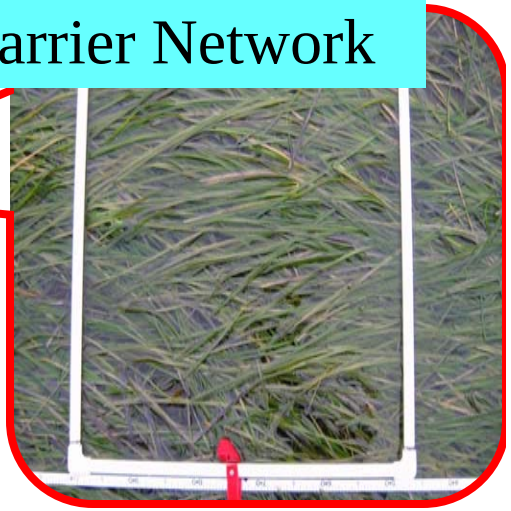
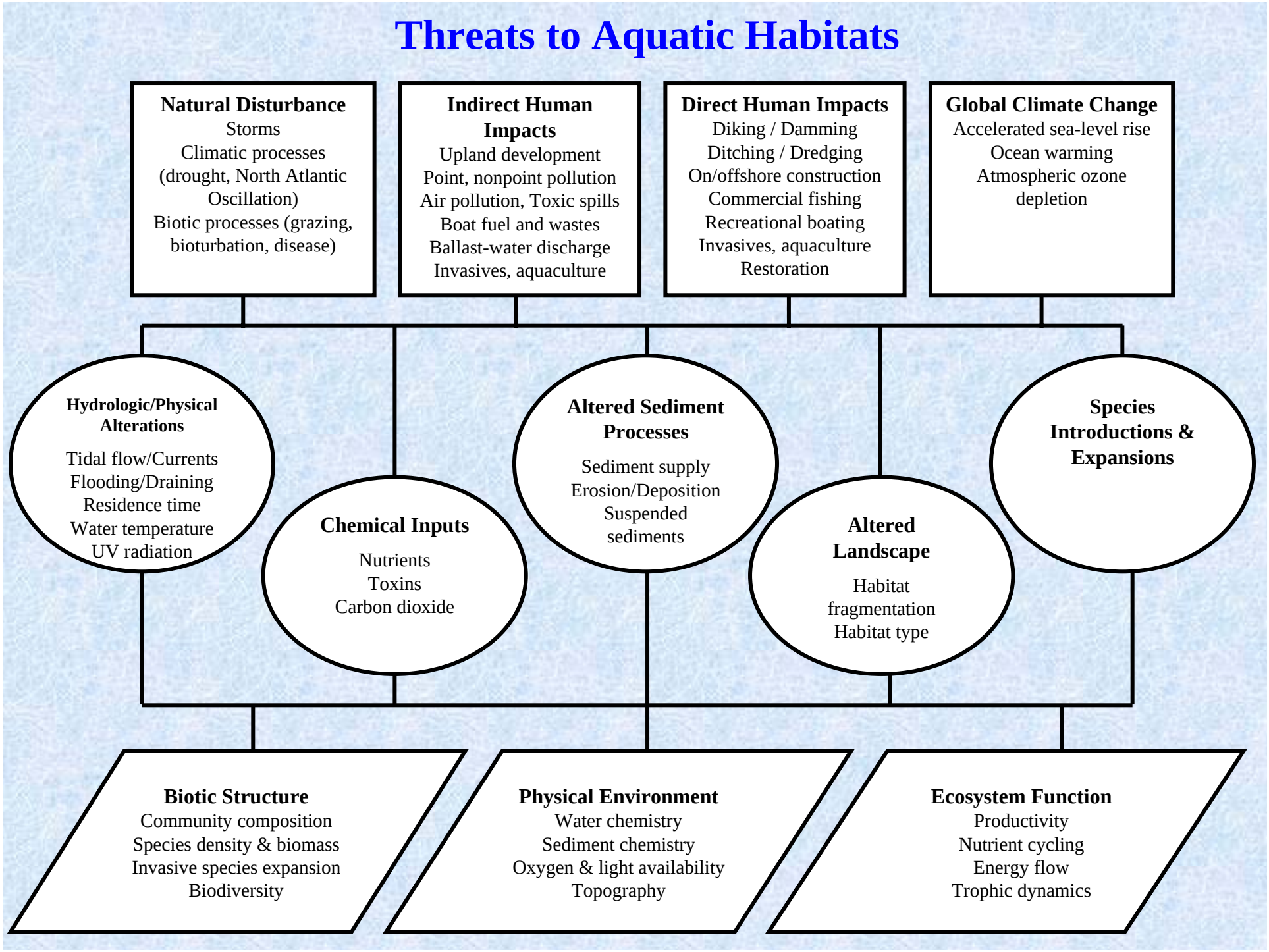
A Multi-scale Framework for Aquatic Habitat Indicators

GOMC Habitat Monitoring Subcommittee
Hilary Neckles, USGS Patuxent Wildlife Research Center
Blaine Kopp, USGS Patuxent Wildlife Research Center
National Park Service Northeast Coastal and Barrier Network

Photo: John Sowles, Maine DMR



Threats to Aquatic Habitats



Management Questions:

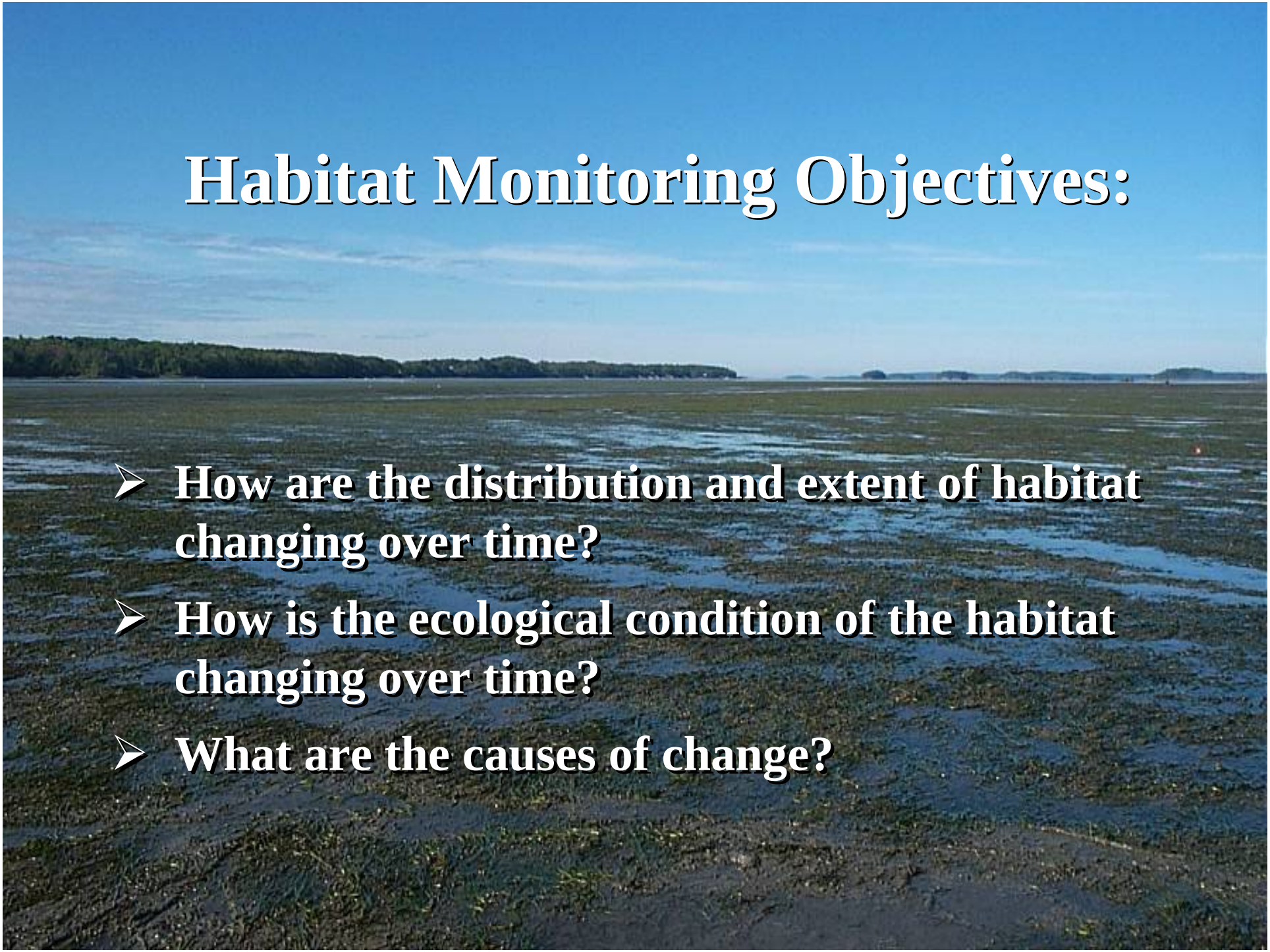
- ***Is the habitat getting better or worse?***
- ***Why?***
- ***What can we do about it?***

Habitat Monitoring Goals

Document status, detect threats, and evaluate trends

Understand causes and consequences of ecosystem change

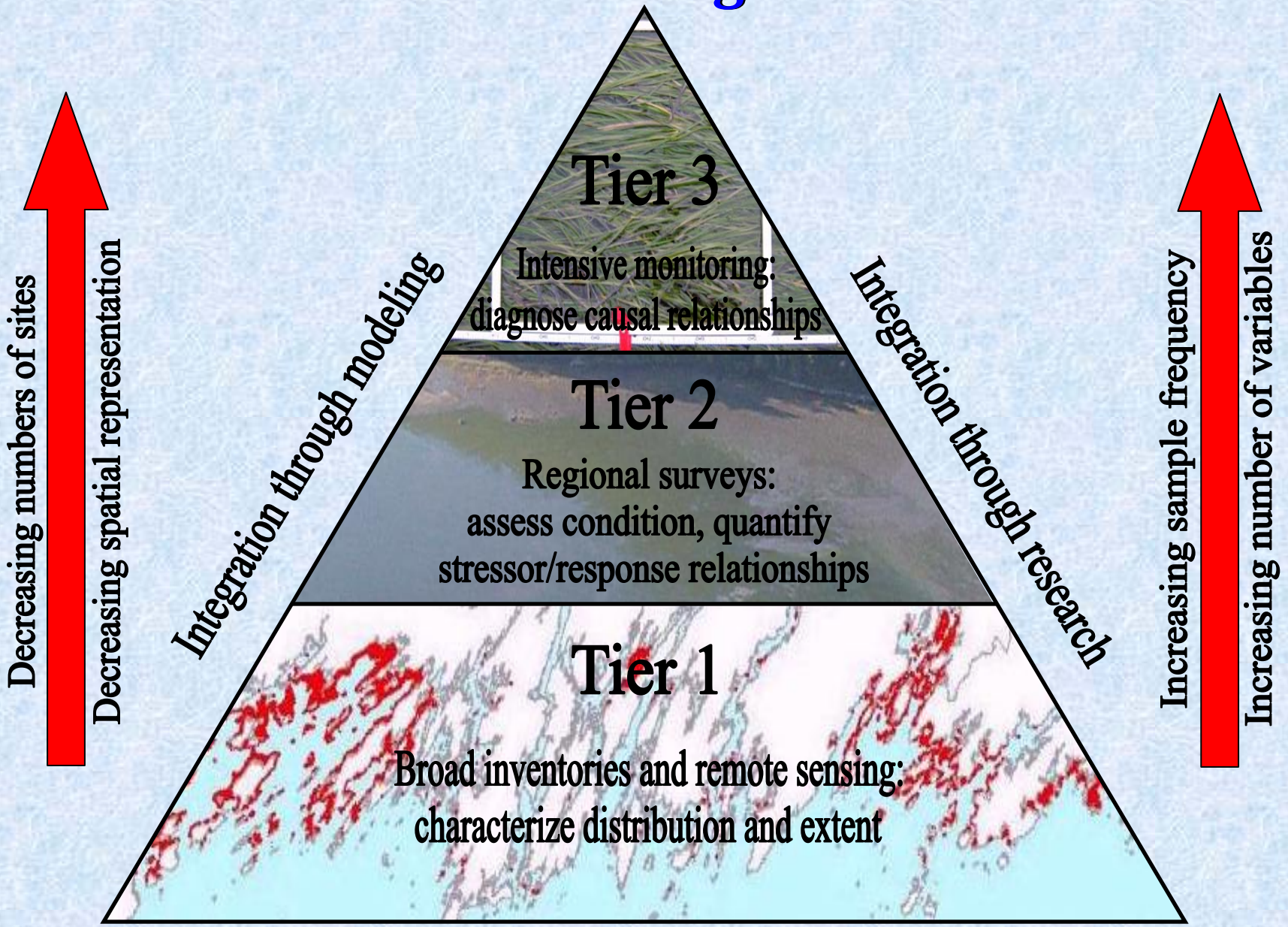
Evaluate management options and outcomes



