Ecological indicators for assessing seagrass ecosystem condition in the Gulf of Mexico

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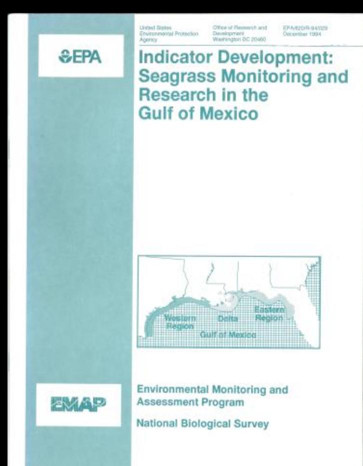
Ecological Indicators

Environmental Monitoring and Assessment Program (EMAP)

Goal: Address the question, "What can our agencies and institutions do together to begin to reverse the trend of seagrass loss in the GOM?"



RESPONSE INDICATORS

Abundance
- Shoot density by species
- SAV biomass
- Algae biomass
- Leaf width
- Leaf area index

Plant constituents
- Soluble carbohydrate concentration
- Ratio of C:N:P

Species composition
- Seagrasses
- Macroalgae
- Filamentous algae

Depth limit of bed
Genetic diversity
Stress proteins
Animals
Productivity

EXPOSURE INDICATORS

Light
Nutrients
- Total nitrogen, total phosphorus
- Ammonium, nitrate, soluble reactive phosphate

Dissolved oxygen
Physical conditions
- Physical energy regime
- Sediment characteristics

Table 1. Ecological indicators proposed for inclusion in the EMAP sampling network.

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Objectives

1) Develop a conceptual ecological model and identify indicators used to assess seagrass ecosystem condition.

1) Identify metrics for each indicator and set metric ratings and assessment points.

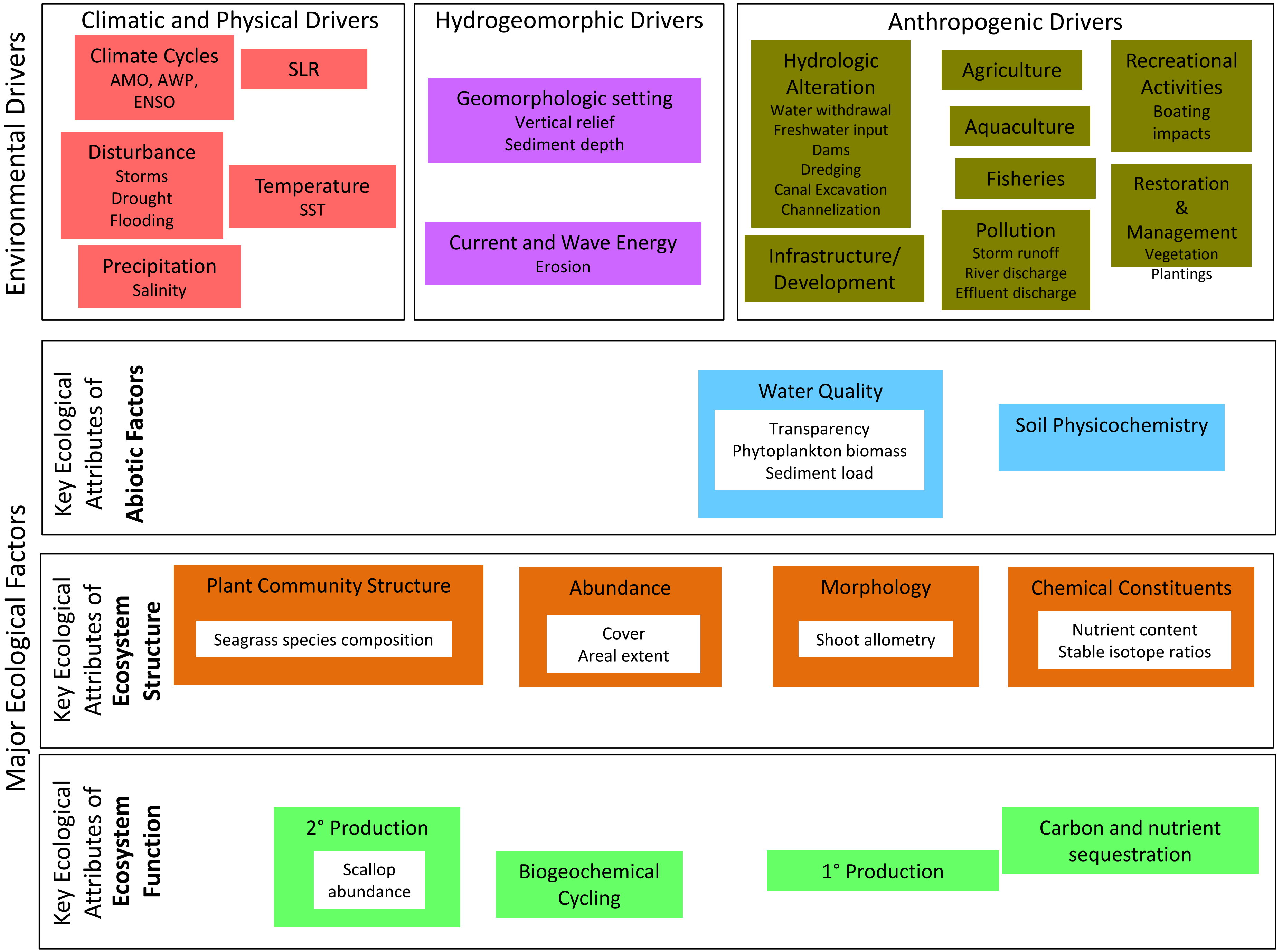
1) Evaluate seagrass ecosystem health in Texas by applying these "thresholds" using indicators collected by the Texas Seagrass Monitoring Program (Tier 2).

