

# Multimetric Indices for Integrated Assessment of Salt Marsh Integrity

Hilary Neckles, Glenn Guntenspergen, Jessica Nagel, James Lyons:  
*USGS Patuxent Wildlife Research Center*

Susan Adamowicz, Toni Mikula:  
*USFWS Rachel Carson National Wildlife Refuge*

Erika Rocks, Dennis Skidds, Sara Stevens:  
*NPS Northeast Coastal and Barrier Network*

Donald Schoolmaster Jr., James Grace:  
*USGS National Wetlands Research Center*

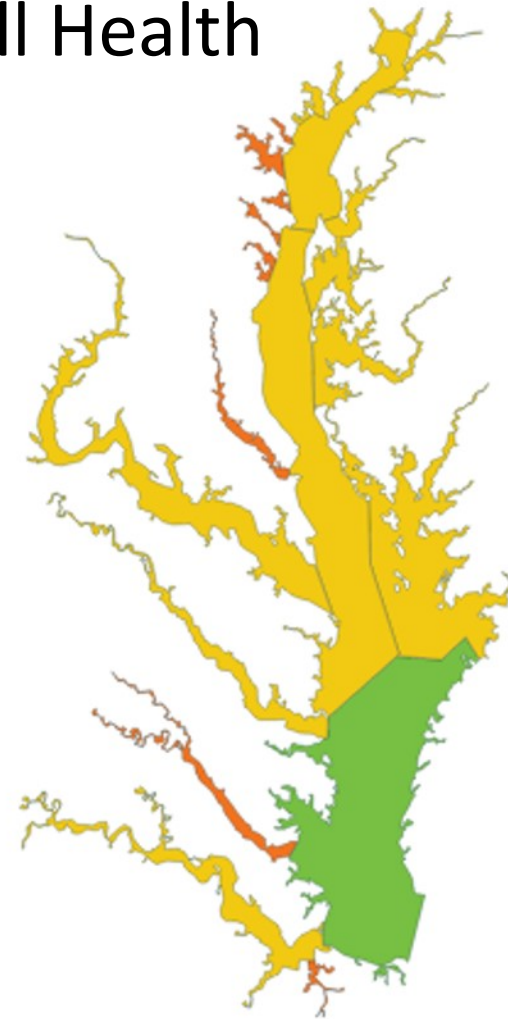
Gregory Shriver, Whitney Wiest:  
*University of Delaware*

# Chesapeake Bay Report Card

## Individual Metrics:

- DO
- N
- P
- Chl a
- Water clarity
- SAV
- Benthos
- Blue crabs
- Anchovies
- Striped bass

## MMI of Overall Health





# US Dept. of the Interior Salt Marsh Holdings

Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors



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# Law Defines Management Goals

Public law directs the US Fish and Wildlife Service to maintain and, where appropriate, ***restore the biological integrity, diversity, and environmental health*** of land held by the National Wildlife Refuge System

