Investigating the Potential for Tidal Marsh Migration

If sea level rises as projected where will marshes go?

Funded by:

Maine Coastal Program

Municipal Planning and Assistance
Maine Natural Areas Program
Maine Geological Survey

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NOAA

MAINE OUTDOOR HERITAGE FUND

Tidal Marsh Migration Analysis

Two phases:

1 – South coast
2 – Entire coast

Scope - only estuaries with existing tidal marshes

Analysis elements

- land cover types / land uses
- freshwater wetlands (NWI)
- conservation lands
- coastal ecoregions
- planning considerations

Project Area

Tidal Marsh Migration Project

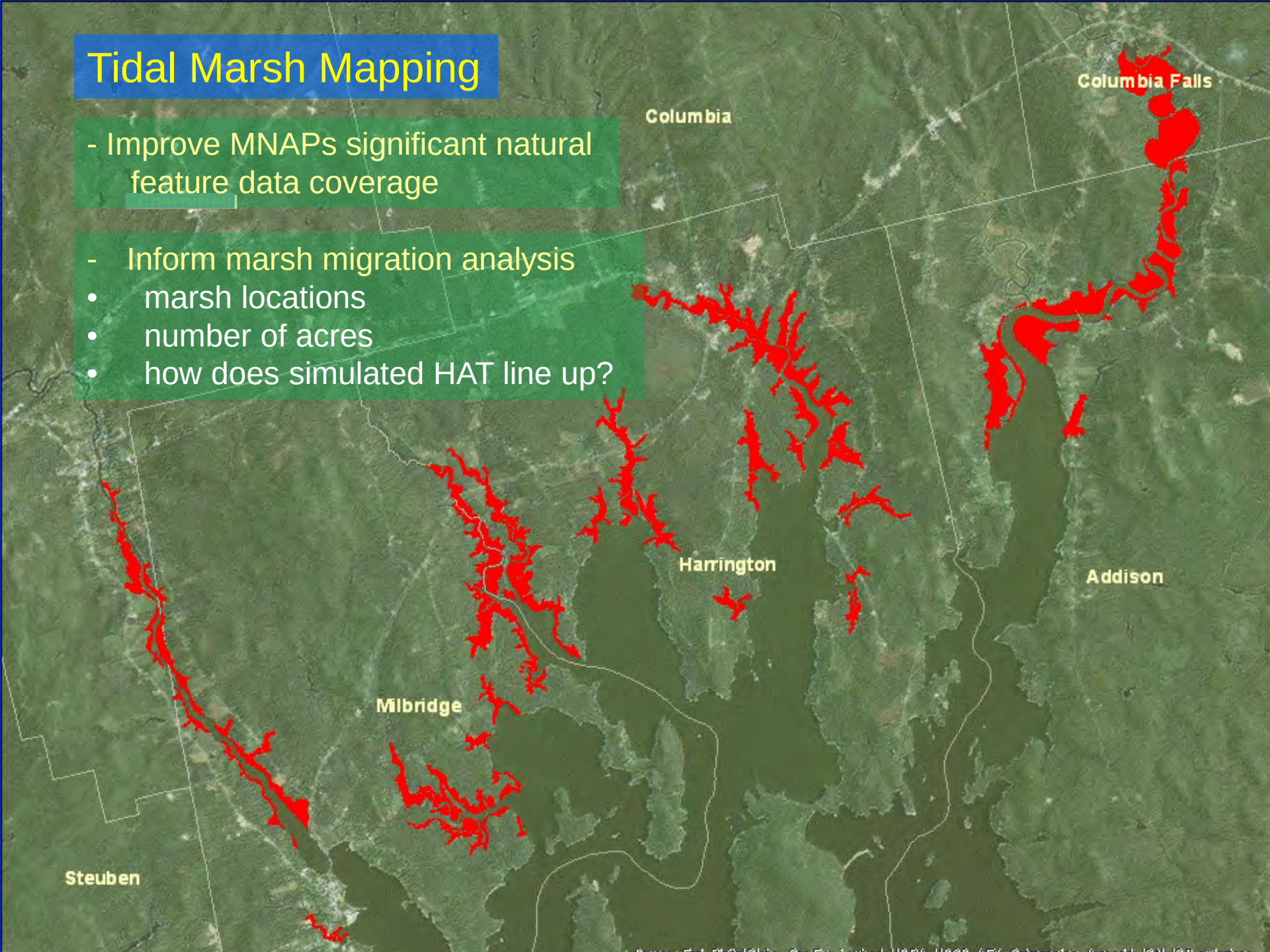
Steps

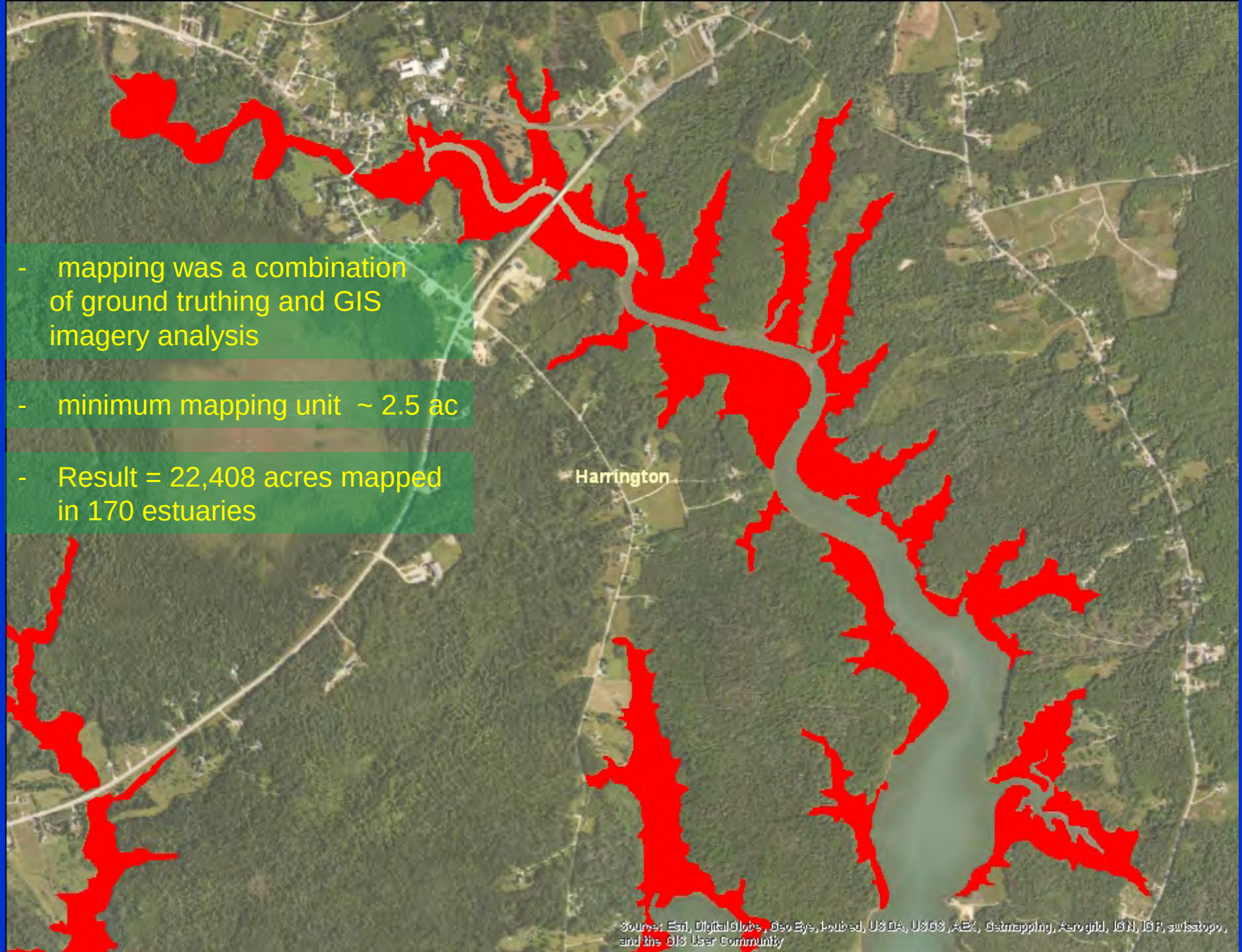
1. Tidal marsh mapping
2. LiDAR ground truthing
3. Sea level rise simulations
4. Marsh migration analysis
5. Communicate results

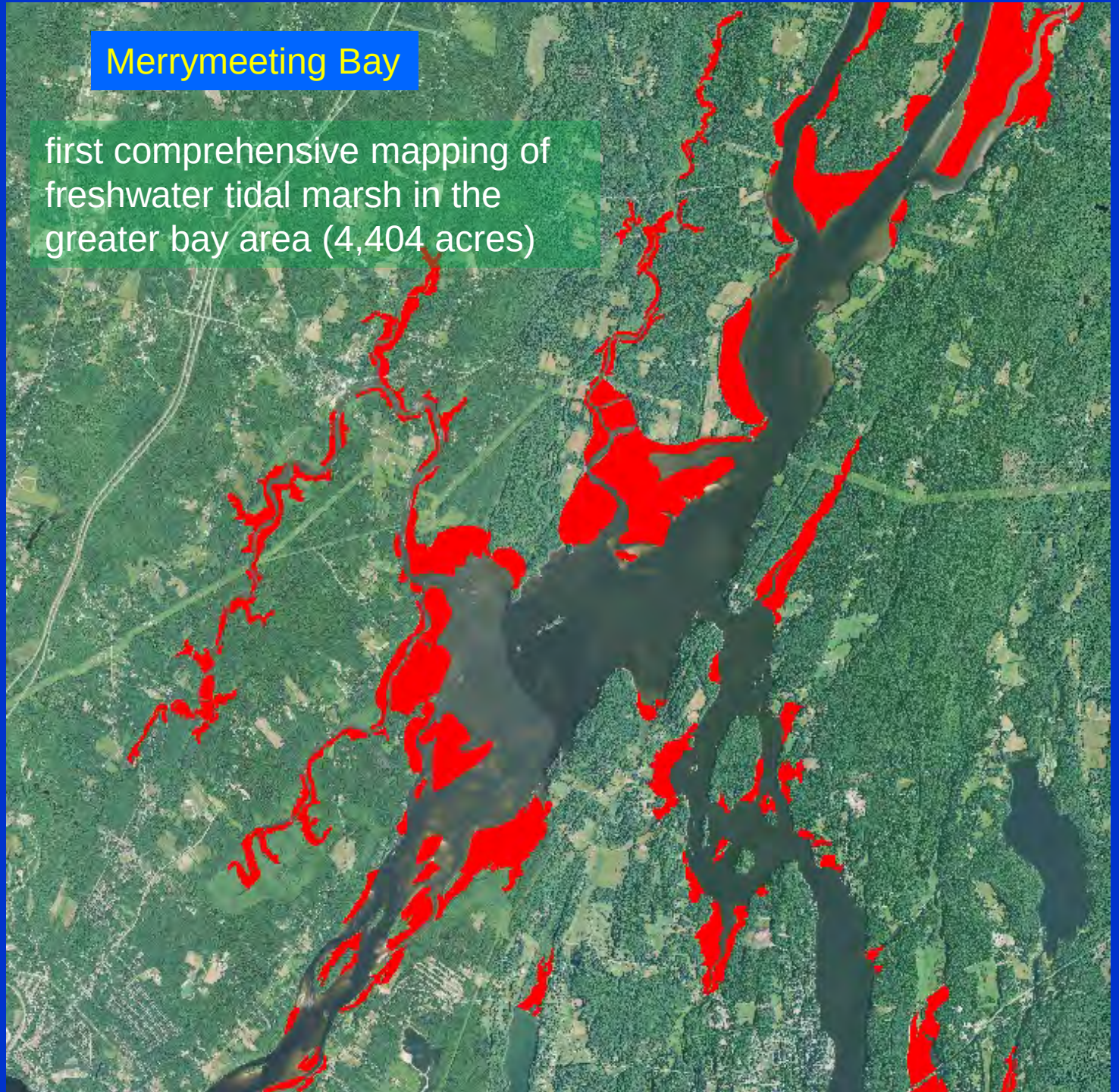
Tidal Marsh Mapping

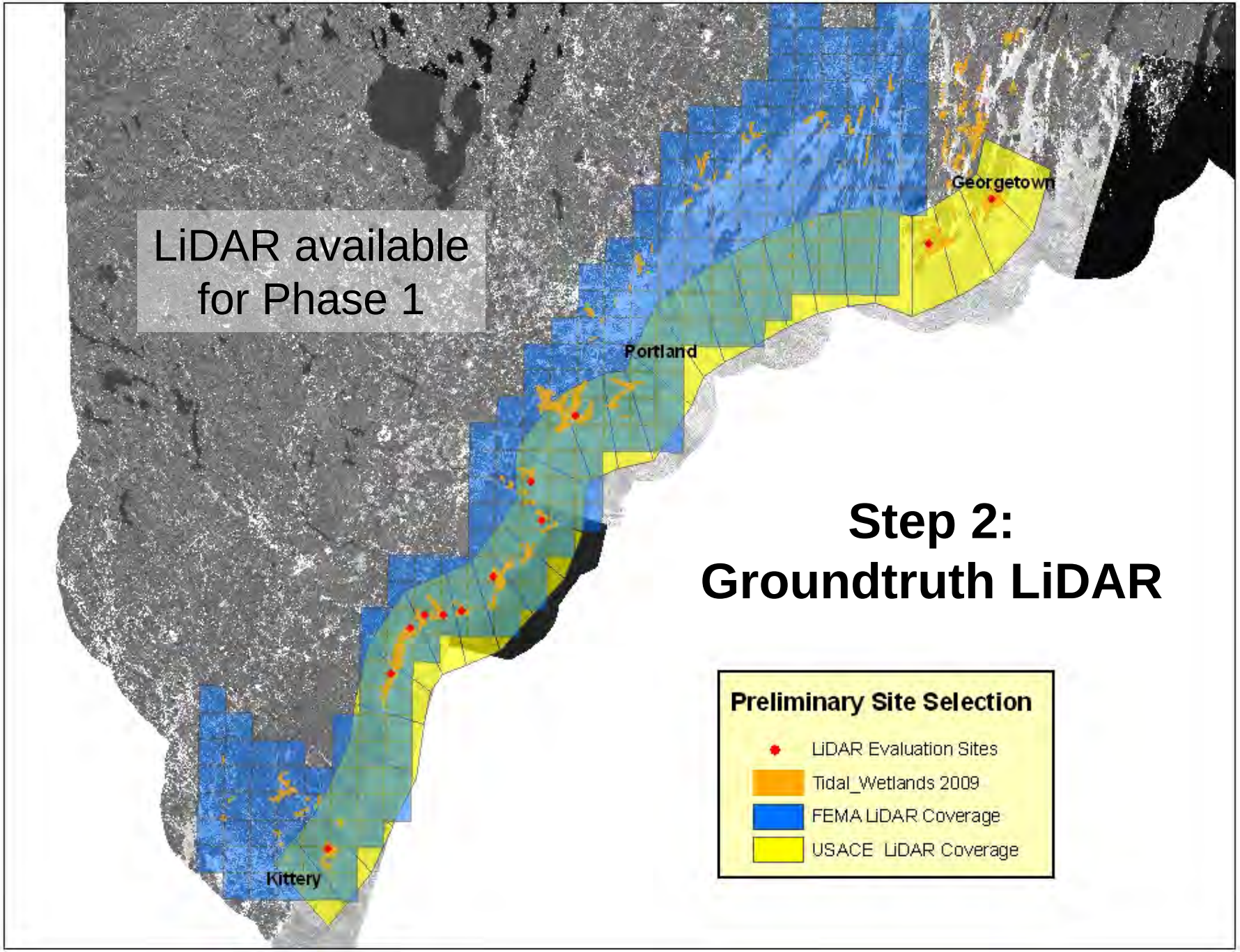
- Improve MNAPs significant natural feature data coverage

