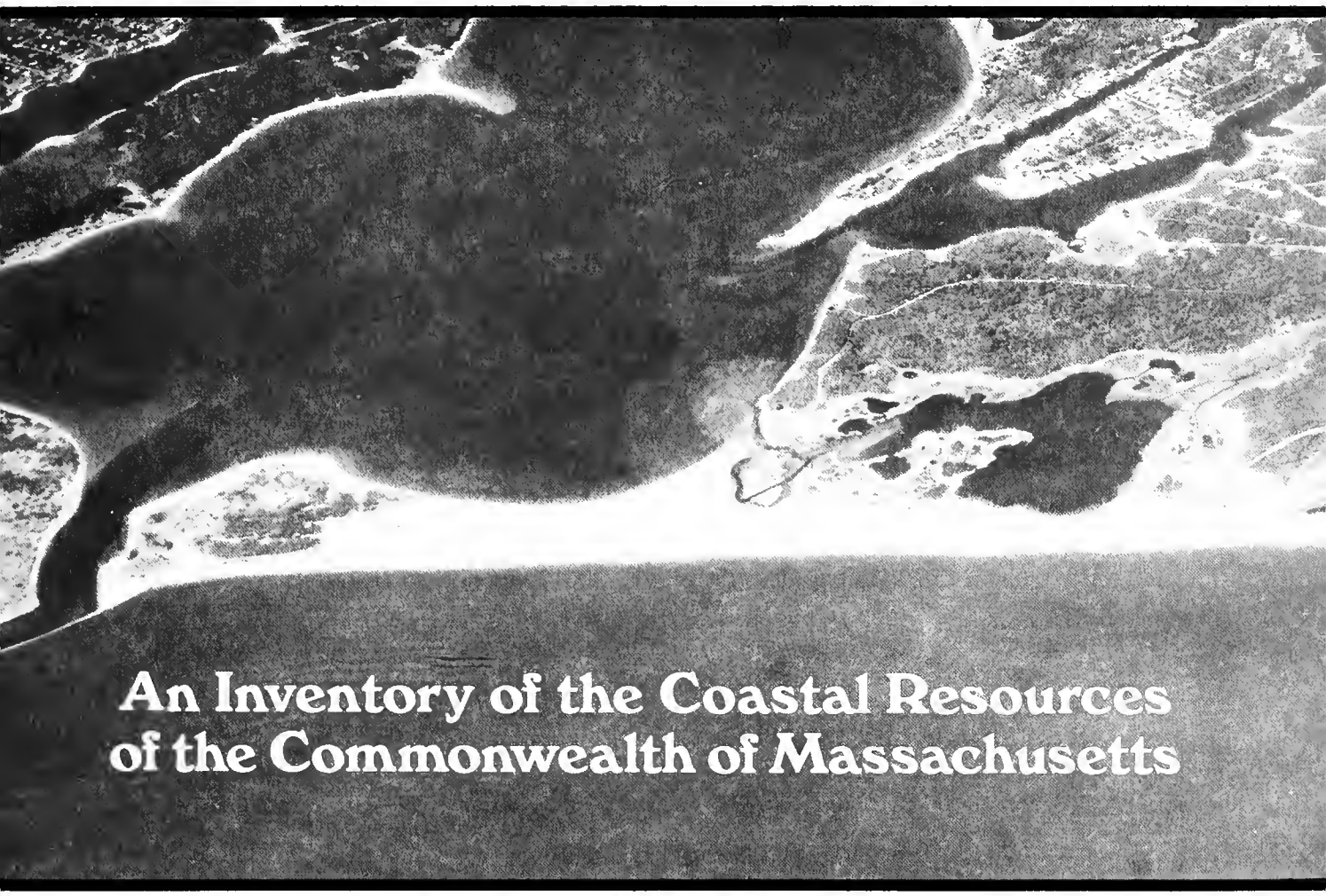
SUMMER BEACHES SALT MARSHES & TIDAL FLATS



An Inventory of the Coastal Resources of the Commonwealth of Massachusetts

Lloyd Center
For
Environmental
Studies

Massachusetts
Coastal Zone
Management
Program

BARRIER BEACHES, SALT MARSHES, AND TIDAL FLATS

An Inventory of the Coastal Resources of the Commonwealth of Massachusetts

by

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January 1985

THE LLOYD CENTER FOR ENVIRONMENTAL STUDIES

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INTRODUCTION

Cities and towns throughout the Commonwealth of Massachusetts have been charged with the primary responsibility for the management of local wetlands resources, particularly through the administration and enforcement of the Massachusetts Wetlands Protection Act (MGL C.131 s. 40). Although some political divisions have inventoried the wetlands within their borders, most do not have quantified information on the amount of resources under their protection. Local Conservation Commissions and Planning Boards are therefore often unaware of the extent of salt marsh, barrier beach, and tidal flat acreage within their jurisdiction. Additionally, the regional, county, and state agencies charged with developing broader scale planning, resource protection, and enforcement activities often have difficulty setting priorities for their work. By providing basic information on the extent of some of these coastal wetland areas, this report seeks to address these problems.

The following report will present a quantification of three of the most important coastal wetland resources in the Commonwealth; salt marshes, tidal flats, and barrier beaches. For each of these resource areas the report presents a brief introduction to the resource, a discussion of the methodology used in determining the acreage, a discussion of the results, and various tables to present the data. It is hoped that this study will lead to additional work further defining and analyzing these important resource areas.

For further information about the details of this project, data for individual communities, or further projects, please contact the Lloyd Center for Environmental Studies.

Table 1

STATE AND COUNTY ACREAGE OF THREE MAJOR NATURAL RESOURCES

	Barrier Beaches	Salt Marshes	Tidal Flats
Massachusetts	18,888.0	48,104.6	41,514.2
Barnstable County	8,723.1	15,201.0	17,808.6
Bristol County	1,008.1	3,748.0	3,130.5
Dukes County	2,135.7	1,027.7	1,258.7
Essex County	2,955.4	18,026.9	6,087.7
Middlesex County	0.0	0.0	0.0
Nantucket County	1,841.7	657.3	136.9
Norfolk County	95.7	1,056.7	2,334.6
Plymouth County	1,933.8	7,400.0	9,369.9
Suffolk County	194.5	987.0	1,387.3

All areas given in acres

SALT MARSHES

Introduction

Salt marshes are generally typified by flat, open, grassy areas along tidal waters. They are almost always found in sites protected from the high energy of the open coast; estuaries, salt ponds, or low, entrapped portions of barrier beaches. In Massachusetts' environmental regulations, salt marshes are defined as coastal wetlands "that extend landward up to the highest high tide line, that is the highest spring tide of the year, and are characterized by plants that are well adapted to, or prefer living in, saline soils. Dominant plants within salt marshes are salt meadow cord grass (Spartina patens) and/or salt marsh cord grass (Spartina alterniflora)." (From the Coastal regulations to the Massachusetts Wetlands Protection Act, MGL C.131, s.40.) Other plant species often found within a salt marsh may include spikegrass (Distichlis spicata), marsh elder (Iva frutescens), saltworts (Salicornia sp.), and sea lavender (Limonium carolinanum).

