

Potential for Tidal Marsh Migration in Maine

NOAA – Project of Special Merit

Maine Natural Areas Program & Maine Geological Survey

Principal Investigators: Donald Cameron, Peter Slovinsky

Introduction

Salt, brackish, and freshwater tidal marsh habitats are threatened by the potential impacts of accelerated sea level rise caused by global warming. The Intergovernmental Panel on Climate Change is predicting a rise in sea level of between 0.6 and 2.0 feet by 2100 (CCSP 2009). The northeastern United States may be affected by additional sea level rise due to changes in ocean circulation (Yin et al. 2009). Tidal marsh habitats and the species they support will be highly vulnerable to damage or loss depending on the amount of sea level rise and the rate at which it occurs. The potential for sea level rise, along with existing coastal development patterns, have made tidal marshes one of the most threatened habitat types in Maine. If conditions are ideal, salt marshes have the ability to “migrate” landward in equilibrium with sea level rise-induced changes in shoreline position (U.S. EPA 1995). Tidal marshes will either be inundated by rising sea level or migrate to new areas where geomorphic conditions permit. As sea level rises, tidal marsh migration may be the only alternative to loss for a significant proportion of Maine’s tidal wetlands.

The goal of this project is to enable communities, conservation entities, and state and federal agencies to plan for the preservation of those areas of Maine’s coastal landscape where tidal marshes are likely to migrate as sea level rises. The geographic area covered by the project includes the entire coast extending from the tidal reaches of the Piscataqua River (York County), to the furthest Downeast towns of Eastport and Perry (Washington County).

Part 1: Tidal Marsh Mapping

The Maine Natural Areas Program documents the composition and condition of rare and exemplary natural communities throughout Maine. Data, locational information, and mapping of these features are maintained in a GIS referenced database. Natural community types are based on the state’s natural community classification, *Natural Landscapes of Maine: A Guide to Natural Communities and Ecosystems* (Gawler and Cutko 2010). *Natural Landscapes of Maine* includes four types of tidal wetland natural communities: *Spartina* saltmarsh, Mixed graminoid – forb saltmarsh, Brackish tidal marsh, and Freshwater tidal marsh. Over the years MNAP’s data on the state’s tidal marshes has progressively increased, but prior to this work there were still numerous marshes that had never been surveyed. As part of this project we performed reconnaissance at over 80 marshes, particularly marshes in the less well-surveyed Downeast region and in the upper Kennebec Estuary.

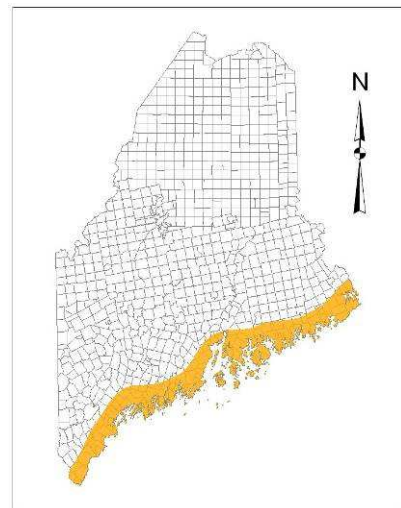


Figure 1. Project area

Types of tidal wetland natural communities found in Maine (Figure 2):

- **Spartina saltmarsh** – typically dominated by spartina grasses and black grass.
- **Mixed graminoid – forb saltmarsh** – mix of spartina grasses, salt water bulrush, wire rush, New York aster, and other salt tolerant species.
- **Brackish tidal marsh** – typically dominated by a mix of cat-tail, chair-maker’s rush, and other bulrushes.
- **Freshwater tidal marsh** – often dominated by wild rice or soft stem bulrush mixed with pickerel weed, can support a high number of rare plant species.

For more detailed descriptions see *Natural Landscapes of Maine: A Guide to Natural Communities and Ecosystems* (Gawler and 2010), or visit the Maine Natural Areas Program website at: <http://www.maine.gov/dacf/mnap/features/commsheets.htm>.



Spartina Saltmarsh (Jonesport)



Freshwater Tidal Marsh (Bath)



Brackish Tidal Marsh (Arrowsic)



Mixed Graminoid - Forb Saltmarsh (Addison)

Figure 2. Examples of four tidal marsh types surveyed during the project

METHODS

Tidal marsh mapping had two components. The first was to revise and make comprehensive mapping for all of the state's tidal marshes greater than approximately 2.5 acres regardless of condition. This mapping informed the tidal marsh migration analysis as described in Section 2 of this report, and provides a base map for future work on tidal marshes. The second component was to map marshes of relatively greater ecological significance that will be tracked in MNAP's biological and conservation database. Criteria for determining ecological significance include size, species composition, degree of anthropogenic disturbance (i.e., ditching, fill, inadequate culverts, etc.), and landscape context including proximity to development and natural buffer integrity. The purpose of this mapping is to inform both conservation and development planning, and to track the status of these marshes over time. Data collected during field surveys informed both mapping efforts.

As stated, the goal for a minimum mapping unit for the comprehensive mapping was approximately 2.5 acres, though numerous marsh areas smaller than 2.5 acres were also included, particularly in the freshwater tidal areas of the Kennebec Estuary. In general, fringing salt marshes, defined as salt marshes with an average width less than 60 feet, were excluded. Multiple sources of high resolution ortho imagery were used for mapping. The quality and relevance of available imagery varies by region. Southern Maine generally has better resolution imagery than other parts of the coast. Limitations to mapping tidal marshes with aerial imagery include tree-line shadows, variation in imagery alignment or registration, and the tidal status when the imagery was collected. When possible, more than one imagery type was reviewed to aid in mapping quality.

Field Surveys: For marshes with potential to be considered ecologically significant, inventory and assessment methods used were based on those developed by state Heritage Programs throughout North America. Field surveys documented the presence or absence of rare species and intact natural communities. At each of these sites visited, we collected quantitative data characterizing the plant community composition and structure, recorded the quality condition of the habitat, and listed evidence of existing or past anthropogenic disturbances.

Landowners for sites on private lands were contacted for permission to access for field surveys. Only parcels where permission was granted were accessed for surveys. For all areas visited, landowners were informed via letter of the results of surveys for their property, regardless of what was found.

Data on ecologically significant sites and populations of rare plant species were incorporated into MNAP's Biological and Conservation Database as a first important step to make it available for conservation and development planning, and for use by permitting agencies.

MAPPING RESULTS

The completed statewide tidal marsh mapping shapefile includes 1,158 polygons representing over 170 estuarine areas and occupying a total of 22,408 acres (see Figure 3). The largest number of new polygons was added in the greater Merrymeeting Bay area where older, limited quality mapping represented by 38 polygons covering 3,327 acres, was replaced with significantly more precise mapping of 291 polygons covering 4,404 acres. The greater Merrymeeting Bay area supports 98% of the state's freshwater tidal marshes. The precision of the new mapping excluded more than 1/3 (1,201 acres) of what had been previously mapped for the freshwater tidal marshes of the greater Merrymeeting Bay area. The excluded areas were primarily areas of open water (i.e., river channel and bay). In sum, the new mapping has added 2,203 acres of actual marsh area in the greater Merrymeeting Bay area.

One unexpected result of the mapping and field surveys in the greater Merrymeeting Bay area was the identification of tidal scrub-shrub and forested swamp wetlands. These natural community types have not been previously recognized within the state's natural community classification. Typically, freshwater tidal marsh surveys are completed at the low end of the tide when plant species are more visible, and at these times the tidal nature of the adjacent scrub-shrub and forested swamps is not obvious. Signs of inundation in these areas such as sediment on vegetation or water marks on tree trunks can be easily interpreted to be the result of peak run off events rather than as a result of tides. To determine the tidal nature of these other wetland types, it was necessary to conduct surveys at peak high tide when there was negligible influence from run off, and check for tidal inundation into the sites. This was completed