# Restoration and Enhancement



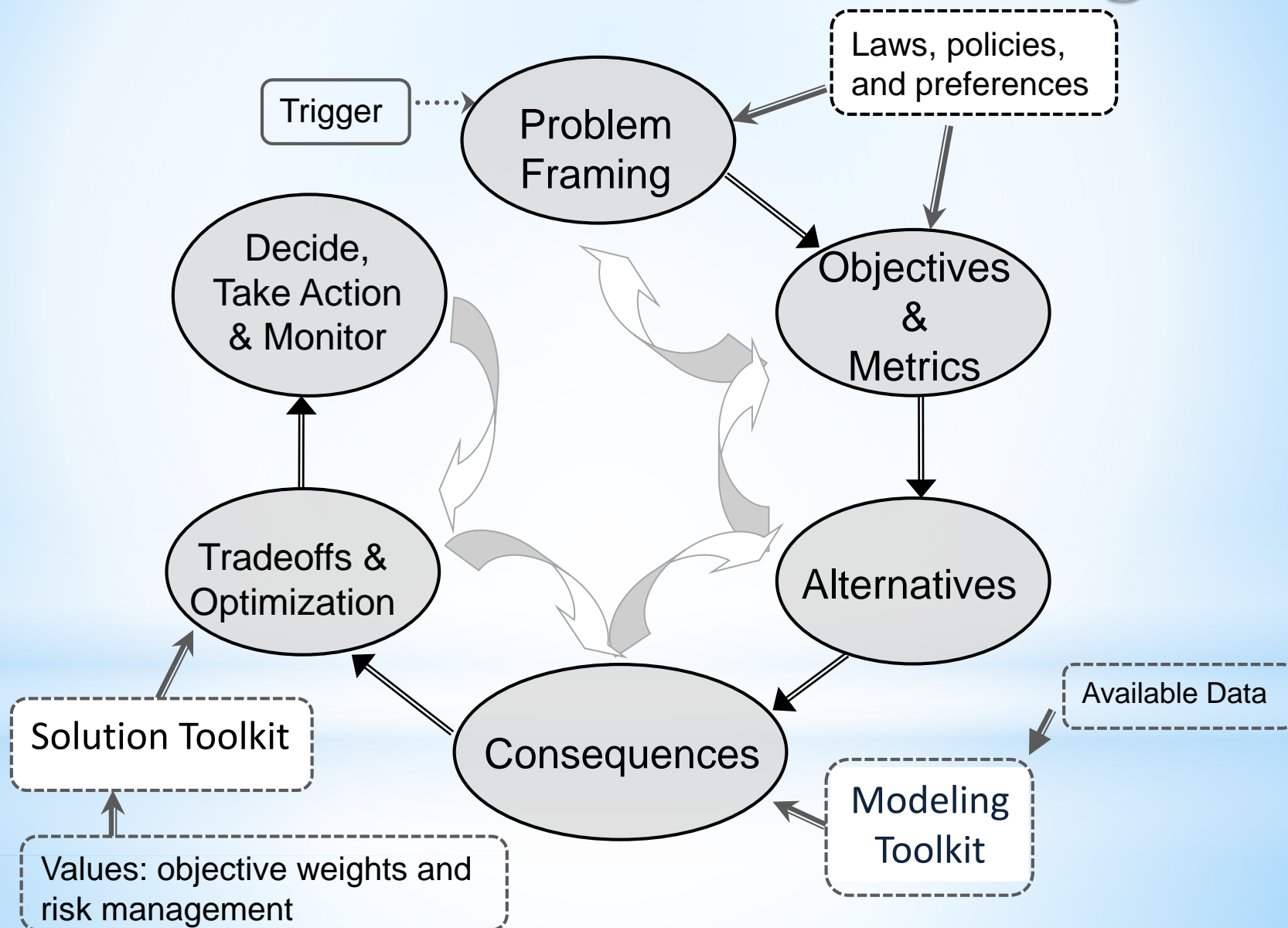
Before



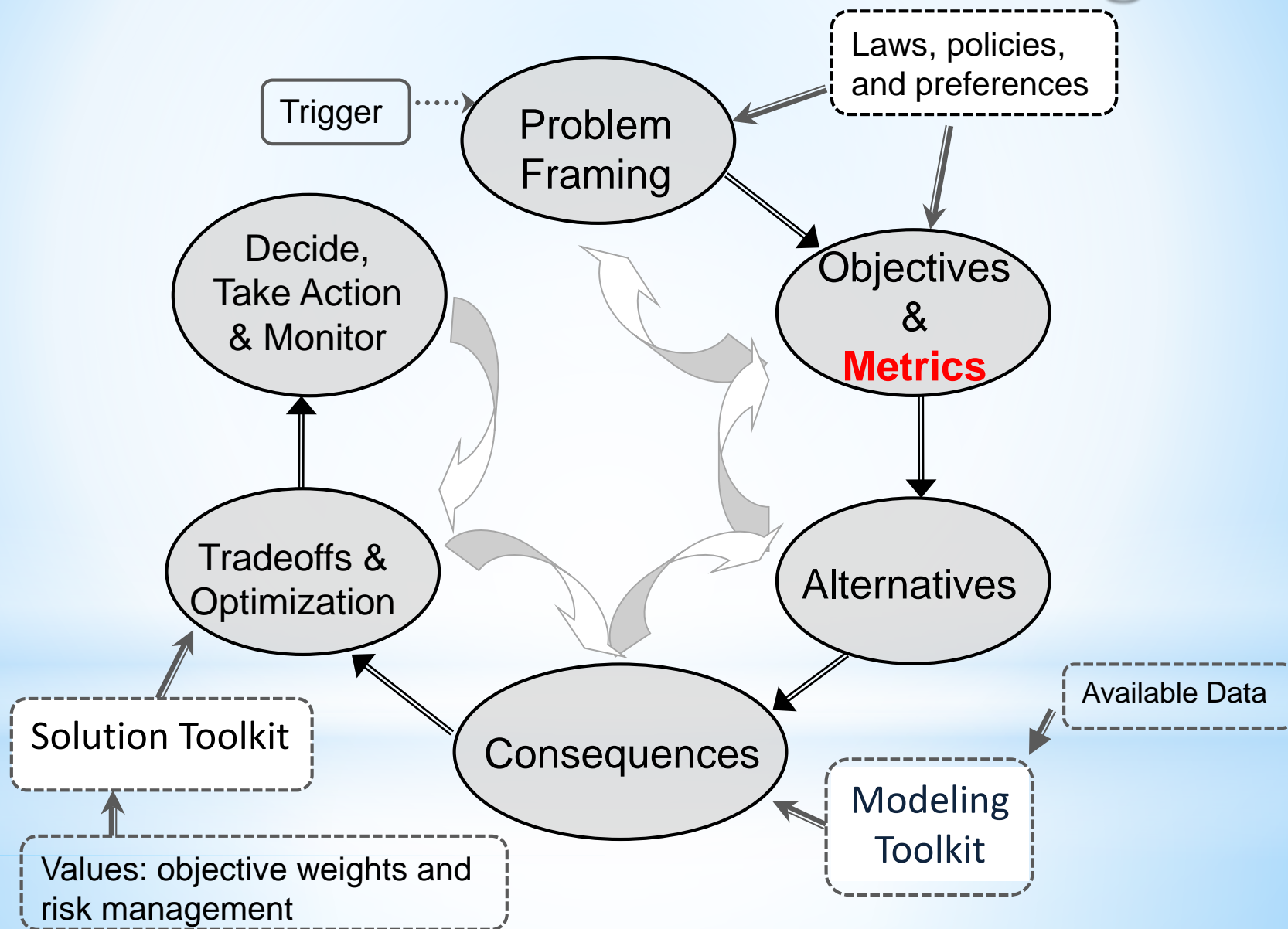
After

