massachusetts Audubon Society
Wayne Castonguay	The Trustees of Reservations
Chris Leahy	Massachusetts Audubon Society
Jim MacDougall	Essex County Greenbelt Association
Deborah Melvin	USFWS Parker River National Wildlife Refuge
Rob Stevenson	Parker River Clean Water Association

1. Based on the information gathered through existing research, have wildlife populations and biodiversity improved or declined in the past 20 years? Where is this trend going in the next 20 years?

- Assessments of the past 20 years vary:
  - Some species have declined while others have prospered. It is difficult to make generalizations about population trends since many migratory species are affected by regional and global impacts. In general, species being properly managed like terns and plovers have increased in the past 20 years, but overall, there has been a regional (not just ACEC) decline in shorebirds.
  - Many groups of wildlife have benefited from increased conservation efforts from federal, state, and private groups to restore avian diversity throughout the Atlantic Flyway.
  - In the past 20 years, biodiversity has decreased as human impacts (roads and housing developments) fragment wildlife habitat and exotic species such as *Phragmites*, green crab, and Japanese shore crab populations increase.
- Projections of the next 20 years include:
  - More plans, programs, and groups working towards sustaining and improving existing populations will likely improve population trends for species being managed. However, as human pressures, habitat fragmentation, and exotic species increase, there will likely be an overall decline in biodiversity.
  - The future of many wildlife populations (especially migratory species) will depend on regional and global conditions that are especially hard to predict. As long as information continues to be gathered about population increases and declines, we will have a better understanding of wildlife, human, and habitat interactions.

2. What additional research and data is needed to improve our assessment of wildlife populations?

- More rigorous, long-term, systematic surveys are needed for shore and migratory bird populations. Existing historic databases include: 1) the U.S. Fish and Wildlife Service monitoring of avifauna trends on the Plum Island Refuge (See Appendix B), and 2) The Trustees of Reservations monitoring of endangered piping plover and tern populations.
- Fact sheets including information for each species, potential threats, and field expert contact information need to be created and stored in a “wildlife information clearinghouse”. This information will provide a broader demographic base for each species and a systematic way to maintain and update species information.

- Past research tends to focus on single species rather than ecosystem studies. Although these trends are beginning to change, more emphasis needs to be placed on ecosystem studies, such as the relationship of marsh benthic communities to bird presence and abundance. With salt marsh restoration activities gaining more attention, additional monitoring of plant, invertebrate, and vertebrate responses to these restorations should be well documented as part of an ecosystem study.
- A better understanding about the effects of human impact on wildlife habitats is needed. For example, what are the effects of recreational boating activities on wildlife disturbance, water quality, and bank erosion? What effect does habitat fragmentation (i.e, roads, housing developments, etc.) have on wildlife migration? The effects of salt marsh hay cutting on wildlife habitat which is currently being studied by the Massachusetts Audubon Society and the Woods Hole Ecosystems Center can serve as a model for other human impact and wildlife studies (Woods Hole MBL 1999).
- Many birds have disappeared from the region without a known cause of decline such as American Bitterns, Golden-Winged Warblers, and Common Moorhens. If both long-term wildlife population and human impact studies are combined, we will gain a better understanding for mechanisms causing these types of population declines.

3. What are important threats or issues for wildlife that need to be addressed?

- Increased development on the salt marsh edge where wildlife are sensitive to disturbance.
- Increased development (especially roads) and loss of open space which creates more habitat fragmentation and loss of wildlife corridors.
- Continued recreational boating and beach use and the associated disturbance of shorebird feeding and breeding habitats.
- Endangered species migration to neighboring beaches without management policies (i.e., migrating plovers and terns from TTOR owned Crane Beach to privately owned Wingaersheek Beach).
- Increased cars and domestic pets, which are a direct cause of mortality and disturbance.
- Global and regional impacts of habitat loss and fragmentation, hunting, and lack of migratory route protection.

4. What are opportunities for improvement or restoration of the wildlife populations?

- Increase volunteer opportunities for waterfowl monitoring and habitat restoration projects.
- Continue vigilance for protection of endangered species on beaches.
- Implement boating restrictions on beaches (Wingersheek, Coffins, and Sandy Point) to help manage shorebirds and increase areas of essential breeding/feeding habitats.
- Protect areas between municipal and state owned lands to reduce habitat fragmentation. By identifying linkages and corridors between these areas, wildlife migratory routes can be protected.
- Promote the use of 300 foot wetland buffers for local conservation commission jurisdictional review.
- Increase education and outreach to residents about using their backyards as wildlife habitat (i.e., manicured green lawns are not as good as native plants). This effort will promote a better understanding, awareness, and stewardship of local wildlife and habitats.

FINFISH

The network of tidal creeks in the ACEC are used as spawning, nursery, and feeding areas by many important species of finfish. Forage fishes, such as the sticklebacks and silversides, spawn in emergent salt marsh vegetation; large numbers of winter flounder use marsh creeks for nursery areas; blueback herring and alewives spawn in portions of the upper watersheds (Jerome et al. 1968). Many fish in the ACEC and surrounding waters are migratory, making regular movements between the rivers, estuaries, and ocean (Buchsbaum and Purinton 2000).

For centuries, fish have provided a bountiful source of food, first to Native Americans and then to European settlers in the region. In the seventeenth century, cod, pollock, Atlantic sturgeon, and haddock were the most important exported fish. However as fishing pressures increased with human settlement, finfish abundance decreased. Sharp population declines in the 1730s led to the first fisheries management decision with a closure of the Parker River striped bass fishery in 1771. In the early 1900s, an intense herring fishery caused a serious decline in alewife populations throughout the region. An alewife stocking program, initiated in the Ipswich River in the early 1920s by the Fish and Game Association, transplanted fish from the Essex to the upper Ipswich Rivers. During the late 1930s, sport fishing in the Plum Island Sound region began to increase and is still popular today. Species presently sought by sport fishermen include striped bass, white perch, winter flounder, and smelt (Buchsbaum and Purinton 2000).

The Massachusetts Division of Marine Fisheries (DMF) estuarine monograph series (1968, 1973), the Massachusetts Audubon Society's (MAS) Plum Island Sound Minibay Report (1996), and the Woods Hole Ecosystem Center Plum Island Sound Comparative Ecosystem Study (PISCES) provide assessments of fish populations for the ACEC region. For example, 28 species of finfish were collected by DMF at shore and offshore stations in Plum Island Sound and the Parker River in 1965, while 34 species were collected by the MAS-PISCES study in 1993-1994 (Table 10) (Buchsbaum and Purinton 2000).

Table 10. A check list of finfish species collected at all sampling stations in the Parker River-Plum Island Sound Estuary, 1965 (DMF study) and 1993-4 (MAS-WH study) . The year(s) at which the fish were observed is noted. (Buchsbaum et al. 1996)

Class & Order	**Family**	**Genus & Species**	**Common Name**	**Years seen** 1965	1993-4
CHONDRICHTHYS					
Squaliformes	Squalidae	*Squalus acanthias*	spiny dogfish	X	
Rajiformes	Rajidae	*Raja erinacea*	little skate	X	
		Raja ocellata	winter skate	X	
		Raja spp.	skate species		X
OSTEICHTHYS					
Acipensiformes	Acipenseridae	*Acipenser oxyrhynchus*	Atlantic sturgeon	X	
Clupeiformes	Clupeidae	*Alosa aestivalis*	blueback herring	X	X
		Alosa pseudoharengus	alewife	X	X
		Alosa sapidissima	shad		X

		Brevoortia tyrannus	Atlantic menhaden		X
		Clupea harengus	Atlantic herring		X
		Opisthonema oglinum	thread herring		X
	Osmeridae	*Osmerus mordax*	American smelt	X	X
	Salmonidae	*Salmo trutta*	brown trout		X
Cypriniformes	Cyprinidae	*Notemigonus chrysoleucus*	golden shiner		X
Anguiliformes	Anguillidae	*Anguilla rostrata*	American eel	X	X
Cyprinodontiformes	Cyprinodontidae	*Fundulus heteroclitus*	mummichog	X	X
		Fundulus diaphanus	banded killifish		X
Gadiformes	Gadidae	*Gadus morhua*	Atlantic cod	X	
		Microgadus tomcod	Atlantic tomcod	X	X
		Urophycis spp..	hake	X	X
Gasterosteiformes	Gasterosteidae	*Apeltes quadricus*	four-spined stickleback	X	X
		Gasterosteus aculeatus	three-spined stickleback	X	X
		Gasterosteus wheatlandi	black-spotted stickleback		X
		Pungitius pungitius	nine-spined stickleback	X	X
	Syngnathidae	*Syngnathus fuscus*	northern pipefish	X	X
Perciformes	Percicthyidae	*Morone americanus*	white perch	X	X
		Morone saxatilis	striped bass		X
	Centrarchidae	*Lepomis macrochirus*	bluegill sunfish		X
	Percidae	*Perca flavescens*	yellow perch		X
	Pomatomidae	*Pomatomus saltatrix*	bluefish		X
	Carangidae	*Vomer setapinnus*	moonfish		X
	Labridae	*Tautogolabrus adspersus*	cunner		X
	Ammodytidae	*Ammodytes americanus*	American sand lance	X	X
	Cottidae	*Hemipterus americanus*	sea raven	X	
		Myoxocephalus octodecemspinousus	longhorn sculpin	X	
		Myoxocephalus	grubby		X

		aenaeus			
	Cyclopteridae	*Cyclopterus lumpus*	lumpfish	X	X
	Anarhichadidae	*Anarhichus lupus*	Atlantic wolffish	X	
	Zoarcidae	*Macrozoarces americanus*	ocean pout	X	
	Atherinidiae	*Menidia menidia*	Atlantic silversides	X	X
	Pholidae	*Pholis gunnellus*	rock gunnel		X
Pleuronectiformes	Bothidae	*Scopthalmus aquosus*	windowpane	X	X
	Pleuronectidae	*Limanda ferruginea*	yellowtail flounder	X	
		Pleuronectes americanus	winter flounder	X	X
Lophiformes	Lophiidae	*Lophius americanus*	goosefish	X	

There were significant differences between the 1960's and 1990's fish assessments in Plum Island Sound. The average catch per unit effort of fish caught by beach seining was about six times higher in early 1990s compared with 1965. The dramatic increase in fish catch is attributable to a five-fold increase in mummichogs and an eleven-fold increase in Atlantic silversides, the two most common species in both studies (Buchsbaum et al. 1996). Reasons for differences between the two studies could include: 1) differences in sampling methodology, 2) differences in physical parameters, 3) random fluctuations, 4) local changes in the ecosystem, 5) changes in pesticide use, and 6) changes in predator numbers (Buchsbaum et al. 1996). Aside from Atlantic silversides and mummichogs, the number of individuals of other species were not different between the two studies.

Major Fisheries and Regional Fish Counts

Striped Bass. The striped bass has been an important commercial and recreational fish species for over a half century. Large numbers of stripers appear in the spring and remain until fall. In the 1980s, striped bass numbers were low along the East Coast as a result of overfishing and pollution of spawning areas. After the implementation of strict management measures that reduced both the commercial and recreational take, their resurgence has been a management success (Buchsbaum and Purinton 2000).

Smelt. Smelt are anadromous fish that spend most of their life in salt water, then migrate up into fresh water to spawn. Historically, abundant populations supported a large number of smelt houses (shelters put on the ice for fishing) through the 1960s. However, populations have plummeted in recent years to the point where there is no longer a winter fishery. Researchers at DMF suggest that algal growth in the upstream spawning habitats is a possible cause of the smelt decline; few eggs are now found (Buchsbaum and Purinton 2000). However, this winter, local recreational fishermen were catching smelt of a good size near the Ipswich town landing. This is the first report of smelt in the Plum Island Sound estuary in recent years (Mountain per comm 2000).

River Herring. River herring (alewives and blueback herring) are also anadromous fish, meaning they are born in fresh water, live for two to three years in the ocean and then return to their original spawning stream to breed. Both alewives and blueback herring are closely related and are hard to distinguish by sight. However, the alewife arrives earlier in the spring and migrates much further up river to breed in headwater ponds, while the bluebacks arrive later and breed in the river current. Juvenile alewives remain in fresh water until later in summer or autumn when they migrate downstream to the ocean (Stevenson et al. 1998).

Historically, the Ipswich River supported a thriving alewife fishery. This fishery was severely impacted due to obstructions on the mainstem of the river and the use of alewife spawning ponds for water supply. Similar to the fish stocking programs in the 1920s, the Massachusetts Department of Fisheries and Wildlife Riverways Program and Division of Marine Fisheries have been working in the 1990s to restore this fishery. This renewed restoration effort has centered on replacing the Sylvania Dam fish ladder and transporting migrating blueback herring from the Charles River to the Ipswich River. It is hoped that the offspring of these transported fish will imprint upon the Ipswich River and return to spawn in the future. To determine if the restoration project is working, the Ipswich Basin Team, Riverways Program, and the Ipswich River Watershed Association are working in partnership to organize volunteer fish counts. The counts are designed to establish sampling to see if, when, and under what conditions the fish are migrating. A total of 53 herring were sighted on 16 different counts with the majority of sightings being between May 14 and May 23, 1999 in the evening hours (IRWA 1999).

From 1997 - 2000 the Parker River Clean Water Association, in partnership with the Essex County Sportsmen's Club, have launched similar volunteer-based fish counts on the Parker River. In the 1970s, runs between 12,000 and 38,000 fish were recorded. However, in the 1997 and 1998 counts, the alewives numbered only 6,396 and 4,242 respectively and in 1999 and 2000, numbers increased to 7964 and 7890. These runs are approximately only 25 percent of that recorded 25 years ago (Stevenson et al. 1998). Possible reasons for decline might be related to changing ocean conditions (where National Oceanic and Atmospheric National Marine Fisheries Survey (NMFS) studies have shown that alewife landings in New England waters have significantly declined in the last 50 years) or loss of spawning habitat in the upper watersheds. In addition to the Ipswich and Parker Rivers, the Essex River also supports an alewife run to Chebacco Lake.

In the Parker Watershed, construction of dams without adequate provisions for fish passage prevent access to historic spawning grounds. Although there are six fishways along the length of the Parker River, many of them are now as much as 70 years old with each being in some state of disrepair (Stevenson et al. 1998). The Parker River Fishway Restoration Action Plan (1998) was written by DMF to provide recommendations for fish passage. The recommendations were based on observations made during several site visits by DMF personnel, as well as an inspection and report prepared by Dick Quinn, Fishway Engineer for the U.S. Fish and Wildlife Service (1997). The purpose of the action plan is to provide a strategy for improvement of fish passage, a priority list for restoration projects, and specific recommendations for maintenance, reconstruction, and alterations to existing structures. *To view a collection of Parker River dam, culvert, and fishway drawings, visit the website http://www.parker-river.org/maps/dams.* Civil engineering students at Tufts University are currently studying the Main Street Dam in Byfield on the Parker River. The students are working to provide alternatives to the current fishway situation including: 1) complete dam removal, 2) installation of two sections of a steep- pass fishway, and 3) lowering the dam by two feet and installing one section of steep-pass. As part of this study, the students will assess the impact of all three alternatives on Parker River hydrology, water quality, aesthetics, and long-term stability.

Waters of the ACEC provide important spawning, nursery, and feeding areas for many finfish species. Although historically finfish populations in the area were of great economic importance, the commercial fisheries markedly declined by the early 1900s and no longer make substantial contributions to the economy of the area. Sport fishing in the area has fluctuated greatly in the past 30 years and depends largely on change in abundance of favored fish (Buchsbaum and Purinton 2000). The watershed association's fish counts help to document change in population abundance as efforts to maintain fishways and investigations of dam removal continue.

Finfish Field Notes

The following responses are individual opinions rather than a consensus reached by those interviewed. Field note information can be used by local and regional resource managers to assess research needs, guide restoration efforts, prioritize future workplans, and design technical assistance programs.

The following people were interviewed about finfish resources:

Robert Buchsbaum	Massachusetts Audubon Society
Chuck Hopkinson	Woods Hole Marine Biological Laboratory
Eric Hutchins	NOAA National Marine Fisheries Service
Rusty Iwanowicz	Massachusetts Division of Marine Fisheries
Rob Stevenson	Parker River Clean Water Association

1. Based on the information gathered through existing research, have finfish populations increased or declined in the past 20 years? Where is this trend going in the next 20 years?

- ♦ Without long-term, time-series data, it is hard to adequately assess population trends in the past 20 years. Generally, there has been a decline in anadromous fish populations (alewives and smelt in particular), while small bait fish (mummichogs and silversides), striped bass, and bluefish populations have improved in the last 20 years.
- ♦ It is hard to predict population trends in the next 20 years because there are many large-scale issues, such as changing ocean conditions, fishing pressures, and fisheries management practices that will affect ACEC fisheries.

2. What additional research and data is needed to improve assessments of finfish populations?

- ♦ More long-term, quantifiable estimates of pelagic species including bluefish, striped bass, winter flounder, and herring are needed. To specifically assess the health of ACEC fisheries, more resources should be allocated to monitoring winter flounder and alewives, which are better local indicators than striped bass or bluefish whose populations reflect larger scale, regional impacts of climate change, overfishing, etc. Both the Plum Island Sound Minibay project and the Woods Hole Ecosystems Center seine and trawl experiments provide data to assess shore fish populations, while the watershed association’s volunteer fish counts are a useful model for collecting long-term, quantifiable evidence for herring populations.
- ♦ Reasons for the smelt decline need to be researched (i.e., is algal growth in spawning areas causing a decline in smelt populations?). Currently, observational evidence and institutional memory from fishermen exists, but no quantifiable results of smelt populations have been collected.
- ♦ More education and outreach about the dependence of juvenile fish on salt marsh habitats and the effects of eutrophication on fish spawning habitats is needed.
- ♦ Education and outreach about the connection between inshore and offshore fisheries is needed. For example, since the estuary is acting as a nursery for offshore species, there is more incentive to manage inshore waters properly because these areas impact larger system dynamics.

3. What are the most important threats or issues that need to be addressed for finfish populations?

- Loss of salt marsh due to tidal restrictions and habitat degradation, which reduces the amount of habitat for juvenile and spawning fish populations.
- Water withdrawals, especially in the Ipswich and Parker Rivers during summer drought conditions, which reduce the necessary flow of water needed to maintain healthy fish populations.
- Historic fish ladders in need of maintenance and upgrades.
- Loss of riparian vegetative cover along stream banks caused by increasing development and habitat degradation.

4. Where are opportunities for improvement or restoration of the finfish populations?

- Increase the amount of fish habitat by restoring tidally restricted salt marsh.
- Continue to maintain and upgrade regional fish ladders.
- Continue investigations of dam removal where conditions are favorable.
- Continue doing shoreline surveys to target riparian areas in need of restoration; special attention should be paid to maintaining tributary spawning habitats.
- Plant submerged aquatic vegetation such as eelgrass to increase shoreline habitat.

SHELLFISH

Historically, both Plum Island Sound and Essex Bay have been major shellfishing areas with six species being harvested in the region: soft-shell clam (*Mya arenaria*), surf clam (*Spisula solidissima*), blue mussel (*Mytilus edulis*), razor clam (*Enis directus*), oyster (*Crassostrea virginica*), and ocean quahog (*Arctica islandica*) (*for a detailed account of locations and economic characteristics of each species see Buchsbaum and Purinton 2000*). The distribution of shellfish is partially determined by the tidal flat grain size. Since medium grain sands tend to shift more often than fine grain sands, larger populations of shellfish are generally found in the fine grain sand conditions between high and low water (*for current maps of shellfish bed types and locations, see Appendix C to contact the Merrimack Valley Planning Commission*). Predators of the soft-shell clam include: moon snails or cockels (*Lunatia heros*), horseshoe crabs (*Limulus polyphemus*), the Herring Gull (*Larus agentatus*), the Great Black-Backed Gull (*Larus marinus*), and the green crab (*Carcinus maenus*) (Buchsbaum and Purinton 2000). Historically predation by the green crab was considered a major threat, and today it is again a concern of clammers throughout the ACEC.

Native Americans and early settlers found the soft-shell clam to be a vital source of food, while commercial fisherman used it to support a bait industry for the Grand Banks fishery in the early 19th century (Roach 1992). However, in the late 19th century, over harvesting caused the resource to decline and led to local control of harvesting practices in Ipswich and Essex. Pollution forced the closure of many shellfish beds during the 1920s by the Massachusetts Department of Public Health. Although over harvesting, predation, and natural mortality have depleted the resource through time, statistics indicate that landings have varied greatly from year to year and town to town. For example, in 1945 a combination of over harvesting and high predation rates caused the Ipswich clam industry to be severely depleted (Buchsbaum and Purinton 2000), while in 1949 and 1950, Essex was the leading producer of soft shell clams in Massachusetts. By the 1960s, the shellfish industry in Plum Island Sound recovered to be highly productive as the flats accounted for over half the soft-shell clam harvest in Massachusetts (Jerome et al. 1968).

