An overview of potential marsh migration in response to sea level rise datasets created as part of Maine's NOAA Project of Special Merit

NROC Marsh Migration and Policy Workshop

Peter A. Slovinsky, Marine Geologist

Maine Department of Agriculture, Conservation and Forestry

Maine Geological Survey

Funded by:

I'll cover….

- Maine's marsh migration analysis method – the why, how and when.
- Marsh migration/change summary results for modeled time steps
- Most significant 'limiting factors' to predicting marsh migration/change using marsh migration modeling
- What would the state do differently if it were to repeat the marsh migration modeling exercise
- Anticipated or implemented policy changes as a result of this work

SLR scenarios selected for mapping

- Short Term: approximately 1 ft by 2050
- Long Term: 2-4 ft *but potentially more* by 2100;

- We decided to examine scenarios of **1 foot, 2 feet, 3.3 feet, and 6 feet** on top of the **highest annual tide (HAT).**
- These SLR scenarios relate well to the National Climate Assessment, and also **correspond well with evaluating potential impacts from storm surges that may coincide with higher tides today.**

Integrating Science into Policy: Adaptation Strategies for Marsh Migration

Funded by:

Our POSM Project Goals

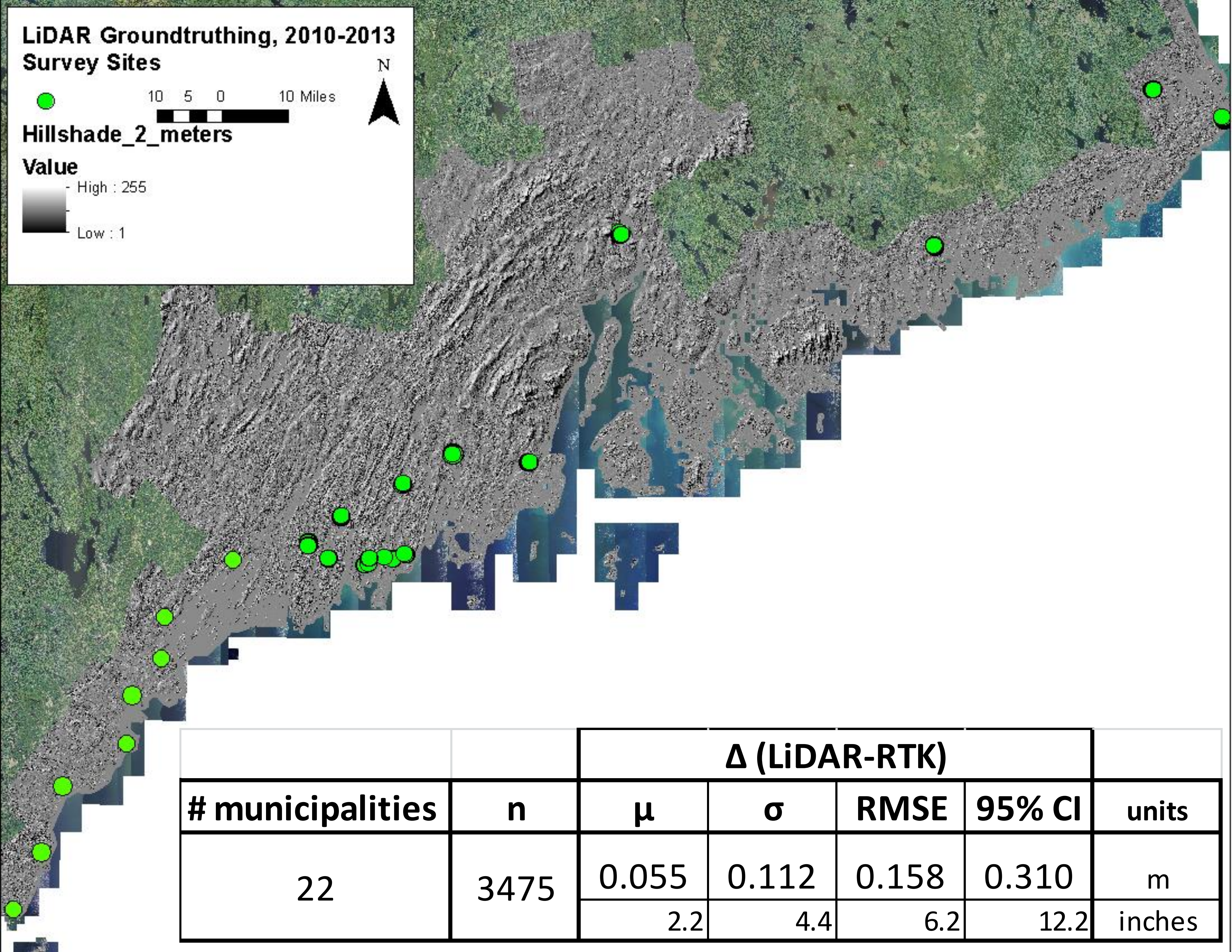
- ***Minimal project goal***:
  - increase pubic awareness on SLR and marsh migration

- ***Preferred goals:***

  - **Map the limits of the Highest Annual Tide on a state-wide basis in support of Shoreland Zoning purposes;**

  - **Map potential marsh migration areas on a state-wide basis using a scenario based approach of future sea level rise, and determine what types of existing landcover might be impacted (MNAP).**

  - **in six partner communities, *use this data to work to develop and implement local partner-driven but transferable adaptation strategies for community resiliency and marsh migration*.**



		Δ (LiDAR-RTK)				
# municipalities	**n**	**μ**	**σ**	**RMSE**	**95% CI**	**units**
22	3475	0.055	0.112	0.158	0.310	m
		2.2	4.4	6.2	12.2	inches

Coastal wetlands

"Coastal wetlands" means all tidal and subtidal lands; all areas with vegetation present that is tolerant of salt water and occurs primarily in salt water or estuarine habitat; and any swamp, marsh, bog, beach, flat or other contiguous lowland that is subject to tidal action during the **highest tide level for each year** in which an activity is proposed as identified in tide tables published by the National Ocean Service. Coastal wetlands may include portions of coastal sand dunes.

Required in Maine's Municipal Shoreland Zoning

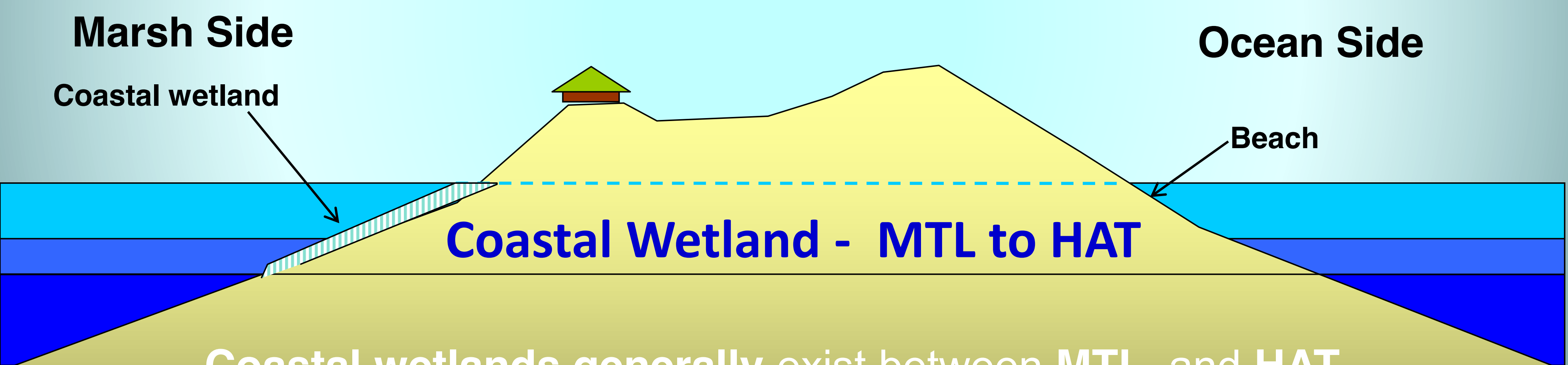
P.A. Slovinsky, MGS

Using Tidal Elevations as Proxies for the Marsh…

Highest Annual Tide (HAT) - “spring” tide, the highest predicted water level for any given year but is reached within several inches numerous tides a year

Mean High Water (MHW) – the averaged daily high water mark

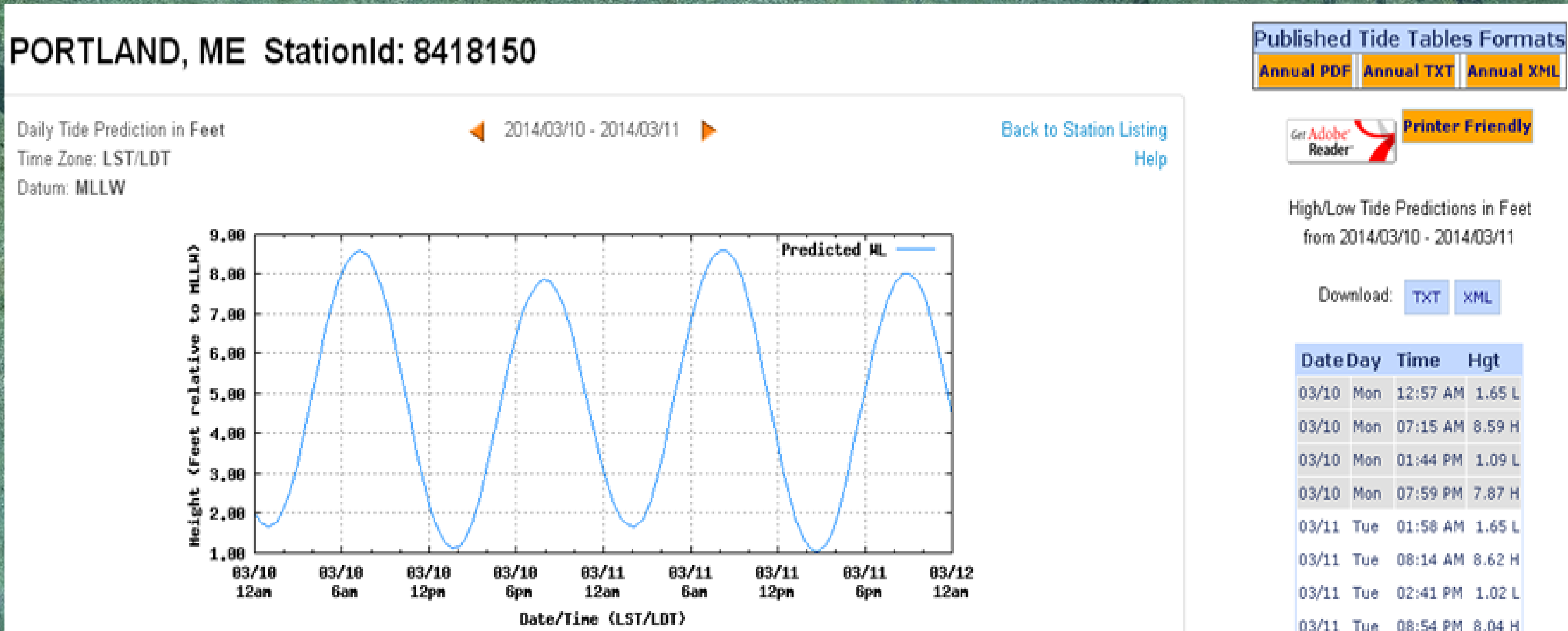
Mean Tide Level (MTL) = average height of the ocean’s surface (between mean high and mean low tide).



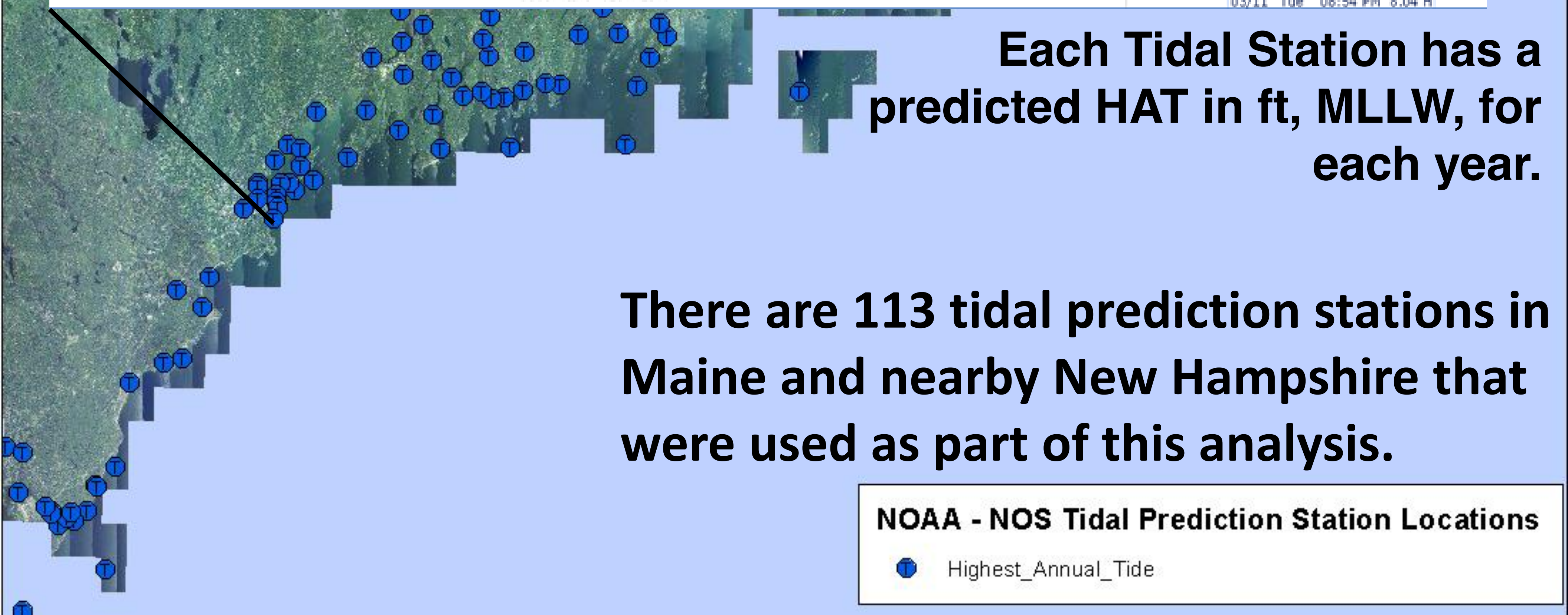
Coastal wetlands generally exist between **MTL** and **HAT**.
Low marsh generally exists between **MTL and MHW.**
High marsh generally exists between **MHW and HAT.**

Tidal elevations are determined from nearby applicable NOAA National Ocean Service/CO-OPs tidal prediction stations (Old Orchard Beach)
http://tidesandcurrents.noaa.gov

P.A. Slovinsky, MGS



Date	Day	Time	Hgt
03/10	Mon	12:57 AM	1.65 L
03/10	Mon	07:15 AM	8.59 H
03/10	Mon	01:44 PM	1.09 L
03/10	Mon	07:59 PM	7.87 H
03/11	Tue	01:58 AM	1.65 L
03/11	Tue	08:14 AM	8.62 H
03/11	Tue	02:41 PM	1.02 L
03/11	Tue	08:54 PM	8.04 H



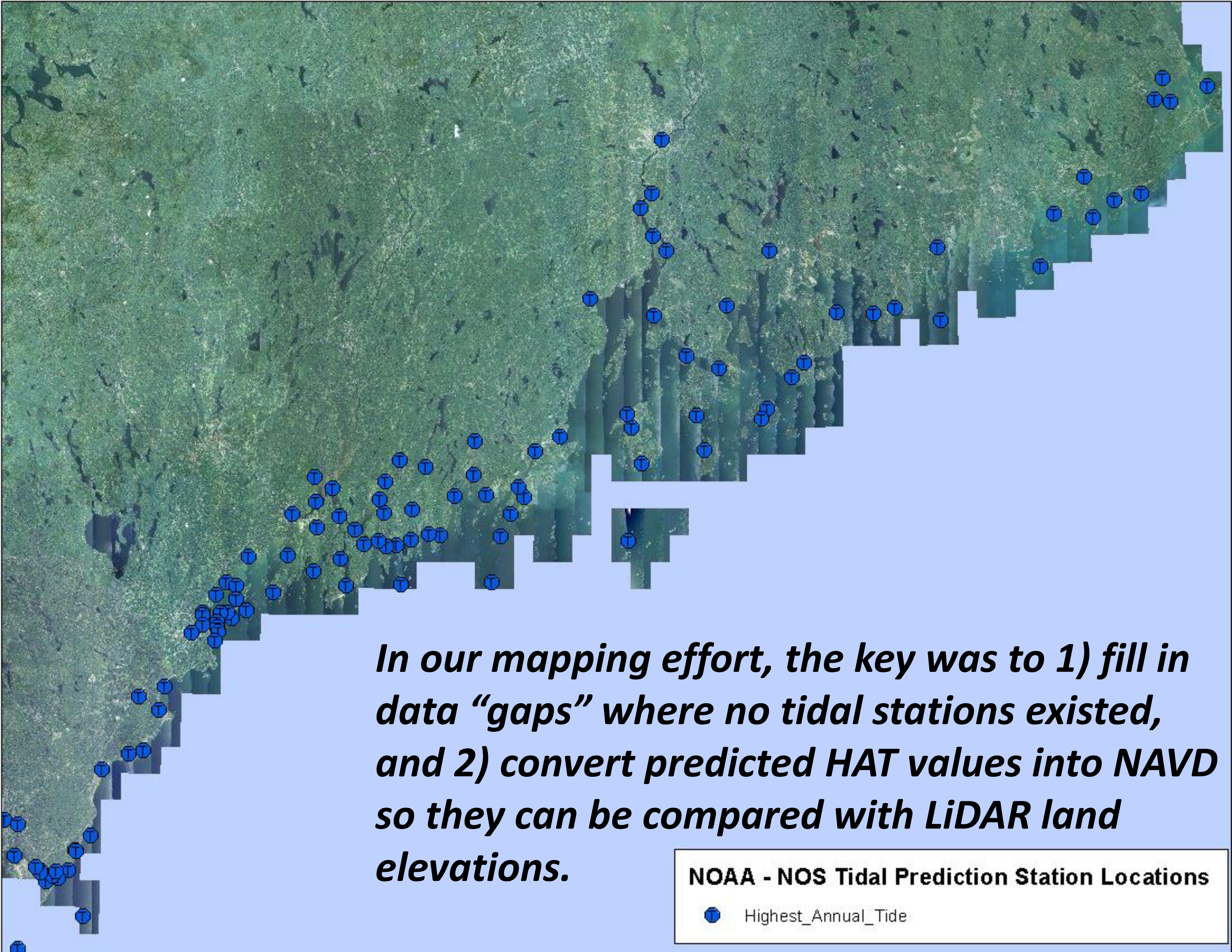
Each Tidal Station has a predicted HAT in ft, MLLW, for each year.

There are 113 tidal prediction stations in Maine and nearby New Hampshire that were used as part of this analysis.

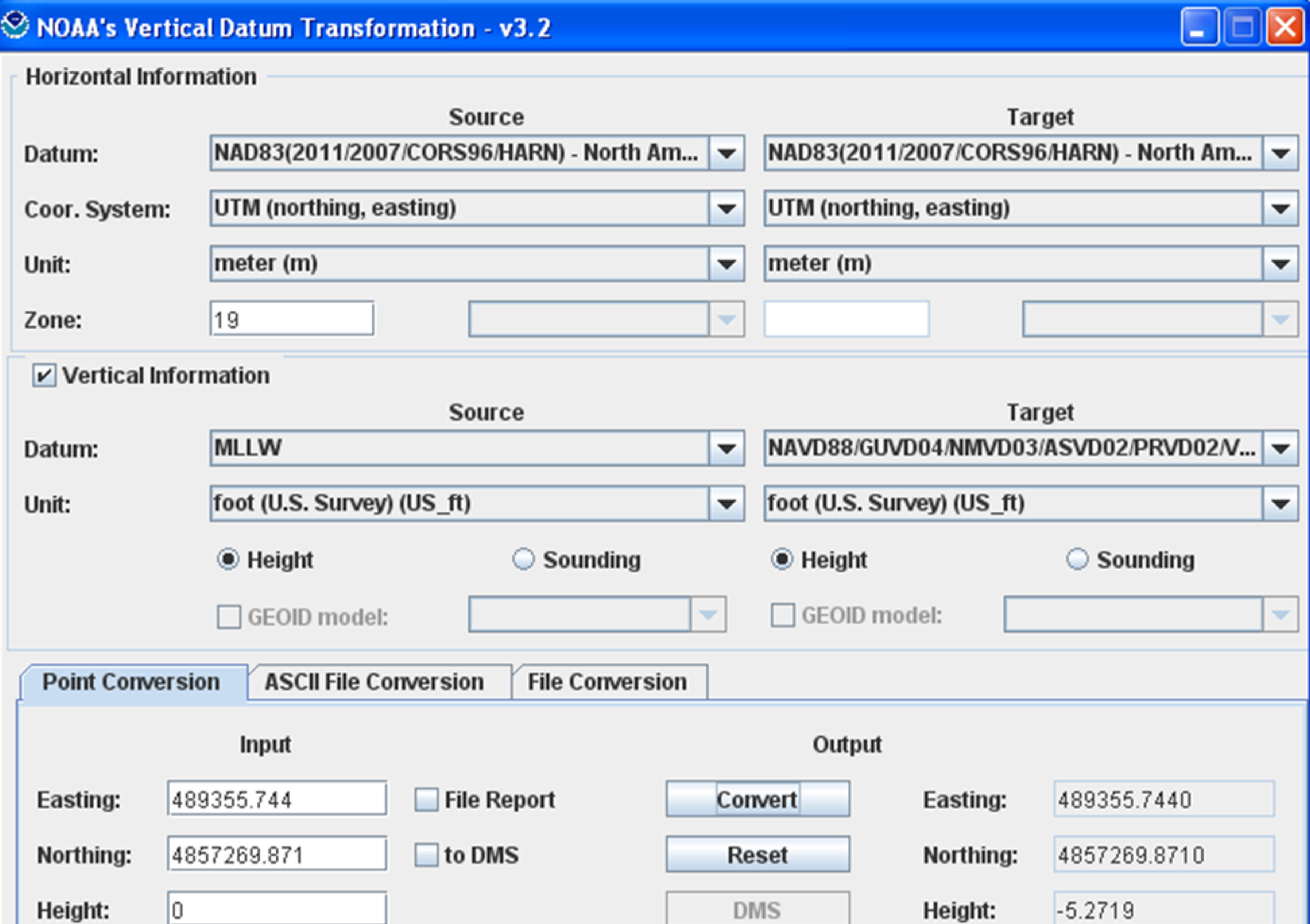
Maine DEP
Highest Annual Tide (HAT) Levels for Year 2013
Maine Coast from Eastport to Portsmouth, NH

Location	2013HAT (Tide Table- ft.)	HAT (NGVD29) (elev. feet)	HAT (NAVD88) (elev. feet)	Ref. Station
Primary Control Stations				
New Castle, NH (Fort Point)	11.5	7.6	6.8	
Portland	11.9	7.4	6.6	
Bar Harbor	13.5	8.2	7.5	
Eastport	22.3	13.0	12.4	
Secondary Stations				
EASTPORT	22.3	13.0	12.4	Eastport
Cobscook Bay				
Garnet Point, Pennamquan R.	23.2	13.4	12.8	Eastport
Coffins Point	21.0	12.3	11.6	Eastport
Birch Islands	21.0	12.3	11.6	Eastport
Cutler, Little River	16.5	9.7	9.1	Eastport
Cutler, Naval Radio Station	15.6	9.1	8.5	Eastport
Stone Island, Machias Bay	15.2	9.0	8.3	Eastport
Machiasport, Machias River	15.4	9.1	8.5	Eastport
Shoppee Point, Englishman Bay	14.7	8.8	8.2	Eastport
Steele Harbor Island	15.1	9.3	8.5	Portland
Millbridge, Narraguagus River	14.6	9.0	8.2	Portland
Green Island, Petit Manan Bar	13.8	8.5	7.7	Portland
Prospect Harbor	13.7	8.3	7.6	Portland
Winter Harbor, Frenchman Bay	12.8	7.8	7.1	Bar Harbor
Mount Desert Island				
BAR HARBOR	13.5	8.2	7.5	Bar Harbor
Southwest Harbor	12.9	7.8	7.1	Bar Harbor
Bass Harbor	12.5	7.5	6.8	Bar Harbor
Blue Hill Bay		0.0		
Blue Hill Harbor	12.8	7.8	7.1	Bar Harbor
Mackerel Cove	12.7	7.7	6.9	Bar Harbor
Ellsworth	13.5	8.2	7.5	Bar Harbor
Burnt Coat Harbor, Swans Island	12.0	7.3	6.6	Bar Harbor
Penobscot Bay				
Eggemoggin Reach				
Center Harbor	12.8	7.8	7.1	Bar Harbor
Little Deer Isle	12.7	7.7	6.9	Bar Harbor
Isle Au Haut	11.7	7.1	6.4	Bar Harbor
Stonington, Deer Isle	12.3	7.4	6.7	Bar Harbor

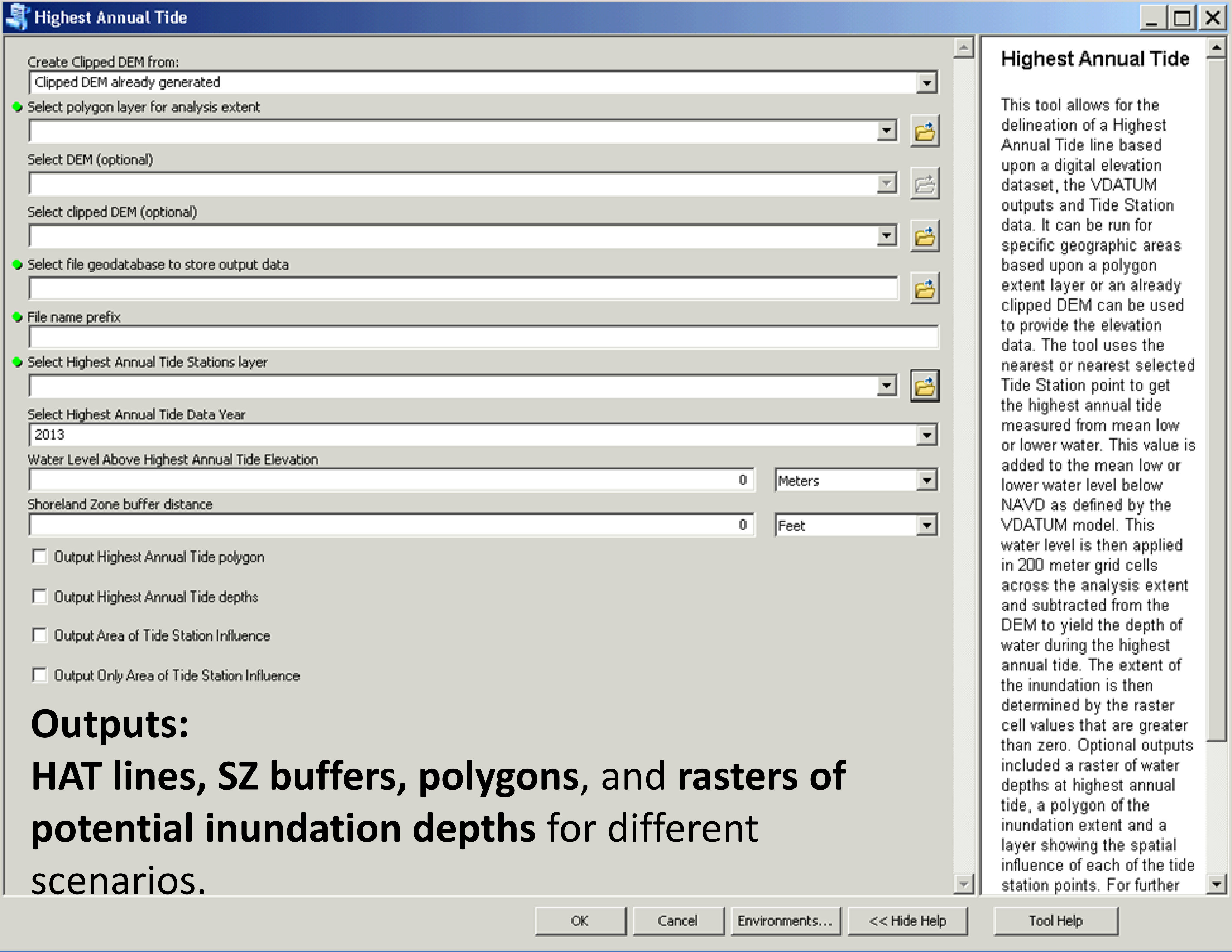
Each year, MGS would calculate the HAT at the 113 tidal stations for Maine DEP in support of Maine's Shoreland Zoning Regulations.



In our mapping effort, the key was to 1) fill in data "gaps" where no tidal stations existed, and 2) convert predicted HAT values into NAVD so they can be compared with LiDAR land elevations.



VDATUM can be used to spatially estimate variability in the water's surface by determining separations in different datums (i.e., MLLW to NAVD88).



Outputs:

HAT lines, SZ buffers, polygons, and **rasters of potential inundation depths** for different scenarios.

Some Assumptions and Limitations

- Our mapping differs from other states in that we use the **Highest Annual Tide** per Shoreland Zoning regulations, not MHHW**. In Maine, the HAT is between 2-3 feet higher than the MHHW level. We are trying to both map the limits of existing HAT for Shoreland Zoning and visualize the impacts of SLR scenarios on potential wetland expansion and inundation*, not necessarily map the actual limits of wetlands.***

- We use a "bare earth" LiDAR DEM that represents a "snapshot" of topography that **may have changed since the data was captured**.

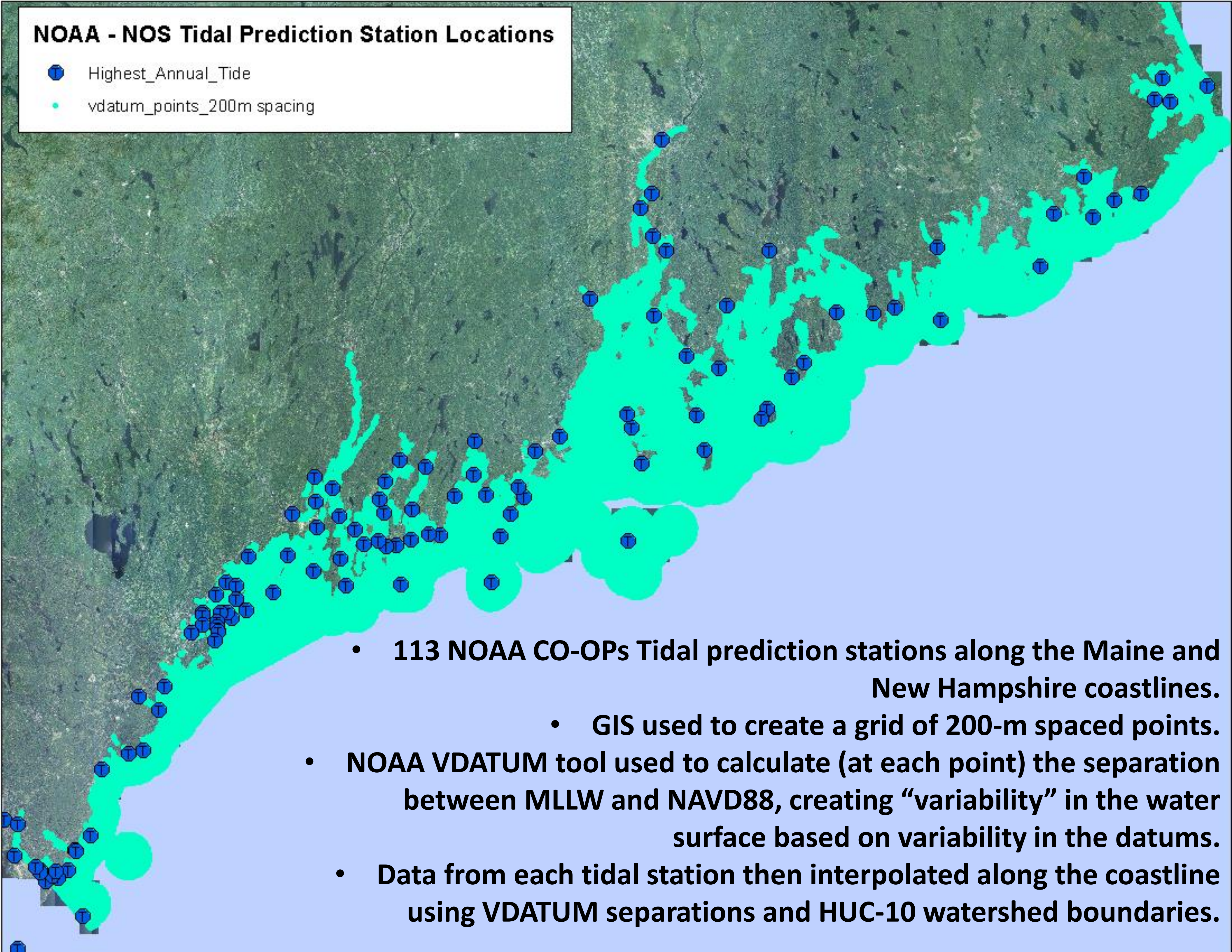
- Our simulations use a **bathtub approach** that **doesn't account for erosion, sedimentation, or dynamic influences like freshwater flow or waves**.

Some Assumptions and Limitations

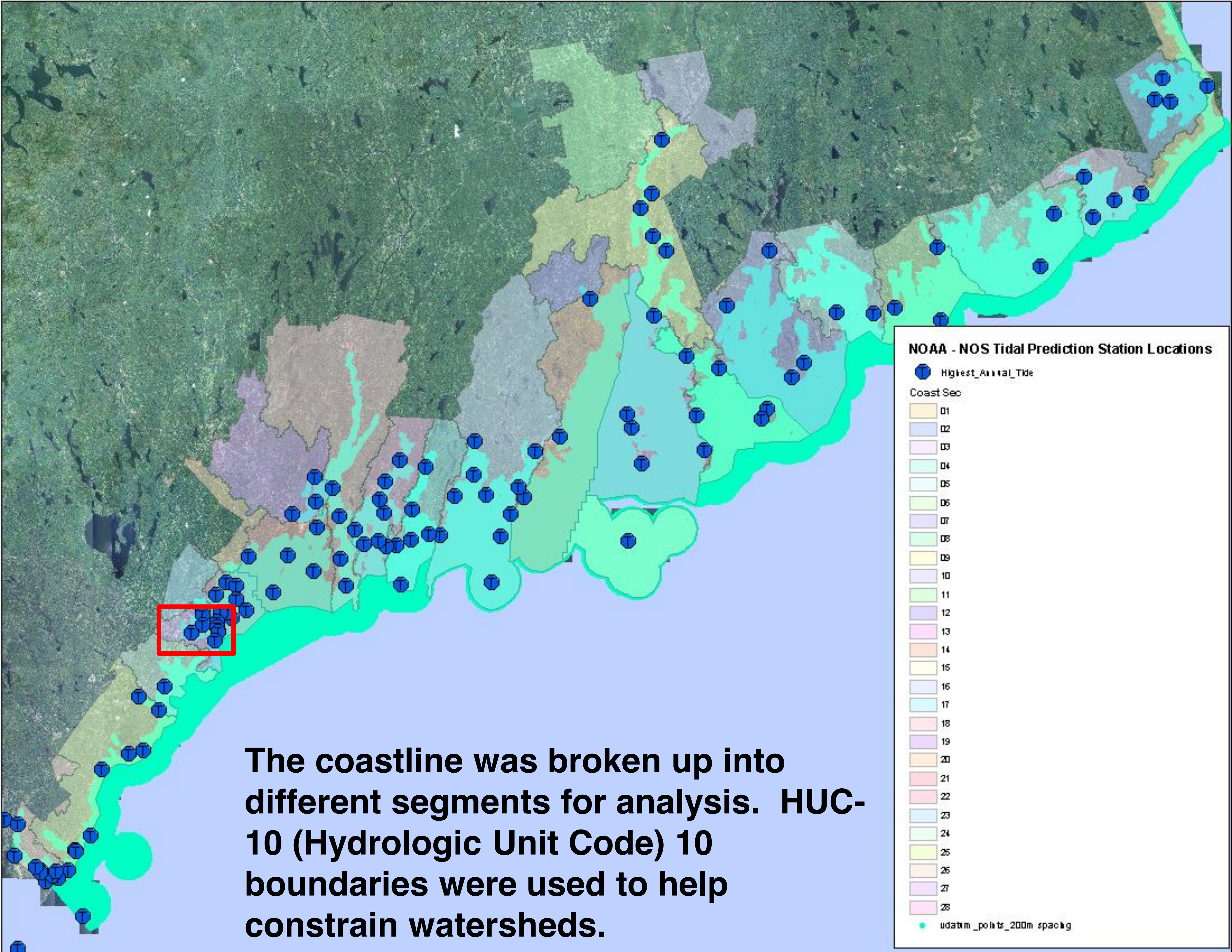
- In Maine, our LiDAR was flown at **any tide** so in some areas, LiDAR points were reflected by water (i.e., data collected at a higher tide), resulting in bad or no data in some areas.

- We use NOAA's VDATUM to convert from MLLW to NAVD88 to translate elevations across water surfaces. This helps adjust tidal predictions, but also **adds additional vertical error (up to a published 13.2 cm per NOAA)** to our datasets.

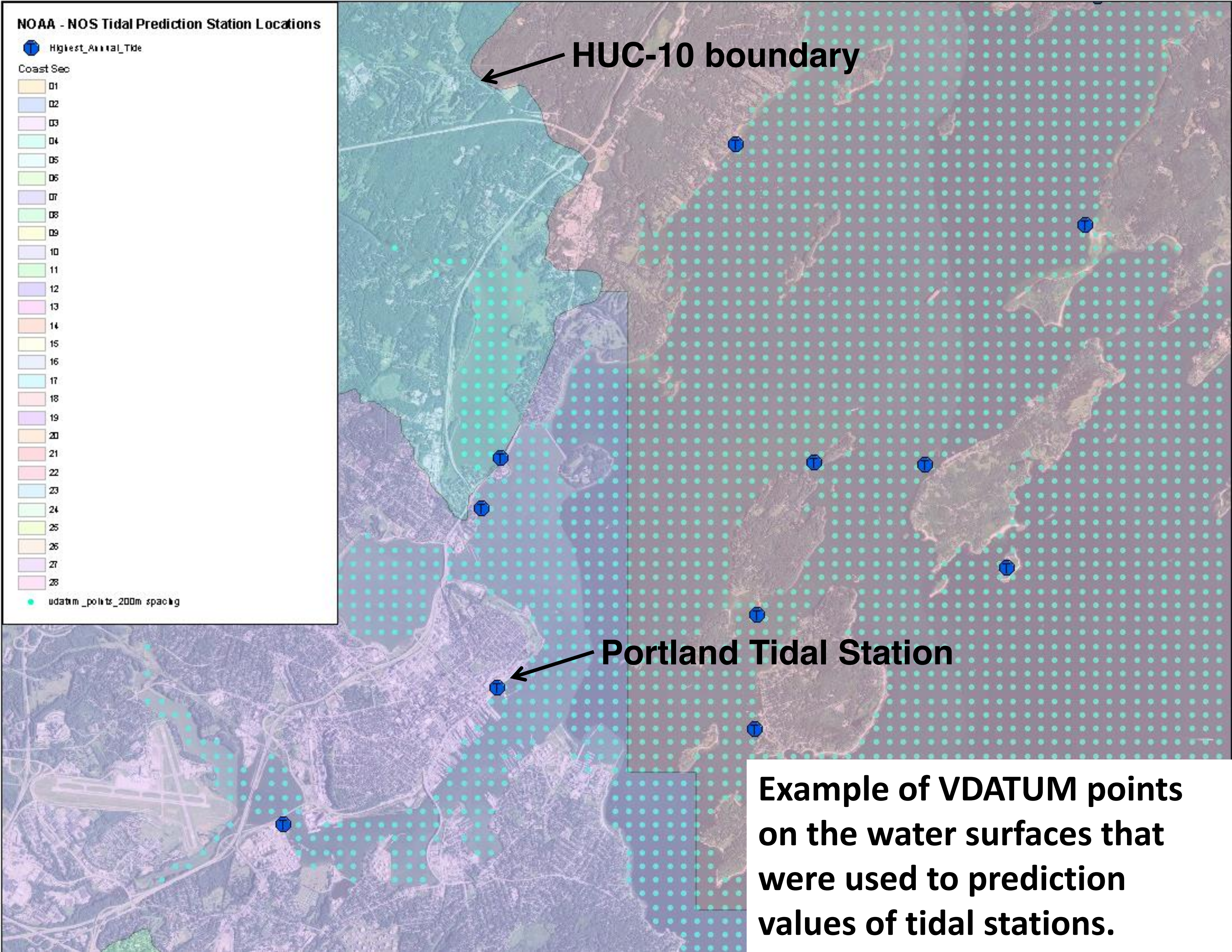
- **Our state-wide analysis doesn't look at wetland type conversion or wetland loss on a state-wide level.** This was done only in select areas for partner communities (Scarborough River marsh).



