The Role of Genetics in Eelgrass Population Resilience in Southern New England and New York

Fred Short, Holly Bayley, David Burdick, Anita Klein and Gregg Moore

Resilience in Eelgrass

Genetics

- Diversity / clonality
- Unique populations

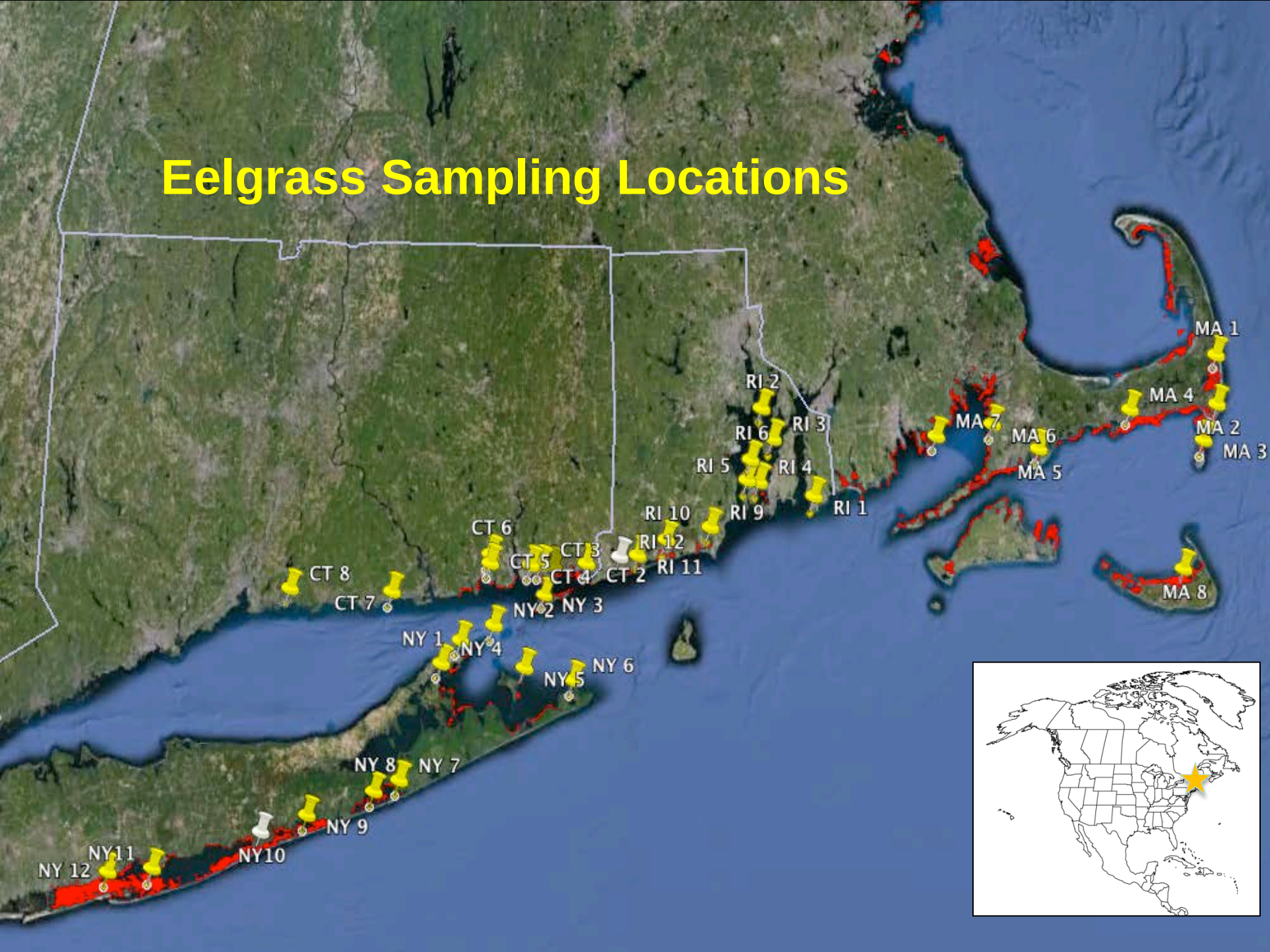
Plant characteristics

- Morphology
- Constituents (C, N, wt., isotopes)

Response to stressors

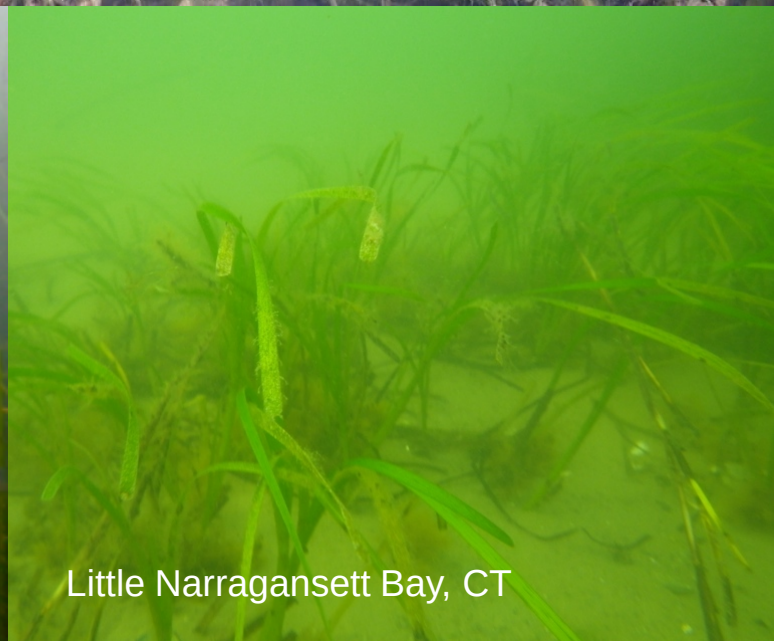
- Excess N
- Reduced light
- Elevated temperature
- Sediment organic enrichment
- Wasting disease