As of 1984, 1,691 acres of clam flats were estimated to be available for clamming in Plum Island Sound (Buchsbaum et al. 1996) *(see Appendix D for maps of shellfish bed names and locations in Plum Island Sound and Essex Bay*). Based on 1992-1993 data, the total annual value of all bivalves harvested (including soft shell clams, mussels, razor clams, and surf clams) in the Sound was estimated to be $3,345,840. Although numbers vary on a town-by-town basis, Ipswich historically has the highest harvest rates. In 1964, 15,811 bushels were harvested with a value of $134,000 ($8.50/bu.), while a total of 15,400 bushels valued at $924,000 ($60.00/bu.) were taken by commercial Ipswich shellfishermen in 1990 (Jerome et al. 1968, Buchsbaum et al. 1996). Although roughly the same amount of shellfish were harvested, the value increased almost seven times in 30 years (*for detailed historical shellfish investigations of Newbury, Rowley, Ipswich, and Essex see the Jerome, 1968 and Chesmore, 1973 DMF Monographs*).

Although the soft-shell clam is still the most important economic fishery and supports a community of harvesters, distributors, processors, and restaurant owners in the ACEC region, pollution continues to hurt the modern shellfish industry. In Massachusetts, DMF has responsibility for monitoring waters above shellfish beds for fecal coliform bacteria to determine whether shellfish are safe to eat. DMF samples and classifies shellfish harvesting areas according to requirements of the National Shellfish Sanitation Program (NSSP) guidelines (Table 11).

Table 11. DMF classification of shellfish beds in Massachusetts (Roach per comm 2000)

Approved. Suitable for human consumption. Sanitary surveys complete, monitoring indicates low levels of fecal coliform bacteria averaging less than 14 fecal coliform bacteria per 100 ml of seawater with no more than 10 percent of the samples higher than 43.

Conditionally Approved. Approved for shellfishing, except during intermittent and predictable pollution events such as rainfall or sewage system overflows. These beds require detailed water quality monitoring during rainfall events. Seasonally approved shellfish beds fall within this category and are often closed during the summer because of higher human activity from residents and tourists. Considerable water quality monitoring is required under this classification when the area is open and available for harvest. Shellfish in conditionally approved areas are suitable for human consumption only during approved periods.

Conditionally Restricted. Areas that are affected by intermittent and predictable pollution events, and meet "restricted" area criteria when a pollution event is not occurring. Fecal coliform concentrations averaging between 14 to 88 per 100 ml seawater with no more than 10 percent of the samples greater that 260. Beds are closed after a rainfall of .5 inches or more (this value is likely to change over time and between growing areas). Shellfish harvested from conditionally restricted areas are not suitable for direct consumption and must be either relayed to an approved area or to a shellfish purification facility and allowed to purge themselves of the pollution over time. These shellfish must be closely monitored and determined to meet strict sanitary standards prior to being marketed for consumption. Shellfish in restricted or conditionally restricted areas can only be harvested by specially licensed commercial diggers – recreational harvesting is not allowed.

Restricted. Averaging between 14 and 88 fecal coliforms per 100 ml seawater with no more than 10 percent of the samples greater than 260. No rainfall component. Following harvest by specially licensed individuals, shellfish must be subject to a suitable and effective treatment process by relaying to clean water or depuration plant. Not suitable for direct human consumption.

Prohibited. Closed due to fecal coliform levels consistently exceeding 80 fecal coliforms per 100 ml seawater. Not suitable for human consumption.

Management Closure. This is not an official classification category under the NSSP. Rather, it is an administrative and management procedure that must be approved by the Director of Marine Fisheries to close a shellfishing area. It is used in lieu of the Prohibited classification to distinguish that an area is closed due to a lack of water quality information. Areas placed under a Management Closure are difficult to obtain water quality information from, located offshore, generally not productive, and were not prioritized by coastal communities when DMF first assumed the program. Slowly as the appropriate water quality information is obtained, many of these areas have been reclassified as Approved.

DMF conducts sanitary surveys at a minimum of once every 12 years to determine sources of pollution in waters overlying shellfish beds. The survey and report are updated and kept current through annual and triennial evaluations which continually assess water quality for classification purposes. Field observations by technically trained persons who reliably evaluate pollution sources and associated impacts on growing areas is another critical component of the survey and reevaluation process.

DMF classifies most of Plum Island Sound as Conditionally Approved for shellfishing (Figure 9); this classification means the flats are closed for five days after 0.5 inches of rainfall because stormwater runoff and bacterial counts increase. If more than one inch of rain falls, the flats are closed for at least eight days. During dry weather, results from the Plum Island Sound Minibay study (1996) indicate that bacterial counts for most of the Sound do not exceed the standard for clean shellfish beds (Buchsbaum et al. 1996). Although development and associated water quality pollution has increased in the last 35 years, most new subdivisions in the region are located some distance from the Sound, leaving it buffered from pollutants generated by new development. Roughly the same acreage of shellfish beds in Plum Island Sound are classified as Prohibited now as when DMF did their Monograph Study in 1965 (Buchsbaum et al. 1996).

During the past decade, bacterial pollution of Essex Bay has become increasingly prevalent, resulting in a greater frequency of shellfish bed closures (Figure 10) (Roach 1992). Based on findings from the 1992 DMF Sanitary Survey, the previously assigned Approved classification in many areas is no longer applicable and now requires a classification downgrade to Conditionally Approved. Survey results found that rain events and subsequent bacterial loadings are "much more complex with far more serious public health implications than originally presumed" (Roach 1992). Essex Bay is now classified as Conditionally Approved with areas closed to shellfishing five days in the winter with 0.75 inches of rainfall and in the summer with greater than 0.4 inches of rain. Pollution source mitigation by the towns of Essex and Ispwich has allowed middle portions of the Castle Neck River to be reopened under a Conditionally Approved classification in January, 1999. Upper portions of Walker Creek, and Essex River are all classified as Prohibited (Roach 1992).

There is hope that water quality and shellfish closures will gradually improve with ongoing pollution abatement programs in the ACEC. For the past decade, Ipswich has made a conscientious effort to control coastal pollution and protect its shellfishing resources. In 1991, The Ipswich Shellfish Advisory Board reported that high levels of fecal coliform seriously affected recreational and commercial shellfishing. In response to this report, the Board of Selectmen created the Ipswich Coastal Pollution Control Committee (CPCC) to develop a Coastal Pollution Management Plan. After three years of research, the CPCC wrote a final report that focused on coastal pollution remediation and incorporated recommendations to the town. In 1999, CZM funding allowed the town to hire a temporary planning assistant to help implement these recommendations (Keane 1999). In the fall of 1999, shellfish beds opened in Fox Creek and Treadwell Island Creek due to successful water quality remediation efforts by the town of Ipswich. The flat openings were an historic event as parts of the Ipswich River have been closed to shellfishing for 74 years and some flats have not been dug for 15 years (Kuhn 1999).

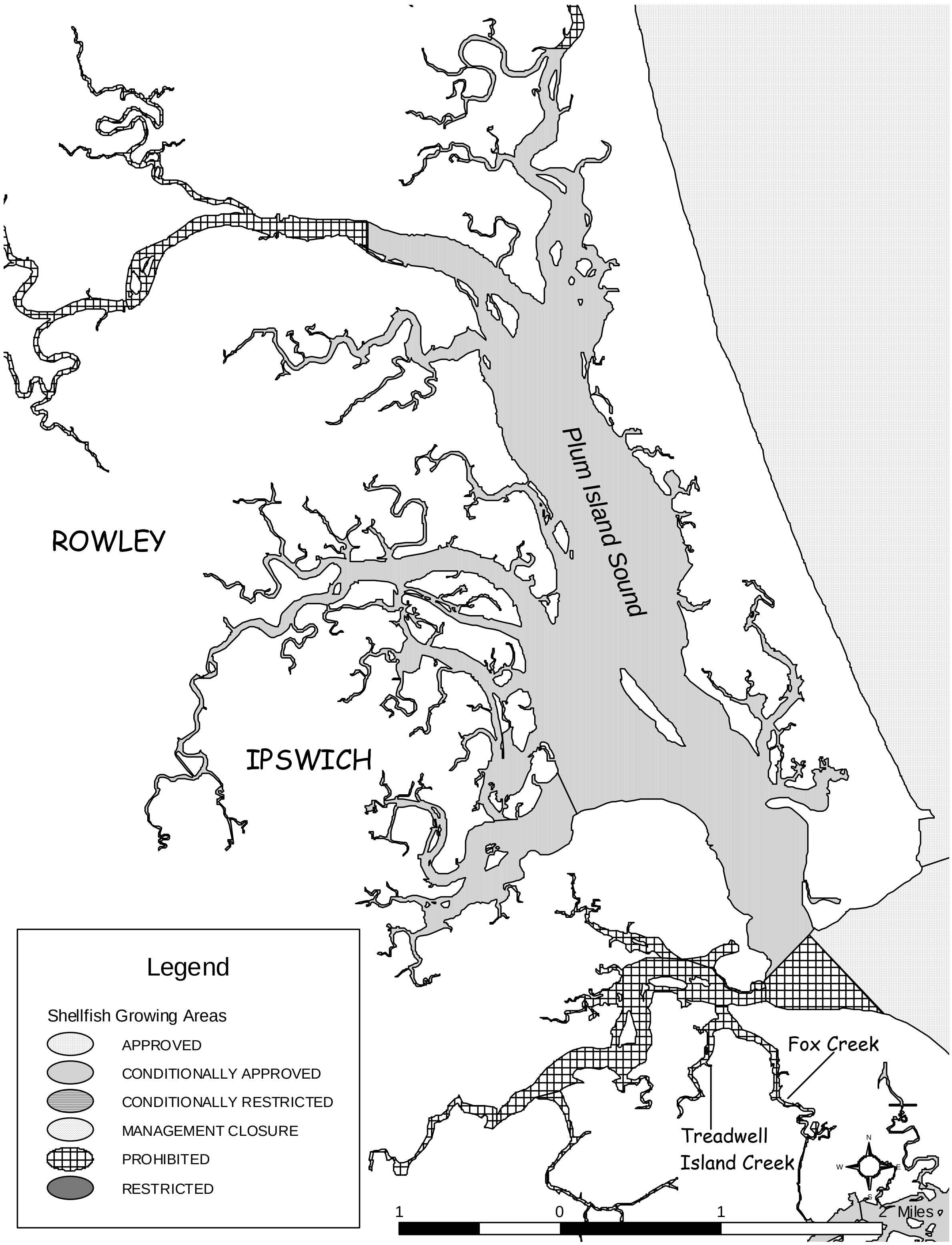

Figure 9. DMF designated shellfish growing areas in Plum Island Sound (April, 1998)
NOTE: Conditionally Approved classification upgrades at Fox and Treadwell Island Creeks in October, 1999 do not appear on this map

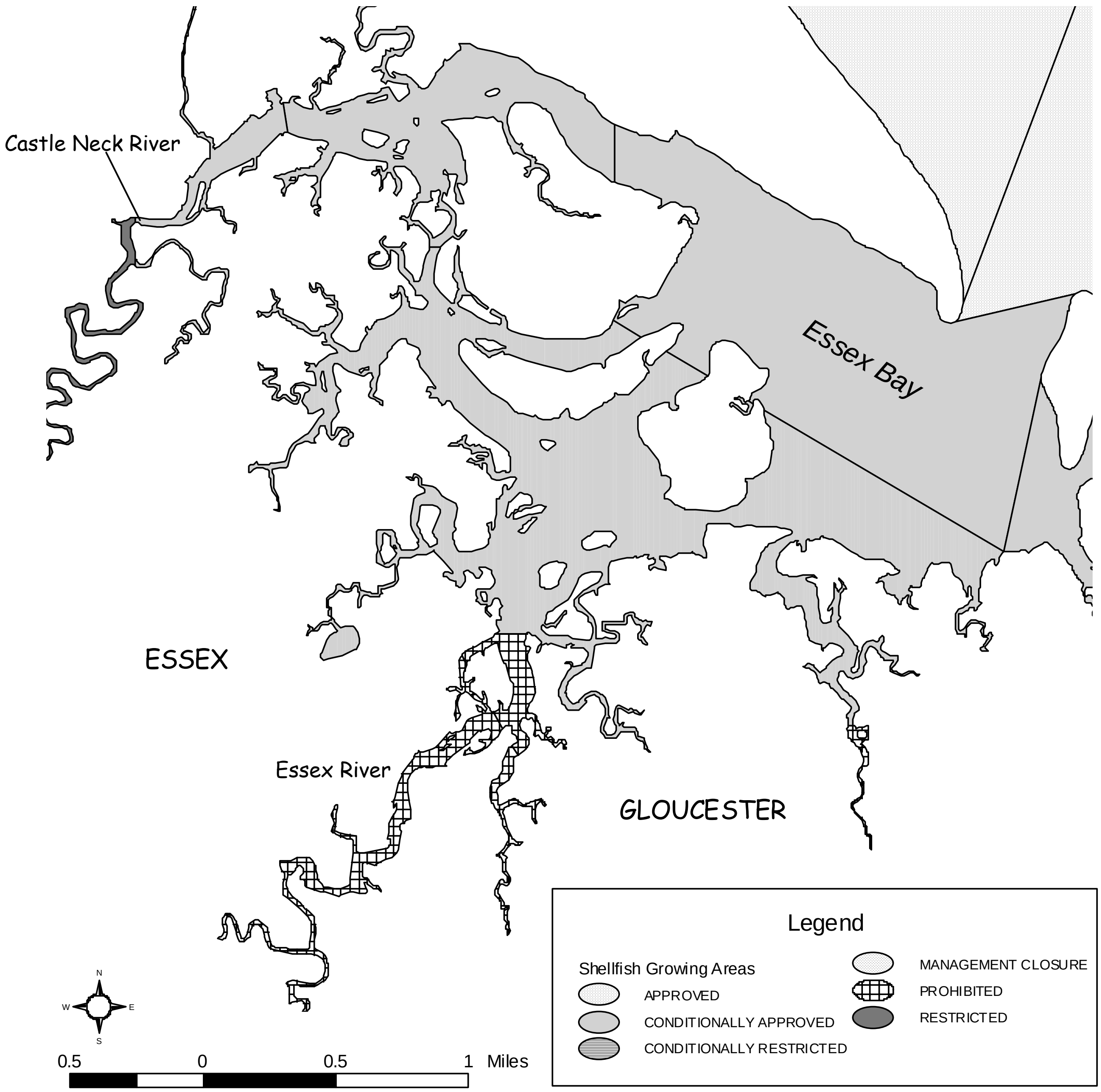

Figure 10. DMF designated shellfish growing areas in Essex Bay (April, 1998)
NOTE: Conditionally Approved classification upgrades for middle portions of the Castle Neck River in January, 1999 do not appear on this map

In Essex, years of water quality data have shown problems with septic system failures. In the late 1990s, the town began addressing the need to create some form of sewage collection and treatment beyond the use of septic systems (Dames and Moore 1999b). In March, 2000 the Gloucester City Council agreed to allow Essex to hook up to the city's sewer system (Mandarini 2000). With this plan in place, water quality in Essex Bay and impacts on shellfish resources are expected to improve *(see the Water Quality section for more information)*.

A multi-year shellfish aquaculture research project was launched on the North Shore in 1995 by a partnership of the Merrimack Valley Planning Commission, Eight Towns and the Bay, the Northeast Massachusetts Aquaculture Center, and the towns of Gloucester, Ipswich, and Rowley. The project goal is to research the feasibility of rearing soft-shell clams for both private aquaculture and public stock enhancement by investigating two techniques of hatchery production and wild seed (or young clam) harvesting. The hatchery component is working to develop a soft-shell clam hatchery at the Aquaculture Center at Salem State College (Castonguay 1999). This research will lead to the development of a critically needed, reliable, and local source of seed. The wild seed harvesting component is exploring ways to "catch" naturally produced seed in the wild to determine if this is a viable alternative to hatchery produced seed. Several types of experimental seed catching nets have been deployed at eight locations in Ipswich, Rowley, and Gloucester. The nets function by allowing clam larvae in the water column to settle and grow under the nets, while protecting them from predators. Based on previous research, it is expected that the nets will capture and protect many thousands of naturally produced young clams that would otherwise perish due to predation and other types of mortality. These clams can then be thinned and the excess transplanted to underproductive or non-productive shellfish areas (Castonguay 1999).

The introduction of exotic marine species, through sources of shipping ballast waters, hull fouling, aquaculture, or aquarium trade, is a threat to the biodiversity in many coastal areas. On the North Shore, biologists are becoming more concerned about invasive populations of green crab, Japanese shore crab, orange tunicates, and European oysters. In many cases, the invaders are able to out-compete native species for food or space and may carry parasites that are harmful to local populations. Organizations such as DMF, CZM, and the Massachusetts Audubon Society are studying the impacts of invasive species on the ecology of coastal waters on the North Shore (Blake 2000). CZM is beginning to identify ways of evaluating biodiversity and ecosystem effects from invaders through a state-wide project that will: 1) conduct a systematic field survey of marine invaders in coastal habitats, especially harbors, ports, and marinas, 2) use this information to evaluate potential sources and impacts, and 3) develop a state management plan for preventing, mitigating, and controlling non-indigenous marine introductions.

Shellfish Field Notes

The following responses are individual opinions rather than a consensus reached by those interviewed. Information does not necessarily reflect the views or policies of each respective agency/organization. Field note information can be used by local and regional resource managers to assess research needs, guide restoration efforts, prioritize future workplans, and design technical assistance programs.

The following people were interviewed about shellfish resources:

Robert Buchsbaum	Massachusetts Audubon Society
Wayne Castonguay	The Trustees of Reservations
Jeff Kennedy	Massachusetts Division of Marine Fisheries
Phil Kent	Ipswich Shellfish Constable
Stubby Knowles	Gloucester Shellfish Constable
Dave Roach	Massachusetts Division of Marine Fisheries
Dave Sargent	Gloucester Shellfish Advisory Board

1. Based on the information gathered through existing research, have shellfish populations increased or declined in the past 20 years? Where is this trend going in the next 20 years?

- Shellfish populations have natural boom/bust cycles that are dynamic and unpredictable. Although it is hard to estimate past resource trends and forecast future trends, *shorter* boom and *longer* bust cycles may be due to cumulative impacts of over harvesting and predation over the past 20 years.
- In the next 20 years, the boom and bust cycles will depend a lot on the economy and market price. In a poor economy, clamming pressures will increase as more people find alternative ways such as shellfishing to make money. If the market price remains high, continued over harvesting combined with a noticeable increase in green crab populations will cause greater cumulative damages to shellfish populations. However, in the next 20 years, longer rainfall closures from increased land-based pollution may serve as a conservation tool that limits harvest pressures.

2. What additional research and data is needed to improve our assessment of shellfish resources?

- *Qualitative* information needs to be gathered about: 1) population impacts from harvesting and green crab predation, 2) seasonal shifts in species size, and 3) effects of pesticides, herbicides, and heavy metal pollutants.
- *Quantitative* information about population estimates, density, location, recruitment, productivity, and mortality needs to be gathered through systematic survey. However, it is hard to track all the variables that influence shellfish populations; where seed settles, creek bottom formations and currents, the type of winter, predation, and harvesting make it hard to estimate quantitative results. Since numbers can change dramatically, it might be more useful to collect data about estuarine sedimentation and flushing characteristics, which directly influence shellfish populations.
- Shellfish Constables submit annual catch reports to DMF on the number of commercial and recreational licenses issued, catch estimates and value, shellfish species, and harvest method. If a database were set up to collect and organize this information, these catch reports would help improve quantitative estimates.
- Additional research is needed for potential effects and impacts of aquaculture practices in the region.
- Research on the effects of recreational boating on shellfish populations is needed.

3. What are important resource threats or issues that need to be addressed for shellfish resources?

- As the number of commercial permits being allocated increases, shellfish over harvesting becomes an issue. Although towns develop their own municipal shellfish program best suited to meet their needs and resources, some beneficial regional approaches could be developed to address the resource decline. Regional strategies might include: 1) collective purchasing of propagation and seeding materials/equipment/supplies in order to leverage the lowest costs for each community and 2) coordination of a regional predator control program, particularly for green crabs.
- With greater development in the upper and lower watersheds, nonpoint source pollution will likely increase and it will be harder to maintain or improve the DMF shellfish classifications from Prohibited or Restricted to Conditionally Approved. However, pollution trends will largely be dependent on local commitment to identifying sources, mitigation work, and proper planning for future development. Recent efforts have already allowed upgrades in shellfish classifications. Thus, it is important to continue implementing agricultural and stormwater Best Management Practices, such as holding basins or vegetated swales if shellfish harvesting is to continue at the same or an improved rate.
- As recreational boating is becoming more popular in Plum Island Sound and Essex Bay, wastewater, petroleum products, and increased turbidity will impact shellfish populations.
- Increasing green crab populations will continue to stress shellfish populations.

