Assessing ecological integrity of salt marshes in the Northeast

A project of the North Atlantic Landscape Conservation Cooperative

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Designing Sustainable Landscapes (DSL) assesses the capability of current and potential future landscapes to provide integral ecosystems and suitable habitat for a suite of representative species, and provides guidance for strategic habitat conservation.

Landscapes are modeled in the present, and projected into the future (70 years in 10-year timesteps).

Change, including urban growth, climate change, sea level rise, and succession/disturbance.

Assessment of ecological integrity ("coarse filter") and habitat for representative species.

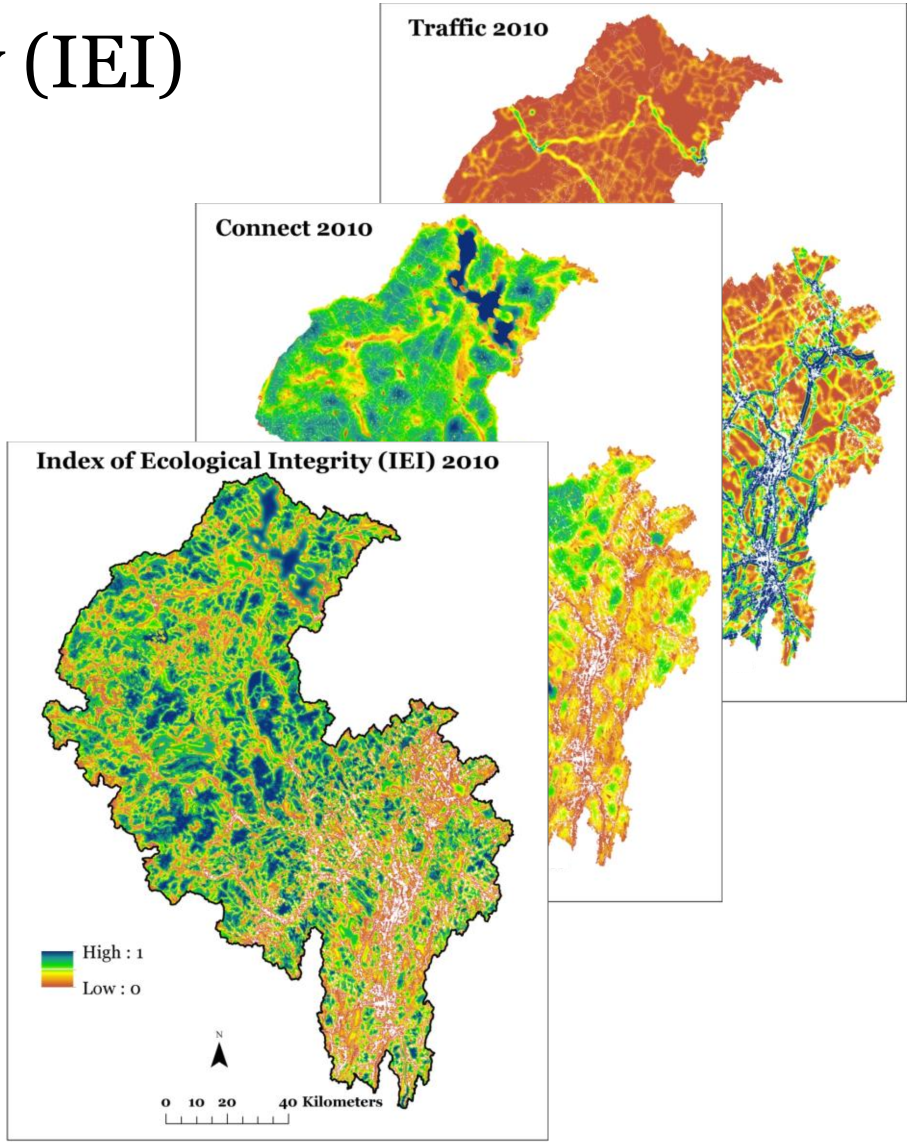
Design of landscape-based conservation strategies.

Index of Ecological Integrity (IEI)

Ecological integrity: the capability of an area to sustain biodiversity and ecosystem processes over the short and long term, especially in the face of disturbance and stress.

Metrics: Road traffic, Microclimate alterations, Watershed road salt, Edge predators, Similarity, Connectedness, …and 15 others.

Metrics are combined in a weighted linear combination specific to each ecological system, resulting in IEI.



2009-2010: Under an EPA WPD grant, UMass/Amherst, MA CZM, and MA DEP convened a group to scope out a number of new metrics that apply to coastal systems.

Criteria: must be reasonably important to integrity, and must be feasible to model at broad scales.

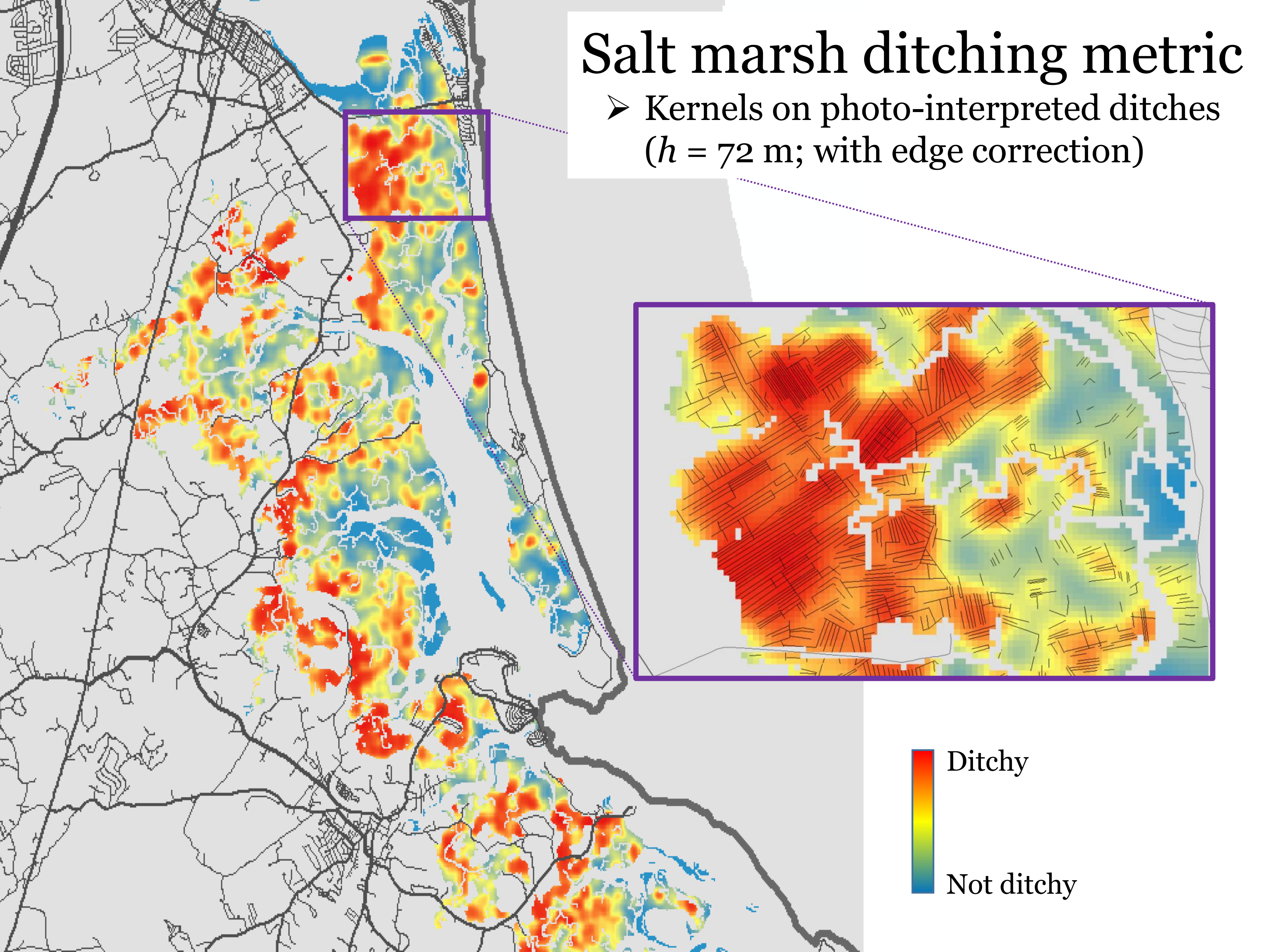
Two metrics apply to salt marshes:

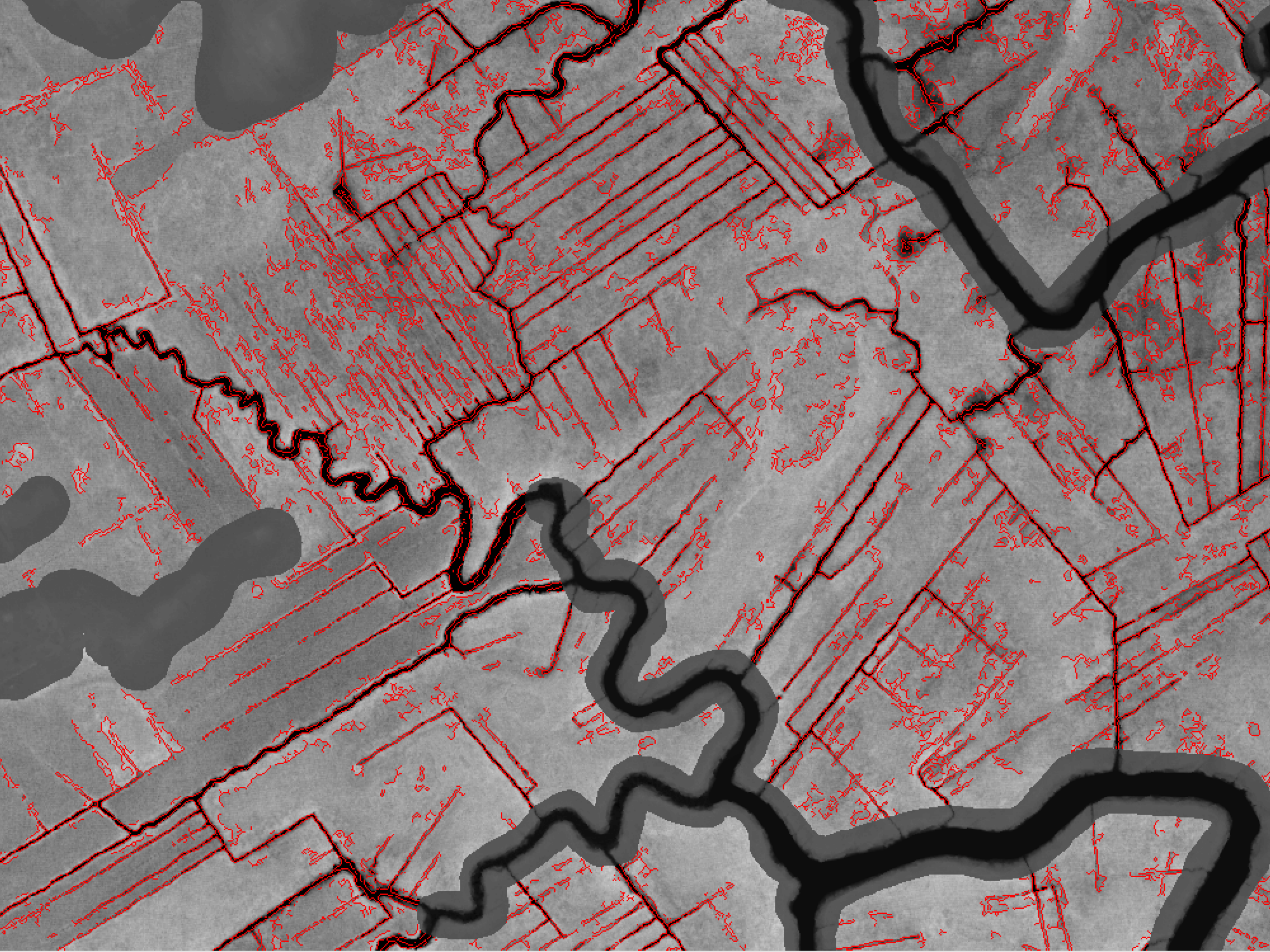
- **Salt marsh ditching**: loss of open water habitat as a legacy of mosquito control ditches in salt marshes.
- **Tidal restrictions**: loss of tidal effects and saltwater input due to undersized culverts, bridges, and tidegates (applied to freshwater systems too).

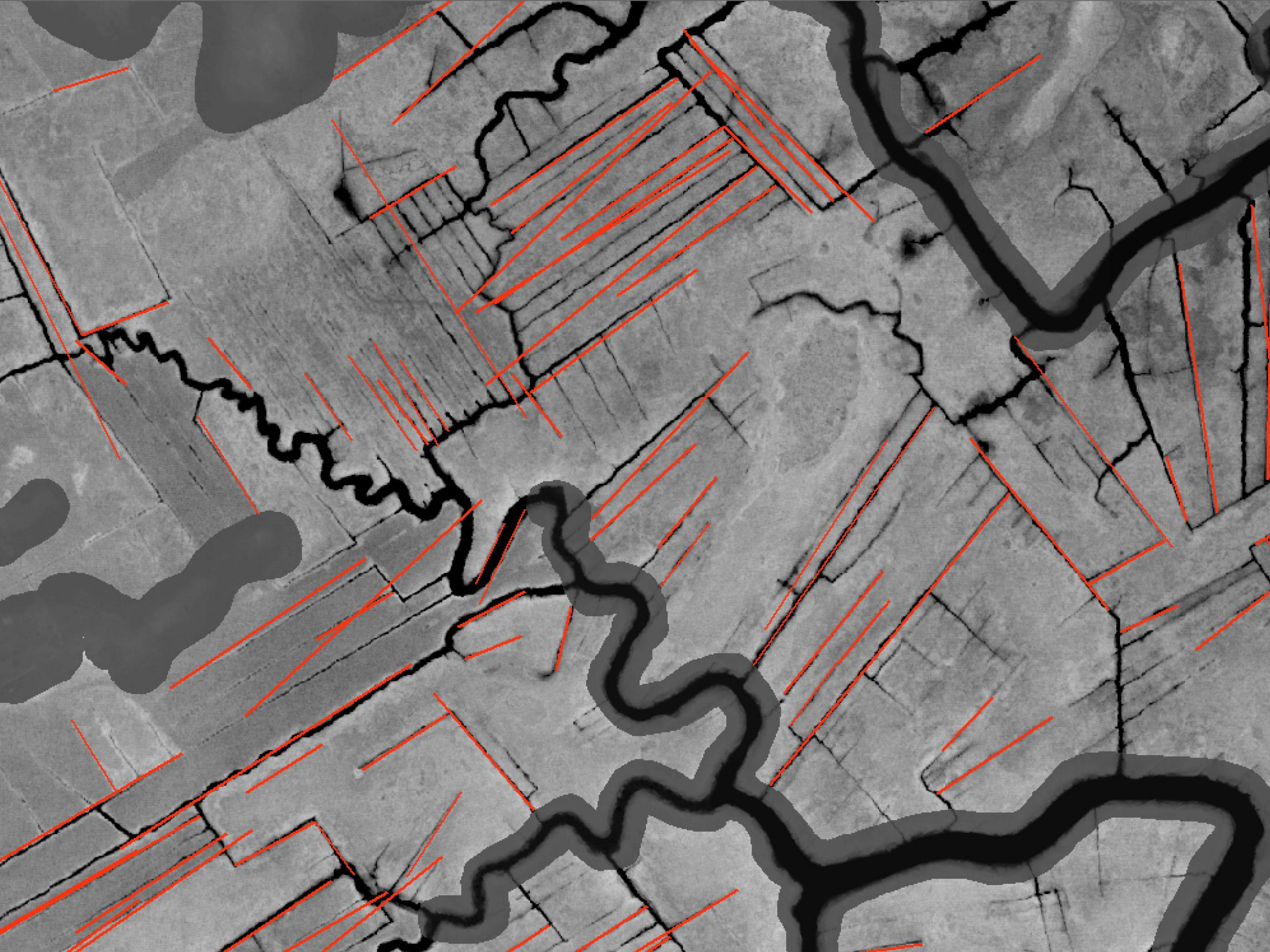
2015: can we apply these metrics to the northeast (VA to ME)?

