6TH ANNUAL
CAPE COASTAL CONFERENCE
DECEMBER 4-5, 2018



Innovative use of SLAMM to guide wetland restoration planning and adaptive management decisions for the Herring River Estuary

Presenter: Elise Leduc

WOODS HOLE GROUP
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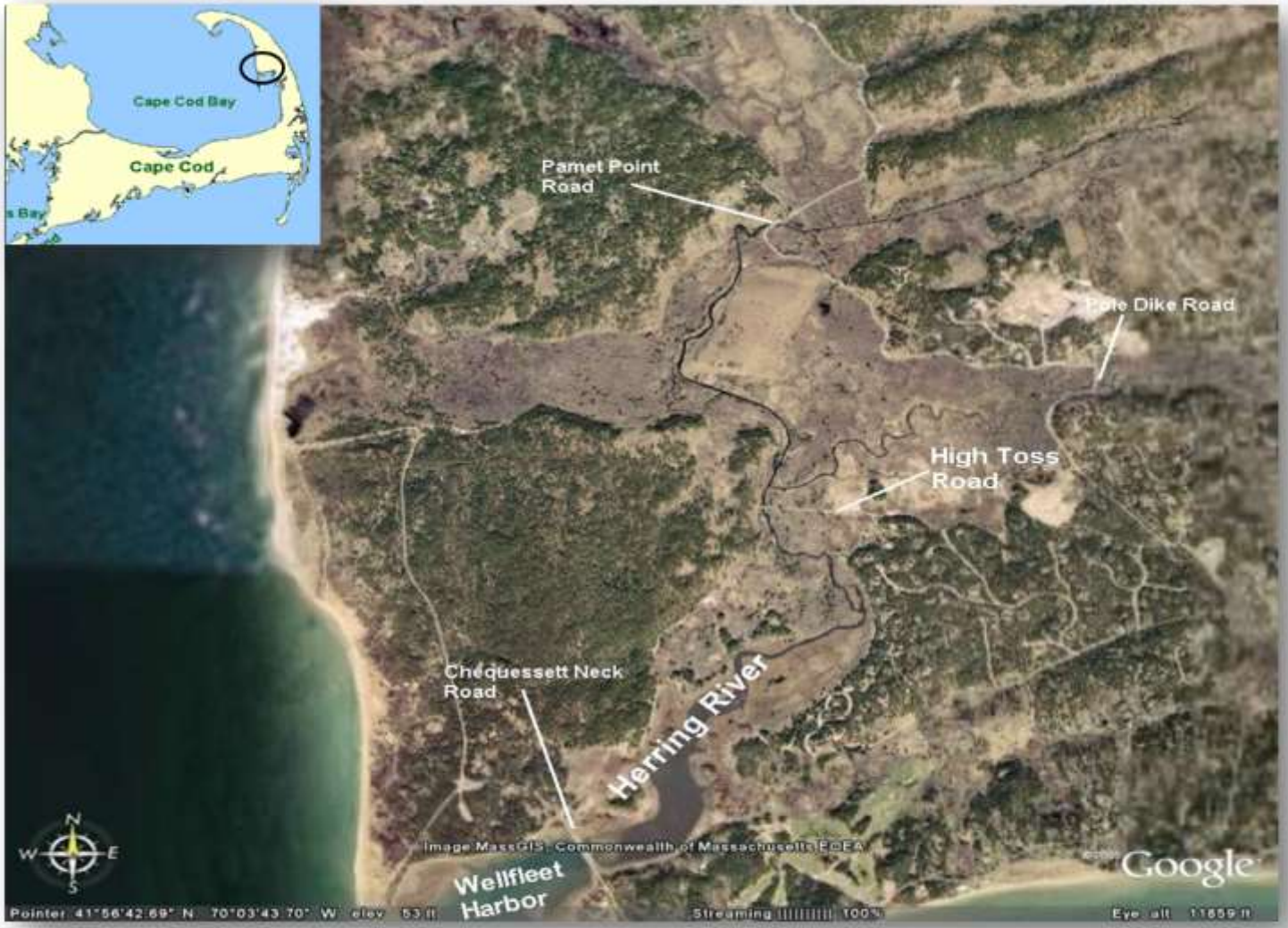
Background

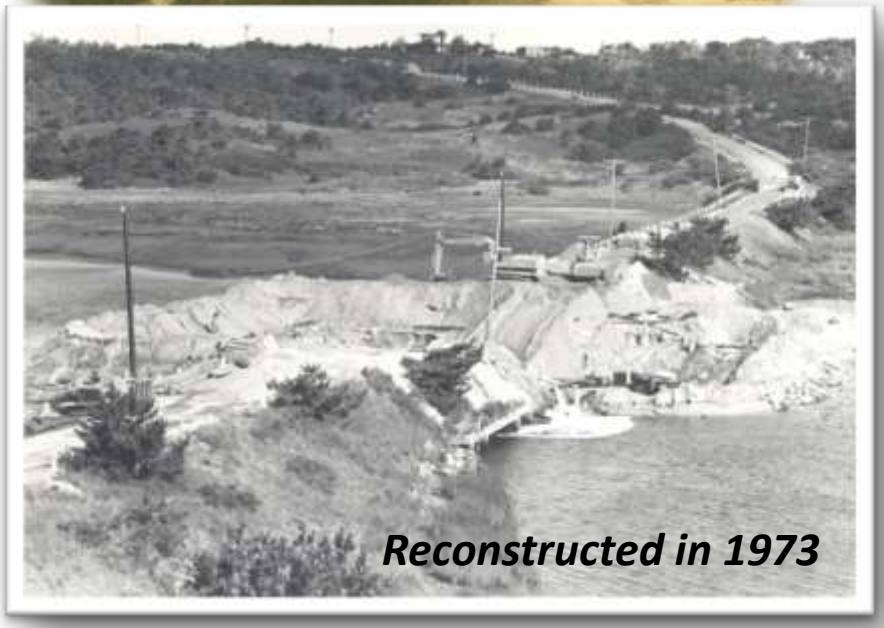
Herring River Restoration Project



Background

Herring River Restoration Project

Winter 1908-09

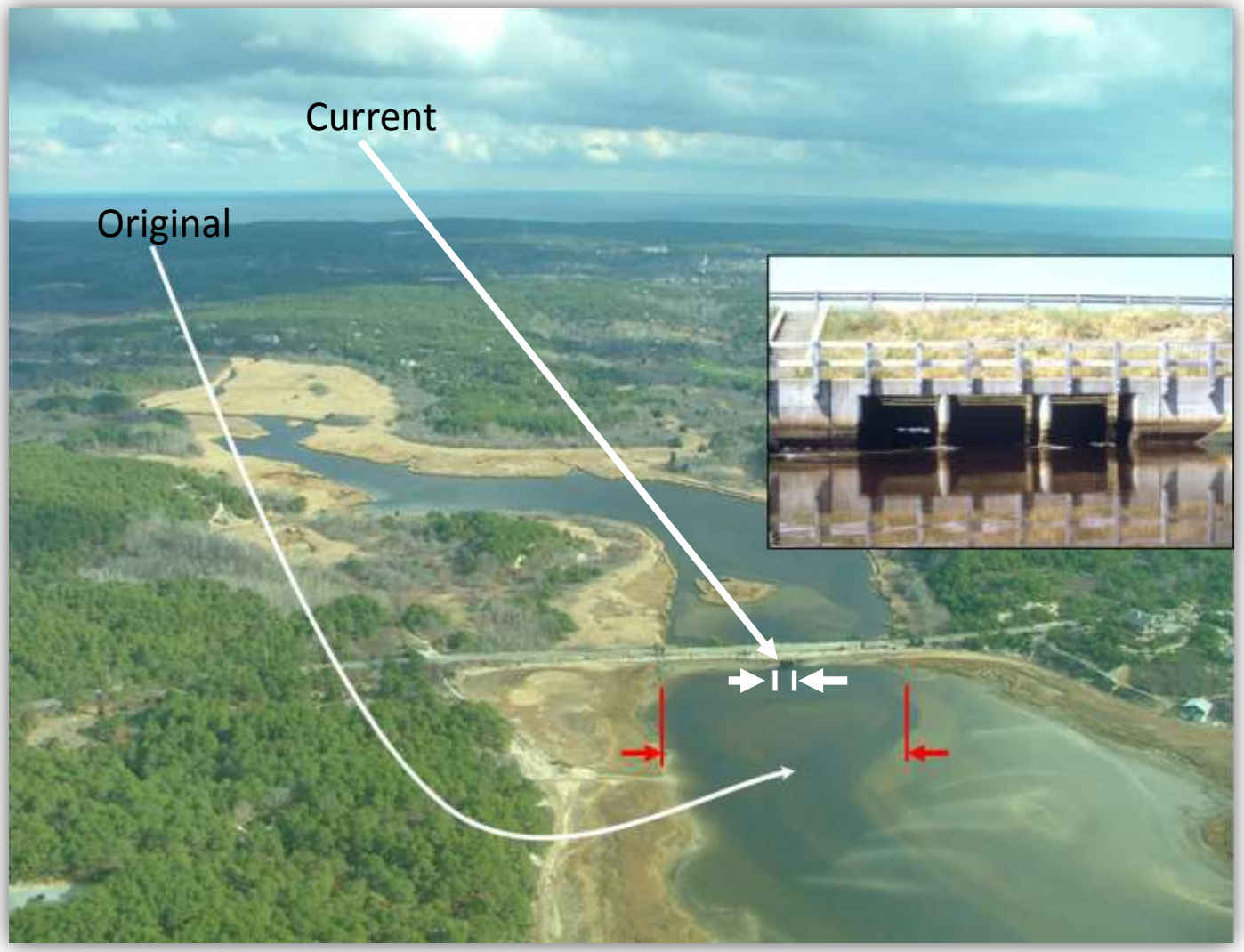


Reconstructed in 1973

Images courtesy of the Wellfleet Historical Society

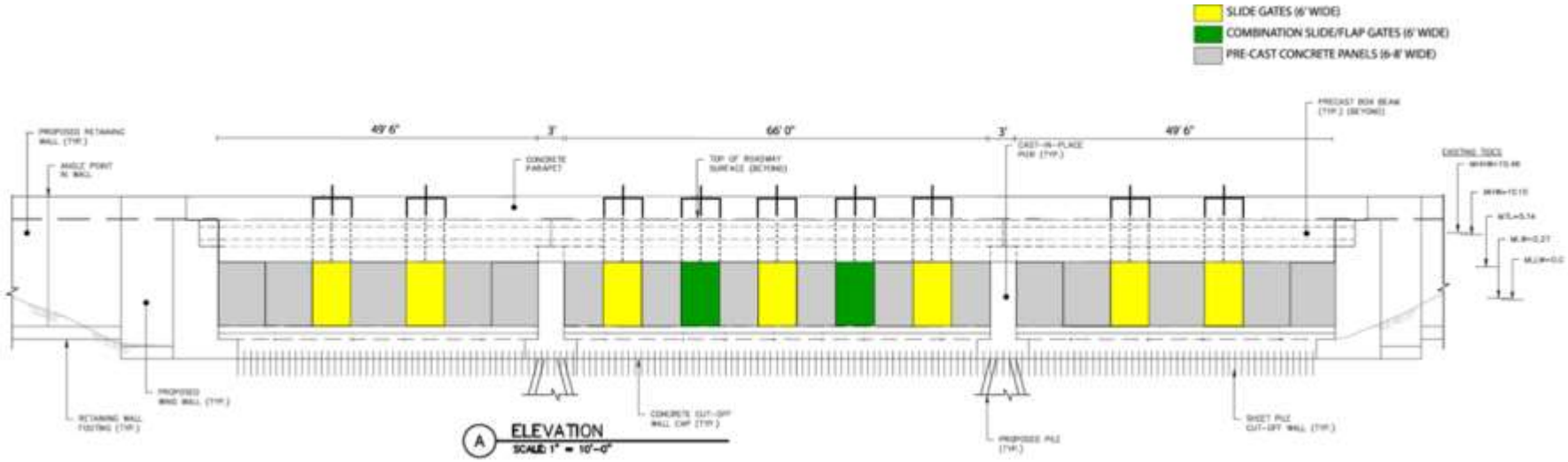
Background

Herring River Restoration Project



Background

Herring River Restoration Project



- 7 slide gates, 2 combination slide/flap gates, 16 pre-cast concrete panels
- Provides full operational control during all phases of the restoration
- In the early stages, the restoration process will rely on slide and combination gates and not full panel removal