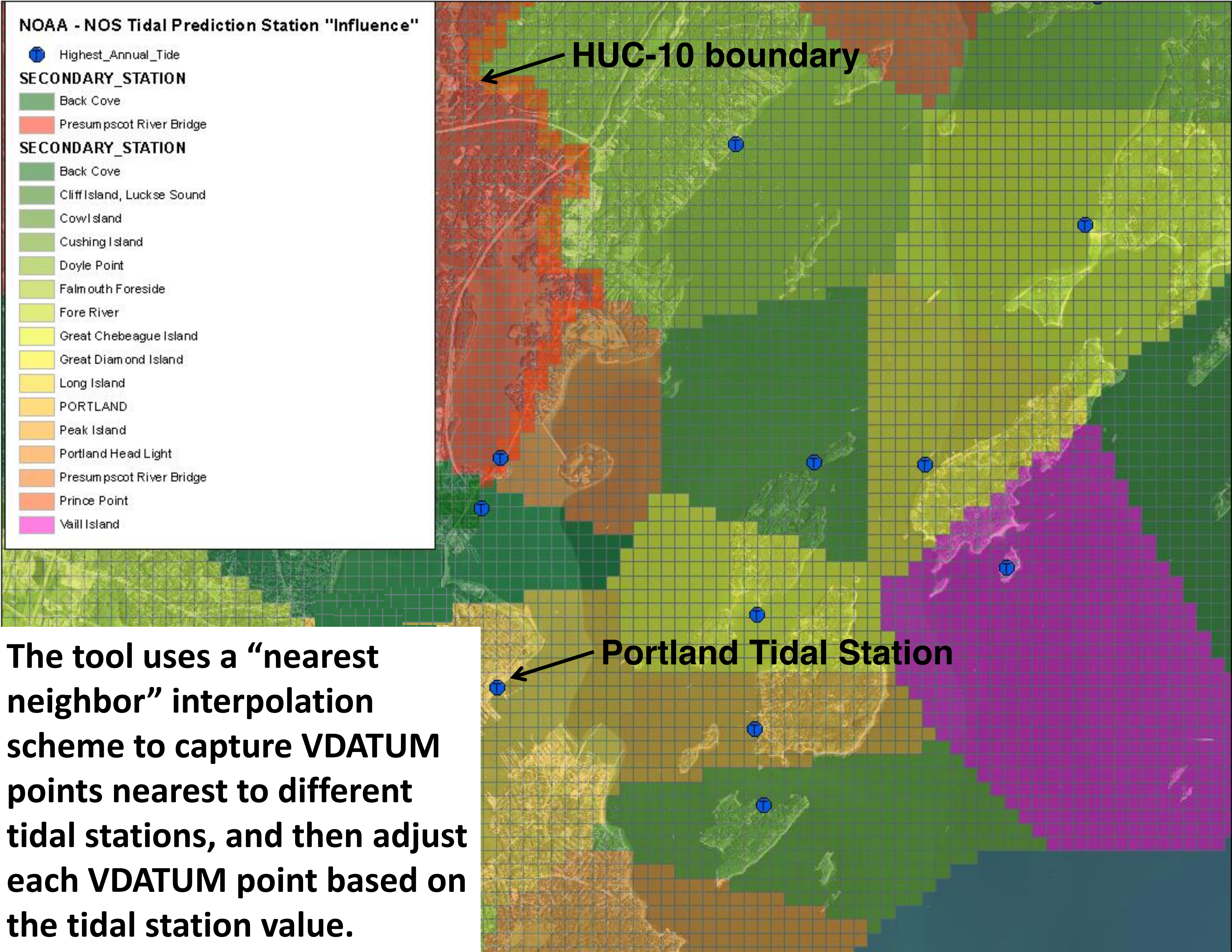
- 113 NOAA CO-OPs Tidal prediction stations along the Maine and New Hampshire coastlines.
- GIS used to create a grid of 200-m spaced points.
- NOAA VDATUM tool used to calculate (at each point) the separation between MLLW and NAVD88, creating "variability" in the water surface based on variability in the datums.
- Data from each tidal station then interpolated along the coastline using VDATUM separations and HUC-10 watershed boundaries.



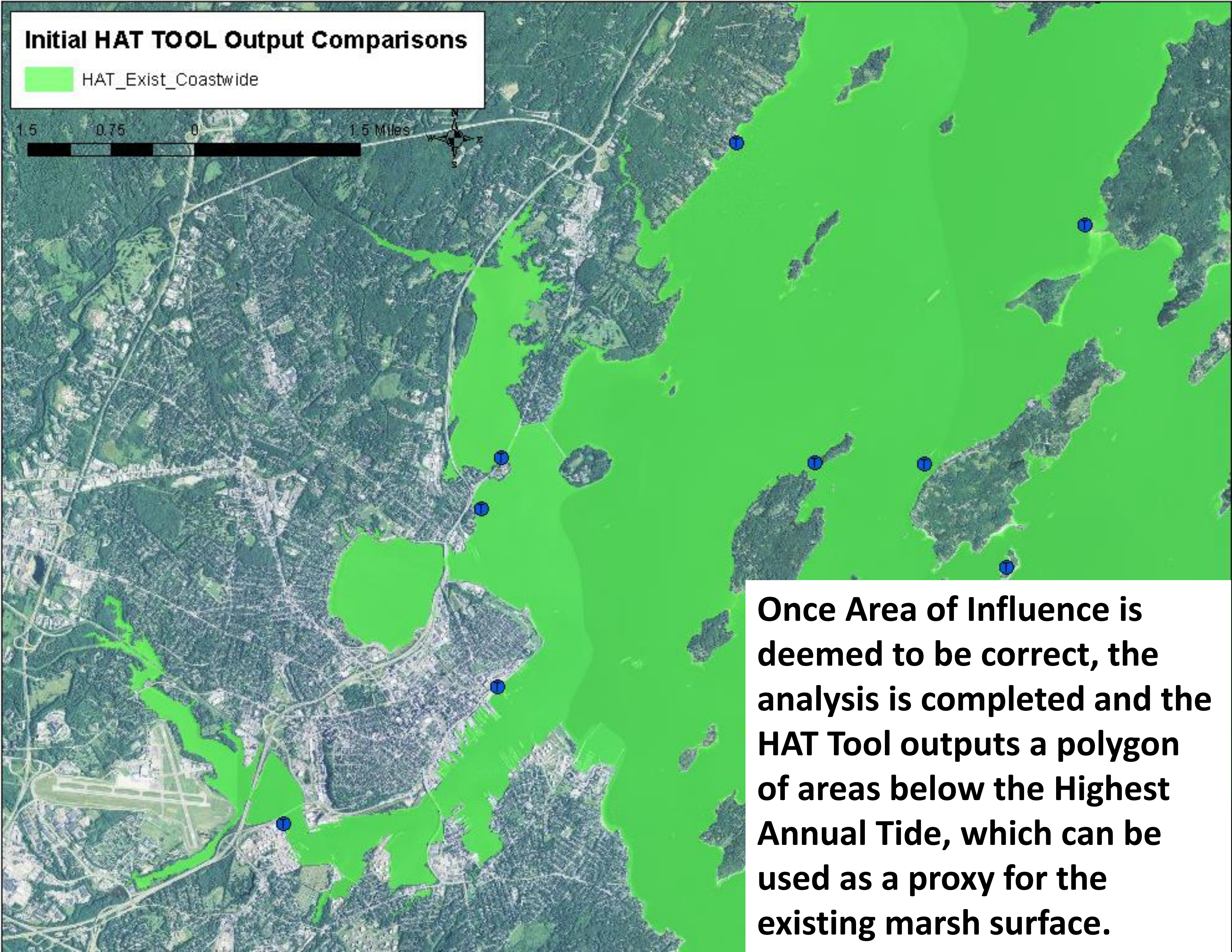
The coastline was broken up into different segments for analysis. HUC-10 (Hydrologic Unit Code) 10 boundaries were used to help constrain watersheds.



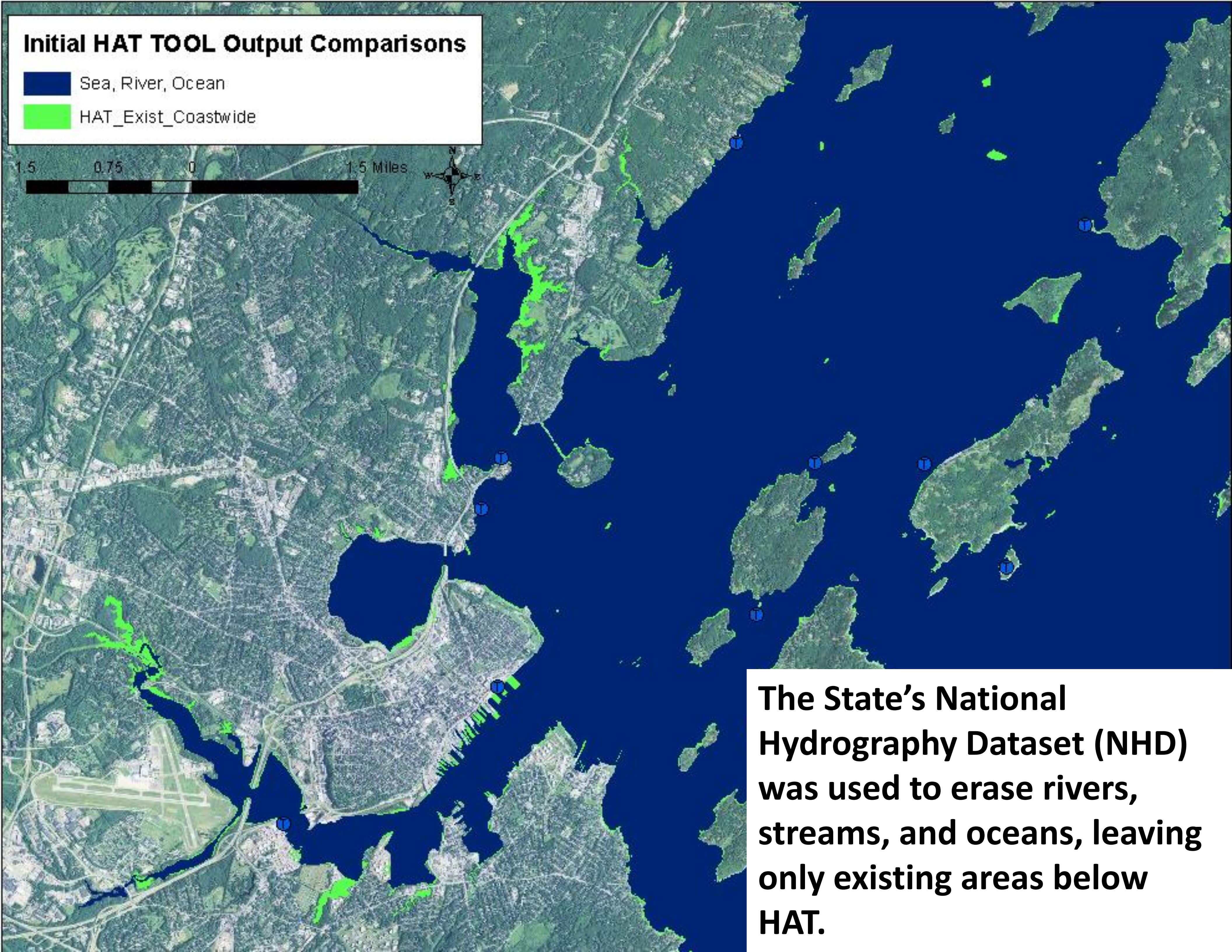
Example of VDATUM points on the water surfaces that were used to prediction values of tidal stations.



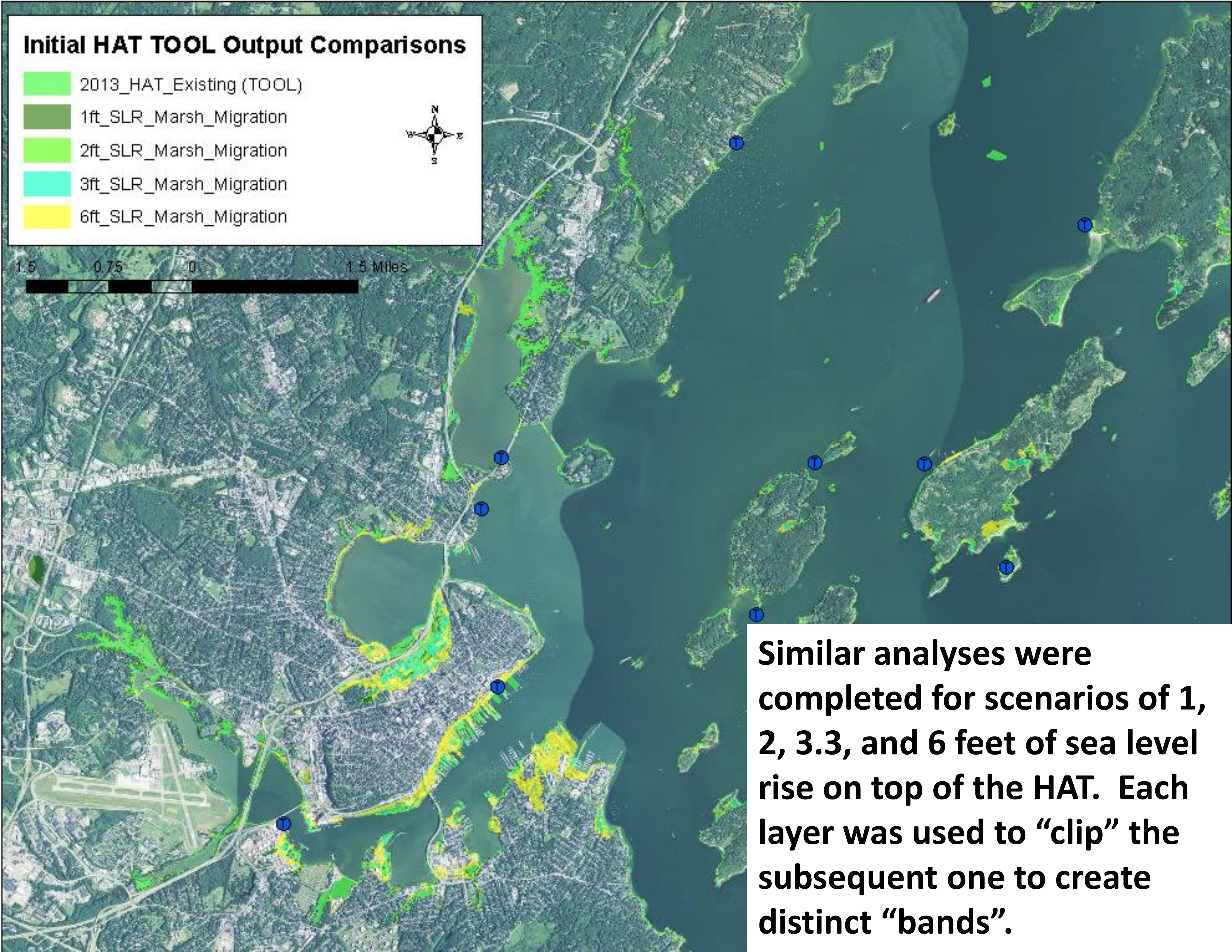
The tool uses a "nearest neighbor" interpolation scheme to capture VDATUM points nearest to different tidal stations, and then adjust each VDATUM point based on the tidal station value.



Once Area of Influence is deemed to be correct, the analysis is completed and the HAT Tool outputs a polygon of areas below the Highest Annual Tide, which can be used as a proxy for the existing marsh surface.

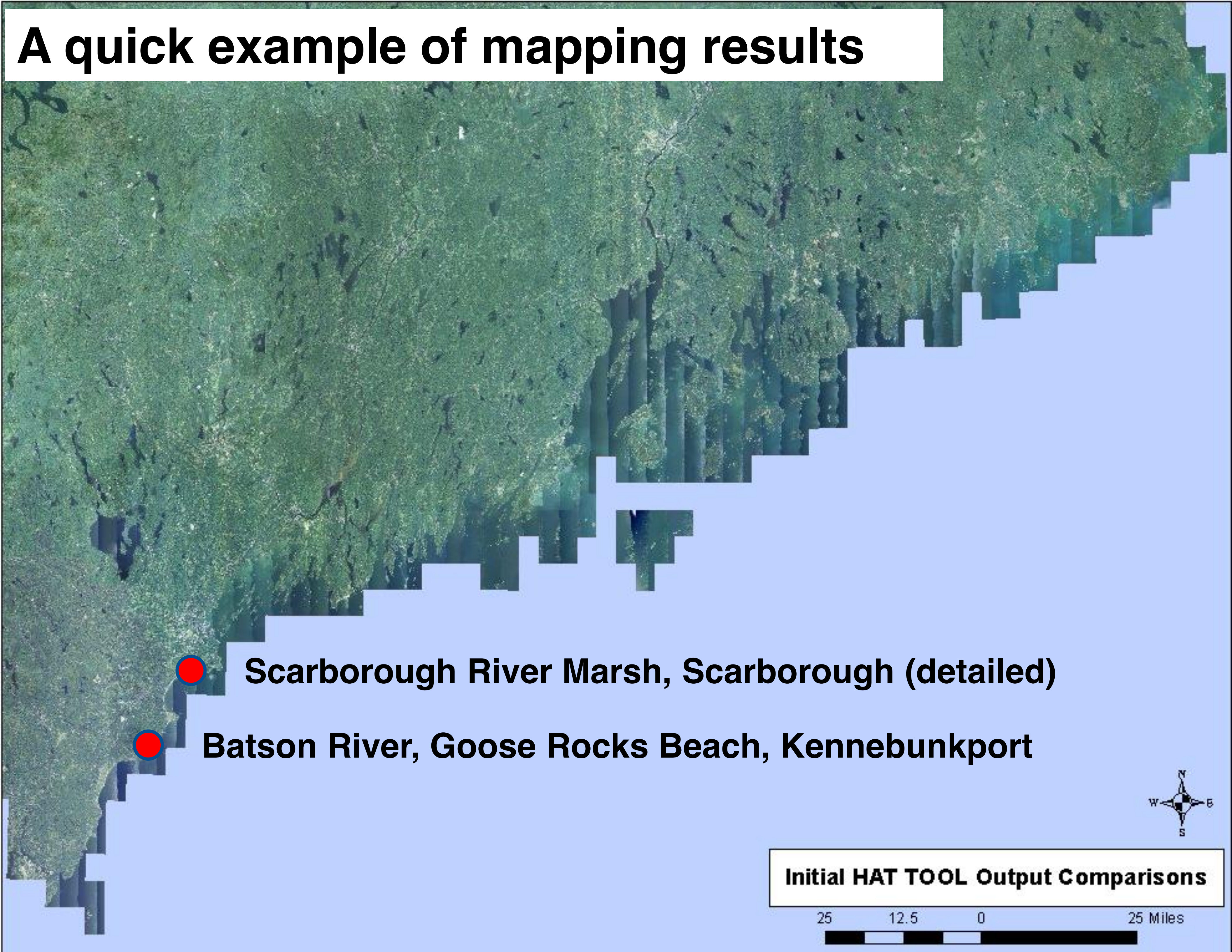


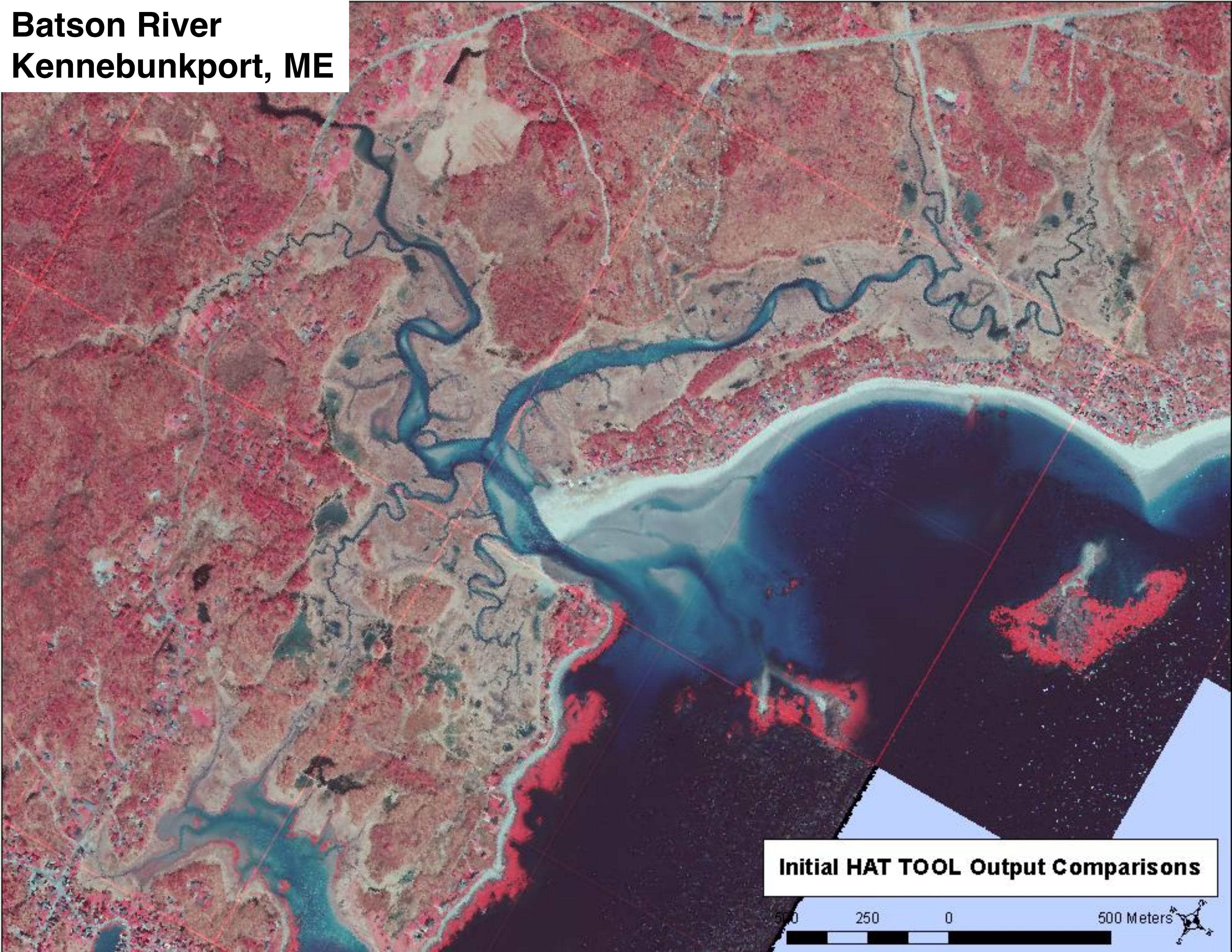
The State’s National Hydrography Dataset (NHD) was used to erase rivers, streams, and oceans, leaving only existing areas below HAT.



Similar analyses were completed for scenarios of 1, 2, 3.3, and 6 feet of sea level rise on top of the HAT. Each layer was used to “clip” the subsequent one to create distinct “bands”.

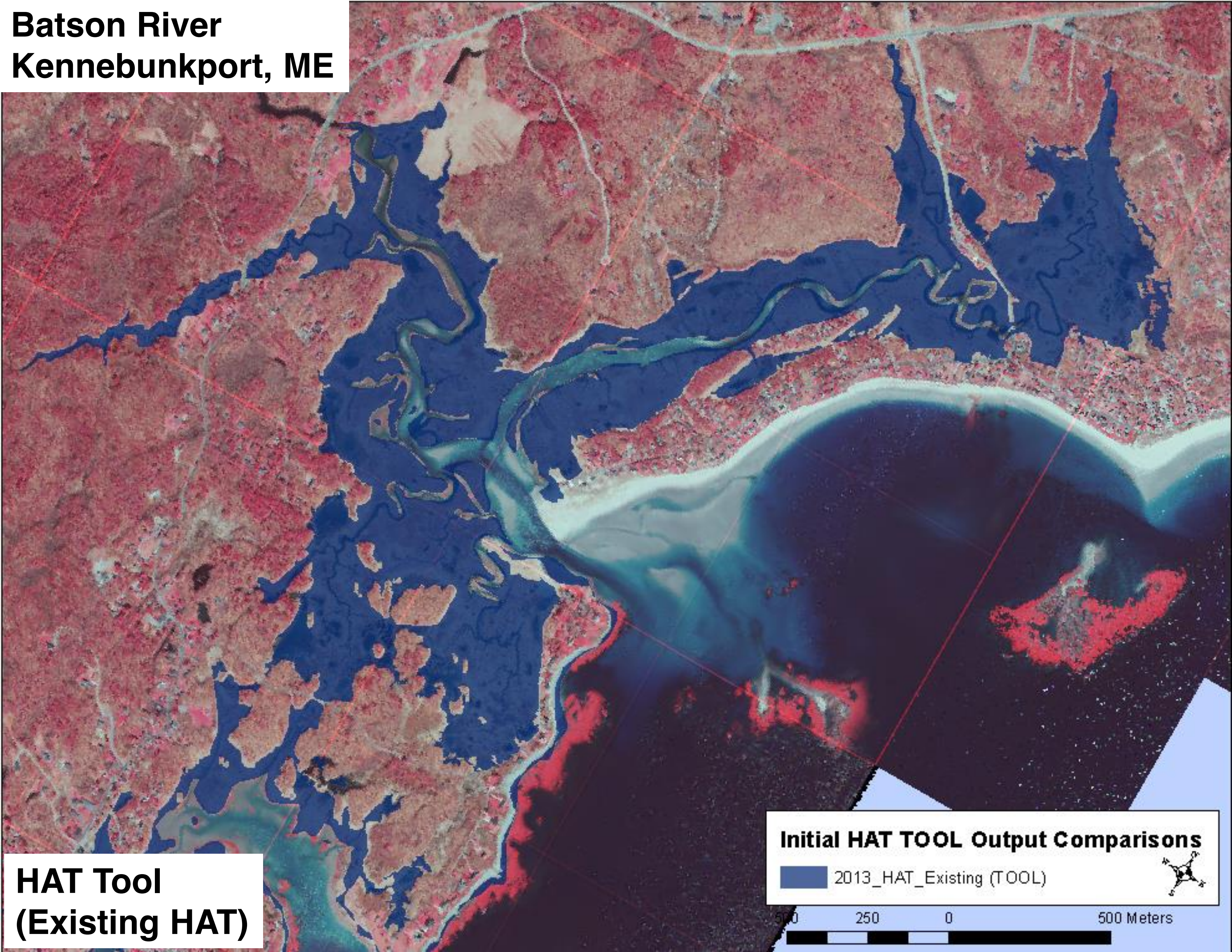
A quick example of mapping results

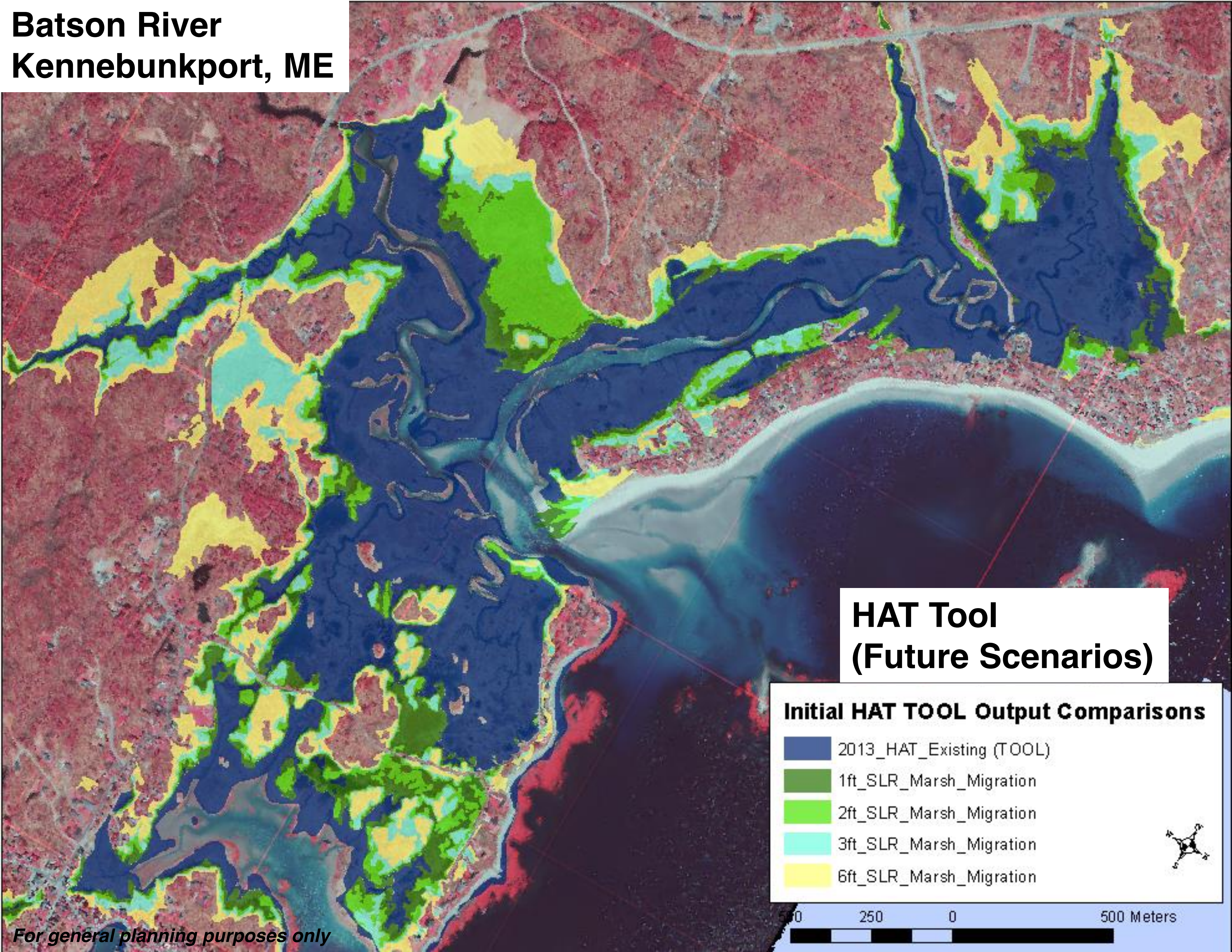




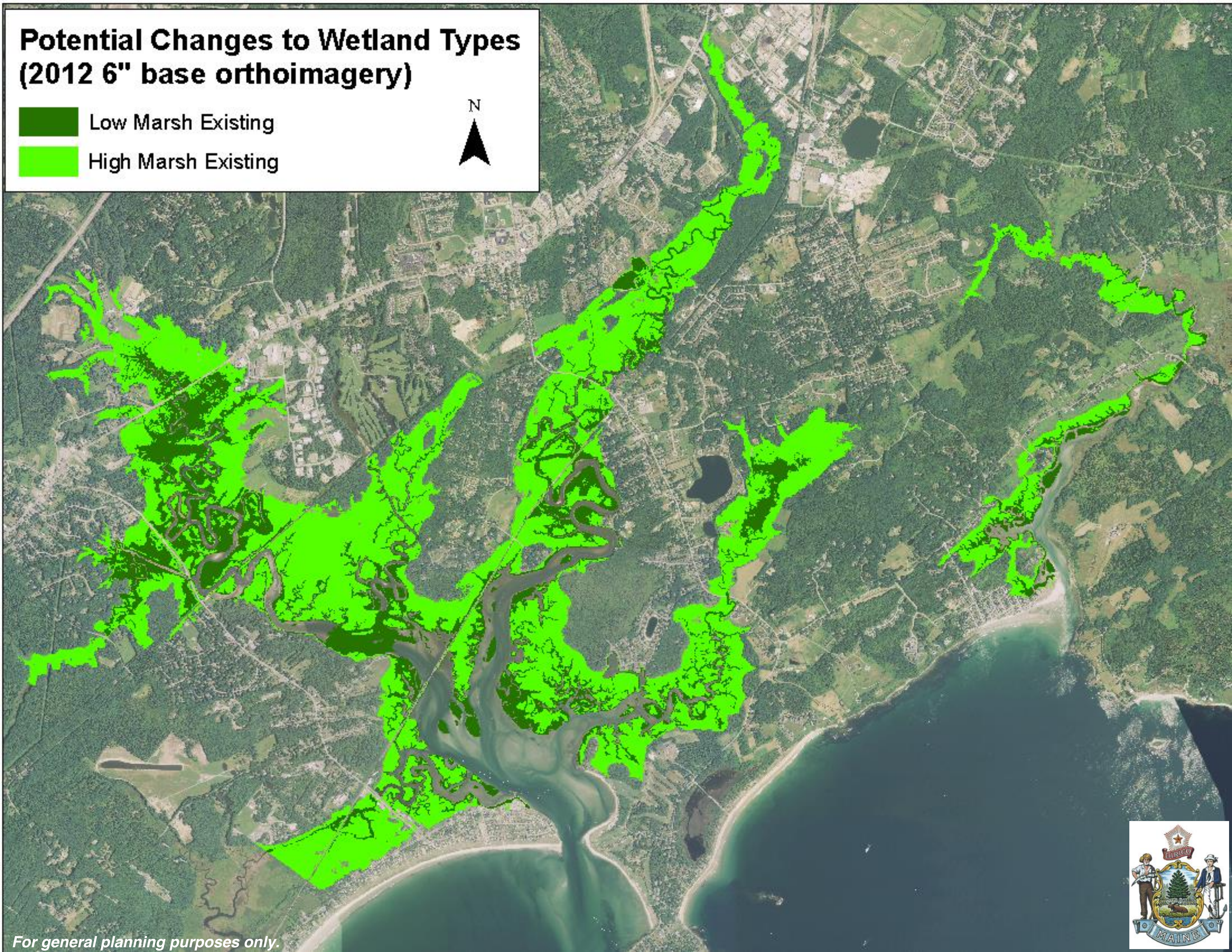
Batson River
Kennebunkport, ME
Initial HAT TOOL Output Comparisons
500
250
0
500 Meters

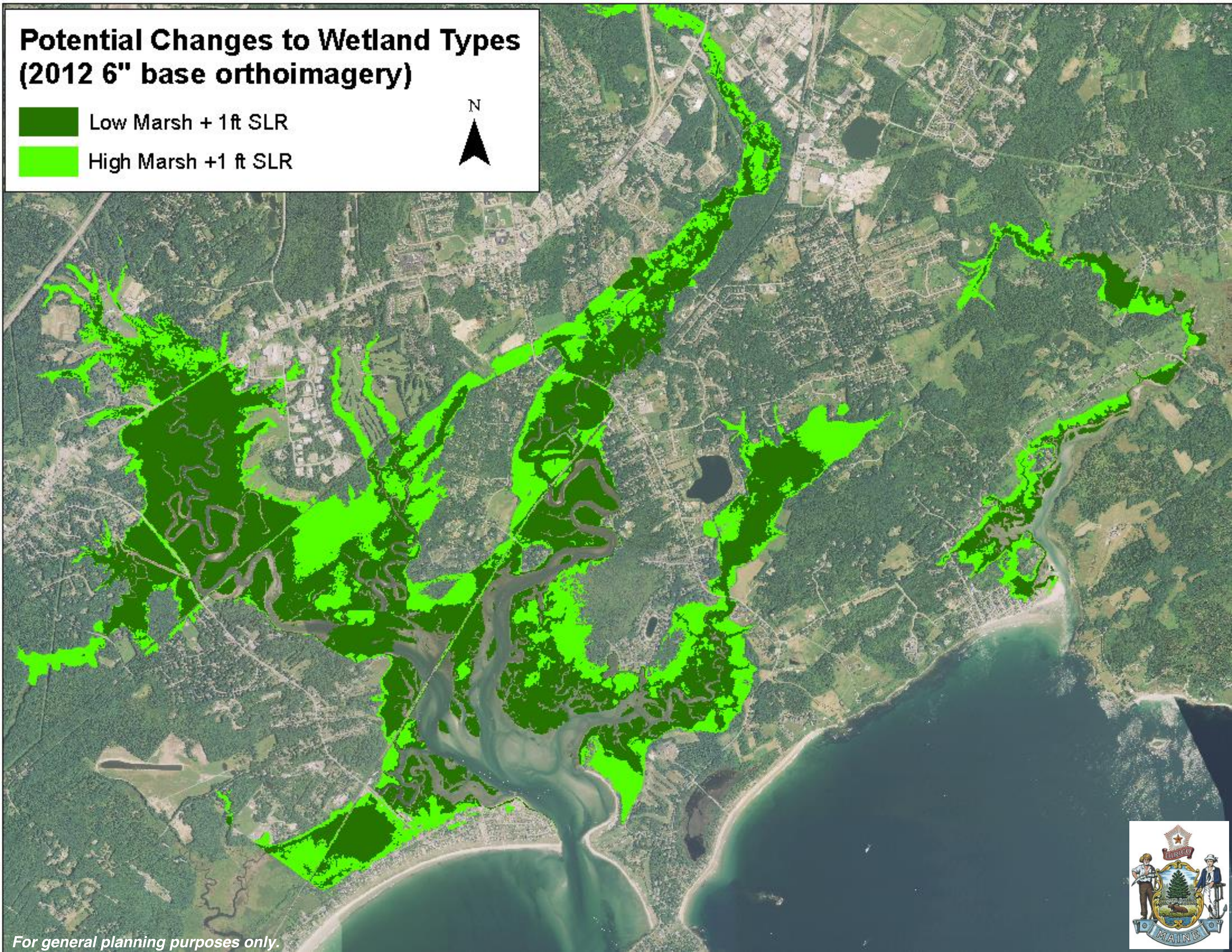

Batson River
Kennebunkport, ME
Comparison with
MNAP Mapping – “ground-truthing”
Initial HAT TOOL Output Comparisons
2013_HAT_Existing (TOOL)
2014_Tidal_Marshes_Final (MNAP)
500 250 0 500 Meters

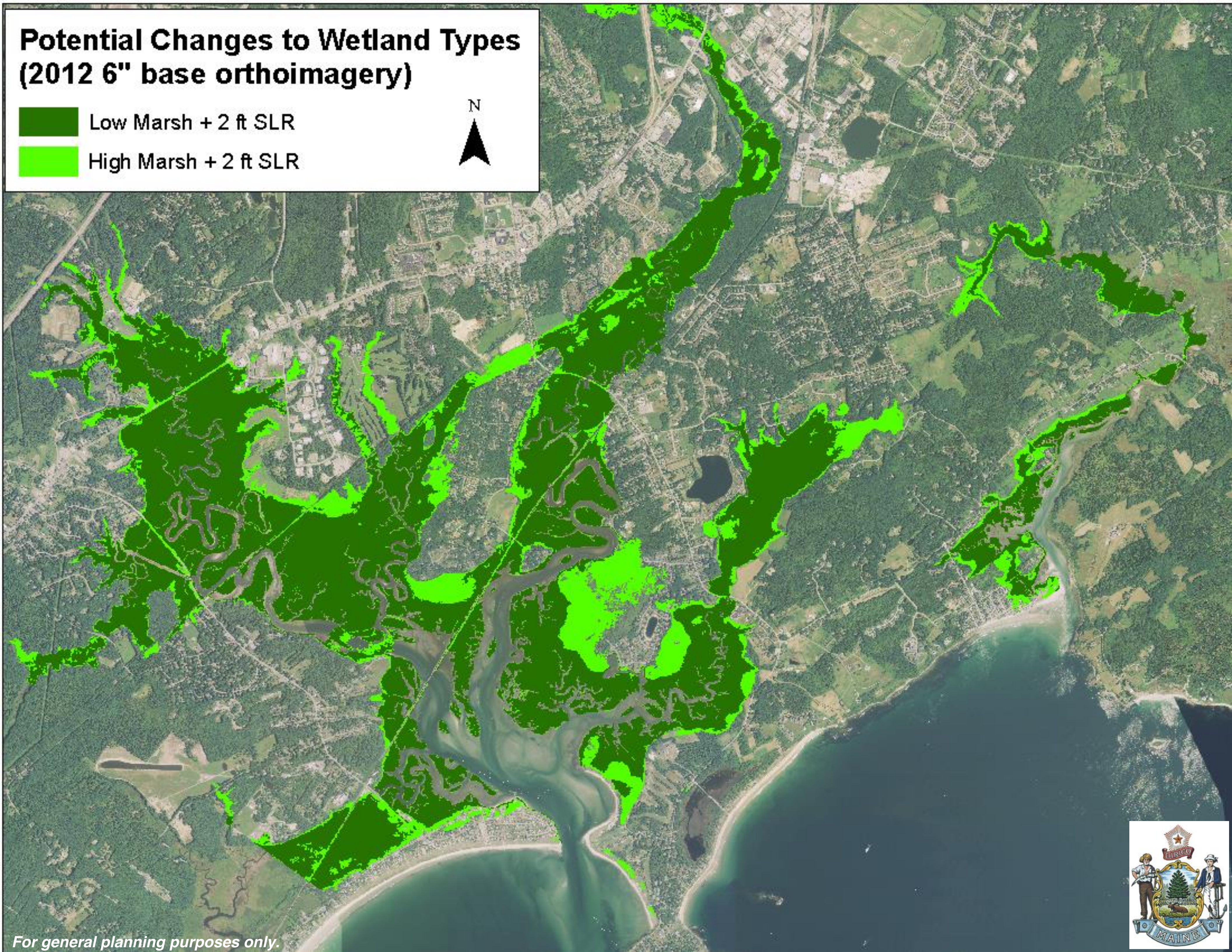

Batson River
Kennebunkport, ME
HAT Tool
(Existing HAT)
Initial HAT TOOL Output Comparisons
2013_HAT_Existing (TOOL)
500
250
0
500 Meters

