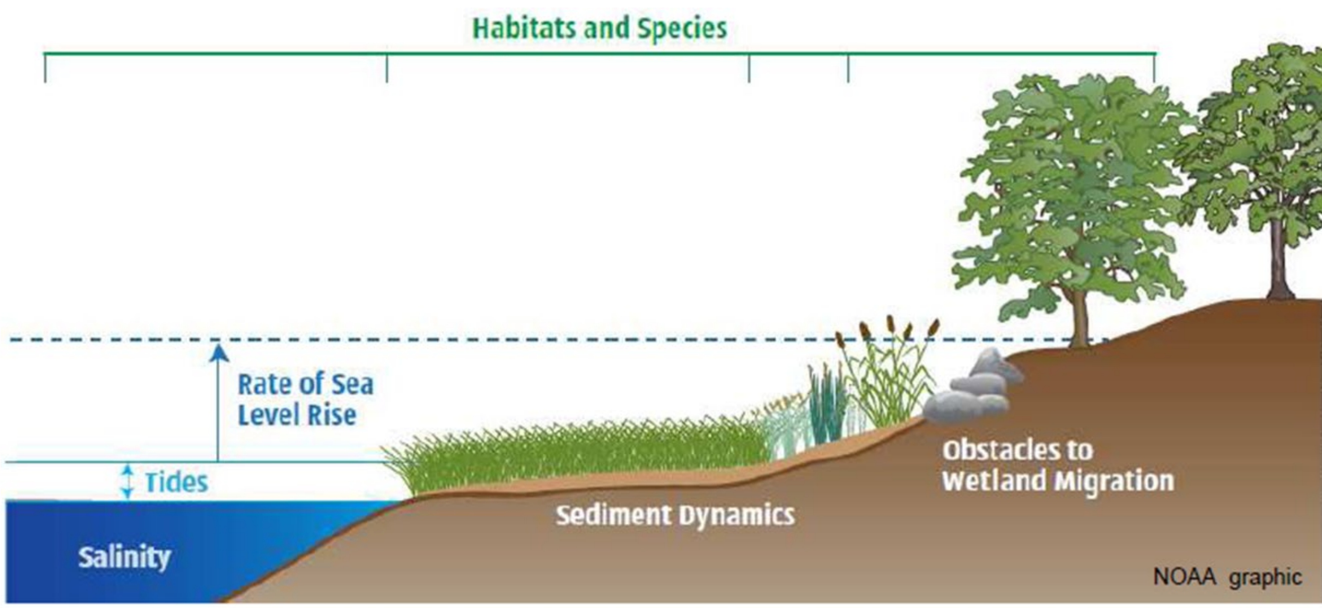
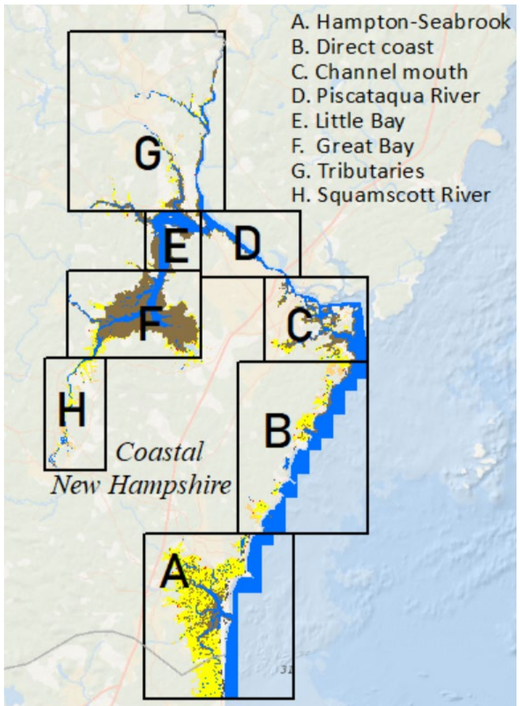
Sea Level Affecting Marshes Model

