Application of the Sea Level Rise Affecting Marsh Model (SLAMM) for Prime Hook NWR Using High Resolution Data

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SLAMM Model

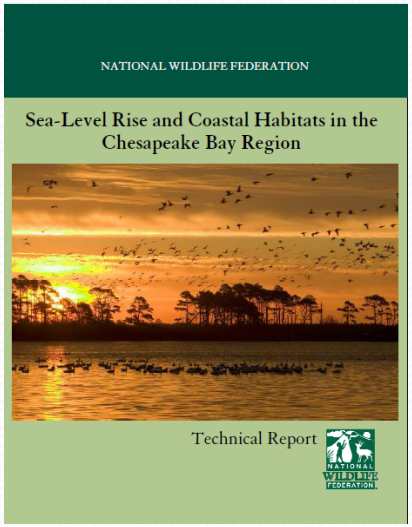
The **Sea Level Affecting Marshes Model** (SLAMM Ver. 5.0) simulates the dominant processes involved in wetland conversions and shoreline modifications during long-term sea level rise.

Processes:	Inundation	Erosion
	Overwash	Saturation
	Accretion	

SLAMM

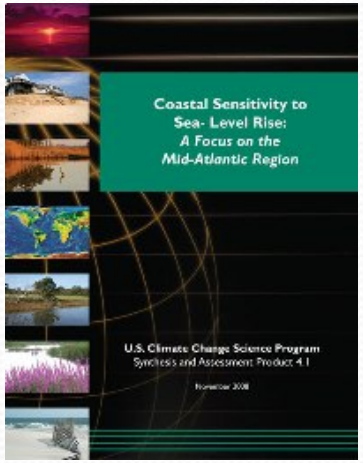
- Regional Scale Model
- Ease of use
  - PC based
  - ArcView knowledge
- Minimal Inputs
  - Tidal Parameters
  - Accretion/Erosion rates
  - DEM, NWI files
- Outputs
  - Maps
  - Tables

NWF Report



"It is our hope that this report will provide coastal resource managers and other relevant decision-makers with much needed information about local impacts of sea-level rise on the Chesapeake Bay's coastal habitats to help them assess the risks and identify reasonable steps to manage those risks. **Ultimately, the appropriate response strategies will vary for different areas, and site-specific studies may be warranted to supplement these findings by identify factors that have not effectively characterized by the model or are uncertain**. However, the results of this analysis can be used to inform a number of important decisions regarding coastal restoration and management"

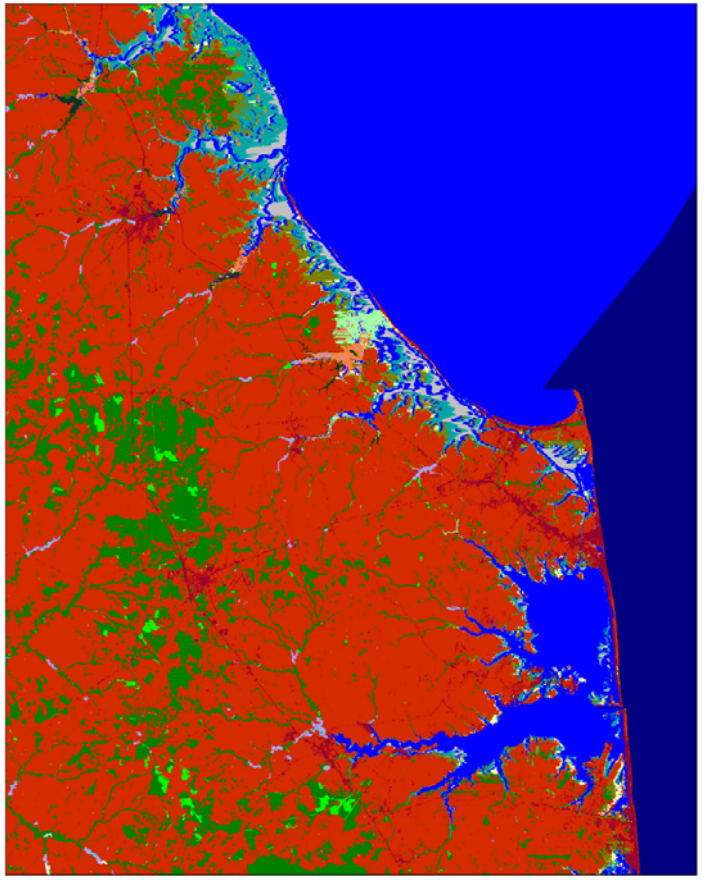
CCSP 4.1



Large scale landscape models, such as the Sea Level Affecting Marshes Model (SLAMM) (Park et al., 1989), simulate general trends over large areas, but typically at a very coarse resolution. *These landscape models do not mechanistically simulate the processes that contribute to wetland elevation; the processes are input as forcing functions and are not simulated within the model. Thus, this modeling approach does not account for infrequent events that influence wetland vertical development, such as storms and floods, or for frequent elevation feedback mechanisms affecting processes (for example, elevation change alters flooding patterns that in turn affect sediment deposition, decomposition, and plant production). In addition, these models are not suitable for site-specific research and management problems because scaling down of results to the local level is not feasible.* ***Therefore, although landscape models can simulate wetland sustainability on broad spatial scales, their coarse resolution limits their accuracy and usefulness to the local manager.*** **(CCSP 2009).**

Is SLAMM the Best Choice?

