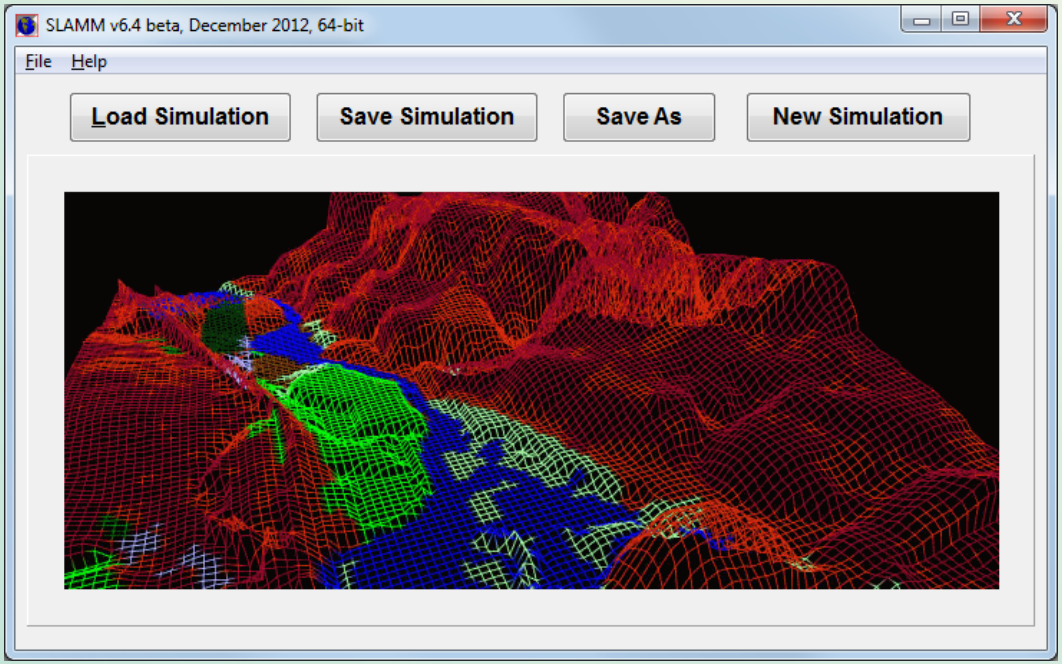
Sea Level Affecting Marshes Model (SLAMM)

November 12-13, 2014
Wallops Island, VA

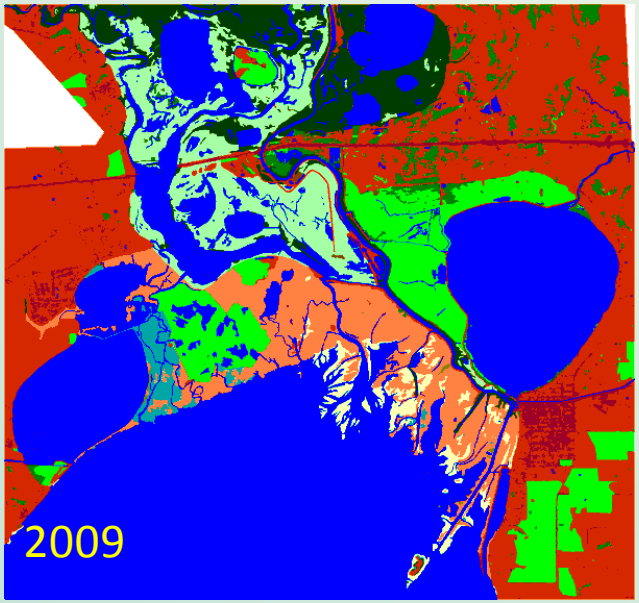


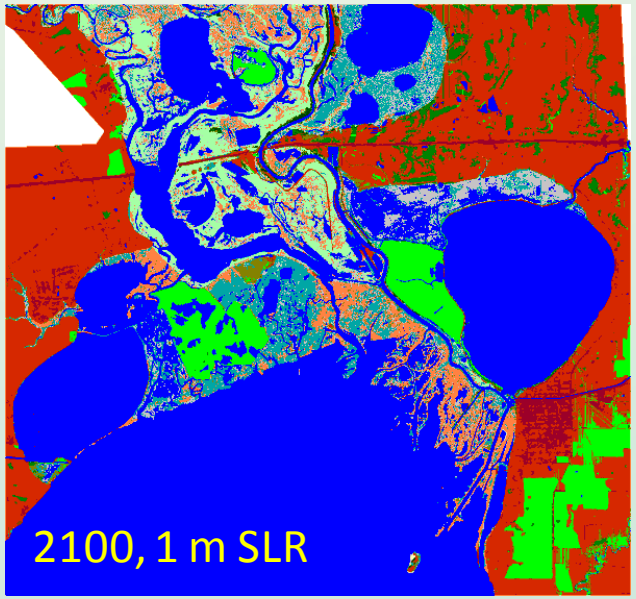
Marco Propato

warren pinnacle consulting, inc.

SLAMM
Sea Level Affecting Marshes Model

- Simulates the dominant processes involved in wetland conversions under different scenarios of sea level rise
- Uses a complex decision tree incorporating geometric and qualitative relationships to represent transfers among coastal classes
- Provides maps and projections of how coastal habitats will change in response to sea-level rise



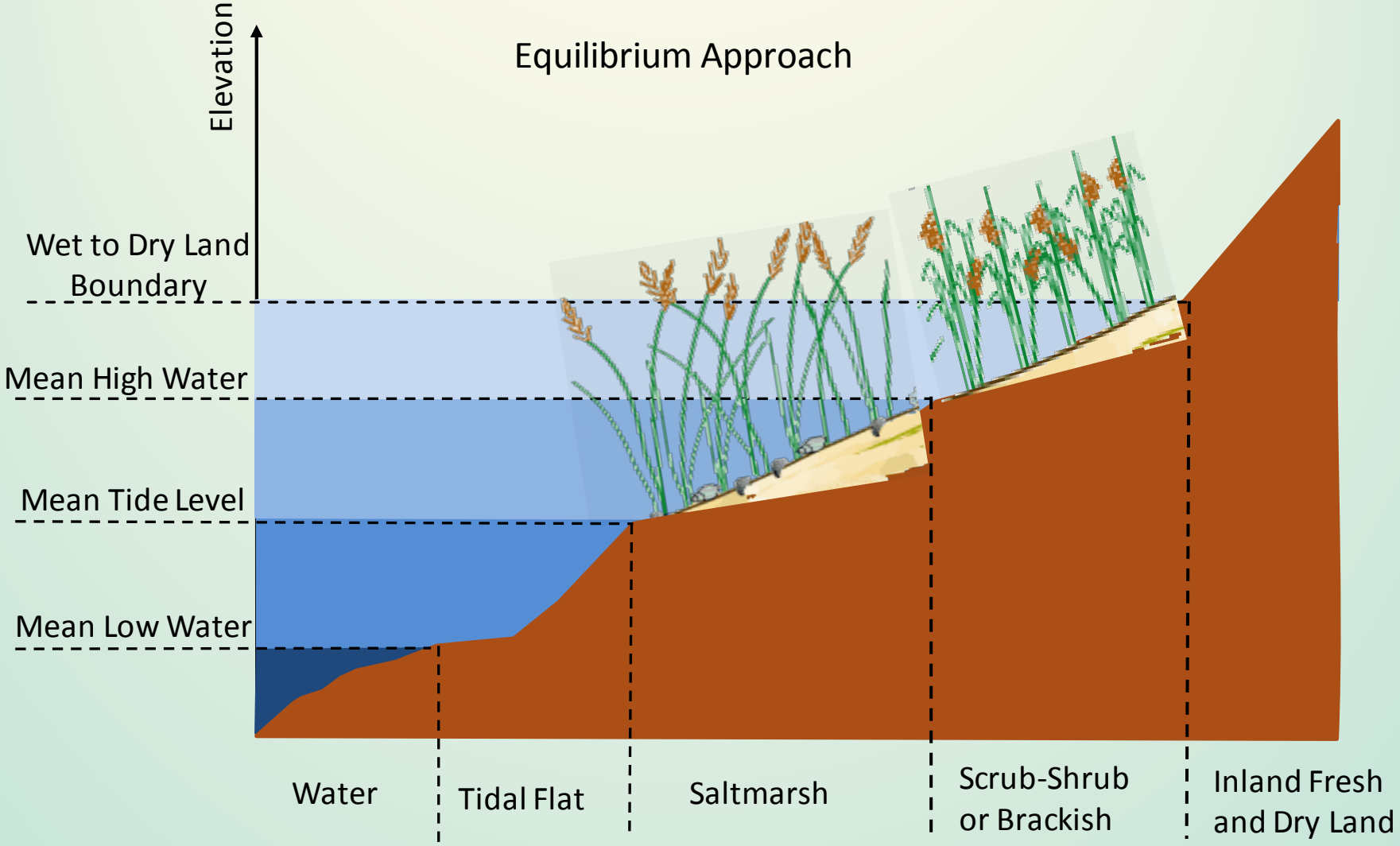


Open Ocean
Estuarine Open Water
Undeveloped Dry Land
Inland Fresh Marsh
Developed Dry Land
Irregularly Flooded Marsh
Inland Open Water
Swamp
Regularly Flooded Marsh
Tidal Swamp
Tidal Fresh Marsh
Inland Shore
Estuarine Beach
Riverine Tidal
Ocean Beach
Transitional Salt Marsh
Cypress Swamp
Tidal Flat