Tidal marshes are susceptible to climate change, especially sea level rise (SLR). Changes in tidal marsh area and habitat type may be modeled using the Sea Level Affecting Marshes Model (SLAMM). The model simulates the dominant processes involved in wetland conversion and shoreline modification under different scenarios of sea level rise. In 2014 the NH Fish and Game Department and the Great Bay National Estuarine Research Reserve, completed a first run of SLAMM. In 2022 that model was improved with higher resolution LiDAR and updated parameters. Output from SLAMM will be used in the Comprehensive Plan for Resilient Salt Marsh in New Hampshire. The goal is to guide conservation strategies that will protect the coastal wetland areas that are likely to provide high quality wildlife habitat and persist for the longest duration.

SLAMM simulates the dominant processes involved in wetland conversions and shoreline modifications under different scenarios of long-term sea level rise: **inundation** (based on elevation and slope), **erosion** (based on threshold of maximum fetch and proximity to tidal water), **accretion** (sea level rise is offset by sedimentation and vertical accretion), **soil saturation** (sea level rise affects the fresh water table) and barrier island **overwash** (for islands under 500m width).



How the SLAMM software works:



SLAMM converts the 2019 LiDAR digital elevation model from Navd88 to Mean Tide Level using a correction factor derived from NOAA's vdatum software program, and which differs between sites →

SLAMM tracks the rise of water levels and the salt boundary by reducing the elevation of each cell, as sea levels rise. It then predicts changes to wetland habitat based on known relationships between wetland types and tide ranges. For example: "Regularly Flooded Marsh" ranges from MTL to 120% of MHHW.

Predictions are always affected by uncertainties and therefore, there is a distribution of possible future wetland habitat. In New Hampshire, SLAMM was run for 0.3-meter and 0.5-meter SLR at Year 2050, and 0.75-meter, 1.2-meter, and 1.5-meter SLR at Year 2100.

Assumed Effects of Inundation and Erosion used by SLAMM

	Inundation (non-adjacent to open water, or fetch < 9km)	**Erosion** (adjacent to open water and fetch > 9km)
Converting From	Converts To	Converts To
Dry Land	Transitional salt marsh, ocean beach, tidal swamp, or estuarine beach, depending on context	Erosion of dry land is ignored
Swamp	Transitional salt marsh *or Tidal swamp if designated as freshwater-flow influenced*	Erosion to Tidal Flat
Inland Fresh Marsh	Transitional salt marsh *or Tidal fresh marsh if designated as freshwater-flow influenced*	Erosion to Tidal Flat
Tidal Swamp	Irregularly flooded marsh *or Tidal fresh marsh if designated as freshwater-flow influenced*	Erosion to Tidal Flat
Tidal Fresh Marsh	Irregularly Flooded Marsh	Erosion to Tidal Flat
Transitional or Irregularly-flooded Marsh	Regularly Flooded Marsh	Erosion to Tidal Flat
Regularly Flooded Marsh	Tidal Flat	Tidal Flat
Ocean Flat	Open Ocean	Open Ocean
Tidal Flat	Estuarine water	Estuarine water
Estuarine Beach, Ocean Beach	Open water	Open water

The SLAMM model was run using the "protection off" mode for the simulations, thereby depicting the potential for marsh migration into upland areas despite current limitations such as existing hardened shorelines and development. A second option is to turn on a connectivity sub-model, which determines whether dry land or freshwater wetlands will be subject to saline inundation based on an uninterrupted low-elevation pathway to estuarine or ocean water. NH ran the SLAMM model with connectivity OFF (simulations based on elevation alone without requiring a flow pathway to saline water).

