Gulf EcoHealth Metrics: Conceptual Framework and Proof-of-Concept Studies

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The Gulf EcoHealth Metrics — an initiative of the Harte Research Institute for Gulf of Mexico Studies

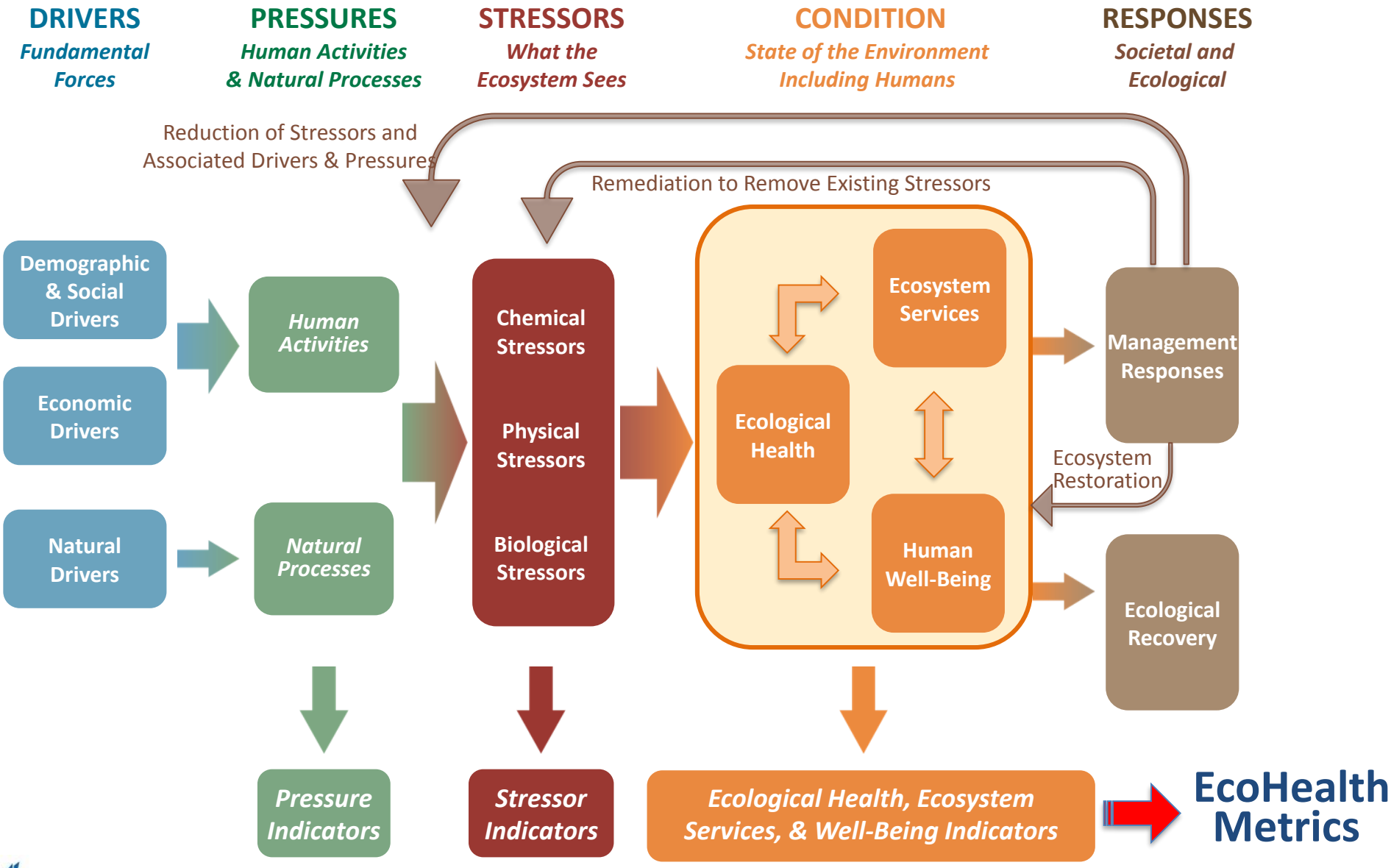
Vision:

- scientifically-based characterization of the environmental condition of the Gulf of Mexico;
- widely accessible and understandable by policy-makers, managers, stakeholders, scientists, and the public.

Objectives:

- to provide the scientific information and understanding to assess the health of Gulf ecosystems and their linkages to humans;
- to inform the decision-making process on policies needed to achieve sustainability of a healthy Gulf of Mexico;
- to clearly demonstrate how well it is or is not progressing towards desired long-term goals.

EcoHealth Indicators & Assessment Framework ($DPSCR_4$)