Background

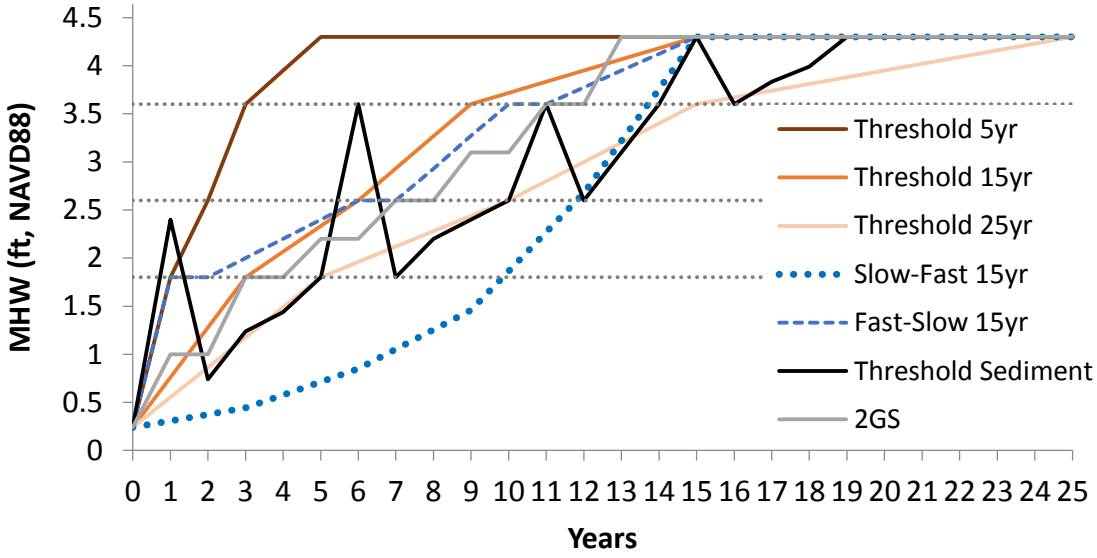
Herring River Restoration Project

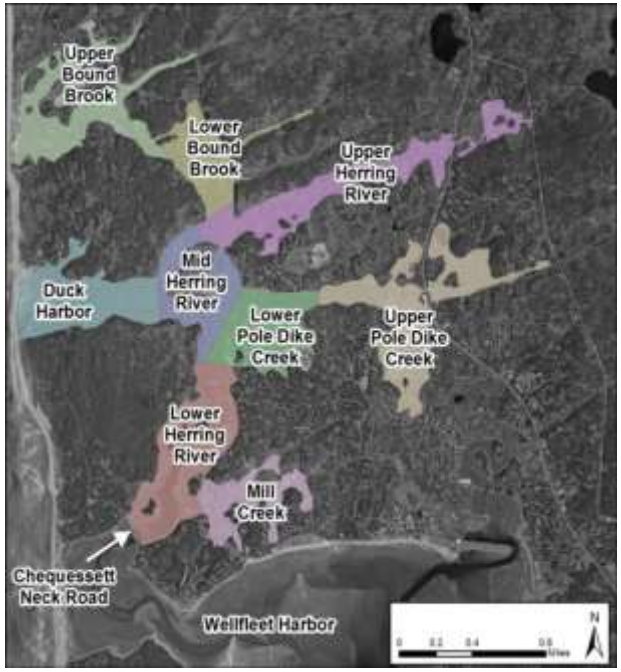
Background

Herring River Restoration Project

Adaptive Management Approach

- The Herring River Restoration Committee has developed a comprehensive adaptive management strategy to restore this system.
- A targeted ecological modeling effort was undertaken to understand how wetland types will change in response to the alterations in tidal regime.

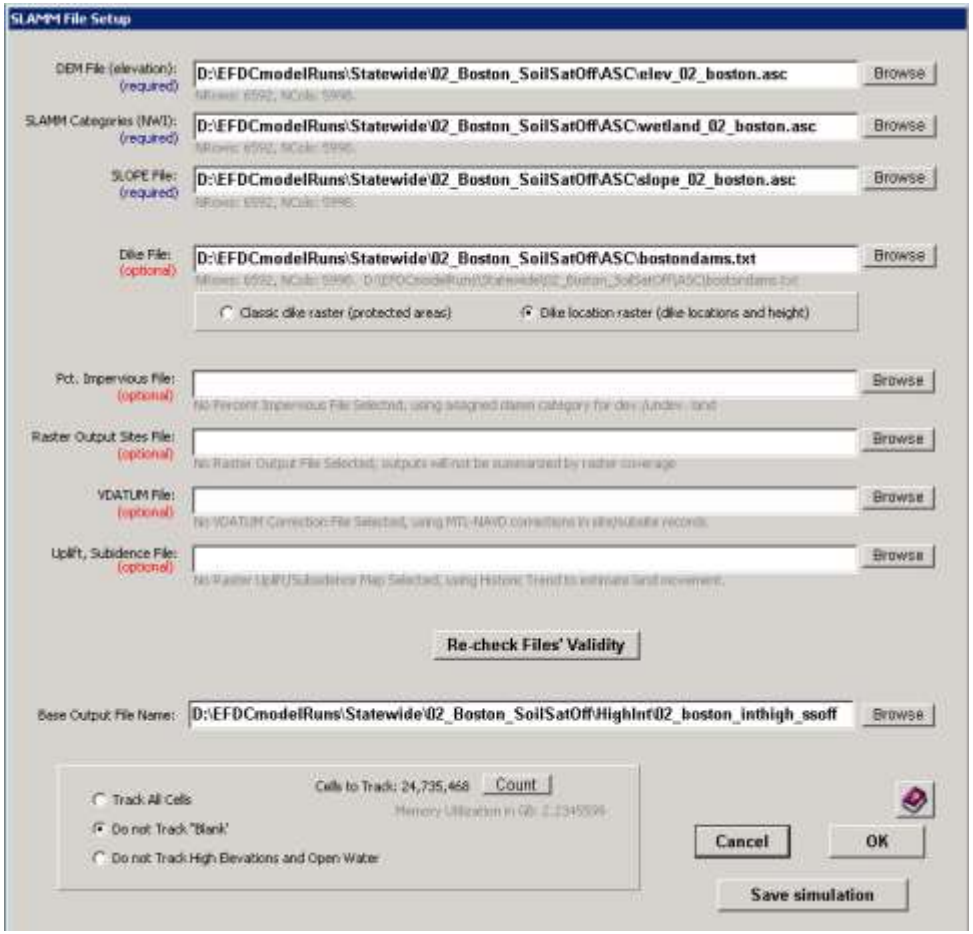


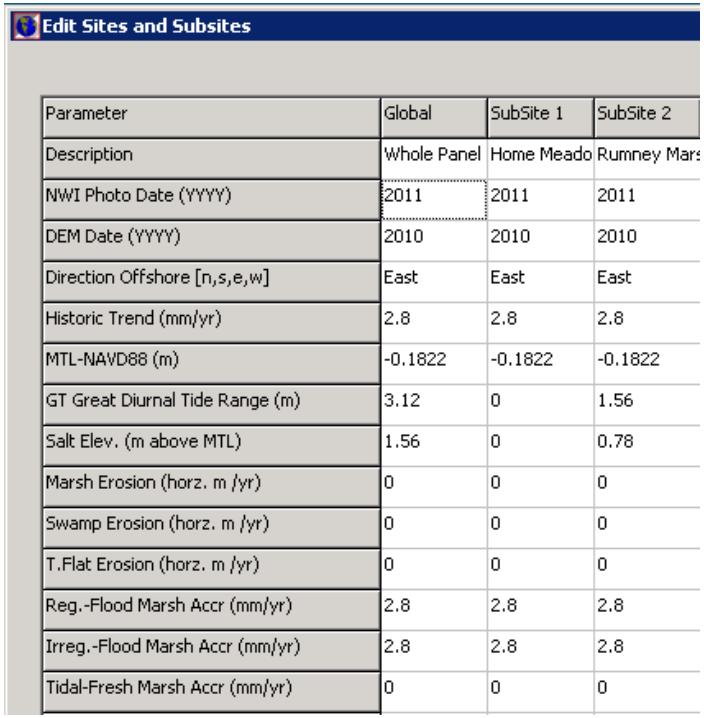


SLAMM

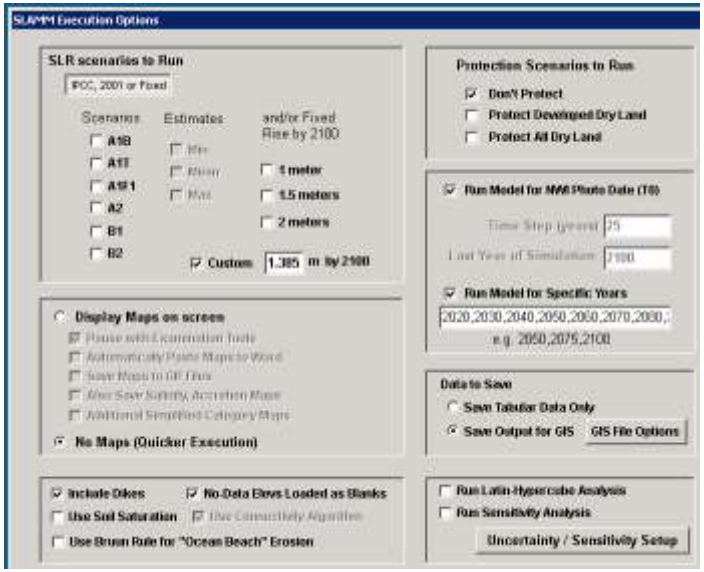
What is SLAMM?

