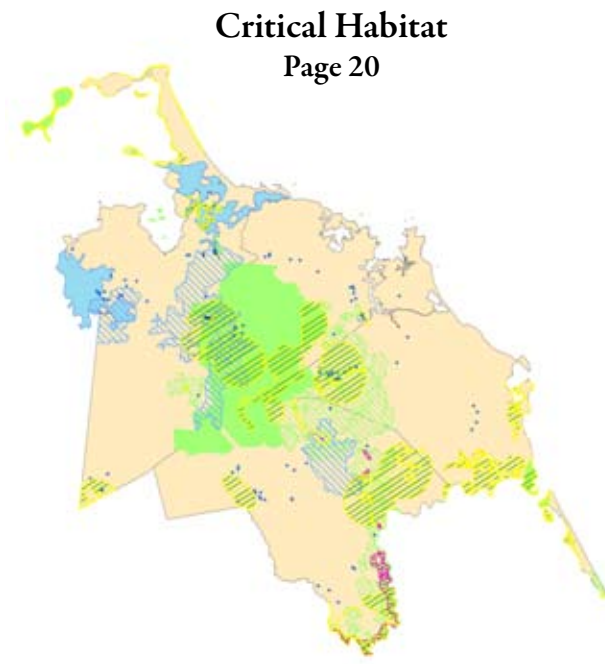
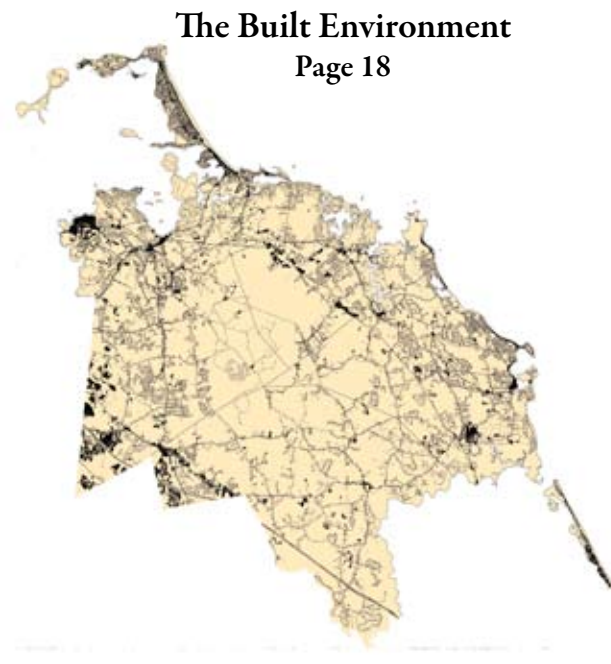
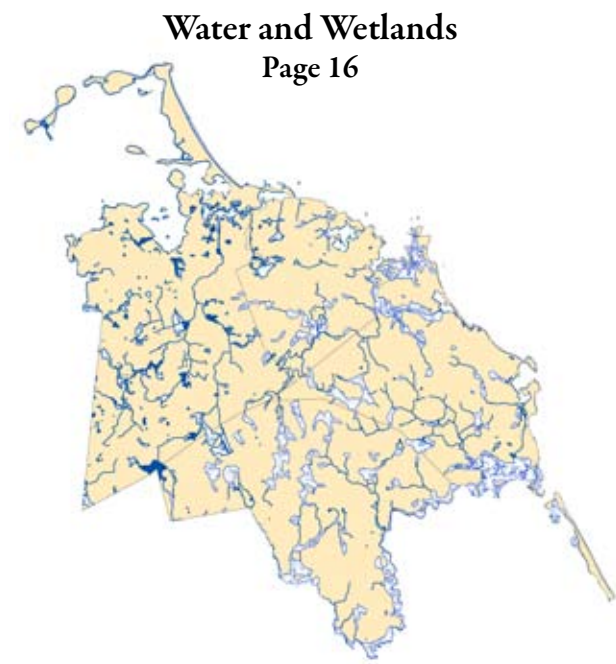


## Introduction: Physical Environment

Five key analyses of the study region—topography, open space, water and wetlands, the built environment, and sensitive environmental areas—are presented in this chapter. These analyses suggest directions for the future greenway. In summary these are:

- The greenway should skirt low-lying coastal regions to avoid future flooding.
- The greenway should make use of the resources provided by Wompatuck State Park and other already protected open space.
- The greenway should respect the ecological importance of water in the region.
- The greenway should act to buffer streams and wetlands from run-off from impervious surfaces.
- The greenway should act to preserve or enhance wildlife habitat integrity.