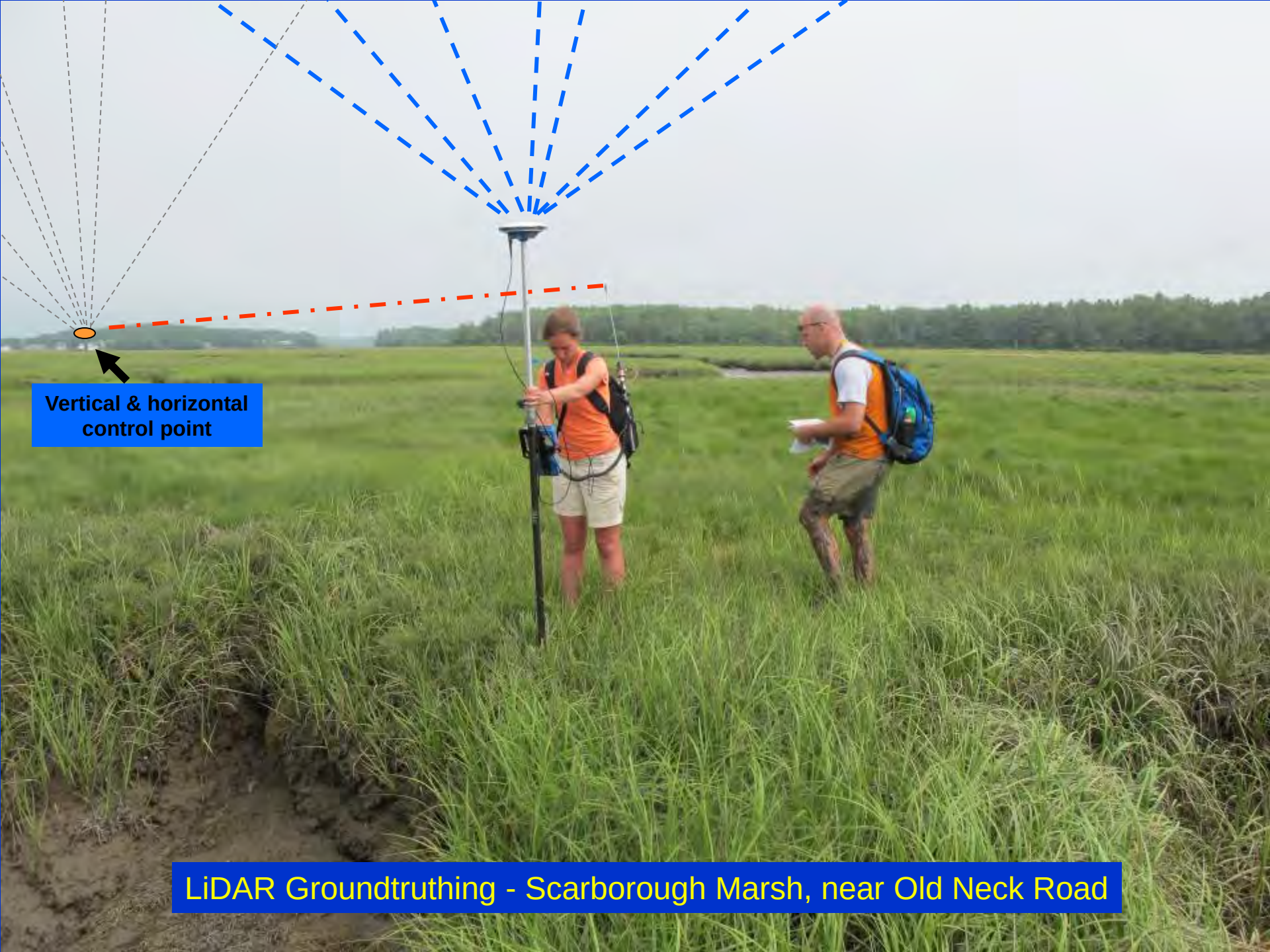
- Inform marsh migration analysis
  - marsh locations
  - number of acres
  - how does simulated HAT line up?



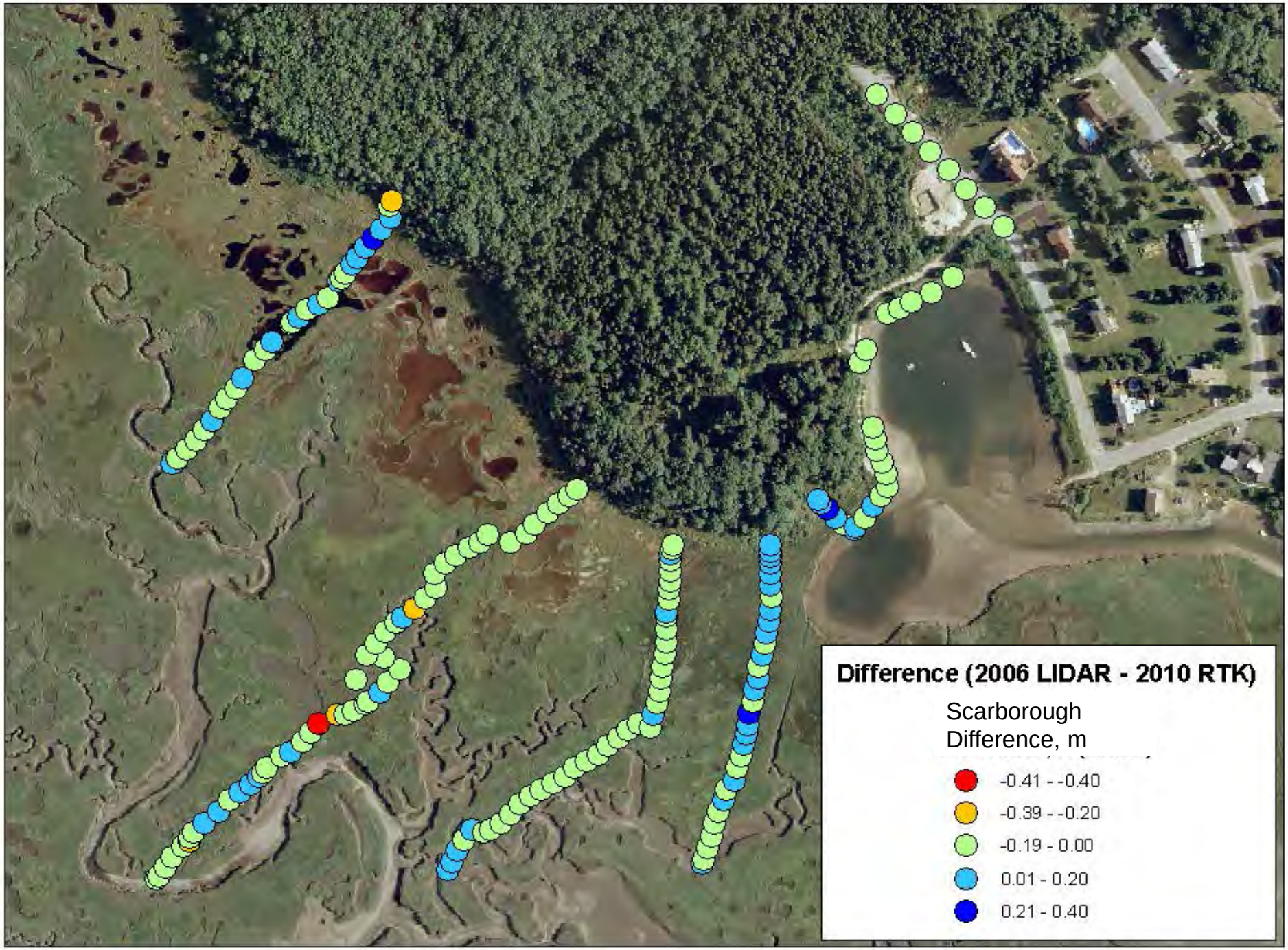

- mapping was a combination of ground truthing and GIS imagery analysis
- minimum mapping unit ~ 2.5 ac
- Result = 22,408 acres mapped in 170 estuaries
Harrington
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Merrymeeting Bay
first comprehensive mapping of freshwater tidal marsh in the greater bay area (4,404 acres)


LiDAR available for Phase 1
Georgetown
Portland
Kittery
Step 2:
Groundtruth LiDAR
Preliminary Site Selection
LiDAR Evaluation Sites
Tidal_Wetlands 2009
FEMA LiDAR Coverage
USACE LiDAR Coverage



LiDAR Groundtruthing - Scarborough Marsh, near Old Neck Road


Difference (2006 LIDAR - 2010 RTK)
Scarborough
Difference, m
-0.41 - -0.40
-0.39 - -0.20
-0.19 - 0.00
0.01 - 0.20
0.21 - 0.40

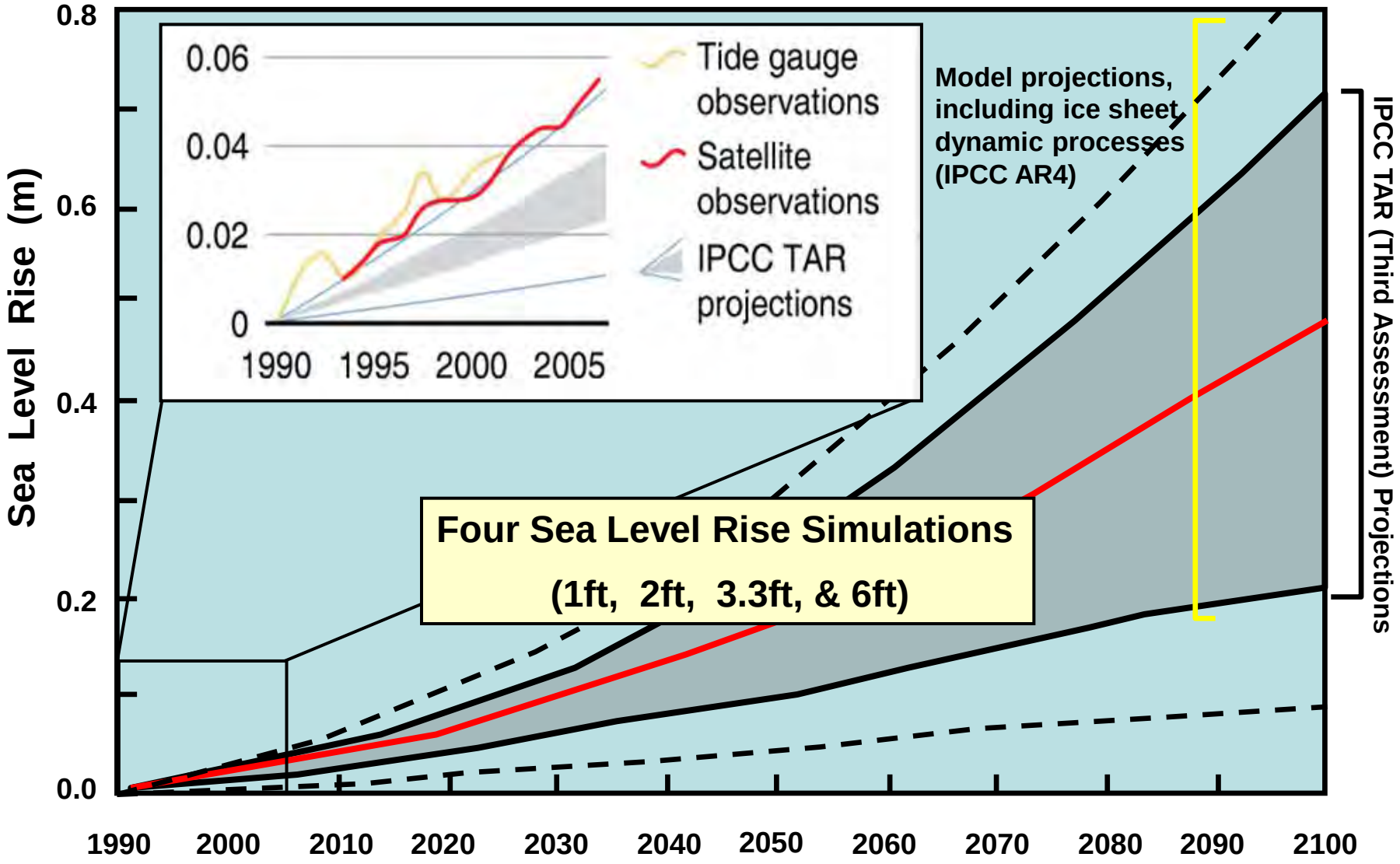
LiDAR Groundtruthing Results

11 sites, 4-6 transects per site

N = 2240 (elevation points)

