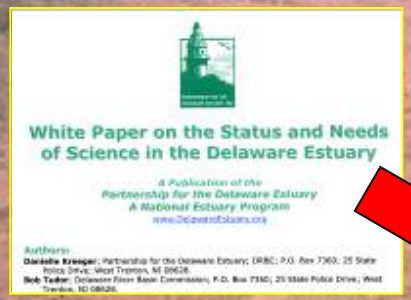
Variation in coastal wetland condition and stressors among eight watersheds of the Delaware Estuary

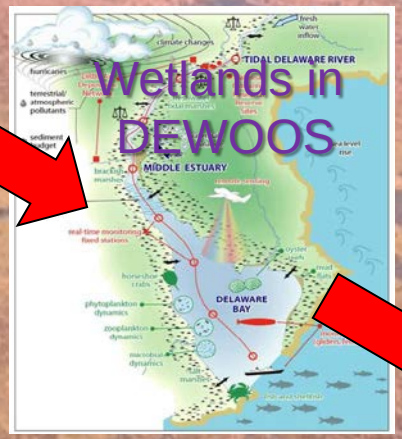
Danielle Kreeger
Angela Padeletti
Alison Rogerson
Andy Howard
Martha Maxwell Doyle
Kurt Cheng
Jessie Buckner

2006



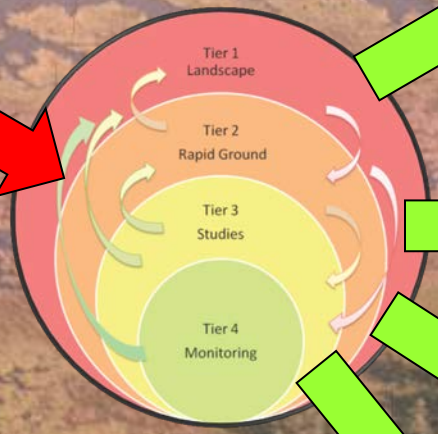
Recognize Problem

2007

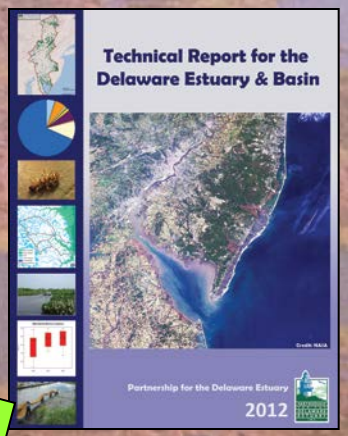


Designed DEWMAP

2009



Expanded to 4-Tier MACWA



Census Data

Rapid Surveys

Studies

Stations

PARTNERSHIP FOR THE DELAWARE ESTUARY, INC

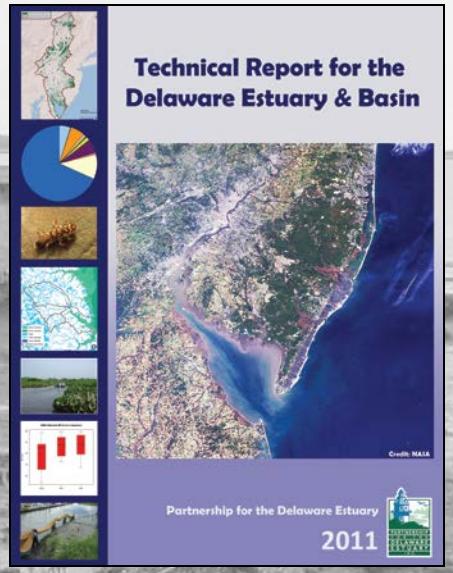
2010-present

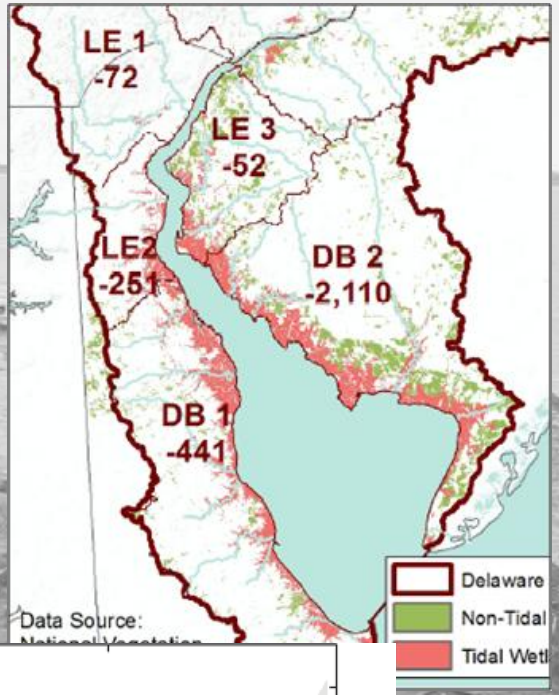
MACWA Tier 1 – Census at Landscape Level

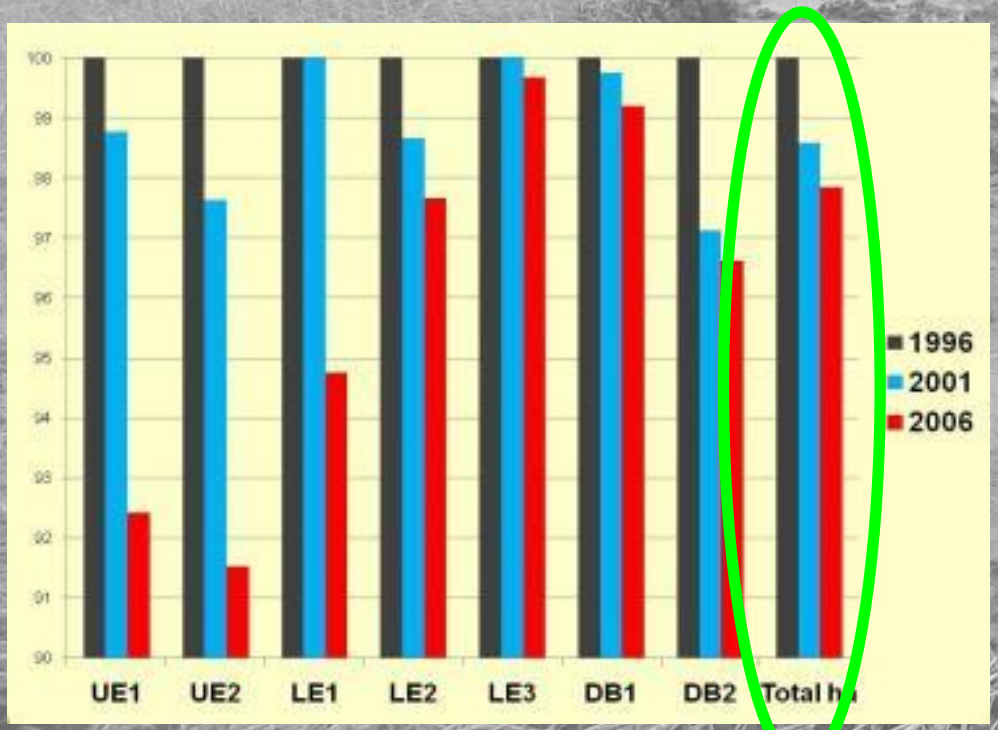
<u>2012 State of the Estuary Report</u>

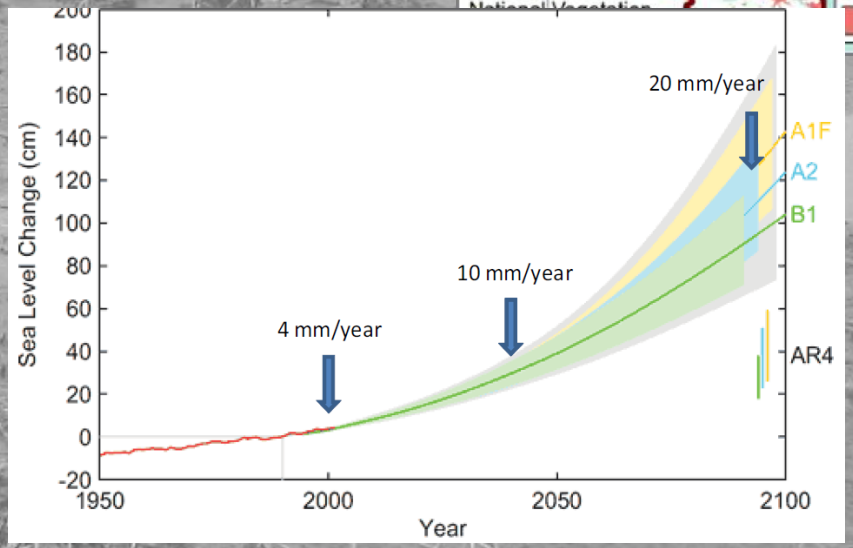
Losing an acre per day (1996-2006)

Future scenarios are worrisome



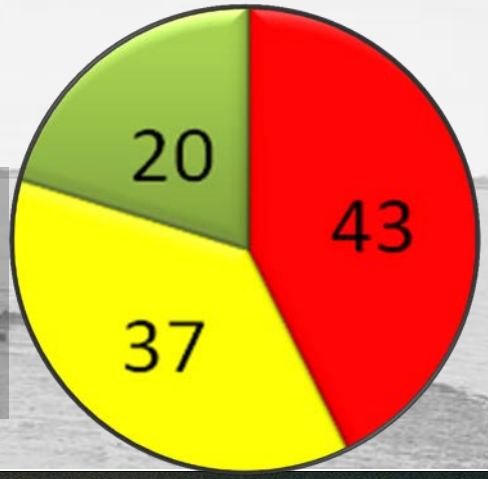


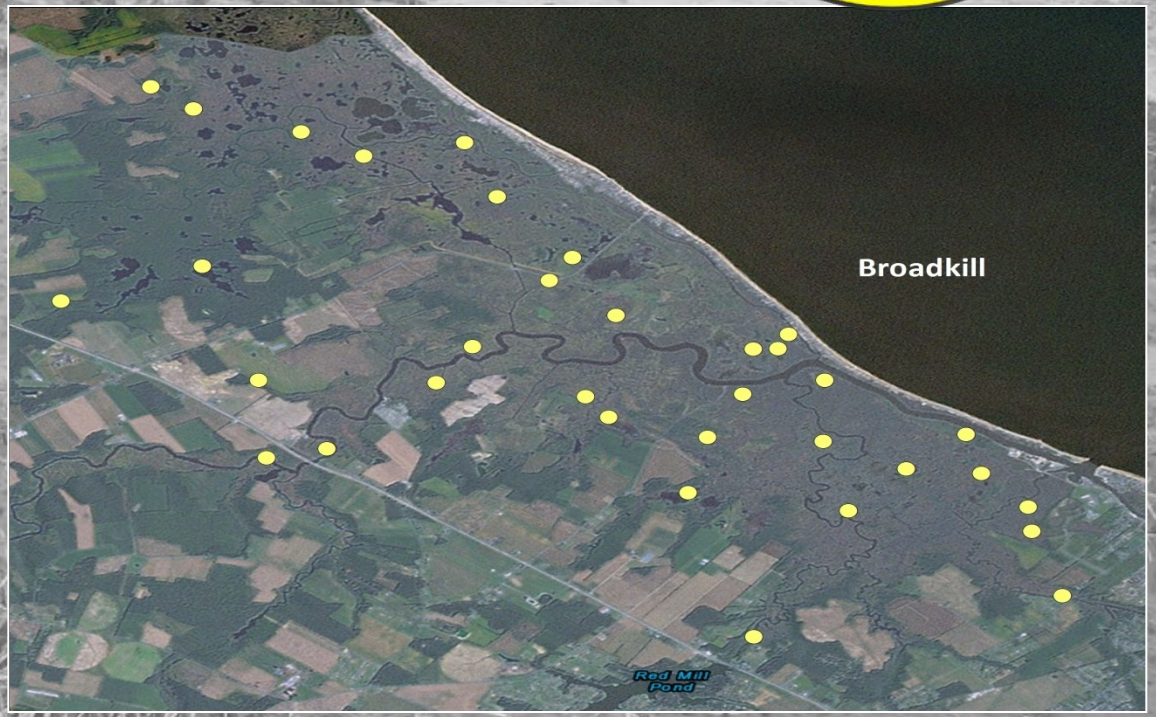




MACWA Tier 2 – Rapid Assessments

- Sample Frame: Tidal Marshes
- Protocol = MidTRAM v.3
- Rapid Measures (18 metrics)
- ~30 per Watershed (HUC 10/12)
- Random Probabilistic
- Main Condition Attributes
  - Habitat
  - Buffers
  - Hydrology
  - Shorelines

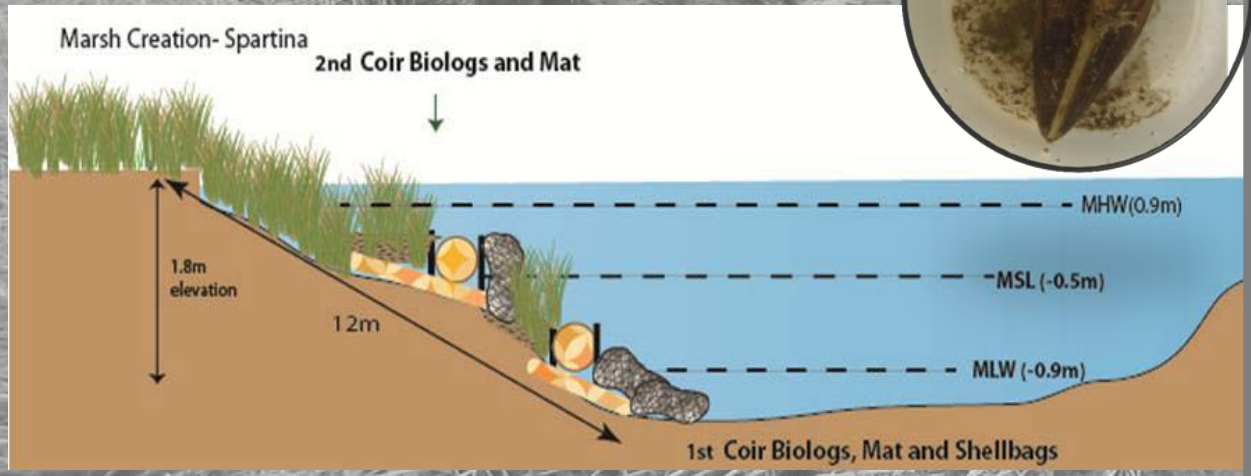




MACWA Tier 3 – Intensive Studies

Examples:

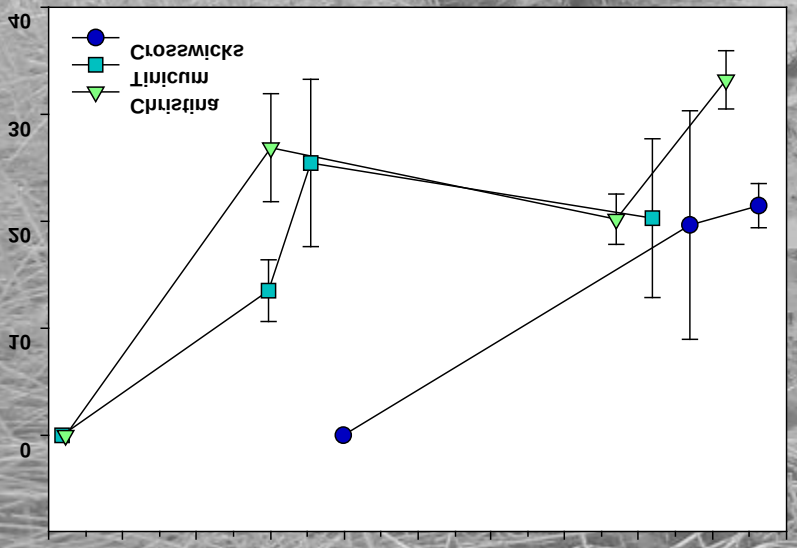
- **Living Shoreline Tactics, Outcomes**
- **Ecosystem Services, Mapping**
- **"Marsh Futures" Restoration Plans**