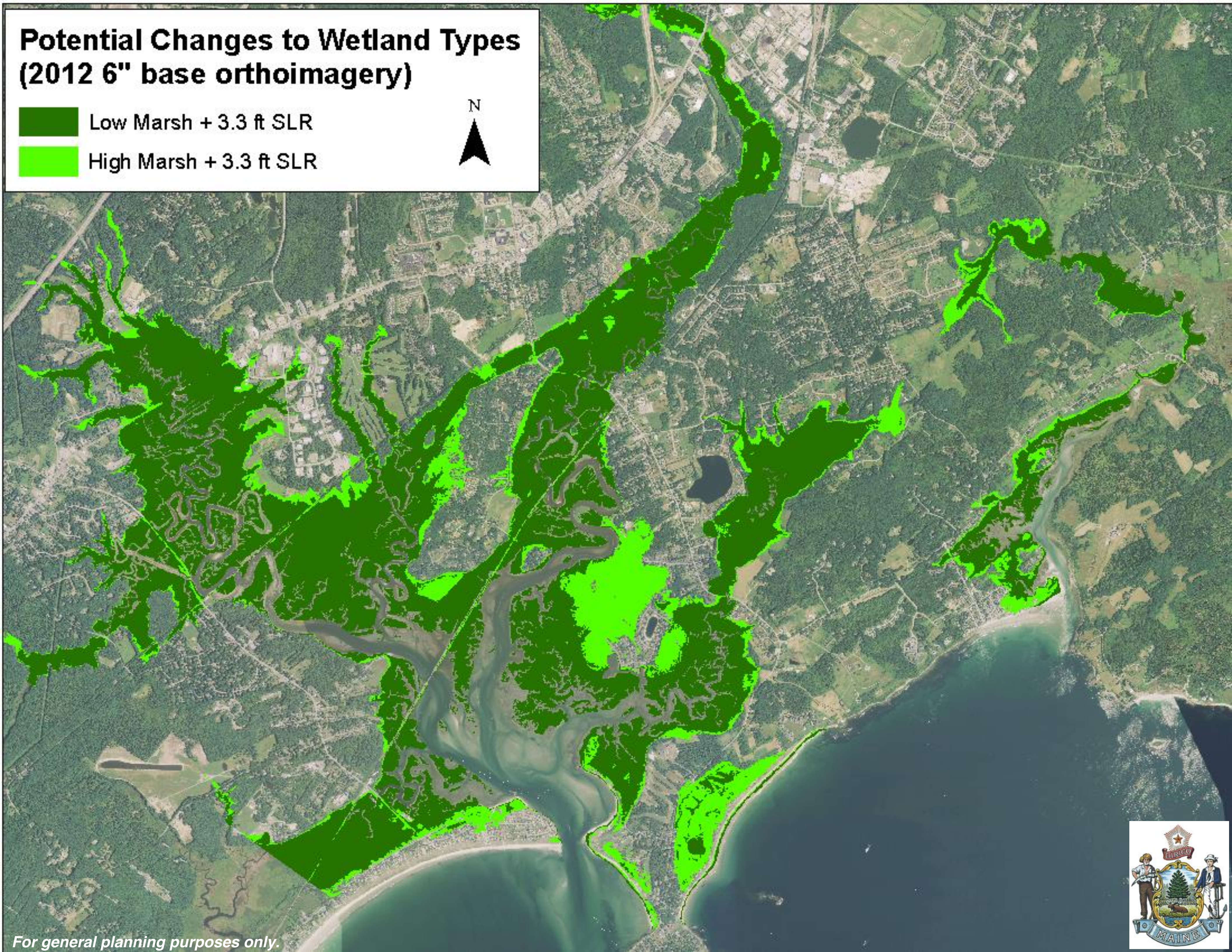

Batson River
Kennebunkport, ME
HAT Tool
(Future Scenarios)
Initial HAT TOOL Output Comparisons
2013_HAT_Existing (TOOL)
1ft_SLR_Marsh_Migration
2ft_SLR_Marsh_Migration
3ft_SLR_Marsh_Migration
6ft_SLR_Marsh_Migration
500 250 0 500 Meters
For general planning purposes only

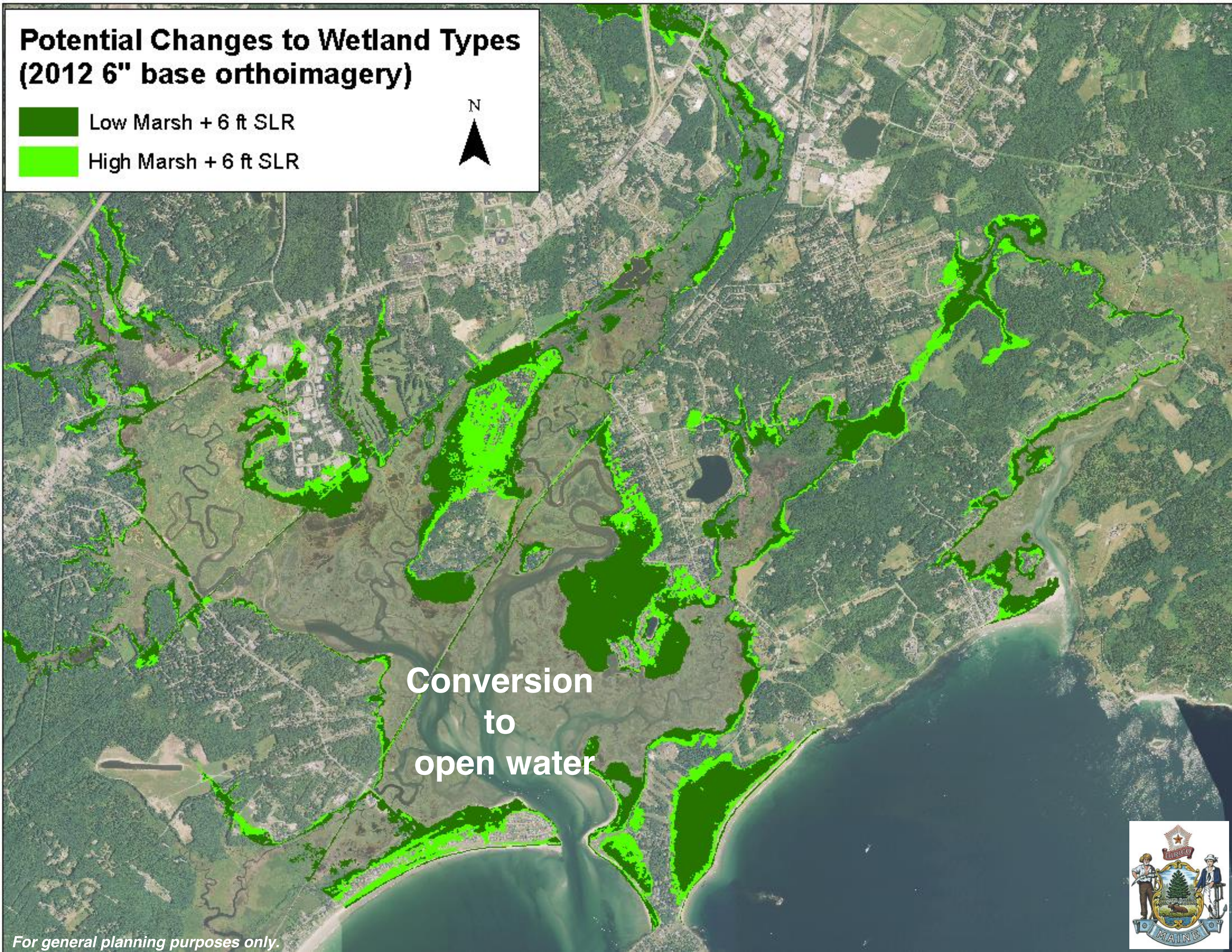
A detailed look: Scarborough Marsh

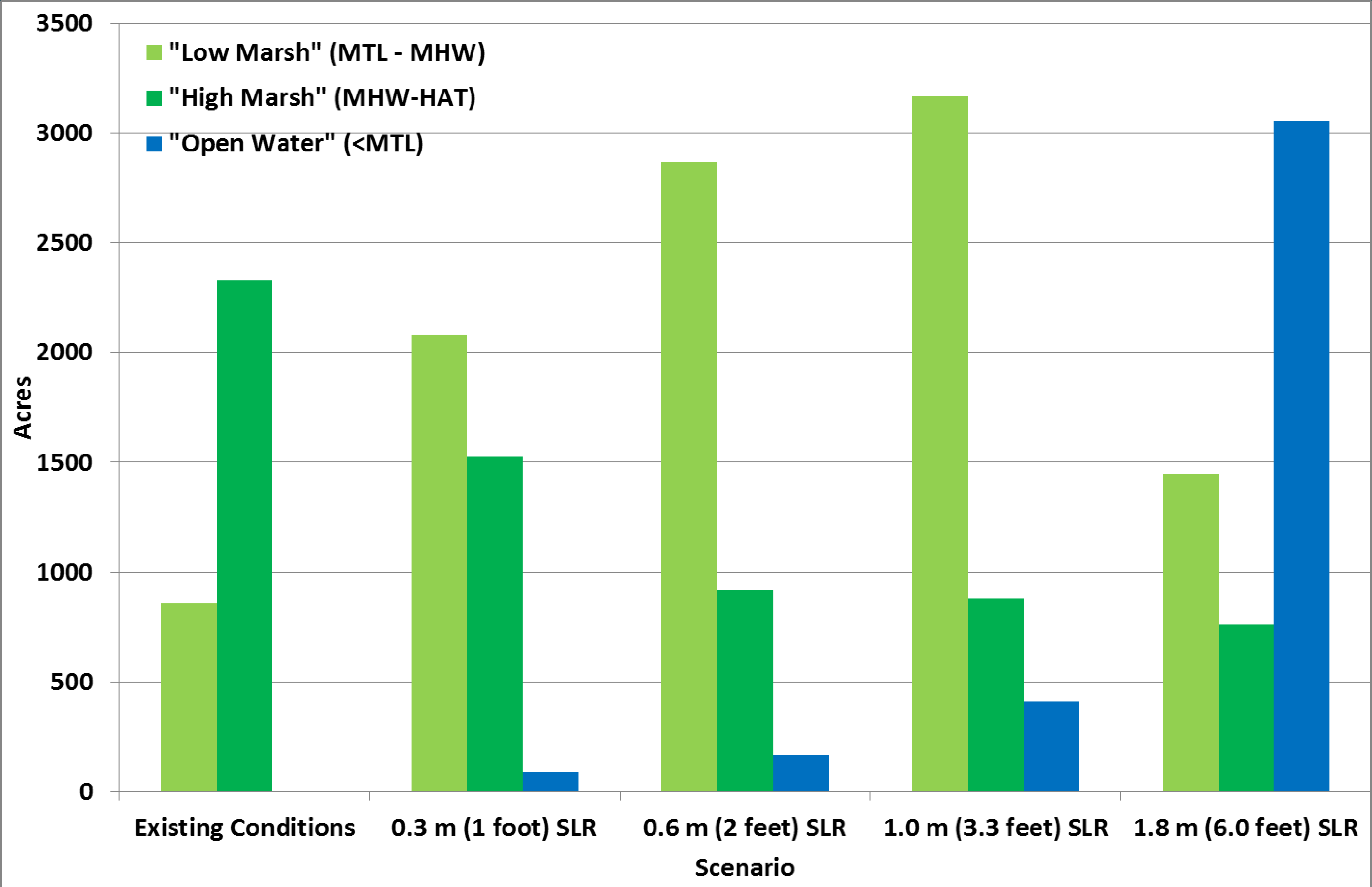

Potential Changes to Wetland Types
(2012 6" base orthoimagery)
Low Marsh Existing
High Marsh Existing
N
For general planning purposes only.
MAINE


Potential Changes to Wetland Types
(2012 6" base orthoimagery)
Low Marsh + 1ft SLR
High Marsh +1 ft SLR
N
For general planning purposes only.
MAINE


Potential Changes to Wetland Types
(2012 6" base orthoimagery)
Low Marsh + 2 ft SLR
High Marsh + 2 ft SLR
N
For general planning purposes only.
MAINE


Potential Changes to Wetland Types
(2012 6" base orthoimagery)
Low Marsh + 3.3 ft SLR
High Marsh + 3.3 ft SLR
N
For general planning purposes only.


Potential Changes to Wetland Types
(2012 6" base orthoimagery)
Low Marsh + 6 ft SLR
High Marsh + 6 ft SLR
N
Conversion
to
open water
For general planning purposes only.
DIRIGO
MAINE



Take home point: **Wetlands may convert to a low-marsh dominated system (high marsh expansion limited by steep sloped or developed uplands) and we may lose marsh to open water under higher scenarios.**

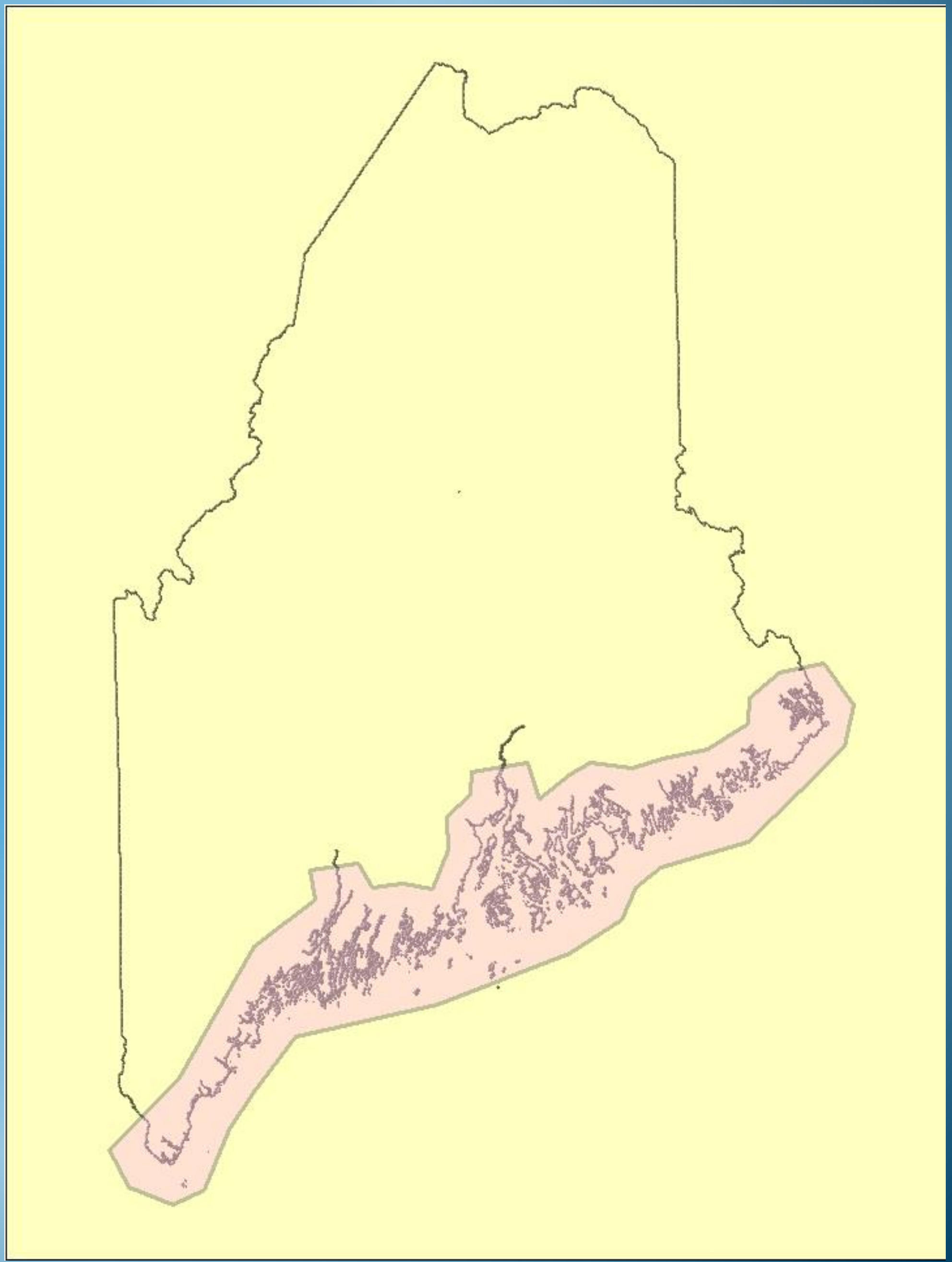
Phase II: MNAP's Statewide Mapping Analysis

1) MNAP completed updated statewide mapping of *existing coastal wetlands* using aerial-imagery, LiDAR interpretation, and ground-truthing

2) MNAP completed analysis of four Sea Level Rise Simulations

(1ft, 2ft, 3.3ft, & 6ft)

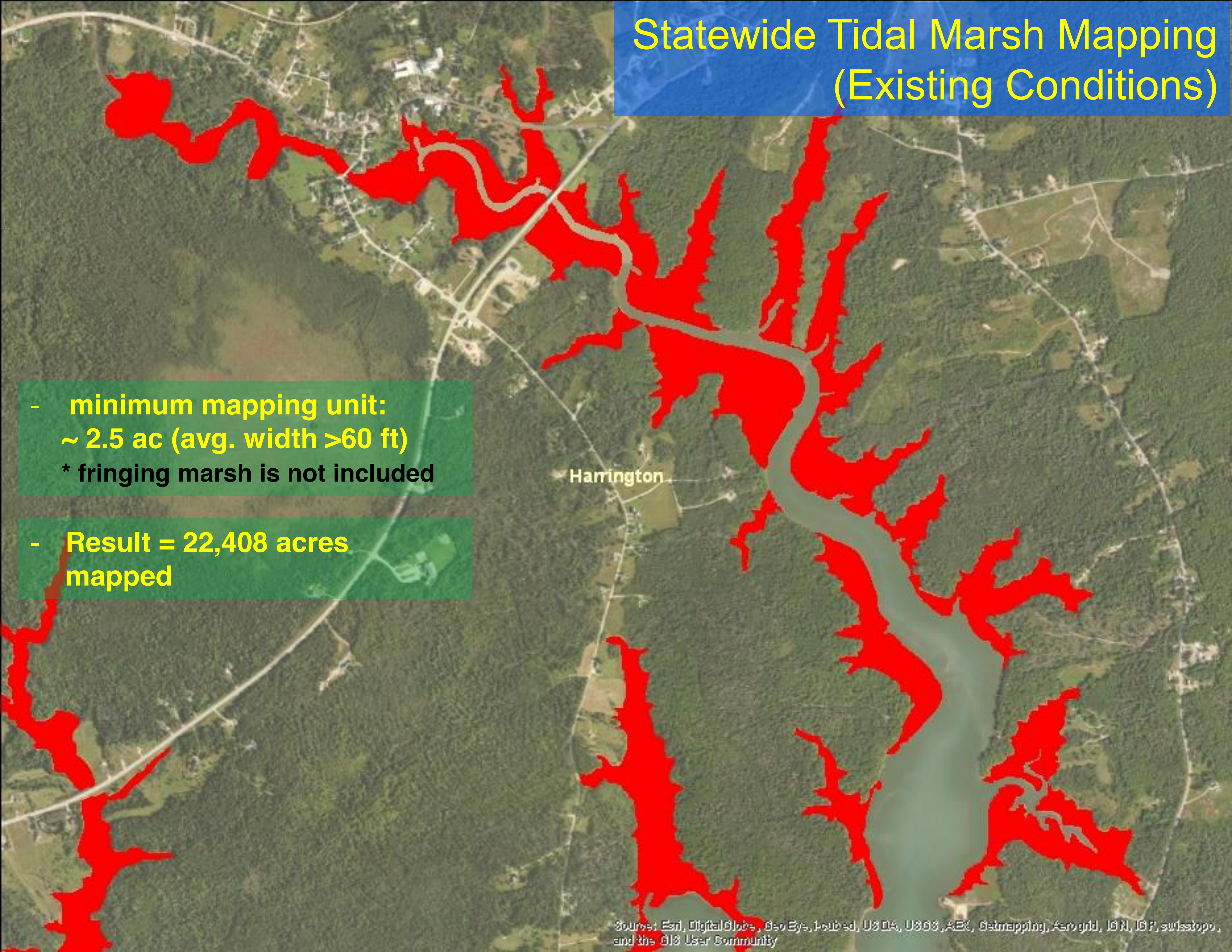
- **where do we expect marsh migration?**
- **what land cover types will be affected?**
- **how much is conservation land?**
- **how much is freshwater wetland?**



Statewide Tidal Marsh Mapping (Existing Conditions)

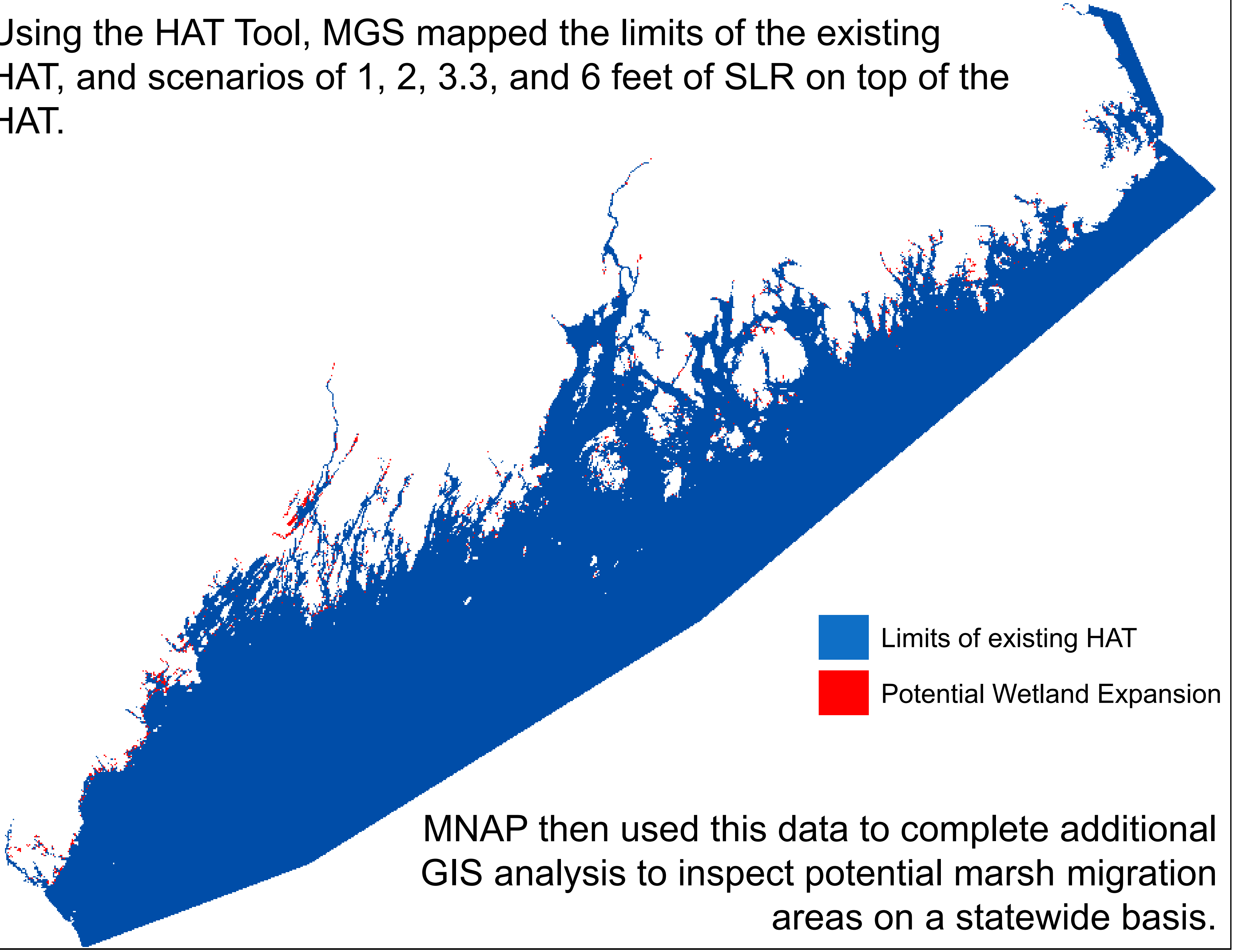
- **minimum mapping unit: ~ 2.5 ac (avg. width >60 ft)**
  *** fringing marsh is not included**

- **Result = 22,408 acres mapped**

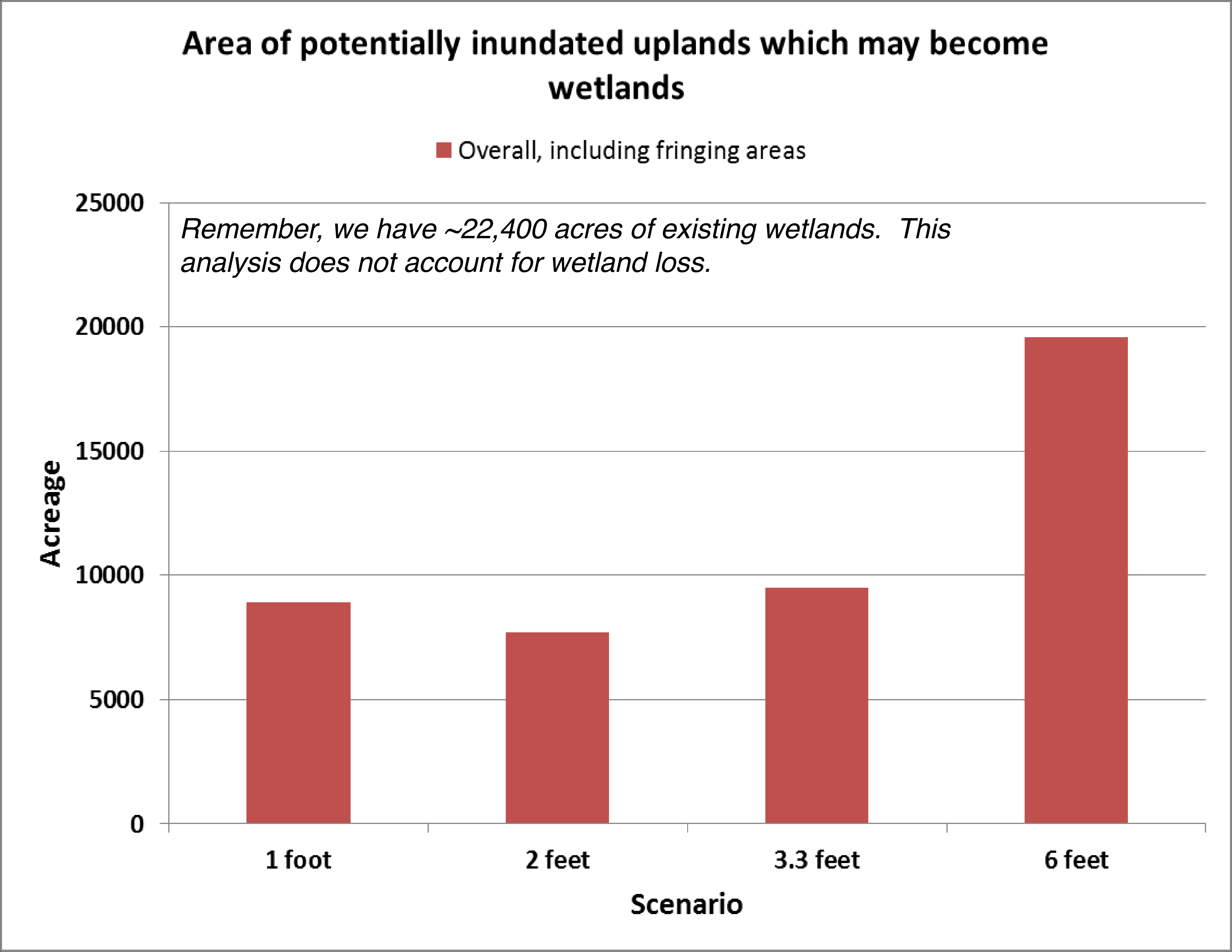


Using the HAT Tool, MGS mapped the limits of the existing HAT, and scenarios of 1, 2, 3.3, and 6 feet of SLR on top of the HAT.

.

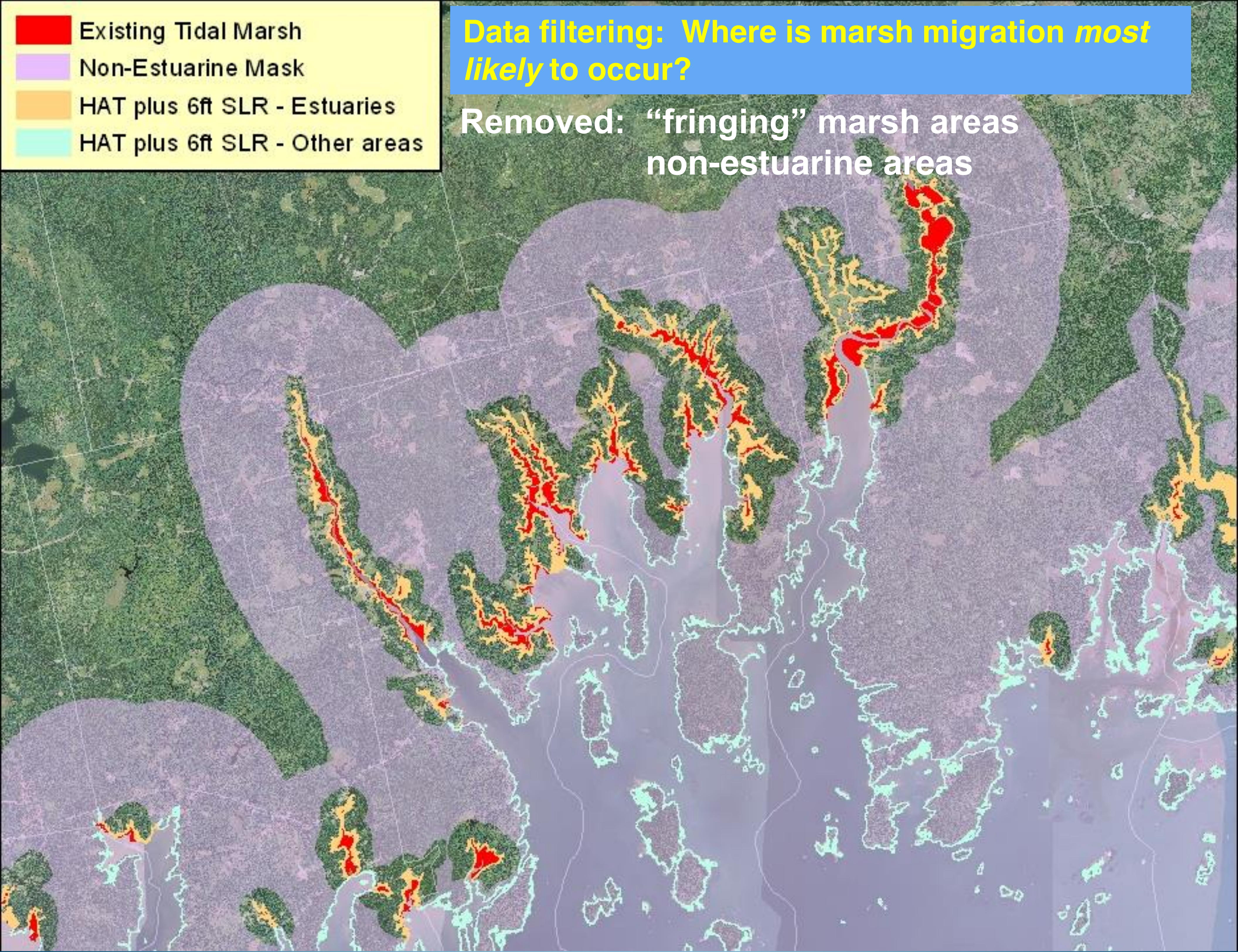


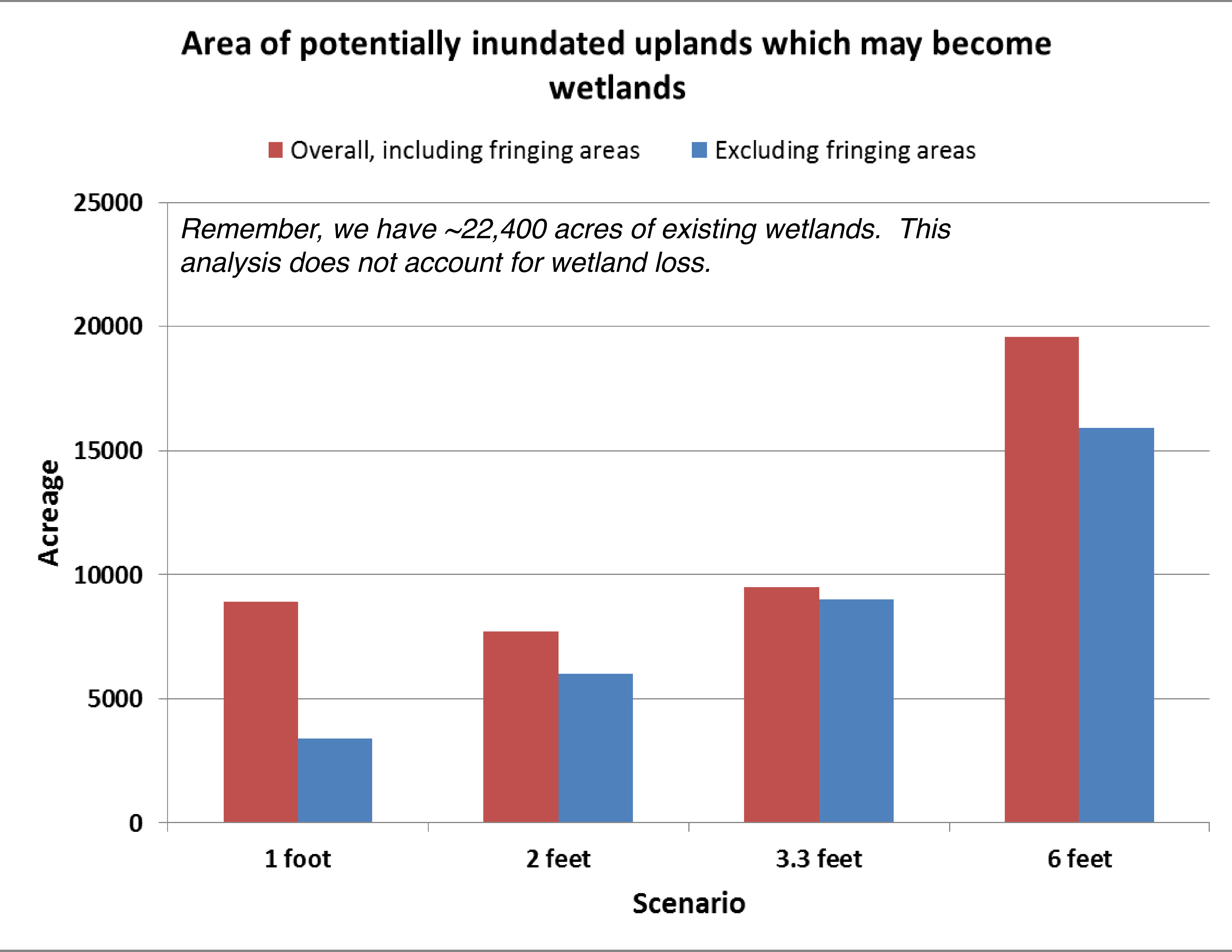
MNAP then used this data to complete additional GIS analysis to inspect potential marsh migration areas on a statewide basis.


Area of potentially inundated uplands which may become wetlands
Overall, including fringing areas
Remember, we have ~22,400 acres of existing wetlands. This analysis does not account for wetland loss.
25000
20000
15000
10000
5000
0
Acreage
1 foot
2 feet
3.3 feet
6 feet
Scenario

Data filtering: Where is marsh migration *most likely* to occur?

Removed: "fringing" marsh areas
non-estuarine areas





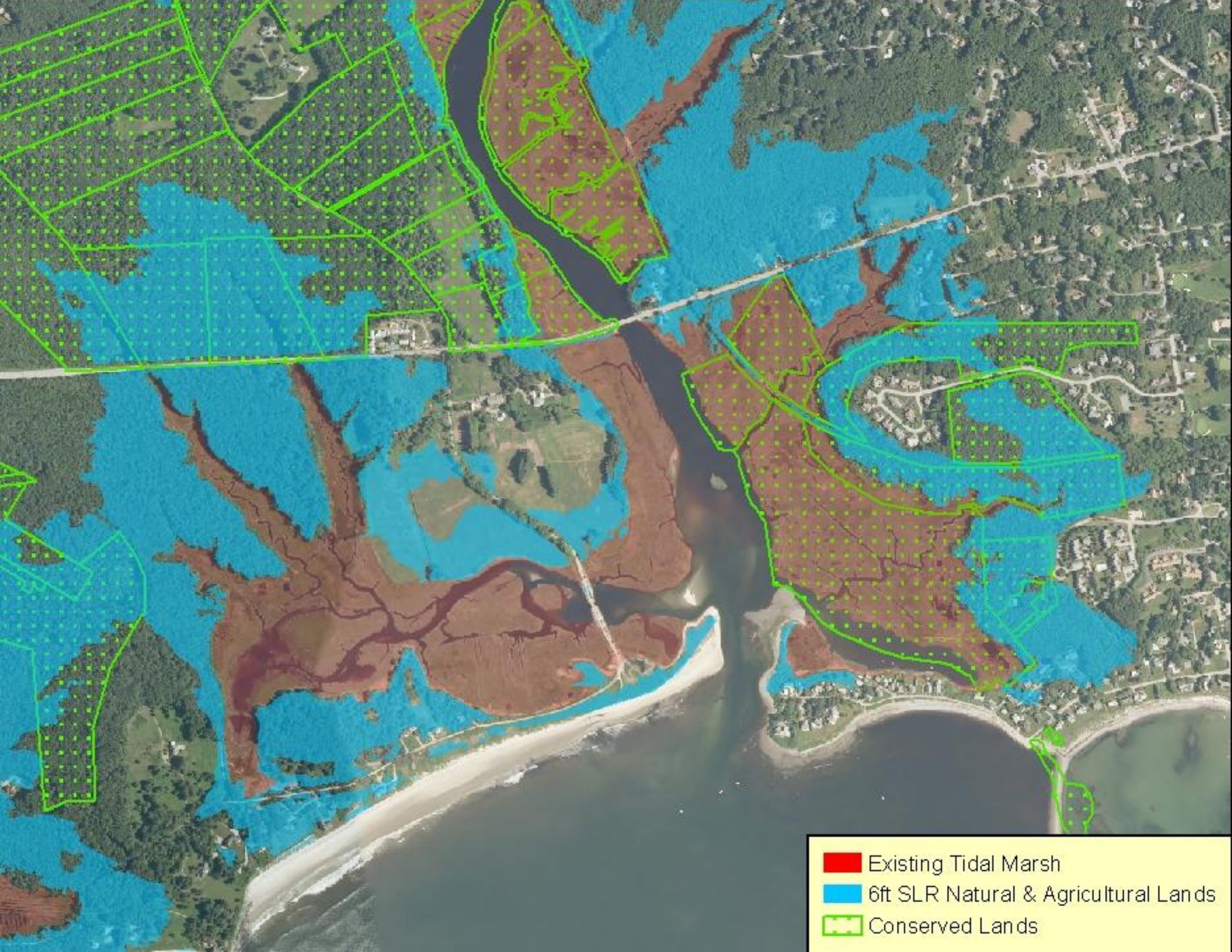
Area of potentially inundated uplands which may become wetlands
Overall, including fringing areas
Excluding fringing areas
25000
20000
15000
10000
5000
0
Acreage
Remember, we have ~22,400 acres of existing wetlands. This analysis does not account for wetland loss.
1 foot
2 feet
3.3 feet
6 feet
Scenario

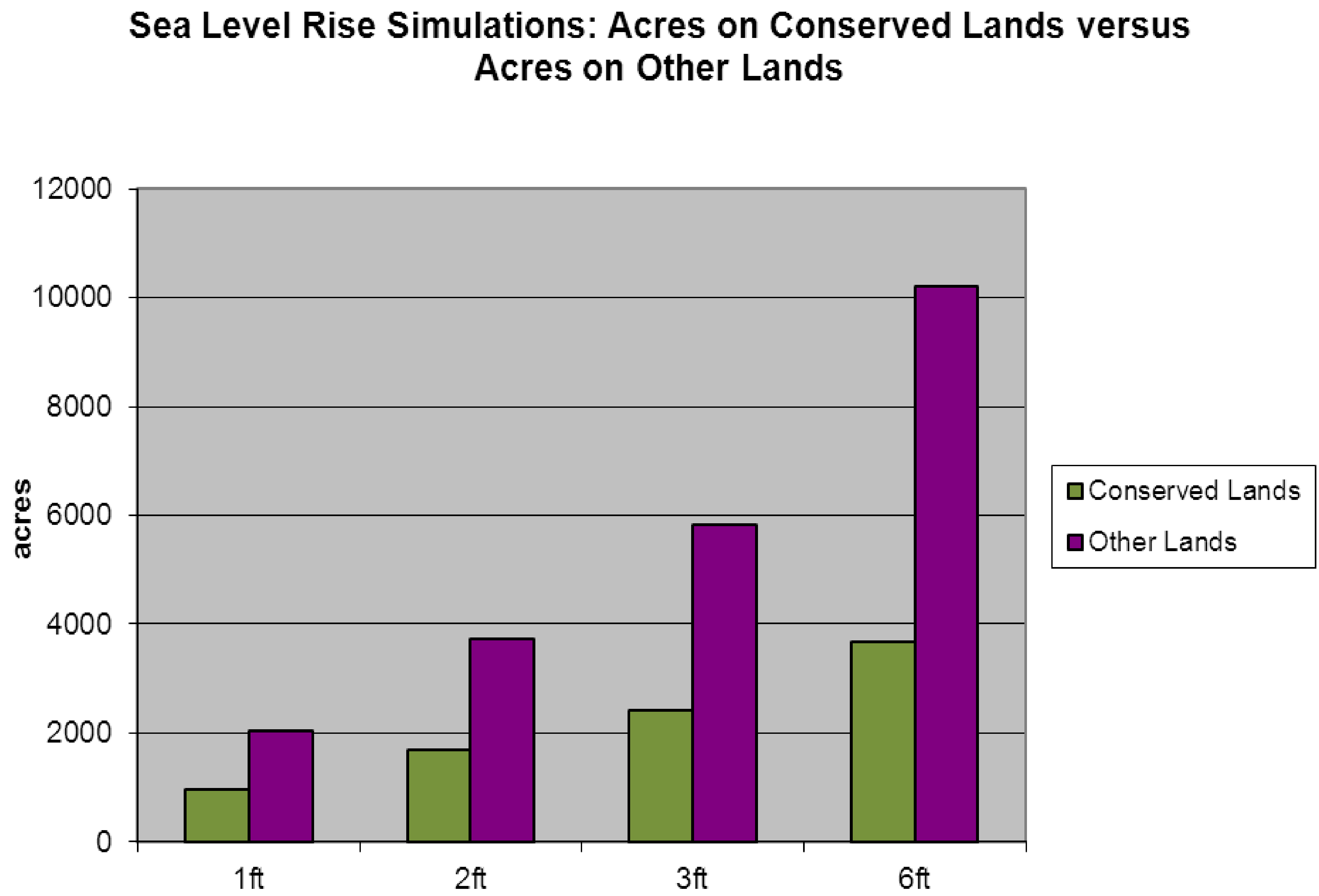
What data is most relevant for planning?