Mean Difference = +1.2 cm

SD = 11.7 cm



Pete Slovinsky, Maine Geological Survey 2015

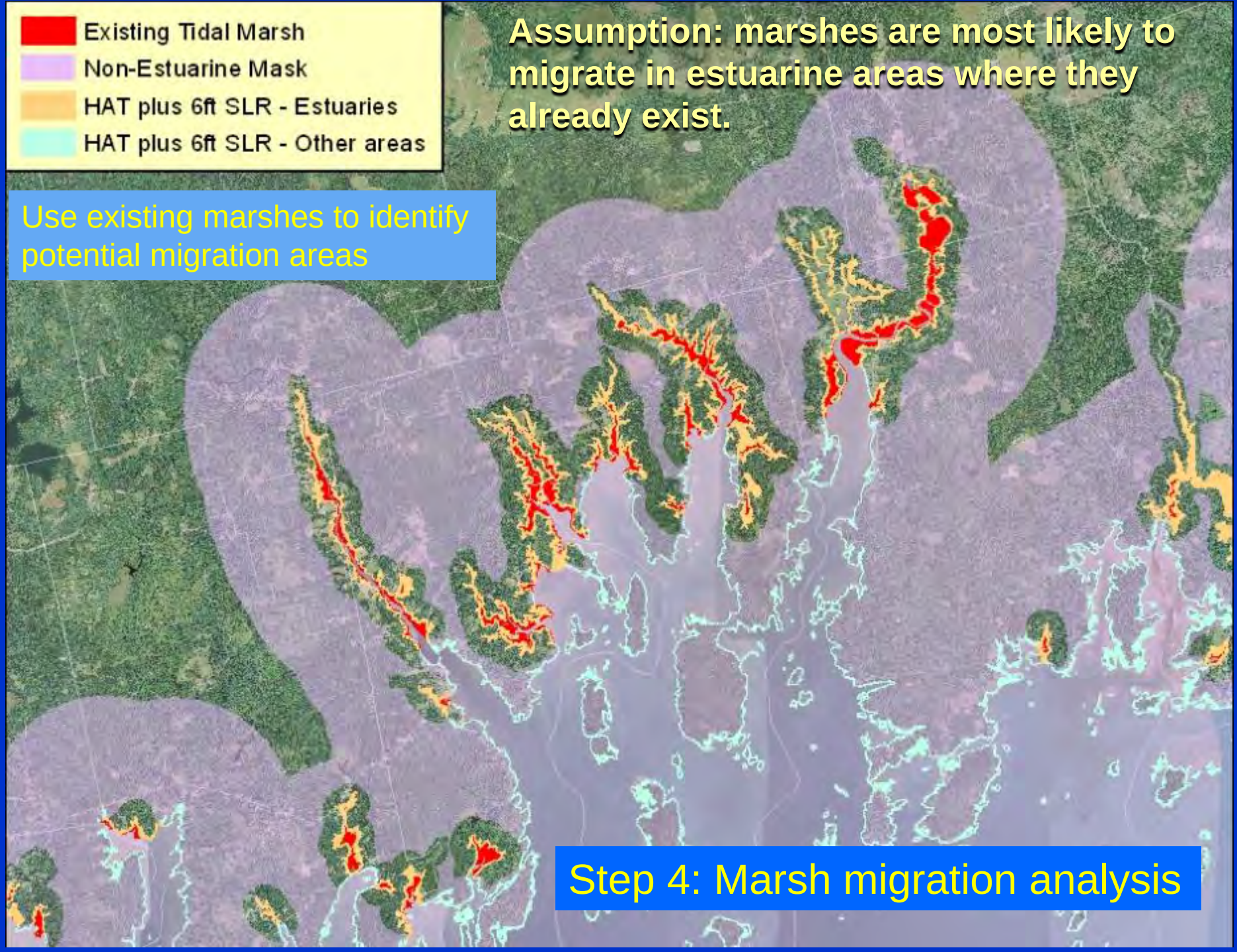
Sea Level Rise Simulations - 1', 2', 3.3', 6'

1 – create a model of highest annual tide (HAT) coastwide

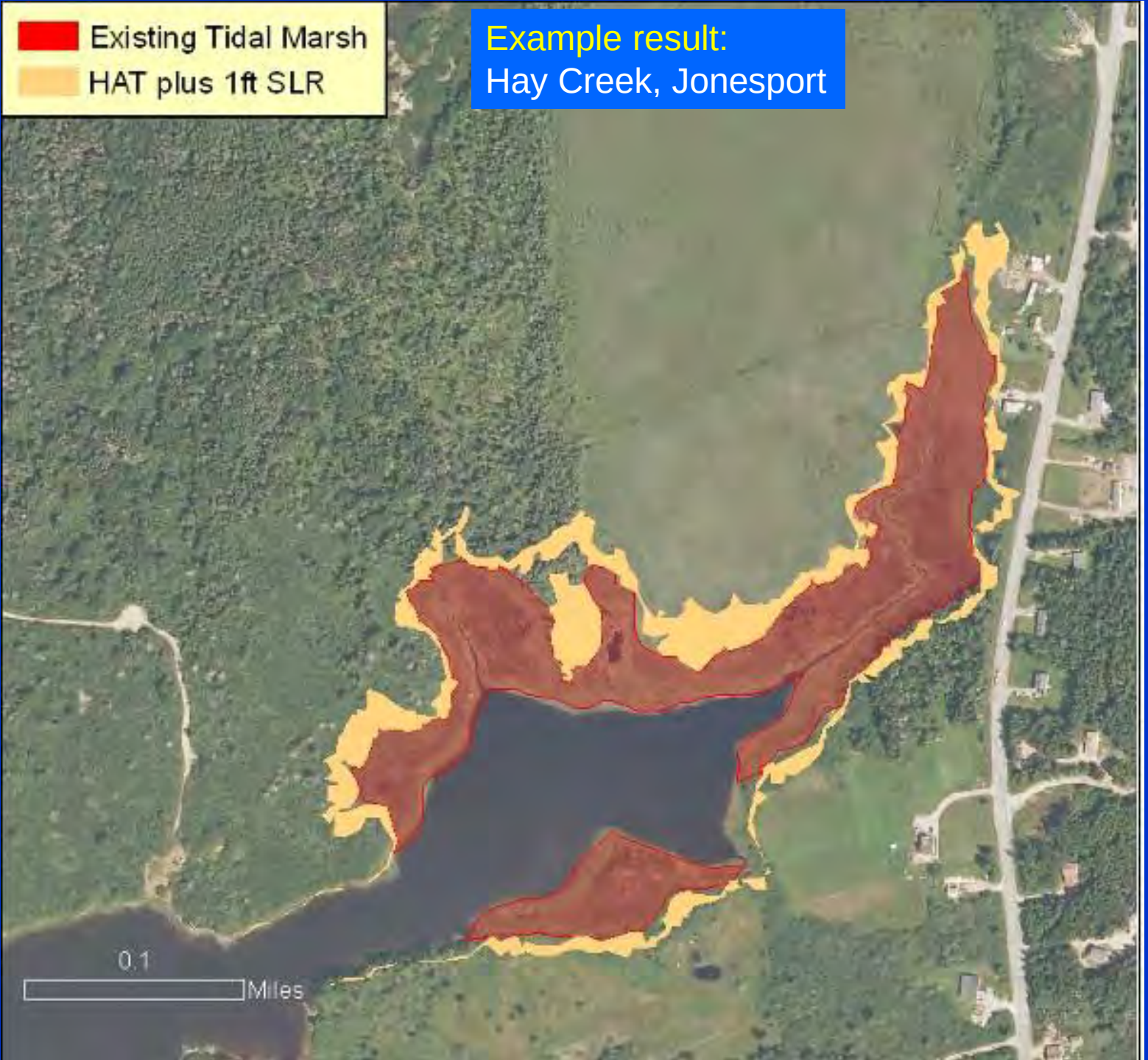
- data from local tide stations was used to address wide tidal variability, and was interpolated across a grid to assign values to sections of the coast (MGS - Slovinsky, Hallstead).

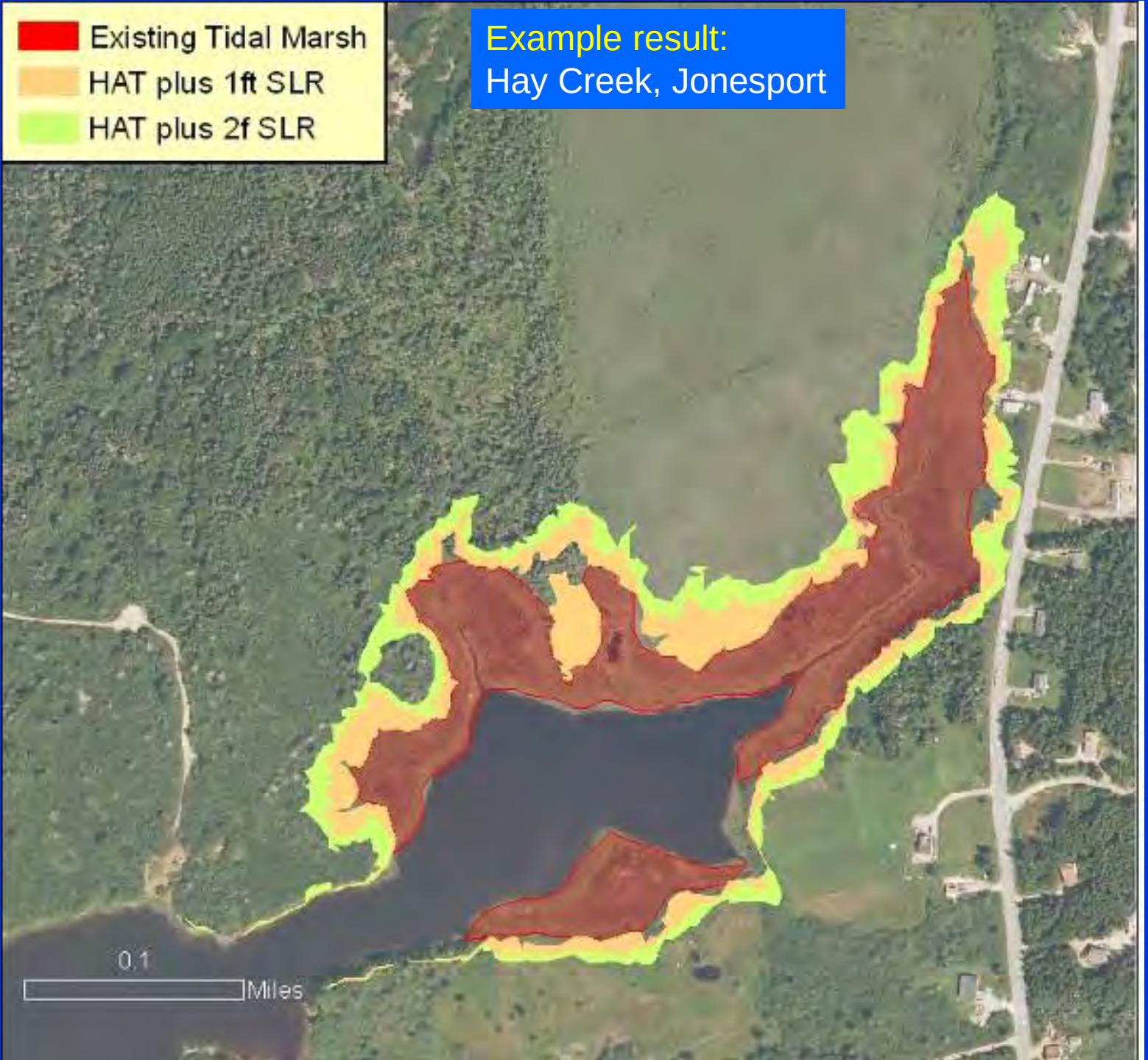
2 – create 4 SLR simulations with HAT as starting point