- SLAMM use being encouraged by USFWS for Refuge Planning
- Other models available
  - Accuracy vs. ease of use/data requirements
  - How do we deal with scalability?
  - How do we deal with uncertainty?



Year 2100 Scenario A1B-Maximum (0.69 meters of global sea-level rise)
Protect Developed Land, Rehoboth Beach & Oceanic Delaware

Issues with SLAMM at the local level

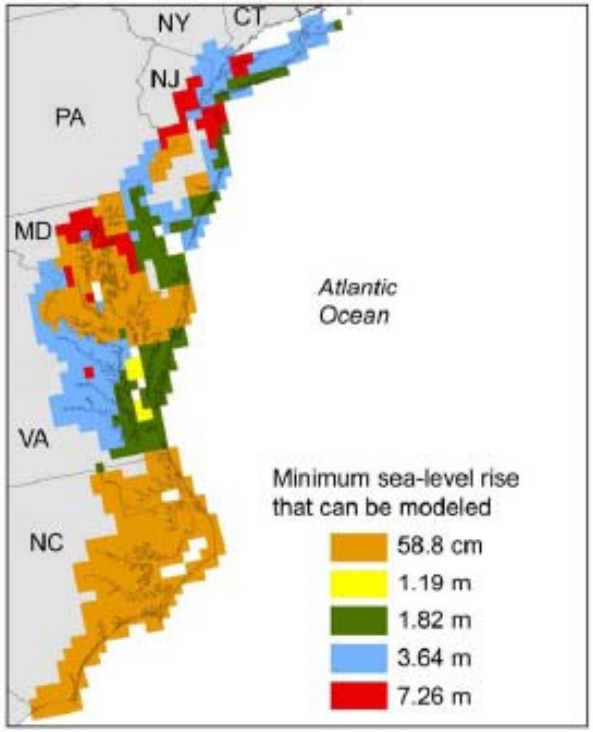
- Accuracy of the data
- Resolution of data
- Lack/Uncertainty of site specific data
- Model lacks feedback loops *
- Boundary requirements
- Data file size limitations*

** Partially addressed in Version 6.0*

Elevation Accuracy

Table 2.4 Minimum sea-level rise scenarios for vulnerability assessments supported by elevation datasets of varying vertical accuracy.

Elevation data source	Vertical accuracy: RMSE	Vertical accuracy: linear error at 95-percent confidence	Minimum sea-level rise increment for inundation modeling
1-foot contour interval map	9.3 cm	18.2 cm	36.4 cm
Lidar	15.0 cm	29.4 cm	58.8 cm
2-foot contour interval map	18.5 cm	36.3 cm	72.6 cm
1-meter contour interval map	30.4 cm	59.6 cm	1.19 m
5-foot contour interval map	46.3 cm	90.7 cm	1.82 m
10-foot contour interval map	92.7 cm	1.82 m	3.64 m
20-foot contour interval map	1.85 m	3.63 m	7.26 m