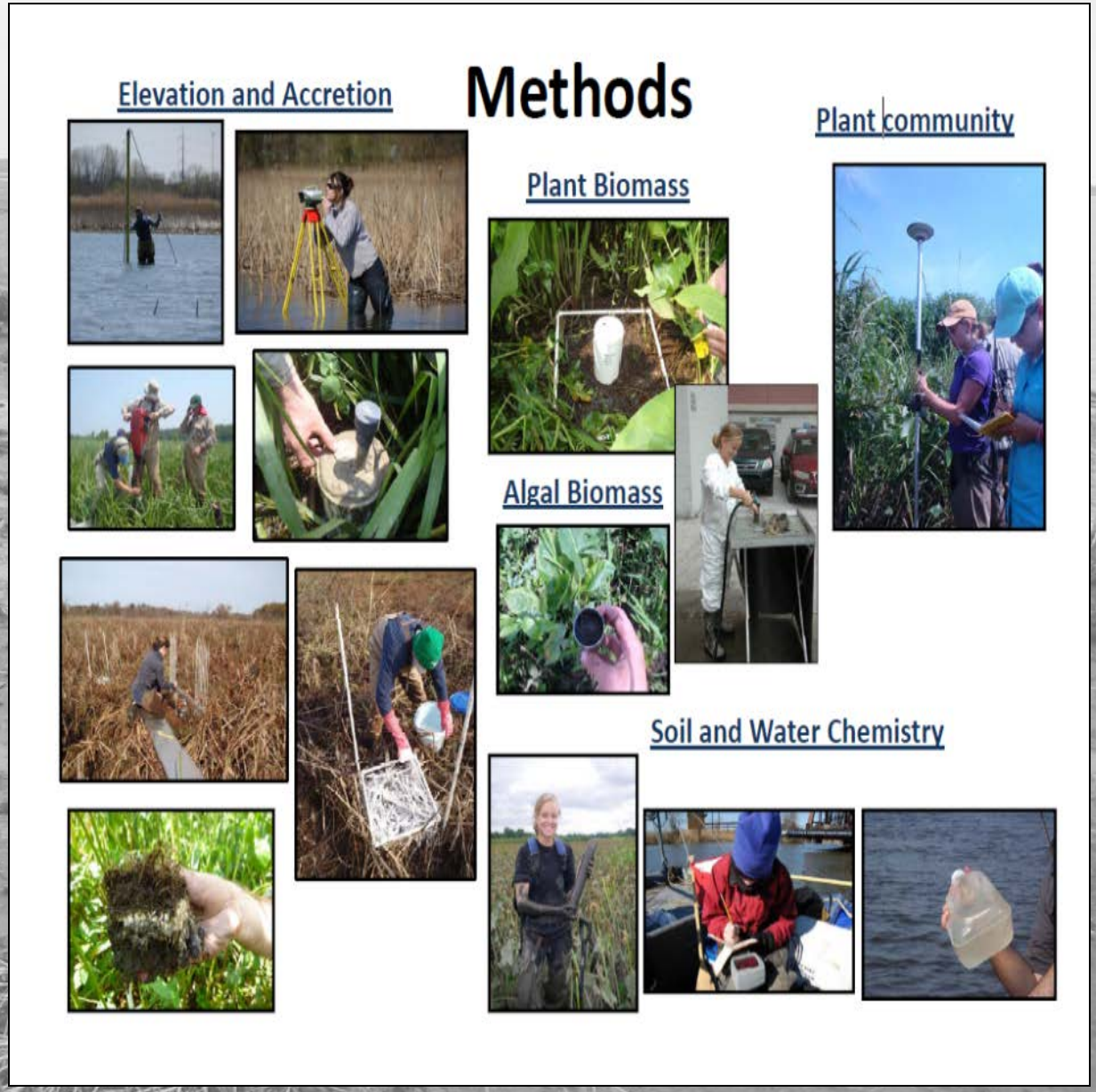
MACWA Tier 4 – Station Monitoring

Update:

- Intensive monitoring consists of ~20 physical, chemical and biological core metrics
- Supplemental metrics are assessed when possible



Surface Elevation Change



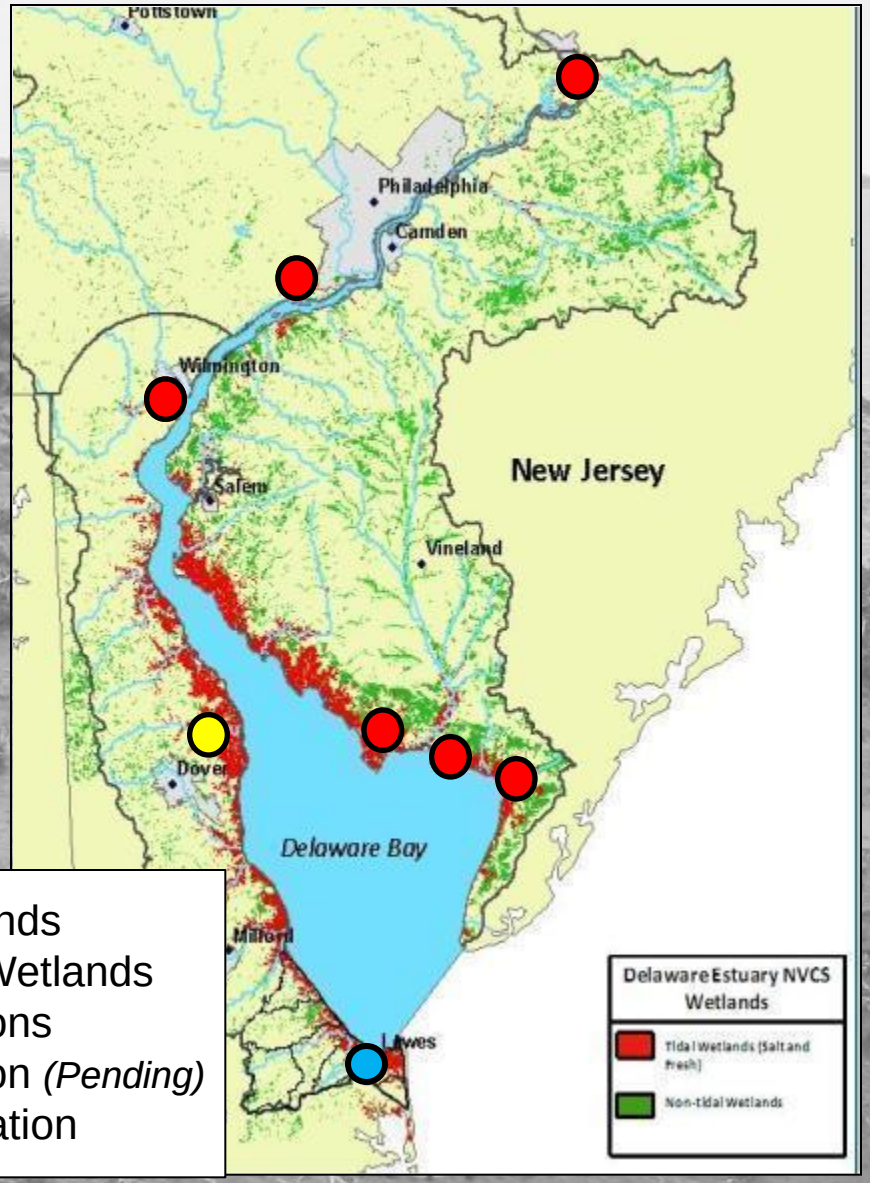
MACWA Tier 4 – Station Monitoring

Core Partners:

- PDE, Barnegat Bay Partnership
- Academy of Natural Sciences
- DNREC

Stations:

- 6 in Delaware Estuary
- 3 in Barnegat Bay
- Broadkill Station in 2014



Tidal Wetlands
Non-Tidal Wetlands
SSIM Stations
SSIM Station *(Pending)*
DNREC Station

2014 ➡ Future

- Contrast Data from Different Tiers

  Verify design and relationships

  Can intensive station data be extrapolated ?

  see Buckner poster

- Build on Intra-Watershed Report Cards with Inter-Watershed Analyses

  Comparison of >250 RAM points

  remainder of this talk

RAM

Mid-Atlantic Tidal Rapid Assessment Method (Mid-TRAM v.3*)

- Buffer Integrity
- Hydrologic Integrity
- Habitat/Bio Integrity
- Shoreline Integrity

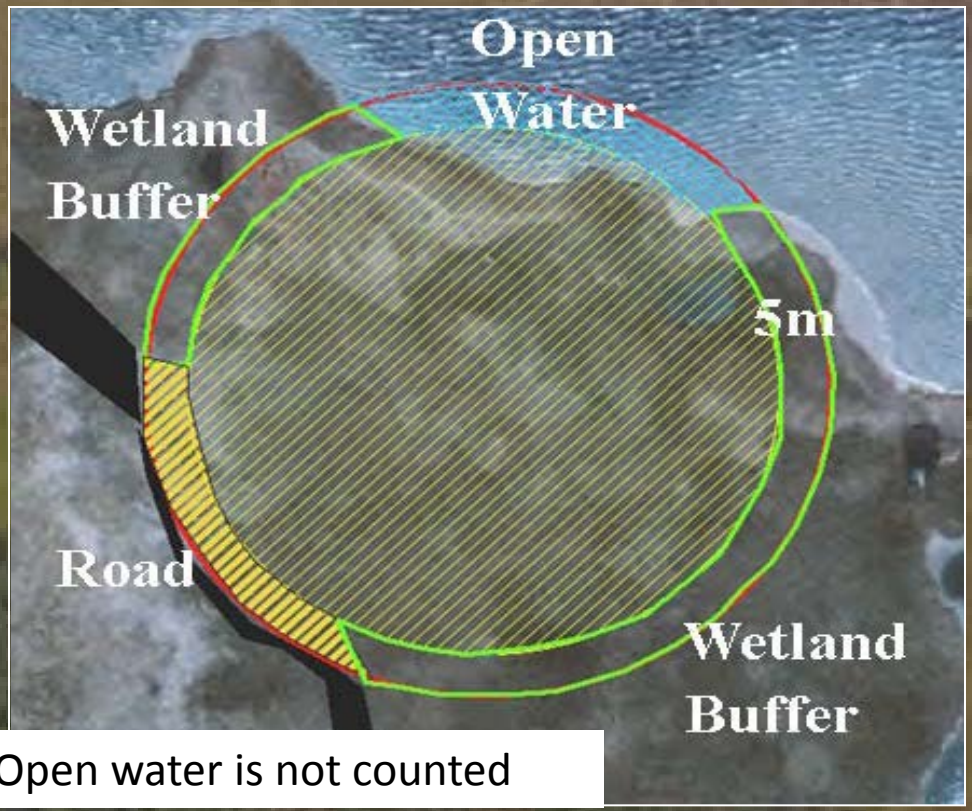
Attribute	Metric	Description
Buffer/Landscape	Percent of AA Perimeter with 5m-Buffer	Percent of AA perimeter that has at least 5m of natural or semi-natural condition land cover
Buffer/Landscape	Average Buffer Width	The average buffer width surrounding the AA that is in natural or semi-natural condition
Buffer/Landscape	Surrounding Development	Percent of developed land within 250m from the edge of the AA
Buffer/Landscape	250m Landscape Condition	Landscape condition within 250m surrounding the AA based on the nativeness of vegetation, disturbance to substrate and extent of human visitation
Buffer/Landscape	Barriers to Landward Migration	Percent of landward perimeter of wetland within 250m that has physical barriers preventing wetland migration inland
Hydrology	Ditching & Draining	The presence of ditches in the AA
Hydrology	Fill & Fragmentation	The presence of fill or wetland fragmentation from anthropogenic sources in the AA
Hydrology	Wetland Diking / Tidal Restriction	The presence of dikes or other tidal flow restrictions
Hydrology	Point Sources	The presence of localized sources of pollution
Habitat	Bearing Capacity	Soil resistance using a slide hammer
Habitat	Vegetative Obstruction	Visual obstruction by vegetation <1m measured with a cover board.
Habitat	Number of Plant Layers	Number of plant layers in the AA based on plant height
Habitat	Percent Co-dominant Invasive Species	Percent of co-dominant invasive species in the AA
Habitat	Percent Invasive	Percent cover of invasive species in the AA

** Jacobs et al. 2010*

For PDE QAPP and methods: http://delawareestuary.org/node/199

Step 1. GIS Analysis

e.g. Barriers to Landward Migration, Development



Open water is not counted

~30% is road or development

Step 2. Field Assessment

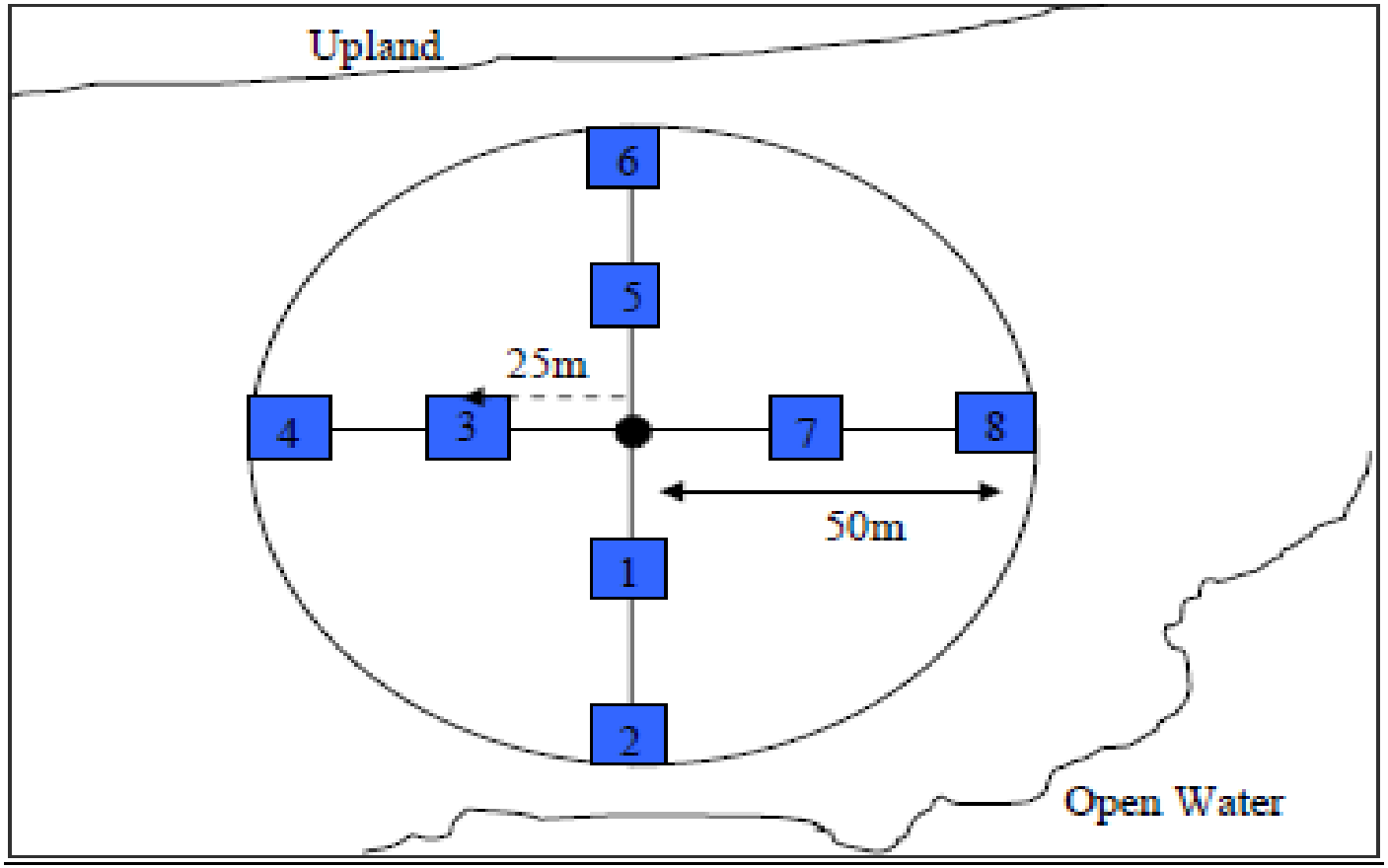
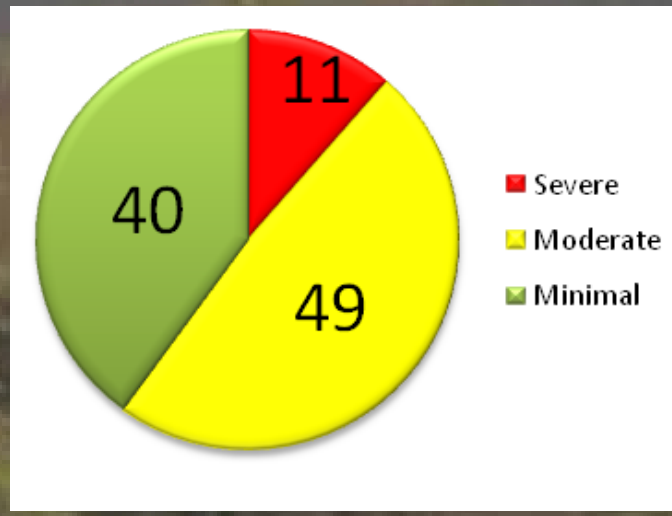