How much is already conservation lands?

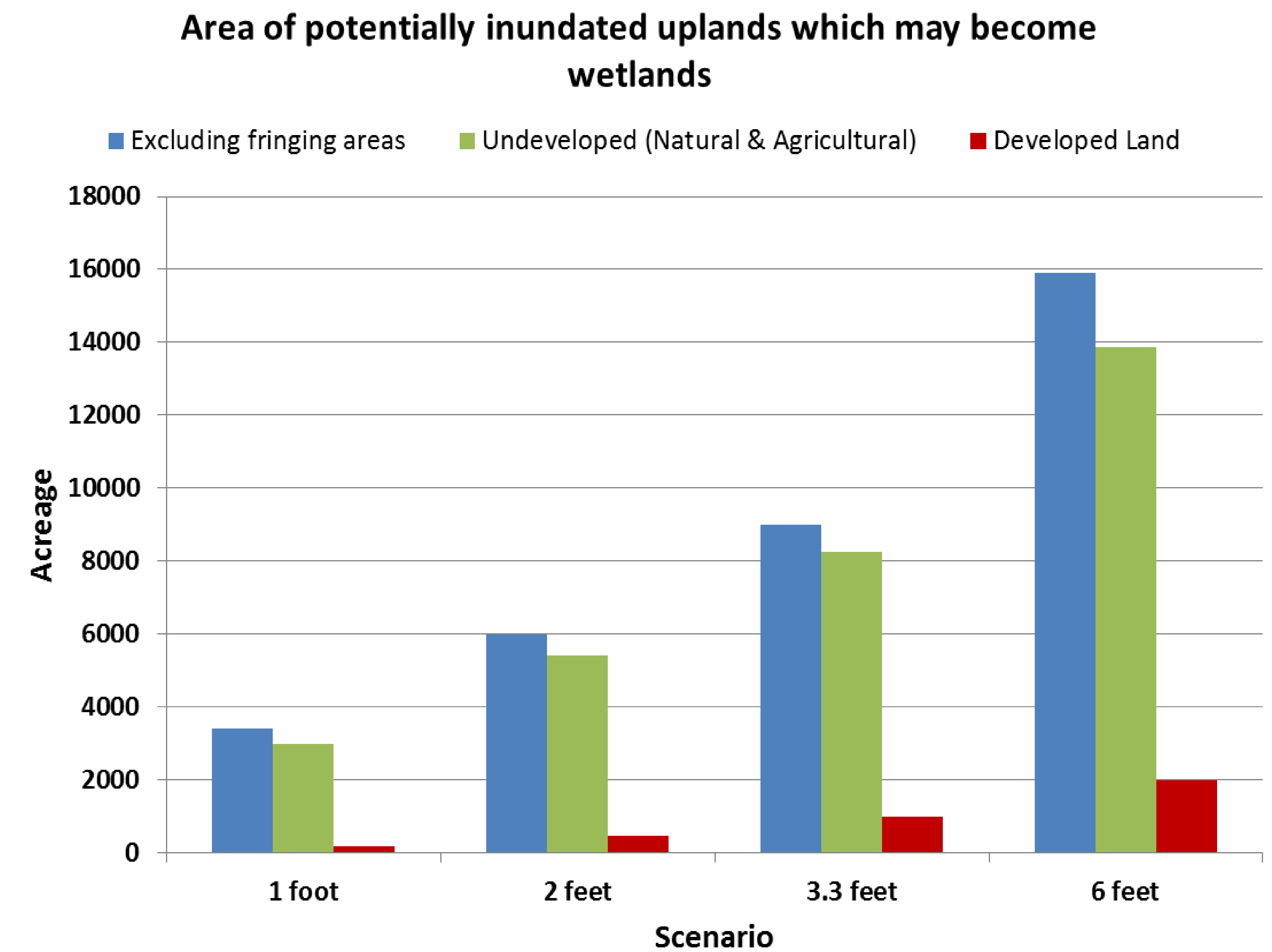
How much is developed vs not developed?

How much is freshwater wetlands?

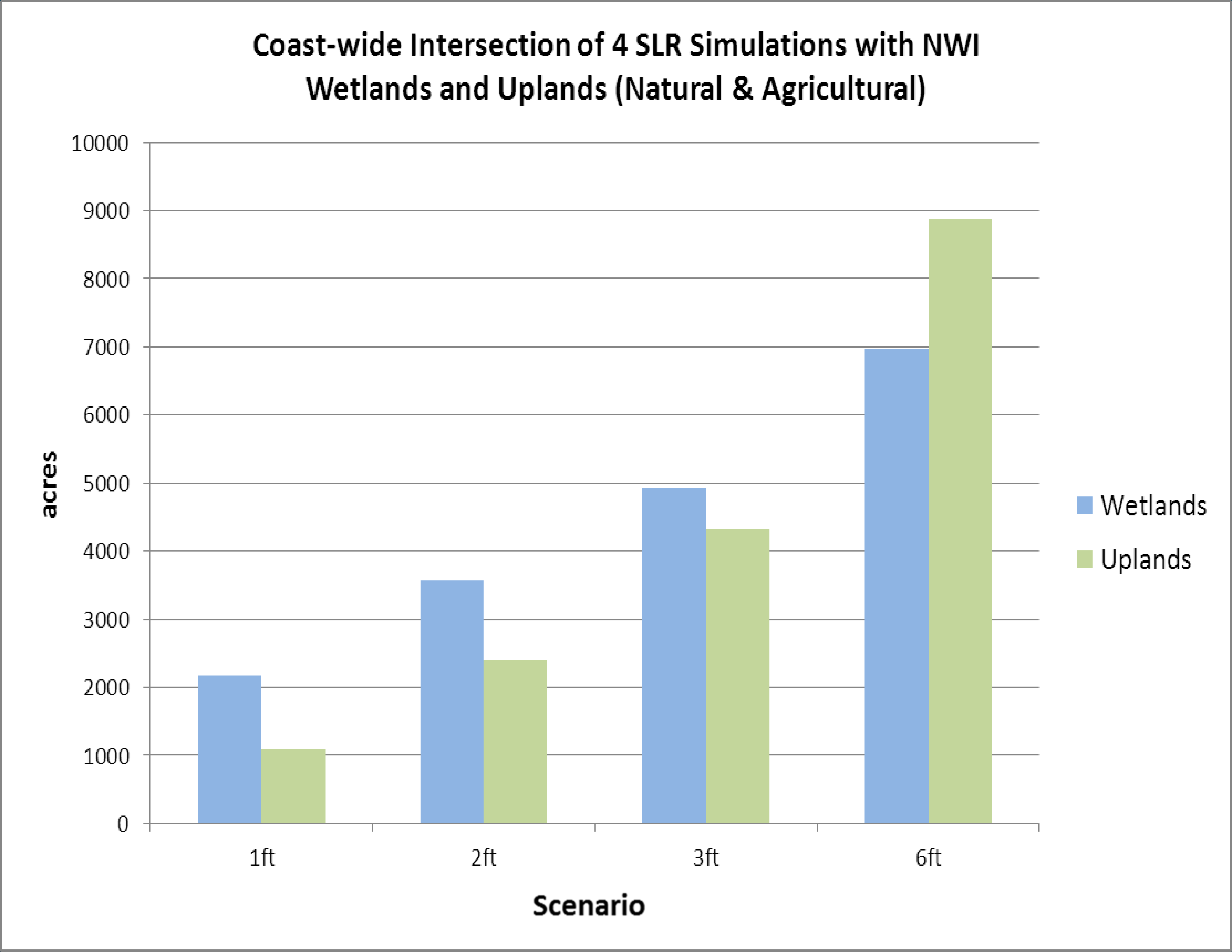

Existing Tidal Marsh
6ft SLR Natural & Agricultural Lands
Conserved Lands



Conserved Lands – Coast wide



With fringing areas and non-estuarine areas removed


Coast-wide Intersection of 4 SLR Simulations with NWI Wetlands and Uplands (Natural & Agricultural)
acres
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1ft
2ft
3ft
6ft
Scenario
Wetlands
Uplands

Summary Findings

- Based on our **state-wide analysis**, there **is some room for wetlands to migrate in response to SLR, though many existing wetlands are "at capacity" and limited by steep sloped uplands or development.**

- For the most part, **coastal wetlands will be migrating either into adjacent freshwater wetlands or currently "undeveloped" uplands (natural or agricultural).** This accounts for about 90% in each scenario. The majority of "developed" land that might be impacted is made up of road networks.

- Results of our analyses are being used by **MEDOT** in a **pilot FHWA project** on infrastructure resiliency, by **IF&W** for updating the **State Wildlife Action Plan**, and by **MCHT for conservation purposes.**

- At the local level, partner POSM communities are using results to develop **local adaptation strategies that work in their communities** (i.e., increasing knowledge, comprehensive plan chapters, economic studies, climate change guidance documents). To do this, data had to be presented in **GoogleEarth format**, which was much easier for communities to work with.

Summary Findings

- Our relatively simple GIS-based “bathtub” highest annual tide/sea level rise mapping is unique in that it supports **regulatory** (Shoreland Zoning) and future **sea level rise planning purposes**. *We are different in using the HAT!*

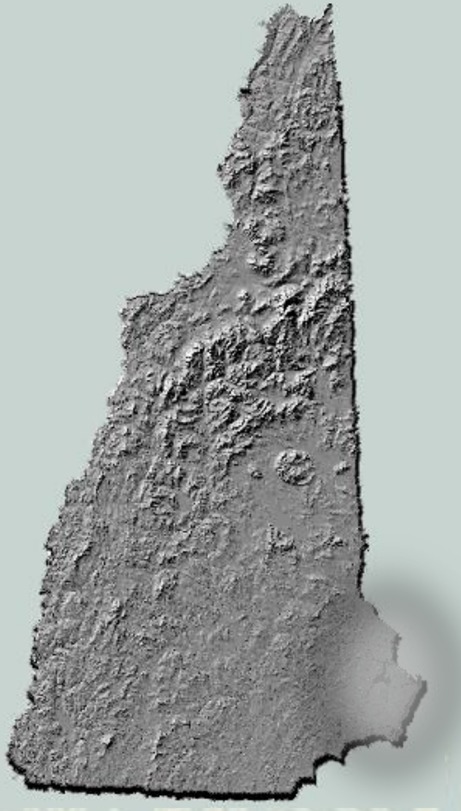
- **Limiting factors in our analysis** included a **lack of accretion rate data**, a **lack of including the influence of freshwater flow on marsh migration**, and **lack of tidally controlled LiDAR data**.

- ***What would we do differently***? **Compare our results with SLAMM** in a pilot study area. Map the lower boundary movement and different marsh types, as possible, on a state-wide scale.

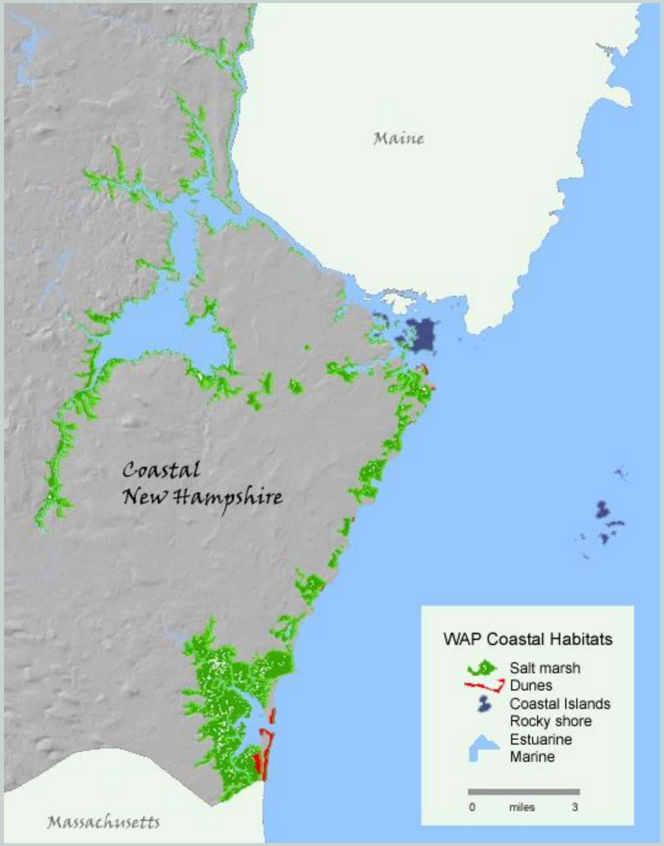
- ***Next steps?*** We will be releasing 2015 HAT mapping data through an online tool, in addition to the different sea level rise/marsh migration scenarios.
    - We anticipate moving forward with a change **in Shoreland Zoning language to use the Highest Astronomical Tide** instead of the Highest Annual Tide.
    - We are currently completing field ground-truthing using RTK-GPS of the tool’s mapping results.

Modeling Marsh Migration in New Hampshire

- **Mechanics**
- Products
- Opportunities
- Action



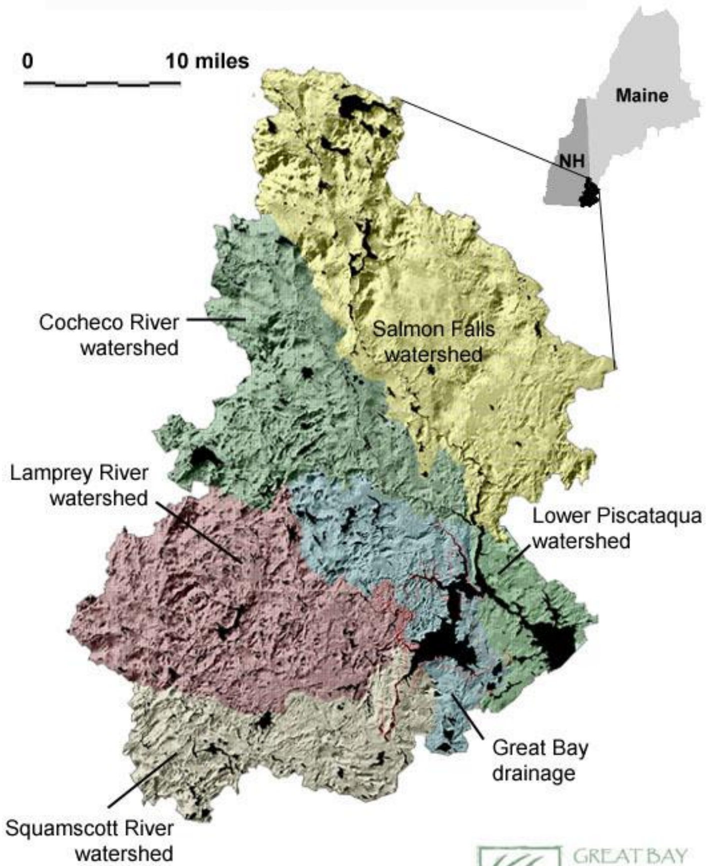
New Hampshire's Wildlife Action Plan



FISH AND GAME

GREAT BAY
NATIONAL
ESTUARINE
RESEARCH
RESERVE

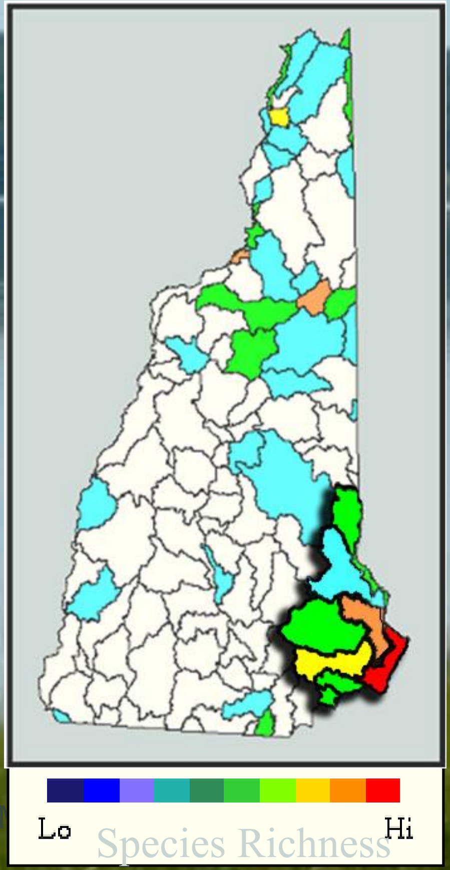
New Hampshire's Wildlife Action Plan



1, 084 square miles

Covers 9% of NH

49 municipalities (39 NH and 10



Coastal Wetland Ecosystem Functions

- Plant growth to support food webs
- Secondary production for wildlife
- Plant structure provides habitat
- Support of biodiversity
- Removal of sediments/nutrients
- Carbon storage
- Protection from flooding
- Protection from coastal erosion
- Aesthetic, Recreational & Educational values
- Self-sustaining ecosystems

NH Planning Scenarios

New Hampshire Coastal Risks & Hazards Commission

Home | About | Meetings | Committees | Working Groups | CRHC Reports | Resources | StormSmart Coasts

Archive | Scientific Advisory Panel

The Scientific Advisory Panel will meet on March 17.

by **Cathy Coletti** on March 13, 2014 in **Meeting Announcements**, **Scientific Advisory Panel**

The Scientific Advisory Panel Meeting of the N.H. Coastal Risks and Hazards Commission will meet on March 17 from 10:30am-12:00pm at 320 Gregg Hall at the University of New Hampshire in Durham, N.H. View the agenda.

Continue Reading 0

Sign up for updates!

Your email:

Enter email address...

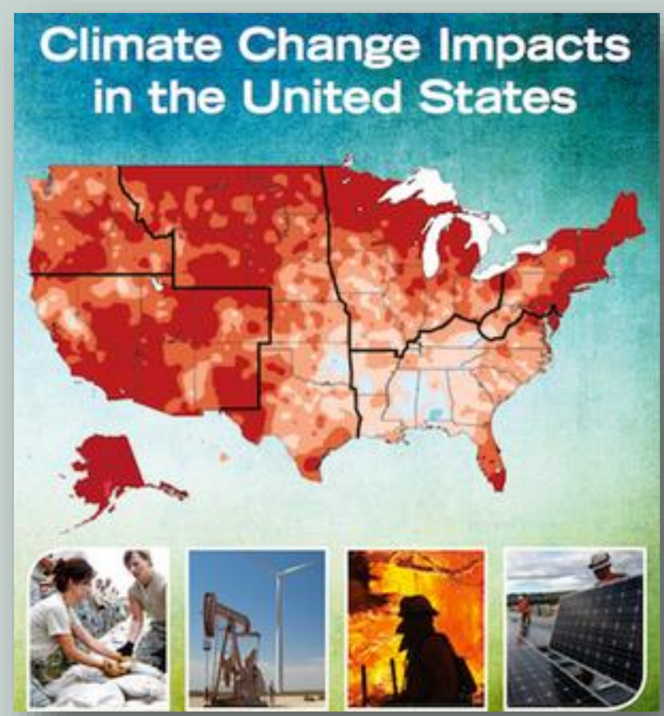
Subscribe

Topics

- Grant Proposal
- Meeting Announcements
- Scientific Advisory Panel
- Steering Committee
- Uncategorized
- Working Groups

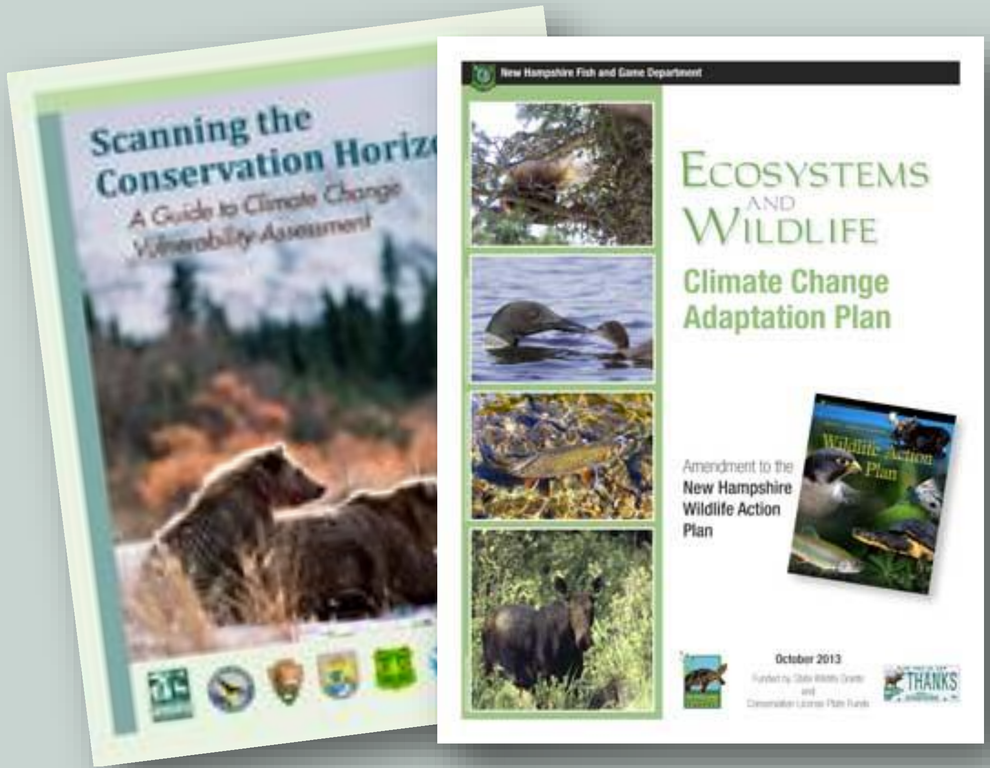
NH Planning Scenarios

SLR at 2100



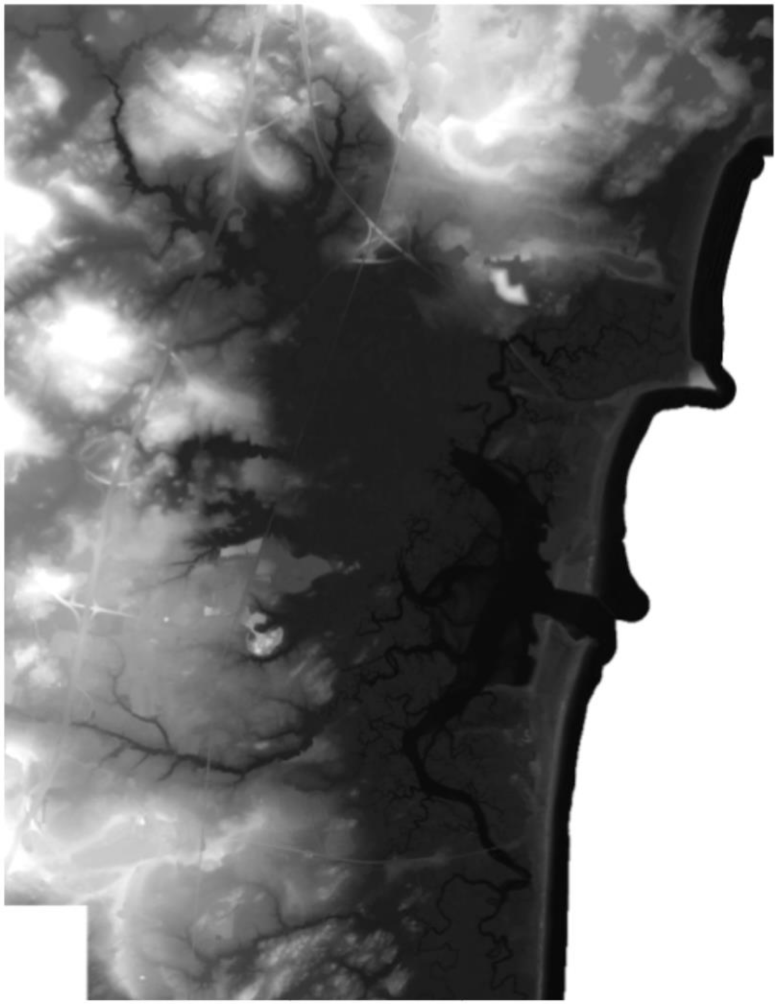
0.5m (1.6ft), 1.2m (3.9ft), 2m (6.6ft)

Temporal Scale



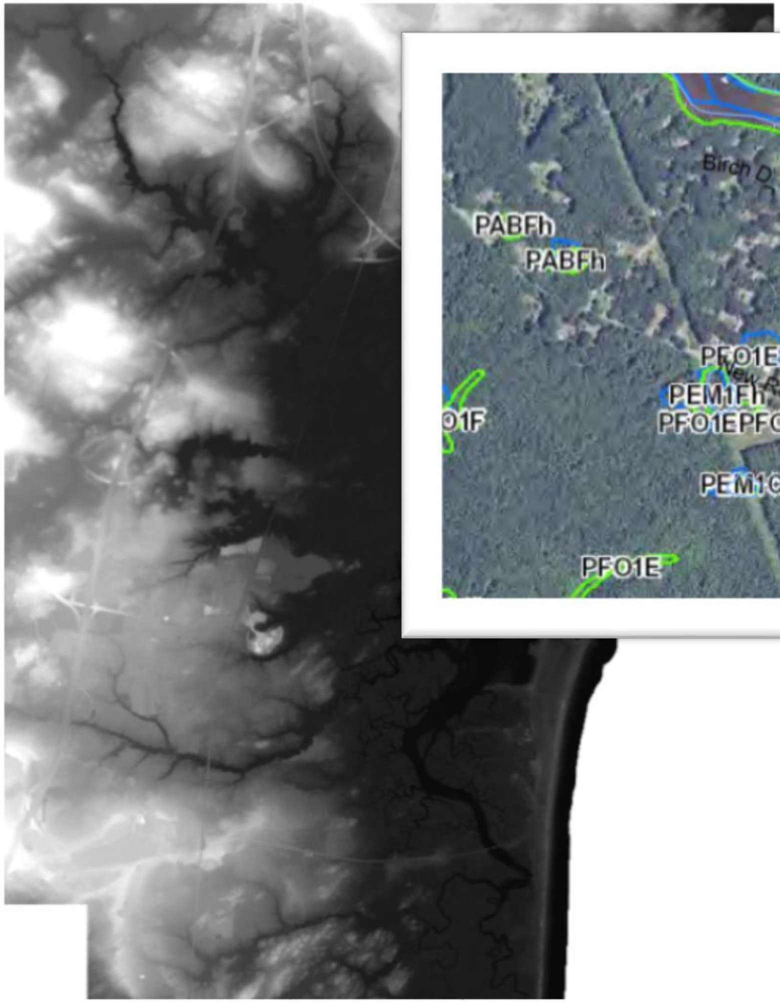
2025, 2050, 2075, 2100

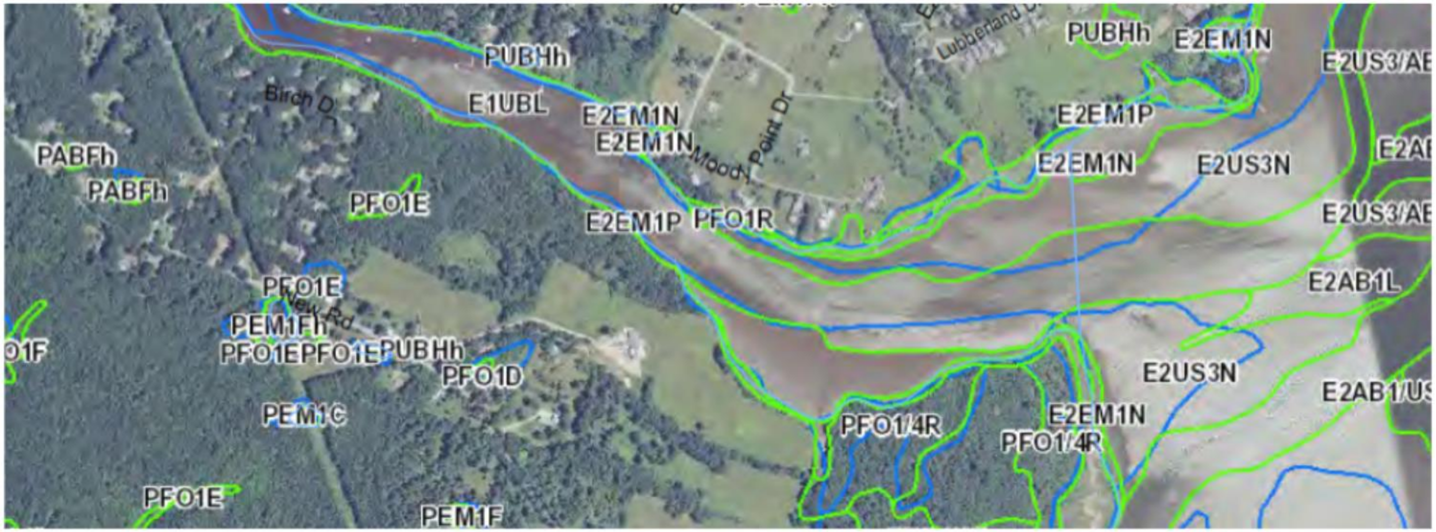
NH’s Approach to SLAMM: Statewide data inputs



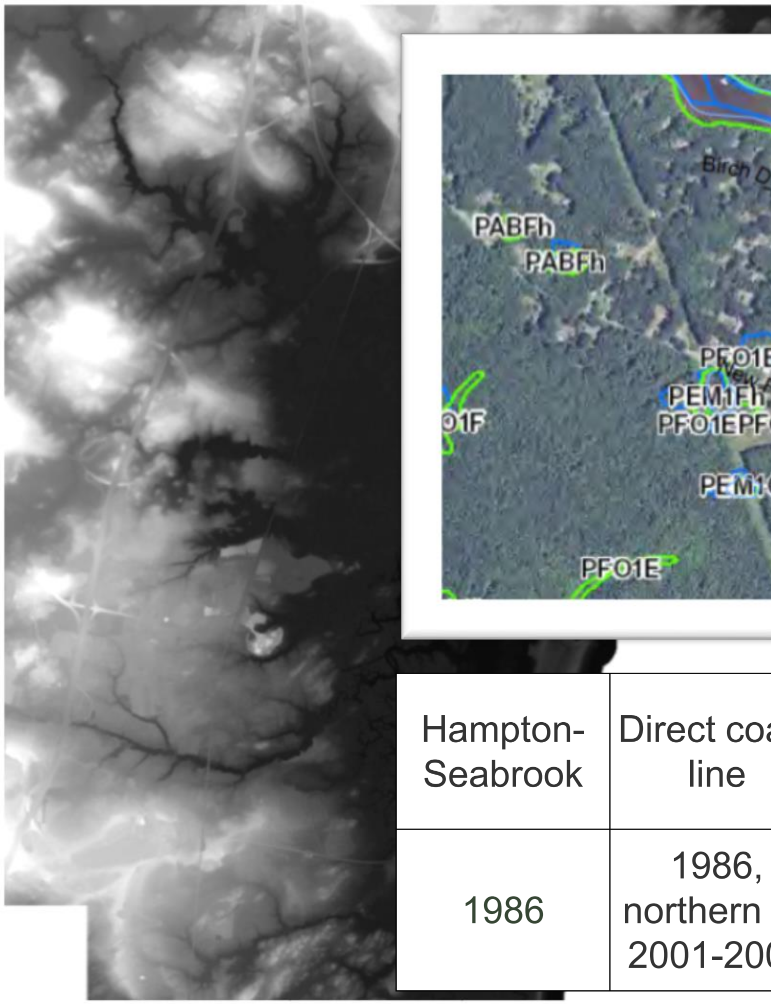
LiDAR based on 2011 data collection

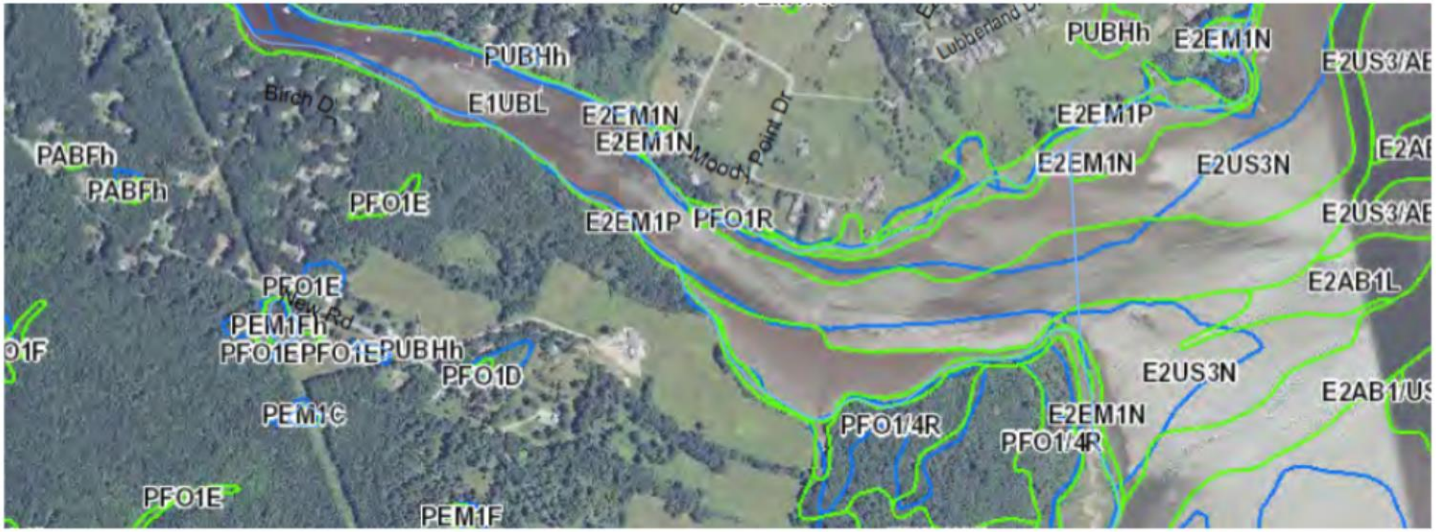
NH's Approach to SLAMM: Statewide data inputs



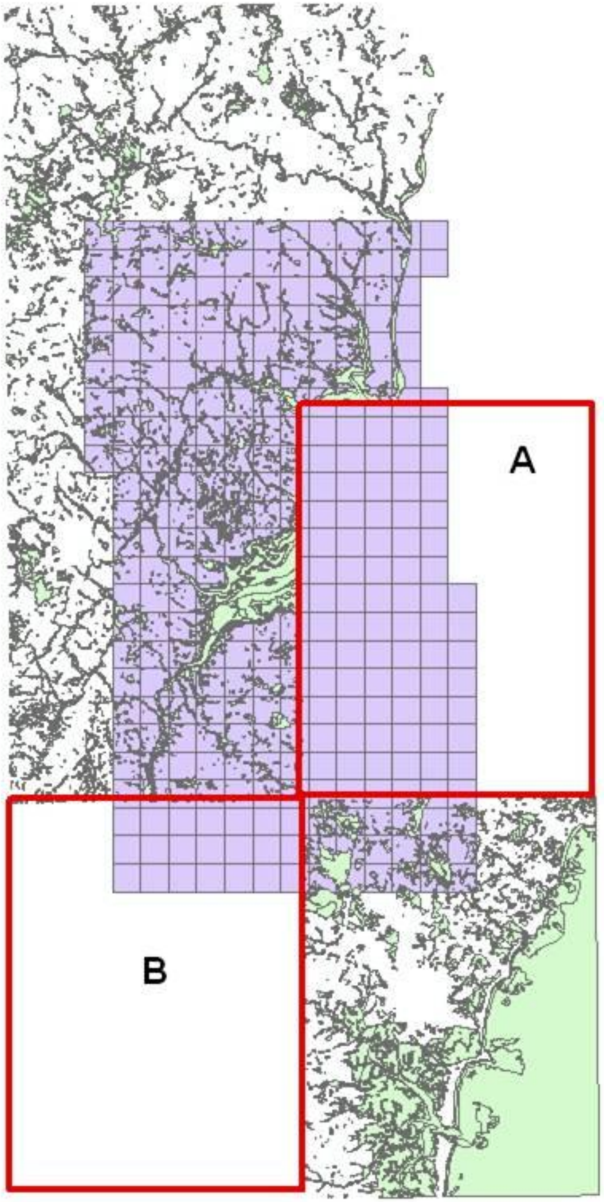


NH's Approach to SLAMM: Statewide data inputs

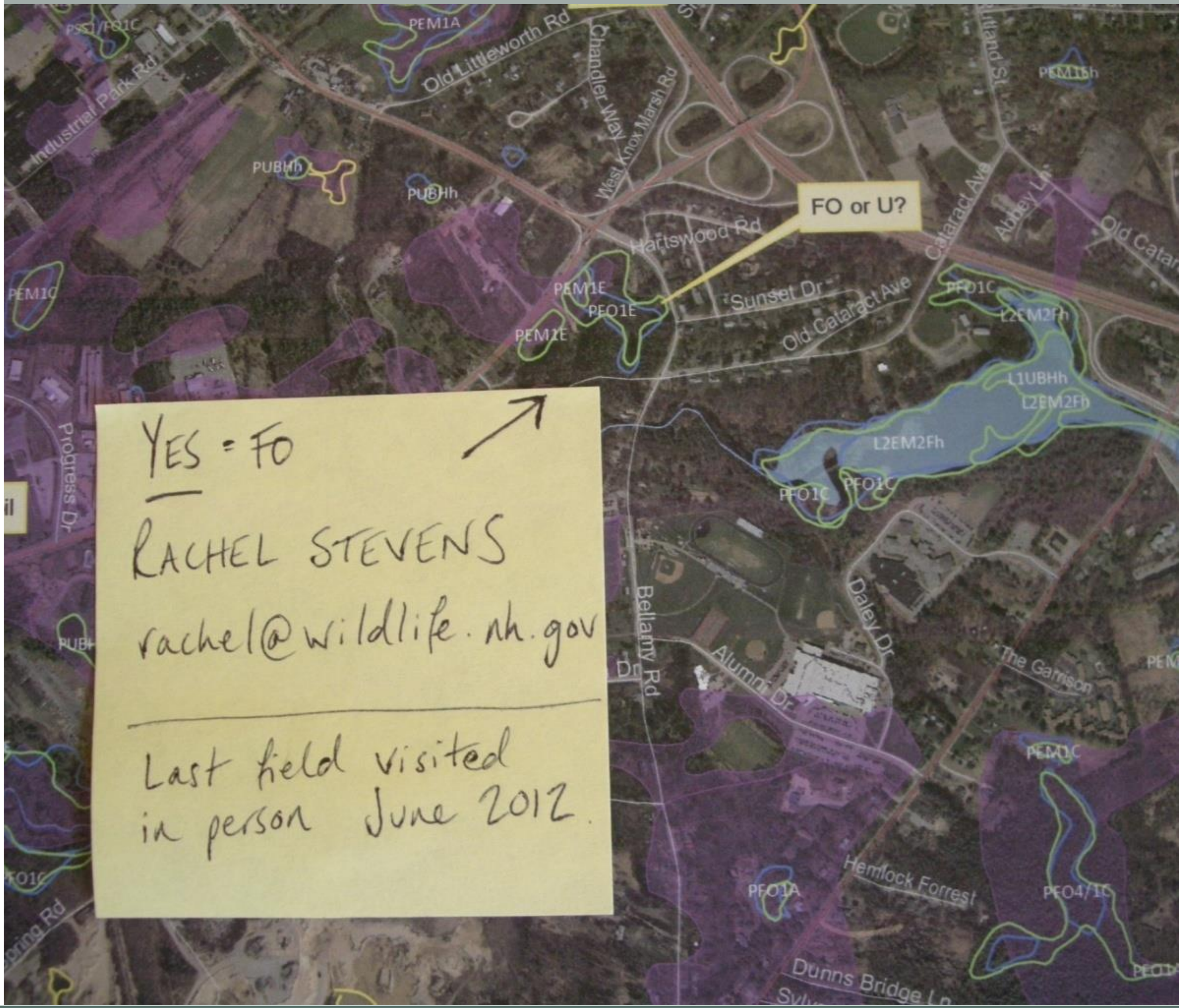




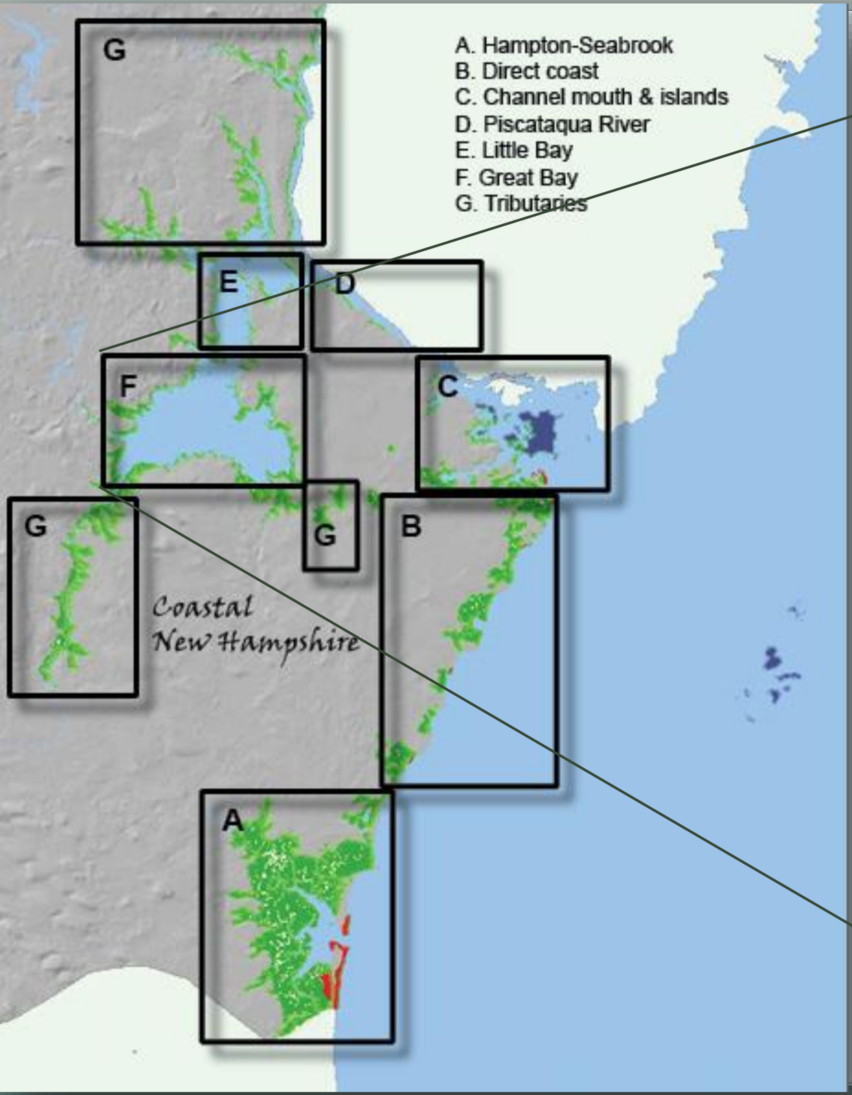
Hampton-Seabrook	Direct coast line	Harbor entrance	Piscataqua River	Little Bay	Great Bay	Tributaries
1986	1986, northern tip 2001-2004	2001-2004	2001-2004	2001-2004	Half 2001-2004, half 1986	Both 1986 and 2001-2004