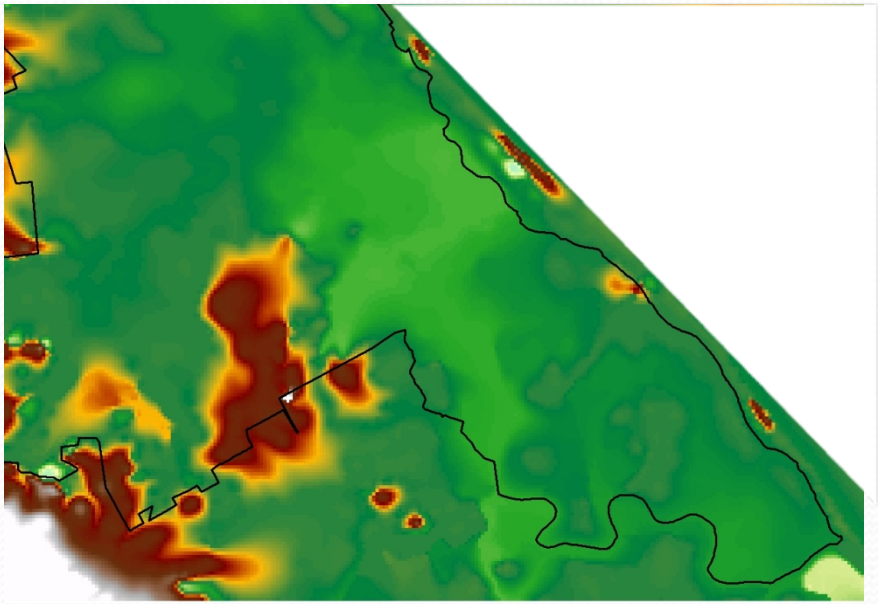


SLAMM Vegetation Index

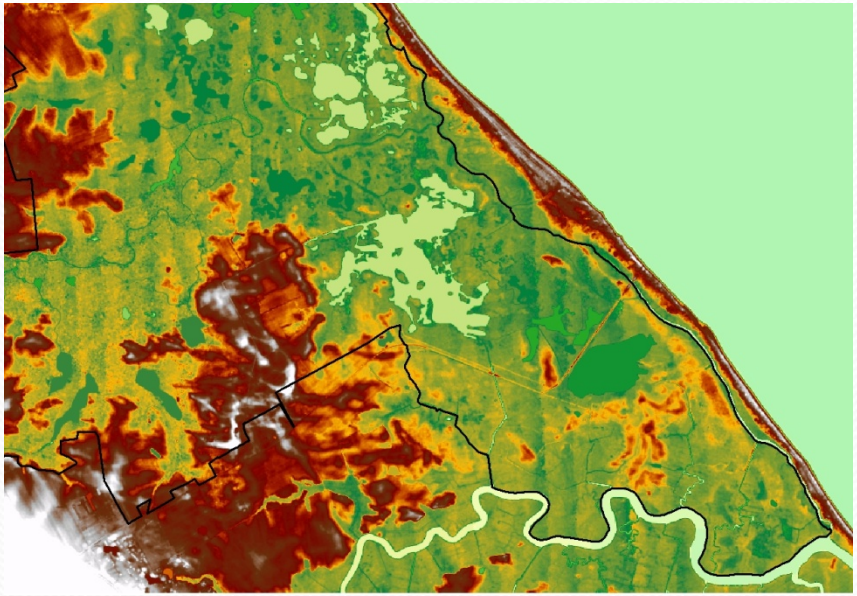
- 18 Local Vegetation Categories*
  - Water level
  - Distance inland
  - Salinity
- 6 Tidal dependent regimes
  - Some less than 1 foot vertical zones

** Can now be user defined based on elevation (Ver. 6.0)*

Available DEMs



30 m horizontal resolution
50 cm vertical resolution
(5 foot contour)



2 m horizontal resolution
15 cm vertical resolution
(LiDAR)

File Size for PH-NWR

- 30 m DEM
  - 153,000 data points per file (4 files)
- 2m DEM
  - 34,750,000 data points per file
- 5m DEM
  - 5,500,000 data points per files

Other Issues

- Lack of Feedback
  - As the rate of sea level rise changes accretion rate can not change*
  - Tide regimes can not change*

- Boundary Requirements
  - Erosion requires 9km fetch
  - Estuary feature difficult to use in smaller areas