Historically viewed as wasted land, salt marshes are now valued for their resource features. They provide wildlife habitat, produce and export large quantities of plant material to nearby waters to form the base of the marine food chain, lessen the effects of storms, take up some water-borne contaminants, and protect ground water from salt intrusion by forming a peat "dam" along the shore. A discussion of salt marsh ecology and resource values may be found in The Ecology of New England High Salt Marshes: A community profile (1).

Study Methodology

Acreage of individual salt marsh segments was taken from National Wetlands Inventory (NWI) maps provided by the US Fish and Wildlife Service (FWS) through their Region V office. These maps are based on US Geological Survey 7 1/2 minute quadrangle topographic sheets. The wetlands boundaries delineated on these maps were prepared through analysis of aerial photography taken in April of 1977. Classification was based on vegetation, visible hydrology, and geography in accordance with Classification of Wetlands and Deepwater Habitats (2). All marshes over one-half acre in size are identified and located on the maps. Appendix I explains the classification scheme. For the purposes of this study, all areas classified as Estuarine Intertidal Emergent (E2EM) were considered to be salt marsh, notwithstanding any further subclassification. Areas classified as Estuarine Intertidal Scrub/shrub (E2SS) were listed as shrub marsh.

Each polygon representing E2EM vegetation was located on blackline paper copies from mylar originals. Acreage was measured by tracing each polygon with a Numonics digital read-out planimeter. Each polygon was traced at least twice to ensure accuracy. Data were recorded by quadrangle, city or town, and county. County and state totals are presented in Table 1. Acreages by town within county are found in Table 2. Table 3 lists acreages for all communities in the Commonwealth in sequential order; those communities with the most salt marsh are at the top, those with the least at the bottom.

Comparison with previous measurements

In the past 30 years several measurements have been made of salt marsh acreages in Massachusetts. Results have varied depending on several factors, including:

1- Year of measurement
Strong regulatory protection of salt marshes was not enacted until 1963 (the Hatch Act and the Coastal Wetlands Restriction Act) and the current high level of protection under the Coastal Regulations of the Wetlands Protection Act was not implemented until 1978. Prior to this, marshes were still being dredged or filled in significant increments.

2- Methodology of areal measurement
The areas of mapped salt marsh units have been calculated using the cell method (dividing the unit into squares of a known area; cells less than half "full" are ignored, those more than half "full" are considered equal to the known area), or by the use of planimeters of varying accuracy.

3- Differences in base map interpretation
As discussed below, different methods of aerial photo interpretation and different type and scale of base maps have been used.

4- Different levels of discrimination of polygon size
Depending on the purpose of the study, different thresholds for minimum marsh unit size have been used, ranging from 1/2 acre to 40 acres.

A brief description of the various prior surveys is provided below. For additional details the reader is directed to the original sources listed under References on Page 24.

1- MacConnell Mapdown (3)
Using aerial photography from 1951/1952 and 1971/1972, William MacConnell and his colleagues at the the University of Massachusetts in Amherst mapped the land use of the entire state. Included in the list of 100 categories were tidal marsh (defined as flooded twice daily, primarily Spartina alterniflora), irregularly flooded salt marsh (flooded at monthly high tides and by storms, primarily Spartina patens and Distichlis spicata), and salt meadows ditched for mosquito control. MacConnell and his staff made their interpretations of vegetation and land use from 1:20,000 scale black and white aerial photography. In 1951 the minimum land area mapped was 10 acres, for 1971 better photography allowed this to be reduced to 3 acres. A cell, or dot-grid, method was used to calculate areas.

2- US Fish and Wildlife Service
Two different types of study that included salt marsh areas have been done by the FWS. In 1954, an evaluation of those Massachusetts wetlands areas significant to waterfowl was done through the Office of River Basin Studies (4). Using US Geological Survey 7 1/2 minute quadrangle

topographic sheets, wetland areas of 40 acres or more were identified, delineated, and measured using either a planimeter or the cell method. Figures were provided for both high (Spartina patens and Distichlis spicata) marshes and low (Spartina alterniflora) marshes.

A second study was done in 1954 and repeated in 1959 and 1964 to determine vulnerability of wetlands and changes in wetlands areas (5). The minimum threshold size was not stated in the report, but it may have been the same 40 acres as in the above study. The report estimates that 90% of the wetlands in Massachusetts were surveyed. A planimeter was used to measure areas.

Table 4 compares the results of these studies at the county and state levels with the results of the work at hand. It is the feeling of the authors that the present study, using recent, accurate mapping, interpretive, and measurment techniques provides the most up-to-date, comprehensive definition of Massachusetts' salt marshes.

Discussion

Almost 70% of Massachusetts' 48,104.6 acres of salt marsh are found in Essex (37.5%) and Barnstable (32%) Counties. In Essex County, marshes make up over 10% of the total land area and within several towns the percentage is significantly higher. The town of Newbury is 30% marsh (4,646 acres), Salisbury is 25% marsh (2,536 acres), Essex is 24% marsh (2,188 acres), and Ipswich is 21% marsh (4,376 acres).

Aptly named Marshfield on the south shore is 13% marsh (2,312 acres) and on Cape Cod (Barnstable County), Orleans and Eastham are each 15% marsh (1377 and 1376 acres respectively) while Barnstable's 4,085 acres of marsh make up 10% of the town.

