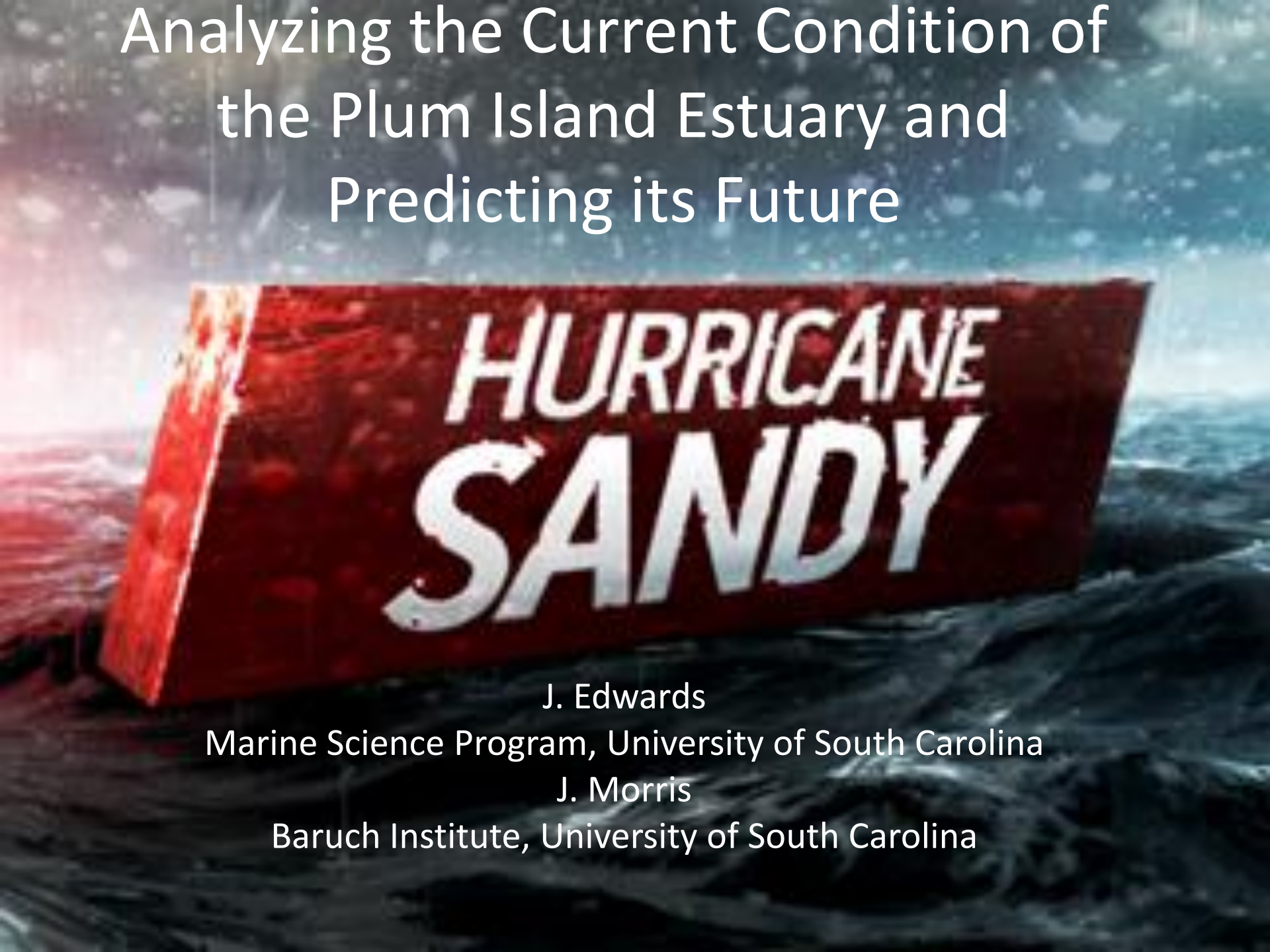
Analyzing the Current Condition of the Plum Island Estuary and Predicting its Future



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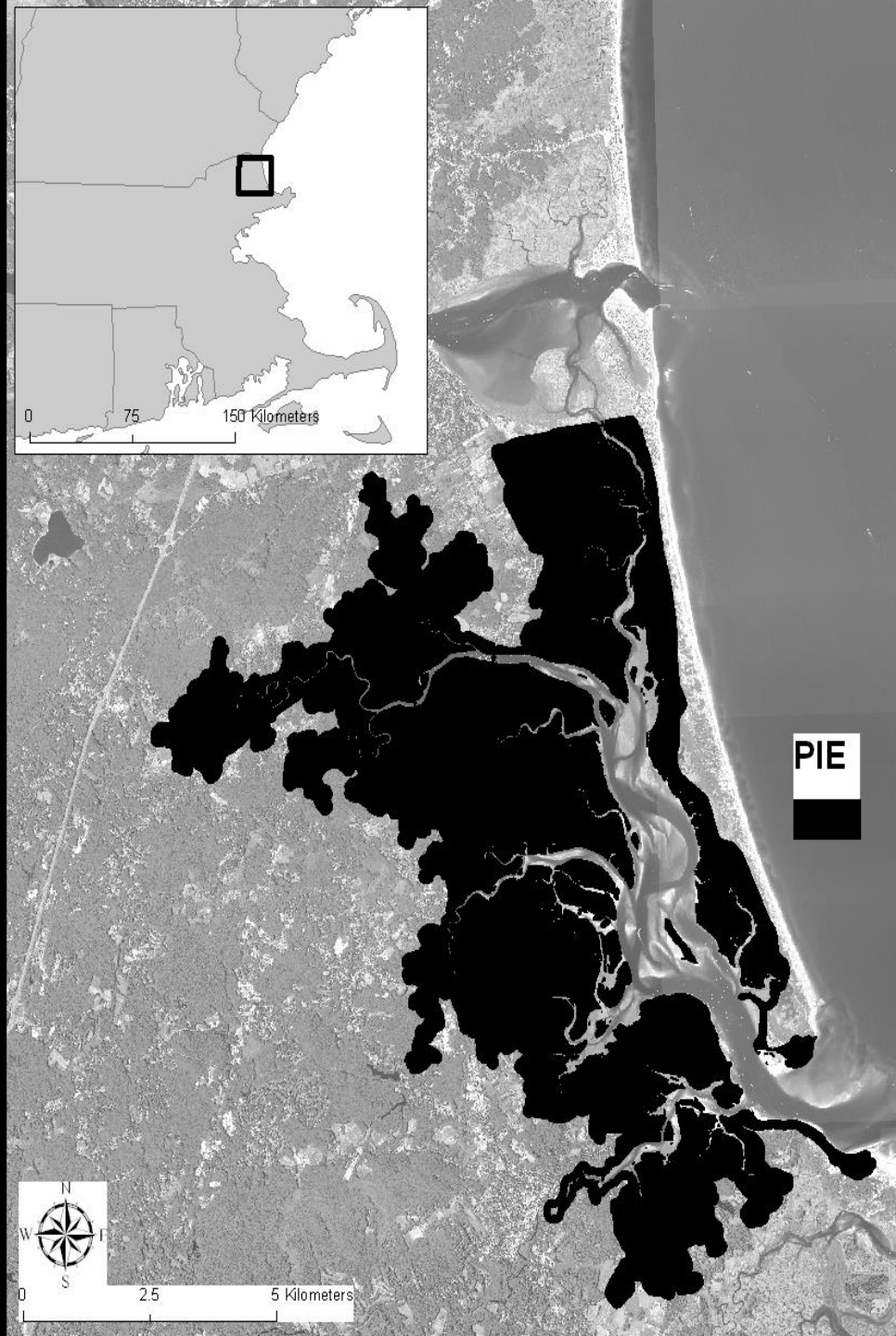
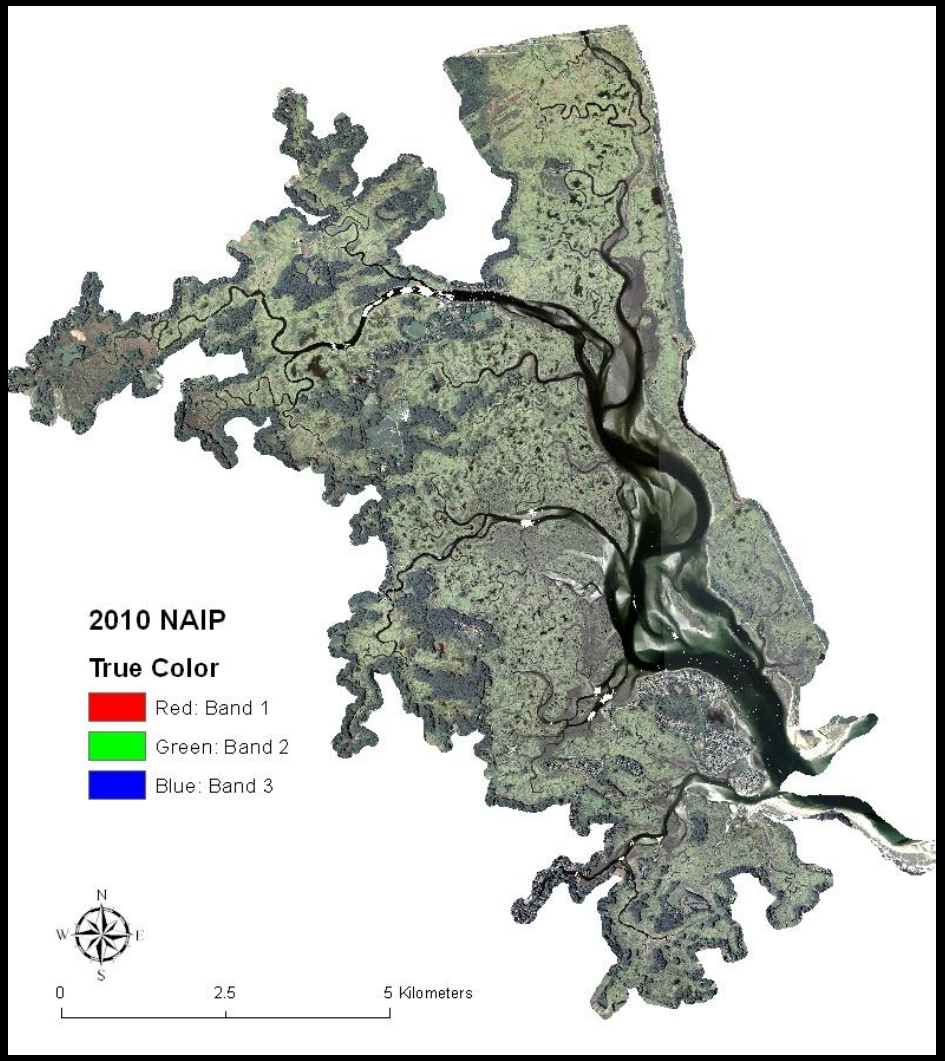
Study Site and Significance

