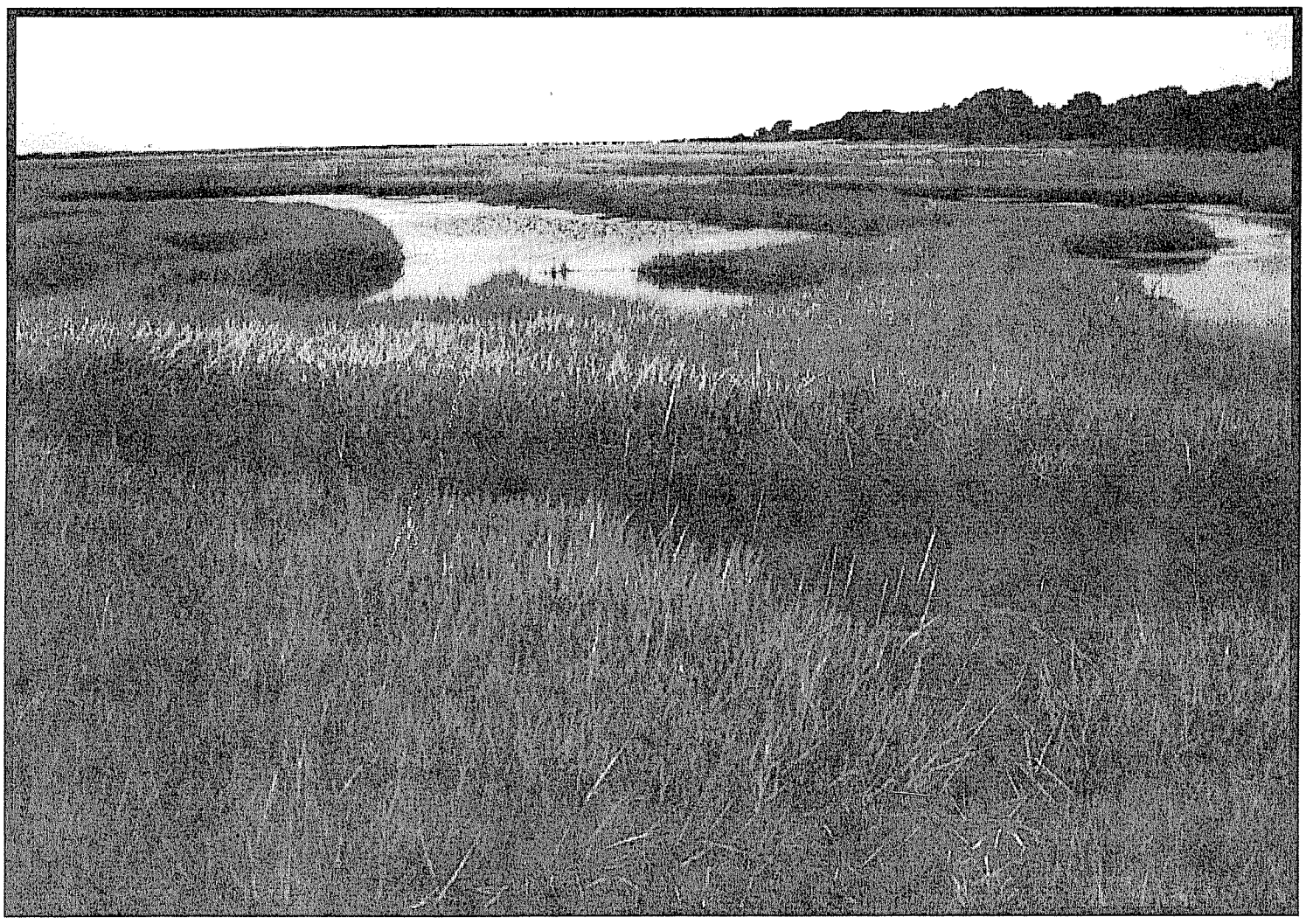
ATLAS OF TIDALLY RESTRICTED MARSHES

North Shore of Massachusetts



Salt marsh at Parker River National Wildlife Refuge (Newbury). (R. Tiner photo)

December 1996

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North Shore of Massachusetts

Prepared by

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December 1996

Prepared with partial funding from

Massachusetts Bays Program,
a cooperative venture of
the Massachusetts Coastal Zone Management Office
and the U. S. Environmental Protection Agency
through U.S. Environmental Protection Agency Cooperative Agreement CEOO1534-01.

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Acknowledgments

This Atlas represents the results of a multi-agency cooperative study of tidal wetlands on the North Shore of Massachusetts. The project was initiated by the Massachusetts Wetlands Restoration and Banking Program (WRBP), Executive Office of Environmental Affairs (EOEA), Boston, Massachusetts under the direction of Christy Foote-Smith. The project was designed and managed by Ralph Tiner, Wetland Scientist with WRBP. Partial funding was provided through a Bays Action Grant from the MassBays Program within EOEA. Additional support was provided by the University of Massachusetts/Amherst, Department of Plant and Soil Sciences, the Massachusetts Wetlands Restoration & Banking Program, and the U.S. Fish and Wildlife Service, Northeast Region, Hadley, Massachusetts.

The maps and data summaries published in the Atlas were produced by the Natural Resources Assessment Group (NRAG) at the University of Massachusetts/Amherst. The following individuals contributed greatly to the preparation of the Atlas: David Foulis (photointerpretation, field work, and coordination of Atlas preparation), Christine Nichols (map production, data tabulation, and GIS services), John Eaton (GIS services), and Weston Sechrest (field work). Peter Veneman coordinated project schedules and budget for NRAG. The Office of Geographic Information Analysis at the University assisted with database design, MassGIS and NWI data compatibility resolution, and Atlas design and production. The U.S. Fish and Wildlife Service's National Wetlands Inventory Program provided access to GIS equipment and stereoscopes for completion of this project.

Ralph Tiner and Christy Foote-Smith prepared the narrative for the Atlas. Staff from the U.S. Fish and Wildlife Service helped prepare the Atlas for publication. Mary O'Connor typeset and designed the camera-ready report. Jim Clark prepared Figure 15. Paul Caruso of the Massachusetts Division of Marine Fisheries provided information on fish and shellfish use of Massachusetts tidal marshes.

About This Atlas

Study Purpose

This study was undertaken to encourage and facilitate the restoration of salt marshes in the Commonwealth of Massachusetts. The Wetlands Restoration & Banking Program and the Natural Resources Assessment Group in the Department of Plant and Soil Sciences at the University of Massachusetts/Amherst prepared a joint proposal to the MassBays Program to produce a map atlas showing the general distribution of salt marshes and other tidal wetlands and highlighting tidally restricted wetlands for the North Shore. The MassBays Program provided partial funding through a Bays Action Grant. The rest of the funding came in the form of technical support from WRBP, administrative support from UMass, and graphics support from the U.S. Fish and Wildlife Service, Northeast Region.

Information in the Atlas

The study area encompasses the North Shore region of Massachusetts which extends from the New Hampshire border south to Boston. The study focused on existing tidal marshes or formerly connected marshes in 20 towns: Amesbury, Beverly, Danvers, Essex, Gloucester, Ipswich, Lynn, Manchester, Marblehead, Nahant, Newbury, Newburyport, Peabody, Revere, Rowley, Rockport, Salem, Salisbury, Saugus, and Swampscott.

This Atlas contains the following information:

- Maps of tidal wetland habitats.
- Maps showing locations of potential tidal marsh restoration sites.
- Acreage summaries of tidal wetlands by type and by town, with special emphasis on those that may have restricted tidal flows.
- Background information on tidal restrictions and restoration of tidal flowage.

Distribution of the Atlas

Copies of the Atlas have been distributed to the following municipal agencies of each community in the study area: municipal executive (mayor, town manager, selectmen), planning board, department of public works, and conservation commission. In addition, the Atlas has been distributed to environmental groups and other interested parties.

The following supplementary information for each municipality in the study area has been presented to the conservation commission and will be available in the public library of each community:

- Color maps of tidal wetland habitats.
- Color maps showing locations of potential tidal marsh restoration sites.
- Field data sheets providing site-specific information for potential tidally restricted salt marshes that were field checked. (Note: The only sites evaluated were those that could be reached with public access.)

Complete sets of colored maps and field data sheets for the entire study area will be available for public review at the following locations. Please call in advance to make an appointment.

Wetlands Restoration & Banking Program
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, MA 02202
(617) 727-9800 x213

Massachusetts Coastal Zone Management
North Shore Office
2 State Pier
Gloucester, MA 01930
(508) 281-3972

8 Towns & The Bay
Merrimack Valley Regional Planning Commission
160 Main Street
Haverhill, MA 01830
(508) 374-0519

Massachusetts Audubon Society
North Shore
346 Grapevine Road
Wenham, MA 01984
(508) 927-1122

Massachusetts Bays Program
100 Cambridge Street – 21st Floor
Boston, MA 02202
(617) 727-9530

Additional copies of this Atlas may be obtained by writing:

Wetlands Restoration & Banking Program
Executive Office of Environmental Affairs
100 Cambridge Street – 20th Floor
Boston, Massachusetts 02202

How To Use The Information in the Atlas

The Atlas has been produced to document the extent of salt marshes that have been adversely impacted by human activities, especially transportation facilities, and to identify potential sites where restoration of salt marshes may be undertaken. It is hoped that this information will be used by municipal agencies, state agencies, and others to initiate salt marsh restoration activities at appropriate sites. Municipal public works departments are particularly encouraged to check this Atlas when road or bridge work is contemplated to determine whether a redesign in structure could produce a positive environmental result. The Atlas may serve as a source of projects to be included in the Regional Transportation Plan for possible state/federal transportation funding.

The Wetlands Restoration & Banking Program supports the efforts of municipalities, landowners, other agencies, and groups that wish to undertake wetland restoration projects. Individual wetland restoration projects may be initiated under WRBP's GROWetlands (Groups Restoring Our Wetlands) initiative. WRBP has organized the Wetlands Restoration Assistance Team (WetRATs), a network of volunteer wetland scientists to assist GROWetlands project sponsors in evaluating the restoration potential of wetland sites. WRBP helps GROWetlands sponsors develop goals and a work plan for restoration projects, secure project funding, organize volunteers, use restoration sites as learning laboratories for schools and groups, and monitor restored wetlands to ensure success. Please see the Appendix for a more complete description of GROWetlands and a Project Nomination Form.

Background

Coastal wetlands are primarily comprised of tidal marshes and associated intertidal habitats (e.g., mud flats, sandy beaches, and rocky shores) that occur along tidal rivers and estuarine embayments (Figure 1). Salt marshes are one of the most familiar tidal wetlands and most abundant types of coastal wetlands (Figure 2). These wetlands are located at the mouths of estuaries and along tidal embayments flooded by salt water on a regular basis. Plants growing in these wetlands have developed special adaptations for life in salt water. These plants are called halophytes ("salt-loving plants"). A list of some common species is presented in Table 1.

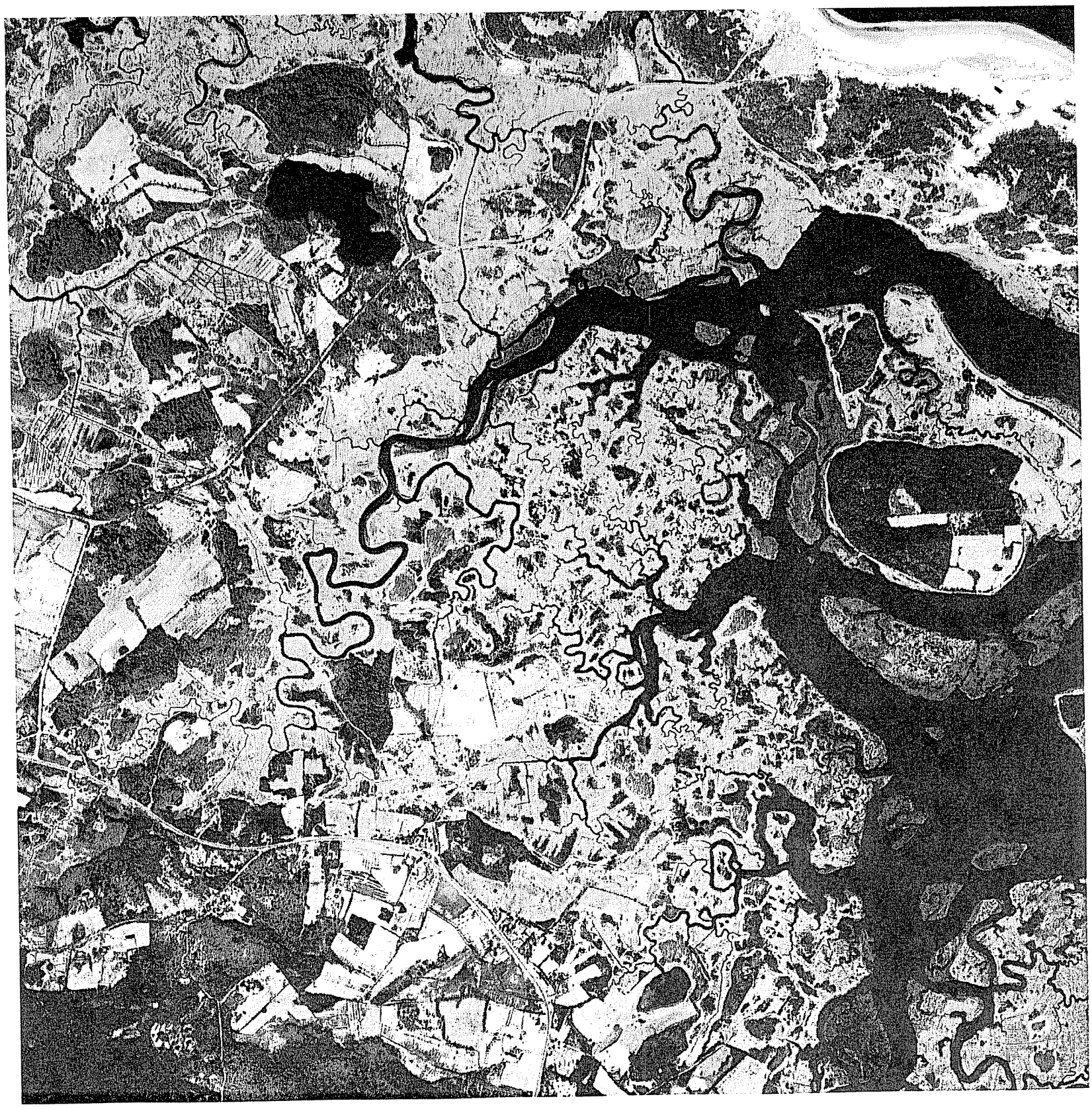


Figure 1. Aerial view of tidal wetlands and adjacent areas in Ipswich and Essex (Castle Neck and Essex Rivers).

Table 1. Some common tidal marsh plants in Massachusetts. (For illustrations, see *A Field Guide to Coastal Wetland Plants of the Northeastern United States* by R.W. Tiner, 1986, University of Massachusetts Press.)