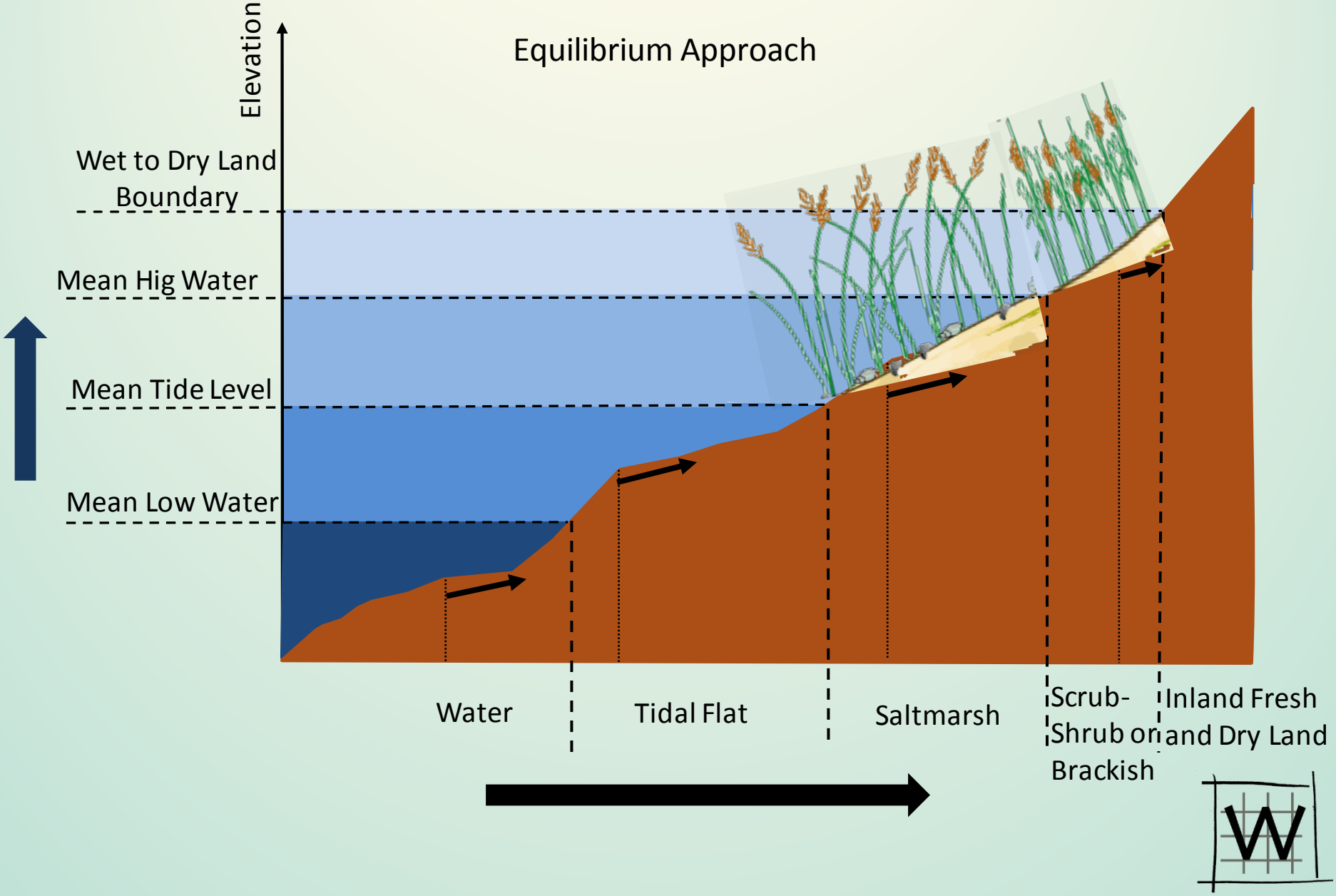
Model Strengths

- Relatively simple model
- Open source
- Minimal data requirements
- Ease and cost of application
- Quick to run
- Contains the major processes pertinent to wetland fate
- Provides information needed by policymakers

SLAMM Inundation Model



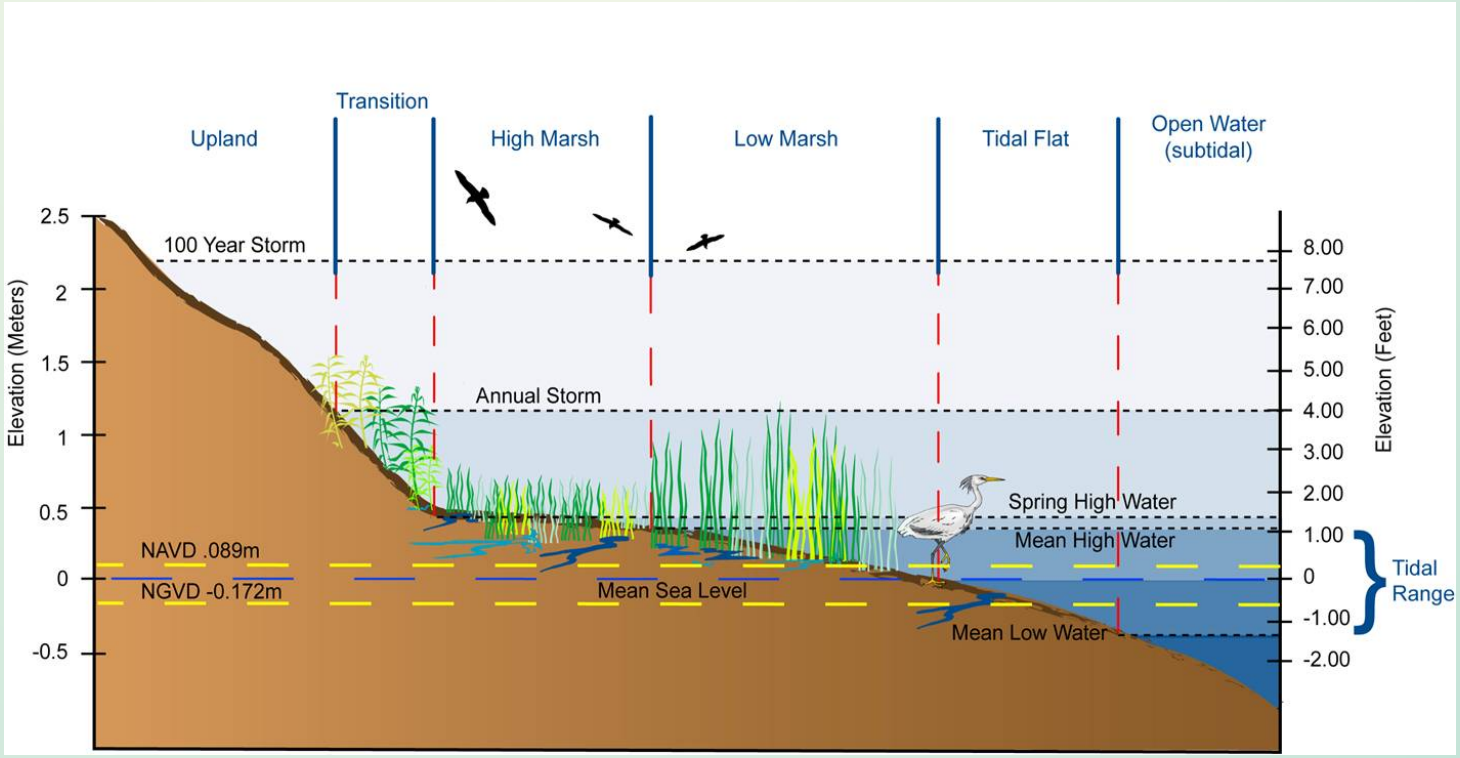
SLAMM Inundation Model



Model Process Overview

Addresses Six Primary Processes:

- Inundation
- Erosion
- Accretion
- Saturation
- Overwash
- Salinity



Titus and Wang 2008

Hydro-Connectivity

- Assesses whether land barriers or roads prevent saline inundation
- Culverts, ditches, dikes, leeves considered
- Can be used for levee overtop model with fine-scale elevation model

Model Limitations

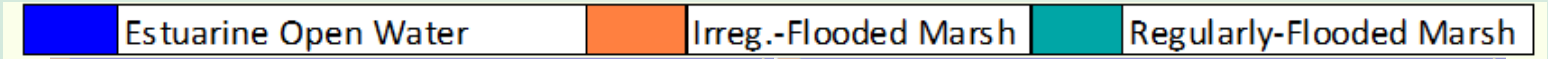
- **Does not model actual water flows**
- **Modeled processes are relatively simple**
- **Anthropogenic changes not included**
  - Beach nourishment, shoreline armoring, construction of levees, tide gates
- **Large Storm Effects undercounted**

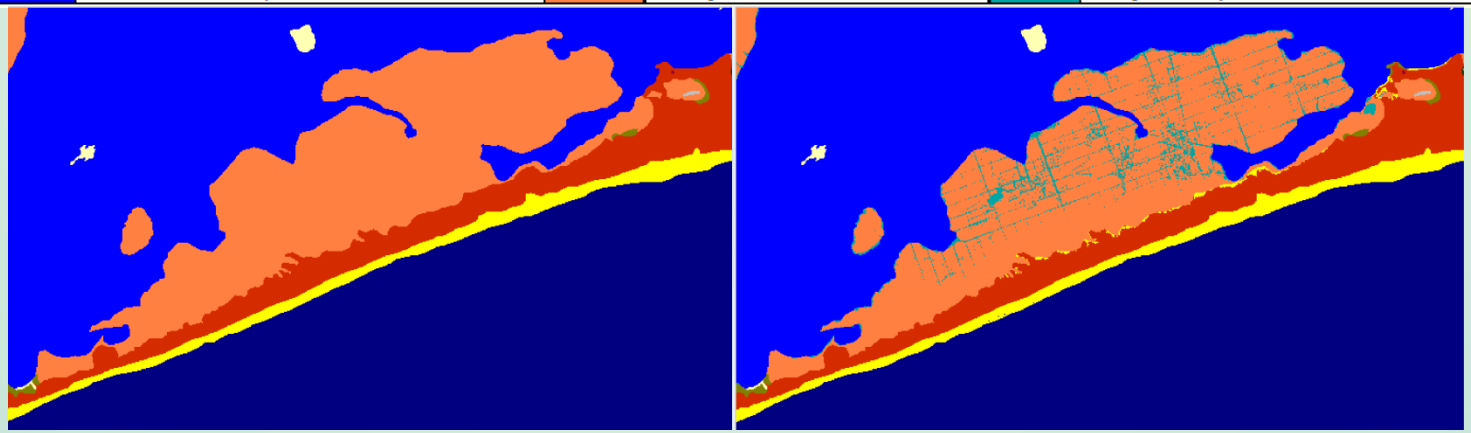
Data Sources

- Elevation Data
- Wetland Layers
- Tide Ranges & Frequency of Flooding
- Dikes and Impoundments
  - NWI, USACE NLD, manual additions
- Percent Impervious
- Accretion Rates
- Erosion Rates
- Uncertainty and Variability