- Plum Island Estuary Long-Term Ecological Research Reserve (PIE-LTERR)
- Significance
  - Cultural
  - Ecological
    - Rozas, L. P., & Zimmerman, R. J. (2000). Small-scale patterns of nekton use among marsh and adjacent shallow non-vegetated areas of the Galveston Bay Estuary, Texas (USA). *Marine ecology. Progress series*, *193*, 217-239.
- How do we derive the current condition of PIE?
  - Classification
  - Segmentation
  - Prediction



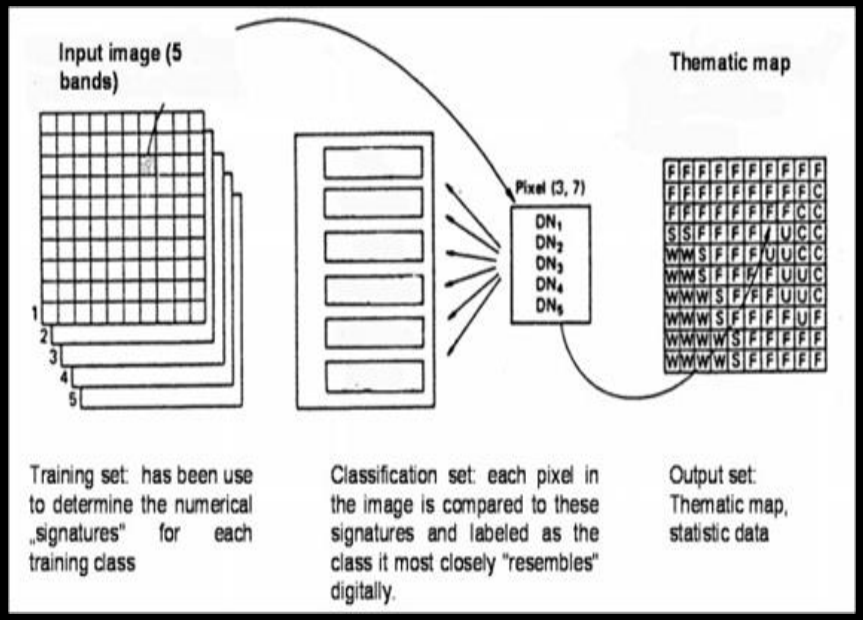
Classification

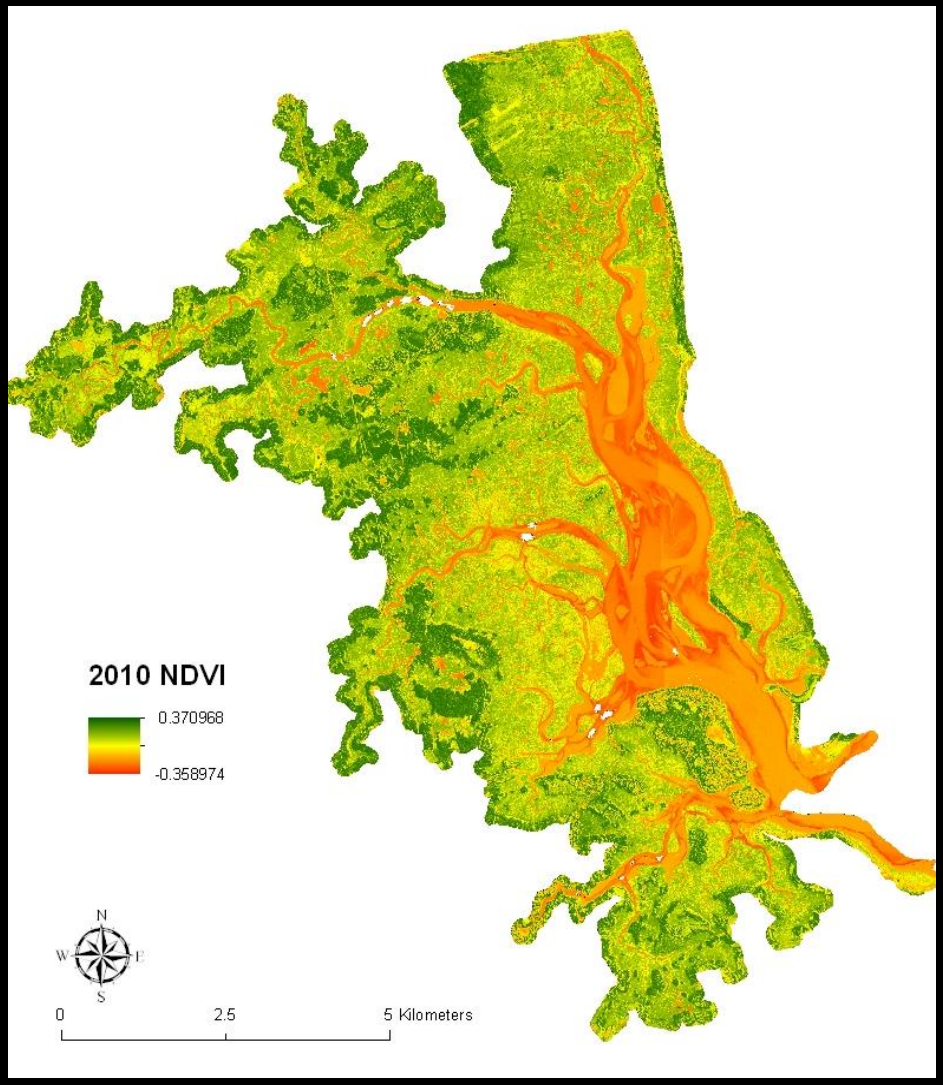
- 2010 NAIP
  - Supplemented with 2011 LiDAR