Sea Level Affecting Marsh Migration





Parameter	Global	SubSite 1	SubSite 2
Description	Whole Panel	Home Meado	Rumney Mars
NWI Photo Date (YYYY)	2011	2011	2011
DEM Date (YYYY)	2010	2010	2010
Direction Offshore [n,s,e,w]	East	East	East
Historic Trend (mm/yr)	2.8	2.8	2.8
MTL-NAVD88 (m)	-0.1822	-0.1822	-0.1822
GT Great Diurnal Tide Range (m)	3.12	0	1.56
Salt Elev. (m above MTL)	1.56	0	0.78
Marsh Erosion (horz. m /yr)	0	0	0
Swamp Erosion (horz. m /yr)	0	0	0
T.Flat Erosion (horz. m /yr)	0	0	0
Reg.-Flood Marsh Accr (mm/yr)	2.8	2.8	2.8
Irreg.-Flood Marsh Accr (mm/yr)	2.8	2.8	2.8
Tidal-Fresh Marsh Accr (mm/yr)	0	0	0



SLAMM

How is SLAMM typically used?

- Originally designed to simulate the dominant processes involved with wetland conversions due to sea-level rise

Inputs

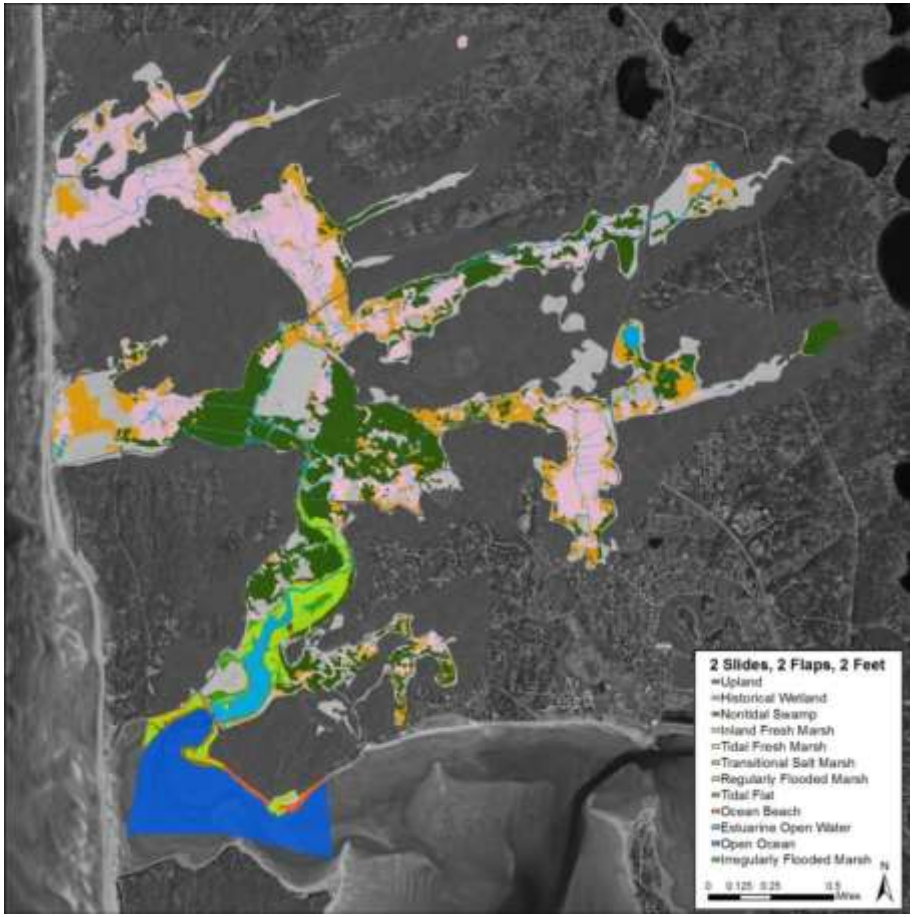
- SLR rates
- Elevations
- Tide Range
- Accretion Rates
- Erosion Rates

Strengths

- Open source
- Simple
- Includes most major processes
- Limited computational requirements

Limitations

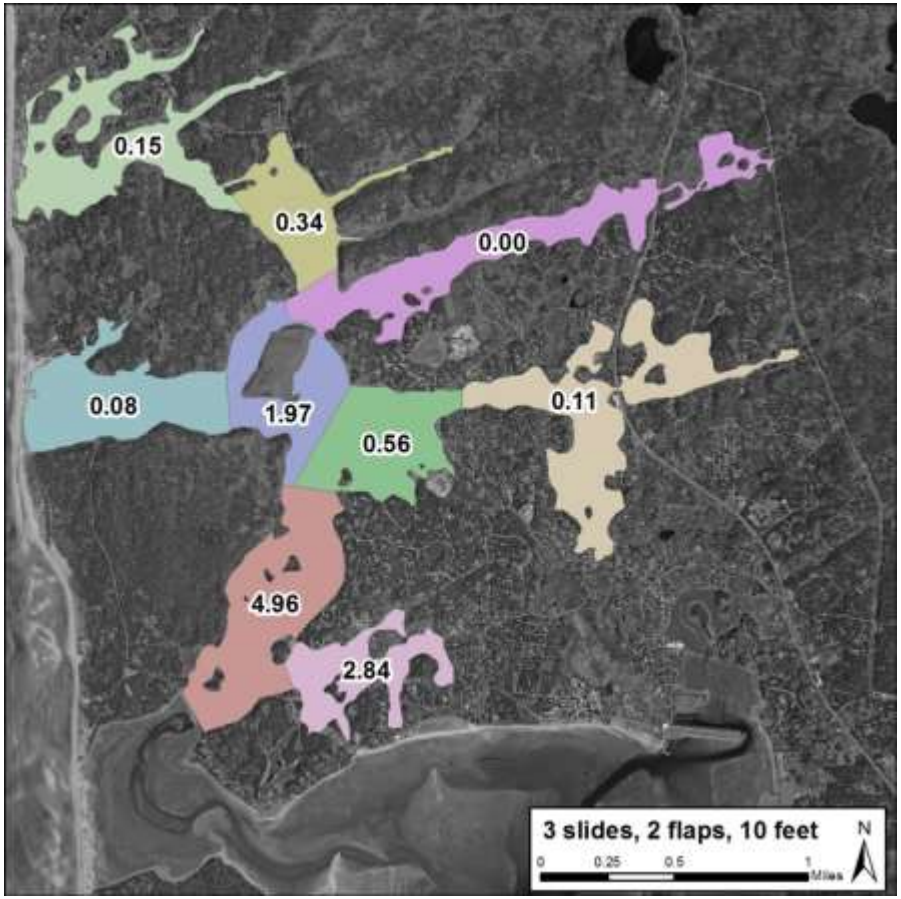
- No hydrodynamics
- Simple erosion model
- Empirical accretion rates
- No mass balance of solids

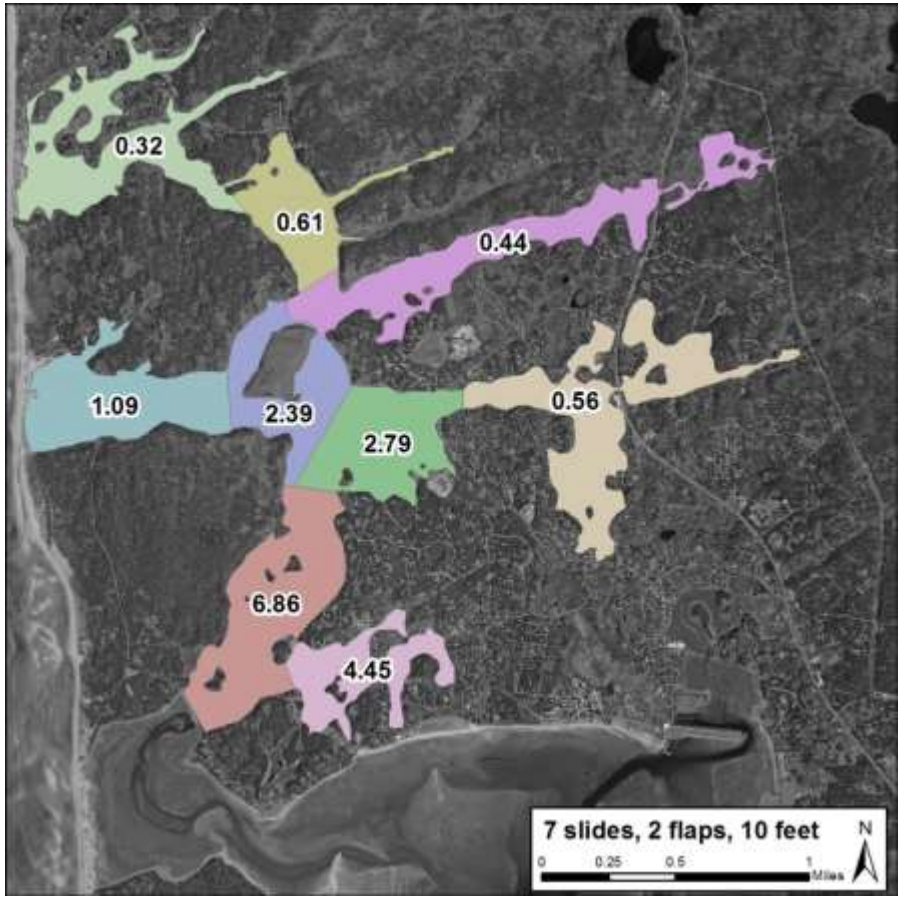


SLAMM

How we applied it…

- Because water level is the main factor driving wetland conversion, simply specifying different tidal ranges from each gate opening can drive change





SLAMM

How we applied it…

- Because water level is the main factor driving wetland conversion, simply specifying different tidal ranges from each gate opening can drive change