Taylor, P.H. 2008. GOM Council

# Structured Decision Making

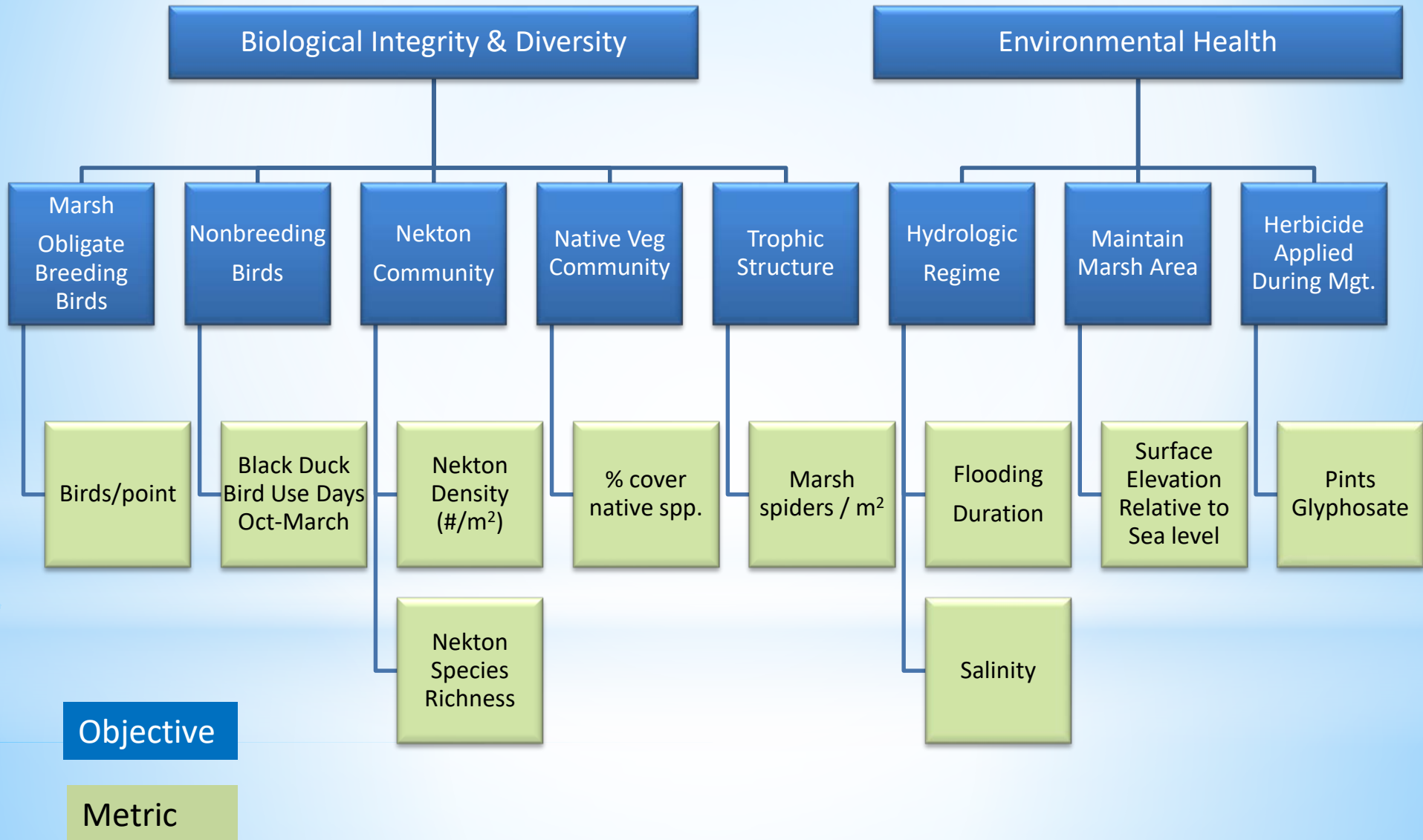


# Structured Decision