** Partially addressed in Ver. 6.0*

Delaware Approach

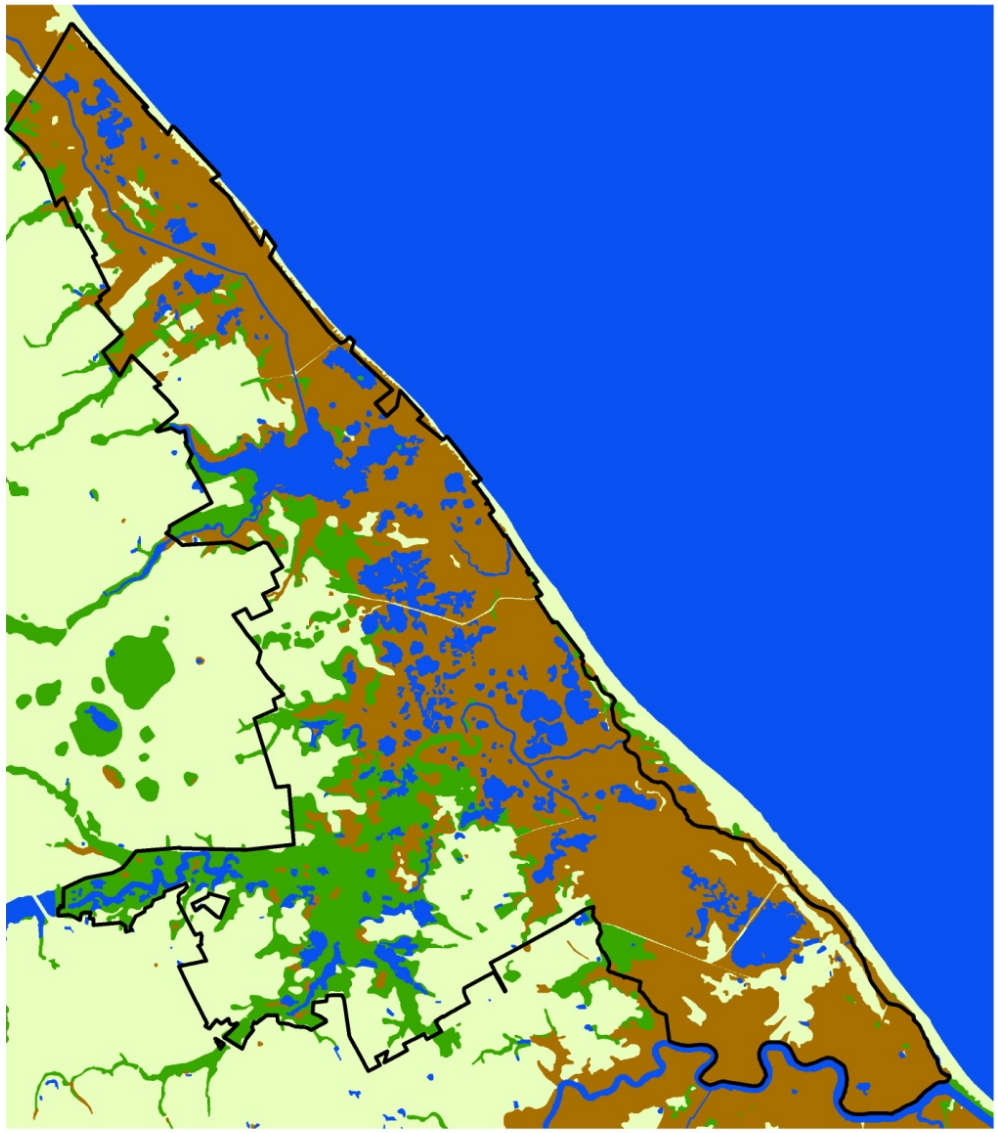
- SLR Rates
  - A1B (0.50 m)
  - 1 meter

- Vegetation Type Aggregation
  - Upland
  - Forested Wetlands/Scrub Shrub
  - Marsh
  - Open Water/Tidal Mud Flat

Delaware Approach

- Highest Possible Horizontal Resolution
  - 5 meter grid

- Multiple Scenarios
  - Expected input extremes
    - Accretion rates
      - 3.1 mm/yr
      - Equal to SLR
    - Inland tide
      - 50% Coastal Tide (current)
      - 100% Coastal Tide (dune breach)



Prime Hook NWR SLAMM Output

Year = 2007
SLR Scenario = A1B
Sea Level Rise = 0.00 meter

Accretion Rate = 3.1 mm/yr
Inland Tide = 50% Coastal Tide

- NWR Boundary
- Uplands
- Forested Wetlands/Scrub Shrub
- Marsh
- Open Water/Tidal Mud Flats

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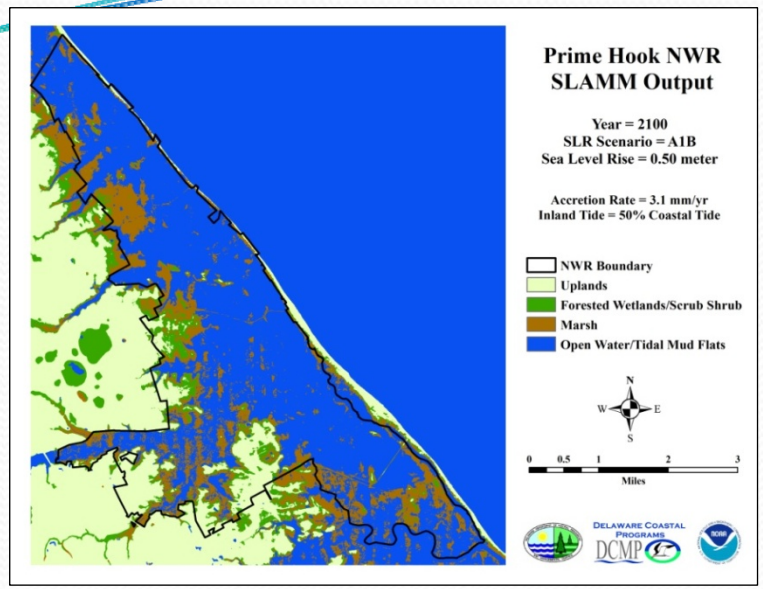
0 0.5 1 2 3
Miles