Conceptual Ecological Model (CEM) and Indicator Development

Indicator Monitoring Catalog

Submerged Aquatic Vegetation

ID	Name	Program_Website	Summary	Parameters
576	NPS Gulf Coast Inventory and Monitoring Program: Padre Island National Seashore Seagrass Monitoring	http://science.nature.nps.gov/im/units/guln/monitor/seagrass.cfm	Seagrass community ecology, water quality	Seagrass species composition, canopy height, percent coverage, temperature, pH, dissolved oxygen, salinity, turbidity, chlorophyll, transparency (secchi depth)
577	Texas Seagrass Monitoring Program	http://texasseagrass.org/	Seagrass cover and distribution, water quality	Aerial cover/distribution, species composition, areal coverage, percent cover, water depth, conductivity, temperature, salinity, dissolved oxygen, chlorophyll fluorescence, pH, nutrient availability (tissue carbon, nitrogen, phosphorus content), total suspended solids, transparency
578	Alabama Coastal Area Management Program's Submerged Aquatic Vegetation Mapping	http://www.mobilebaynep.com/library	Seagrass status and trends mapping	Distribution, percent cover, species composition, acreage


Environmental Drivers
Climatic and Physical Drivers
Climate Cycles
AMO, AWP, ENSO
SLR
Disturbance
Storms
Drought
Flooding
Temperature
SST
Precipitation
Salinity
Hydrogeomorphic Drivers
Geomorphologic setting
Vertical relief
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Anthropogenic Drivers
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Water Quality
Transparency
Phytoplankton biomass
Sediment load
Soil Physicochemistry
Key Ecological Attributes of Ecosystem Structure
Plant Community Structure
Seagrass species composition
Abundance
Cover
Areal extent
Morphology
Shoot allometry
Chemical Constituents
Nutrient content
Stable isotope ratios
Key Ecological Attributes of Ecosystem Function
2° Production
Scallop abundance
Biogeochemical Cycling
1° Production
Carbon and nutrient sequestration