Output data from all SLR scenarios, with SLAMM classification, available in raster or polygon format from Great Bay National Estuarine Research Reserve, Greenland NH. E-mail: Rachel.A.Stevens@wildlife.nh.gov Stewardship Coordinator and Wildlife Ecologist, Phone: (603) 778-0015

DATA AND PARAMETER SOURCES:

1.) NOAA OCM high resolution tidal wetlands data for New Hampshire (2013 photo date) available for download at coast.noaa.gov/digitalcoast/data/ccapsalthabitat.html
2.) National Wetlands Inventory NWI-Plus (2021), US Fish and Wildlife Service. Source: NH GRANIT
3.) 1.25-feet bare earth digital elevation model DEM, derived from the coastal LiDAR collected Nov. 2019, nominal post spacing 0.35m, vertical accuracy 10 cm, NAVD88 feet. Source: NH GRANIT
4.) Sea Level Rise Historic Trend (mm/year) at Fort Point and Seavey Island from CO-OPS
5.) Difference between Mean Tide Level and NAVD88 datum, calculated from NOAA's VDatum service
6.) Great Diurnal Tide Range: Sean Denny's thesis calculations for areas E and F. Combination of both for G. B and D uses Fort Point value. Hampton-Seabrook from Trowbridge DES 2007 hydrologic parameters for NH Estuaries report. Establishing a High-Precision Tide Station in the Great Bay Estuary, 2022, for F. NHFG deployed equipment in Squamscott River 7/27/2022-9/9/2022 to estimate value for the new sub site H.
7.) Salt Elevation: GT / 2 * 1.4 elevation at which dry land and fresh water wetlands begin (elevation that is inundated by salt water less than every 30 days)
8.) Marsh, Swamp, and Tidal Flat Erosion (horiz. m/year): values from closest national wildlife refuge
9.) Marsh Accretion: Parker River NWR pers. comm. (data 2008-2012). GBNERR biomonitoring 2011 for E-G. Goodman et al., 2006.
10.) Impervious Surfaces in the Coastal Watershed of NH and Maine, High Resolution – 2021. NH GRANIT

SLAMM results displayed in the NH Coastal Viewer (www.nhcoastalviewer.org) use a subset of the full model, and are listed in the table below:

SLAMMCODE	SLAMMNAME	Saltmarsh_Status	CoastalViewer
1	Developed	No	
1	Developed-Impervious	No	
2	Undeveloped	No	
3	Swamp	No	
5	Inland Fresh Marsh	No	
6	Tidal Fresh Marsh	**Potential**	Tidal wetland
7	Transitional Salt Marsh	**Potential**	Transitional salt marsh
8	Regularly-flooded Marsh	**Yes**	Salt marsh
10	Estuarine Beach	No	
11	Tidal Flat	No	Mud flat
12	Ocean Beach	No	
14	Rocky Intertidal	No	
15	Inland Open Water	No	
16	Riverine Tidal	No	Tidal water
17	Estuarine Open Water	No	Tidal water
19	Open Ocean	No	Tidal water
20	Irregularly-flooded Marsh	**Yes**	Salt marsh
22	Inland Shore	No	
23	Tidal Swamp	**Potential**	Tidal wetland

ATTRIBUTES:

SLAMMCODE	Initial Condition Code assigned to high-res marsh data or NWIplus wetlands
SLAMMNAME	Initial Condition Name corresponding to code (from SLAMM software documentation)
SLAMMCODE1	Future Condition Code (output from SLAMM software)
SLAMMNAME1	Future Condition Name
Saltmarsh_Initial	Initial Condition Saltmarsh habitat (Yes, No, or Potential)
Saltmarsh_Future	Future Condition Saltmarsh habitat (Yes, No, Potential, or Potential-Impervious)
Saltmarsh_Status	Future Status of Salt marsh (Lost, Potential, or Persistent) – *see table below*
IC_2021	if = 1, initial condition is impervious land cover (2021)
CV_Initial	Coastal Viewer class for Initial Condition
CV_Future	Coastal Viewer class for Future Condition

Initial	Future	Saltmarsh_Status
No	No	No
No	Potential	Potential
No	Yes	Potential
Potential	No	Lost
Potential	Potential	Potential
Potential	Yes	Potential
Yes	No	Lost
Yes	Potential	Persistent
Yes	Yes	Persistent