GDTR by Sub-basin	Existing Cond.	Fully Open	1 slide 2 flap	1 slide 2 flap	1 slide 2 flap	2 slide 2 flap	2 slide 2 flap	2 slide 2 flap	3 slide 2 flap	4 slide 2 flap	4 slide 2 flap	4 slide 2 flap	5 slide 2 flap	5 slide 2 flap	6 slide 2 flap	6 slide 2 flap	7 slide 2 flap	7 slide 2 flap	All Open	All Open
Opening Height (feet)	NA	NA	1	2	8	1	2	6	10	1	6	8	2	6	2	6	1	10	3	7
Lower Herring River	2.56	8.94	2.00	2.41	3.35	2.56	3.32	4.29	4.96	3.48	5.74	5.96	5.09	6.18	5.28	6.43	4.56	6.86	7.22	7.80
Mill Creek	0.82	6.12	0.25	0.55	1.77	0.52	1.13	2.59	2.84	1.12	3.41	3.67	2.53	3.69	2.81	3.89	1.98	4.45	4.80	5.44
Duck Harbor	0.00	2.46	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.34	0.43	0.00	0.43	0.08	0.59	0.00	1.09	1.47	2.00
Upper Herring River	0.00	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.44	0.59	0.90
Upper Pole Dike Creek	0.00	1.95	0.00	0.00	0.00	0.00	0.00	0.22	0.11	0.00	0.50	0.49	0.16	0.42	0.21	0.40	0.11	0.56	0.88	1.46
Upper Bound Brook	0.00	1.10	0.00	0.00	0.00	0.00	0.00	0.22	0.15	0.00	0.31	0.31	0.17	0.28	0.25	0.30	0.00	0.32	0.31	0.40
Mid Herring River	0.72	2.97	0.30	0.48	1.44	0.47	0.93	1.94	1.97	0.94	2.15	2.22	1.87	2.15	1.98	2.15	1.51	2.39	2.38	2.40
Lower Bound Brook	0.00	1.13	0.00	0.10	0.73	0.09	0.35	0.66	0.34	0.31	0.44	0.43	0.63	0.38	0.62	0.41	0.64	0.61	0.67	0.91
Lower Pole Dike Creek	0.00	2.74	0.00	0.00	0.00	0.00	0.00	0.62	0.56	0.00	0.85	0.91	0.56	0.81	0.65	0.89	0.34	2.79	1.68	2.27

Results

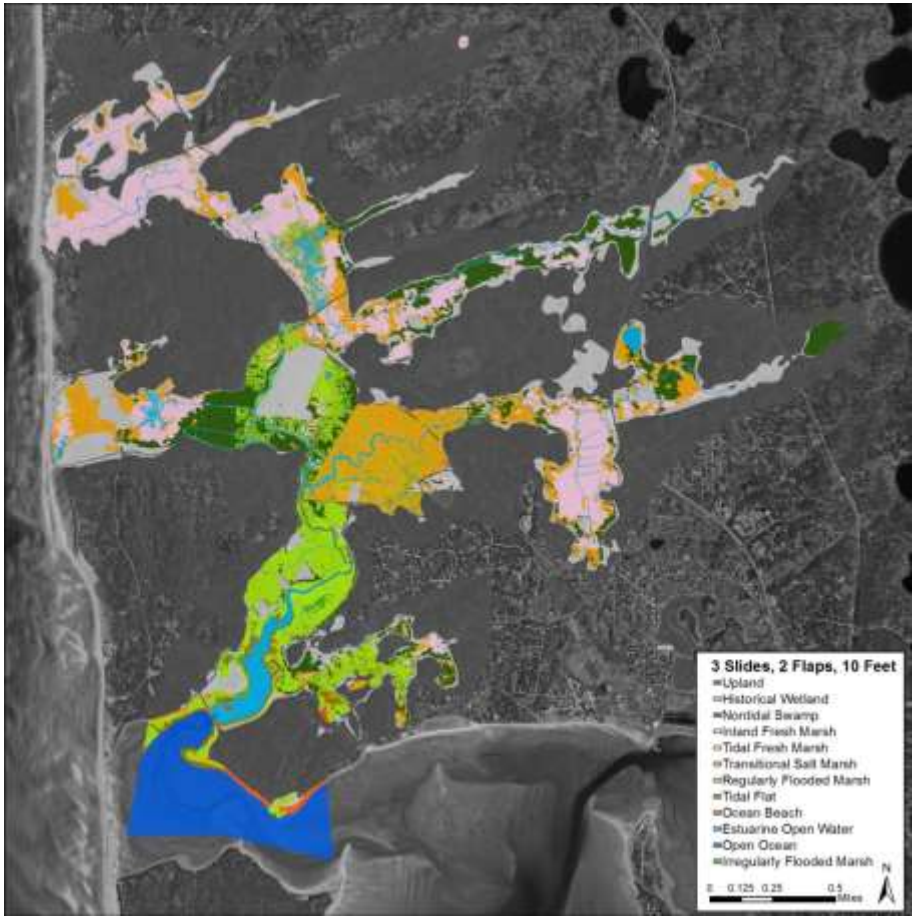
Simulations for different gate openings

Results include

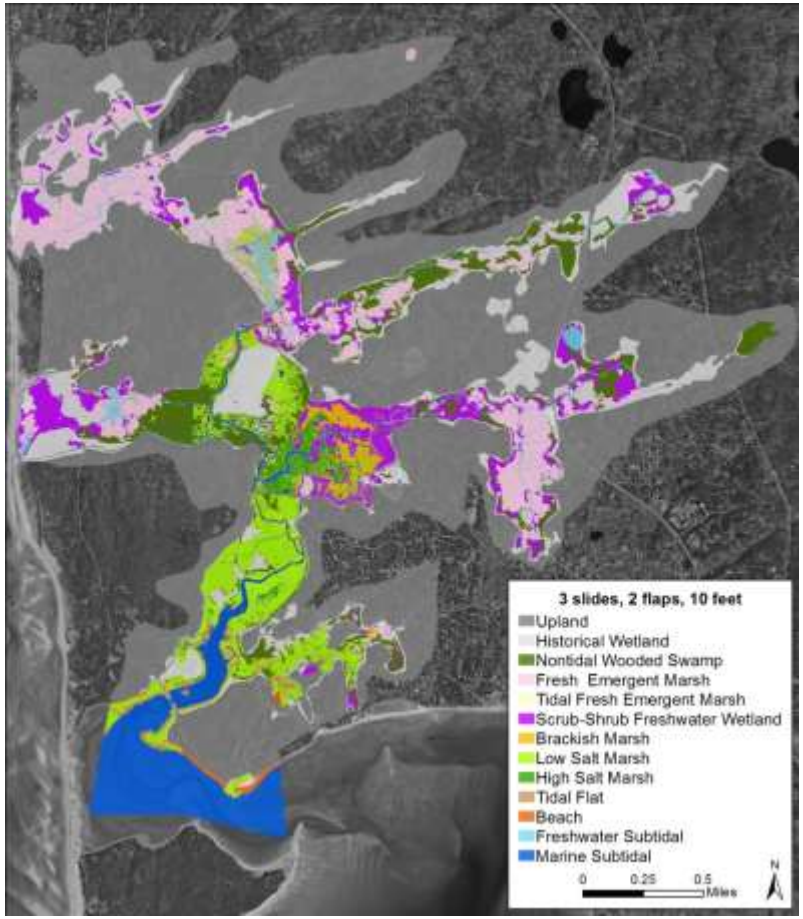
- Change in total acres of each wetland type
- Raster-based map outputs to visualize and spatially evaluate changes

Results

Refined using modeled salinity



Original SLAMM Classifications

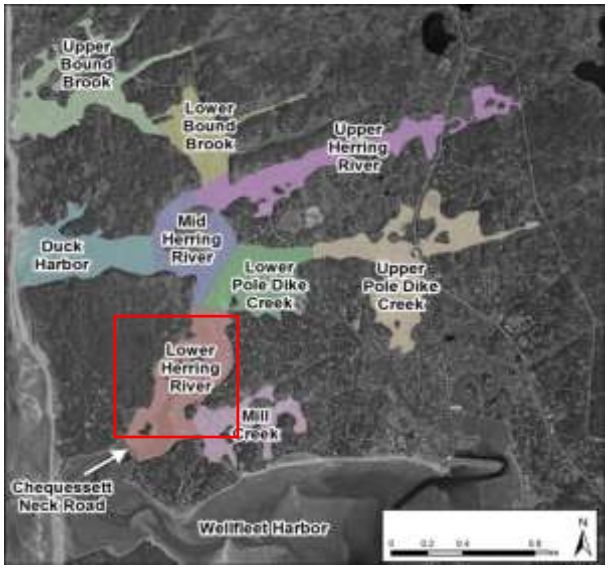


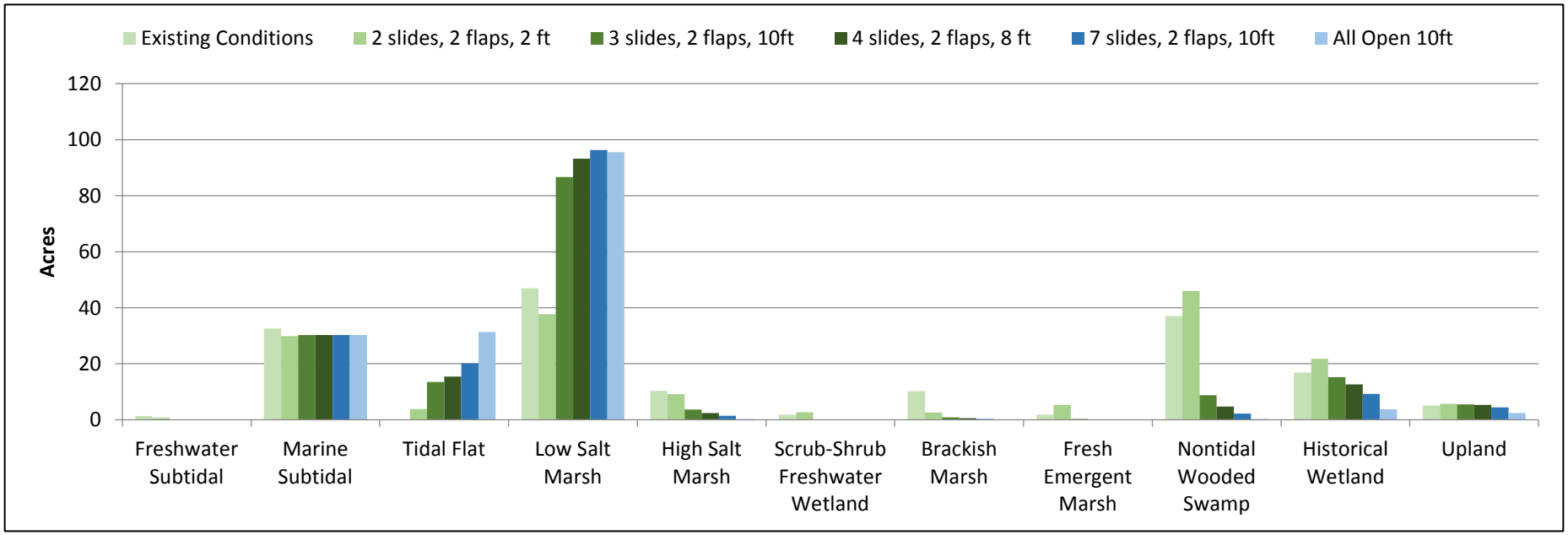
Refined Classifications

Results

Simulations for different gate openings

- Change in total acres of each wetland type
  - 5 example gate openings
  - Lower Herring River sub-basin