Model Calibration

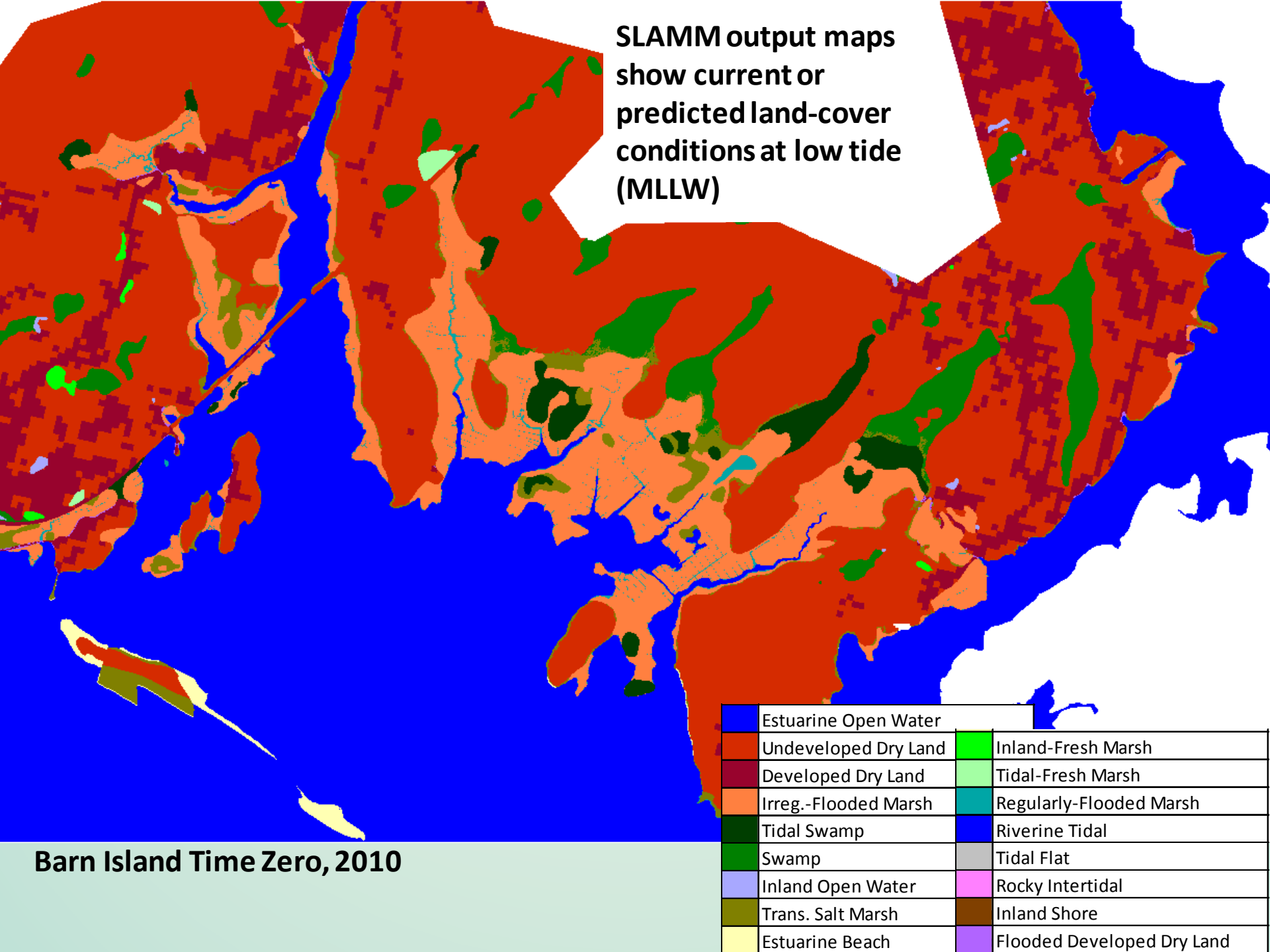
Salt Panne near Mastic, NY

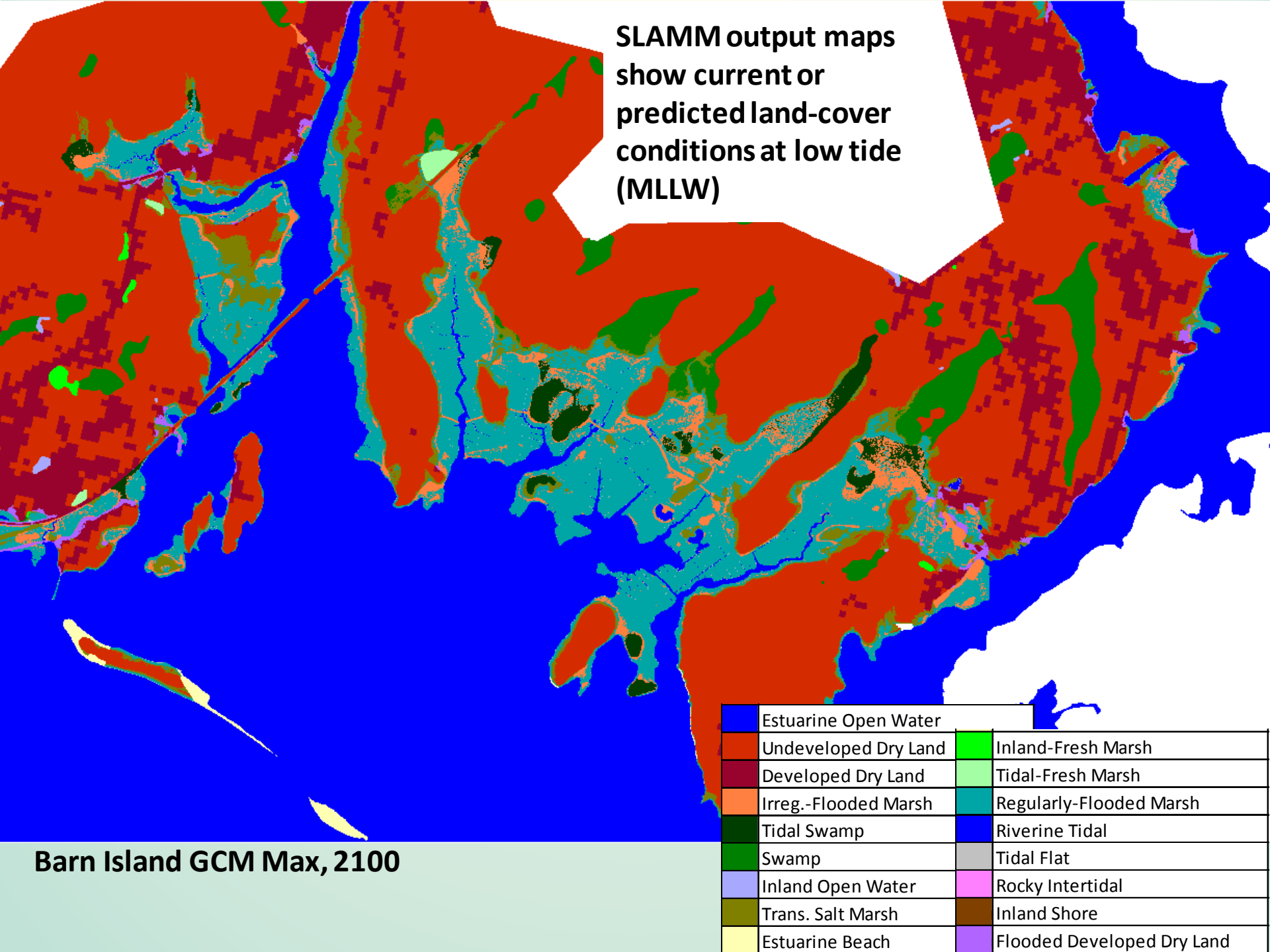




Initial Condition

Time Zero


SLAMM output maps show current or predicted land-cover conditions at low tide (MLLW)
Barn Island Time Zero, 2010
Estuarine Open Water
Undeveloped Dry Land
Developed Dry Land
Irreg.-Flooded Marsh
Tidal Swamp
Swamp
Inland Open Water
Trans. Salt Marsh
Estuarine Beach
Inland-Fresh Marsh
Tidal-Fresh Marsh
Regularly-Flooded Marsh
Riverine Tidal
Tidal Flat
Rocky Intertidal
Inland Shore
Flooded Developed Dry Land