Salt marsh ditching metric

- Kernels on photo-interpreted ditches (h = 72 m; with edge correction)





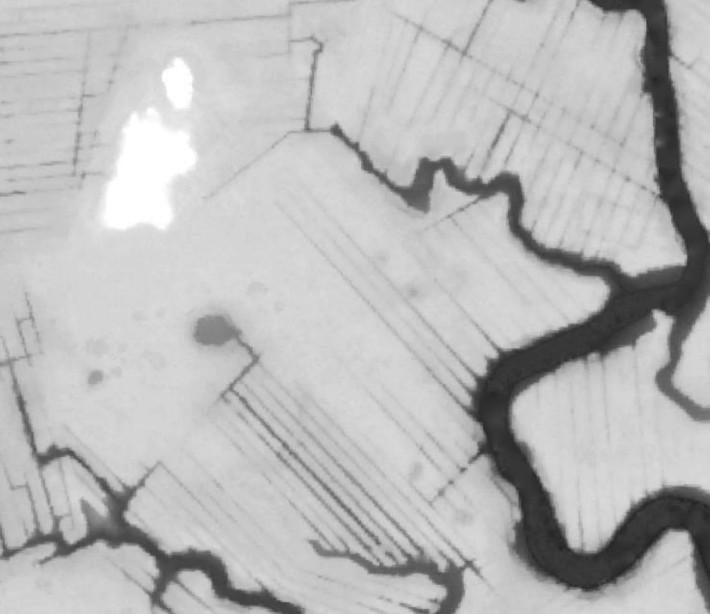


Comparison of ditching metric results

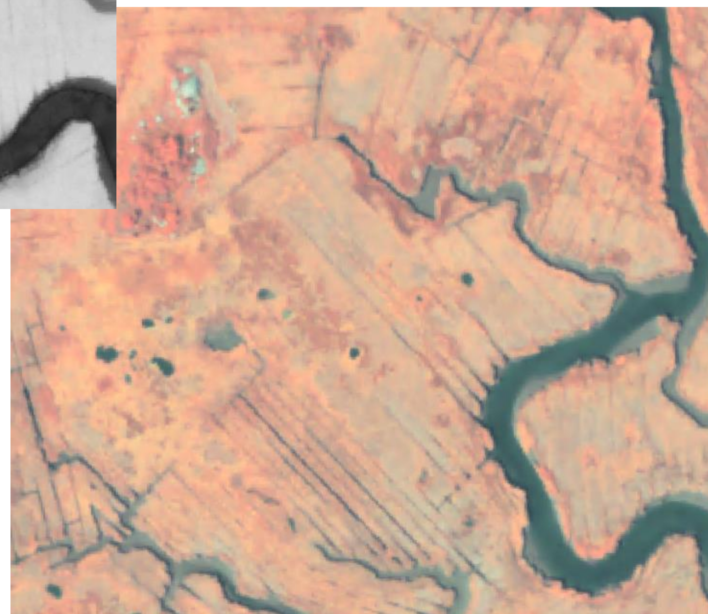
- 9 tiles (1.5 km²)
- Comparison of ditching metric from PI with…

- **1 m ditches**:
  mean *r* = 0.74 (0.60 – 0.93)

- **3 m ditches** (CoNED):
  mean *r* = 0.52 (0.08 – 0.85)



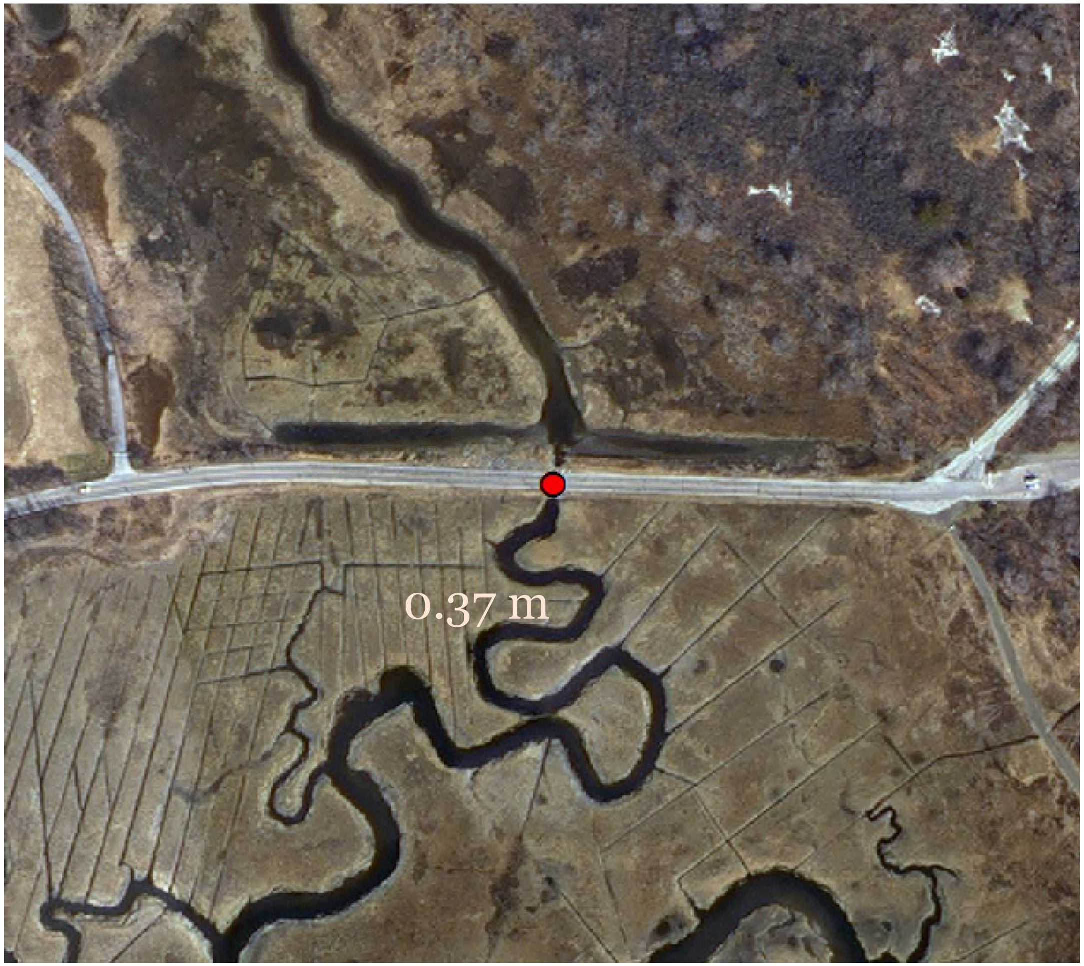
1 m LiDAR (MA only)