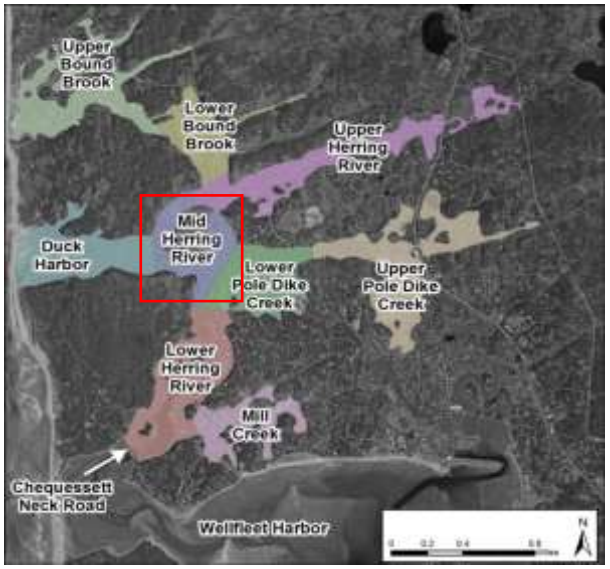


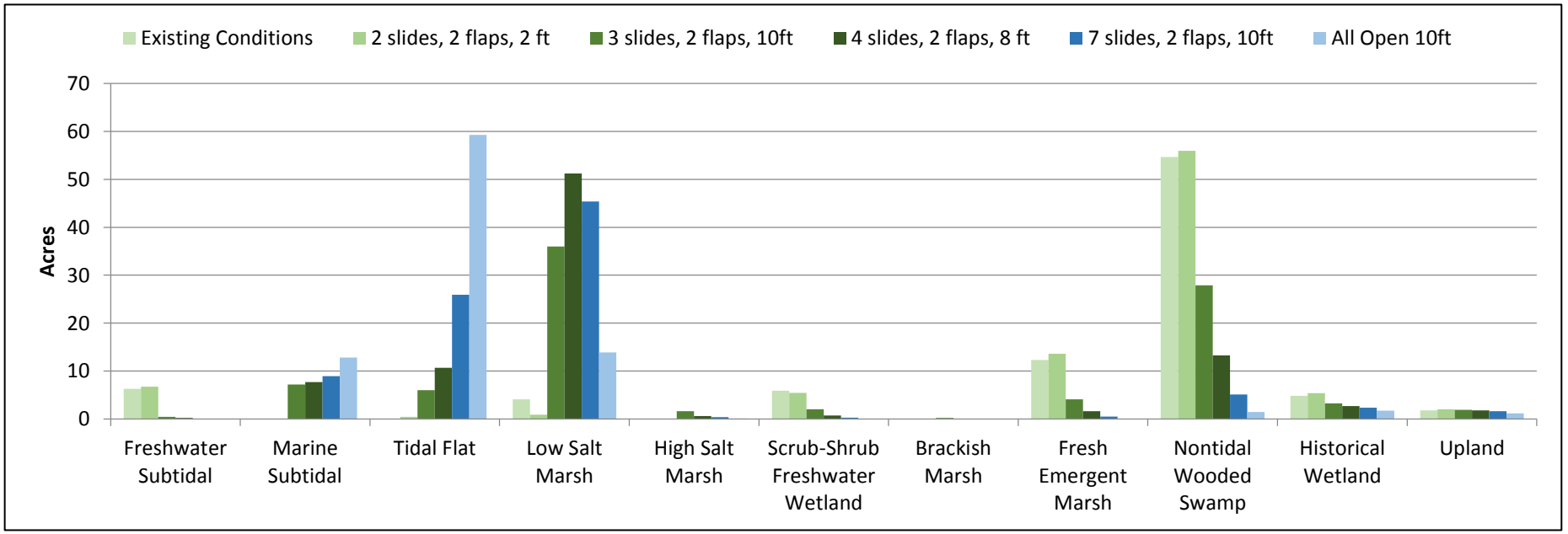


Results

Simulations for different gate openings

- Change in total acres of each wetland type
  - 5 example gate openings
  - Mid Herring River sub-basin