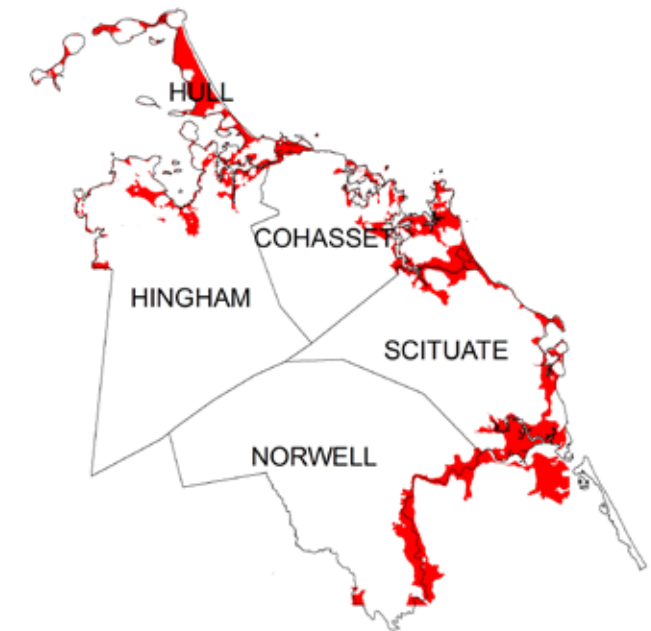
## Global Warming and Sea Level Change

The increase in sea level as a result of global warming is largely being caused by the thermal expansion of water and the melting of land ice (especially in Antarctica). The latter is particularly hard to predict and overall sea-level rise thus includes a number of potential sources of error (global warming calculations, ice flow models, etc.). The admittedly cautious estimates of the Intergovernmental Panel on Climate Change (4th Assessment Report, 2007) range from an increase of 21 cm to 70 cm by 2099 with an additional 10 to 20 cm or more possible arising from the unknown behavior of ice sheets. Estimates for the increase between 2100 and 2200 are on the order of 350 percent of the rise until 2100, even if the emission of the greenhouse gases that cause global warming stops immediately instead of continuing to grow as is currently the case. It is thus reasonable to expect an overall increase of three meters in mean sea level to occur sometime within the next two hundred years and possibly sooner.

Global warming also makes the overall weather system more energetic and is expected to lead to more frequent and stronger major storms.

## Topography

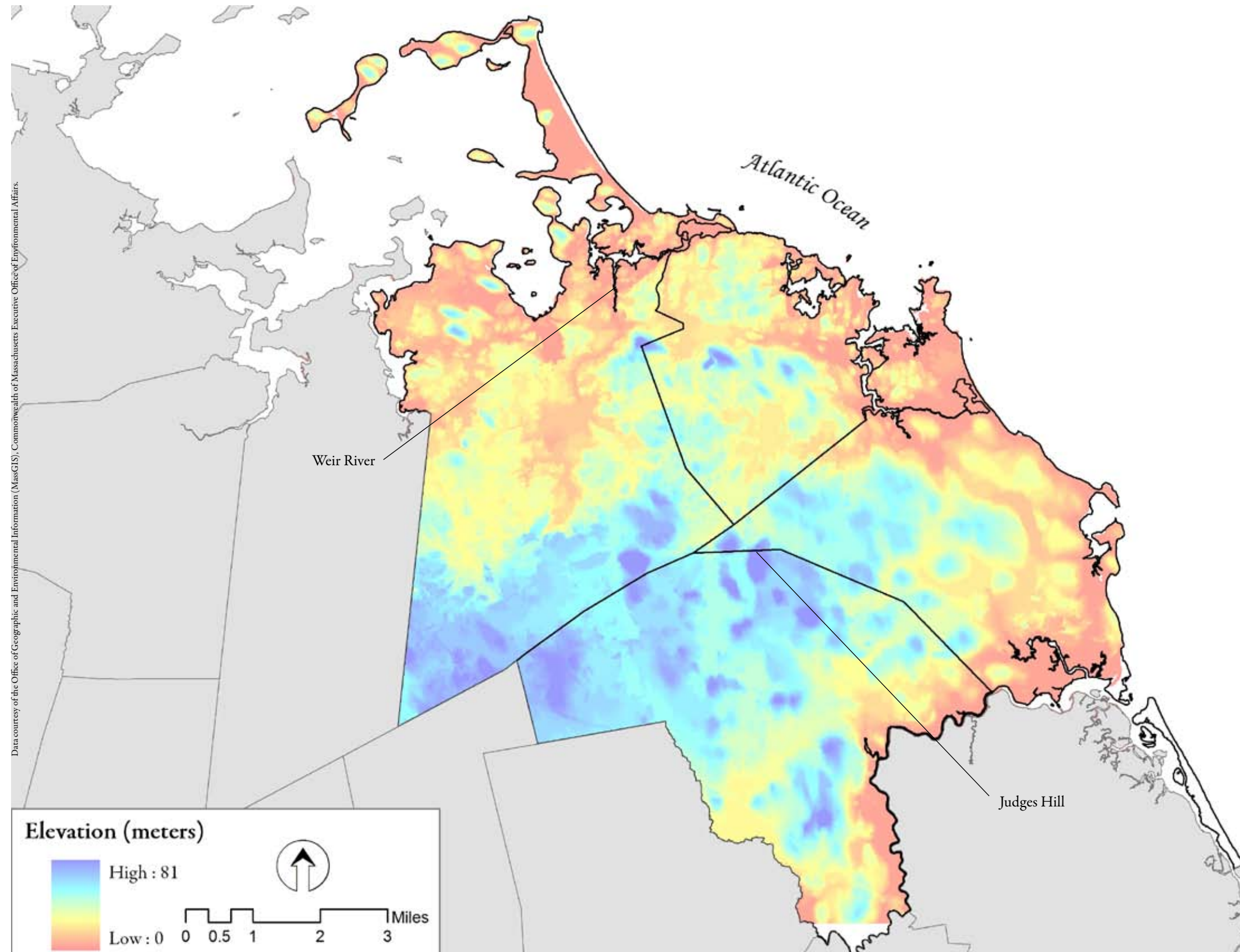
Elevation in the five towns ranges from sea level (0 meters) to 73 meters (240 feet) at Judges Hill in Norwell. Much of the coastal region (and virtually all of Hull) is low lying and vulnerable to rising sea levels associated with global warming.