4. What are opportunities for improvement or restoration of shellfish resources?

- Continue using information from DMF shoreline surveys to target land-based water quality hot spots and promote wastewater management.
- Promote the Ipswich CPCC report and use of a planning assistant to implement water quality remediation and shellfish management recommendations as a model to other ACEC towns.
- Continue researching the establishment of shellfish hatcheries and seeding experiments as potential restoration and aquaculture models for the region. Pilot seeding experiments currently underway in Gloucester, Rowley, and Ipswich that are being monitored for their success and challenges can be used as models throughout the region.
- Reduce over harvesting by setting limits on the number of commercial permits issued during times of high market price or by lowering the take allowed for each harvester. An alternative to harvest reduction is to focus more attention on shellfish seeding programs which help maintain the resource.
- Decrease exotic species and harvest pressures on shellfish populations by finding viable green crab markets.
- Allocate more staff and money to local shellfish constables. Much of the restoration work such as harvest enforcement, predator reduction, and seeding programs depend on the amount of time these officials spend in the field.
- Create a more reliable data collection system. For example, data obtained from DMF "shellfish transaction cards" should be cross-checked with data that shellfish constables and individual harvesters submit. This system would promote greater accountability among harvesters and increase the reliability of data collected for quantitative and qualitative estimates (i.e., shellfish bed locations, population densities, and species compositions). Implementing a better system to collect shellfish information will also provide data needed to put water quality remediation projects into economic terms. The greatest obstacle to setting up a database to collect this information is funding.

WATER QUALITY

A number of organizations currently take water quality samples throughout the ACEC (Figure 11). Some of these sampling stations have been used in comprehensive regional water quality studies including the DMF Monograph Series (Jerome 1968, Chesmore 1973), DEP water quality surveys (1989), DMF Sanitation Surveys (Roach 1992), the Plum Island Sound Minibay Project (Buchsbaum et al. 1996), and the Plum Island Sound Comparative Ecosystem Study (PISCES) (Woods Hole MBL 1997). Flushing characteristics, temperature, salinity, dissolved oxygen, and fecal coliform parameters were commonly sampled in these water quality studies. In the older DMF monographs (Jerome 1968, Chesmore 1973), pesticide analysis was also done because of the historic widespread use of DDT (modern reports do not contain this information as the use of DDT has been banned). Results from portions of both Plum Island Sound and Essex Bay water quality studies are summarized below.

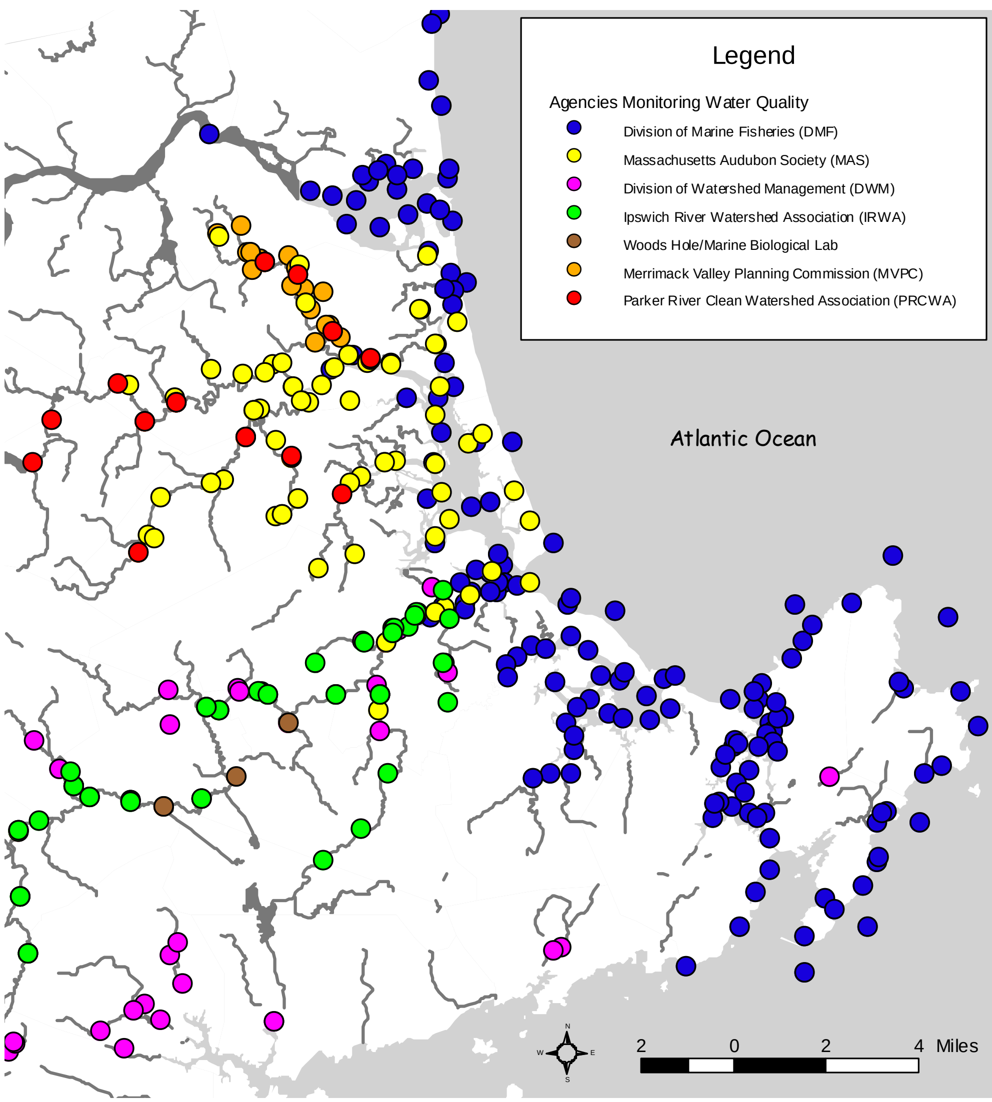

Figure 11. Water quality sampling sites and contacts

PLUM ISLAND SOUND

Physical and Chemical Results

The following physical and chemical factors were evaluated in this inventory: flushing time, dissolved oxygen, salinity, nutrients, and toxic contaminants.

Flushing time. Flushing is a measure of the speed at which a drop of water enters and leaves a certain segment of a water body. Flushing is an important consideration in water pollution studies because it determines how long a given pollutant remains within an area. Dry weather flushing times in the lower part of Plum Island Sound are one day or less. This means that there is a rapid turnover of water and any pollutant entering from the rivers is rapidly flushed out to the ocean through the Sound. In contrast, the longest flushing times were in the upper parts of the Sound where water entering from the Parker and Rowley Rivers remains for over nine days (Massachusetts Audubon Society 1999).

Dissolved oxygen. The 1968 and 1992 DMF surveys and the 1996 Minibay results indicated that Plum Island Sound does not have a low dissolved oxygen (DO) problem. However, both the 1996 Minibay project and 1989 DEP survey found that dissolved oxygen levels in some of the upstream monitoring stations were occasionally below the state standard of 6.0 ppm. This indicates that tributaries have a potential problem of organic matter input and nutrient loading (DEP 1989, Buchsbaum and Purinton 2000).

Salinity. Salinity surveys in 1992 and 1993 ranged from 0.22 - 30.4 ppt in the Parker River stations and from 22.3 - 30.8 ppt in the Plum Island Sound stations (Buchsbaum and Purinton 2000).

Nutrients. Suspended solids for Ipswich River and Bay were sampled as part of the 1989 DEP Division of Water Pollution Control water quality survey. Results indicate that suspended solids in the river main stem and open water stations were lower than readings from the tributaries. The 1989 DEP survey of the Ipswich River found that nutrient levels were highest at tributary rather than open-water stations where nutrient values were lower as a result of dilution. This survey identified hot spots of high nitrogen and phosphorus levels located at Greenwood Creek below the Ipswich wastewater treatment plant outfall (DEP 1989, 1990). Although the treatment plant, (which had several upgrades in recent years) could be one source of high nutrient levels, other causes might be from nearby failing septic systems or slow pollutant flushing times in Greenwood Creek (Roach per comm 2000).

Phosphate, silicate, total nitrogen, total phosphorus, and chlorophyll α were sampled as part of the Minibay study in 1992 and 1993. Nutrient analyses indicate a range of values varying over seasons and among different sample stations. Because the results vary so much, "…it is difficult to make generalizations. Phosphate, for instance, appears to have a pattern of increasing upstream concentrations in June and August, but less obviously so or not at all during the other three surveys. Silicate routinely shows increasing upstream concentrations, most obviously for the Parker River. Nitrate plus nitrite, and to a lesser degree ammonia, show similar patterns to silicate, but are less consistent" (Buchsbaum et al. 1996). *(For detailed nutrient sampling results in Plum Island Sound, see the 1996 Minibay report*).

Toxic contaminants. Landfills, private industries, marinas, junkyards, and underground storage tanks are located in ACEC towns. Although the source of most contamination from metals, inorganics, volatile organic compounds, and total dissolved solids is known, the degree of pollution from these sources is not well documented (Buchsbaum et al. 1996). Of the landfills located in Ipswich, Rowley, Newbury, and Newburyport, only two have pollutant monitoring data. Both Newbury and Rowley's landfills are adjacent to salt marsh habitats within the ACEC (Buchsbaum et al. 1996). Test results from the Rowley landfill (which opened in the 1950s and closed in 1992) indicate low levels of toxins. The engineering firm that prepared the report determined that, "…the levels were not of concern and future analysis was deemed unnecessary" (Buchsbaum 1996). As a result of high levels of contaminants found at the Newbury landfill, DEP has been keeping close watch on the environmental impacts (Mountain per comm 2000).

Industrial contamination is mostly a concern in the Parker Watershed where the Lord Timothy Dexter Industrial Park in Newburyport is located along the Little River. Sediment tests performed by the Parker River Basin Team in 1994 indicate that metal concentrations were below levels determined to cause significant detrimental impacts to biota even though high levels of arsenic and aluminum were found (Buchsbaum and Purinton 2000). In the Ipswich River, a DEP study of water quality found high levels of zinc from samples collected near the public boat ramp (DEP 1989, 1990).

Microbial Contamination

Fecal coliform bacteria are common indicators that disease-causing bacteria and viruses from human and/or animal wastes are likely to be in the water. Generally, downstream and open water sampling sites in Plum Island Sound show lower bacteria counts than upstream sites as a result of dilution and mortality as distances from land-based sources increase (DEP 1989, 1990). Between 1992 and 1995, the Minibay study collected and tested more than 600 water samples from 42 stations in Plum Island Sound and its tributaries. This data was used to determine hot spots of unusually high fecal coliform concentrations in the region and to identify rivers and streams that contribute high bacterial loading to the Sound. Study results are summarized for five areas: Plum Island Sound, Ipswich River, Parker River, Rowley River, and Parker River National Wildlife Refuge. The following section (except for italicized text) summarizing fecal coliform results is taken directly from *Conserving the Plum Island Sound/River Ecosystems* report (Massachusetts Audubon Society, 1999).

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Plum Island Sound and Plum Island River

Plum Island Sound itself is characterized by low concentrations of fecal coliform bacteria during dry weather. The state standard for shellfishing, which is a geometric mean of 14 colony forming units (cfu) per 100 ml, was met at all stations in the Sound itself when the weather was dry. During rain events, however, a number of stations exceeded 14 cfu/100 ml, which supports the current designation of the Sound as conditionally approved depending on rainfall.

Table 12. Fecal coliform concentrations in Plum Island Sound and Plum Island River Stations					
Station Location	Station Type	# of Samples Dry	# of Samples Wet	E coli/100ml Dry	E coli/100ml Wet
Off Castle Hill	boat	7	2	3	38
Off Helicat Swamp	boat	7	2	5	13
Eagle Hill River	boat	7	2	9	24
Rowley River Mouth	boat	3	1	2	8
Plum Island River at Jericho Creek	boat	6	2	10	12
Pine Island Creek	shore	4	3	15	51

Ipswich River Segment
Water flowing over the Sylvania Dam is relatively clean, but then a jump in fecal coliform concentrations occurs as the river passes through the center of Ipswich between the dam and the town landing. Bacterial concentrations remain high throughout the estuary but are gradually diluted closer to the mouth of Ipswich Bay (*note: since the 1996 Minibay study, DMF has detected fecal coliform concentrations increasing in dry weather from the Ipswich Town Landing to the mouth of the Ipswich River. At this time, a cause for these trends is not well understood*). High concentrations of fecal coliforms also occur in three tributaries of the Ipswich River, particularly Kimball Brook. *See the Ipswich Coastal Pollution Control Committee Report (1995) for additional information.*

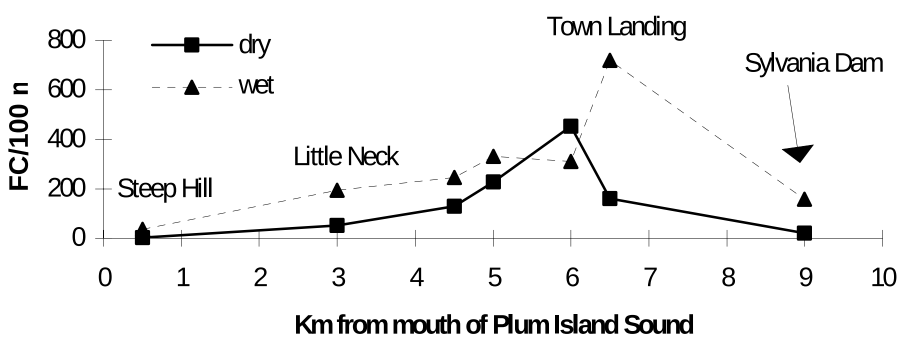

Figure 12. Gradients of Fecal Coliform – Ipswich River Main stem

Rowley River Segment
The main stem of the Rowley River averaged less than 25 fecal coliform concentrations per 100 ml during dry weather, slightly above the allowable levels for shellfishing. The increase in fecal coliform contamination throughout the Rowley River after heavy rainfalls suggests that there are inputs of contaminated stormwater, particularly in the area just downstream from the town landing.

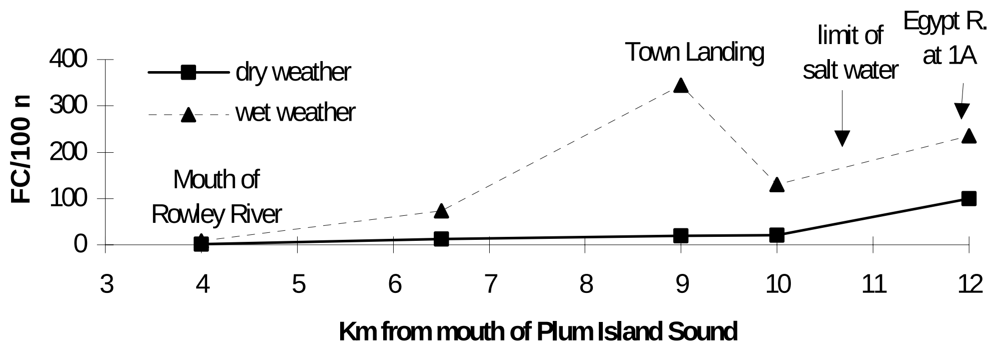

Figure 13. Gradients of Fecal Coliform – Rowley River Segment

Parker River Segment

The main stem of the Parker River is relatively clean when it passes over the dam in Byfield. Within the estuarine part of the Parker, however, there is a slight increase in bacteria from as yet undiscovered sources. This is then gradually diluted before the Parker River flows into Plum Island Sound. Hot spots for fecal coliforms within the Parker River segment include a small creek near the Governor Dummer Academy, Ox Pasture Brook in the center of Rowley, and the Little River, particularly at Hanover Street.

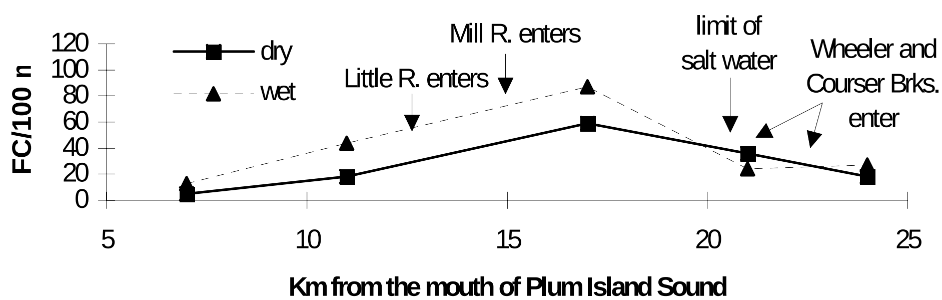

Figure 14. Gradients of Fecal Coliform - Parker River Segment

Relative Loadings to the Sound from Different Segments

Over 70 percent of the fecal coliforms entering Plum Island Sound during dry weather and 52 percent during wet weather originate from the center of Ipswich between the Sylvania Dam and the town wharf. Despite this relatively large load, it is highly unlikely that the Ipswich River has a significant impact on water quality in the central and northern parts of the Sound, where many clam flats are located because water from the Ipswich River is rapidly flushed out into Ipswich Bay. Nonetheless, about one-quarter of the potential clam flats in the Plum Island Sound region are located in the Ipswich River estuary itself, and these are closed due to the contamination entering the river downstream from the Sylvania Dam.

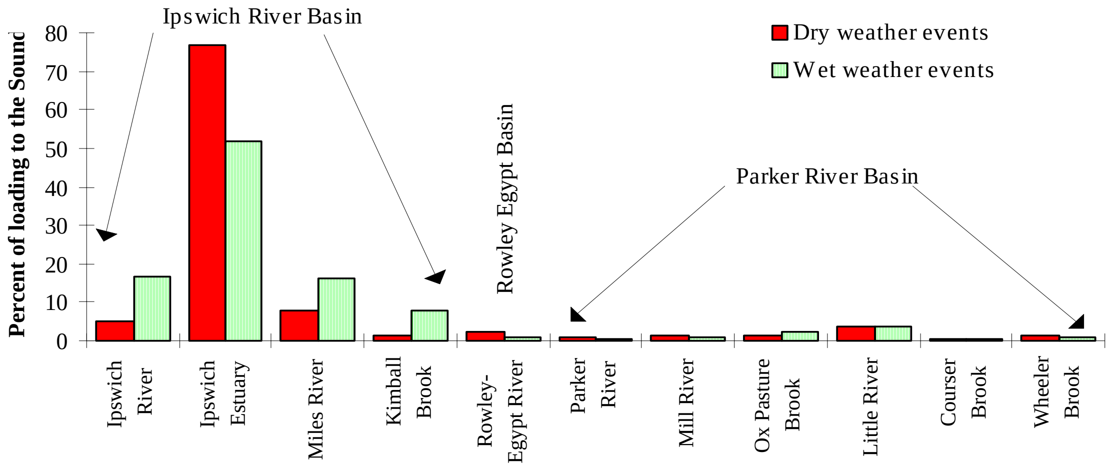

Figure 15. Relative Loadings of Fecal Coliform to Plum Island Sound from All Basins

Bacteria from the Parker River affect the central and northern sections of the Sound. The Little River in Newbury is the largest source of bacteria to the Parker River estuary (about 40 percent in both dry and wet weather). The Rowley River and the Parker River National Wildlife Refuge do not contribute significantly to fecal coliform loadings in Plum Island Sound.

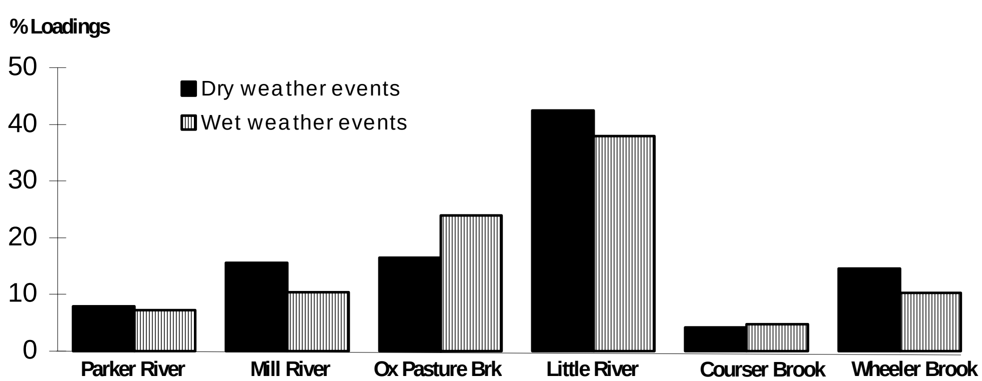

Figure 16. Relative Loadings of Fecal Coliform to Plum Island Sound: Parker River Basin

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Pollution Sources in Plum Island Sound
To determine sources of pollution, shoreline surveys were conducted throughout Plum Island Sound as part of the 1996 Minibay project. Sources such as drainage ditches, discharge pipes, faulty septic systems, outfall from sewage treatment facilities, and agricultural runoff were documented as part of this study (Buchsbaum et al. 1996). Because multiple sources of potential pollution were identified in each segment of the watershed surveyed, it is difficult to attribute cause to any one source of pollution. "One exception is the wastewater treatment plant for Governor Dummer Academy located in the Mill River where consistently high levels of fecal coliform contamination were identified through water quality sampling" (Buchsbaum et al. 1996). Although Governor Dummer upgraded their treatment system five years ago, studies show that their collection system is inadequate. Other sources identified that warrant further investigation are shown in Table 13.