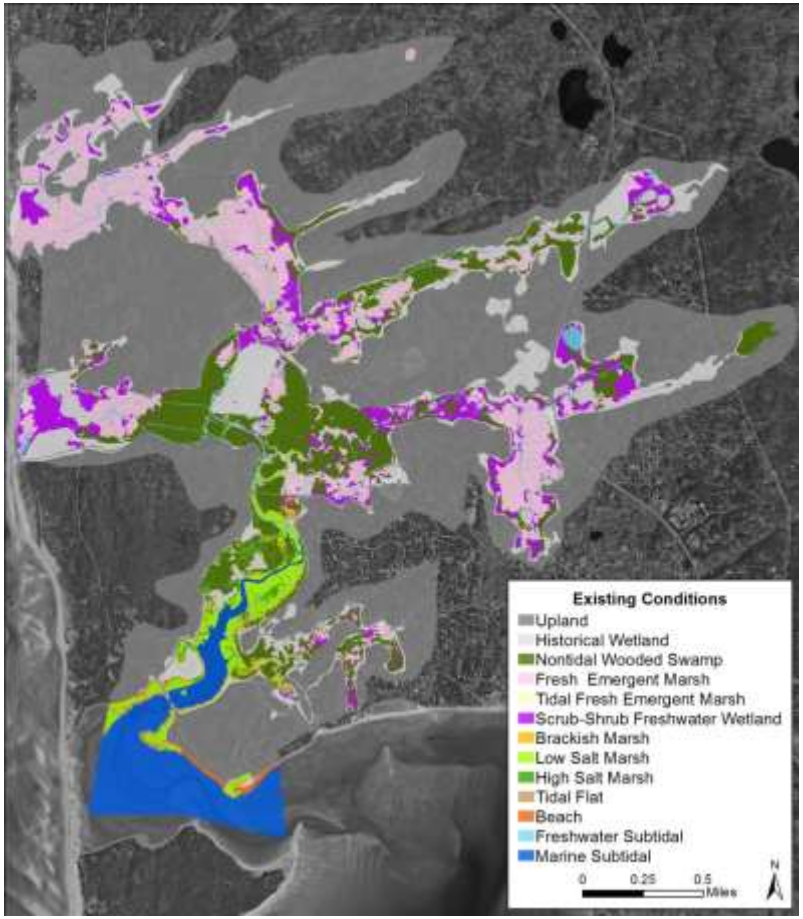


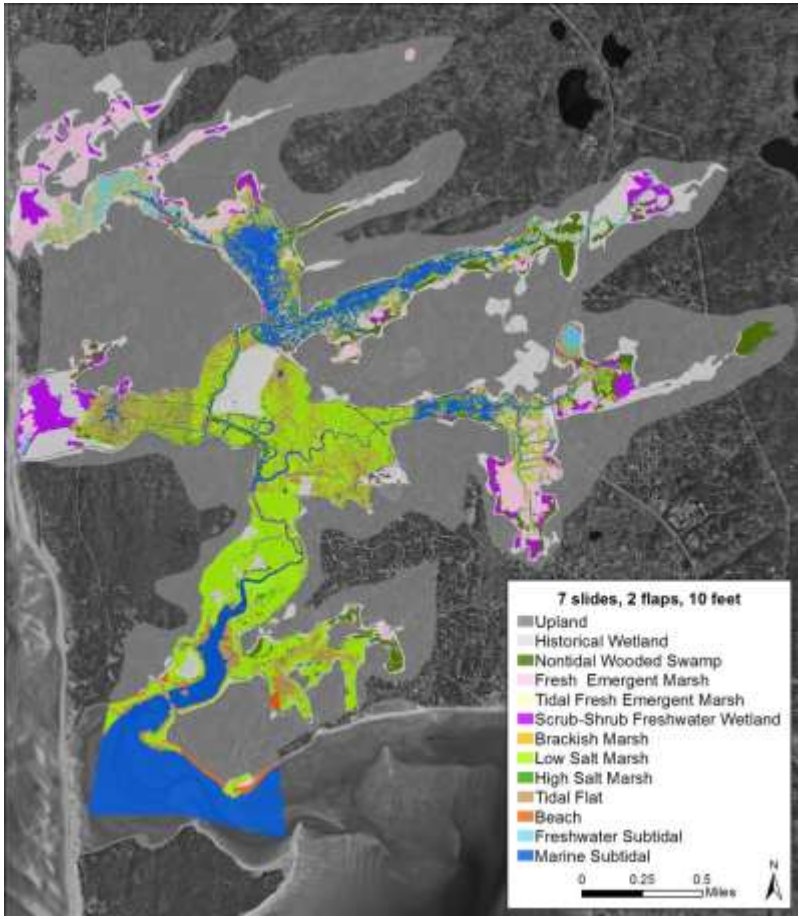


Results

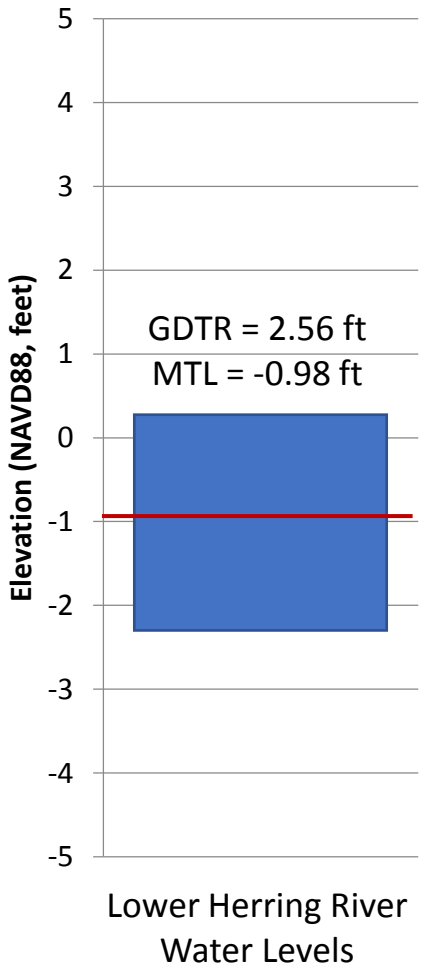
Simulations for different gate openings

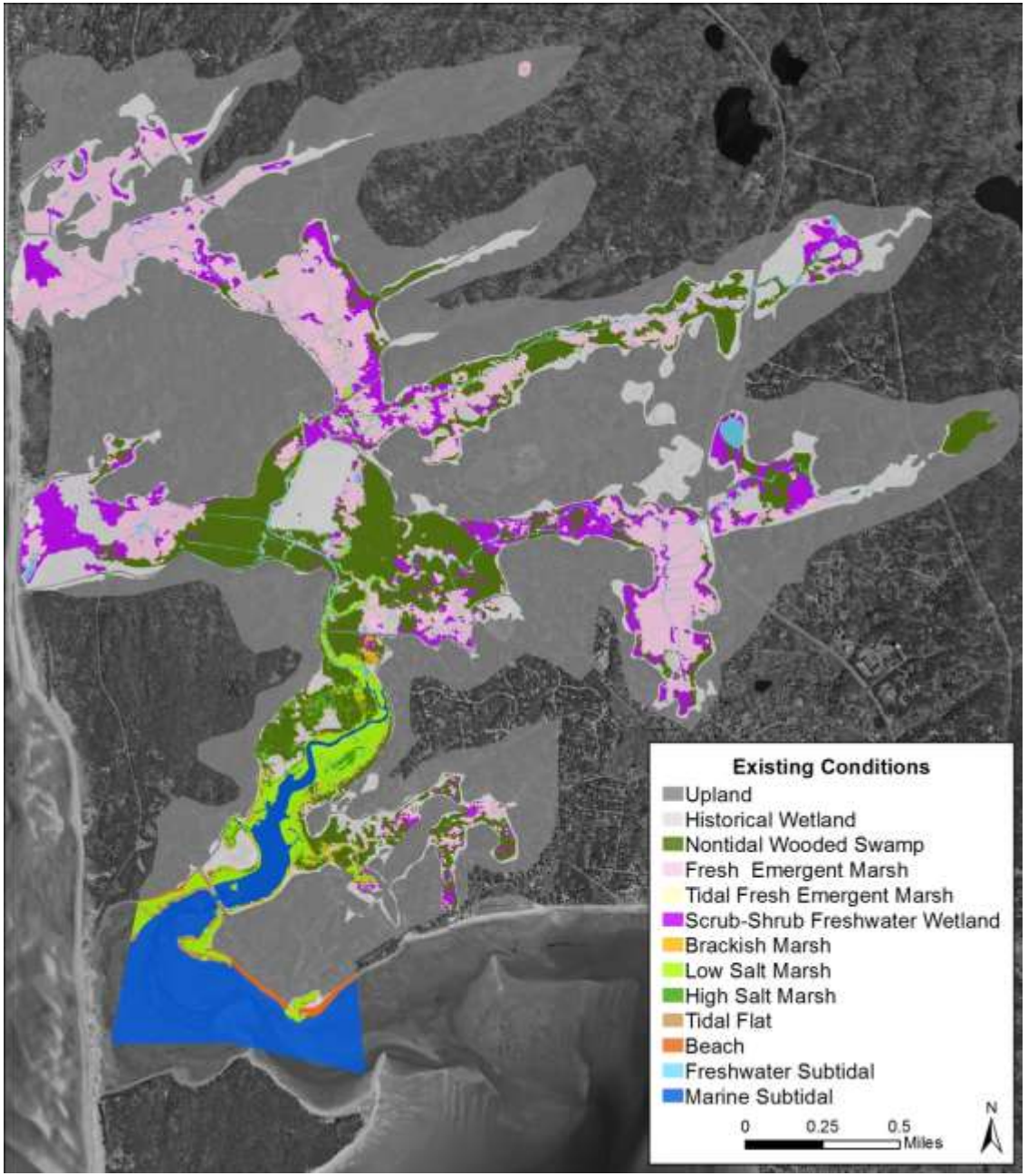
- Raster-based map outputs to visualize and spatially evaluate changes



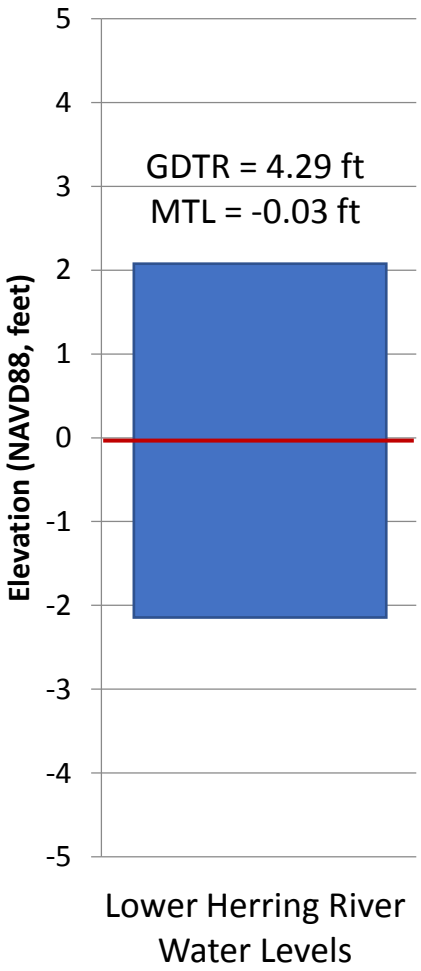


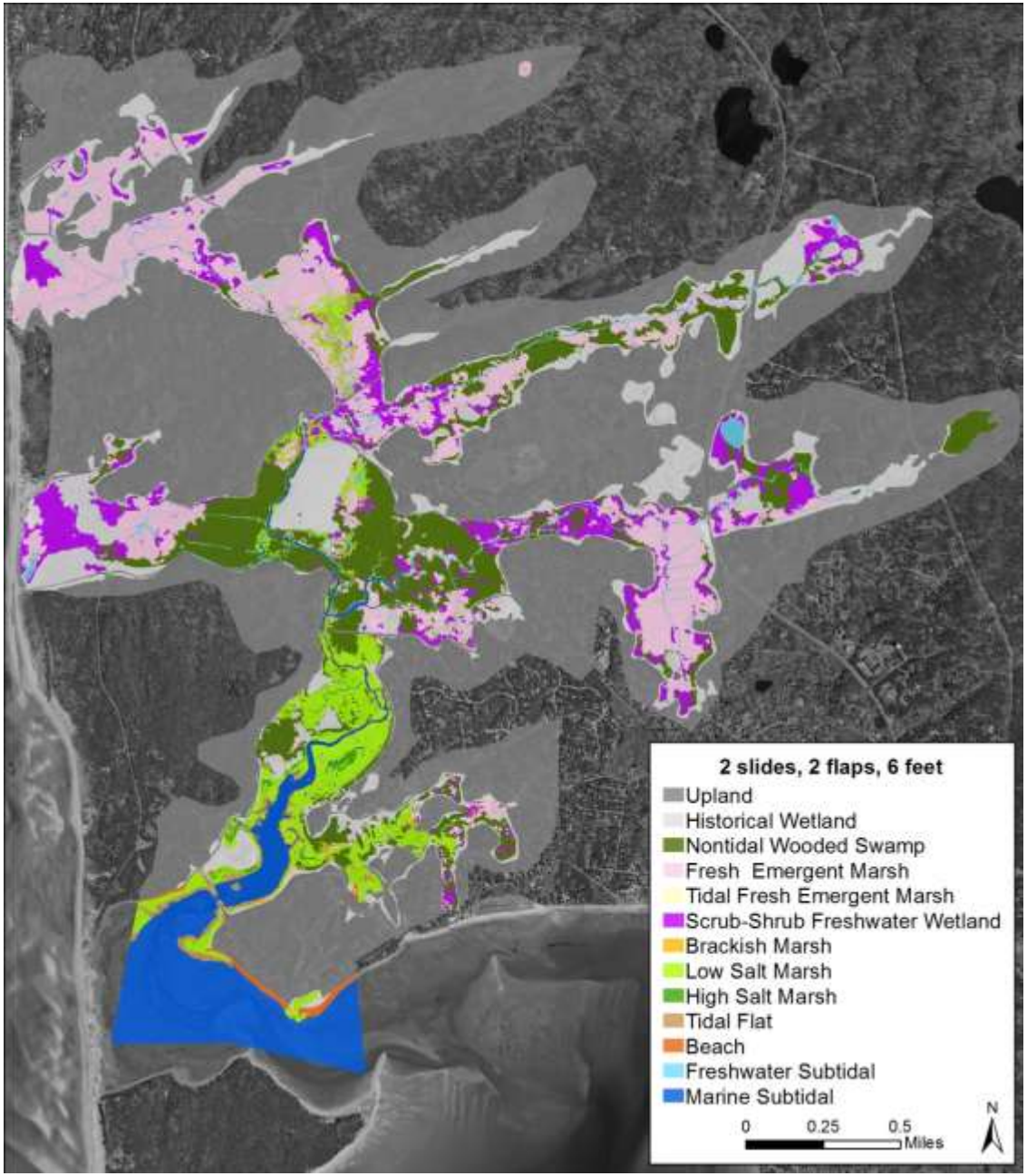
Results


5
4
3
2
1
0
-1
-2
-3
-4
-5
Elevation (NAVD88, feet)
GDTR = 2.56 ft
MTL = -0.98 ft
Lower Herring River
Water Levels

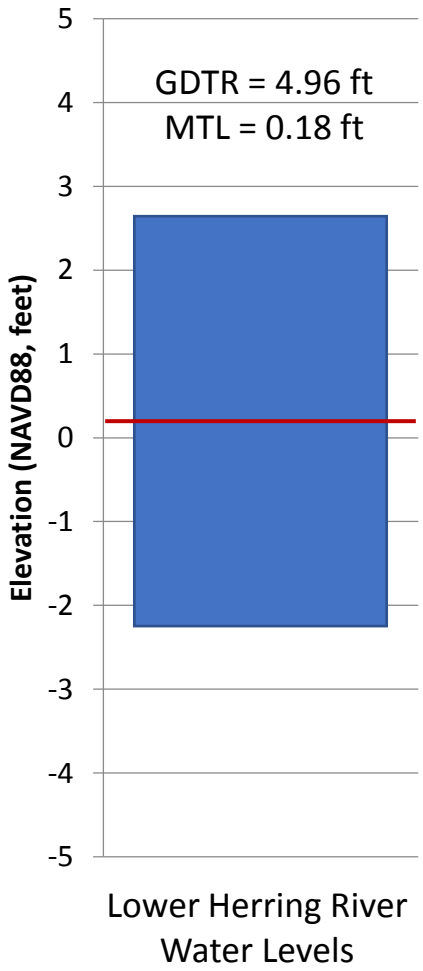

Existing Conditions
Upland
Historical Wetland
Nontidal Wooded Swamp
Fresh Emergent Marsh
Tidal Fresh Emergent Marsh
Scrub-Shrub Freshwater Wetland
Brackish Marsh
Low Salt Marsh
High Salt Marsh
Tidal Flat
Beach
Freshwater Subtidal
Marine Subtidal
0
0.25
0.5
Miles
N