Table 2

SALT MARSH ACREAGE WITHIN COUNTIES

Town	Town Area in Acres	Salt Marsh acreage in Town	Shrub Marsh acreage in Town
Barnstable County			
Barnstable	40,153.6	4,085.1	0.0
Orleans	9,081.6	1,377.0	0.0
Eastham	9,344.0	1,376.2	9.3
Yarmouth	16,339.2	1,230.0	0.0
Dennis	14,016.0	1,138.9	5.5
Sandwich	27,916.8	1,128.2	0.0
Chatham	10,438.4	1,117.1	7.4
Wellfleet	13,324.8	1,039.5	2.4
Harwich	14,342.4	558.2	0.0
Falmouth	29,260.8	529.4	0.0
Brewster	16,102.4	420.5	0.0
Mashpee	16,614.4	337.5	0.0
Provincetown	5,600.0	332.6	0.0
Bourne	26,585.6	297.7	0.0
Truro	13,824.0	233.1	0.0
Totals	262,944.0	15,201.0	24.6
Bristol County			
Dartmouth	39,558.4	1,143.1	0.0
Westport	35,353.6	1,116.6	0.0
Fairhaven	7,936.0	607.5	0.0
Swansea	14,585.6	184.8	0.0
Dighton	14,304.0	151.4	0.0
Freetown	23,174.4	145.8	0.0
Berkley	10,496.0	125.9	0.0
Somerset	5,446.4	97.3	0.0
Rehoboth	30,374.4	88.5	0.0
Seekonk	11,955.2	52.8	0.0
Acushnet	12,038.4	30.4	0.0
Fall River	24,371.2	3.9	0.0
New Bedford	12,691.2	0.0	0.0
Totals	242,284.8	3,748.0	0.0
Dukes County			
Edgartown	18,720.0	504.1	0.0
Chilmark	14,182.4	241.1	0.0
Gosnold	8,288.0	89.7	0.0
Oak Bluffs	4,640.0	89.3	2.7
Tisbury	4,825.6	53.6	0.0
Gay Head	4,057.6	29.0	6.6
West Tisbury	17,075.2	20.9	0.0
Totals	71,788.8	1,027.7	9.3

Essex County			
Newbury	15,577.6	4,669.5	6.6
Ipswich	21,344.0	4,376.0	2.2
Salisbury	10,323.2	2,535.5	0.0
Essex	9,203.4	2,188.3	0.0
Rowley	12,179.2	1,983.3	0.0
Gloucester	16,928.0	1,188.1	2.7
Saugus	7,411.2	670.4	0.0
Newburyport	5,702.4	179.9	0.0
Rockport	4,531.2	48.2	0.0
Danvers	8,857.6	34.9	0.0
Nahant	678.4	32.8	0.0
Salem	5,235.2	30.8	0.0
Beverly	9,830.4	29.5	0.0
Manchester	4,940.8	19.1	0.0
Lynn	7,174.4	17.6	0.0
Peabody	10,758.4	9.0	0.0
Amesbury	8,838.4	8.0	0.0
Marblehead	2,828.8	6.0	0.0
Swampscott	1,984.0	0.0	0.0
Totals	164,326.6	18,026.9	11.5
Middlesex County			
Everett	2,400.0	0.0	0.0
Nantucket County			
Nantucket	32,217.6	657.3	3.7
Norfolk County			
Quincy	10,649.6	587.2	0.0
Cohasset	6,438.4	158.4	0.0
Weymouth	11,340.8	157.2	0.0
Milton	8,448.0	147.9	0.0
Braintree	9,222.4	6.0	0.0
Totals	46,099.2	1,056.7	0.0
Plymouth County			
Marshfield	18,252.8	2,311.9	0.0
Scituate	10,924.8	1,245.2	0.0
Duxbury	15,686.4	1,093.0	1.7
Wareham	24,339.2	917.0	0.0
Norwell	13,651.2	462.5	0.0
Mattapoiset	11,187.2	349.9	0.0
Marion	9,152.0	305.8	0.0
Plymouth	66,048.0	290.5	0.0
Pembroke	14,886.4	145.4	0.0
Hull	1,619.2	89.6	0.0
Hingham	14,457.6	89.2	3.7
Kingston	12,179.2	83.8	0.0
Hanover	10,003.2	16.2	0.0
Totals	222,387.2	7,400.0	5.4
Suffolk County			
Revere	4,044.8	490.6	0.0
Boston	29,056.0	391.7	0.0
Winthrop	1,043.2	102.7	0.0
Chelsea	1,388.8	2.0	0.0
Totals	35,532.8	987.0	0.0

Table 3

SALT MARSH ACREAGE BY TOWN (arranged in descending order)

Town	County	Town Area	Salt Marsh	Shrub Marsh
Newbury	ES	15,577.6	4,669.5	6.6
Ipswich	ES	21,344.0	4,376.0	2.2
Barnstable	BA	40,153.6	4,085.1	0.0
Salisbury	ES	10,323.2	2,535.5	0.0
Marshfield	PL	18,252.8	2,311.9	0.0
Essex	ES	9,203.4	2,188.3	0.0
Rowley	ES	12,179.2	1,983.3	0.0
Orleans	BA	9,081.6	1,377.0	0.0
Eastham	BA	9,344.0	1,376.2	9.3
Scituate	PL	10,924.8	1,245.2	0.0
Yarmouth	BA	16,339.2	1,230.0	0.0
Gloucester	ES	16,928.0	1,188.1	2.7
Dartmouth	BR	39,558.4	1,143.1	0.0
Dennis	BA	14,016.0	1,138.9	5.5
Sandwich	BA	27,916.8	1,128.2	0.0
Chatham	BA	10,438.4	1,117.1	7.4
Westport	BR	35,353.6	1,116.6	0.0
Duxbury	PL	15,686.4	1,093.0	1.7
Wellfleet	BA	13,324.8	1,039.5	2.4
Wareham	PL	24,339.2	917.0	0.0
Saugus	ES	7,411.2	670.4	0.0
Nantucket	NA	32,217.6	657.3	3.7
Fairhaven	BR	7,936.0	607.5	0.0
Quincy	NO	10,649.6	587.2	0.0
Harwich	BA	14,342.4	558.2	0.0
Falmouth	BA	29,260.8	529.4	0.0
Edgartown	DU	18,720.0	504.1	0.0
Revere	SU	4,044.8	490.6	0.0
Norwell	PL	13,651.2	462.5	0.0
Brewster	BA	16,102.4	420.5	0.0
Boston	SU	29,056.0	391.7	0.0
Mattapoiset	PL	11,187.2	349.9	0.0
Mashpee	BA	16,614.4	337.5	0.0
Provincetown	BA	5,600.0	332.6	0.0
Marion	PL	9,152.0	305.8	0.0
Bourne	BA	26,585.6	297.7	0.0
Plymouth	PL	66,048.0	290.5	0.0
Chilmark	DU	14,182.4	241.1	0.0
Truro	BA	13,824.0	233.1	0.0
Swansea	BR	14,585.6	184.8	0.0

All areas given in acres

SALT MARSH ACREAGE BY TOWN (continued)