Classification

- Maximum likelihood classification
- Layers?

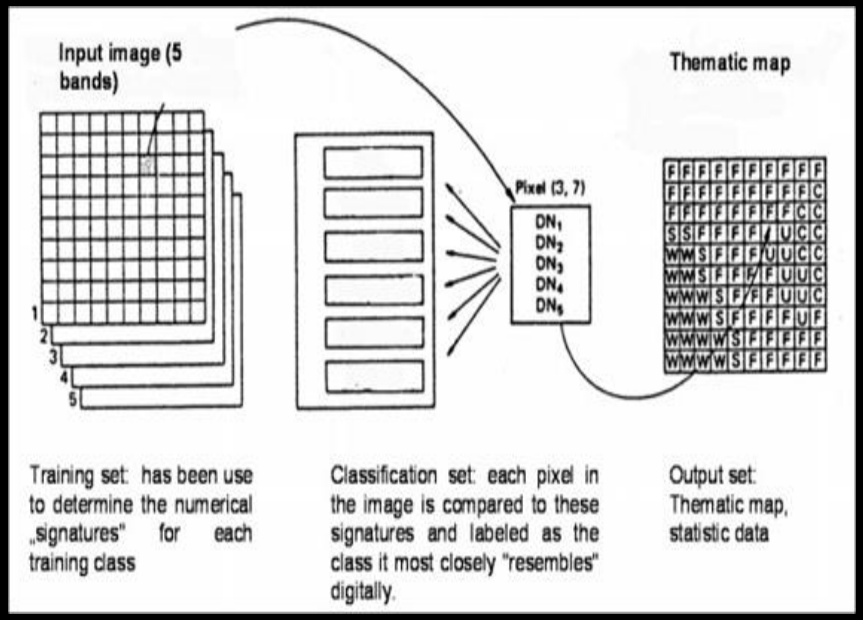


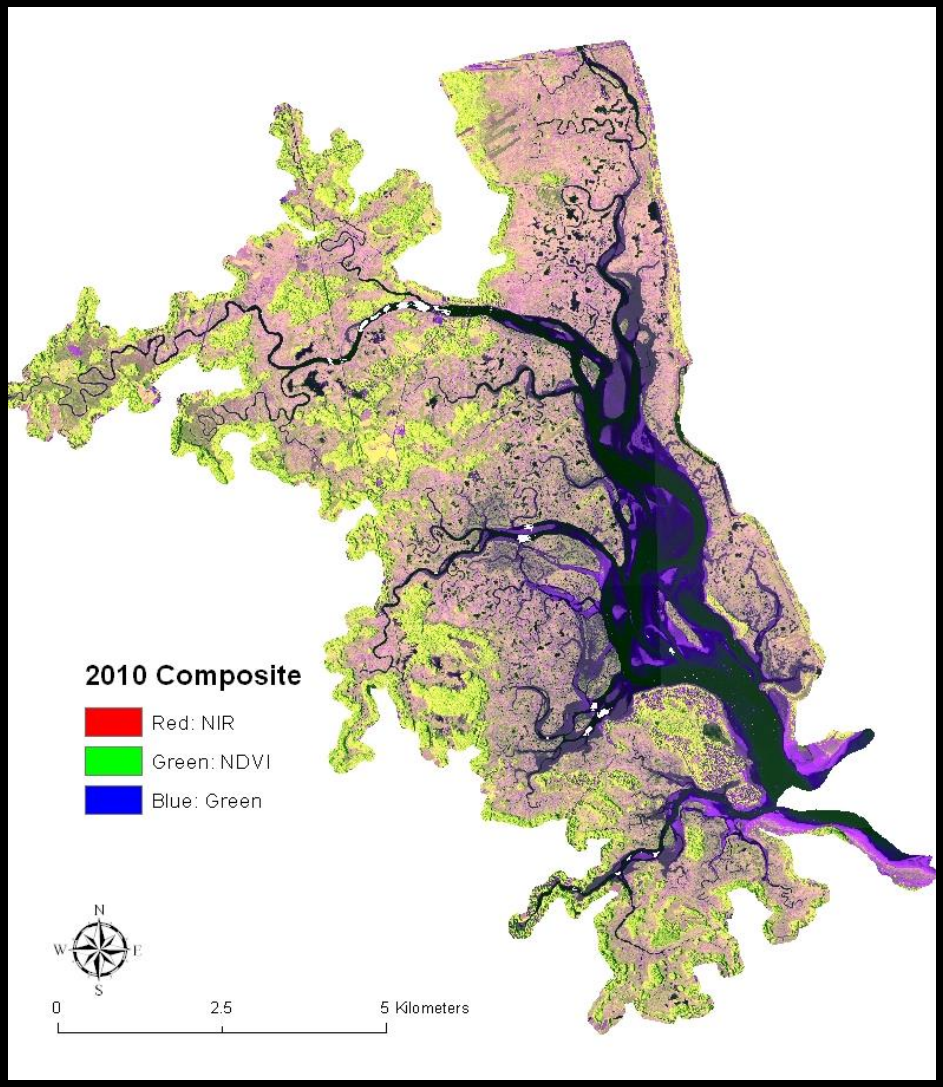


Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2008). Remote sensing and image interpretation, Hoboken.

Classification

- Maximum likelihood classification
- Layers?