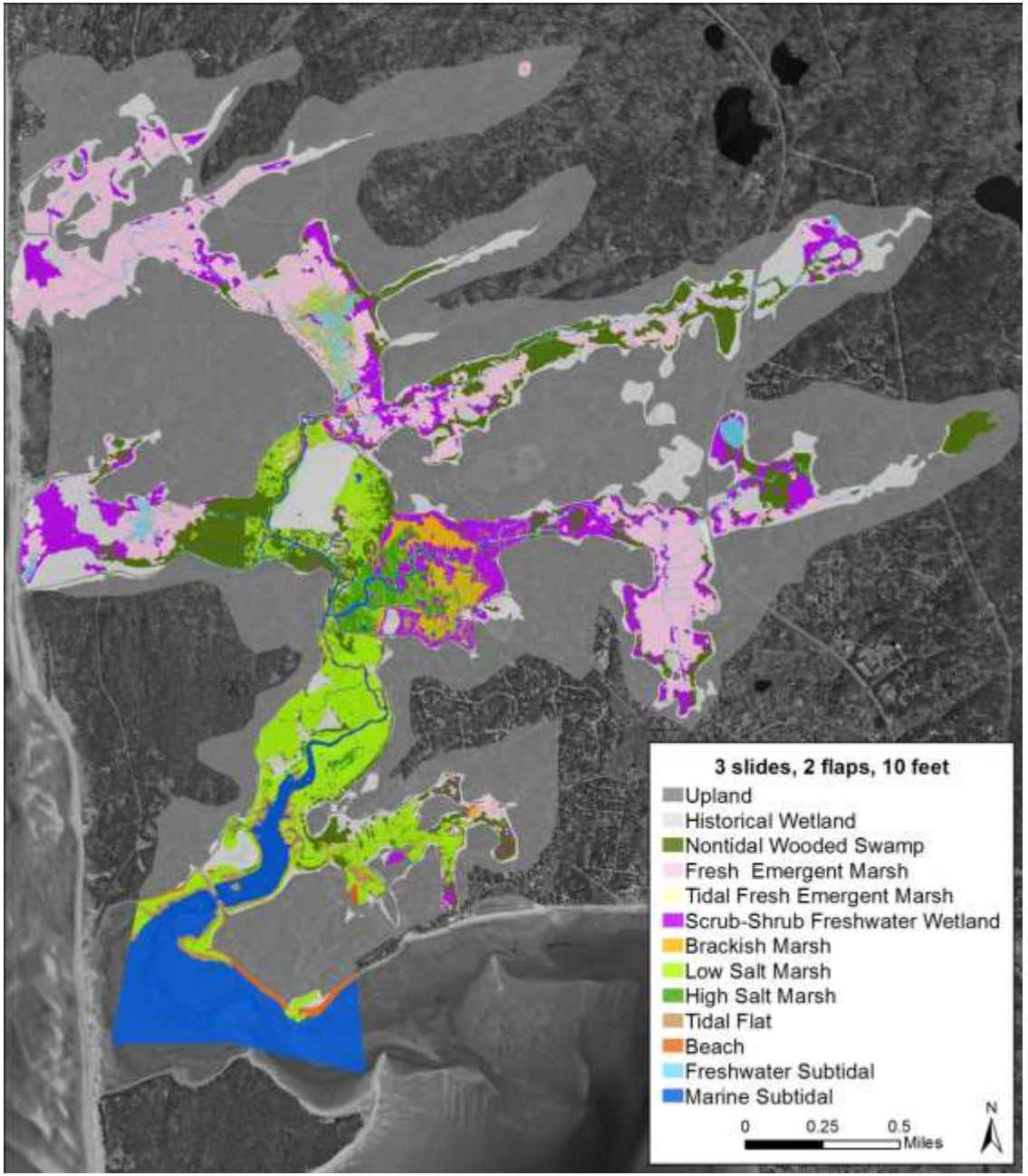
Results


5
4
3
2
1
0
-1
-2
-3
-4
-5
GDTR = 4.29 ft
MTL = -0.03 ft
Elevation (NAVD88, feet)
Lower Herring River
Water Levels

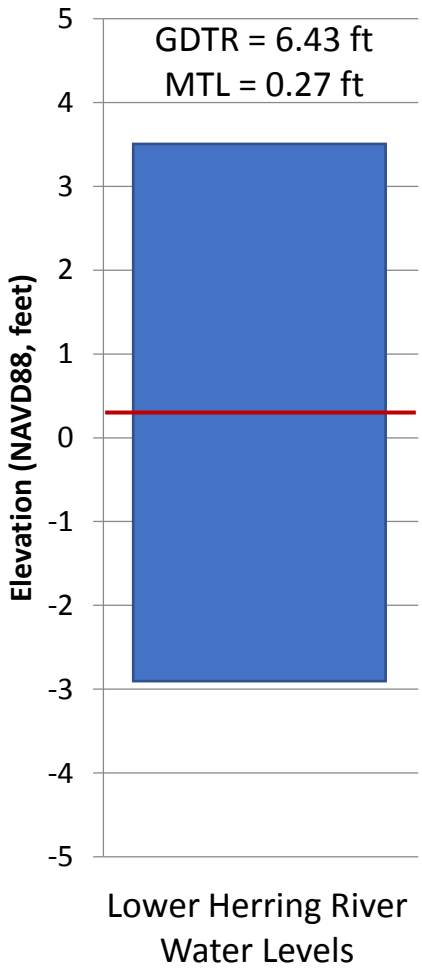

2 slides, 2 flaps, 6 feet
Upland
Historical Wetland
Nontidal Wooded Swamp
Fresh Emergent Marsh
Tidal Fresh Emergent Marsh
Scrub-Shrub Freshwater Wetland
Brackish Marsh
Low Salt Marsh
High Salt Marsh
Tidal Flat
Beach
Freshwater Subtidal
Marine Subtidal
0
0.25
0.5
Miles
N

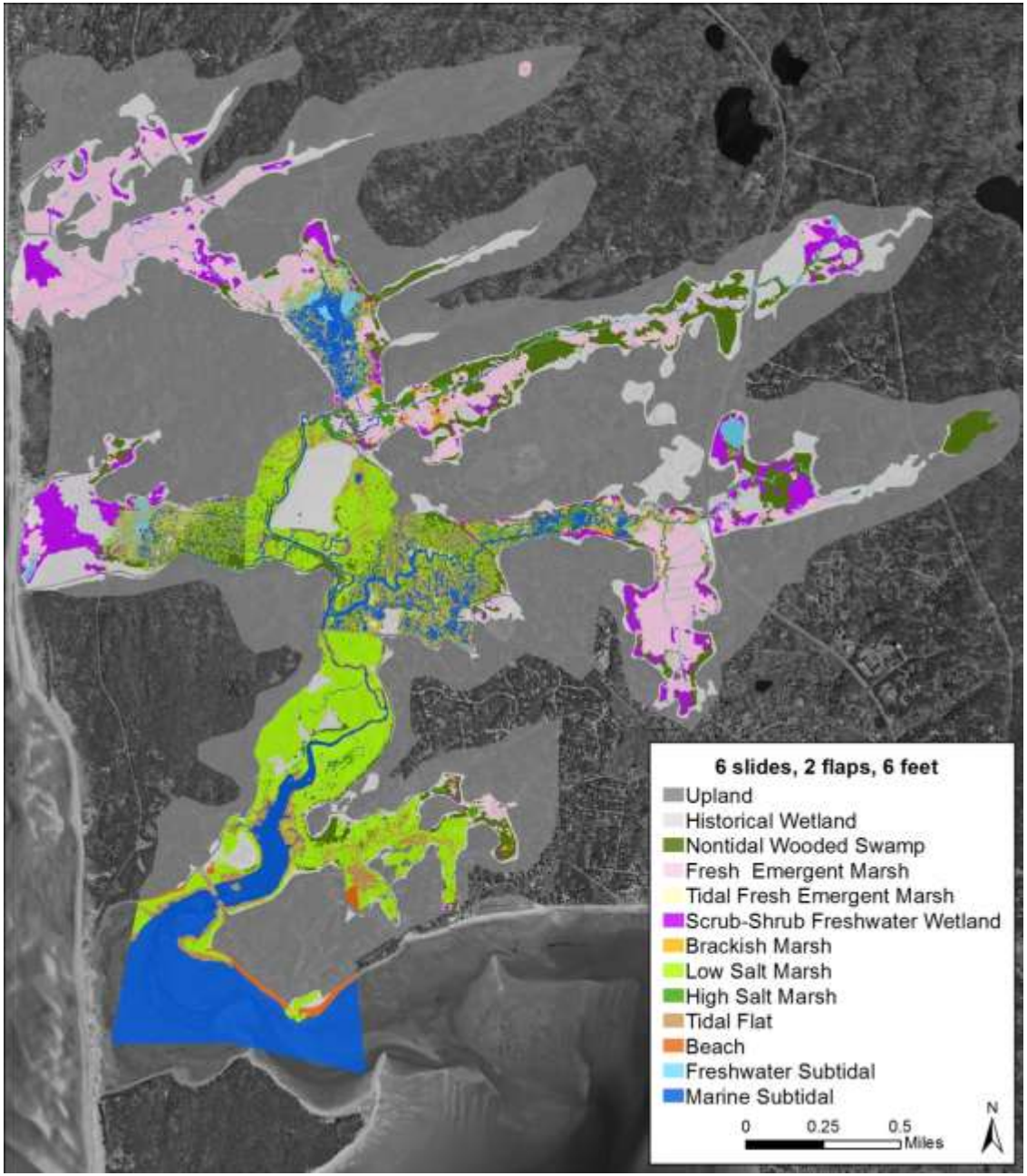
Results


5
4
3
2
1
0
-1
-2
-3
-4
-5
Elevation (NAVD88, feet)
GDTR = 4.96 ft
MTL = 0.18 ft
Lower Herring River
Water Levels

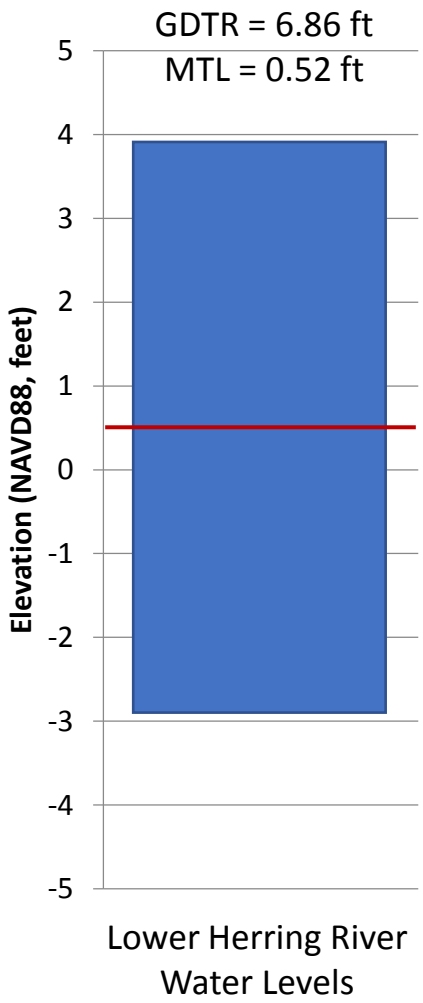

3 slides, 2 flaps, 10 feet
Upland
Historical Wetland
Nontidal Wooded Swamp
Fresh Emergent Marsh
Tidal Fresh Emergent Marsh
Scrub-Shrub Freshwater Wetland
Brackish Marsh
Low Salt Marsh
High Salt Marsh
Tidal Flat
Beach
Freshwater Subtidal
Marine Subtidal
0
0.25
0.5
Miles
N