Eelgrass Sampling Locations



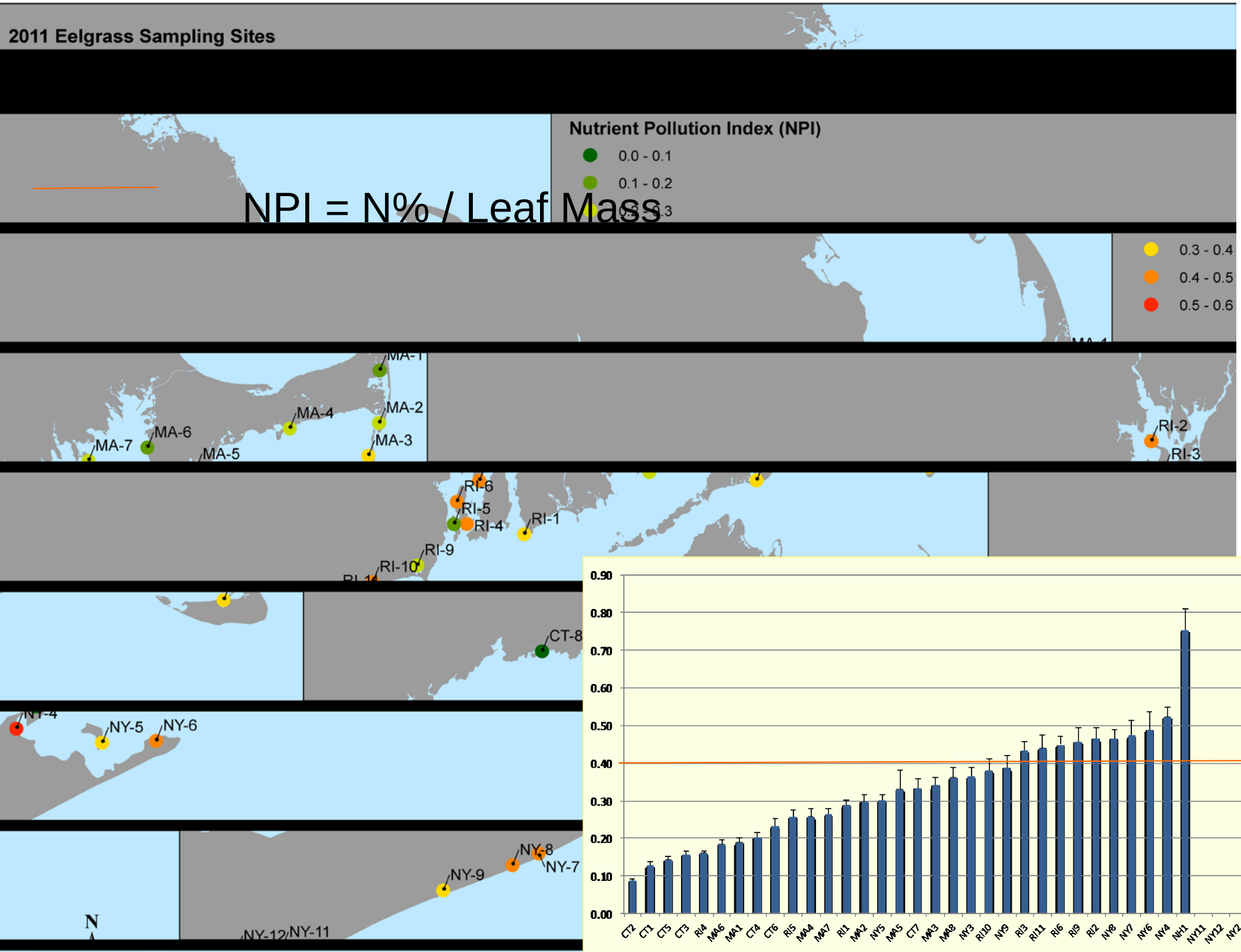

Pleasant Bay, MA


Niantic Bay, CT


Little Narragansett Bay, CT

2011 Eelgrass Sampling Sites

NPI = N% / Leaf Mass



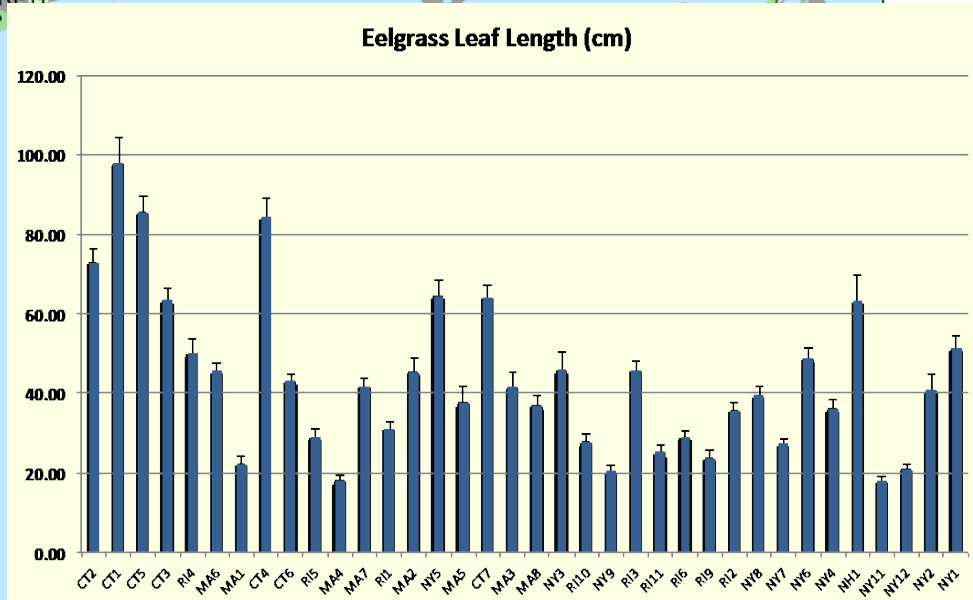
2011 Eelgrass Sampling Sites

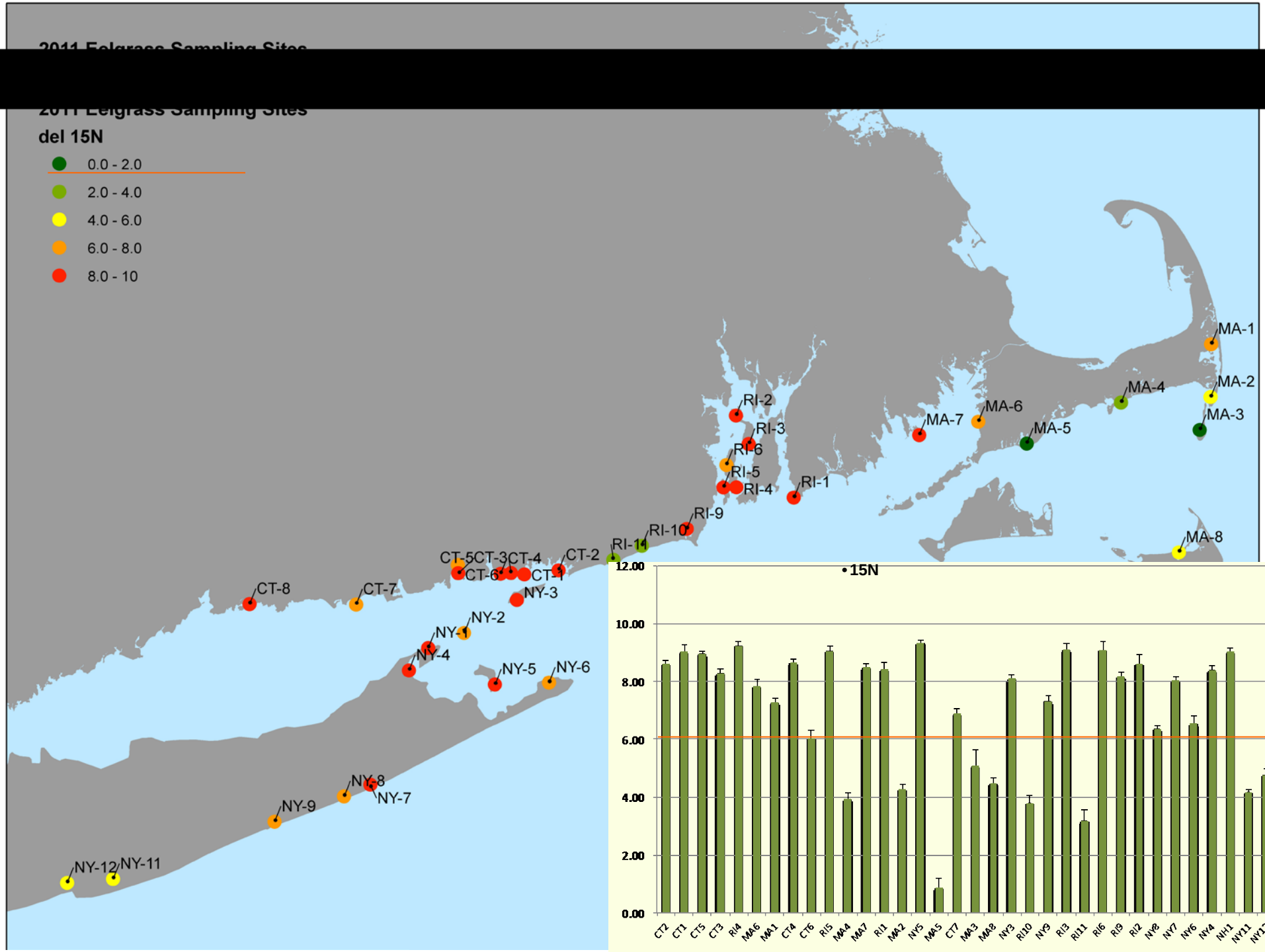
[redacted]

Length of 2nd Eelgrass Leaf (cm)

- 0.0 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 125

MA-1
MA-2
MA-3
MA-4
MA-5
MA-6
MA-7
MA-8
RI-1
RI-2
RI-3
RI-4
RI-5
RI-6
RI-9
RI-10
RI-11
CT-1
CT-2
CT-3
CT-4
CT-5
CT-6
CT-7
CT-8
NY-1
NY-2
NY-3
NY-4
NY-5
NY-6
NY-7
NY-8
NY-9
NY-11
NY-12