The above map shows South Shore regions that will be submersed by a three-meter rise in sea level (see Global Warming and Sea Level, opposite). Large sections of Hull will be lost as well as significant coastal sections in Scituate and, to a lesser extent, in Cohasset. With the exception of Norwell, these at-risk areas are heavily urbanized. In addition, the more energetic storms and increased storm surges associated with global warming will cause increased flooding in low-lying areas well before sea level rise reaches three meters.

Further development in areas at risk should be slowed or halted. Non-vehicle transport should be promoted to reduce greenhouse gas emission and help reduce global warming.





### Chapter 61 Protection

In the early 1970s, rising property values forced many farmers and forestland owners to sell their land because the tax burden was so great. Farmers, conservationists, and landowners formed a coalition to promote an amendment to the Massachusetts Constitution allowing preferential assessment of property.

The constitutional referendum passed in 1973 and Massachusetts voters approved legislation known as Chapter 61, the Forestland Act; Chapter 61A, the Farmland Assessment Act; and Chapter 61B, the Open Space Act.

These new laws required cities and towns to reduce assessments on farm, forest, and open space lands, provided the owners made a commitment to keep their land in one or more of those uses. It is a voluntary form of conservation.

A provision of these statutes grants cities and towns right of first refusal on lands classified under Chapter 61, if lands are sold for residential, commercial, or industrial purposes. The right of first refusal grants the city or town the right to match a bona fide offer for conversion of the property from its forest, agricultural, or recreational use.

## Open Space

Open space (defined as conservation lands and outdoor recreational facilities) constitutes over 28 percent of the 47,600 acres in this region with the dominant landholders being the state and municipalities (approximately 3,900 and 6,600 acres respectively). Land trusts and assorted private landowners each own about 1000 acres (this figure includes Chapter 61 land; see left). Other categories of ownership account for the remaining small holdings.

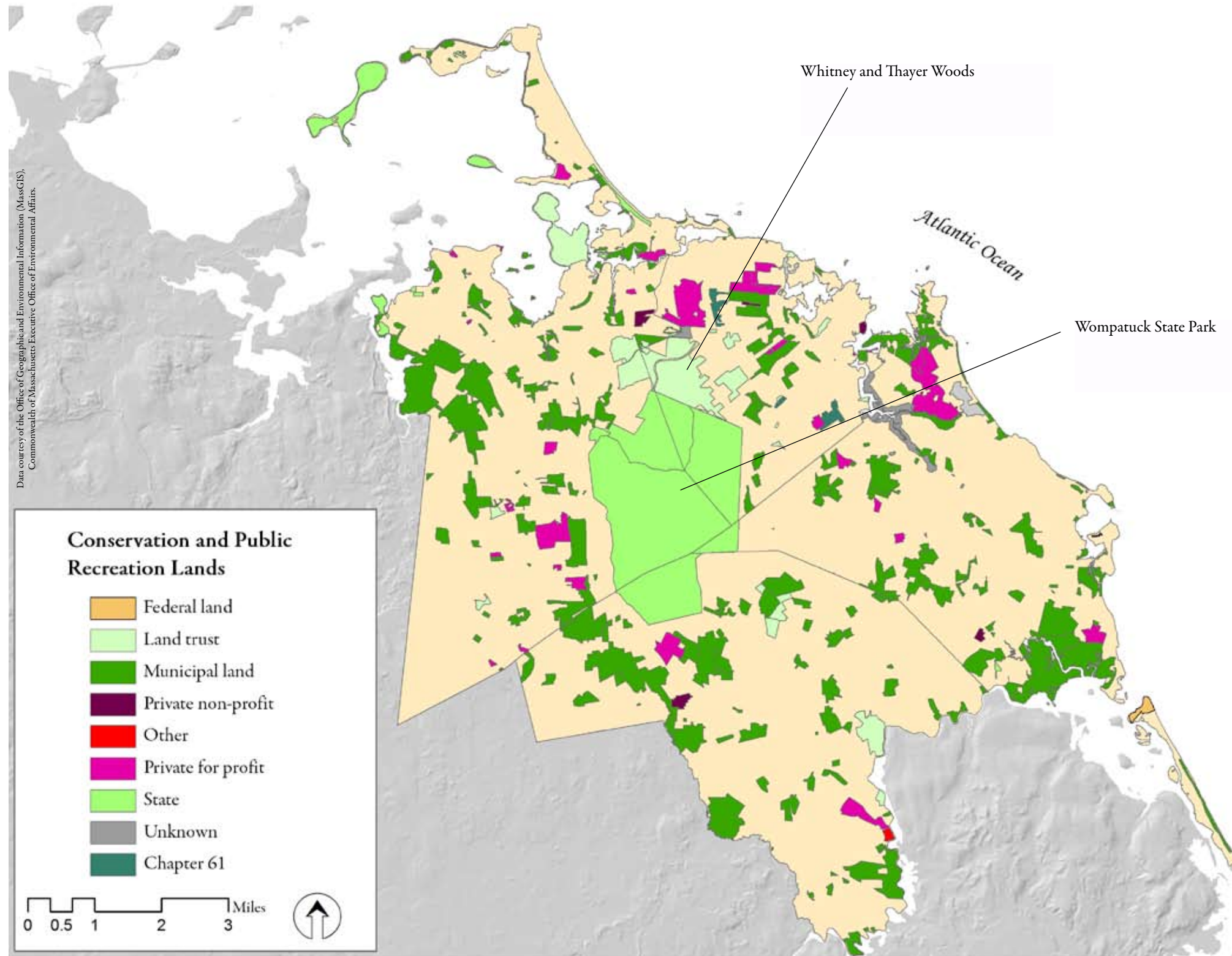
The region’s open space is dominated by the 3,600-acre Wompatuck State Park which lies at the intersection of Cohasset, Scituate, Norwell, and Hingham. The adjacent land trust property to the north, Whitney and Thayer Woods, provides an additional 640 acres of continuous conservation land. The remaining open space is heavily fragmented with one near-continuous chain running diagonally down the west flank of the region.