Common Name *(Scientific Name)*	**Type of Tidal Wetland**	**Common Name** *(Scientific Name)*	**Type of Tidal Wetland**
Smooth Cordgrass *(Spartina alterniflora)*	Salt and Brackish Marshes	Salt Marsh Aster *(Aster tenuifolius)*	Salt and Brackish Marshes
Salt Hay Grass *(Spartina patens)*	Salt and Brackish Marshes	Common Reed *(Phragmites australis)*	Salt, Brackish, and Fresh Marshes
Salt Grass *(Distichlis spicata)*	Salt and Brackish Marshes	Switchgrass *(Panicum virgatum)*	Salt, Brackish, and Fresh Marshes
Black Grass *(Juncus gerardii)*	Salt and Brackish Marshes	Three-squares *(Scirpus pungens and americanus)*	Brackish and Fresh Marshes
Glassworts *(Salicornia spp.)*	Salt Marshes	Rose Mallow *(Hibiscus moscheutos)*	Brackish Marshes
Seaside Arrowgrass *(Triglochin maritima)*	Salt Marshes	Creeping Bent Grass *(Agrostis stolonifera var. compacta)*	Brackish and Fresh Marshes
Seaside Plantain *(Plantago maritima)*	Salt Marshes	Spikerushes *(Eleocharis spp.)*	Brackish and Fresh Marshes
High-tide Bush *(Iva frutescens)*	Salt Marshes	Narrow-leaved Cattail *(Typha angustifolia)*	Brackish Marshes
Groundsel Bush *(Baccharis halimifolia)*	Salt and Brackish Marshes	Broad-leaved Cattail *(Typha latifolia)*	Slightly Brackish and Fresh Marshes
Salt Marsh Bulrush *(Scirpus robustus)*	Salt and Brackish Marshes	Wild Rice *(Zizania aquatica)*	Fresh Marshes
Seaside Goldenrod *(Solidago sempervirens)*	Salt and Brackish Marshes	Soft-stemmed Bulrush *(Scirpus validus)*	Fresh Marshes

Figure 2. Typical salt marsh on the North Shore (Salisbury). (R. Tiner photo)

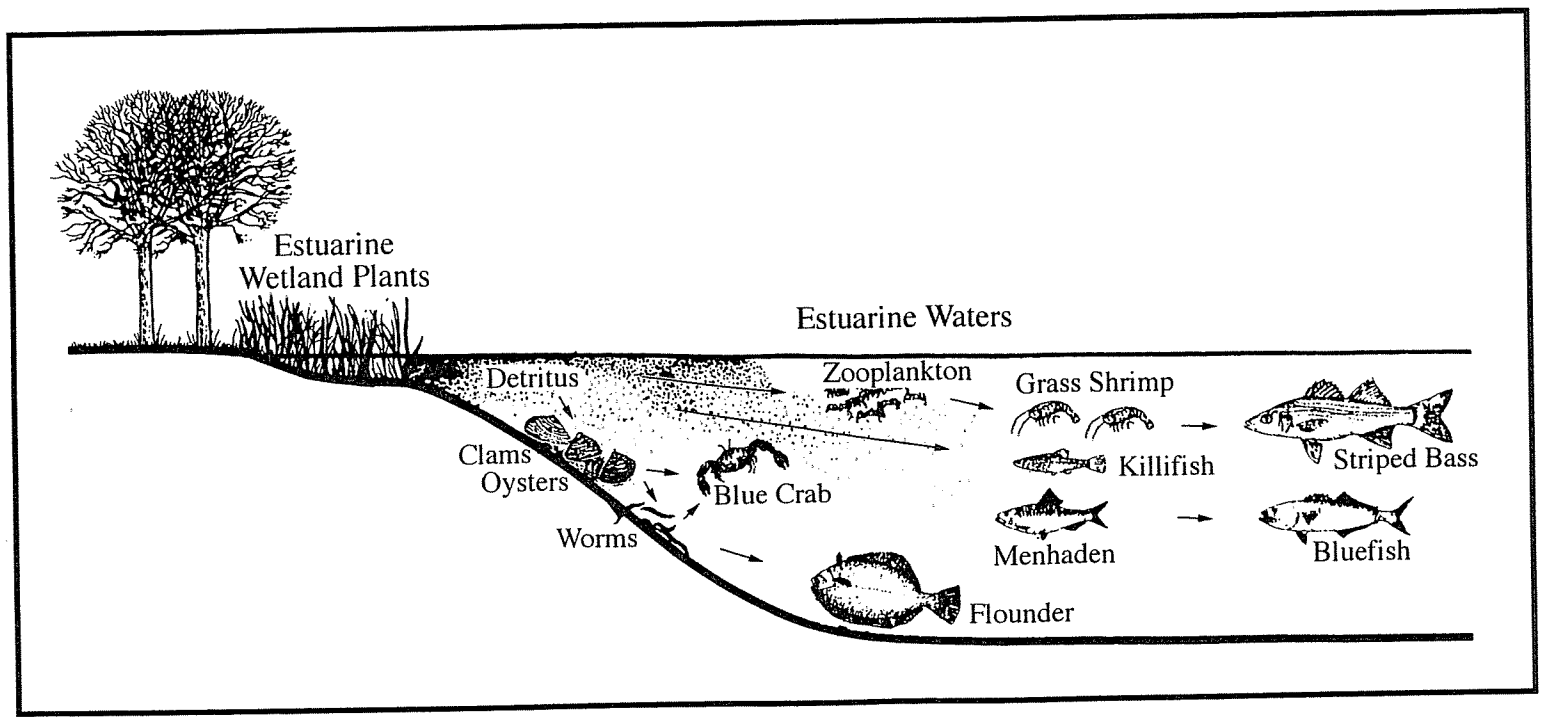


Figure 3. Tidal marsh plants produce tons of organic matter that support coastal fisheries.

Coastal wetlands are among the Commonwealth's most valuable natural resources. Tidal flushing has created a highly productive environment that provides food and habitat for many animals. Coastal wetlands are the ocean's farmlands with each acre of marsh producing tons of organic matter each year, providing the foundation of a detritus-based food web that ultimately supports many coastal fishes and birds (Figure 3). Numerous bird species breed in and around tidal marshes. They are vital habitats along the Atlantic Flyway for migratory waterfowl and other birds. New England salt marshes are critical overwintering areas for black ducks. Tidal wetlands serve as vital nursery and spawning grounds for many commercially and recreationally important fish and shellfish species (Table 2). Coastal wetlands also buffer the land against erosive storm-generated waves and temporarily store flood waters on a frequent basis.

In colonial times, salt marshes provided salt hay which was used for fodder, mulch, insulation, packaging, and other purposes. Today, there is high demand for the weed-free mulch salt hay provides for use in suburban gardens. Many salt marshes on the North Shore are mowed to produce salt hay for such use. Some salt marshes have been hayed for over 200 years.

Recognizing the values of salt marsh functions, in 1963 Massachusetts passed the "Jones Act" to protect salt marshes. This was the first law in the country adopted to protect coastal wetlands from dredging, filling, and other impacts. Prior to this time, many salt marshes were used for disposal of dredged material or filled for port development, industrial facilities, and housing. Many remaining salt marshes have been degraded by minor filling, mosquito ditching, and restriction of tidal flow.

Since the 1960s, new impacts to Massachusetts salt marshes have been strictly controlled. In the 1970s, Massachusetts adopted the Wetlands Protection Act which requires that no development take place in inland or coastal wetlands unless approved by the municipal conservation commission, with oversight from the Massachusetts Department of Environmental Protection. Strict regulations under this law virtually prohibit adverse impacts to salt marshes.

While regulatory efforts have halted most alterations of Massachusetts salt marshes, until recently, there was no program to address the historic destruction and degradation of these vital resources. In 1994, Secretary Trudy Coxe of the Executive Office of Environmental Affairs established the Massachusetts Wetlands Restoration & Banking Program (WRBP). The purpose of the program is to further implement the state's policy of "no net loss of wetlands in the short-term and a net gain in the long-term". WRBP's two-part mission is to: 1) restore proactively the state's degraded and destroyed wetlands and 2) explore whether wetlands mitigation banking can improve mitigation success for unavoidable, permitted wetland losses. Unlike wetland replication required under permits to compensate for wetland destruction caused by construction and other activities, WRBP proactive wetland restoration projects may be initiated by project sponsors who simply want to bring back our wetland heritage or who want to help address community water quality and flooding problems or restore wildlife habitat.

The Atlas has been prepared as part of WRBP's proactive wetland restoration efforts. WRBP will work with North Shore communities, environmental groups, state and federal agencies, and others on an ongoing basis to implement priority wetland restoration projects identified in this Atlas.

Table 2. List of marine and estuarine fish and shellfish dependent on Massachusetts tidal wetlands.(Source: Paul Caruso, Division of Marine Fisheries, personal communication, July 19, 1996)

Species	Adult Use	Spawn In/Near	Nursery Use	Species	Adult Use	Spawn In/Near	Nursery Use
Striped Bass	x	x	x	River Herring	x	x	x
Bluefish			x	Shad	x		x
Winter Flounder	x	x	x	Smelt	x	x	x
Scup			x	Blue Crab	x	x	x
Tautog			x	Jonah Crab			x
Black Sea Bass			x	Lobster			x
Menhaden	x	x	x	Quahog	x	x	x
Summer Flounder			x	Soft Shell Clam	x	x	x
Weakfish	x		x	Bay Scallop		x	x
Eel	x		x	Oyster	x	x	x
White Perch	x	x	x	Conch			x

Impacts to Salt Marshes and Restoration Approaches

What is a Tidally Restricted Salt Marsh?

Many salt and brackish marshes are crossed by highways, roads, and railroads of various dimensions. Roads may be either public or private ways. These transportation routes through tidal marshes may cross tidal creeks or rivers at one or more locations. Usually bridges are required to span rivers and broad creeks (Figure 4). Many roadways leading to bridges are built on fill deposited in wetlands — these thoroughfares are called causeways. Roads crossing small creeks may have culverts installed to allow passage of tidal waters beneath the roadway (Figure 5). In many cases, the culvert may be too small to pass sufficient tidal water to maintain salt marsh vegetation upstream (Figure 6). Culverts may be fitted with tide gates which may further restrict tidal flow or flapper valves which allow fresh water to leave the marsh but will not allow tidal flow to enter the marsh. Bridges may have a similar effect if the opening is not wide enough to pass sufficient tidal water to maintain salt and brackish marshes further upstream (Figure 7). At some road crossings, no culvert has been provided and tidal flow has been eliminated altogether.

These hydrologic changes significantly alter the chemical integrity of the upstream salt marshes. The once strongly saline environment changes to a brackish or fresh water condition. This freshening of salt marshes causes a major transformation in the vegetation — salt marsh grasses and rushes are displaced by common reed (Figure 8). Common reed often forms a monoculture of tall reeds (up to 12 feet or more), leading to both lowered plant diversity and a change in vegetative structure (from a low grassy meadow to a tall reedy thicket). This causes a major shift in wildlife use as typical salt marsh inhabitants are replaced by fewer species that may perch on or nest in the common reed. Despite some use of the reeds, no animals prefer common reed over other habitats, thus a reed marsh is not preferred habitat for any species. This is in marked contrast to distinct preferences for salt marsh vegetation over other habitats by many wildlife species.

Restricted tidal flows and blockage of streams by common reed reduce access to tidal marshes by estuarine organisms. This prevents use of the affected marshes by many species. In addition, the export of organic matter from the salt marshes, a vital life-support function for the detrital-based food web of estuarine and marine environments, is reduced or eliminated where tidal exchange is restricted or cut off by a tide gate, a flapper valve, or a dike.

The effects of tidal restriction are clearly detrimental from an ecological standpoint. The entire ecosystem upstream of the restriction is damaged. Eliminating or reducing tidal exchange to salt marshes has a negative impact on adjacent estuarine and marine ecosystems.

Restoring Tidal Flow

The main objective of salt marsh restoration where the tidal flow is restricted is a simple one — to improve tidal flowage to the affected marsh. In many cases, restoration is easily accomplished by removing the restrictive feature or by providing a sufficient opening to allow adequate tidal flow. For example, where tidal flow is reduced by undersized culverts (too small to pass the full spring tide), simply replacing the culvert with a larger one, generally the width of the original channel and of appropriate height, may be enough to restore tidal flow.

In other cases, development has taken place in low-lying areas surrounding the marsh and sometimes on fill in the marsh itself. Due to flood risk, restoring full tidal flow to these areas is not possible. However, restoration of sufficient tidal flow to flood a lower portion of the marsh on a regular basis may be possible, if it can be shown that this will not increase the risk of flooding to adjacent structures. Improving tidal flow to the marsh while preventing property flooding can be accomplished by expanding the culvert size and adding a protective device, such as a self-regulating tide gate or a manually or electronically operated tide gate (Figure 9). These gates can establish an opening that allows passage of normal tides, but prevents entry of storm tides. Some structures can be completely closed, if necessary, to facilitate storm protection. Each proposed salt marsh restoration site should consider potential adverse impacts such as flooding before work is begun.

Allowing for frequent tidal flooding should be sufficient to promote the return of salt marsh vegetation in areas of high salinity (greater than 18 parts per thousand). In areas of lower salinity, improved tidal exchange through reconnection of the marsh to the adjacent estuary is still beneficial, even though the vegetation usually does not change simply by this act alone.

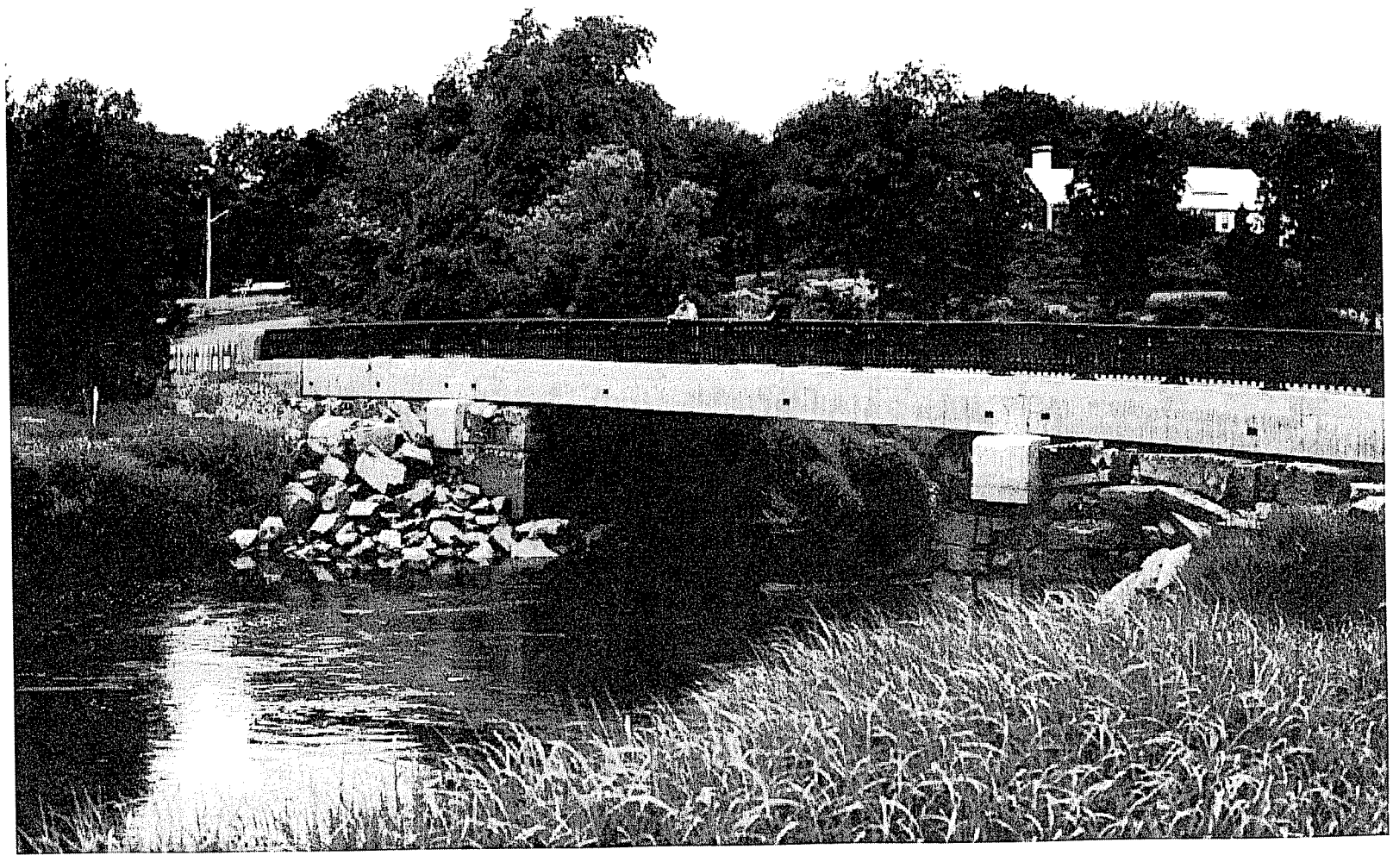


Figure 4. Bridge spanning the Parker River in Newbury. (D. Foulis photo)

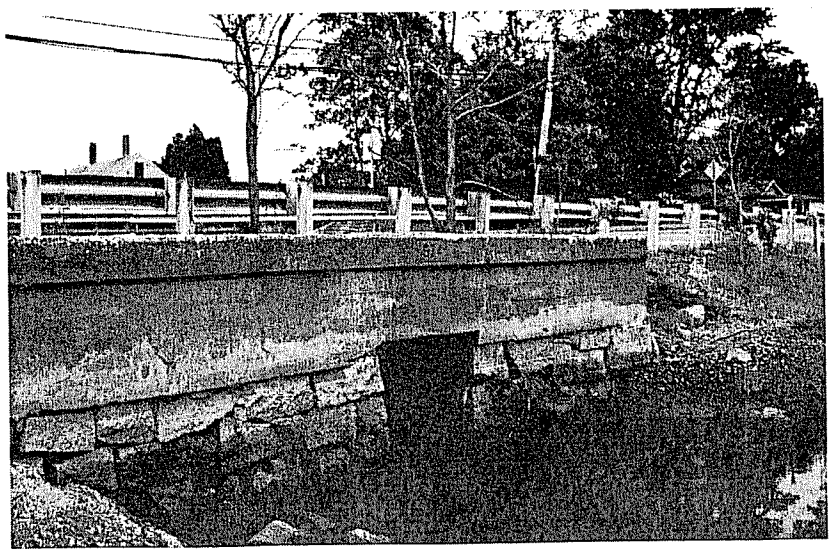


Figure 5. Two types of culverts: a) corrugated metal pipe culvert (above left; Argilla Road, Ipswich) and b) box culvert (above right; Ebben Creek, Essex). (D. Foulis photos)