Habitat Monitoring Objectives:

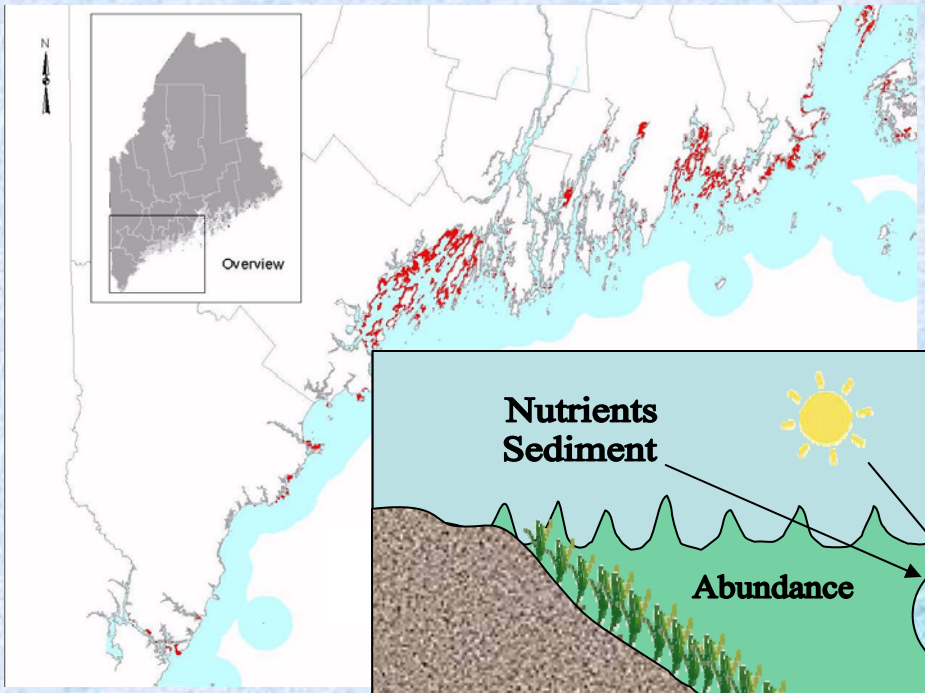
- How are the distribution and extent of habitat changing over time?
- How is the ecological condition of the habitat changing over time?
- What are the causes of change?

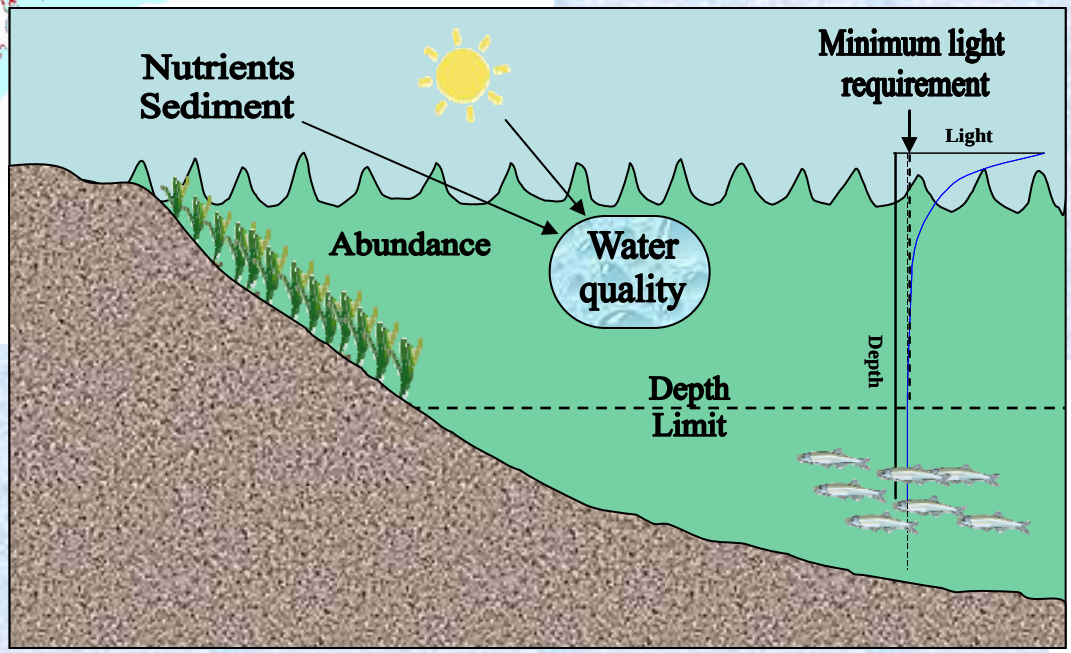
Habitat Monitoring Framework



National Science and Technology Council. 1997. Integrating the nation's environmental monitoring and research networks and programs: A proposed framework. Washington, DC.