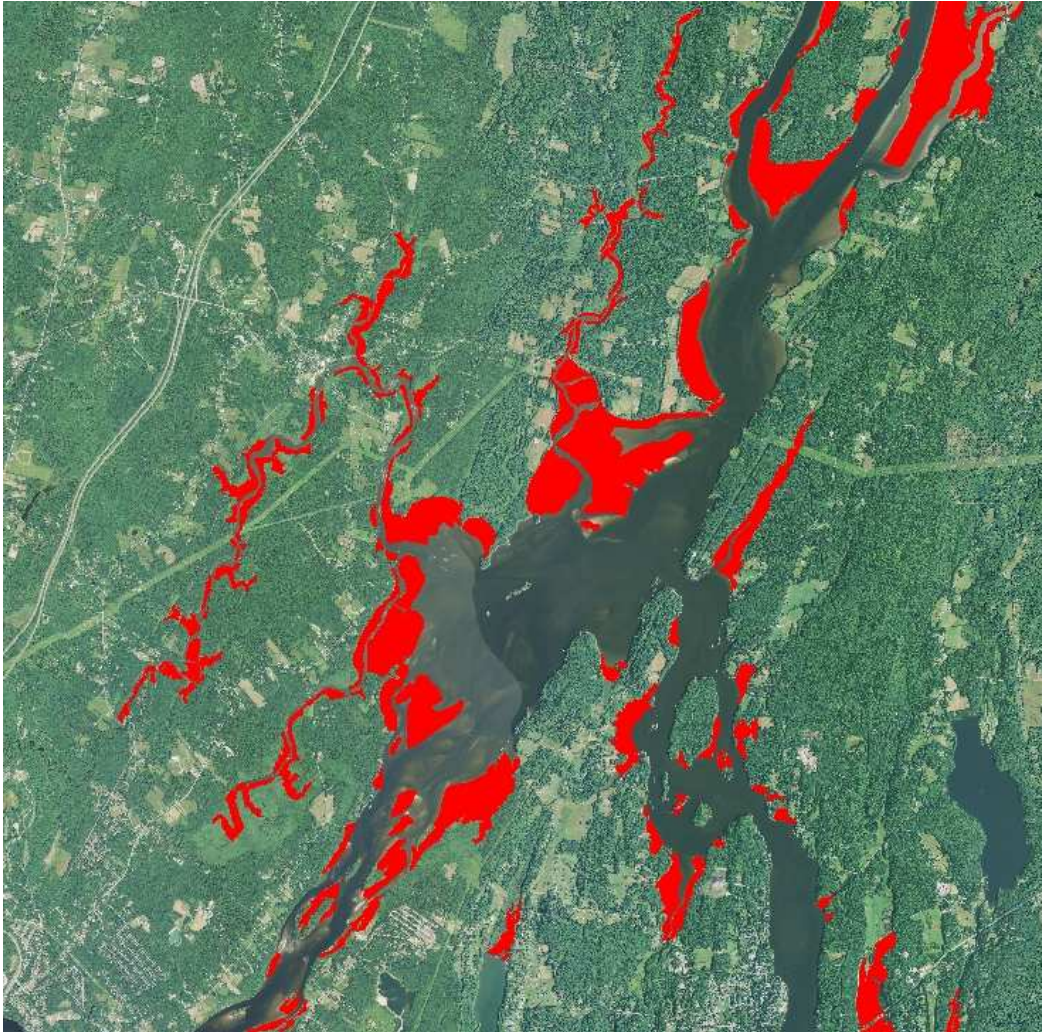


Figure 3. The central area of greater Merrymeeting Bay showing mapped freshwater tidal marshes. Not shown are the many miles of rivershore of the Kennebec and Eastern Rivers to the north which also support extensive areas of freshwater tidal marshes.

at several widely spaced locations around the bay, and as expected tidal water was found flowing through these wetlands (example site in Figure 4 below). The peak tide height on the day of the survey (October 17, 2013) was somewhat above average (7.3 feet listed for nearby Bath) but a foot below the peak annual high tide which was 8.3 feet in Bath on May 24, 2013, and 8.2 feet in Bath on December 2, 2013. There were 18 days in October 2013 when one or both high tides reached reached 7 feet or more, so even if the lower tide levels do not inundate the sites, they are being inundated frequently enough to be considered tidally influenced systems. These tidal scrub-shrub and forested swamp wetlands need additional

sampling before they will be formally documented and added to the list of natural communities tracked by MNAP. They are not currently included in the statewide mapping of tidal marshes, as that mapping is intended to only include marshes.



Figure 4. Forested swamp area being inundated by freshwater tidal flow at peak tide on October 17, 2013, at Green Point in Dresden

FIELD SURVEYS RESULTS

Field surveys were conducted during the growing seasons of 2012 and 2013. Over 80 marsh areas were visited, and about half were documented as significant ecological communities. Examples of all four types of tidal marshes were documented during the effort (*Spartina* saltmarsh, Mixed graminoid – forb saltmarsh, Brackish tidal marsh, and Freshwater tidal marsh). The most new acres were mapped for Freshwater tidal marsh, with all of the mapping for this type being within the greater Merrymeeting Bay as previously noted. A large number of sites were visited in this area, including numerous marshes on the Eastern, Cathance, Abagadasset, Androscoggin, and Kennebec Rivers, as well as within the bay itself. A second area with a high concentration of surveys was in the Downeast region, where most of the tidal marshes between Columbia Falls and Eastport were visited. Some of these marshes, particularly smaller ones were only ground-truthed for mapping purposes. A small subset of the marshes in this region had been previously mapped as ecologically significant, and only a few additional marshes were documented as significant in this area.

Part 2: Simulating Sea Level Rise and Marsh Migration Potential.

The development of coast wide sea level rise (SLR) simulations was contingent upon the acquisition of coast wide LiDAR data. The collection and processing of coast wide LiDAR data was completed in 2012. Once the data was available, as was done for the previous south coastal marsh migration project (Cameron and Slovinsky 2012), it was ground-truthed in a series of tidal marshes and adjacent uplands spread across the central and eastern coastal regions. The results of the ground truthing exercise for these regions were combined with the results from the southern Maine region for a total of 22 towns sampled

with an $n = 3475$. The resulting accuracy was 31 cm with a 95% C.I. (with a mean of 11 cm and RMSE of 15 cm) which exceeds the predicted accuracy.

The next step was to create a simulation of the existing highest annual tide (HAT), as well as four sea level rise simulations, 1 foot, 2 foot, 3 foot, and 6 foot above the current HAT, that reflected the widely varying tidal ranges along the coast. Existing highest annual tide should generally correlate with the upper edges of existing tidal marshes. Staff at Maine Geological Survey (MGS) created a GIS model that uses local tidal readings interpolated across a grid to predict localized highest annual tides, and subsequently sea level rise simulations, for localized sections of the coast. The result of the model is a suite of coast wide shapefiles that simulates the current highest annual tide, and the four sea level rise simulations.

The relative accuracy of the model was checked by comparing the upper boundary of the simulated HAT to the upper edges of mapped existing tidal marshes. In many areas the model closely matches the existing marshes; in others there are minor discrepancies, with the model predicting either a slightly higher or slightly lower highest annual tide than the marsh boundary suggests. The only area where there were significant differences between the model and marsh boundaries was in Merrymeeting Bay. Merrymeeting Bay has a highly complex tidal regime with significant influence from the Kennebec and Androscoggin Rivers, and the very narrow bay outlet at The Chops. The coast wide model may have been under informed due to too few local tidal stations to accurately accommodate the high variability of tides within the Bay. Marshes through this entire area are freshwater tidal and, unlike most salt marshes, are fully submerged at every high tide. The morphology and plant communities of these marshes are significantly different from salt and brackish marshes. For this reason, it was decided to exclude Merrymeeting Bay from the greater coast wide sea level rise simulation analysis, and to treat it as a separate case for modeling purposes (to be completed as a later date).

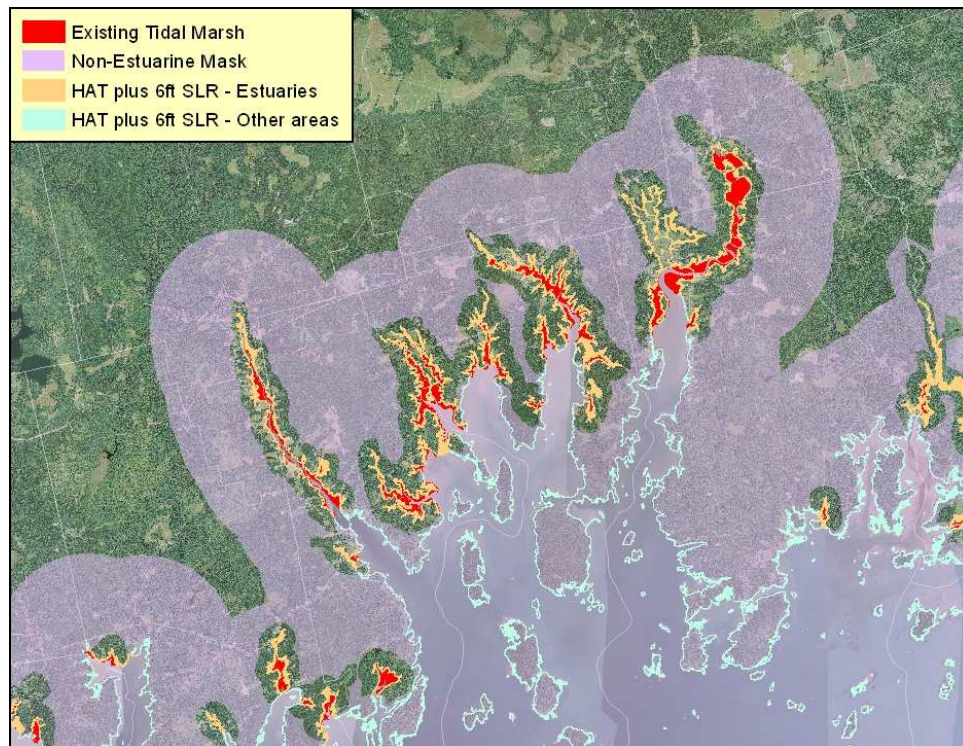


Figure 5: Example from the Downeast coast showing simulation layers areas (in light blue) that were erased from the four simulation layers

The SLR simulations developed by MGS include all areas of the state's coastline and have the potential for a wide variety of uses. In considering the potential for marsh migration, we have made the assumption that marshes are most likely to migrate in estuarine areas where they already exist. Presumably increases in sea level will also allow marshes to develop in other areas where there are currently no marshes, but predicting these areas could be very challenging. Therefore, we focused our analysis on estuaries with existing marshes. This was accomplished by editing the simulation layers to show only the areas that are within estuaries that are adjacent to existing tidal marshes. Figure 5 on the previous page provides an example from the Downeast coast that illustrates how data was edited to remove non-marsh coast.

