Identification of Gulf of Mexico Ecosystem Indicators using an Ecological Resilience Framework

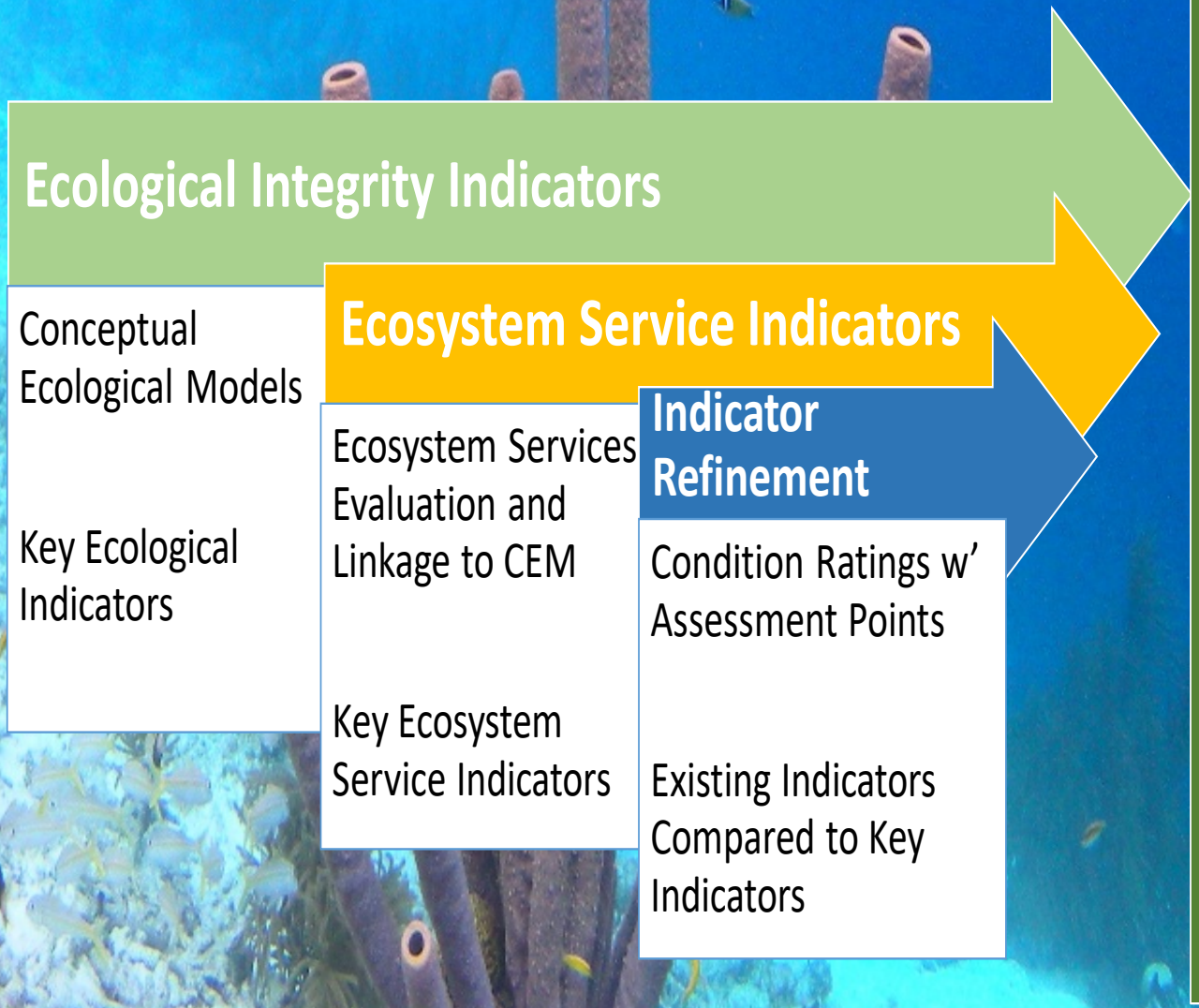
Kathy Goodin

Director, Marine Program

NatureServe
A Network Connecting Science With Conservation

GOMOSES 2017
New Orleans, LA

Ecological Resilience Framework



Recommended Indicators

IMPROVED:

- Management of sustainable Living Marine Resources
- Restoration planning and evaluation
- Damage assessment and recovery

Project Team

- Methodology
  - Don Faber-Langendoen, Kathy Goodin, NatureServe; Greg Steyer, USGS
- Indicator Inventory
  - Matt Love, Ocean Conservancy
- Mapping
  - Dave Reed, Katie Ames FWRI
- Ecosystem Services
  - Jorge Brenner, TNC
- NOAA Coordinators
  - Becky Allee, Frank Parker
- Salt Marshes
  - Camille Stagg, Chris Gabler Scott Allen, USGS
- Mangroves
  - Richard Day, Scott Allen, USGS
- Seagrasses
  - Ken Dunton, Victoria Congdon, U Texas, Austin
- Corals
  - Rob Ruzicka, Katy Cummings, Kate Lunz, FWRI
- Oysters
  - Chris Shepard, TNC

Project Objectives

- Develop conceptual ecological models and identify indicators of ecological integrity for the five major ecosystems
- Identify key ecosystem services provided by the ecosystems and identify indicators of their sustainability
- Experts evaluate the models and proposed indicators
- Catalog and map indicators/metrics currently collected
- Align selected indicators against current indicators to determine gaps
- Make recommendations for a comprehensive set of indicators

Applications

- Management of sustainable ecosystems and living marine resources
- Damage assessment and recovery planning
- Restoration planning and evaluation
- Ecosystem health assessments
- Vulnerability assessment