Town	County	Town Area	Salt Marsh	Shrub Marsh
Newburyport	ES	5,702.4	179.9	0.0
Cohasset	NO	6,438.4	158.4	0.0
Weymouth	NO	11,340.8	157.2	0.0
Dighton	BR	14,304.0	151.4	0.0
Milton	NO	8,448.0	147.9	0.0
Freetown	BR	23,174.4	145.8	0.0
Pembroke	PL	14,886.4	145.4	0.0
Berkley	BR	10,496.0	125.9	0.0
Winthrop	SU	1,043.2	102.7	0.0
Somerset	BR	5,446.4	97.3	0.0
Gosnold	DU	8,288.0	89.7	0.0
Hull	PL	1,619.2	89.6	0.0
Oak Bluffs	DU	4,640.0	89.3	2.7
Hingham	PL	14,457.6	89.2	3.7
Rehoboth	BR	30,374.4	88.5	0.0
Kingston	PL	12,179.2	83.8	0.0
Tisbury	DU	4,825.6	53.6	0.0
Seekonk	BR	11,955.2	52.8	0.0
Rockport	ES	4,531.2	48.2	0.0
Danvers	ES	8,857.6	34.9	0.0
Nahant	ES	678.4	32.8	0.0
Salem	ES	5,235.2	30.8	0.0
Acushnet	BR	12,038.4	30.4	0.0
Beverly	ES	9,830.4	29.5	0.0
Gay Head	DU	4,057.6	29.0	6.6
West Tisbury	DU	17,075.2	20.9	0.0
Manchester	ES	4,940.8	19.1	0.0
Lynn	ES	7,174.4	17.6	0.0
Hanover	PL	10,003.2	16.2	0.0
Peabody	ES	10,758.4	9.0	0.0
Amesbury	ES	8,838.4	8.0	0.0
Braintree	NO	9,222.4	6.0	0.0
Marblehead	ES	2,828.8	6.0	0.0
Fall River	BR	24,371.2	3.9	0.0
Chelsea	SU	1,388.8	2.0	0.0
Everett	MI	2,400.0	0.0	0.0
New Bedford	BR	12,691.2	0.0	0.0
Swampscott	ES	1,984.0	0.0	0.0
State Totals		1,079,981.0	48,104.6	54.5

All areas given in acres

Comparison of Salt Marsh Acreages in Prior Studies

	Lloyd Center/MCZM (1984)	MacConnell Map-Down (1971)	FWS Vulnerability (1964)	FWS Vulnerability (1959)	FWS Vulnerability (1954)	FWS Habitat (1954)	MacConnell Map-Down (1951)
State Total	48,104.6	43,280	40,617	40,940	41,627	42,460	52,433
Counties							
Barnstable	15,201.0	11,460	13,153	13,320	13,800	11,460	16,142
Bristol	3,748.0	2,841	2,623	2,670	2,670	2,800	3,907
Dukes	1,027.7	773	400	400	400	180	1,048
Essex	18,026.9	17,141	17,550	17,631	17,822	20,625	19,753
Middlesex	0.0	50	-	-	-	250	88
Nantucket	657.3	708	720	720	720	580	740
Norfolk	1,056.7	937	-	-	-	560	1,491
Plymouth	7,400.0	6,762	5,601	5,624	5,640	5,955	8,139
Suffolk	987.0	884	570	575	575	0	1,125
(Reference)		(3)	(5)	(5)	(5)	(4)	(3)

Table 4

TIDAL FLATS

Introduction

Tidal flats, as defined by the coastal regulations to the Massachusetts Wetlands Protection Act, are those nearly level parts of coastal beaches which usually extend from the mean low water line landward to the more steeply sloping face of the beach, or which may be separated from the beach by an area of deeper water. They are exposed at low tide and may or may not be connected to the rest of a coastal beach. Tidal flats are commonly found both along shorelines exposed to the open ocean or within estuaries and the material making up the flat will generally reflect these differences in location; finer sediments are generally more common on protected flats and larger, sandy material more common in exposed areas. The values of tidal flats are often underestimated in the public eye. Most people recognize them as habitat for shellfish, however, they also play an important role in lessening storm waves and providing sediment to down-current beaches. The critical relationships with saltmarshes in the flow of nutrients within the estaurine or marine ecosystem are presently becoming better understood (6). For further information on the nature and values of tidal flats, the reader is referred to The Ecology of New England Tidal Flats: a community profile (7).

Study Methodology

The methodology to determine tidal flat locations and areas was the same as that described above for salt marshes. Both estuarine and marine tidal flats (E2FL and M2FL respectively in the NWI indicator codes) were identified and planimetered on black line copies of the National Wetlands Inventory maps. Again, one half acre was the minimum threshold for resource area size used in developing the NWI maps.

To our knowledge, this is the first systematic survey of tidal flats within the Commonwealth.

Table 5 lists acreages by town within counties. Table 6 provides the acreage of tidal flats by community in descending, sequential order. In each case, totals are provided for both marine (open ocean) and estuarine (within bays, river mouths, salt ponds, etc.) flats and combined as tidal flats.

Discussion

The north side of Cape Cod (Barnstable County) has extensive marine flats as may be seen in the figures of Eastham, Brewster, Wellfleet and Yarmouth. Estuarine flats are concentrated in such areas as Duxbury Bay, Pleasant Bay (Chatham and Orleans), Barnstable Harbor, Plymouth Bay, and the Westport River.

Table 5

TIDAL FLAT ACREAGE WITHIN COUNTIES

Town	Town Area in Acres	Tidal Flat acreage in Town	Marine Flat Acreage	Estuarine Flat Acreage
Barnstable County				
Eastham	9,344.0	2,817.9	2,275.4	542.5
Barnstable	40,153.6	2,646.4	689.2	1,957.2
Orleans	9,081.6	2,441.1	413.5	2,027.6
Brewster	16,102.4	2,367.2	2,352.3	14.9
Chatham	10,438.4	2,231.9	1,098.0	1,133.9
Wellfleet	13,324.8	1,893.7	1,107.2	786.5
Yarmouth	16,339.2	1,542.1	1,065.3	476.8
Dennis	14,016.0	1,002.1	880.1	122.0
Falmouth	29,260.8	307.5	127.3	180.2
Provincetown	5,600.0	205.4	43.0	162.4
Bourne	26,585.6	201.8	35.8	166.0
Truro	13,824.0	92.5	0.0	92.5
Mashpee	16,614.4	51.6	0.0	51.6
Sandwich	27,916.8	7.4	0.0	7.4
Harwich	14,342.4	0.0	0.0	0.0
Totals	262,944.0	17,808.6	10,087.1	7,721.5
Bristol County				
Westport	35,353.6	2,032.8	0.0	2,032.8
Fairhaven	7,936.0	582.1	442.0	140.1
Dartmouth	39,558.4	281.7	14.7	267.0
New Bedford	12,691.2	107.7	0.0	107.7
Berkley	10,496.0	53.6	0.0	53.6
Acushnet	12,038.4	49.8	0.0	49.8
Swansea	14,585.6	11.4	0.0	11.4
Dighton	14,304.0	7.0	0.0	7.0
Somerset	5,446.4	4.4	0.0	4.4
Fall River	24,371.2	0.0	0.0	0.0
Freetown	23,174.4	0.0	0.0	0.0
Rehoboth	30,374.4	0.0	0.0	0.0
Seekonk	11,955.2	0.0	0.0	0.0
Totals	242,284.8	3,130.5	456.7	2,673.8
Dukes County				
Edgartown	18,720.0	786.9	154.1	632.8
Tisbury	4,825.6	221.1	0.0	221.1
Chilmark	14,182.4	119.5	6.0	113.5
Gay Head	4,057.6	47.8	0.0	47.8
Oak Bluffs	4,640.0	37.9	0.0	37.9
Gosnold	8,288.0	34.1	25.4	8.7
West Tisbury	17,075.2	11.4	0.0	11.4
Totals	71,788.8	1,258.7	185.5	1,073.2