On the next page is a series of aerial images of the tidal marsh at Hay Creek in Jonesport, ME, that show the extent of the existing tidal marsh and the extent to which the four SLR simulations are predicted to inundate the landscape adjacent to the marsh (Figure 6 a-e).

To further refine the simulations such that they show potential marsh migration areas only where some form of conservation may be practical, we intersected each of the SLR simulations with the Maine Land Cover Data (MELCD 2006) to identify which areas predicted for potential marsh migration are undeveloped versus developed. The Maine Land Cover Data is based on aerial imagery from 2004 and should be considered somewhat dated, but it is the best data of this type currently available for the entire project area and is still widely accurate for many regions of the state. The 21 land cover types represented in the resulting file were categorized into two classes: 1) Developed and 2) Natural + Agriculture (Figure 7 shows this intersection for the 6 foot SLR simulation, see also Appendix 1, page 21, for land cover type list by class).

An analysis of the distribution of these two cover classes within the migration areas is included in the Analysis section on pages 16 -17. The Developed cover class was excluded from further simulation analysis as SLR planning for those areas is not relevant to this project.

A further step taken in the analysis was to remove any parts of the simulated marsh migration areas that occur on existing conservation lands, thus highlighting potential marsh migration areas that might benefit from new conservation or from other resource protection action. This was accomplished by intersecting the state's coverage of conservation lands (MEGIS Conserved Lands - 2013) with potential migration areas (Figure 9). The 2013 conservation lands coverage includes all state and federal conservation lands, along with a high percentage of local public and private conservation lands, and is considered to be mostly complete with some limited exceptions. Approximately two thirds of the acreage of conservation lands along Maine's coast that occur in and around tidal marsh estuaries is state and federal, and approximately one third is municipal or private.

With the conserved lands excluded, the resulting simulation data can be evaluated by region or town or other geographic unit, to plan for future marsh migration (see Figures 11 and 12).

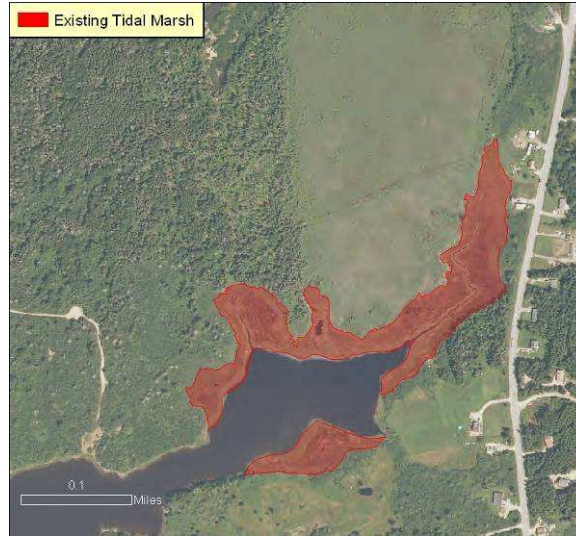


Figure 6a. Existing tidal marsh at Hay Creek, Jonesport, ME

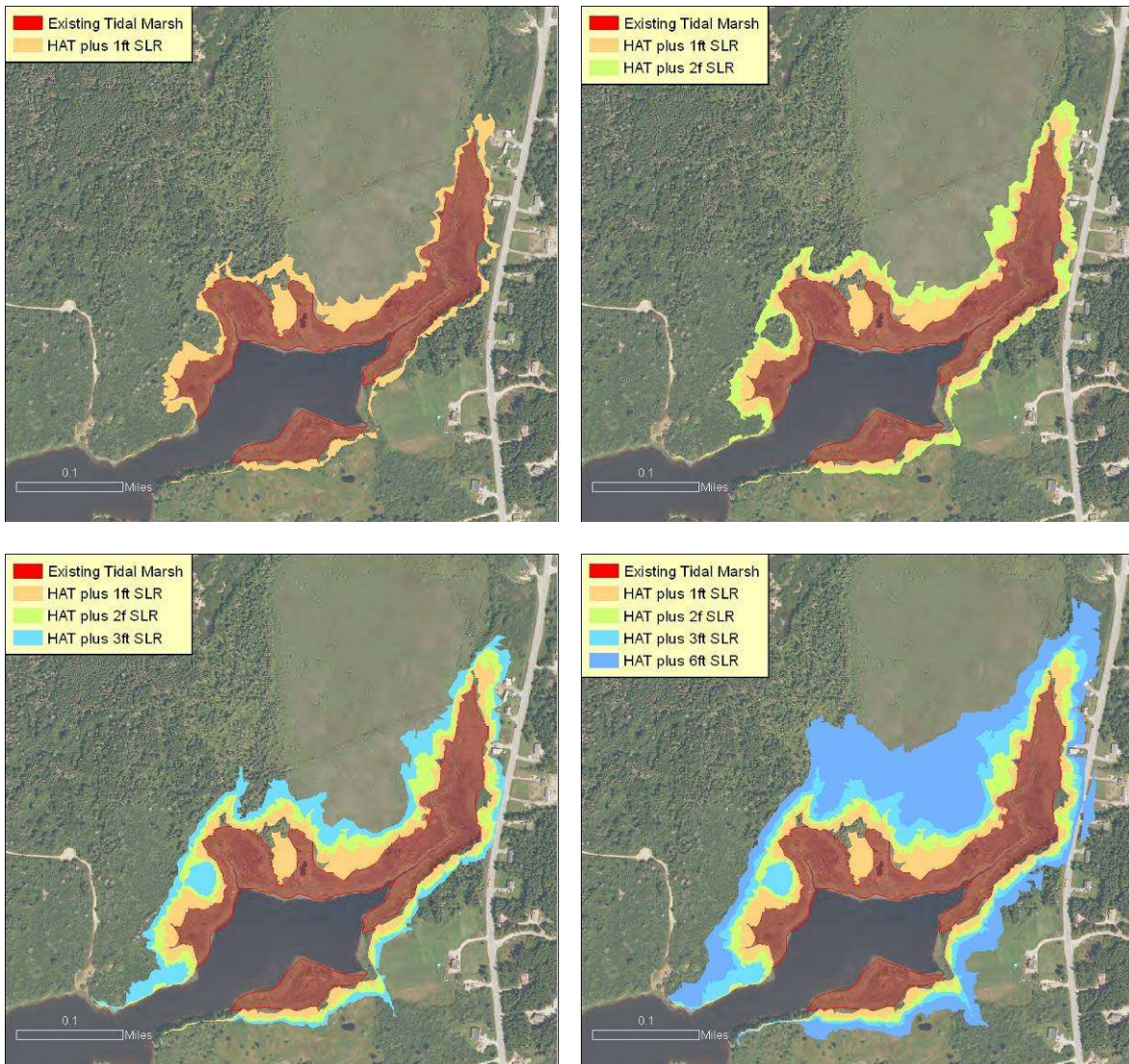


Figure 6b-e. SLR Simulations – 1foot, 2foot, 3foot, and 6foot above HAT, Hay Creek (Jonesport, ME)