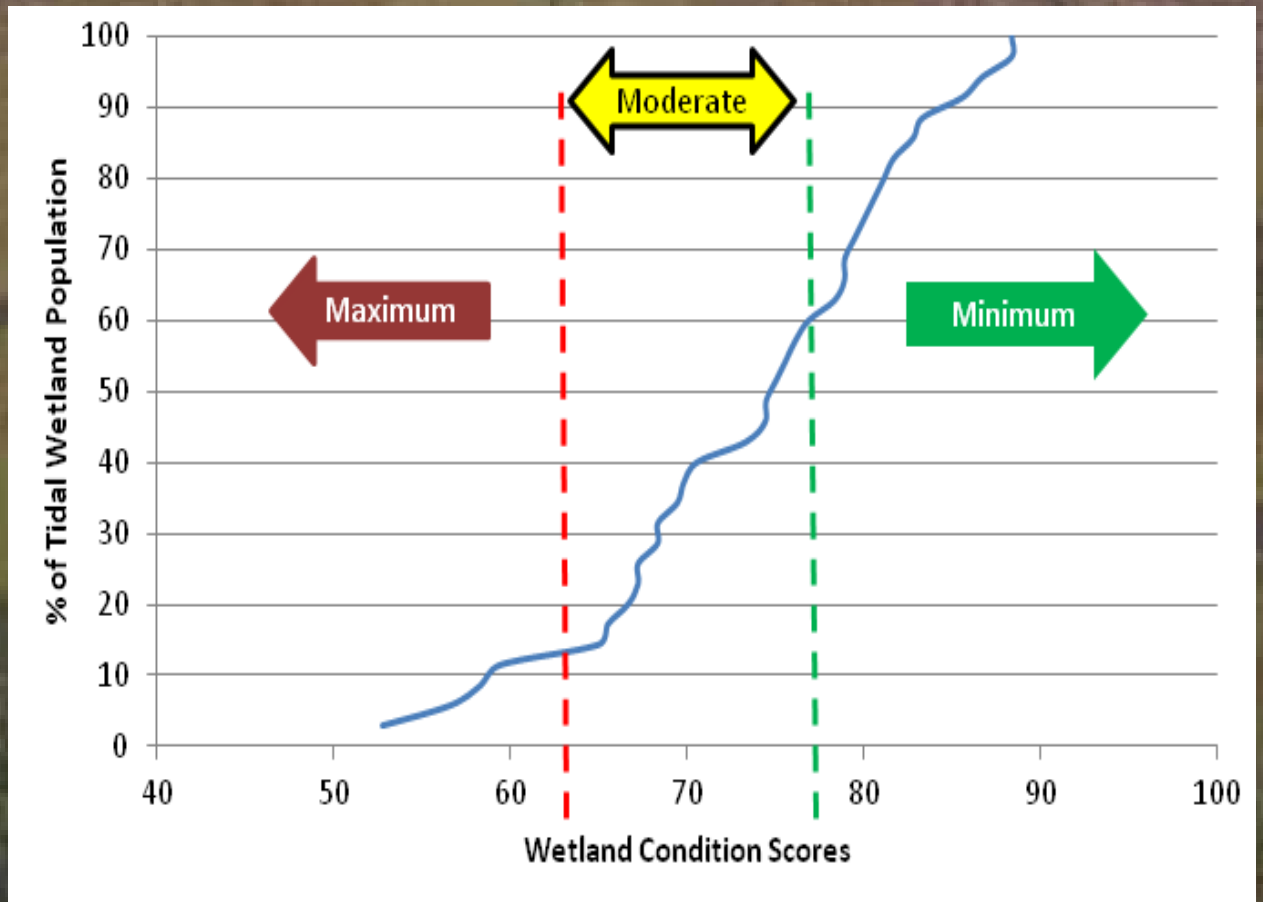
Figure 3: Location of Subplots in a circular assessment area.

Step 2. Field Assessment

Step 3. Intra-Watershed Analysis

Assign stress categories relative to cumulative distribution of data per watershed

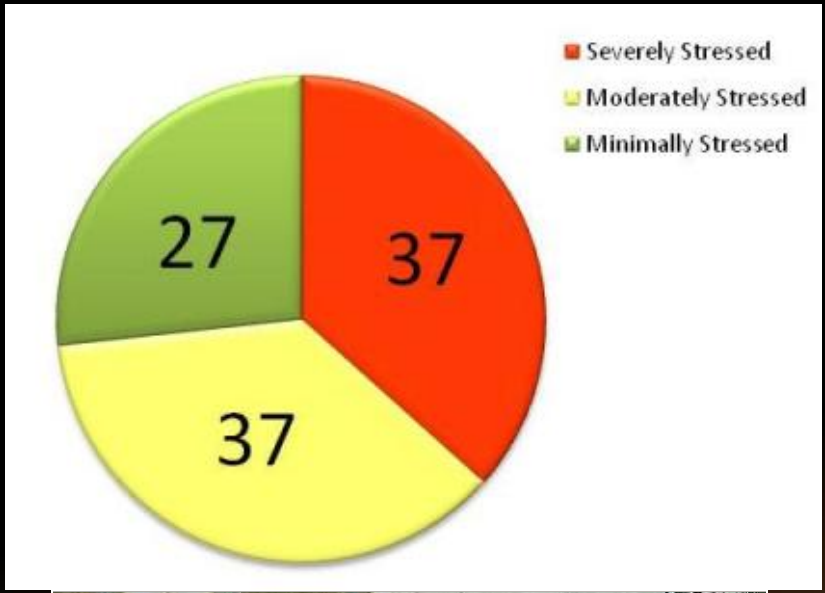


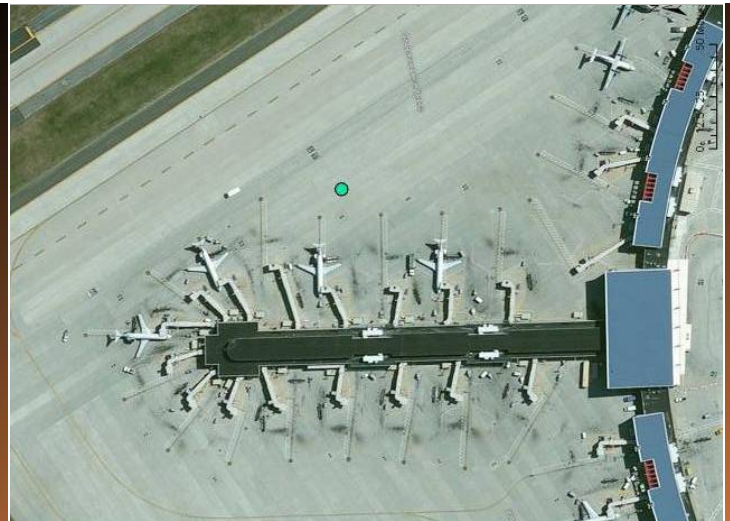


But problem, …

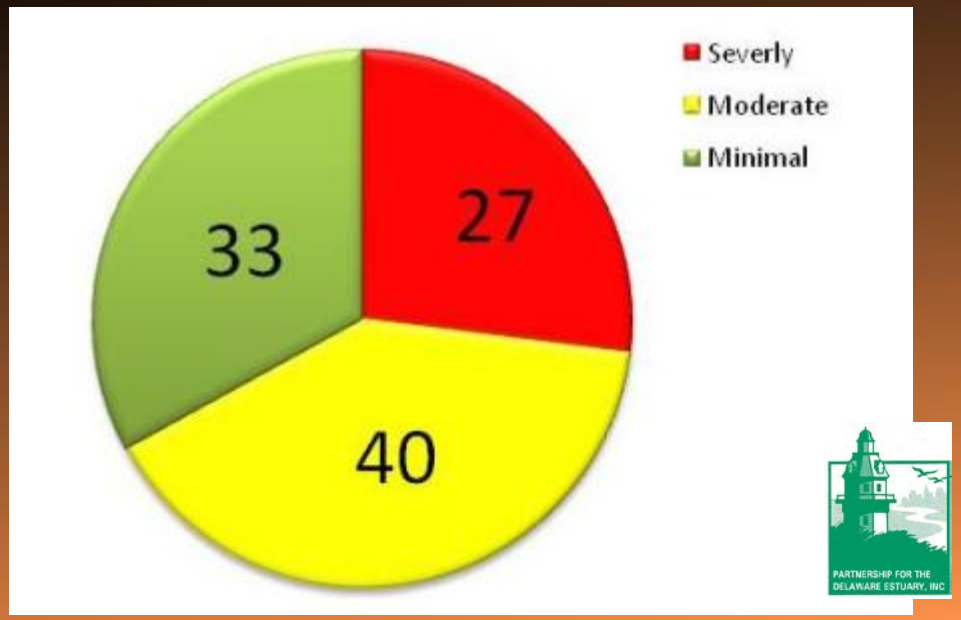
Loses the detail of specific stressor-response relationships

