

ResilientCoasts

FINAL PLAN

APPENDIX V

Publicly Accessible Beach Vulnerability Technical Documentation



ResilientMass



ResilientCoasts

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Technical Documentation for Publicly Accessible Beach Vulnerability

1 | Introduction

The Massachusetts coast is largely composed of sandy and gravelly beaches interspersed with rocky headlands, developed shoreline, and salt marsh. Beaches make up a majority of coastline exposed to waves and coastal storms and provide significant economic and ecological value, tourism revenue, coastal flood defense, and biodiversity. Like many natural features, beaches are subject to numerous threats including rising sea levels, erosion, and human interference.

Human alteration of the shoreline in the form of shoreline stabilization structures (revetments, groins, seawalls, bulkheads, etc.) is designed to block or alter the natural movement of sand and other sediment across and along the coast (longshore drift). Updrift accretion occurs when sand gets trapped on the side of a shore-perpendicular structure that faces prevailing currents, building up the beach. Concurrently, downdrift erosion occurs on the opposite side of the structure with the shortage of sediment leading to beach loss. Seawalls and other vertical shore-parallel structures reflect wave energy back towards the shore, which can concentrate wave force and accelerate erosion in front of the structure.

More research is needed to better understand the relative long-term vulnerability of Massachusetts beaches to climate change and other forces; however, some publicly available data can help identify areas at more or less risk. To narrow the focus on the beaches that currently provide the greatest public benefits, this analysis was limited to publicly accessible beaches (both publicly and privately-owned) on, mostly, the ocean-facing shoreline. The following section details the analysis of stretches of publicly accessible beaches along the Massachusetts coast that are most at risk for erosion and potential disappearance, using publicly available data, statewide and for each Coastal Resilience District.

2 | Publicly Accessible Beach Vulnerability

The primary data sources used to analyze beach vulnerability were:

- Massachusetts Shoreline Change Transects¹
- Massachusetts Department of Environmental Protection Wetlands dataset²
- Massachusetts Shoreline Stabilization Structures dataset³
- Massachusetts Land Cover/Land Use dataset⁴
- Massachusetts Protected and Recreational Open Space dataset⁵

¹ Massachusetts shoreline change transects (1970-2018), available at: <https://www.sciencebase.gov/catalog/item/60ff22dad34e3ccd830d62aa>

² MassDEP Wetlands dataset (2005), December 2017, available at: <https://www.mass.gov/info-details/massgis-data-massdep-wetlands-2005>

³ MA Shoreline Stabilization Structures dataset, available at: <https://czm-moris-mass-eoea.hub.arcgis.com/mapTht/s/14938ac47b43427f87a96231fc1eacc5/about>

⁴ MA Land Cover/Land Use (2016) dataset, available at: <https://www.mass.gov/info-details/massgis-data-2016-land-coverland-use>

⁵ MA Protected and Recreational OpenSpace (2025) dataset, available at: <https://www.mass.gov/info-details/massgis-data-protected-and-recreational-openspace>

Four datasets were used to understand the development conditions of the ocean-facing shoreline: Massachusetts Shoreline Change Transects (to identify whether beaches are eroding or have remained static), Massachusetts Department of Environmental Protection Wetlands dataset (to identify locations of beaches), Massachusetts Shoreline Stabilization Structures dataset (to identify locations of shoreline armoring), and Massachusetts Land Cover/Land Use dataset (to identify areas where the beach is backed by developed lands). The Massachusetts Protected and Recreational Open Space dataset was used to isolate only the beaches that are publicly accessible, whether publicly or privately-owned.

The focus on publicly accessible beaches is important because in many districts these community assets are limited. Where limited publicly accessible beaches are vulnerable and threaten to further narrow or disappear over time, a critical public resource may be lost. To identify which stretches of publicly accessible beach, as identified with the MassGIS Protected and Recreational Open Space data layer, along the coast are vulnerable to erosion (both horizontal and vertical) and even potential disappearance with sea level rise, the analysis first identified Massachusetts beaches that have eroded or remained relatively static over the past approximately 50 years. As dynamic features, some beaches have accreted (accumulated sand rather than lost it) during that timeframe, and those beaches were excluded from the analysis and commensurately considered not vulnerable for the purposes of this exercise.

To focus the analysis on publicly accessible beaches with the highest potential vulnerability, vulnerable beaches with human alterations – shoreline stabilization structures (armoring) and backed by developed lands in the form of commercial, residential, or other development including roads and other impervious surface – were identified. The reasoning for the combination of these three criteria is that while developed shorelines are vulnerable to erosion because of the impact they have on natural, dynamic processes of beaches, developed shorelines that have been armored are even more vulnerable because they interrupt sediment transport and often reflect wave energy, intensifying scouring at the base and along adjacent unprotected areas. Ultimately, the analysis isolated publicly accessible beaches that met all the following criteria: eroding or static (i.e., non-accreting), armored, and backed by development; collectively, these beaches are considered "highly vulnerable" and are identified in the far-right column in the table below.