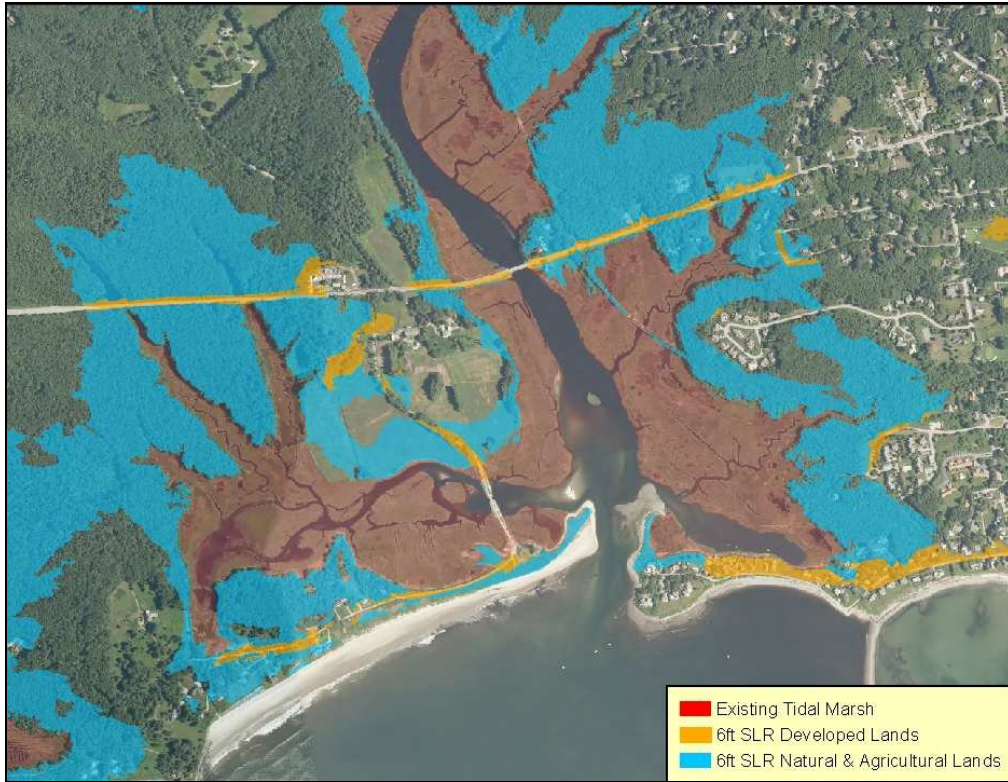


Figure 7: Intersection of potential marsh migration areas with Developed lands vs Natural & Agricultural lands - per MELCD classes, (6 foot SLR simulation, Mousam River).

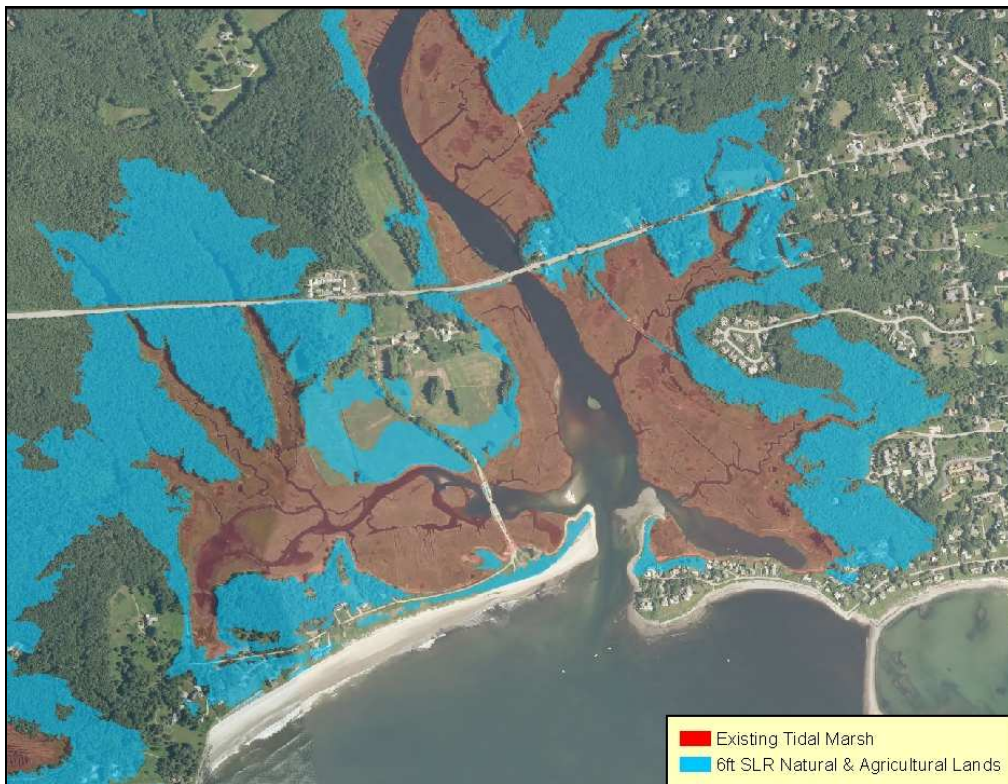


Figure 8: Natural & Agricultural lands (6 foot SLR simulation, Mousam River).

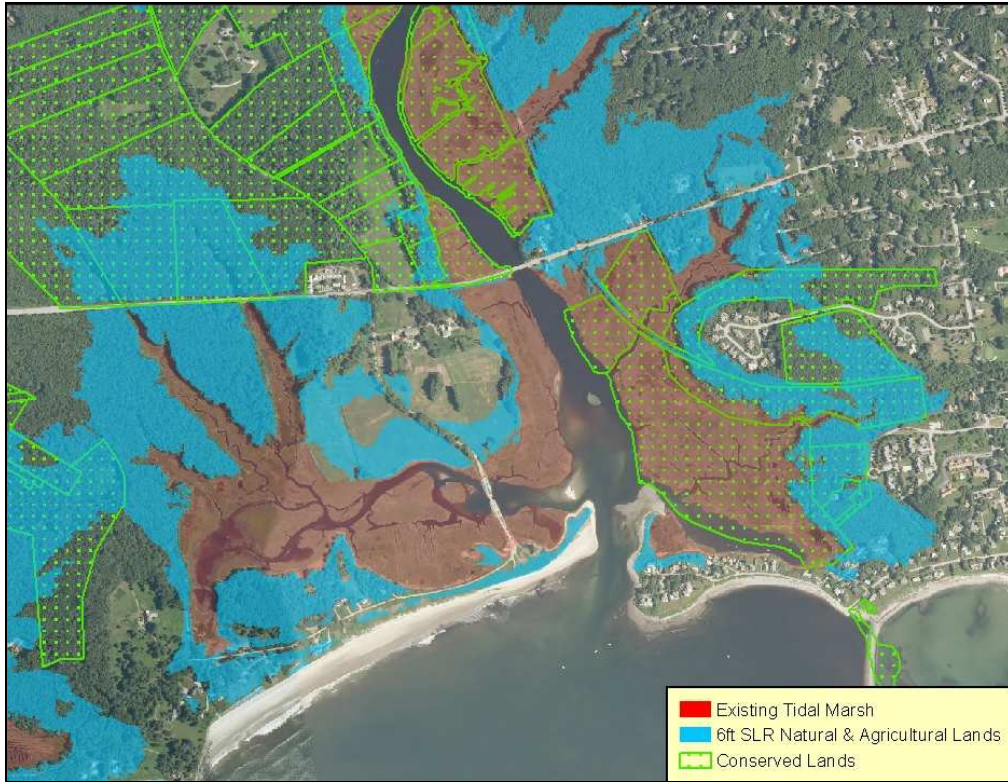


Figure 9: Natural & Agricultural lands with Conserved lands (6 foot SLR simulation, Mousam River)

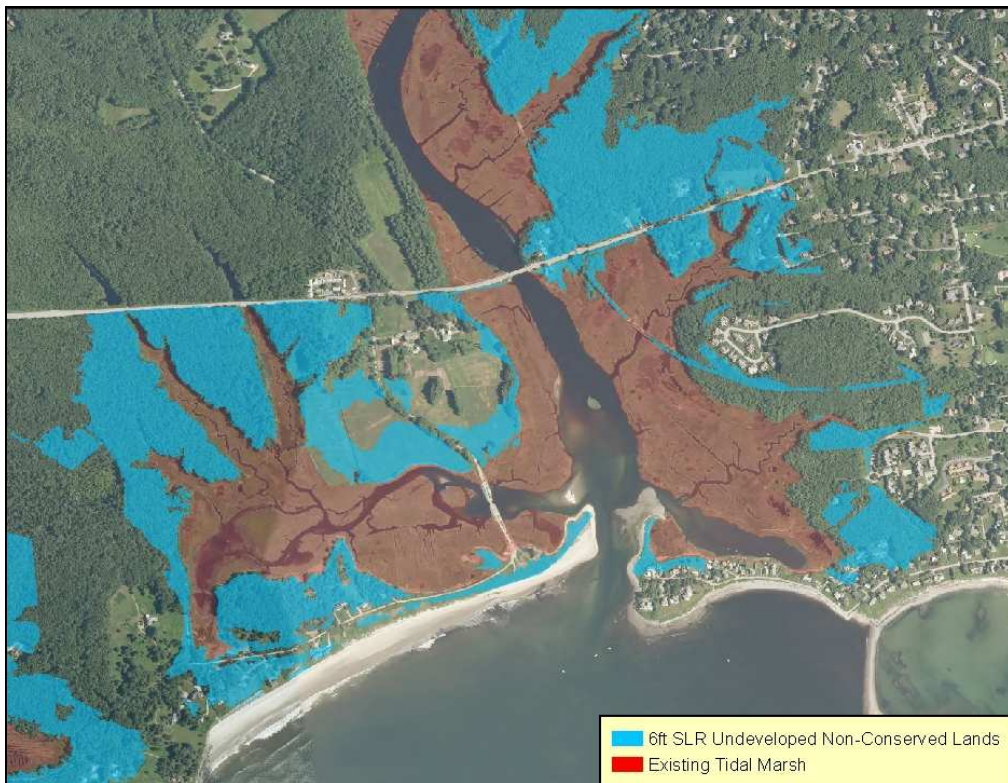


Figure 10: Example of areas of potential marsh migration that are undeveloped and not currently conserved, for use in planning (6 foot SLR simulation, Mousam River).