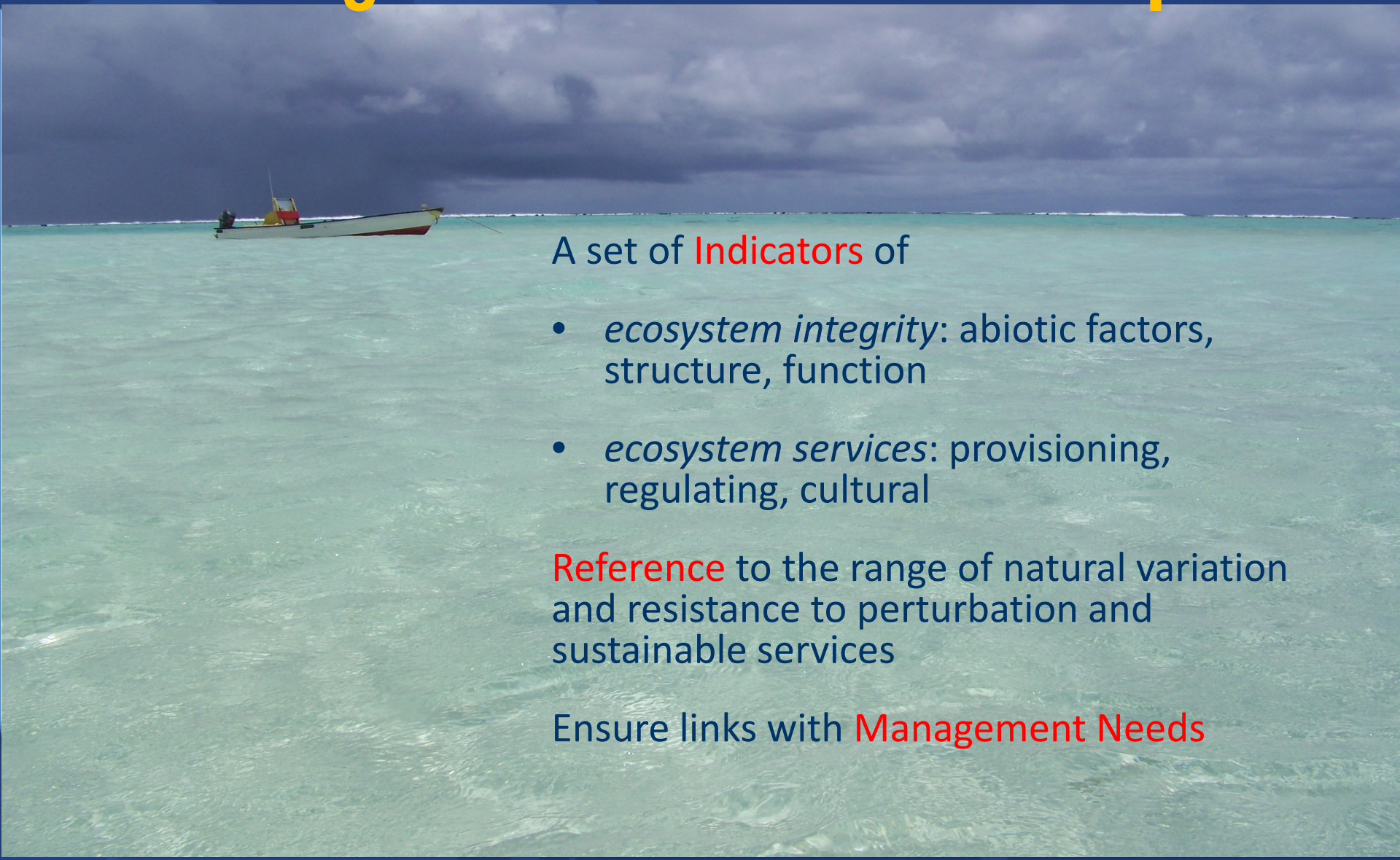
Ecosystems

- Salt marshes
- Mangroves
- Seagrasses
- Oysters
- Corals

Resilience, Restoration, and Management

- A successfully managed or restored ecosystem is one that is *resilient*:
  - Able to recover from natural and anthropogenic disturbances.
  - Contains key characteristics of historic, native ecosystems (ecological adaptive capacity).
  - Contains key characteristics reflective of desired ecosystem services (human adaptive capacity)

Implementing Ecological Resilience Concepts



A set of Indicators of

- *ecosystem integrity*: abiotic factors, structure, function
- *ecosystem services*: provisioning, regulating, cultural

Reference to the range of natural variation and resistance to perturbation and sustainable services