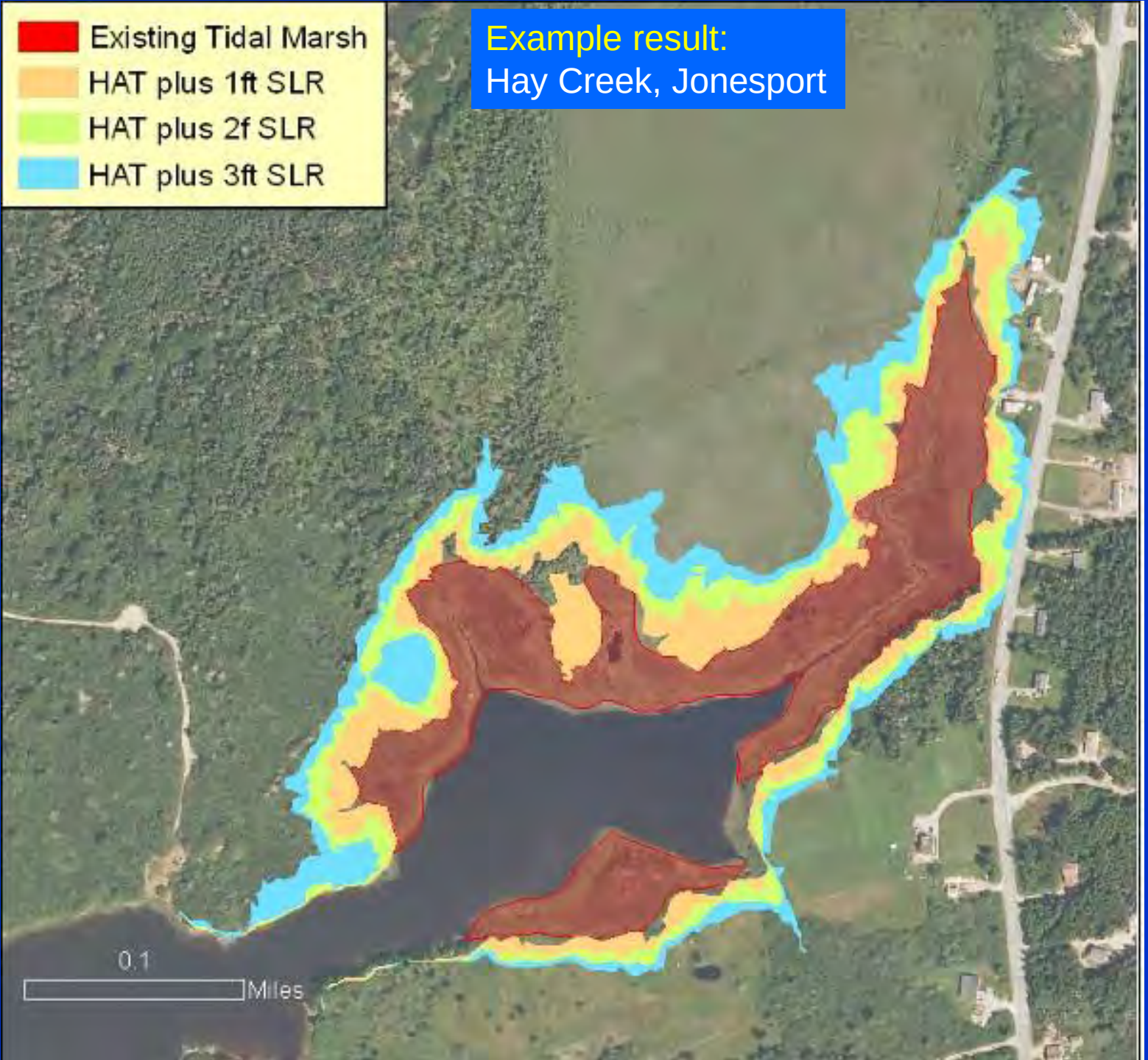
- simulations are described as a bath tub model, only showing what non-tidal areas will inundated at each SLR depth, and do not address what may happen to existing marshes. SLAMM (Sea Level Affecting Marshes Model) was not used due to a lack of sedimentation data for most of the estuaries.

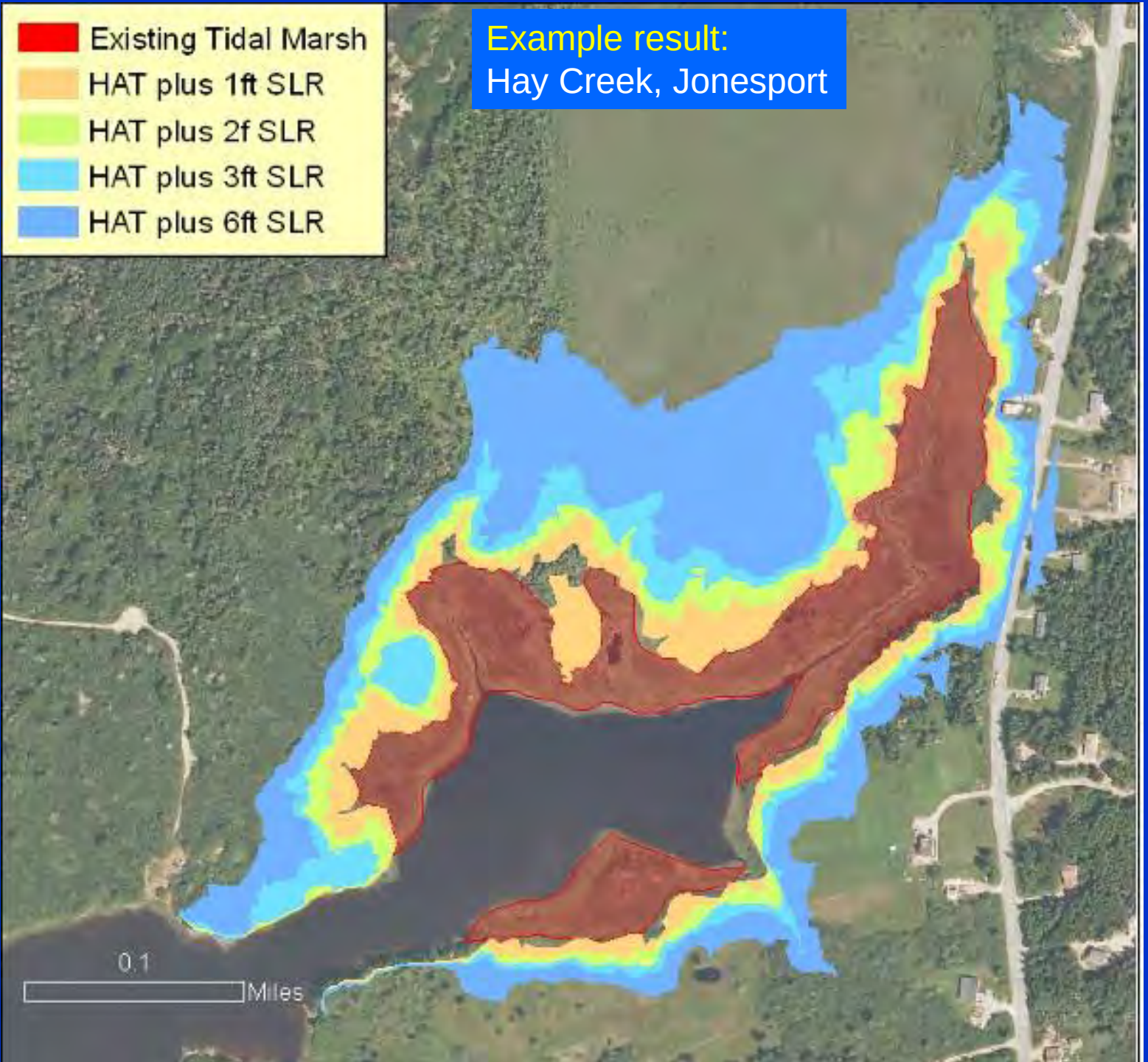

Existing Tidal Marsh
Non-Estuarine Mask
HAT plus 6ft SLR - Estuaries
HAT plus 6ft SLR - Other areas
Assumption: marshes are most likely to migrate in estuarine areas where they already exist.
Use existing marshes to identify potential migration areas
Step 4: Marsh migration analysis


Existing Tidal Marsh
Example result:
Hay Creek, Jonesport
0.1
Miles

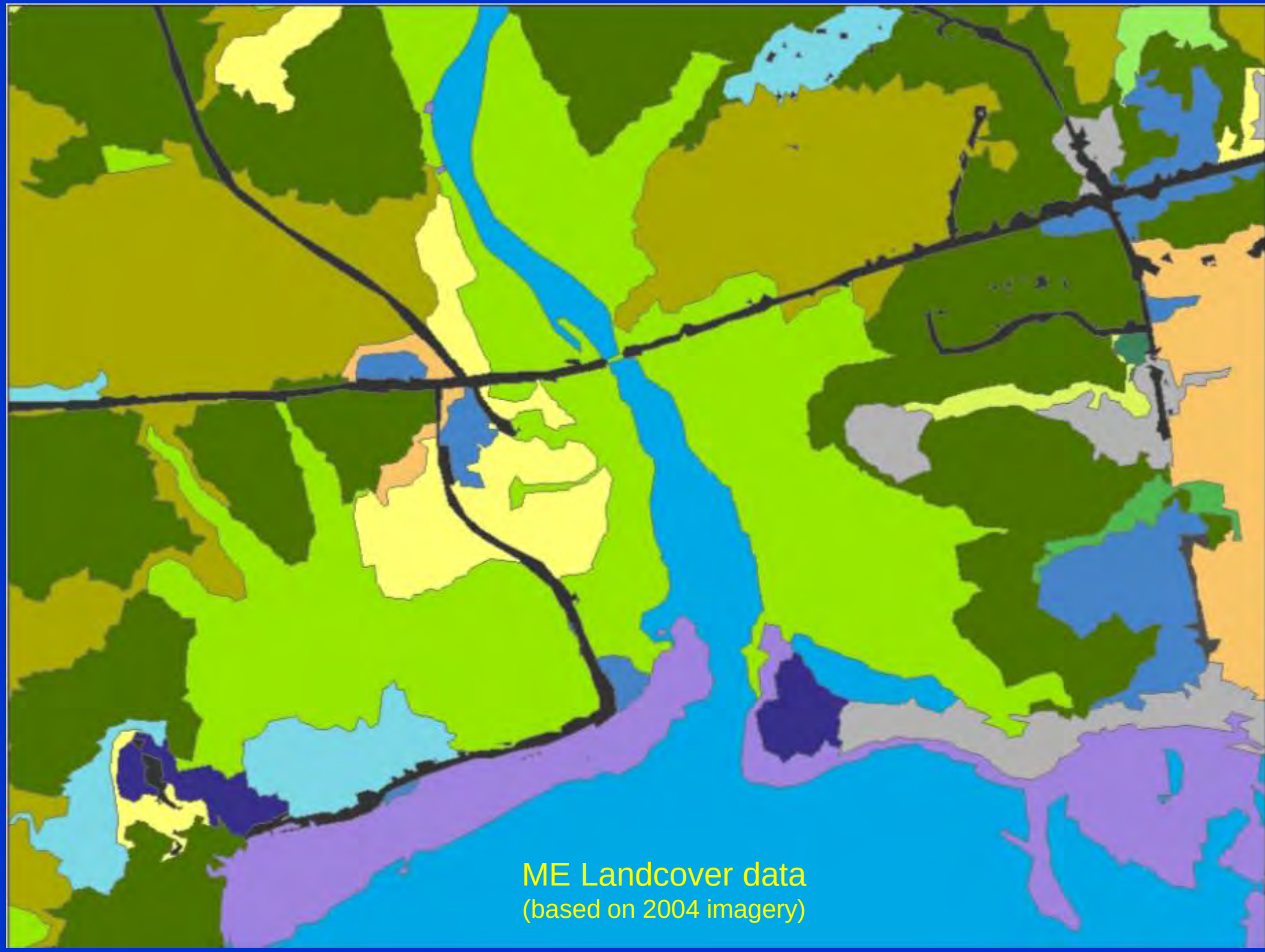

Existing Tidal Marsh
HAT plus 1ft SLR
Example result:
Hay Creek, Jonesport
0.1
Miles


Existing Tidal Marsh
HAT plus 1ft SLR
HAT plus 2f SLR
Example result:
Hay Creek, Jonesport
0.1
Miles


Existing Tidal Marsh
HAT plus 1ft SLR
HAT plus 2f SLR
HAT plus 3ft SLR
Example result:
Hay Creek, Jonesport
0.1
Miles

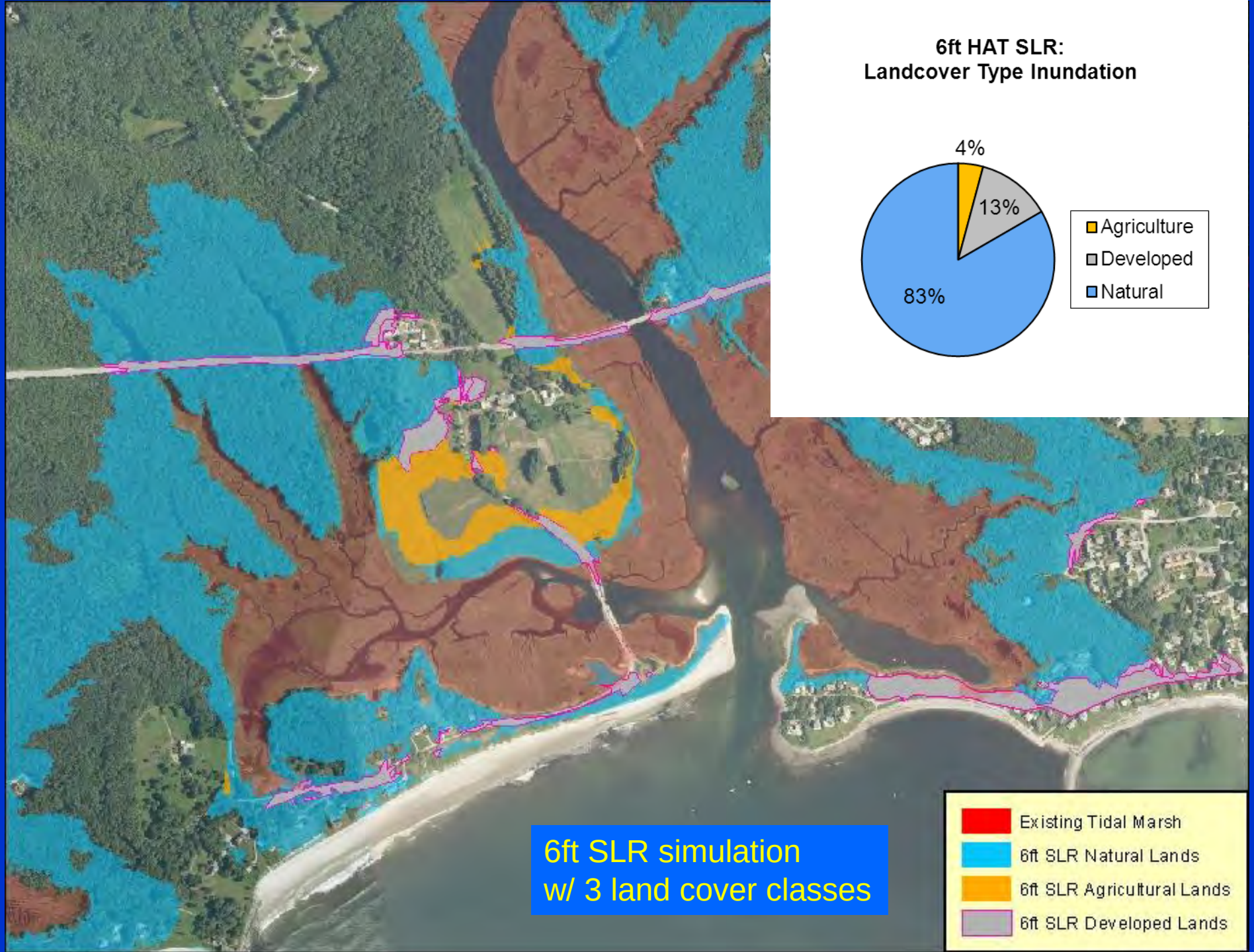

Existing Tidal Marsh
HAT plus 1ft SLR
HAT plus 2f SLR
HAT plus 3ft SLR
HAT plus 6ft SLR
Example result:
Hay Creek, Jonesport
0.1
Miles