SLAMM output maps show current or predicted land-cover conditions at low tide (MLLW)
Barn Island GCM Max, 2100
Estuarine Open Water
Undeveloped Dry Land
Developed Dry Land
Irreg.-Flooded Marsh
Tidal Swamp
Swamp
Inland Open Water
Trans. Salt Marsh
Estuarine Beach
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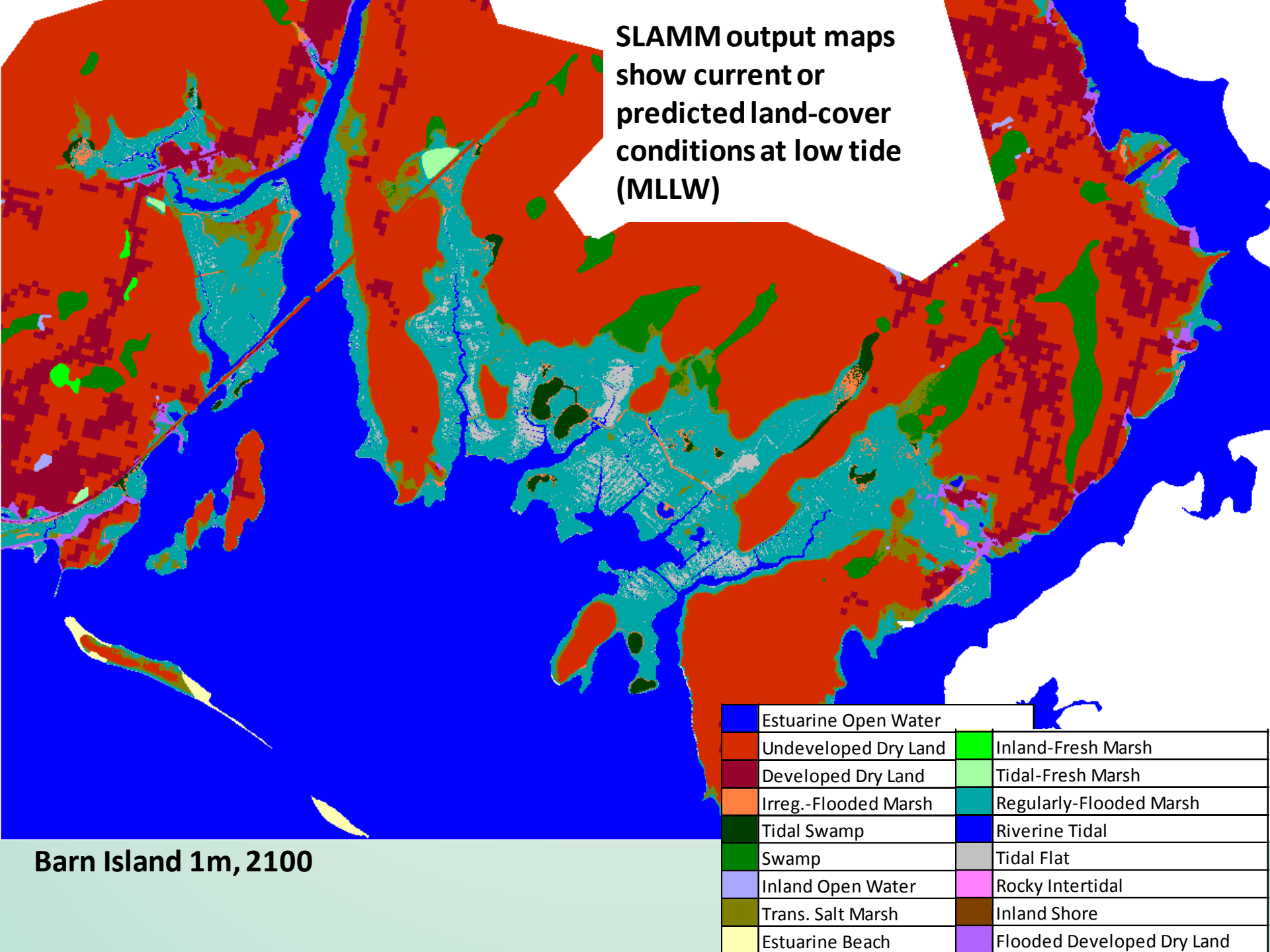
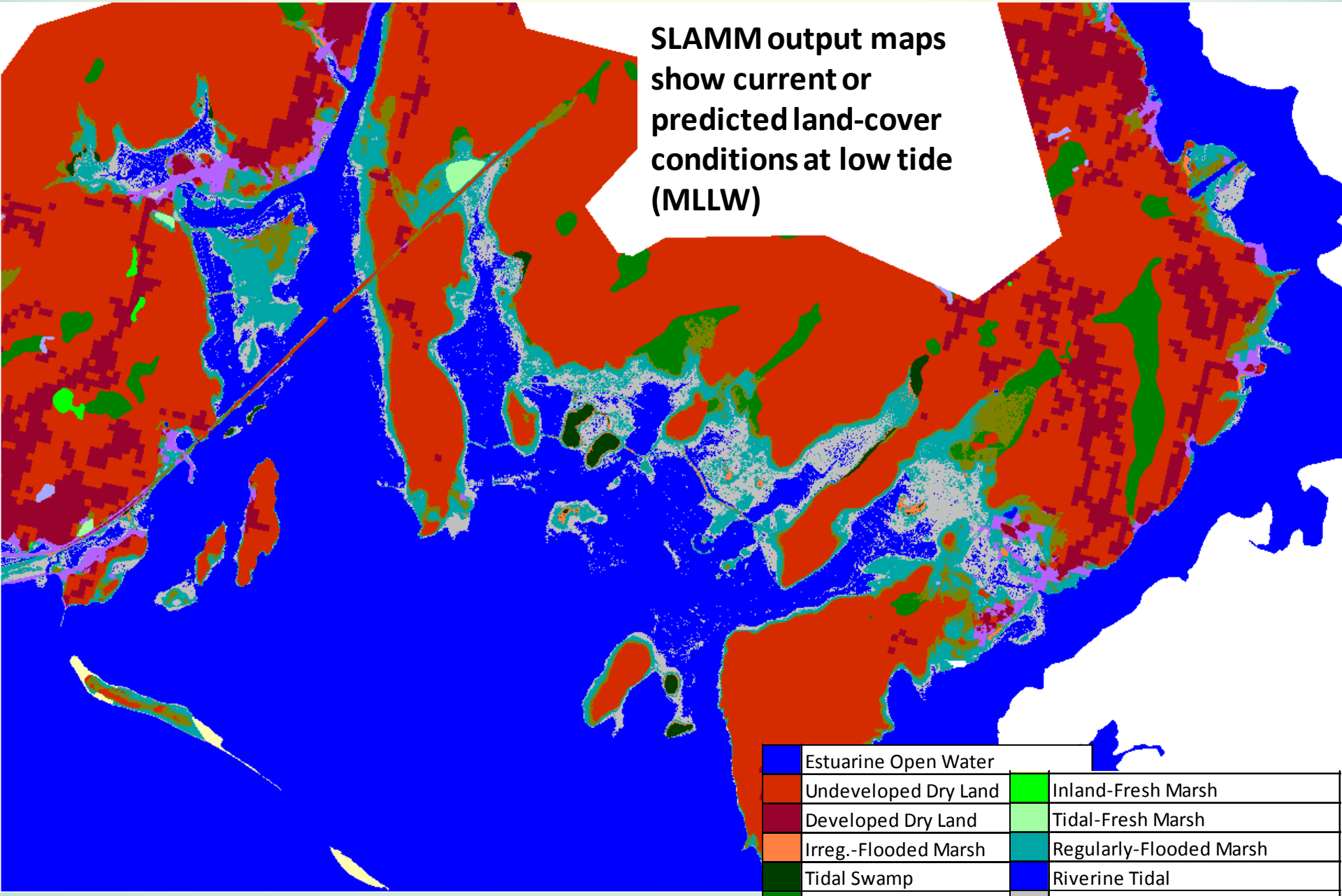
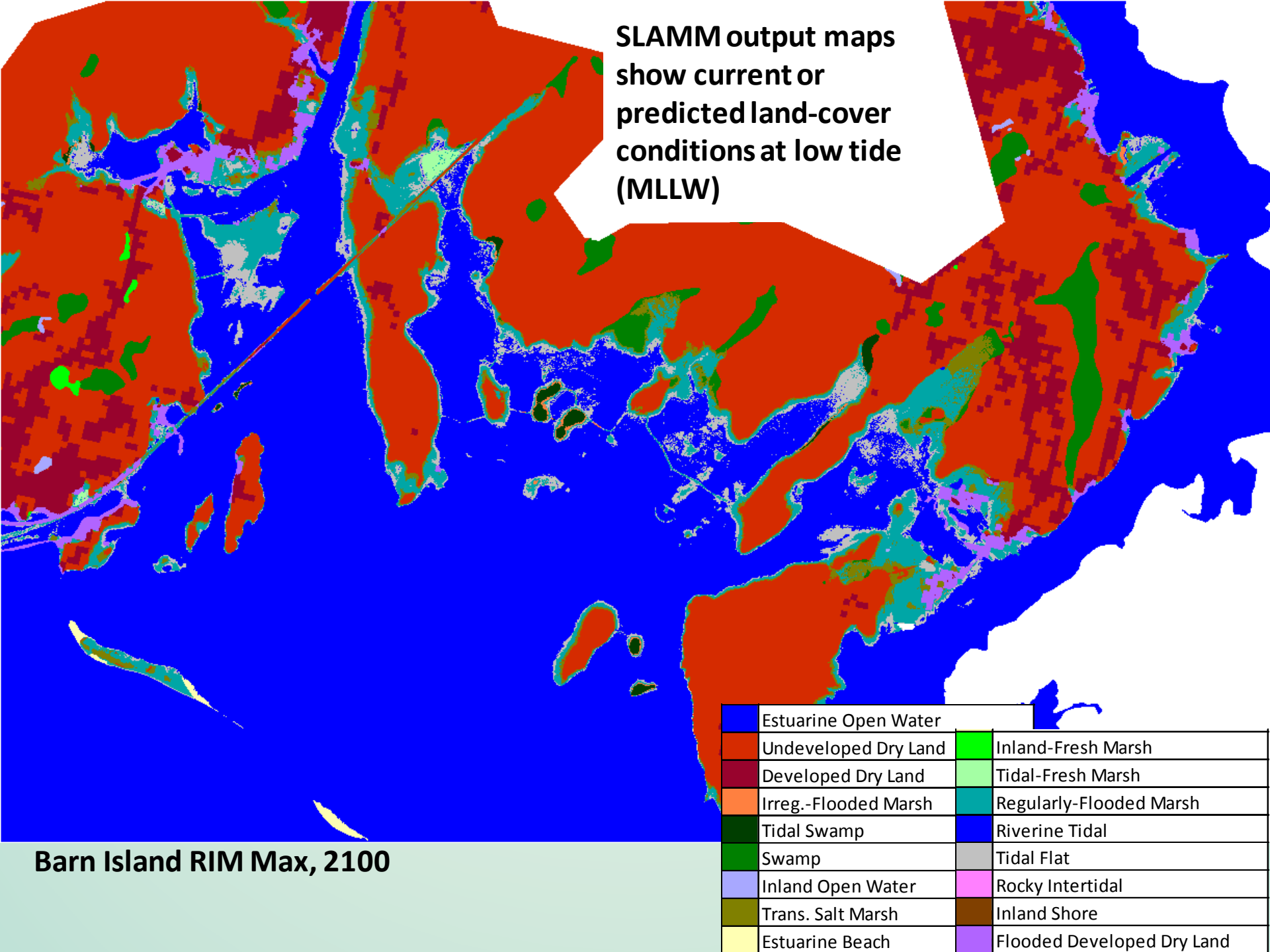