Ensure links with Management Needs

Environmental Drivers

CLIMATE DRIVERS

HYDROGEO-MORPHOLOGICAL DRIVERS

ANTHROPOGENIC DRIVERS

Major Ecological Factors

ABIOTIC FACTORS:
Key Ecological Attributes
Indicators

ECOSYSTEM STRUCTURE:
Key Ecological Attributes
Indicators

ECOSYSTEM FUNCTION:
Key Ecological Attributes
Indicators

Major Ecosystem Services

Supporting
Key Services
Indicators

Provisioning
Key Services
Indicators

Regulating
Key Services
Indicators

Cultural
Key Services
Indicators

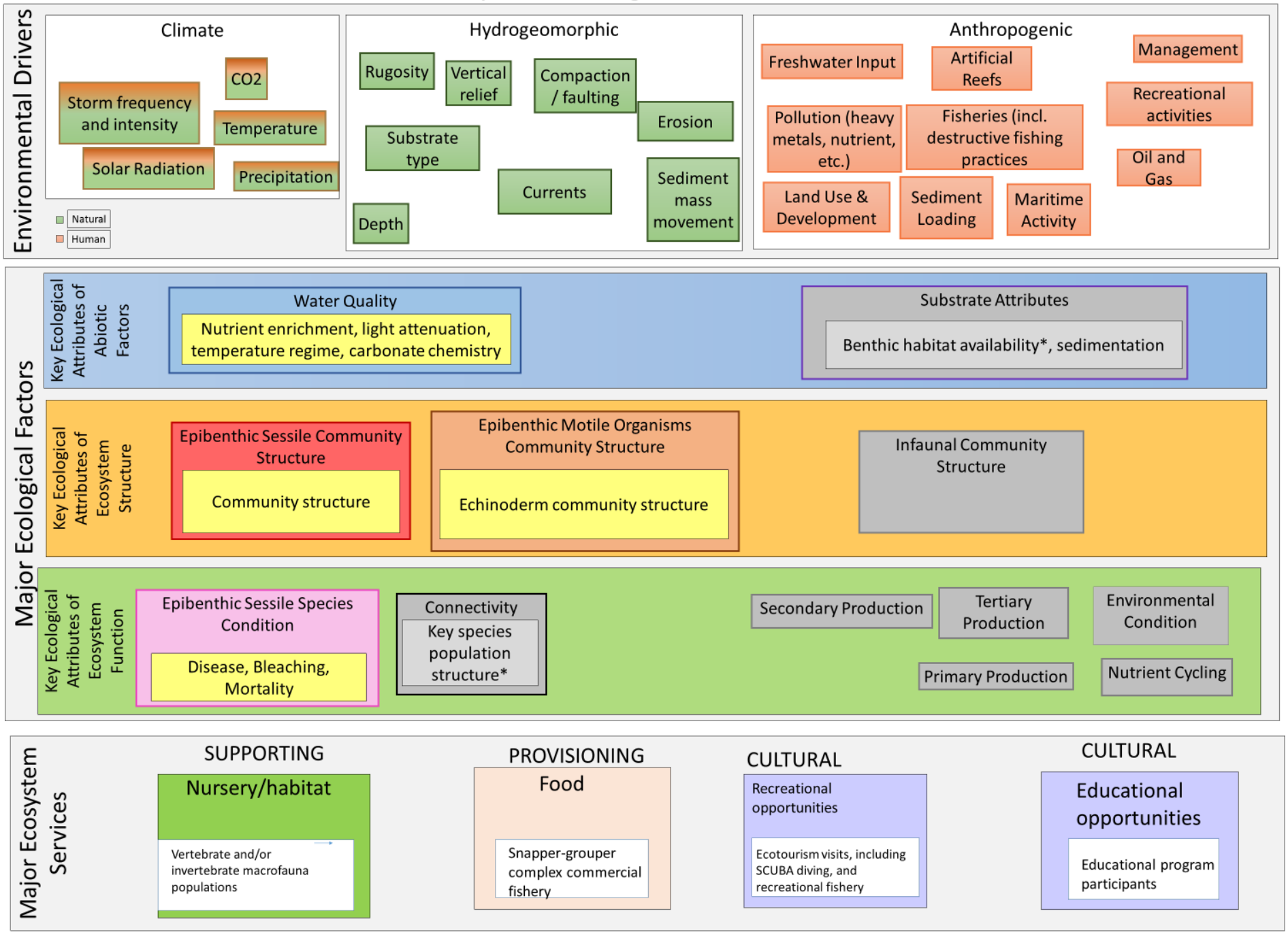
Expert Workshops

- Experts reviewed models, indicators, metrics
- Pilot Workshop - April, 2016
  - Salt Marshes
  - 21 participants
- Second Workshop- October, 2016
  - Corals, Mangroves, Oysters, Seagrass
  - 40 participants

INDICATOR EVALUATION CRITERIA

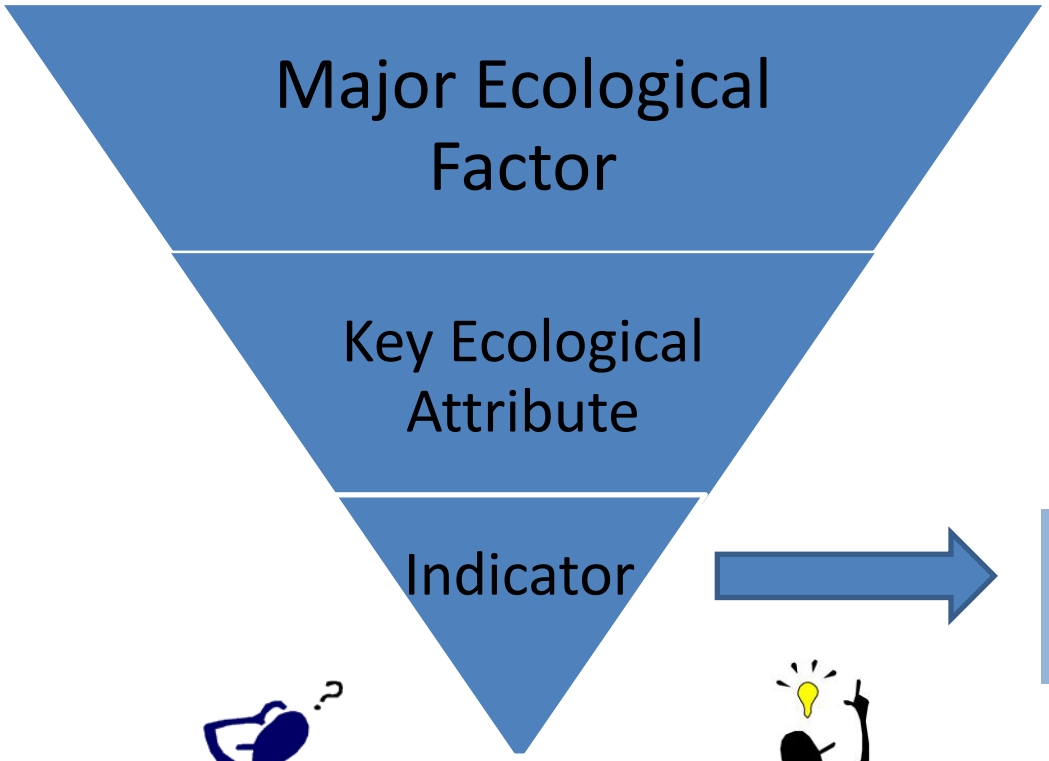
- **Represents key ecological attributes or ecosystem services**
- Good signal/noise ratio (i.e. short and long term trends can be recognized)
- Not prone to measurement error
- Cost-effective
- Feasible
- Relevant to management objectives
- Already being collected