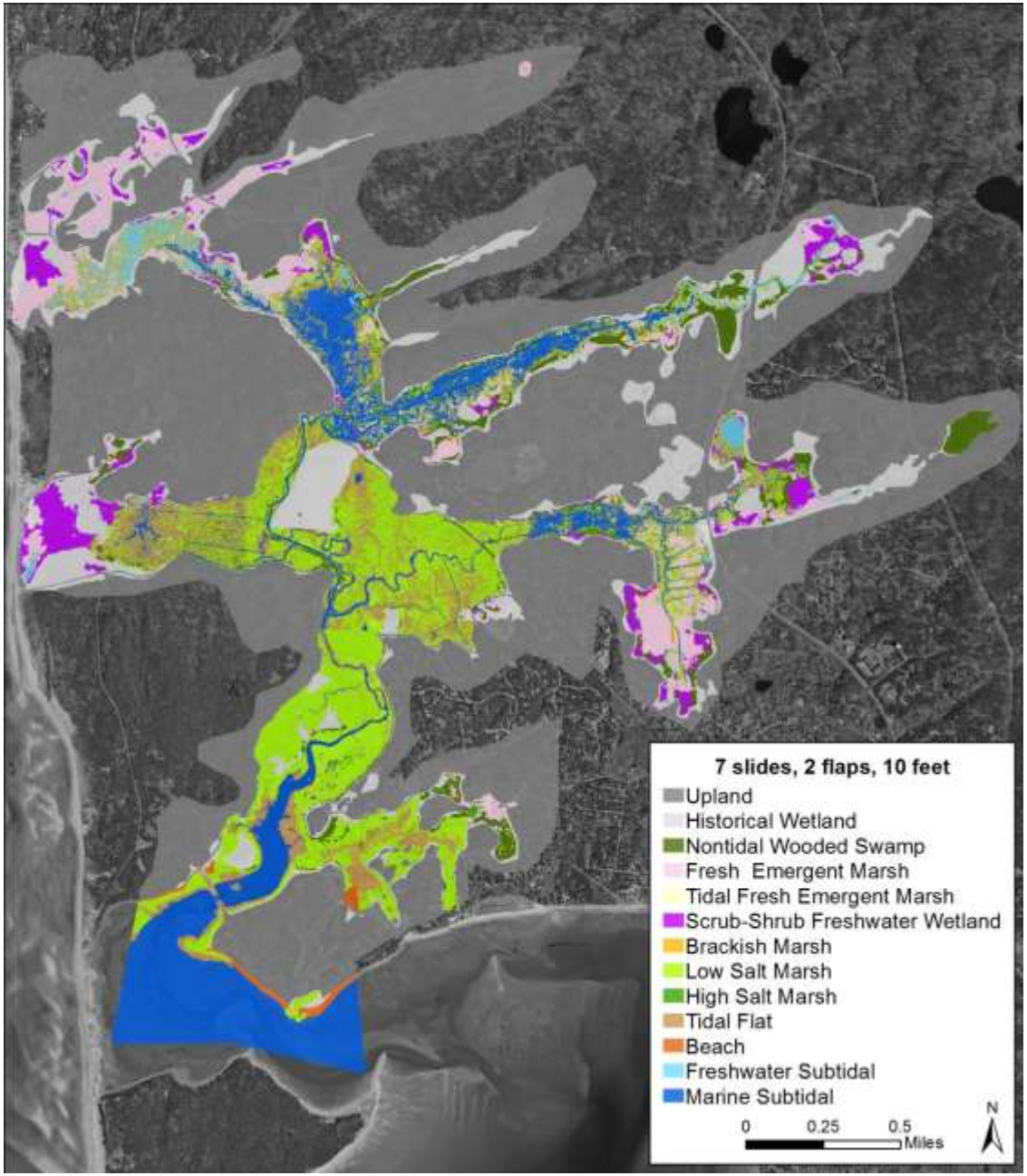
Results


GDTR = 6.43 ft
MTL = 0.27 ft
Elevation (NAVD88, feet)
5
4
3
2
1
0
-1
-2
-3
-4
-5
Lower Herring River
Water Levels


6 slides, 2 flaps, 6 feet
Upland
Historical Wetland
Nontidal Wooded Swamp
Fresh Emergent Marsh
Tidal Fresh Emergent Marsh
Scrub-Shrub Freshwater Wetland
Brackish Marsh
Low Salt Marsh
High Salt Marsh
Tidal Flat
Beach
Freshwater Subtidal
Marine Subtidal
0
0.25
0.5
Miles
N

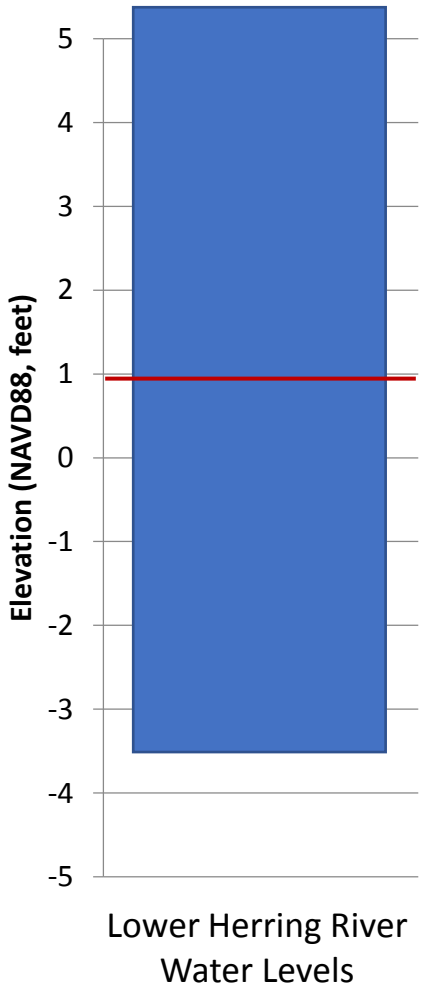
Results


GDTR = 6.86 ft
MTL = 0.52 ft
Elevation (NAVD88, feet)
5
4
3
2
1
0
-1
-2
-3
-4
-5
Lower Herring River
Water Levels

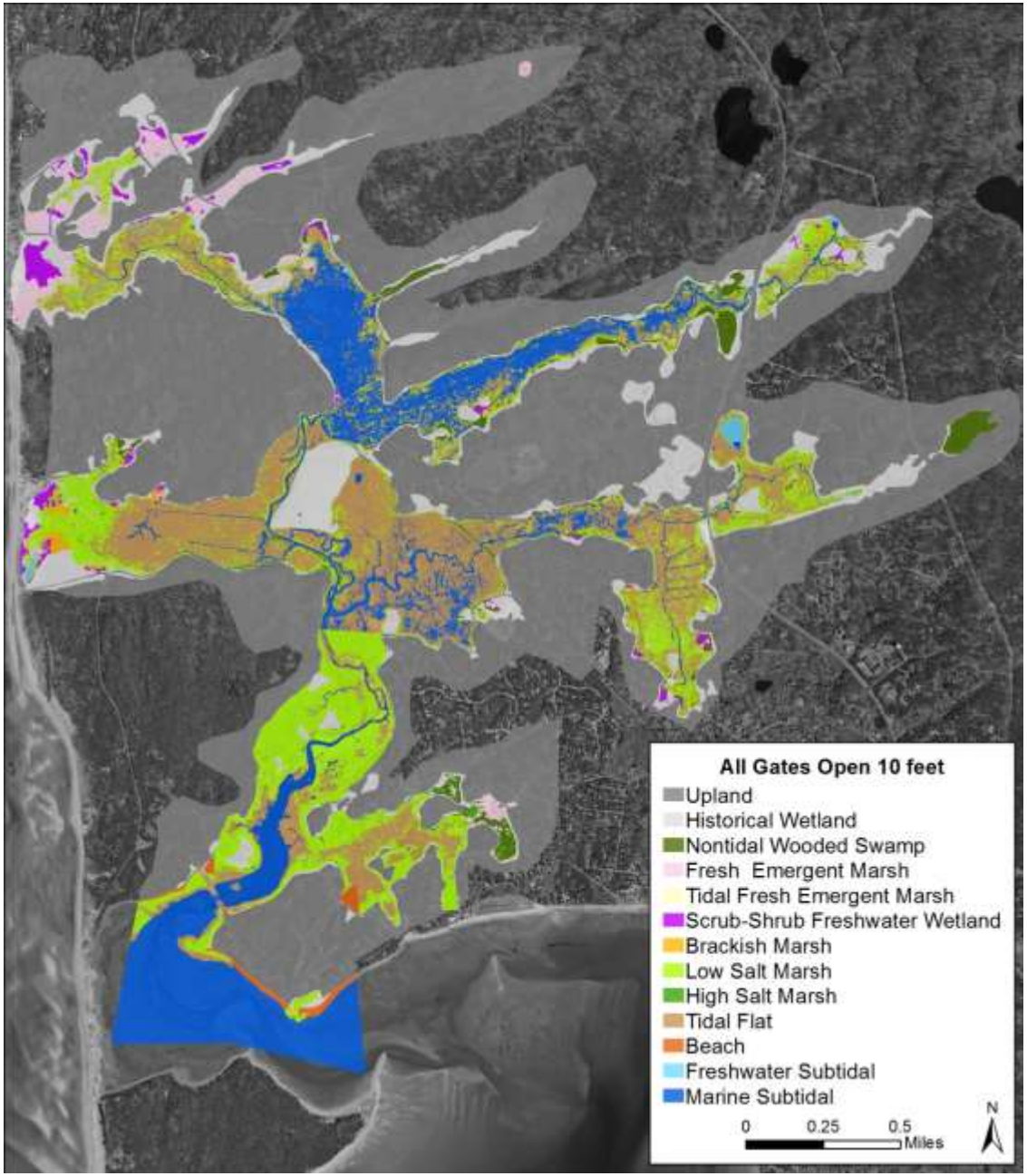

7 slides, 2 flaps, 10 feet
Upland
Historical Wetland
Nontidal Wooded Swamp
Fresh Emergent Marsh
Tidal Fresh Emergent Marsh
Scrub-Shrub Freshwater Wetland
Brackish Marsh
Low Salt Marsh
High Salt Marsh
Tidal Flat
Beach
Freshwater Subtidal
Marine Subtidal
0
0.25
0.5
Miles
N

Results

GDTR = 8.94 ft
MTL = 0.96 ft



Lower Herring River
Water Levels



Moving forward

SLAMM results feed into adaptive management decision process

- Results feed directly into a broader 38-measurement endpoint decision tool

- Provide predictions for habitat type and viewscape objectives
  - How many acres of emergent vegetated wetland?
  - How many acres of dead standing trees?

- Assist restoration managers in
  - Choosing gate openings that produce desirable equilibrium habitat conditions
  - Identifying scenarios that may require secondary management actions (tree removal, additional sediment)
  - Eliminating alternatives too small to affect any meaningful change

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FOR EARTH, FROM SPACE

Questions?

Contact Information:

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