Barn Island 1m, 2100

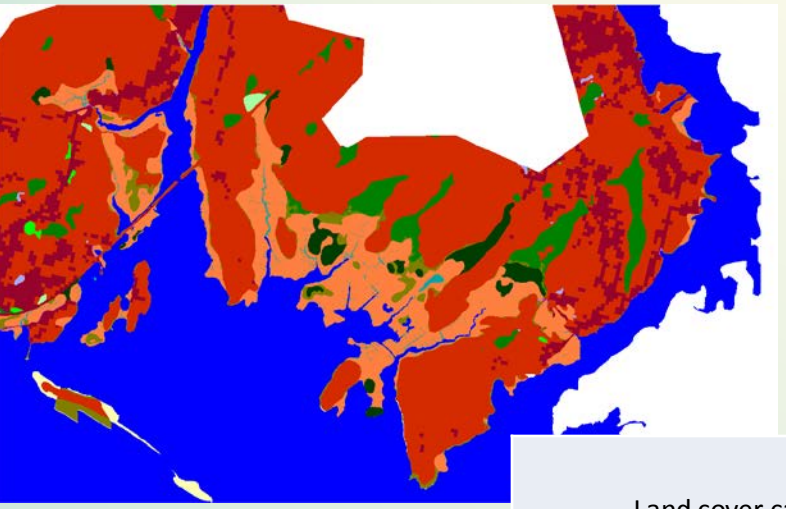


Barn Island RIM Min, 2100



Barn Island RIM Max, 2100

Example - Barn Island, CT

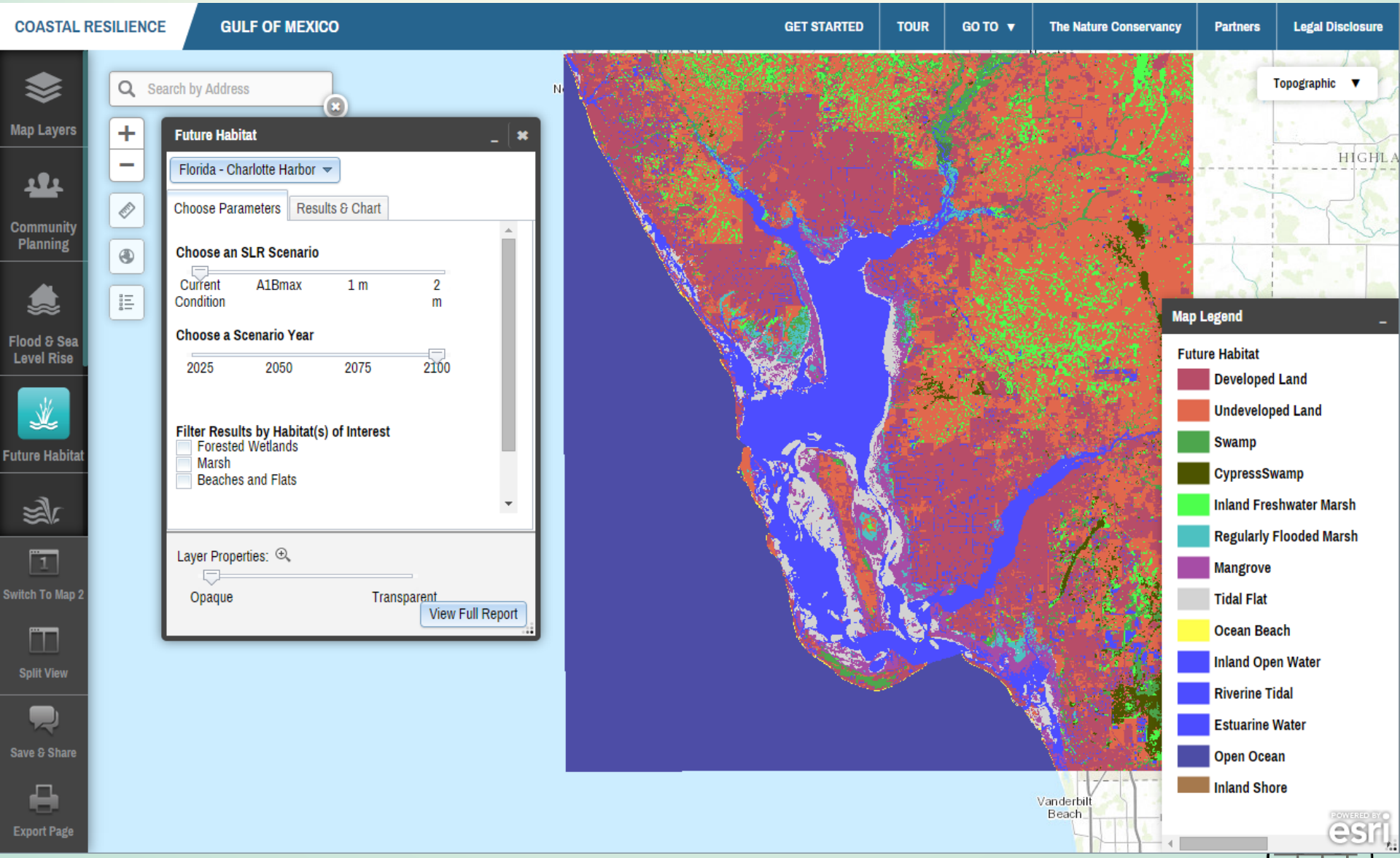


Land cover category	Acres in 2010	Percentage Land cover change from 2010 to 2100 for different SLR scenarios			
		GCM Max	1m	RIM Min	RIM Max
Estuarine Open Water	1,969	1.3	1.8	17.6	29.3
Undeveloped Dry Land	1,856	-7.0	-10.9	-15.3	-18.7
Irreg.-Flooded Marsh	457	-77.6	-94.0	-97.4	-98.8
Developed Dry Land	337	-4.6	-8.0	-14.0	-18.9
Swamp	153	-11.5	-17.4	-30.4	-40.7
Trans. Salt Marsh	87	49.0	41.9	45.5	8.7
Tidal Swamp	65	-32.5	-62.4	-76.6	-83.5
Regularly-Flooded Marsh	19	2363.1	2951.2	1287.7	1111.0
Estuarine Beach	17	-34.1	-42.9	-55.9	-67.7
Inland-Fresh Marsh	6	-12.4	-22.2	-22.3	-22.4
Tidal-Fresh Marsh	6	0.0	0.0	-0.1	-18.0
Inland Open Water	4	-14.6	-16.1	-19.6	-20.4
Flooded Developed Dry Land	3	438.3	774.1	1344.4	1817.0

