FACILITATING MARSH MIGRATION FOR FLORIDA'S GULF COAST

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CONTEXT

Florida's Gulf Coast has wide expanses of salt marsh alongside freshwater coastal forest further inland and in elevated patches throughout the marsh. These ecosystems provide critical benefits for marine water quality, wildlife, and human safety. Sea level rise is a growing threat, causing salt marsh to erode and submerge at the coastal edge and coastal forest to die-off and be replaced by salt marsh or open water.

To forecast these changes, I created datasets showing the vulnerability of salt marsh to sea level rise as well as the potential of salt marsh to establish further inland. Salt marsh migration is typically viewed in terms of marsh survival, yet it is important to consider the ecosystems with lower salinity tolerance that are lost as salt marsh migrates inland. Scientists from the Lower Suwannee National Wildlife Refuge (LSNWR) have stated that knowledge of likely changes in the extent of coastal forest would be useful for developing management plans. Accordingly, I have created datasets that show coastal forest converted to marsh or open water. A final dataset identifies salt marsh migration area held as protected land.

EXISTING MARSHES AND COASTAL FOREST BY ELEVATION CLASS

Florida Natural Areas Inventory Cooperative Land Cover (CLC) Map (10-m grid) was downloaded and resampled to 20-m grid cells, and classes falling within salt marsh and coastal forest were extracted. I included mangrove forest within the salt marsh category due to their similar tidal hydrology and migration mechanisms. Additionally, LSNWR scientists agreed it was inadvisable to map mangrove separately, as it is difficult or impossible to find a current state-wide layer that accurately separates the two, given the rapid expansion of mangrove distributions. As there is no standard definition of coastal forest and it can include forest habitat types which also exist far inland, I extracted areas within 40 km of the coastline and designated all present forest classes as coastal forest, confirming this decision with a coastal forest specialist at FWC. Additionally, I included CLC category "Tree Plantations" as coastal forest upon the recommendation of LSNWR.

Elevation datasets (1/9 arc second) were downloaded from NOAA's Continuously Updated Digital Elevation Model Bathymetric-Topographic Tiles, and USGS National Elevation Datasets (1/3 arc second) were downloaded to fill in missing areas. Datasets were resampled to 20-m grid cells. NOAA's VDATUM program was used to convert elevation from NAVD88 to a MHHW datum. Along this coastline, low-elevation coastal habitats extend much further inland than VDATUM covers, so large portions of elevation data were not adjusted. To fix this, I subtracted the VDATUM output from the input raster, yielding a raster with NAVD88-MHHW adjustments. I used the Euclidean Allocation tool to find the nearest NAVD88-MHHW value for each elevation grid cell not covered by VDATUM, and I applied this adjustment raster, attaining a full elevation dataset adjusted to MHHW. This was clipped into separate datasets for coastal forest and salt marsh and each dataset was reclassified into elevation categories 0-1.5, 1.5-3, 3-4, and 4-6.5 feet, plus a 6.5-20 feet category for coastal forest.

MARSH MIGRATION SPACE BY PROTECTION STATUS

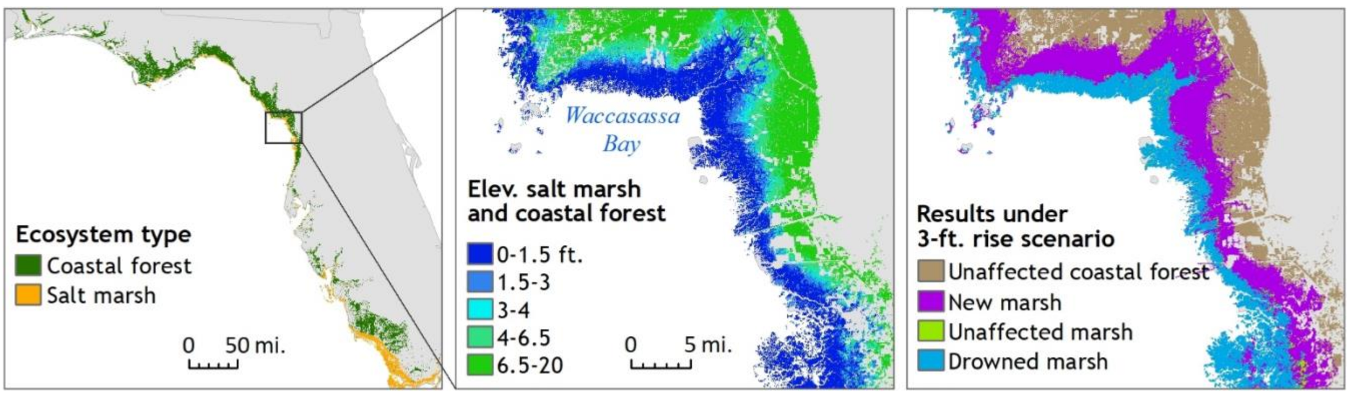
Coastal Migration Space shapefiles were downloaded from the Nature Conservancy's Resilient Coastal Sites for Conservation in the Gulf of Mexico collection and converted to rasters. These datasets show areas predicted to support new tidal habitat under 1.5, 3, 4, and 6.5 feet of sea level rise, based on bathtub-approach sea level rise modeling combined with spatial data on marsh physical properties (e.g., marsh area, sediment supply, development proximity, freshwater flow alteration) and local tidal regime. It should be noted that migration space here includes areas likely to support some combination of salt marsh, brackish marsh, and tidal flat, rather than salt marsh alone.

The migration space shapefiles for all sea level rise levels were merged into a single dataset. This was overlaid with the USGS Protected Areas Database, a dataset of public lands and waters, as well as private holdings under easements and other designations, to create a raster of all marsh migration space coded by whether it is protected or not.

FUTURE MARSH AND COASTAL FOREST SCENARIOS

For each sea level rise scenario, the salt marsh elevation raster was overlaid with the migration raster for the corresponding sea level rise scenario to create a raster of drowned marsh, unaffected existing marsh, and new marsh. Coastal forest impacts rasters were also created for each scenario, showing forest lost to water, forest converted to salt marsh, and unaffected forest. Specifically, to create the future marsh raster for a scenario (e.g., 3 ft.), first all existing salt marsh below the sea level rise elevation (3 ft.) was set to drowned marsh and marsh above it was set to unaffected marsh. Then cells designated as migration space cells were set to new marsh. To create the coastal forest impacts raster, coastal forest overlapping with migration space was set to forest converted to salt marsh; coastal forest not within migration space was set to forrest lost to water if it was below the level of rise, and unaffected forest if it was above the level of rise.

In some cases, cells identified as marsh migration space for a given scenario overlapped with existing marsh cells forecast to be drowned based on my elevation classes. This likely occurs because of differently sourced elevation and ecosystem extent data used in my elevation class datasets vs. the Nature Conservancy migration space datasets. However, it supports the notion that the marsh identified in that location by the CLC data can persist, and therefore those cells were set to unaffected marsh. In contrast, although marsh migration space frequently overlapped with coastal forest that would be classified as drowned based on elevation alone, this was to be expected, given that the Nature Conservancy's migration datasets rely on more than elevation alone to predict migration space.



CONCLUSION

This exercise reveals that vast acreage of salt marsh along low development sections of the coast is likely to be very resilient to sea level rise, given high potential for salt marsh and other tidal habitats to migrate inland and accrete in place.

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