Making





# Marsh Integrity Objectives Hierarchy

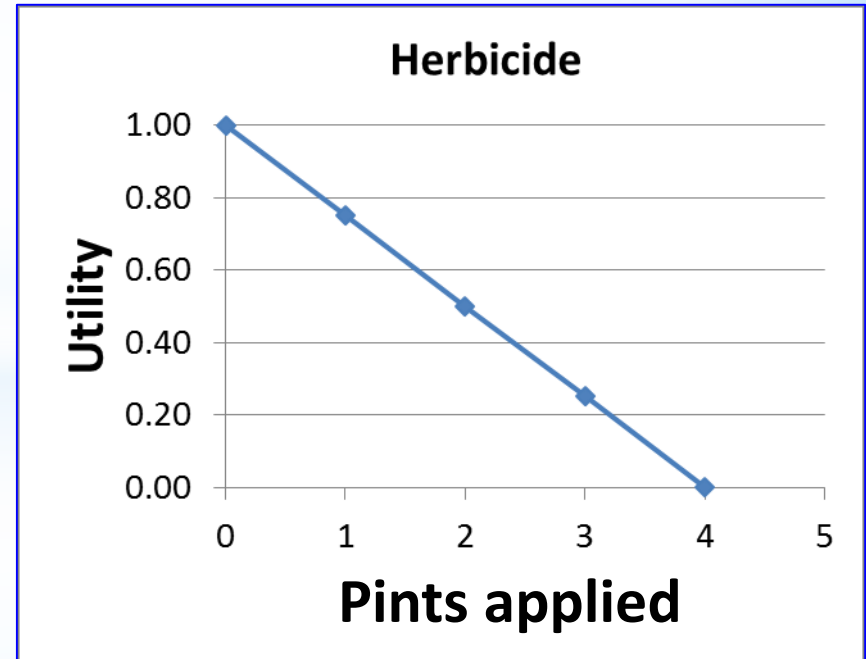
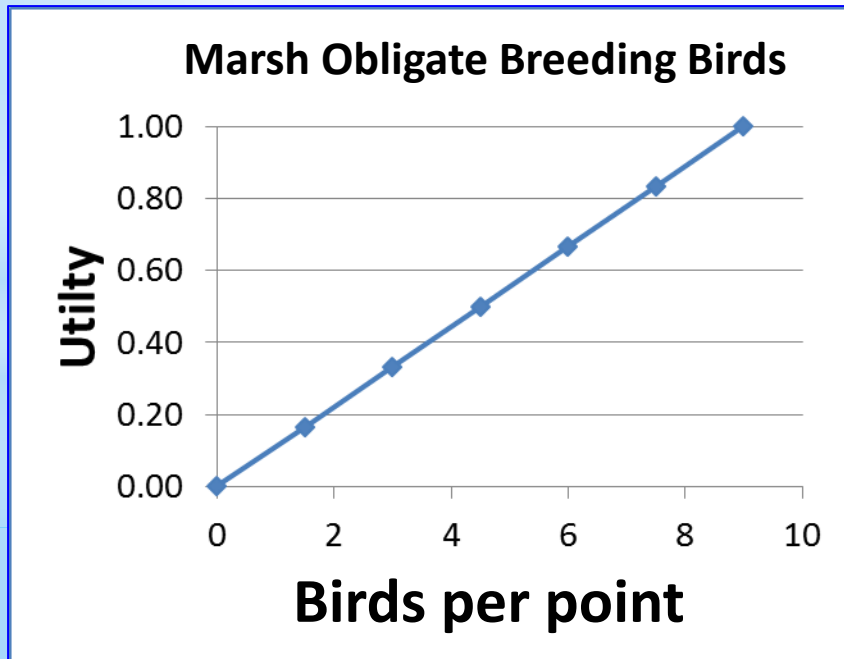