Conceptual Ecological Model - Corals



FROM CONCEPTUAL MODELS TO METRICS

CEM



Metrics and Measures

Indicators need metrics

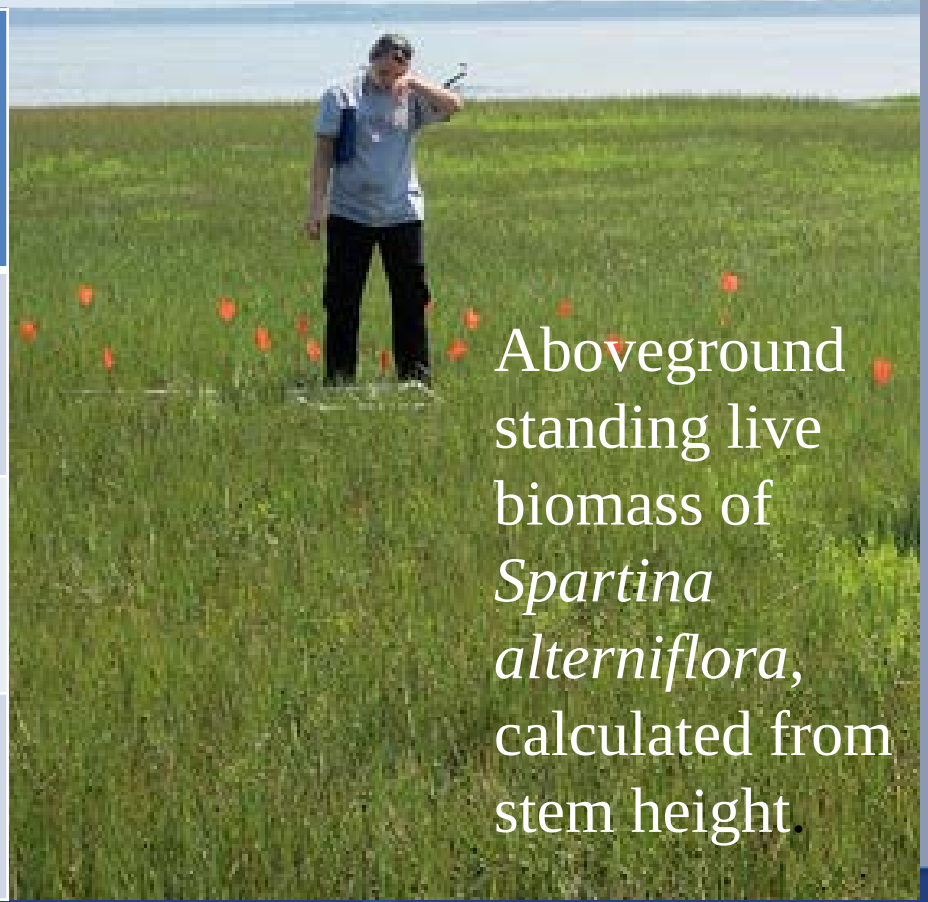
	METRIC ASSESSMENT POINTS		
Metrics	**Reference Excellent/ Good**	**Fair**	**Poor**
Total cholesterol	150-200	125 - 149 or 201-225	< 125 or > 225
High density lipoprotein -HDL or “good” cholesterol	40-60	30-39 or > 61-70	< 30 or > 70
Low density lipoprotein – LDL or “bad” cholesterol	< 150	150-175	> 175
Total cholesterol/HDL	< 5.0	5.0-6.0	> 6.0

Salt Marsh Metric: Aboveground Standing Live Biomass

MEF: Ecosystem Function
KEA: Primary Production
Indicator: Aboveground Primary Production

Rapid field measure

Metric Rating	Aboveground Standing Live Biomass
Good / Excellent	> 600 g m^{-2}
Fair	300 – 600 g m^{-2}
Poor	< 300 g m^{-2}



Aboveground standing live biomass of *Spartina alterniflora*, calculated from stem height.

Example Ecological Condition Indicators, Metrics, & Measures

Salt Marsh

Major Ecological Factor	Key Ecological Attribute	Indicator	Metric	Measure (based on metric)
ABIOTIC FACTORS	Water Quality	*Sediment Load*	Basin-wide Total Suspended Solids	Total Suspended Solids (TSS) mg L^{-1} (basin wide)
		Eutrophication	Basin-wide Nutrient Load (Total Nitrogen, Total Phosphorus)	Total Phosphorus in mg L^{-1} and Total Nitrogen in mg L^{-1} (basin-wide)
ECOSYSTEM STRUCTURE	Marsh Morphology	*Land Aggregation*	Aggregation Index (AI)	Landsat 30 m pixels classified as water / marsh.
		Lateral Migration	Shoreline Migration	Change in shoreline position (cm / yr) along a transect.
ECOSYSTEM FUNCTION	Secondary Production	*Specialist birds*	Clapper Rail and Seaside Sparrow Density	Density (birds ha^{-1}) of individuals of clapper rail and male seaside sparrow
	Elevation Change	Submergence Vulnerability	/ Wetland Relative Sea Level Rise ($RSLR_{wet}$) and Submergence Vulnerability Index (SVI)	Rate of change in marsh surface elevation using RSET, with respect to a hydrologic datum.