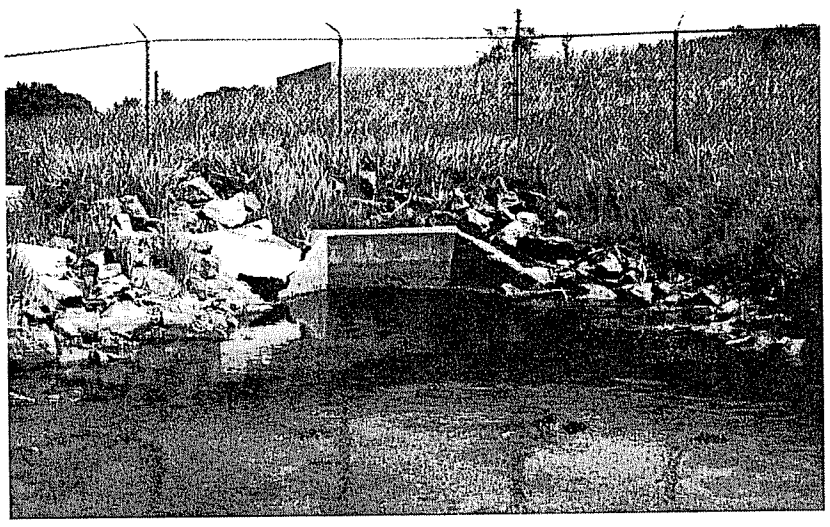


Figure 6. Submerged culvert is too small and too low to pass high tides. Daily tides may pass freely, but the higher tides (e.g., spring tides and storm tides) are impeded. (D. Foulis photo)

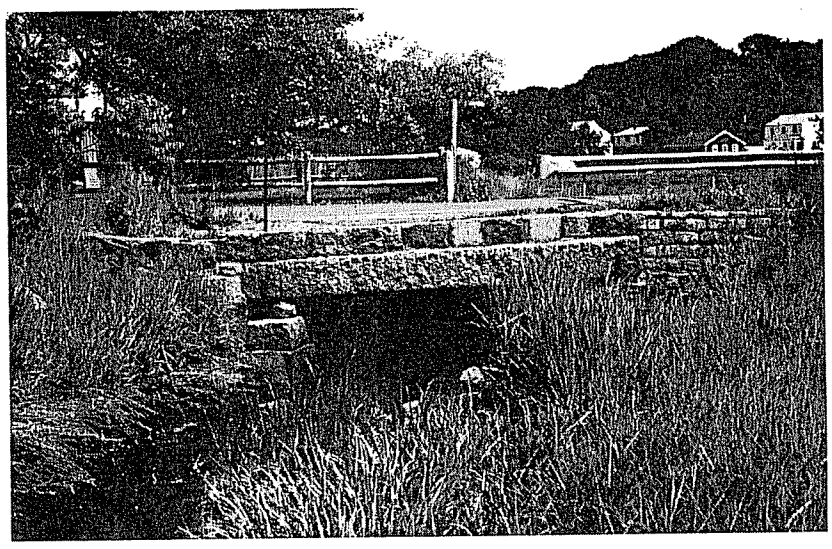


Figure 7. Bridge over tidal creek in Gloucester. This appears to be a restrictive feature since the seaward marsh is dominated by salt hay grass, while the upstream marsh is dominated by common reed. (D. Foulis photo)

Figure 8. Common reed (*Phragmites australis*) usually dominates the most severely restricted tidal marshes. (Source: Tiner 1986) (Abigail Rorer illustration)

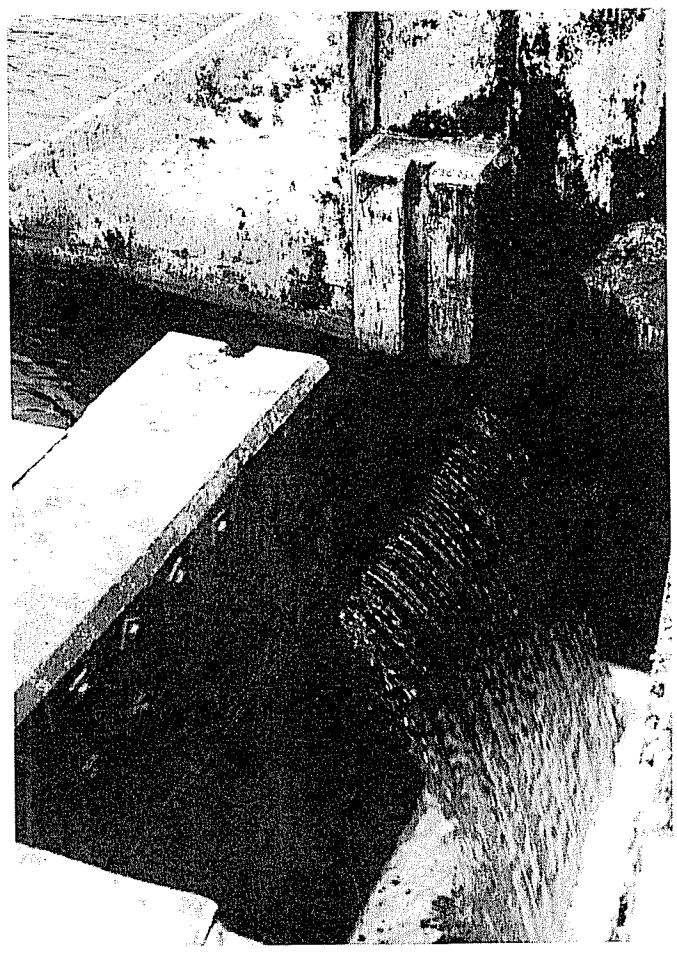
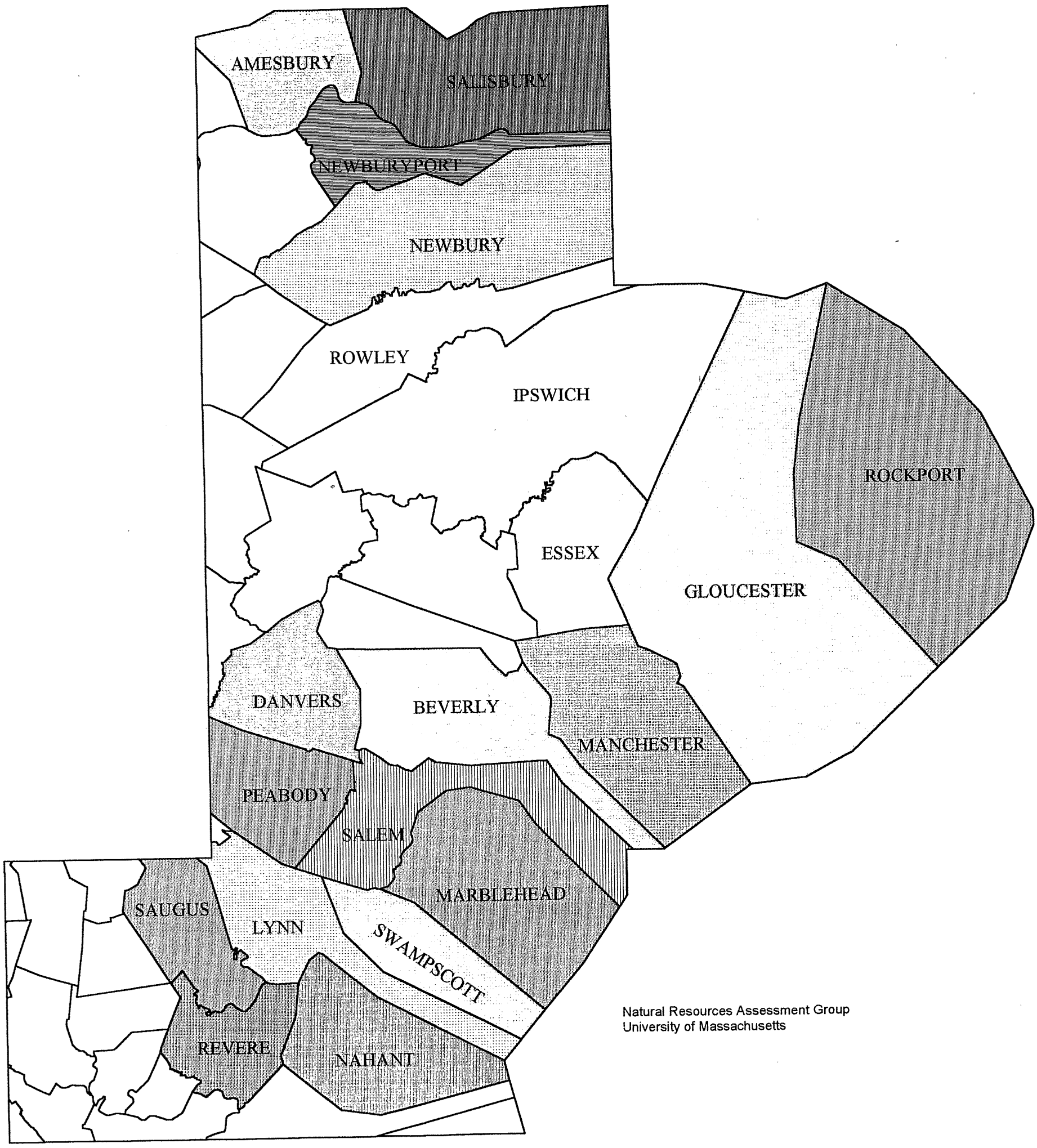


Figure 9. Tide gate at Mill River in Gloucester has eliminated tidal flow upstream creating a freshwater pond – Mill Pond. (D. Foulis photo)

Study Area

The North Shore study area includes 20 towns: Amesbury, Beverly, Danvers, Essex, Gloucester, Ipswich, Lynn, Manchester, Marblehead, Nahant, Newbury, Newburyport, Peabody, Revere, Rockport, Rowley, Salisbury, Salem, Saugus, and Swampscott (Figure 10). Parts of five watersheds occur in this region: North Coastal, Boston Harbor, Ipswich, Parker, and Merrimack (Figure 11).

Potential Tidally Restricted Wetlands of the North Shore of Massachusetts



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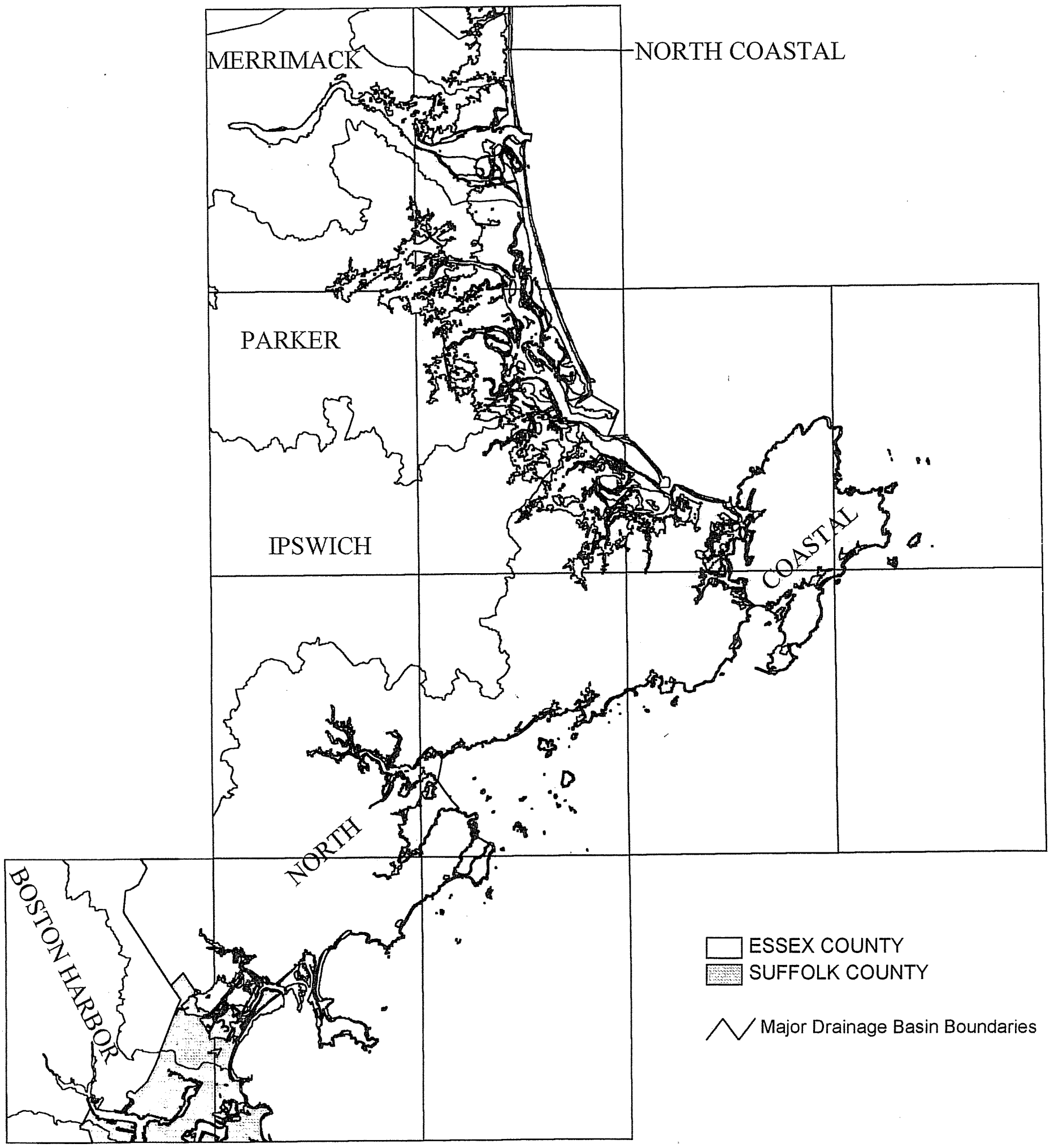
University of Massachusetts

Cities & Towns Comprising the North Shore of Massachusetts Study Area

Figure 10. Map showing study area towns.

Potential Tidally Restricted Wetlands of the North Shore of Massachusetts



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Major Drainage Basins & Counties Comprising the North Shore of Massachusetts Study Area

Figure 11. Map showing watersheds in the study towns.

Study Methods

Preparation of the Atlas

In preparing the Atlas, a combination of geographic information processing, photointerpretation, and field work was performed. The base maps were derived from the U.S. Fish and Wildlife Service's National Wetlands Inventory maps that were available through the Internet (http://www.nwi.fws.gov — for information: op@enterprise.nwi.fws.gov). These maps were prepared after completion of a wetland trends study for selected areas along the Gulf of Maine (see Foulis and Tiner 1994 and Foulis, et al. 1994 for results). The digital data also provided statistics on wetland acreages for the study area. The maps served as the base for recording the presence of tidally restricted marshes as determined through photointerpretation.

The updated NWI maps were based on interpretation of 1985-86 color infrared aerial photographs (scale 1:58,000) acquired by the National High Altitude Photography Program. This photography was supplemented with 1:40,000 color infrared photos captured in 1991-92 (see Figure 1 for example). The photos were examined to identify estuarine and palustrine wetlands that appeared to be tidally restricted. The presence of a road or railroad embankment with common reed on the upstream side and typical salt marsh vegetation on the seaward side signified a likely restriction. In other cases, the presence of a scouring basin (Figure 12) on one or both sides of the embankment suggested uneven flows (e.g., too much water collecting around the restriction and increased outflows with high erosive potential). Although many areas may adequately pass the daily high tides, passage of the spring tides should be most important in maintaining salinity of upstream marshes. Bridges with short spans that did not completely cross the underlying river channel also were viewed as potential restricting structures and scouring basins usually were evident.

Common reed stands were also photointerpreted. In general, stands larger than one acre were included in the inventory. Narrow marginal bands of common reed along the upland border of salt marshes and small stands of common reed were not identified.

Field work was conducted for two purposes: 1) to become familiar with photo-signatures associated with restricted wetlands and common reed-dominated marshes, and 2) to collect data on specific restricting structures. Field work was limited to sites with public access. Field data sheets were prepared for 94 check sites. A sample of a blank field form is shown in Figure 13.

A new database was constructed by adding the location of potential tidally restricted wetlands and common reed-dominated stands in tidal marshes to the existing wetland map database. In addition, the following data were derived from MassGIS for geographic location and generating town-based information: community boundaries without coast data layer (April 1992), roads data layer (March 1991), and trains coverage (December 1995). These data also helped identify potential restrictive features. Selected place names from U.S. Geological Survey topographic maps were added to the database.

This new database was used to produce a series of 1:40,000 scale maps. The maps use names consistent with the double metric quad map sheets produced by the U.S. Geological Survey (1:25,000). For this Atlas, each of the sheets were divided into two halves — an eastern half and western half (see Index Map). For example, the Ipswich sheet was separated into two maps: West Half of Ipswich and East Half of Ipswich.