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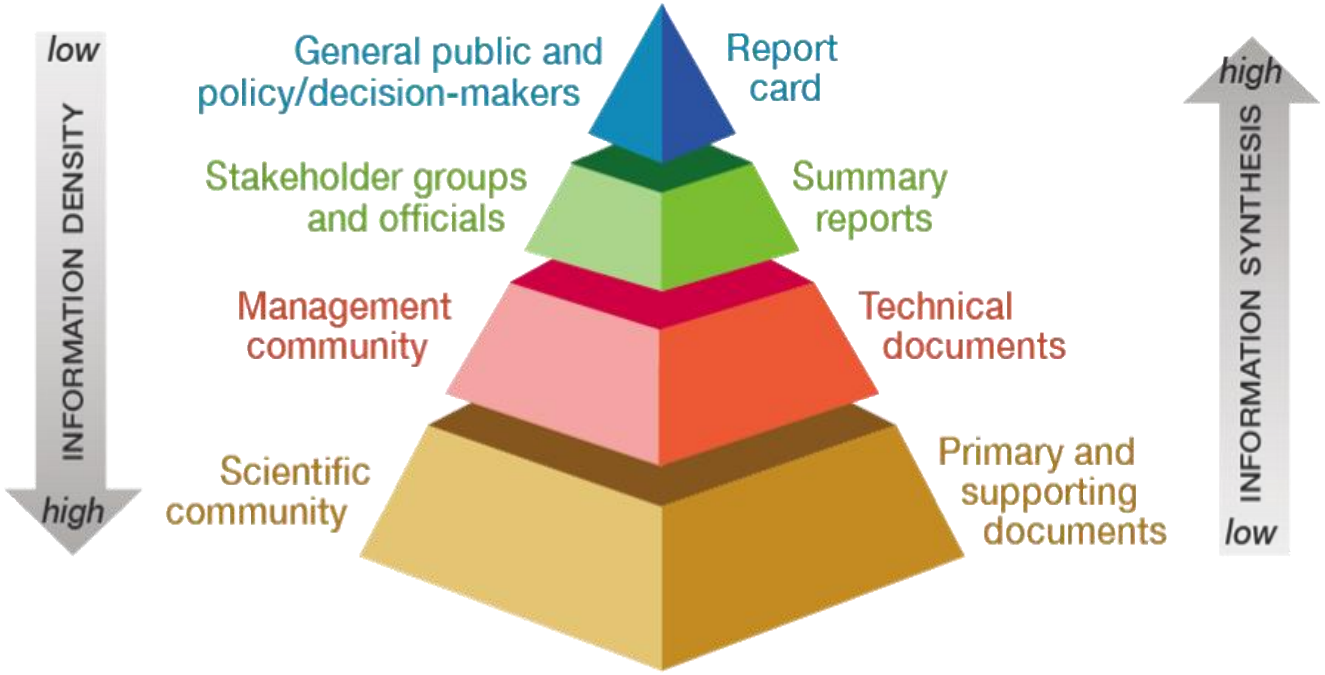
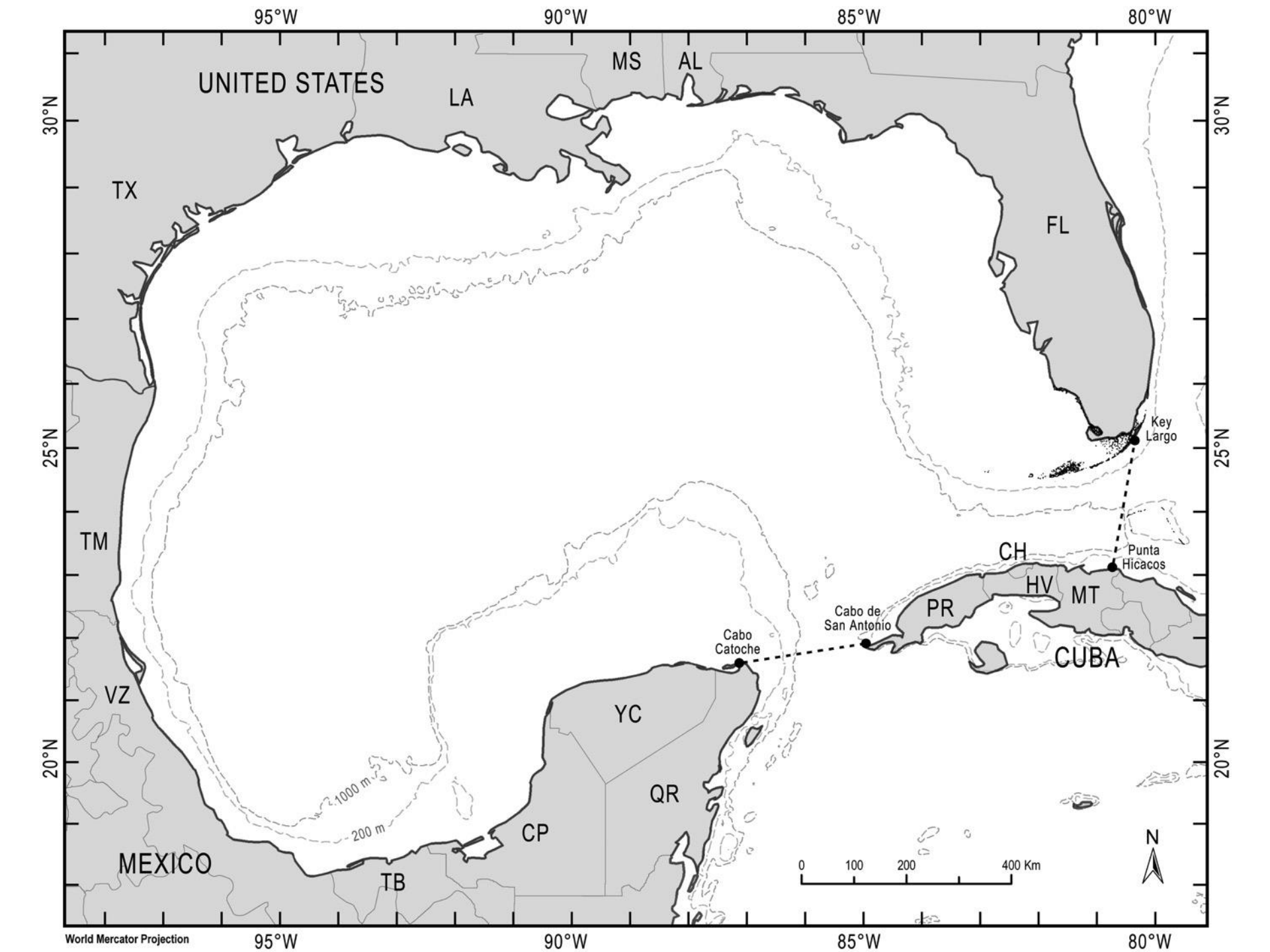
Gulf EcoHealth Metrics
Hierarchical Reporting Structure for Various Audiences

DPSIR Science Framework

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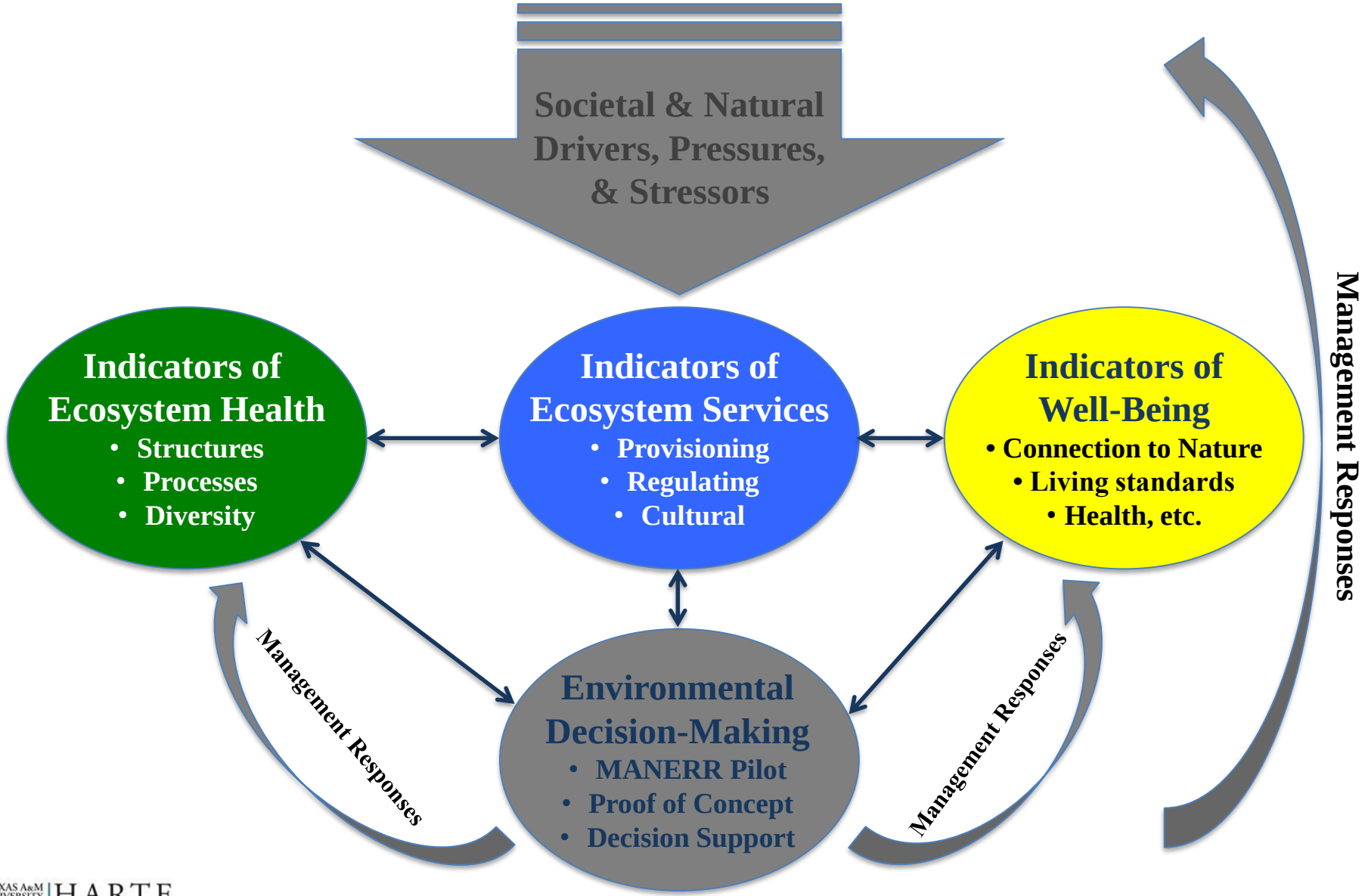
World Mercator Projection