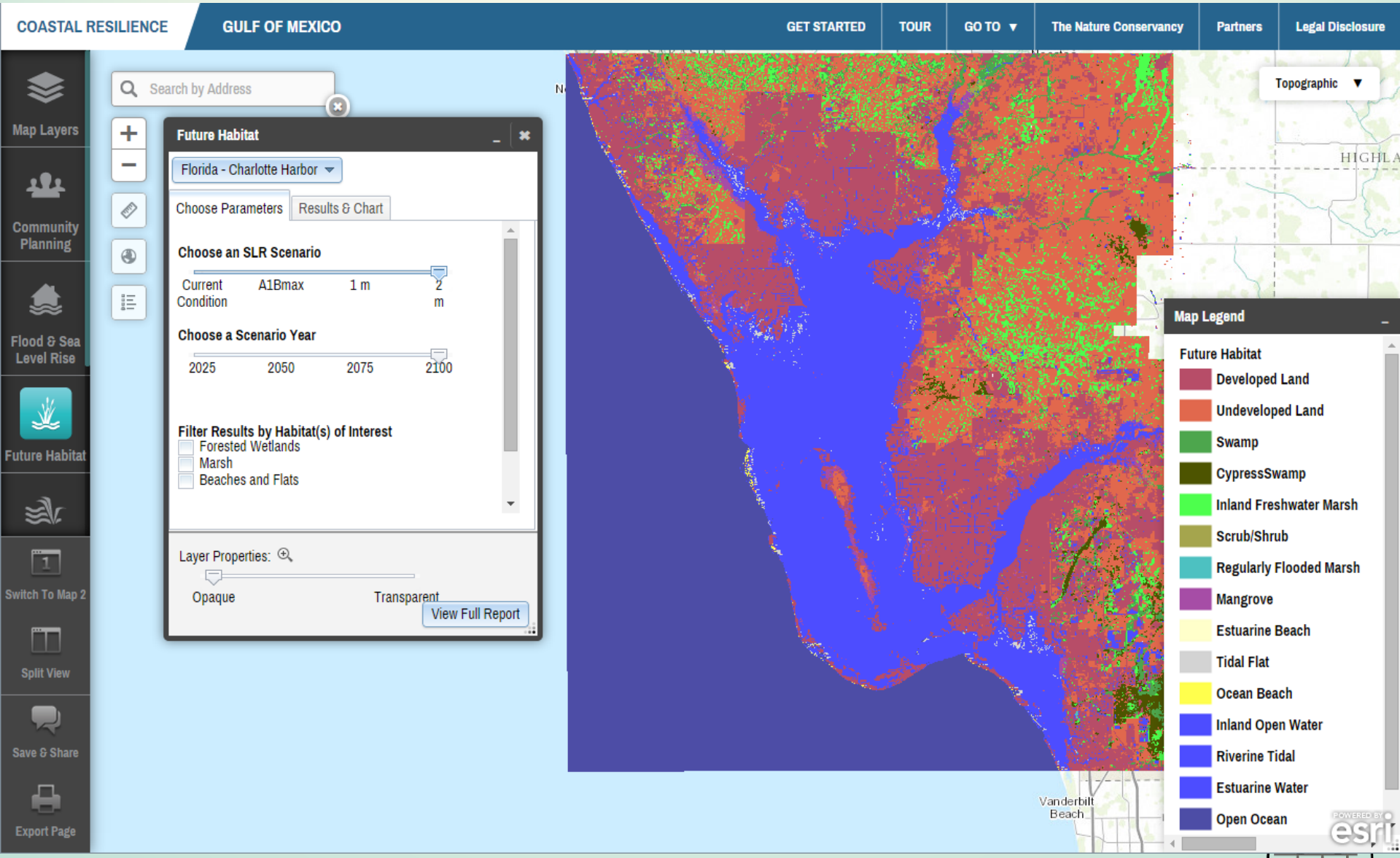
Planning, management and adaptation strategies

- Identify appropriate strategies regarding land acquisition, restoration, reduced infrastructure development, etc.
- Identify priorities and effectiveness in allocating available resources - e.g. protection and maintenance vs. migration pathways
- Risk identification