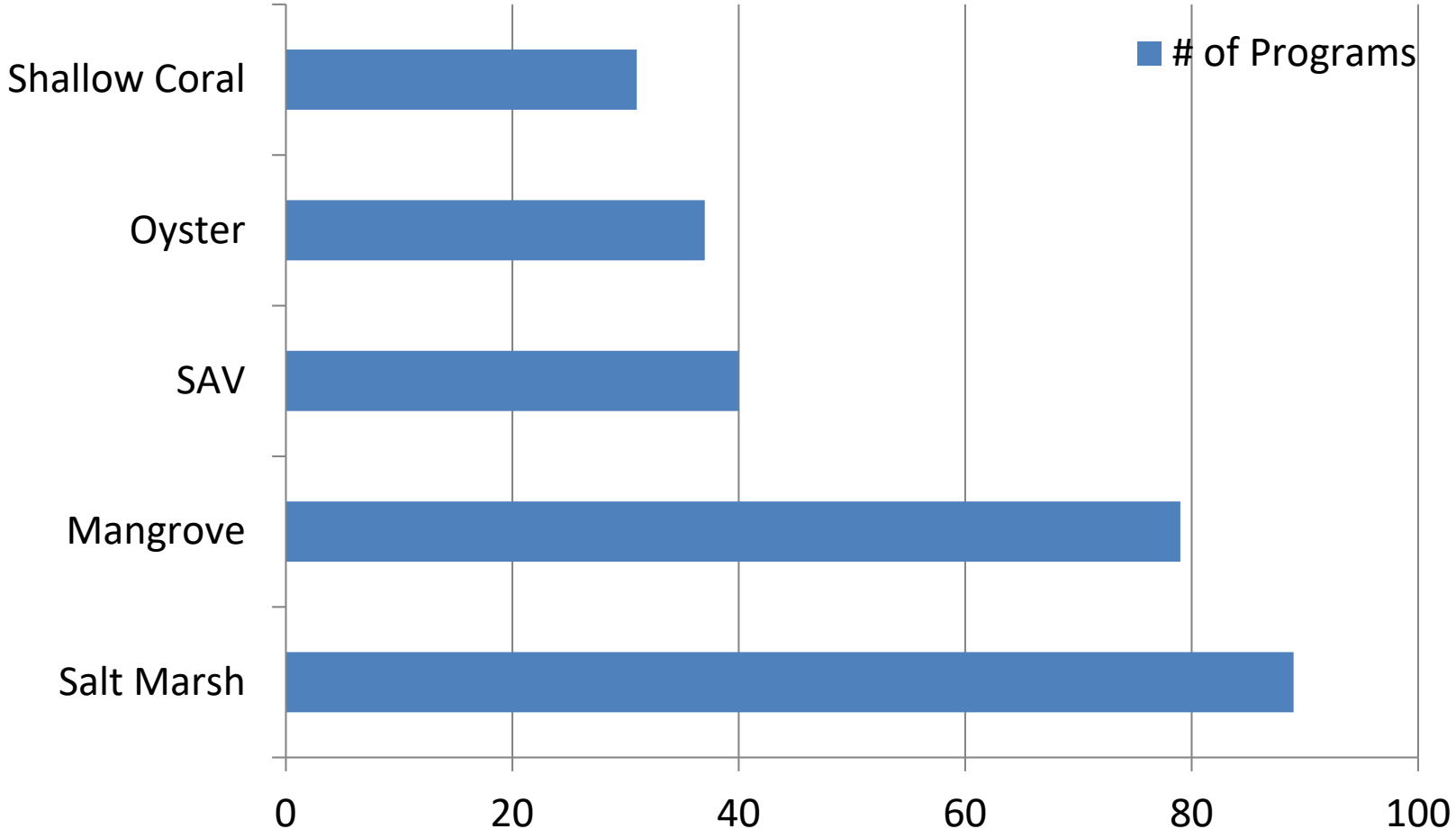
Example Ecosystem Service Indicators, Metrics & Measures

CORAL REEF				
Major Ecosystem Services	**Key Services**	**Indicators**	**Metrics**	**Measures**
SUPPORTING	Habitat	Invertebrate macrofauna population	*Live hard coral cover*	Live coral percent cover
PROVISIONING	Food	Snapper-grouper commercial fishery	*State commercial annual landings of gray snapper*	Metrics tons landed per year
CULTURAL	Recreational Opportunities	Ecotourism visits	*# divers & snorkelers relative to site carrying capacity*	Total number divers/snorkelers per site per year
	Educational Opportunities	Education programs	*Interpretive Program type*	Type of Interpretive Program provided