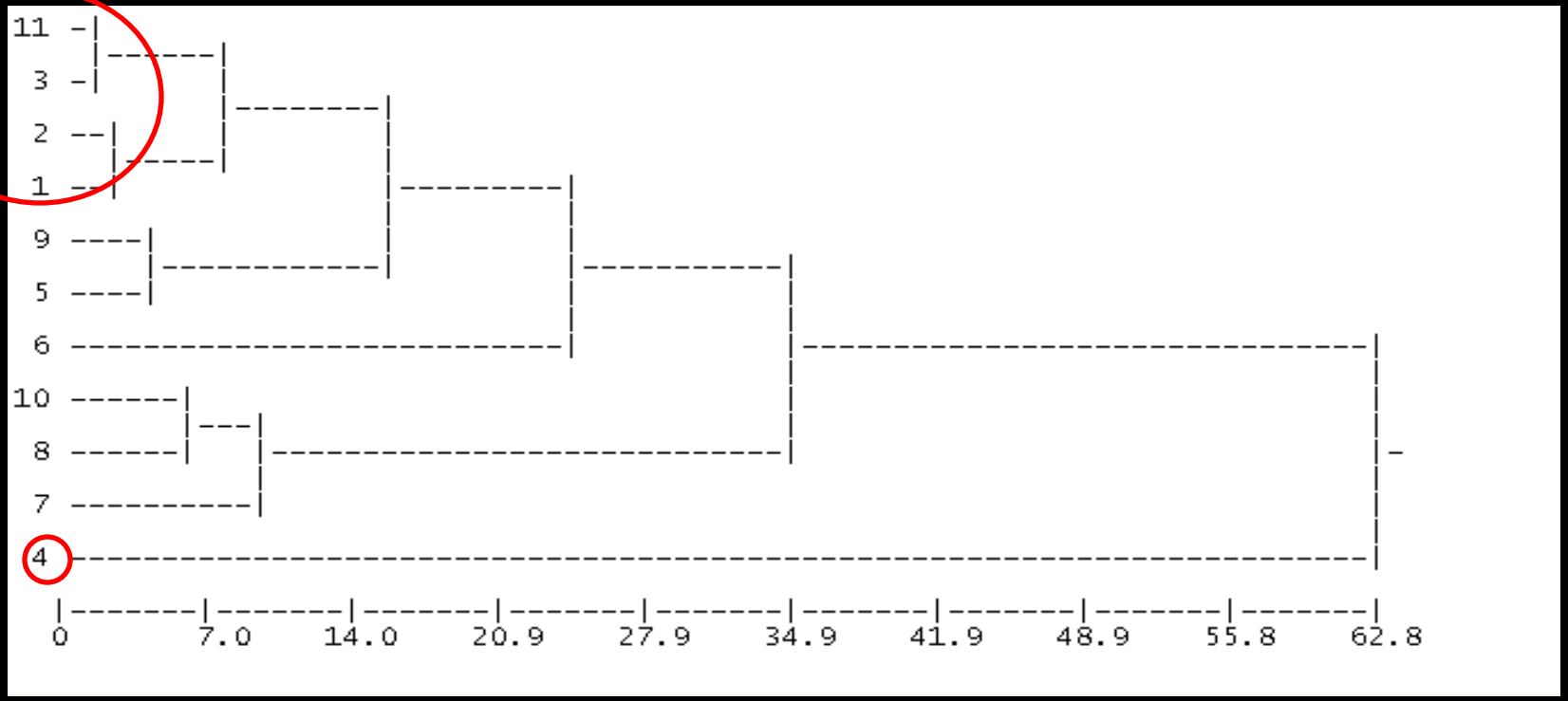




Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2008). Remote sensing and image interpretation, Hoboken.

Classification

- Grouping of Landcover
  - Distance between clusters in multidimensional space



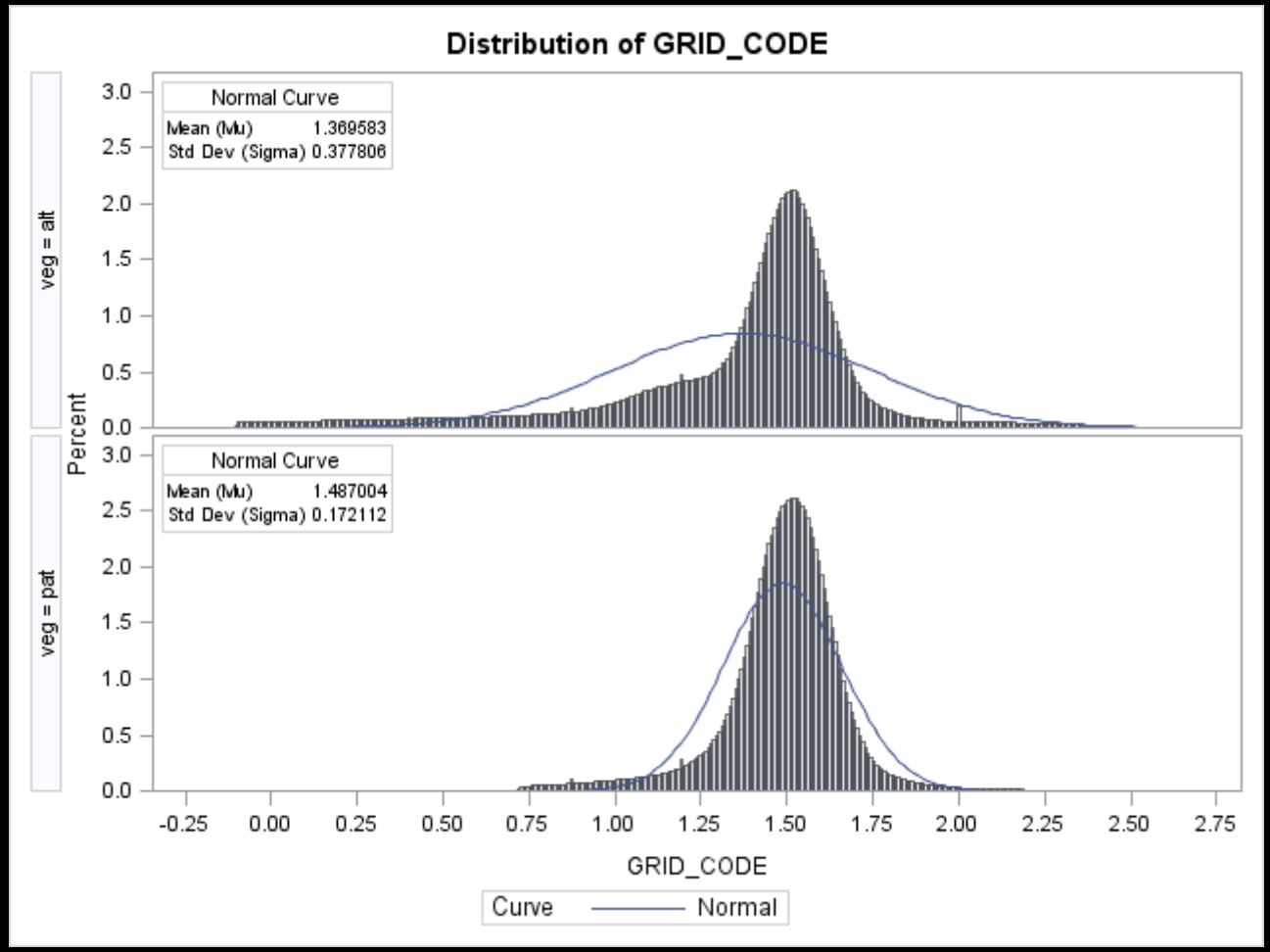
Classification

- Accuracy?