Essex County					
	Ipswich	21,344.0	1,539.9	516.8	1,023.1
	Gloucester	16,928.0	1,412.9	510.0	902.9
	Newburyport	5,702.4	690.7	0.0	690.7
	Essex	9,203.4	512.5	0.0	512.5
	Newbury	15,577.6	431.6	127.7	303.9
	Salem	5,235.2	317.0	196.0	121.0
	Beverly	9,830.4	303.9	198.5	105.4
	Rowley	12,179.2	211.2	12.6	198.6
	Manchester	4,940.8	127.6	111.4	16.2
	Salisbury	10,323.2	115.5	115.5	0.0
	Marblehead	2,828.8	112.2	112.2	0.0
	Danvers	8,857.6	96.5	0.0	96.5
	Saugus	7,411.2	92.2	0.0	92.2
	Rockport	4,531.2	74.7	74.7	0.0
	Lynn	7,174.4	49.3	0.0	49.3
	Amesbury	8,838.4	0.0	0.0	0.0
	Nahant	678.4	0.0	0.0	0.0
	Peabody	10,758.4	0.0	0.0	0.0
	Swampscott	1,984.0	0.0	0.0	0.0
	Totals	164,326.6	6,087.7	1,975.4	4,112.3
Middlesex County					
	Everett	2,400.0	0.0	0.0	0.0
Nantucket County					
	Nantucket	32,217.6	136.9	0.0	136.9
Norfolk County					
	Quincy	10,649.6	1,459.6	0.0	1,459.6
	Weymouth	11,340.8	549.7	0.0	549.7
	Cohasset	6,438.4	287.6	0.0	287.6
	Braintree	9,222.4	37.7	0.0	37.7
	Milton	8,448.0	0.0	0.0	0.0
	Totals	46,099.2	2,334.6	0.0	2,334.6
Plymouth County					
	Duxbury	15,686.4	3,436.8	0.0	3,436.8
	Plymouth	66,048.0	2,109.5	20.3	2,089.2
	Kingston	12,179.2	905.0	0.0	905.0
	Scituate	10,924.8	621.8	0.0	621.8
	Hingham	14,457.6	614.5	0.0	614.5
	Hull	1,619.2	511.0	0.0	511.0
	Mattapoiset	11,187.2	453.6	439.5	14.1
	Wareham	24,339.2	451.2	256.3	194.9
	Marshfield	18,252.8	172.9	0.0	172.9
	Marion	9,152.0	93.6	46.7	46.9
	Hanover	10,003.2	0.0	0.0	0.0
	Norwell	13,651.2	0.0	0.0	0.0
	Pembroke	14,886.4	0.0	0.0	0.0
	Totals	222,387.2	9,369.9	762.8	8,607.1
Suffolk County					
	Boston	29,056.0	878.5	0.0	878.5
	Winthrop	1,043.2	295.8	0.0	295.8
	Revere	4,044.8	183.5	129.1	54.4
	Chelsea	1,388.8	29.5	0.0	29.5
	Totals	35,532.8	1,387.3	129.1	1,258.2

Table 6

TIDAL FLAT ACREAGE BY TOWN (arranged in descending order)

Town	County	Town Area	Tidal Flats	Marine Flats	Estuarine Flats
Duxbury	PL	15,686.4	3,436.8	0.0	3,436.8
Eastham	BA	9,344.0	2,817.9	2,275.4	542.5
Barnstable	BA	40,153.6	2,646.4	689.2	1,957.2
Orleans	BA	9,081.6	2,441.1	413.5	2,027.6
Brewster	BA	16,102.4	2,367.2	2,352.3	14.9
Chatham	BA	10,438.4	2,231.9	1,098.0	1,133.9
Plymouth	PL	66,048.0	2,109.5	20.3	2,089.2
Westport	BR	35,353.6	2,032.8	0.0	2,032.8
Wellfleet	BA	13,324.8	1,893.7	1,107.2	786.5
Yarmouth	BA	16,339.2	1,542.1	1,065.3	476.8
Ipswich	ES	21,344.0	1,539.9	516.8	1,023.1
Quincy	NO	10,649.6	1,459.6	0.0	1,459.6
Gloucester	ES	16,928.0	1,412.9	510.0	902.9
Dennis	BA	14,016.0	1,002.1	880.1	122.0
Kingston	PL	12,179.2	905.0	0.0	905.0
Boston	SU	29,056.0	878.5	0.0	878.5
Edgartown	DU	18,720.0	786.9	154.1	632.8
Newburyport	ES	5,702.4	690.7	0.0	690.7
Scituate	PL	10,924.8	621.8	0.0	621.8
Hingham	PL	14,457.6	614.5	0.0	614.5
Fairhaven	BR	7,936.0	582.1	442.0	140.1
Weymouth	NO	11,340.8	549.7	0.0	549.7
Essex	ES	9,203.4	512.5	0.0	512.5
Hull	PL	1,619.2	511.0	0.0	511.0
Mattapoiset	PL	11,187.2	453.6	439.5	14.1
Wareham	PL	24,339.2	451.2	256.3	194.9
Newbury	ES	15,577.6	431.6	127.7	303.9
Salem	ES	5,235.2	317.0	196.0	121.0
Falmouth	BA	29,260.8	307.5	127.3	180.2
Beverly	ES	9,830.4	303.9	198.5	105.4
Winthrop	SU	1,043.2	295.8	0.0	295.8
Cohasset	NO	6,438.4	287.6	0.0	287.6
Dartmouth	BR	39,558.4	281.7	14.7	267.0
Tisbury	DU	4,825.6	221.1	0.0	221.1
Rowley	ES	12,179.2	211.2	12.6	198.6
Provincetown	BA	5,600.0	205.4	43.0	162.4
Bourne	BA	26,585.6	201.8	35.8	166.0
Revere	SU	4,044.8	183.5	129.1	54.4
Marshfield	PL	18,252.8	172.9	0.0	172.9
Nantucket	NA	32,217.6	136.9	0.0	136.9

