ResilientCoasts

FINAL PLAN

APPENDIX IV

Salt Marsh Loss and Migration Technical Documentation

November 2025

Technical Documentation for Salt Marsh Loss and Migration

1 | Introduction

Increases in sea level, precipitation, and air and water temperature, pose a serious threat to salt marshes. Increased sea levels will result in salt marsh change and loss, particularly for locations where the opportunity to migrate inland or into other wetlands is limited. The Massachusetts Sea Level Affecting Marshes Model (SLAMM) dataset was used to derive salt marsh loss and salt marsh migration data for this analysis. The SLAMM dataset represents predictions of the extent and distribution of coastal wetlands under various sea level rise scenarios (SLR) for 2030, 2050, 2070, and 2100, beginning with 2011 (initial condition). The SLAMM Intermediate High SLR scenario was used for this analysis. It represents 4.5 feet of SLR from 2011 to 2100 in Boston and closely resembles the SLR scenario used in the Massachusetts Coast Flood Risk Model (MC-FRM), which forms the basis of the Coastal Resilience Districts (CRDs) and other analyses in the ResilientCoasts Plan (2025).

2 | Salt Marsh Loss

The primary data sources used to analyze salt marsh loss were:

- Massachusetts SLAMM 2011 Wetlands – Initial Condition[1]
- Massachusetts SLAMM 2100 Intermediate High SLR Scenario (4.5 feet from 2011 to 2100 in Boston)[2]

For this analysis, salt marsh is represented by the SLAMM wetland classes: Regularly Flooded Marsh and Irregularly Flooded Marsh, which effectively represent low marsh and high marsh, respectively. The focus of this analysis is potential loss of existing salt marsh; gains in salt marsh area by means of marsh migration, for example, are not considered (i.e., this is not an analysis of net loss of salt marsh). The reason for this is that a potential marsh migration area, whether it is currently upland or a freshwater wetland, should not be held in the same regard as an existing salt marsh. There is no guarantee that an area identified as potentially supporting salt marsh in the future will become salt marsh.

SLAMM data were analyzed to identify changes from 2011 salt marsh (SLAMM Regularly Flooded Marsh [CLASS ID=8] and Irregularly Flooded Marsh [CLASS ID=20]) to 2100 non-salt marsh with the 4.5-foot sea level rise scenario (Intermediate High SLR). Examples of non-salt marsh SLAMM classes include Tidal Flat, Estuarine Open Water, Open Ocean, etc.

[1] Massachusetts Office of Coastal Zone Management, 2019, Massachusetts SLAMM 2011 Wetlands—Initial Condition [FGDB].
[2] Massachusetts Office of Coastal Zone Management, 2019, Massachusetts SLAMM 2100 Wetlands – Int High SLR (4.5 ft) [FGDB].

The resulting salt marsh data were summarized by CRD as follows:

1. Present Day salt marsh area (acres) equates to the SLAMM 2011 Initial Condition salt marsh area (CLASS ID= 8 or 20).
2. Persistent salt marsh area (acres) equates to the SLAMM 2011 Initial Condition salt marsh area that is predicted to remain salt marsh in 2100 (2011 CLASS= 8 and 2100 CLASS=8; 2011 CLASS=20 and 2100 CLASS=20).
3. Loss area (acres) equates to SLAMM 2011 Initial Condition salt marsh area that is predicted to convert to something other than salt marsh (essentially, 2011 CLASS=8 and 2100 CLASS≠8 or 20; 2011 CLASS=20 and 2100 CLASS≠8 or 20).

Salt marsh loss data summaries by CRD are provided in the table below.

Table 1. Potential Salt Marsh Loss with 4.5 Feet of Sea Level Rise

Coastal Resilience District	Salt Marsh Area (acres)			% Loss
	Present Day	Persistent	Loss	
Boston Harbor Islands	52.3	38.2	14.1	27.0
Buzzards Bay	4,795.2	344.3	4,450.9	92.8
Great Marsh	16,850.4	14,739.7	2,110.7	12.5
Islands	1,944.8	463.1	1,481.7	76.2
Lower Merrimack	79.4	23.5	55.9	70.4
Manomet-Sagamore	70.7	50.7	20.0	28.2
Mid-North Shore	421.0	358.3	62.7	14.9
Mid-South Shore	5,589.6	4,738.9	850.7	15.2
Mystic-Charles Watersheds	193.3	124.6	68.7	35.5
Neponset-Weir Watersheds	1,402.9	1,189.8	213.1	15.2
North Cape Cod	9,882.9	7,404.0	2,478.9	25.1
Outer Cape Cod	2,771.2	724.7	2,046.5	73.8
Saugus Watershed	1,423.4	1,294.5	128.9	9.1
South Cape Cod	2,343.7	112.2	2,231.5	95.2
Taunton Watershed	470.0	132.2	337.8	71.9
Statewide CRD Total	**48,290.8**	**31,738.7**	**16,552.1**	**34.3**