Integration of Indicators Across Scales





Kilometers ← SPACE → Centimeters
Decades ← TIME → Days
Ecosystem ← COMPLEXITY → Molecules

Thayer et al. 1984

What to Monitor: Indicator Selection

1. **How are the distribution and extent of habitat changing over time?**
2. **How is the ecological condition of the habitat changing over time?**
3. **What are the causes of change?**

Characteristics of Effective Indicators

Relevant to management concerns

- Address monitoring questions
- Related to critical resource
- Integrative in space and time

Responsive to stressors

- Known error
- Low variability
- Sensitive to stressor of interest

Applicable for monitoring program

- Easy and practical to measure
- Non-destructive or low impact
- Standard methods exist
- Cost-effective
- Generate compatible data

Interpretable and useful

- Predictable response to stress
- Anticipatory: “canary in coal mine”
- Linked to management actions
- Known thresholds of response
- Easily communicated to public

Dale, V.H. and S.C. Beyeler. 2001. Ecological Indicators 1:3-10.
Jackson, L.E., J.C. Kurtz, and W.W. Fisher, eds. 2000. EPA/620/R-99/005.
Kurtz, J. C., L. E. Jackson, and W. S. Fisher. 2001. Ecological Indicators 1:49-60

Eelgrass Indicators

1. How are the distribution and extent habitat changing over time?

Indicator	Measure	Scale of Implementation		
		Tier 1	Tier 2	Tier 3
Meadow size and distribution	Area of beds of different density classes	**X**		
	Mapped location of beds	**X**		
Extent of habitat in protected status	Proportion protected	**X**		
	Mapped location of protected beds	X		

Eelgrass Indicators, cont.

2. How is the ecological condition of the habitat changing over time?

Indicator	Measure	Scale of Implementation		
		Tier 1	Tier 2	Tier 3
Plant community structure	Percent cover		X	
	Canopy height		X	
	Density, Biomass			X
Trophic structure	Index within target taxonomic groups		X	
	Density within target taxonomic groups			X
Invasive spp.	Presence of target spp.		X	
	Quadrat measurements of target spp.			X
Habitat boundary	Location, depth of deep edge of bed			X

Eelgrass Indicators, cont.

3. What are the causes of habitat change**?**

Indicator	Measure	Scale of Implementation		
		Tier 1	Tier 2	Tier 3
Indirect Human Impacts				
Adjacent land use	Land-use Index	**X**	**X**	
Light transmission	Light attenuation coefficient			**X**
Habitat edge	Depth of deep edge of bed			**X**
Plant nutrient assimilation	Eelgrass Nutrient Pollution Indicator			**X**
Macro-, microalgae	Presence, cover class		**X**	
	Biomass			**X**

Eelgrass Indicators, cont.

3. What are the causes of habitat change**?**

Indicator	Measure	Scale of Implementation		
		Tier 1	Tier 2	Tier 3
Direct Human Impacts				
Physical Alterations	Dredged and dragged area	**X**	**X**	
	Number, location of coastal and marine structures	**X**	**X**	
Natural Disturbance				
Wasting disease	Eelgrass Wasting Index		**X**	**X**
Global Climate Change				
Phenology	Timing of flowering, seed production			**X**
Habitat boundary	Location of deep edge of bed			**X**

Salt Marsh Indicators

3. What are the causes of habitat change**?**

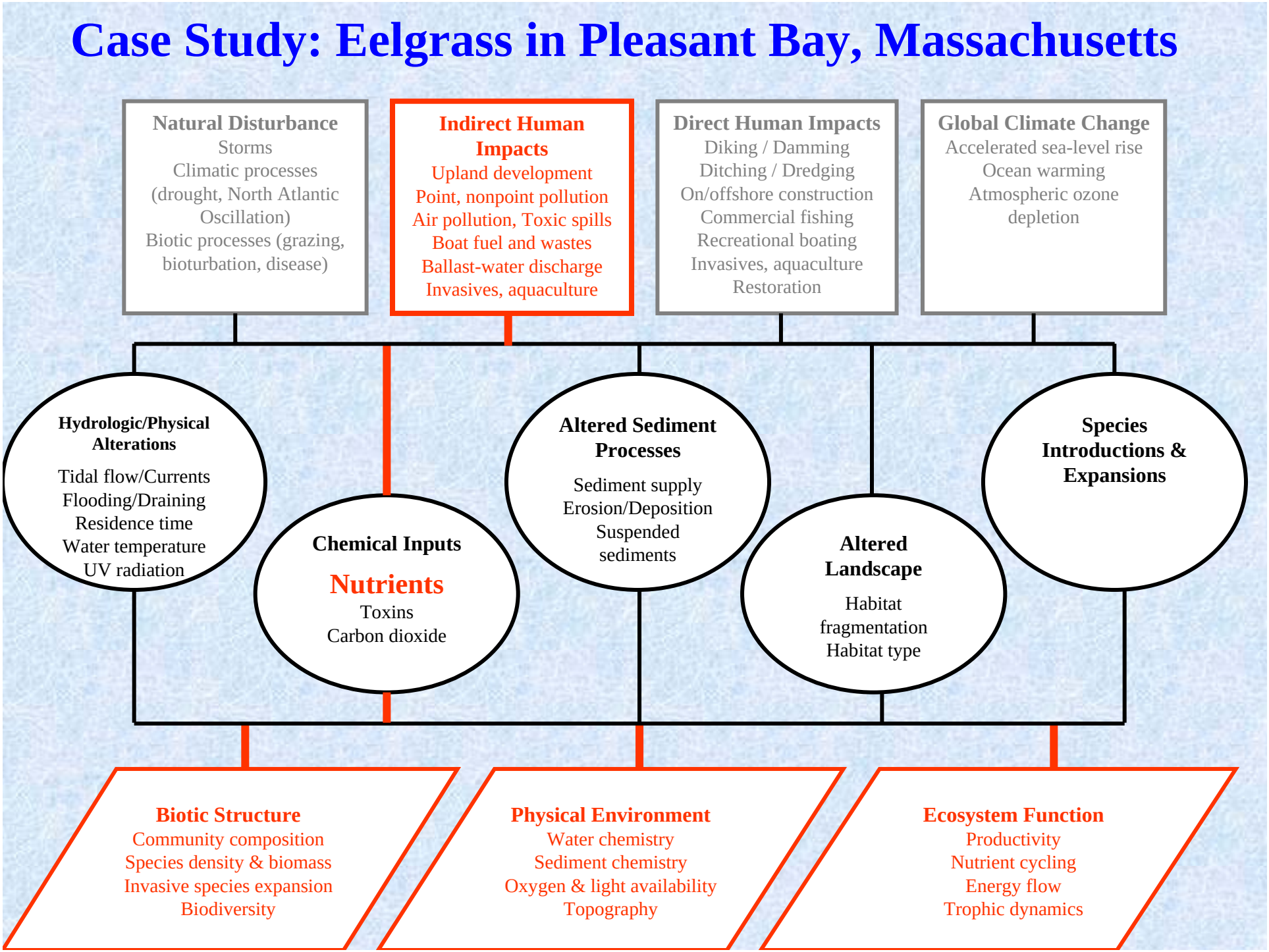
Indicator	Measure	Scale of Implementation		
		Tier 1	Tier 2	Tier 3
Indirect Human Impacts				
Adjacent land use	Land-use Index	**X**	**X**	
Direct Human Impacts				
Physical Alterations	Area of restricted marsh	**X**		
	Width of creek above & below restriction		X	
	Tidal regime above & below restriction			X
	Amount of hardened shoreline and structures	X	**X**	
Sediment elevation	Marsh surface elevation measured with SET			**X**