	Ground Truth						
Predicted Class	**Unsuitable**	***S. alterniflora***	**Upland Trees**	***S. patens***	**Row Total**	**User Accuracy (%)**	**Commission Error (%)**
Unsuitable	**245**	0	4	0	249	98.39	1.61
S. alterniflora	19	**309**	0	50	378	81.75	18.25
Upland Trees	4	0	**48**	0	52	92.31	7.69
S. patens	0	14	1	**319**	334	95.51	4.49
Column Total	268	323	53	369	1013		
Producer Accuracy (%)	91.42	95.67	90.57	86.45			
Omission Error (%)	8.58	4.33	9.43	13.55			
Overall Accuracy (%)	90.92						
Kappa (%)	86.89						

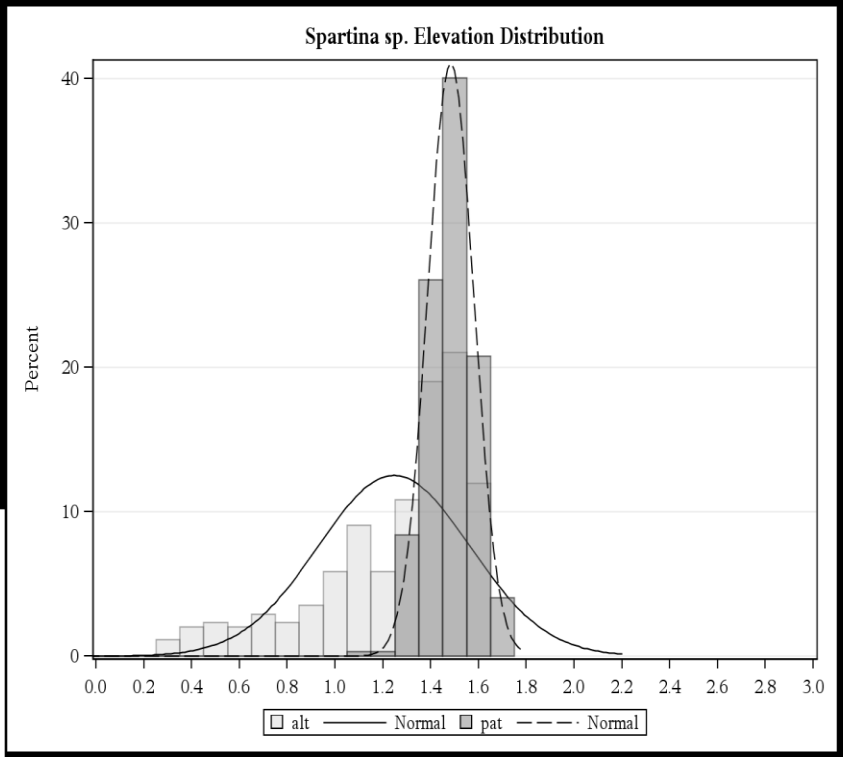
Classification

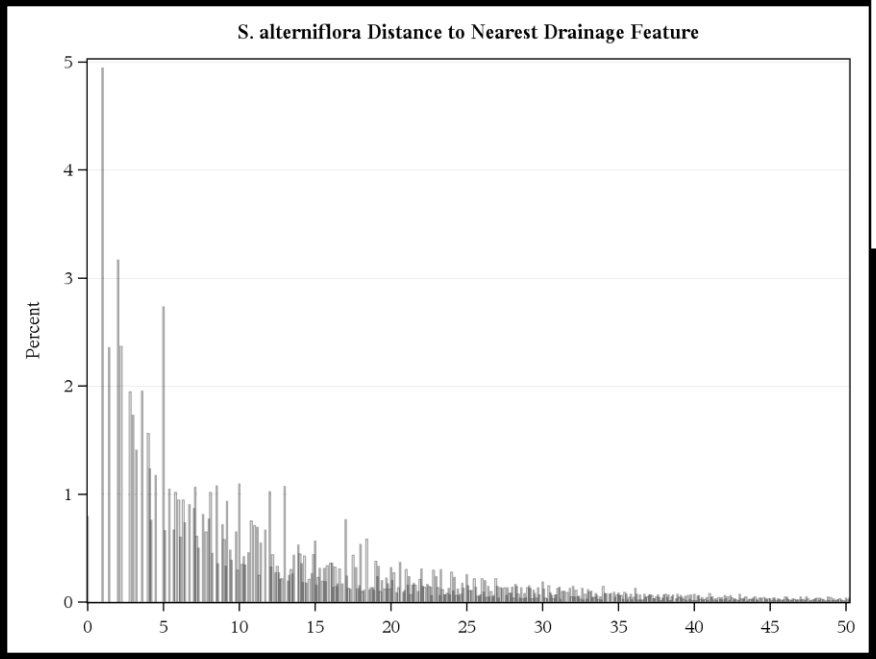
- Does the elevation distribution of each saltmarsh species match what we know?

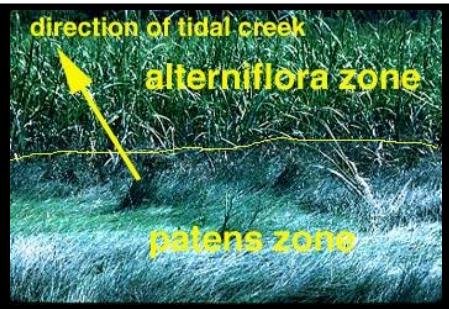


Classification

- Probability
- Distance to hydrologic feature



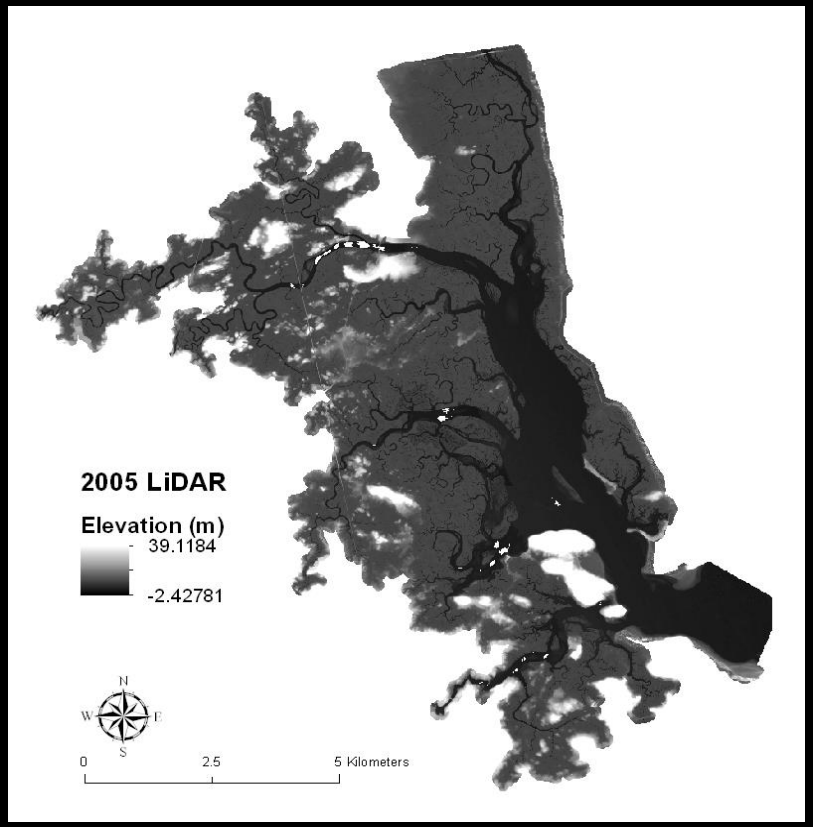




http://life.bio.sunysb.edu/marinebio/spartina.html

Data Preparation

- LiDAR
  - Where is Mean Sea Level?