Table 13. Potential sources of pollution in the Plum Island Sound region (Massachusetts Audubon Society 1999)

Source Type	Location
Wastewater treatment facilities and other point sources	Ipswich River estuary
	Mill River (Rowley)
Urban stormwater runoff	Ipswich River
Faulty or inadequate septic systems or illegal hookups	Little River (Newbury, Newburyport)
	Ox Pasture Brook (Rowley)
	Ipswich River estuary
	Kimball Brook
	Farley Brook
Agricultural, including horses	Miles River (Ipswich)
	Little River (Newbury)
	Mill River (Rowley)
Feral Waterfowl	Ipswich River Estuary
	Ox Pasture Brook

ESSEX BAY

A water quality survey in tidal portions of Essex Bay and rivers was performed by DEP's Division of Water Pollution Control during the summer of 1989. Samples were collected at 48 stations for assessment of water quality, sediment quality, and selected biological parameters. Physical and chemical parameters sampled at open water stations include depth, dissolved oxygen, salinity, temperature, and specific conductivity. Biological parameters sampled include phytoplankton and chlorophyll, bacteria, macroalgae, and mussel tissue (DEP 1989, 1990, Roach 1992).

Physical and Chemical Results

Flushing time. Essex Bay is a tidally dominated estuary where contaminants are quickly dispersed bay wide in as little time as ½ a tidal cycle (Roach 1992).

Dissolved oxygen. Dissolved oxygen (DO) concentrations measured at Essex River tributary and town stations were generally lower than concentrations found farther downstream or in open water. DO concentrations dropped below the state water quality standard of 6.0 ppm in seven of the Essex sampling stations. As in Plum Island Sound, "the reason for depressed oxygen values is unknown, but suggests that upstream sources may be imposing an oxygen demand" (DEP 1989, 1990).

Salinity. Salinity surveys ranged from 13 - 30.3 ppt in the main stem of the Essex River, Castle River, and bay stations, from 0.5 - 30.1 ppt in the tributary stations, and from 20.5 – 32.0 ppt in Bay stations (DEP 1989, 1990).

Turbidity. Suspended solids and turbidity were generally higher in tributary stations which suggests that runoff and erosion or sediment resuspension may be occurring in these areas. Consistently elevated suspended solids and turbidity were especially high in an unnamed creek that flows into the Essex River near the public boat ramp in Essex town center.

Nutrients. Total nitrogen concentrations were also generally higher in tributary samples with values ranging from < 0.90 mg/l in the main stem river and open water stations. Nitrate concentrations in Essex Bay were usually low throughout the survey period. Similarly, open water stations tended to exhibit lower ammonia concentrations than the tributary and upriver stations. "This pattern indicates that pollutants are being diluted as they flow further from their land-base sources through the estuary and out into open waters" (DEP 1989, 1990). Phosphorus concentrations also followed this trend.

Toxic contaminants. Heavy metals and PCBs were assessed by doing tissue analysis on mussels collected from three sites in the estuary. Results from mussel tissues and sediments collected at these stations suggest that metals and PCBs are not present in the water column in concentrations that cause measurable bioaccumulation.

Microbial Results

Several sampling stations showed notably high densities of fecal coliform bacteria throughout the survey period. Essex River samples all exceeded the criteria of 14 coliform/ml for approved shellfish areas. Tributary stations at the Castle Neck River, an unnamed tributary off Burnham Road, and Walker Creek greatly exceeded the Water Quality Standards for class SA waters every time they were sampled (SA = excellent habitat for fish, wildlife, primary/secondary contact recreation, approved areas for shellfish harvesting without depuration, and excellent aesthetic values) (Commonwealth of Massachusetts 1995). Stations in tributaries or upriver near Essex town center showed occasional or slightly elevated coliform densities. Results from these sites, "indicate possible sewage contamination from nearby septic systems that may be failing. These sites should be investigated further to pinpoint sources so that remedial action can be implemented. Stations with only slightly elevated counts were most likely influenced by upstream sources of bacterial contamination or possibly from road runoff" (DEP 1989, 1990). Open water stations in Essex Bay rarely exceed water quality standards for coliform bacteria because of high flushing rates and minimal impacts of land use activities nearby.

The town of Essex instituted a sampling program in 1995 to investigate pollutant types and sources as part of their wastewater management planning. The program includes sampling: 1) selected points in the town's lakes, streams, rivers, and estuary, 2) storm drains, and 3) septic systems. A description of each sampling program follows (Dames and Moore 1999b).

1) In August, 1995, the town initiated a sampling program in major streams and drainage ways with significant development near Chebacco Lake, the coastline, and

marshes. Additionally, minor streams or drainage ways that were suspected of contamination were sampled. This monitoring consisted of bacteria sampling and shoreline surveys. Chebacco Lake shoreline, Alewife Brook, Essex River, Eben Creek, Soginese Creek, and Essex Bay were also visually surveyed for illegal discharges.

2) In April, 1995, the town initiated a storm drain outfall sampling program during dry and wet weather events. Samples were analyzed for fecal coliform and streptococci concentrations. In drains where fecal coliform concentrations were above 200 coliform/100 ml and the coliform to streptococci ratio was greater than 4.0, the drain was posted as being contaminated (Figure 17). Storm drains identified as contaminated are sampled quarterly while historically clean drains (fecal coliform levels less than 200 coliform/100ml) are sampled annually. *For a list of clean and contaminated storm drains, see the Town of Essex Wastewater Facilities Plan/MEPA Special Procedures Phase 1 Report.*

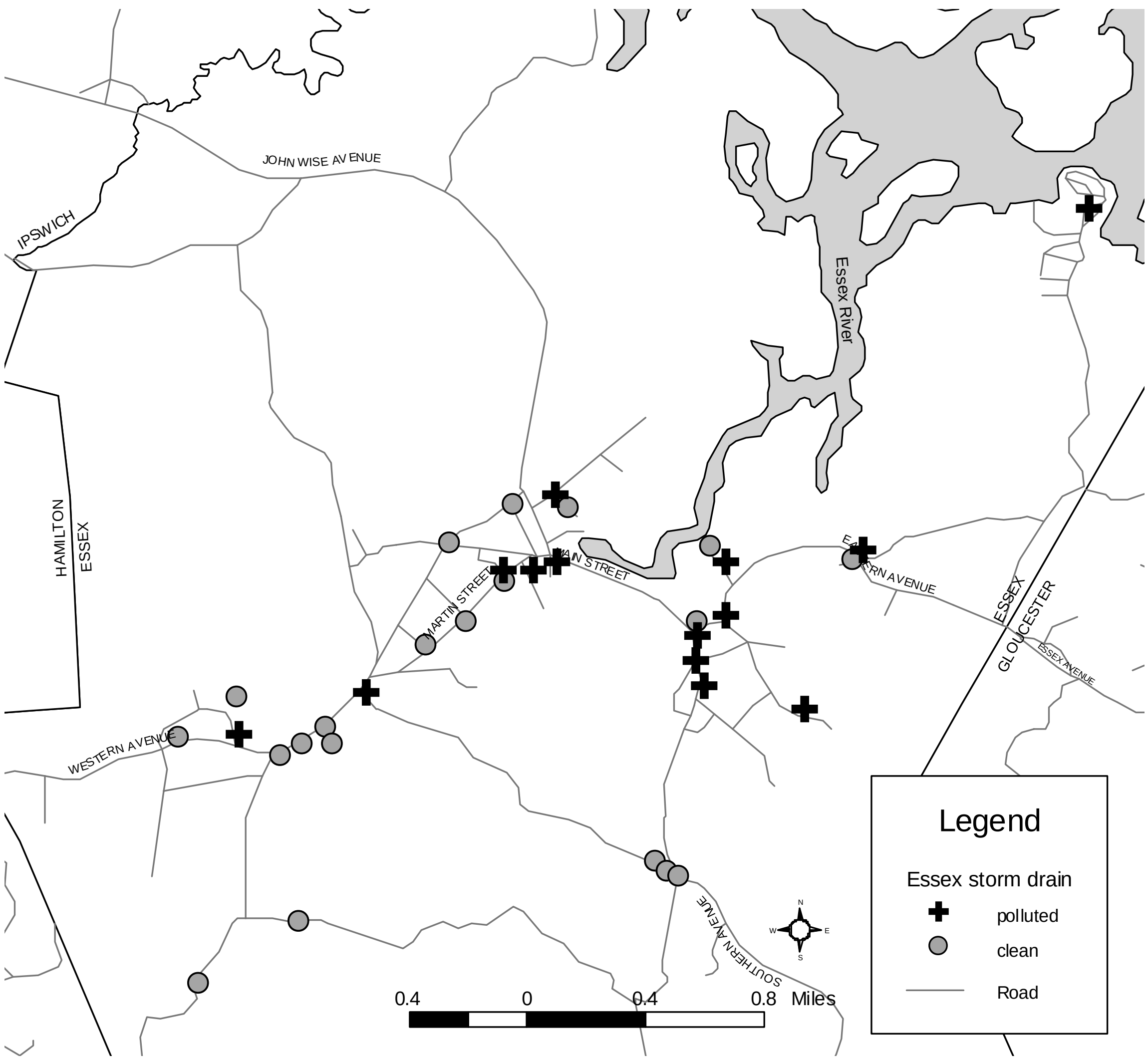

Figure 17. Essex storm drain summary (Dames and Moore 1999b)

3) In areas surrounding contaminated drains, the Board of Health dye tested homes to locate direct discharges. Of the 574 septic systems that were inspected, 292 failed a Title 5 septic system evaluation. The total number of systems that failed a soil evaluation is 160. The most common cause for septic failure is submergence of the disposal system in elevated groundwater. High groundwater and permeable soils in the upper layers provide a pathway for poorly treated wastewater to enter the storm drain system. Septic systems that were found to be directly discharging sewage were ordered to cease discharging and to upgrade their system to meet Title 5 standards. All such systems have been upgraded.

In 1998, the town of Essex also began developing a wastewater management facilities plan and the required Environmental Impact Report. In 1999, the town completed a Phase 1 report, which established the need for a centralized sewer collection system. A Phase 2 report (to be completed in 2000) will include sampling information to date (Dames and Moore 1999a). In March 2000, the Gloucester City Council agreed to allow Essex to hook up to the city's sewer system. That agreement allows Essex to construct a sewer line along Essex Avenue from the Wellspring House in Gloucester to the Essex border. The town will pay approximately $1.12 million for the right to send their wastewater to Gloucester (Mandarini 2000). River and stream monitoring will continue as part of this plan (Ferris per comm 2000).

Pollution Sources in Essex Bay

Data from these sampling programs indicate that high levels of fecal coliform (greater than 1,000 coliform/100ml) were observed in Alewife Brook (at Landing Road), Addison Brook (at Addison Street and Southern Avenue), Burnhams Court, Eben Creek (at Grove Street and Eastern Avenue), Essex River (at Apple Street), and Soginese Creek. All but the sampling locations at Eben Creek (at Grove Street), Essex River, and Soginese Creek are likely impacted from nearby failing septic systems. These other three locations drain large agricultural areas with domesticated animals and wildlife that mostly contribute to the high bacteria levels. Less elevated levels of fecal coliform (200 to 1,000 fc/100ml) were observed in Alewife Brook (at Pond Street and Apple Street), Ebens Creek (upstream of Eastern Avenue), and Coffils Hollow (at Martin Street) (Dames and Moore 1999b). For more specific data about pollution sources at these locations see the 1999 *Town of Essex Wastewater Facilities Plan/MEPA Special Procedures Report* and the 1992 DMF *Sanitary Survey Report of Essex Bay*.

Water Quality Field Notes

The following responses are individual opinions rather than a consensus reached by those interviewed. Field note information can be used by local and regional resource managers to assess research needs, guide restoration efforts, prioritize future workplans, and design technical assistance programs.

The following people were interviewed about water quality:

Robert Buchsbaum	Massachusetts Audubon Society
Wayne Castonguay	The Trustees of Reservations and Ipswich Pollution Control Committee
Chuck Hopkinson	Woods Hole Marine Biological Laboratory
Jeff Kennedy	Massachusetts Division of Marine Fisheries
Dave Roach	Massachusetts Division of Marine Fisheries

1. Based on the information gathered through existing research, has water quality improved or declined in the past 20 years? Where is this trend going in the next 20 years?

- In the past 20 years, results have varied depending on the location; Ipswich River water quality has improved by implementing the Ipswich CPCC recommendations while places in the Parker River Watershed, especially the Mill and Little Rivers, have declined. Plum Island Sound and Essex Bay water quality continues to have low to moderate levels of pollutants and consistently has better water quality than the tributaries because of higher flushing rates.
- In the next 20 years, nonpoint source pollution will continue to degrade water quality as development and land use patterns change; tributary water quality will decline as impervious surface increases, open space decreases, and impaired wetland functions reduce pollutant filtration. Also, unless recreational boating practices are better managed, leaking petroleum products, toxic metals, human waste, and resuspended sediments will further degrade estuarine water quality. However, we currently know much more about water quality pollutants and their sources than we did in the past; state agencies like DMF and CZM are committed to monitoring coastal waters. If agency actions are combined with improvements at the local level (i.e, Ipswich upgrading the wastewater treatment plant and Essex exploring sewering options), then water quality will likely improve.

2. What additional research and data is needed to improve water quality assessments?

- A more frequent, regional sampling schedule is needed to determine changing hot spots and sources of bacterial contamination in tributaries. Existing data from tributary sampling is hard to interpret since sampling is not done regularly. For example, recent DMF sampling indicates that fecal coliform concentrations in dry weather are increasing from the town landing to the mouth of the Ipswich River; more research is needed to explain these results.
- In places where monitoring consistently shows elevated pollution levels, efforts should focus on remediating pollutant sources rather than doing more monitoring. The Ipswich CPCC report is an example where hot spots have been identified and need to be remediated before more resources should be put toward monitoring.
- More research is needed on tributary nutrient loading (phosphorus and nitrogen). This monitoring will be especially important as future development and stormwater runoff increases. Data gathered from these studies will help researchers and managers prepare for and predict problems of eutrophication in ACEC coastal waters.
- More data from the Newbury landfill is needed to make an assessment of its water quality impact.

3. What are important water quality threats or issues that need to be addressed?

- Increased development in ACEC watersheds and resulting nutrient loading from lawn fertilizers, wastewater, and impervious surface runoff.
- Agricultural runoff from the upper watersheds. For example, the expansion of Tendercrop Farm and the lease of surrounding wetlands for cattle grazing is resulting in discharge of sediment, bacteria, and nutrients into the Little River.
- Nutrient and microbial inputs from failing septic systems.
- Discharge from the Newburyport industrial park into the Little River.
- Discharge levels and monitoring practices at the Governor Dummer Academy treatment plant.
- Ultimate impacts of the Essex/Gloucester sewer system solution.
- Upgrade performance of the Ipswich treatment plant.

4. What are opportunities for water quality improvement?

- Work with local officials to implement growth management bylaws and regulations related to subdivision development, stormwater management, and wetlands protection. These efforts will help reduce future nonpoint source pollution from land-based development.
- Promote the use of Best Management Practices (BMPs) to remediate sources of agricultural and stormwater runoff.
- Continue using information from DMF shoreline surveys to target water quality hot spots and promote septic system upgrades or use of BMPs.
- Remediate hot spots where monitoring consistently shows elevated pollutant levels. In addition to identified failing septic systems, specific hot spots where remediation efforts should focus include:
  - Essex: Contaminated storm drains (Figure 17),
  - Ipswich: Labor in Vain Creek, Miles Brook, and Kimball Brook all have spikes in wet weather from agricultural waste in the upper watershed,
  - Parker River Watershed: Little River, Mill River, and Ox Pasture Brook, which have agricultural and industrial park pollution sources as well as the Governor Dummer Academy wastewater treatment plant.
- Promote the Ipswich CPCC report and use of a planning assistant to implement water quality remediation and shellfish management recommendations as a model in other ACEC towns.

LAND USE

Land use in each ACEC town is mainly categorized as forest, wetland, agriculture, and residential (Figure 18). Agricultural use is primarily in the form of cropland, pasture, horse farms, and dairy farms. Residential land consists mainly of low to medium density single-family dwellings.

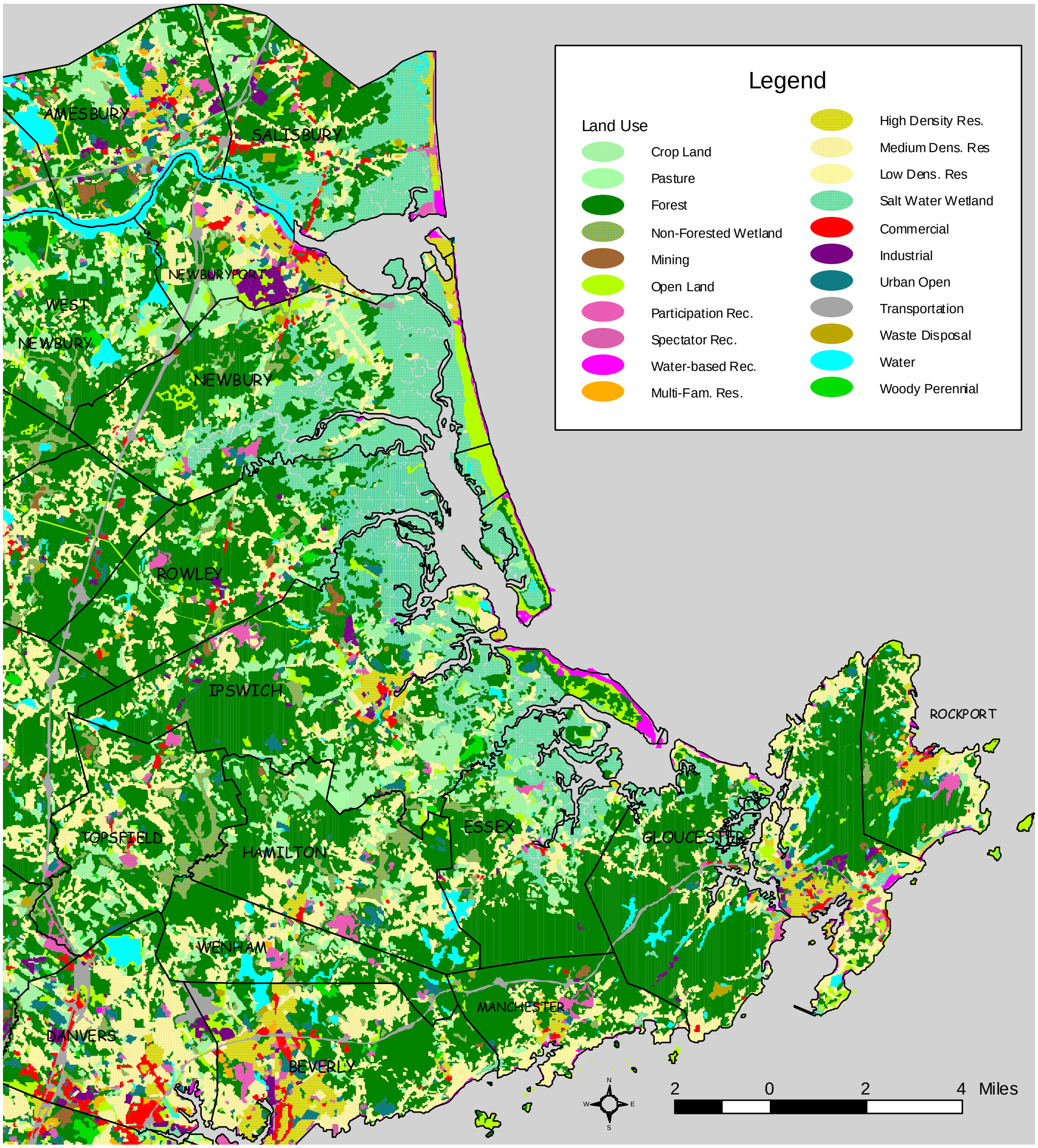

Figure 18. Land use

Over the last 15 years, ACEC towns have all experienced significant population growth. Based on Massachusetts Executive Office of Environmental Affairs (EOEA) buildout analysis, population and development in each of the ACEC towns is projected to increase (Table 14). (*Results for Newbury were estimated as part of the Minibay study (1996) while Rowley, Ipswich, Essex, and Gloucester estimates were derived from the 1999-2000 EOEA buildout analysis*).