Salt Marsh Indicators, cont.

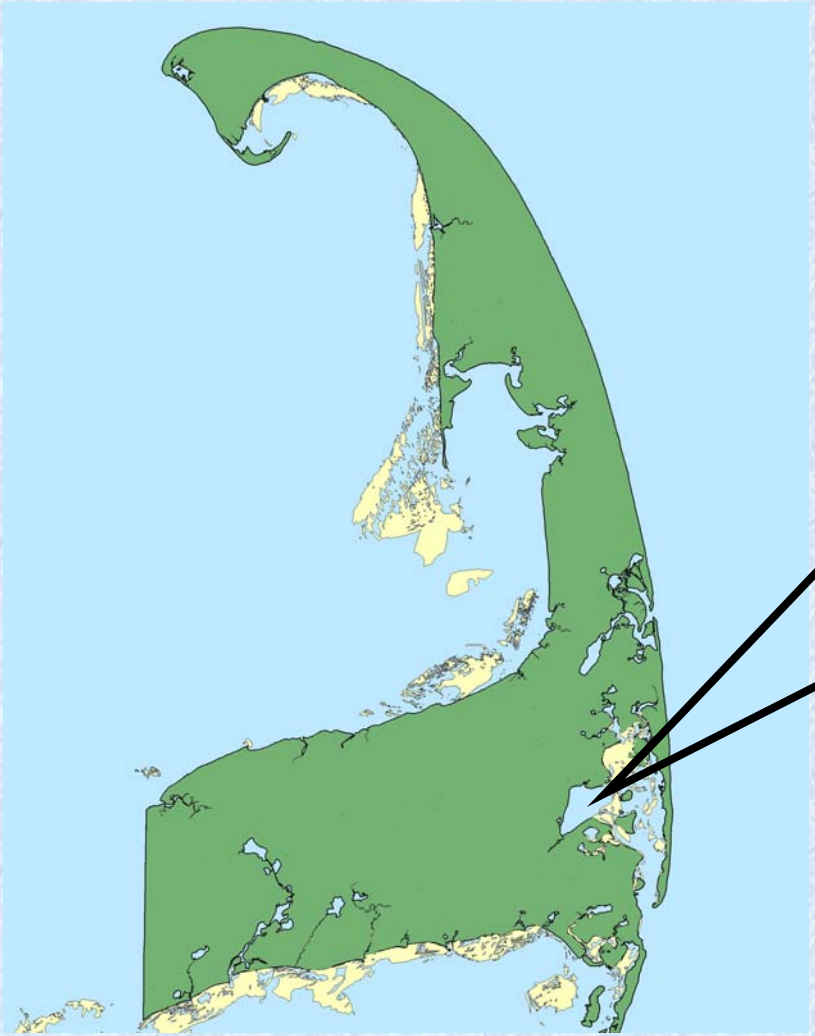
3. What are the causes of habitat change**?**

Indicator	Measure	Scale of Implementation		
		Tier 1	Tier 2	Tier 3
Global Climate Change				
Habitat boundaries	Location, relative elevation of high marsh and low marsh zones		X	
Sediment elevation	Marsh surface elevation measured with SET			**X**
Phenology	Timing of flowering			**X**
	Emergence of first leaves			**X**

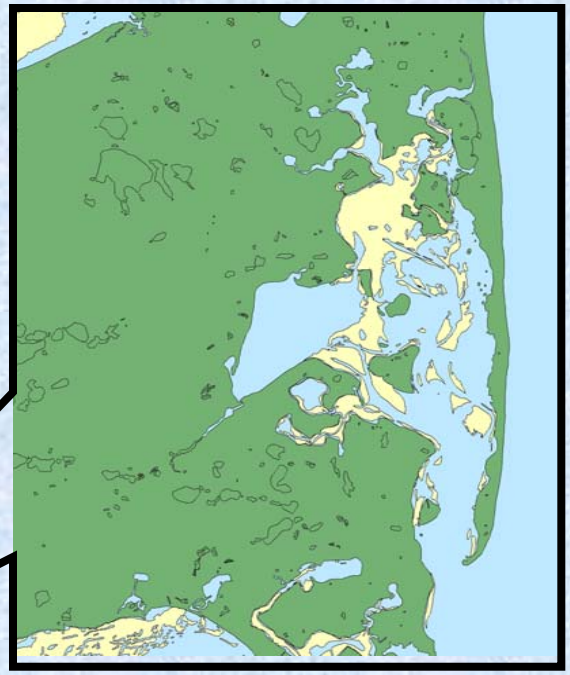
Case Study: Eelgrass in Pleasant Bay, Massachusetts