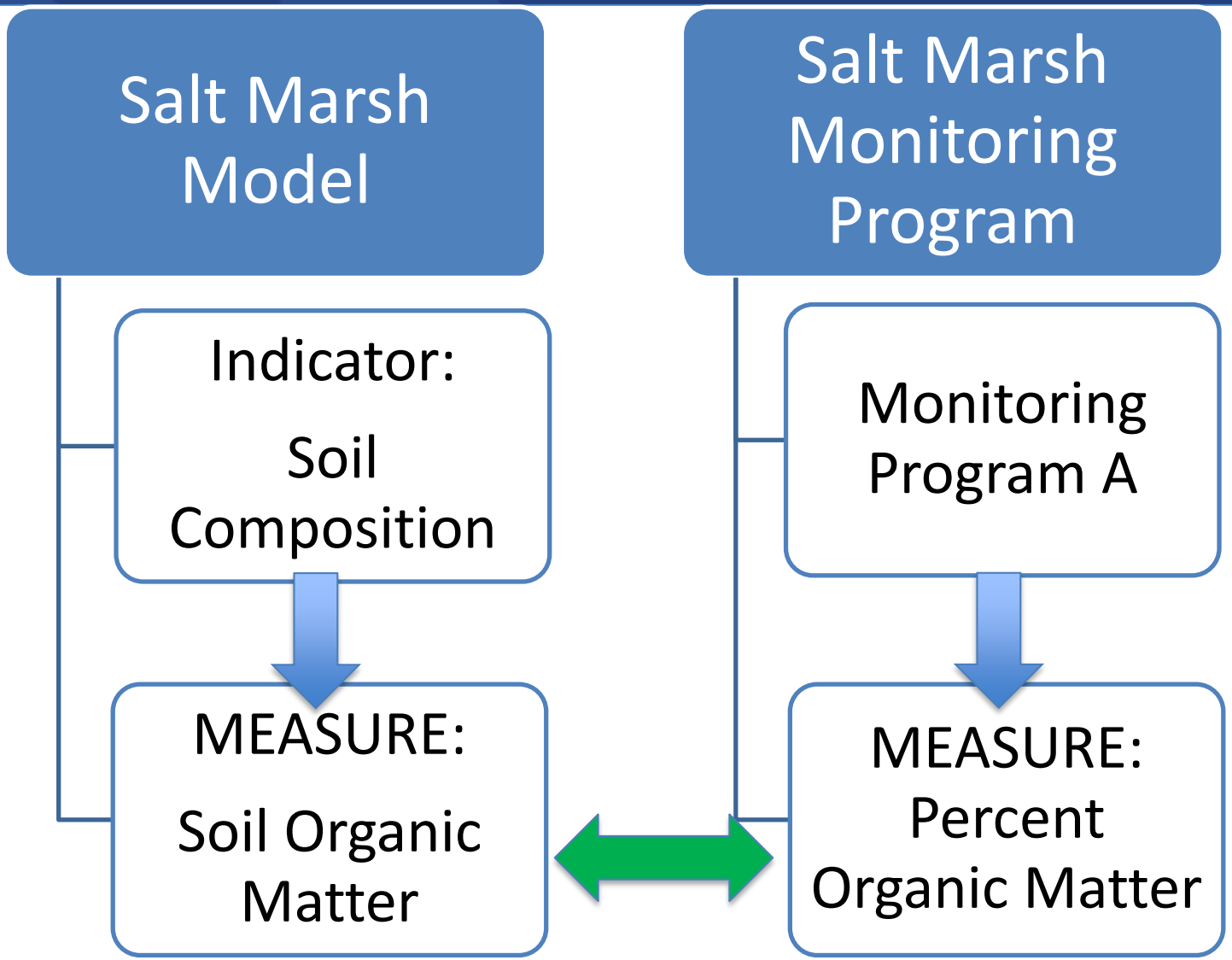
Ocean Conservancy Monitoring Inventory

- Roughly 900 long-term monitoring efforts
- 13 NRDA injury categories:
  - Water Column and Invertebrates
  - Birds
  - Marine Mammals
  - Sea Turtles
  - Nearshore Sediment and Associated Resources
  - Oysters
  - Submerged Aquatic Vegetation
  - Deep-water communities
  - Shallow- and Mid-water Corals
  - Shorelines
  - Terrestrial Species
  - ***Ecosystem Drivers**
  - ****Salt Marsh**
  - ****Mangrove**