Please help us with *your* field knowledge



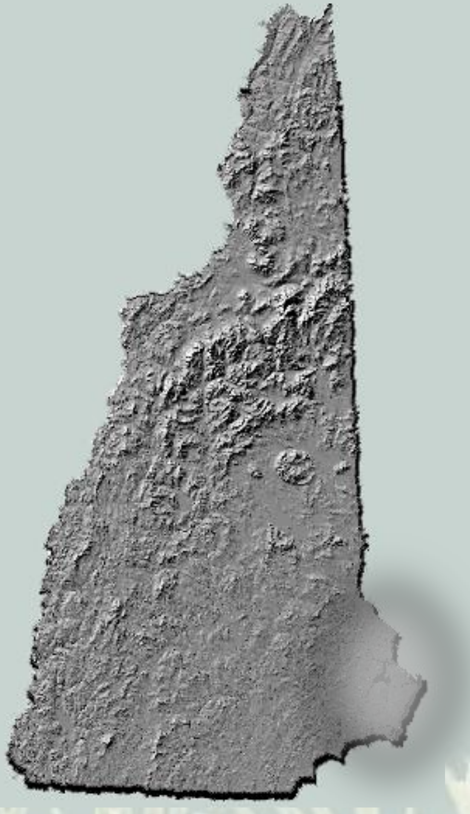
NH's Approach to SLAMM: Locally relevant input parameters



Parameter	Global
Description	GreatBay
NWI Photo Date (YYYY)	2001
DEM Date (YYYY)	2011
Direction Offshore [n,s,e,w]	East
Historic Trend (mm/yr)	1.76
MTL-NAVD88 (m)	0.067
GT Great Diurnal Tide Range (m)	2.3
Salt Elev. (m above MTL)	1.61
Marsh Erosion (horz. m /yr)	1.8
Swamp Erosion (horz. m /yr)	1
T.Flat Erosion (horz. m /yr)	0.5
Reg.-Flood Marsh Accr (mm/yr)	4.3
Irreg.-Flood Marsh Accr (mm/yr)	4.3
Tidal-Fresh Marsh Accr (mm/yr)	5.38
Inland-Fresh Marsh Accr (mm/yr)	0
Mangrove Accr (mm/yr)	7
Tidal Swamp Accr (mm/yr)	1.1
Swamp Accretion (mm/yr)	0.3
Beach Sed. Rate (mm/yr)	0.5
Freq. Overwash (years)	50
Use Elev Pre-processor [True,False]	FALSE

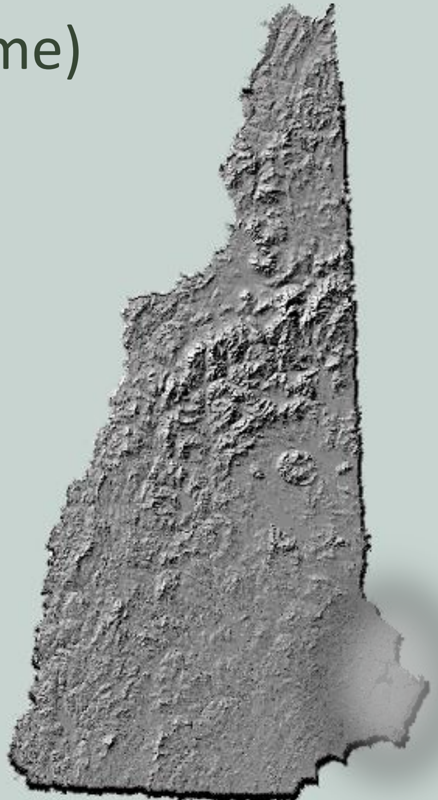
Modeling Marsh Migration in New Hampshire

- Mechanics
- **Products**
- Opportunities
- Action

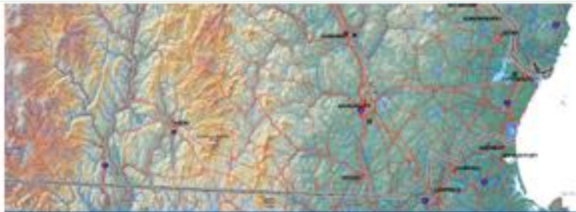


Modeling Marsh Migration in New Hampshire

- Mapping products (quantitative to come)
  - Uncertainty Analysis



Mapping Products



NH GRANIT

NEW HAMPSHIRE'S STATEWIDE GIS CLEARINGHOUSE

Home | About Us | News | Projects | Resource Library

DATA | Data 101 | Download Free Data | Order Data | Online Maps & Services | Map Library

Search GRANIT

QUICK LINKS

Search Database using Data Discovery Tool

Layer List: Alphabetical Order

Layer List: Data Category

Tax Parcel Information

GRANIT Data Questions?

Login

Contact Us

GIS Event Calendar

December

GRANIT Data Discovery Tool

You may search the GRANIT database by theme keyword and/or geography using the form below. Click "Advanced Search" for more options.

Note: Some GRANIT data layers are not available to download using the Data Discovery Tool. For a listing of/access to all GRANIT data layers, use the Layer List Quick Links on the left.

Search by theme keyword: Advanced Search

AND/OR

Search by geography:
Clear selected geography

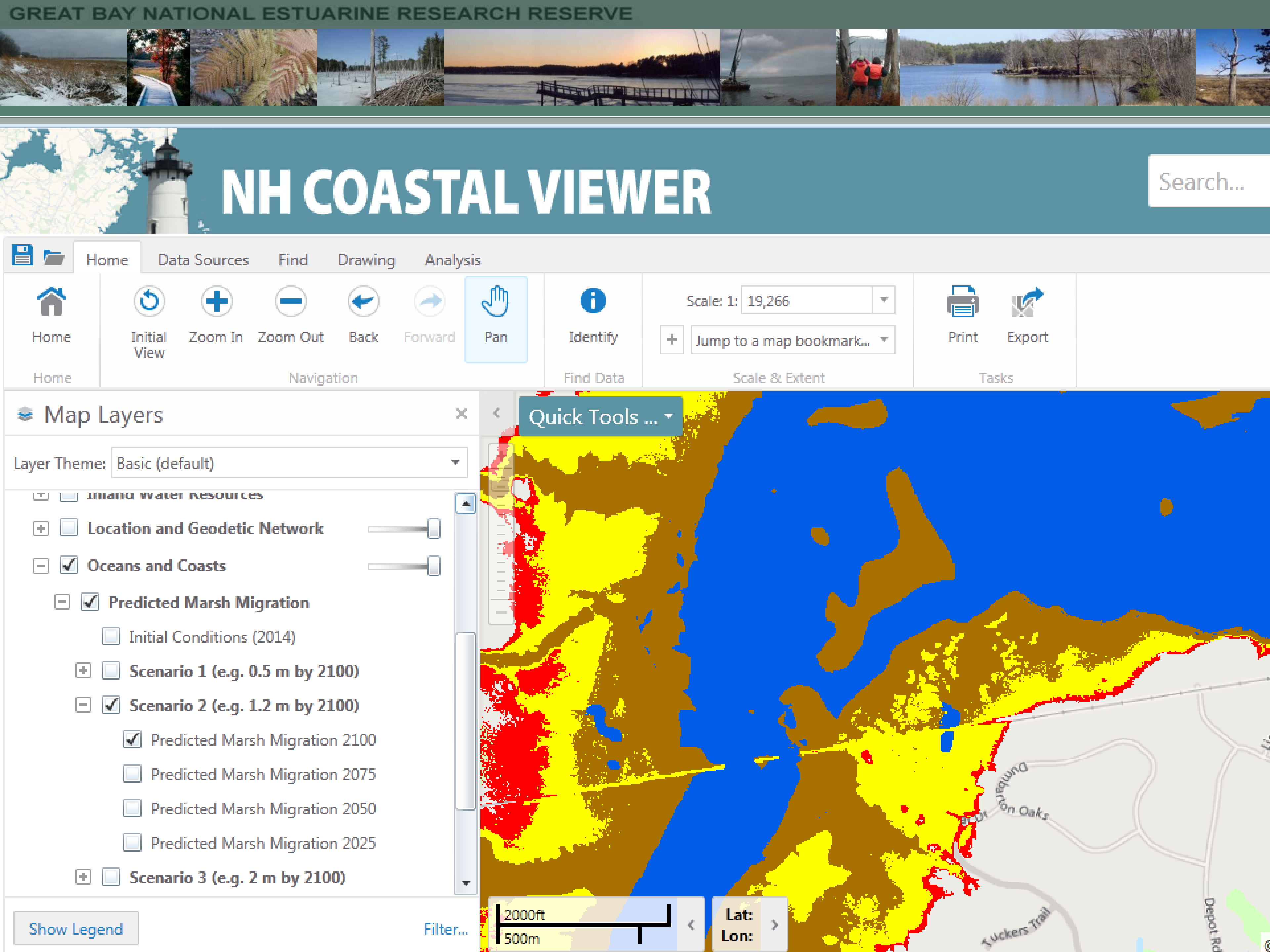
- Town
- County
- Watershed
- 7.5 Minute Quad

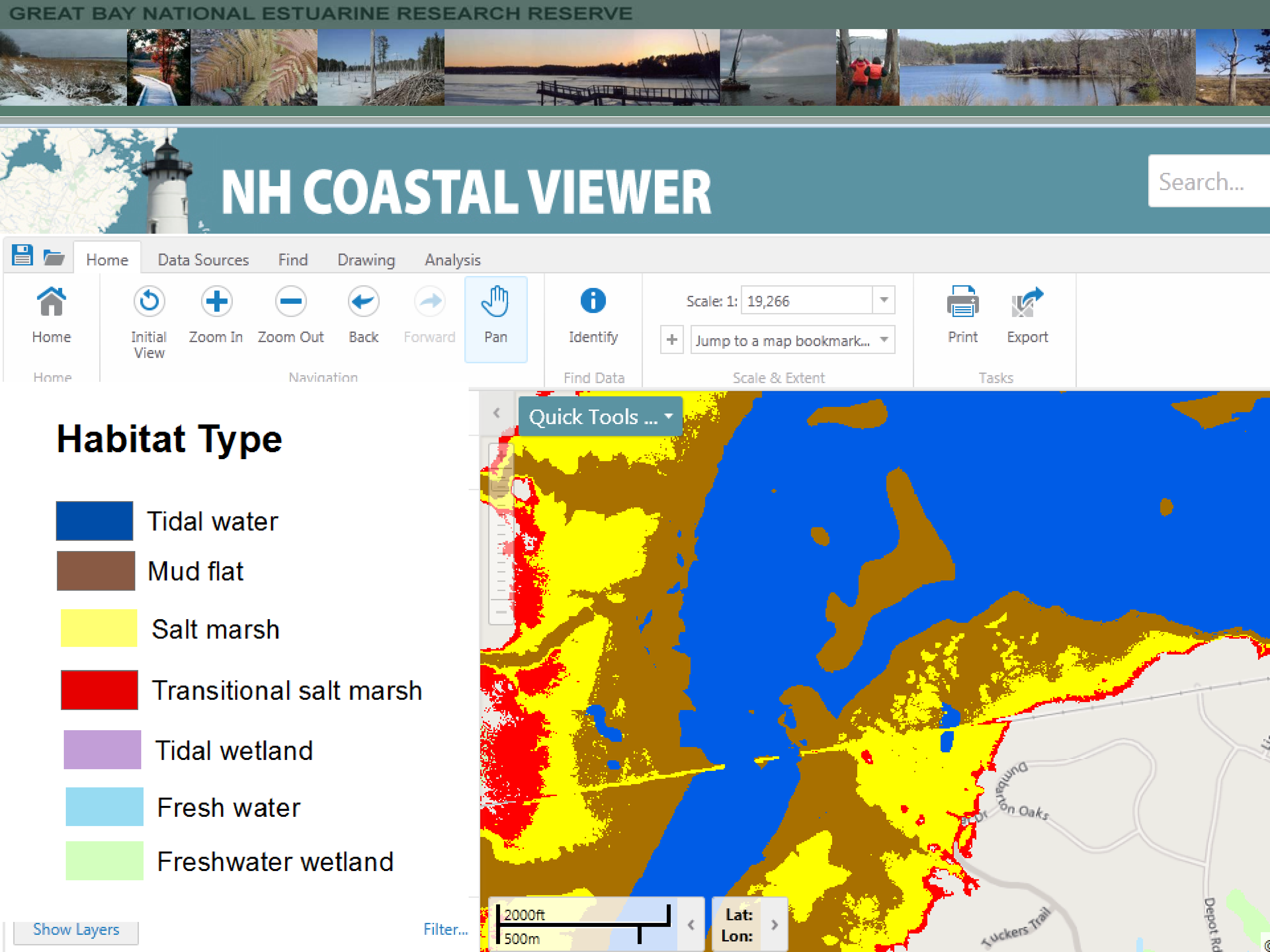
Coastal Drainage

Search

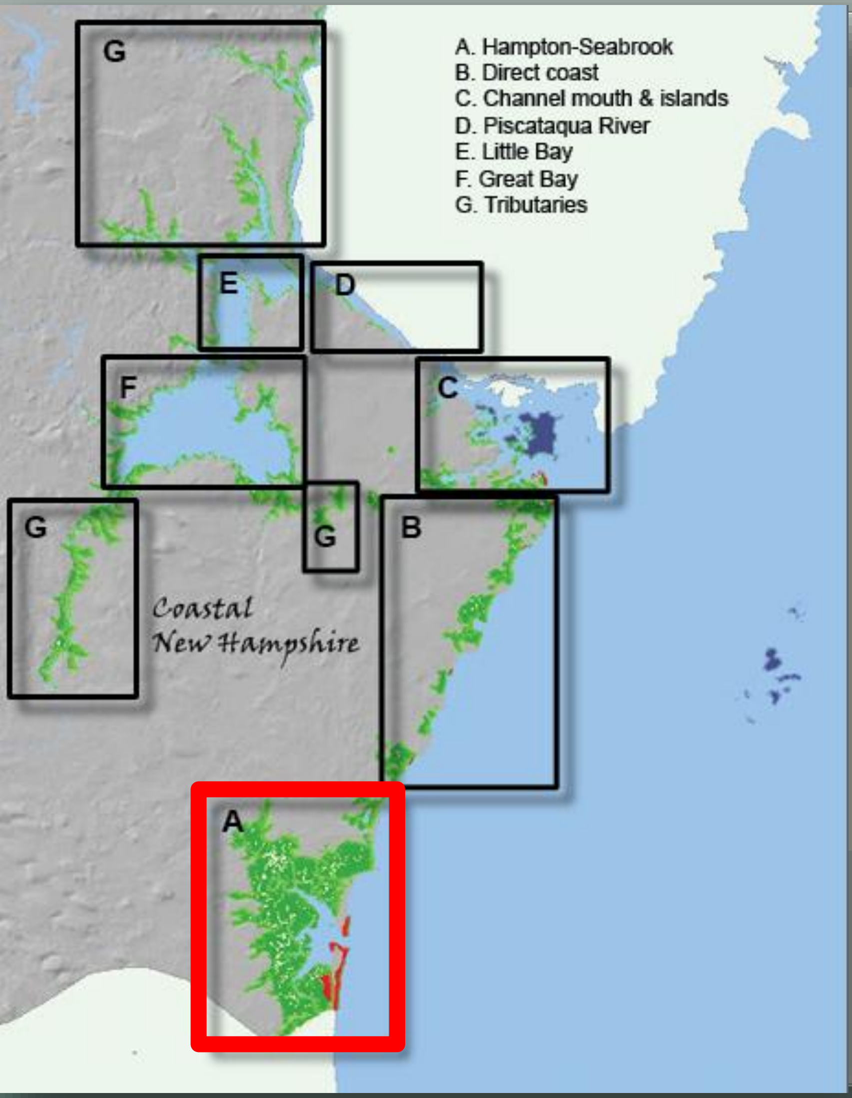
Mapping Products

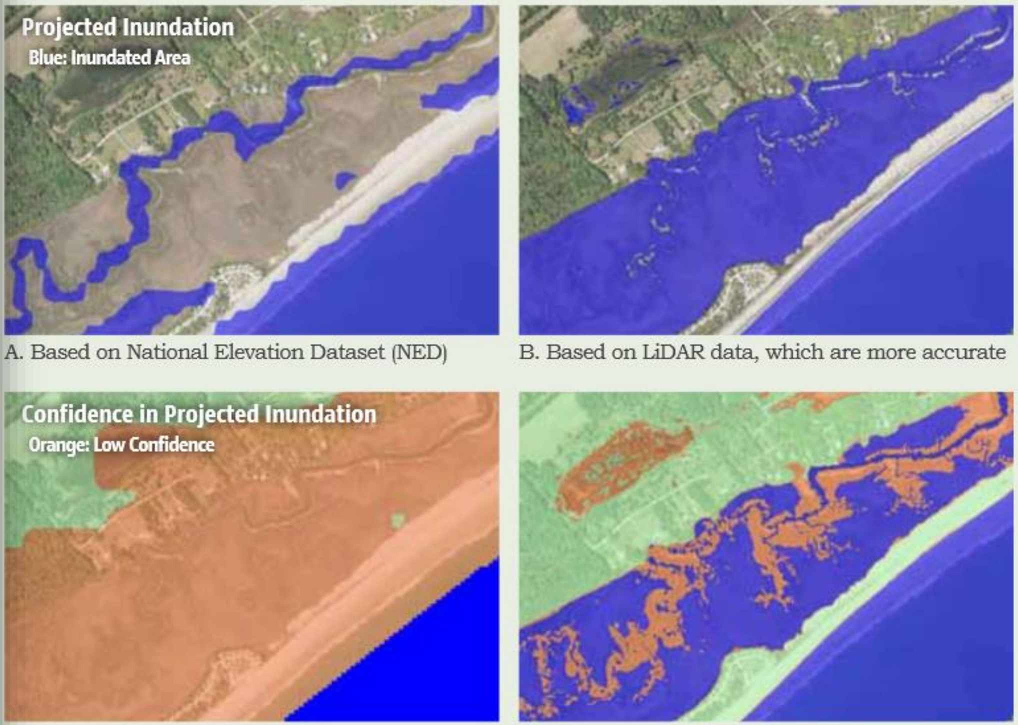
- 3 Swamp
- 5 Inland fresh marsh
- 6 Tidal fresh marsh
- 7 Scrub shrub
- 8 Reg flood marsh
- 10 Estuarine beach
- 11 Tidal flat
- 12 Ocean beach
- 15 Inland open water
- 17 Estuarine water
- 19 Open ocean
- 20 Irreg flood marsh
- 23 Tidal swamp


GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE
NH COASTAL VIEWER
Search...
Home
Data Sources
Find
Drawing
Analysis
Home
Initial View
Zoom In
Zoom Out
Back
Forward
Pan
Identify
Scale: 1: 19,266
Jump to a map bookmark...
Print
Export
Home
Navigation
Find Data
Scale & Extent
Tasks
Map Layers
Layer Theme: Basic (default)
Inland Water Resources
Location and Geodetic Network
Oceans and Coasts
Predicted Marsh Migration
Initial Conditions (2014)
Scenario 1 (e.g. 0.5 m by 2100)
Scenario 2 (e.g. 1.2 m by 2100)
Predicted Marsh Migration 2100
Predicted Marsh Migration 2075
Predicted Marsh Migration 2050
Predicted Marsh Migration 2025
Scenario 3 (e.g. 2 m by 2100)
Show Legend
Filter...
Quick Tools ...
Dumbarton Oaks
Tuckers Trail
Depot Rd
2000ft
500m
Lat:
Lon:


GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE
NH COASTAL VIEWER
Search...
Home
Data Sources
Find
Drawing
Analysis
Home
Initial View
Zoom In
Zoom Out
Back
Forward
Pan
Identify
Scale: 1: 19,266
Jump to a map bookmark...
Print
Export
Home
Navigation
Find Data
Scale & Extent
Tasks
Habitat Type
Tidal water
Mud flat
Salt marsh
Transitional salt marsh
Tidal wetland
Fresh water
Freshwater wetland
Show Layers
Filter...
Quick Tools ...
Dumbarton Oaks Dr
Tuckers Trail
Depot Rd
2000ft
500m
Lat:
Lon:

Confidence Analysis





A. Based on National Elevation Dataset (NED)

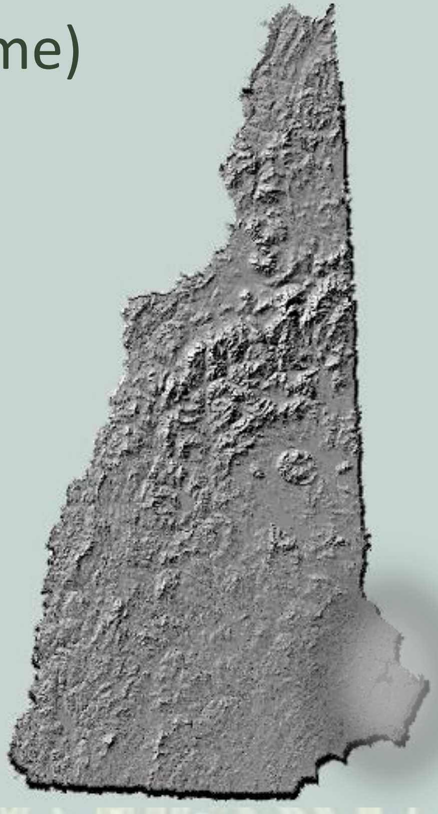
B. Based on LiDAR data, which are more accurate

C. Large area of low confidence using NED

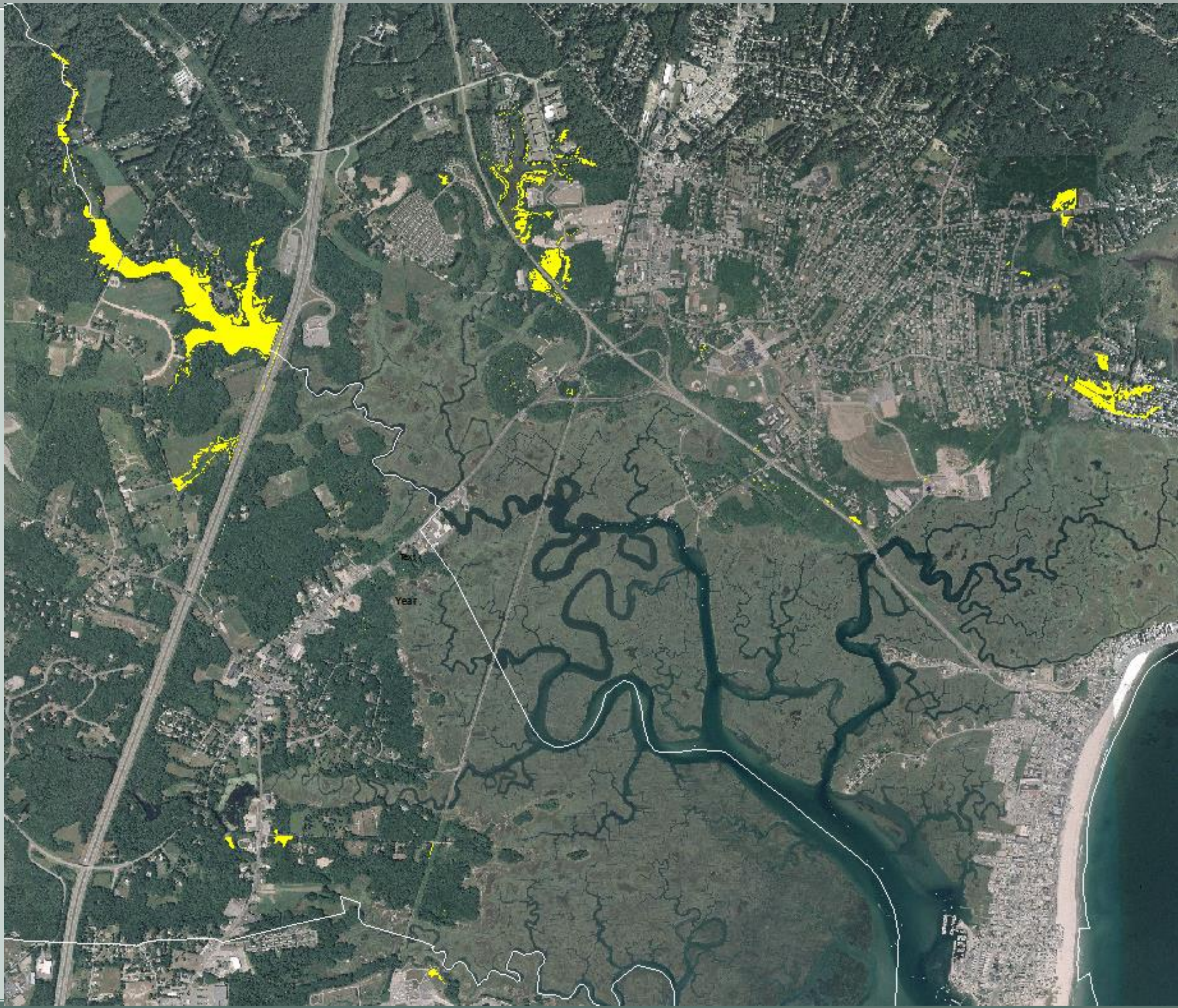
D. Smaller area of low confidence using LiDAR

Modeling Marsh Migration in New Hampshire

- Mapping products (quantitative to come)
    - Uncertainty Analysis
- Restoration opportunities



Restoration Opportunities



(SLR 2m / 7ft)

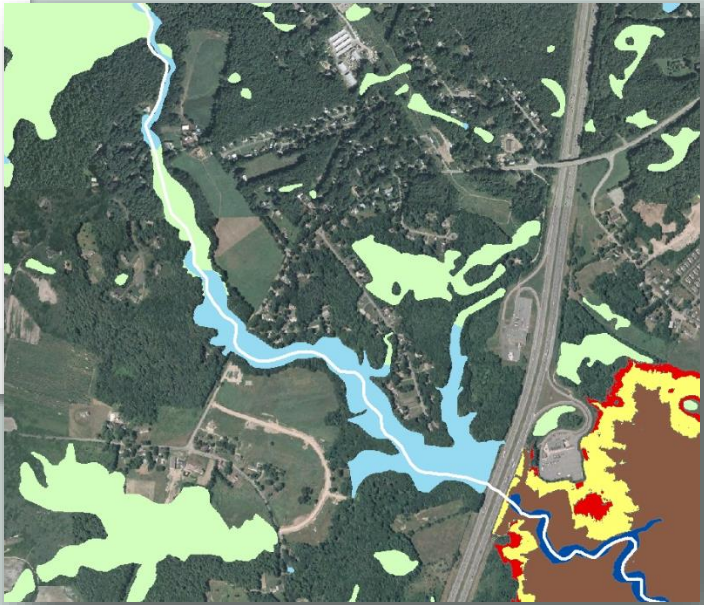
2100

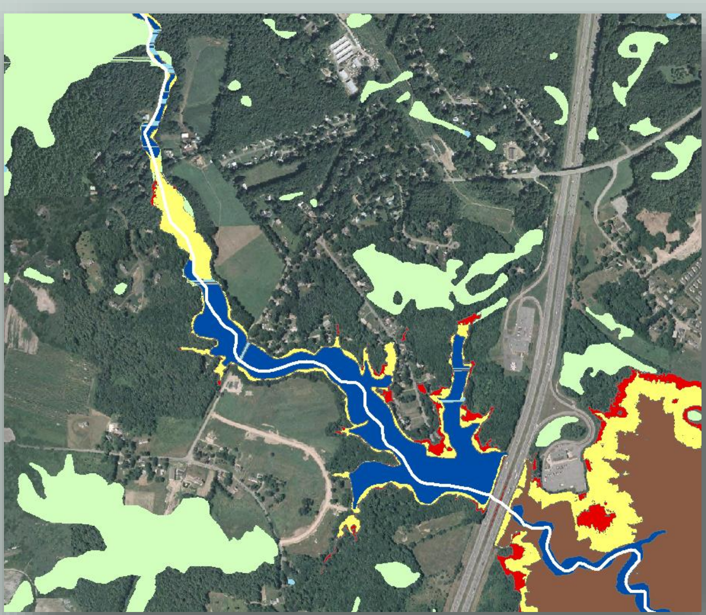
Restoration – Taylor River

Habitat Type

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

SLR 2m / 7ft



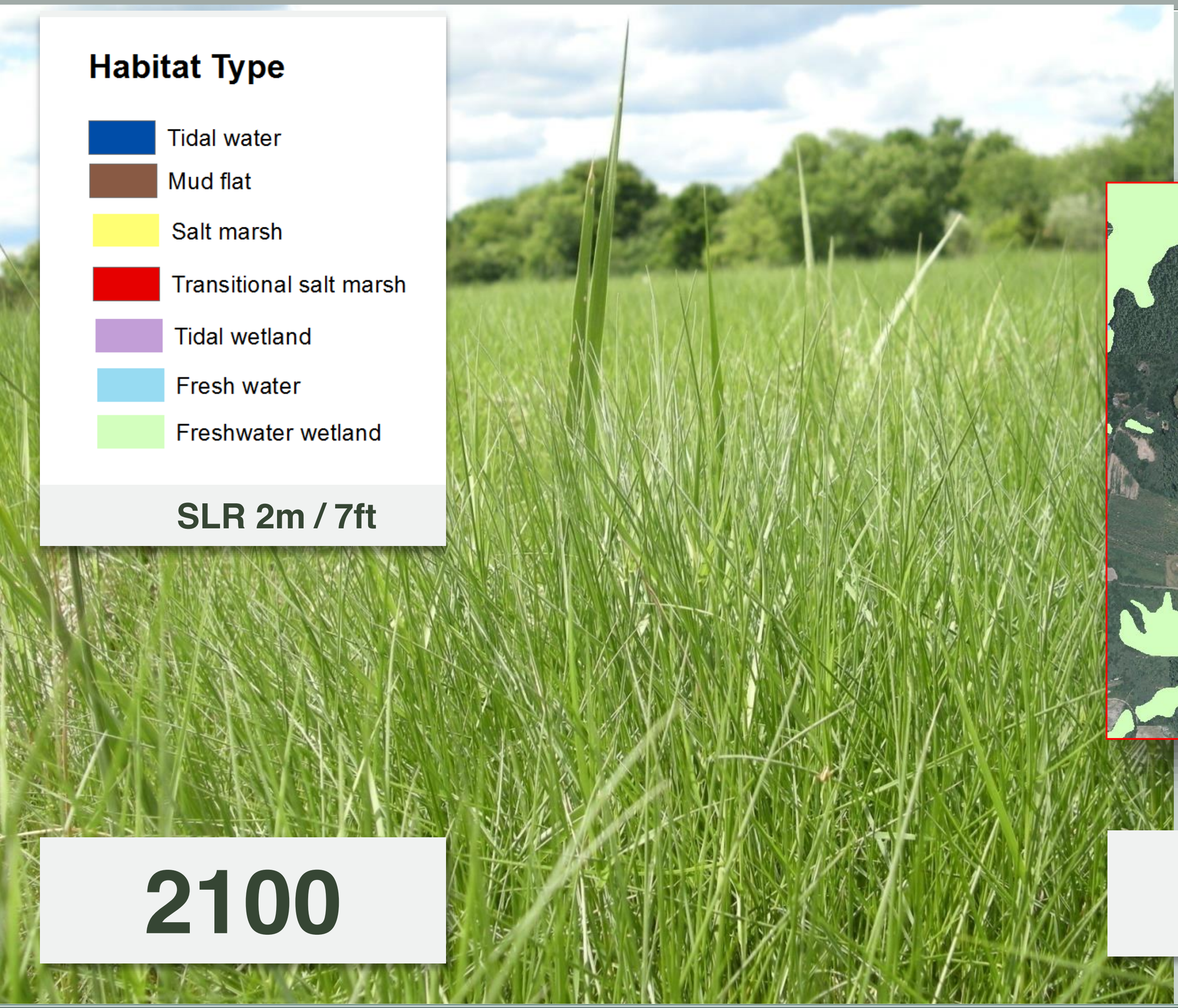


2100

Tidal restriction in place

Tidal restriction removed

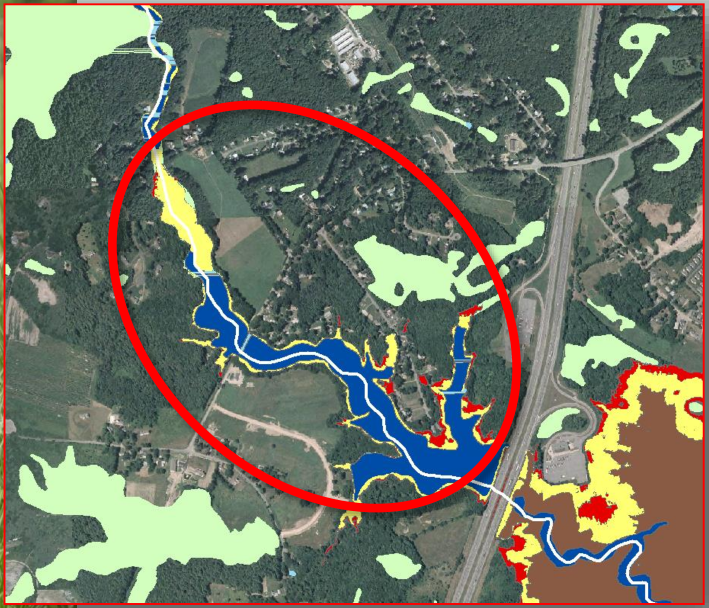
Restoration – Taylor River



Habitat Type

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

SLR 2m / 7ft

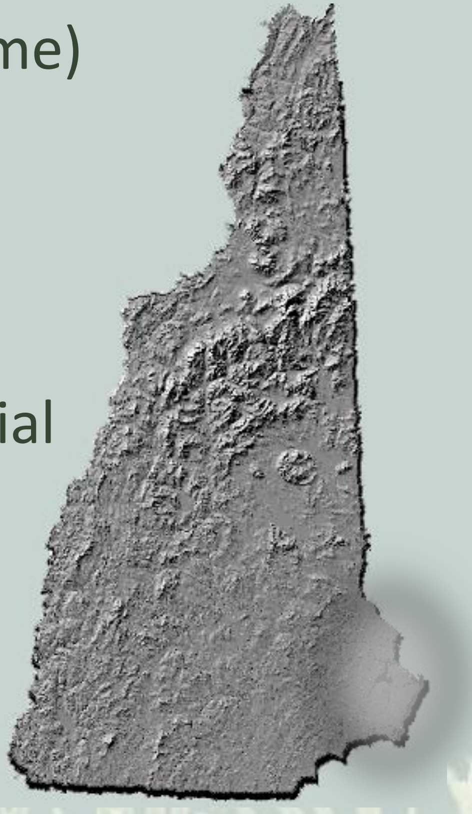


2100

Approximately 12 acres of salt marsh

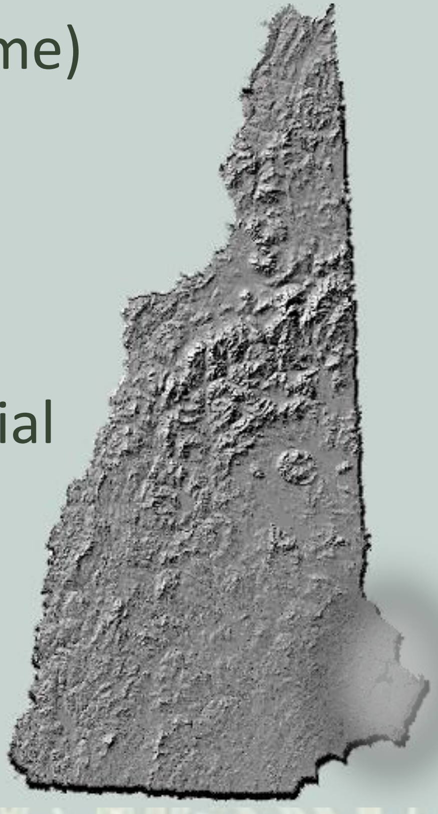
Modeling Marsh Migration in New Hampshire

- Mapping products (quantitative to come)
    - Uncertainty Analysis
- Restoration opportunities
- Habitat quality and adaptation potential

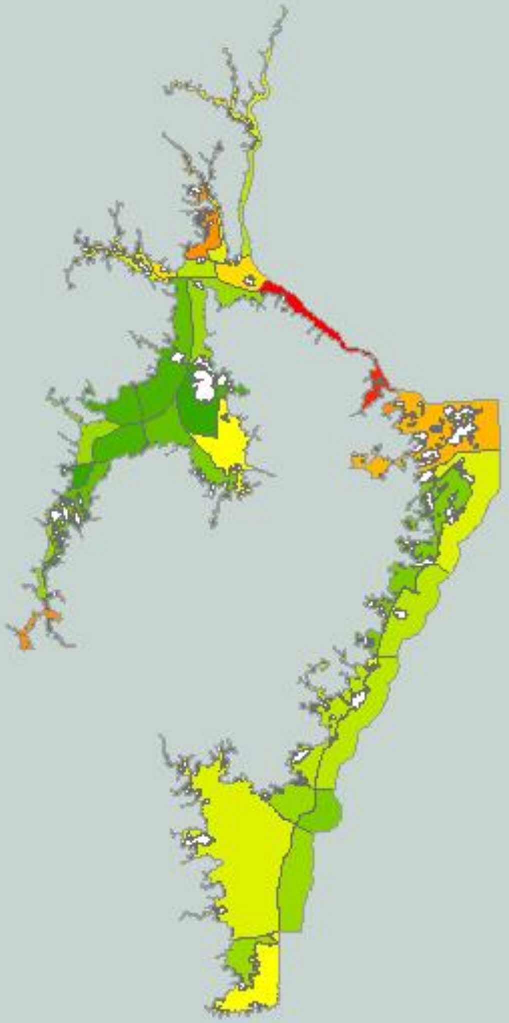


Modeling Marsh Migration in New Hampshire

- Mapping products (quantitative to come)
    - Uncertainty Analysis
- Restoration opportunities
- Habitat quality and adaptation potential
- Priority lands for conservation

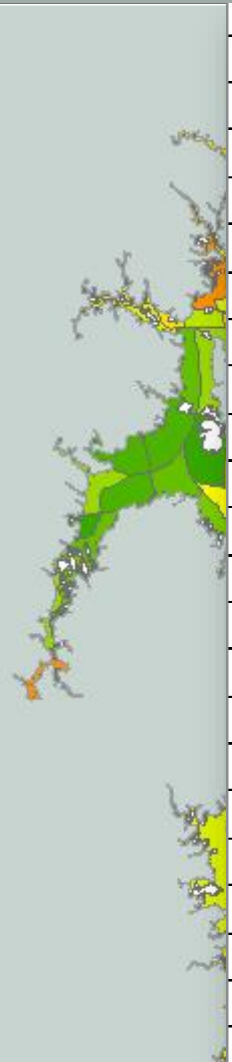


Habitat Conditions and Adaptation Potential



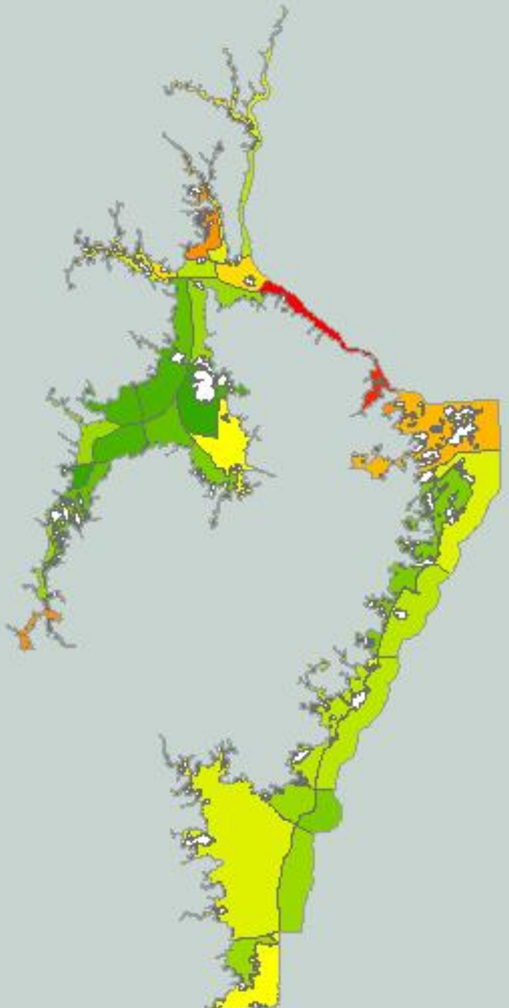
- Landscape scale components of SMI
- Natural Heritage data & bird species richness
- Potential to migrate inland (proximity to low lying undeveloped land)