Figure 12. A scouring basin at Labor in Vain Creek (Ipswich). (D. Foulis photo)

Natural Resources Assessment Group

Tidally Restricted Wetland/Deepwater Habitat Field Data Sheet

Site Location Information

Site # _____ Town or City _____

County _____ State MA USGS map _____

Public/Non-Profit owner name _____

Name of unit _____

Aerial photograph number _____ Slide/photograph number _____

Crossing feature name _____

Channel and/or wetland name (if any) _____ Channel width _____

Date, Time and Tide Conditions

Date _____ Time _____ Tide stage _____

Tidal conditions _____

Type of Restricting Structure

Check one or more: ❑ Bridge ❑ Culvert ❑ Dike ❑ Tide ❑ Gate ❑ Road ❑ Other _____

Bridge Data

Check all applicable: ❑ Drawbridge ❑ Piers present

Fill out following: Date built (if visible) _____ # of piers _____ Length in feet _____ # of lanes _____

Condition of structure: ❑ Excellent ❑ Good ❑ Fair ❑ Poor

Explain _____

Culvert Data

Check one: ❑ Corrugated ❑ Metal ❑ Concrete ❑ Clay ❑ Pebble ❑ Conglomerate

❑ Other Explain _____

Foundation type(s): ❑ Earthen ❑ Concrete ❑ End Wall ❑ Wing Wall ❑ Apron/Sill ❑ Loose Stone ❑ Cemented Stone

Condition of foundation: ❑ Excellent ❑ Good ❑ Fair ❑ Poor

Report pipe dimensions: _____ ❑ Measured ❑ Estimated

Report pipe shape in cross section: _____ Report # of pipes _____

Condition of culvert: ❑ Excellent ❑ Good ❑ Fair ❑ Poor

Explain _____

Dike, Road, or Tide Gate

Give details: _____

Evidence of Restriction

Check one or more: ❑ seaward scouring basin ❑ upstream scouring basin ❑ bank erosion ❑ low marsh slumping

❑ seaward culvert opening submerged at mean high tide ❑ upstream culvert opening submerged at mean high tide

❑ culvert clogged with debris ❑ culvert broken ❑ culvert deteriorating ❑ culvert collapsed

❑ ponded water on seaward side of dike or road ❑ ponded water on upstream side of dike or road

❑ *Phragmites australis* and/or ❑ *Lythrum salicaria* present ❑ culvert invert problem detected

❑ active salthaying or staddles observed ❑ vegetation die-back

Comments _____

Proximity to Low-lying Developed Areas

❑ near a low-lying developed area ❑ not near a low-lying developed area

Wetland Plant Community Characteristics

NWI Classification, seaward side of tidal restriction _____

dominance type, seaward side of tidal restriction _____

NWI Classification, upstream side of tidal restriction _____

dominance type, upstream side of tidal restriction _____

Other plant species of note _____

Wildlife Observations

_____

Results

Maps

The Atlas contains two series of 1:40,000 scale maps. One set shows the distribution of coastal wetlands and deepwater habitats by major type (see Table 3 for definitions of types). The second set shows the location of potential tidally restricted wetlands, potential tidally restricting upland features, and common reed-dominated marshes (both tidally restricted and other tidal wetlands dominated by this species). Potential tidally restricting upland features include roads and causeways to islands, for example, that interrupt surface water flow patterns, without significantly changing marsh vegetation (Figure 14). Some of these features may be suitable for potential salt marsh restoration through removal of fill. The locations of field check sites are also indicated on the second set of maps. A total of 26 maps are included in the Atlas.

Table 3. Major categories of wetlands and deepwater habitats designated on the Atlas maps. (Definitions are consistent with Cowardin, *et al.* 1979.)

Wetland Type	General Definition
Salt Marshes	Tidally flooded emergent wetlands dominated by halophytic grasses and rushes, salinities typically from 30 parts per thousand to 0.5 parts per thousand (includes brackish marshes) (may have some ditches)
Ditched Salt Marshes	Salt marshes with substantial grid-ditching
Marine Deepwater Habitats	Open ocean and large open embayments along the coast
Estuarine Deepwater Habitats	Semi-enclosed coastal embayments and coastal rivers where there is a measurable dilution of salt water with fresh water
Marine and Estuarine Beaches, Flats, and Rocky Shores	Nonvegetated intertidal wetlands associated with salt water bodies
Marine and Estuarine Aquatic Beds	Rockweed-vegetated rocky shores and eelgrass beds in saline waters
Freshwater Tidal Wetlands	Freshwater wetlands (typically marshes) found along major rivers upstream of salt and brackish marshes
Freshwater Tidal Deepwater Habitats	Tidally influenced portions of coastal rivers where no measurable salinity is recorded at low flows (water is fresh)

Figure 14. Stone causeway across salt marsh in Gloucester. (D. Foulis photo)

Tidal Wetland Acreage Summaries

The 20-town North Shore region contains almost 30,000 acres of tidal wetlands (Figure 15). Over half of these wetlands are salt marshes (including brackish marshes) and less than 1,000 acres are tidal freshwater wetlands. Town data are summarized in Table 4. Tidal wetlands are most abundant in Ipswich with over 6,000 acres. Newbury is second-ranked with over 5,000 acres. Ipswich and Newbury possess more than one-third of the region's tidal wetlands. Other towns with more than 1,000 acres of tidal wetlands are Salisbury, Essex, Rowley, Gloucester, and Revere. Tidal freshwater wetlands are most numerous in Salisbury, Newbury, Ipswich, and Rowley, respectively.

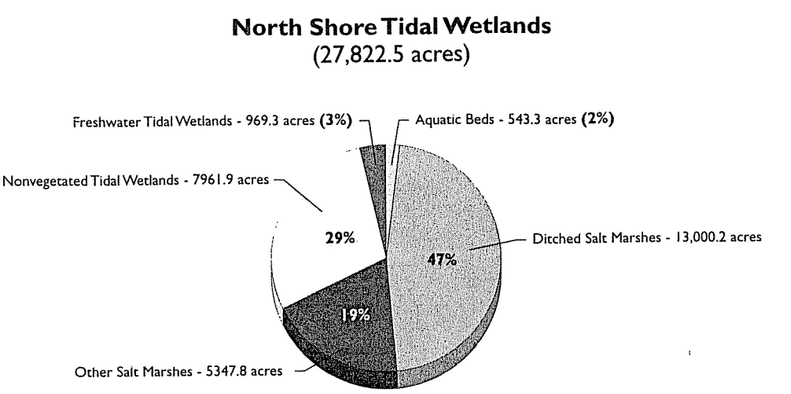

Figure 15. Extent of different types of North Shore tidal wetlands.

Table 4. Extent of tidal wetlands in North Shore communities.

Town	Ditched salt marsh (acres)	Other salt marsh (acres)	Fresh water tidal wetlands (acres)	Tidal aquatic beds	Non-vegetated tidal wetlands (acres)	Total tidal wetlands (acres)
Amesbury		4.9	30.2			35.1
Beverly	35.7	10.4	18.6	63.1	309.1	436.9
Danvers	29.1	24.1	1.6		169.3	224.1
Essex	1,552.8	554.4	9.9		839.8	2,956.9
Gloucester	486.8	531.2	44.3	25.2	558.2	1,645.7
Ipswich	3,031.6	1,112.7	141.6		1,923.8	6,209.7
Lynn	2.8	38.7		6.7	210.0	258.2
Manchester	42.4	4.5	5.7	61.8	157.8	272.2
Marblehead	13.6	2.8		130.6	209.7	356.7
Nahant		96.0		80.0	384.3	560.3
Newbury	3,100.2	1,419.4	162.4		568.8	5,250.8
Newburyport	18.5	367.6	32.7		501.2	920.0
Peabody	7.3	2.6			23.0	32.9
Revere	472.1	43.4	3.1	2.3	583.5	1,104.4
Rockport		35.7	1.9	111.0	166.9	315.5
Rowley	1,599.7	483.2	138.7		355.7	2,577.3
Salem	23.5	39.9	10.3	30.7	411.9	516.3
Salisbury	2,031.7	534.7	301.3	3.0	335.5	3,206.2
Saugus	552.4	41.6	48.9		176.4	819.3
Swampscott			18.1	28.9	77.0	124.0
REGION	13,000.2	5,347.8	969.3	543.3	7,961.9	27,822.5

Tidally Restricted Wetlands

Almost 200 potential tidally restricted wetlands were detected on the North Shore. These wetlands amounted to over 1,400 acres (Table 5). Thirty-five percent of these wetlands (or 507 acres) was located in Saugus. Rowley and Revere possessed about 178 and 170 acres, respectively, representing about one-quarter of the region's tidally restricted wetlands. Newbury, Ipswich, and Salisbury also had more than 100 acres of these wetlands.

Common reed dominated 166 acres of these restricted wetlands. A total of 20 sites had virtual monocultures of this tall grass (Table 6). Ipswich had well over half of the common reed acreage. Another 37 acres of common reed were inventoried in 13 tidal marshes on the North Shore. Common reed was also present along the margins of many salt marshes and in small stands that were beyond the scope of this survey to identify.

Table 5. Extent of potential tidally restricted wetlands in North Shore communities. Number of potential restricting upland features and restricted wetlands are given.

Town	No. of potential restricting upland features	No. of potential restricted wetlands	Acres of potential restricted wetlands
Amesbury	0	1	1.1
Beverly	2	8	9.5
Danvers	8	2	1.6
Essex	0	12	26.2
Gloucester	5	23	43.0
Ipswich	4	22	129.0
Lynn	0	7	10.1
Manchester	0	12	37.8
Marblehead	0	1	7.3
Newbury	7	20	137.3
Newburyport	0	2	0.9
Peabody	2	2	2.9
Revere	4	13	169.8
Rockport	1	6	11.6
Rowley	4	17	178.2
Salem	5	8	21.9
Salisbury	1	12	116.0
Saugus	5	22	507.0
Swampscott	0	0	0
REGION	**48**	**190**	**1,411.2**

Table 6. Tidally restricted and other tidal wetlands dominated by common reed in North Shore communities.

Town	No. of tidally restricted sites	Acres of common reed	No. of other tidal common reed sites	Acres
Beverly	0	0	2	0.9
Essex	0	0	3	4.1
Gloucester	6	31.3	5	4.8
Ipswich	3	106.9	0	0
Marblehead	1	2.8	0	0
Newbury	0	0	1	20.6
Revere	3	1.8	0	0
Rowley	0	0	2	7.0
Salisbury	6	13.6	0	0
Saugus	1	9.6	0	0
TOTALS	**20**	**166.0**	**13**	**37.4**

References

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States.* U.S. Fish and Wildlife Service, Washington, DC. FWS/OBS-79-31.

Foulis, D.B., J.A. Eaton, and R.W. Tiner. 1994. *Wetland Trends for Selected Areas of the Gulf of Maine, from York, Maine to Rowley, Massachusetts (1977 to 1985-86).* U.S. Fish and Wildlife Service, Ecological Services, Hadley, MA.

Foulis, D.B. and R.W. Tiner. 1994. *Wetland Trends for Selected Areas of the Coast of Massachusetts, from Plum Island to Scituate (1977 to 1985-86).* U.S. Fish and Wildlife Service, Ecological Services, Hadley, MA.

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Appendix

THE WETLANDS RESTORATION & BANKING PROGRAM

and the

PARTNERSHIP TO RESTORE MASSACHUSETTS WETLANDS

invite you to

GROWetlands*

You Can Help Reclaim Our Wetland Heritage...

Wetlands are important aquatic resources that provide habitat for fish, birds, and other wildlife; cleanse our waters; and provide storage for flood-waters within our watersheds. Wetlands provide educational, open space, aesthetic, and recreational experiences. Before these values were understood, about 28% of the state's wetlands were filled. Since the 1960s, Massachusetts has had strong laws protecting its wetlands. Many of our remaining wetlands (about 600,000 acres) have been degraded, however. Now there is a program to restore wetlands that have been damaged or destroyed.

By Joining Others...

The Massachusetts Wetlands Restoration & Banking Program (WRBP) has established GROWetlands to encourage and support a collective effort by the citizens of the Commonwealth to restore our precious wetland heritage. WRBP supports inland and coastal wetlands restoration and especially seeks restoration sites that can help heal our degraded rivers and coastal waters.

A GROWetlands site becomes part of a statewide network of wetland restoration projects. GROWetlands projects can be sponsored by anyone - community groups, government agencies, youth groups, schools, land trusts, watershed associations, and landowners. Sponsors may propose a wetland to restore or work with WRBP to identify a wetland restoration site suitable for their group.

In The Partnership To Restore Massachusetts Wetlands.

GROWetlands projects are supported by and are part of the Partnership To Restore Massachusetts Wetlands, an alliance of agencies, organizations, businesses, and individuals committed to wetlands restoration. GROWetlands projects contribute to the partnership by restoring wetlands and provid-ing information about their sites so others can learn from their experience.

*Groups Restoring Our Wetlands

Getting Started Is Easy, And...

GROWetlands project sponsors submit a brief project nomination form to WRBP, participate in a preliminary site visit and project assessment with a team of wetland experts, work with WRBP to prepare a work plan for the site, and then sign an agreement with WRBP to implement the work plan.

GROWetlands Sponsors Can Receive:

- technical information and support from wetland experts
- training sessions for sponsors, teachers, and others
- assistance identifying and obtaining funding
- access to WRBP's wetlands restoration data base
- support of the Partnership To Restore Massachusetts Wetlands
- publication of project results in technical and other literature
- recognition for their contribution to improving the state's wetlands

The Payback Is Forever.

The commitment to GROWetlands sites is long-term. A GROWetlands project is supported by WRBP and other partners from the time it is proposed through project organization and design, implementation, and post-implementation maintenance and monitoring. The payback is restored wetlands that will endure and enhance the lives of generations to come.

For More Information Contact...

GROWetlands
Wetlands Restoration & Banking Program
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, MA 02202
617-727-9800 x213
FAX: 727-2754
EMail: cfoote-smith@state.ma.us

MASSACHUSETTS WETLANDS RESTORATION & BANKING PROGRAM

Atlas of Tidally Restricted Marshes • North Shore of Massachusetts

GROWetlands

Wetlands Restoration Project Nomination Form

Thank you for your interest in restoring Massachusetts wetlands. If you wish to sponsor a wetlands restoration project and would like to propose that it be considered part of the statewide wetlands restoration initiative called GROWetlands (Groups Restoring Our Wetlands) under the Massachusetts Wetlands Restoration & Banking Program, please fill out this form and return to the address below.

Project name: _____

Project location: City/Town _____ Watershed _____

Please attach a U.S.G.S. quad sheet or other map on which the site location has been marked.

If available, please attach current and historic photos and aerial photos of the project site.

Project Sponsor: _____

Designated Representative _____

Telephone _____ FAX _____ EMail _____

Address: _____

Project Co-Sponsors: _____

Landowner: _____

Has landowner expressed support for wetlands restoration at the site? ❑ Yes ❑ No

Explain:

Is all or part of the wetland totally destroyed or does it exist in a degraded condition? Explain:

Briefly describe the current condition of the wetland to be restored.

Is the wetland part of an agricultural facility or was it farmland in the past?

❑ Is in agricultural use now ❑ Was never farmed ❑ Was formerly agricultural land

Explain:

What caused the impact to the wetland?

Is the wetland area under an outstanding enforcement order? ❑ Yes ❑ No If yes, explain:

What is the approximate size of the area proposed to be restored? _____

What is the approximate size of adjacent wetland areas, if any? _____

Please attach a sketch of the area showing the wetland to be restored, adjacent wetlands and waterbodies, roads and buildings in the immediate vicinity, and other pertinent information to describe the site. If possible, indicate different wetland types that are present (phragmites swamp, wet meadow, forested wetland, etc.).

If known, what was the wetland type(s) prior to impact?

If known, what restoration activity would be required to restore the wetland?

If known, what is the approximate cost of the restoration? _____

Has any funding been identified for this project? ❑ Yes ❑ No If yes, describe:

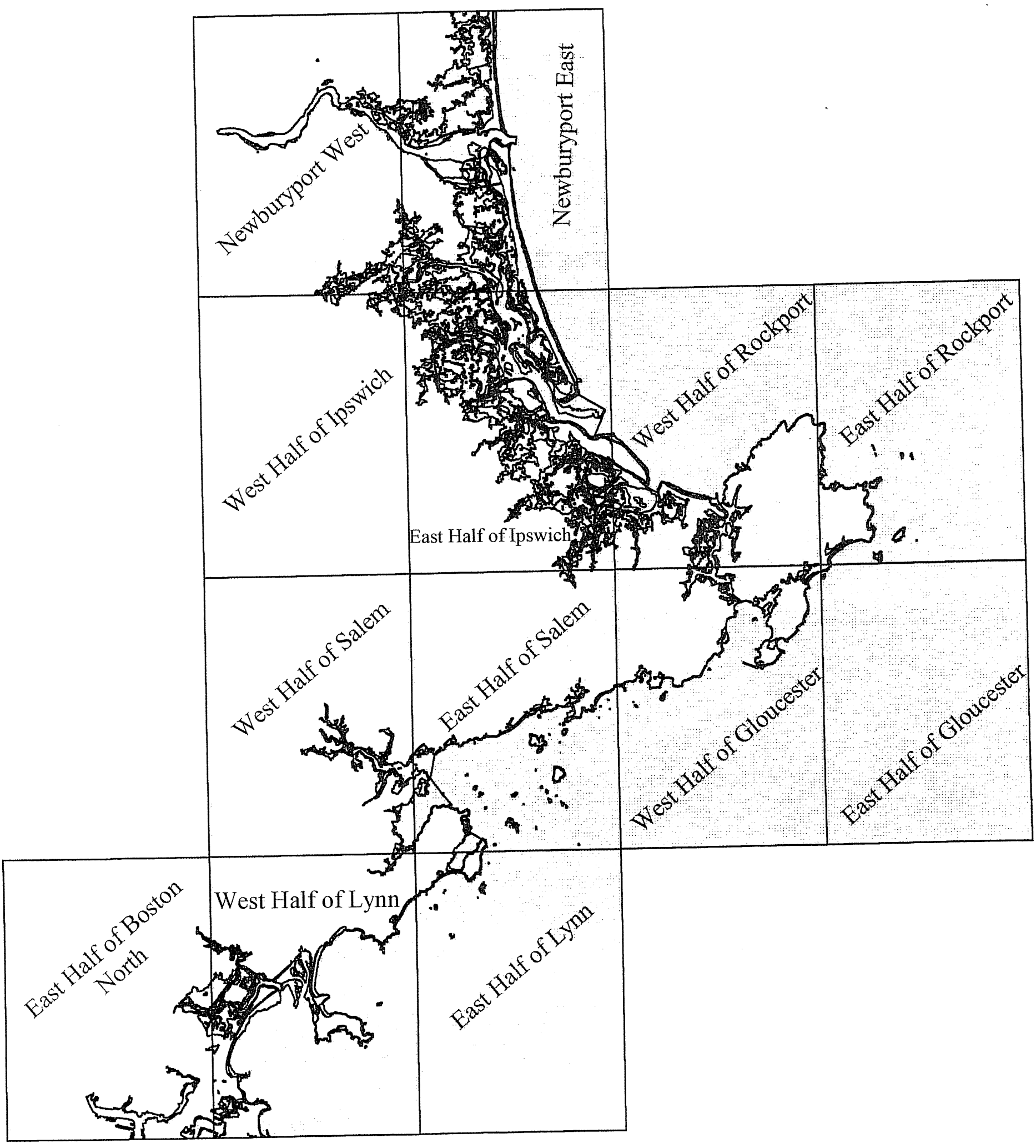
Would you like WRBP to arrange a site visit and evaluation by a Wetlands Restoration Assistance Team, a group of volunteer wetlands scientists? ❑ Yes ❑ No

Signed _____ Date _____

Please send this form with attachments to: GROWetlands, EOEA Wetlands Restoration & Banking Program, 100 Cambridge Street – 20th Floor Boston, MA 02202 (617) 727-9800 x213

A representative of WRBP will contact you as soon as possible. Please call us if you have any questions!