All areas given in acres

TIDAL FLAT ACREAGE BY TOWN (continued)

Town	County	Town Area	Tidal Flats	Marine Flats	Estuarine Flats
Manchester	ES	4,940.8	127.6	111.4	16.2
Chilmark	DU	14,182.4	119.5	6.0	113.5
Salisbury	ES	10,323.2	115.5	115.5	0.0
Marblehead	ES	2,828.8	112.2	112.2	0.0
New Bedford	BR	12,691.2	107.7	0.0	107.7
Danvers	ES	8,857.6	96.5	0.0	96.5
Marion	PL	9,152.0	93.6	46.7	46.9
Truro	BA	13,824.0	92.5	0.0	92.5
Saugus	ES	7,411.2	92.2	0.0	92.2
Rockport	ES	4,531.2	74.7	74.7	0.0
Berkley	BR	10,496.0	53.6	0.0	53.6
Mashpee	BA	16,614.4	51.6	0.0	51.6
Acushnet	BR	12,038.4	49.8	0.0	49.8
Lynn	ES	7,174.4	49.3	0.0	49.3
Gay Head	DU	4,057.6	47.8	0.0	47.8
Oak Bluffs	DU	4,640.0	37.9	0.0	37.9
Braintree	NO	9,222.4	37.7	0.0	37.7
Gosnold	DU	8,288.0	34.1	25.4	8.7
Chelsea	SU	1,388.8	29.5	0.0	29.5
Swansea	BR	14,585.6	11.4	0.0	11.4
West Tisbury	DU	17,075.2	11.4	0.0	11.4
Sandwich	BA	27,916.8	7.4	0.0	7.4
Dighton	BR	14,304.0	7.0	0.0	7.0
Somerset	BR	5,446.4	4.4	0.0	4.4
Amesbury	ES	8,838.4	0.0	0.0	0.0
Everett	MI	2,400.0	0.0	0.0	0.0
Fall River	BR	24,371.2	0.0	0.0	0.0
Freetown	BR	23,174.4	0.0	0.0	0.0
Hanover	PL	10,003.2	0.0	0.0	0.0
Harwich	BA	14,342.4	0.0	0.0	0.0
Milton	NO	8,448.0	0.0	0.0	0.0
Nahant	ES	678.4	0.0	0.0	0.0
Norwell	PL	13,651.2	0.0	0.0	0.0
Peabody	ES	10,758.4	0.0	0.0	0.0
Pembroke	PL	14,886.4	0.0	0.0	0.0
Rehoboth	BR	30,374.4	0.0	0.0	0.0
Seekonk	BR	11,955.2	0.0	0.0	0.0
Swampscott	ES	1,984.0	0.0	0.0	0.0
State Totals		1,079,981.0	41,514.2	13,596.6	27,917.6

All areas given in acres

BARRIER BEACHES

Introduction

Barrier beaches are geologic landforms defined in the regulations to the Massachusetts Wetlands Protection Act as narrow, low-lying strips of land generally consisting of coastal beaches and coastal dunes extending roughly parallel to the trend of the coast. They are separated from the mainland by a relatively narrow body of fresh, brackish, or saline water or by a salt marsh system. A barrier beach may be joined to the mainland at one or both ends.

Storm damage prevention and flood control are two of the most obvious values of these resource areas. The sands of a barrier beach can absorb the force of storm waves, and the reshaping of beaches and dunes by waves provides material to beaches down-current and eases the effects of erosion. Barrier beaches are also often important recreational areas and provide nesting and resting sites for many species of shore and migratory birds.

For further information about barrier beaches, their resources and management, see the Barrier Beach Management Sourcebook (8) and Massachusetts Barrier Beaches (9).

Study Methodology

The acreage of barrier beach units was developed from an inventory prepared for the Massachusetts Coastal Zone Management (MCZM) program by the Provincetown Center for Coastal Studies. Delineation of barrier units was made on US Geological Survey 7 1/2 minute quadrangle topographic sheets. Original versions of these maps are on file in the MCZM office. Reduced size versions as well as identification criteria and study methodology information are available in Massachusetts Barrier Beaches (9) or through MCZM.

As with the salt marshes and tidal flats described above, each defined area was traced using the Numonics digital read-out planimeter at the US Fish and Wildlife Service' Region V office. Numbers of barrier units and their acreage were recorded by town and county. County and state acreages are presented in Table 1. Numbers of barriers and acreages listed by town within county sequence are found in Table 7. Table 8 lists barrier beach acreage by town.

Discussion

A size distribution of the Commonwealth's barriers was prepared and is presented in Table 9. For the purposes of this analysis, the acreage of the entire geologic landform was used, despite any political boundaries. The barrier beach inventory is based on community units and a large barrier such as Plum Island may have its acreage divided among several towns. The distribution analysis indicates that most of the 661 barriers of Massachusetts are relatively small.

More than half are less than 2.5 acres and more than three-quarters are less than 10 acres. Conversely, the 30 largest barriers make up three-quarters of the total barrier beach acreage in the state. These 30 barrier landforms are listed in Table 10.

Interestingly, the Town of Gosnold (the Elizabeth Islands) has the largest number of barriers, and, in fact, has more barrier beaches (77) than year-round residents (63) according to the 1980 census.

Table 7

NUMBERS OF BARRIER BEACH SEGMENTS AND ACREAGE WITHIN COUNTIES

Town		Town Area in Acres	Barrier Beach Acreage in Town	Barrier Beach Segments in Town
Barnstable County				
Falmouth		29,260.8	278.4	44
Barnstable		40,153.6	1,700.7	29
Bourne		26,585.6	75.0	29
Wellfleet		13,324.8	164.4	22
Chatham		10,438.4	3,108.1	20
Orleans		9,081.6	532.1	17
Yarmouth		16,339.2	212.5	13
Dennis		14,016.0	232.2	12
Eastham		9,344.0	224.7	7
Harwich		14,342.4	27.1	7
Truro		13,824.0	1,001.1	7
Mashpee		16,614.4	128.5	6
Sandwich		27,916.8	259.5	5
Brewster		16,102.4	53.0	4
Provincetown		5,600.0	725.8	2
	Totals	262,944.0	8,723.1	224
Bristol County				
Fairhaven		7,936.0	86.3	23
Dartmouth		39,558.4	154.4	13
Westport		35,353.6	729.4	6
Swansea		14,585.6	33.5	2
Somerset		5,446.4	4.5	1
Acushnet		12,038.4	0.0	0
Berkley		10,496.0	0.0	0
Dighton		14,304.0	0.0	0
Fall River		24,371.2	0.0	0
Freetown		23,174.4	0.0	0
New Bedford		12,691.2	0.0	0
Rehoboth		30,374.4	0.0	0
Seekonk		11,955.2	0.0	0
	Totals	242,284.8	1,008.1	45
Dukes County				
Gosnold		8,288.0	186.3	77
Edgartown		18,720.0	962.6	40
Chilmark		14,182.4	297.0	19
West Tisbury		17,075.2	82.5	17
Oak Bluffs		4,640.0	115.4	13
Tisbury		4,825.6	88.1	13
Gay Head		4,057.6	403.8	3
	Totals	71,788.8	2,135.7	182