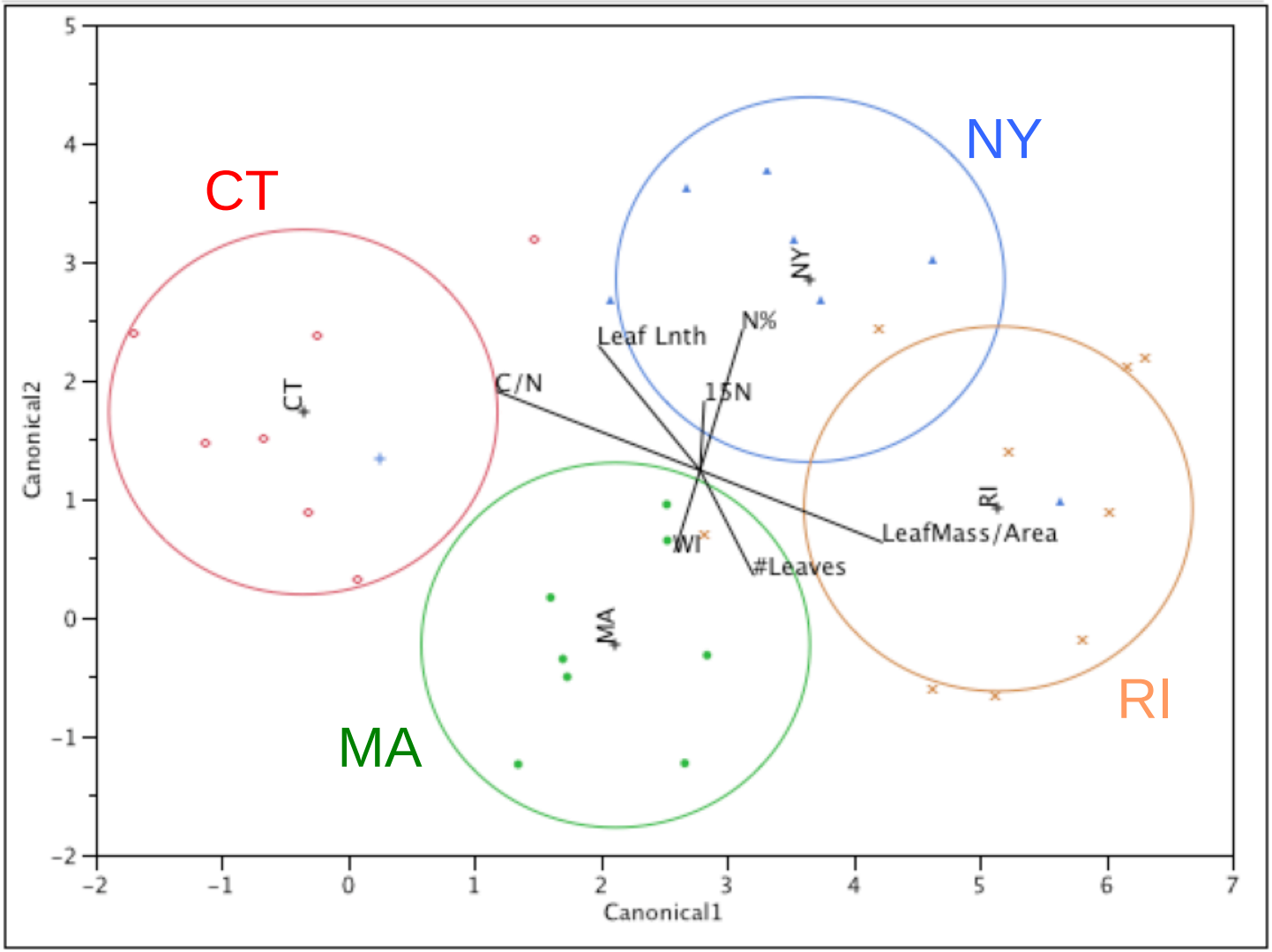



2011 Eelgrass Sampling Sites
del 15N
0.0 - 2.0
2.0 - 4.0
4.0 - 6.0
6.0 - 8.0
8.0 - 10
MA-1
MA-2
MA-3
MA-4
MA-5
MA-6
MA-7
MA-8
RI-1
RI-2
RI-3
RI-4
RI-5
RI-6
RI-9
RI-10
RI-11
CT-1
CT-2
CT-3
CT-4
CT-5
CT-6
CT-7
CT-8
NY-1
NY-2
NY-3
NY-4
NY-5
NY-6
NY-7
NY-8
NY-9
NY-11
NY-12
•15N
12.00
10.00
8.00
6.00
4.00
2.00
0.00
CT2
CT1
CT5
CT3
RI4
MA6
MA1
CT4
CT6
RI5
MA4
MA7
RI1
MA2
NY5
MA5
CT7
MA3
MA8
NY3
RI10
NY9
RI3
RI11
RI6
RI9
RI2
NY8
NY7
NY6
NY4
NH1
NY11
NY12

Discriminant Function Analysis

-

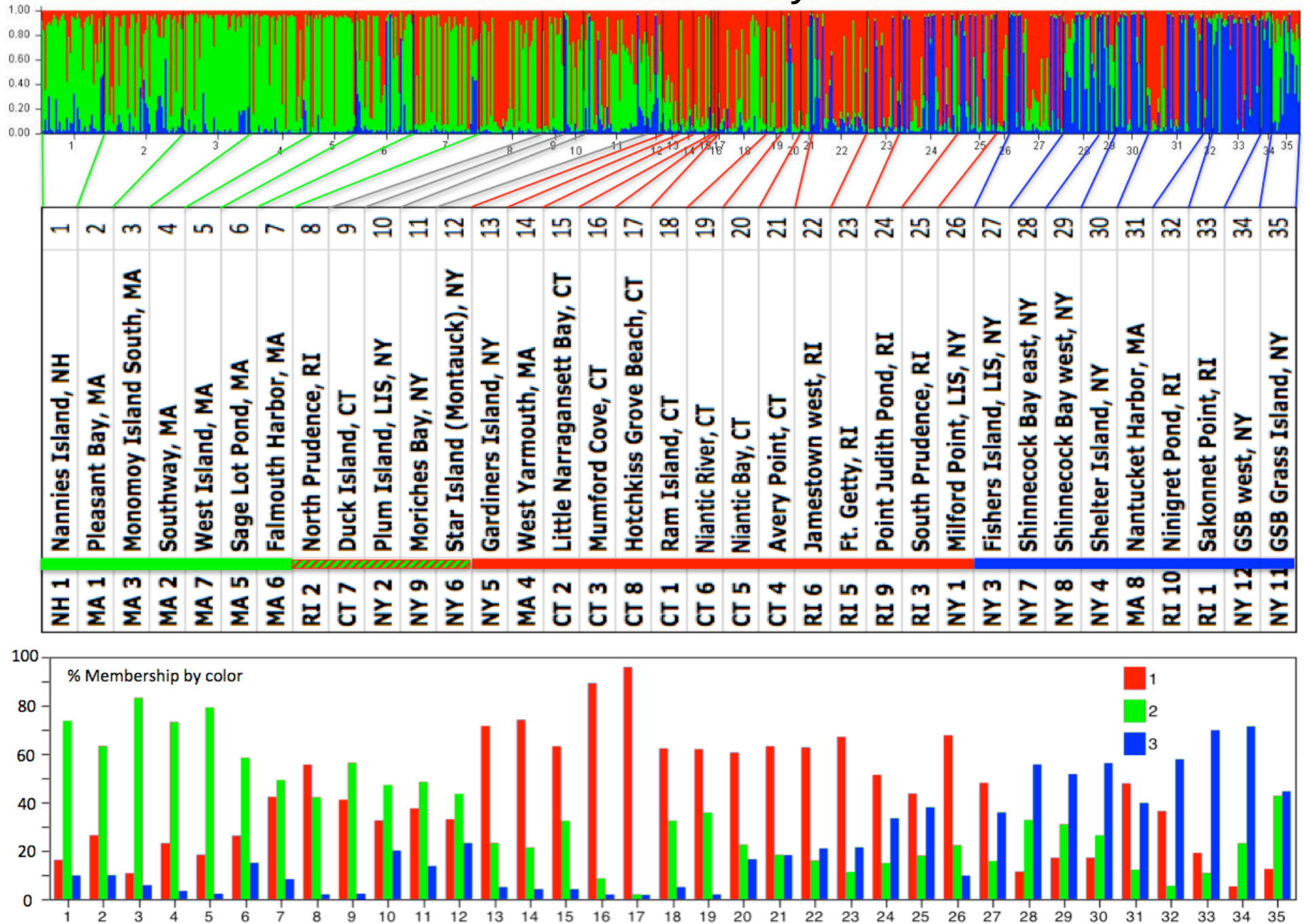
of plant characteristics from the region