Table 1. Publicly Accessible Beach Vulnerability by Coastal Resilience District

Coastal Resilience District	Assessed Shoreline*	Vulnerable Public Beach**		Vulnerable Developed Public Beach	Vulnerable Armored Public Beach	Highly Vulnerable Public Beach***	
	Miles	Miles	% of Assessed Shoreline	Miles	Miles	Miles	% of Vulnerable Public Beach
Boston Harbor Islands	25.6	11.1	43%	0	3.6	0	0%
Buzzards Bay	152.3	27.3	18%	9.7	9.1	6.3	23%
Great Marsh	30.6	20.4	67%	4.2	1.2	0.8	4%
Islands	192.4	47.3	25%	10.5	3.9	3.1	7%
Manomet-Sagamore	14.8	2.3	16%	1.5	1.2	1.2	51%
Mid-North Shore	82.9	8.0	10%	5.8	7.1	5.4	68%
Mid-South Shore	57.7	10.4	18%	3.2	3.0	2.4	23%
Mystic-Charles Watersheds	8.1	0.7	9%	0.7	0.6	0.6	86%
Neponset-Weir Watersheds	45.9	9.0	20%	4.4	6.5	4.2	47%
North Cape Cod	73.8	28.7	39%	7.4	3.7	2.9	10%
Outer Cape Cod	86.3	32.7	38%	3.7	0.9	0.4	1%
Saugus Watershed	29.6	6.9	23%	5.7	6.3	5.7	83%
South Cape Cod	47.9	9.6	20%	5.1	5.5	4.2	44%
Total	848.0	214.5	25%	62	52.6	37.2	17%

*Assessed shoreline includes miles of exposed ocean-facing shoreline.

**Vulnerable Public Beach for this analysis is isolated as those beaches which are publicly accessible and have either eroded or remained static over the past approximately 50 years (i.e., non-accreting) based on the Massachusetts Shoreline Change Transects (1970-2018).

***Highly Vulnerable Public Beach for this analysis meets the criteria for Vulnerable Public Beach and are backed by development and armored with shoreline stabilization structures (including groins, bulkheads, and seawalls).

3 | Data Methods

Step 1. Create input data.

- A. *Static or eroding shoreline*. Open [Massachusetts shoreline change transects \(1970-2018\)](#) and extract features with the following attributes to a new line feature class (*Static or eroding shoreline transects line*).

SYMBOLGY = ERODING

SYMBOLGY = NO STATISTICAL CHANGE

Buffer the transects 40 meters to create a polygon feature class (*Static or eroding shoreline poly*).

- B. *2018 Shoreline*. Open [Massachusetts shorelines \(1800s-2018\)](#) and extract the following attribute to a new class (*2018 Shoreline*).

Year = 2018

- C. *Beaches*. Open [MassGIS Data: MassDEP Wetlands \(2005\), December 2017](#) and extract the following attributes to a new feature class (*Beaches*):

IT_VALDESC = BARRIER BEACH SYSTEM

OR IT_VALDESC = BARRIER BEACH-COASTAL

OR IT_VALDESC = BEACH

OR IT_VALDESC = BARRIER BEACH-COASTAL DUNE

OR IT_VALDESC = COASTAL BEACH

OR IT_VALDESC = COASTAL DUNE

- D. *Public access*. Open [MassGIS Data: Protected and Recreational OpenSpace](#) and extract the following features to a new feature class (*Public access*).

PUBLIC_ACCESS = Y - FULL PUBLIC ACCESS

- E. *Armored*. Open [Shoreline Stabilization Structures](#) and remove the following features to create a new feature class of hardened shoreline stabilization structures (*Armored*):

PrimaryMaterial ≠ Sandbags

PrimaryType ≠ Sandbags

- F. *Developed shoreline*. Open [MassGIS Data: 2016 Land Cover/Land Use](#) and extract all the following attributes to a new feature class (*Developed shoreline*):

Generalized Use Name = Commercial, Industrial, Mixed use, primarily commercial, Mixed use, primarily residential, Residential – multi-family, Residential single family, Residential – single family.

Generalized Use Name = Recreation AND Land Cover Name = Impervious

USEGENNAME = Tax exempt AND COVERNAME = Impervious

USEGENNAME = Right-of-way AND COVERNAME = Impervious

Step 2. Create a derived layer of *Static or Eroding Shoreline poly / Beaches* consisting of the transects from *Static or eroding shoreline transects poly* that intersect *Beaches*.

Step 3. Create a derived layer of *Static or Eroding Shoreline poly / Beaches / Public* by selecting all *Static or Eroding Shoreline poly / Beaches* polygons that intersect *Public Access*.

Step 4. Create a derived layer of *Static or Eroding Shoreline poly / Beaches / Public / Armored* by selecting all *Static or Eroding Shoreline / Beaches / Public* polygons that intersect *Armored*.

Step 5. Create a derived layer of *Static or Eroding Shoreline poly / Beaches / Public / Developed* by selecting all *Static or Eroding Shoreline / Beaches / Public* polygons that intersect *Developed*.

Step 6. Create a derived layer of *Static or Eroding Shoreline poly / Beaches / Public / Armored / Developed* by selecting *Static or Eroding Shoreline poly / Beaches / Public / Developed* that intersect *Armored* and creating a new feature class (*Static or Eroding Shoreline poly / Beaches / Public / Armored / Developed*).

Step 7. Clip the *2018 Shoreline* with the following data layers to create new derived vector feature classes (*Static or Eroding Shoreline / Beaches / Public - 2018 Shoreline*, etc.).

Static or Eroding Shoreline / Beaches / Public

Static or Eroding Shoreline / Beaches / Public / Armored

Static or Eroding Shoreline / Beaches / Public / Developed

Static or Eroding Shoreline / Beaches / Public / Armored / Developed

Step 8. Use the Identity tool to create the geometric intersection of all feature layers developed in Step 7 with the *Coastal Resilience Districts* feature class.

Step 9. Calculate the length of coastline in each resultant feature class broken by Coastal Resilience District boundaries.



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