Wompatuck State Park provides a core of wildlife habitat and outdoor recreational opportunities in the study region. An extensive road and trail network provides cross-region connection and the opportunity for direct experience of nature. Greenways should maximize their use of this resource.

South Shore Open Space Acreage by Ownership

Ownership	Acreage	Percentage of Total Land Area
Federal	40	0.1
State	3929	8.3
Municipal	6623	13.9
Land Trust	1303	2.7
Private (non profit)	85	0.2
Private (for profit)	1068	2.2
Chapter 61	93	0.2
Other Categories	14	0.03
Unknown	192	0.4
Total	13348	28.1





### The Wetlands and River Protection Acts

Wetlands are sponges, absorbing rainwater and trapping sediments. They are essential to healthy fish, shellfish, bird, and wildlife populations. They are important to human survival as they provide flood control and help ensure an abundant and clean water supply. Massachusetts was the first state in the nation to officially recognize the importance of wetlands when they passed the Wetlands Protection Act in 1963.

The act treats wetlands as a resource whose essential functions must be protected. It applies to all freshwater and coastal waterways and waterbodies—rivers, streams, lakes, ponds, marshes, swamps, bogs, beaches, dunes, and estuaries as well as to the flood plain. The act creates a 100-foot buffer zone around waterways and bodies of water.

In 1996, Massachusetts adopted a new law to expand riverfront protection. As defined by the law, riverfronts include dry land as well as wetlands. Wet or dry, riverfront areas protect water quality, stabilize stream banks, reduce flood peaks and downstream

flooding, and support fish and wildlife habitat. The law created a 200-foot riverfront buffer zone on both sides of rivers and streams. The buffer zone is 25 feet in certain densely populated urban areas. The law was created with drinking water supply in mind. Almost 200 public wells are within riverfront areas; more than 60 percent of Massachusetts towns depend on surface water (lakes, rivers, streams as opposed to underground aquifers) for their drinking water.

Any proposed work inside the wetland and riverfront buffer zones must be reviewed by the local Conservation Commission or the Massachusetts Department of Environmental Protection. The proposed work will be evaluated for its impact on wetland and riverfront functions. The act prohibits work which:

- adversely affects the quality or quantity of groundwater and water supplies;
- destabilizes stream, river, lake, or pond banks;
- damages habitat for fish or wildlife;
- reduces water volume or flow;
- alters the flood plain;
- increases water velocity during a flood;

Further information can be found at <http://www.mass.gov/dep/water/resources/wetlands.htm>

### Water and Wetlands

Surface water (lakes, streams, rivers, and ponds), wetlands (swamps and bogs), and tidal flats comprise just under 19 percent acres of the 47,600 acres of this region and have varying degrees of legal protection (see left).

This network of water plays an essential part in the health of the local ecosystem: it regulates river flow and mitigates flooding, it filters pollutants and fertilizers, it provides habitat zones for plants and animals, and it provides corridors along which wildlife can move. Of special note are the three estuaries in the region: the Weir, the Gulf, and the North. Estuaries are one of the most ecologically important habitats on earth because they provide habitat for many species of waterfowl and serve as nurseries for many species of marine life.