Development of metric ratings and assessment points

CEM → Assessment Points Process

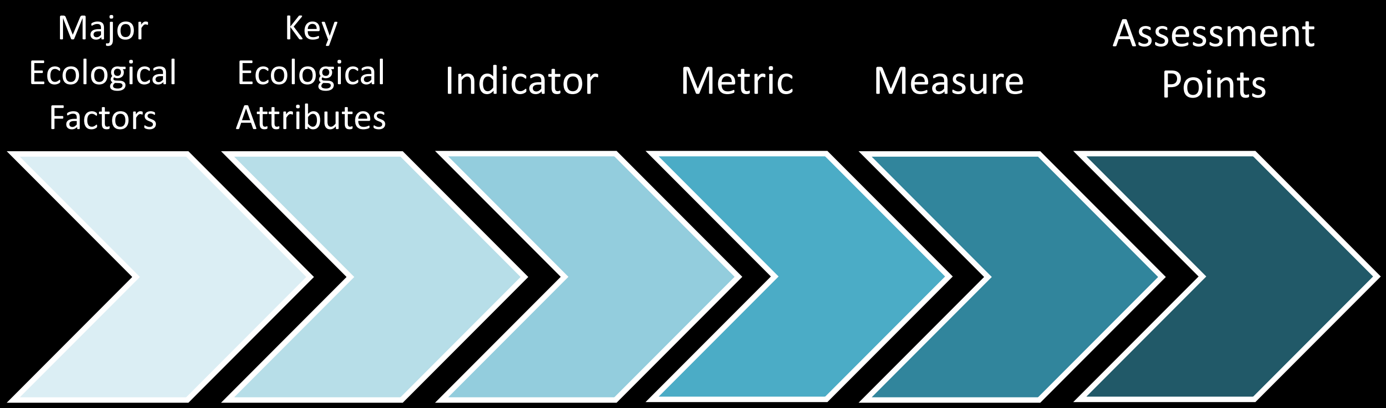
Natural Drivers

Anthropogenic Drivers

Major Ecological Factor	Key Ecological Attribute	Indicator	Metric	Measure	Assessment Points
Ecosystem Structure	Abundance	Cover	Percent cover (% change yr^{-1})	Braun-Blanquet Cover Abundance or % cover	

* for > 50% seagrass cover

Goal for All Indicators



RATING	Percent cover (% change yr^{-1})
Good	0 – 25% ⬆
Fair	< 25% ⬇
Poor	> 25% ⬇

* for > 50% seagrass cover

Services	Major Ecological Factor or Service	Key Ecological Attribute or Service	Indicator/Metric
Sustaining/ Ecological Integrity	Abiotic Factors	Water Quality	Transparency/Percent Surface Irradiance (% SI)
			Phytoplankton biomass/Chlorophyll a concentration (µg L^{-1})
			Sediment Load/Total Suspended Solids (mg L^{-1})
		Soil Physicochemistry	--
	Ecosystem Structure	Abundance	Areal extent/Areal extent (% change yr^{-1})
			Cover/Percent cover (% change yr^{-1})
		Plant Community Structure	Seagrass species composition/Species Dominance Index (ratio change yr^{-1})
		Morphology	Shoot allometry/Leaf length (% change yr^{-1})
			Shoot allometry/Leaf width (% change yr^{-1})
		Chemical Constituents	Nutrient content/Nutrient Limitation Index
			Stable isotope ratios/ $\delta^{13}C$ and $\delta^{15}N$ (‰ change yr^{-1})
	Ecosystem Function	Secondary Production	Scallop abundance/Scallop density (individuals m^{-2})
		Carbon and Nutrient Sequestration	--
		Biogeochemical Cycling	--
		Primary Production	--