Tier 1 – Eelgrass Mapping



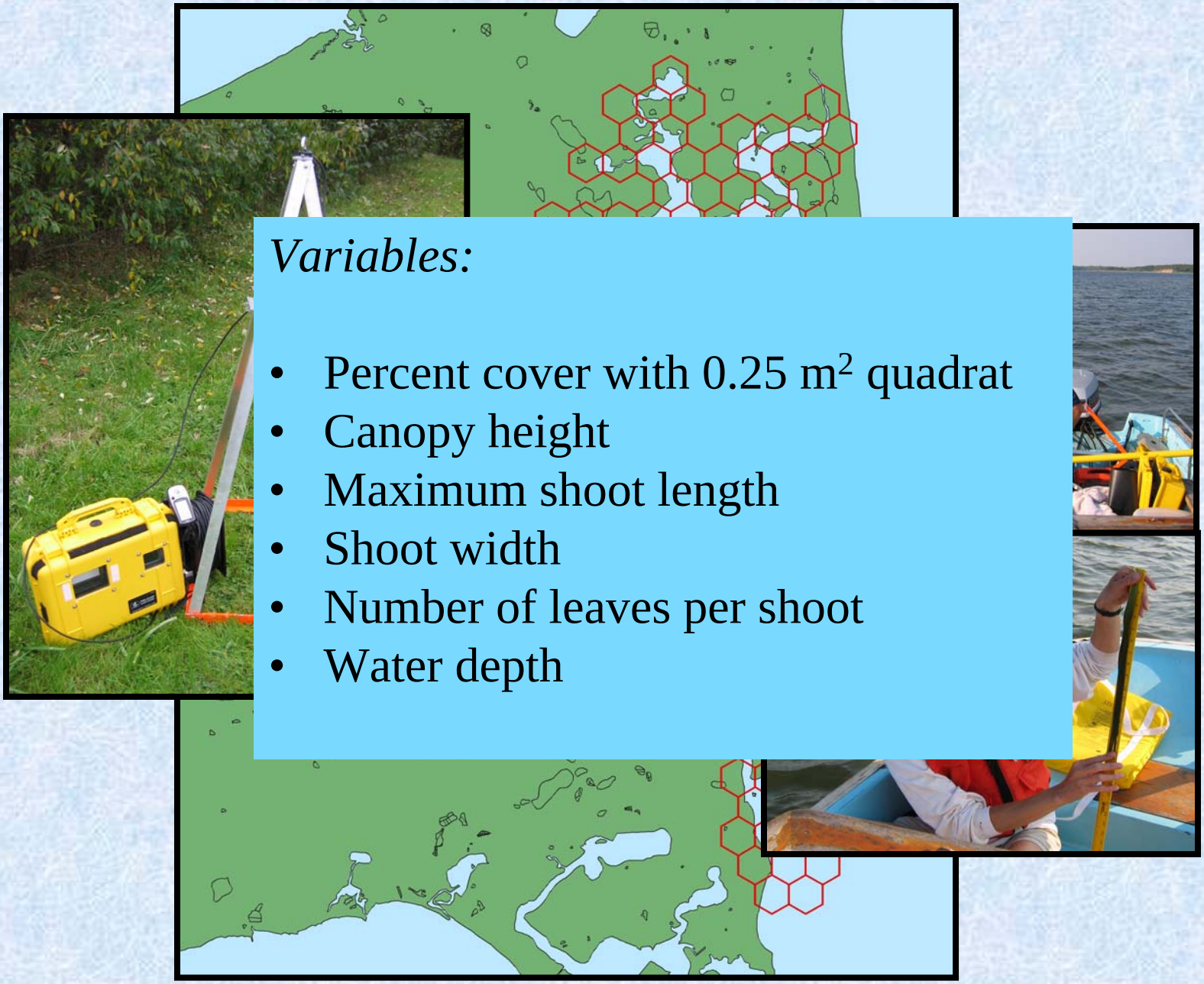
Cape Cod seagrass beds



Eelgrass in Pleasant Bay in 2001

Mapping data from MA DEP

Tier 2: Bay-wide Rapid Assessment



Variables:

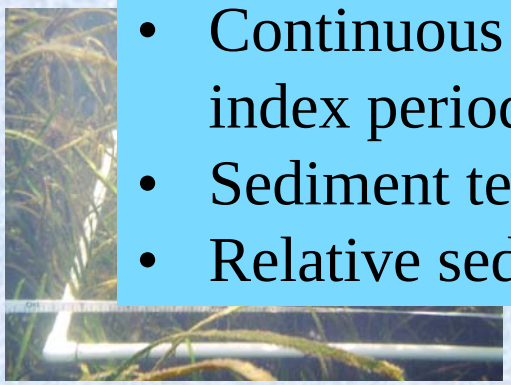
- Percent cover with 0.25 m^2 quadrat
- Canopy height
- Maximum shoot length
- Shoot width
- Number of leaves per shoot
- Water depth

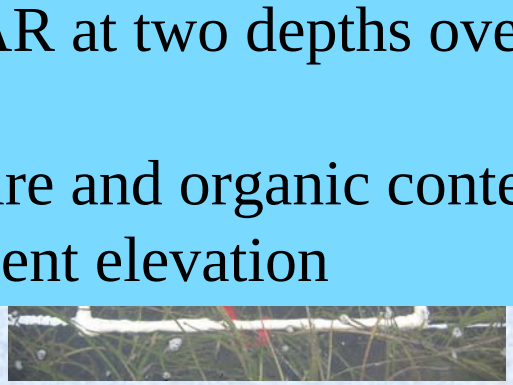
Tier 3: Intensive Monitoring in Permanent Quadrats (SeagrassNet Approach)