# Multi-attribute Utility Theory

**Metric data**



**Utilities**

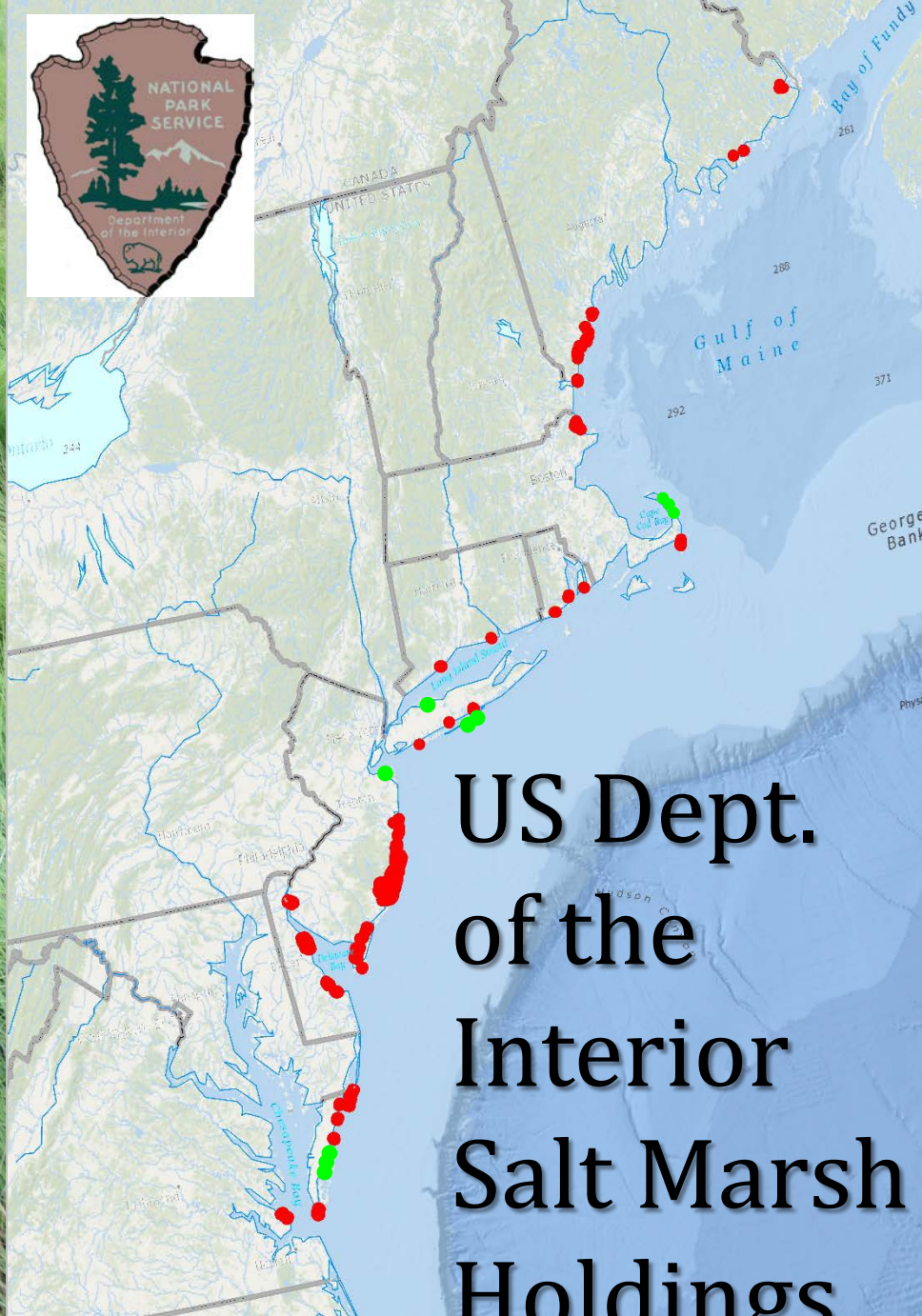


# National Wildlife Refuge MMI of Management Benefit

	Metrics					
	1. Marsh Obligate Breeding Birds	2. Non- breeding Birds	...	9. Native veg. % cover	10. Herbicide Applied	
<b>Raw data</b>	7.6	3	...	97	0	
<b>Utilities</b>	0.084	0.100	...	0.119	0.060	

# National Wildlife Refuge MMI of Management Benefit

	Metrics					
	1. Marsh Obligate Breeding Birds	2. Non- breeding Birds	...	9. Native veg. % cover	10. Herbicide Applied	Total Manage- ment Benefit
<b>Raw data</b>	7.6	3	...	97	0	
<b>Utilities</b>	0.084	0.100	...	0.119	0.060	<b>0.852</b>