Figure 11: An example of the distribution of undeveloped potential marsh migration along a section of the south coast (6 foot SLR simulation)

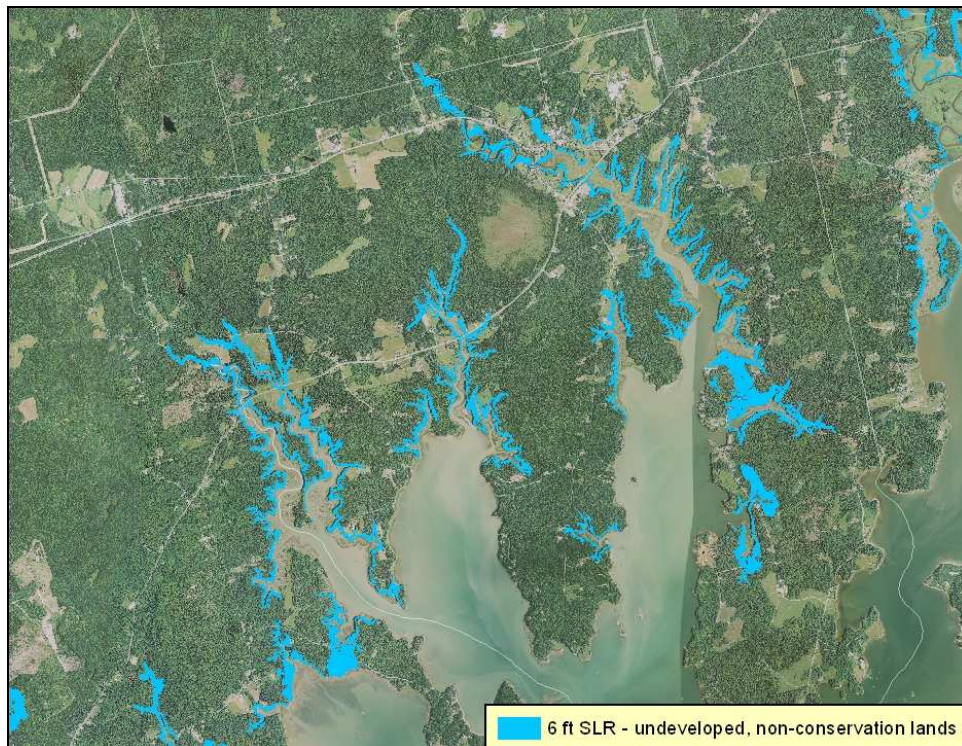


Figure 12: An example of the distribution of undeveloped potential marsh migration along a section of the Downeast coast (6 foot SLR simulation)

SLR Simulation Analysis

Analyses were conducted on the undeveloped potential marsh migration areas for each of the four SLR simulations (1foot, 2foot, 3foot, and 6foot HAT). Some of the questions that were investigated include:

- 1) How much undeveloped potential migration area is there in comparison to existing tidal marsh area?
- 2) What proportions of the simulations are on “Natural” versus “Developed” lands?
- 3) What percentage of these areas are currently identified as freshwater wetlands?
- 4) To what degree are potential migration areas already conserved?
- 5) Are there notable differences between the three coastal ecoregions (Seacoast Plain - Ossippee, Casco Bay - Penobscot Bay - Central Interior, and Eastern Interior - East Coast) for any of these considerations?

Existing marsh versus potential migration area - The total existing tidal marsh acreage along the coast, based on marsh systems > 2.5 acres, and not including fringing marsh, or the freshwater marshes of greater Merrymeeting Bay, is 18,005 acres. Table 1 below shows the acreage of adjacent lands that would be inundated based on each of the four SLR simulations, and the percentage of existing marsh that it represents.

Table 1. Simulation acreage versus existing marsh acreage.

SLR Simulation	Natural + Agricultural Lands (ac)	% of existing tidal marsh area
1ft	3006	17%
2ft	5417	30%
3ft	8245	46%
6ft	13882	77%

Therefore, if all the existing marshes are lost when sea level increases to these elevations then 17% of the existing marsh acres would potentially be replaced under the 1 foot SLR simulation, and 77% of the existing marsh acres would potentially be replaced at the higher end under the 6 foot SLR scenario (Table 1). Whether all or some part of the existing tidal marsh area will be lost under any of the simulations will depend in part on the rate that sea level increases, as well as on local conditions that influence sediment deposition and or erosion for a given marsh system. We consider it unlikely that all existing marshes will be lost under a given SLR scenario, but it is useful to consider this for comparative purposes. Another approach, also highly speculative, would be to consider the potential migration areas as only increasing the total area of the existing marshes, or as expansion areas. In that case, as an example the 1 foot SLR simulation would increase the total area of existing tidal marshes by 17%. In practice it's more likely that there will be both expansion and loss (~migration), and that the greater the depth of SLR and the greater the rate of increase, the more existing marsh will be lost. Aside from this simplistic speculation, the potential for loss of existing tidal marsh is not otherwise addressed by this analysis.

The figures below provide relative comparisons of what percentage of the acres of each simulation falls within each of the three coastal ecoregions (Figure 13), and what percentage of existing tidal marshes there is for each of the four SLR simulations by each of the three coastal ecoregions (Figure 14).

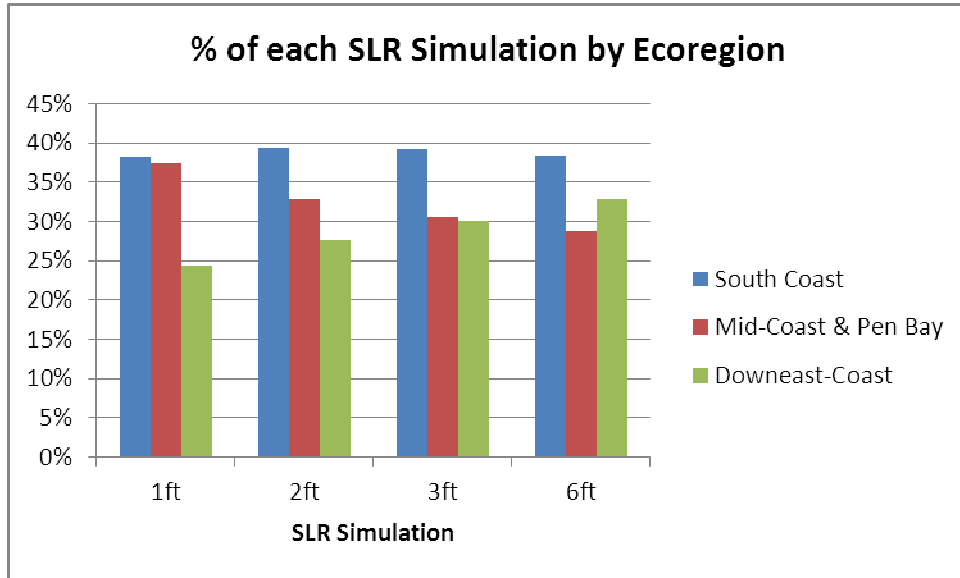


Figure 13: SLR Simulations (Natural + Agricultural) - Percentage by Ecoregion

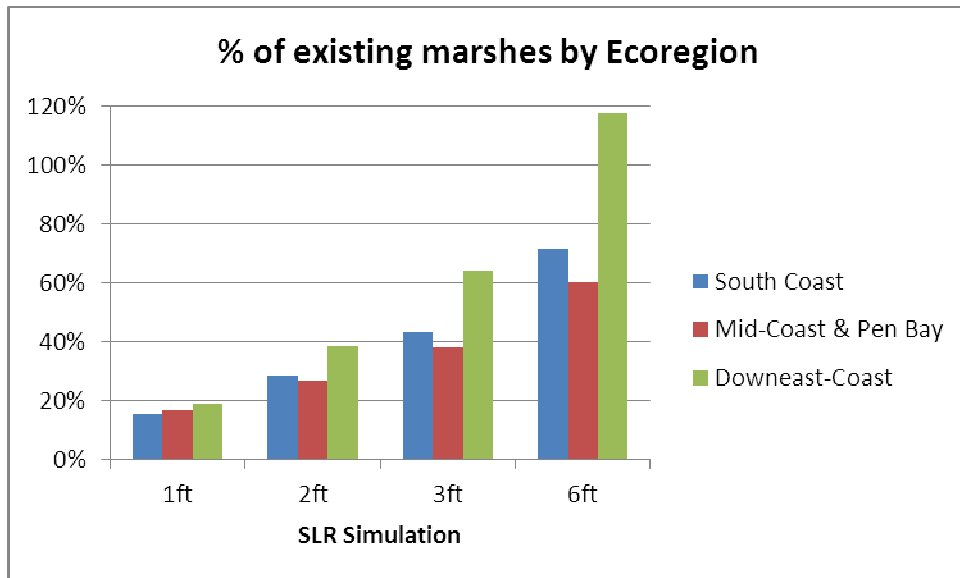


Figure 14: Percentage of existing marshes by Ecoregion (Natural + Agricultural)