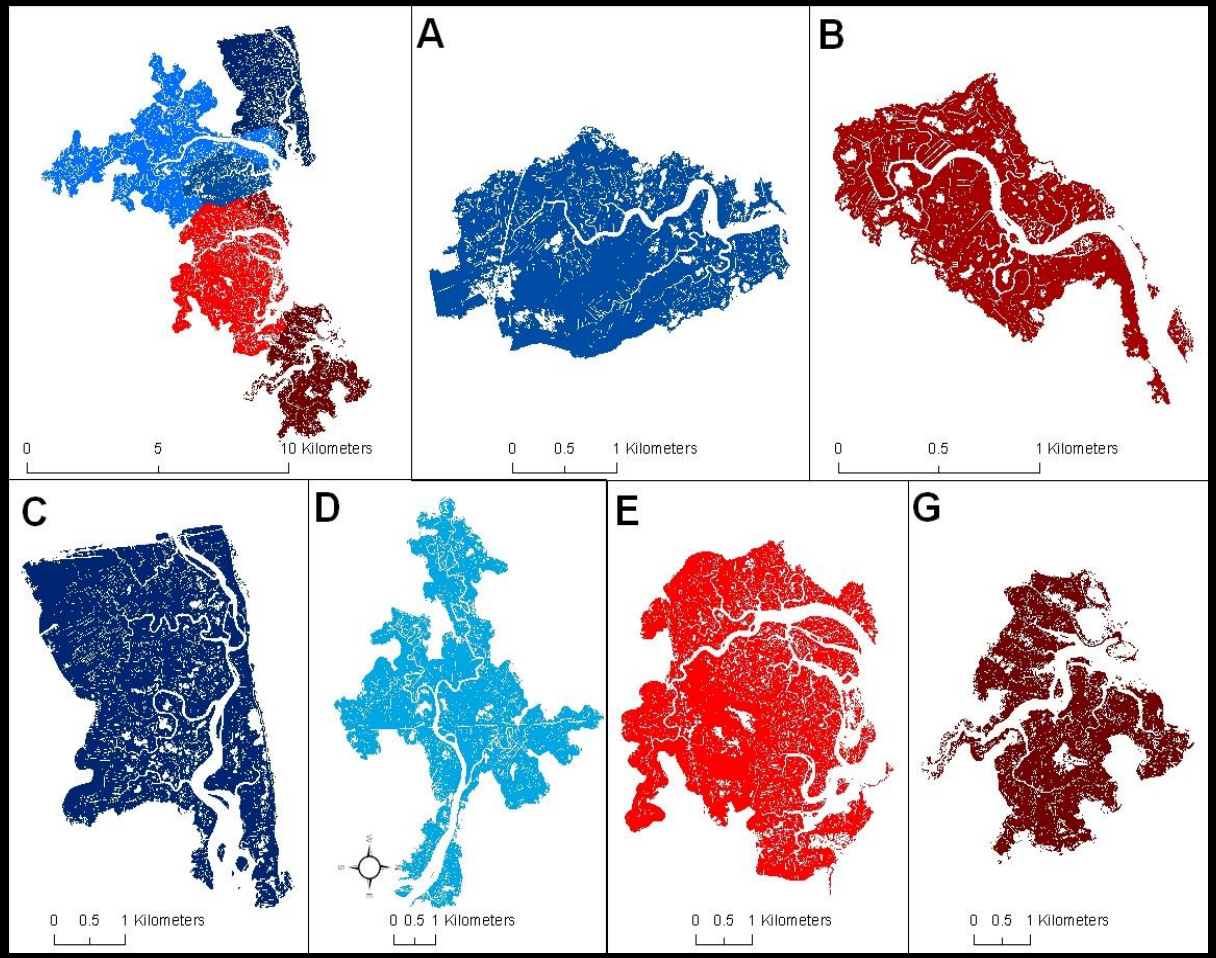
Elevations on Station Datum

Station: 8443970, Boston, MA
Status: Accepted (Apr 17 2003)
Units: Meters
T.M.: 75
Epoch: 1983-2001
Datum: STND

Datum	Value	Description
MHHW	4.205	Mean Higher-High Water
MHW	4.071	Mean High Water
MTL	2.624	Mean Tide Level
MSL	2.660	Mean Sea Level
DTL	2.648	Mean Diurnal Tide Level
MLW	1.178	Mean Low Water
MLLW	1.074	Mean Lower-Low Water
NAVD88	2.752	North American Vertical Datum of 1988
STND	0.000	Station Datum
GT	3.131	Great Diurnal Range
MN	2.893	Mean Range of Tide
DHQ	0.134	Mean Diurnal High Water Inequality
DLQ	0.104	Mean Diurnal Low Water Inequality
HWI	3.740	Greenwich High Water Interval (in hours)
LWI	9.930	Greenwich Low Water Interval (in hours)
Maximum	5.675	Highest Observed Water Level
Max Date & Time	02/07/1978 10:36	Highest Observed Water Level Date and Time
Minimum	-0.061	Lowest Observed Water Level
Min Date & Time	03/24/1940 00:00	Lowest Observed Water Level Date and Time
HAT	4.861	Highest Astronomical Tide
HAT Date & Time	11/05/1998 16:30	HAT Date and Time
LAT	0.382	Lowest Astronomical Tide
LAT Date & Time	12/23/1999 22:30	LAT Date and Time

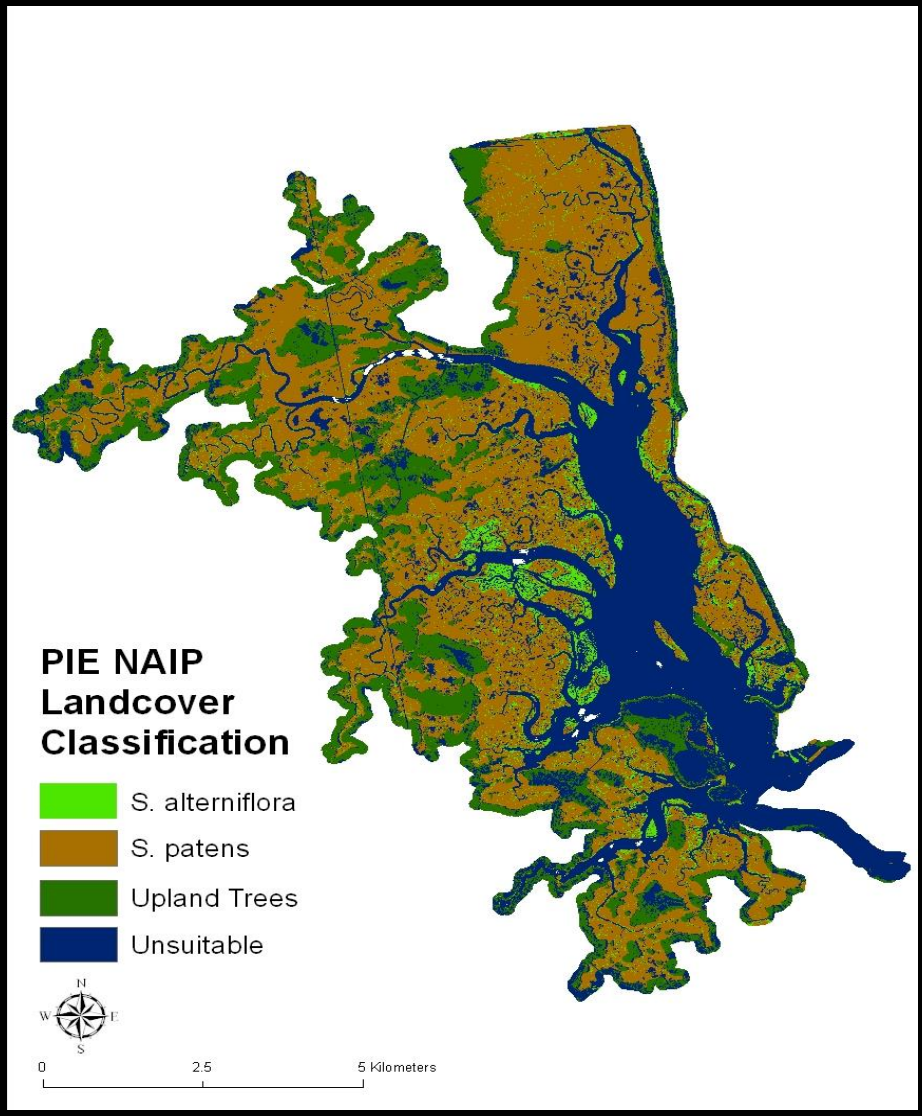
Segmentation

- Variability
- Hydrologic analysis
- Clip by classification



Results

Saltmarsh Vegetation Statistics (km2)		
Watershed	*S. alterniflora**	*S. patens*
Merrimack	0.7 (12.58)	4.87
Parker	0.78 (12.98)	5.23
Tide Creek 2	0.2 (11.97)	1.47
Tide Creek 1	0.16 (24.24)	0.5
Rowley	2.08 (26.98)	5.63
Ipswich	0.87 (21.38)	3.2
*() defined as percent of current intertidal area and used as a region grouping rule		