Table 14. Projected population growth in ACEC towns

Town	Residents (1998/99)	Projected Buildout Populations
Newbury	6,970	11,896
Rowley	5,343	11,395
Ipswich	12,768	22,833
Essex	3,566	11,852
Gloucester	29,252	38,961

"Human activities in rivers and watersheds have altered enormously the timing, magnitude, and nature of inputs of materials such as water, sediments, nutrients, and organic matter to estuaries" (Woods Hole MBL 1999). From 1992 to 1996, the Woods Hole MBL Ecosystem Center studied landscape effects on the Plum Island Sound marine ecosystem. As part of the Land Margin Ecosystem Research Program (LMER), this study focused on linkages between terrestrial and marine ecosystems. The goals of the study were to: 1) measure the quantity of dissolved and particulate organic carbon and organic nitrogen entering coastal waters from surrounding lands, 2) conduct experiments to determine the effects of various nutrient and organic matter inputs and interactions on the flow and recycling of carbon and nitrogen through pelagic and benthic food webs including higher trophic levels, and 3) model food chain transformations and the effects of changes in land use and land cover (Woods Hole MBL 1997). *To see results from this study, visit the LMER website at http://www.mbl.edu/html/ECOSYSTEMS/lmer/plumisla/plumisla.html.*

CZM is beginning a pilot project in the Parker River Watershed to develop an innovative monitoring and analysis framework to link land use/cover, chemical and biological aquatic resource data, and nonpoint source (NPS) pollution controls. This framework will allow coastal managers to: 1) assess the effectiveness of NPS control measures in protecting and restoring the condition of coastal aquatic resources, including estuarine/riverine waters and salt marsh habitat; 2) identify relationships between land side development patterns and practices and corresponding aquatic resource quality or integrity; and 3) determine specific areas which may be at risk or where monitoring stations should be developed. The framework will include the following tasks:

- Analysis of land use trends over the past 15 years.
- Compilation of historic and current water and habitat quality data.
- Detailed analysis of specific land cover and habitat type attributes.
- Descriptive indices to characterize the condition of coastal aquatic resources.
- Assessment of stormwater management practices.
- Development of NPS control measures datalayer.
- Techniques to link land use patterns with water quality and aquatic habitat condition.

If successful, this framework will be applied to other coastal watersheds throughout the state (Baker per comm 2000).

OPEN SPACE AND RECREATION

One reason the ACEC is still relatively pristine is because a large percentage of coastal wetlands and surrounding uplands is protected as conservation land and wildlife sanctuaries. According to MassGIS figures, over 10,000 of the 25,500 ACEC acres are owned by federal, state, municipal, and nonprofit organizations for open space protection. The largest land holdings are federal and nonprofit which total over 8,000 acres. The federal Parker River National Wildlife Refuge (4,662 acres) contains most of the lands immediately surrounding Plum Island Sound. Several state wildlife management areas and lands owned by nonprofit groups also protect valuable open space (Figure 19). While most publicly owned open space and land trust properties are open to the public for passive recreation, other open space is protected through Conservation Restrictions and Agricultural Preservation Restrictions (Figure 19).

The larger protected portions of land with public access in the ACEC include (USFWS 1992) (Figure 20):

- The Parker River National Wildlife Refuge is owned by the U.S. Fish and Wildlife Service. The refuge encompasses 4,662 acres of sandy beach and dunes, bogs, fresh water impoundments, and tidal marshes on Plum Island. The refuge is one of the few natural barrier beach/dune and salt marsh complexes left in the Northeast and is home to more than 800 species of plants and animals. The refuge is known for its wide variety of bird species, and is one of the top bird watching sites in the United States. The refuge has a trail system designed for nature photography and observation, along with an observation tower, visitor station, and beach access boardwalks.
- Sandy Point State Reservation is owned by the Massachusetts Department of Environmental Management and consists of approximately 80 acres at the southern tip of Plum Island that can be used for hiking, fishing, and boating.
- Crane Beach is owned by The Trustees of Reservations and is approximately 1,400 acres in size. The reservation's barrier beach stretches for more than four miles along Ipswich Bay. The reservation also includes shrub thickets, salt marsh, forests, and a drumlin known as Castle Hill where the Great House is located and open for public events. Beach and dune habitat is home for many wildlife species, including the endangered piping plover and least tern.
- In addition to these three locations, Massachusetts Division of Fish and Wildlife and Essex County Greenbelt Association own land with public access. All access sites where residents and visitors can go to recreate in the ACEC are illustrated in Figure 20 (CZM 2000).

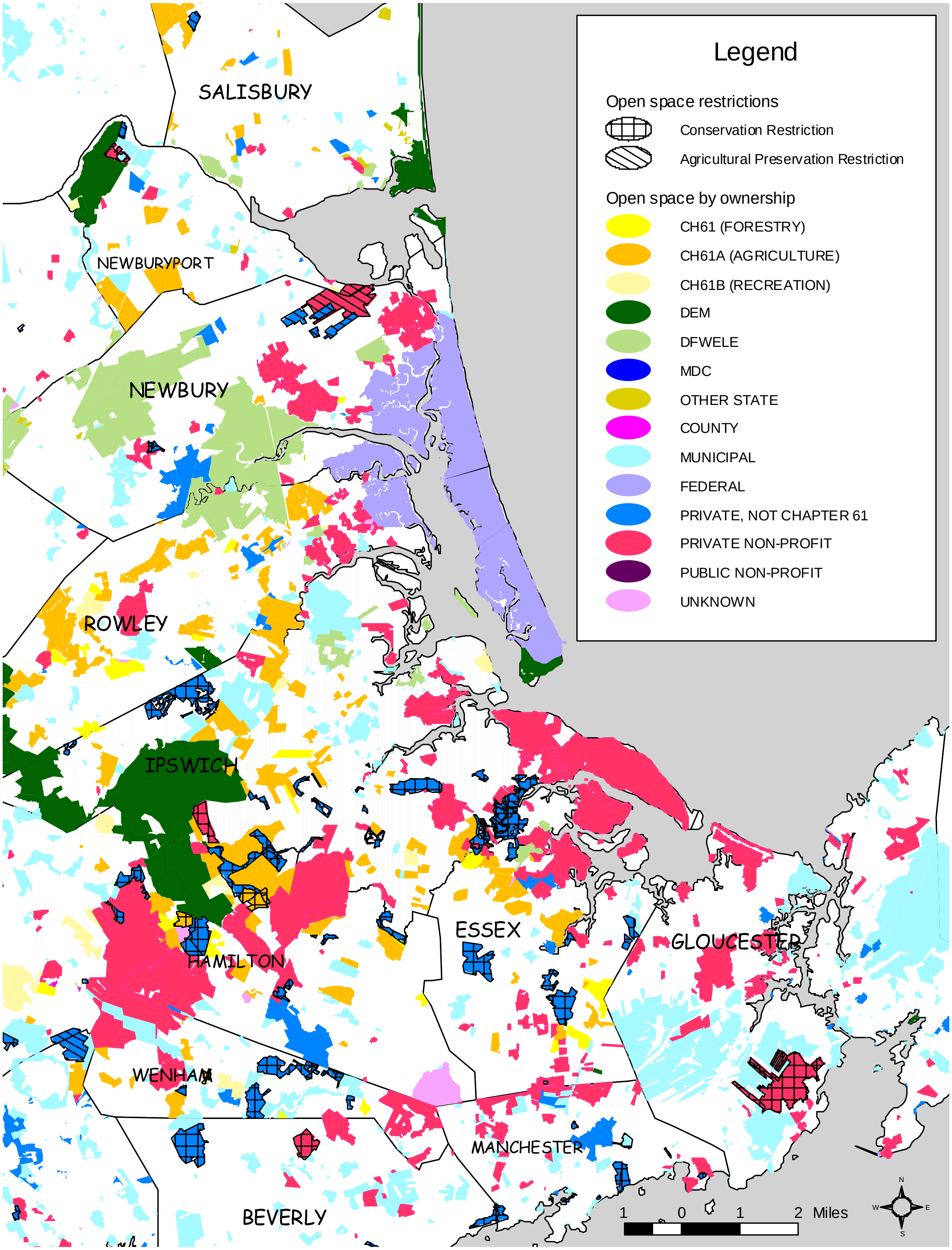

Figure 19. Open space ownership and restrictions

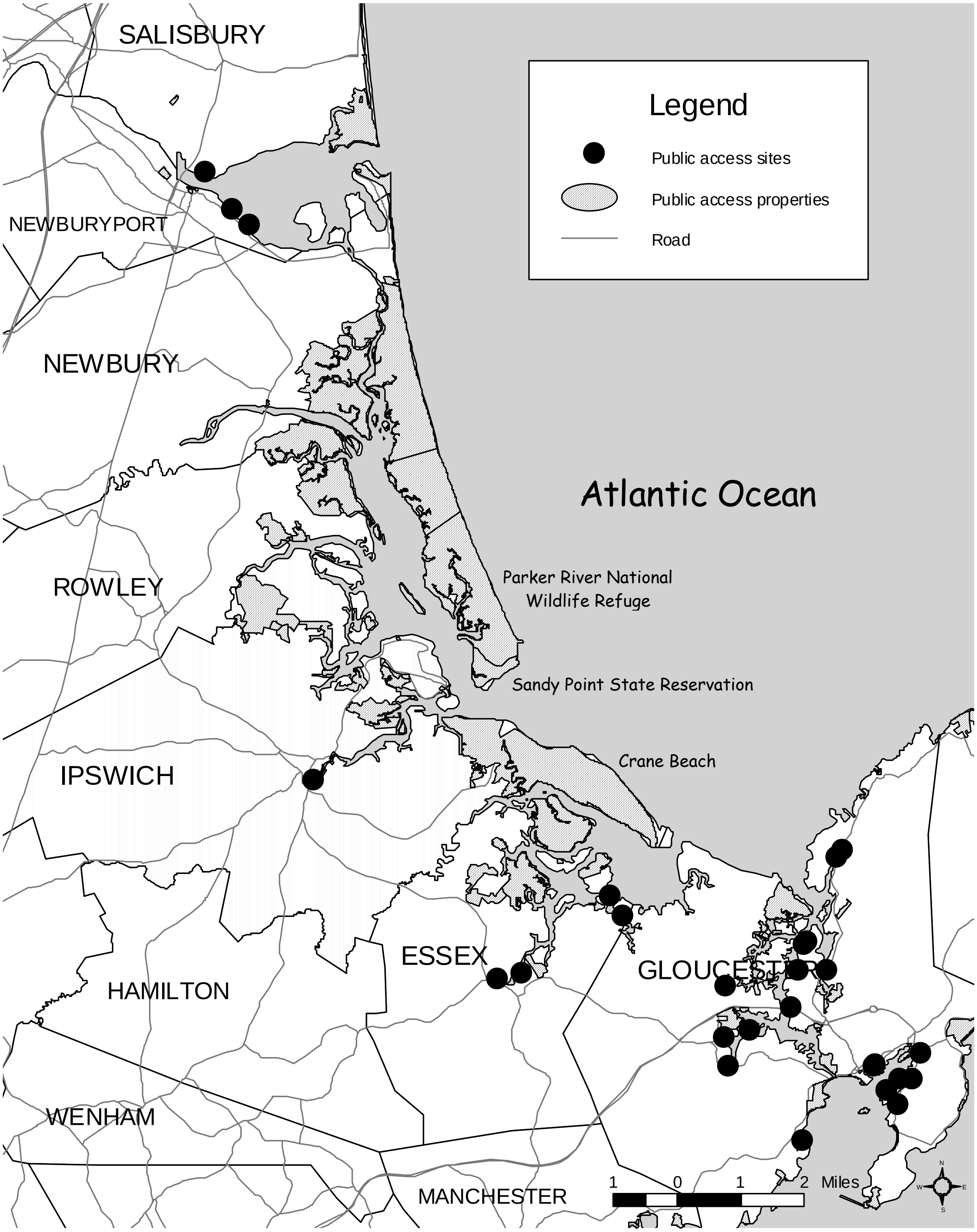

Figure 20. Public access sites and properties

Educational and recreational use of ACEC resources include hiking, nature study, wildlife photography and observation, swimming, boating, fishing, hunting, and clamming. Shorebirds and waterfowl continue to attract birdwatchers to Plum Island Sound and the surrounding USFWS Parker River Wildlife Refuge during spring and fall migrations. Naturalists from the Massachusetts Audubon Society and the Parker River Wildlife Refuge lead regular bird watches in the area. Since the 1990s, other forms of ecotourism have increased throughout the ACEC as boating, kayaking, and walking tours become more popular. Private tour groups lead excursions and public trips to explore the protected estuaries, inland islands, wildlife habitats, beaches, and dunes while teaching some of the area's history.

Recreational boating is also increasing as powerboats, jetskis, fishing vessels, sailboats, kayaks, and canoes become more popular. Much of Plum Island Sound and Essex Bay have designated mooring areas (Figure 21 and 22). Although boats allow people to explore more remote areas and enjoy the ACEC waters, increased boating and the associated marinas, private docks, and mooring fields have been shown to alter nearshore habitats and create water quality problems. Leaking petroleum products, toxic metals, human waste, resuspended sediments, shoreline erosion, and disturbance of wildlife and sensitive habitats are all direct or indirect consequences of boating practices (Buchsbaum 2000). Massachusetts boating regulations require that boats operate at no more than headway speed when within 150 feet of a marina, boat launch or float, within 150 of a swimming area, or within a marked channel unless otherwise posted (Massachusetts Environmental Police 1999). Often defined as "no wake zones", these areas are illustrated in Figure 21 and 22 (*NOTE: 150 feet from **all** shoreline is mapped as the no wake zone in these figures. However, the 150 foot regulations only apply in the areas described above*). In addition to state designated no wake zones, local harbor masters designate additional areas that they enforce (Figure 21, 22).

In Spring, 2000 CZM began addressing boat waste concerns by facilitating the creation of a regional boat waste management plan and outreach tools to promote the use of boat pump-out facilities that dramatically reduce sewage levels found in coastal waters. Both shore-side facilities and pumpout boats are available at various locations in Plum Island Sound (Figure 21). Although no facilities are located directly in Essex Bay, the pumpout boat from Ipswich travels to cover requests from this area; no coverage is available for the Essex River at this time.

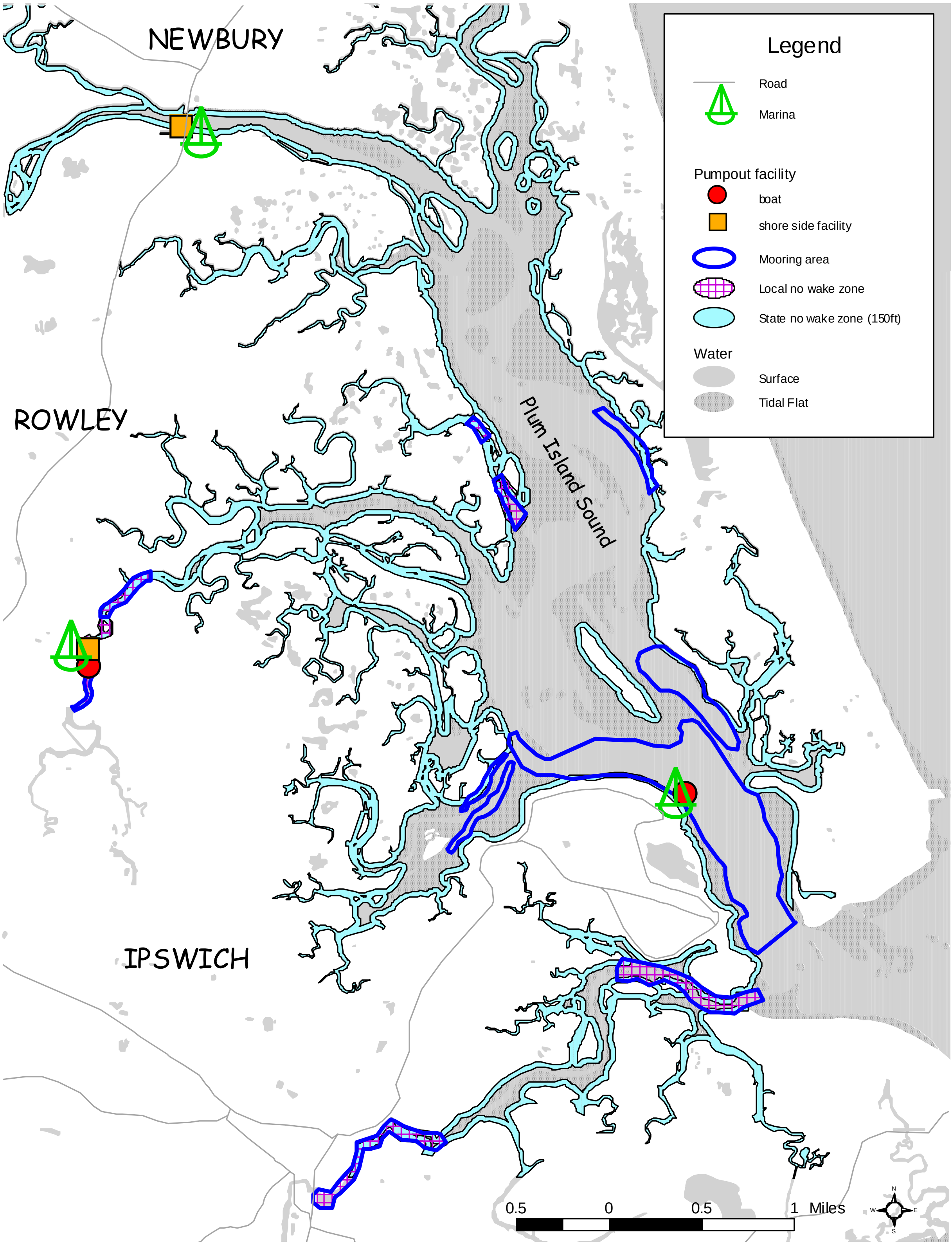

Figure 21. Plum Island Sound boating information

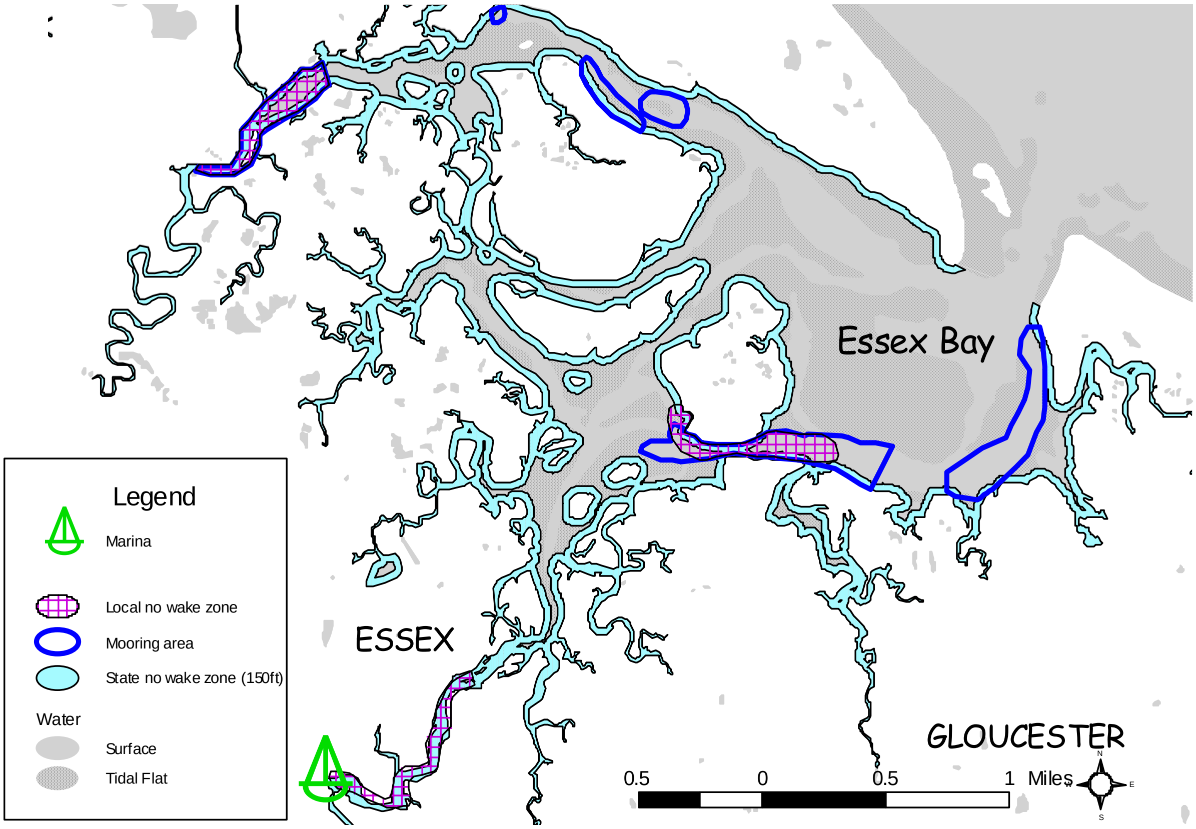

Figure 22. Essex Bay boating information

FUTURE ECOSYSTEM RESEARCH

In 1998, the Woods Hole MBL Ecosystems Center received money from the National Science Foundation to create a six year Long Term Ecological Research (LTER) site in Plum Island Sound. This study builds on the LMER project previously described by studying how such things as climate, sea level, and land use continue to effect the Plum Island Sound estuary. The LTER program will focus specifically on the following question: How will trophic structure and primary and secondary productivity in estuaries be affected by changes in organic matter, and nutrient and water fluxes from changing land cover, climate, and sea level? (Woods Hole MBL 1999).