Habitat Conditions and Adaptation Potential



ACRES	Marsh Study Unit total area (acres)
HECTARES	Marsh Study Unit total area (hectares)
WATER_HA	Hectares of open water within the MSU (NHD derived)
AQ_EDGE_M	Meters of aquatic edge
POSITION	Landscape position: marine, middle-estuary, upper-estuary
MORPHOLOGY	Marsh shape: Marine fringe marsh, Narrow finge marsh, Wide fringe marsh, Salt-meadow
OW_Veg	Ratio of open water to tidal emergent herbaceous wetland
DevPct150m	Percent of the 150m buffer that is developed land cover (2011 NLCD)
AgPct150m	Percent of the 150m buffer that is agriculture (2011 NLCD)
NatPct150m	Percent of the 150m buffer that is natural land cover (2011 NLCD)
NatPct1km	Percent of the 1 km buffer that is natural land cover (2011 NLCD)
BUF150M_HA	Size of the 150m buffer in hectares
BUF1KM_HA	Size of the 1km buffer in hectares
Dev150mRel	Relative development = (DevPct150m / 100) * (BUF150M_HA / HECTARES)
Ag150mRel	Relative agriculture = (AgPct150m / 100) * (BUF150M_HA / HECTARES)
Nat150mRel	Relative natural land cover = (NatPct150m / 100) * (BUF150M_HA / HECTARES)
Nat1kmRel	Relative natural land cover = (NatPct1km / 100) * (BUF1KM_HA / HECTARES)
BirdSpRich	Species Richness of birds of conservation concern
NatCommPct	Percent of the Marsh Study Unit that is NHB-mapped natural community
NatCommHa	Hectares of the Marsh Study Unit that is NHB-mapped natural community
SM_UNIT	Hectares of Salt Marsh in the Unit at time zero, initial conditions
SM_CONTIG	Contiguous Hectares of Salt Marsh that intersects the Unit at time zero
SM_05M	Hectares of Salt Marsh predicted by SLAMM at year 2100 with 0.5m SLR

Habitat Conditions and Adaptation Potential



Marsh Study Units – easily transferable methodology

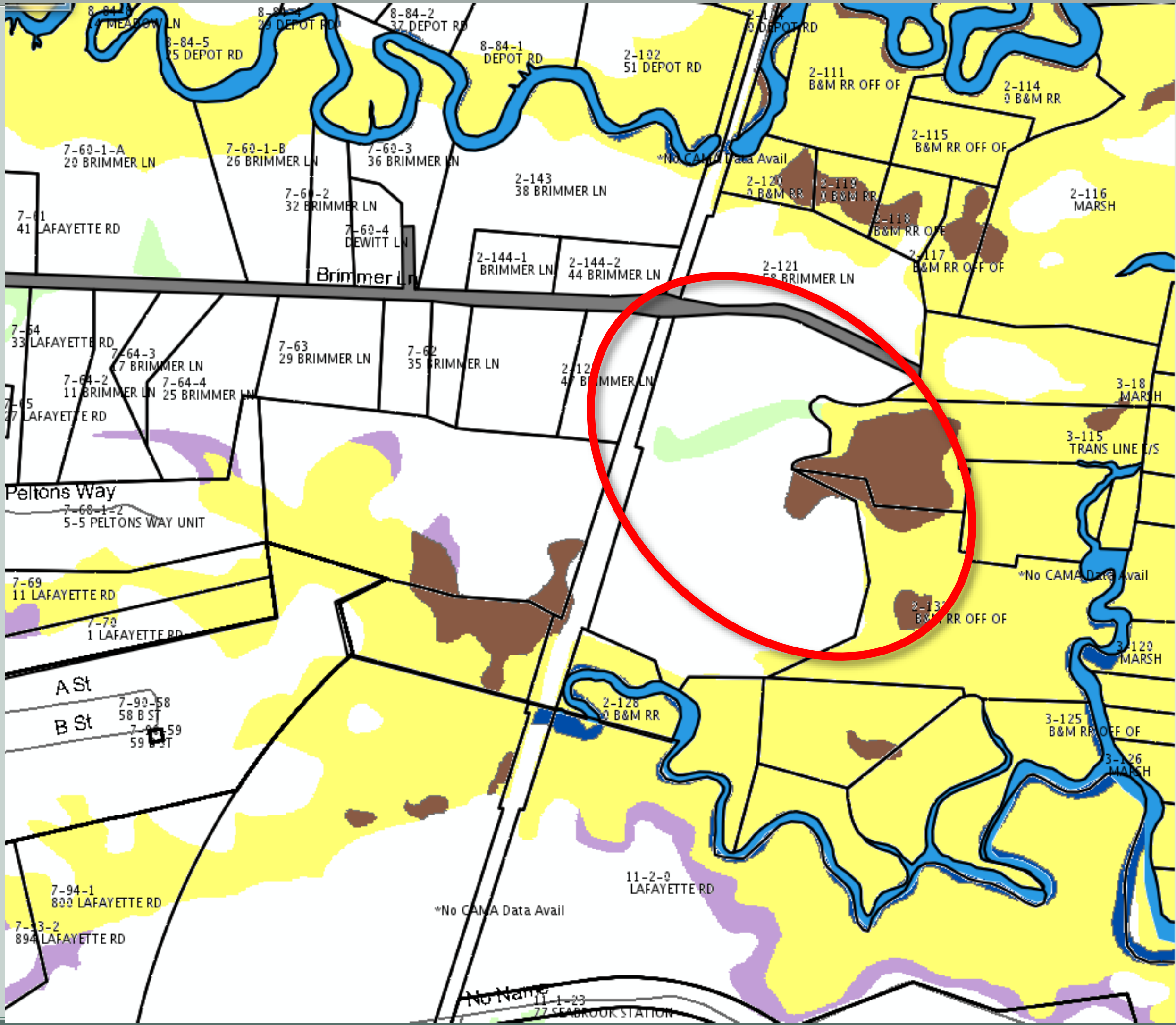
- External boundary defined by maximum extent SLAMM model at 2m SLR
- Internal
  - Center line major rivers and roads
  - Natural breaks in salt marsh continuity along shore

Conservation Opportunities to Support Marsh Migration Inland

Habitat Type

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

SLR 2m / 7ft



2012

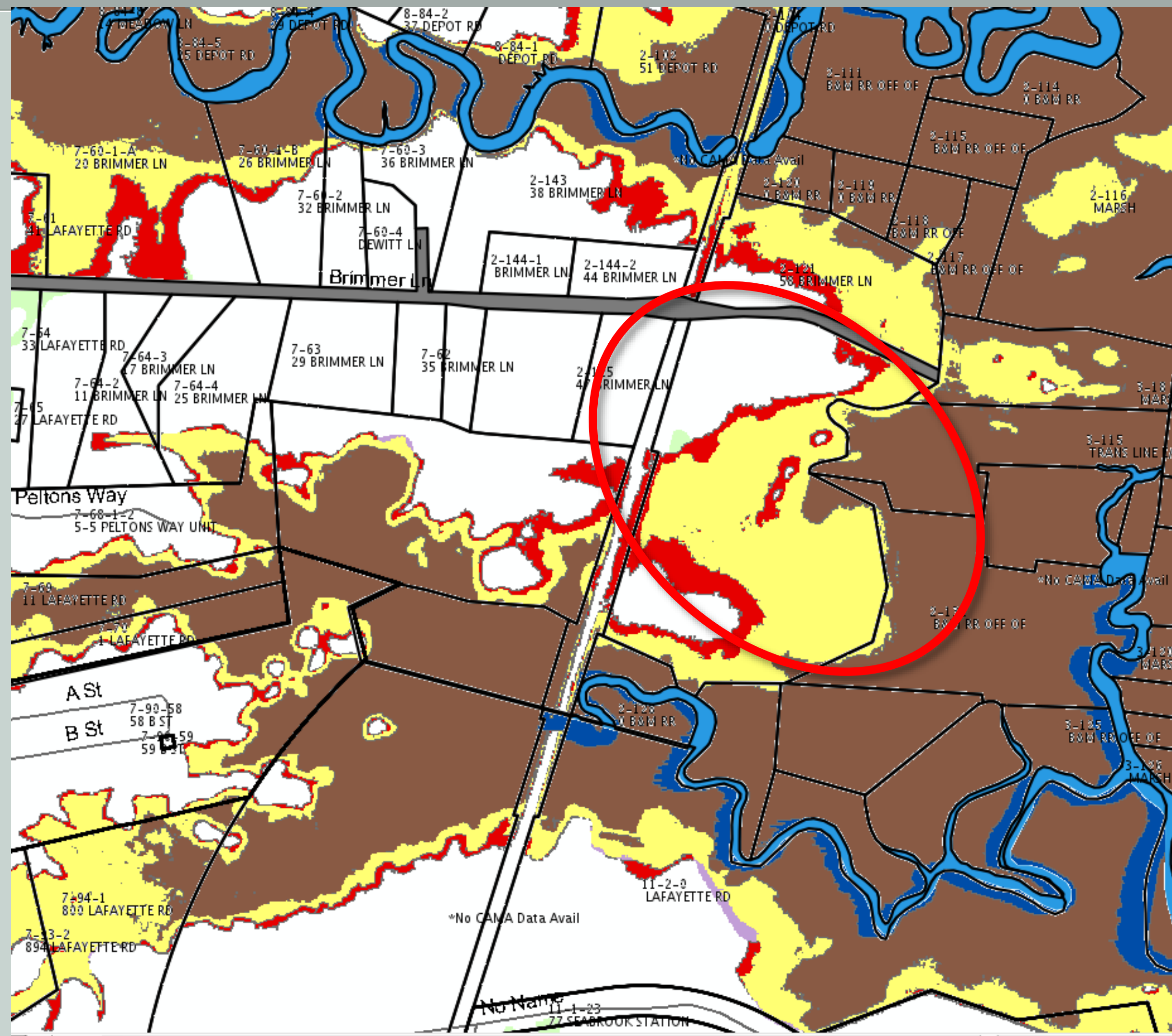
Conservation Opportunities to Support Marsh Migration Inland

Habitat Type

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

SLR 2m / 7ft

2100



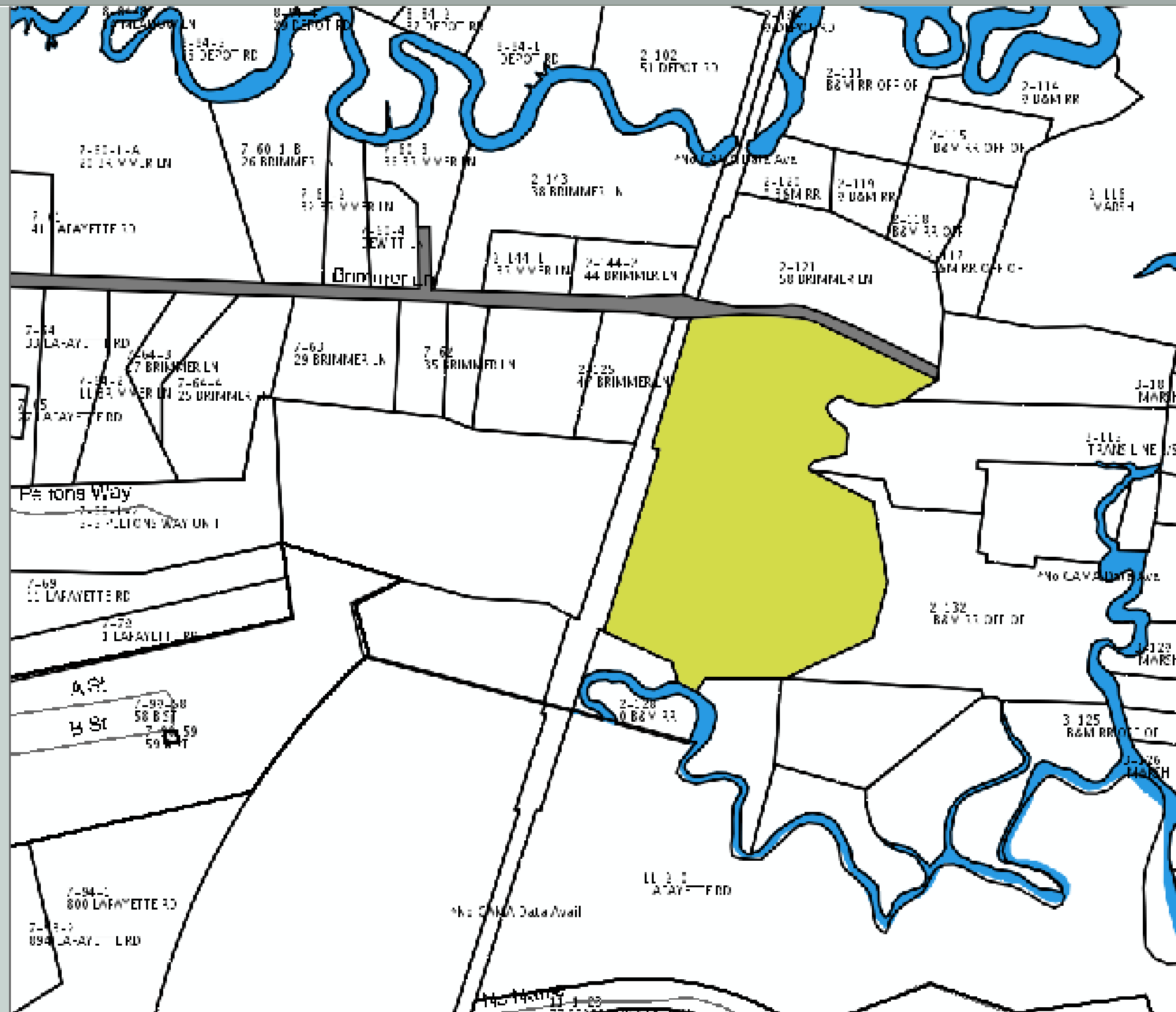
Conservation Opportunities to Support Marsh Migration Inland

Habitat Type

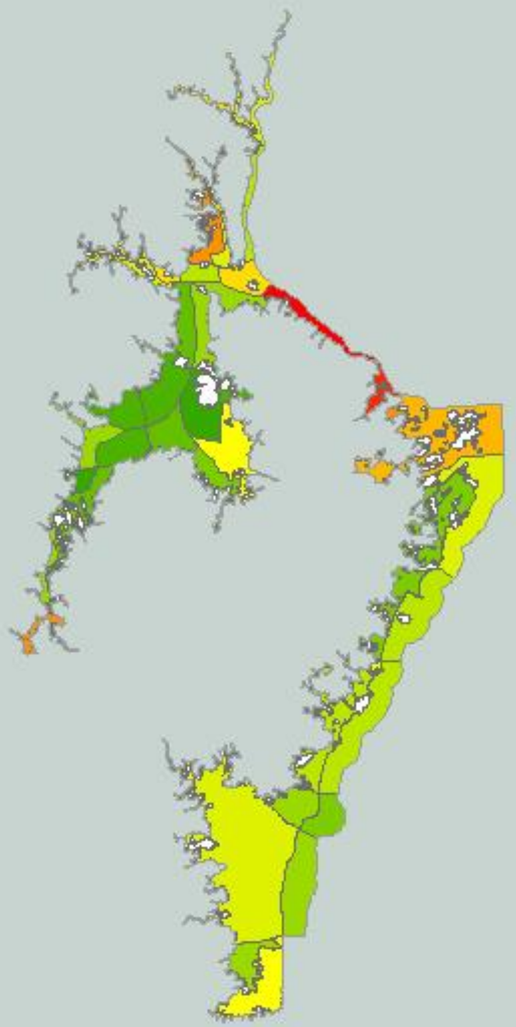
- Tidal water
- Mud flat
- Salt marsh
- Transitional salt marsh
- Tidal wetland
- Fresh water
- Freshwater wetland

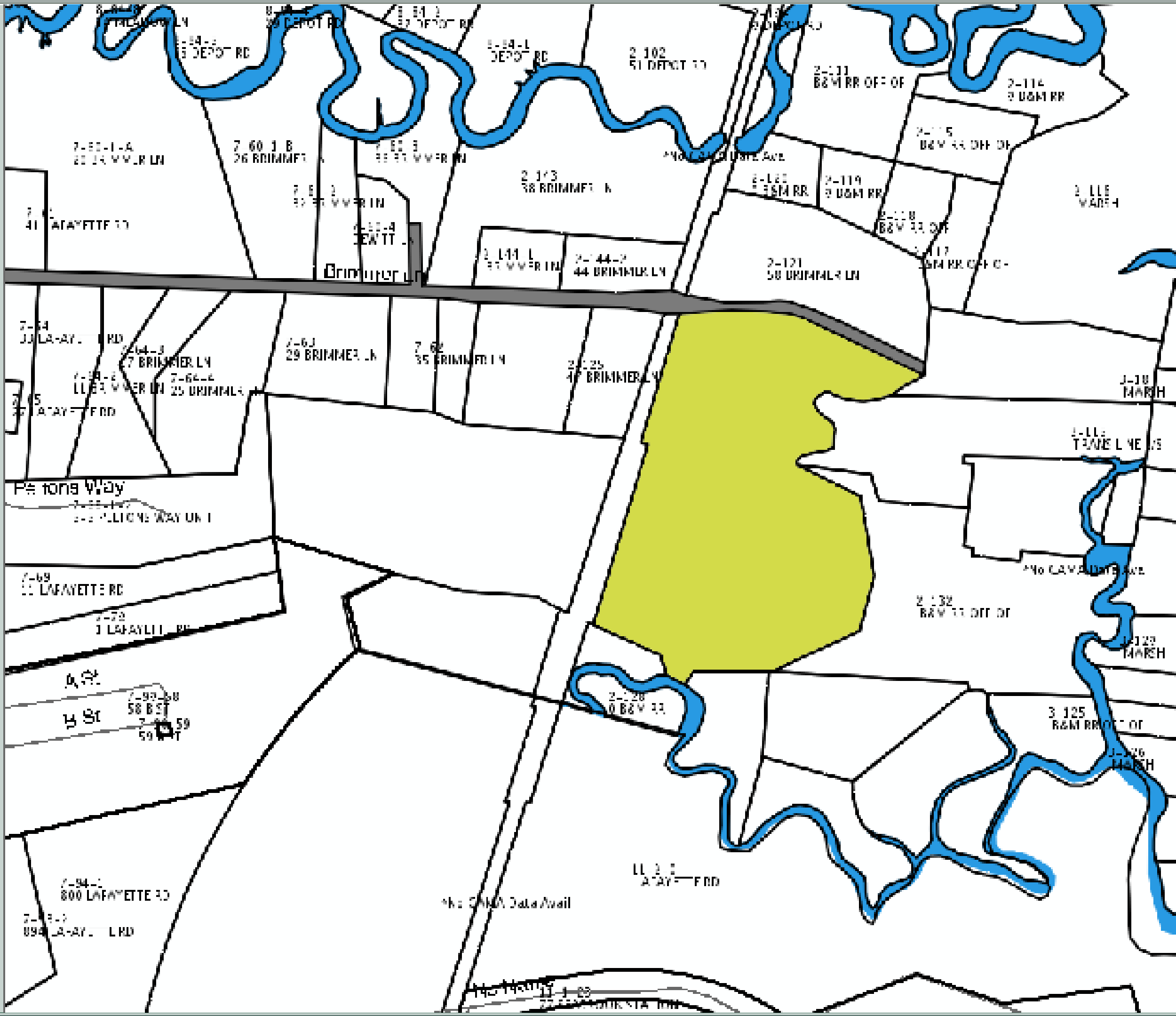
SLR 2m / 7ft

2100

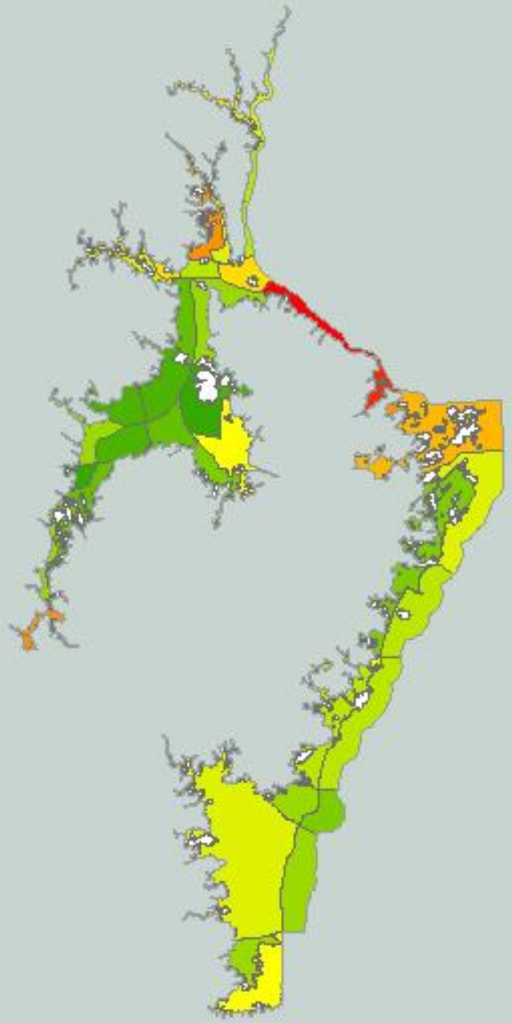


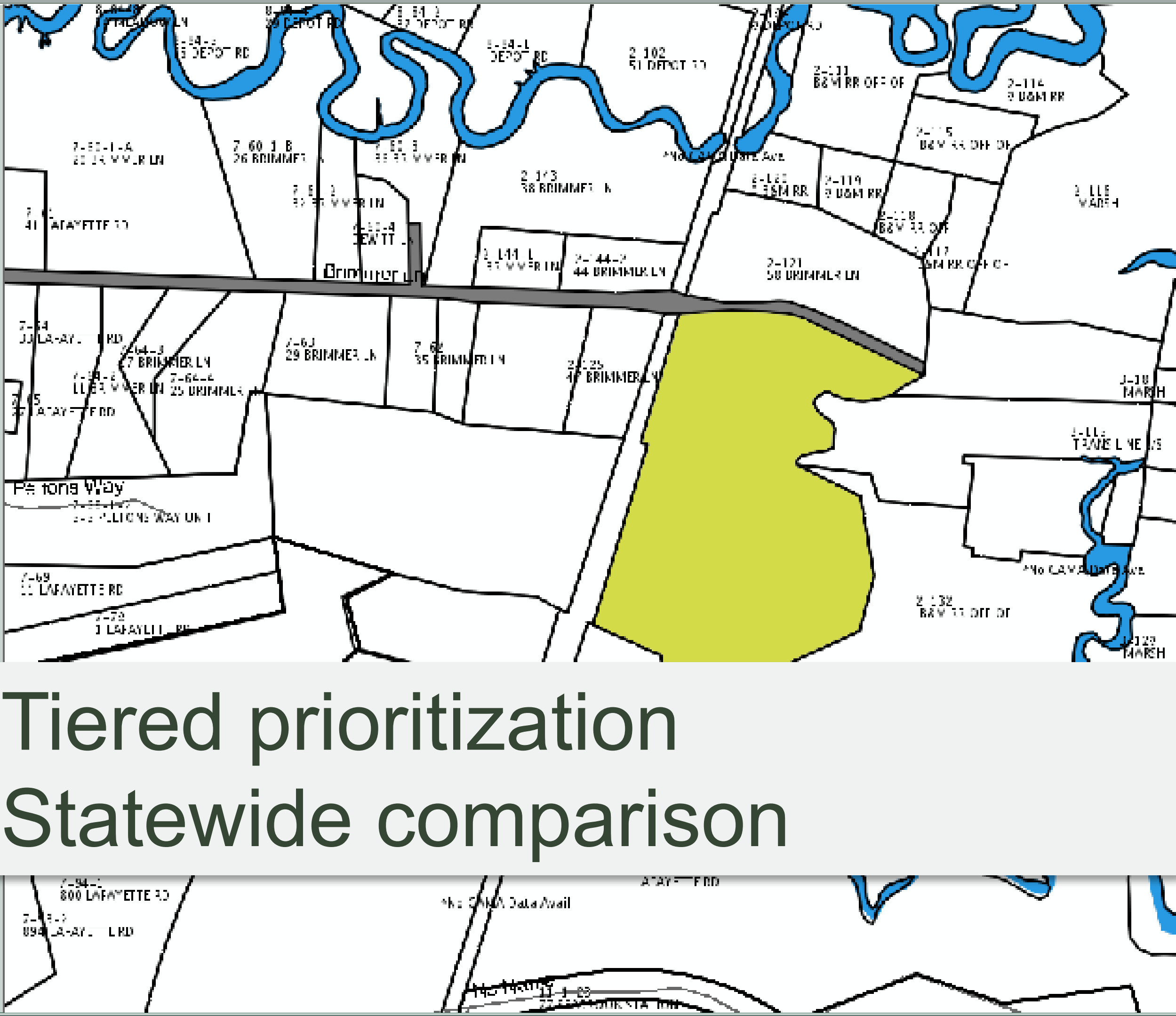
Conservation Opportunities to Support Marsh Migration Inland





Conservation Opportunities to Support Marsh Migration Inland





- Tiered prioritization
- Statewide comparison

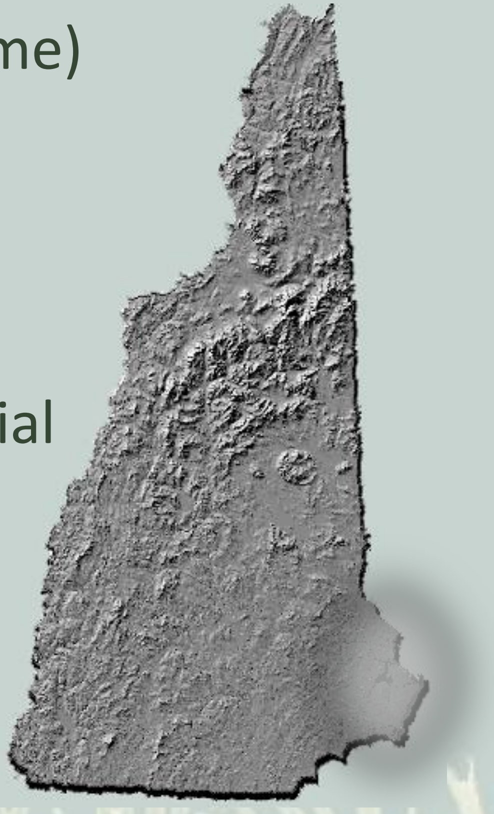
Field Verification

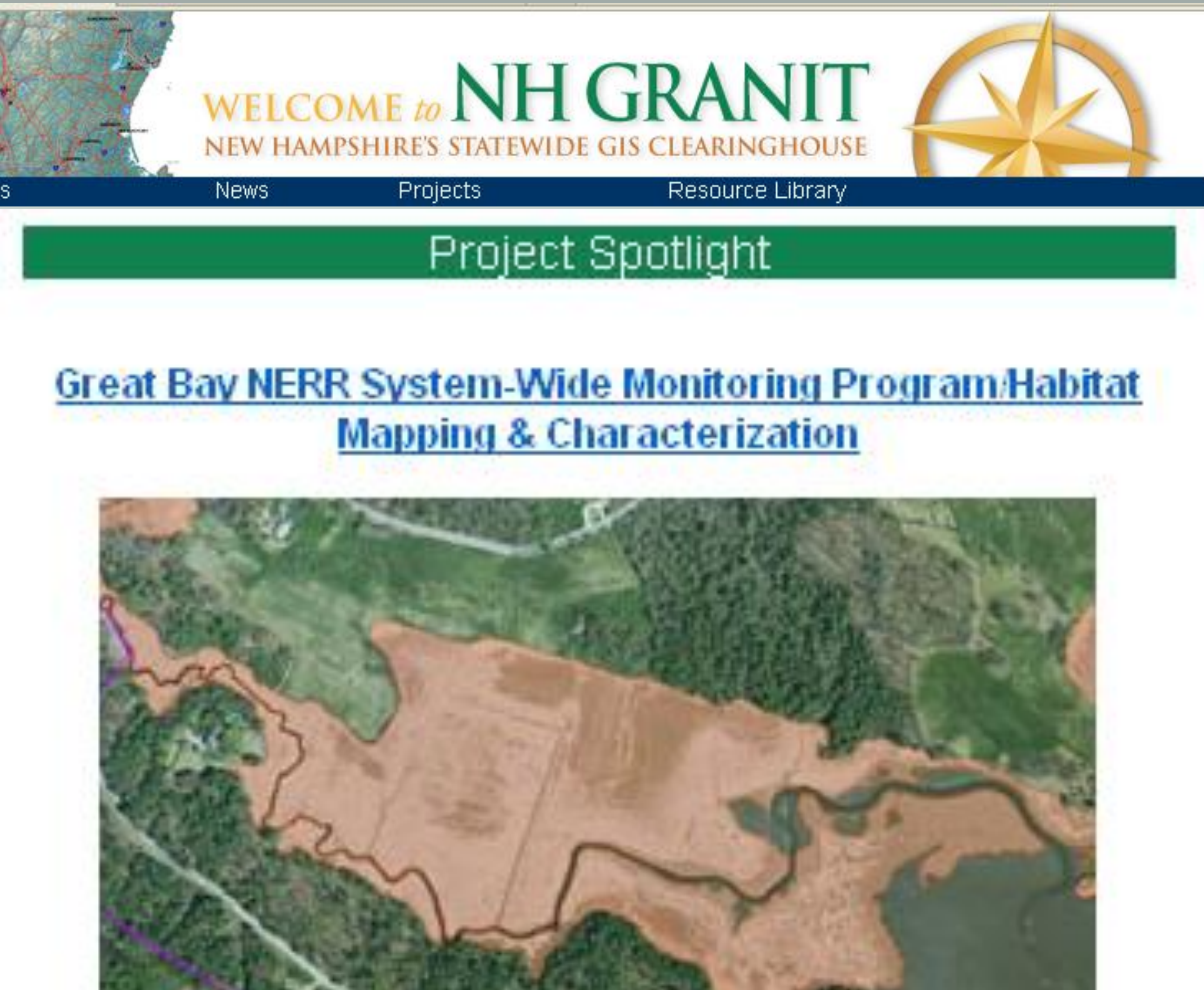
Field Verification

Workshop for land protection professionals. Feb 2015

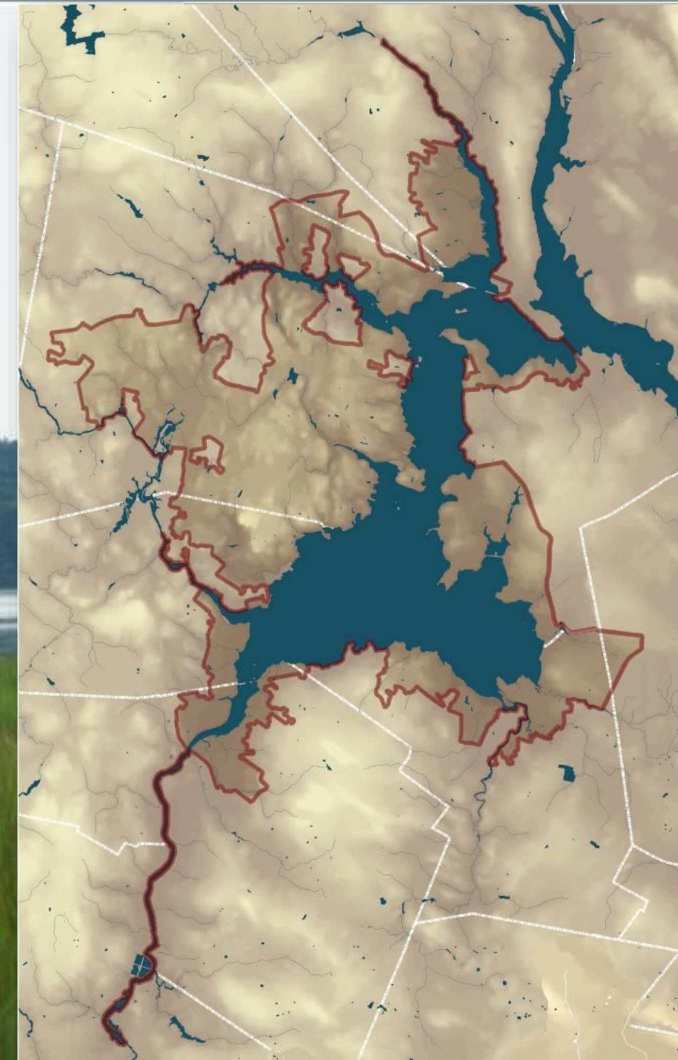
Modeling Marsh Migration in New Hampshire

- Mapping products (quantitative to come)
    - Uncertainty Analysis
- Restoration opportunities
- Habitat quality and adaptation potential
- Priority conservation lands
- Demonstration sites




WELCOME to NH GRANIT
NEW HAMPSHIRE'S STATEWIDE GIS CLEARINGHOUSE
s
News
Projects
Resource Library
Project Spotlight
Great Bay NERR System-Wide Monitoring Program/Habitat Mapping & Characterization

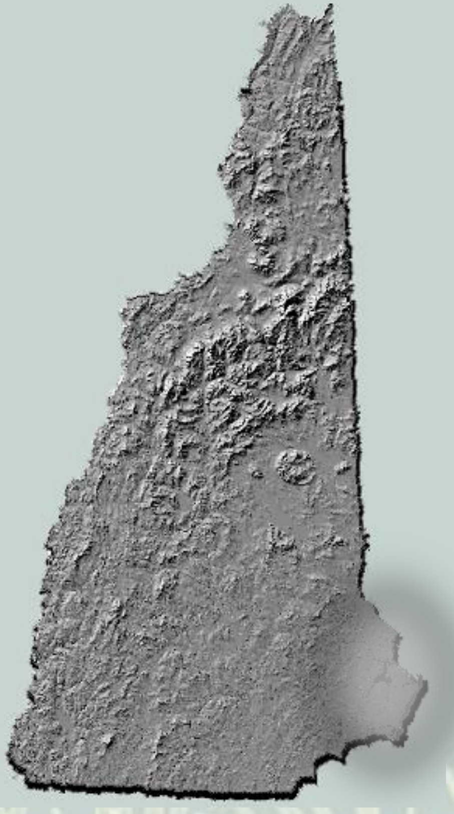
High / Low Marsh boundary



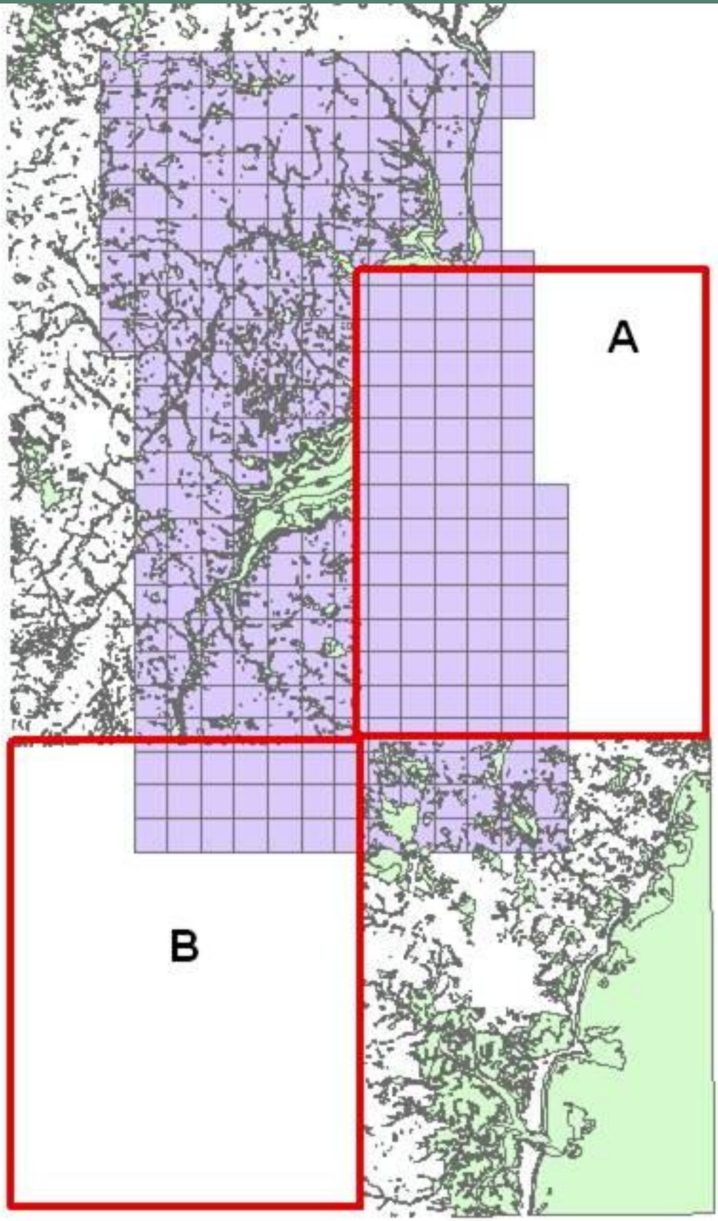

© Doug Wechsler

Modeling Marsh Migration in New Hampshire

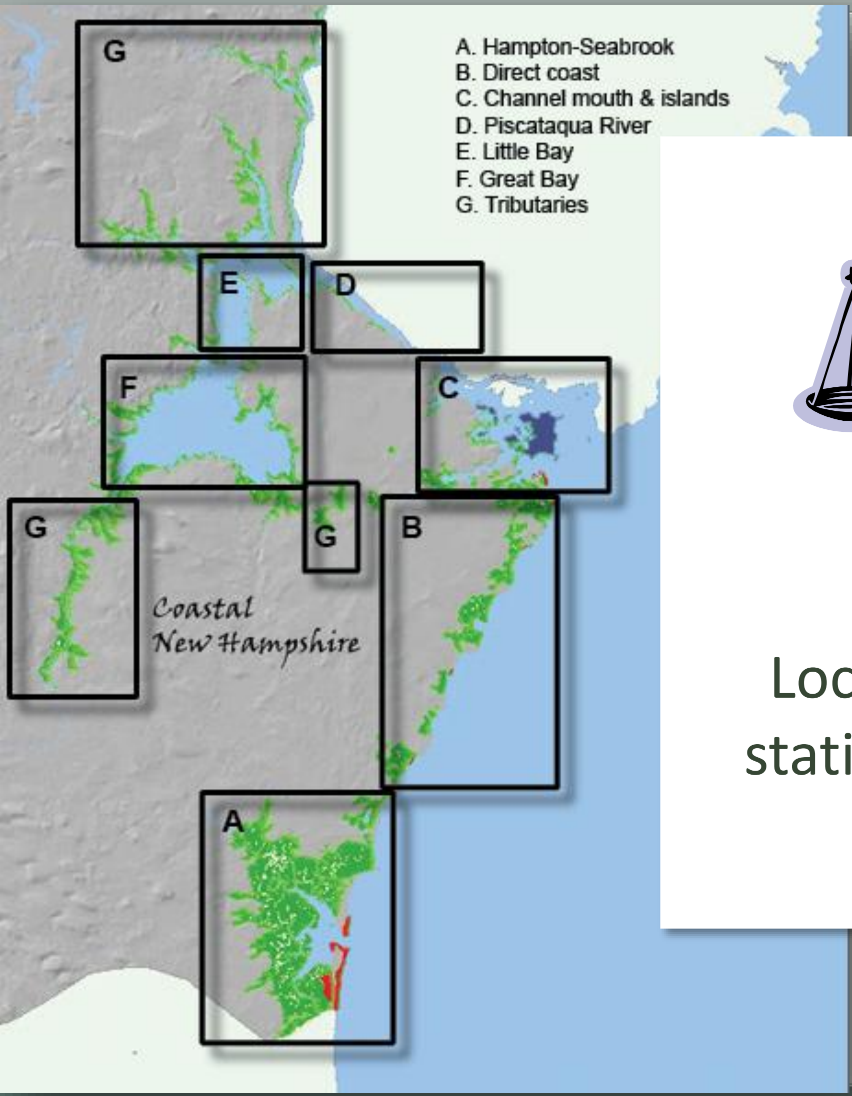
- Mechanics
- Products
- **Opportunities**
- Action