EcoHealth Metrics Texas Pilot Project

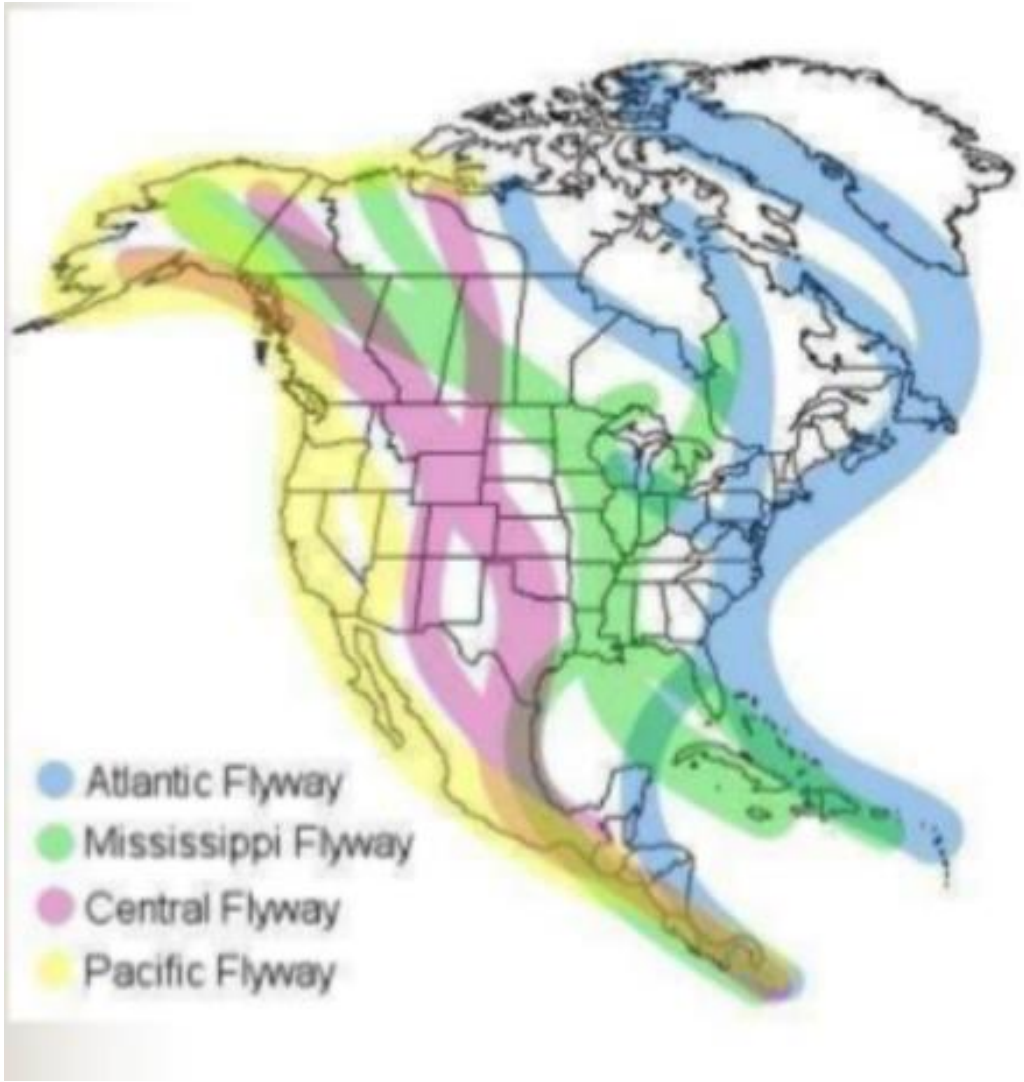
- Focus on Texas coast as proof-of-concept demonstration project

- Developing EcoHealth Metrics for specific coastal systems:
  - Seagrass ecosystems
  - Oyster reefs
  - Fisheries – recreational & commercial
  - Birds - resident populations & migratory birds

Linking Ecosystem Health, Services, and Well-Being



North American Flyways



Categorizing Texas Avian Fauna

Breeding-Residents

Shorebirds (***Colonial Nesters***):
- Un-vegetated Nesting Habitat
- Shallow Open-Water Foraging Habitat

Shorebirds: (***Solitary Nesters***)
- Vegetated Nesting Habitat
- Shallow Marsh Foraging Habitat

Waterfowl: Marshes, Brackish, etc.

Wintering - Migratory

Shorebirds:
- Migration distance
- Migration pattern
- Feeding strategy
- Habitat preference

Waterfowl:
- Habitat preference
- Feeding strategy

Bird Data Sources

Christmas Bird Count - http://netapp.audubon.org/cbcobservation/
Midwinter Waterfowl Surveys - https://migbirdapps.fws.gov/mbdc/databases/mwi/mwsoptions.asp
Breeding Bird Survey - https://www.mbr-pwrc.usgs.gov/bbs/bbs.html
Texas Colonial Waterbird Survey

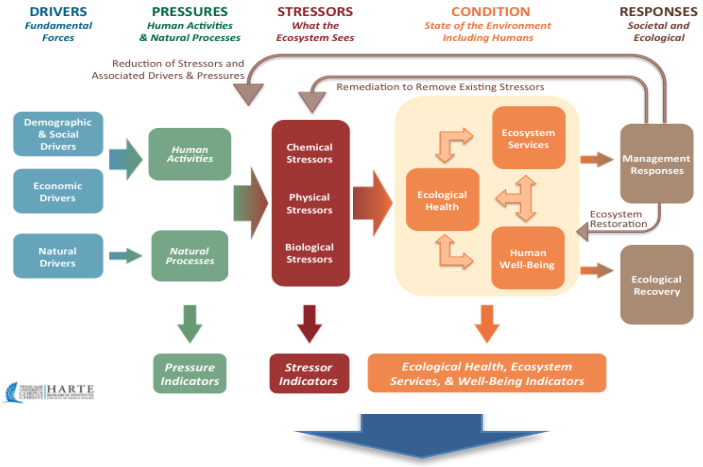
Avian EcoHealth Metrics Strategy

Categorize Coastal Avian Fauna

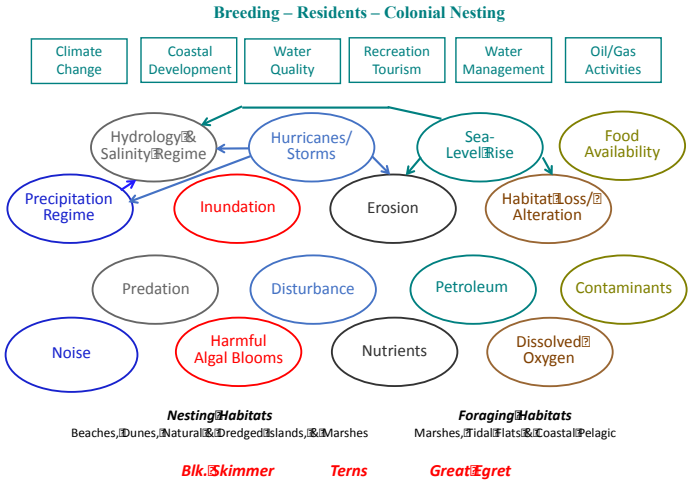
Over-wintering — Migrants
(Plovers, Sandpipers, Knot, etc.)