Results

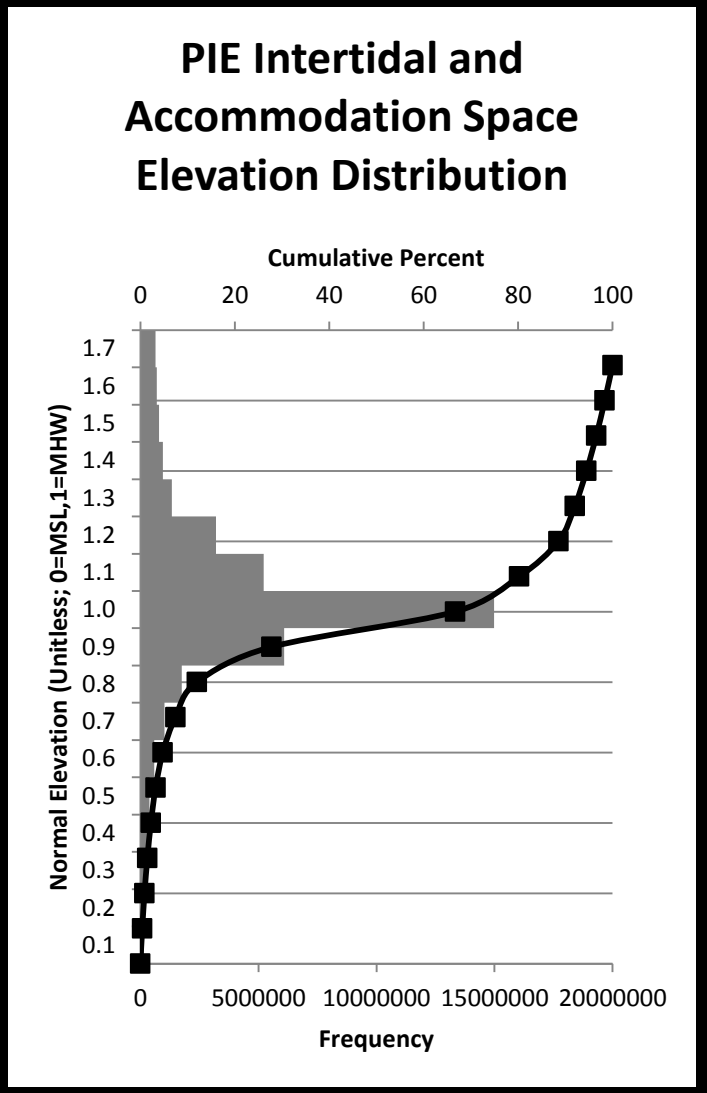
Intertidal Statistics				
Watershed	Area (km2)	Mean Elevation (m)	HI	Mean Slope (degrees)
Merrimack	5.56	1.36	0.88	2.51
Parker	6.01	1.38	0.89	2.68
Tide Creek 2	1.67	1.39	0.90	2.61
Tide Creek 1	0.66	1.32	0.85	3.06
Rowley	7.71	1.3	0.84	2.78
Ipswich	4.07	1.31	0.85	2.53

Accommodation Space Statistics under 1 m SLR*						
Watershed	Area (km2)	Mean Elevation (m)	HI**	Mean Slope (degrees)	Area Lost (km2)***	Total Area After 1m SLR (km2)
Merrimack	2.39	1.72	0.46	1.38	0.33 (13.81)	7.62
Parker	4.33	1.8	0.52	2.29	0.4 (9.24)	9.94
Tide Creek 2	1.37	1.75	0.48	1.79	0.11 (8.01)	2.93
Tide Creek 1	0.15	1.62	0.40	1.13	0.07 (46.62)	0.74
Rowley	2.72	1.8	0.52	2.02	0.96 (35.29)	9.47
Ipswich	1.19	1.88	0.57	2.78	0.35 (29.41)	4.91

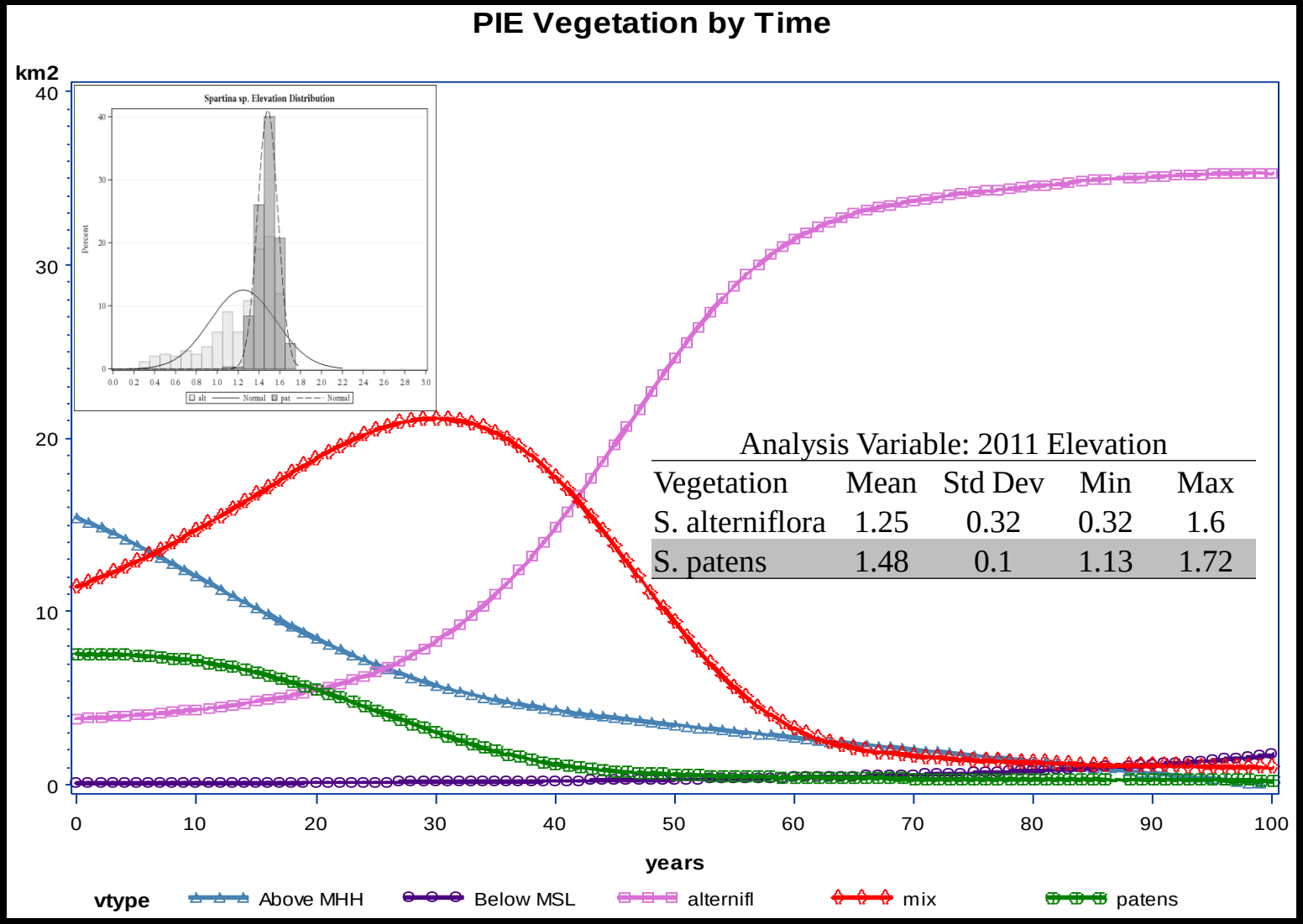
*Accommodation space is the area between 1.55 and 2.55 m