The LTER program will try answering this question through: 1) short and long-term measurements of organic carbon (C) and organic nitrogen (N) entering estuaries from land, marshes and the ocean, 2) short and long-term experiments to determine the effects of various nutrient and organic matter inputs and interactions on the flow of C and N through pelagic and benthic food webs, and 3) modeling the effects of land use changes on food web transformations (Woods Hole MBL 1999). In addition to periodic sampling for these studies, parameters continuously monitored at several locations in the Parker and Ipswich Watersheds include weather, nutrient run-off, river discharge, sea level, and estuarine water quality (dissolved oxygen, pH, florescence, temperature, and salinity). *To see results and ongoing LTER project updates, visit the website at http://www.mbl.edu/PIE/.*

Current LTER research is focused in seven areas: 1) microbial ecology, 2) benthic biogeochemistry, 3) nitrogen tracers, 4) higher trophic levels, 5) intertidal marshes, 6) watersheds, and 7) systems modeling. Each of these areas is briefly described below.

1) **Microbial ecology** researchers are investigating how salt marsh organic matter is linked to estuarine waters by looking at the source and carbon content of bacterial food. The age of carbon, its origins and sinks are being studied to describe carbon cycling and bacterial dynamics (Hobbie per comm 2000).

2) **Benthic biochemistry** researchers are focusing on benthic use and recycling of nutrients/ organic matter and how these vary with changes in water fluxes and organic inputs. Studies are designed to investigate the effects of changing salinity on benthic processes and how annual and seasonal variation of benthic nutrient flux changes with sea level rise (Giblin per comm 2000).

3) **Nitrogen tracer** experiments are focusing on nitrogen concentrations and seasonal chlorophyll levels. As part of this study, the pathway of nitrogen is traced to biotic production (i.e., phytoplankton, zooplankton). Nitrogen discharge, dispersion, and use in primary production are being characterized for the Parker and Rowley Rivers (Peterson per comm 2000).

4) The structure and function of **higher trophic levels** (which include such things as benthic invertebrates, zooplankton, macroalgae, and fish) and their response to variations in organic matter, nutrients, and water fluxes is another research area. As part of these studies, plant sources as well as benthic and pelagic animals are being studied to track changes in the food web.

As part of these higher trophic studies, fish species abundance and the effect of habitat alteration and predation are also being investigated. Both average monthly river discharge and sea level rise are monitored to determine if habitat is a cause of fish population dynamics (Deegan per comm 2000). In addition, the role of striped bass predation on food web dynamics is being studied in the Parker, Rowley, and Essex Rivers by scientists at UMass Boston. Differences across tides, temperature, and estuary configuration all affect these top predators and their impacts on prey species. Data being collected to understand predator/prey interactions include relative predator and prey species abundance, diet, fish condition, weight, age, and growth (Mather per comm 2000).

5) A long term data base describing the structure and function of **intertidal marshes** around Plum Island Sound is being developed. As part of this study, scientists are trying to understand the functional relationships between the salt marsh and estuary. To determine how climate regulates marsh structure and function, plant production, sedimentation, and sediment chemistry are being monitored at control and experimental sites. Another objective of this study is to determine if anomalies in sea level affect the productivity of marsh plants in Plum Island Sound (Morris per comm 2000).

6) **Watershed** studies are focusing on the magnitude and pattern of organic C and N and inorganic N loading from watersheds to the estuary. Nutrient fluxes into the system have accelerated with increased development and agricultural use of the land. This research is focusing on the hydrology and flushing rates, land cover patterns, and origins, sinks, and seasonality of nutrient inputs (Vorosmarty per comm 2000).

7) Several **systems modeling** projects are underway as part of the LTER project. A nutrient transport model is used to predict water and nutrient export and to help understand what causes patterns and differences of nutrient flux in the watersheds. Studies will investigate how to distinguish nutrient loading from terrestrial and aquatic systems by looking at the role of agriculture, suburban, riparian, wetlands, rivers, and estuaries (Vallino per comm 2000).

   In the Ipswich Watershed, a model is being developed to show the conversion of forest to agricultural and urban areas. The estimate of deforestation will be integrated with a map of nutrient flows by looking at land use in the watershed (Pontious per comm 2000).

   Also in the Ipswich Watershed, the effect of land use and climate change on basin scale hydrology is being modeled. As part of this study, water diversions, historic water budgets, and nutrient sampling stations will be used to help model nutrient dynamics. The model will construct a relationship of nitrogen and land use to examine the processing and recycling of nutrients (Claessens per comm 2000).

   In the future, the LTER project will develop a model for Plum Island Sound that integrates much of the ongoing research by linking the benthic areas, water column, and marsh. This model will examine flooding of the marsh (bathymetry and marsh topography data will be developed to include as part of this model), phytoplankton dynamics, biochemistry patterns, benthic ecology, and nutrient transport as a way to synthesize ongoing research (Vallino per comm 2000).

Long-term experiments (10-15 years) are also being planned as part of the LTER project to continue assessing basic marsh functions and to understand impacts of human alterations on the watersheds. Proposed long-term experiments include creek fertilization by adding nitrogen and phosphorus to tidal portions of creeks, detritus removal by studying active haying sites, marsh fertilization by sprinkling nutrients on the marsh surface, and carbon dioxide measurements across the air/water interface through research at the Woods Hole Oceanographic Institute. These future experiments in addition to ongoing research will continue to increase our knowledge and research base for the watersheds and estuaries of the Parker River/Essex Bay ACEC. *To see results and ongoing LTER project updates, visit the website at http://www.mbl.edu/PIE/.*

SUMMARY

The Parker River/Essex Bay ACEC is recognized as a unique complex of ecosystems with environmental, economic, and recreational significance. Although this region with natural and human resource values remains relatively pristine, ever-increasing development pressures threaten many of the fragile resources. Long term protection of these estuarine, riverine, salt marsh, and barrier beach ecosystems requires continued research to document change through time. Future research that builds on our existing knowledge should be used to modify management and planning strategies, bolster education efforts, and design technical assistance programs. Fortunately, an extensive network of agencies, conservation groups, and local communities are working hard to address natural resource issues in the ACEC (Appendix C). Collaboration among these groups will continue to strengthen the monitoring, restoration, protection, and outreach efforts currently underway.

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APPENDIX A: ACEC Reference List by Category

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- Spotlight white-tailed deer survey. Provides a long-term population index as well as a doe:fawn, doe:buck ratio. October-December.
- Aerial white-tailed deer survey. Provides annual minimum winter population estimate and can be used to assess actual and potential population growth. Winter.
- White tailed deer enclosure study. Monitor and quantify effects of browsing by white-tailed deer to examine effects of deer impacts on plant composition and cover. August, every 2 years.
- Predator scent station survey. Obtains annual population index on various mammalian predators which is used in conjunction with nesting waterfowl and shorebird management. September-October.
- Waterfowl breeding pair survey. Estimates annual number of breeding pairs of waterfowl in the three fresh water impoundments on the refuge. May.
- Waterfowl brood survey. Estimates annual brood production for the three impoundments. June-July.
- Tern survey. Estimates breeding numbers of local tern colonies for assistance to Massachusetts Division of Fisheries and Wildlife. June.
- Piping plover/least tern survey. Monitors population and production of piping plovers and least terns on and surrounding the refuge. March-August.
- Waterfowl, marsh and wading bird, shorebird and raptor survey. Monitors species composition and numbers to determine seasonal and long term use of refuge habitats. Year round.
- Purple martin nest box monitoring. Provide nesting habitat for purple martins and subsequently monitor success of nest box use. April-May, September.
- Osprey platform program. Establish a nesting population of osprey and monitor the success of the platform program. April-August.
- Purple loosestrife biocontrol program. Release Galerucella beetles and Hylobious weevils and monitor their impact on purple loosestrife growth in fresh water impoundments. June, August.

- Breeding bird survey. Conduct breeding bird point counts to provide annual index of avian species breeding in refuge scrub/shrub habitat. June.

APPENDIX B: ACEC designation document and fact sheets

Overview of Areas of Critical Environmental Concern (ACEC) Program and State Regulations Concerning ACECs (2000)

ACEC Program

The ACEC Program was established in 1975, when the State Legislature authorized and directed the Secretary of Environmental Affairs to identify and designate "areas of critical environmental concern to the Commonwealth," and to develop policies for their acquisition, protection and use. Since that time 25 ACECs covering 170,000 acres have been designated, from the Berkshires to the North Shore to Cape Cod. The Environmental Affairs Secretary has delegated the administration of the ACEC Program to the Department of Environmental Management (DEM). DEM coordinates very closely with the Massachusetts Coastal Zone Management (MCZM) Office regarding coastal ACECs (MCZM administered the coastal ACEC program until 1993).

The ACEC Regulations (301 CMR 12.00) describe the procedures for the nomination and review of ACECs and amendments to ACECs, and the purpose and general effects of designation. Generally, ACECs are nominated by citizens or by municipal boards, and nominations undergo a rigorous public review prior to formal designation. An ACEC is a formal state designation directed principally to the actions and jurisdictions of state environmental agencies. The ACEC regulations generally direct Executive Office of Environmental Affairs (EOEA) agencies to take actions, administer programs, and revise regulations in order to preserve, restore or enhance the resources of ACECs.

Consequently, an ACEC designation does not create new regulations to implement the goals of designation, nor do the ACEC regulations determine permitting decisions. The designation works through the existing state environmental regulatory and review framework. The principal role of DEM ACEC program staff is to work with other state agencies to help preserve and manage ACECs, to provide overall coordination between federal, state and local agencies and private organizations and citizens regarding ACECs, and to review ACEC nominations (including amendment proposals and resource management plans). Besides the regulatory roles listed below, several agencies and programs give priority attention to ACECs, including the Agricultural Preservation Program, the Self-Help Program, the Natural Heritage and Endangered Species Program, and DEP's Division of Water Supply, Division of Solid Waste Management, and Bureau of Waste Site Cleanup.

State Regulations Concerning ACECs

The principal state agencies with regulations that refer to ACECs are the Massachusetts Environmental Policy Act (MEPA) Office, the Department of Environmental Protection (DEP), and the MCZM Office.

• The **MEPA Regulations** (301 CMR 11.00) require closer scrutiny or review of projects within ACECs that need certain state permits, use state funding, or involve state agency actions. The project review thresholds (size or type) that require the filing of an Environmental Notification Form (ENF) are reduced for projects located within an ACEC. For example, a state highway access permit, a Waterways Chapter 91 license, or a request to DEP for an appeal (i.e., a Superseding Order of Conditions) of a local Conservation Commission decision (i.e., an Order of Conditions) will require the filing of an ENF and initiate a state environmental review, except for a project that consists solely of one single-family dwelling. Outside of an ACEC, these kinds of reviews are generally required only for large-scale projects. Projects using state funding, or projects initiated by state agencies – for example, the Massachusetts Highway Department (such as for highway improvement projects that may affect the resources of an ACEC) or the Department of Environmental Management (for park planning or development) - within an ACEC, also require MEPA reviews. Again, a project that consists solely of one single-family dwelling is exempted from the lower review threshold within ACECs. The purpose of a MEPA review for a project within an ACEC is to ensure that the proposed project will avoid or minimize adverse impacts to the resources of the ACEC.

• The principal **DEP Regulations** or DEP programs regarding ACECs include the Waterways Regulation Program, the Wetlands Protection Program, and the Solid Waste Facilities Site Assignment Regulations:

• The **Waterways (or Chapter 91) Regulations** (310 CMR 9.00) require higher environmental standards for certain kinds of projects located within ACECs. The regulations do not allow new fill in ACECs, and place increased limits on new structures (see sections 9.32(1)(e) and 9.32(2)(d)). Proposed new privately owned structures for water-dependent use below the high-water mark, such as private docks or piers, are only eligible for a license provided that such structures are consistent with a resource management plan for the ACEC which has been adopted by the municipality and approved by the Secretary of Environmental Affairs. Improvement (new) dredging, except for the sole purpose of fisheries and wildlife enhancement, is prohibited within an ACEC. (However, maintenance dredging is eligible for a permit.) The disposal of dredged material is prohibited within an ACEC, except for the purposes of beach nourishment, dune construction or stabilization with proper vegetative cover, or the enhancement of fishery or wildlife resources (see section 9.40(1)(b) regarding dredging or disposal).

• The **Wetlands Protection Act Regulations** (310 CMR 10.00) include provisions regarding ACECs for both coastal and inland wetland Resource Areas. For coastal Resource Areas within ACECs, the performance standard is raised to "no adverse effect" on the interests of the Act, except for maintenance dredging for navigational purposes of "Land Under the Ocean" (see section 10.24(5)(b)). For inland Resource Areas within ACECs, the performance standard is raised to prohibit the destruction or impairment of a "Bordering Vegetated Wetland (BVW)" unless the proposed project qualifies as a "limited project" under the Wetlands Protection Act Regulations (see sections 10.53(3) and 10.55(4)(e)).

• The **Solid Waste Facilities Site Assignment Regulations** (310 CMR 16.00) prohibit the siting of new solid waste facilities within an ACEC (see section 16.40(4)(d)).

• The **Massachusetts Coastal Zone Management Program Regulations** (310 CMR 21.00) call for all appropriate EOEA agencies to preserve, restore and enhance complexes of coastal resources of regional or statewide significance through the ACEC Program. State and federal coastal zone regulations stipulate that any federal activity affecting the coastal zone will be consistent with MCZM's Policies to the maximum extent practicable. As such, any project proposed in an ACEC that requires a federal permit, is federally funded or is a direct federal action is subject to federal consistency review by MCZM before the federal activity can take place.

For more detailed or updated information, please contact ACEC Program staff at the Department of Environmental Management:

Leslie Luchonok, (413) 586-8706, ext. 21; leslie.luchonok@state.ma.us
Elizabeth Sorenson, (617) 973-8780; elizabeth.sorenson@state.ma.us

or contact other state agencies directly.

You may also access the ACEC Program website at http://www.state.ma.us/dem/programs/acec.

Parker River/Essex Bay
Area of Critical Environmental Concern (ACEC)

Date of Designation: March 2, 1979
Total Approximate Acreage: 25,500 acres
Located within the following towns/cities:
Essex, Gloucester, Ipswich, Newbury, and Rowley

USGS Quad Sheets: Georgetown, Gloucester, Ipswich, Newburyport East, Newburyport West

Water Bodies included (partially or entirely) in the ACEC

Harbors, Sounds, Bays: Essex Bay (*Essex, Gloucester*); Plum Island Sound (*Ipswich, Newbury, Rowley*)

Rivers: Essex River *(Essex)*; Castle Neck, Eagle Hill, Egypt, Ipswich, Muddy, Roger Island, and Rowley Rivers *(Ipswich)*; Little, Mill, Parker, and Plum Island Rivers *(Newbury)*; Rowley River *(Rowley)*

Lakes, Ponds: none

Brooks, Creeks: Ebben, Lufkin, and Songinese Creeks *(Essex)*; Farm, Lanes, and Walker Creeks *(Gloucester)*; Broad, Fox, Labor in Vain, Laws, Lords, Metcalf, Neck, Paine, Six Goose, Stacy, Third, and Treadwell Creeks *(Ipswich)*; Jerico, Little Pine Island, Mud, Pine Island, and Plumbush Creeks *(Newbury)*; Carolton, Club Head, Mud, Sand, Sawyer, Shad, and West Creeks; Ox Pasture Brook *(Rowley)*

Barrier Beaches included in ACEC: Castle Neck/Crane Beach (Gt-1; Is-5,6), Plum Island (Is-1,2; Rl-1; Nb-1), area fronting Clark Pond in Ipswich (Is-3), isthmus connecting Little Neck in Ipswich (Is-4), beach on Gloucester side of Essex Bay Inlet (Gt-2)

Resource Summary

The Parker River/Essex Bay ACEC includes 25,500 acres of barrier beach, dunes, saltmarsh, and water bodies. Plum Island and Castle Neck are two of the relatively few major, undeveloped barrier beaches in the Commonwealth. They are over 10 miles in length, combined, with almost all of the area protected under public or private management. The recreational beaches are known throughout Massachusetts. More than 10,000 acres of salt marsh makes this the largest salt marsh system north of Long Island in New York.

Included within the ACEC is the 2900-acre Parker River National Wildlife Refuge, known as an important site on the Atlantic Fly-way Migration route. More than 60 bird species breed here, including the rare seaside sparrow and the least tern. Over 300 species of birds have been sighted in this area, including 75 rare species. During the spring and fall migrations, concentrations of up to 25,000 ducks and 6000 Canadian Geese have been noted. Studies of the flora of Plum Island have recorded over 490 species of vascular plants. Waters of the ACEC contain vast amounts of shellfish and host some of the largest anadromous fish runs of alewives and smelt on the North Shore.

The area is important for fishing, shellfishing, tourism, and recreation. Other protected open space within the area includes the Crane Reservation, Crane Wildlife Refuge, and Plum Island State Park. Archaeological evidence of numerous paleo-Indian artifacts, dating back 10,000 years, places the Ipswich coast as one of the oldest sites of human habitation in Massachusetts.

The Commonwealth of Massachusetts

Executive Office of Environmental Affairs

100 Cambridge Street

Boston, Massachusetts 02202

EDWARD J. KING
GOVERNOR

JOHN A. BEWICK
SECRETARY

Designation of Parker River/Essex Bay Area as an Area of Critical Environmental Concern and Supporting Findings

Following an extensive process, including nomination by a variety of local governmental bodies, many informal meetings with local groups, two public informational meetings, a public hearing, and a formal evaluation of all assembled data, I, the Secretary of Environmental Affairs, hereby designate the Parker River/Essex Bay area as an Area of Critical Environmental Concern pursuant to the authority granted to me by G.L. c. 21A, § 2(7).

I also hereby find that the Parker River/Essex Bay ACEC is significant to flood control, the prevention of storm damage, the protection of land containing shellfish and fisheries; interests protected by the Wetlands Protection Act, G.L. c. 131, § 40.

I. Boundary of the Parker River/Essex Bay Area of Critical Environmental Concern

The boundary of this ACEC runs as follows: from the intersection of the northern boundary of the Parker River National Wildlife Refuge with the mean low water line as it appears on the most recent NOAA National Ocean Survey Chart on the eastern shore of Plum Island; then southerly, following that mean low water line of Plum Island to the southern end of Plum Island; then southerly along a closure line running between the "South Plum" bench mark at Bar Head and the bench mark at Steep Hill to the mean low water line at Crane Beach; then easterly and southerly along the mean low water line of Crane Beach to the southeasternmost point of Castle Neck; then southeasterly along a closure line running between the southeasternmost point of Castle Neck and the highest point of Two Penny Loaf to the 10 foot contour line, which is a line 10 feet above mean sea level, as shown on the appropriate U.S.G.S. 7½ minute series topographic map; then following such 10 foot contour line clockwise around Essex Bay until its intersection with a closure line running northerly between the northernmost point of such 10 foot contour line between Ebben Creek and the Essex River and the easternmost point of such 10 foot contour line between the Essex River and Soginese Creek; then northerly along such closure line to the continuation of such 10 foot contour line on the westerly side of the Essex River; then generally northerly and westerly along such 10 foot contour line to a closure line at the entrance to a former gravel pit off Soginese Creek; then southwesterly along such closure line to the continuation of the 10 foot contour on the westerly side of the entrance to the former gravel pit, then generally northerly along such 10 foot contour line to its intersection with Mitchell Road in Ipswich; then northerly and westerly along Mitchell and Paradise Roads until its intersection with the 10 foot contour line on the westerly side of Muddy Run; then generally northerly along such 10 foot contour line to its intersection with the Newbury-Newburyport corporate boundary; then southeasterly and northeasterly along such boundary to Old Point Road, then southerly along the western edge of Old Point Road and Sunset Drive to its intersection with the northern boundary of the Parker River National Wildlife Refuge; then easterly along such boundary to the point of beginning.

The Parker River/Essex Bay Area of Critical Environmental Concern includes all of the Parker River National Wildlife Refuge, the Plum Island State Park, Castle Neck (including Steep Hill, Castle Hill and Crane Beach), Kent's Island in Newbury and Long, Round, Hog and Dilly Islands in Essex.

All areas not mentioned in the preceding sentence which are upland of the 10 foot contour line are excluded, as is the portion of the Ipswich River west of, and including the Town Wharf; that area near the Newbury town line operated on the date of this designation by the Town of Rowley as a sanitary landfill; and that portion of the Parker River westerly of Central Street in Newbury.

