Regional Evaluation of Salt Marsh Conservation and Restoration Opportunities in a Changing Climate

Rachel Stevens
Stewardship Coordinator, Great Bay National Estuarine Research Reserve
Wildlife Ecologist, New Hampshire Fish and Game Department.
No Management is Active Management
No Management is Active Management

MARSH MIGRATION

Habitats migrate inland

Mean high tide line

Sea level rise

Open water or mudflat
Low salt marsh
High salt marsh
Brackish marsh
Upland

Open water (high tide)
Mudflat (low tide)
Low salt marsh
High salt marsh
Brackish marsh
Upland

Mean high tide line
No Management is Active Management

- Marsh Migration
- Coastal Squeeze

Mean high tide line

Open water or mudflat
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Open water (high tide)
Mudflat (low tide)
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Sea level rise

Habitats migrate inland

Barrier to migration
Conservation and Restoration Opportunities Change Over Time

2025

2100

LAND CONSERVATION

RESTORATION OPPORTUNITIES
Sea Level Affecting Marshes Model (SLAMM)
Modeling Results: Current Conditions

Hampton Falls

Hampton

Seabrook
Modeling Results: Current Conditions
Modeling Results: 2075, 6.6ft
Statewide Marsh Extent

2010
Statewide Total: 6,039 acres

2025
Statewide Total: 5,798 acres

2100
Statewide Total: 295 acres
Protection of Marsh Migration Pathways Critically Important

3,603 acres potential new marsh + 295 acres of present day marsh likely to persist = 3,898 acres

65% current marsh

Primarily fringing marsh
Land Use / Cover Conversion

- Forest: 43%
- Wetland: 21%
- Residential: 13%
- Agriculture: 6%
- Recreational: 5%
- Shrub: 3%
- Other: 9%

Percent of total
Supplemental “Decision Support” Layers
Opportunities for Restoration of Tidal Flow
Supporting Land Protection

- **Salt marsh lost**
- **Salt marsh persistent**
- **Salt marsh potential**
Data Publically Available

nhcoastalviewer.unh.edu
Hampton

“A Natural Choice”: Conservation and Restoration Options to Enhance Coastal Resiliency in N.H.

GREEN GOLD
Salt marsh is an important habitat that exists within only 17 communities in all of New Hampshire. This coastal wetland type has been identified as one of the most valuable habitats in the state and has always been designated “Tier 1,” meaning of statewide importance, in the NH Wildlife Action Plan.

LOW, OR NO, COST FLOOD CONTROL
In addition to wildlife habitat, salt marshes provide multiple human benefits including long term carbon storage, healthy fisheries, storm protection, and flood mitigation. These ecosystem services are provided at no, or low, financial cost.

PROTECTING US FOR THE LONG TERM?
Rising sea level is likely the biggest threat to salt marsh. Using locally relevant data, we can model what future conditions will likely be. If sea level rises at a rate of 6.6 ft by 2100, we will likely lose 4 percent of its current extent in just the next decade. Without significant action, we will see an almost total loss (99%) by the year 2100.

Hampton is home to xx% of marsh that ... and the two largest potential restoration opportunities in the state - or some other community pertinent factoid

OUR CHOICES, OUR FUTURE

1. LAND CONSERVATION
Salt marshes that have a chance to keep pace with rising sea level are those located adjacent to low-lying land where no physical barriers block their inland migration.

Green areas on this map indicate present day upland that has the potential to support future salt marsh.

In Hampton up to xx acres could support future salt marsh if they remain undeveloped.

2. RESTORE TIDAL FLOW
Yellow indicates regions that would become salt marsh if natural tidal flow was allowed to occur.

In Hampton there are X major tidal restrictions. If restored, they would likely support x acres of salt marsh by 2100.
Hampton

“A Natural Choice”: Conservation and Restoration Options to Enhance Coastal Resiliency in New Hampshire

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Protecting Us For The Long Term?
Rising sea level is likely the biggest threat to salt marsh. Using the model we can model what future conditions will likely be. If sea level by 2100 rises more than 2 feet, we will likely lose 4 percent of its current extent. Without significant action, we will see an almost total loss of

Statewide Total: 6,039 acres
Statewide Total: 5,798 acres
Statewide Total: 295 acres

Rye in Focus: Conservation Opportunities

Areas shown in yellow are currently upland that could potentially support salt marsh as sea level rises. Currently developed areas have not been excluded from this modeling. The area circled in red is particularly important as it is a large contiguous block that will likely begin conversion in the next few years. It also a particularly robust area of potential salt marsh that is likely to sustain for the long term, past the year 2100.