Indicator and metric application

texasseagrass.org/index.html

TEXAS SEAGRASS

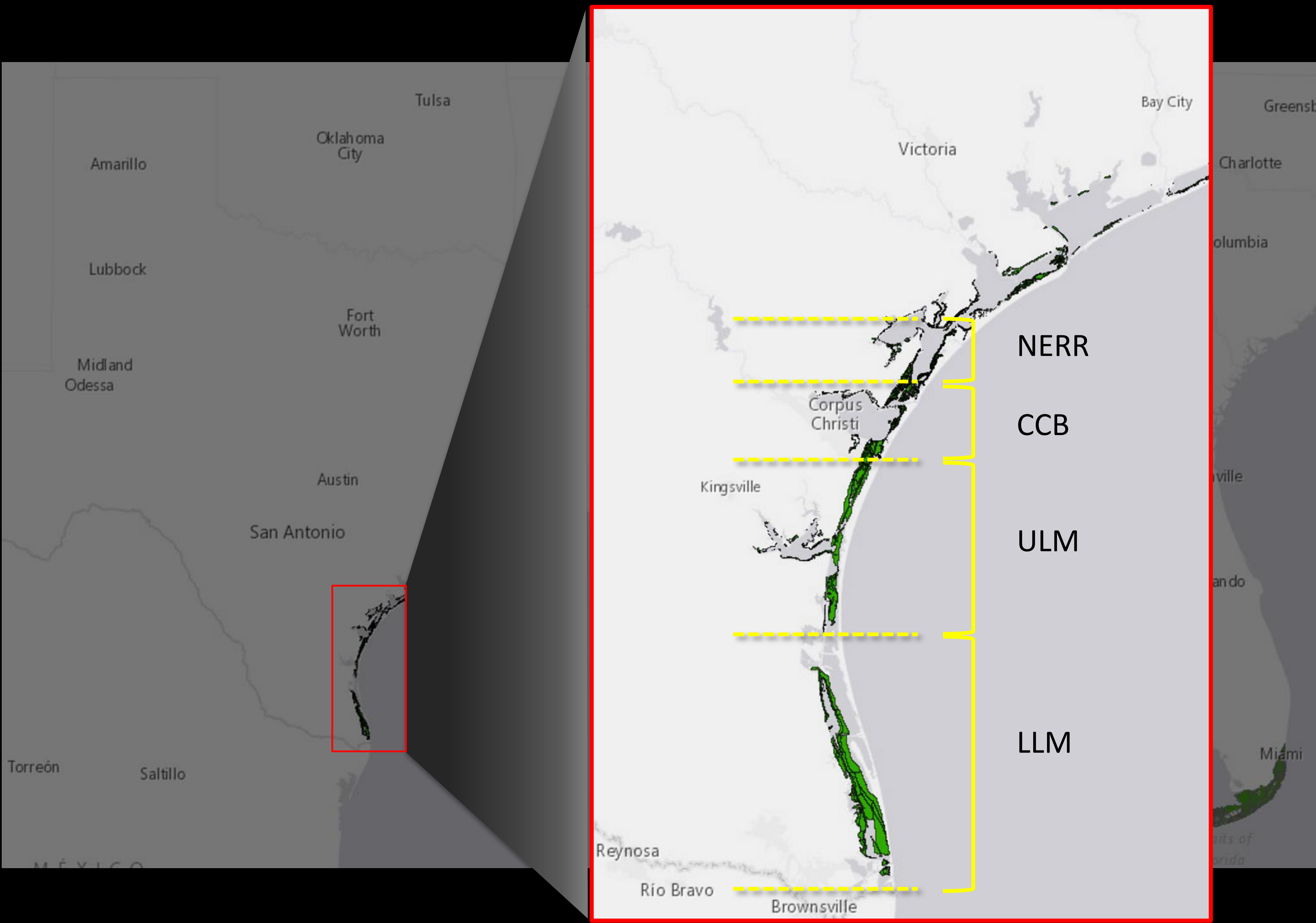
- Maps
- Results
- About Seagrasses
- Texas Seagrasses
- Research Team