**Calculated as: (Mean elevation - 1 m)/1.55m

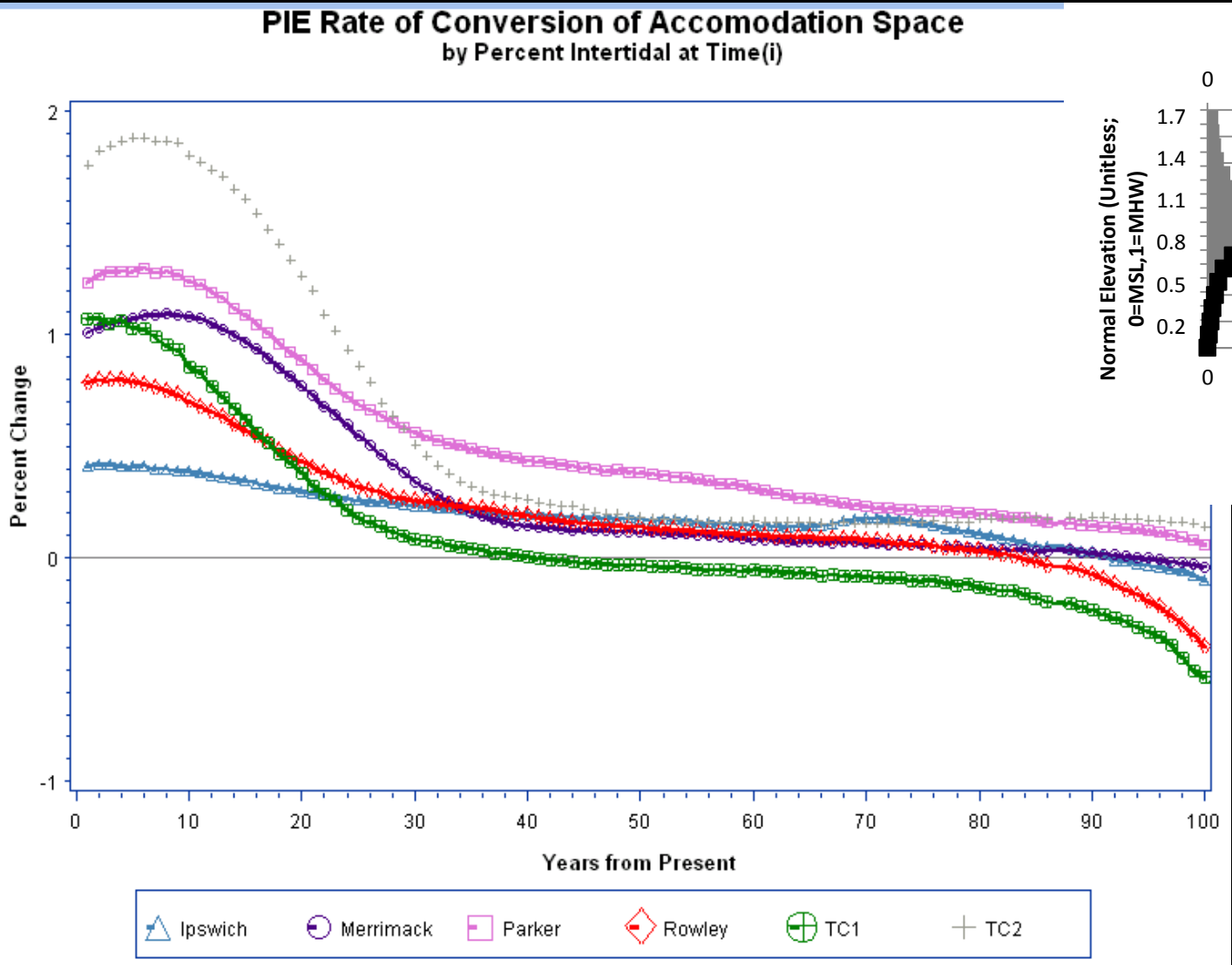
***() defined as the ratio of intertidal area lost to SLR vs. intertidal area gained times 100 and used as a region grouping rule

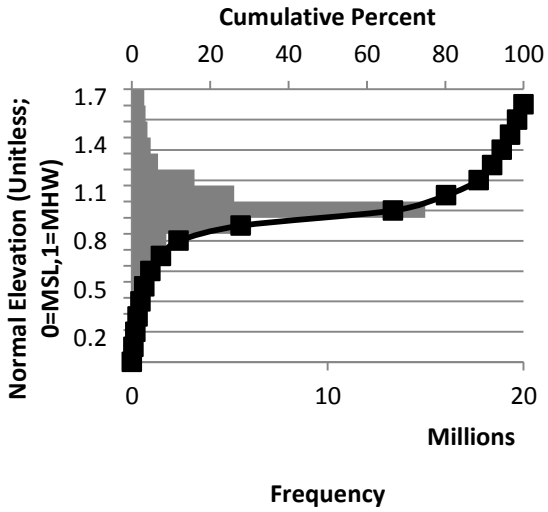


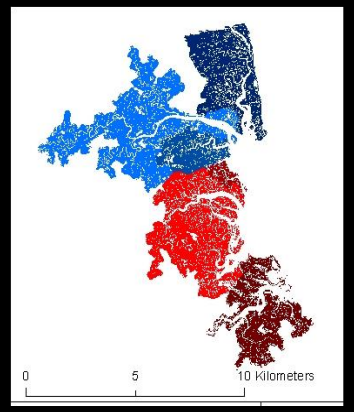
Prediction


PIE Vegetation by Time
km2
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
years
Spartina sp. Elevation Distribution
Percent
alt
Normal
pat
Normal
Analysis Variable: 2011 Elevation
Vegetation Mean Std Dev Min Max
S. alterniflora 1.25 0.32 0.32 1.6
S. patens 1.48 0.1 1.13 1.72
vtype
Above MHH
Below MSL
alternifl
mix
patens

Prediction


PIE Rate of Conversion of Accomodation Space
by Percent Intertidal at Time(i)
Percent Change
2
1
0
-1
0
10
20
30
40
50
60
70
80
90
100
Years from Present
Ipswich
Merrimack
Parker
Rowley
TC1
TC2


Cumulative Percent
0
20
40
60
80
100
Normal Elevation (Unitless; 0=MSL,1=MHW)
1.7
1.4
1.1
0.8
0.5
0.2
0
10
20
Millions
Frequency


0
5
10 Kilometers

Summary

- Vegetation classification
- Regional grouping
- PIE will survive a 1 m SLR but……
  - Inundation loss vs erosion loss
- Numerical modelling?
- Acknowledgements:

PIE LTER

NSF

MBL Biological Discovery in Woods Hole