Delaware Coastal Programs
DCMP


Prime Hook NWR
SLAMM Output
Year = 2100
SLR Scenario = A1B
Sea Level Rise = 0.50 meter
Accretion Rate = 3.1 mm/yr
Inland Tide = 50% Coastal Tide
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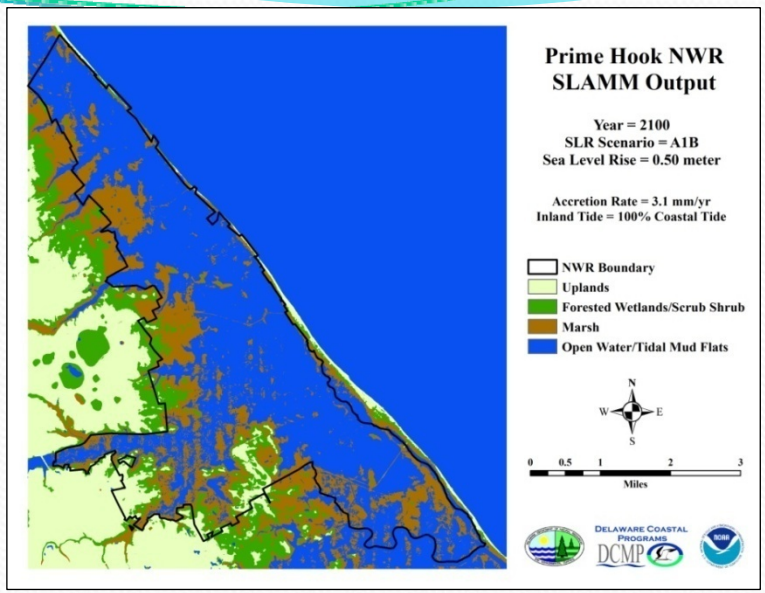
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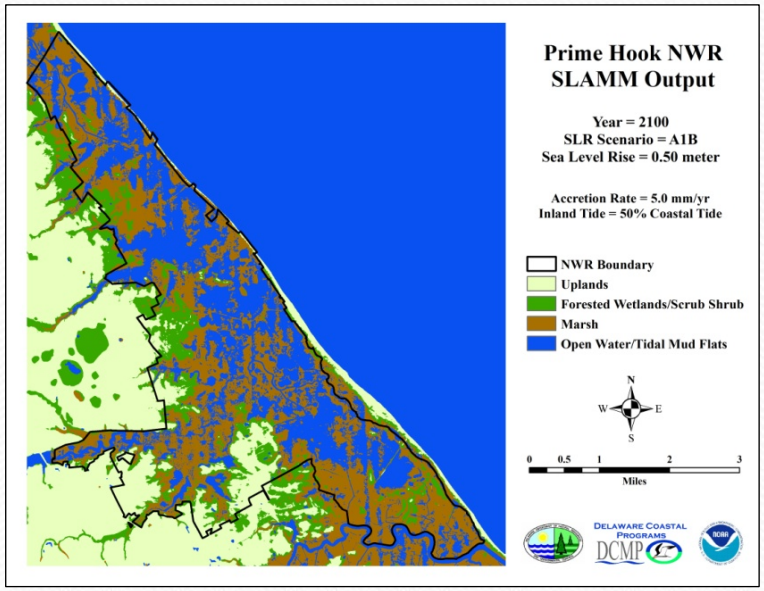
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SLAMM Output
Year = 2100
SLR Scenario = A1B
Sea Level Rise = 0.50 meter
Accretion Rate = 5.0 mm/yr
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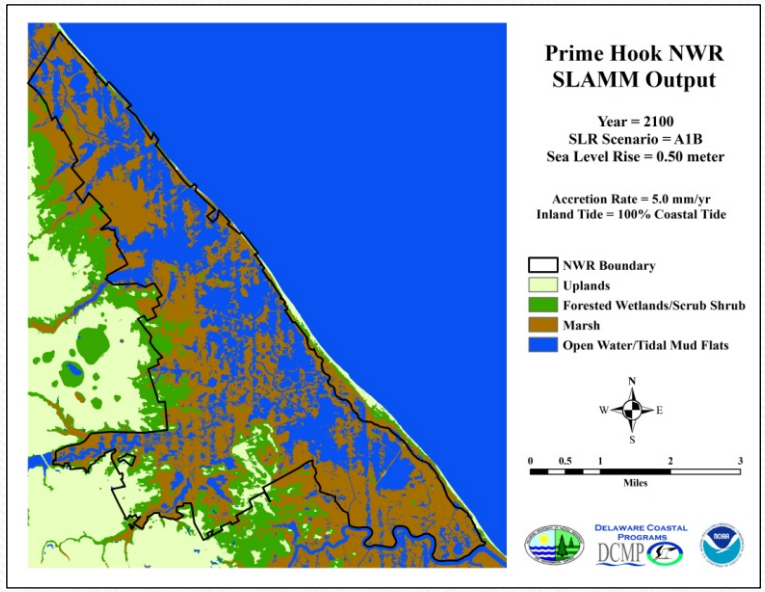
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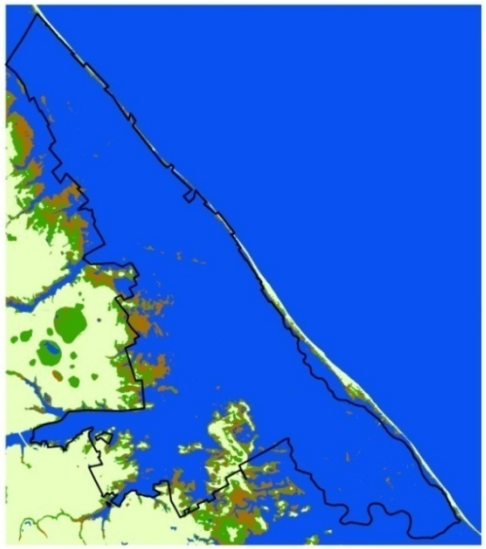
Prime Hook NWR
SLAMM Output
Year = 2100
SLR Scenario = 1 meter
Sea Level Rise = 1.06 meter
Accretion Rate = 3.1 mm/yr
Inland Tide = 50% Coastal Tide