PA Tidal Wetlands – Condition Summary



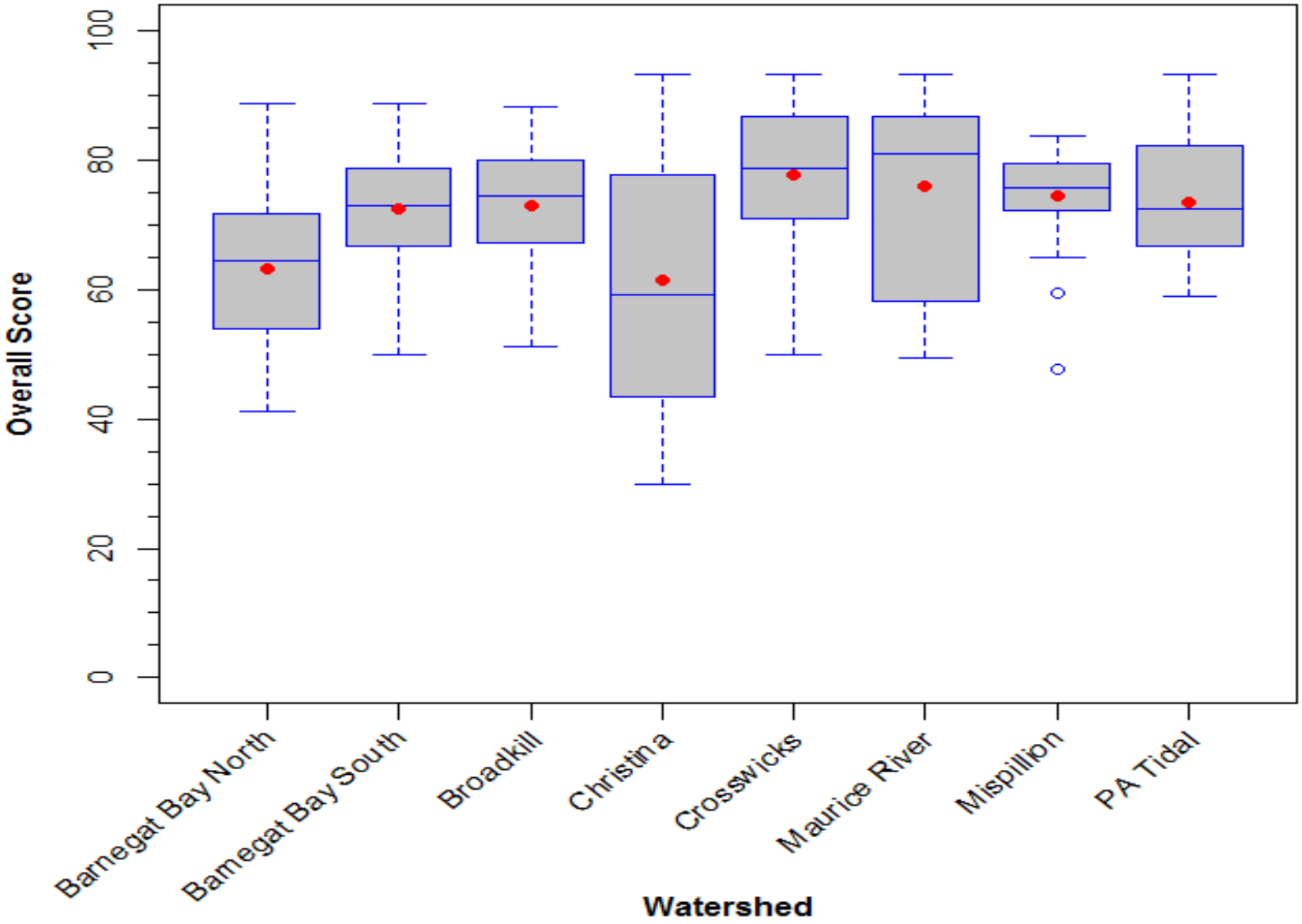


Maurice Tidal Wetlands – Condition Summary



Overall RAM Scores Across Watersheds

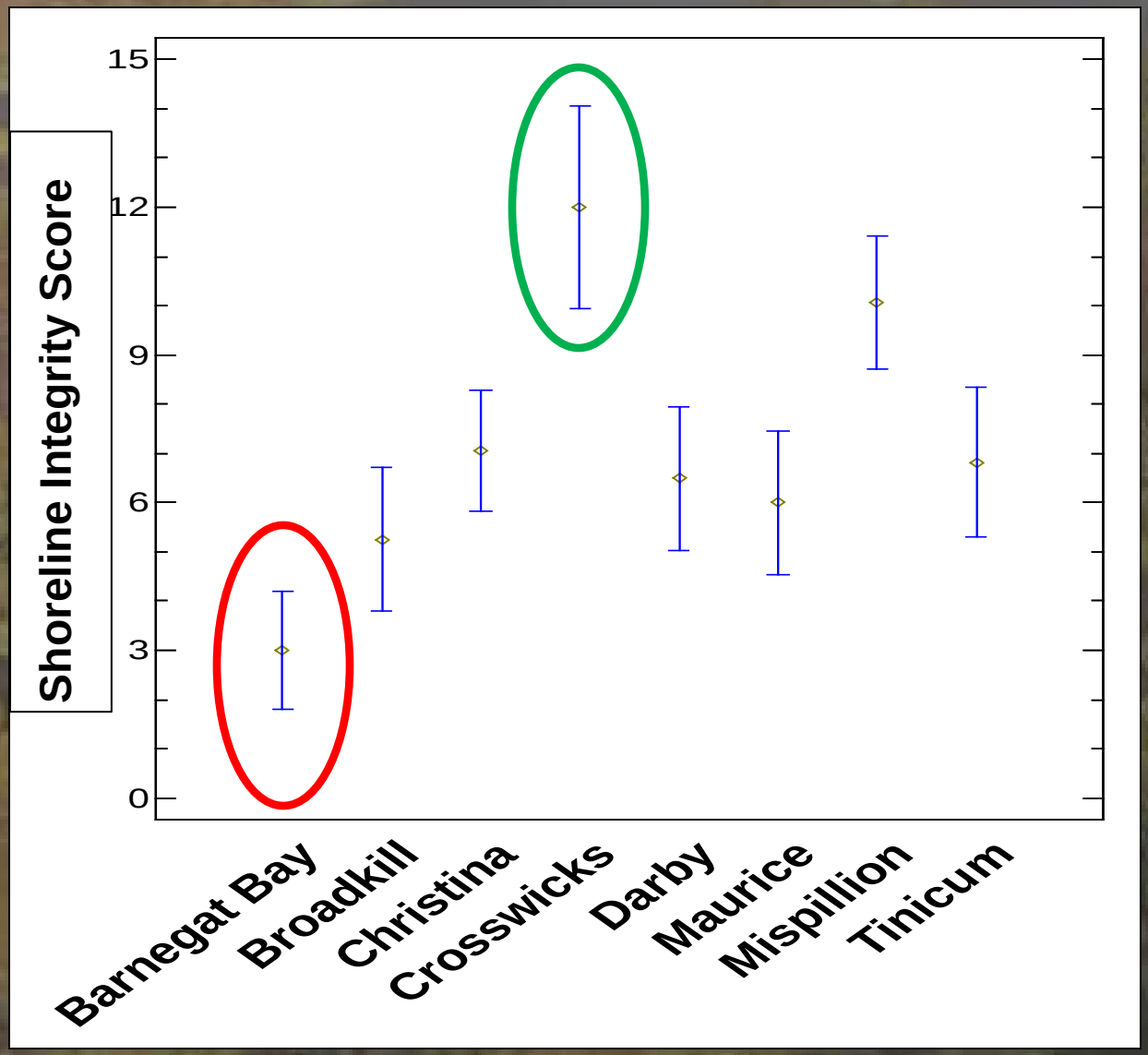
251 Sites



Step 3. Inter-Watershed Metrics Analyses

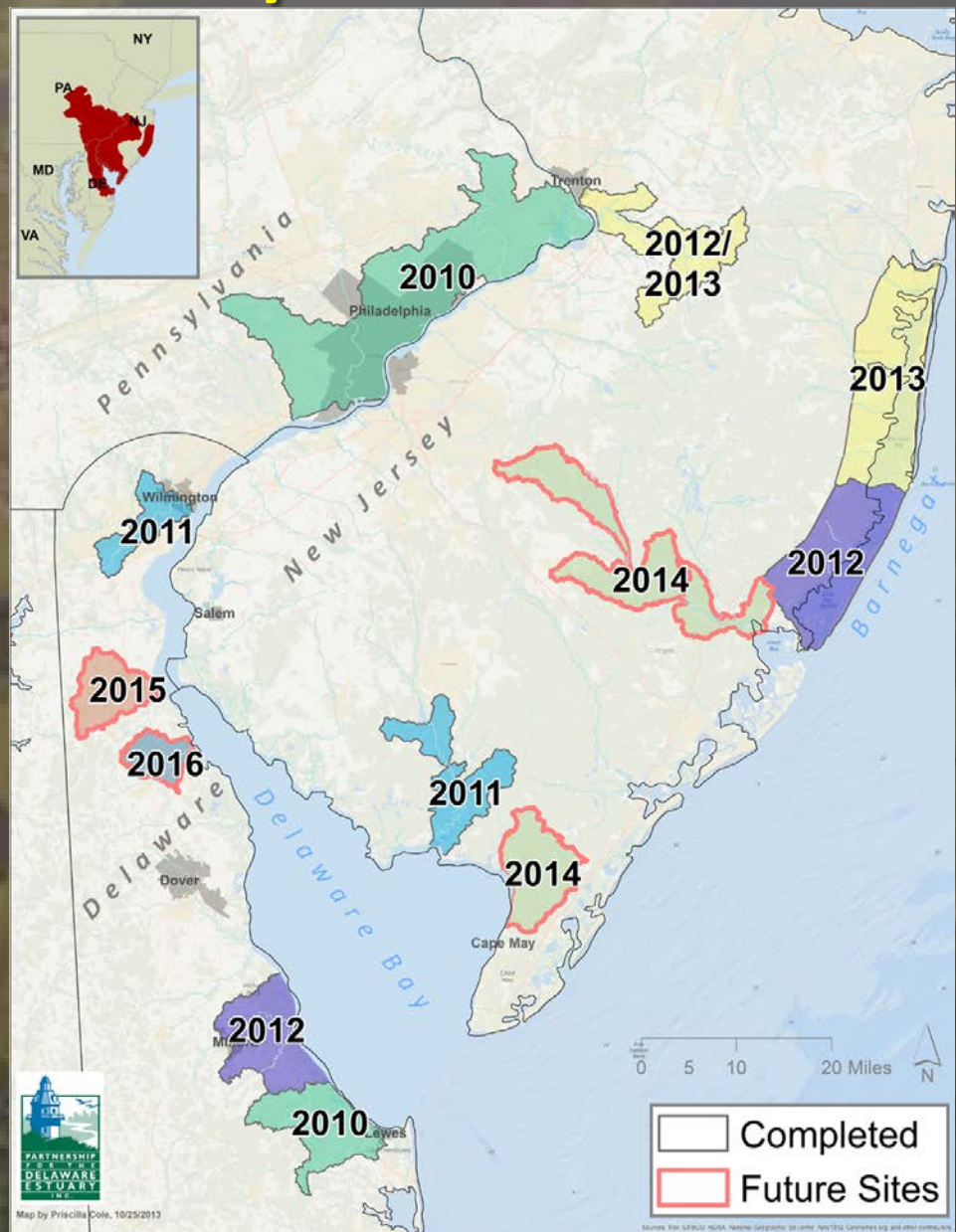
Address specific science and management questions by mining the actual RAM data

more interesting when "get into the weeds"



Step 3. Inter-Watershed Analyses

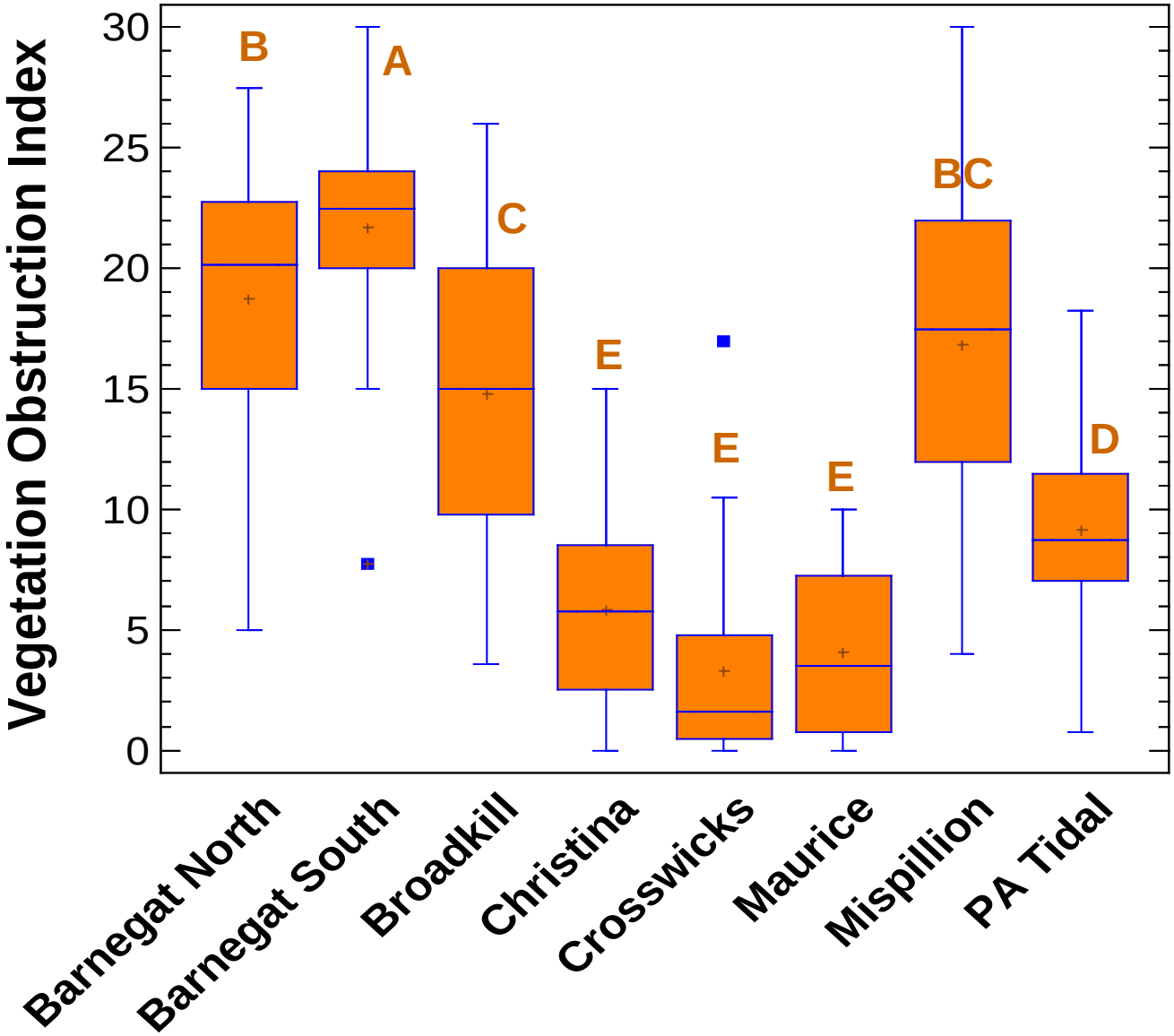
Results presented here are for >250 points collected 2010-2013



RAM - Habitat

Vegetation Obstruction

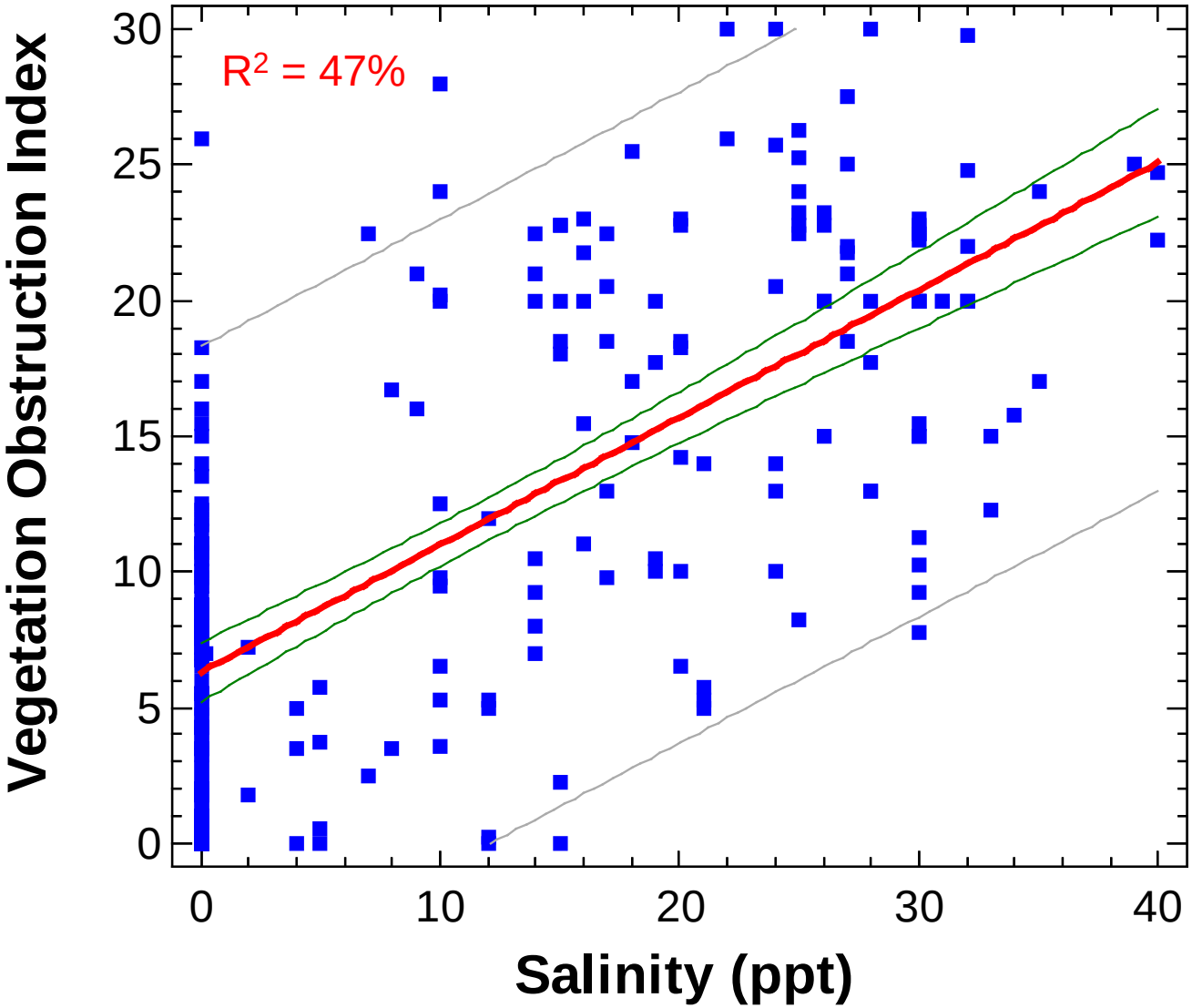
- Very Useful
- Good Separation Among Watersheds
- But.....



RAM - Habitat

Vegetation Obstruction

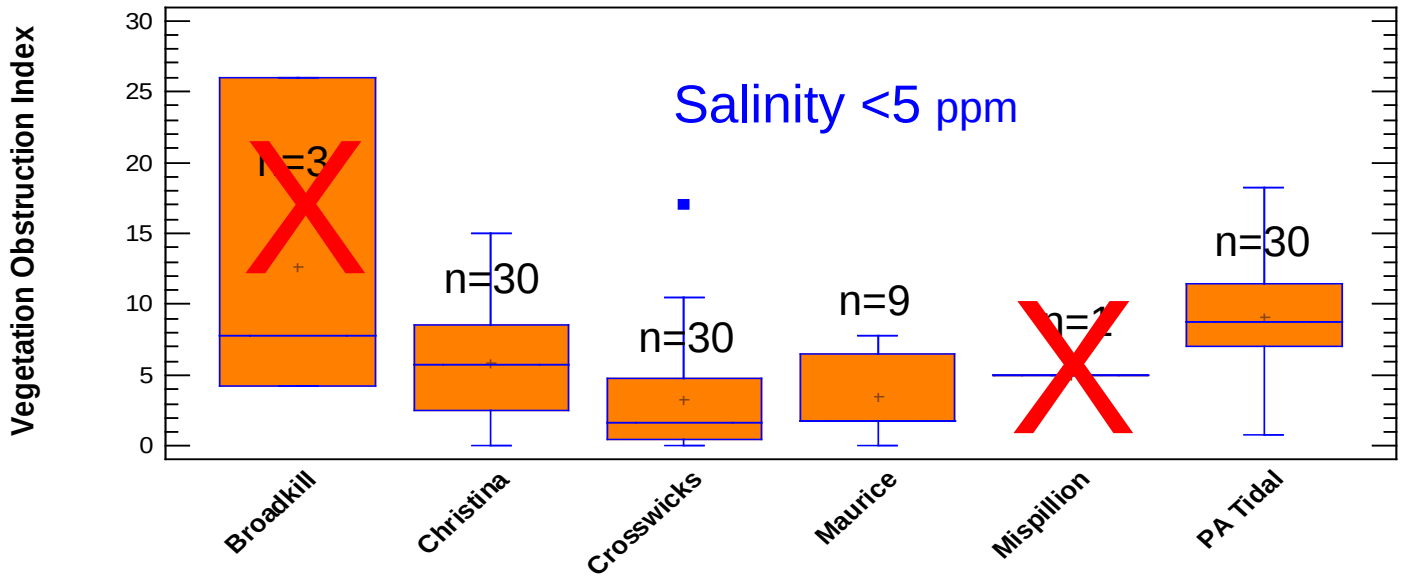
- Index is subject to natural variation among marsh types with salinity gradient
- Therefore….