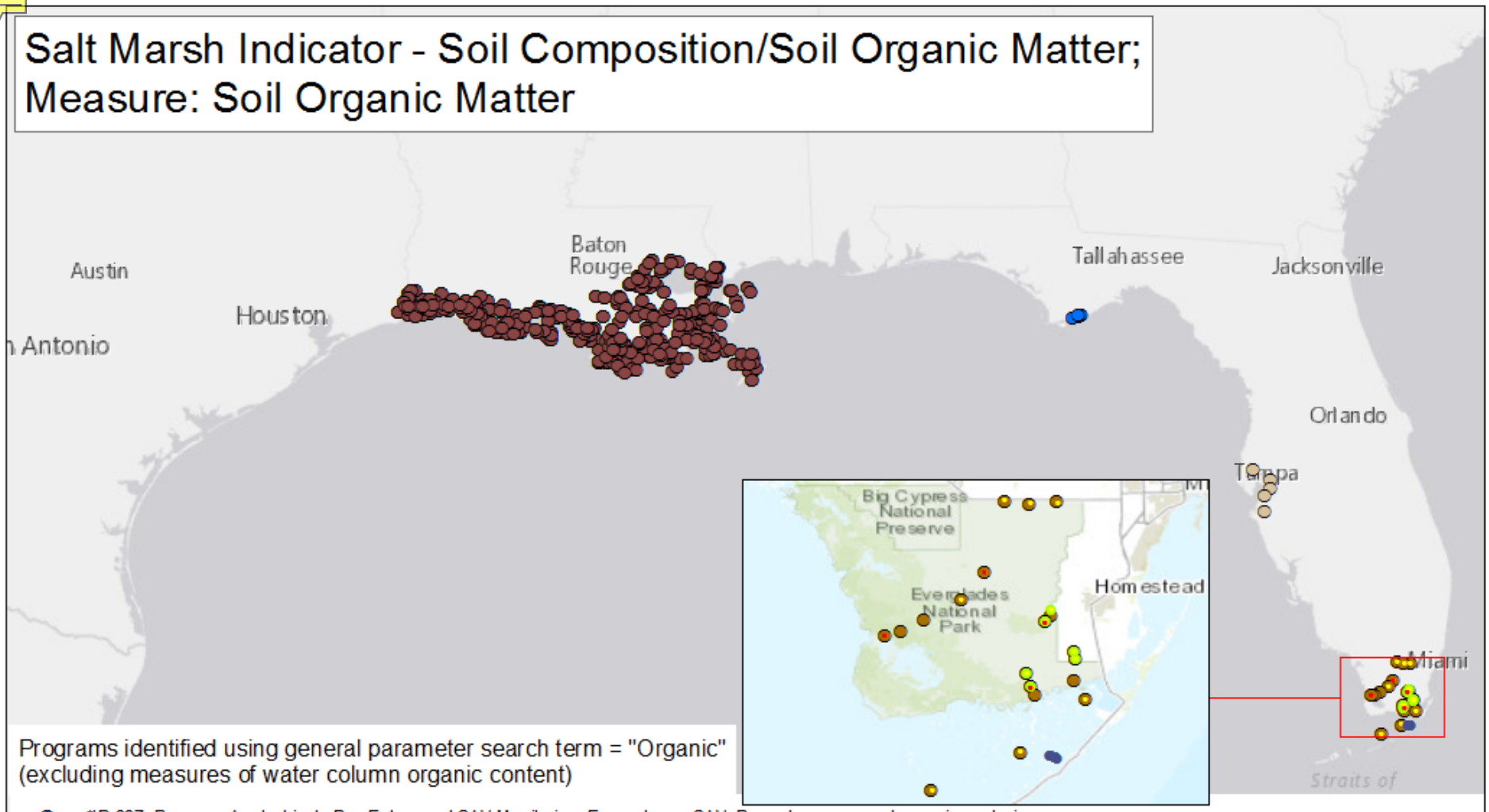
Inventory Programs By Ecosystem



Linking CEM Metrics & Measures to monitoring program measures



Salt Marsh Indicator - Soil Composition/Soil Organic Matter; Measure: Soil Organic Matter

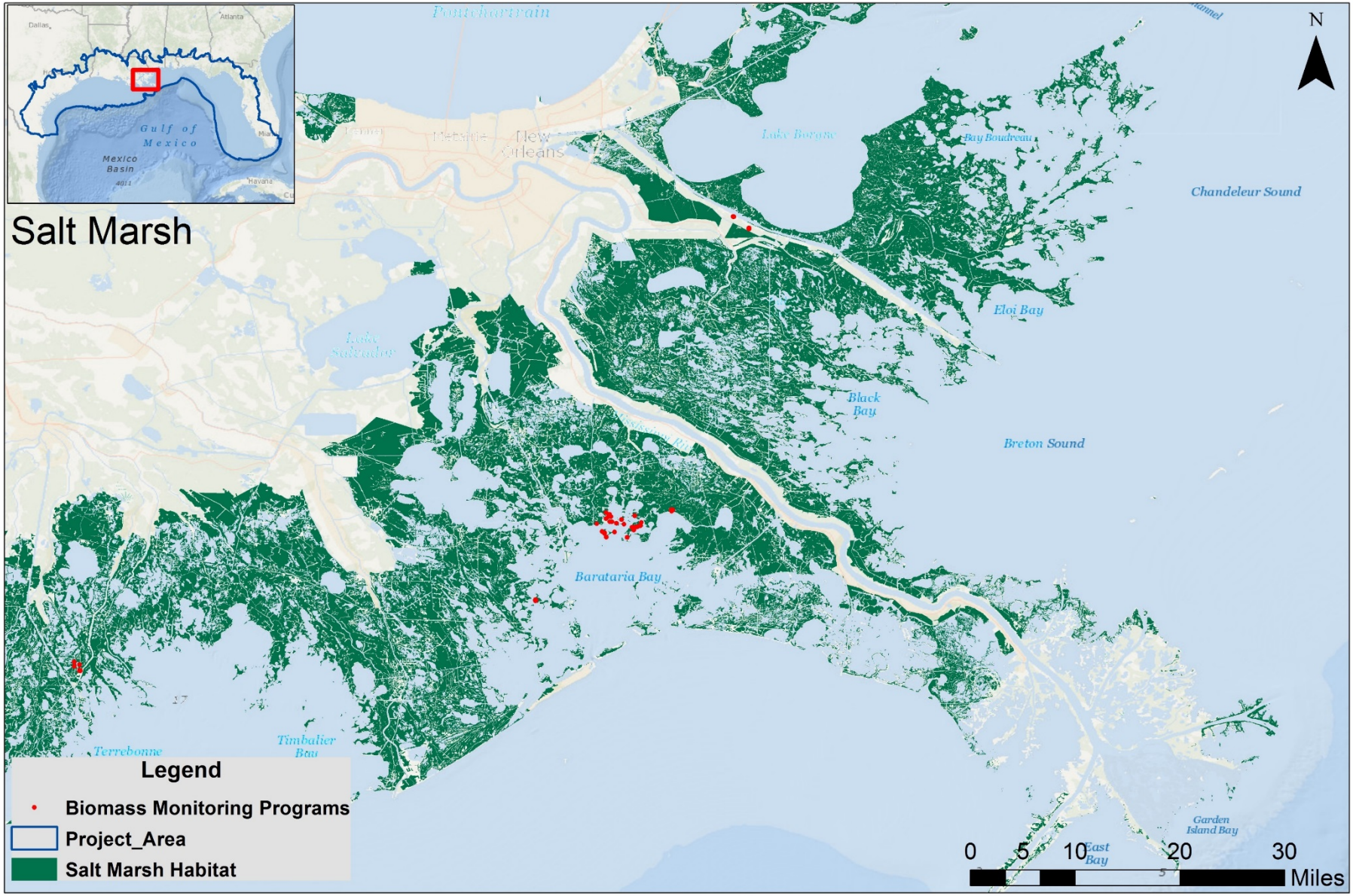


Programs identified using general parameter search term = "Organic" (excluding measures of water column organic content)