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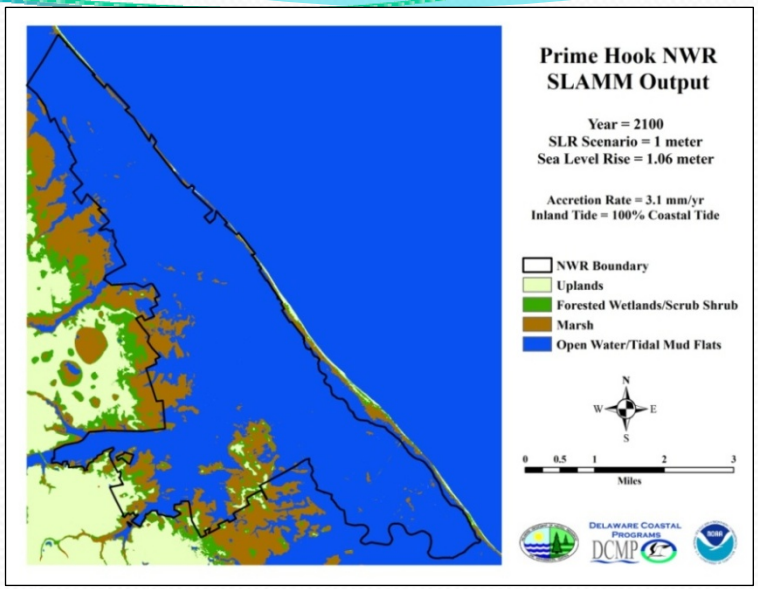
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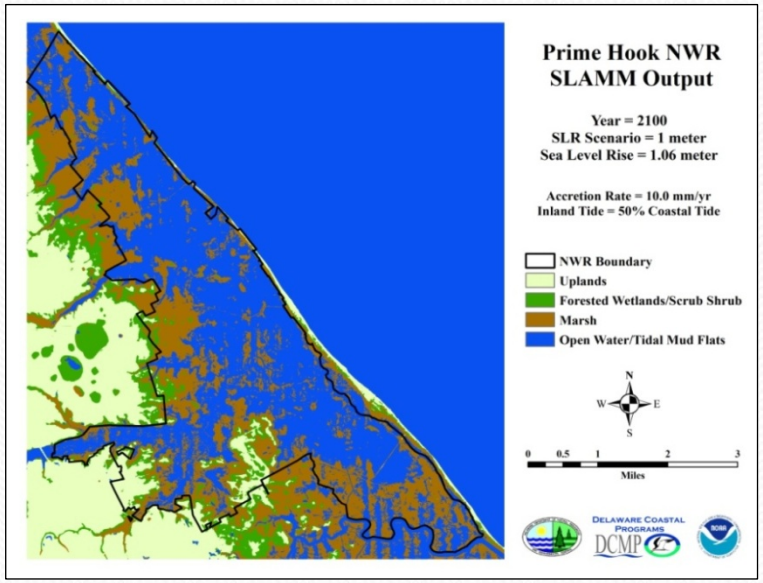
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SLAMM Output
Year = 2100
SLR Scenario = 1 meter
Sea Level Rise = 1.06 meter
Accretion Rate = 10.0 mm/yr
Inland Tide = 50% Coastal Tide
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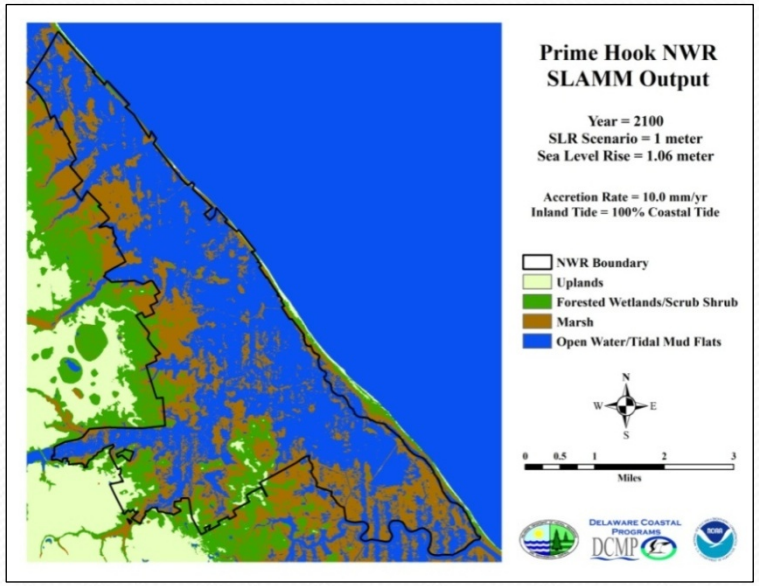
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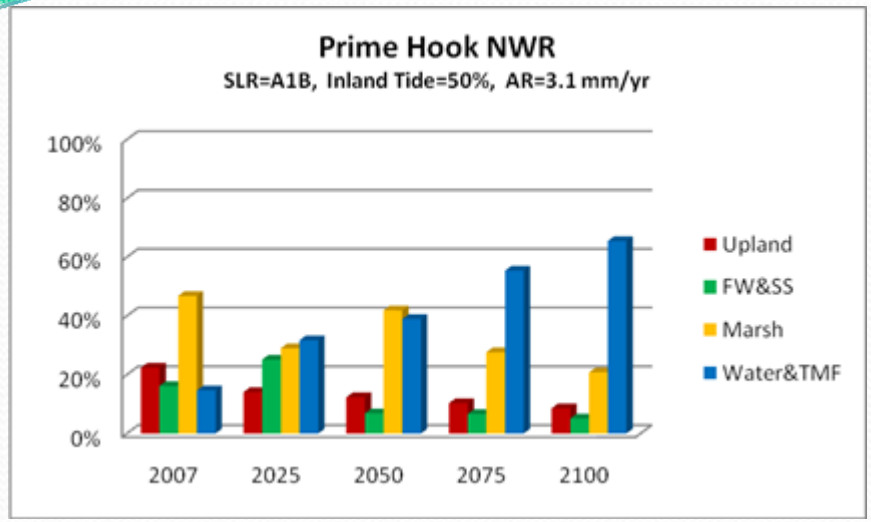
Scenario: A1B SLR, Inland Tide = 50% Coastal Tide, Accretion Rate = 5.0 mm/yr					
Year	Land Cover				
	SLR (meter)	Upland (ha)	FW & SS (ha)	Marsh (ha)	Water & TMF (ha)
2007	0.00	9011	6507	18846	5893
2025	0.07	5677	10144	13145	11290
2050	0.20	4962	3419	20330	11545
2075	0.35	4162	3842	18332	13920
2100	0.50	3466	4239	17143	15408