Texas Statewide Seagrass Monitoring Program

A Seagrass Monitoring Program for Texas Coastal Waters

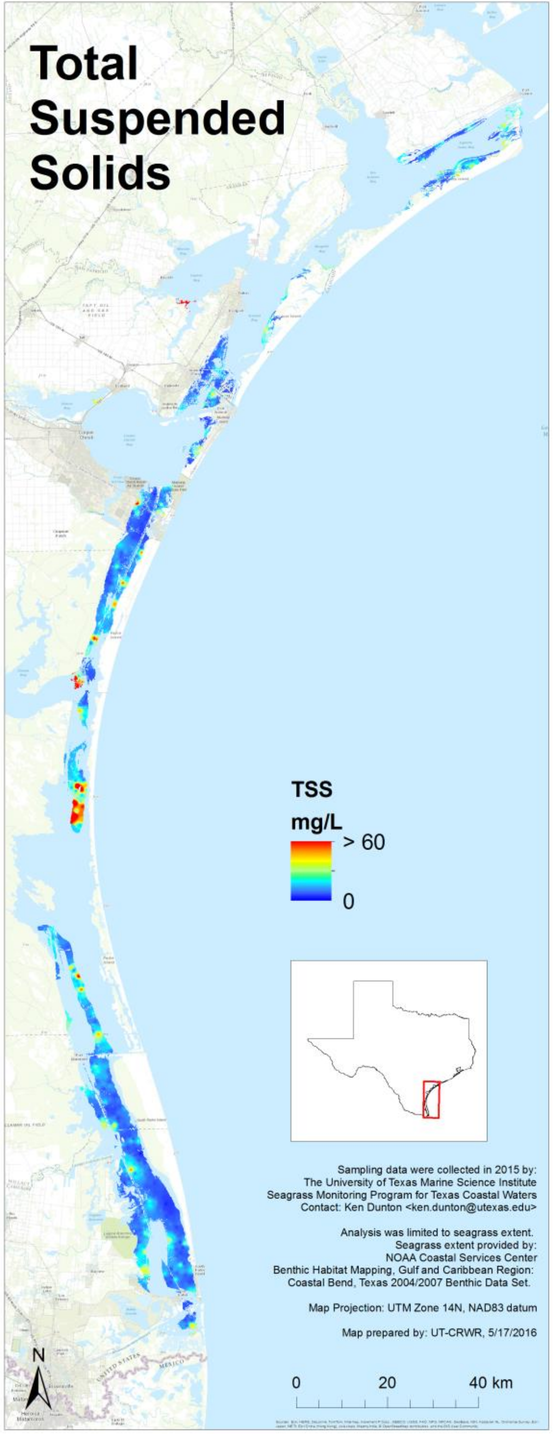
Multi-scale Integration of Landscape Features with Plant and Water Quality Indicators

This website details an implementation program for monitoring Texas seagrasses following protocols that evaluate seagrass condition based on landscape-scale dynamics, including a hierarchical strategy for seagrass monitoring in order to establish the quantitative relationships between physical and biotic parameters that ultimately control seagrass condition, distribution, and persistence.



Tulsa
Oklahoma City
Amarillo
Lubbock
Fort Worth
Midland
Odessa
Austin
San Antonio
Torreón
Saltillo
Victoria
Bay City
Corpus Christi
Kingsville
Reynosa
Río Bravo
Brownsville
NERR
CCB
ULM
LLM
Greensb
Charlotte
olumbia
ville
ando
Miami