Potential Tidally Restricted Wetlands of the North Shore of Massachusetts



Uplands, Nontidal Wetlands & Deepwater Habitats
Tidal Wetlands & Deepwater Habitats

Natural Resources Assessment Group
University of Massachusetts

National Wetlands Inventory Maps
Comprising the North Shore of Massachusetts Study Area

SAUGUS

REVERE

MYSTIC RIVER

CHELSEA RIVER

BOSTON HARBOR

October 18, 1996

East Half of Boston North

N

Ditched Salt Marshes
Salt Marshes
Marine & Estuarine Deepwater Habitats
Freshwater Tidal Wetlands & Deepwater Habitats
Marine & Estuarine Beaches, Flats, & Rocky Shores
Uplands, Nontidal Wetlands & Deepwater Habitats

Township Boundary Lines
Roads & Highways
Railroad Corridors (Active or Abandoned)

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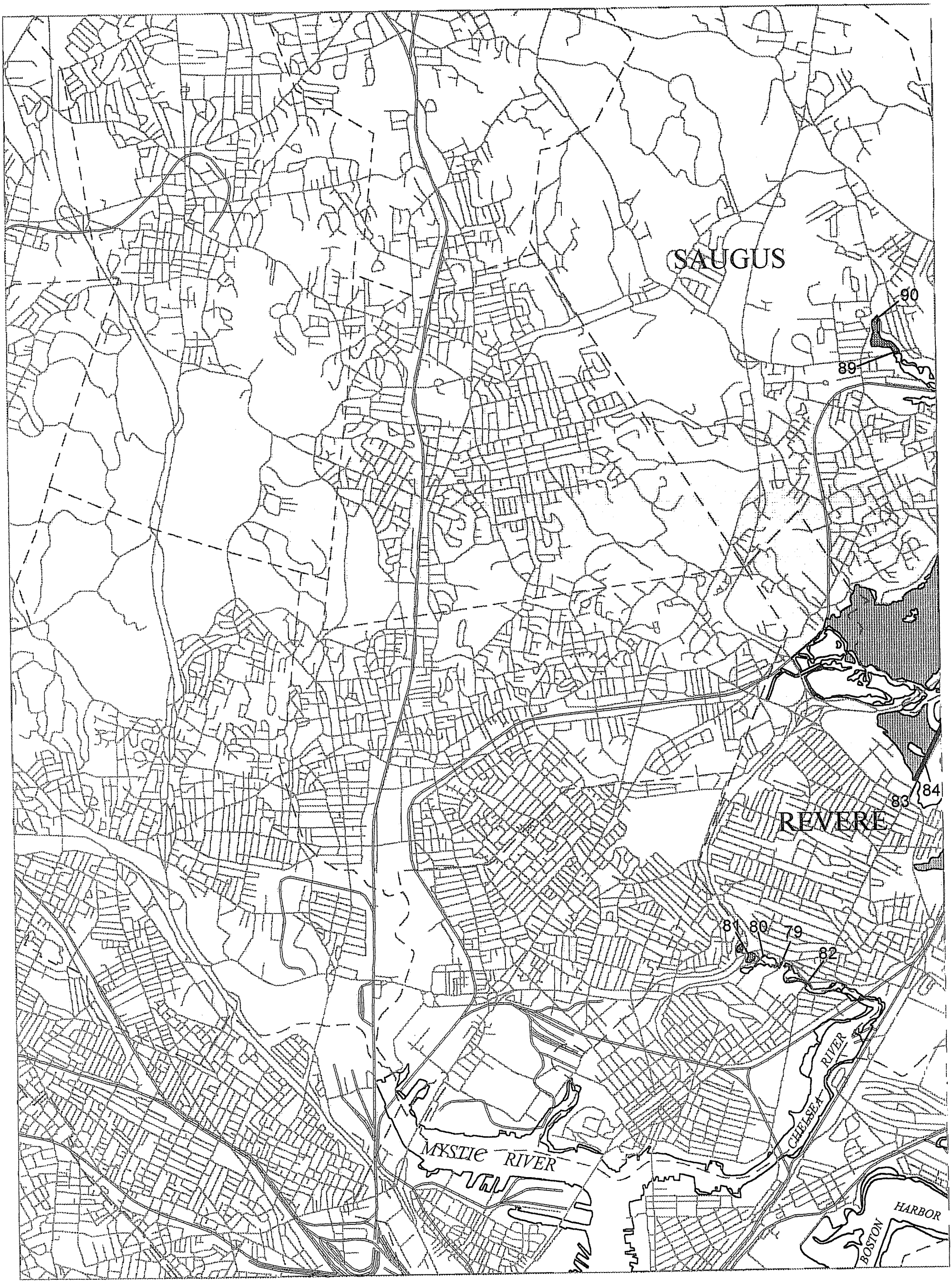
Natural Resources Assessment Group
University of Massachusetts



October 30, 1996

East Half of Boston North

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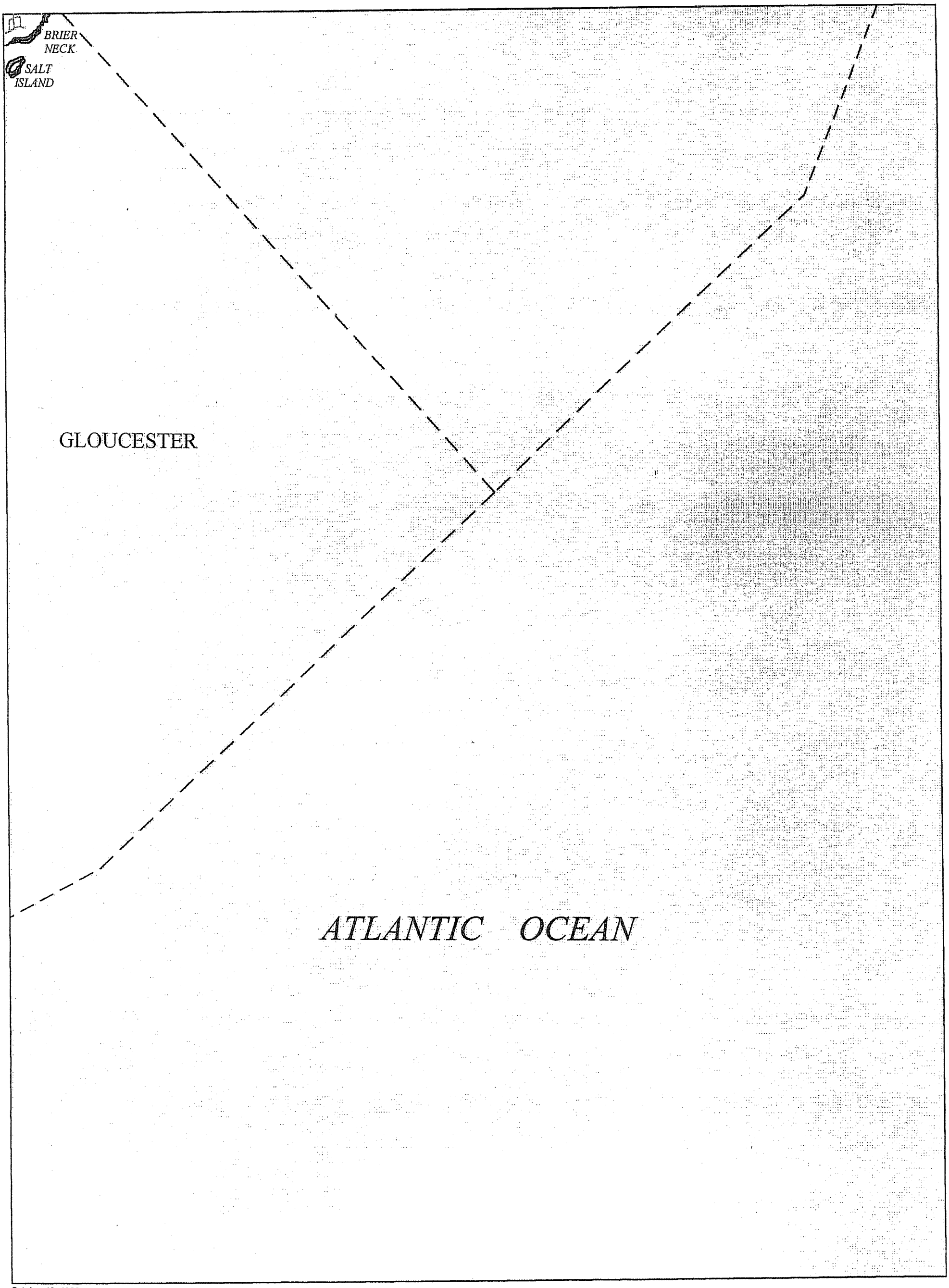
Natural Resources Assessment Group
University of Massachusetts

- Potential Tidally Restricting Upland Features
- Potential Tidally Restricted Wetlands Dominated by Phragmites australis
- Potential Tidally Restricted Wetlands
- Other Tidal Wetlands & Deepwater Habitats
- Other Tidal Wetlands Dominated by Phragmites australis
- Uplands, Nontidal Wetlands & Deepwater Habitats
- Railroad Corridors (Active or Abandoned)
- Township Boundary Lines
- Roads & Highways
- Potential Tidally Restricting Features



October 18, 1996

East Half of Gloucester

- Ditched Salt Marshes
- Salt Marshes
- Marine & Estuarine Deepwater Habitats
- Freshwater Tidal Wetlands & Deepwater Habitats
- Marine & Estuarine Beaches, Flats, & Rocky Shores
- Marine & Estuarine Aquatic Beds
- Uplands, Nontidal Wetlands & Deepwater Habitats

- Township Boundary Lines
- Roads & Highways
- Railroad Corridors (Active or Abandoned)

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Natural Resources Assessment Group
University of Massachusetts

BRIER NECK

SALT ISLAND

GLOUCESTER

ATLANTIC OCEAN

October 30, 1996

East Half of Gloucester

Potential Tidally Restricting Upland Features

Potential Tidally Restricted Wetlands Dominated by Phragmites australis

Potential Tidally Restricted Wetlands

Other Tidal Wetlands & Deepwater Habitats

Other Tidal Wetlands Dominated by Phragmites australis

Uplands, Nontidal Wetlands & Deepwater Habitats

Railroad Corridors (Active or Abandoned)

Township Boundary Lines

Roads & Highways

Potential Tidally Restricting Features

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Natural Resources Assessment Group
University of Massachusetts

GLOUCESTER HARBOR

EASTERN POINT

KETTLE ISLAND

GLOUCESTER

MANCHESTER

MASSACHUSETTS BAY

October 18, 1996

West Half of Gloucester

- Ditched Salt Marshes
- Salt Marshes
- Marine & Estuarine Deepwater Habitats
- Freshwater Tidal Wetlands & Deepwater Habitats
- Marine & Estuarine Beaches, Flats, & Rocky Shores
- Marine & Estuarine Aquatic Beds
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- Township Boundary Lines
- Roads & Highways
- Railroad Corridors (Active or Abandoned)

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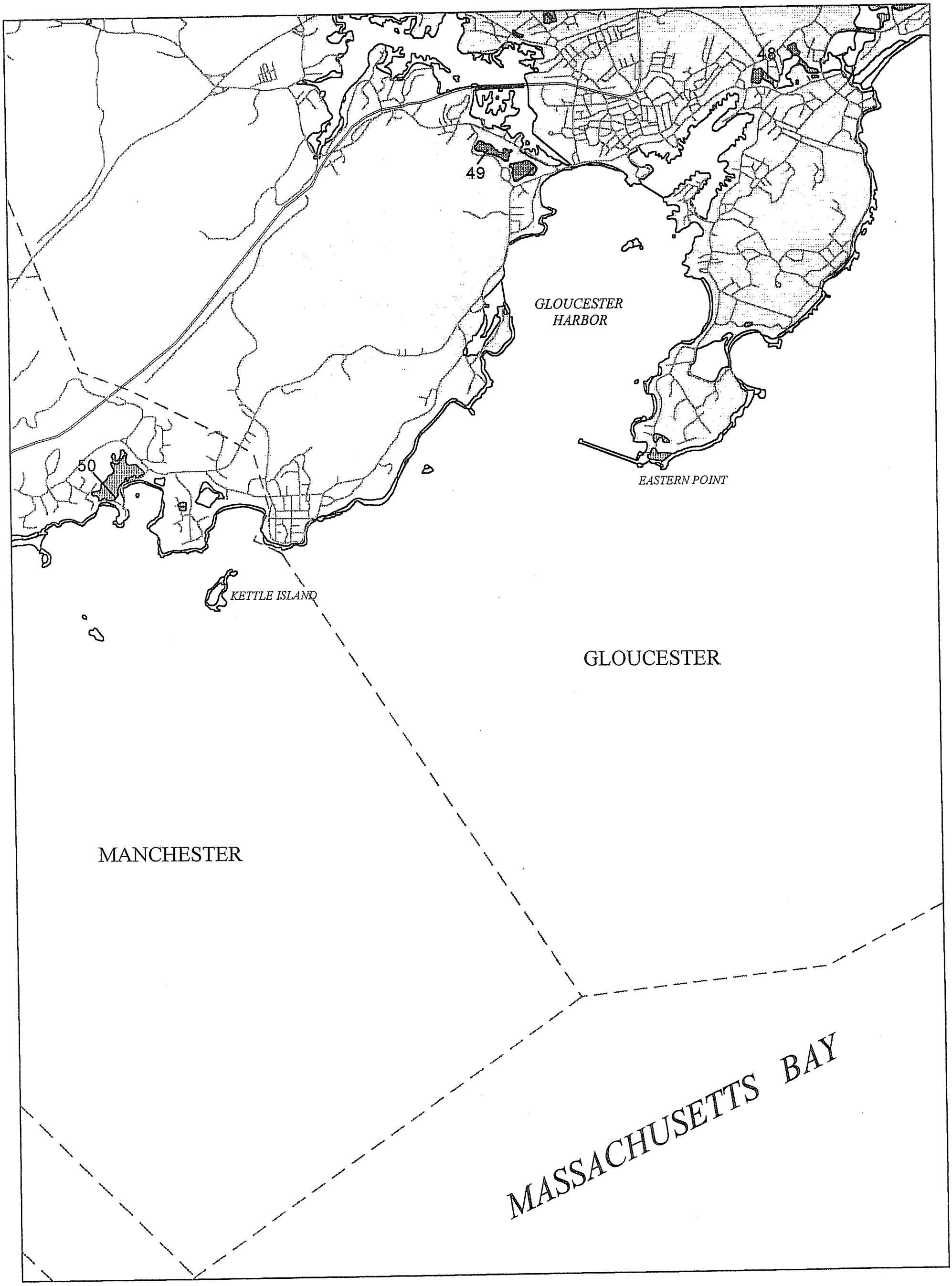
Natural Resources Assessment Group
University of Massachusetts



October 30, 1996

West Half of Gloucester

Potential Tidally Restricting Upland Features

Potential Tidally Restricted Wetlands Dominated by Phragmites australis

Potential Tidally Restricted Wetlands

Other Tidal Wetlands & Deepwater Habitats

Other Tidal Wetlands Dominated by Phragmites australis

Uplands, Nontidal Wetlands & Deepwater Habitats

Railroad Corridors (Active or Abandoned)