1 m NAIP imagery

3 m LiDAR (CoNED)

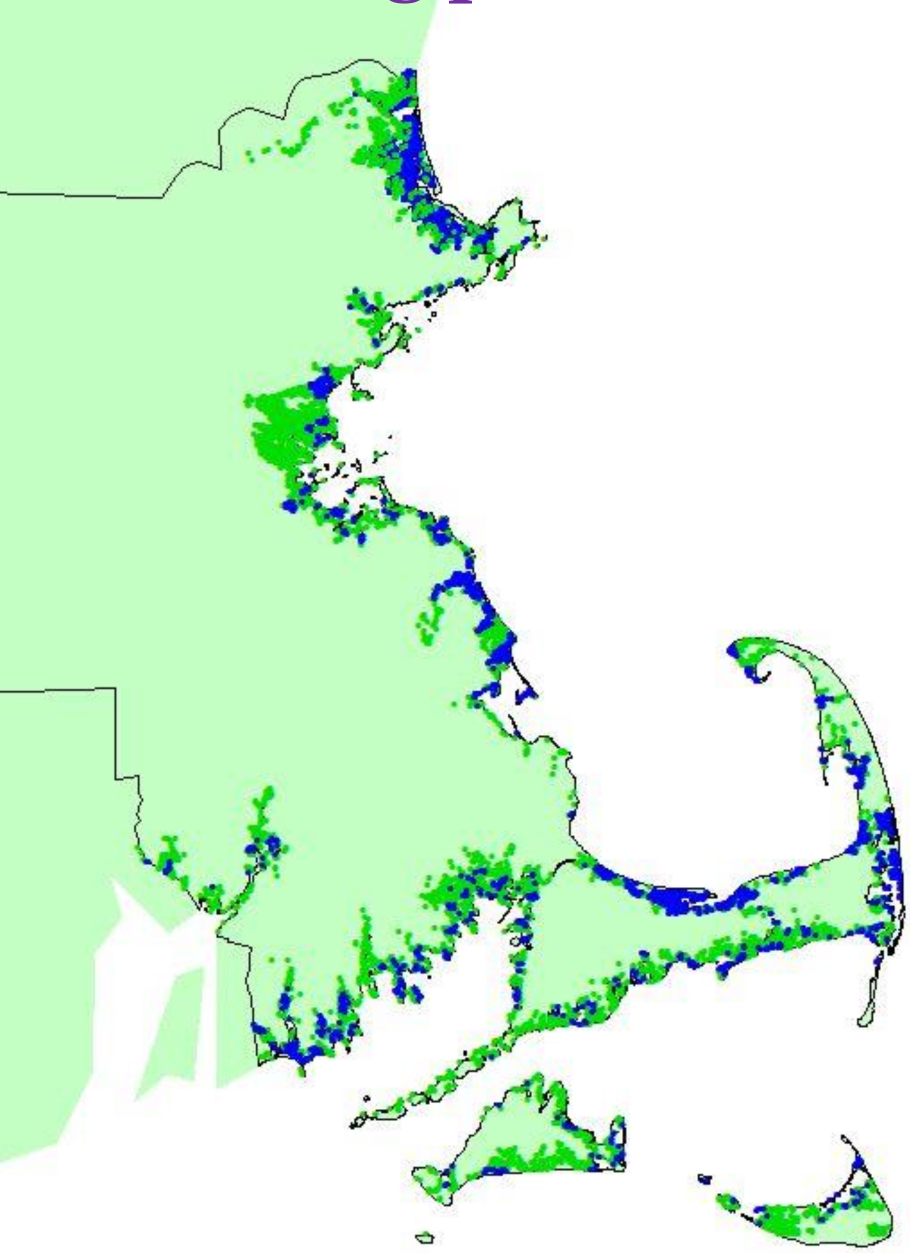
Tidal restrictions



Have 75 measured restrictions from MA CZM/DEP. Each records Δspring high tide (m).

Potential tidal restrictions modeled at all road-stream and railroad-stream crossings in coastal area. We don't have data for tide gates.

Modeling potential salt marshes



Logistic regression:

marsh vs. upland

= elevation + tide range + dummy

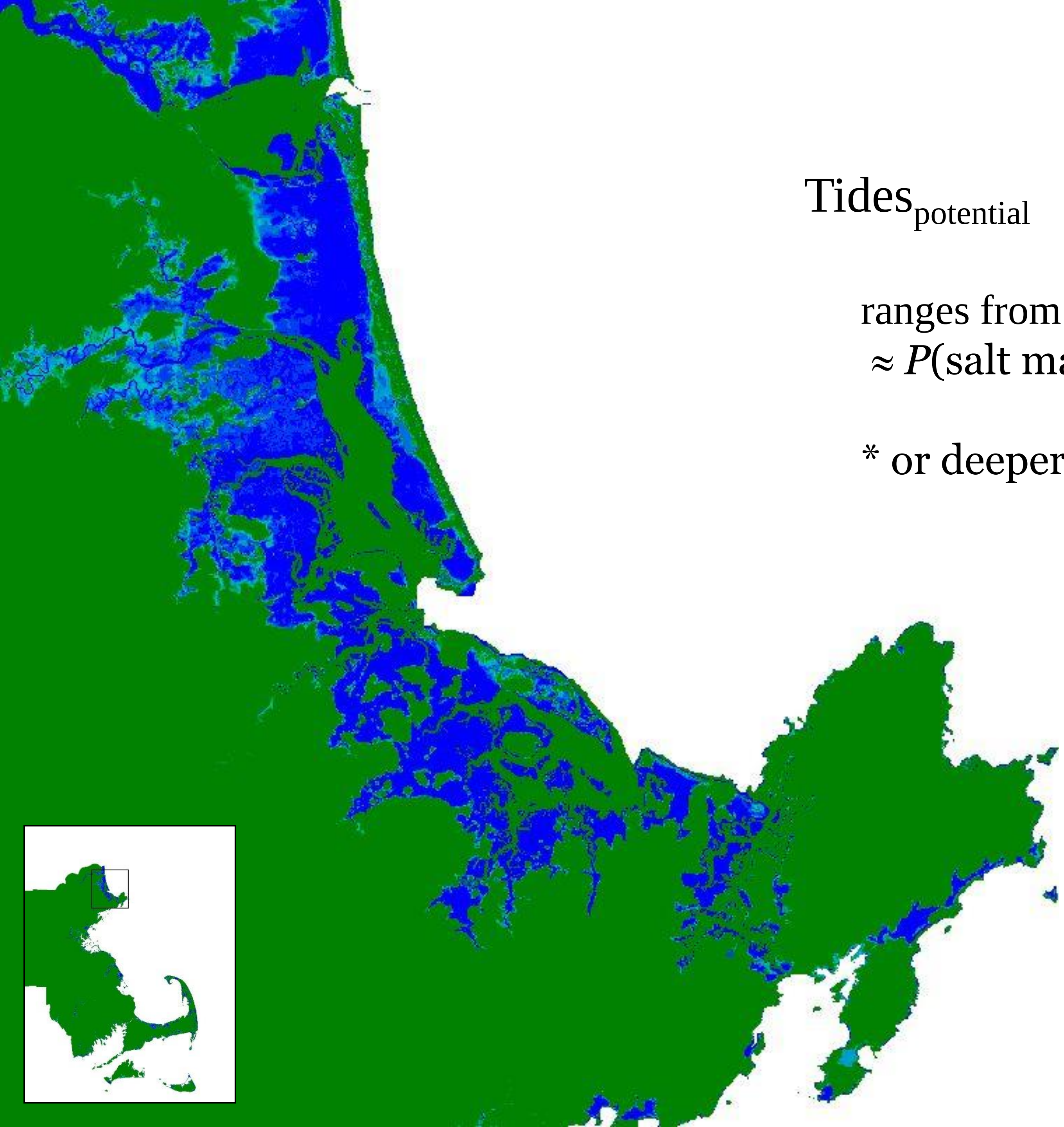
P < 0.001

correct classification rate = 91%

	marsh	upland
marsh	2259	296
upland	149	2406

2500 random points in each

- Upland
- Salt marsh



$\text{Tides}_{\text{potential}}$

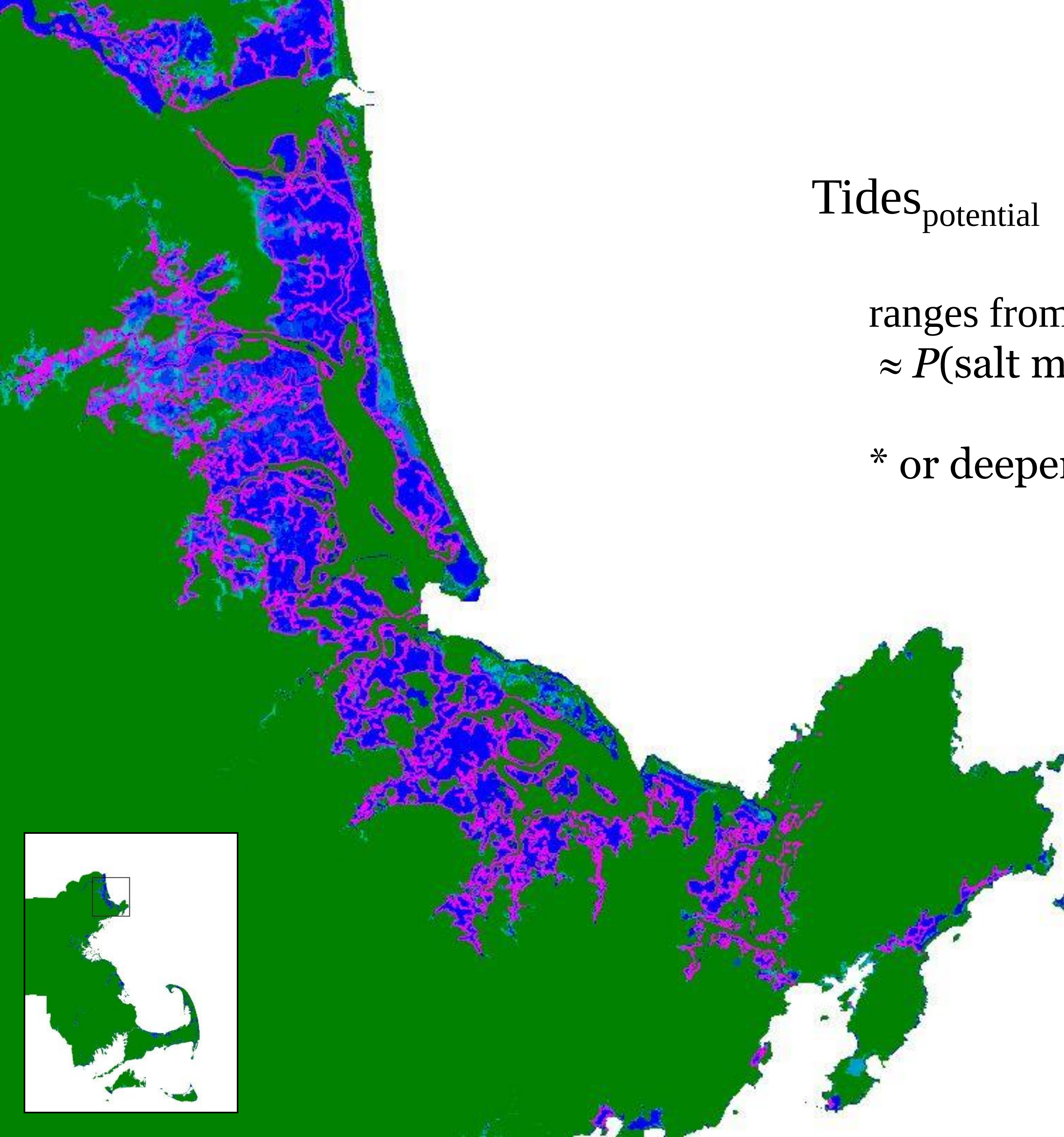
ranges from 0~1
≈ P(salt marsh*)

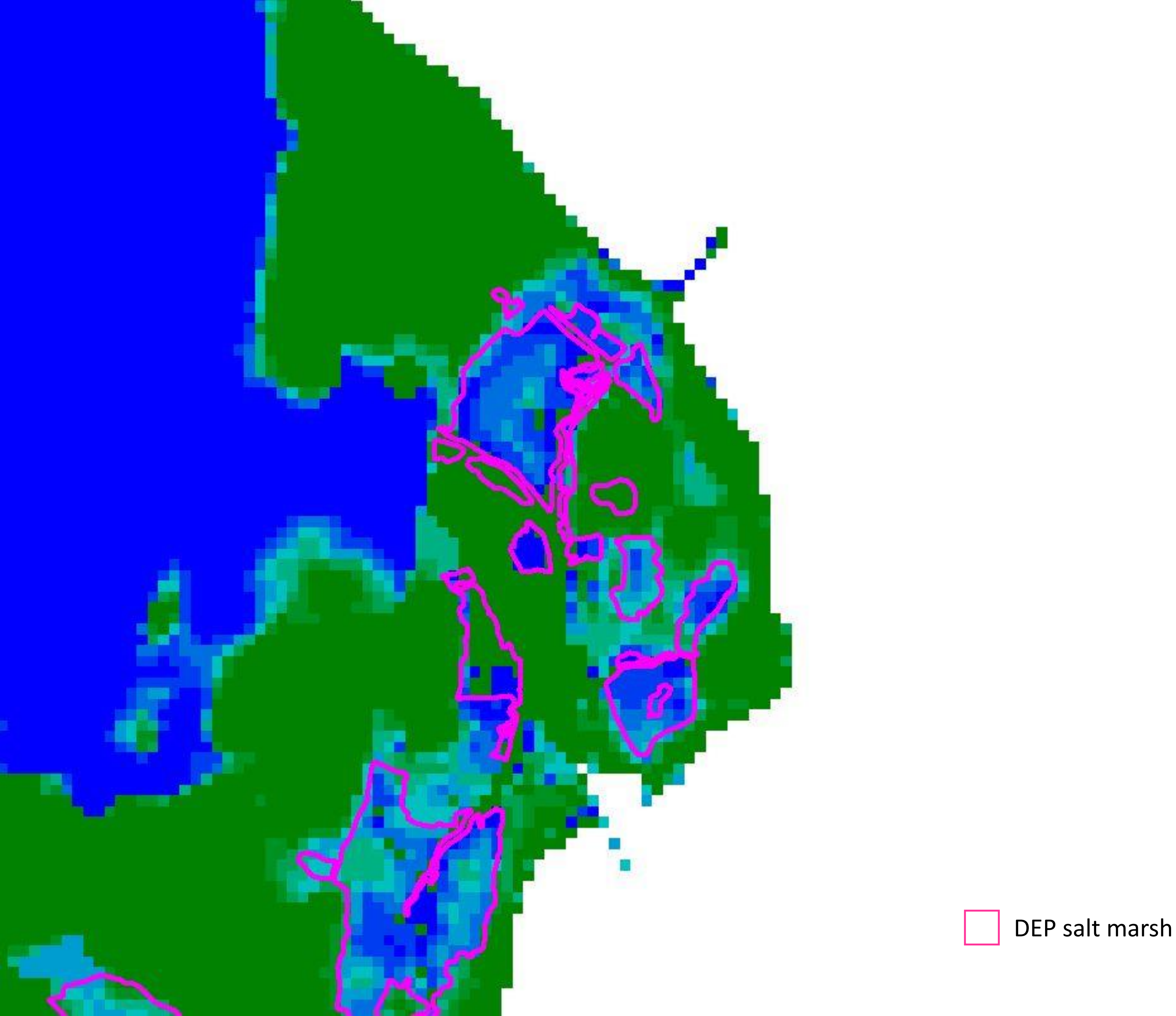
* or deeper

Tides$_{potential}$

ranges from 0~1
≈ P(salt marsh*)