# US Dept. of the Interior Salt Marsh Holdings

Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

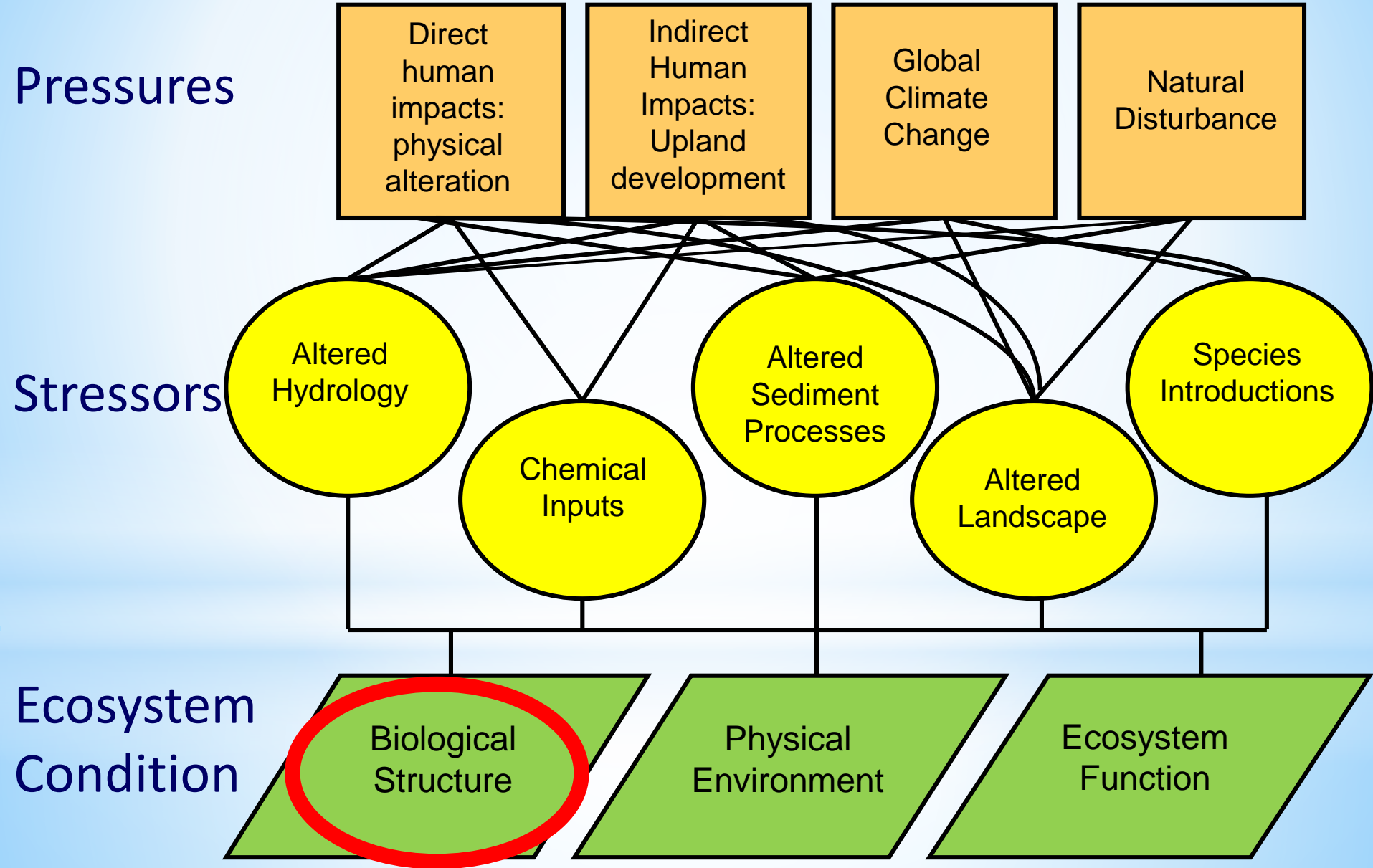


# National Park Service Mission Defines Management Goals

Mission: Preserve natural resources ***unimpaired*** for the enjoyment of future generations

Management: Ensure park resources are passed on in a condition that is as good as, or better than, ***current condition***

# Salt Marsh Ecosystems



# National Park Service MMI Construction

- Generate Human Disturbance Index
- Derive candidate condition metrics
- Generate MMI from optimal metric set
- Apply MMI to evaluate trends

*Nagel et al., 2018, Estuaries and Coasts 41:334-348.*



# Candidate Condition Metrics

A photograph of a coastal marsh landscape. In the foreground, there is a small pond with a wooden frame floating in it. The marsh is covered in green grasses. In the background, there are some buildings and a clear blue sky.

## 28 vegetation metrics, e.g.

- Percent cover *S. patens*
- Frequency of *P. australis*
- Percent cover High marsh species
- Proportion of species that are native

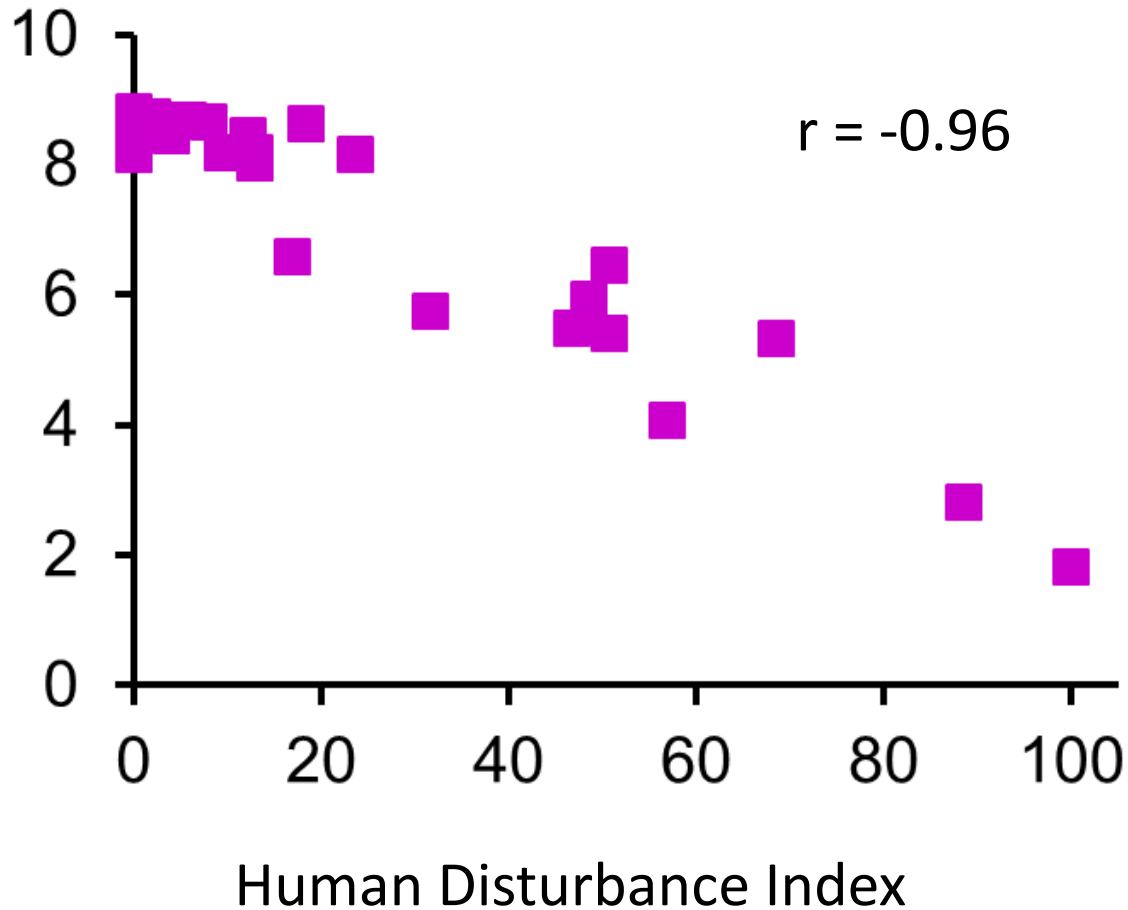
## 18 nekton metrics, e.g.