3 | Salt Marsh Migration

The primary data sources used to analyze salt marsh migration were:

- Massachusetts SLAMM 2011 Wetlands – Initial Condition[3]
- Massachusetts SLAMM 2030, 2050, 2070, and 2100 Intermediate High SLR Scenario (4.5 feet from 2011 to 2100 in Boston)[4]

Marsh migration refers to the potential conversion of upland or freshwater wetland to salt marsh in response to sea level rise. For this analysis, salt marsh includes the following SLAMM classes: Regularly Flooded Marsh, Irregularly Flooded Marsh, and Transitional Marsh/Scrub-Shrub, the latter of which often includes what are known as salt marsh border or brackish border plant communities. The inclusion of Transitional Marsh/Scrub-Shrub is important to consider in long-term planning for conservation of marsh migration areas. These areas have a strong likelihood of converting to Irregularly Flooded Marsh and/or Regularly Flooded Marsh under a longer time horizon.

The SLAMM dataset was analyzed for marsh migration area for each of the SLAMM eras: 2011-2030, 2030-2050, 2050-2070, and 2070-2100; under two sea level rise scenarios: High SLR (7.1 feet from 2011-2100 in Boston) and Intermediate High SLR (4.5 feet from 2011-2100). These were then combined to produce a gross potential marsh migration data layer. For these data, gross potential means that any time upland has potential to convert to salt marsh by the end of each of these eras, that area will be included in the final data layer, regardless of whether SLAMM predicts there is potential for said area to convert to something else from salt marsh by 2100 (e.g., upland to salt marsh to tidal flat).

The primary dataset for gross potential marsh migration area includes two sub-datasets—one representing migration into upland, and a second representing migration into freshwater wetlands. This dataset was further refined to differentiate between two different landscape development scenarios: (1) currently developed lands will be allowed to become marsh, herein referred to as "developed lands included," and (2) currently developed lands, in most cases, will be excluded from becoming marsh under the assumption that infrastructure on these lands will be protected from future tidal flooding and/or conversion to salt marsh, herein referred to as "developed lands excluded."

Like the salt marsh loss analysis conducted for the ResilientCoasts Plan (2025), a change analysis was performed for each of the SLAMM eras, where pixels indicating non-salt marsh to salt marsh conversion were preserved and aggregated to attain a gross potential data layer for each of the SLAMM eras. The resulting dataset represents potential marsh migration area for what is currently upland or freshwater wetland under the developed lands included development scenario (primary dataset).

The potential marsh migration dataset under the developed lands excluded development scenario was created by additional processing of the primary dataset. Automated, semi-automated, and manual techniques were used to further refine the primary dataset to account for the protection of currently

[3] Massachusetts Office of Coastal Zone Management, 2019, Massachusetts SLAMM 2011 Wetlands—Initial Condition [FGDB].
[4] Massachusetts Office of Coastal Zone Management, 2019, Massachusetts SLAMM Wetlands (2030, 2050, 2070, 2100) – Int High SLR (4.5 ft) [FGDB].

developed lands from future tidal flooding and/or conversion to salt marsh, resulting in the secondary dataset.

It is important to note that the second dataset was primarily developed for reporting "more realistic" migration area summaries given the high likelihood that many of our developed areas have infrastructure that will be protected from future tidal flooding and/or conversion to salt marsh. It is not meant to be a final dataset and may be continuously refined to account for currently developed lands and changing priorities.

General processing steps to generate the secondary dataset from the primary dataset involved:

1. Eliminating impervious surfaces derived from the 2016 Massachusetts Land Cover dataset.[5]
2. Eliminating areas smaller than 3 acres that were surrounded by impervious surfaces on all sides.
3. Eliminating areas surrounded by roads (MassGIS-MassDOT Roads[6]) on all sides that DO NOT intersect with hydrologic connections as mapped in:

    - National Hydrography Dataset (NHD) Flowlines[7]
    - Massachusetts Department of Environmental Protection Wetlands Linear Features--Hydrologic Connections and Shorelines[8]
    - Massachusetts Division of Ecological Restoration Tidal Crossing Database Points[9] (buffered 10 meters)

    Quality control was performed to ensure logical consistency and minimize inadvertent omission of prime migration area. Exceptions to Step 3 above were made for large, protected areas (e.g., Cape Cod National Seashore); sandy dune trails mapped as roads (Sandy Neck, Barnstable); and areas that were found to most likely have hydrologic connections despite not being mapped as such in the datasets listed above, as determined using high-resolution, oblique (angled) aerial imagery (EagleView/Pictometry).[10]