* or deeper




DEP salt marsh

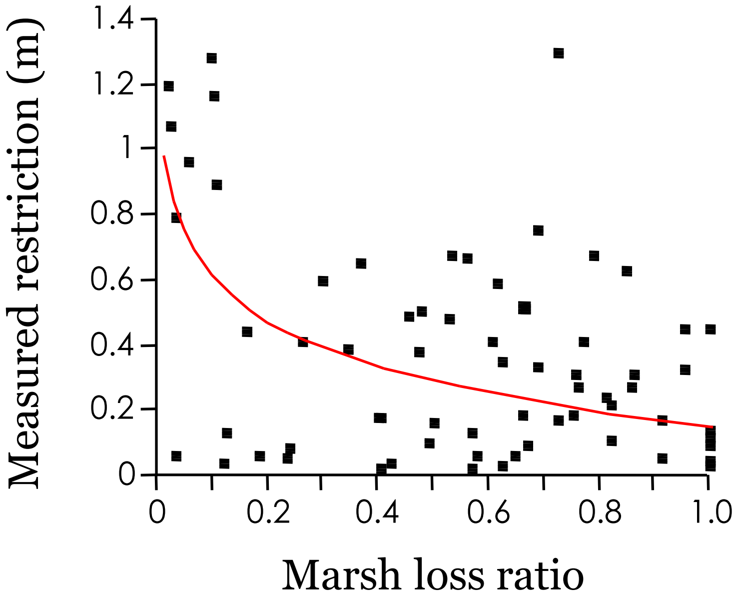

Ocean Bluff
Marsh
SEAWALL
BM 40
Brant Rock
GREEN HARBOR
DIKE ROAD
Pumping Sta
Tidegates
BM 12
RIVER
Brant Rock
Creek
139
Green Harb Pt
Trailer Park
Blackmans Pt
ST
Green Harbor
Radio Towers
CANAL
River
M A S S A C H

Estimating severity of unsurveyed tidal restrictions

$$\textbf{\textit{Marsh loss ratio}} = \frac{\text{area of observed salt marsh (DEP wetlands)}}{\text{area of potential salt marsh (tides}_{\text{potential}} > 0.5\text{)}} \text{ above each restriction}$$