Scenario: A1B SLR, Inland Tide = 100% Coastal Tide, Accretion Rate = 5.0 mm/yr					
Year	Land Cover				
	SLR (meter)	Upland (ha)	FW & SS (ha)	Marsh (ha)	Water & TMF (ha)
2007	0.00	9011	6507	18846	5893
2025	0.07	2683	13079	13204	11290
2050	0.20	2244	2468	23999	11545
2075	0.35	1807	2725	21803	13920
2100	0.50	1411	2967	20465	15412

Scenario: A1B SLR, Inland Tide = 50% Coastal Tide, Accretion Rate = 5.0 mm/yr					
Year	Land Cover				
	SLR (meter)	Upland (%)	FW & SS (%)	Marsh (%)	Water & TMF (%)
2007	0.00	22%	16%	47%	15%
2025	0.07	14%	25%	33%	28%
2050	0.20	12%	8%	51%	29%
2075	0.35	10%	10%	46%	35%
2100	0.50	9%	11%	43%	38%

Scenario: A1B SLR, Inland Tide = 100% Coastal Tide, Accretion Rate = 5.0 mm/yr					
Year	Land Cover				
	SLR (meter)	Upland (%)	FW & SS (%)	Marsh (%)	Water & TMF (%)
2007	0.00	22%	16%	47%	15%
2025	0.07	7%	32%	33%	28%
2050	0.20	6%	6%	60%	29%
2075	0.35	4%	7%	54%	35%
2100	0.50	4%	7%	51%	38%