Breeding – Residents
(Skimmers, Terns, Egrets, etc.)

Apply DPSCR$_4$ Framework



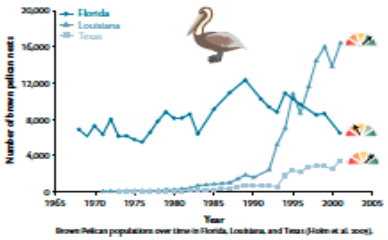
Conceptual Model



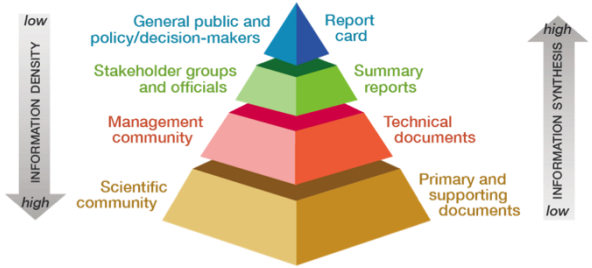
DRIVERS	PRESSURES	STRESSORS
Population Growth	Agriculture	Pesticides
Climate Change	Sea-Level Rise	Salinity Changes
Urban Development	Water Management	Sedimentation
Energy Development	Resource Extraction	Habitat Alteration
Demographics	Land-Use Changes	Invasive Species
Industry	Contaminant Spills	Nutrient Loading

Rank DPSCR$_4$ Relationships
Define Benchmarks
Analyze Data

Analyze Indicator Trends



Communicate Results



Avian Pressure - Stressor – Effects Rankings

Pressures-Stressors	Physical																	
DPSCR MATRICES	Hydrology	Salinity Regime	Precipitation Regime	Sedimentation	Erosion	Habitat Alteration	Fire Regime	Sea-Level Rise	Inundation	Hurricanes/Storms	Resource Harvesting	Marine Debris	Solid Waste Disposal	Temperature Changes	Turbidity	Noise	Subsidence	SAV *Damage*
Breeding-Resident Shorebirds	H	H	H	L	L	L	L	H	H	H	L	L	L	L	L	H	L	L
Wintering-Migratory Shorebirds	H	L	M	L	L	L	L	H	H	H	L	L	L	M	L	M	L	L
Breeding-Resident Waterfowl	H	H	L	H	H	H	L	H	H	H	H	L	L	M	M	H	M	H
Wintering-Migratory Waterfowl	H	H	L	M	M	H	L	H	H	H	H	L	L	M	H	M	M	H

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Avian Pressure - Stressor – Effects Rankings

Pressures-Stressors	Chemical										Biological								
DPSCR MATRICES	Nutrient Loading	Organic Loading	Toxic Metals	Petroleum Releases	Petroleum Spills	Other Chemical Spills/Releases	Pesticides/Herbicides	Hypoxia	Atmospheric Deposition	Pharmaceuticals	Altered Food Availability	Predation	Pathogens	Invasive Species	Resource Harvesting	Harmful Microalgal Blooms	Harmful Macroalgal Blooms	Marsh Management	Human Presence
Breeding-Resident Shorebirds	H	L	L	H	H	H	H	L	L	L	H	H	L	L	L	H	H	L	H
Wintering-Migratory Shorebirds	L	L	L	M-H	M-H	M-H	L	L	L	L	H	M	L	L	L	M	M	H	H
Breeding-Resident Waterfowl	H	L	L	H	H	H	H	L	L	L	H	H	L	L	H	H	M	H	H
Wintering-Migratory Waterfowl	H	L	L	H	H	H	M	L	L	L	H	M	L	L	H	H	M	H	H

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Breeding Resident Shorebirds – DPSCR$_4$ Framework

Pressures/Stressors

Physical
- Hydrology
- Salinity
- Precipitation
- SLR/Inundation
- Storms
- Noise

Chemical
- Nutrients
- Petroleum releases
- Pesticides/Herbicides

Biological
- Food Availability
- Predation
- HAB
- Human Presence

Condition Attributes

Structural Attributes
- Areal Extent
- Habitat diversity
- Structural complexity
- Successional Patterns
- Population Trends
- Reproductive Trends

Functional Attributes
- Erosion Protection
- CWB Breeding Habitat
- CWB Non-Breeding Habitat
- Fish Habitat
- Invertebrate Habitat
- Marsh Habitat