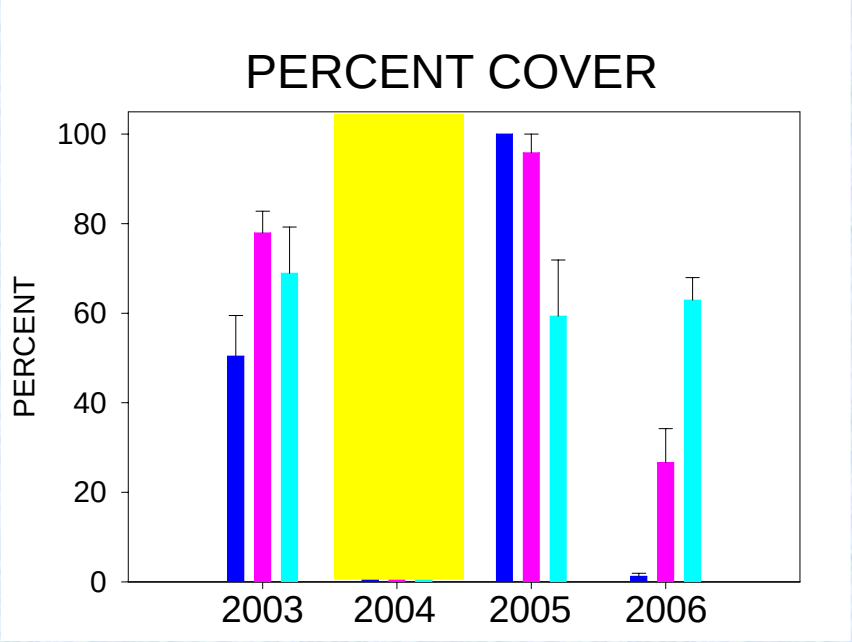
Variables:

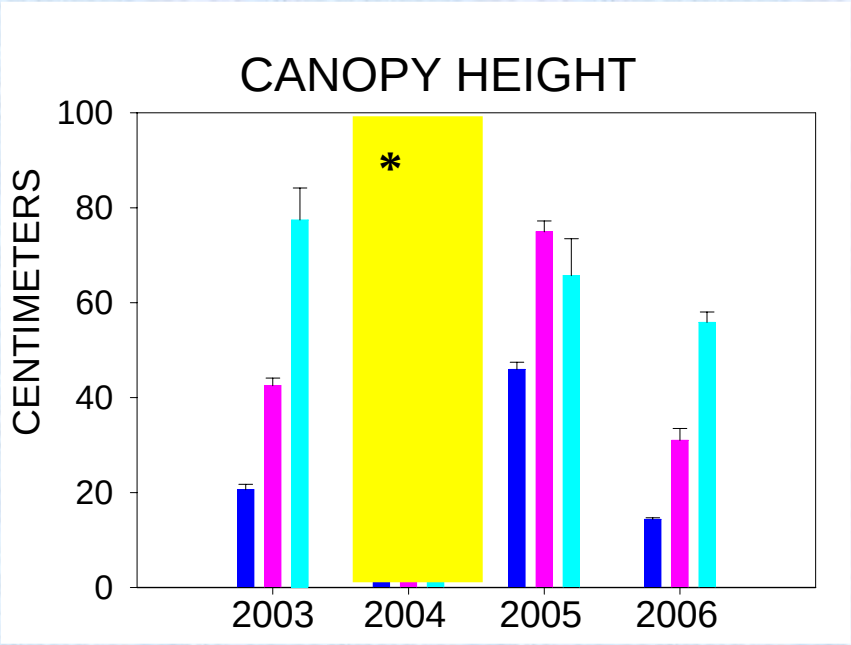
- Eelgrass percent cover
- Canopy height
- Shoot density
- Biomass partitioned by leaf, sheath, and root/rhizome fractions
- Wasting disease index
- Depth of deep edge of seagrass bed
- Epiphyte cover
- Continuous PAR at two depths over 4-week index period
- Sediment texture and organic content
- Relative sediment elevation