Prime Hook NWR
SLR=A1B, Inland Tide=50%, AR=3.1 mm/yr
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Upland
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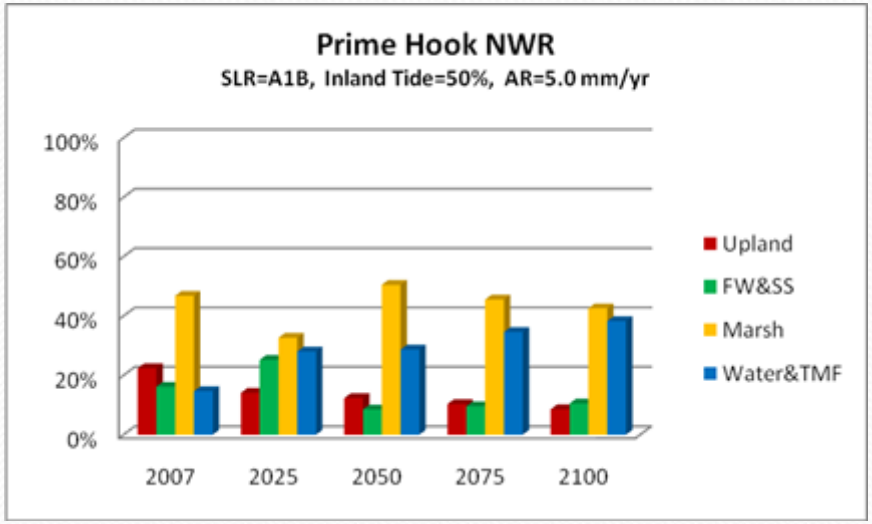
Marsh
Water&TMF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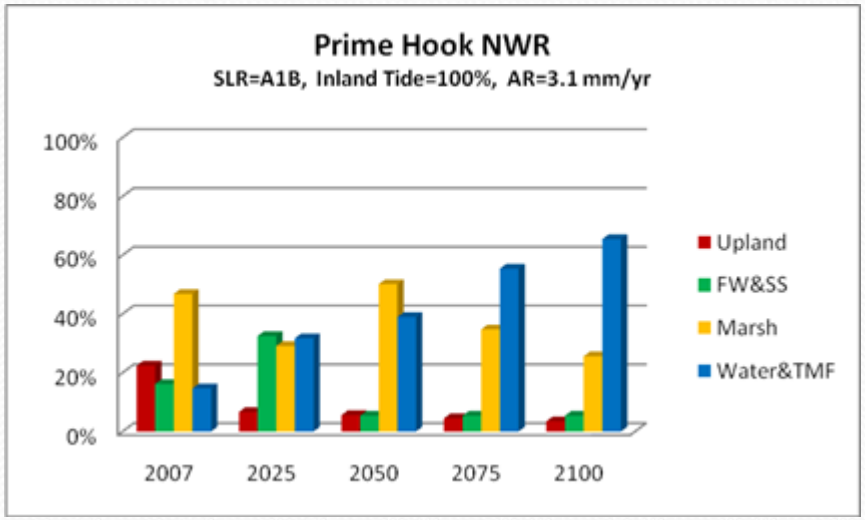
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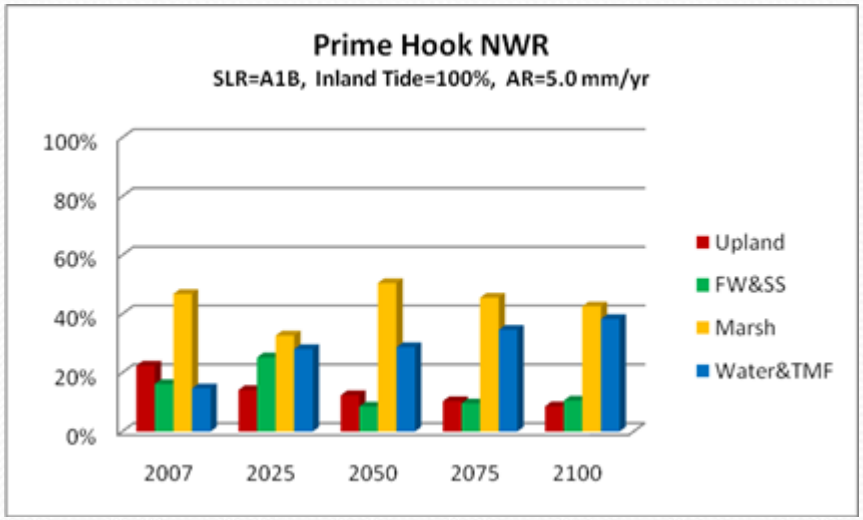
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Conclusions

- SLAMM appropriate for regional simulations
  - Using low resolution data
  - Show net regional change and trends

- Limited usefulness for site specific applications
  - Significant levels of SLR
  - Need high resolution data
  - Limit output categories
  - Ranged outputs based on input extremes

Other Information

- Prime Hook Report
  - http://www.swc.dnrec.delaware.gov/coastal/Documents/PHNWR%20SLAMM.pdf
- SLAMM Website
  - http://www.warrenpinnacle.com/prof/SLAMM/index.html
- CCSP4.1 Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region
  - http://www.climatescience.gov/Library/sap/sap4-1/final-report/default.htm