Fresh water wetlands (NWI) intersection with potential marsh migration areas (Figures 15 & 16). Potential marsh migration areas were intersected with NWI mapping for freshwater wetlands. There is a significant amount of intersection with existing wetlands for all four simulations (Natural + Agricultural lands) in all coastal ecoregions. For the 1ft simulation, the amount of acre intersection with wetlands over the entire coast is nearly double the amount of intersection with uplands. The ratio between the intersection of wetlands and uplands decreases progressively with each increase in height of the SLR simulation, such that for the 6ft simulation, more uplands are intersected than wetlands (~10% more).

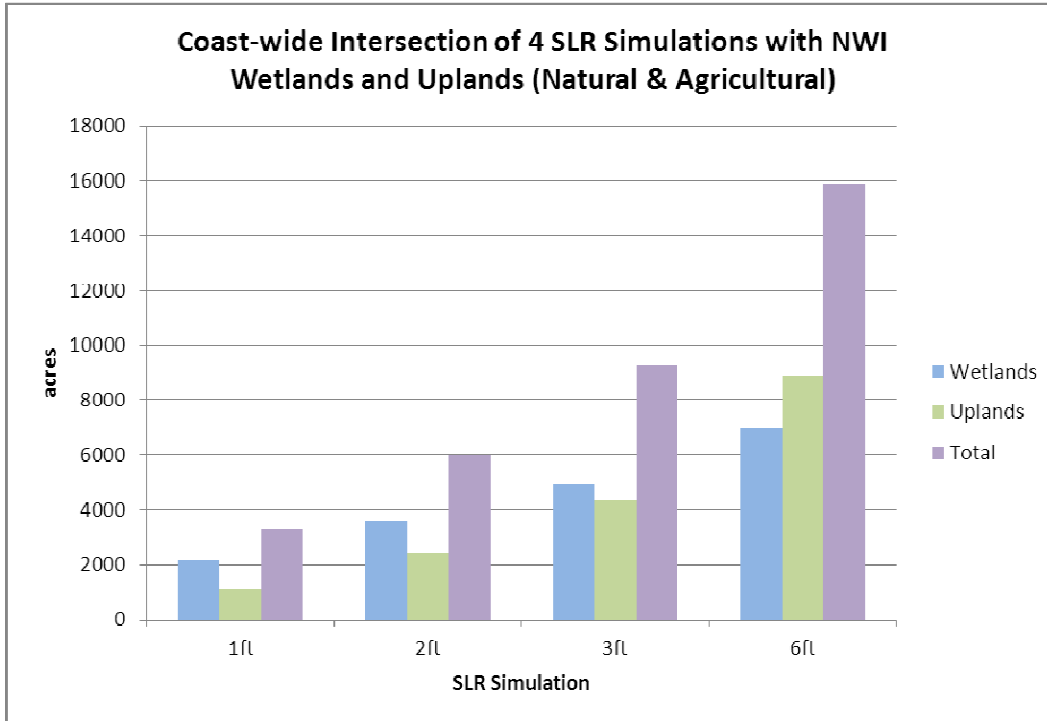


Figure 15: Coast-wide intersection of 4 SLR simulations with NWI wetlands and uplands

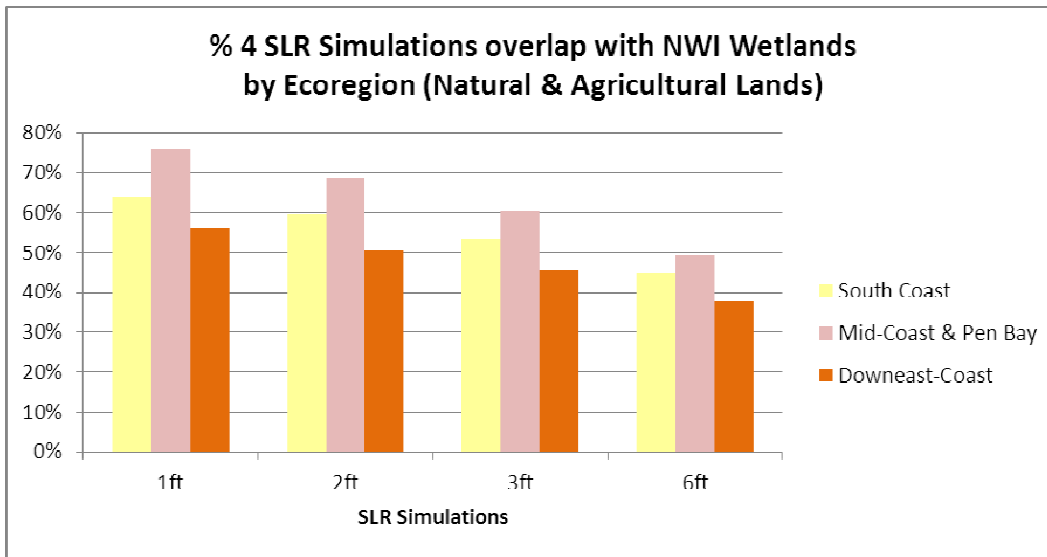


Figure 16: Percent overlap 4 SLR simulations with NWI wetlands by Ecoregion

On a regional basis (Figure 16), the highest percent intersection with wetlands is with the 1 foot SLR simulation in the Mid-Coast – Penobscot Bay region with 76% intersection (871 acres). The percentage

of wetland intersection decreases as SLR increases for all ecoregions, and is lowest in the Downeast region for the 6 foot simulation with only 38% intersection (1,822 acres). The Mid-Coast – Penobscot Bay region consistently has the highest percent wetland intersection, where as the Downeast region consistently has lower wetland intersection for all four SLR simulations.

Land use cover type classes (Figures 17a-d & 18) - In this analysis, the simulation areas (within existing marsh estuaries only) for each SLR scenario were examined for intersection with three land use classes derived from the MELCD data set: 1) Natural, 2) Agricultural, and 3) Developed (Figures 17 a - d). Results of the land cover intersection were very similar for all four SLR simulations with the Natural cover type class ranging between 83% - 89%, the Agricultural cover class ranging between 3% - 4%, and the Developed cover class ranging between 8% - 13% respectively. The percentage of Developed area intersected by shows a slight increase with each increase in SLR, and conversely the percentage Natural area intersected shows a slight decrease with each increase in SLR. Figure 18 compares the acreage of Developed lands to the combined Natural + Agricultural lands for the four simulations.