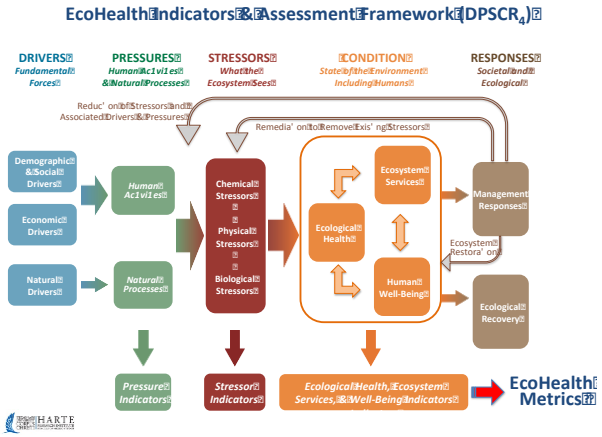
Eco-Services

- Recreation
- Tourism
- Birdwatching
- Economy

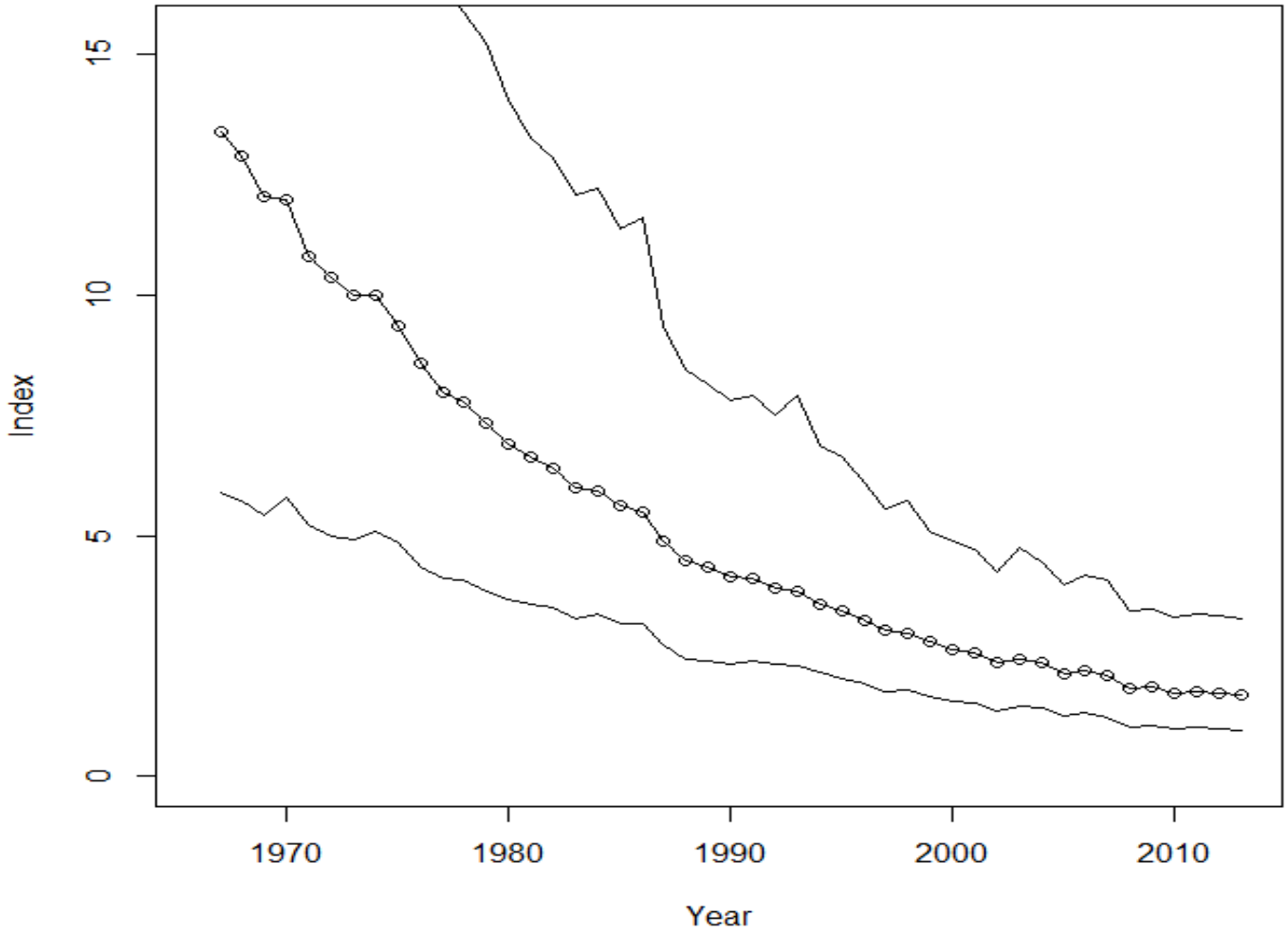
Well-Being

- Health
- Economic
- Recreation
- Cultural

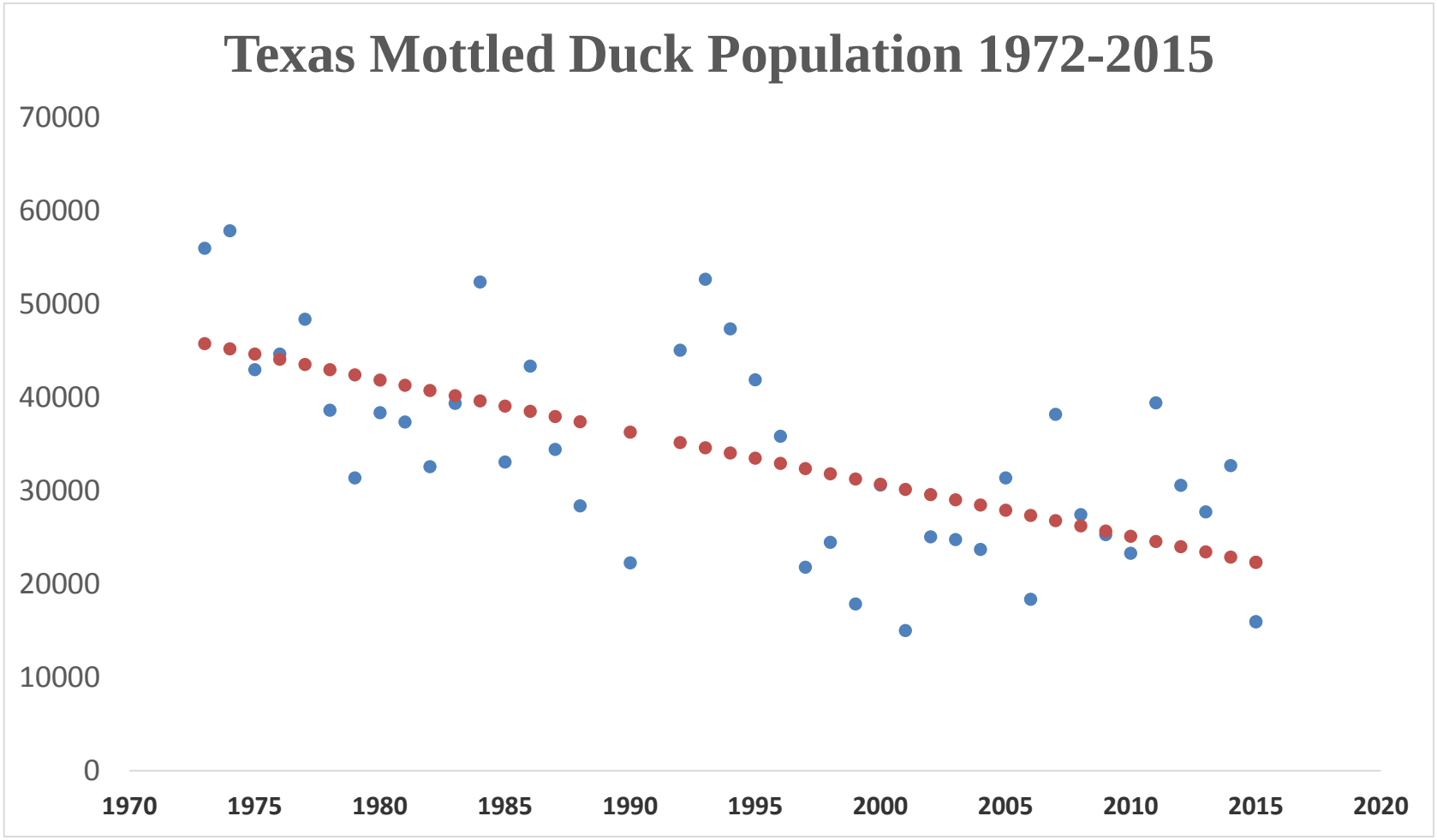
Populate DPSCR$_4$ Framework



Mottled Duck Trend Analysis (1970-2015)

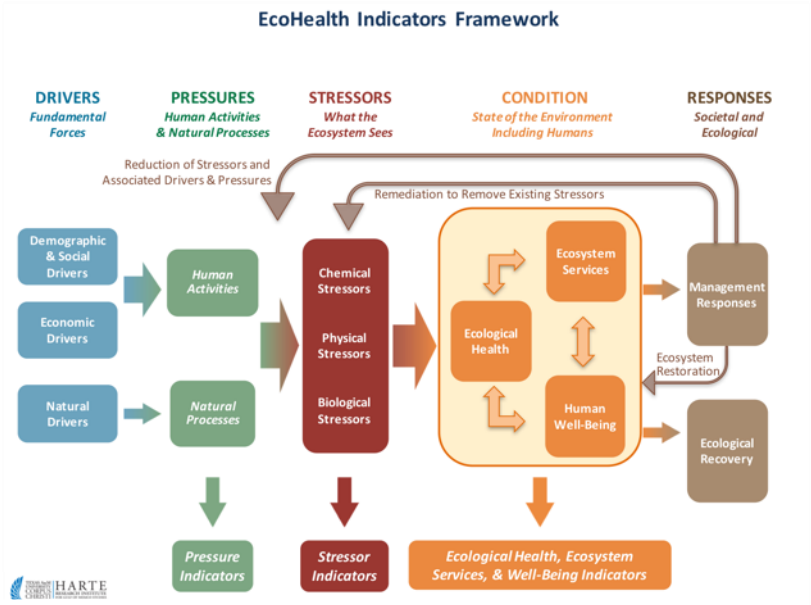


USSGS North American Breeding Bird Survey

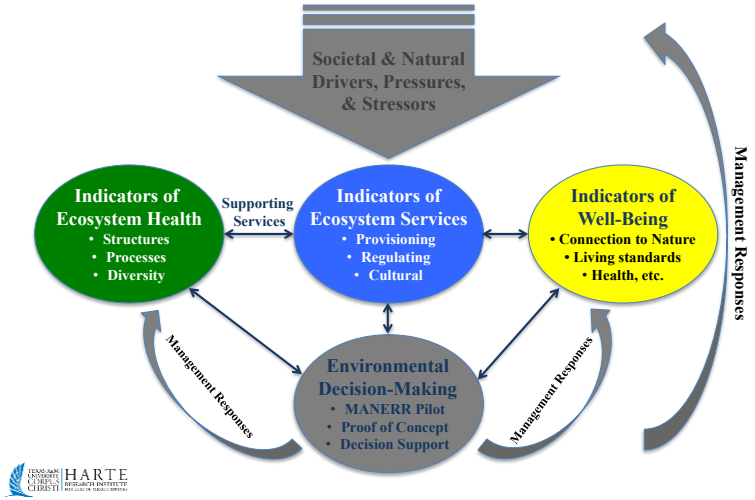


US FWS Mid-Winter Waterfowl Survey - 2015

Mission-Aransas Reserve Pilot Study



Linking Ecosystem Health, Services, and Well-Being



Goals:

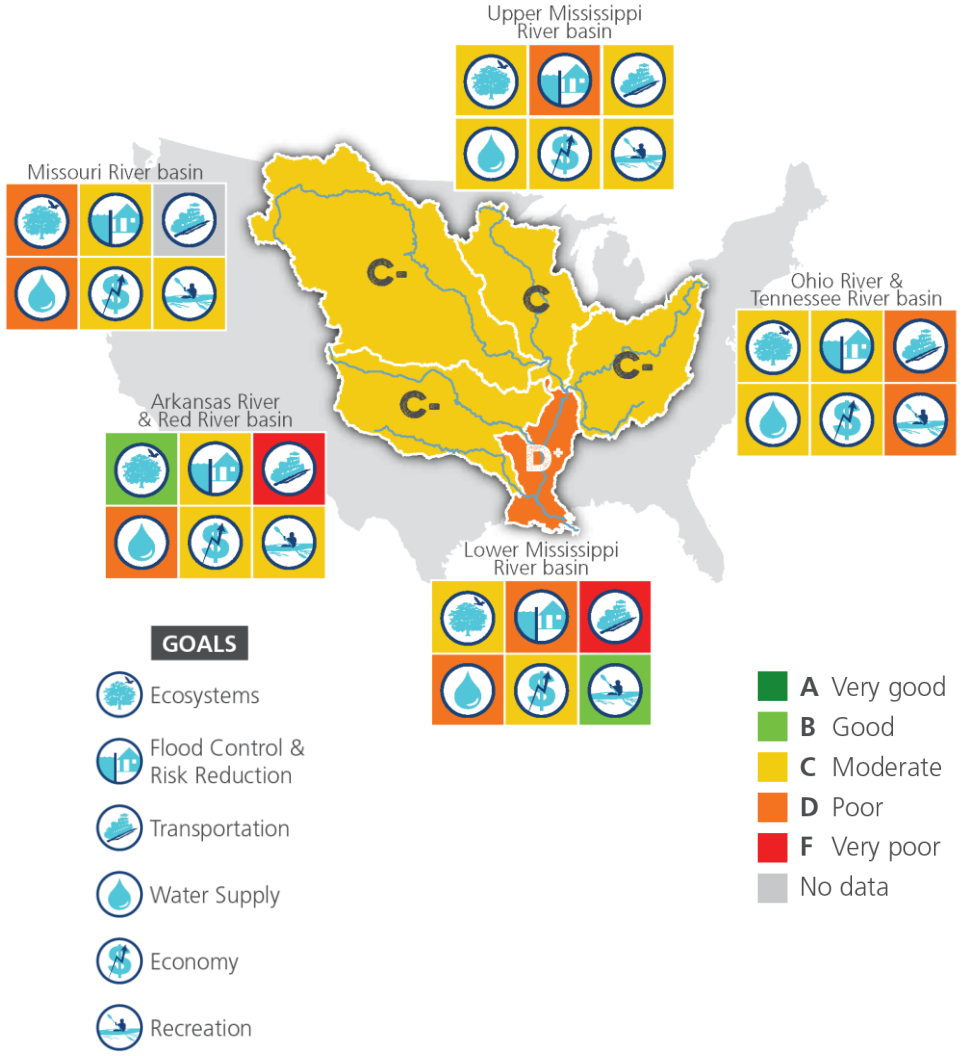
- **To test the integrated assessment framework and associated indicators in a real-world environmental management application.**
- **To specify key indicators for assessing ecological health and ecosystem services and identify their linkages to well-being.**
- **To conduct a proof-of-concept pilot study focused on specific management issues of the Mission-Aransas NERR.**

EcoHealth Metrics Mission-Aransas Pilot Project

- **Focus on Mission-Aransas National Estuarine Research Reserve**
- **Extend EcoHealth Metrics to ecosystem services and well-being**
- **Management Goals:**
  - ***Enhance recovery of resident and migratory coastal birds***
  - ***Increase bird feeding and breeding habitat***
  - ***Develop new or extended rookery islands***
  - ***Enrich ecosystem services***
- **Approach: Apply decision-support framework**
  - ***Develop site-specific conceptual models***
  - ***Identify management alternatives***
  - ***Conduct geospatial scenario-consequence analyses***
  - ***Select optimal alternative***
  - ***Inform decision process***

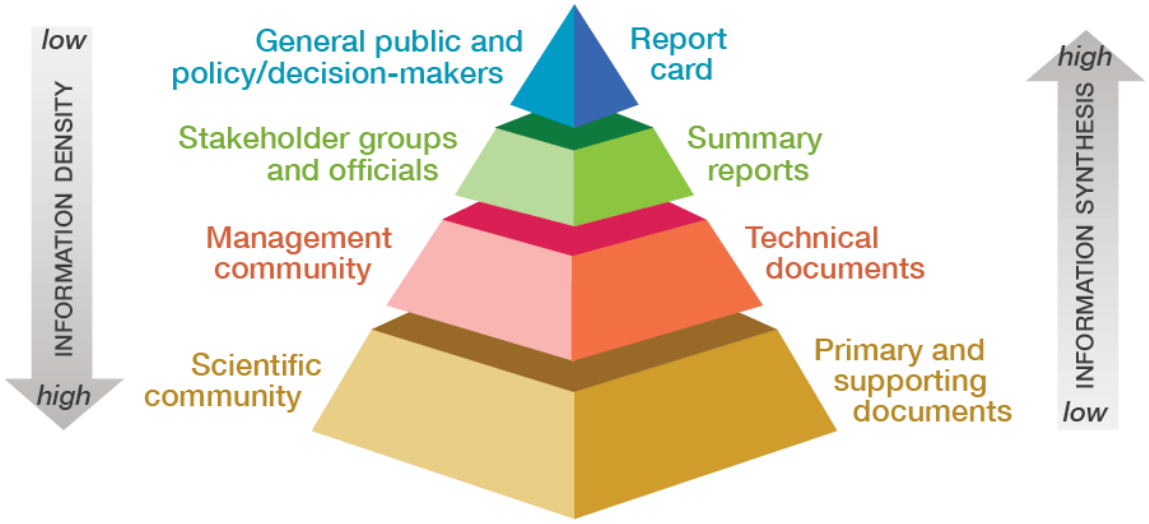
What is an ecosystem health report card?