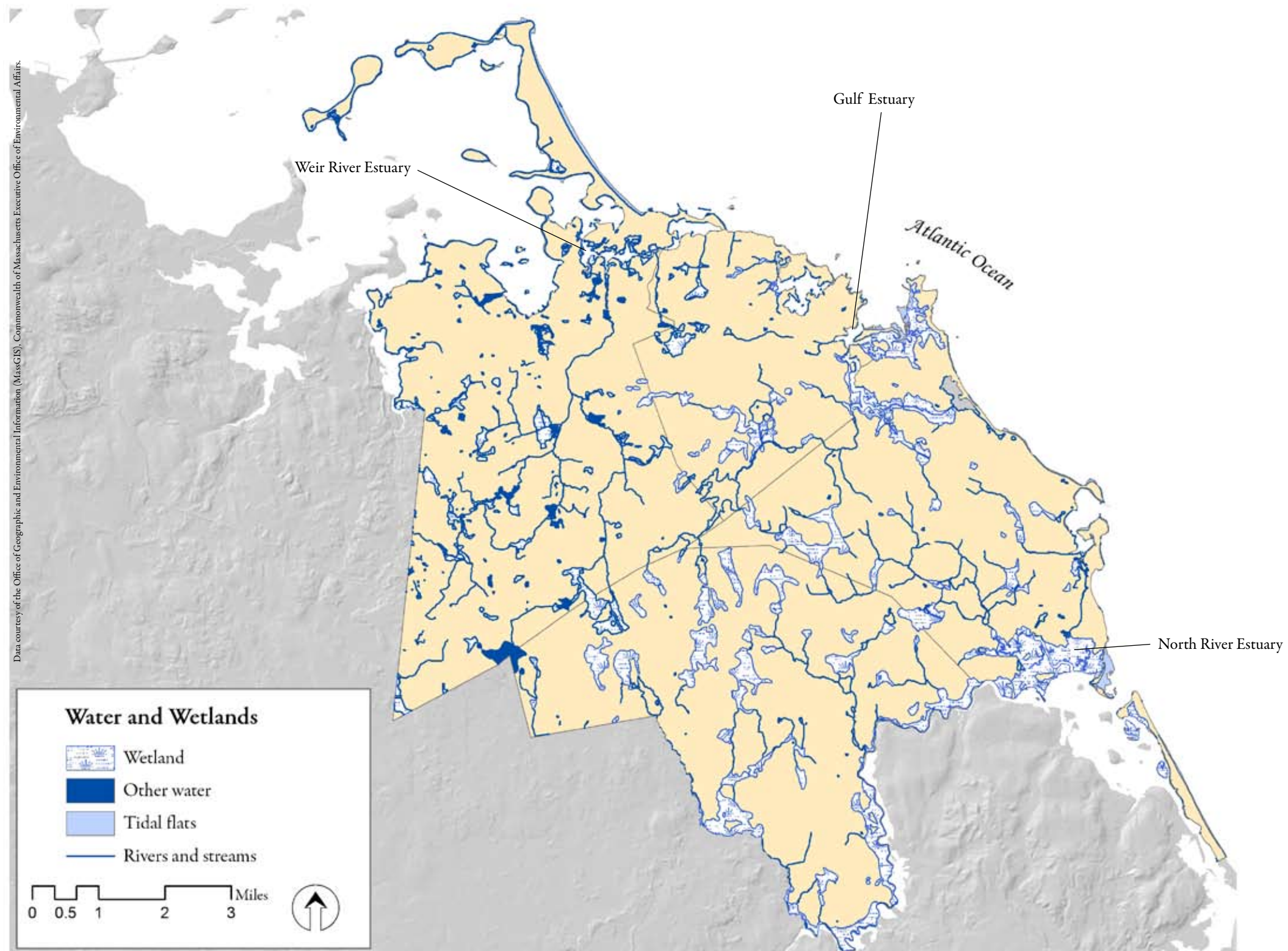
Water has shaped the history of the region through the ship-building and fishing industries, and it continues to do so through its natural beauty and its use for recreation (boating, sailing, kayaking, fishing, and many others). Much of the region's drinking water is obtained from surface water. Cohasset, in particular obtains its drinking water from Lily Pond.

Legal restrictions, the ecological importance of waterways and wetlands, and the importance of preventing pollutants entering the drinking water supply all have to be respected by the greenway.

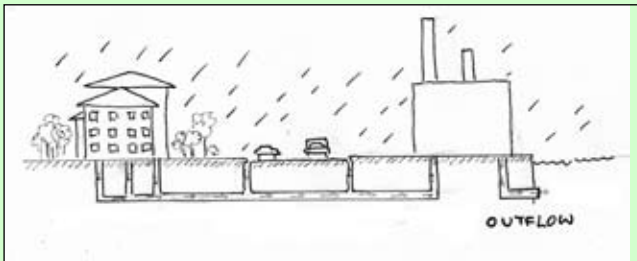
South Shore Wetlands Acreage by Type

Category	Acreage	Percentage of Total Land Area
Surface water	1656	3.5
Wetland	4669.9	9.8
Tidal flats	2630.8	5.5
Cranberry bog	27.3	0.1
Total	8984.5	18.9

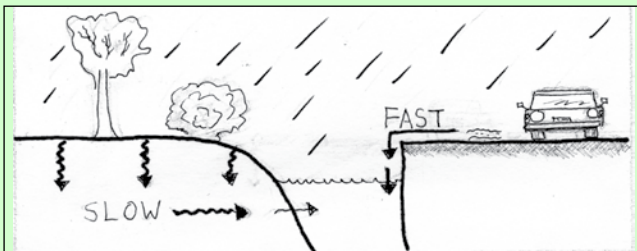




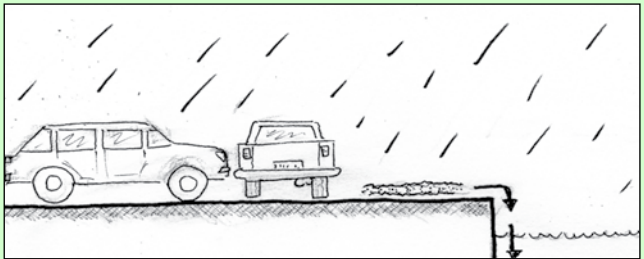
## Effects of Impervious Surfaces



In combined sewer outflow systems water collected from storm drains in streets and parking lots is treated along with sewage. Storms cause an increased load on the water treatment facilities, possibly overwhelming them and leading to direct discharge of untreated sewage.



Impervious surfaces increase the rate at which rain from storms enters waterways. This causes higher levels of erosion and possible flooding. In addition to the damage done to stream and river banks, erosion washes sediment into the rivers and streams, clouding water, clogging fish gills, and suffocating fish eggs.



Surface pollutants (oil, gasoline, rubber) build up on surfaces then wash off into nearby water and waterways.