Township Boundary Lines

Roads & Highways

Potential Tidally Restricting Features

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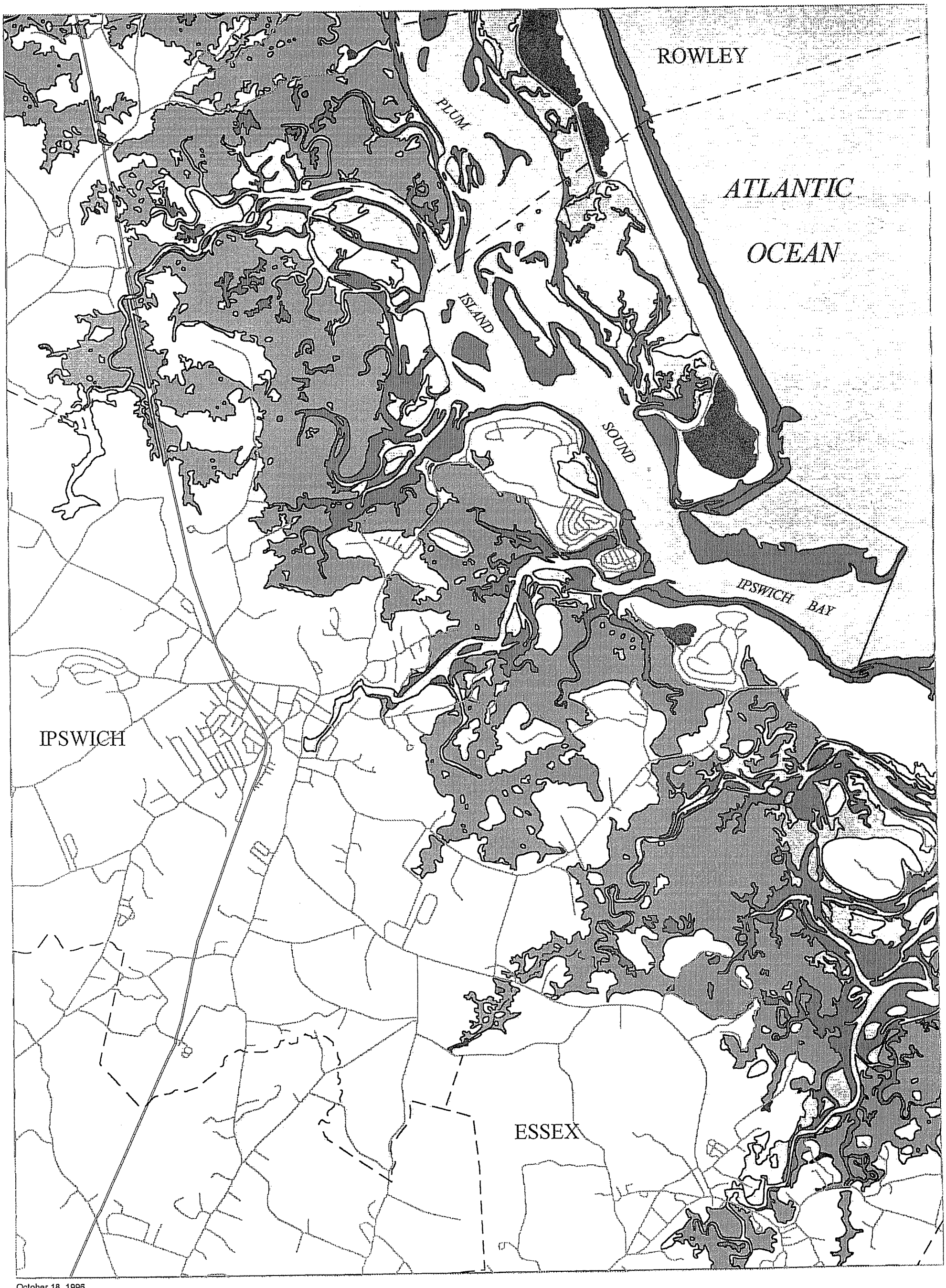
Natural Resources Assessment Group
University of Massachusetts



October 18, 1996

East Half of Ipswich

- Ditched Salt Marshes
- Salt Marshes
- Marine & Estuarine Deepwater Habitats
- Freshwater Tidal Wetlands & Deepwater Habitats
- Marine & Estuarine Beaches, Flats, & Rocky Shores
- Marine & Estuarine Aquatic Beds
- Uplands, Nontidal Wetlands & Deepwater Habitats

- Township Boundary Lines
- Roads & Highways
- Railroad Corridors (Active or Abandoned)

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Natural Resources Assessment Group
University of Massachusetts

ROWLEY

ATLANTIC OCEAN

PLUM ISLAND SOUND

IPSWICH BAY

IPSWICH

ESSEX

60 61 22 21 20 19 18 25 23 24 26 28 29 27 30 31 32 33

October 30, 1996

East Half of Ipswich

N

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540 0 540 Meters

Natural Resources Assessment Group
University of Massachusetts

Potential Tidally Restricting Upland Features

Potential Tidally Restricted Wetlands Dominated by Phragmites australis

Potential Tidally Restricted Wetlands

Other Tidal Wetlands & Deepwater Habitats

Other Tidal Wetlands Dominated by Phragmites australis

Uplands, Nontidal Wetlands & Deepwater Habitats

Railroad Corridors (Active or Abandoned)

Township Boundary Lines

Roads & Highways

Potential Tidally Restricting Features

NEWBURY

ROWLEY

IPSWICH

October 18, 1996

West Half of Ipswich

- Ditched Salt Marshes
- Salt Marshes
- Marine & Estuarine Deepwater Habitats
- Freshwater Tidal Wetlands & Deepwater Habitats
- Marine & Estuarine Beaches, Flats, & Rocky Shores
- Marine & Estuarine Aquatic Beds
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- Township Boundary Lines
- Roads & Highways
- Railroad Corridors (Active or Abandoned)

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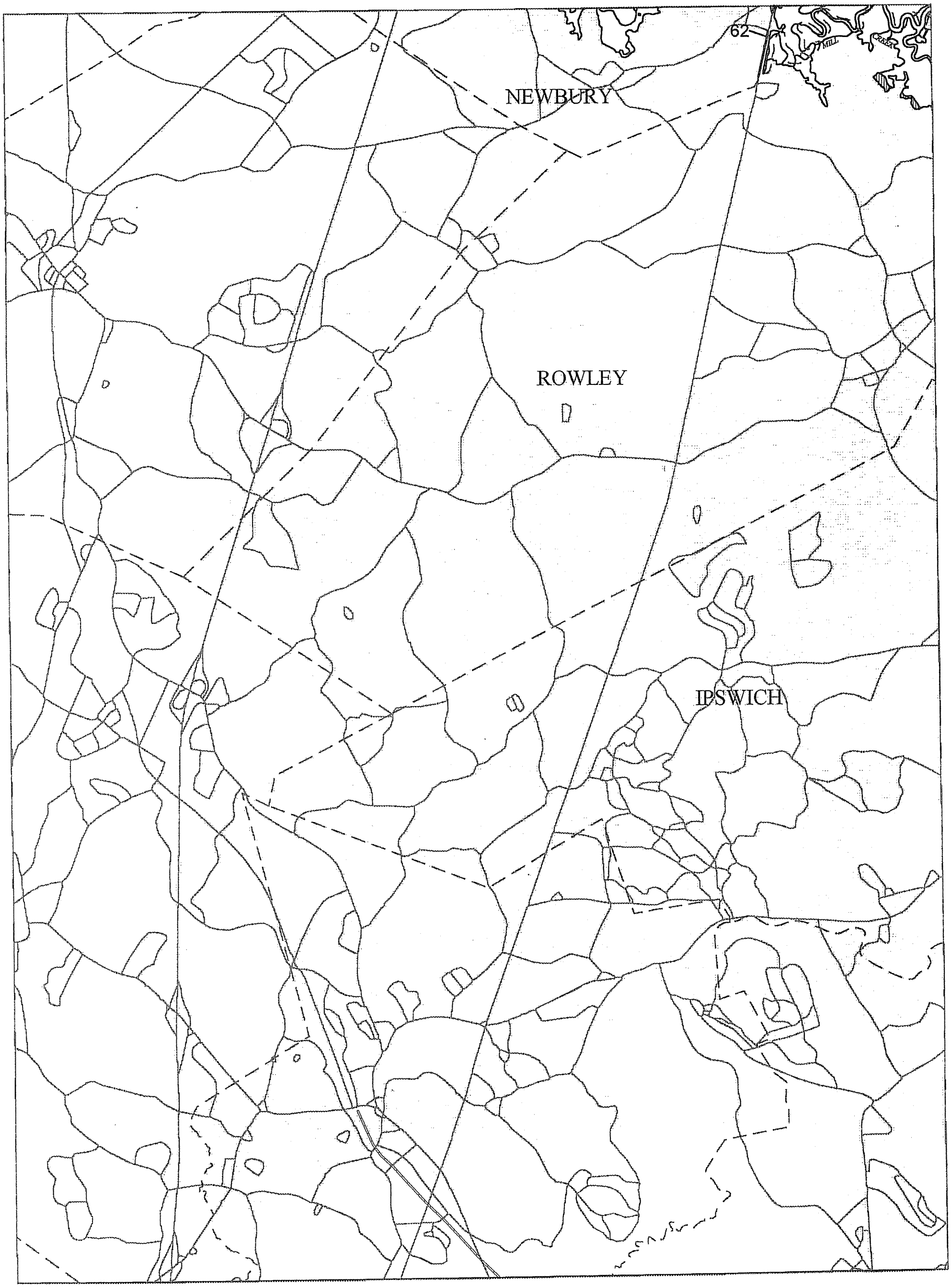
Natural Resources Assessment Group
University of Massachusetts



October 30, 1996

West Half of Ipswich

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Natural Resources Assessment Group
University of Massachusetts

- Potential Tidally Restricting Upland Features
- Potential Tidally Restricted Wetlands Dominated by Phragmites australis
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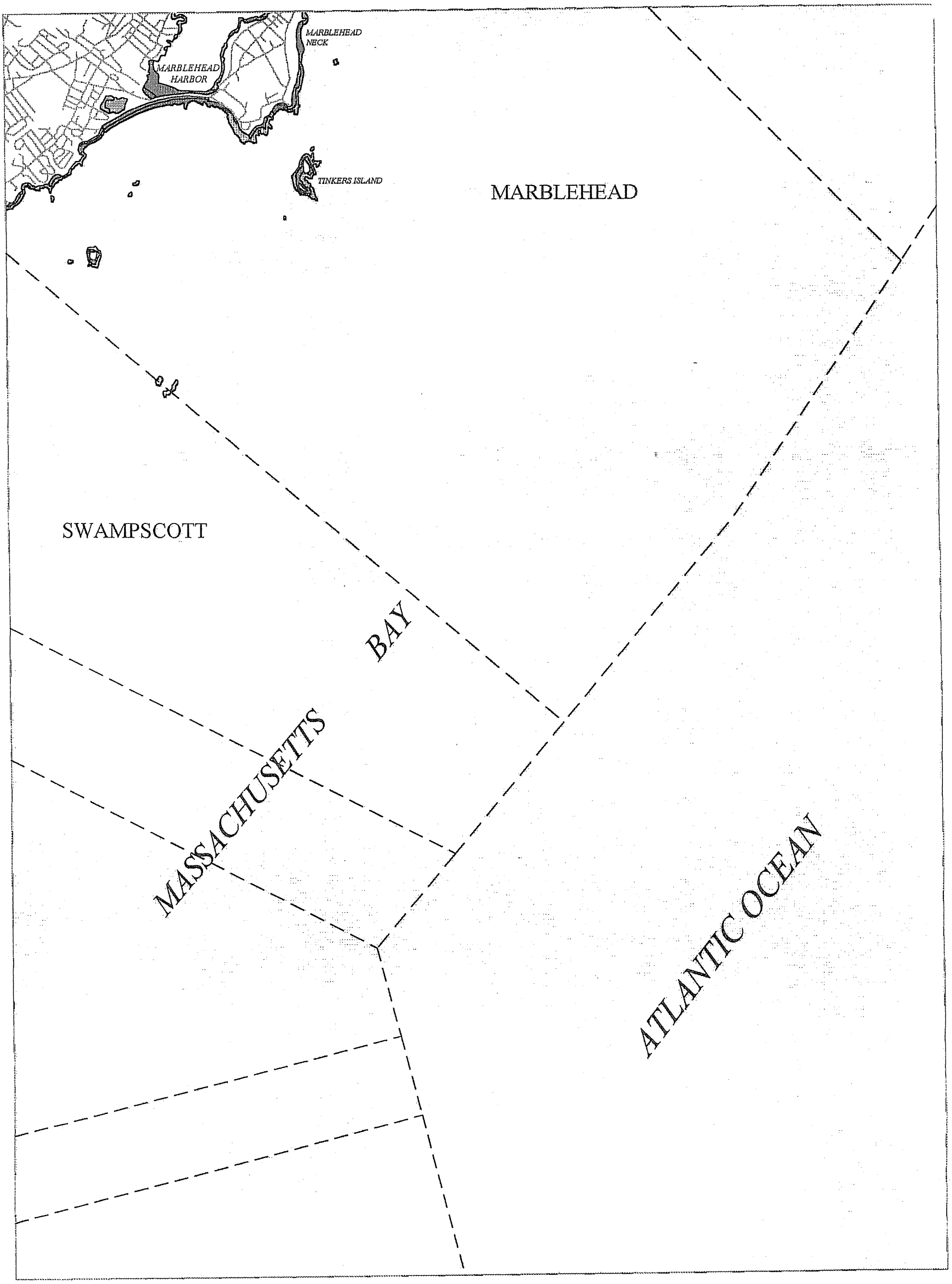

October 18, 1996

East Half of Lynn

Ditched Salt Marshes
Marine & Estuarine Deepwater Habitats
Marine & Estuarine Beaches, Flats, & Rocky Shores
Marine & Estuarine Aquatic Beds
Uplands, Nontidal Wetlands & Deepwater Habitats

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Roads & Highways
Railroad Corridors (Active or Abandoned)

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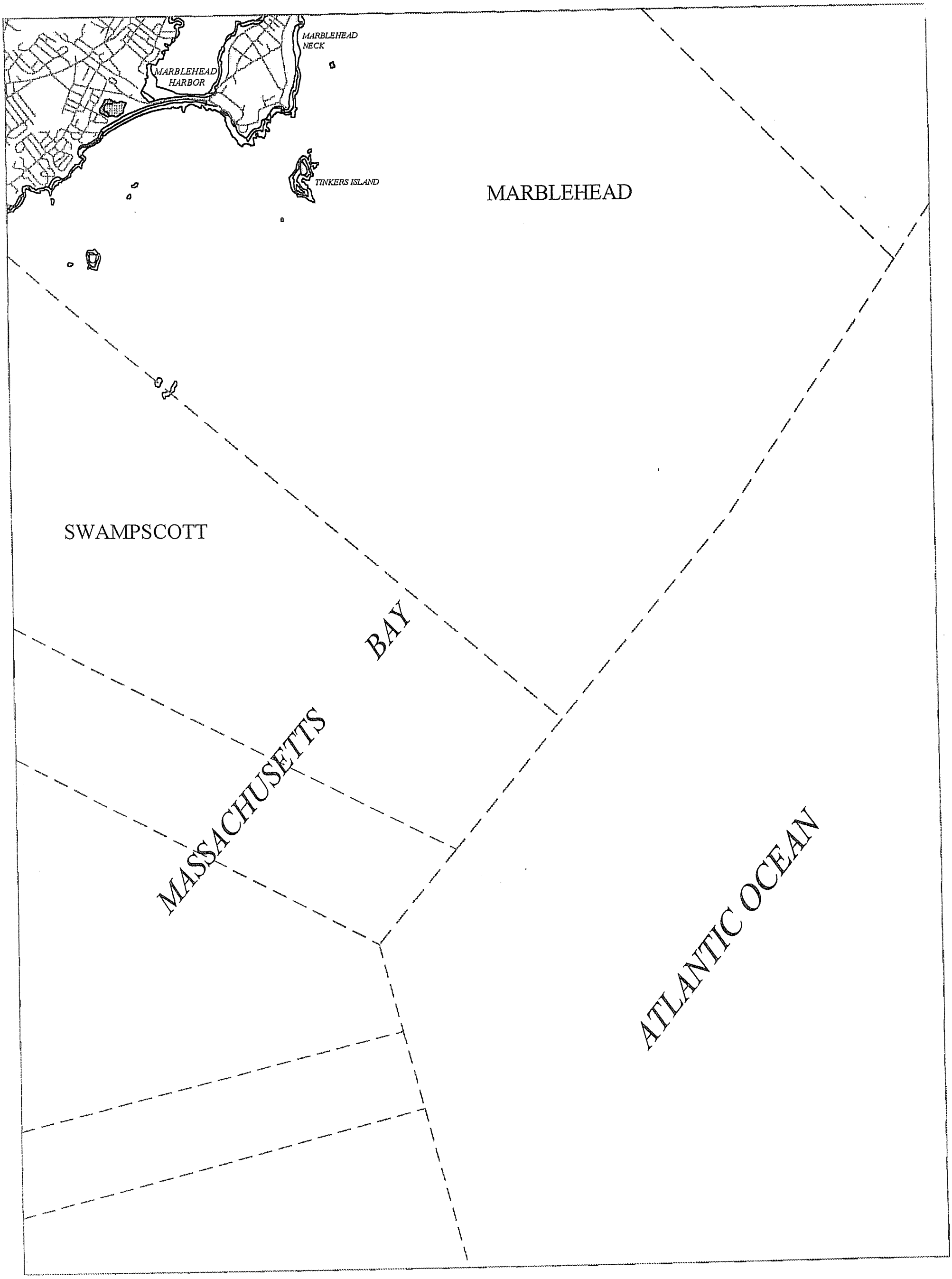
Natural Resources Assessment Group
University of Massachusetts