- Relative abundance of *Fundulus* sp.
- Density of decapods
- Proportion of fish species that are resident

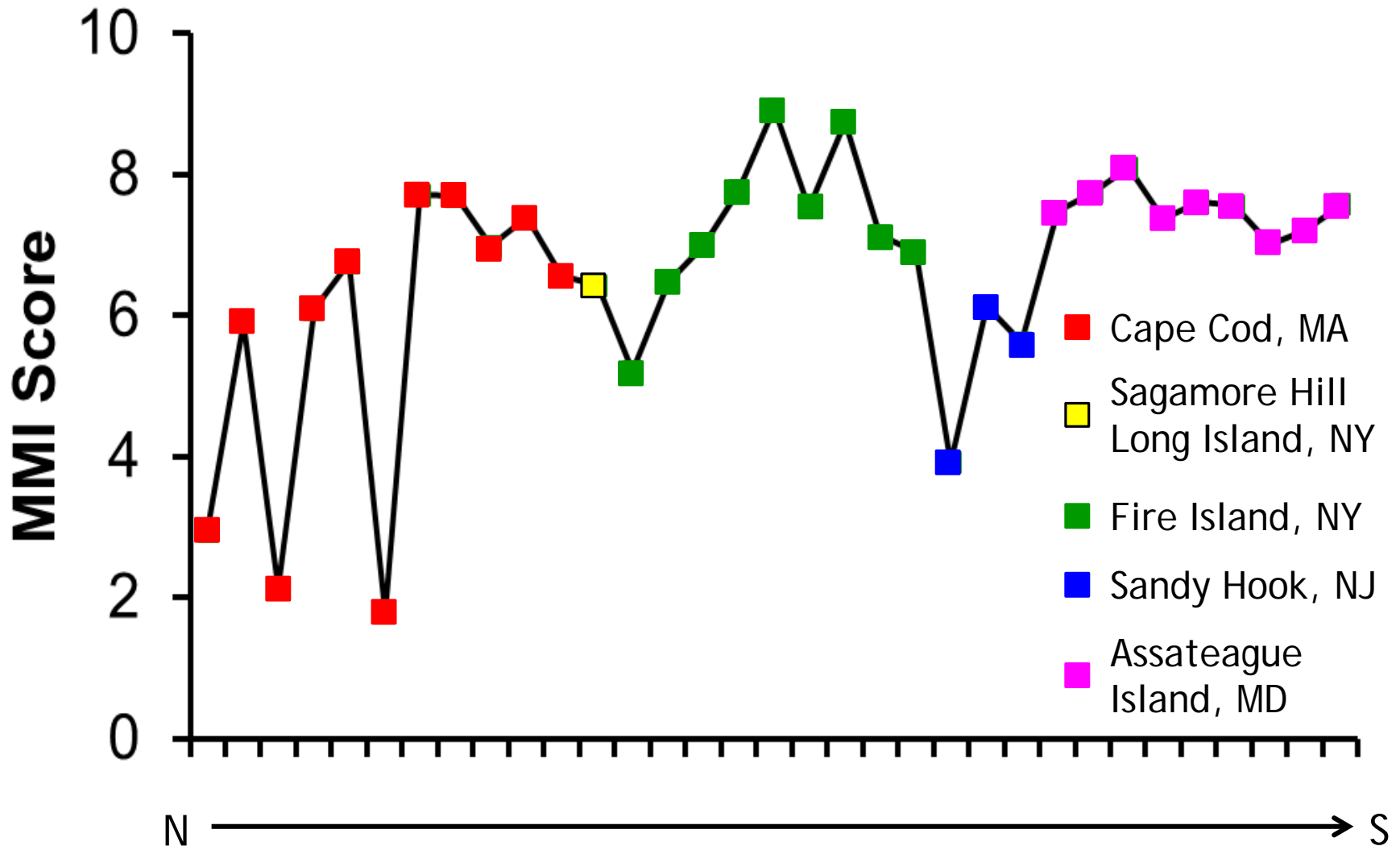
# MMI of Condition

Metrics included	Correlation with HDI
Percent cover of native vegetation	-0.44
Percent cover of brackish border vegetation	0.64
Relative abundance resident shrimp	0.49
Relative abundance of resident fish	-0.79