NERR	14.8	Good
CCB	13.6	Good
ULM	18.7	Fair
LLM	12.7	Good



Indicator

Sediment Load

TSS (mg L^{-1})	RATING
< 15	Good
15 - 25	Fair
> 25	Poor

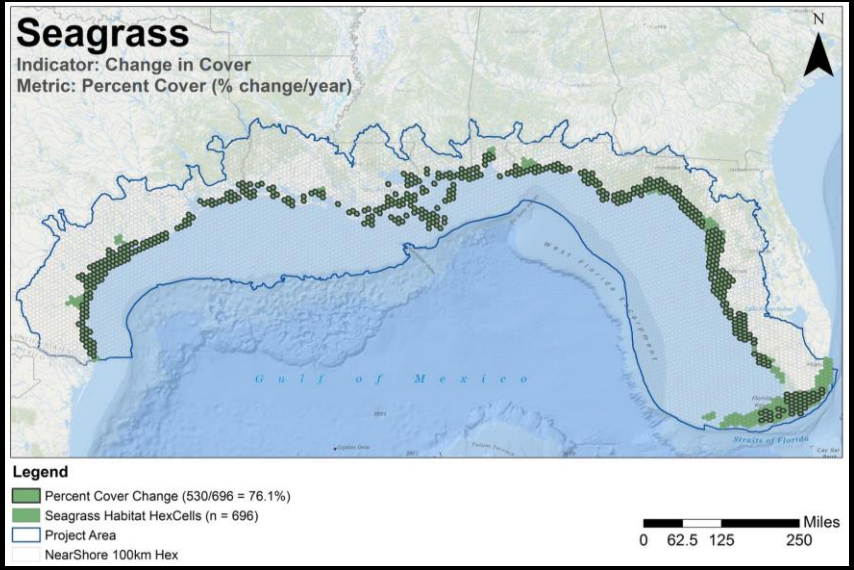
www.texasseagrass.org

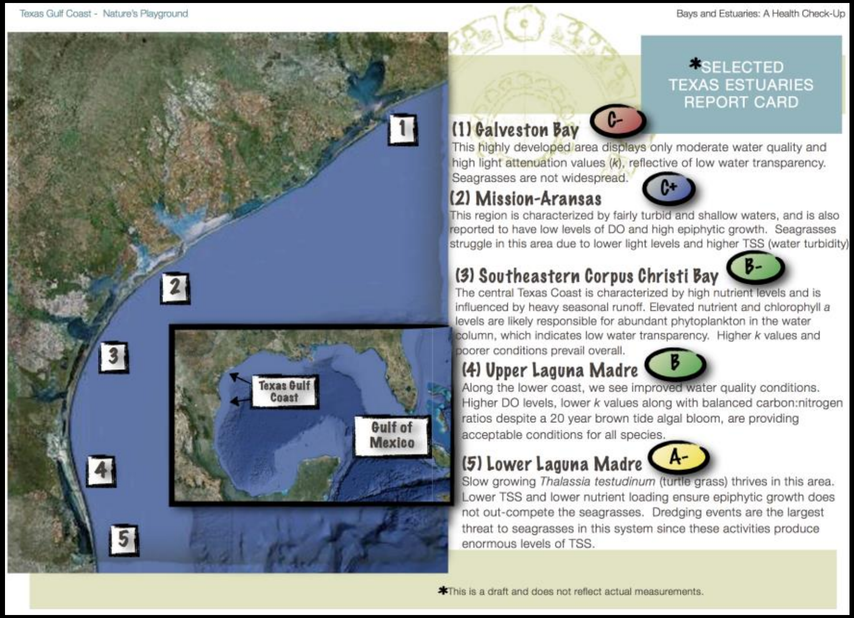
		LOCATION			
Indicator	**Metric**	**NERR**	**CCB**	**ULM**	**LLM**
Transparency	% SI	[illegible]	[illegible]	[illegible]	[illegible]
Phytoplankton biomass	Chlorophyll *a*	[illegible]	[illegible]	[illegible]	[illegible]
Sediment load	Total suspended solids	14.8	13.6	18.7	12.7
Cover	Percent cover	[illegible]	[illegible]	[illegible]	[illegible]
Seagrass species composition	Species Dominance Index	[illegible]	[illegible]	[illegible]	[illegible]
Nutrient content	Nutrient Limitation Index	[illegible]	[illegible]	[illegible]	[illegible]
Stable isotope ratios	$\delta^{13}C$ and $\delta^{15}N$	[illegible]	[illegible]	[illegible]	[illegible]
Shoot allometry	Leaf length	[illegible]	[illegible]	[illegible]	[illegible]
Shoot allometry	Leaf width	--	--	--	--
Areal extent	Areal extent	--	--	--	--
Scallop abundance	Scallop density	--	--	--	--

Conclusions

- Measures/Metrics are repeatable, applicable at multiple scales, and currently collected in the Gulf
- Resource managers can assess seagrass ecosystem condition using a suite of metrics
- Red-yellow-green = easy format for outreach and awareness