NWI Update



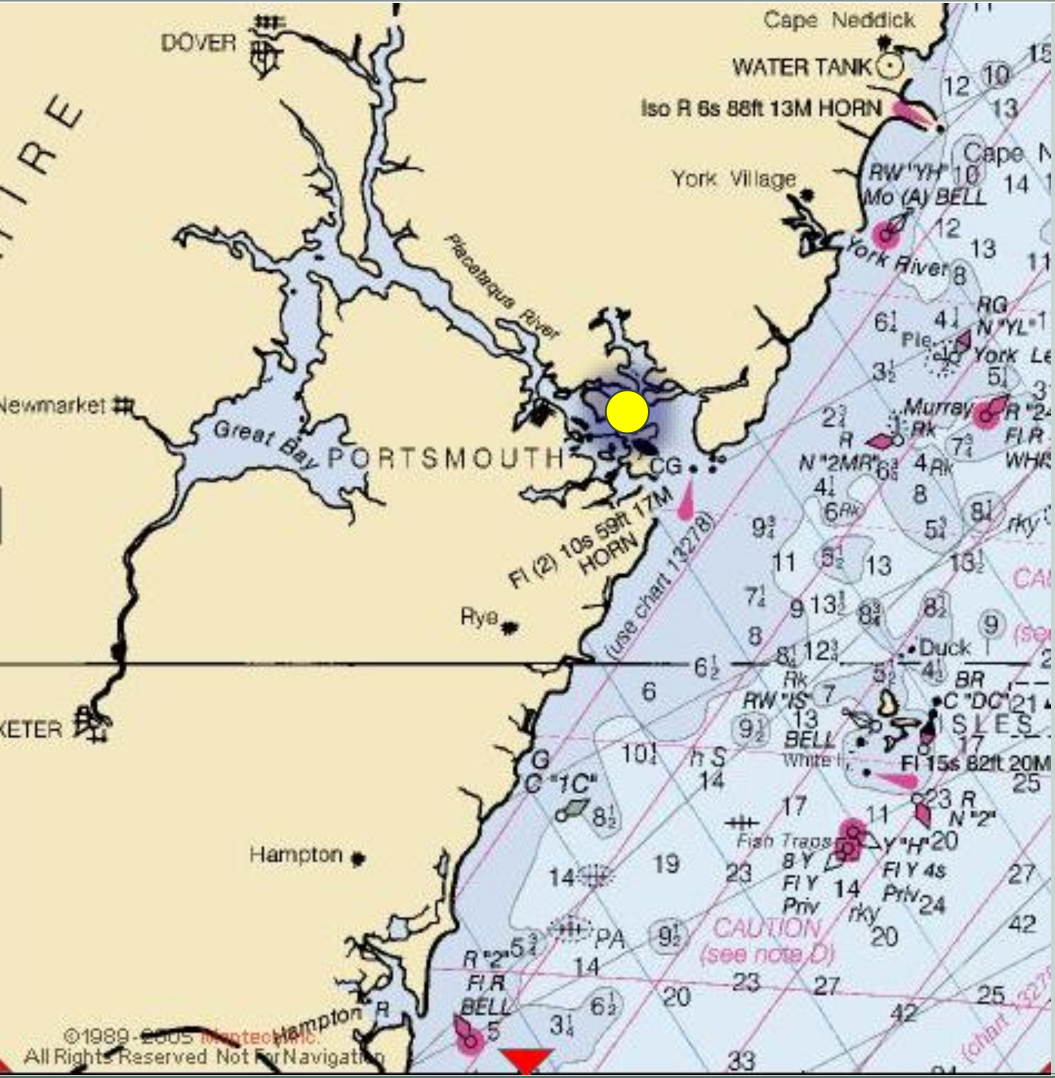
NH's Approach to SLAMM: Locally relevant input parameters



Parameter	Global
[illegible]	GreatBay
…YY)	2001
	2011
…,s,e,w]	East
…r)	1.76
	0.067
…le Range (m)	2.3
…MTL)	1.61
… m /yr)	1.8
…z. m /yr)	1
… m /yr)	0.5
…ccr (mm/yr)	4.3
…ccr (mm/yr)	4.3
…ccr (mm/yr)	5.38
…Accr (mm/yr)	0
…/yr)	7
…mm/yr)	1.1
…m/yr)	0.3
…m/yr)	0.5
Freq. Overwash (years)	50
Use Elev Pre-processor [True,False]	FALSE

Locally relevant, statistically robust

Local Water Level Data



NSRS

LiDAR / RTK

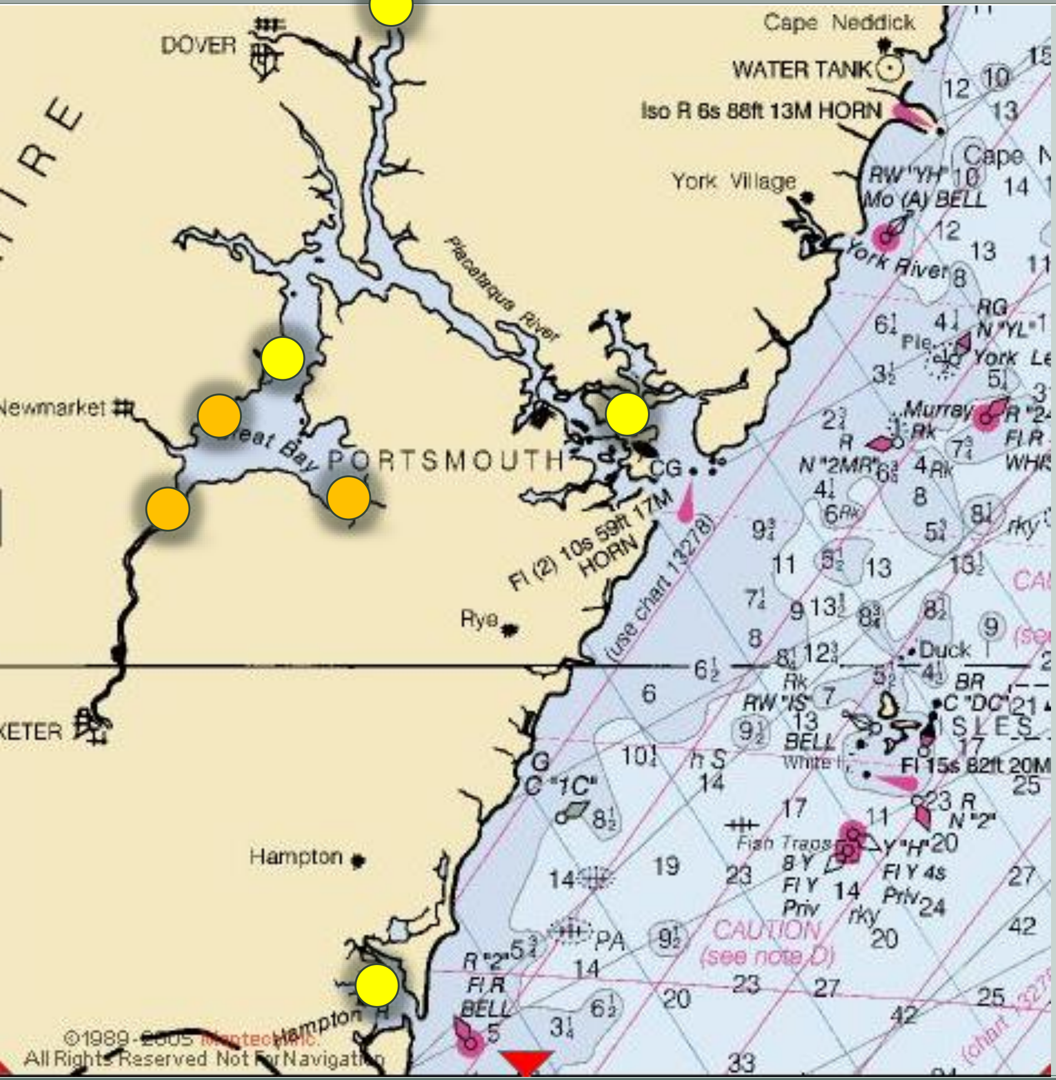
NWI update / Biological Mapping

Tidal Barriers & Restrictions

SETs

Water Level Data

Local Water Level Data



NSRS

LiDAR / RTK

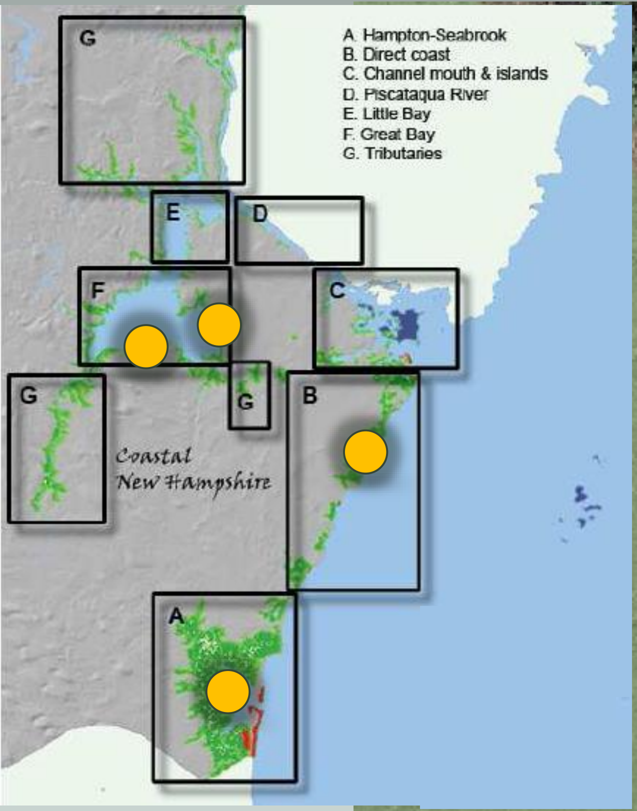
NWI update / Biological Mapping

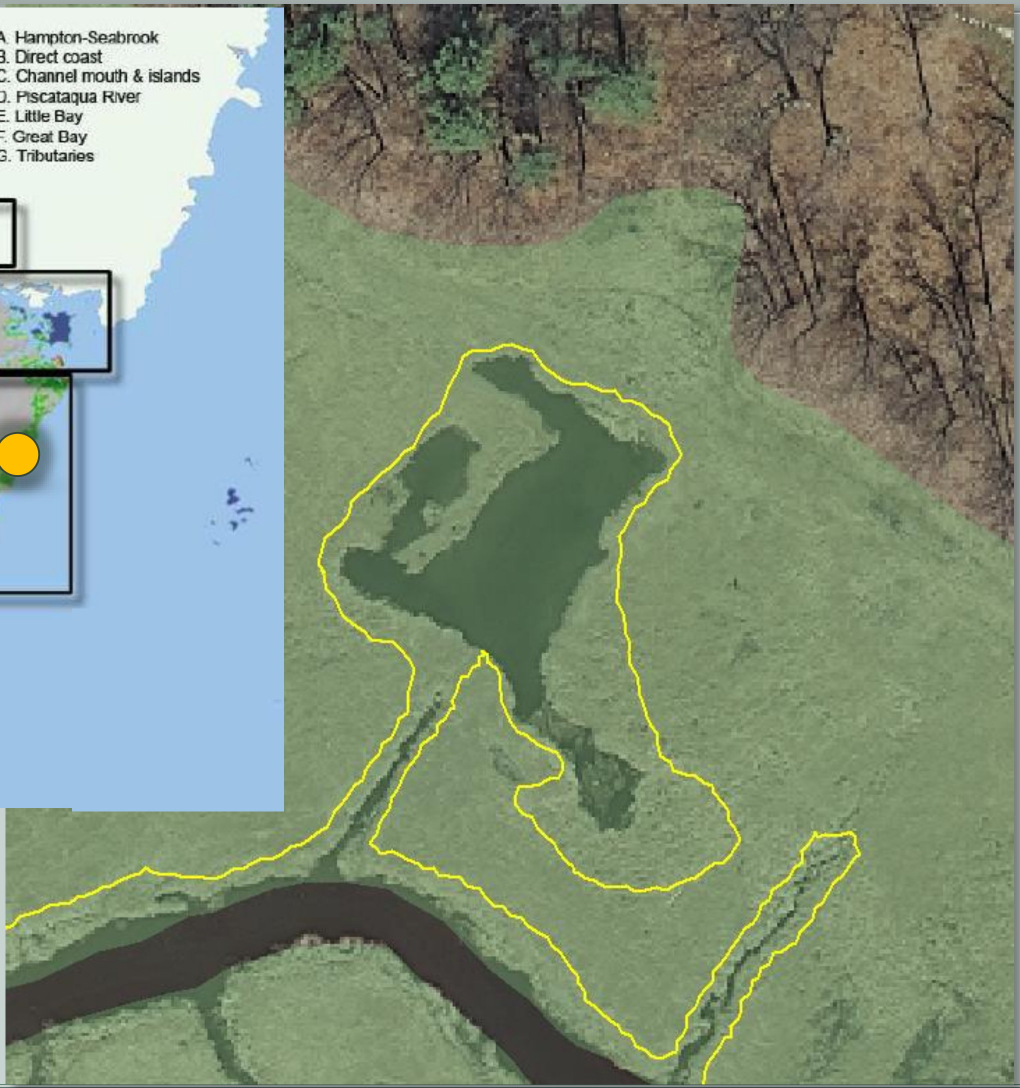
Tidal Barriers & Restrictions

SETs

Water Level Data

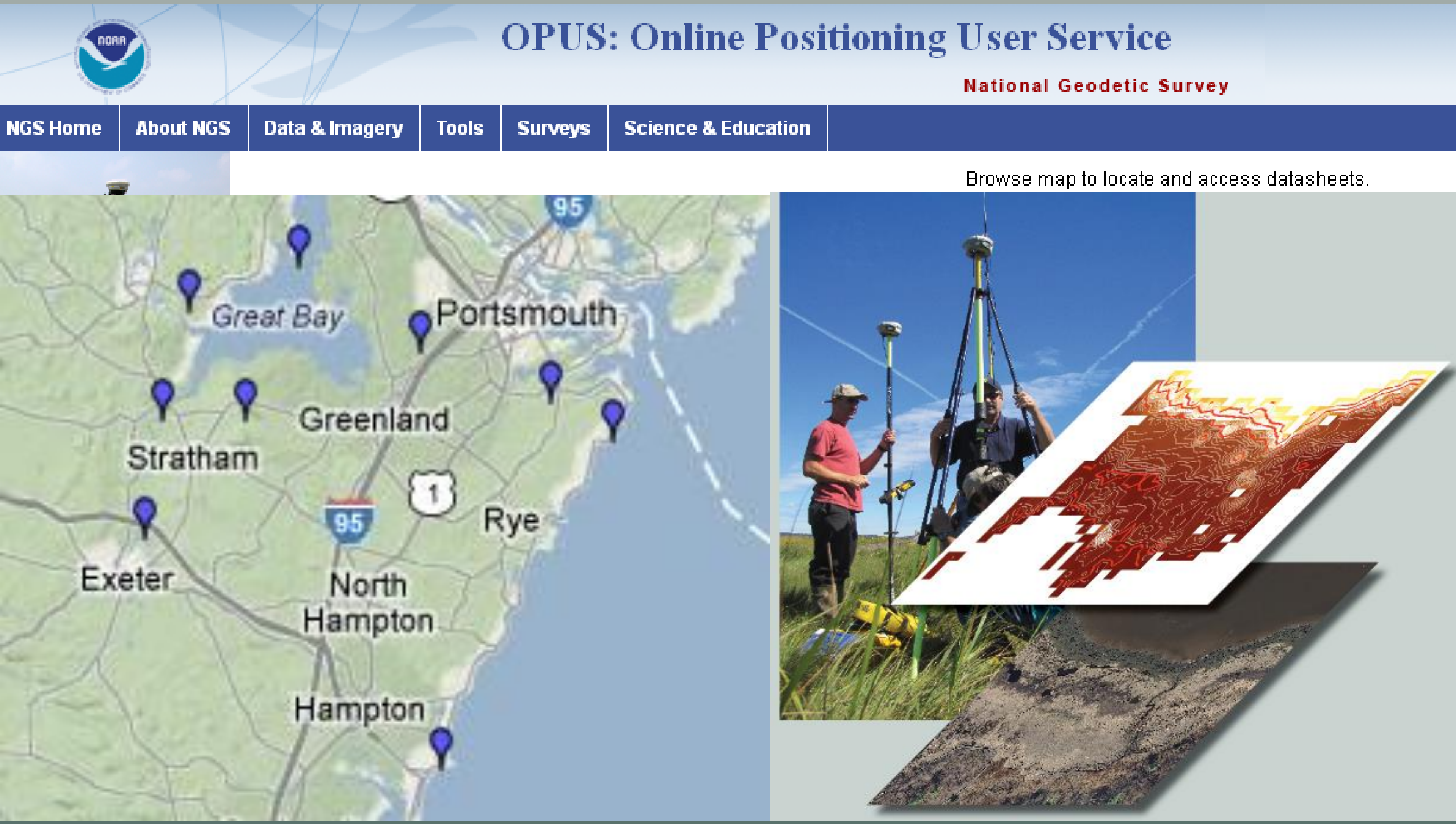
SETs


A. Hampton-Seabrook
B. Direct coast
C. Channel mouth & islands
D. Piscataqua River
E. Little Bay
F. Great Bay
G. Tributaries
G
E
D
F
C
G
G
B
A
Coastal
New Hampshire



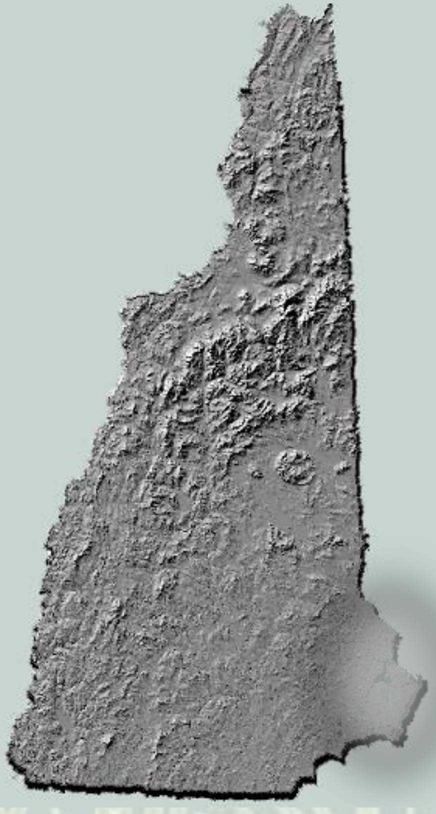
Connecting to NSRS

Connecting to NSRS



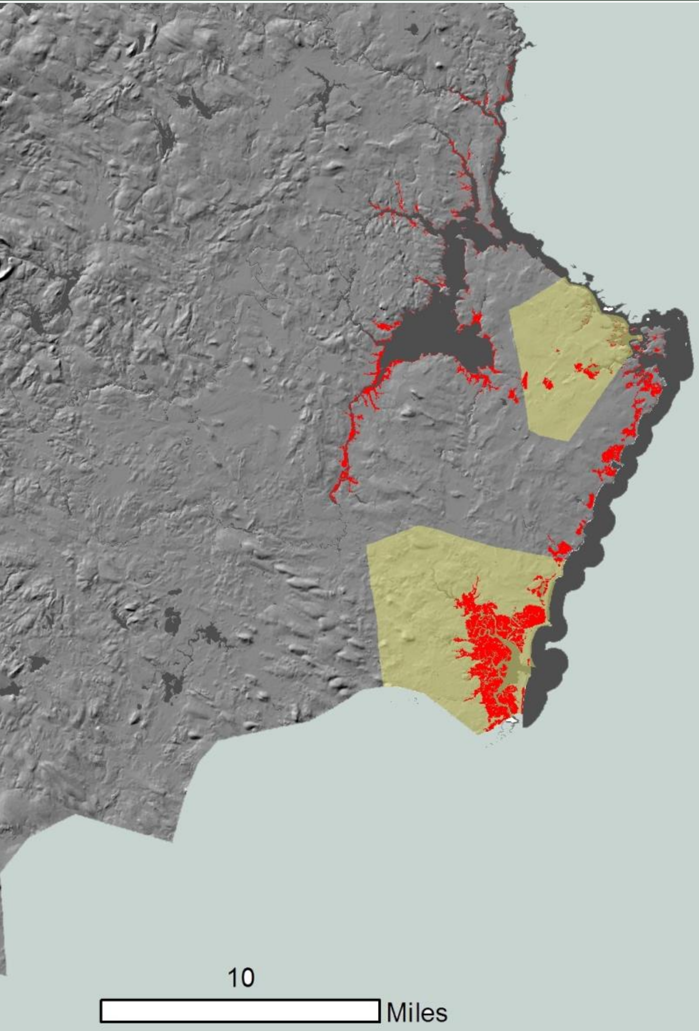
Modeling Marsh Migration in New Hampshire

- Mechanics
- Products
- Opportunities
- **Action**



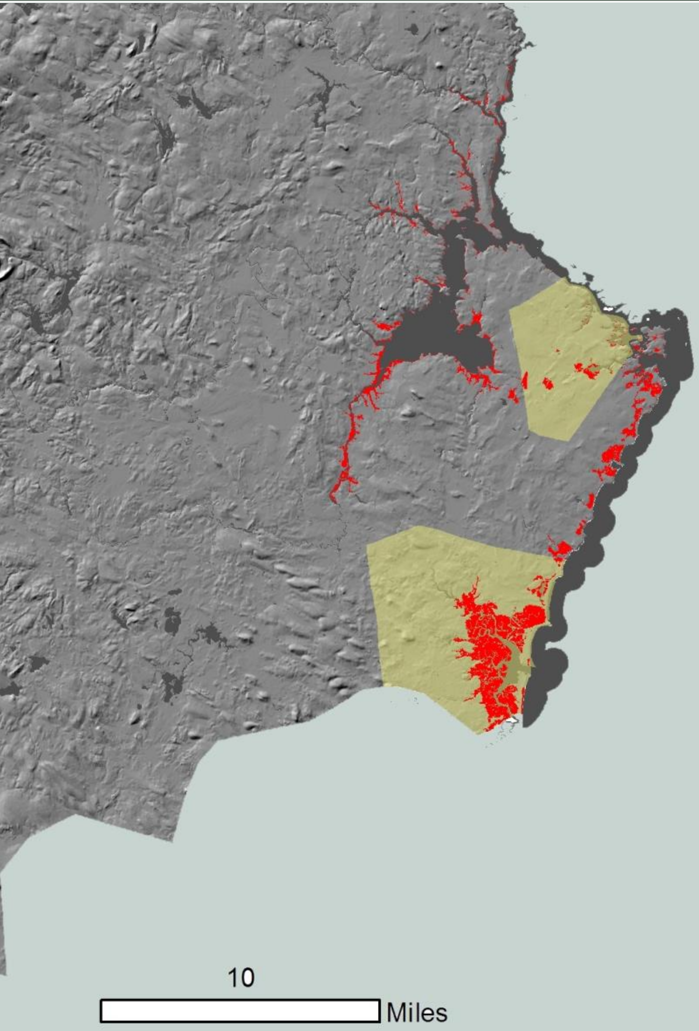
Resilient New Hampshire Coasts

Resilient New Hampshire Coasts



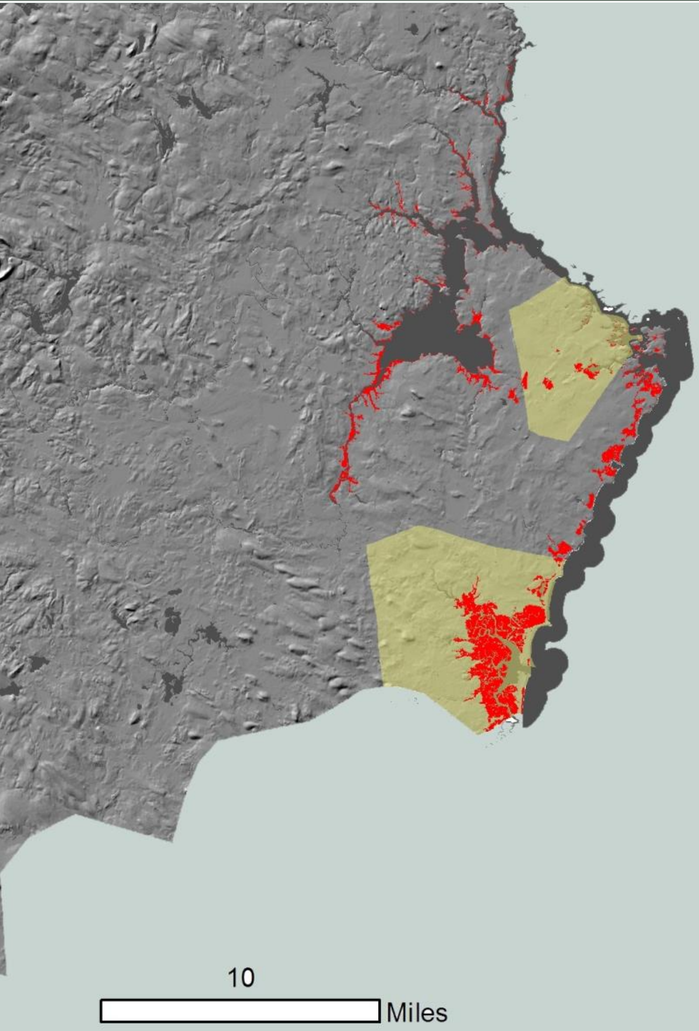
- 4 municipalities

Resilient New Hampshire Coasts



- Priority lands for conservation
- Restoration opportunities

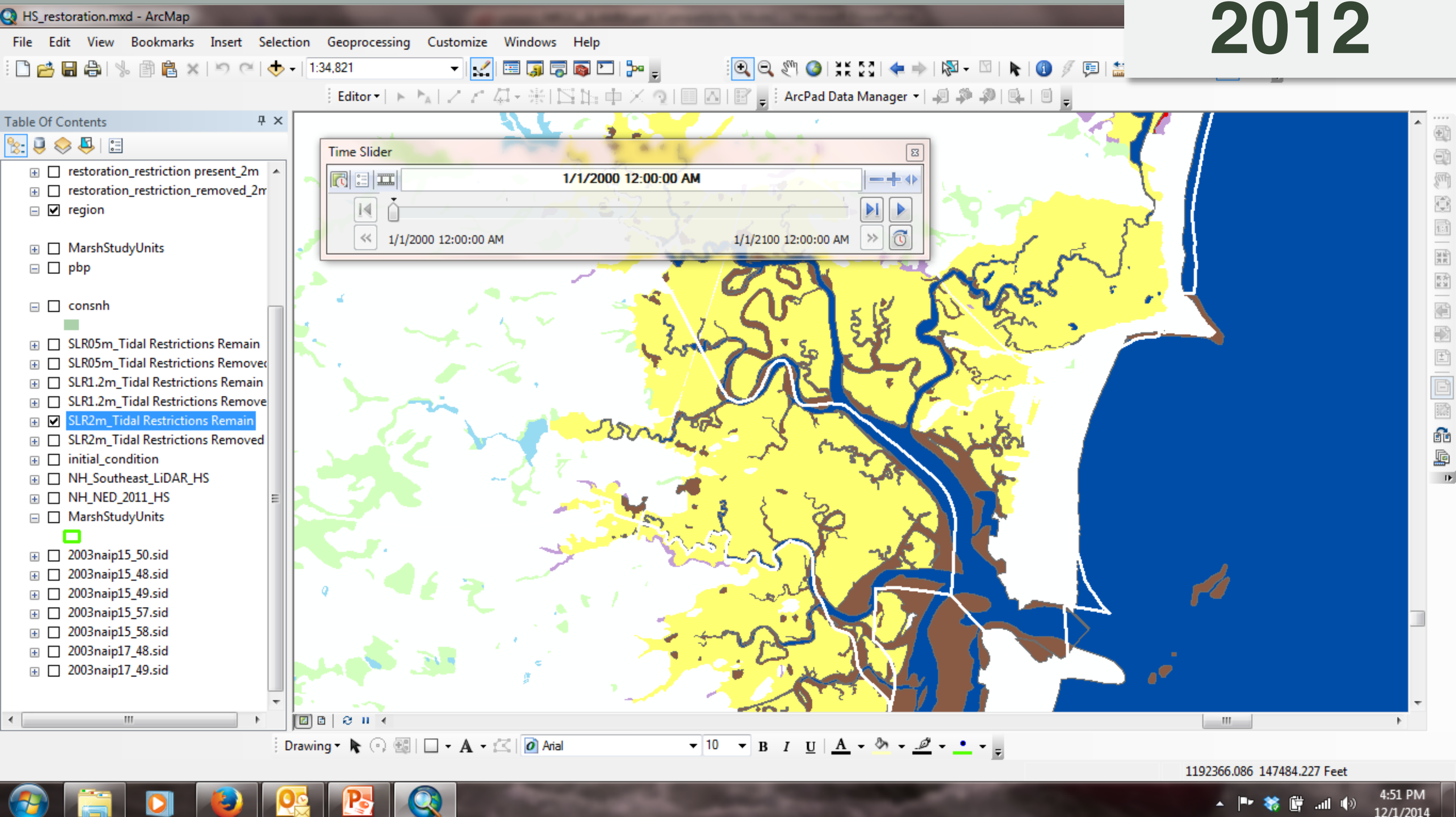
Resilient New Hampshire Coasts



- Priority lands for conservation
- Restoration opportunities
- Infrastructure mitigation / planning
- Policy - buffers

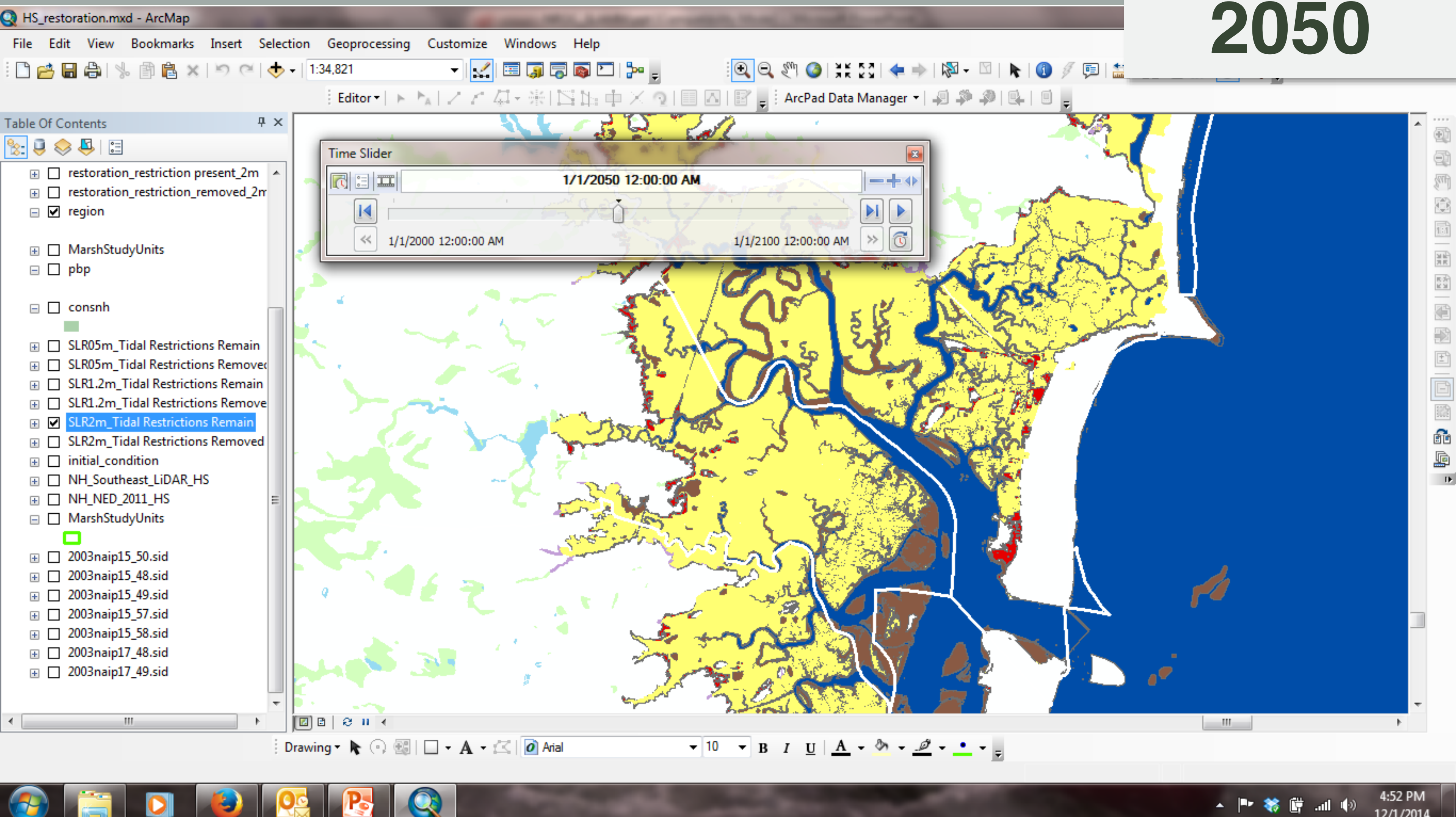
Mapping Products

2012



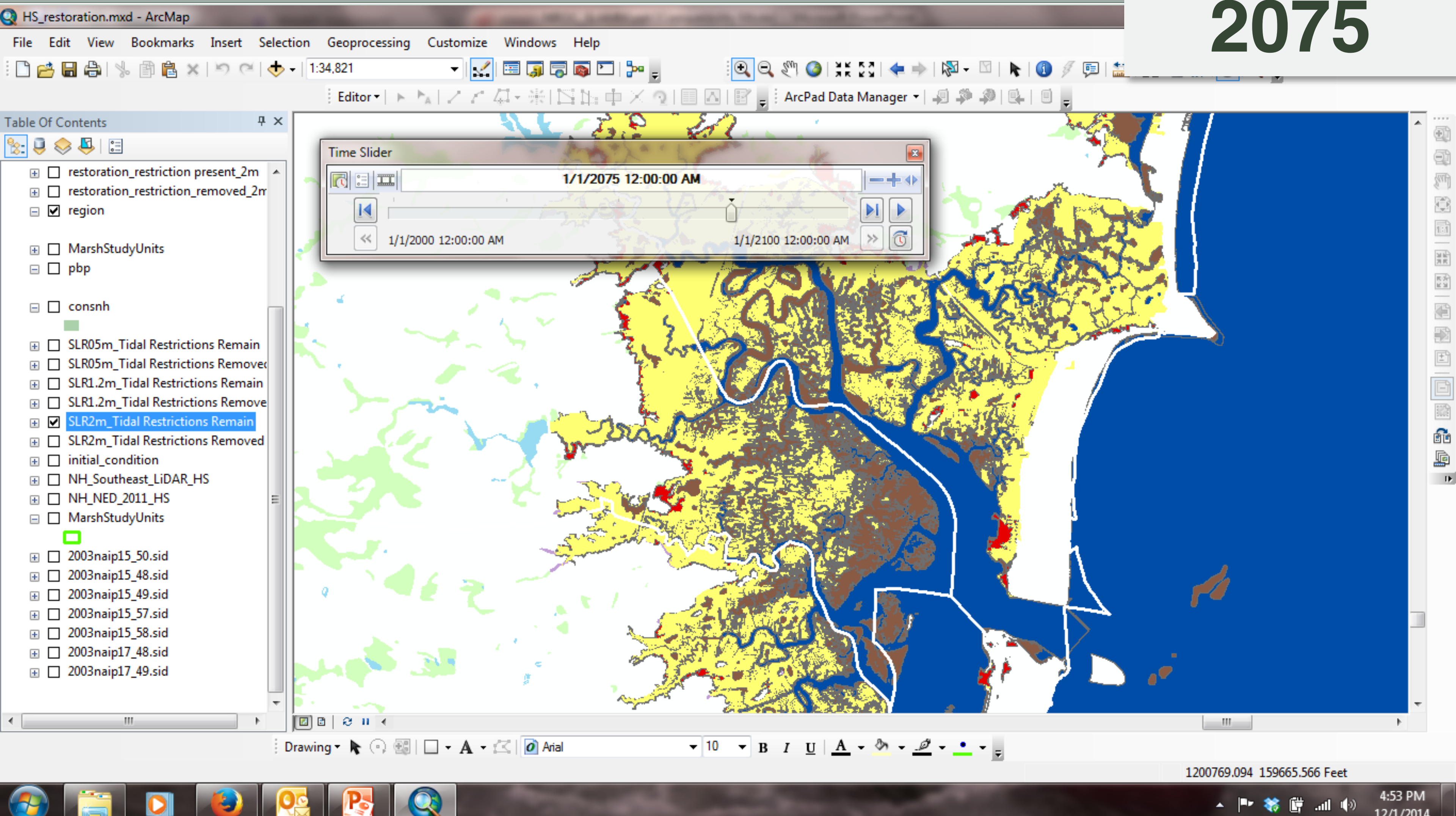
Mapping Products

2050



Mapping Products

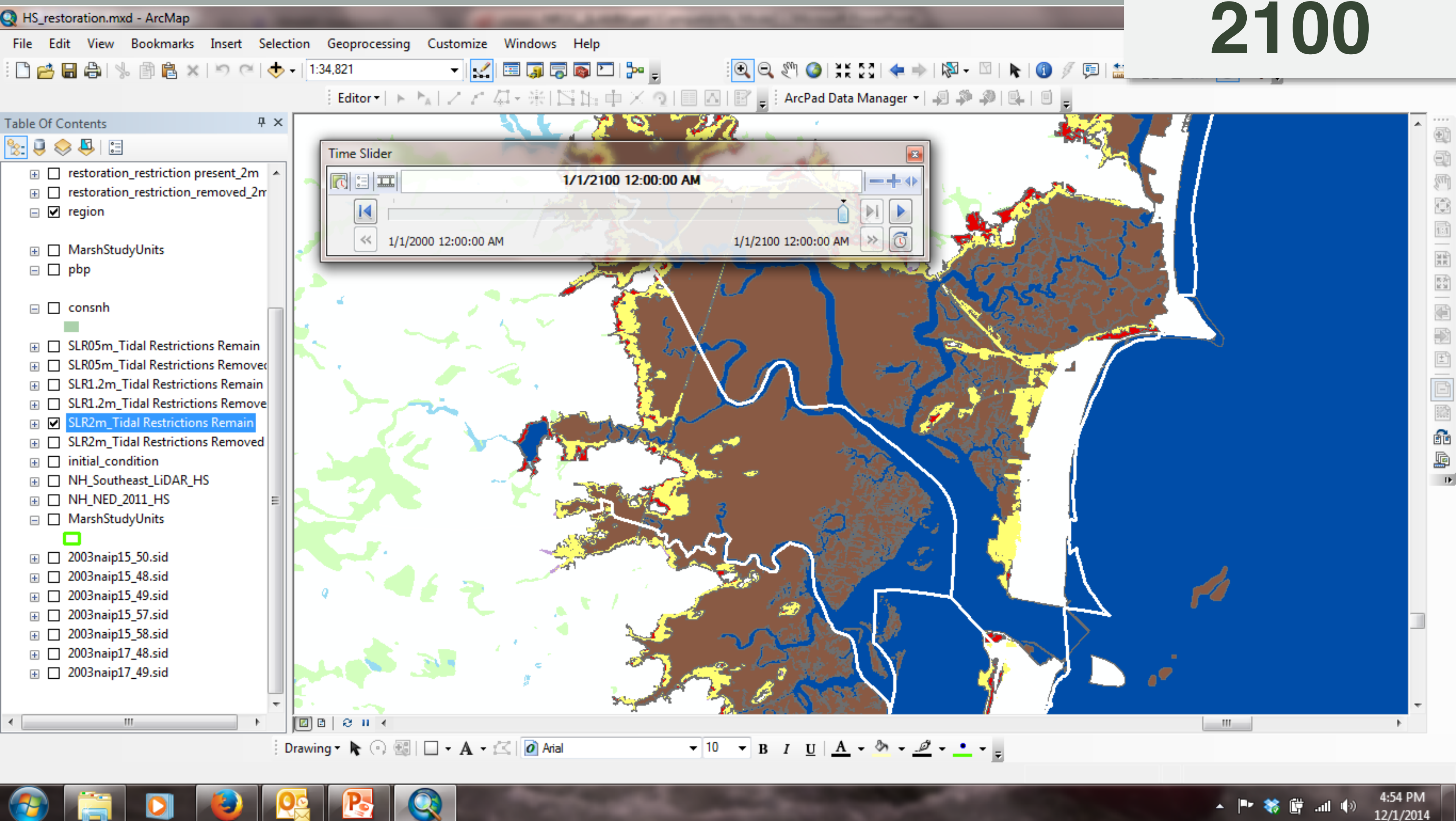
2075



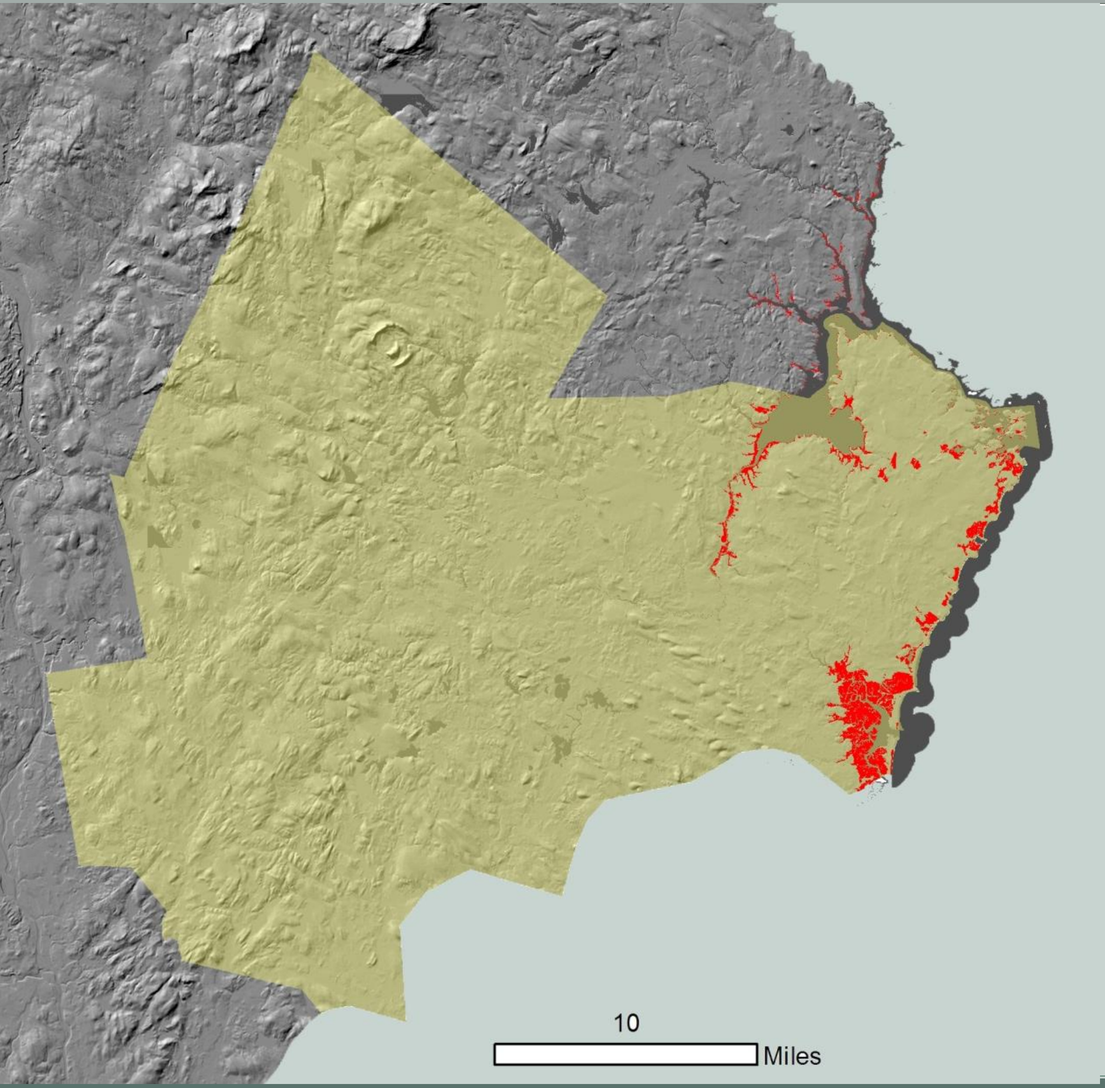
GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE