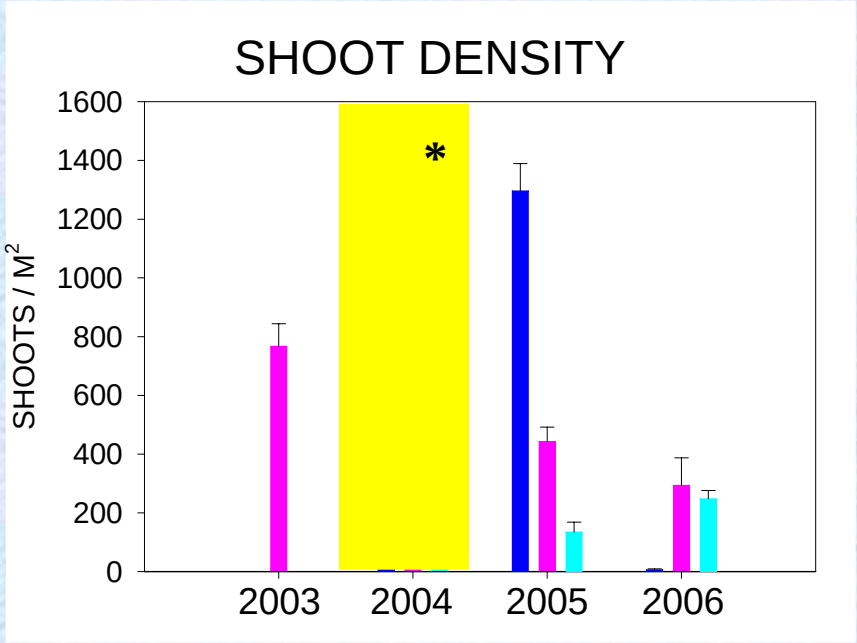
w transect

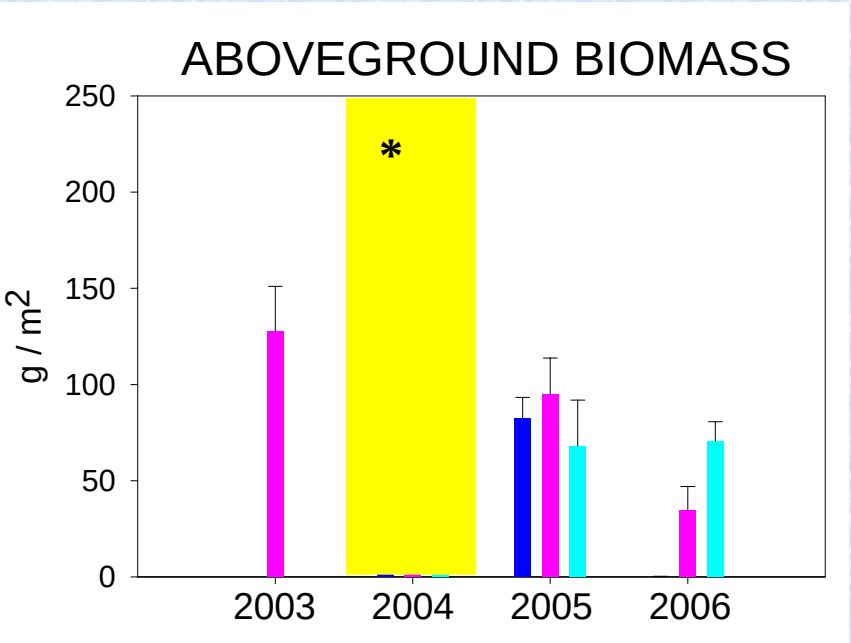






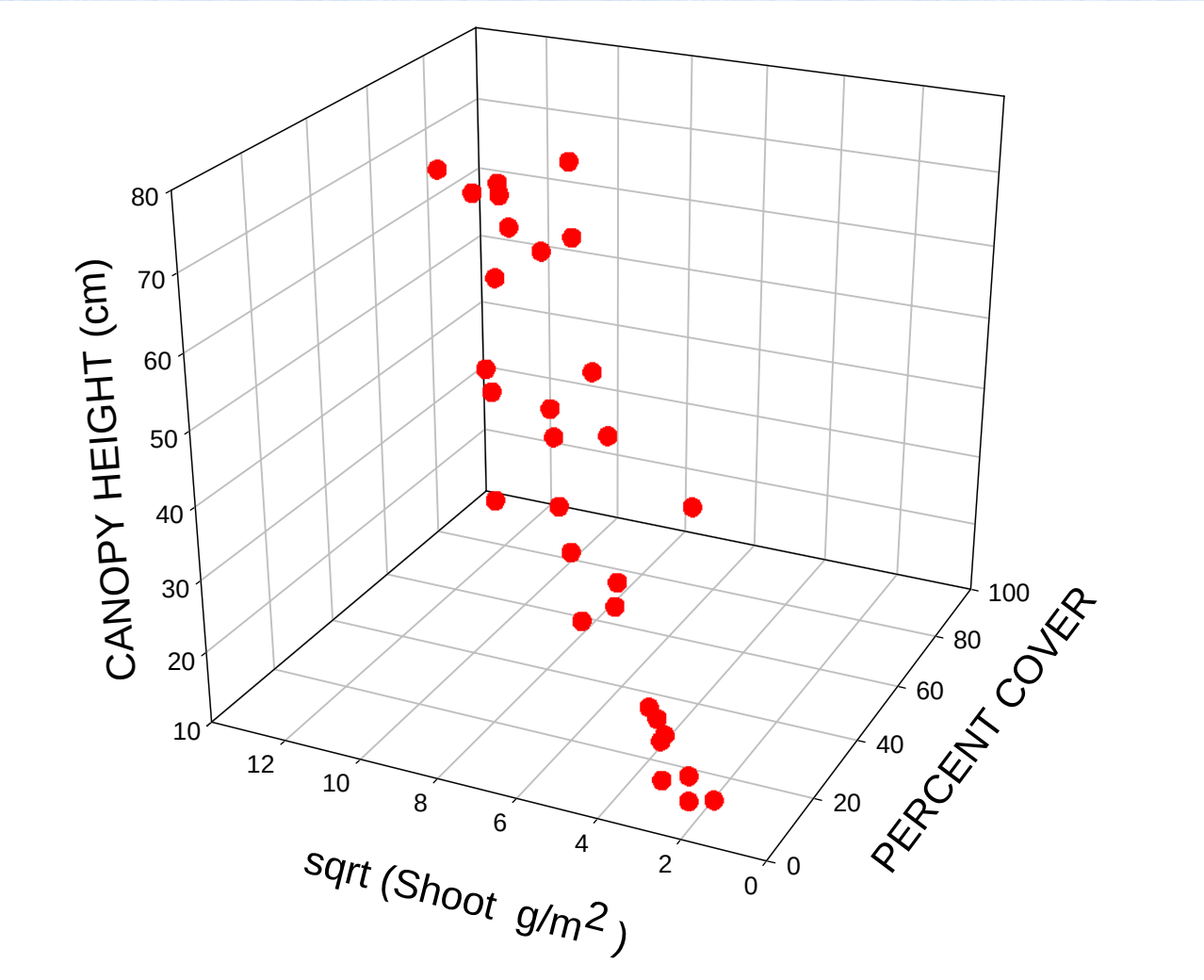






Shallow transect **Mid-depth transect** **Deep transect**

Eelgrass Biomass Prediction



Sqrt (g/m^2) = 1.26 + 0.055*Percent Cover + 0.097*Canopy Height

R^2 = .93, P<.001

Acknowledgements:

Members of the Gulf of Maine Council –
Habitat Monitoring Subcommittee
National Park Service Vital Signs Monitoring Program