October 30, 1996

East Half of Lynn

Potential Tidally Restricting Upland Features

Potential Tidally Restricted Wetlands Dominated by Phragmites australis

Potential Tidally Restricted Wetlands

Other Tidal Wetlands & Deepwater Habitats

Other Tidal Wetlands Dominated by Phragmites australis

Uplands, Nontidal Wetlands & Deepwater Habitats

Railroad Corridors (Active or Abandoned)

Township Boundary Lines

Roads & Highways

Potential Tidally Restricting Features

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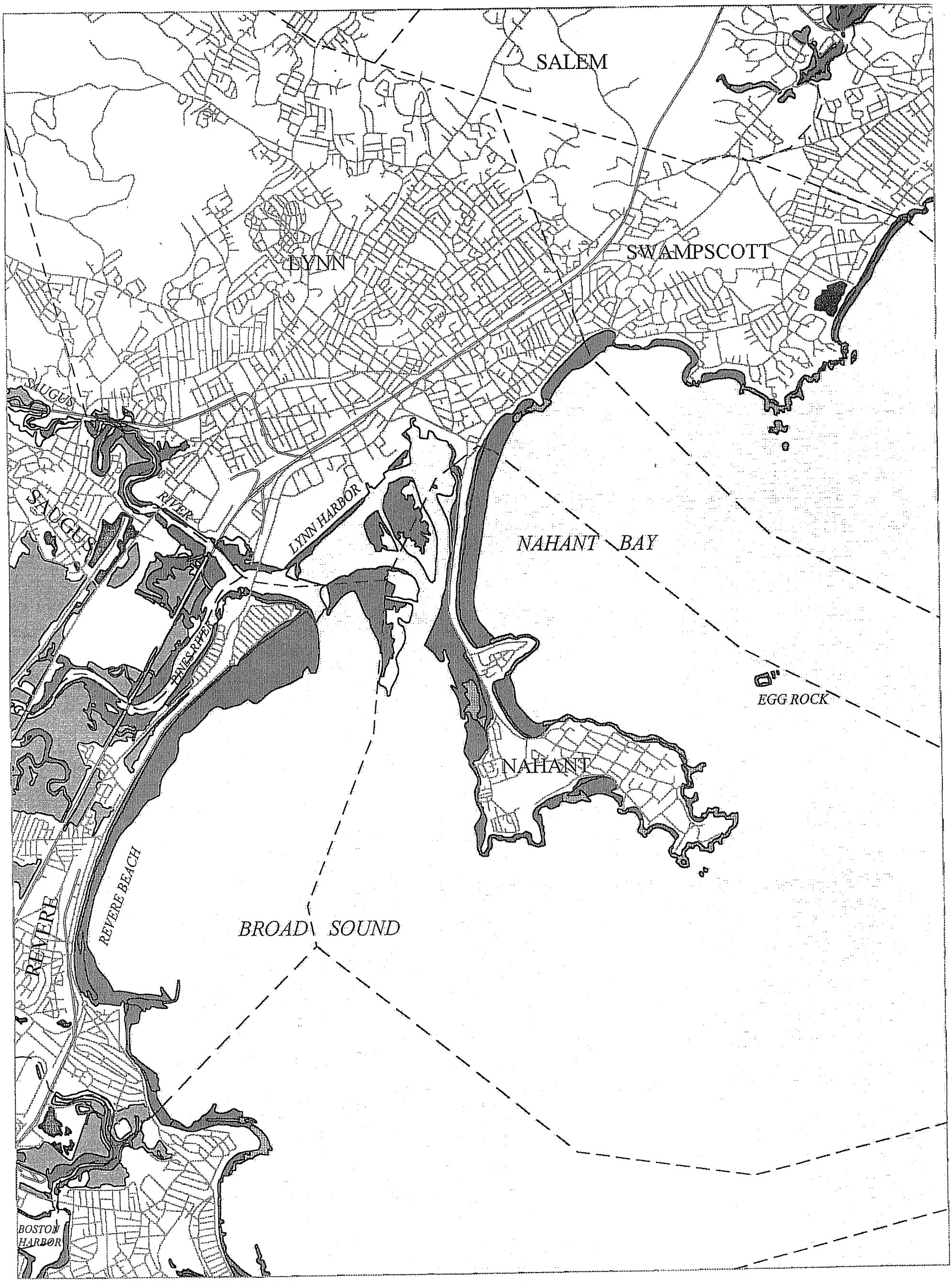
Natural Resources Assessment Group
University of Massachusetts



October 18, 1996

West Half of Lynn

- Ditched Salt Marshes
- Salt Marshes
- Marine & Estuarine Deepwater Habitats
- Freshwater Tidal Wetlands & Deepwater Habitats
- Marine & Estuarine Beaches, Flats, & Rocky Shores
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- Uplands, Nontidal Wetlands & Deepwater Habitats

- Township Boundary Lines
- Roads & Highways
- Railroad Corridors (Active or Abandoned)

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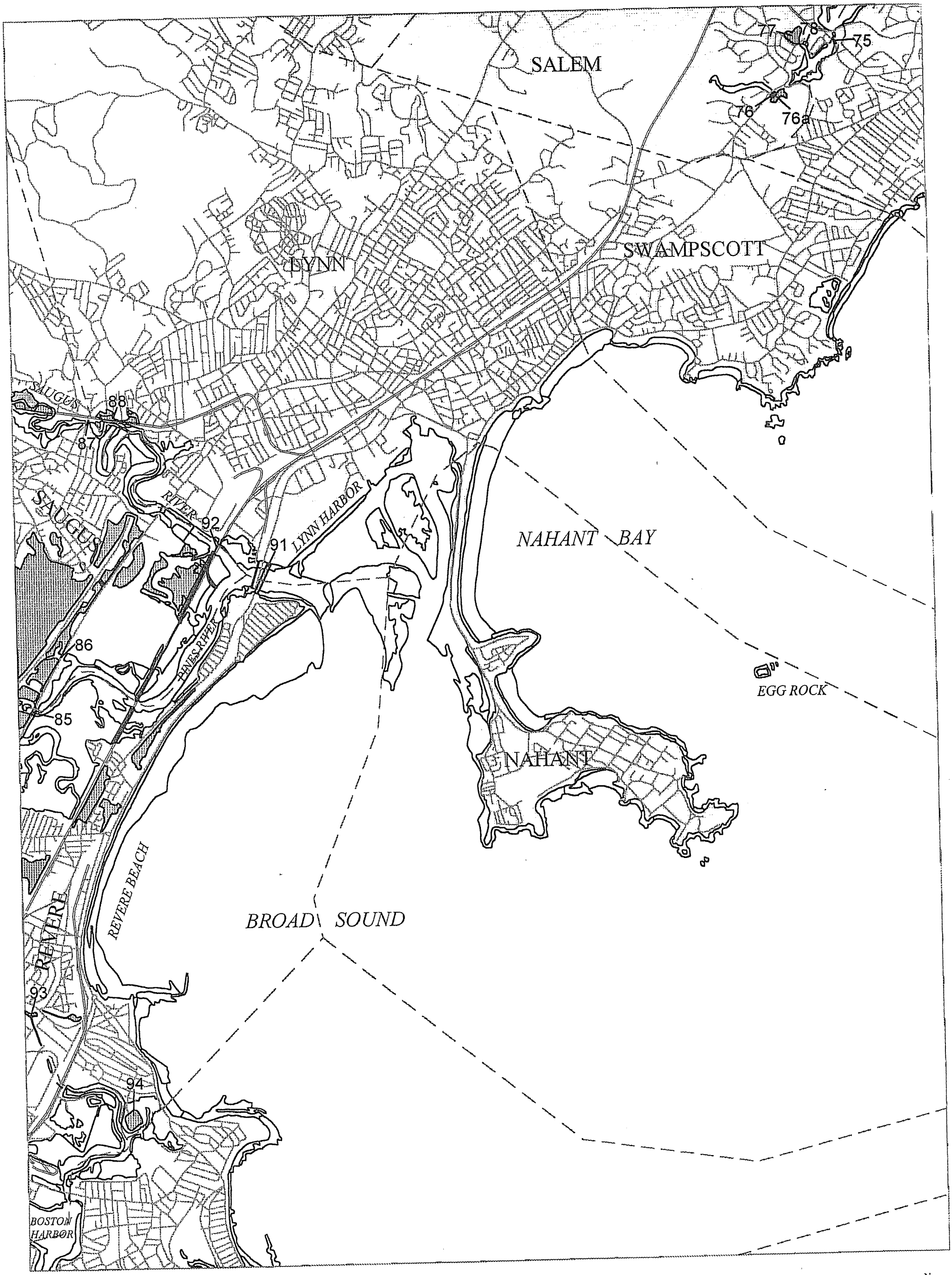
Natural Resources Assessment Group
University of Massachusetts



October 18, 1996

West Half of Lynn

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930 0 930 Meters

Natural Resources Assessment Group
University of Massachusetts

- Potential Tidally Restricting Upland Features
- Potential Tidally Restricted Wetlands Dominated by Phragmites australis
- Potential Tidally Restricted Wetlands
- Other Tidal Wetlands & Deepwater Habitats
- Other Tidal Wetlands Dominated by Phragmites australis
- Uplands, Nontidal Wetlands & Deepwater Habitats
- Railroad Corridors (Active or Abandoned)
- Township Boundary Lines
- Roads & Highways
- Potential Tidally Restricting Features

NEW HAMPSHIRE

SALISBURY

MERRIMACK RIVER

NEWBURYPORT

NEWBURY

PARKER RIVER

PLUM ISLAND

ATLANTIC OCEAN

ROWLEY

October 18, 1996

Newburyport East

- Ditched Salt Marshes
- Salt Marshes
- Marine & Estuarine Deepwater Habitats
- Freshwater Tidal Wetlands & Deepwater Habitats
- Marine & Estuarine Beaches, Flats, & Rocky Shores
- Marine & Estuarine Aquatic Beds
- Uplands, Nontidal Wetlands & Deepwater Habitats

- Township Boundary Lines
- Roads & Highways
- Railroad Corridors (Active or Abandoned)

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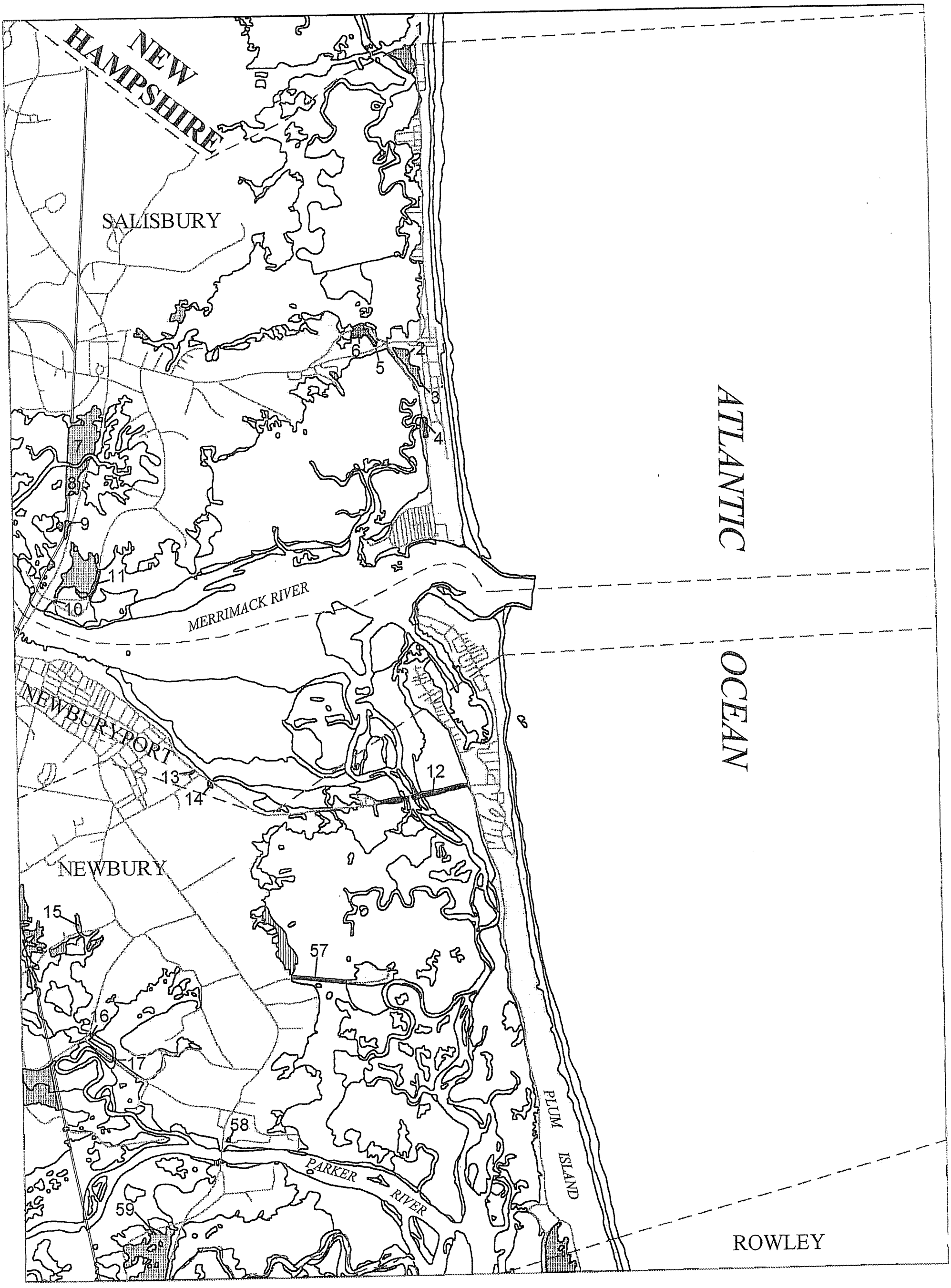
Natural Resources Assessment Group
University of Massachusetts



October 18, 1996

Newburyport East

N

Potential Tidally Restricting Upland Features

Potential Tidally Restricted Wetlands Dominated by Phragmites australis

Potential Tidally Restricted Wetlands

Other Tidal Wetlands & Deepwater Habitats

Other Tidal Wetlands Dominated by Phragmites australis

Uplands, Nontidal Wetlands & Deepwater Habitats

Railroad Corridors (Active or Abandoned)

Township Boundary Lines

Roads & Highways

Potential Tidally Restricting Features

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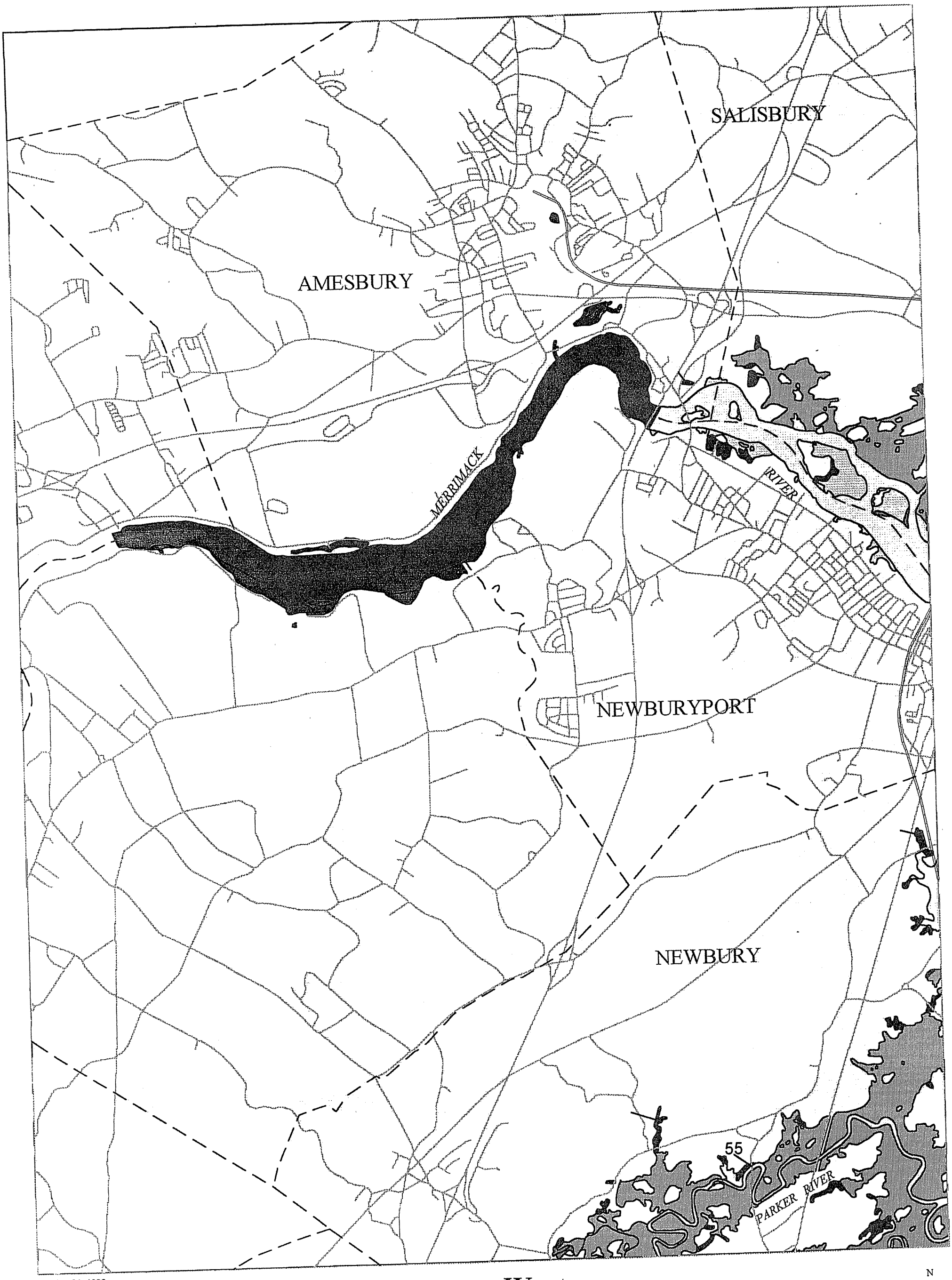
Natural Resources Assessment Group
University of Massachusetts