Courtesy of Florida Fish and Wildlife Conservation Commission





www.texasseagrass.org

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Seagrass Ecosystem Workgroup

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Ken Dunton
Brad Furman

Indicator pre-screen

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Sara Wilson and FIU Fourqurean lab

NatureServe
A Network Connecting Science With Conservation

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

THE UNIVERSITY OF TEXAS
MARINE SCIENCE INSTITUTE

USGS
science for a changing world

Ocean Conservancy®

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

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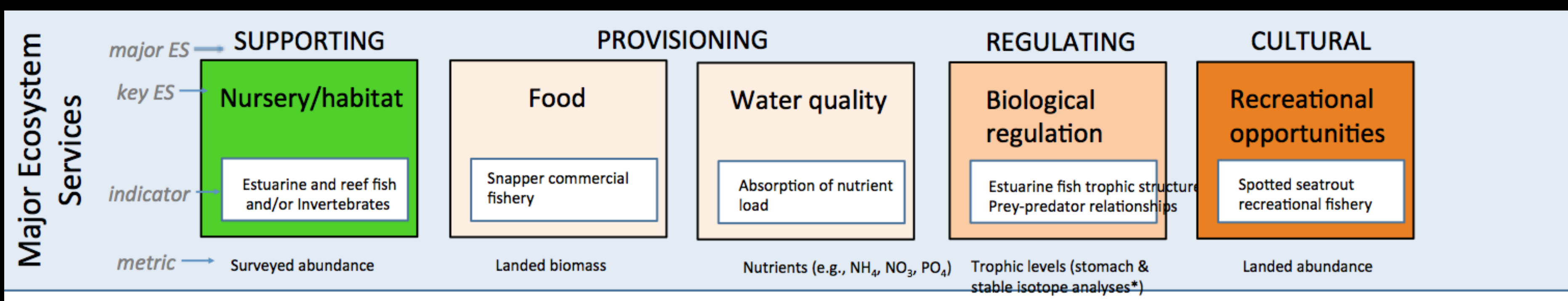
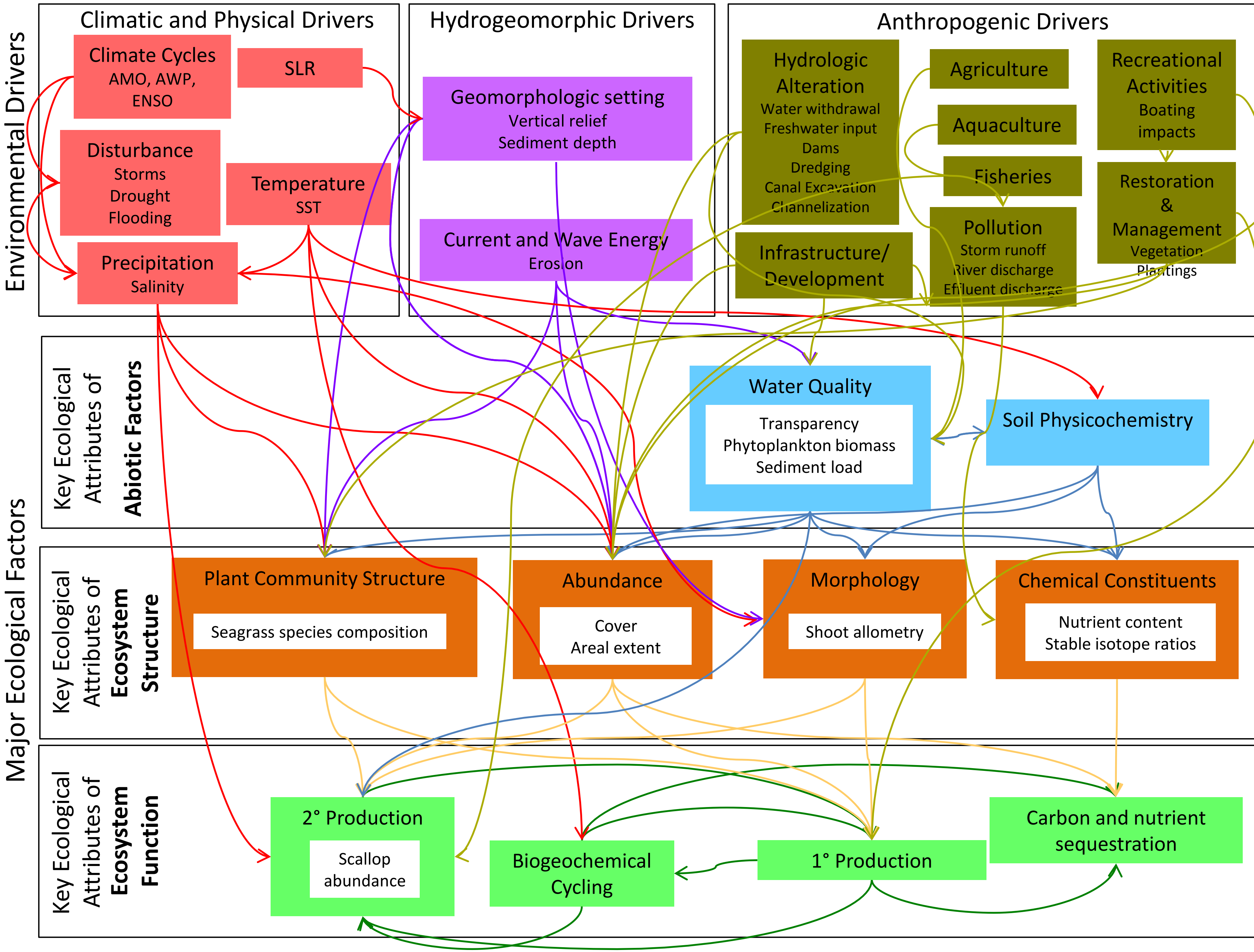
Ecosystem Services (ES)