4. Eliminating areas that are not likely to become marsh by manual editing of marsh migration data, based on interpretation of very high-resolution aerial imagery (MassGIS 2023 Aerial Imagery, 15 cm resolution[11]) and other imagery and feature datasets described in Steps 1-3. Manual editing included deleting migration area from front yards of single-family homes, for example, which would otherwise cut off access to these structures. Areas of maintained open space (e.g.,

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[5] Massachusetts Bureau of Geographic Information (MassGIS), 2019, 2016 Land Cover/Land Use FGDB, accessed July 30, 2024, at URL https://www.mass.gov/info-details/massgis-data-2016-land-coverland-use.
[6] Massachusetts Bureau of Geographic Information (MassGIS), 2025, MassGIS-MasDOT Roads, accessed February 2025, at URL https://arcgisserver.digital.mass.gov/arcgisserver/rest/services/AGOL.
[7] U.S. Geological Survey, 2023, USGS National Hydrography Dataset Plus High Resolution (NHDPlus HR) for Hydrological Unit (HU) 4 - 0109 (published 20230713) FileGDB, accessed July 26, 2024, at URL https://www.usgs.gov/national-hydrography/access-national-hydrography-products.
[8] Massachusetts Department of Environmental Protection, 2017, MassDEP Wetlands (2005), Massachusetts Bureau of Geographic Information (MassGIS), accessed February 2025, at URL https://arcgisserver.digital.mass.gov/arcgisserver/rest/services/AGOL.
[9] Massachusetts Division of Ecological Restoration, 2025, DER Tidal Crossing Locations, accessed February 2025, at URL https://services1.arcgis.com/7iJyYTjCtKsZS1LR/ArcGIS/rest/services.
[10] Massachusetts Department of Transportation, (n.d.), MassDOT Pictometry Viewer, accessed February 2025, at URL https://services1.arcgis.com/7iJyYTjCtKsZS1LR/ArcGIS/rest/services.
[11] Massachusetts Bureau of Geographic Information (MassGIS), 2023, 2023 Aerial Imagery, accessed February 2025, at URL https://tiles.arcgis.com/tiles/hGdibHYSPO59RG1h/arcgis/rest/services/orthos2023/MapServer.

parkland) with minor infrastructure (narrow, paved walking path) were not excluded from becoming marsh migration area.

Both datasets are likely an overestimation of marsh migration area given the uncertainty of how future conditions will shape adaptation responses for any given area (e.g., future dam capacity, tide gate management, shoreline armoring, managed retreat, etc.) and the unknowns and uncertainties in ecological processes leading to marsh migration.

Marsh migration data summaries by CRD are provided in the table below.

Table 2. Potential Marsh Migration Area with 4.5 Feet of Sea Level Rise

	Developed Lands Included			Developed Lands Excluded		
Coastal Resilience District	Upland Acres	Fresh-water Wetland Acres	Total Acres	Upland Acres	Fresh-water Wetland Acres	Total Acres
Boston Harbor Islands	59.8	9.5	69.3	53.6	9.5	63.1
Buzzards Bay	2,401.6	1,036.2	3,437.8	1,980.2	1,019.6	2,999.8
Great Marsh	1,538.8	699.5	2,238.3	1,329.3	693.4	2,022.7
Islands	1,329.7	624.6	1,954.3	1,138.7	602.7	1,741.4
Lower Merrimack	52.0	71.9	123.9	49.3	70.5	119.8
Manomet-Sagamore	4.0	12.0	16.0	3.5	11.9	15.4
Mid-North Shore	417.1	82.6	499.7	227.5	81.4	308.9
Mid-South Shore	1,460.7	1,536.4	2,997.1	1,225.5	1,512.2	2,737.7
Mystic-Charles Watersheds	1,397.8	9.2	1,407.0	176.6	8.6	185.2
Neponset-Weir Watersheds	873.0	71.0	944.0	358.4	64.6	423.0
North Cape Cod	1,711.0	1,063.3	2,774.3	1,479.3	1,035.0	2,514.3
Outer Cape Cod	661.3	360.0	1,021.3	603.2	356.6	959.8
Saugus Watershed	1,051.8	64.5	1,116.3	258.3	53.9	312.2
South Cape Cod	1,111.3	620.9	1,732.2	881.6	611.6	1,493.2
Taunton Watershed	358.0	287.2	645.2	319.5	280.9	600.4
Statewide CRD Total	**14,427.9**	**6,548.8**	**20,976.7**	**10,084.5**	**6,412.4**	**16,496.9**

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