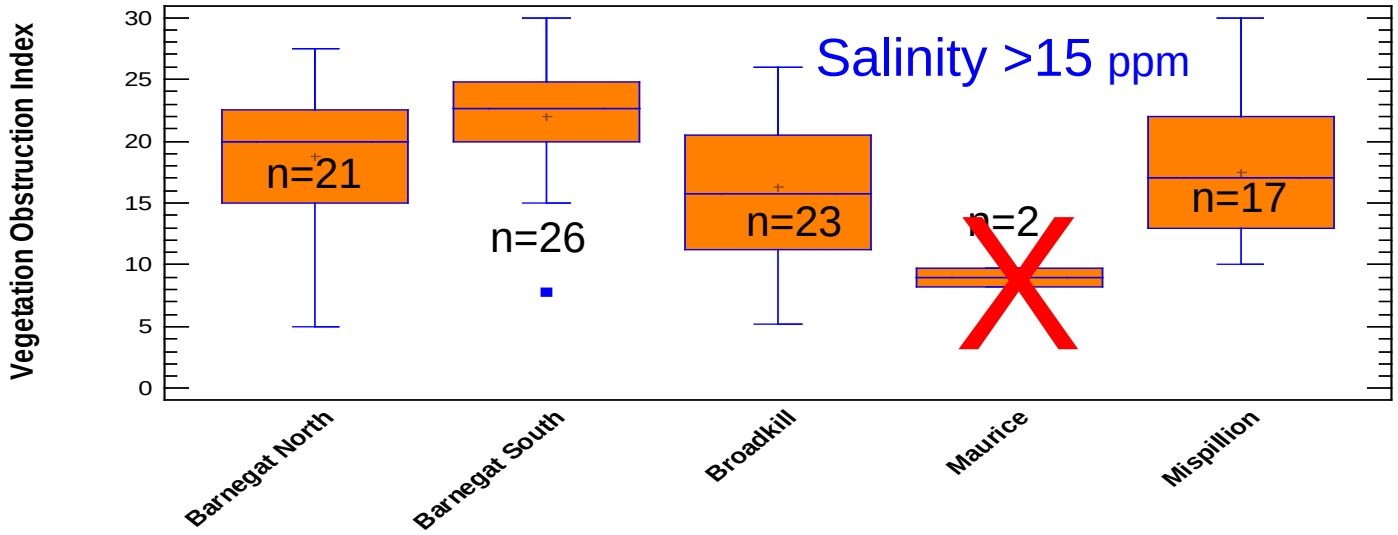


RAM - Habitat

Vegetation Obstruction

- Need to analyze data only among similar marsh types
- But consider sample sizes

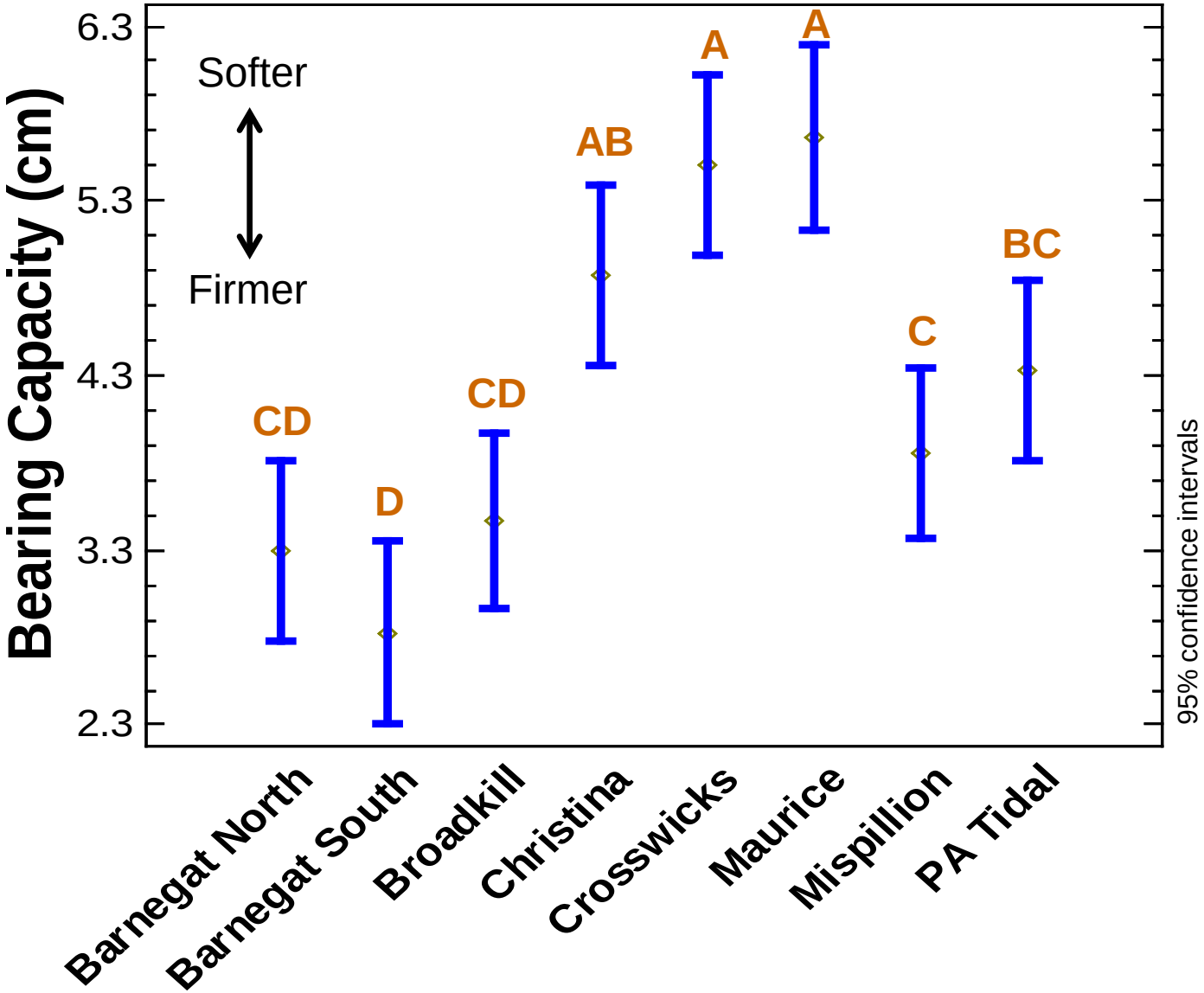




RAM - Habitat

Bearing Capacity

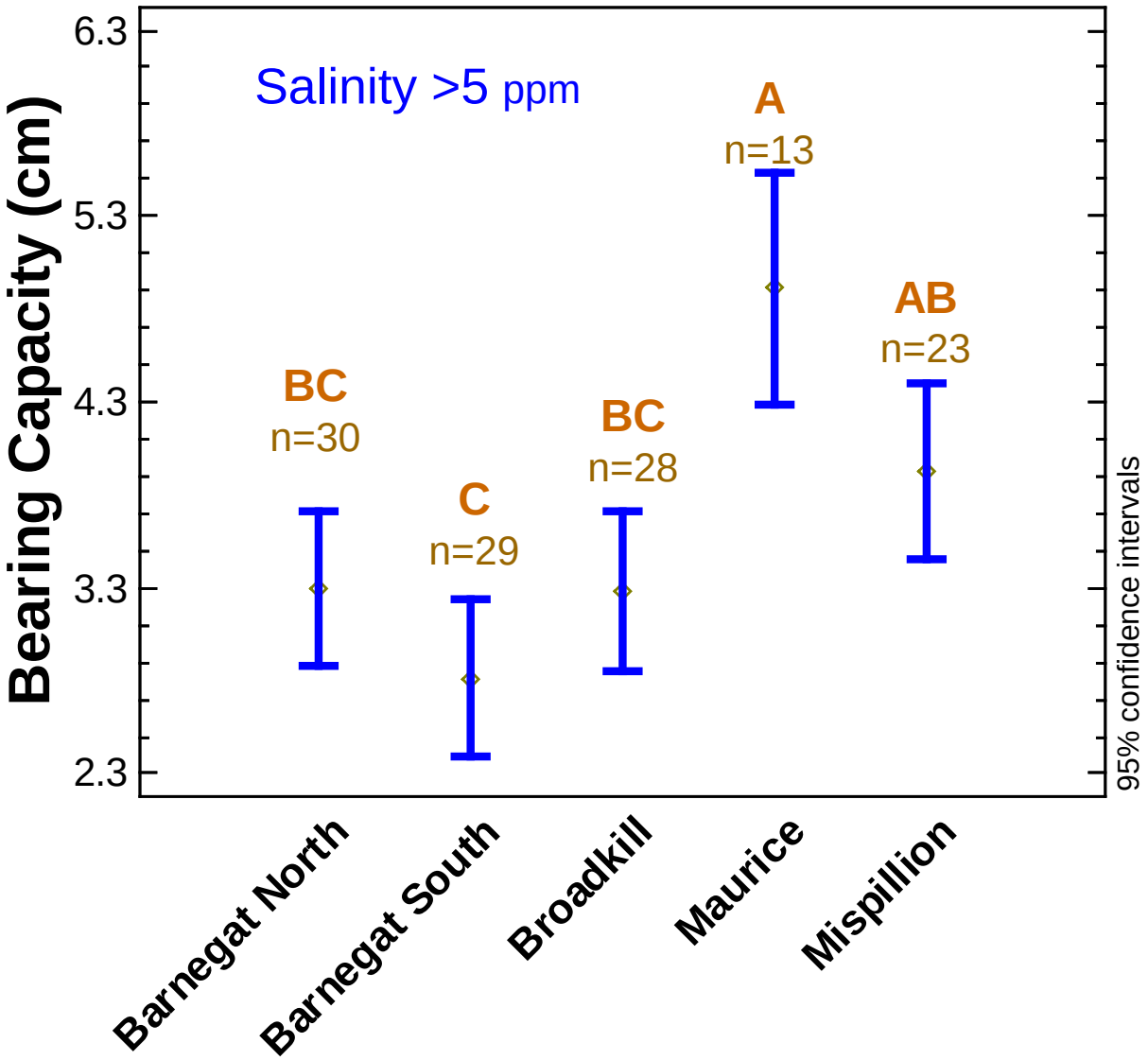
- Very useful
- Good separation among watersheds
- But also varied along natural salinity gradient



RAM - Habitat

Bearing Capacity

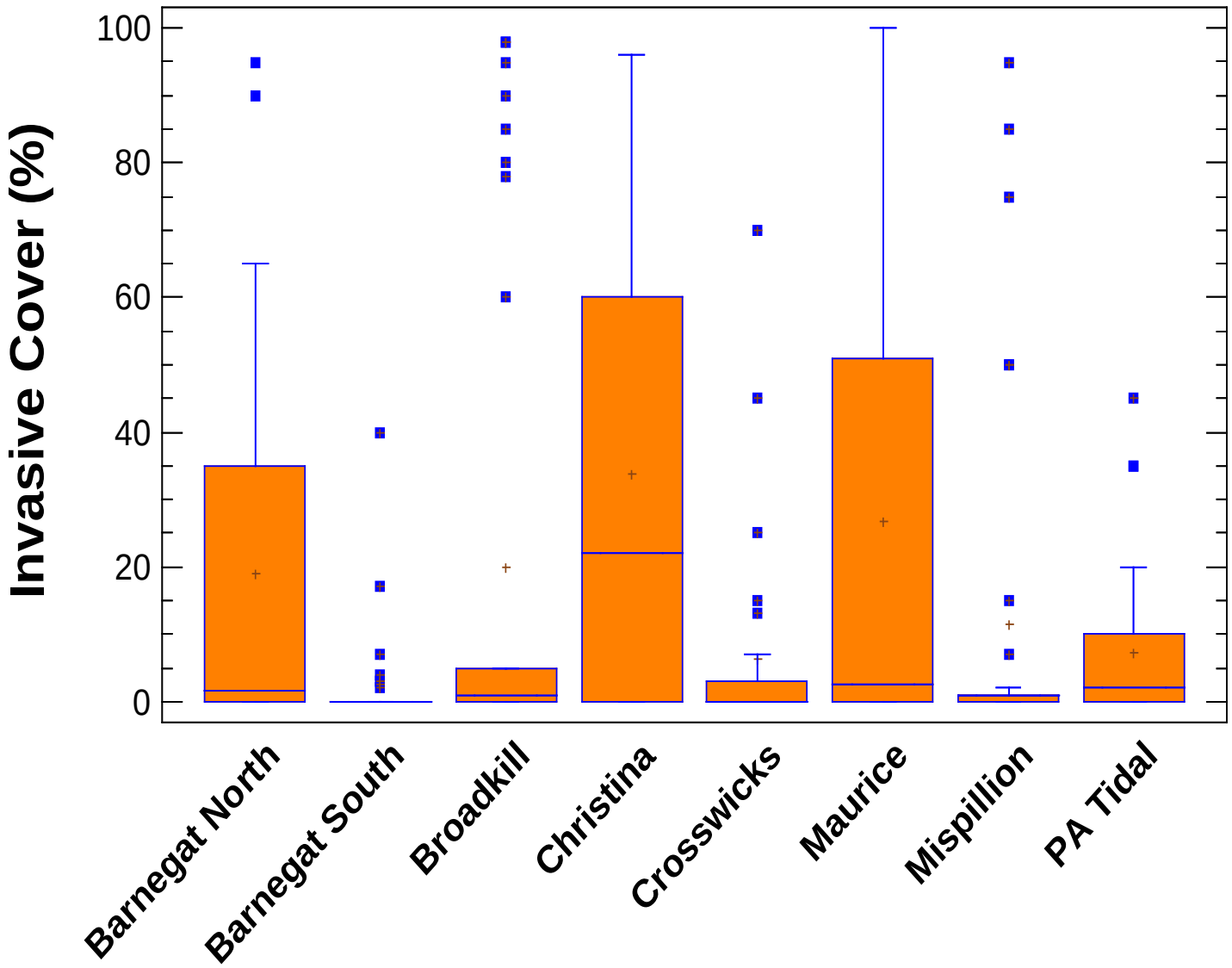
- Still very useful when comparing apples and apples
- Maurice has "softer" salt marsh substrates