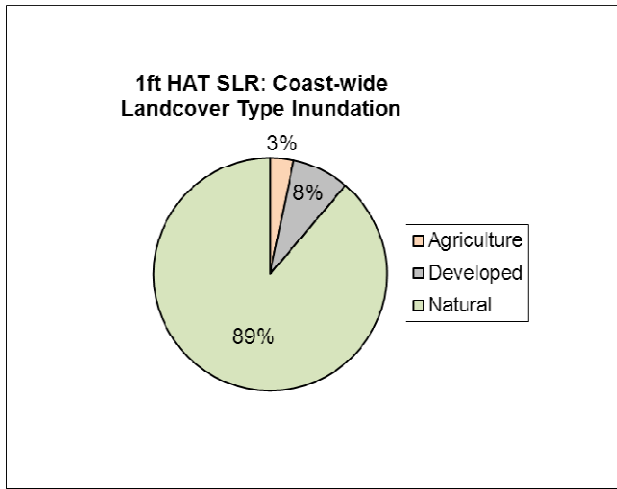


Figure 17a

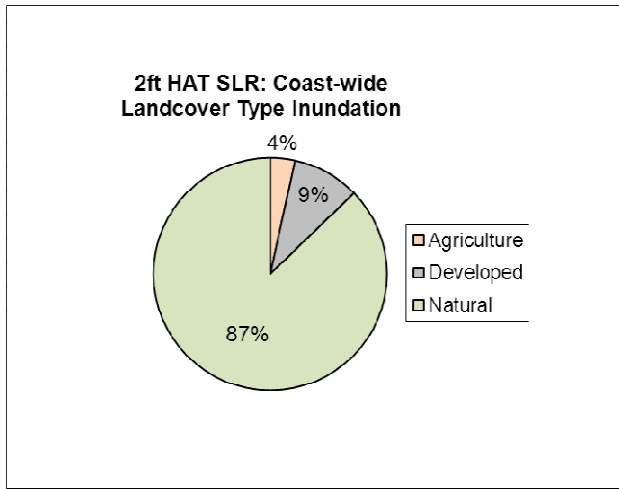


Figure 17b

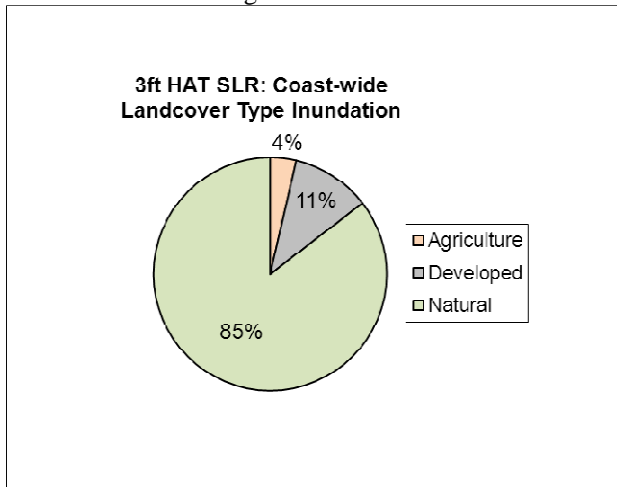


Figure 17c

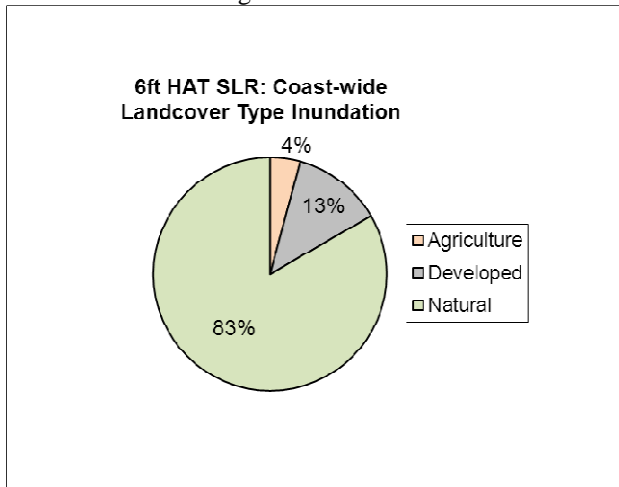


Figure 17d

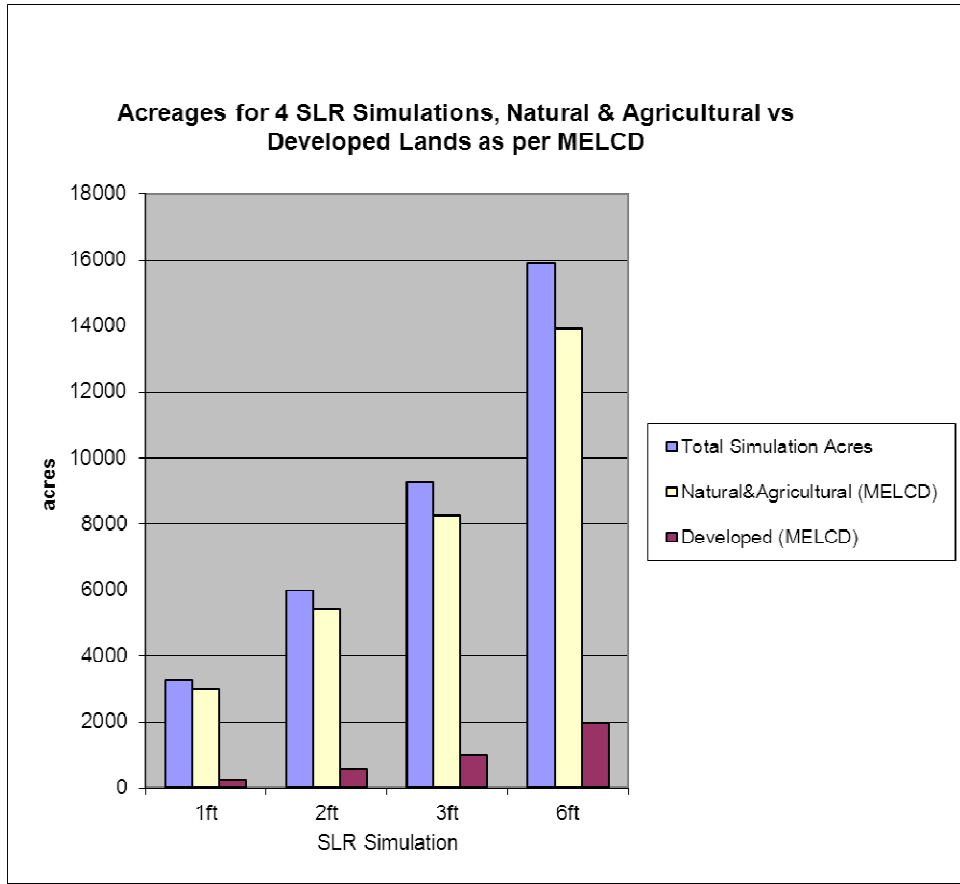


Figure 18: Acreeges for 4 SLR simulations

Conservation lands - The simulation data layers used for analysis of intersection with conservation lands were the ones that represent only Natural + Agricultural lands. Table 2 shows the acres and percentages of Natural + Agricultural lands (i.e., undeveloped lands) that intersect with existing conservation lands for each SLR simulation over the entire coast. There is a clear trend of subtly decreasing intersection with conserved lands as SLR increases. Figure 19 compares the number of acres intersecting with conserved lands to acres of intersection with other lands, and Figure 20 shows the percentage of each simulation that intersects conserved lands by ecoregion. The trend of subtly decreasing intersection with conserved lands is consistent across all three coastal ecoregions.

Table 2:

Simulation (Sim)	Conserved Lands (ac)	Other Lands (ac)	% Sim on Consland
1ft	976	2030	32.5%
2ft	1691	3726	31.2%
3ft	2413	5832	29.3%
6ft	3684	10198	26.5%