What data is most relevant in planning for tidal mash migration?
Mousam River tidal marshes
(Kennebunk)

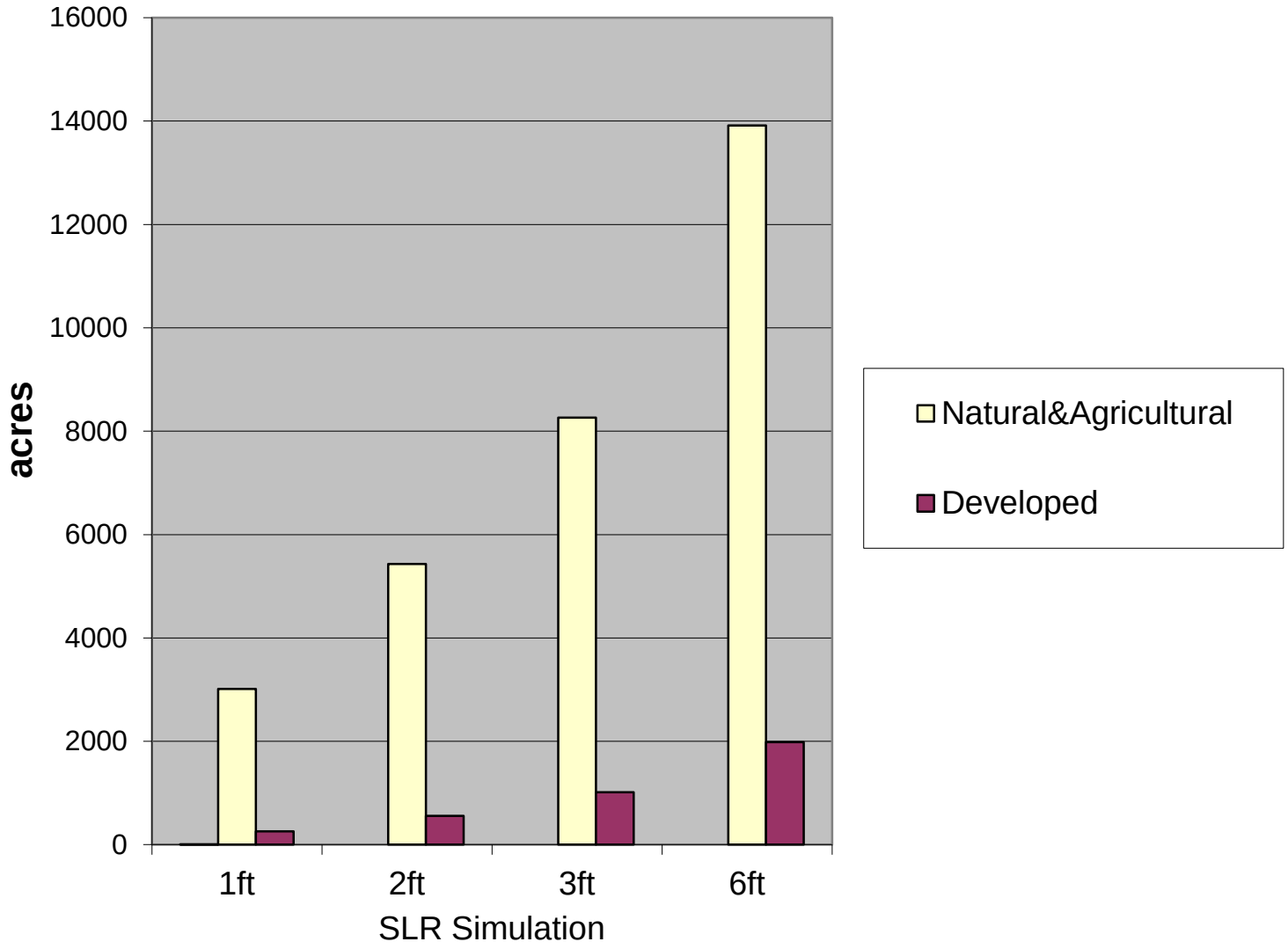

ME Landcover data
(based on 2004 imagery)

ME Landcover Categories

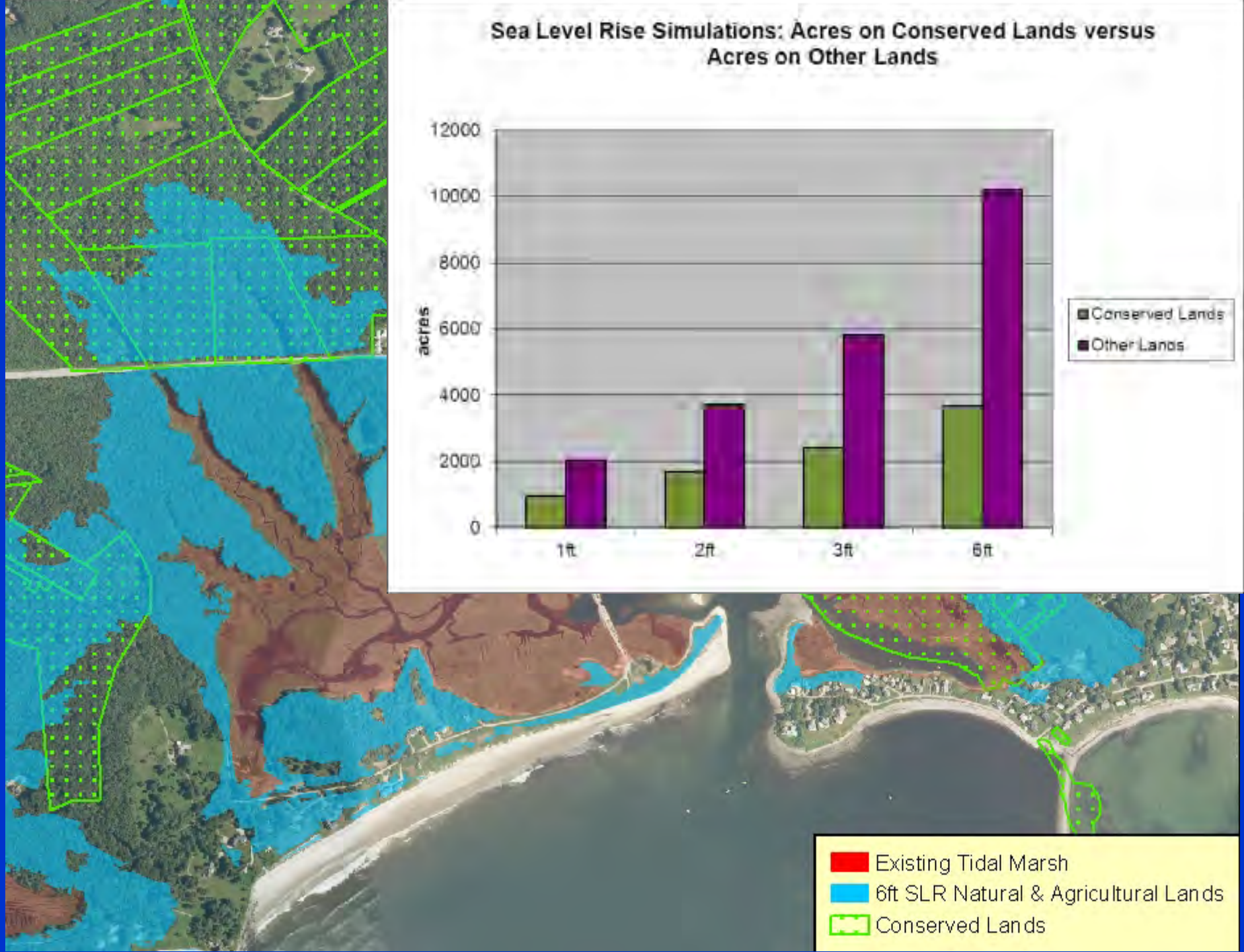
Pixel value	Cover type
Developed	
2	Developed, High Intensity (80-100% impervious)
3	Developed, Medium Intensity (50-79% impervious)
4	Developed, Low Intensity (21-49% impervious)
5	Developed, Open Space (developed areas, but 0-20% impervious - city parks, golf courses, baseball fields, etc.)
16	Road/Runway (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)

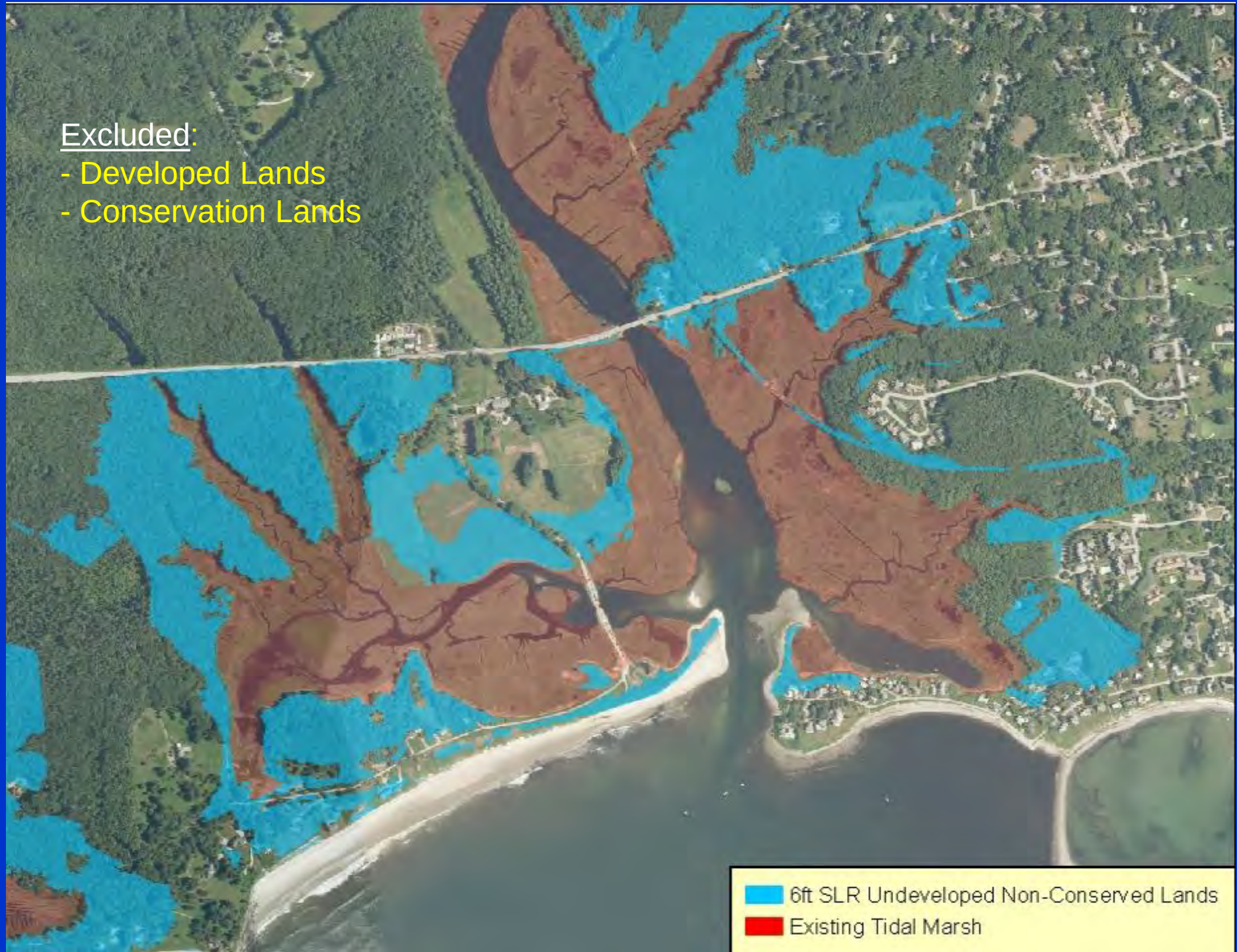

6ft HAT SLR:
Landcover Type Inundation
4%
13%
83%
Agriculture
Developed
Natural
6ft SLR simulation
w/ 3 land cover classes
Existing Tidal Marsh
6ft SLR Natural Lands
6ft SLR Agricultural Lands
6ft SLR Developed Lands