Essex County				
	Gloucester		16,928.0	171.6	9
	Ipswich		21,344.0	1,333.3	6
	Rockport		4,531.2	35.6	5
	Manchester		4,940.8	10.7	4
	Nahant		678.4	80.0	3
	Beverly		9,830.4	1.5	1
	Marblehead		2,828.8	14.6	1
	Newbury		15,577.6	606.6	1
	Newburyport		5,702.4	166.1	1
	Rowley		12,179.2	186.0	1
	Salisbury		10,323.2	345.3	1
	Swampscott		1,984.0	4.1	1
	Amesbury		8,838.4	0.0	0
	Danvers		8,857.6	0.0	0
	Essex		9,203.4	0.0	0
	Lynn		7,174.4	0.0	0
	Peabody		10,758.4	0.0	0
	Salem		5,235.2	0.0	0
	Saugus		7,411.2	0.0	0
		Totals	164,326.6	2,955.4	34
Middlesex County					
	Everett		2,400.0	0.0	0
Nantucket County					
	Nantucket		32,217.6	1,841.7	56
Norfolk County					
	Quincy		10,649.6	71.4	6
	Cohasset		6,438.4	20.1	3
	Weymouth		11,340.8	4.2	1
	Braintree		9,222.4	0.0	0
	Milton		8,448.0	0.0	0
		Totals	46,099.2	95.7	10
Plymouth County					
	Wareham		24,339.2	58.7	36
	Mattapoiset		11,187.2	83.5	26
	Marion		9,152.0	36.9	14
	Plymouth		66,048.0	348.0	12
	Scituate		10,924.8	323.1	11
	Hull		1,619.2	599.0	9
	Marshfield		18,252.8	232.1	6
	Hingham		14,457.6	4.8	3
	Duxbury		15,686.4	247.7	1
	Hanover		10,003.2	0.0	0
	Kingston		12,179.2	0.0	0
	Norwell		13,651.2	0.0	0
	Pembroke		14,886.4	0.0	0
		Totals	222,387.2	1,933.8	118
Suffolk County					
	Boston		29,056.0	28.4	11
	Revere		4,044.8	151.2	2
	Winthrop		1,043.2	14.9	2
	Chelsea		1,388.8	0.0	0
		Totals	35,532.8	194.5	15

Table 8

BARRIER BEACH ACREAGE BY TOWN (arranged in descending order)

Town	County	Town Area in acres	Barrier Beach Acreage within Town	Number of barriers in Town
Chatham	BA	10,438.4	3,108.1	20
Nantucket	NA	32,217.6	1,841.7	56
Barnstable	BA	40,153.6	1,700.7	29
Ipswich	ES	21,344.0	1,333.3	6
Truro	BA	13,824.0	1,001.1	7
Edgartown	DU	18,720.0	962.6	40
Westport	BR	35,353.6	729.4	6
Provincetown	BA	5,600.0	725.8	2
Newbury	ES	15,577.6	606.6	1
Hull	PL	1,619.2	599.0	9
Orleans	BA	9,081.6	532.1	17
Gay Head	DU	4,057.6	403.8	3
Plymouth	PL	66,048.0	348.0	12
Salisbury	ES	10,323.2	345.3	1
Scituate	PL	10,924.8	323.1	11
Chilmark	DU	14,182.4	297.0	19
Falmouth	BA	29,260.8	278.4	44
Sandwich	BA	27,916.8	259.5	5
Duxbury	PL	15,686.4	247.7	1
Dennis	BA	14,016.0	232.2	12
Marshfield	PL	18,252.8	232.1	6
Eastham	BA	9,344.0	224.7	7
Yarmouth	BA	16,339.2	212.5	13
Gosnold	DU	8,288.0	186.3	77
Rowley	ES	12,179.2	186.0	1
Gloucester	ES	16,928.0	171.6	9
Newburyport	ES	5,702.4	166.1	1
Wellfleet	BA	13,324.8	164.4	22
Dartmouth	BR	39,558.4	154.4	13
Revere	SU	4,044.8	151.2	2
Mashpee	BA	16,614.4	128.5	6
Oak Bluffs	DU	4,640.0	115.4	13
Tisbury	DU	4,825.6	88.1	13
Fairhaven	BR	7,936.0	86.3	23
Mattapoiset	PL	11,187.2	83.5	26
West Tisbury	DU	17,075.2	82.5	17
Nahant	ES	678.4	80.0	3
Bourne	BA	26,585.6	75.0	29
Quincy	NO	10,649.6	71.4	6
Wareham	PL	24,339.2	58.7	36

BARRIER BEACH ACREAGE BY TOWN (continued)

Town	County	Town Area in acres	Barrier Beach Acreage within Town	Number of barriers in Town
Brewster	BA	16,102.4	53.0	4
Marion	PL	9,152.0	36.9	14
Rockport	ES	4,531.2	35.6	5
Swansea	BR	14,585.6	33.5	2
Boston	SU	29,056.0	28.4	11
Harwich	BA	14,342.4	27.1	7
Cohasset	NO	6,438.4	20.1	3
Winthrop	SU	1,043.2	14.9	2
Marblehead	ES	2,828.8	14.6	1
Manchester	ES	4,940.8	10.7	4
Hingham	PL	14,457.6	4.8	3
Somerset	BR	5,446.4	4.5	1
Weymouth	NO	11,340.8	4.2	1
Swampscott	ES	1,984.0	4.1	1
Beverly	ES	9,830.4	1.5	1
Acushnet	BR	12,038.4	0.0	0
Amesbury	ES	8,838.4	0.0	0
Berkley	BR	10,496.0	0.0	0
Braintree	NO	9,222.4	0.0	0
Chelsea	SU	1,388.8	0.0	0
Danvers	ES	8,857.6	0.0	0
Dighton	BR	14,304.0	0.0	0
Essex	ES	9,203.4	0.0	0
Everett	MI	2,400.0	0.0	0
Fall River	BR	24,371.2	0.0	0
Freetown	BR	23,174.4	0.0	0
Hanover	PL	10,003.2	0.0	0
Kingston	PL	12,179.2	0.0	0
Lynn	ES	7,174.4	0.0	0
Milton	NO	8,448.0	0.0	0
New Bedford	BR	12,691.2	0.0	0
Norwell	PL	13,651.2	0.0	0
Peabody	ES	10,758.4	0.0	0
Pembroke	PL	14,886.4	0.0	0
Rehoboth	BR	30,374.4	0.0	0
Salem	ES	5,235.2	0.0	0
Saugus	ES	7,411.2	0.0	0
Seekonk	BR	11,955.2	0.0	0
State Totals		1,079,981.0	18,888.0	684