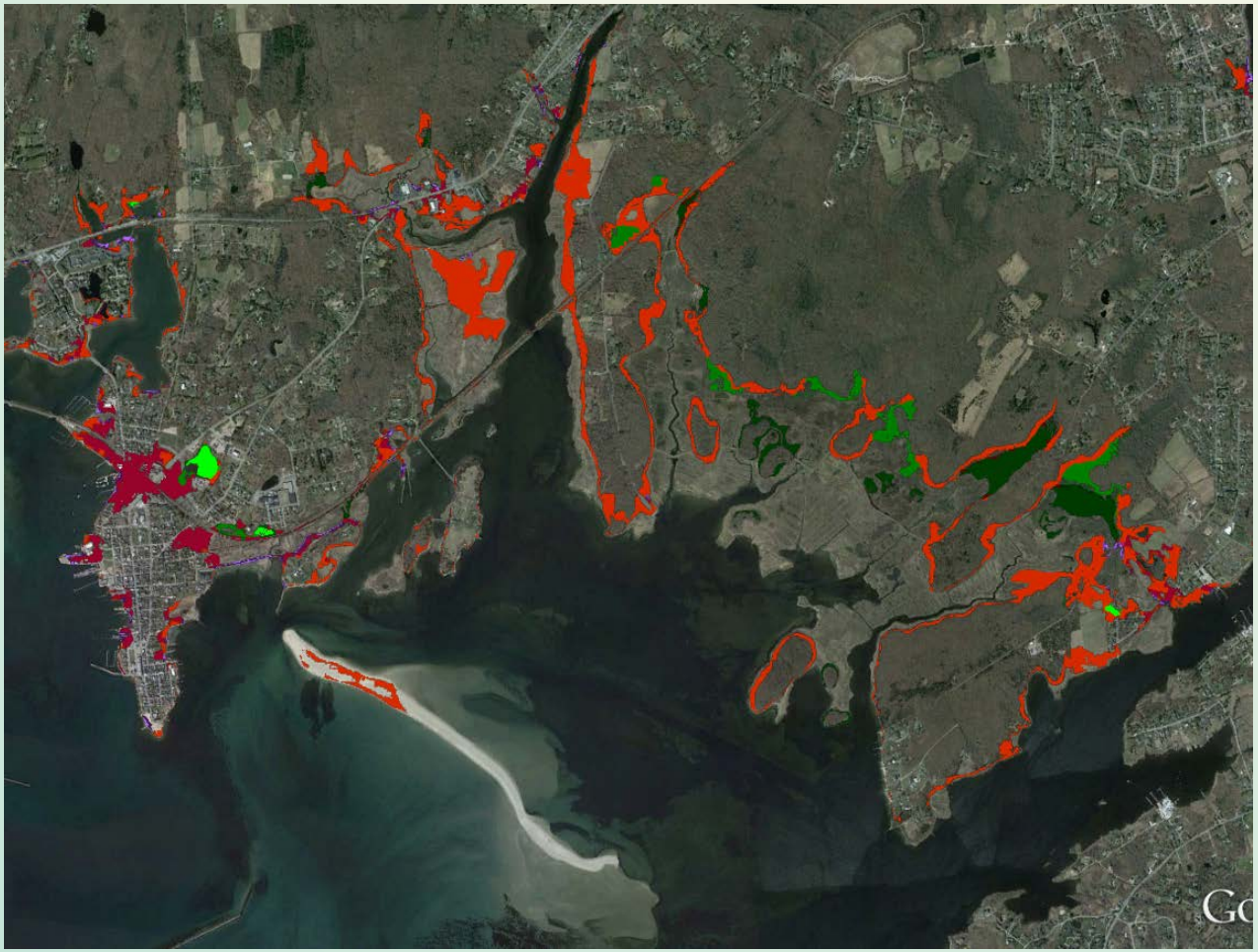
Coastal Resilience Mapping Portal



Coastal Resilience Mapping Portal

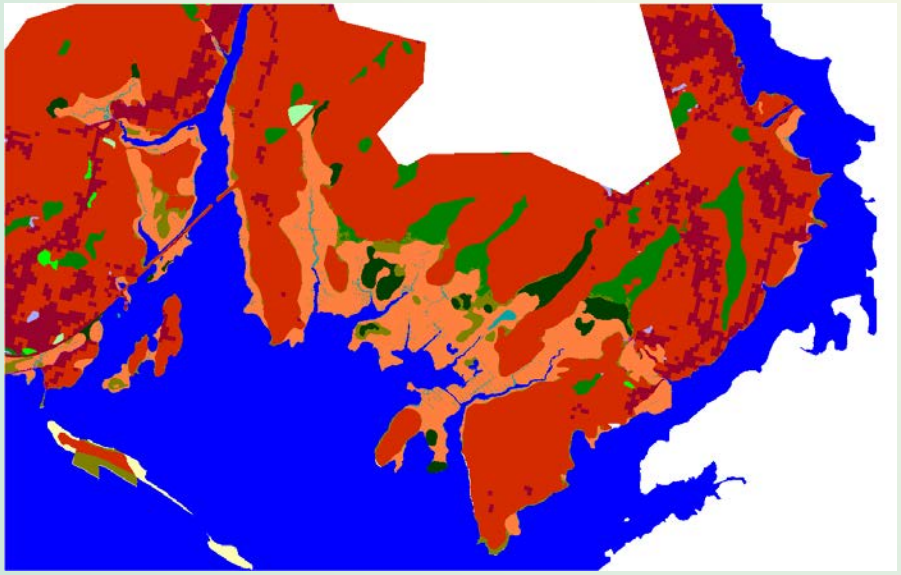


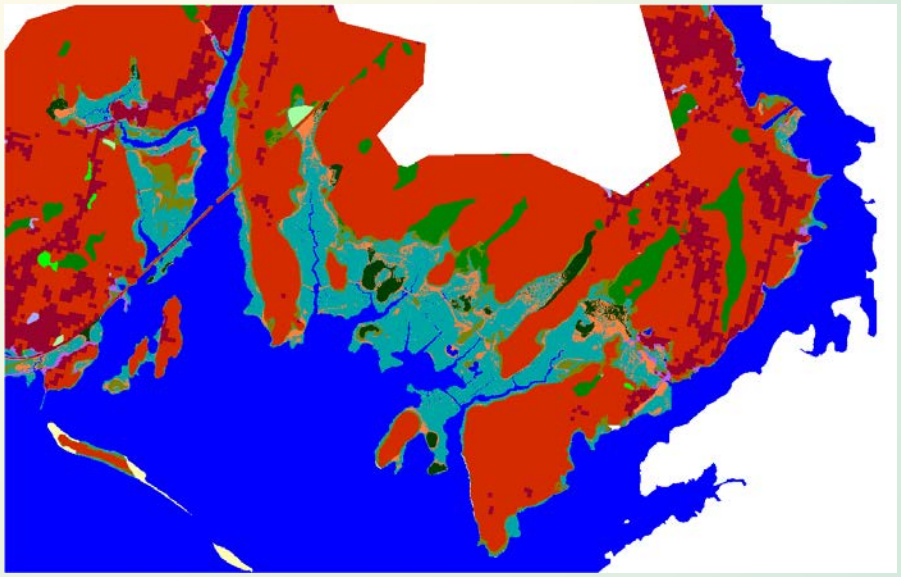
GIS Analyses

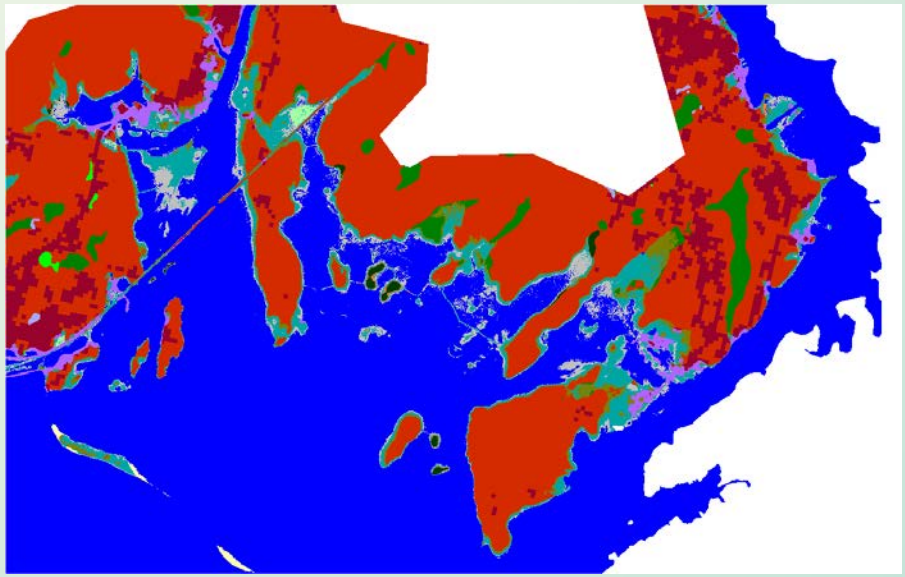


- 1m SLR by 2100
- Locations of new marshes
  - Previous land cover type shown
- Potential marsh migration pathways

Adaptation strategies priorities

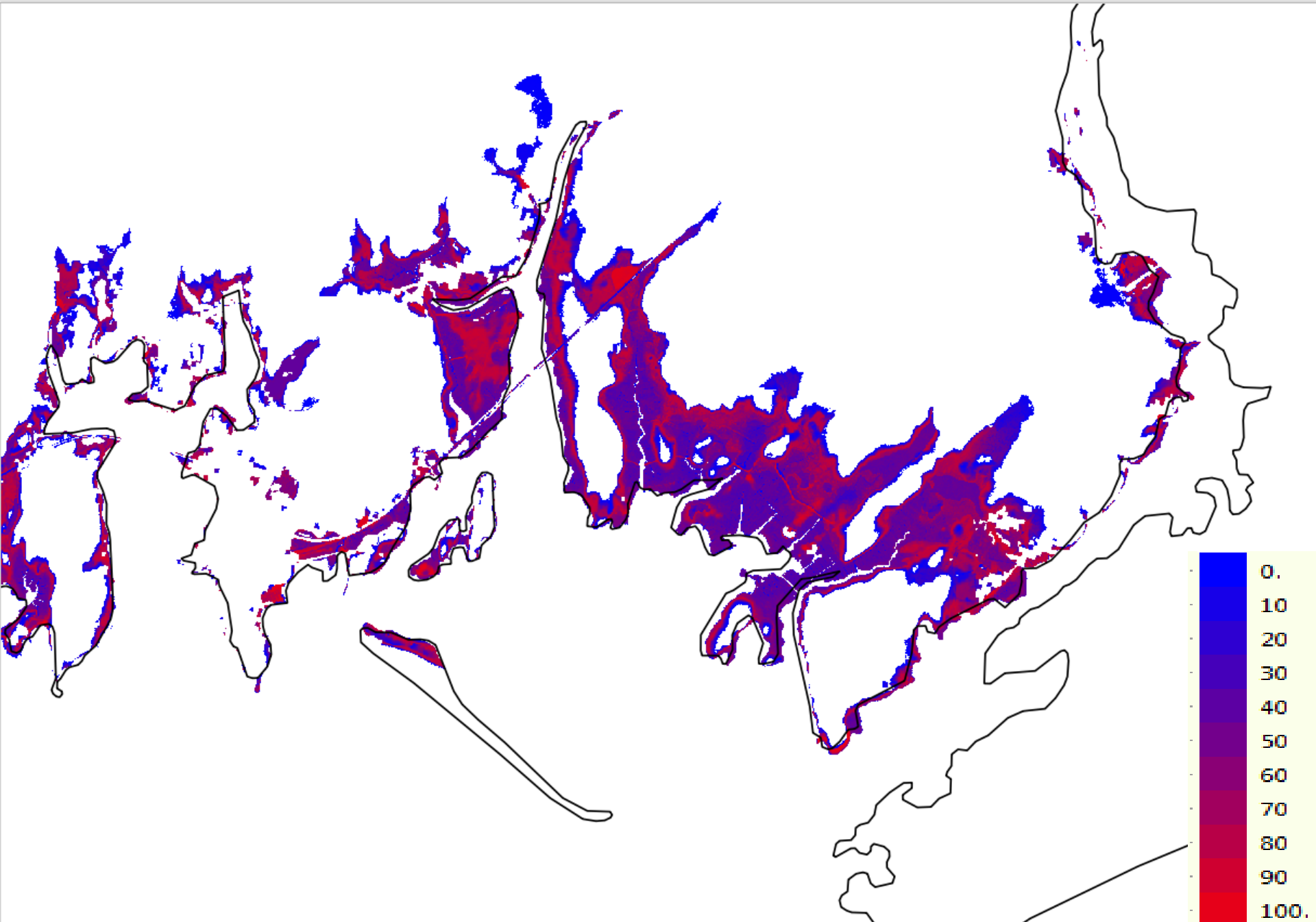




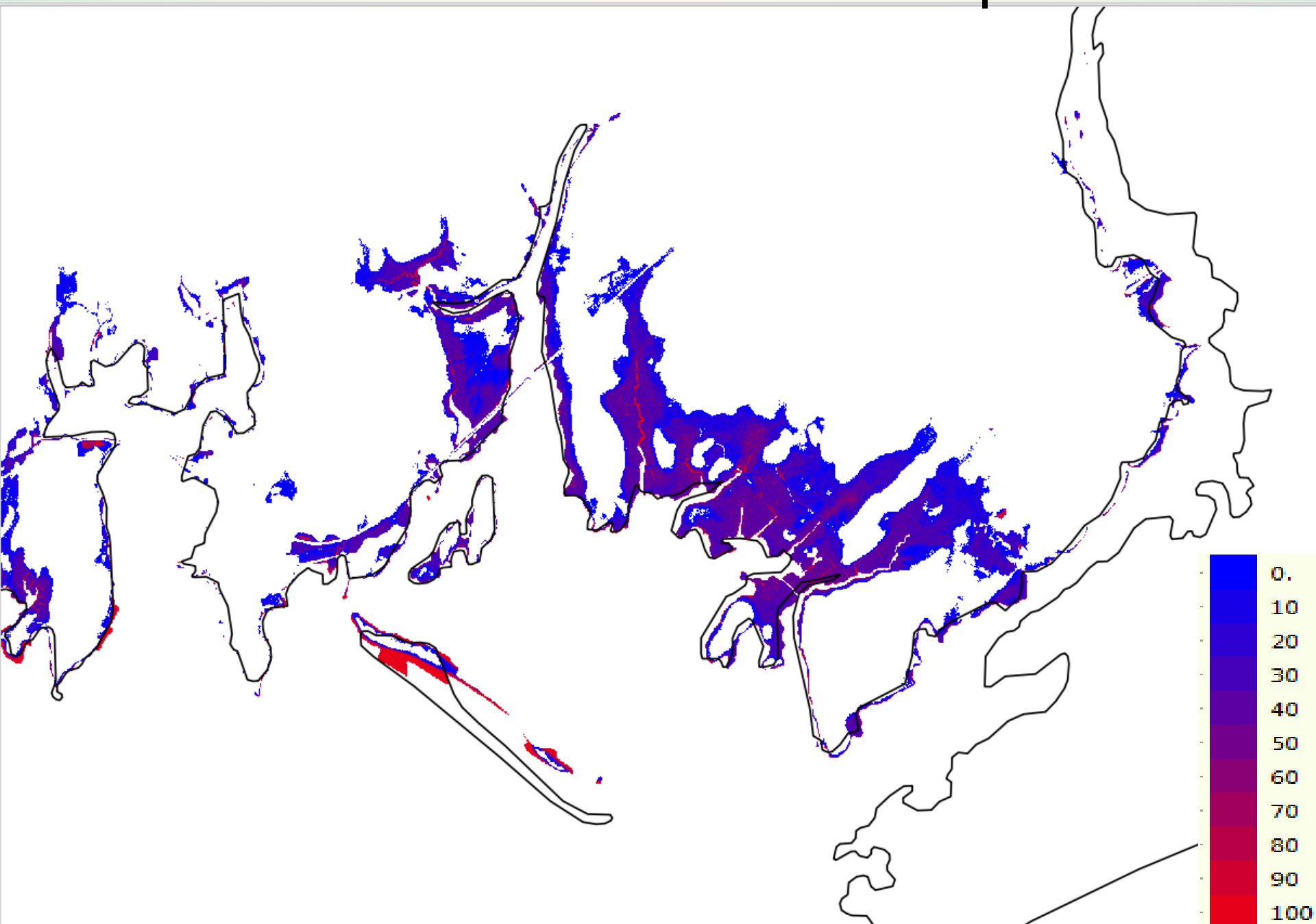


Should we try to protect and maintain this marsh system?