…Assumption: tidal restrictions are sole cause of salt marsh loss

Estimating severity of unsurveyed tidal restrictions



restriction height = ln(marsh loss ratio), weighted by predicted marsh size

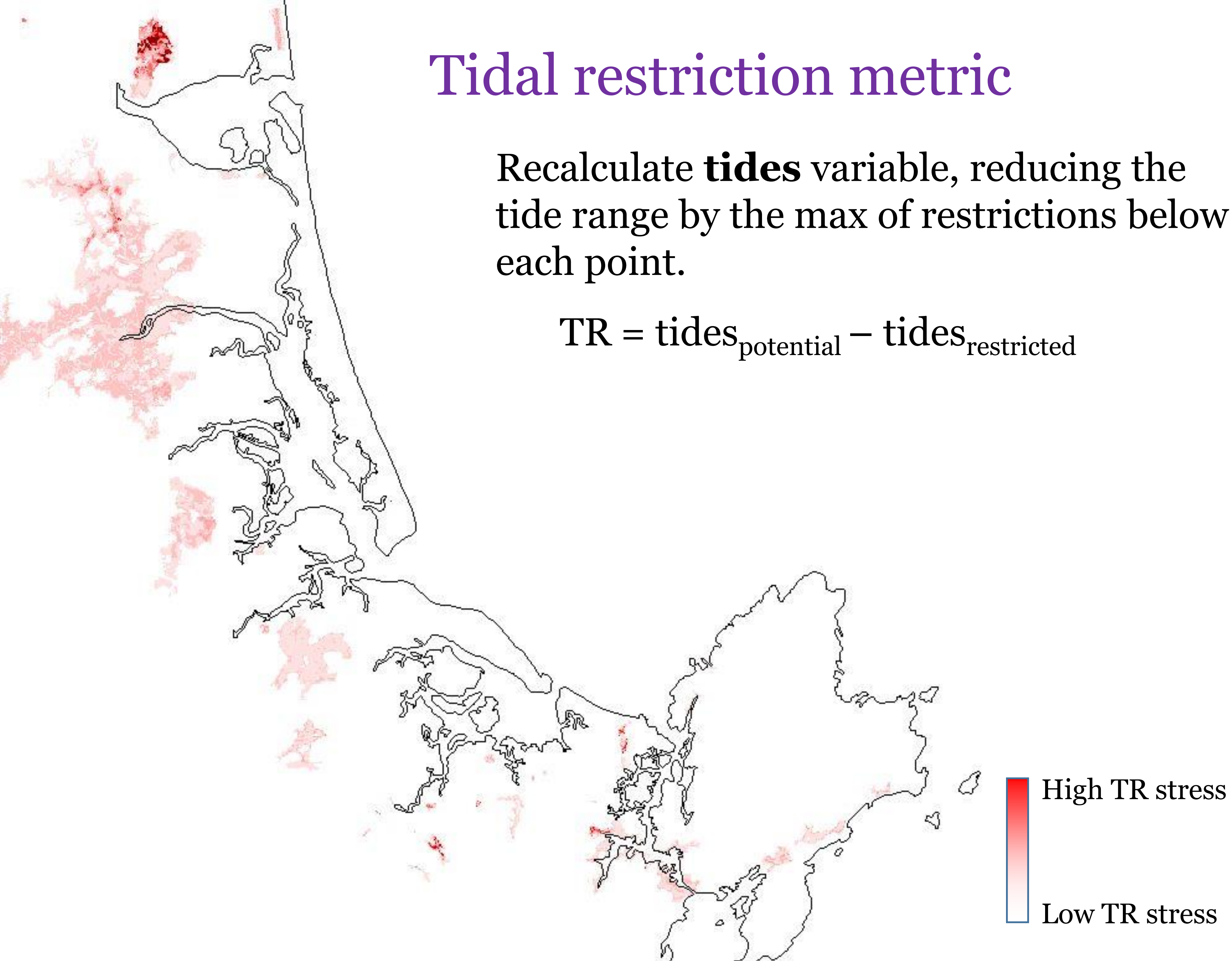
n = 67
P < 0.001
r^2 = 0.364

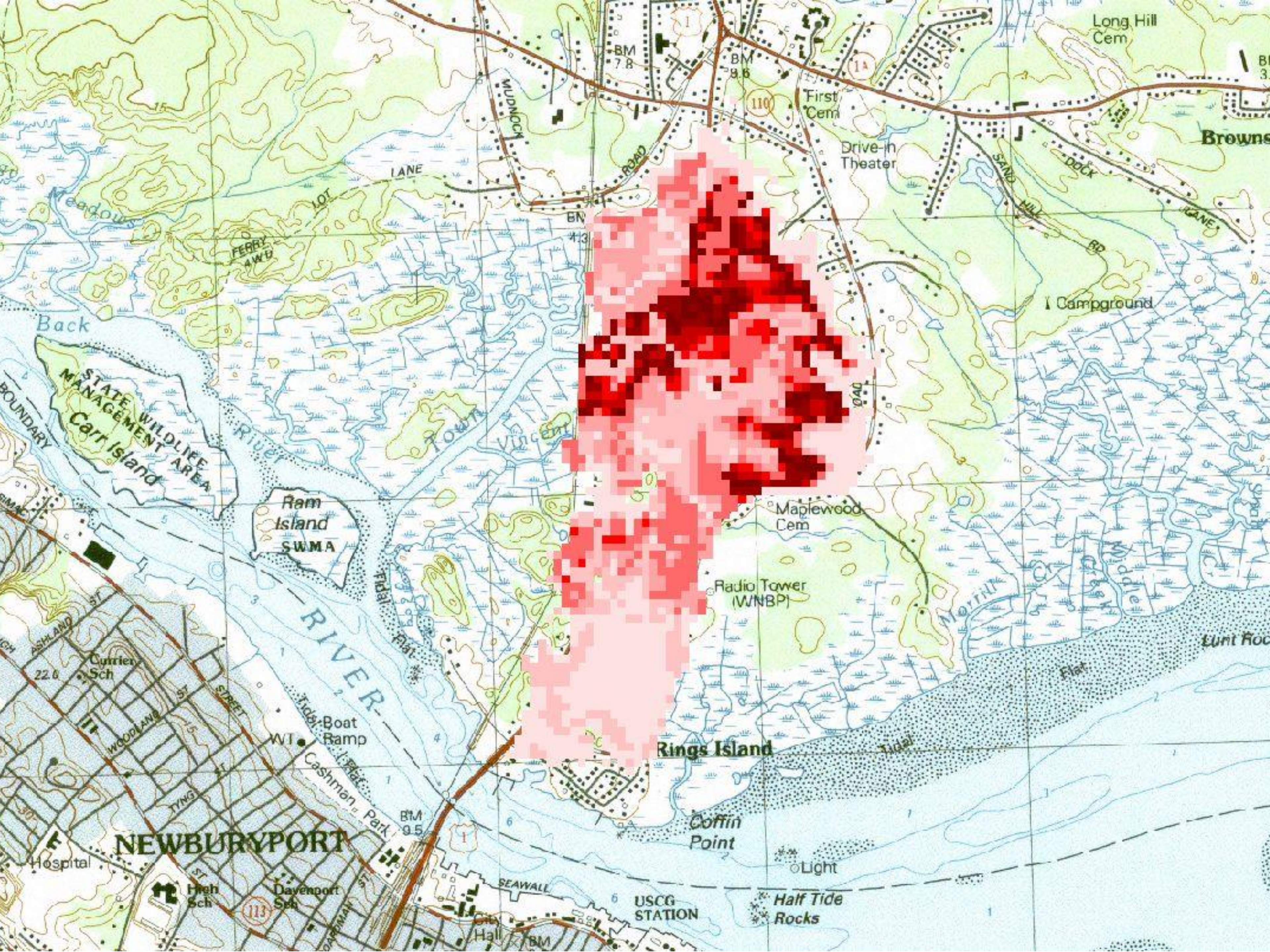
Applied to 1,528 potential tidal restrictions, giving us an estimate of the Δ (in m) for each potential restriction.

Tidal restriction metric

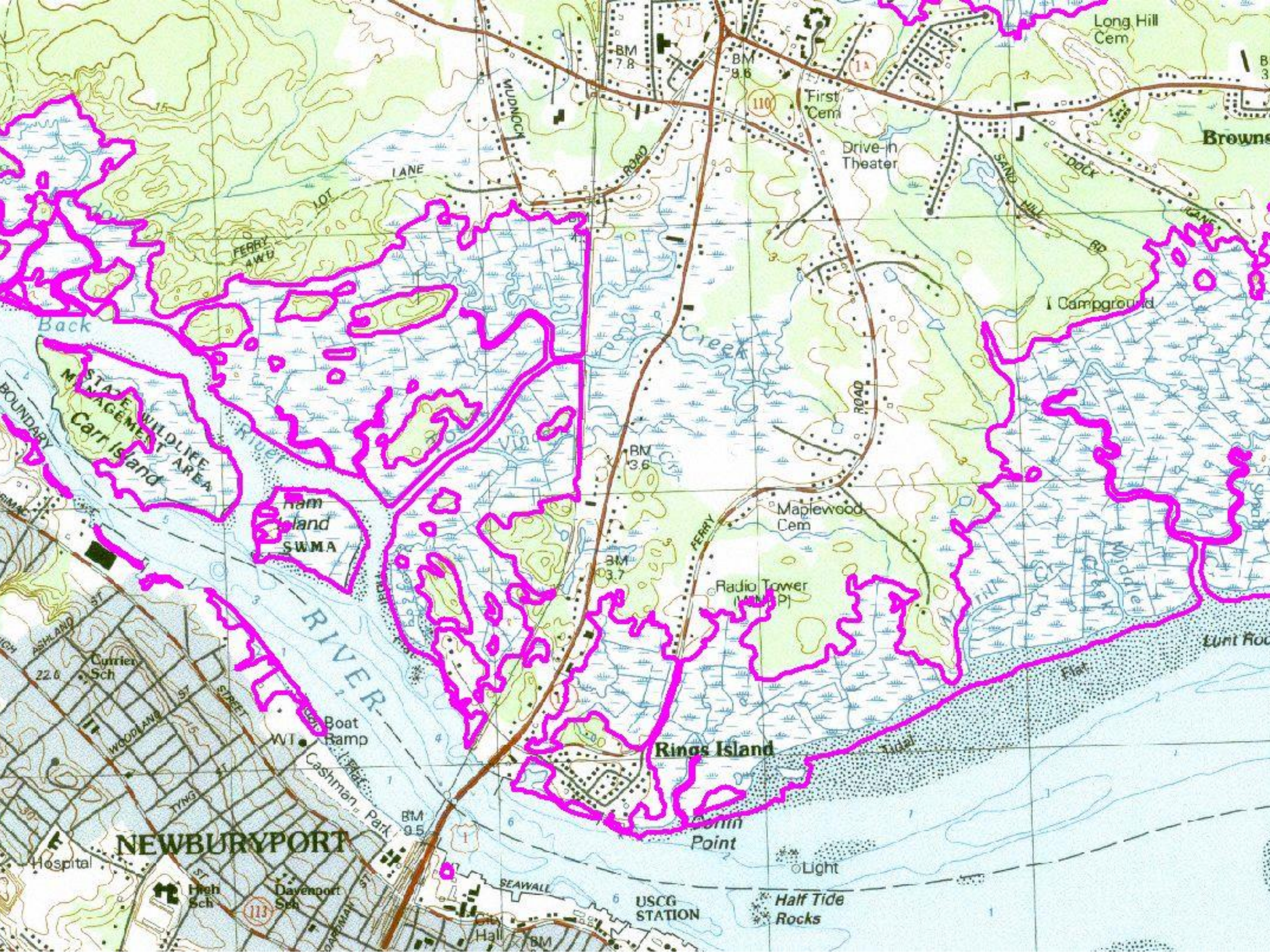
Recalculate **tides** variable, reducing the tide range by the max of restrictions below each point.

$$TR = tides_{potential} - tides_{restricted}$$





Long Hill Cem
BM 7.8
BM 8.6
First Cem
Drive-in Theater
Browns
LANE
LOT
FERRY 4WD
ROAD
MUDNOCK
SAND HILL
DOCK
LANE
RD
Campground
Back
Meadows
STATE WILDLIFE MANAGEMENT AREA
Carr Island
BOUNDARY
River
Town
Vincent
Ram Island
SWMA
Maplewood Cem
Radio Tower (WNBP)
Middle
Creek
Morrill
Tidal
Flat
RIVER
Lunt Roc
Flat
Tidal
Rings Island
Coffin Point
Light
Half Tide Rocks
USCG STATION
SEAWALL
City Hall
BM 9.5
Boat Ramp
WT
Cashman Park
NEWBURYPORT
Hospital
High Sch
Davenport Sch
Currier Sch
ASHLAND
WOODLAND
STREET