October 31, 1996

Newburyport West

N

1:40000

1000 0 1000 Meters

Natural Resources Assessment Group
University of Massachusetts

- Ditched Salt Marshes
- Salt Marshes
- Marine & Estuarine Deepwater Habitats
- Freshwater Tidal Wetlands & Deepwater Habitats
- Marine & Estuarine Beaches, Flats, & Rocky Shores
- Marine & Estuarine Aquatic Beds
- Uplands, Nontidal Wetlands & Deepwater Habitats

- Township Boundary Lines
- Roads & Highways
- Railroad Corridors (Active or Abandoned)

SALISBURY

AMESBURY

53

MERRIMACK

RIVER

NEWBURYPORT

54

NEWBURY

56

55

PARKER RIVER

N

Newburyport West

October 31, 1996

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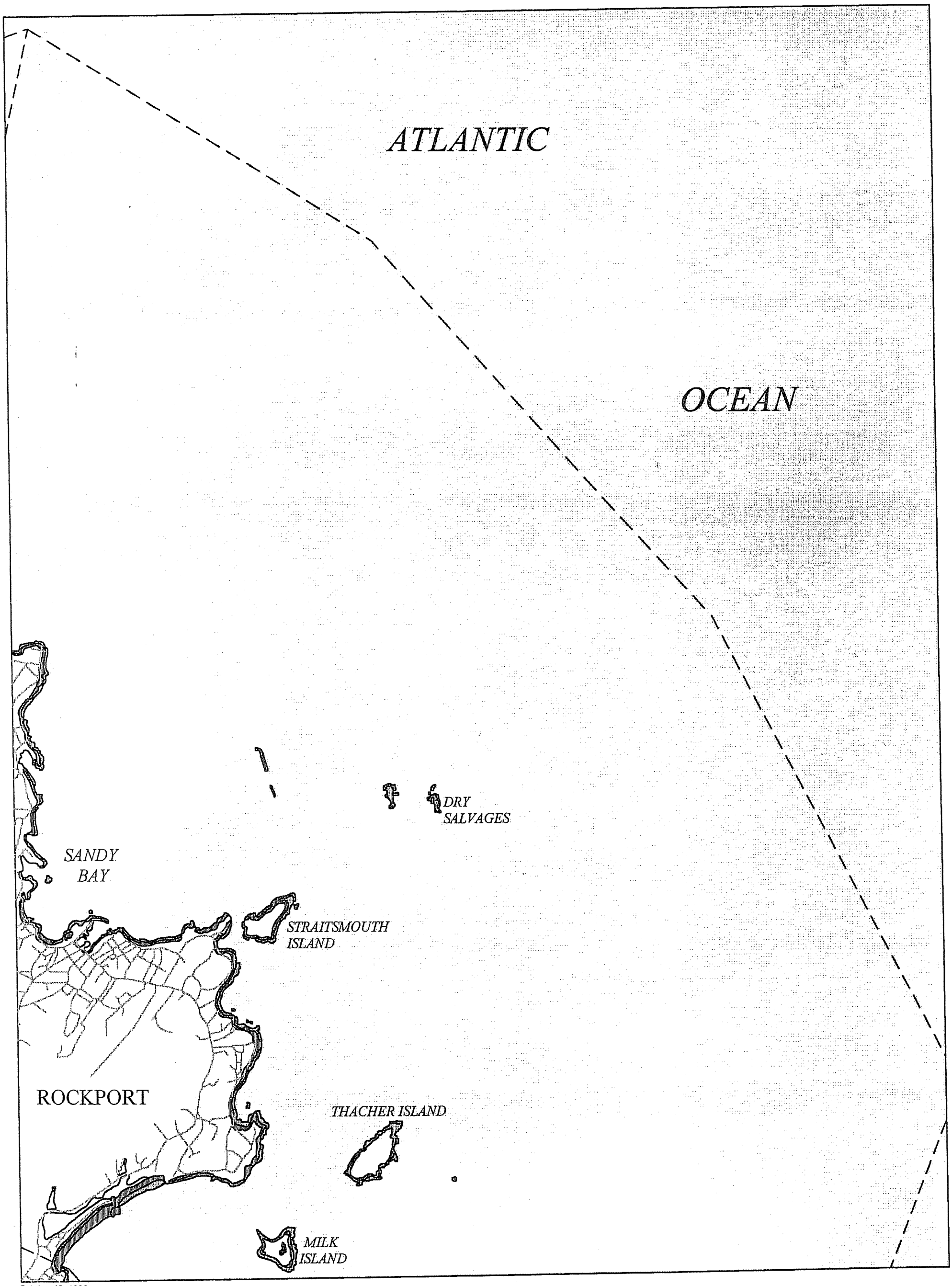
Natural Resources Assessment Group
University of Massachusetts

- Potential Tidally Restricting Upland Features
- Potential Tidally Restricted Wetlands Dominated by Phragmites australis
- Potential Tidally Restricted Wetlands
- Other Tidal Wetlands & Deepwater Habitats
- Other Tidal Wetlands Dominated by Phragmites australis
- Uplands, Nontidal Wetlands & Deepwater Habitats
- Railroad Corridors (Active or Abandoned)
- Township Boundary Lines
- Roads & Highways
- Potential Tidally Restricting Features



October 18, 1996

East Half of Rockport

- Ditched Salt Marshes
- Salt Marshes
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- Freshwater Tidal Wetlands & Deepwater Habitats
- Marine & Estuarine Beaches, Flats, & Rocky Shores
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- Township Boundary Lines
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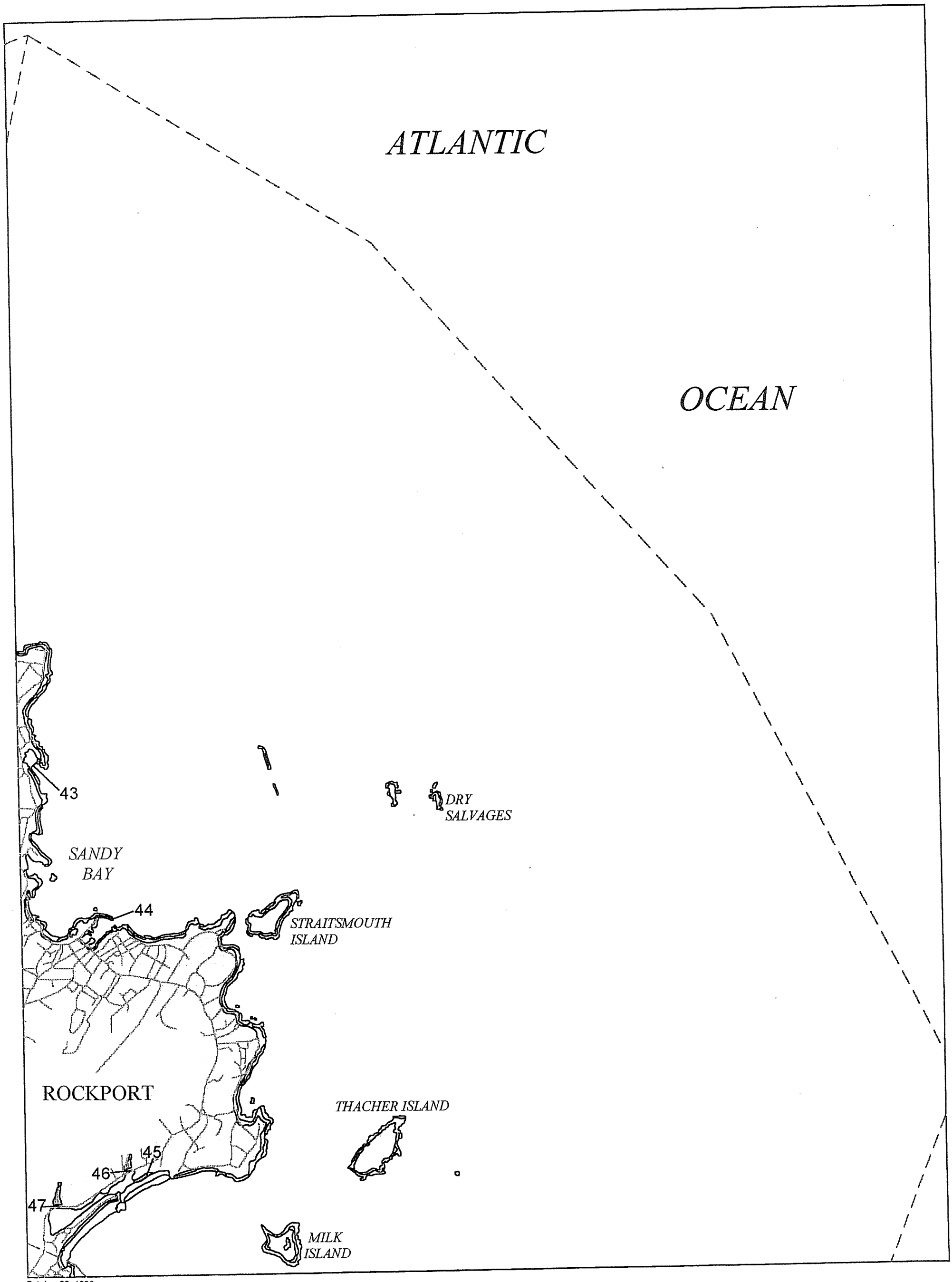
Natural Resources Assessment Group
University of Massachusetts



October 30, 1996

East Half of Rockport

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Natural Resources Assessment Group
University of Massachusetts

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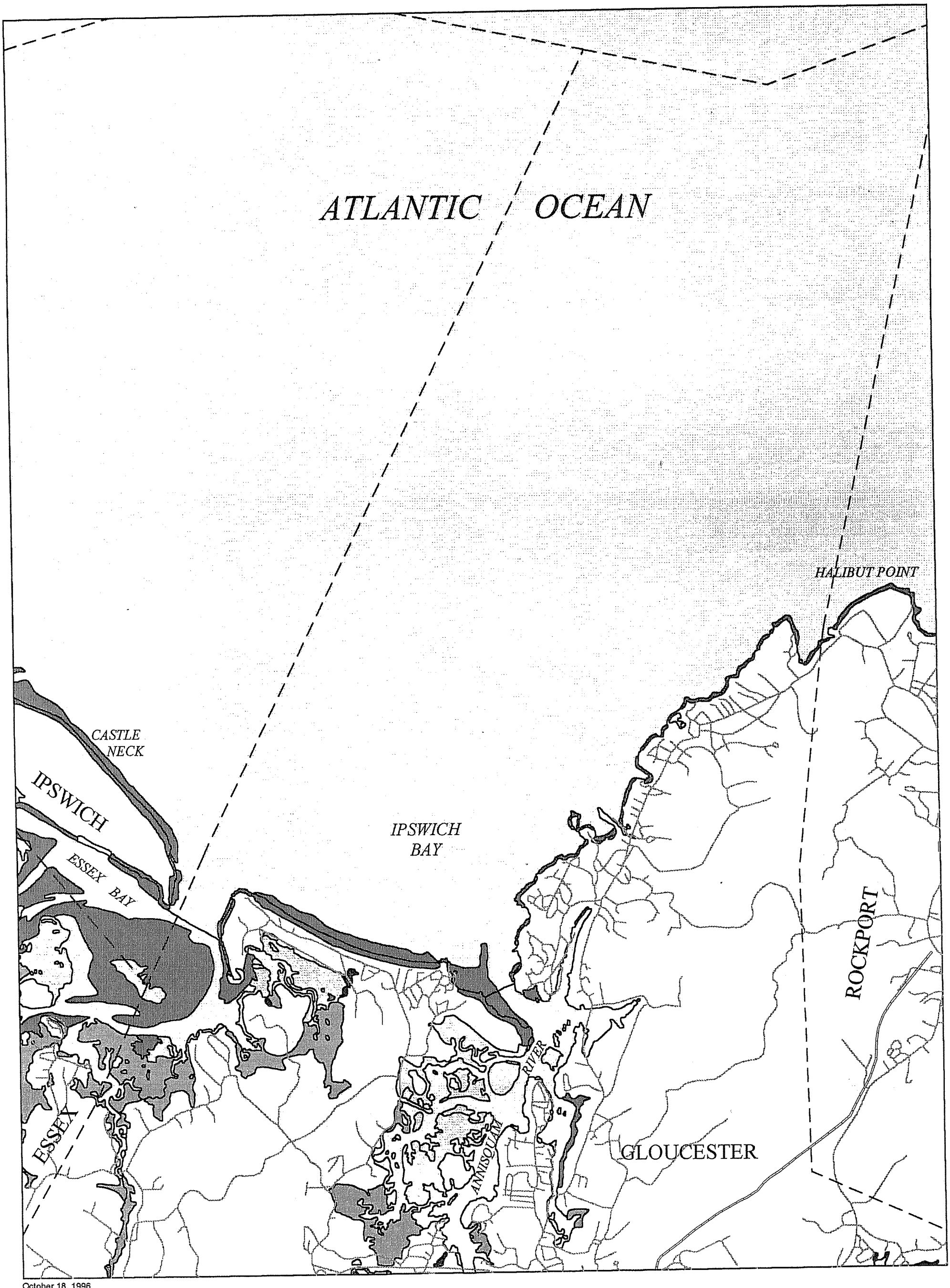

October 18, 1996

West Half of Rockport

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Natural Resources Assessment Group
University of Massachusetts

ATLANTIC OCEAN

HALIBUT POINT

CASTLE NECK

IPSWICH

ESSEX BAY

IPSWICH BAY

ROCKPORT

ESSEX

ANNISQUAM RIVER

GLOUCESTER

42

41

40

39

38

37

35

34

36

October 29, 1996

West Half of Rockport

N

Potential Tidally Restricting Upland Features

Potential Tidally Restricted Wetlands Dominated by Phragmites australis

Potential Tidally Restricted Wetlands

Other Tidal Wetlands & Deepwater Habitats

Other Tidal Wetlands Dominated by Phragmites australis

Uplands, Nontidal Wetlands & Deepwater Habitats

Railroad Corridors (Active or Abandoned)

Township Boundary Lines

Roads & Highways

Potential Tidally Restricting Features

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Natural Resources Assessment Group
University of Massachusetts

ESSEX

MANCHESTER

BEVERLY

GREAT MISERY ISLAND

SALEM SOUND

SALEM NECK

SALEM

BAKERS ISLAND

MARBLEHEAD

MARBLEHEAD NECK

ATLANTIC OCEAN

October 18, 1996

East Half of Salem

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- Railroad Corridors (Active or Abandoned)

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Natural Resources Assessment Group
University of Massachusetts

ESSEX

MANCHESTER

51

52

BEVERLY

GREAT MISERY ISLAND

SALEM SOUND

SALEM NECK

BAKERS ISLAND

SALEM

74

73

MARBLEHEAD

MARBLEHEAD NECK

ATLANTIC OCEAN

October 30, 1996

East Half of Salem

Potential Tidally Restricting Upland Features

Potential Tidally Restricted Wetlands Dominated by Phragmites australis

Potential Tidally Restricted Wetlands

Other Tidal Wetlands & Deepwater Habitats

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Uplands, Nontidal Wetlands & Deepwater Habitats

Railroad Corridors (Active or Abandoned)

Township Boundary Lines

Roads & Highways

Potential Tidally Restricting Features

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Natural Resources Assessment Group
University of Massachusetts

DANVERS

BEVERLY

PEABODY

SALEM

DANVERS RIVER

SALEM HARBOR

MARBLEHEAD

October 18, 1996

West Half of Salem

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Natural Resources Assessment Group
University of Massachusetts

DANVERS

BEVERLY

66

69

65

67

64

68

63

70

DANVERS RIVER

PEABODY

71

72

SALEM HARBOR

SALEM

MARBLEHEAD

October 30, 1996

West Half of Salem

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Natural Resources Assessment Group
University of Massachusetts