RAM - Habitat

Invasives

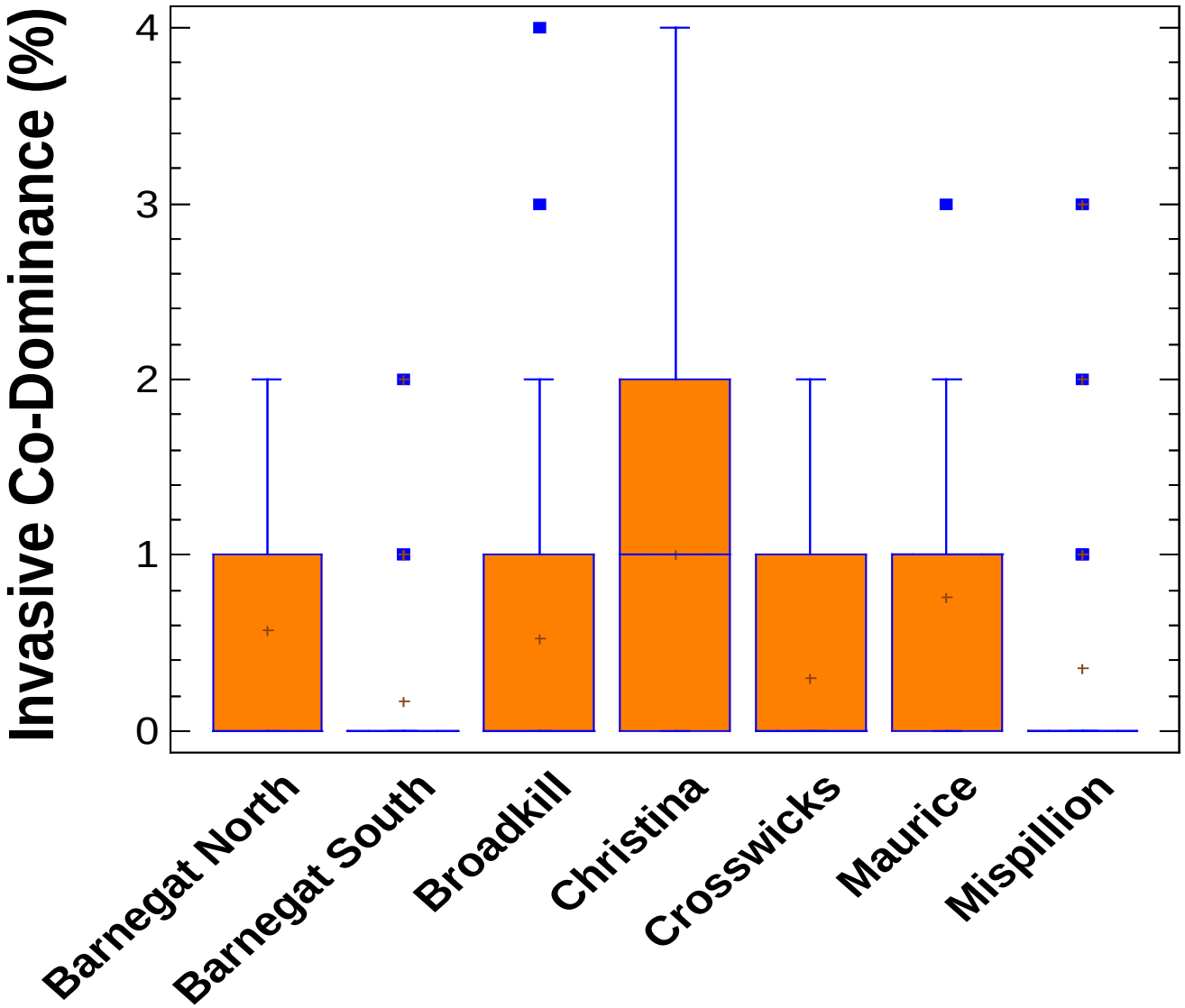
- No major salinity effect
- Many watersheds had high outliers
- Christina significantly more invasives
- Useful



RAM - Habitat

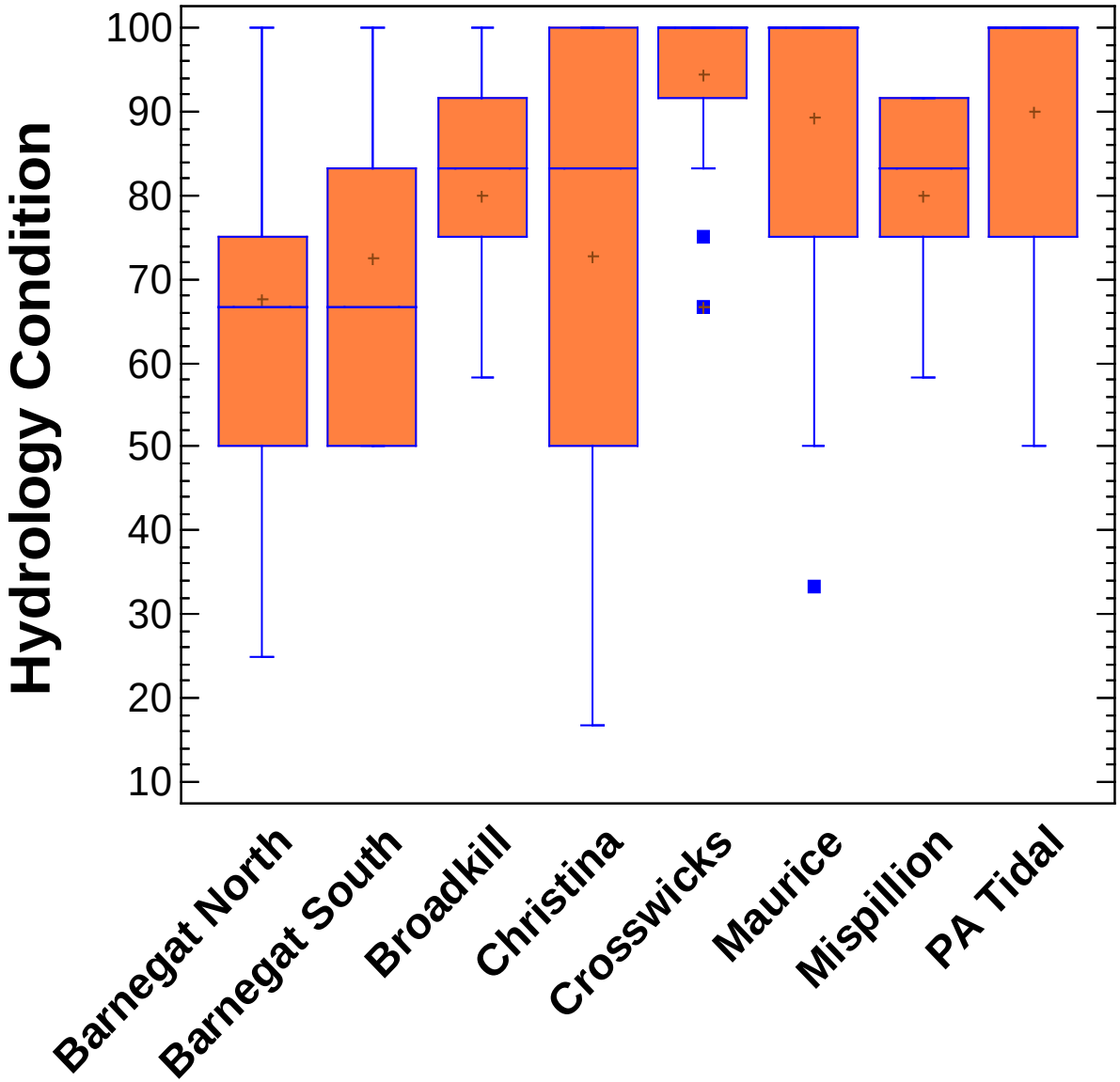
Invasives

- But.. 2 metrics show similar patterns (Christina significantly more invasives)
- Consider dropping co-dominance from Mid-TRAM



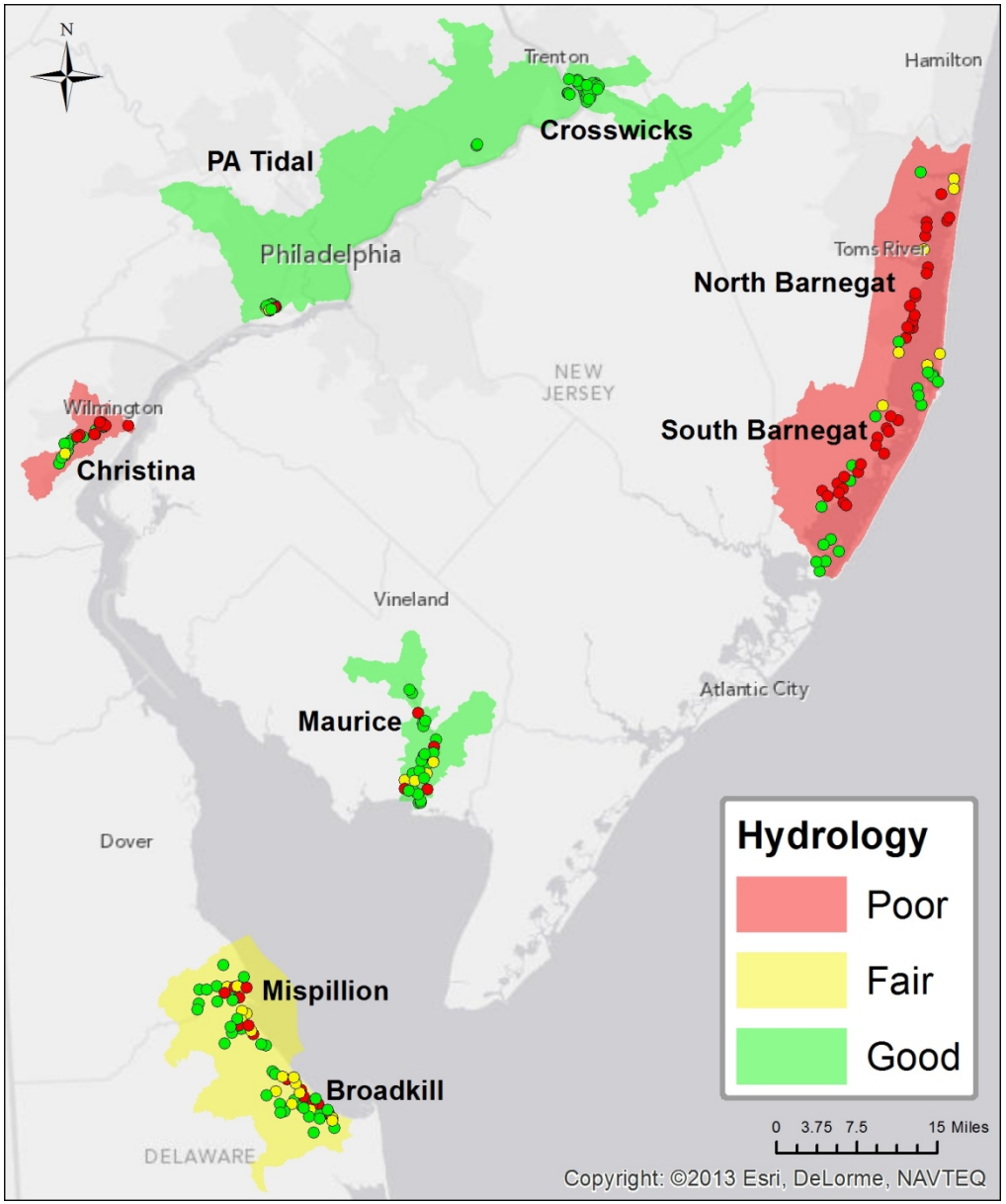
RAM - Hydrology

- Good variability, and no natural gradient effects (salinity)
  - Ditching/Draining
  - Fill/Fragmentation
  - Dikes/Restrictions
  - Point Sources



RAM - Hydrology

- Good variability, and no natural gradient effects (salinity)
  - Ditching/Draining
  - Fill/Fragmentation
  - Dikes/Restrictions
  - Point Sources
- Christina low score due to tidal restrictions and point sources
- Barnegat scored low due to fragmentation



RAM - Hydrology

MidTRAM protocol suggestion:

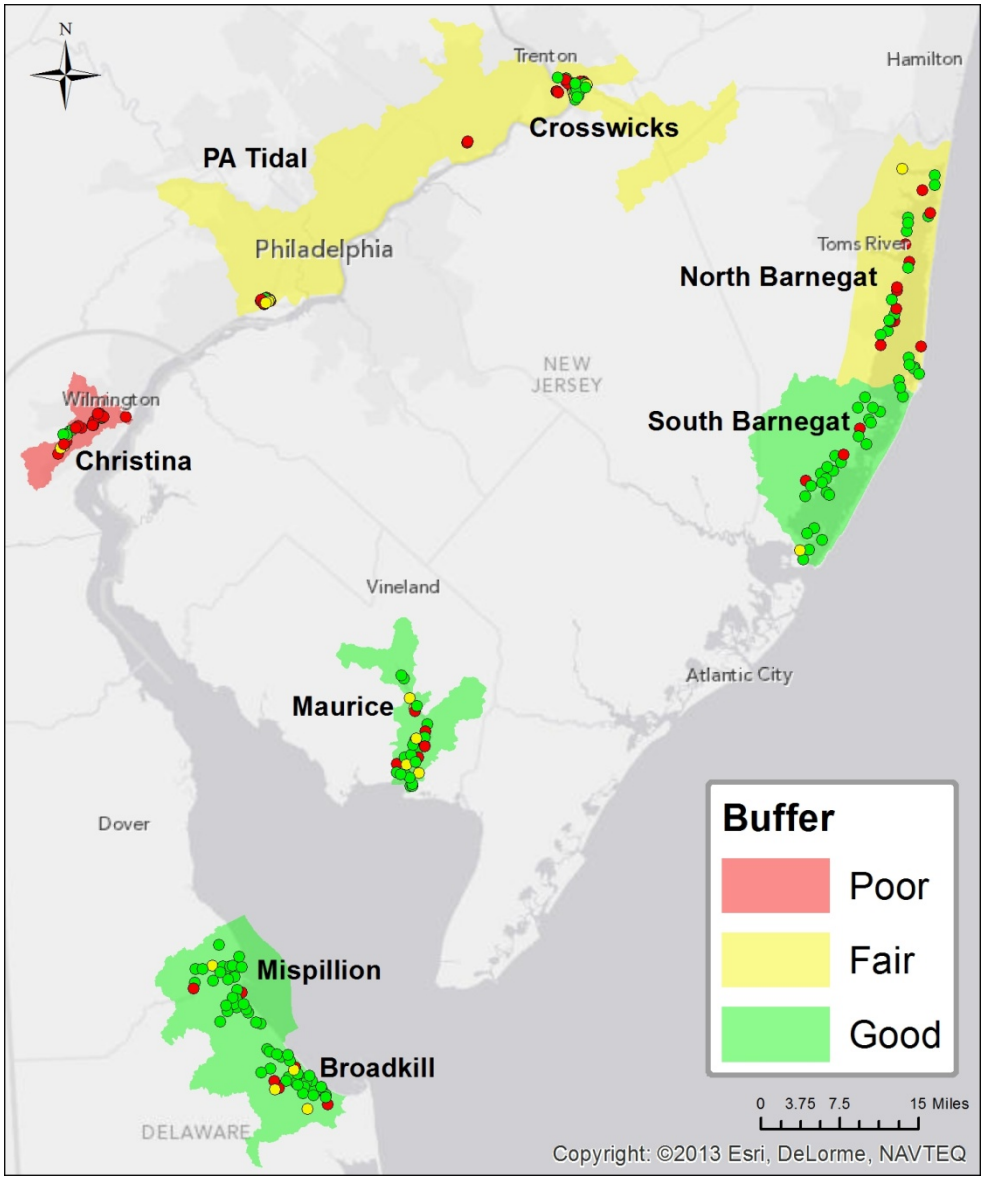
- Strengthen quantitative measures

  Examples:

  - use aerial images to quantify ditch densities
  - use elevation data to quantify dikes

RAM - Buffers

- **Good variability**
  - Buffer % in 5 m
  - Buffer Width
  - Development %
  - Buffer Condition
  - Migration Barriers
- **Christina scored lowest**
- **North Barnegat and PA Tidal scored moderately low**