## The Built Environment

The built environment consists of manmade structures. A major environmental problem results from impervious surfaces—the totality of roads, parking lots, buildings, paved surfaces, and other structures—preventing the infiltration of rainwater into the soil beneath where cleaning and aquifer recharge normally occur (see left). In this study region impervious surfaces comprise 13 percent of the total area (i.e., approximately 6,200 acres of the 47,600 acre region) and include over 600 miles of roads. Impervious surfaces are concentrated along the coast (Hull is notably heavily built up) and along Route 3 (in the southwest quadrant of the study region) and Route 3A (in the northeast of the area). Hingham, to the northwest, is also heavily developed.

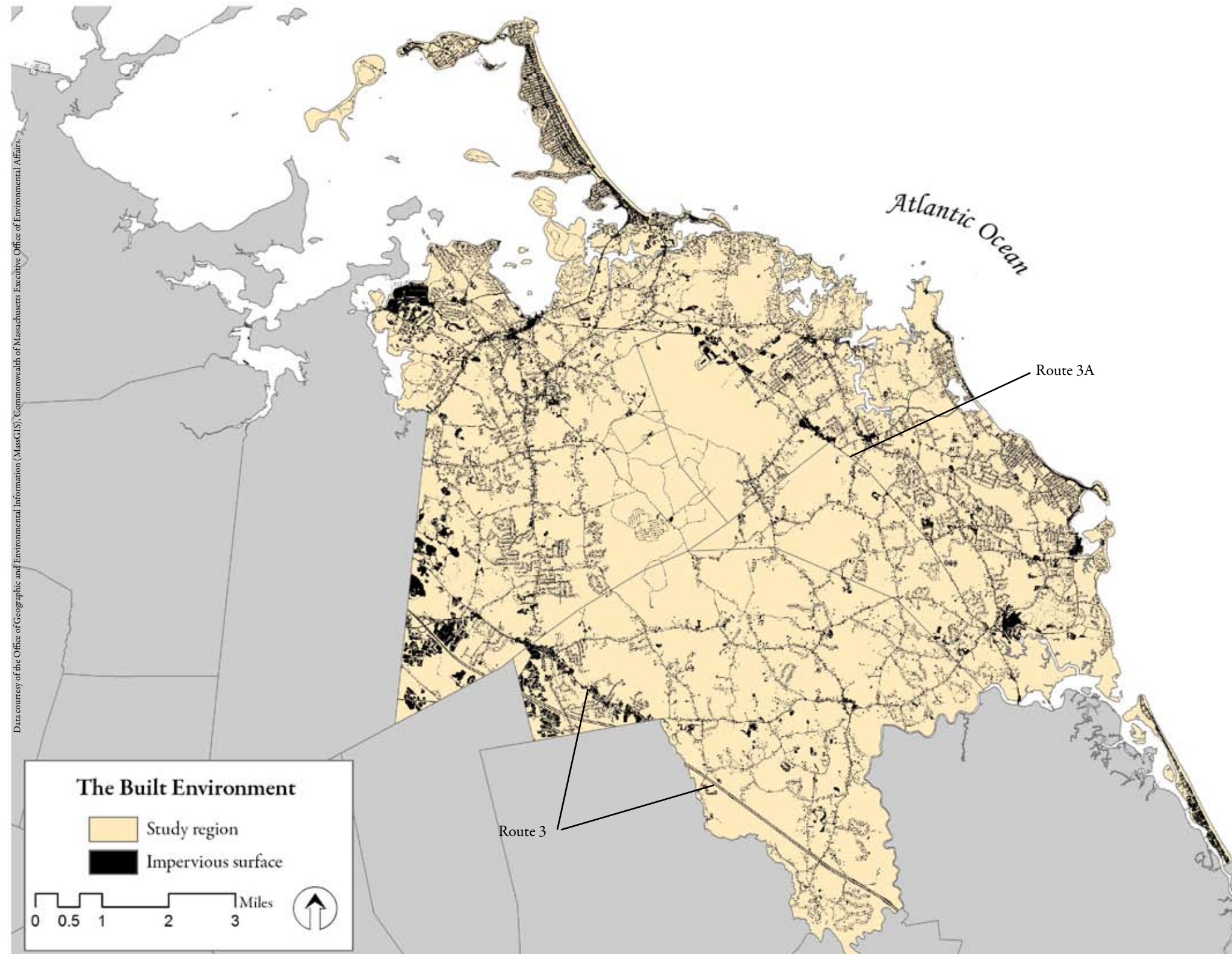
Percentage of Impervious Surfaces by Town

Town	Percentage
Hull	30
Hingham	15
Scituate	12
Cohasset	11
Norwell	9
Area Weighted Average	13

Recent research (*Clausen et al.*, 2003) indicates that by the time impervious surfaces reach 25 percent by area, then substantial pollution of surface water will have already occurred. Only Hull has exceeded this threshold, and since the town has no surface water, this implies that significant surface pollution is being discharged into the ocean. With the exception of Norwell, however, the towns fall into the 10-25 percent range, where streams are at risk of water quality problems.

Where possible, greenways should buffer wetlands and surface water from impervious surfaces by slowing and filtering surface run-off. Any paving should be porous to allow rain water infiltration.