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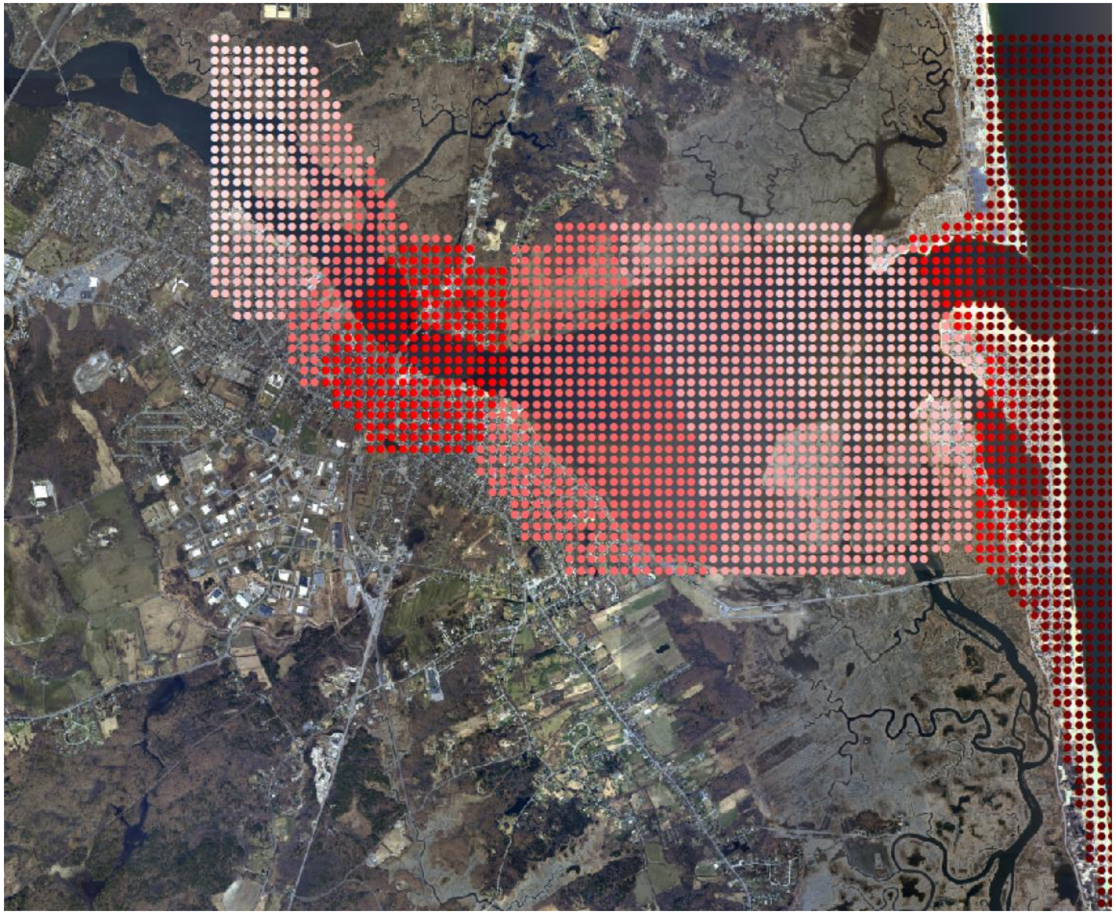
Tide ranges from NOAA's VDatum



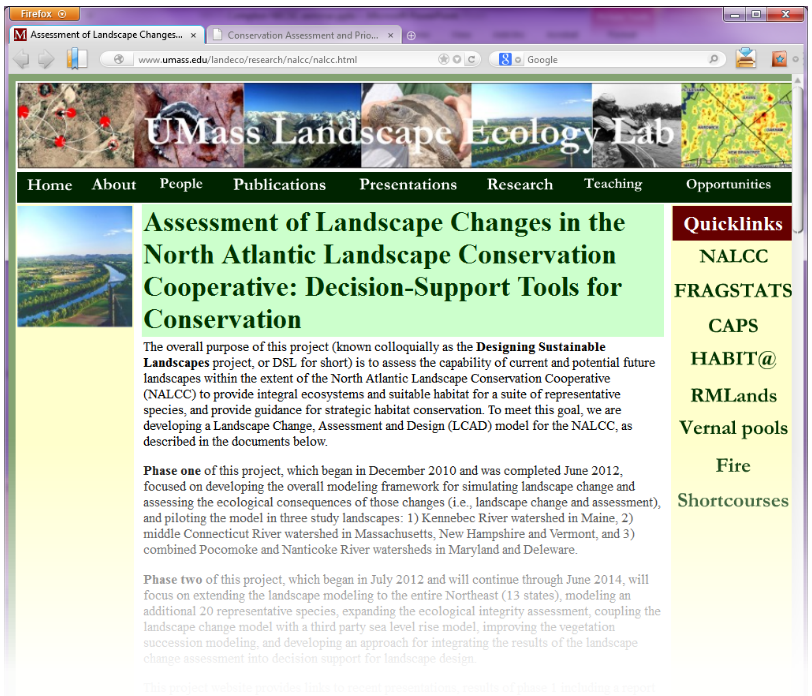
VDatum doesn't go very far inland, so we're forced to extrapolate upflow (bathtub assumption).

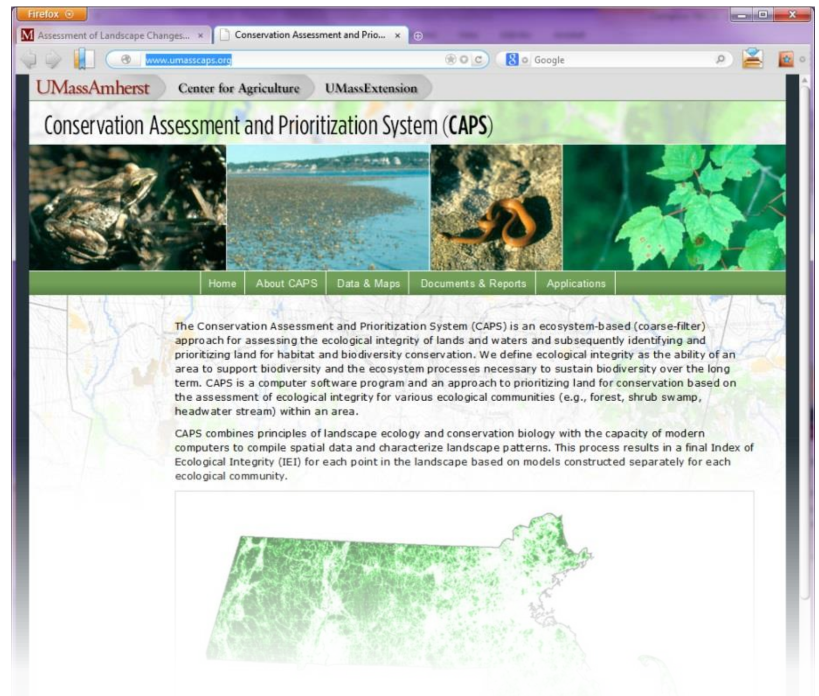
Designing Sustainable Landscapes:

www.umass.edu/landeco/research/nalcc/nalcc.html

CAPS (existing MA results):

www.umasscaps.org





Contact:

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Data needs

- 1 m DEM for northeast (ditches)
- Complete 3 m CoNED (tidal restrictions)
- Samples of field-measured tidal restrictions (tidal restrictions)