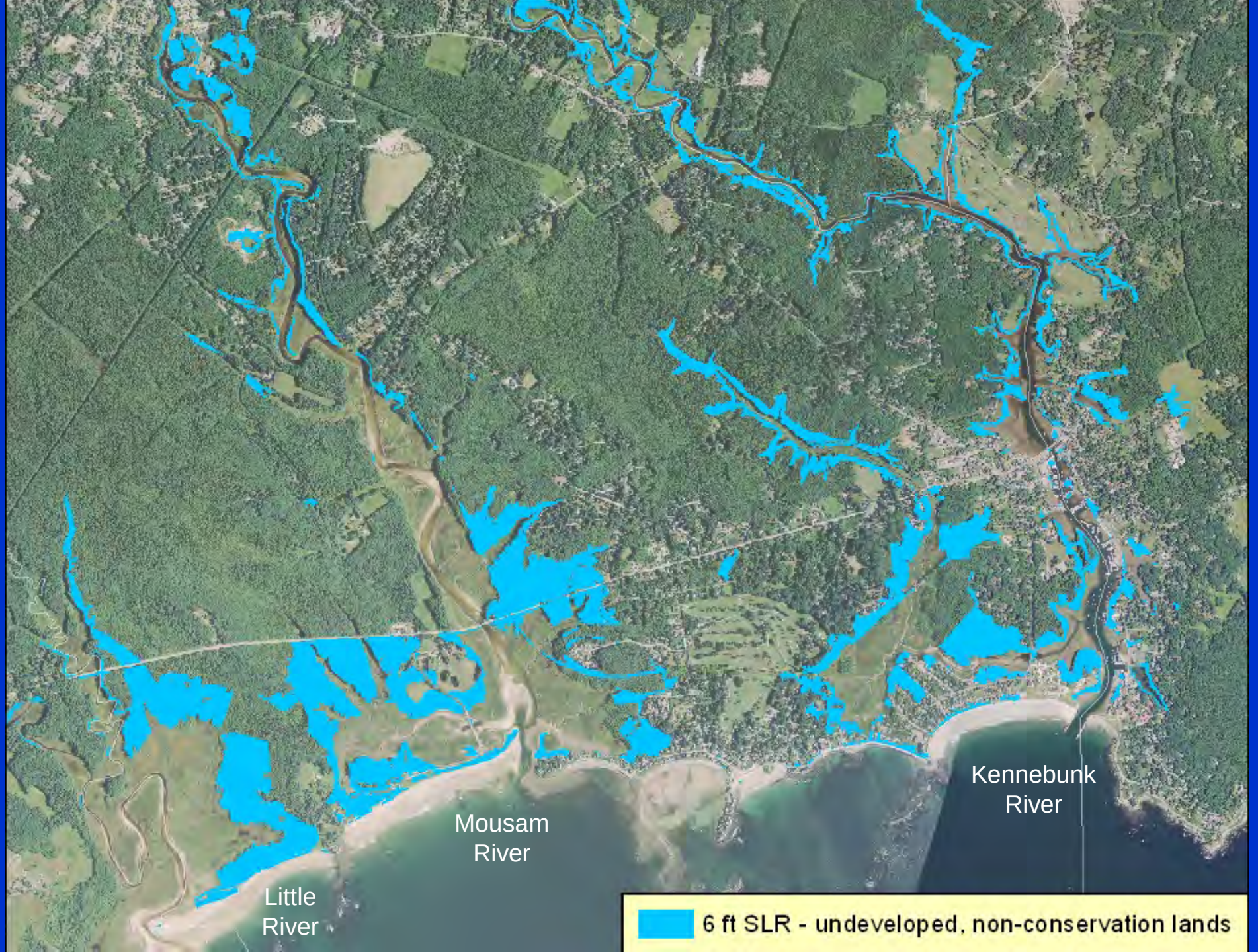
Acreages for 4 SLR Simulations, Natural & Agricultural vs Developed Lands as per MELCD



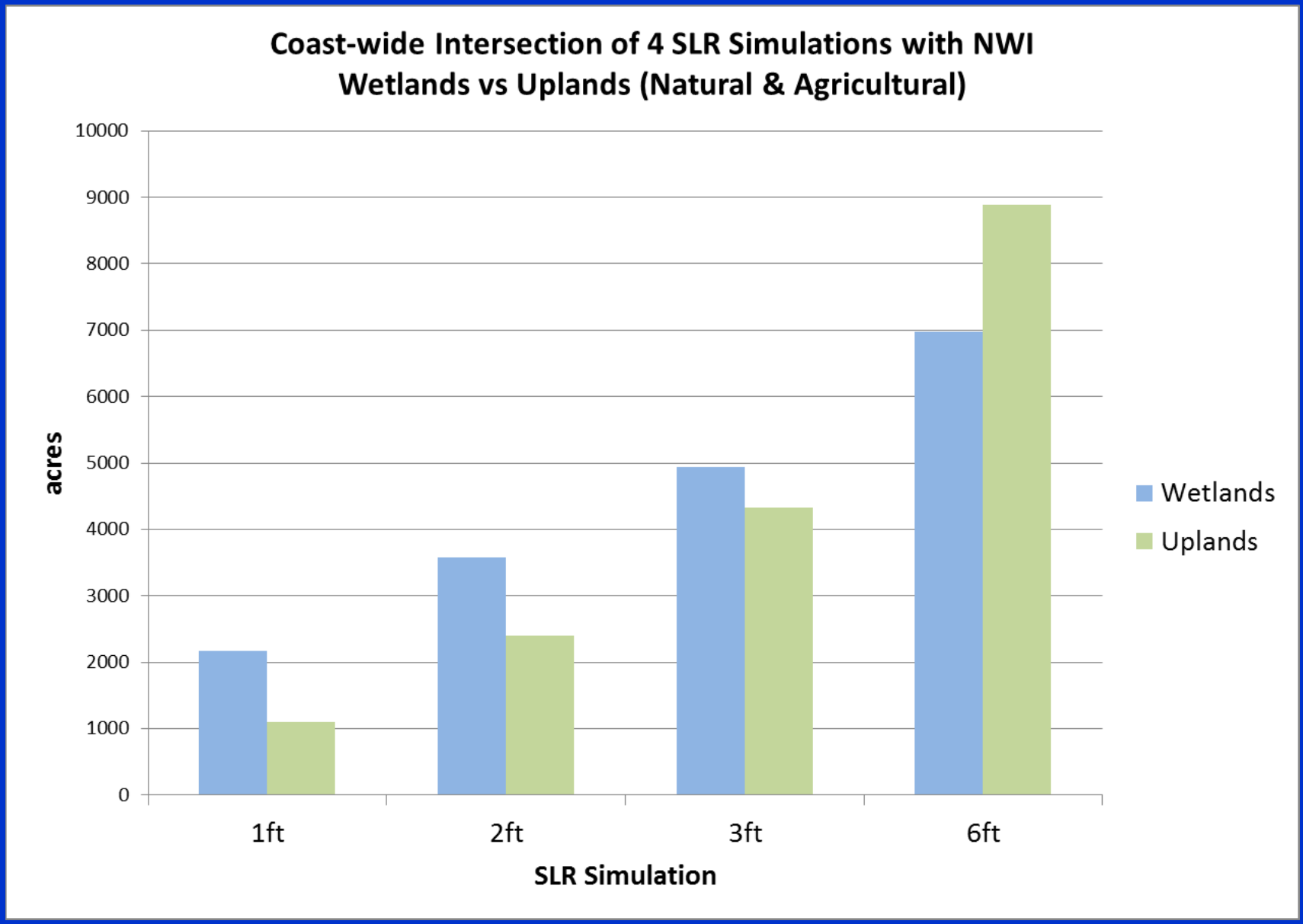

Excluded:
- Developed Lands
Existing Tidal Marsh
6ft SLR Natural & Agricultural Lands


Sea Level Rise Simulations: Acres on Conserved Lands versus Acres on Other Lands
12000
10000
8000
6000
4000
2000
0
acres
1ft
2ft
3ft
6ft
Conserved Lands
Other Lands
Existing Tidal Marsh
6ft SLR Natural & Agricultural Lands
Conserved Lands


Excluded:
- Developed Lands
- Conservation Lands
6ft SLR Undeveloped Non-Conserved Lands
Existing Tidal Marsh

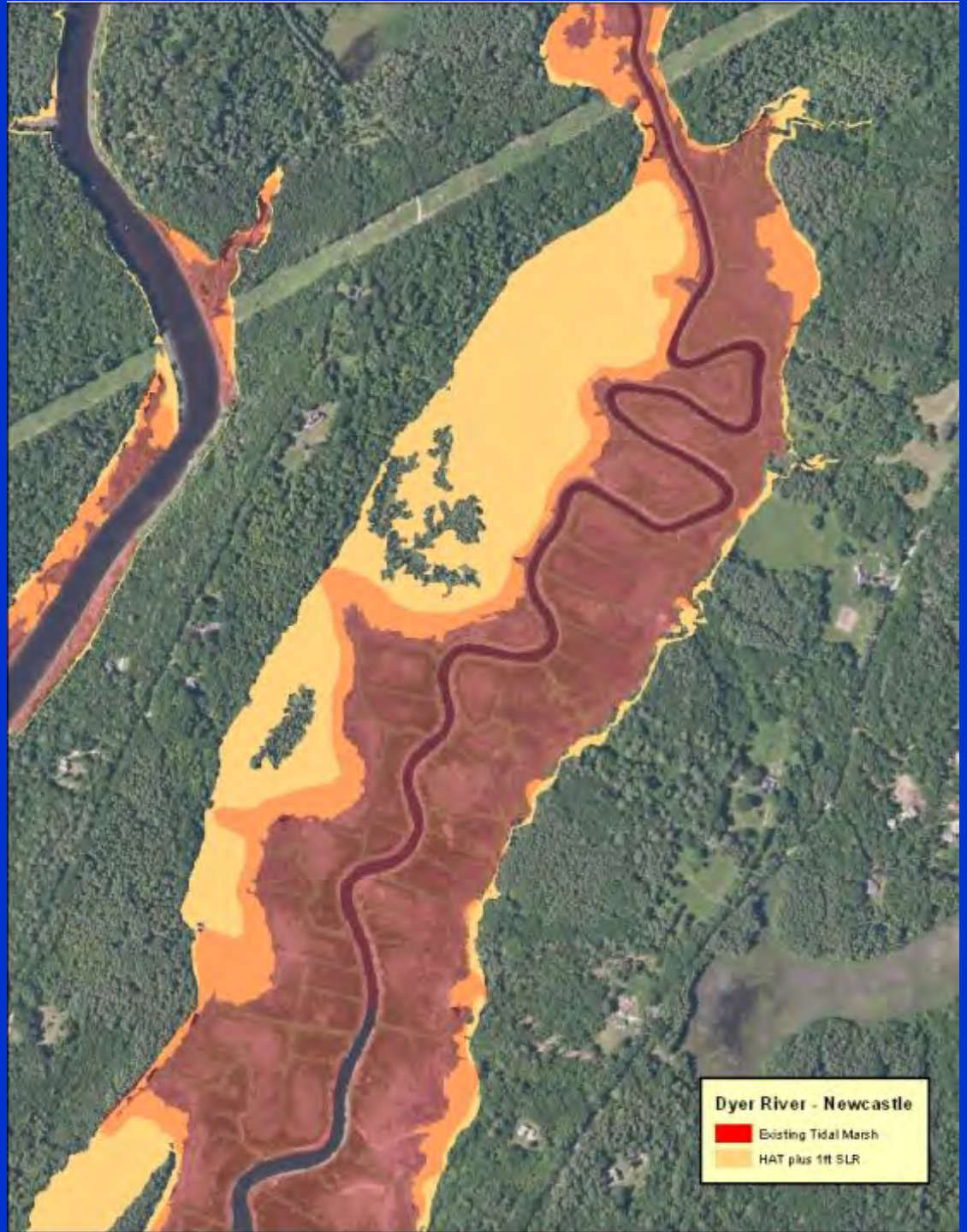

Kennebunk
River
Mousam
River
Little
River
6 ft SLR - undeveloped, non-conservation lands