### Endangered Species in Massachusetts

There are ten species of fish, five species of amphibians, fifteen species of reptiles, twenty-eight species of birds, and eleven species of mammals listed as endangered, threatened, or of special concern in Massachusetts. In addition there are 109 species of invertebrates (including 48 species of butterfly and moth) and 264 species of plants similarly listed.



Special Concern: Least Tern



Special Concern: Four-toed Salamander

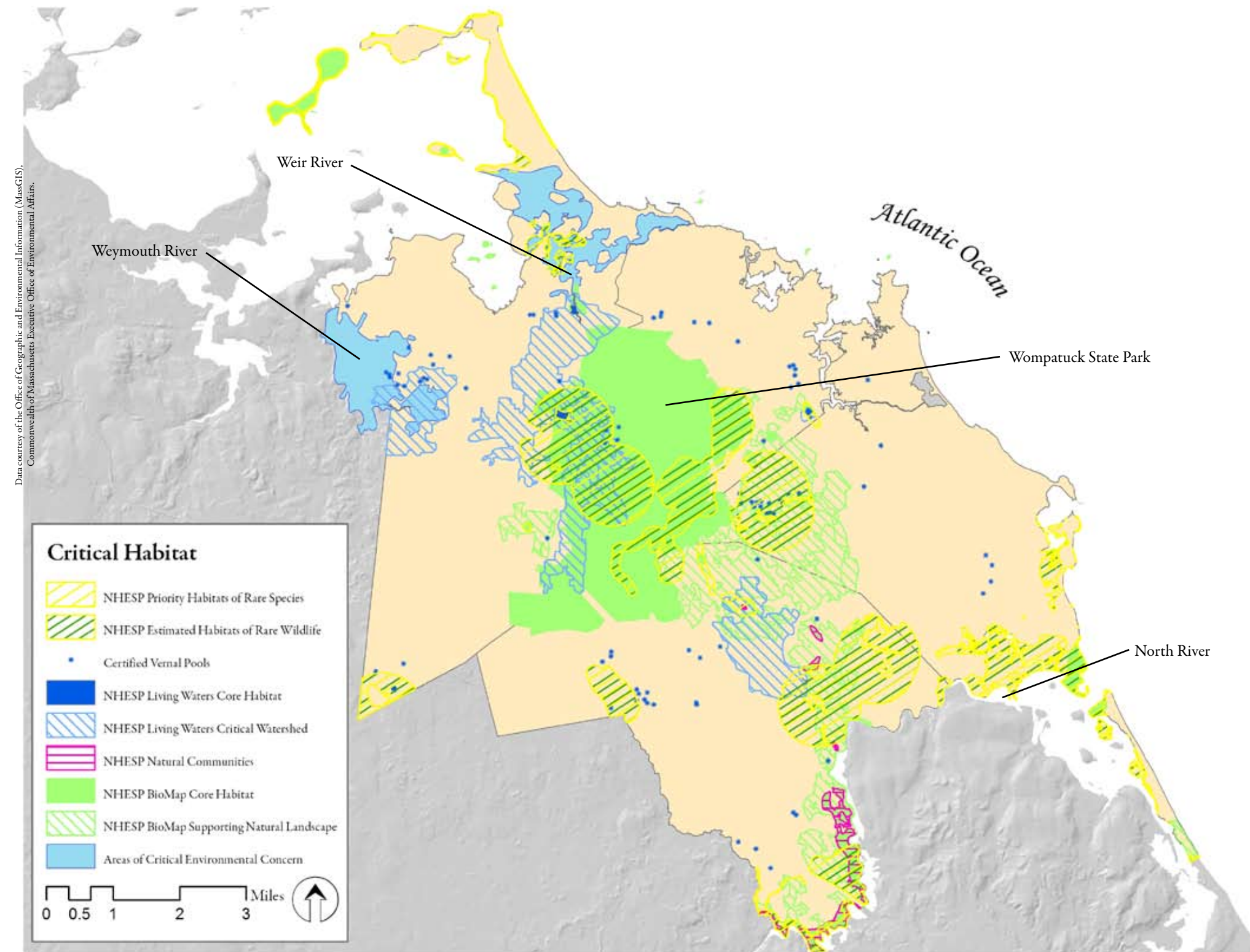
### Critical Habitat

The Natural Heritage and Endangered Species Program (NHESP) is responsible for the protection of hundreds of species that are not hunted, fished, trapped, or commercially harvested in the state. The program’s highest priority is protecting the 178 species of vertebrate and invertebrate animals and 264 species of native plants that are officially listed as endangered, threatened or of special concern in Massachusetts. Information about which animal or plant is under protection in each area is restricted. Instead, only their habitats are mapped. These priority habitats help determine whether or not a proposed project must be reviewed for compliance with the Massachusetts Endangered Species Act (MESA). Certified vernal pools may also be protected under the Wetlands Protection Act (WPA). Also shown on the map are areas of critical environmental concern (ACEC) as designated by the Massachusetts Secretary of Environmental Affairs. ACECs receive special recognition because of the significance of their natural and cultural resources. Such areas are identified and nominated at the community level. ACEC designation creates a framework for local, regional, and state stewardship of these critical resources.

The areas of special value in terms of habitat and associated supporting landscape are largely concentrated in a broad corridor from the North River in the southeast, through Wompatuck State Park, and to the Weir River estuary in the northwest. The Weymouth River on the western edge of Hingham and the Weir River estuary bordering Hull are areas of critical environmental concern.

Greenway development should act to preserve or enhance habitat integrity by connecting separated open spaces or by buffering water and wetlands from pollution.