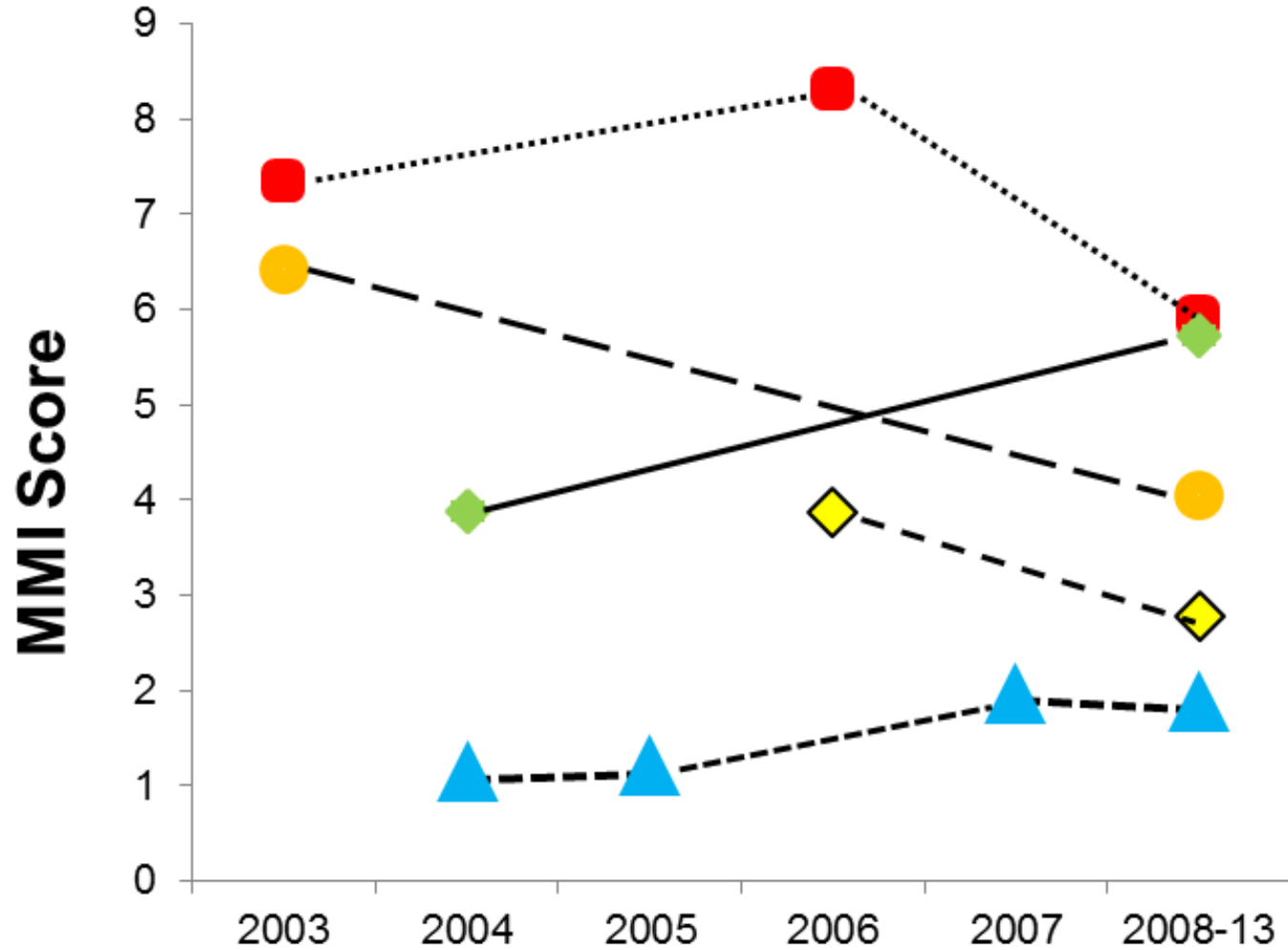
# MMI Scores vs HDI



# Salt Marsh Condition



# Salt Marsh Condition



# Multimetric Indices for Salt Marsh Management

- Efficient way to incorporate assessment data into conservation practice
- Utility enhanced by
  - Transparency in construction
  - Explicit linkage to management goals
  - Sensitivity to change

# *Thank you!*

*Thanks to many FWS and NPS professional staff, assistants, and summer employees for many grueling hours of salt marsh sampling!*