Natural Choice™: Conservation and Restoration Options to Enhance Coastal Resiliency in New Hampshire

In Hampton there are X major tidal restrictions. If restored, they would likely support x acres of salt marsh by 2100.
SLAMM: Supporting Land Acquisition, Leveraging $
Durham’s Wagon Hill Farm
Living Shoreline Collaboration

Kirsten Howard, New Hampshire Department of Environmental Services Coastal Program
Mike Leuck, Town of Durham
Tom Ballostat, University of New Hampshire
SLAMM: Component of Other Coastal Modeling Projects

FINAL REPORT

How People Benefit from New Hampshire’s Great Bay Estuary
A collaborative assessment of the value of ecosystem services and how our decisions might affect those values in the future

November 2016

NOAA Office for Coastal Management (OCM)
Silver Spring, MD

New Hampshire Department of Environmental Services Coastal Program (NHCP)
Portsmouth, NH

Eastern Research Group, Inc. (ERG)
Lexington, MA
(Under contract to the NOAA Office for Coastal Management)
Traditional Management Principles Evolving
Traditional Conservation Priorities Changing

- Models like SLAMM and MEM model multiple scenarios, allowing managers to choose where restoration or land protection make sense and understanding how human development and interventions like active restoration do or could impact the marsh for better or for worse.

- Intensive monitoring sites provide the data that fuels modeling efforts, ground truths models and GIS based monitoring, and gives researchers an opportunity to understand specific relationships between parameters.

Salt marsh migration pathways
Conservation and Public Lands
Traditional Conservation Priorities Changing

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Saltmarsh Sparrow (Ammodramus caudacutus)

- NH Species of Special Concern
- Global population estimate 60,000
- Species-specific population trends (1998 – 2012) include annual declines of 9.0%
- Breeds in high marsh
Chapman’s Landing
Habitat Type

- Tidal water
- Mud flat
- Salt marsh
- Transitional salt marsh
- Tidal wetland
- Fresh water
- Freshwater wetland

2012

6.6ft (2m) Sea Level Rise
6.6ft (2m) Sea Level Rise

Irregularly Flooded Marsh
Regularly Flooded Marsh

2025
6.6ft (2m) Sea Level Rise

- Irregularly Flooded Marsh
- Regularly Flooded Marsh

2050
6.6ft (2m) Sea Level Rise

![Map showing areas affected by sea level rise at 2075]
Innovative Restoration Techniques

- Lowering Adjacent Upland
- Restoration of Developed Areas
- Thin Layer Deposition
- Ditch Remediation
Marsh restoration or land protection projects located in areas with the greatest migration potential will likely be sustained for the longest term.
Landscape Scale Assessment of Marsh Conditions
Integrating Scales of Marsh Assessment
Locate Projects in Most Ecologically Strategic Manner

LANDSCAPE  SITE  PLOT

(long term and cost effective)
Assess Marsh Conditions Systematically Throughout System

<table>
<thead>
<tr>
<th>Category</th>
<th>Metric</th>
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<tbody>
<tr>
<td>Current Condition</td>
<td>Size</td>
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<tr>
<td>Marsh unit configuration</td>
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Identify all tidally influenced wetlands
Assess influence of surrounding landuse

1m (approx 3ft) 150m
Horizontal 150ft

1m (approx 3ft)
What is the Relative Condition of a Specific Marsh?
Strategically Locate Site-Specific Projects

Landscape assessment of current marsh conditions can objectively identify marshes in greatest need of restoration.

Relative Marsh Condition

Current condition

RESTORE
Strategically Locating Restoration Projects

Landscape assessment of current marsh conditions can objectively identify marshes in greatest need of restoration

Relative Marsh Condition

Current condition

ABANDON
Strategically Locating Restoration Projects

Landscape assessment of current marsh conditions can objectively identify marshes in greatest need of restoration

INNOVATIVE SCIENCE

Relative Marsh Condition

Current condition
Strategically Locating Restoration Projects

Landscape assessment of current marsh conditions can objectively identify marshes in greatest need of restoration.