- Broad-level assessments of a region or system
- Communicate complex information clearly
- Based on real data: transparent and defendable

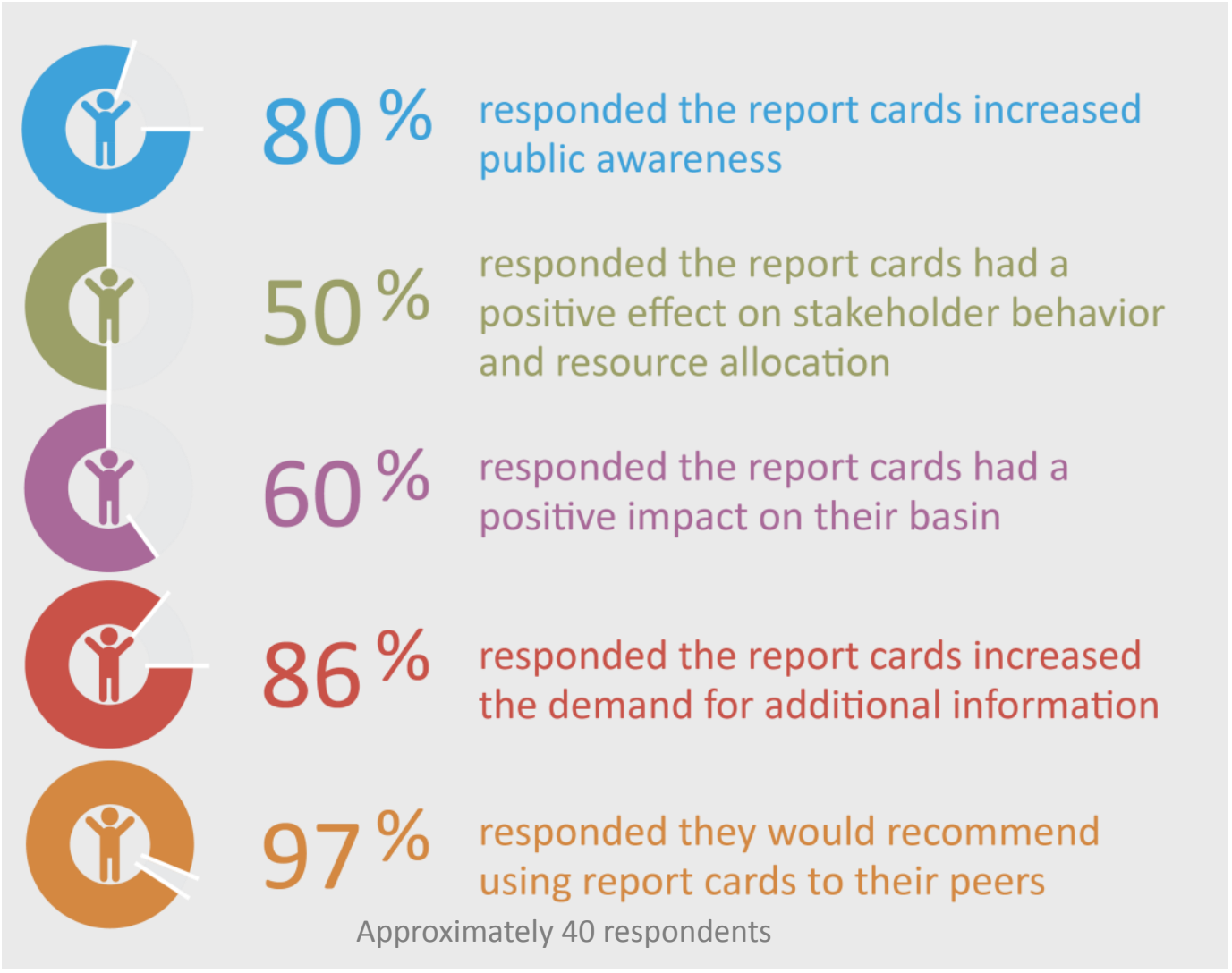


The report card provides information for multiple users

- Report Card is supported by data
- Methods are transparent
- Users can access information most relevant to them



The report card provides information for multiple users



UMCES Report Card work

The process provides big benefits

- Creates full engagement from multiple stakeholders
- Forces a critical review of available data
- Forces goal setting and status assessment
- Creates a shared vision

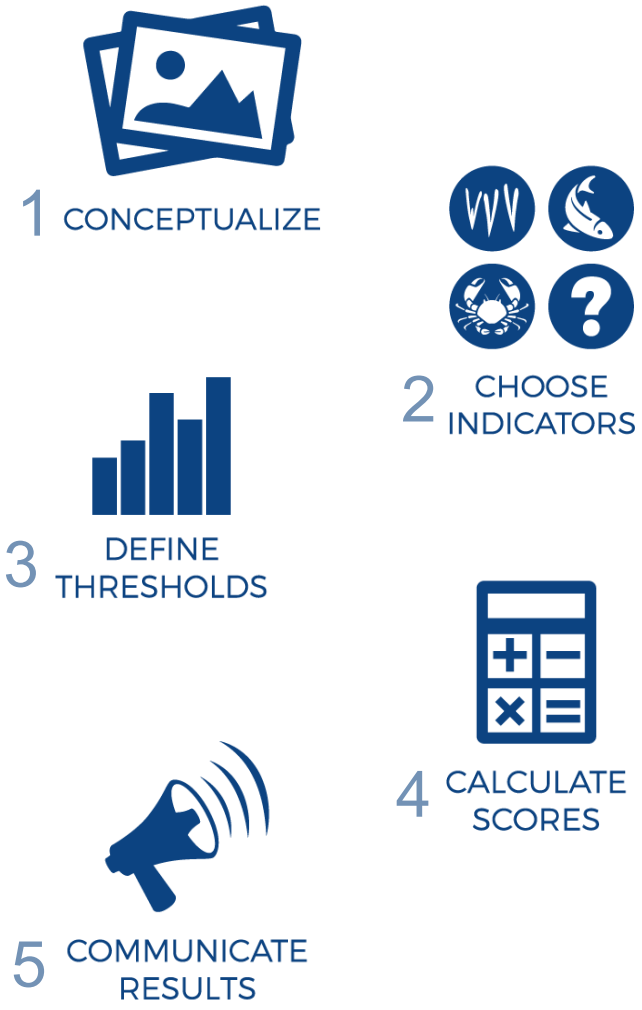


Table 3-7. *Temperature monitoring stations in the Willamette River and number of days the 7-day average maximum temperature (7DAM) criterion is exceeded during the summer of 2014. Percent of 7DAM meeting criteria based on 94 days from June 21 to September 22, 2014.*

Willamette Report Card region	USGS station number	Station location	Summer criterion °C 7DAM	Summer 7DAM meeting criterion	Report card region Average 7DAM meeting criterion	Percent of 7DAM meeting criterion	Report Card score (%)
Lower Willamette River	14211720	Portland	20	21	21	22%	22%
Mid Willamette River	14197900	Newberg	20	28	16	17%	17%
	14192015	Keizer	18	3			
Upper Willamette River	14174000	Albany	18	12	22	23%	23%
	14166000	Harrisburg	18	31			
	14158100	Eugene	18	23			

Water Quality Indicators

DO Dissolved oxygen

Dissolved oxygen is critical to the survival of fish and shellfish. The amount of dissolved oxygen needed before fish and shellfish are stressed, or even die, varies between species.

N Nitrogen

Nitrogen comes from human sources like wastewater, septic systems, and lawn fertilizer. Nitrogen, coupled with phosphorus, is leading to algal blooms and decreased dissolved oxygen levels. Nitrogen is taken up and used quickly by phytoplankton (microalgae).