II. Description of the Resources of the Parker River/Essex Bay Area of Critical Environmental Concern

To qualify as an ACEC an area must have at least five of the 17 significant resources in Section 6.44 of the CZM Program Regulations. The Parker River/Essex Bay ACEC contains virtually all of these significant resources, the most important of which are listed below:

(1) Barrier Beach System: Plum Island, protecting Plum Island Sound and the Parker River estuary, and Castle Neck, protecting Essex Bay and the Ipswich River estuary, combine to form a barrier beach system of over 10 miles in length. Relatively undeveloped, nearly all of this area is protected under public or private management.

(2) Salt Marsh: This ACEC contains the largest expanse of salt marsh north of Long Island, New York, containing some 10,700 acres of high and low marsh. The salt marsh has high biological productivity and acts as a natural filtration system for river waters flowing into the estuary.

(3) Dunes: Castle Neck and Plum Island contain extensive dune formations that, in many areas, extend from the barrier beach to inland bays and marshes. They provide storm shelters for Plum Island Sound and Essex Bay and are a natural source of sand for replenishment of Crane and Plum Island beaches.

(4) Beach: There are approximately 12 miles of clean, sandy beaches within the ACEC; nearly all of them are open to the public.

(5) Shellfish: The rivers, estuaries and bays of this area contain some of the richest soft shell clam flats on the east coast. With the exception of a portion of the Ipswich River, the shellfish are uncontaminated and provide the basis for a significant local industry catering to the wholesale, retail and restaurant trade.

Shellfish wardens from 4 of the towns have estimated the shellfish harvest for 1976 as follows:

Newbury	10,800 bushels
Rowley	5,805 bushels
Ipswich	30,000 bushels
Essex	6,200 bushels

(6) Estuaries and Embayments: A series of rivers (the Parker, Mill, Rowley, Eagle Hill, Ipswich and Essex Rivers) and Plum Island Sound and Essex Bay produce an intricate network of estuarine environments. These estuaries are valuable commercial, recreational and scenic resources.

The outstanding feature of these estuaries is the abundance of clean, unpolluted water that ensures productive marine life and creates a healthy environment for recreation. Although the Ipswich River clam flats are closed due to pollution, the vast majority of the water within these estuarine systems is classified as "water of highest purity" (the coliform count has been documented to be below 50 for Plum Island Sound, Ipswich Bay, Essex Bay, the Rowley River, and most of the Parker River). Another important environmental indicator, dissolved oxygen, has been shown to be substantially above the 6 parts per million needed to sustain healthy aquatic flora and fauna. Average dissolved oxygen within Plum Island Sound and Essex Bay is 8 ppm and 9.8 ppm, respectively.

(7) Anadromous Fish Runs: There are five anadromous fish runs in this area. They are, from north to south, the Parker, Mill, Rowley, Ipswich and Essex Rivers. All provide spawning areas for smelt, and the Rowley, Parker and Mill Rivers host alewife and blueback herring runs. The Parker is the largest alewife run on the North Shore.

(8) Floodplain: The 100 year floodplain within the ACEC is primarily marsh land, but there are fringes of dry lowland. The lowlands are covered by a thin layer of glacial till and are underlain by clay-silt soil or bedrock. These soils are, in general, unsuitable for residential development relying on individual septic systems.

(9) Erosion and Accretion Areas: Because barrier beaches are among the most dynamic coastal environments, it is only logical that the ocean shoreline of this area is not stationary. Littoral drift, moving from

north to south, is eroding the beach along the ocean side of both Plum Island and Castle Neck and depositing sand at the southern ends of these beaches.

(10) Coastal Related Recreation: The beaches, dunes, marshes, rivers and bays of this ACEC are used for swimming, boating, hunting, fishing and many other recreational pastimes. Crane Beach attracted some 170,000 people during the summer of 1977, and Plum Island is well known for its bathing, surf fishing and birdwatching opportunities. Plum Island Sound and Essex Bay are prime recreational boating areas, with traffic on the Ipswich and Essex Rivers classified as "very heavy" by the U.S. Army Corps of Engineers. Sport fishing for striped bass, winter flounder, mackerel, white perch and smelt is becoming increasingly popular.

(11) Salt Pond: Clark's Pond on Great Neck in Ipswich is the only salt pond along this stretch of coast. Although relatively small, it is noteworthy for the many rare and unusual birds seen in the vicinity.

(12) Historic Site or District: In addition to being one of the first settlements in the Massachusetts Bay Colony, the Ipswich coastal area is the site of numerous discoveries of paleo-Indian artifacts. Dating back some 10,000 years, archeological evidence from this area shows it to be one of the oldest sites of human habitation in the Commonwealth.

(13) Significant Wildlife Habitat: The area hosts two wildlife refuges: the Parker River National Wildlife Refuge and the Cornelius and Mine Crane Wildlife Refuge. The Parker River Refuge is nationally noted for its importance as a stopover on the Atlantic Flyway.

It is a primary feeding area for Snowy and Great Egrets, Glossy Ibises and Little Blue, Louisiana and Black-crowned Night Herons, which breed nearby. It is also an important night roosting area for herons in late summer when the young have fledged (more than a thousand individuals). It is one of five major heron locations in the state.

It is an important roosting, feeding and staging area for shorebirds in spring and particularly during the fall migration when concentrations numbering in the tens of thousands utilize the area. It is one of six such areas on the northeast Atlantic coast.

Recently, it has been an important staging area for Snow Geese during spring migration and, historically, important for Canada Geese and other migrating waterfowl during both the spring and fall.

The Crane Refuge hosts the last remaining deer herd in the area.

(14) Significant Scenic Site: Because the entire ACEC area is in a natural, undeveloped state, it is extremely scenic and attracts a significant summer tourist trade. The many glacially formed hills which dot the area provide outstanding vistas of the marshes, beaches and ocean. From the higher elevations, one can see downtown Boston, the Isles of Shoals off the New Hampshire coast and Mt. Agamenticus in Maine.

III. Procedures Leading to ACEC Designation

The Parker River/Essex Bay ACEC located in the Towns of Newbury, Rowley, Ipswich, Essex and the City of Gloucester was initially nominated by the Ipswich Conservation Commission on October 25, 1978. Subsequently, nominations were received from the Newbury Board of Selectmen, Planning Board and Conservation Commission, the Rowley Conservation Commission and the Essex Board of Selectmen and Conservation Commission. After reviewing these nominations, the Secretary of Environmental Affairs decided on December 15, 1978 to proceed with a full review of the proposed ACEC.

Notice of the receipt of the nominations and an announcement of a public hearing was published in the Environmental Monitor, the Gloucester Daily Times, the Salem Evening News, the Beverly Times and the Newburyport Daily News on December 22, 1978 and in the Ipswich Chronicle on December 21, 1978. Additional information on the region was collected by the Coastal Zone Management Office staff in consultation with local officials, town boards and natural resource officers. Individual meetings were held with town selectmen, planning boards, and conservation commissions. Two meetings of the regional CZM Citizen Advisory Council were held on the proposal. Two public informational meetings were held on January 11th and January 18th, 1979, with a total attendance of about 45 persons. Over 100 copies of a background report on the resources of the proposed ACEC were sent out to town officials, organized interest groups and to interested private individuals. More than 24 articles appeared in local papers regarding the ACEC nomination.

The public hearing on the designation of the Parker River/Essex Bay area as an ACEC was held at the Ipswich High School on Wednesday, January 31, 1979. Over 100 area residents attended and approximately 30 made formal comments. With one exception, all speakers were in favor of proceeding with the designation. All speakers emphasized the ecological value of the area and its susceptibility to development. Many speakers felt the environmental resources were an important part of their town's character and economy. The importance of recreation and the shellfish industry was stressed. Many saw the ACEC designation as a way to strengthen further efforts by the towns and city involved and citizen groups to protect the area. The overwhelming impression given by the statements at the hearing was one of great concern for the Parker River/Essex Bay area and support for its designation as an ACEC. The hearing record remained open until February 7, 1979 for those persons who wished to submit written comments. All comments received, whether oral or written, were given full consideration.

I then reviewed the hearing record and the results of the staff work with respect to the natural resources of the area and decided to make this ACEC designation.

IV. Discussion of Factors Specified in Section 6.48 of the CZM Program Regulations

Prior to designation of a region as an Area of Critical Environmental Concern, the Secretary must consider the factors specified in Section 6.48 of the CZM Program regulations. Based on research and information from local residents, I find that the following factors are applicable to the Parker River/Essex Bay area:

Threat to the Public Health: The use of the rivers and bays for shellfishing, water sports, and fishing is dependent upon maintaining the existing high water quality. Any pollutants discharged into these waters could adversely affect their users and consumers. In particular, pollutants could threaten the resource base of the economically important shellfish industry. Public safety could also be threatened if marshes or beaches are destroyed. These features act as storm buffers and their destruction would be potentially damaging to harbors and inland development.

Quality of the Natural Characteristics: Because there has been a minimum of alteration of the natural features of this area, they are presently functioning at their maximum capacity. The vegetation is healthy and wildlife habitat is plentiful; marsh production is unimpaired; the dunes, undiminished, offer highly affective storm protection; and the unpolluted water helps create optimal conditions for water life and recreation. In addition to these functional characteristics, the scenic quality of the area significantly contributes to the recreational enjoyment of its visitors.

Productivity: The high productivity of the area is documented in Section II under the headings: salt marsh, shellfish, estuaries, and anadromous fish runs. This area has a biological productivity that is nearly double that of the most productive agricultural lands.

Uniqueness: There are only ten major barrier beach systems on the Massachusetts mainland that remain undeveloped. This ACEC contains two; the Castle Neck barrier beach system and the Plum Island barrier beach system. The importance of the area to migratory waterfowl, its extensive shellfish resources and vast salt marshes also contribute to its uniqueness. The area is also unique from an archeological perspective, as pointed out in Section II.

Irreversibility of Impact: Man's destruction of estuaries, marshland and barrier beaches is irreversible. Alteration of barrier beaches will result in the loss of a natural storm barrier, the destruction of marshland will decrease the nutrient supply within the adjacent rivers and bay and inappropriate development can pollute ground and surface water. It is technically possible to correct some of this pollution, but the time and money needed to do so usually result in such pollution becoming a permanent condition.

Economic Benefits: The natural resources of this ACEC contribute directly to the financial well-being of the region. The shellfish industry is the largest employer in the area. The average annual harvest of about 60,000 bushels of clams represents $1.5 million in direct income to clammers. By the time the clams end up on someone's plate in a restaurant, they are worth over $200 per bushel or $12 million. The restaurant and tourist trades are heavily dependent on both the scenic qualities of the area and its fish and shellfish resources.

Recreation is a very significant economic factor in the region, but its value is difficult to quantify due to the lack of statistics. But there can be no question but that the beaches are heavily used and recreational boating and fishing activity is substantial during the summer season.

Supporting Factors: The strong public consensus on the intrinsic value of the area weighs heavily in favor of the ACEC designation. There was overwhelming support voiced at the public hearing and in numerous written comments. The presence of the nationally recognized Parker River Wildlife Refuge, the Plum Island State Park, and the Crane Reservation all lend importance to the area. Local wetlands zoning by-laws, shellfish management programs and conservation restrictions further demonstrate local efforts to protect the area.

All of these factors taken together convince me that the Parker River/ Essex Bay area is indeed an Area of Critical Environmental Concern to the Commonwealth. Application of the ACEC designation criteria to this area demonstrates that the area is unique and is valuable in both environmental and economic senses. Local residents have long recognized the importance of the region. Through the designation of this ACEC, I intend to enlist the support of state agencies in the continued protection and appropriate use of this important region.

John A. Bewick

John A. Bewick
Secretary of Environmental Affairs

March 2, 1979
Date

APPENDIX C: Parker River/Essex Bay ACEC contact list

PARKER RIVER/ESSEX BAY ACEC CONTACT LIST

NOTE: this matrix only highlights the priority focus areas of the listed programs and organizations. For more information, visit the appropriate web sites.

PROGRAM/ORGANIZATION	COMMON ACRONYM	PROGRAMMATIC FOCUS: ACEC	water quality	water conservation	boat waste	agricultural issues	wetlands/saltmarsh	river protection	barrier beach	wildlife	fisheries	shellfish	aquaculture	growth management	open space protection	public access	technical assistance	permitting	PHONE	WEBSITE
Conservation Organizations																				
The Bay Circuit Alliance															X	X			978-470-1982	www.serve.com/baycircuit
Ducks Unlimited							X	X		X									800-453-8257	www.ducks.org/community/
Essex County Greenbelt										X	X				X	X	X		978-768-7241	www.ecga.org/
Essex County Sportsmen's Association										X	X								978-462-2694	www.goal.org/clublist.html
Essex County Trails Association						X									X	X				www.thecompass.org/foot/pages/groups.html
Friends of our Trails	FOOT														X	X			978-463-8843	www.thecompass.org/foot/
Friends of the Parker River Wildlife Refuge			X							X		X				X			978-749-9647	www.parkerriver.org/
Ipswich River Watershed Association	IRWA		X	X				X			X					X	X		978-887-8404	www.tiac.net/users/irwa/
Massachusetts Audubon Society	MAS	X	X			X	X	X	X	X	X	X		X	X		X		978-927-1122	www.massaudubon.org/

PROGRAM/ORGANIZATION	COMMON ACRONYM	PROGRAMMATIC FOCUS																	PHONE	WEBSITE
		ACEC	water quality	water conservation	boat waste	agricultural issues	wetlands/saltmarsh	river protection	barrier beach	wildlife	fisheries	shellfish	aquaculture	growth management	open space protection	public access	technical assistance	permitting		
Newbury Bay Circuit Committee															X	X			978-462-4605	www1.shore.net/~dwstr/bct/bctnewbury.html
Parker River Clean Water Association	PRCWA		X	X			X	X		X	X				X	X	X		978-462-2551,	www.Parker-River.org
The Trustees of Reservations	TTOR						X		X	X					X	X			978-921-1944	www.thetrustees.org/
Interstate Organizations																				
Gulf of Maine Council on the Marine Environment			X				X	X	X	X	X	X								www.gulfofmaine.org/
Educational Institutions																				
Ecosystems Center - Woods Hole Marine Biological Laboratory	MBL		X				X	X		X	X	X							508-289-7688	www.mbl.edu/PIE/
Jackson Estuarine Lab - University of New Hampshire	UNH						X												603-862-2175	bioscience.unh.edu/zoology/jel/jel.html
Federal Agencies																				
EPA Region I - Office of Ecosystem Protection	EPA		X				X							X			X	X	888-372-7341	www.epa.gov/region01/
NOAA National Marine Fisheries Service	NMFS		X				X	X		X	X	X	X				X		978-281-9300	www.wh.whoi.edu/ro/doc/nero.html

PROGRAM/ORGANIZATION	COMMON ACRONYM	PROGRAMMATIC FOCUS																	PHONE	WEBSITE
		ACEC	water quality	water conservation	boat waste	agricultural issues	wetlands/saltmarsh	river protection	barrier beach	wildlife	fisheries	shellfish	aquaculture	growth management	open space protection	public access	technical assistance	permitting		
Natural Resources Conservation Services	NRCS		X	X		X	X	X									X		978-692-1904	www.nrcs.usda.gov/
Parker River National Wildlife Refuge			X				X		X	X	X	X							978-465-5753	northeast.fws.gov/ma/pkr.htm
State Agencies																				
Department of Environmental Management	DEM	X			X		X								X	X	X		617-626-1000	www.state.ma.us/dem/
Department of Environmental Protection	DEP		X	X			X	X	X							X	X	X	617-292-5500	www.state.ma.us/dep/contact.htm
Department of Food and Agriculture	DFA		X			X									X		X		617-626-1700	www.massdfa.org/
Division of Fisheries and Wildlife	DFW									X	X				X		X		617-626-1591	www.state.ma.us/dfwele/dfw/dfw_toc.htm
Division of Marine Fisheries	DMF		X								X	X	X				X		617-626-1520	www.state.ma.us/dfwele/dmf/dmf_toc.htm
Massachusetts Coastal Zone Management	MCZM	X	X	X	X	X	X		X		X	X	X	X	X	X	X		978-281-3972	www.state.ma.us/czm/
Massachusetts Watershed Initiative	MWI	X	X	X	X	X	X	X		X	X	X		X	X	X	X		978-661-7817	http://www.magnet.state.ma.us/envir/watersheds.htm
Natural Heritage and Endangered Species Program	NHESP									X	X						X		617-727-9194	http://www.heritage.tnc.org/nhp/us/ma

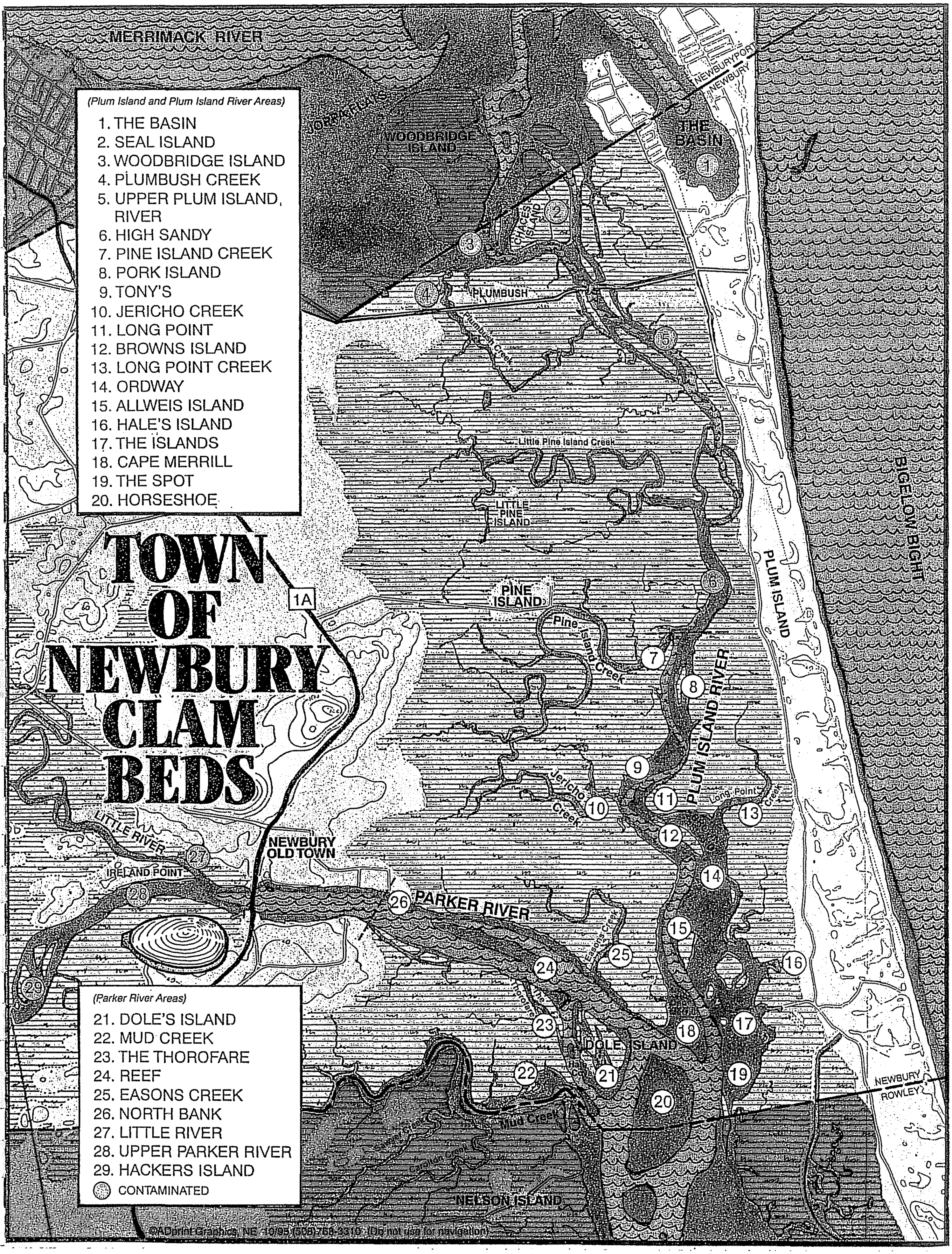
PROGRAM/ORGANIZATION	COMMON ACRONYM	ACEC	water quality	water conservation	boat waste	agricultural issues	wetlands/saltmarsh	river protection	barrier beach	wildlife	fisheries	shellfish	aquaculture	growth management	open space protection	public access	technical assistance	permitting	PHONE	WEBSITE
		PROGRAMMATIC FOCUS																		
Northeast Massachusetts Mosquito Control and Wetlands Management							X												978-474-4640	
Riverways Program			X	X			X	X			X						X		617-626-1540	www.state.ma.us/dfwele/River/riv_toc.htm
Wetlands Restoration and Banking Program	WRBP						X										X		617-292-5991	
Regional Groups																				
Eight Towns and the Bay	8TB		X		X	X	X	X	X		X	X	X		X		X		978-374-0519	www.thecompass.org/8TB/
Essex County Conservation District			X	X		X	X	X									X		978-962-8225	www.som.clarkson.edu/agweb/nnycounty/essex.html
Merrimack Valley Planning Commission	MVPC		X	X		X		X	X			X	X	X	X		X		978-374-0519	www.mvpc.org/
Metropolitan Area Planning Commission	MAPC		X	X										X	X		X		617-451-2770	www.mapc.org/