RESTORE

INNOVATIVE SCIENCE

Relative Marsh Condition

Current condition
Marsh Resilience

Current condition
### Marsh Resilience: Example Metrics

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**SLAMM**

**RESILIENCE**
Assess Marsh Resilience Regionally
Prioritize Land Conservation: Beyond Migration Pathways
Assess Marsh Resilience Systematically: Nationally

Why this Project?

Tidal marshes are under significant pressure from sea level rise and development. To evaluate marsh resilience to these pressures, in order to inform resiliency research, monitoring programs, restoration projects, and marsh management plans, there is a need to support "apples to apples" comparisons of marsh conditions across large geographic areas.

Current habitat information is typically presented with variable, site-specific data. This protocol will provide a mechanism to compare marshes in different areas in a systematic way that is not dependent on variable, site-specific data. It integrates information about subsurface tidal conditions, making it a useful tool for assessing large areas of marshes with particular characteristics, targeting restoration, and determining experimental design. Because the protocol’s metrics are future-oriented, they can be used for marsh restoration and mitigation planning. It is particularly valuable for assessing marshes that are difficult to access or inadaptable regions.

Project Products

- GIS-based, nationally consistent, landscape-scale protocol to assess marsh resilience
- Tidal marsh conditions that are linked to sea level rise, based on
  - Current marsh conditions, i.e., connectivity, ratio of open water to emergent marsh, and subsurface hydrology
  - Vulnerability, i.e., percentage below mean high water, planform distribution at water elevations, and tidal range
- Adaptation potential, i.e., elevation, rate of sea level rise, and removal
- Map to identify NERR sites within three categories using a hierarchical image segmentation method for scale-dependent data
- Story map showing how NERRs use this protocol and tool to assess marsh resilience at different scales
Assess Marsh Resilience Systematically: High Resolution

This project is developing a protocol to assess tidal marsh resilience at the landscape scale by using GIS-based metrics of current marsh condition, vulnerability to sea level rise, and potential for adaptation. The protocol will support standardized comparisons of marsh conditions across large areas (NURCS) with respect to similar land use, land cover, and hydrologic characteristics, allowing the coasts and within the National Estuarine Research Reserve System (NERRS) and in tandem with other NERRS-based marsh assessments. This can provide an integrated continuum of information to inform efforts to study, monitor, or protect tidal marshes at local, state, regional, and national scales.

Why this Project?
Tidal marshes are under significant pressure from sea level rise and development. There is an urgent need to evaluate marsh resilience to such pressures in order to inform restoration and management programs, restoration projects, and restoration management plans. However, there is no tool to support "apples to apples" comparisons of marsh condition across geographic areas.

By using nationally standardized data sets that reflect current and future conditions, this protocol provides a mechanism to compare marshes in different states in a systematic way that is not susceptible to variable, site-specific data. It integrates information about subsurface soil conditions, making it a useful tool for screening large areas for marshes with particular characteristics, targeting floodplains, and strengthening experimental design. Because the protocol's metrics (no site specific) can be used for marsh restoration and mitigation planning, it is particularly valuable for assessing marshes that are difficult to access or where visual surveys...

Project Products
The NERRS/NOAA project team will deliver the following products through this project:

- GIS-based, nationally consistent, landscape-scale protocol to assess marsh resilience
- Landscape-scale mapping for characterization of marsh resilience to sea level rise, based on...
- Climate model conditions, i.e., current, mid-century, and future conditions
- Spatial modeling...Vulnerability, i.e., percentage below mean high water, pixel distribution at future elevations, and tidal range
- Adaptation potential, i.e., elevation, land use, and cover, soils, and removing
- Maps to optimize NERRS sites within these locations using a high-resolution image classification protocol for extant sites
- Story map showing how NERRS use this protocol and tools to assess marsh resilience at different scales

Contact

Natalie Silvera
Site/area Coordinator
Eastern Bay National Estuarine Research Reserve
(301) 789-1234

Bauerine Shuff
GIS Specialist
Eastern Bay National Estuarine Research Reserve
(301) 789-1234
Integrating Scales of Marsh Assessment