Table 9

SIZE DISTRIBUTION OF MASSACHUSETTS BARRIER BEACHES

Range of Acreage	# within range & % of Total		Cumulative total & % of Total	
0 - .4	47	7 %		
.5 - .9	94	14 %	141	21 %
1.0 - 1.4	88	13 %	229	35 %
1.5 - 1.9	59	9 %	288	44 %
2.0 - 2.9	69	10 %	357	54 %
3.0 - 4.9	70	11 %	427	65 %
5.0 - 9.9	87	13 %	514	78 %
10.0 - 49.9	99	15 %	613	93 %
50.0 - 99.9	18	3 %	631	95 %
100.0 - 999.9	25	4 %	656	99 %
over 1000	5	less than 1 %	661	100 %

The 5 largest barriers (1 % of total) make up 38 % of total acres.
The 30 largest barriers (5 % of total) make up 75 % of total acres.

All areas given in acres.

Table 10

THE 30 LARGEST BARRIER BEACH LANDFORMS IN MASSACHUSETTS

Acreage	Barrier Name	Town(s)	County
2126.8	Monomoy Island	Chatham	Barnstable
1381.7	Sandy Neck	Barnstable, Sandwich	Barnstable
1255.0	Nauset Beach	Chatham, Orleans	Barnstable
1241.4	Plum Island	Ipswich, Newbury, Newburyport, Rowley	Essex
1119.6	Coatue Point and Beach	Nantucket	Nantucket
875.2	Castle Neck/Cranes Beach	Ipswich, Gloucester	Essex
789.0	Head of the Meadow Beach	Truro	Barnstable
651.7	Horseneck Beach	Westport	Bristol
527.7	Nantasket Beach	Hull	Plymouth
442.7	Race Point/Hatches Harbor	Provincetown	Barnstable
345.3	Salisbury Beach	Salisbury	Essex
337.5	Lobsterville/West Payson Road	Gay Head	Dukes
310.8	Duxbury Beach	Duxbury, Marshfield, Plymouth	Plymouth
301.2	Cape Poge	Edgartown	Dukes
283.1	Wood End/Long Point	Provincetown	Barnstable
270.6	Hummarock/Rexhame	Marshfield, Scituate	Plymouth
223.5	Norton Point	Edgartown	Dukes
149.7	Revere Beach	Revere	Suffolk
138.7	Wauwinet	Nantucket	Nantucket
135.7	Coast Guard/Nauset Beach	Eastham	Barnstable
134.6	Great Island	Yarmouth	Barnstable
133.5	Chapin Beach	Dennis	Barnstable
132.2	Beach Point	Truro	Barnstable
129.3	Edgartown Great Pond	Edgartown	Dukes
127.0	Squibnocket/Long Beach	Chilmark, Gay Head	Dukes
124.1	Plymouth Beach	Plymouth	Plymouth
122.2	East Sandwich/Springhill	Sandwich	Barnstable
121.2	Eel Point	Nantucket	Nantucket
116.4	Dead Neck	Barnstable	Barnstable
103.3	Ester Island	Nantucket	Nantucket

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APPENDIX

Classification Scheme for Salt Marshes and Tidal Flats

The classification scheme used on the National Wetlands Inventory maps is that provided in Classification of Wetlands and Deepwater Habitats of the United States (2). This is based on a hierarchical model of System/ Sub-system Class / Sub-Class based on ecosystem and abiotic factors:

- Systems: include Estuarine and Marine (the two important to this study) as well as Palustrine, Lacustrine, and Riverine.
- Subsystems: where applicable, Intertidal (both salt marshes and tidal flats are found here) and Subtidal.
- Class: flat, emergent, scrub/shrub (the classes important here), rocky shore, beach bar, etc.
- Subclass: includes type of vegetation, water regimes and the like. (Subclasses were not used in this analysis.)

For the resources included in this work, the inter-relationships between the various systems, classes, and subsets of each are schematically illustrated below.

System	Subsystem	Class
Marine	Intertidal	Flat
Estuarine	Intertidal	Flat Emergent Vegetation (salt marsh) Scrub/Shrub (shrub marsh)

An Estuarine System consists of deepwater tidal habitats and adjacent tidal wetlands that are semienclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is diluted by fresh water runoff from the landward side. The Estuarine System extends upstream and landward to the point that ocean-derived salinity measures less than 0.5 o/oo (parts per thousand) during the period of average low flow. The seaward boundary is an imaginary line closing the mouth of the river, bay, or sound, or the seaward limit of emergent vegetation, whichever is greater.

The Marine System consists of the open ocean and its associated high-energy coastline. Marine habitats are exposed to the waves and currents of the open ocean. Salinities generally exceed 30 o/oo with little or no dilution except directly outside mouths of estuaries.

Emergent vegetation is characterized by erect, rooted, herbaceous, aquatic or

water tolerant plants. This vegetation is present for most of the growing season in most years. Emergent wetlands are relative stable and retain the same appearance year after year.

Included within each polygon on the National Wetlands Inventory maps is an encoded classification of wetland type. These take the following form:

Example 1.	Salt Marsh	
	E2EM	E - Estuarine System
		2 - Intertidal Subsystem
		EM - Emergent vegetation (Class)
Example 2.	Shrub Marsh	
	E2SS	E - Estuarine
		2 - Intertidal Subsystem
		SS - Scrub/Shrub (Class)
Example 3.	Estuarine Flat	
	E2FL	E - Estuarine System
		2 - Intertidal Subsystem
		FL - Flat (Class)
Example 4.	Marine Flat	
	M2FL	M - Marine System
		2 - Intertidal Subsystem
		FL - Flat (Class)

Each polygon containing these codes was identified and measured to develop the acreage figures shown in the text. Estuarine and Marine Flats were also combined to be listed as Tidal Flats.