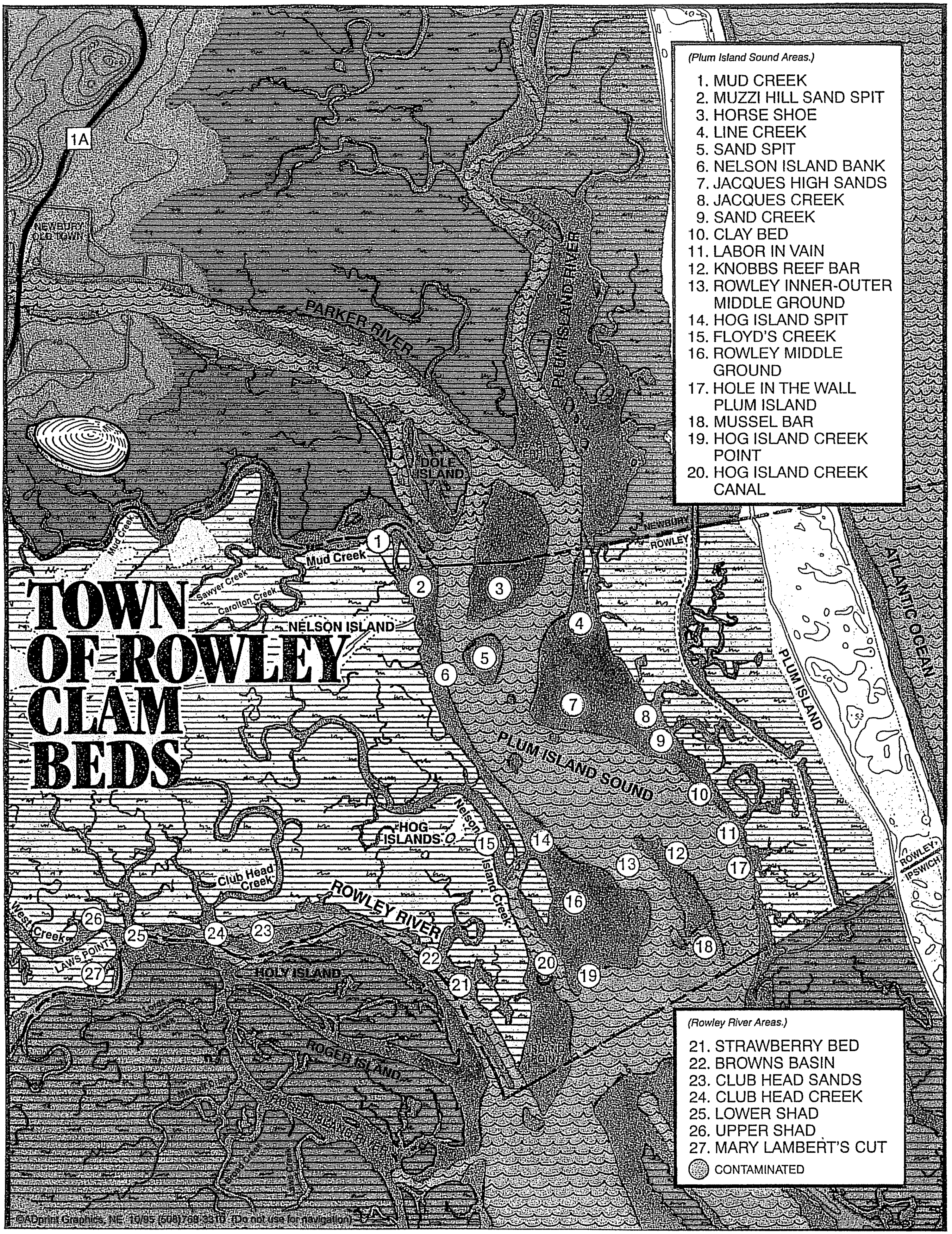
Local Officials. Several local authorities address natural resource issues. An appropriate first contact is the local conservation commission office listed below. Depending on the topic of interest, you can also contact boards of health, planning boards, open space committees, harbor masters, and shellfish constables. Contact information for these officials can be obtained by calling the town/city clerk listed below.

Town	Gloucester	Essex	Ipswich	Rowley	Newbury
Conservation Commission	978-281-9781	978-768-7111	978-356-6661	978-948-2330	978-462-2332
Town Clerk	978-281-9720	978-768-7111	978-356-6600	978-948-2081	978-462-2332

APPENDIX D: Clam bed location maps

Description. Clam bed maps for the five ACEC towns of Newbury, Rowley, Ipswich, Essex, and Gloucester were compiled in 1995 by ADprint Graphics. Information for shellfish bed locations was gathered by meeting with local shellfish constables and clammers; the basemap was redrawn from NOAA nautical charts and is not to be used for navigational purposes. In previous years, only active clammers were aware of bed names because they were passed on verbally, through generations, and rarely written down. These maps were developed to record and preserve historic designations of digging areas. For more information, call ADprint Graphics at 978-768-3310.


TOWN OF NEWBURY CLAM BEDS
(Plum Island and Plum Island River Areas)
1. THE BASIN
2. SEAL ISLAND
3. WOODBRIDGE ISLAND
4. PLUMBUSH CREEK
5. UPPER PLUM ISLAND, RIVER
6. HIGH SANDY
7. PINE ISLAND CREEK
8. PORK ISLAND
9. TONY'S
10. JERICHO CREEK
11. LONG POINT
12. BROWNS ISLAND
13. LONG POINT CREEK
14. ORDWAY
15. ALLWEIS ISLAND
16. HALE'S ISLAND
17. THE ISLANDS
18. CAPE MERRILL
19. THE SPOT
20. HORSESHOE
(Parker River Areas)
21. DOLE'S ISLAND
22. MUD CREEK
23. THE THOROFARE
24. REEF
25. EASONS CREEK
26. NORTH BANK
27. LITTLE RIVER
28. UPPER PARKER RIVER
29. HACKERS ISLAND
CONTAMINATED
MERRIMACK RIVER
WOODBRIDGE ISLAND
CHACES ISLAND
THE BASIN
NEWBURYPORT
NEWBURY
PLUMBUSH
Plumbush Creek
Little Pine Island Creek
LITTLE PINE ISLAND
PINE ISLAND
Pine Island Creek
Jericho Creek
Long Point Creek
PLUM ISLAND RIVER
PLUM ISLAND
BIGELOW BIGHT
1A
LITTLE RIVER
IRELAND POINT
NEWBURY OLD TOWN
PARKER RIVER
Easons Creek
Thorofare
DOLE ISLAND
Mud Creek
NELSON ISLAND
NEWBURY
ROWLEY
©ADprint Graphics, NE 10/95 (508) 768-3310 (Do not use for navigation)

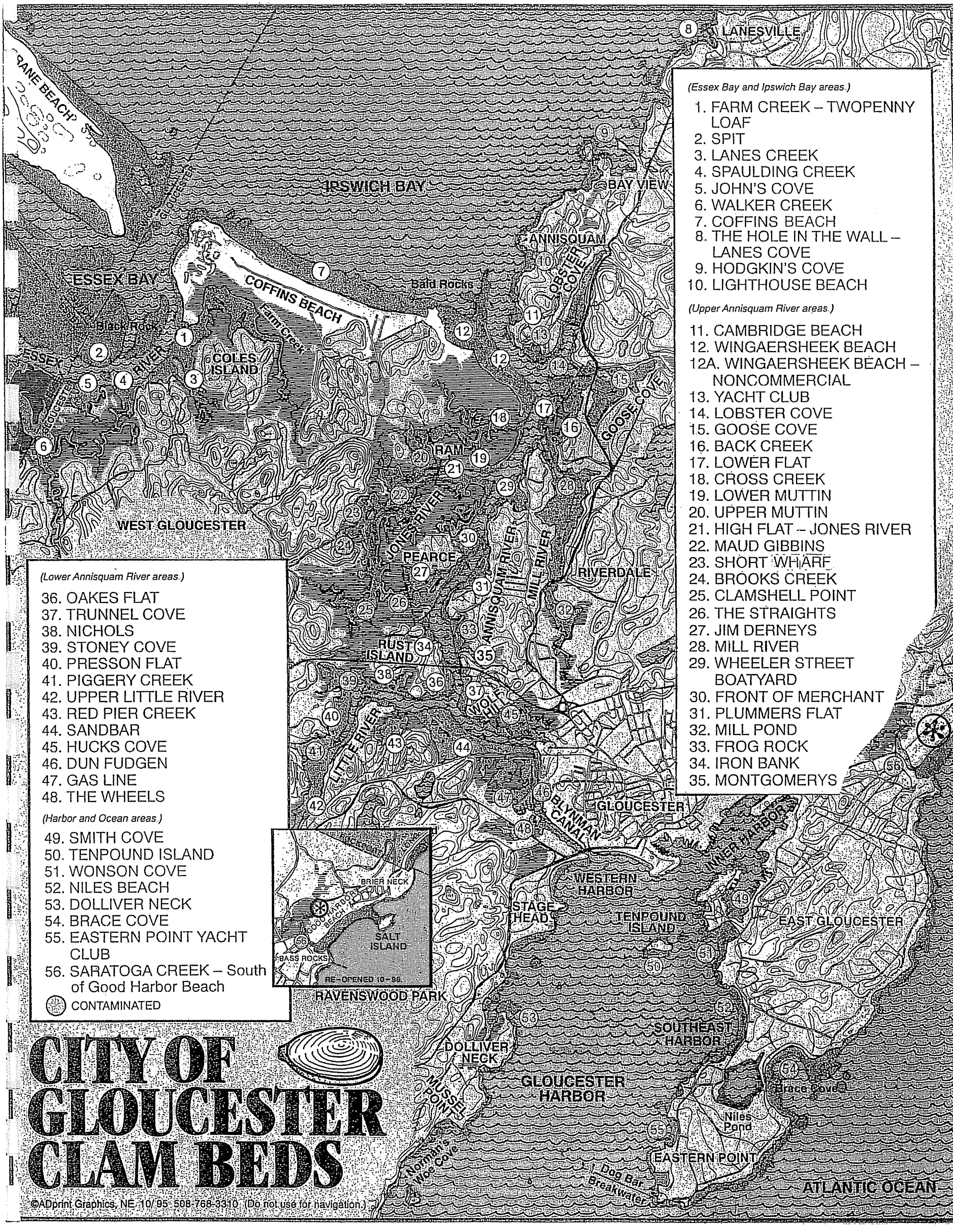

TOWN OF ROWLEY CLAM BEDS
(Plum Island Sound Areas.)
1. MUD CREEK
2. MUZZI HILL SAND SPIT
3. HORSE SHOE
4. LINE CREEK
5. SAND SPIT
6. NELSON ISLAND BANK
7. JACQUES HIGH SANDS
8. JACQUES CREEK
9. SAND CREEK
10. CLAY BED
11. LABOR IN VAIN
12. KNOBBS REEF BAR
13. ROWLEY INNER-OUTER MIDDLE GROUND
14. HOG ISLAND SPIT
15. FLOYD'S CREEK
16. ROWLEY MIDDLE GROUND
17. HOLE IN THE WALL PLUM ISLAND
18. MUSSEL BAR
19. HOG ISLAND CREEK POINT
20. HOG ISLAND CREEK CANAL
(Rowley River Areas.)
21. STRAWBERRY BED
22. BROWNS BASIN
23. CLUB HEAD SANDS
24. CLUB HEAD CREEK
25. LOWER SHAD
26. UPPER SHAD
27. MARY LAMBERT'S CUT
CONTAMINATED
1A
NEWBURY OLD TOWN
PARKER RIVER
PLUM ISLAND RIVER
DOLE ISLAND
Mud Creek
Sawyer Creek
Carolton Creek
NELSON ISLAND
PLUM ISLAND SOUND
PLUM ISLAND
ATLANTIC OCEAN
NEWBURY
ROWLEY
HOG ISLANDS
Nelson Island Creek
Club Head Creek
ROWLEY RIVER
West Creek
LAWS POINT
HOLY ISLAND
ROGER ISLAND
ROWLEY
IPSWICH
(Do not use for navigation)

TOWN OF IPSWICH CLAM BEDS

TOWN of ESSEX CLAM BEDS

KEY:

1. SEAVEY'S SAND FLAT
2. THIRD MUD CREEK
3. THIRD MUD FLAT
4. SECOND MUD FLAT
5. CASTLE
6. ROUND ISLAND
7. SILVER BANK
8. FIRST MUD FLAT
9. ROUND ISLAND CREEK
10. BIG ROCK
11. OAKES CREEK
12. BRIDGE CREEK
13. HORSE BANK RUN
14. HARDY'S CREEK
15. FLAT, off the Bridge Nub
16. THE WRECK
17. THE BRIDGE
18. THE STRAITS
19. PERCY LOWE'S ACRE
20. GEORGE ELYIN'S
21. MARSHALL'S NUB
22. LAMONT'S
23. HOYT'S
24. CLEVELAND'S
25. THE DUMPS
26. NEWFOUNDLAND
27. TOWN NUB
28. HORRACE'S ACRE
29. CORN ISLAND FLAT
30. CORN ISLAND CREEK
31. ESKA'S NUB, North of Cross Island
32. DILLY FLAT
33. DILLY BANK
34. DILLY'S CREEK
35. NIX ISLAND
36. POOL CREEK
37. BULL ISLAND FLAT
38. SEAL BANK
39. SHANGHI
40. SPIT, Northern End
41. LANE'S PIT
42. SOGINESE CREEK
43. BULL ISLAND RUN
44. BOOTMAN'S
45. LOWE'S GULLY, off Robin Island
46. CORBET'S CREEK
47. ROBINS ISLAND CREEK
48. AMERICA'S BANK
49. JOE'S CREEK
50. BAGGETT'S, Southeast of Cross Island
51. SPIT GULLY
52. JEHO
53. HOG'S CREEK
54. LUFKIN'S CREEK
55. POOR FARM CREEK
56. GIDION'S GARDEN
57. GROTON'S GIZZARD


CITY OF GLOUCESTER CLAM BEDS
(Essex Bay and Ipswich Bay areas.)
1. FARM CREEK – TWOPENNY LOAF
2. SPIT
3. LANES CREEK
4. SPAULDING CREEK
5. JOHN'S COVE
6. WALKER CREEK
7. COFFINS BEACH
8. THE HOLE IN THE WALL – LANES COVE
9. HODGKIN'S COVE
10. LIGHTHOUSE BEACH
(Upper Annisquam River areas.)
11. CAMBRIDGE BEACH
12. WINGAERSHEEK BEACH
12A. WINGAERSHEEK BEACH – NONCOMMERCIAL
13. YACHT CLUB
14. LOBSTER COVE
15. GOOSE COVE
16. BACK CREEK
17. LOWER FLAT
18. CROSS CREEK
19. LOWER MUTTIN
20. UPPER MUTTIN
21. HIGH FLAT – JONES RIVER
22. MAUD GIBBINS
23. SHORT WHARF
24. BROOKS CREEK
25. CLAMSHELL POINT
26. THE STRAIGHTS
27. JIM DERNEYS
28. MILL RIVER
29. WHEELER STREET BOATYARD
30. FRONT OF MERCHANT
31. PLUMMERS FLAT
32. MILL POND
33. FROG ROCK
34. IRON BANK
35. MONTGOMERYS
(Lower Annisquam River areas.)
36. OAKES FLAT
37. TRUNNEL COVE
38. NICHOLS
39. STONEY COVE
40. PRESSON FLAT
41. PIGGERY CREEK
42. UPPER LITTLE RIVER
43. RED PIER CREEK
44. SANDBAR
45. HUCKS COVE
46. DUN FUDGEN
47. GAS LINE
48. THE WHEELS
(Harbor and Ocean areas.)
49. SMITH COVE
50. TENPOUND ISLAND
51. WONSON COVE
52. NILES BEACH
53. DOLLIVER NECK
54. BRACE COVE
55. EASTERN POINT YACHT CLUB
56. SARATOGA CREEK – South of Good Harbor Beach
CONTAMINATED
LANESVILLE
IPSWICH BAY
BAY VIEW
ANNISQUAM
LOBSTER COVE
ESSEX BAY
COFFINS BEACH
Bald Rocks
Black Rock
Farm Creek
COLES ISLAND
ESSEX
RIVER
GOOSE COVE
RAM
WEST GLOUCESTER
JONES RIVER
PEARCE
ANNISQUAM RIVER
MILL RIVER
RIVERDALE
RUST ISLAND
WOLF HILL
LITTLE RIVER
BLYNMAN CANAL
GLOUCESTER
INNER HARBOR
WESTERN HARBOR
STAGE HEAD
TENPOUND ISLAND
EAST GLOUCESTER
BRIER NECK
GOOD HARBOR BEACH
SALT ISLAND
BASS ROCKS
RE-OPENED 10-96.
RAVENSWOOD PARK
SOUTHEAST HARBOR
DOLLIVER NECK
GLOUCESTER HARBOR
Brace Cove
MUSSEL POINT
Niles Pond
Norman's Woe Cove
EASTERN POINT
Dog Bar Breakwater
ATLANTIC OCEAN
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APPENDIX E: Natural Heritage and Endangered Species Program (NHESP) Parker River/Essex Bay ACEC rare species list

Description. The NHESP database indicates that the Parker River/Essex Bay ACEC is habitat for the state-protected rare species listed on the following page. These species are protected under the Massachusetts Endangered Species Act (M.G.L. c.131A) and its implementing regulations (321 CMR 10.00). The animals are also protected under the state's Wetlands Protection Act (M.G.L. c.131) and its implementing regulations (310 CMR 10.00). This evaluation is based on the most recent information available in the NHESP database, which is constantly being expanded and updated through ongoing research and inventory. Should new rare species information become available, this evaluation may be reconsidered. For more information, see the NHESP website at http://www.state.ma.us/dfwele/dfw.

***** PARKER RIVER/ESSEX BAY ACEC RARE SPECIES LIST – 23 JUNE 2000

Animal Species	Taxon	Status
American Bittern (*Botaurus lentiginosus*)	Bird	E
Bald Eagle (*Haliaeetus leucocephalus*)	Bird	E
Least Bittern (*Ixobrychus exilis*)	Bird	E
Pied-billed Grebe (*Podilymbus podiceps*)	Bird	E
Roseate Tern (*Sterna dougallii*)	Bird	E
Sedge Wren (*Cistothorus platensis*)	Bird	E
Upland Sandpiper (*Bartramia longicauda*)	Bird	E
Grasshopper Sparrow (*Ammodramus savannarum*)	Bird	T
King Rail (*Rallus elegans*)	Bird	T
Northern Harrier (*Circus cyaenus*)	Bird	T
Piping Plover (*Charadrius melodus*)	Bird	T
Vesper Sparrow (*Pooecetes gramineus*)	Bird	T
Barn Owl (*Tyto alba*)	Bird	SC
Common Moorhen (*Gallinula chloropus*)	Bird	SC
Common Tern (*Sterna hirundo*)	Bird	SC
Cooper's Hawk (*Accipiter cooperii*)	Bird	SC
Least Tern (*Sterna antillarum*)	Bird	SC
Atlantic Sturgeon (*Acipenser oxyrhynchus*)	Fish	E
Shortnose Sturgeon (*Acipenser brevirostrum*)	Fish	E
Spotted Turtle (*Clemmys guttata*)	Reptile	SC
Wood Turtle (*Clemmys insculpta*)	Reptile	SC
Eastern Spadefoot (*Scaphiopus holbrookii*)	Amphibian	T
Blue-spotted Salamander (*Ambystoma laterale*)	Amphibian	SC
Eastern Pondmussel (*Ligumia nasuta*)	Mussel	SC
New England Siltsnail (*Cincinnatia winkleyi*)	Snail	SC
Persius Duskywing (*Erynnis persius persius*)	Butterfly	T
Plant Species		
Long's Bulrush (*Scirpus longii*)	Vascular Plant	E
Silverling (*Paronychia argyrocoma*)	Vascular Plant	E
Eaton's Beggar-ticks (*Bidens eatonii*)	Vascular Plant	T
Hairy Wild Rye (*Elymus villosus*)	Vascular Plant	T
Seabeach Dock (*Rumex pallidus*)	Vascular Plant	T
American Sea-blite (*Suaeda americana*)	Vascular Plant	SC
Engelmann's Umbrella-sedge (*Cyperus engelmannii*)	Vascular Plant	SC
River Bulrush (*Scirpus fluviatilis*)	Vascular Plant	SC
Seabeach Needlegrass (*Aristidia tuberculosa*)	Vascular Plant	SC

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This information is available in alternate formats upon request.

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