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Indicators:

Transparency

Metric: % SI

Good	> 30%
Fair	20 – 30%
Poor	< 20%

Sediment Load

Metric: TSS

Good	< 15 mg L^{-1}
Fair	15 – 25 mg L^{-1}
Poor	> 25 mg L^{-1}

Indicator: Phytoplankton biomass
Metric: Chl *a*

Clastic sediments		Carbonate sediments	
Good	0 – 10.0 µg L^{-1}	Good	0 – 1.0 µg L^{-1}
Fair	10.0 – 25.0 µg L^{-1}	Fair	1.0 – 3.0 µg L^{-1}
Poor	> 25.0 µg L^{-1}	Poor	> 3.0 µg L^{-1}

Indicators: Change in Areal Extent		Seagrass species composition	
Metric: Areal extent		**Metric: Sp. Dominance Index**	
Good	0 – 25% ↑	Good	No change or ↑
Fair	< 25% ↓	Fair	< 0.25 ratio decrease
Poor	> 25% ↓	Poor	> 0.25 ratio decrease

Indicator: Change in cover
Metric: Percent cover

% cover > 50%		
Good	0 – 25%	↑
Fair	< 25%	↓
Poor	> 25%	↓

% cover < 50%		
Good	< 10%	↓
Poor	> 10%	↓

Indicators:

Nutrient content

Metric: Nutrient Limitation Index

Good	0 to ±1
Fair	±1 to 2.5
Poor	> ±2.5

Stable Isotope ratios

Metric: $\delta^{13}C$, $\delta^{15}N$

Good	< 0.5‰
Fair	0.5 to 1.0‰
Poor	> 1.0‰

Indicators:

Shoot allometry

Metrics: Shoot leaf length, leaf width

Good	< 10%
Fair	10 – 25%
Poor	> 25%

Scallop abundance

Metric: Scallop density

Good	> 0.4 indiv m^{-2}
Fair	0.1 – 0.4 indiv m^{-2}
Poor	< 0.01 indiv m^{-2}


Questions?