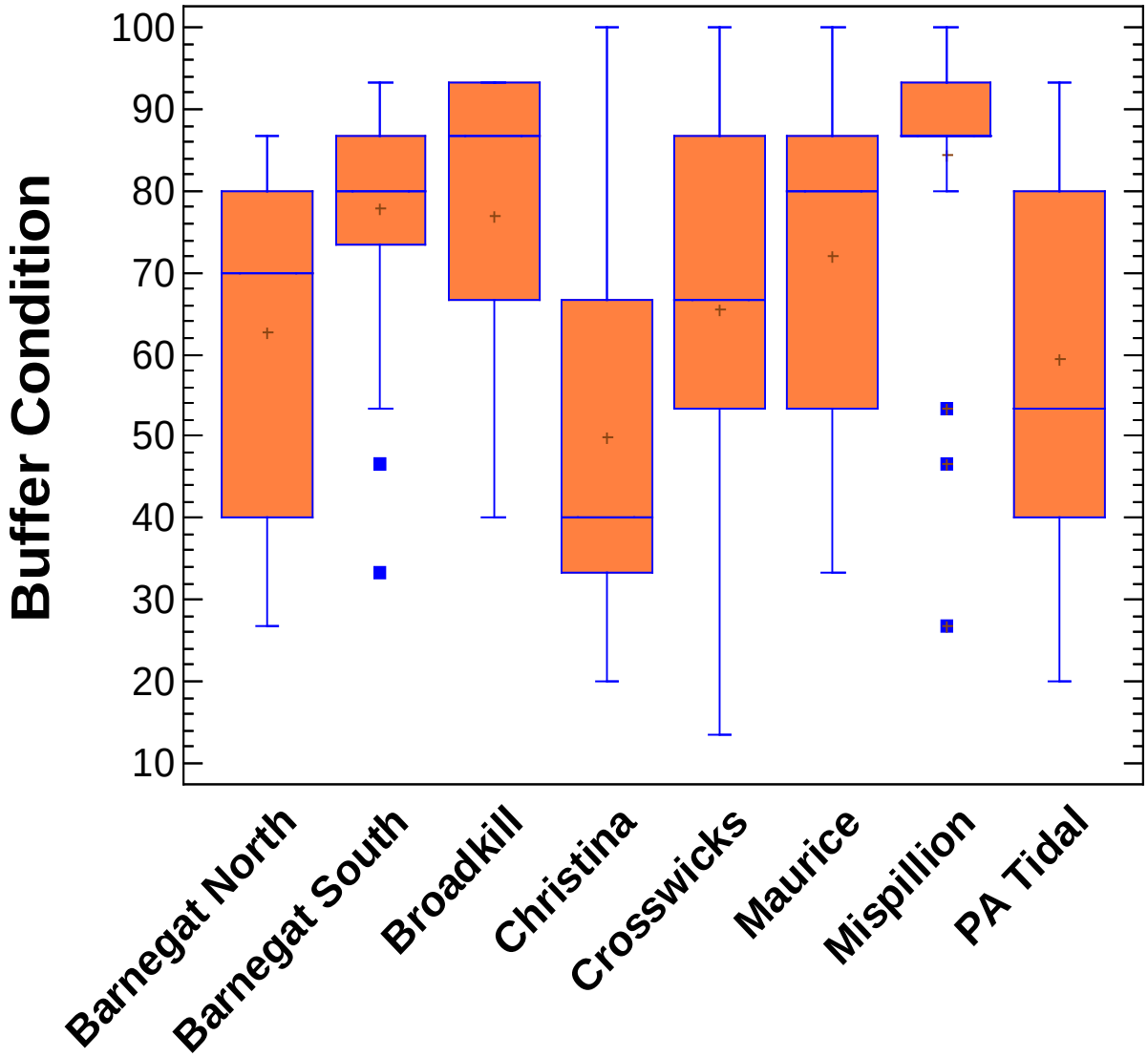


RAM - Buffers

- Slight increase in buffers with salinity…

  …but not a *natural* gradient – related to development patterns

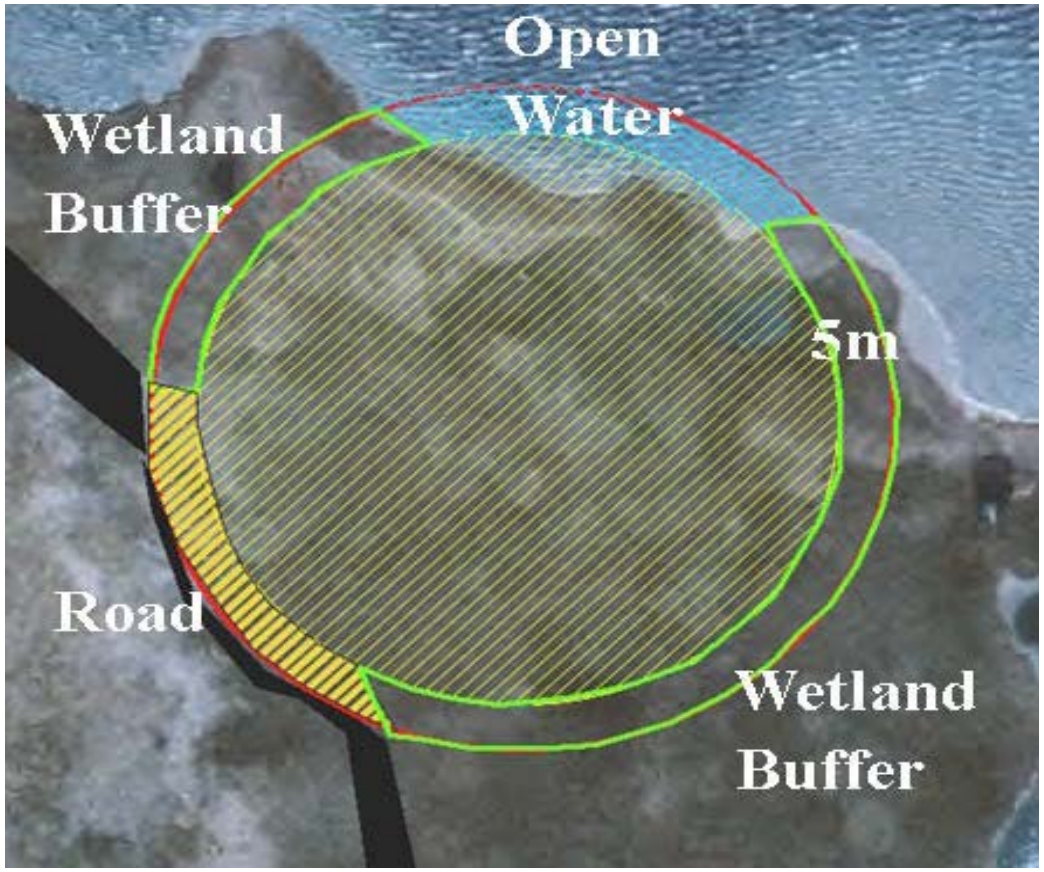
- Metrics showing salinity relationship were development percentage (B3) and migration barriers (B5)



RAM - Buffers

MidTRAM protocol suggestion:

- Retain B3 and B5 – very useful
- B1, B2 and B3 are similar, and were weakly correlated with overall buffer score
- Therefore, reevaluate and possibly condense B1, B2, B3

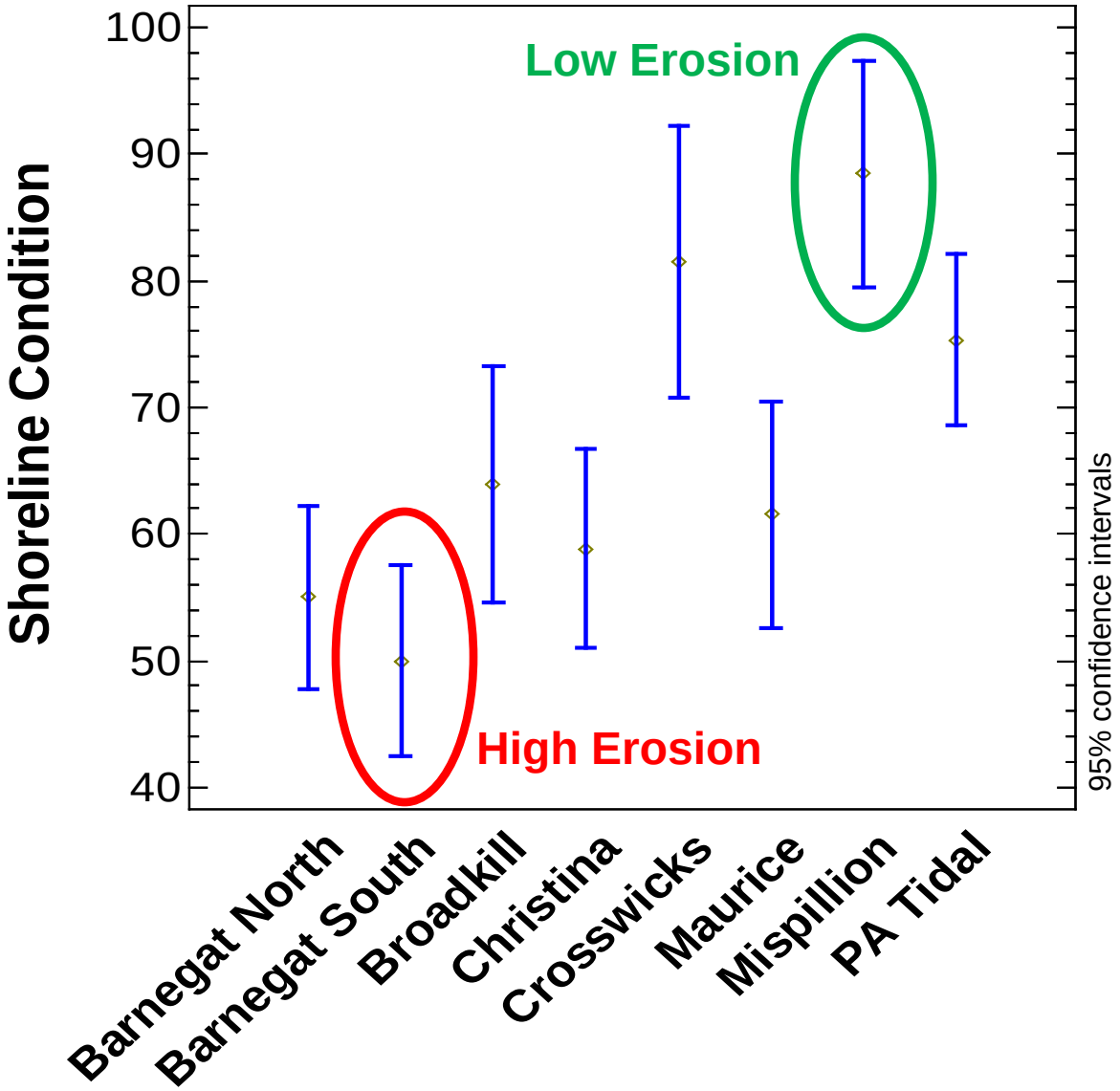


RAM – Shoreline Condition

- **Experimental**
  - Erosion/Accretion
  - Alterations
- **Limitation:** not always assessable
  (n=125 of 250 points)
- **But good variability ….**

RAM - Shorelines

- Mispillion and Crosswicks scored highest
- Barnegat scored lowest

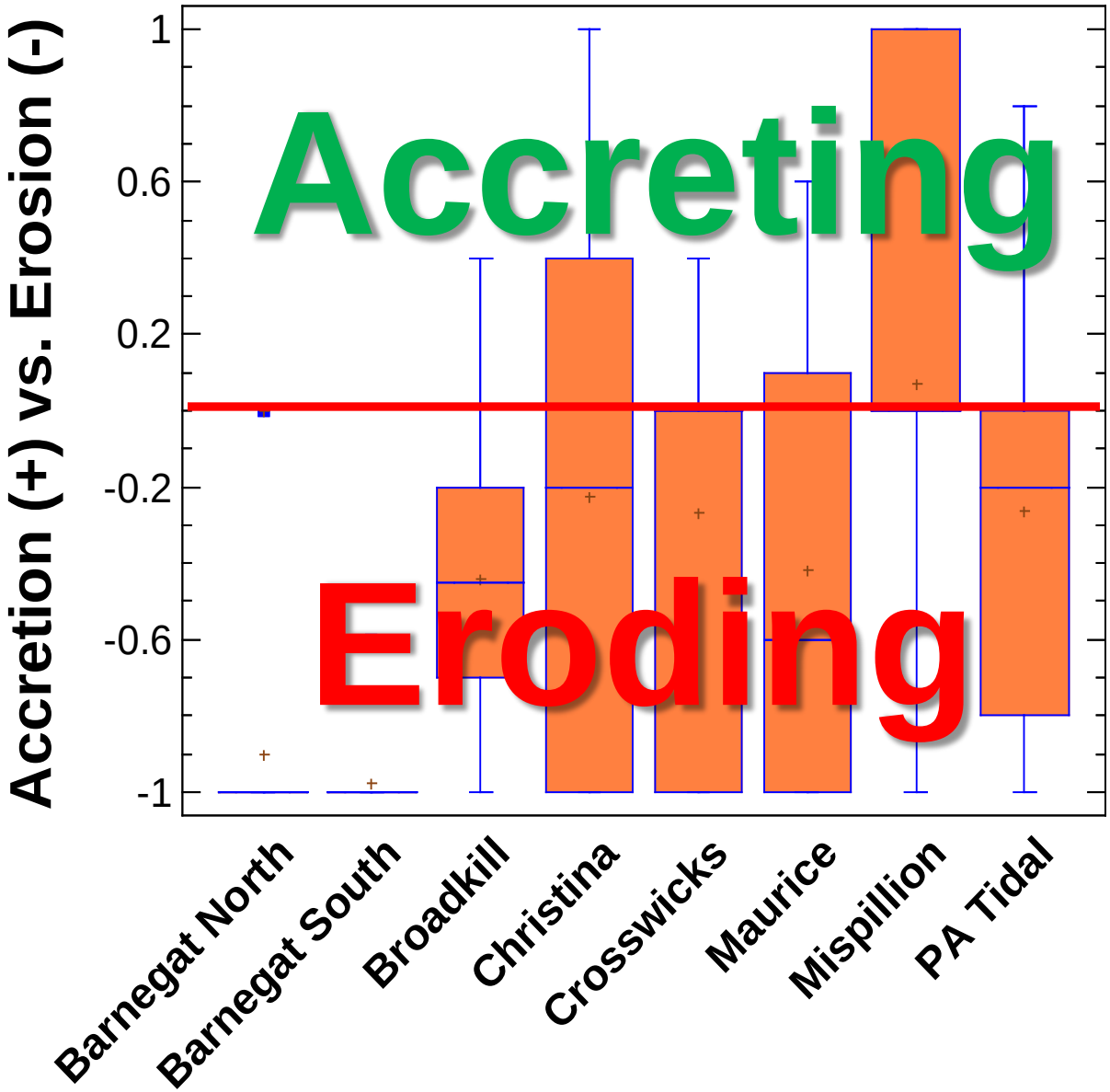


RAM - Shorelines

** In all watersheds except Mispillion, majority of shorelines <u>were eroding</u>

MidTRAM Suggestion:

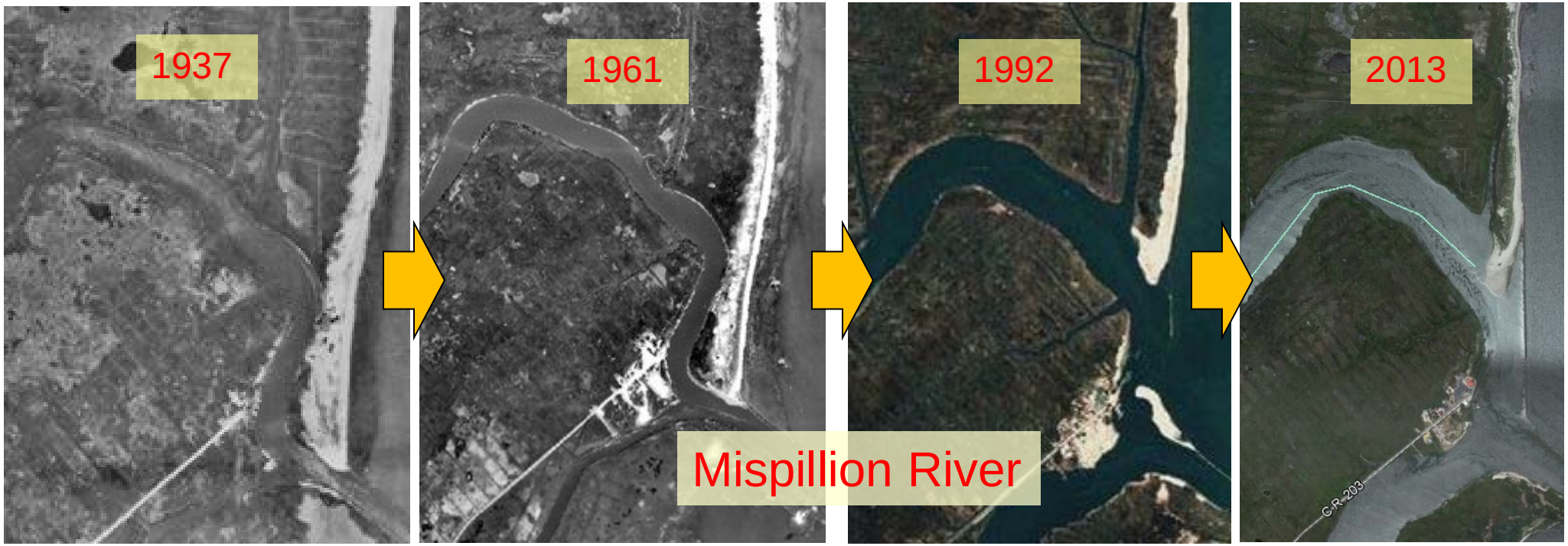
- Retain and possibly expand shoreline assessments



RAM - Shorelines

Examples:

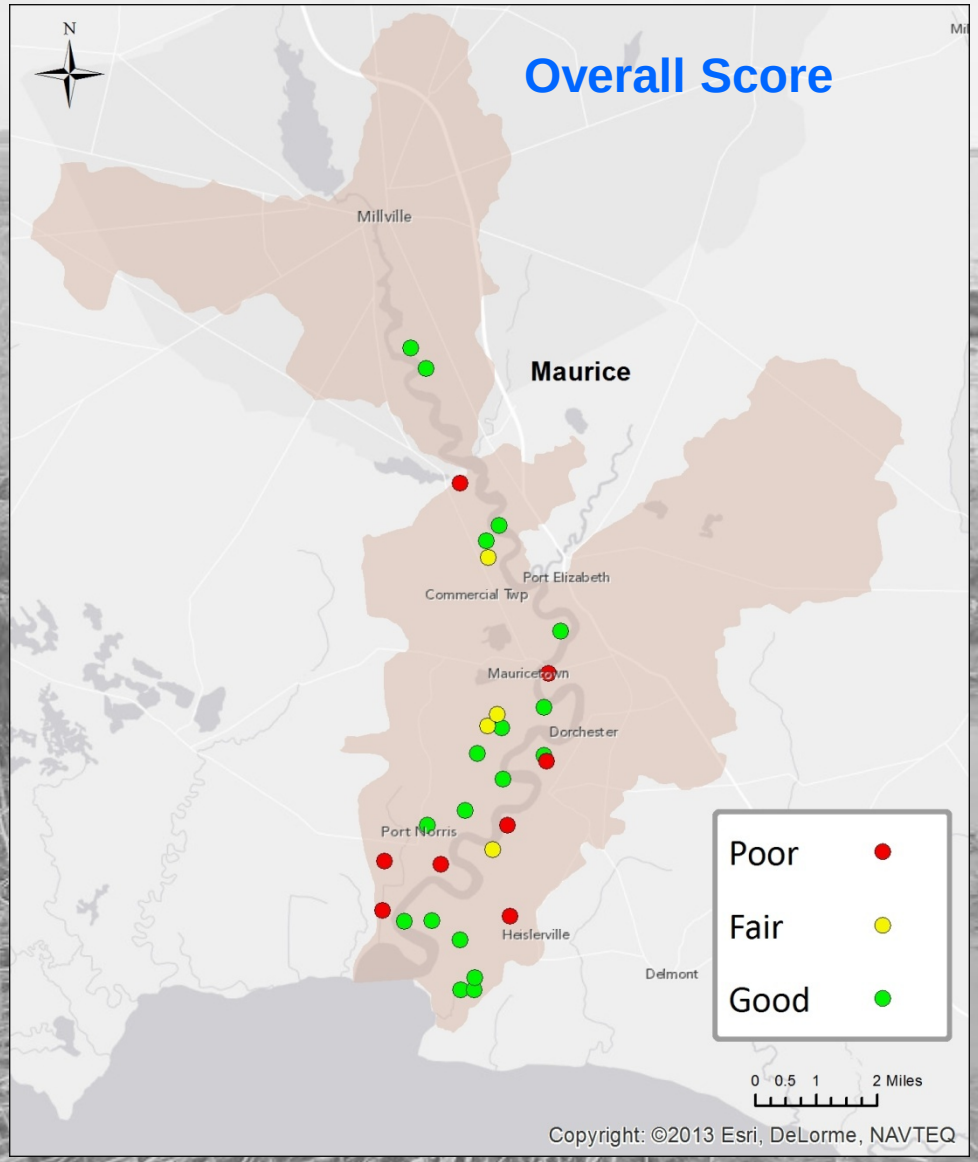
- **GIS in Office: Shoreline change from historic aerials**

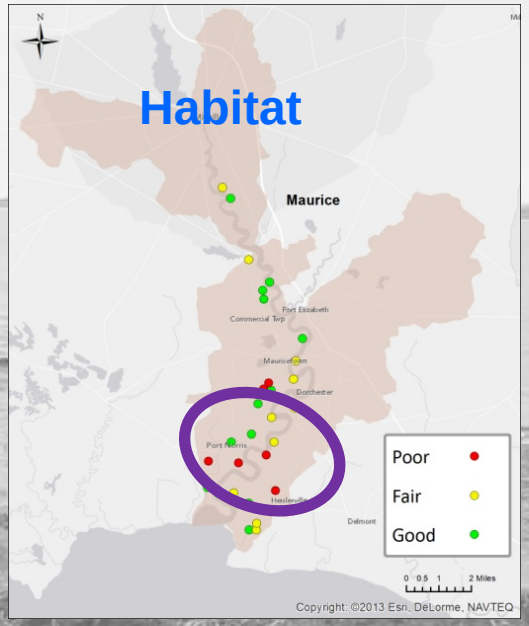


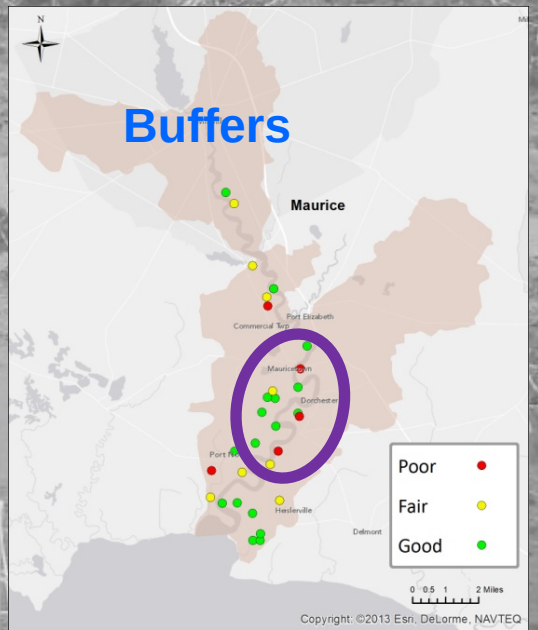
- **In field: Integrity of edge biota**

Next Steps

- Cluster Analysis
- MidTRAM Version 4?







Conclusions

- Rapid assessment data are useful for studying both watershed-specific conditions (e.g. report cards) *and* estuary-wide relationships
- The Delaware Estuary contains diverse wetland types along the salinity gradient; data analysis should examine stressor-response relationships in the context of natural gradients
- Canopy robustness, migration blockages, and shoreline erosion were the most responsive rapid assessment metrics, explaining more variability in condition than other metrics
- Ditching, filling, hydrological alteration, migration blockages, invasives and shoreline erosion were the most common stressors
- MidTRAM could be revised to strengthen the most informative metrics and streamline the rest
- These results point to broadly problematic wetland stressors as well as local impairments, thereby helping managers prioritize both general and site-specific actions to conserve/enhance the most coastal marshes

For More Info: *http://www.delawareestuary.org/Wetlands*

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Wetlands

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What is a Wetland?

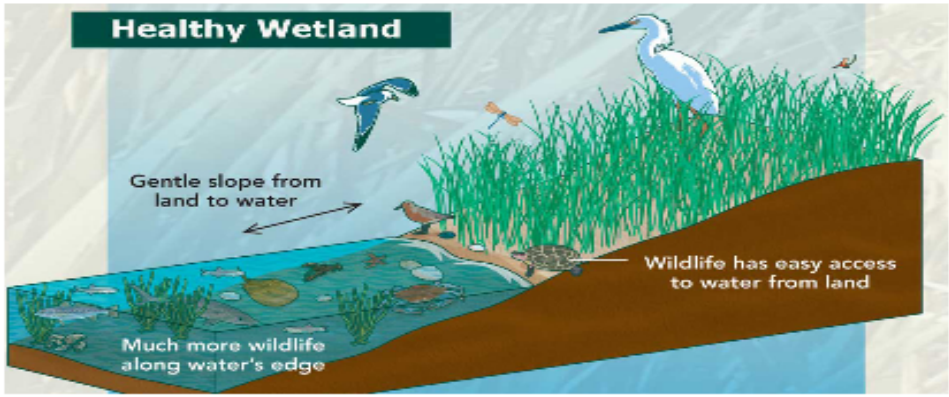
Wetlands are important natural areas that are found all over the world, except in Antarctica. Wetlands help to provide food and homes to fish, amphibians, shellfish, insects, birds, and other animals. They also clean our water and provide flood protection for our communities. These lands have soils that are often saturated with water permanently or part of the year. Most importantly they have plants and animals that can withstand this flooding. Wetlands are important transition areas between the water and higher land.

Delaware Estuary's Tidal Wetlands

Wetlands are called many things—marshes, bogs, swamps, etc. The Delaware Estuary is unique in that it has an almost continuous ring of fringing wetlands from the southern sides of the bay in Cape May and Cape Henlopen up to Trenton, NJ. This large geographic area is home to many types of tidally-influenced wetlands, saltwater wetlands, freshwater wetlands, and those in-between. Our tidal wetlands naturally capture lots of mud! These habitats are critical in our area to protect against flooding, help clean water, and sustain native fish, birds and crustaceans as well as migrating species. Our tidal wetlands also serve as natural buffers for climate change because they trap carbon.

Wetland Losses Are Important

Wetlands are threatened by a whole host of human and environmental influences. As our cities and towns grow, new roads, schools, and housing developments are often built on or near wetlands, sometimes disturbing the flow of water into and out of the wetlands. At the same time, rising sea levels and storms are submerging and eroding many wetlands, leading to a loss of acres and a decrease in the health of wetlands. Unhealthy wetlands provide fewer benefits than healthy wetlands. For example, wetlands in poor health filter fewer pollutants, capture less carbon and provide less protection from the next storm.



Why is Monitoring Important?

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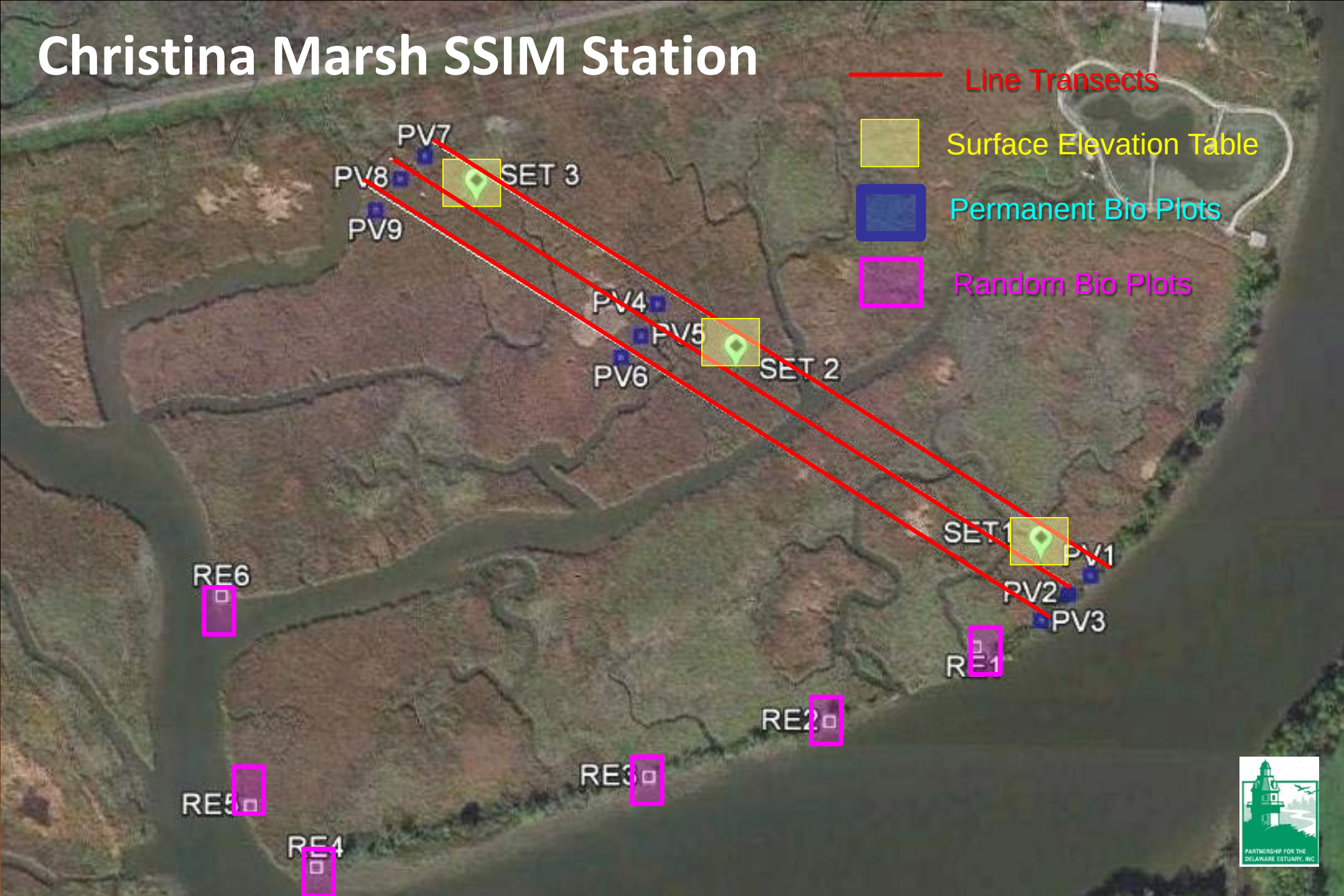

Why Monitor Wetlands?

- Coastal wetlands are a hallmark feature of the Delaware and Barnegat Estuaries
- They provide diverse benefits that sustain lives and livelihoods
- They are vulnerable to combined watershed and climate stressors, especially post-Sandy
- Monitoring of wetland status and trends will assist in managing and sustaining them
- Regional coordination strengthens scientific outcomes, improves management and leverages more diverse funding

Martha Maxwell Doyle