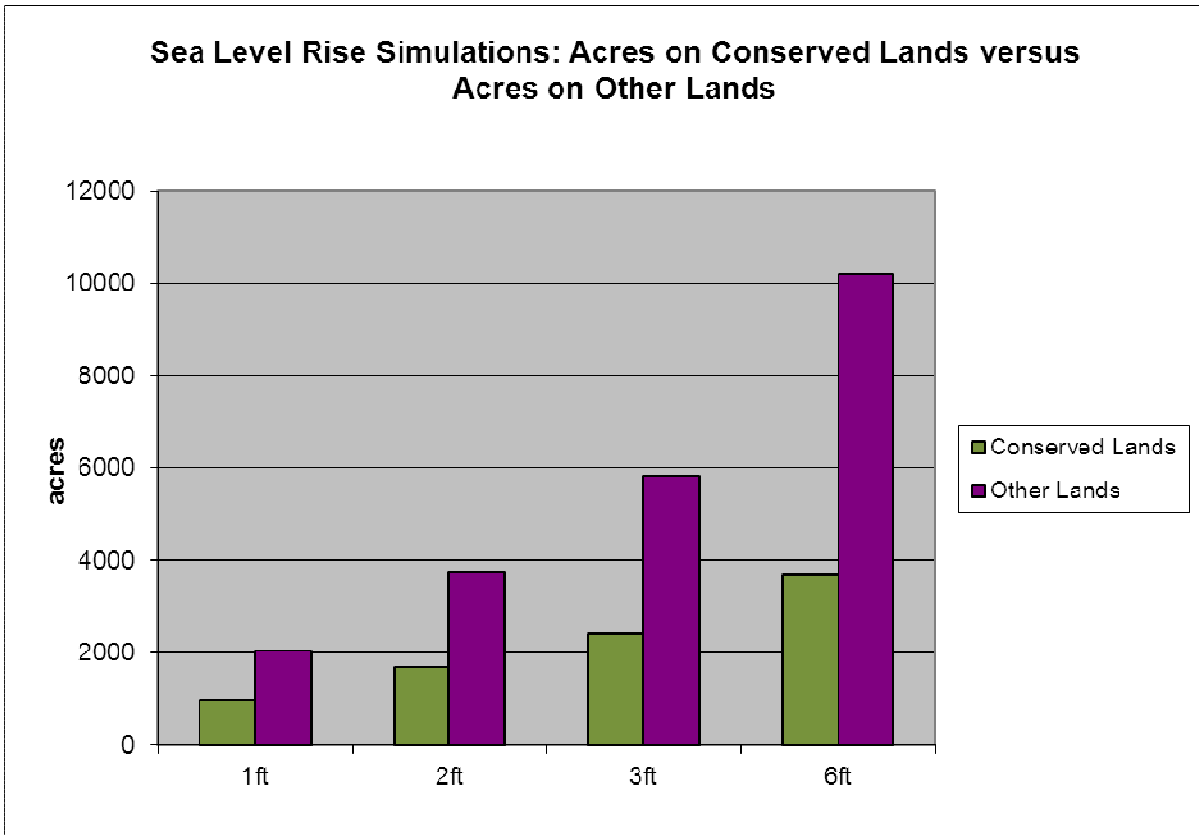


Figure 19: SLR simulations, acres on conserved lands versus acres other lands

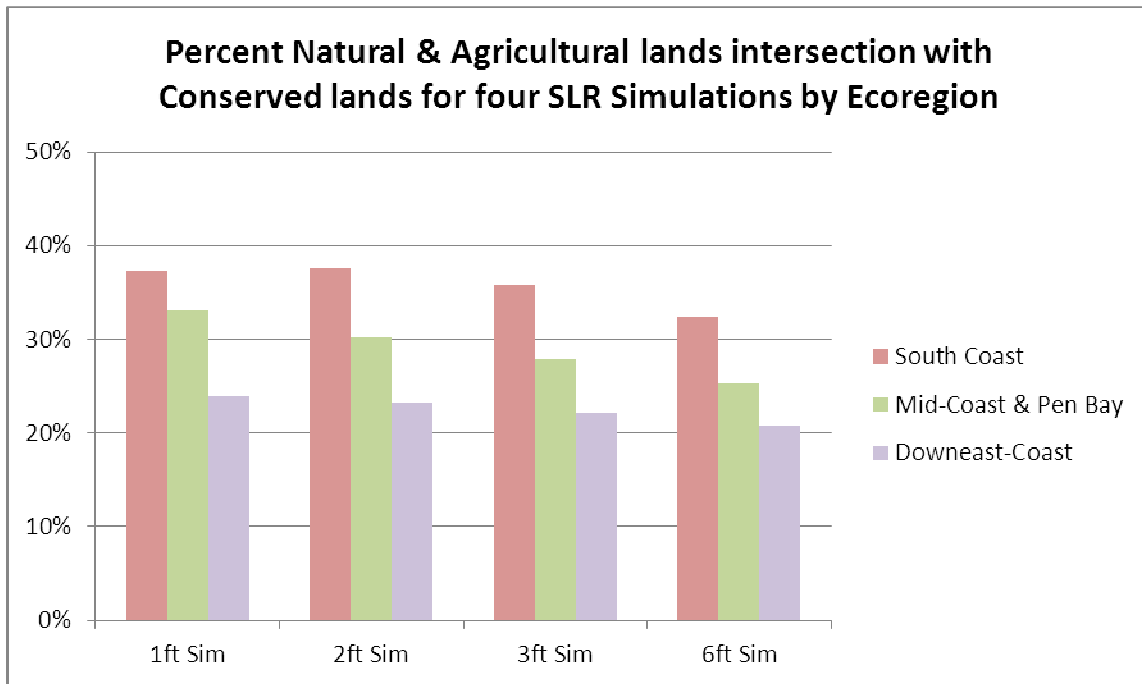


Figure 20: Percent natural and agricultural lands intersection with conserved lands

Summary

Existing marsh versus SLR simulation area: The ratio of potential marsh migration area on Natural + Agricultural lands for each of the four simulations to currently existing tidal marsh ranges from 17% coast wide for the 1 foot simulation to 77% coast wide for the 6 foot simulation. The ratio is nearly equal for the three ecoregions for the 1 foot simulation (15-19%), but it increases at a substantially higher rate for the Downeast ecoregion as the SLR simulation depth increases. The ratio for the Downeast ecoregion for the 6 foot simulation is 118%, while for the same simulation it is only 60% for the Mid-Coast – Penobscot Bay region and 71% for the south coast region. This suggests there will be a relative increase in acres of tidal marsh in the Downeast region with increased sea level in comparison to the two other regions.

Developed versus Undeveloped lands: The overwhelming majority (average 86%) of lands inundated by each of the simulations is undeveloped, with only minimal differences based on ecoregion.

Intersection with NWI Wetlands: There is a significant amount of intersection with existing wetlands for all four simulations (Natural + Agricultural lands) in all coastal ecoregions. The highest percent intersection is with the 1 foot SLR simulation in the Mid-Coast – Penobscot Bay region with 76%. The percentage of wetland intersection decreases as SLR increases for all ecoregions, and is lowest in the Downeast region for the 6 foot simulation with only 38% intersection. The Downeast region has substantially lower wetland intersection than the other regions for all four simulations. The relatively high percentage of wetlands intersected by each of the SLR simulations helps explain in part why there is relatively low intersection with development in the simulation areas.

Intersection with Conserved lands: The greater the depth of the SLR simulation, the greater the proportion of lands that are intersected that are not conserved, ranging coast-wide from 67.5% for the 1 foot simulation to 73.5% for the 6 foot simulation. The difference in percentage seems low, but in actual acres, it is very high with only 2,030 acres not conserved lands for the 1 foot simulation compared to 10,198 acres not conserved for the 6 foot simulation.

Literature Cited

- Cameron, D. and P. Slovinsky. 2012. Conservation Planning for Tidal Marsh Migration Due to Sea Level Rise. A Report to the US EPA. Maine Natural Areas Program, Augusta, ME.
- CCSP. 2009: Coastal Sensitivity to Sea-Level Rise on the Mid-Atlantic Region. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [James G. Titus (Coordinating Lead Author), K. Eric Anderson, Donald R. Cahoon, Dean B. Gesch, Stephen K. Gill, Benjamin T. Gutierrez, E. Robert Thieler, and S. Jeffress Williams (Lead Authors)], U.S. Environmental Protection Agency, Washington, DC, USA.
- Gawler, S. and A. Cutko. 2010. Natural Landscapes of Maine: A Guide to Natural Communities and Ecosystems. Maine Natural Areas Program, Maine Department of Conservation, Augusta, Maine.
- United States Environmental Protection Agency. 1995. Anticipatory Planning For Sea-Level Rise Along the Coast of Maine. Maine State Planning Office, Augusta, ME.
- Yin, J, M.E. Schlesinger, and R.J. Stouffer. 2009. Model projections of rapid sea-level rise on the northeast coast of the United States. Nature Geoscience: March 15, 2009.

Appendix 1: Land Cover Types Classification

The source for the landcover data used in the GIS analysis is the MELCD layer available from the Maine Office of GIS. The land cover data in the file was updated using 2004 aerial imagery and published in 2006. The metadata for MELCD are available at:

<http://geolibportal.usm.maine.edu/geonetwork/srv/en/metadata.show?id=427>.

The data includes 26 cover types of which 21 types intersected with the four sea level rise simulations. Each of these 21 types was placed into one of three categories, Developed, Agriculture, and Natural, as per the list below.

Pixel

value Cover type

Developed

- 2 Developed, High Intensity (80-100% impervious)
- 3 Developed, Medium Intensity (50-79% impervious)
- 4 Developed, Low Intensity (21-49% impervious)
- 5 Developed, Open Space (developed areas, but 0-20% impervious - city parks, golf courses, baseball fields, etc.)
- 16 Road/Runway (impervious road or runway, but not in developed areas)

Agricultural

- 6 Cultivated Crop (production of annual crops such as corn, potatoes, strawberries, and tilled barren fields)
- 7 Pasture/Hay (grasses are major vegetation, managed for harvesting as hay or grazing)

Natural

- 8 Grassland/Herbaceous (unmanaged grasslands - rare in Maine)
- 9 Deciduous Forest (> 20% tree canopy cover, > 75% of trees are deciduous)
- 10 Evergreen Forest (> 20% tree canopy cover, > 75% of trees are evergreen)
- 11 Mixed Forest (> 20% tree canopy cover, 25-75% are deciduous)
- 12 Scrub/Shrub (woody vegetation < 5m tall is > 20% of cover - typically regenerating fields, cuts, or rights-of-way)
- 13 Wetland Forest (freshwater wetland with > 20% tree canopy cover)
- 15 Wetland (all other wetlands)
- 19 Unconsolidated Shore (rocky shore, mudflats, sand beach, exposed lake shoreline)
- 20 Bare Ground (open quarries and pits, granite outcrops and peaks)
- 21 Open Water (water bodies typically > 10m wide)
- 23 Recent Clearcut (forested area with > 90% canopy removal 2001-2004)
- 24 Light Partial Cut (forested area with 20-50% canopy removal 1995-2001)
- 25 Heavy Partial Cut (forested area with 50-100% canopy removal 1995-2001)
- 26 Regenerating Forest (forested area with canopy increase 1995-2001)