Endangered Species in the Study Region

Town	Taxonomic Group	Scientific Name	Common Name	Status	Last Seen
COHASSET	Bird	<i>Gavia immer</i>	Common Loon	SC	1922
	Butterfly / Moth	<i>Cingilia catenaria</i>	Chain Dot Geometer	SC	Historic
	Butterfly / Moth	<i>Eacles imperialis</i>	Imperial Moth	T	1934
	Butterfly / Moth	<i>Spartiniphaga inops</i>	Spartina Borer Moth	SC	Historic
	Dragonfly / Damselfly	<i>Neurocordulia obsoleta</i>	Umber Shadowdragon	SC	2004
	Dragonfly / Damselfly	<i>Somatochlora linearis</i>	Mocha Emerald	SC	2003
	Dragonfly / Damselfly	<i>Enallagma daeckii</i>	Attenuated Bluet	SC	2003
	Vascular Plant	<i>Ophioglossum pusillum</i>	Adder's-tongue Fern	T	Historic
	Vascular Plant	<i>Rumex verticillatus</i>	Swamp Dock	T	1996
	Vascular Plant	<i>Rumex pallidus</i>	Seabeach Dock	T	1876
HINGHAM	Bird	<i>Podilymbus podiceps</i>	Pied-billed Grebe	E	1977
	Bird	<i>Tyto alba</i>	Barn Owl	SC	1970
	Butterfly / Moth	<i>Spartiniphaga inops</i>	Spartina Borer Moth	SC	2001
	Dragonfly / Damselfly	<i>Anax longipes</i>	Comet Darner	SC	2001
	Reptile	<i>Glyptemys insculpta</i>	Wood Turtle	SC	1979
	Reptile	<i>Terrapene carolina</i>	Eastern Box Turtle	SC	2004
	Vascular Plant	<i>Ophioglossum pusillum</i>	Adder's-tongue Fern	T	1893
	Vascular Plant	<i>Platanthera flava</i> var. <i>herbiola</i>	Pale Green Orchid	T	1915
	Vascular Plant	<i>Ranunculus pensylvanicus</i>	Bristly Buttercup	T	1885
	Vascular Plant	<i>Ranunculus micranthus</i>	Tiny-flowered Buttercup	E	1800s
	Vascular Plant	<i>Rumex pallidus</i>	Seabeach Dock	T	2001
	Vascular Plant	<i>Asclepias verticillata</i>	Linear-leaved Milkweed	T	1914
HULL	Bird	<i>Sterna hirundo</i>	Common Tern	SC	2003
	Bird	<i>Tyto alba</i>	Barn Owl	SC	1989
	Vascular Plant	<i>Rumex pallidus</i>	Seabeach Dock	T	2004
	Vascular Plant	<i>Triosteum perfoliatum</i>	Broad Tinker's-weed	E	1890

Town	Taxonomic Group	Scientific Name	Common Name	Status	Last Seen
NORWELL	Dragonfly / Damselfly	<i>Somatochlora linearis</i>	Mocha Emerald	SC	2003
	Dragonfly / Damselfly	<i>Enallagma laterale</i>	New England Bluet	SC	2003
	Reptile	<i>Terrapene carolina</i>	Eastern Box Turtle	SC	2004
	Vascular Plant	<i>Platanthera flava</i> var. <i>herbiola</i>	Pale Green Orchid	T	1981
	Vascular Plant	<i>Eriocaulon parkeri</i>	Estuary Pipewort	E	1997
	Vascular Plant	<i>Sagittaria subulata</i>	River Arrowhead	E	1928
	Vascular Plant	<i>Lycopus rubellus</i>	Gypsywort	E	2000
	Vascular Plant	<i>Senna hebecarpa</i>	Wild Senna	E	Historic
	Vascular Plant	<i>Bidens hyperborea</i> var. <i>colpophila</i>	Estuary Beggar-ticks	E	2003
	Vascular Plant	<i>Conioselinum chinense</i>	Hemlock Parsley	SC	1998
SCITUATE	Amphibian	<i>Hemidactylium scutatum</i>	Four-toed Salamander	SC	2002
	Beetle	<i>Cicindela purpurea</i>	Purple Tiger Beetle	SC	1935
	Bird	<i>Charadrius melodus</i>	Piping Plover	T	2002
	Bird	<i>Sterna hirundo</i>	Common Tern	SC	2004
	Bird	<i>Sterna paradisaea</i>	Arctic Tern	SC	1932
	Bird	<i>Sterna antillarum</i>	Least Tern	SC	2004
	Reptile	<i>Terrapene carolina</i>	Eastern Box Turtle	SC	2002
	Vascular Plant	<i>Aristida tuberculosa</i>	Seabeach Needlegrass	T	1998
	Vascular Plant	<i>Platanthera flava</i> var. <i>herbiola</i>	Pale Green Orchid	T	1916
	Vascular Plant	<i>Sabatia kennedyana</i>	Plymouth Gentian	SC	1914
	Vascular Plant	<i>Suaeda calceoliformis</i>	American Sea-blite	SC	1987
	Vascular Plant	<i>Sanicula canadensis</i>	Canadian Sanicle	T	1933

E = Endangered, T =Threatened, SC = Special Concern

For further information on the NaturalHeritage and Endangered Species Program see <http://www.mass.gov/dfwele/dfw/nhesp/nhesp.htm>