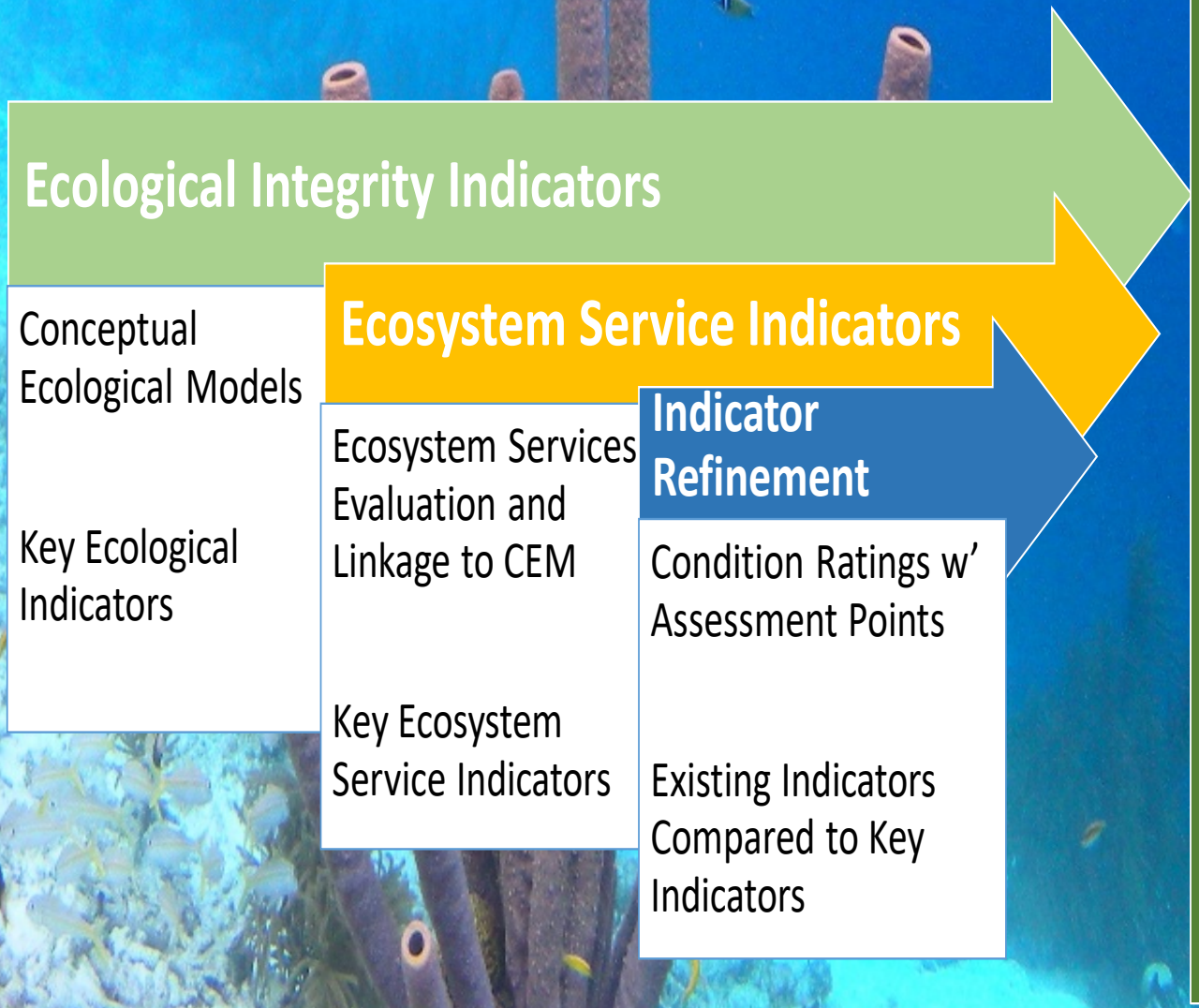
- *ID 997; Program: Apalachicola Bay Ephemeral SAV Monitoring; Ecosystem = SAV; Paramters = percent organic analysis
- *ID 916; Program: Cross Bank Sediment Characteristics, Everglades National Park (FCE), South Florida from 2014; Ecosystem = SAV; Paramter = % C organic, %C inorganic
- *ID 929; Program: Biomarker assessment of composition of flocculent material in Coastal Everglades; Ecosystem = Shorelines, Salt Marsh, Mangrove; Paramters = Organic Matter
- *ID 925; Program: Periphyton Accumulation Rates, Everglades NP; Ecosystem: Shorelines, Salt Marsh, Mangroves; Parameter = Percent total organic content
- ID 906; Program: Tampa Bay Critical Coastal Habitat Assessment; Ecosystem = Shorelines, Salt Marsh, Mangrove; Parameter = Soil percent organic content
- ID 932; Program: Soil Characteristic and Nutrient Data from the Taylor Slough, within Everglades National Park; Ecosystem = Shorelines, Salt Marsh, Mangrove
- ID 927; Program: Characteristics of Soil from Shark River and Taylor Sloughs, Everglades NP; Ecoystem = Shorelines, Salt Marsh, Mangrove; Parameters = Soil Percent Organics
- ID 954; Program: Coastwide Reference Monitoring System Soil Proporties Data; Ecosystem = Shorelines, Salt Marsh, Mangrove; Paramters: percent organic matter

* Denotes measure not collected in salt marsh

Distribution of Indicator Monitoring Programs



Ecological Resilience Framework



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