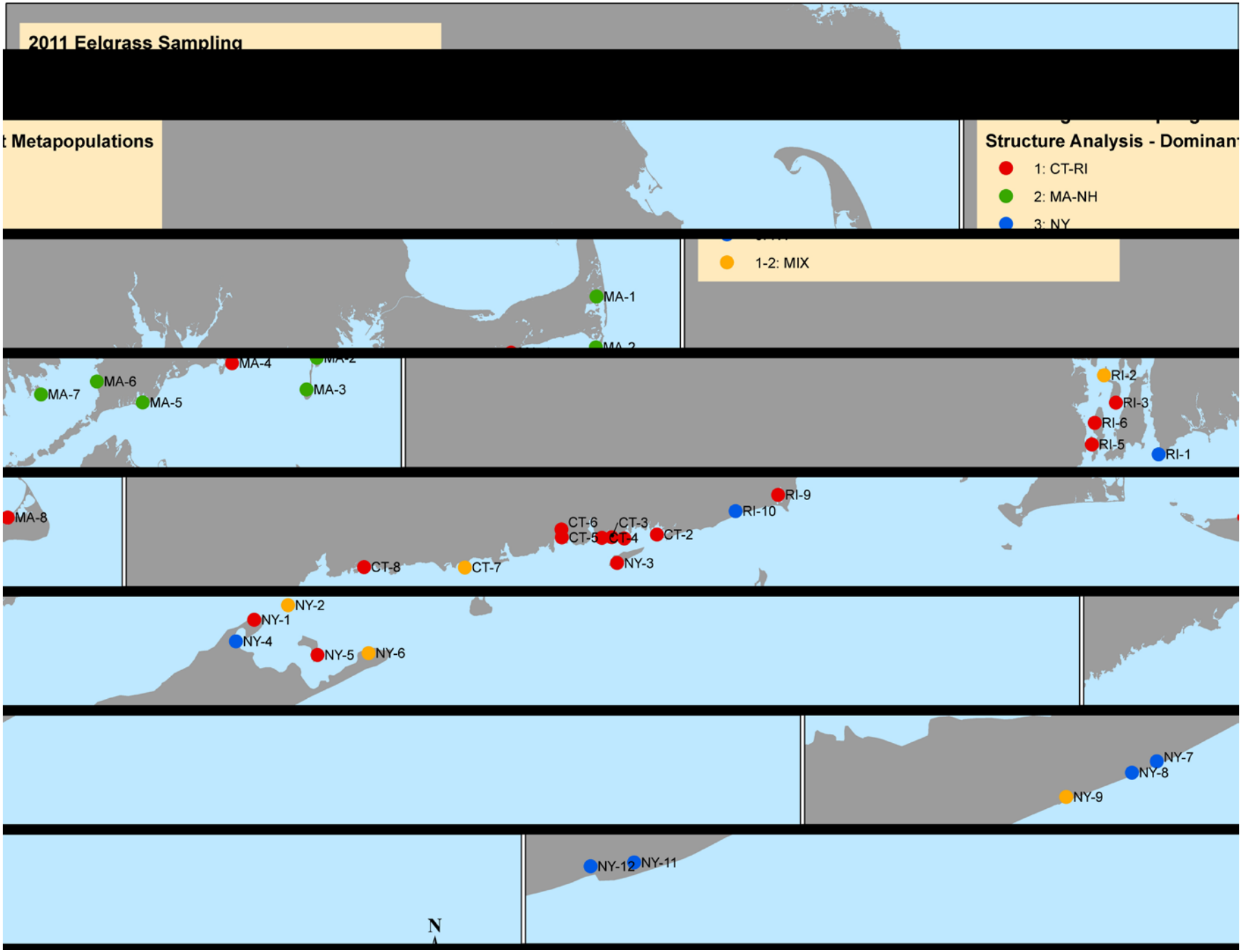


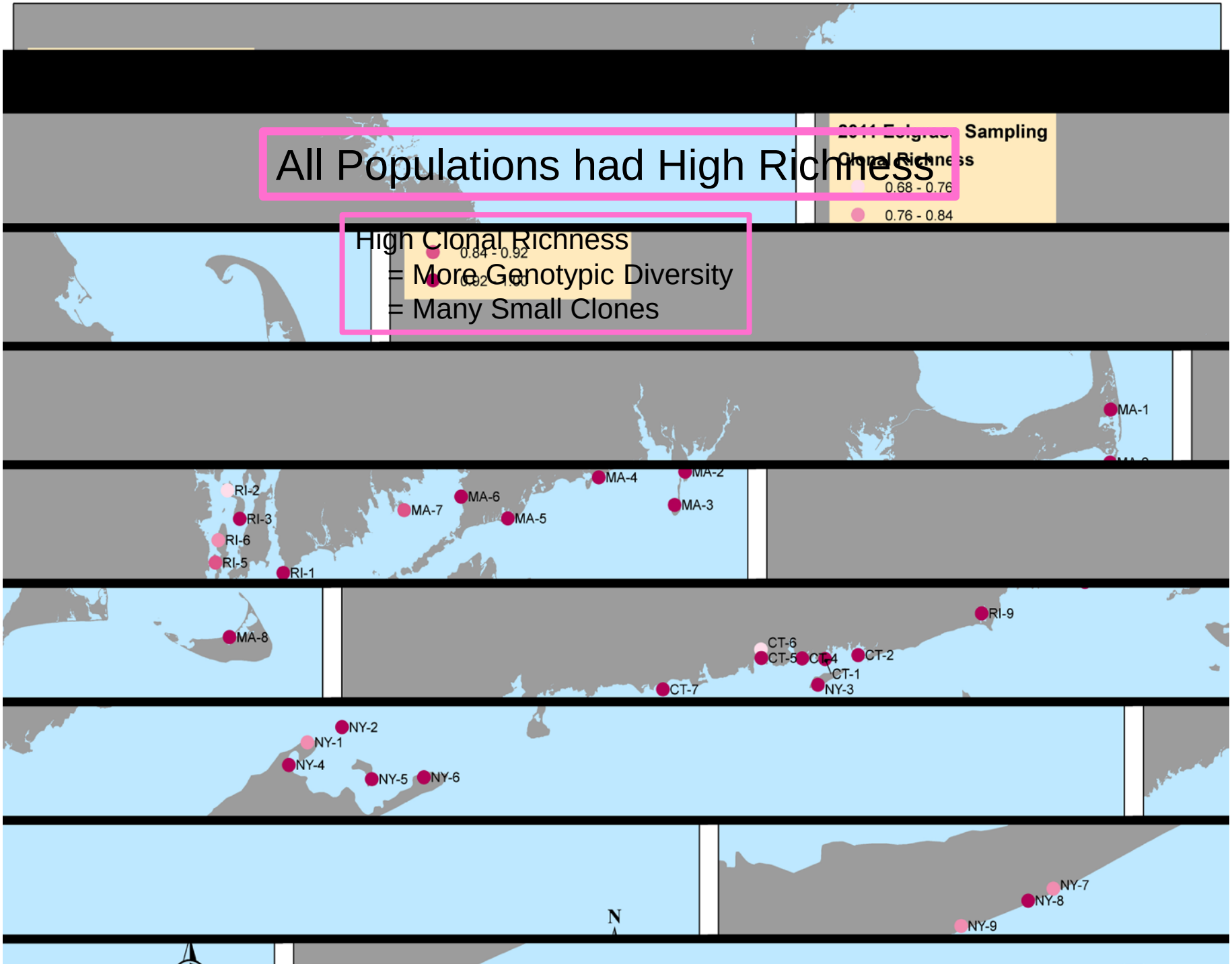
Genetic Analysis

- Collected:
  - 39 eelgrass populations sampled
- Genotyped:
  - 7 microsatellites
  - 709 eelgrass plants (i.e., ramets)
  - 688 unique genets (i.e., clones)
- Analyzed
  - Genetic Diversity (allelic diversity, genetic or allelic richness)
  - Inbreeding (pollination within a clone)
  - Clonal Diversity (genotypic diversity, clonal richness, small clones)
  - Differentiation (genetically different populations)

STRUCTURE Analysis




2011 Eelgrass Sampling
t Metapopulations
Structure Analysis - Dominant
1: CT-RI
2: MA-NH
3: NY
1-2: MIX
MA-1
MA-2
MA-3
MA-4
MA-5
MA-6
MA-7
MA-8
RI-1
RI-2
RI-3
RI-5
RI-6
RI-9
RI-10
CT-2
CT-3
CT-4
CT-5
CT-6
CT-7
CT-8
NY-1
NY-2
NY-3
NY-4
NY-5
NY-6
NY-7
NY-8
NY-9
NY-11
NY-12
N



All Populations had High Richness

High Clonal Richness
= More Genotypic Diversity
= Many Small Clones

Eelgrass Mesocosms

UNH Tested effects:

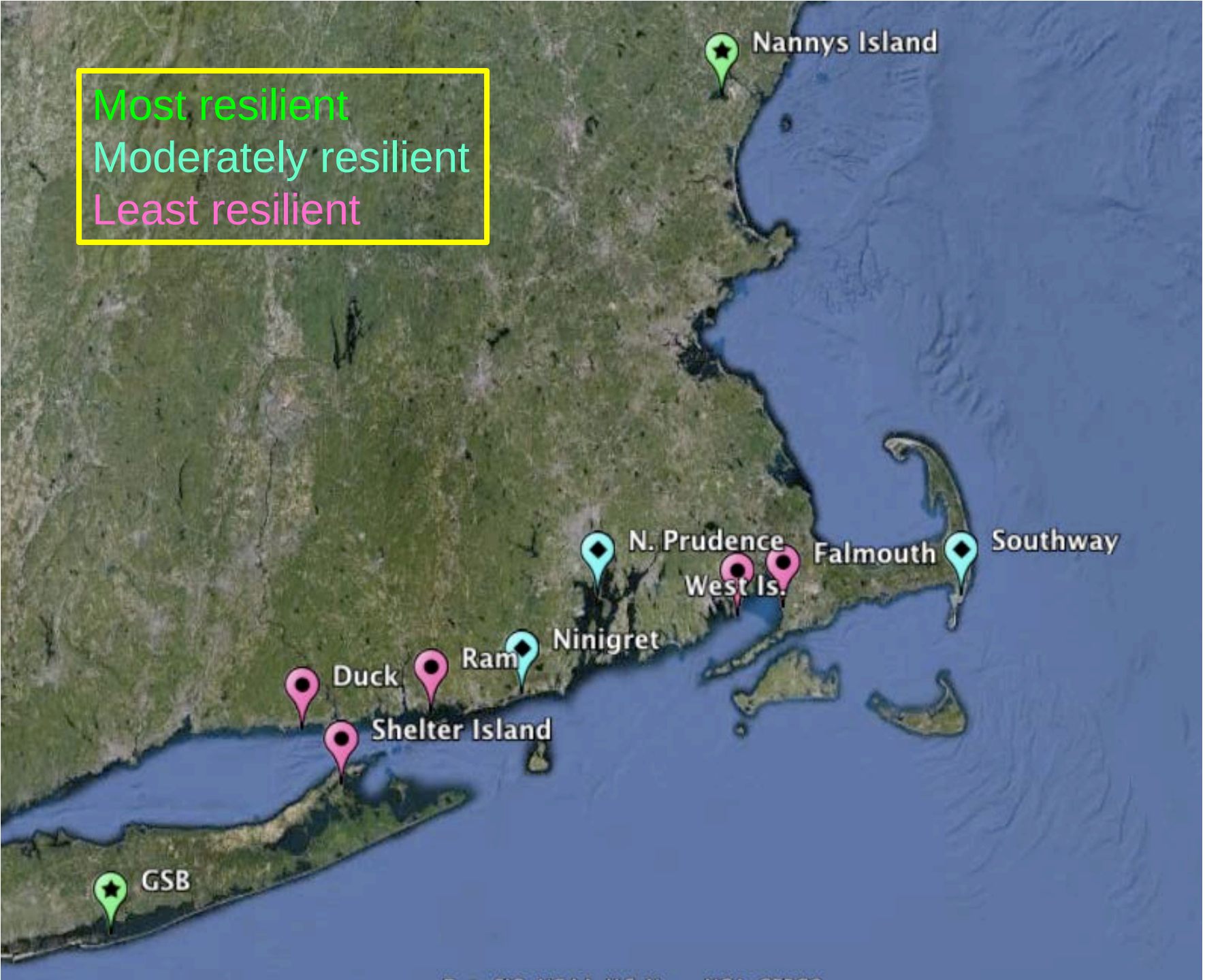
High sediment OM
Reduced Light

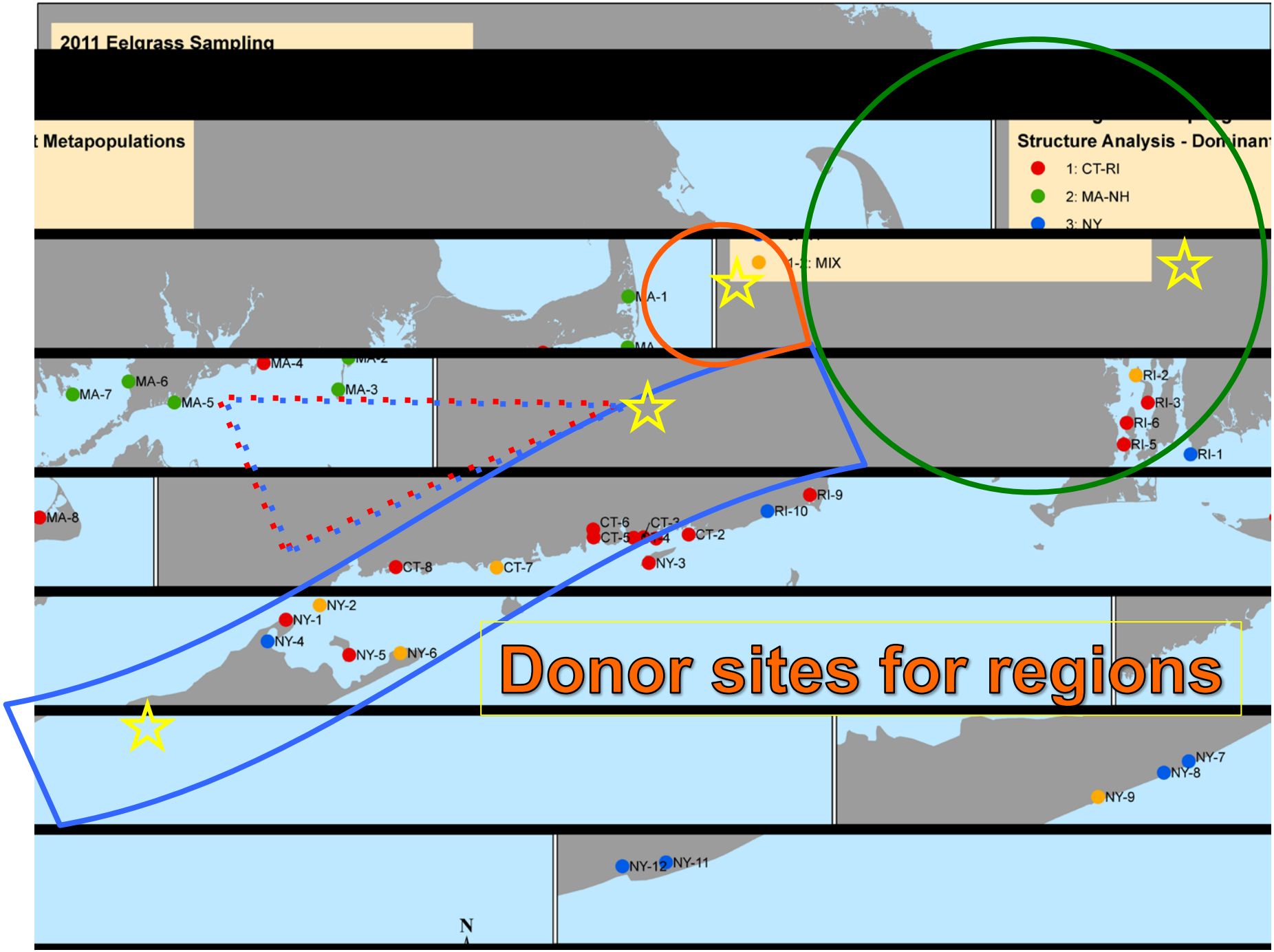
URI Tested effects:

High sediment OM
Increased Temperature

Stressor Experiment Results by Population

Stress Resilience	Reduced Light	High Temperature	High water N, High Organic Sediment	Low water N, High Organic Sediment
Great South Bay, NY	Good	Good	Low	Excellent
Nannies Is, NH	Good	-	Low	-
Prudence Is, RI	Fair	Fair	Low	Good
Southway, MA	Fair	Fair	Low	Good
Ninigret Pond, RI	Fair	Fair	Low	Good
Shelter Is, NY	Low	Low	Low	Fair
West Falmouth, MA	Low	Low	Low	Fair
West Is, MA	Low	-	Low	-
Duck Is, CT	Very low	-	Low	-
Ram Is, CT	Very low	-	Low	-


Most resilient
Moderately resilient
Least resilient
Nannys Island
N. Prudence
Falmouth
Southway
West Is.
Ninigret
Ram
Duck
Shelter Island
GSB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RI-6
RI-5
RI-1
MA-8
RI-9
RI-10
CT-6
CT-5
CT-3
CT-4
CT-2
NY-3
CT-8
CT-7
NY-2
NY-1
NY-4
NY-5
NY-6
NY-7
NY-8
NY-9
NY-12
NY-11
N
Donor sites for regions

Conclusions: Genetic information supports eelgrass management and restoration success

- Identifies areas for protection
- Prioritizes restoration donor populations
- Determines eelgrass resilience to climate change and habitat degradation

Thanks to regional colleagues: Steve Granger, Chris Pickerell, Jamie Vaudrey, and Tay Evans.

Thanks to TNC coordinators:
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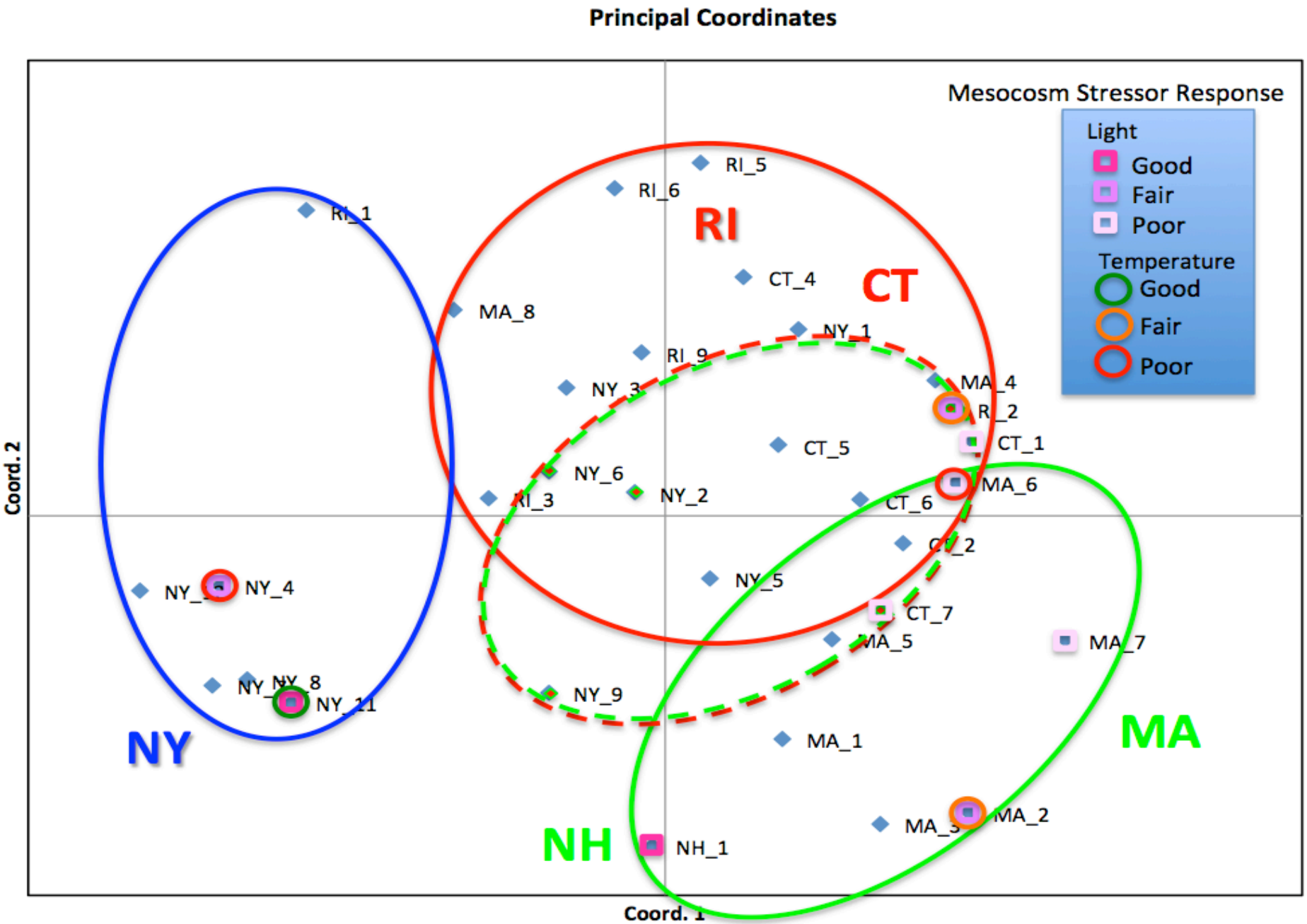
Principal Coordinates
Mesocosm Stressor Response
Light
Good
Fair
Poor
Temperature
Good
Fair
Poor
RI
CT
NY
NH
MA
RI_1
RI_5
RI_6
CT_4
MA_8
NY_1
RI_9
NY_3
MA_4
RI_2
CT_1
CT_5
NY_6
MA_6
RI_3
NY_2
CT_6
CT_2
NY_5
NY_4
CT_7
MA_5
MA_7
NY_8
NY_11
NY_9
MA_1
MA_2
MA_3
NH_1
Coord. 2
Coord. 1