2100 Percent Likelihood of Coastal Marsh



2100 Percent Likelihood: Land to Open Water

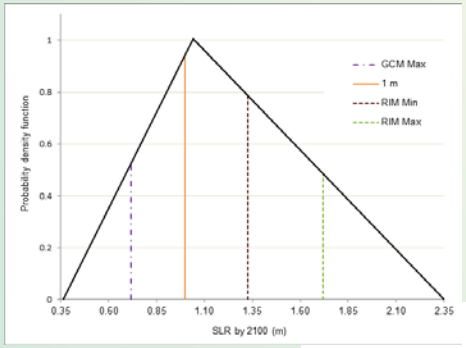


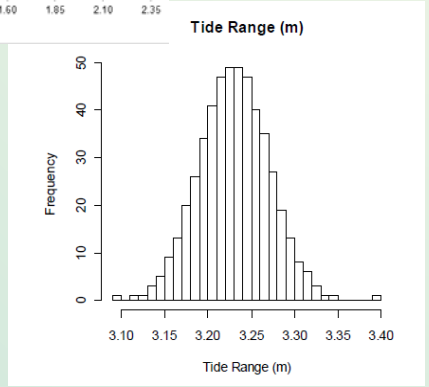
Thanks and Questions

High Marsh Habitat in Clinton CT looking east from Town Beach (J. Clough)

Uncertainty Setup

Parametric Model Input Distributions





Model Output Distributions

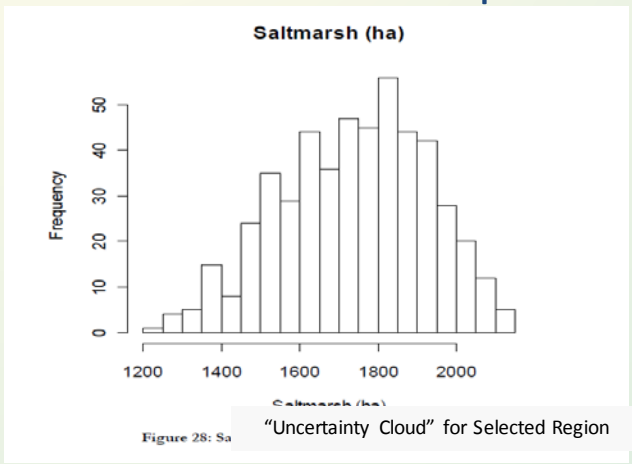
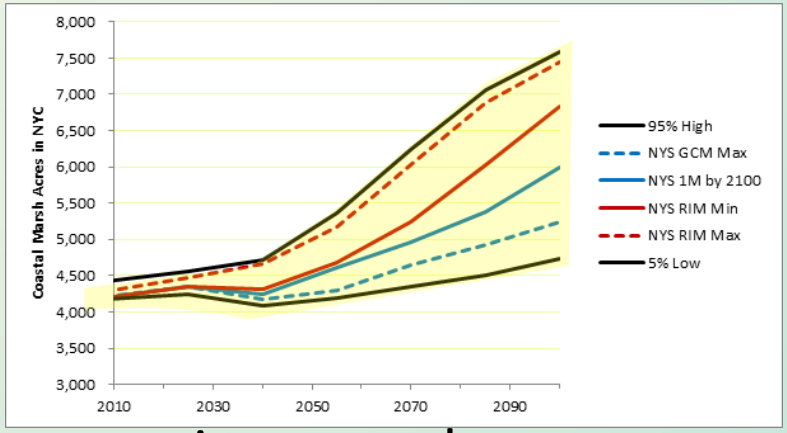


Figure 28: Sa

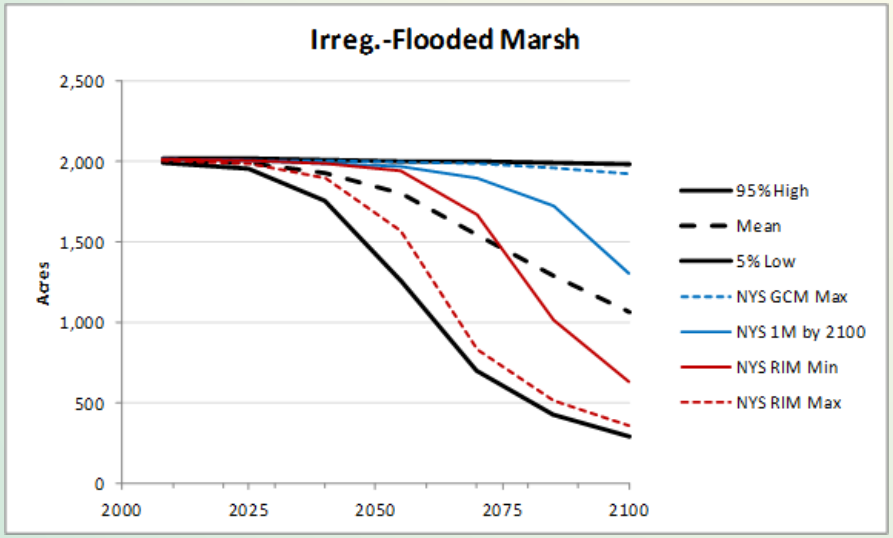
"Uncertainty Cloud" for Selected Region



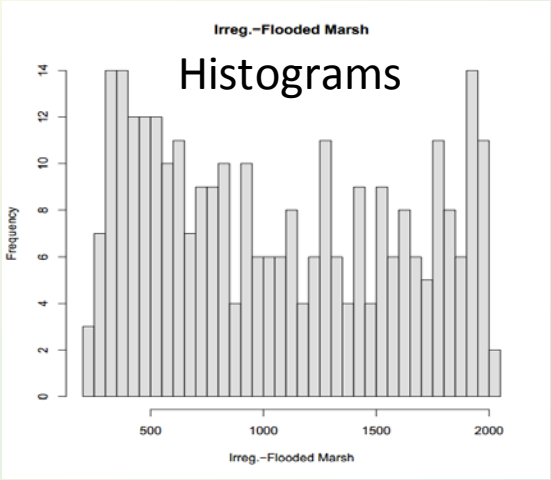
Examining SLAMM results as distributions can improve the decision making process

- Results account for parametric uncertainties
- Range of possible outcomes and their likelihood
- Robustness of deterministic results may be evaluated

Example Uncertainty Outputs



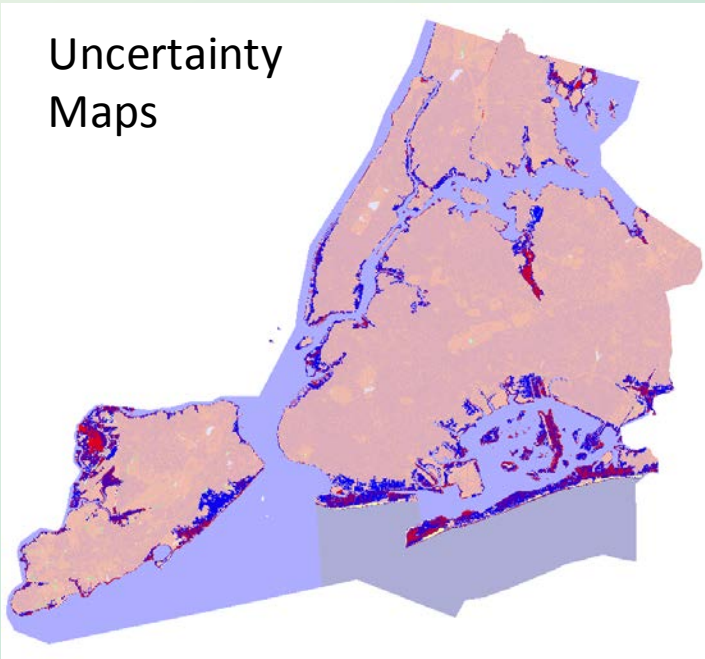
Time series with confidence intervals



Tables of Results

Landcover Type	Min	5th Percentile (Low)	Mean	95th Percentile (High)	Max	Std. Dev.
Developed Dry Land	109,753	113,237	119,835	123,439	123,701	2,902
Estuarine Open Water	75,347	75,619	76,933	78,591	79,534	784
Undeveloped Dry Land	51,628	53,031	56,617	59,072	59,396	1,653
Open Ocean	32,746	32,790	32,887	32,975	33,007	46
Regularly-Flooded Marsh	1,823	1,949	3,795	5,154	5,312	1,020
Tidal Flat	815	853	1,200	2,030	2,231	312
Inland Open Water	623	659	742	1,015	1,021	92
Trans. Salt Marsh	613	789	1,446	2,288	2,597	385
Ocean Beach	523	550	790	1,042	1,147	144
Swamp	386	401	486	541	544	38
Flooded Developed Dry Land	273	535	4,139	10,736	14,220	2,902
Irreg.-Flooded Marsh	237	290	1,065	1,982	2,011	551
Inland-Fresh Marsh	177	192	332	413	420	66
Estuarine Beach	138	157	222	308	352	41

Uncertainty Maps



Site or Subsite Parameters

- Parameters not specific to cell but specific to entire site or subsite

- DEM Date (yyyy)
- NWI Photo Date (yyyy)
- Direction OffShore (N|S|E|W)
- Historic Trend (mm/yr)
- Historic Eustatic Trend (mm/yr)
- NAVD88 Correction (MTL-NAVD88 in meters)
- Great Diurnal Tide Range (meters)
- Salt Elevation (meters)
- Marsh erosion (horz. meters/year)
- Swamp erosion (horz. meters/year)
- Tflat. erosion (horz. meters/year)
- Reg. flooded marsh vertical accretion (mm/yr)
- Irreg. flooded marsh vert. accretion (mm/yr)
- Tidal fresh marsh vertical accretion (mm/yr)
- Inland fresh marsh vertical accretion (mm/yr)
- Mangrove vertical accretion (mm/yr)
- Tidal swamp vertical accretion (mm/yr)
- Swamp vertical accretion (mm/yr)
- Beach/T.Flat Sedimentation Rate (mm/yr)
- Frequency of Overwash (yr/washover)
- Use Elevation Preprocessor for Wetlands (Boolean)