Mapping Products

2100



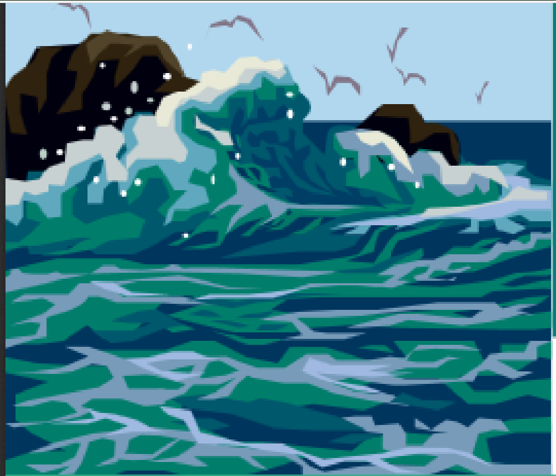
Rockingham Planning Commission



- 37 municipalities

ROCKINGHAM
PLANNING
COMMISSION

Rockingham Planning Commission



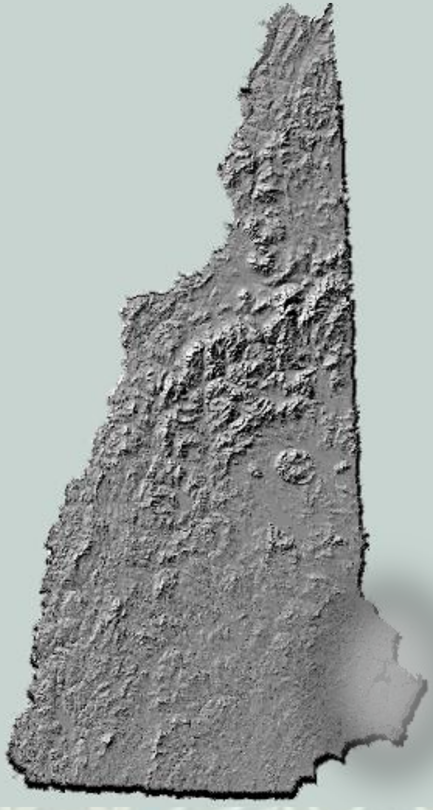
FROM TIDES TO STORMS: PREPARING FOR NEW HAMPSHIRE'S FUTURE COAST

Assessing Risk and Vulnerability of Coastal Communities to Sea Level Rise and Storm Surge

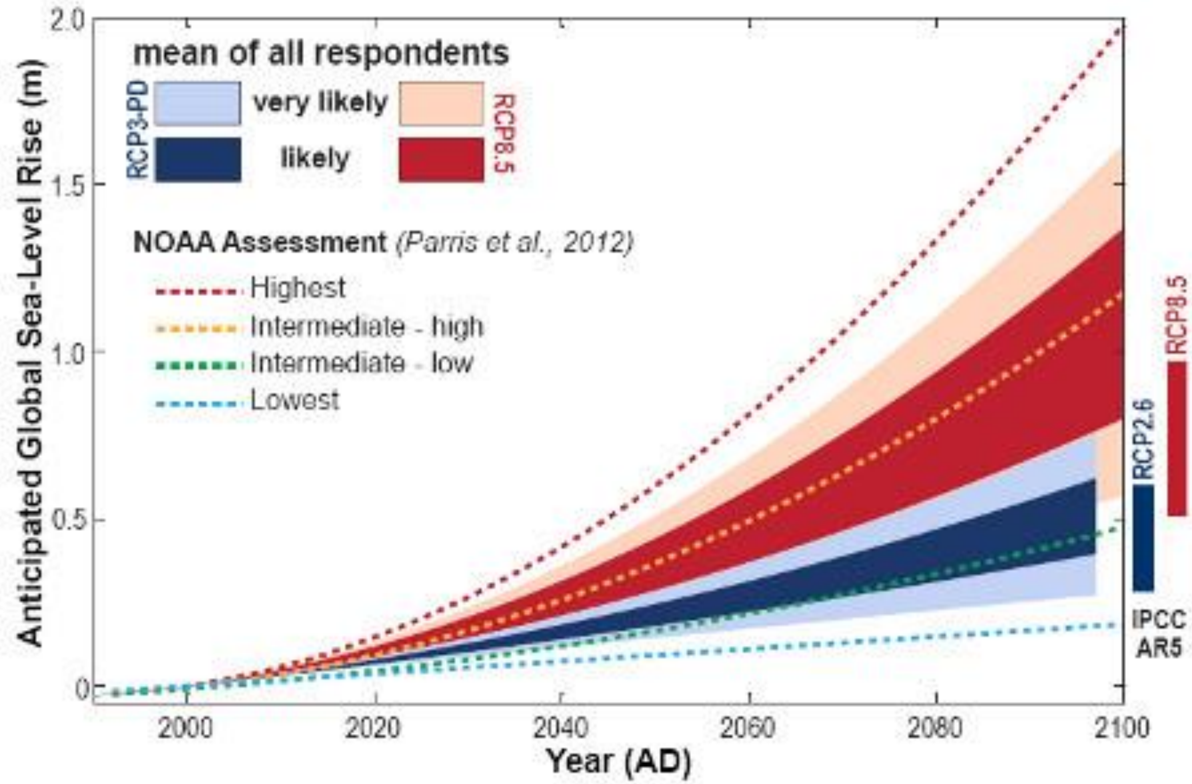
Seabrook - Hampton Falls – Hampton - North Hampton – Rye - New Castle - Portsmouth

- Mapping products
- Statistical assessment acreages of change
- Lot assessed values

Modeling Marsh Migration in New Hampshire



Locally relevant, statistically robust



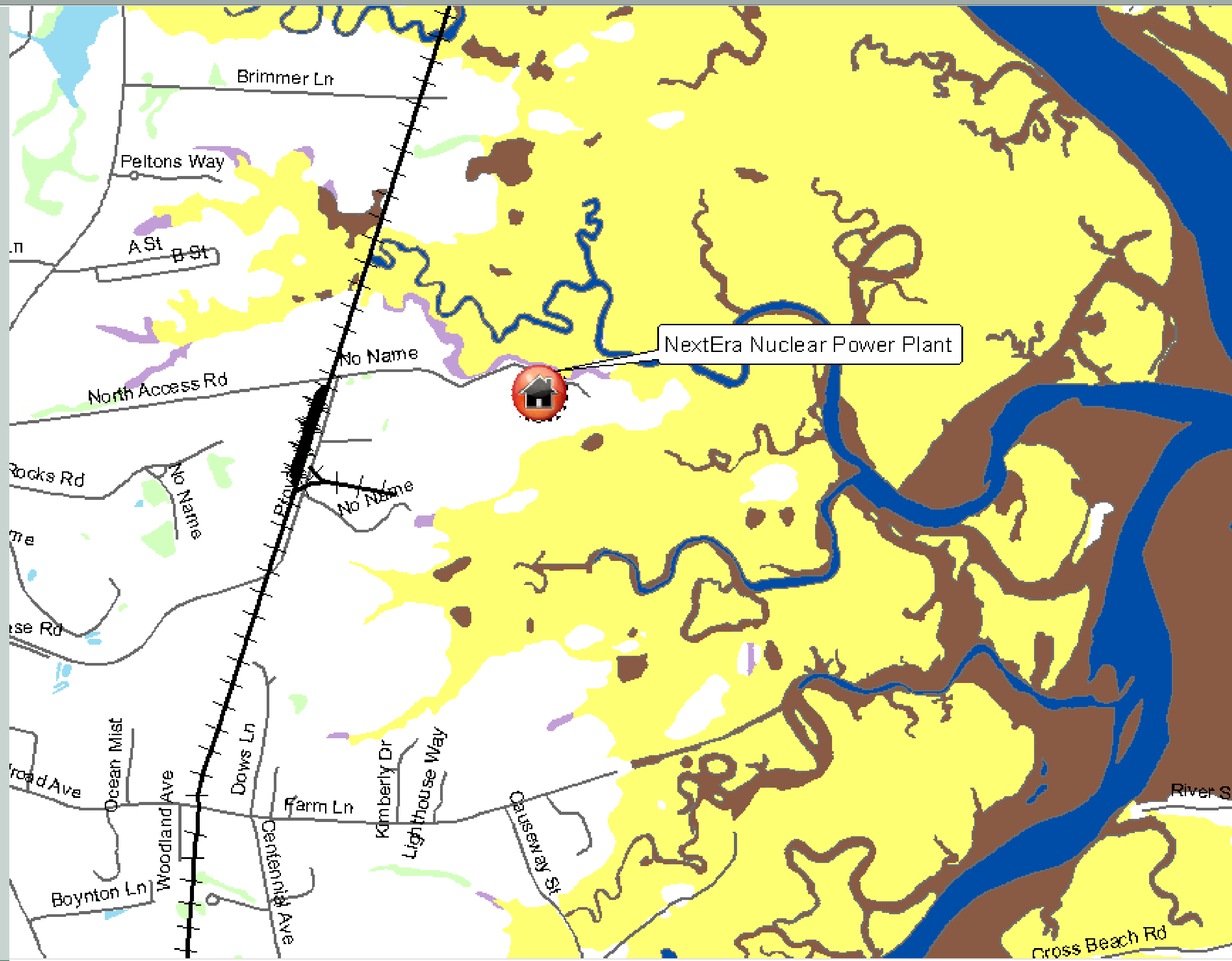

BEEN THERE
WRECKED THAT

Example Infrastructure

Habitat Type

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

SLR 2m / 7ft



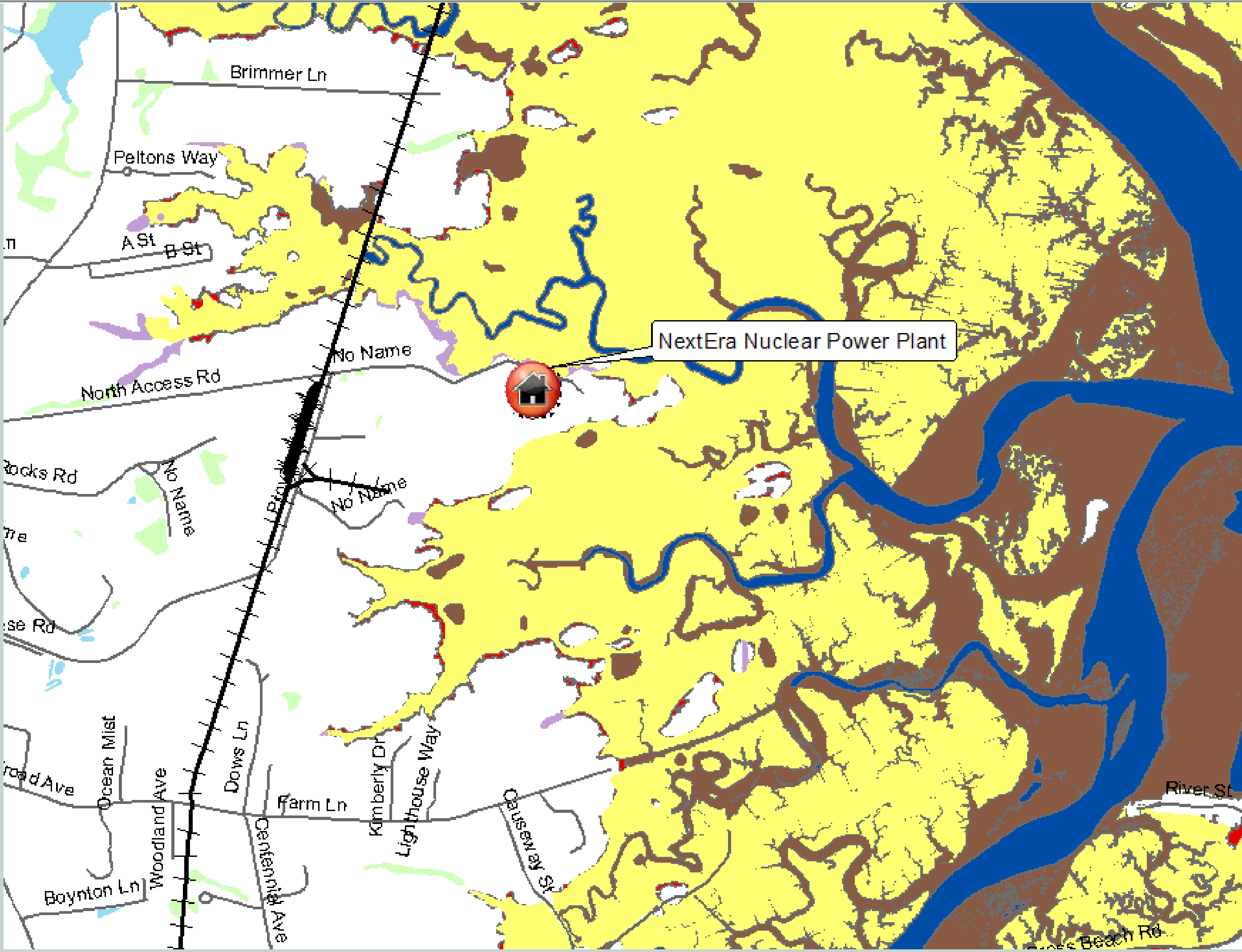
2012

Example Infrastructure

Habitat Type

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

SLR 2m / 7ft



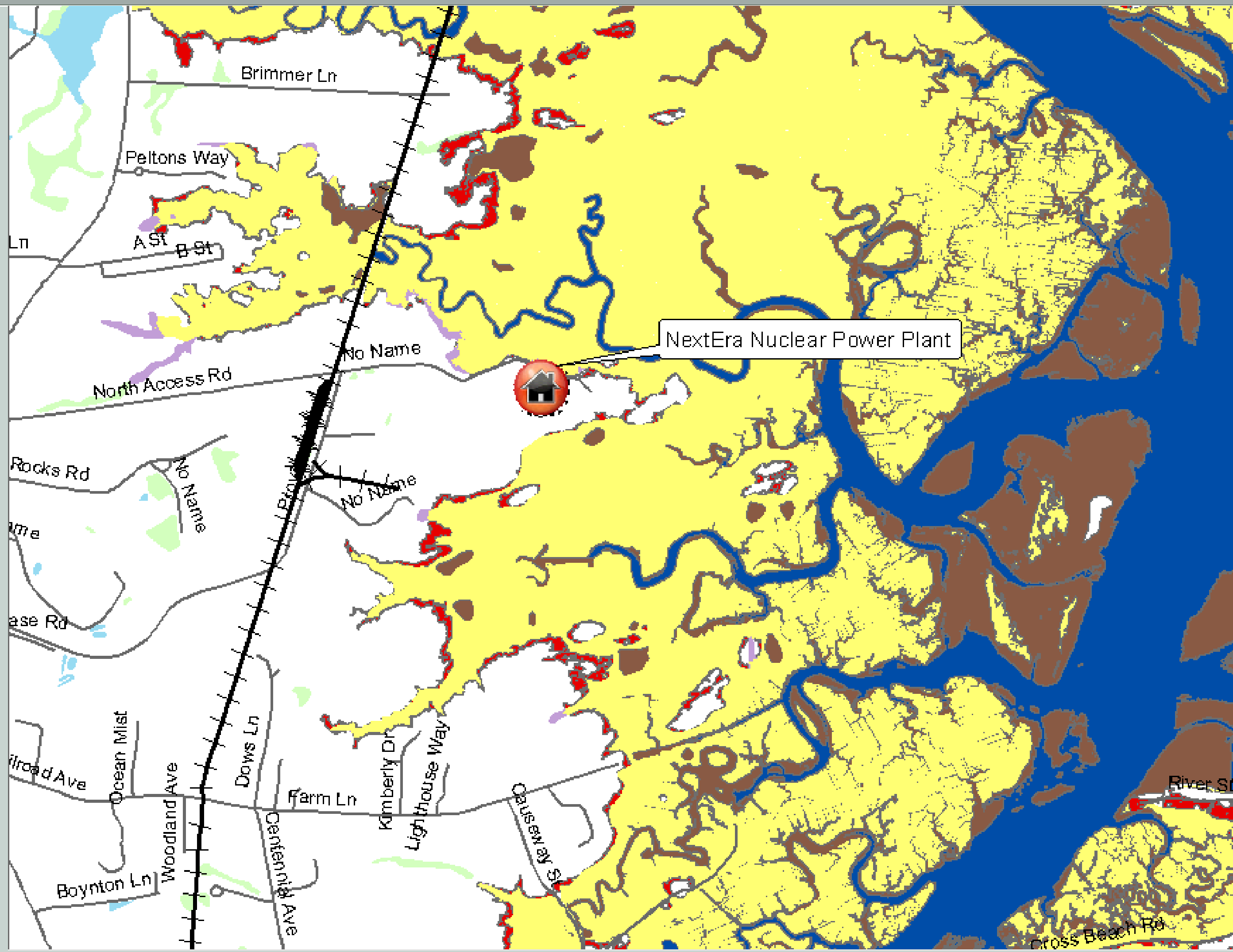
2025

Example Infrastructure

Habitat Type

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

SLR 2m / 7ft



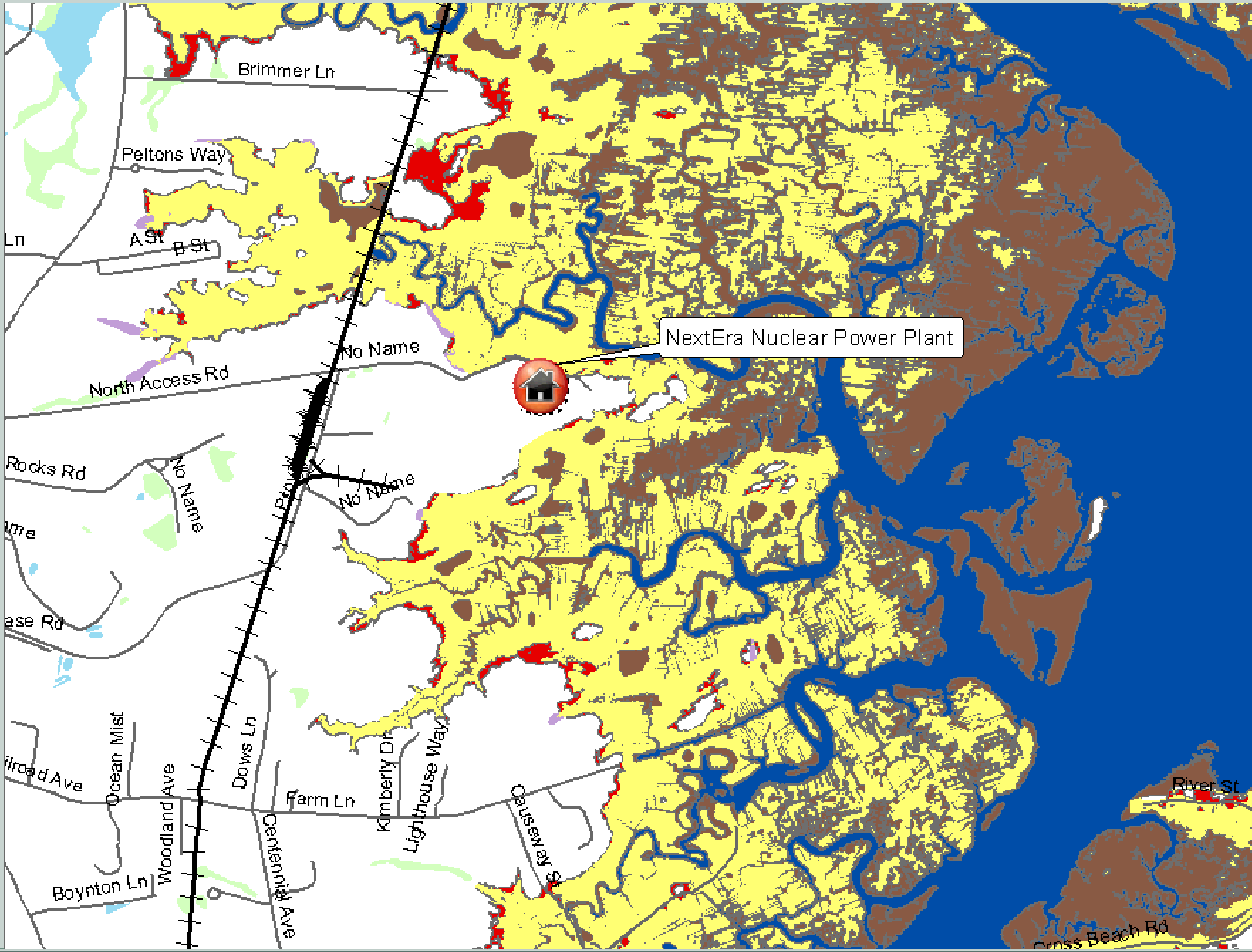
2050

Example Infrastructure

Habitat Type

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

SLR 2m / 7ft



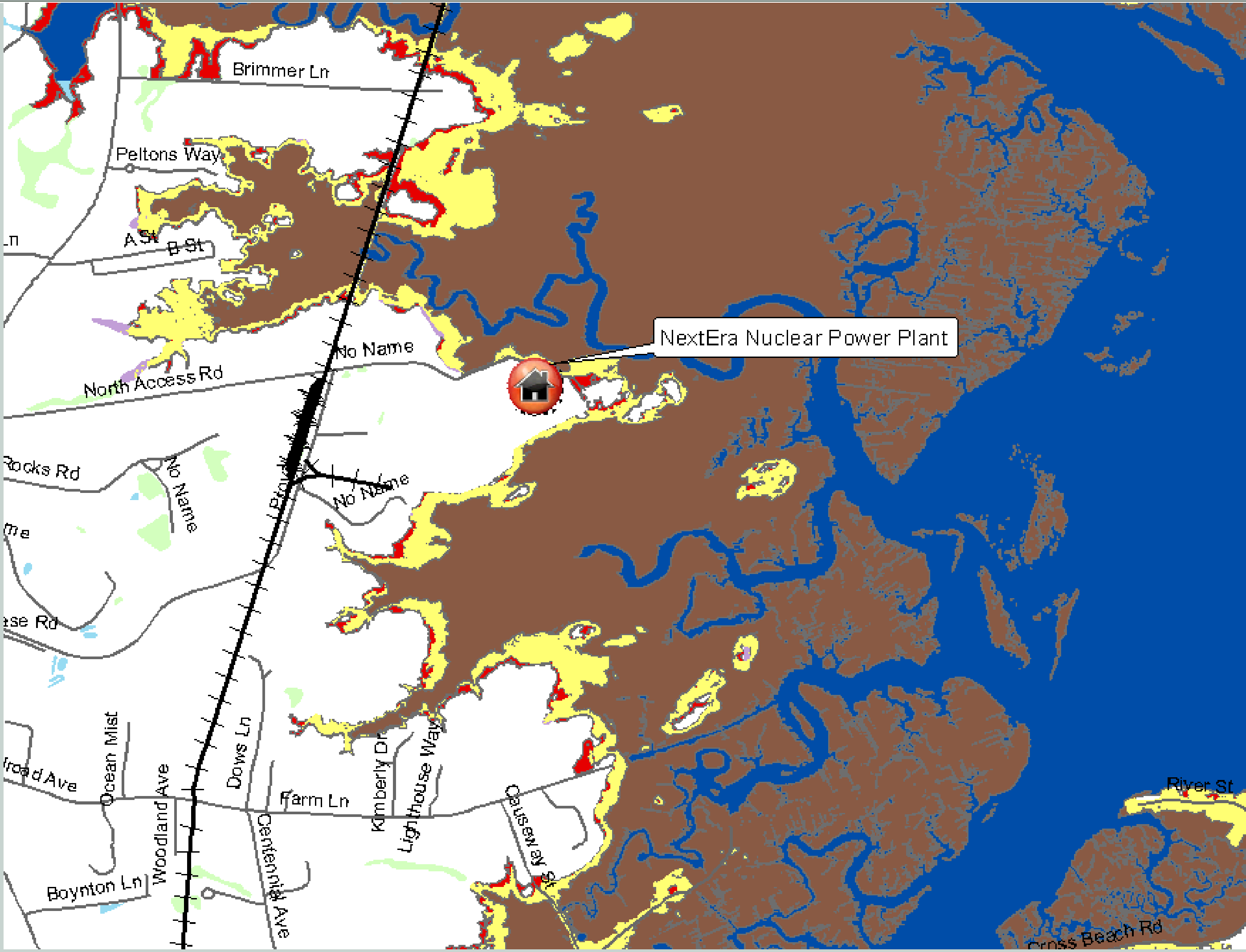
2075

Example Infrastructure

Habitat Type

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

SLR 2m / 7ft



2100

Buffers – horizontal

Buffer distance

Horizontal

- 50 feet
- 100 feet

Vertical

- 2 feet
- 5 feet
- 10 feet

2012

Buffers - vertical

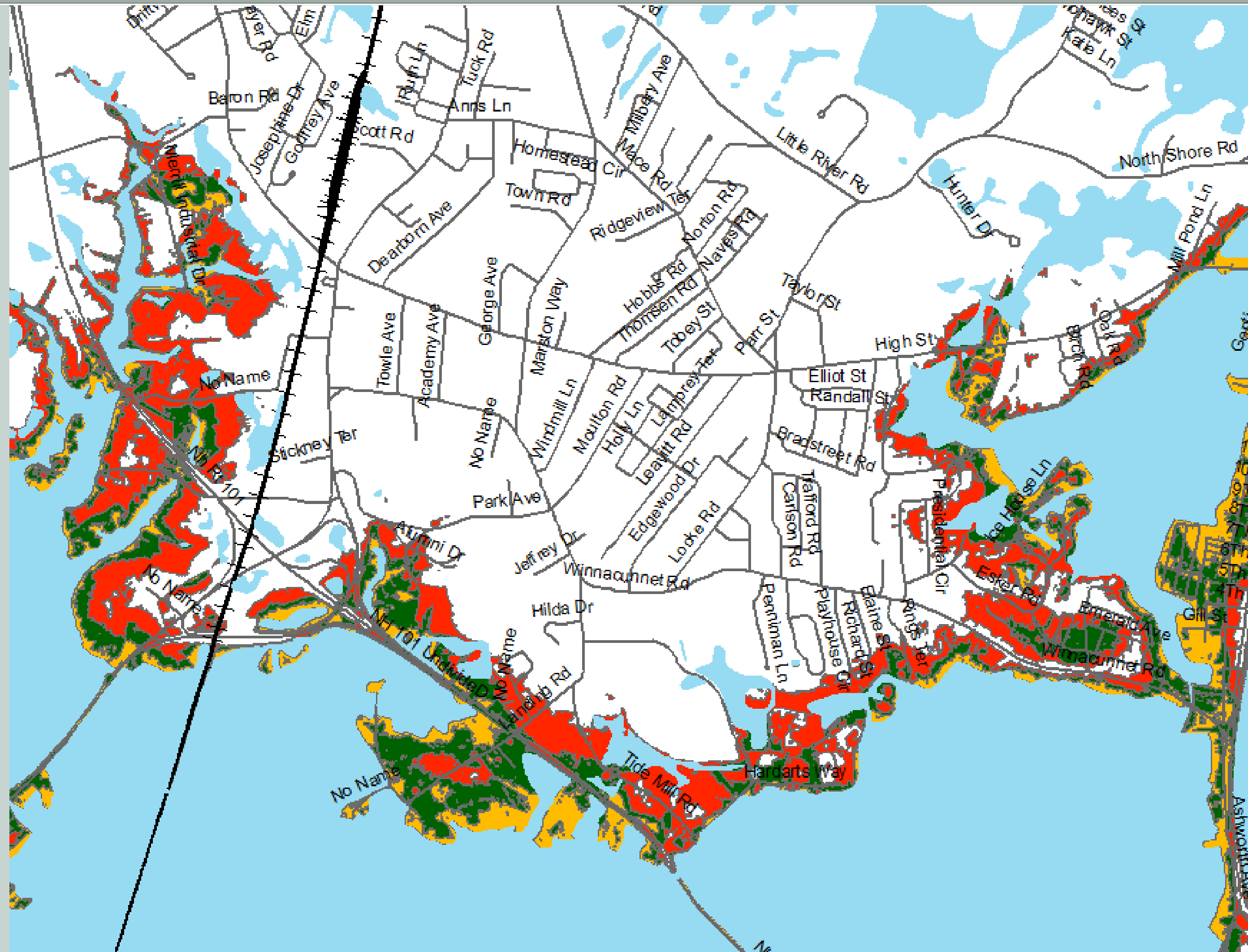
Buffer distance

Horizontal

- 50 feet
- 100 feet

Vertical

- 2 feet
- 5 feet
- 10 feet



2012

Buffers

Buffer distance

Horizontal

- 50 feet
- 100 feet

Vertical

- 2 feet
- 5 feet
- 10 feet

2012

Buffers – horizontal change over time (100ft)

Buffer distance

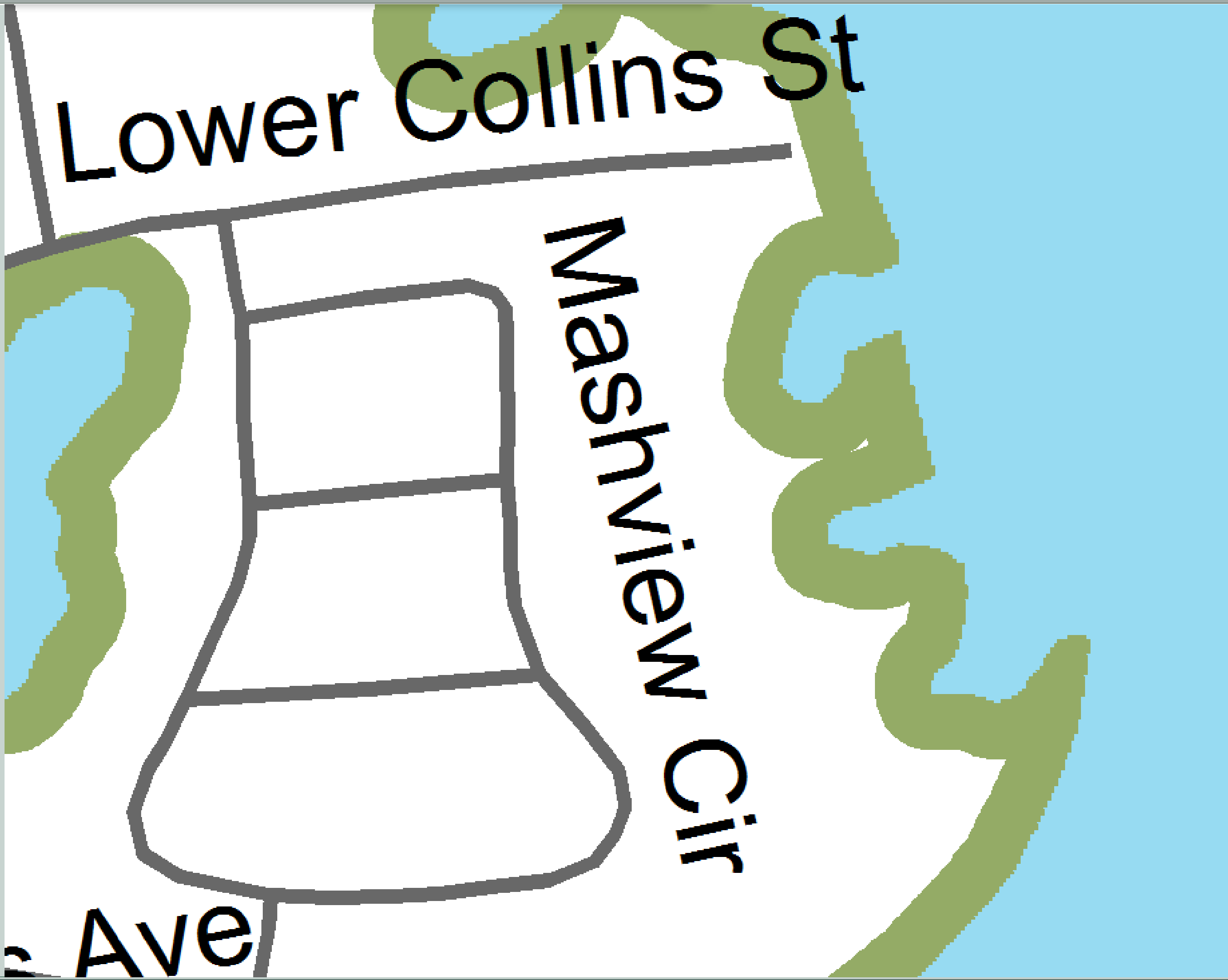
Horizontal

- 50 feet
- 100 feet

Vertical

- 2 feet
- 5 feet
- 10 feet

SLR 2m / 7ft



2012

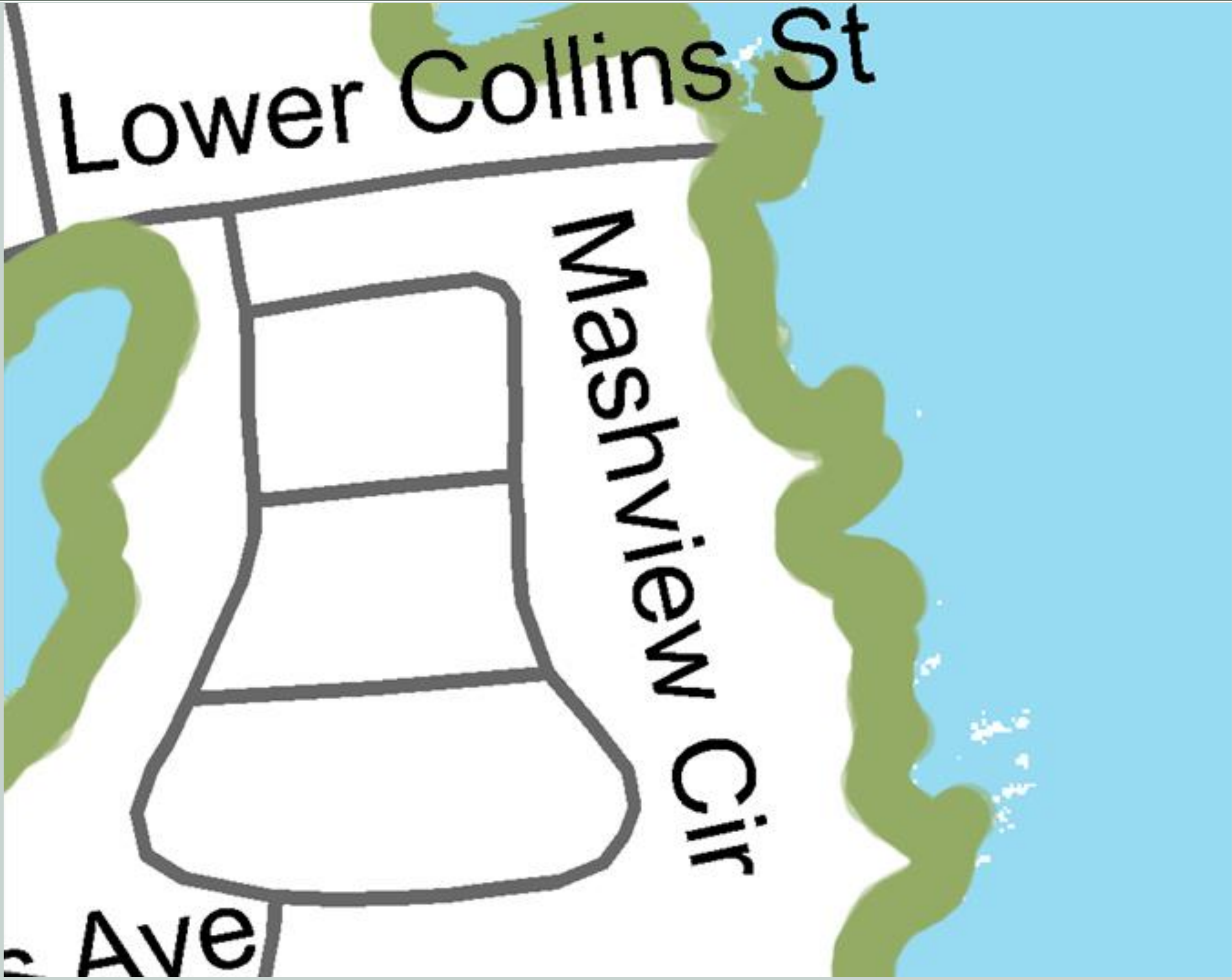
Buffers – horizontal change over time (100ft)

Buffer distance

Horizontal
- 50 feet
- 100 feet

Vertical
- 2 feet
- 5 feet
- 10 feet

SLR 2m / 7ft



2050

Buffers – horizontal change over time (100ft)

Buffer distance

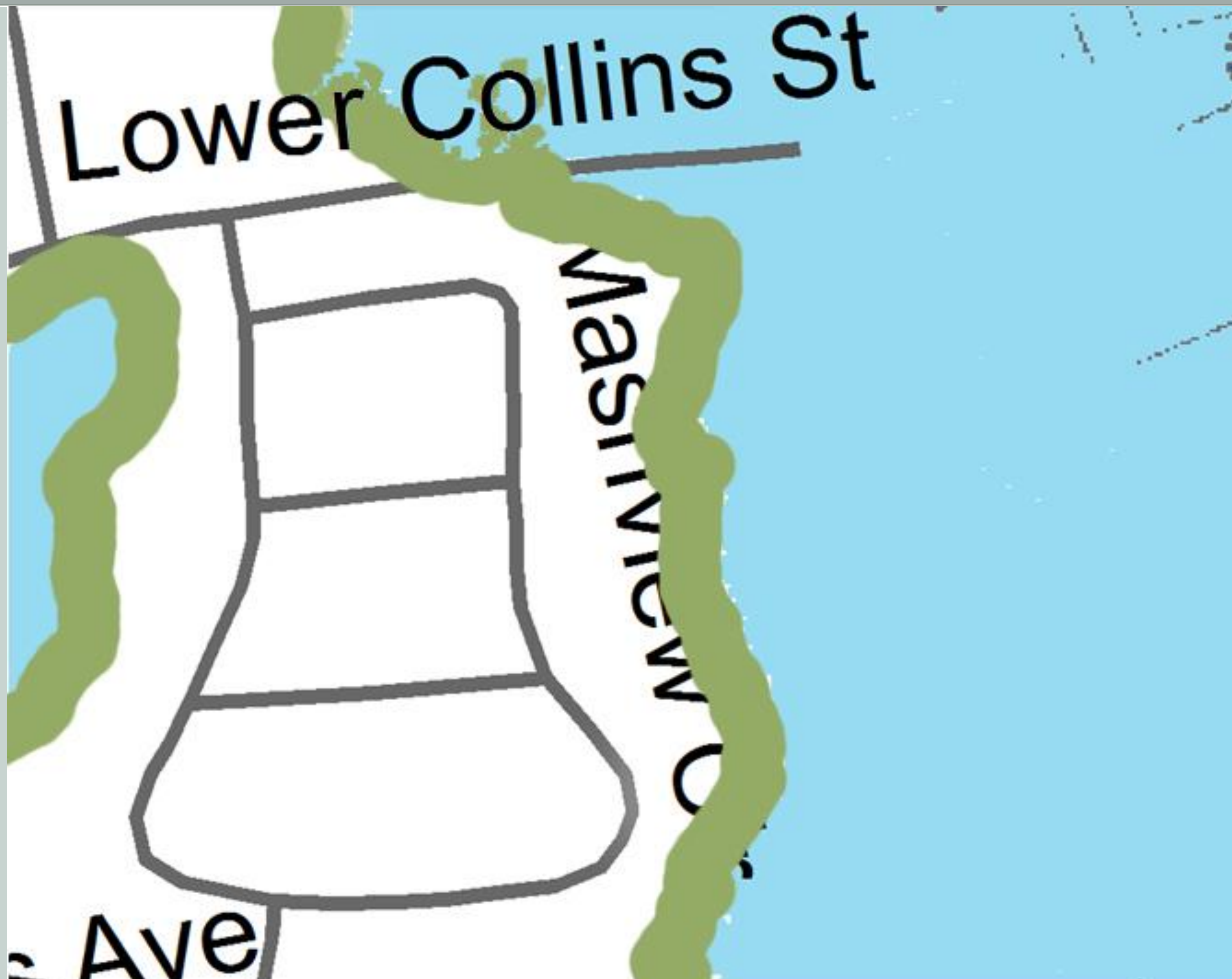
Horizontal

- 50 feet
- 100 feet

Vertical

- 2 feet
- 5 feet
- 10 feet

SLR 2m / 7ft



2100