Freshwater Wetlands

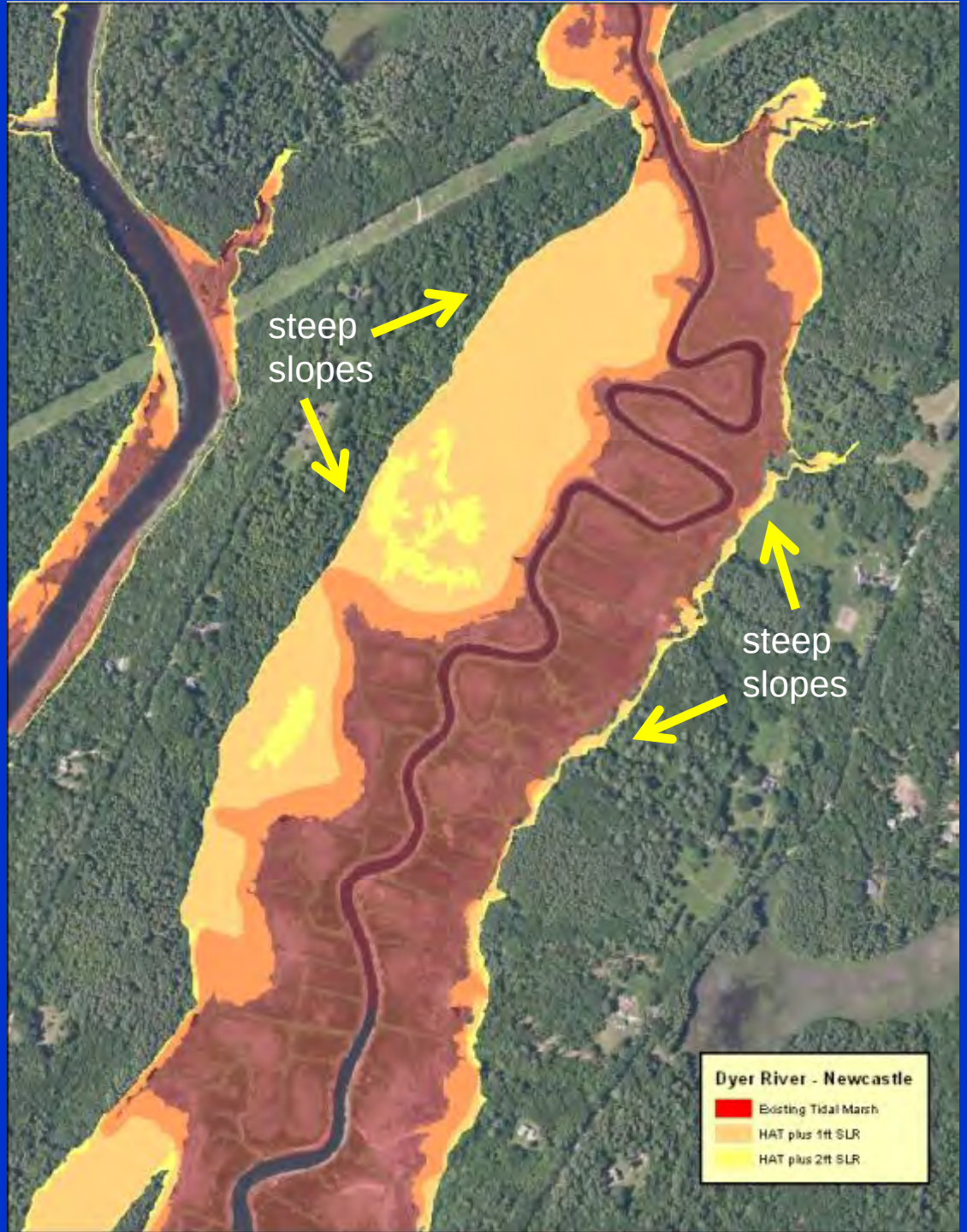


Thinking about planning

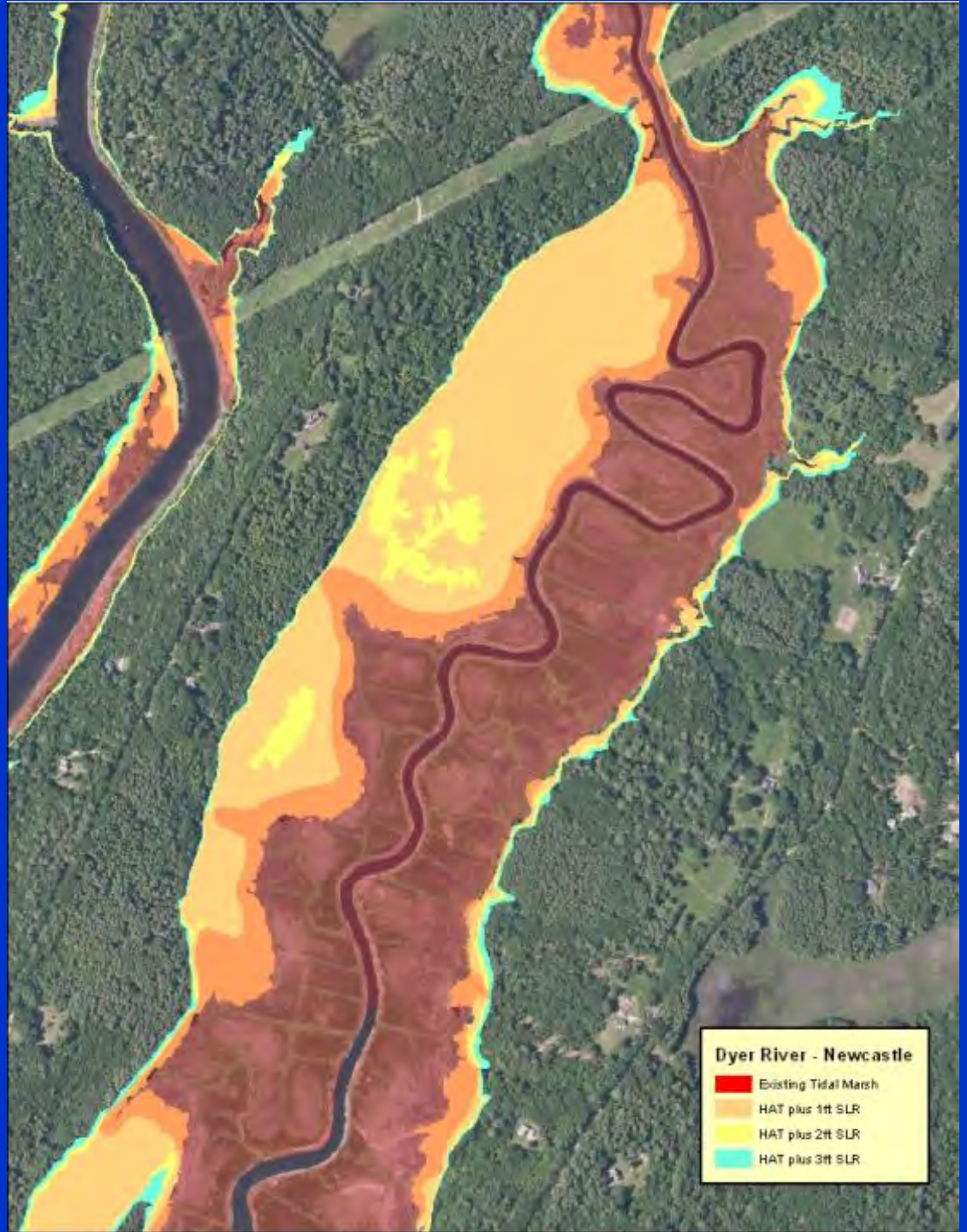
Thinking about planning



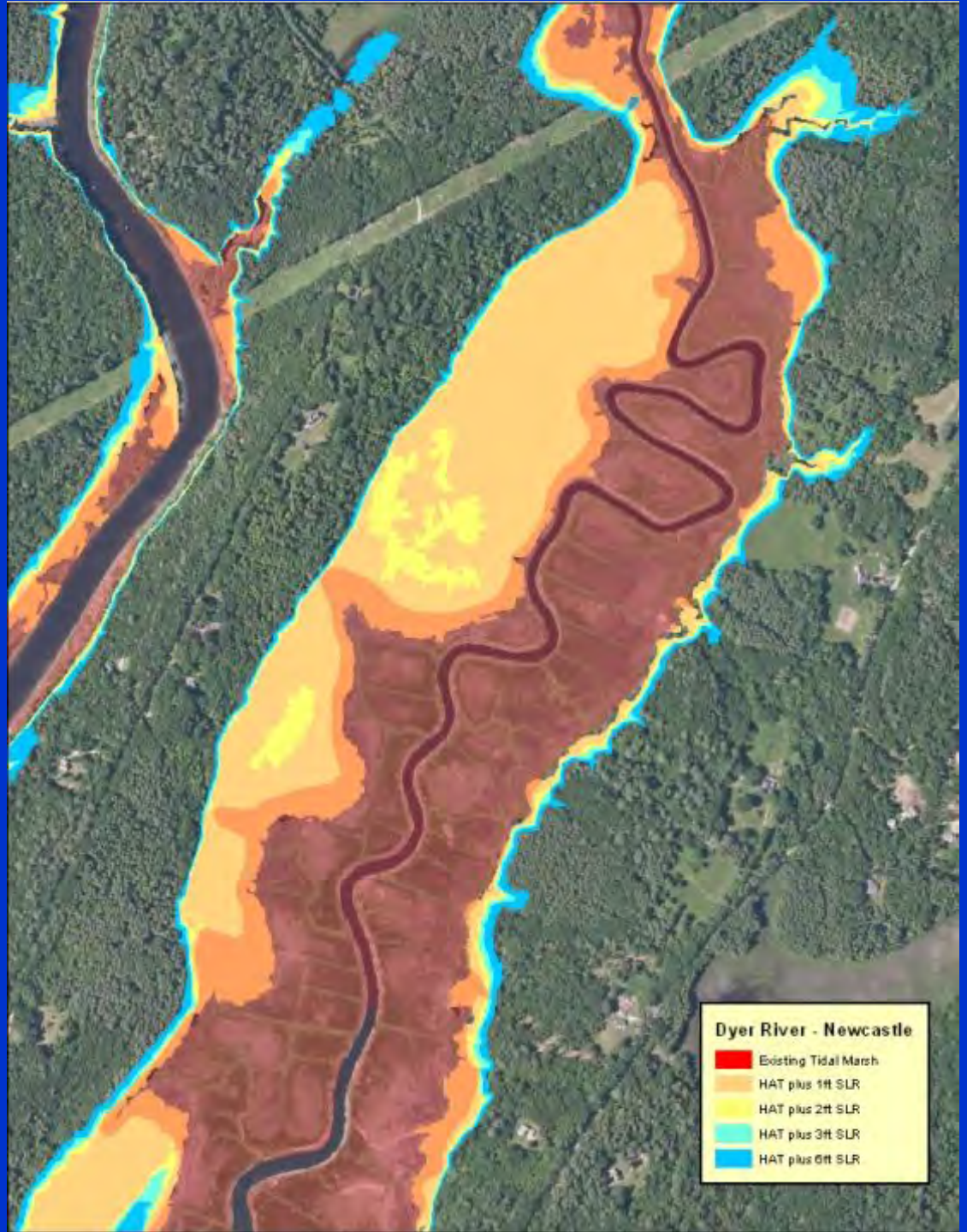
Thinking about planning

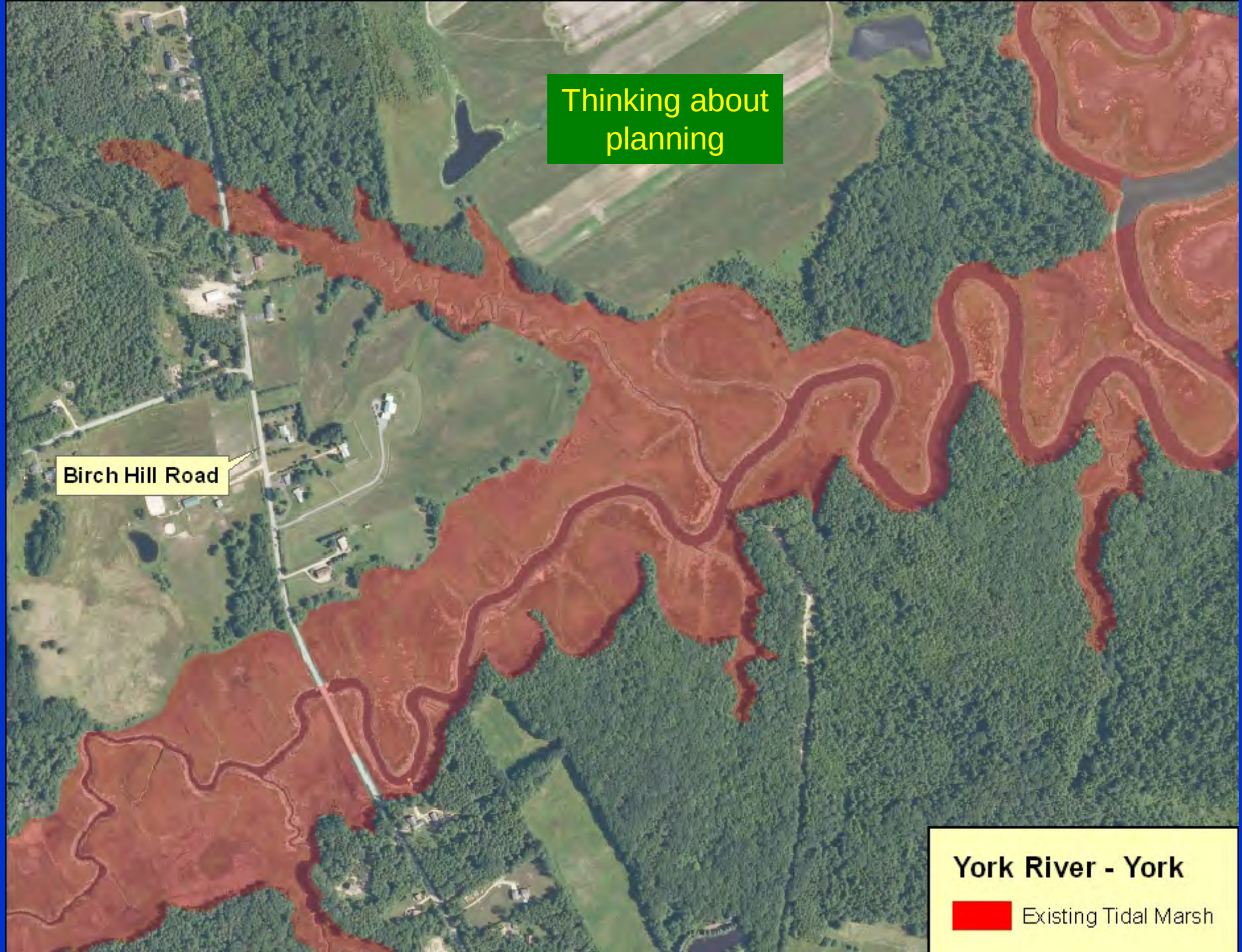


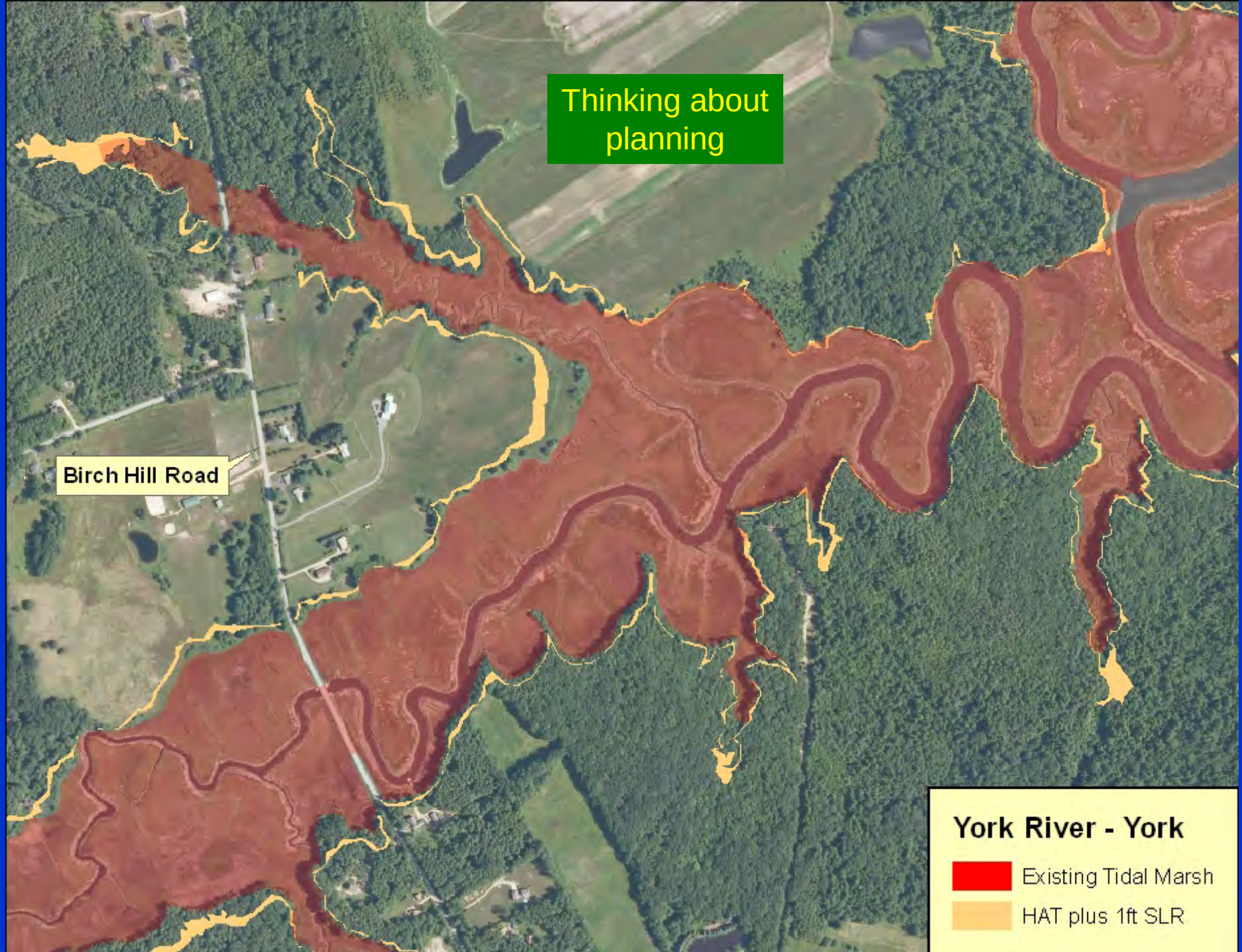
Thinking about planning

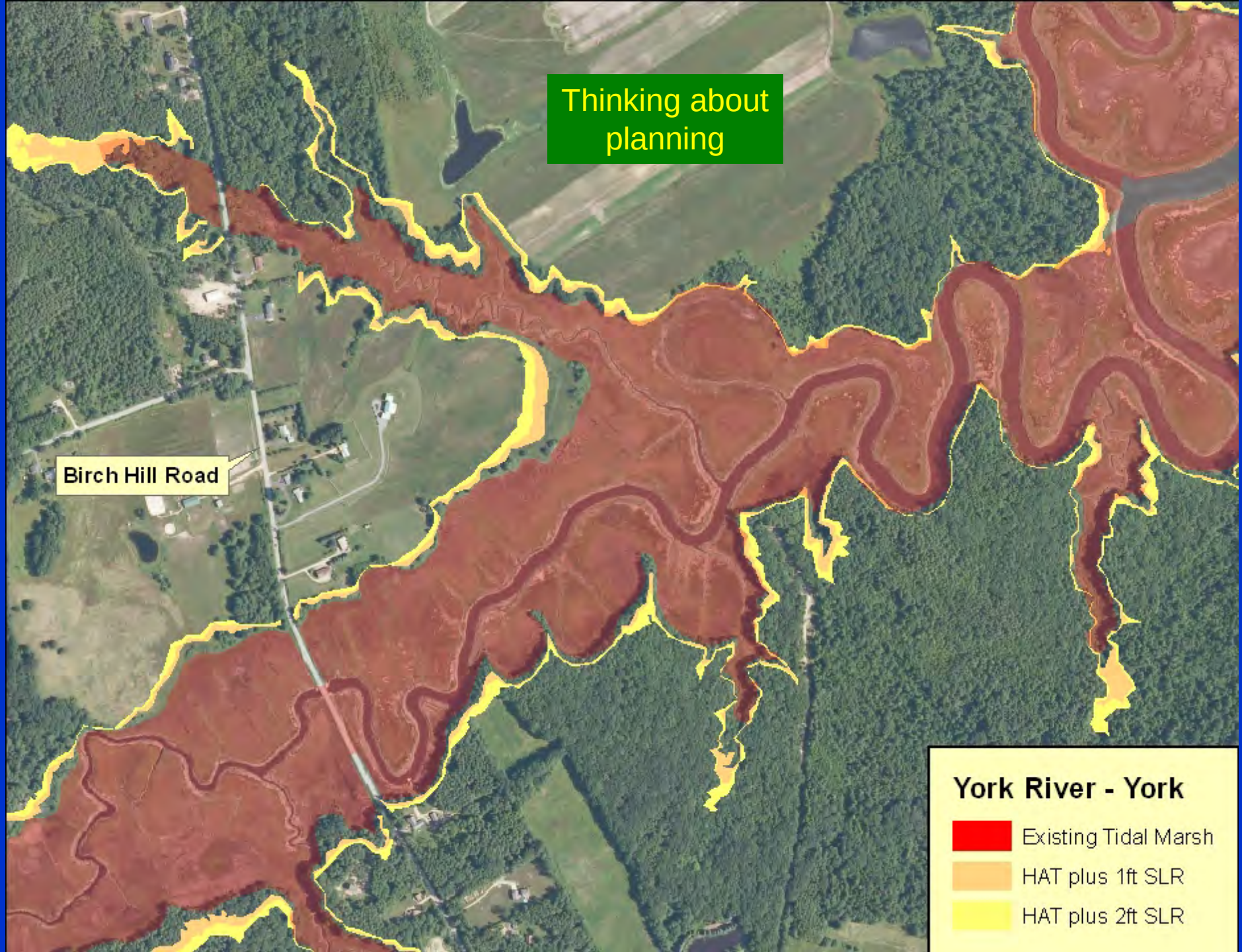


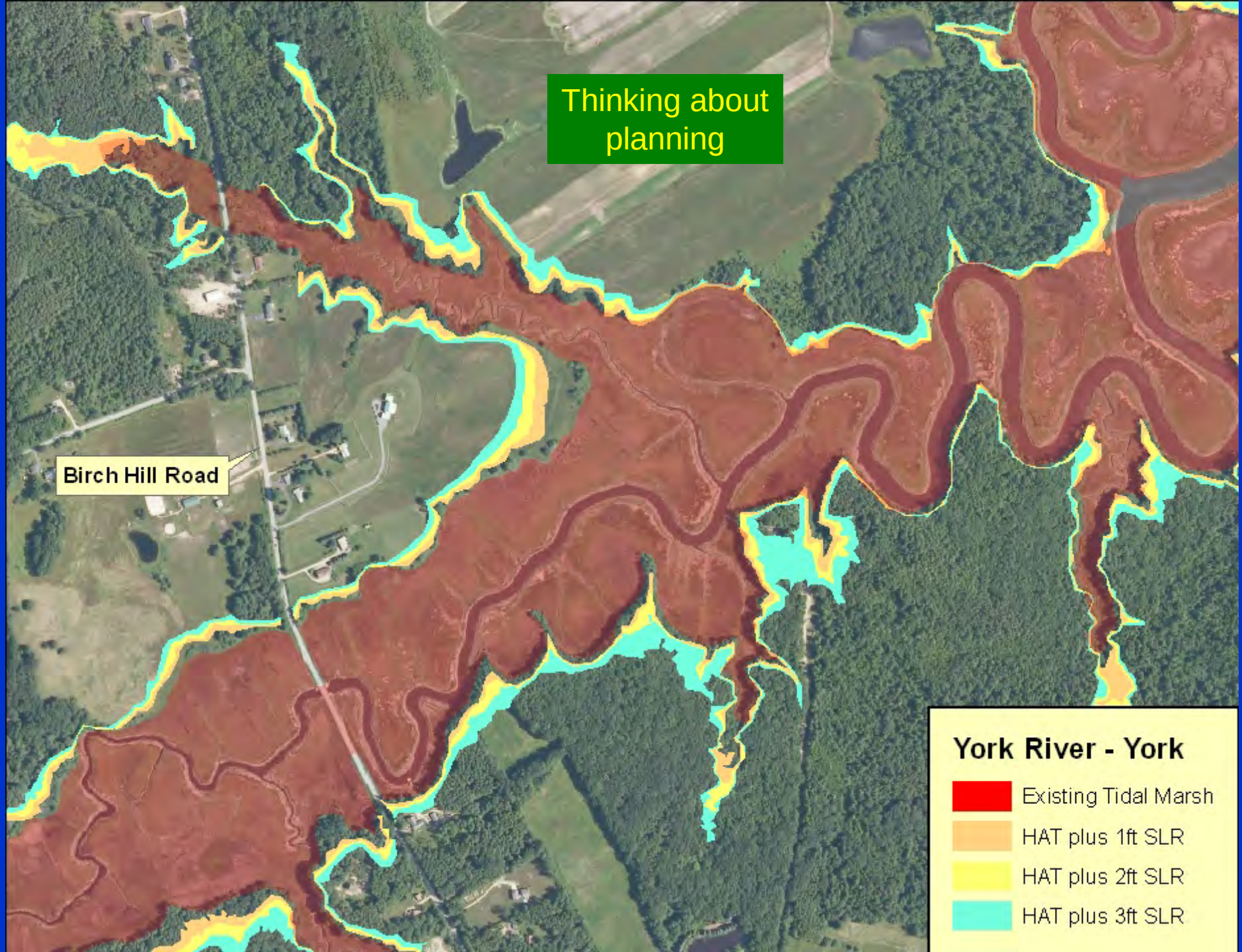
Thinking about Planning:
steep slopes = limited long term benefit

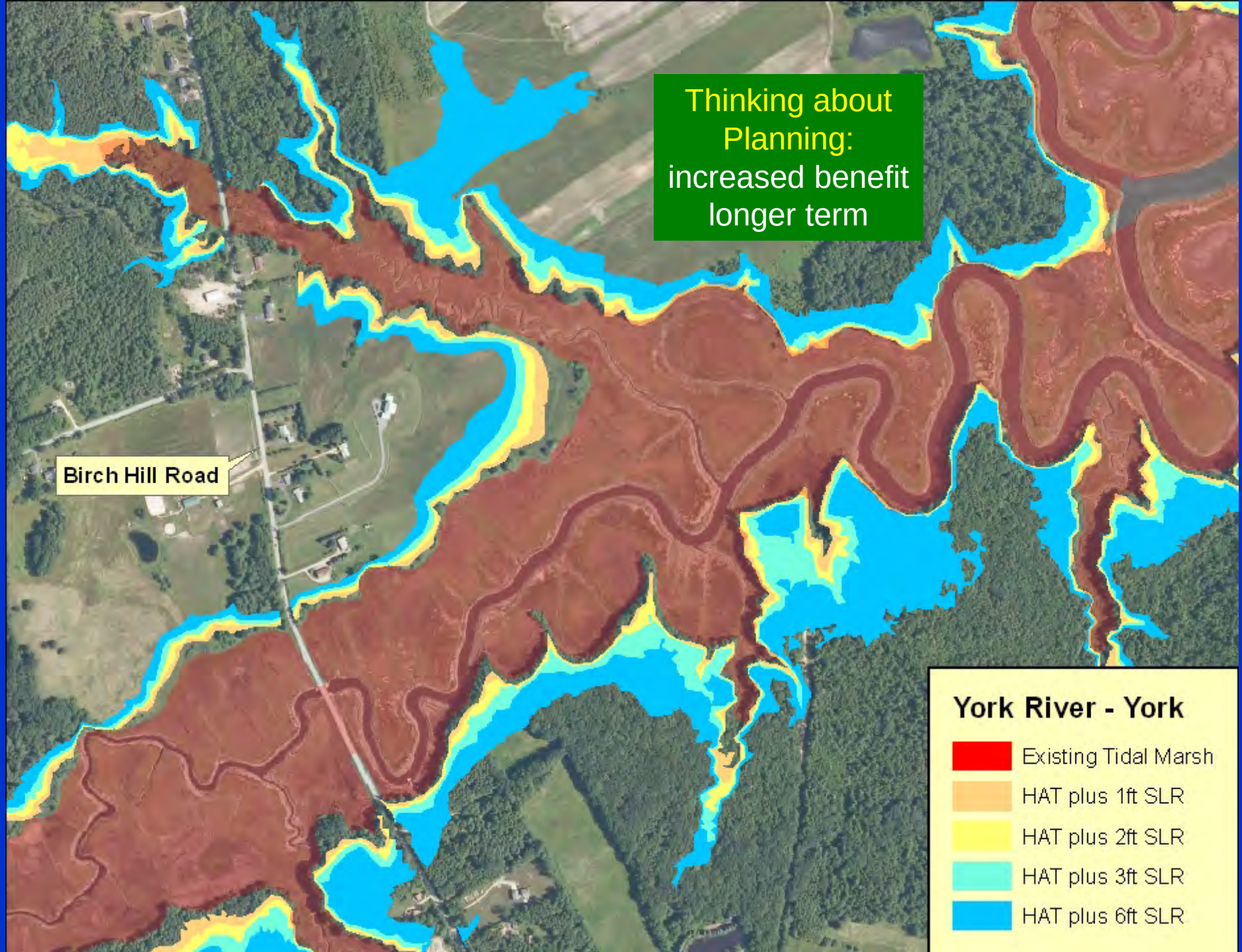



Thinking about planning
Birch Hill Road
York River - York
Existing Tidal Marsh


Thinking about planning
Birch Hill Road
York River - York
Existing Tidal Marsh
HAT plus 1ft SLR


Thinking about planning
Birch Hill Road
York River - York
Existing Tidal Marsh
HAT plus 1ft SLR
HAT plus 2ft SLR


Thinking about planning
Birch Hill Road
York River - York
Existing Tidal Marsh
HAT plus 1ft SLR
HAT plus 2ft SLR
HAT plus 3ft SLR


Thinking about Planning:
increased benefit longer term
Birch Hill Road
York River - York
Existing Tidal Marsh
HAT plus 1ft SLR
HAT plus 2ft SLR
HAT plus 3ft SLR
HAT plus 6ft SLR

Step 5: Communicate results

- Results presented and shared with primary coastal conservation programs including Rachel Carson NWR, TNC, MCHT, as well as to reps from other orgs & agencies at several conferences

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Sea Level Rise simulations are now being used to:

- Assist coastal towns in planning and preparing for SLR impacts
- Inform conservation planning
- Assess vulnerability at Maine's most popular State Parks
- Start identifying sites with high resilience to climate change

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