P Phosphorus

Nitrogen and light limits algal growth in most of Long Island Sound. Phosphorus entering the Sound is greater than what the algae can use; the generally conservative nature of phosphorus therefore makes it a good indicator of human inputs to the system.

Chlorophyll *a*

Chlorophyll *a* measures the amount of phytoplankton (microalgae), which uses both nitrogen and phosphorus to grow. Too much algae in the water reduces water clarity, and decomposing algae leads to reduced dissolved oxygen.

Water clarity

Water clarity is a measure of how far light penetrates through the water. Clear water allows fish to find prey and helps underwater plants to thrive.

Water quality illustrates the story of pollution and dilution in Long Island Sound

D+ Eastern Narrows

The Eastern Narrows received a D+ (69%), a poor grade, because dissolved oxygen, water clarity, and nutrients continue to be problems. The Eastern Narrows has urban and suburban development and the water has little exchange with the Atlantic Ocean.

B Central

Central Long Island Sound received a B (84%), a moderately good grade, because most indicators scored well. This area is less developed than the Narrows, with fewer pollution impacts, and has better exchange with the Atlantic Ocean.

Long Island Sound

There is a variation from west to east of unhealthy (F) to healthy water quality (A). The Western Narrows is affected by the highly populated, suburban-urban communities surrounding New York City and scored the worst. Moving east from western Connecticut and western Long Island, the water quality improves. In the eastern Sound, the pollution is diluted by exchange with the Atlantic Ocean. Overall, water quality indicators in Long Island Sound scored good or very good except phosphorus, which scored poorly. Very high turbidity in the Western Narrows restricts light, preventing phytoplankton growth; however, moving east from western Connecticut and western Long Island, turbidity improves, which allows phytoplankton to grow.

Reducing nutrient inputs from human activities on land is critical to improving the health of the Sound. Check out the back page for actions you can take to help the Sound. To find out more about the report card indicators and grades, visit longislandsound.ecoreportcard.org.

F Western Narrows

The Western Narrows received an F (45%), the worst grade out of the entire Sound. Almost every indicator scored very poor or poor. Very high turbidity restricts light, preventing phytoplankton growth, which leads to a good chlorophyll *a* grade. This area is densely developed, and has very little exchange with the Atlantic Ocean.

B- Western

The Western Long Island Sound received a B- (81%), a moderately good grade. There is a mix of healthy and unhealthy indicator grades. Improved water clarity led to a moderate chlorophyll *a* grade. This region is influenced by the poor health of the Eastern Narrows, but is somewhat less developed than the Narrows.

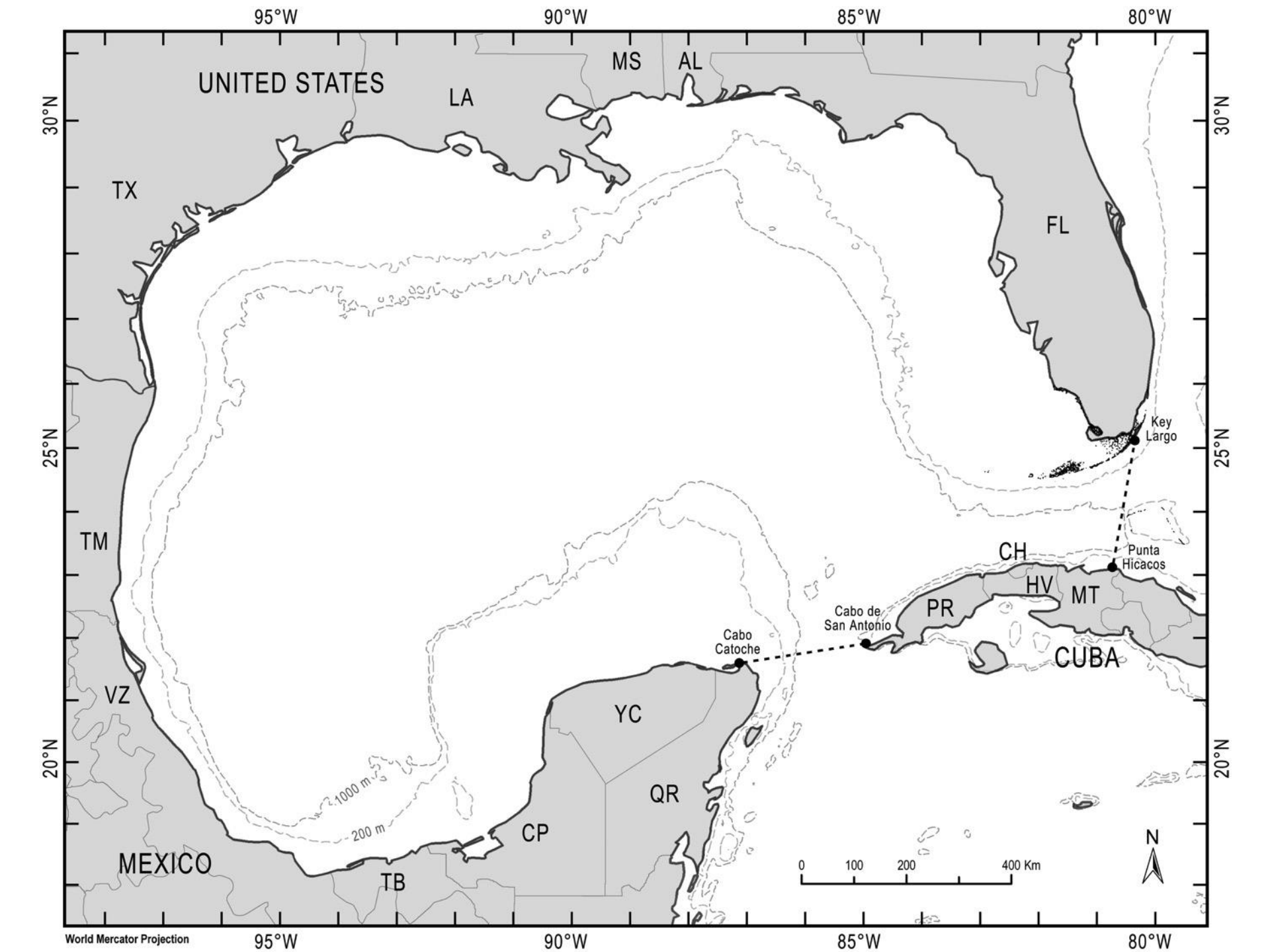
A Eastern

The Eastern Long Island Sound received an A (93%), the best grade out of the entire Sound. All indicators scored very good. This region has a lower population and a mix of rural, suburban, and agricultural uses, and has a lot of exchange with the Atlantic Ocean.

How are the scores calculated?

This report card compares water quality indicators (dissolved oxygen, nitrogen, phosphorus, chlorophyll *a*, and water clarity) to scientifically derived thresholds or goals. These indicators are combined into an overarching Water Quality Index, which is presented as a subregion percent score. Other indicators presented on these pages are not included in the score. For more information about methods, please visit longislandsound.ecoreportcard.org.

- **A** 90–100%: All water quality indicators meet desired levels. Quality of water in these locations tends to be very good, most often leading to preferred habitat conditions for aquatic plants and animals.
- **B** 80–90%: Most water quality indicators meet desired levels. Quality of water in these locations tends to be good, often leading to acceptable habitat conditions for aquatic plants and animals.
- **C** 70–80%: There is a mix of good and poor levels of water quality indicators. Quality of water in these locations tends to be fair, leading to sufficient habitat conditions for aquatic plants and animals.
- **D** 60–70%: Some or few water quality indicators meet desired levels. Quality of water in these locations tends to be poor, often leading to degraded habitat conditions for aquatic plants and animals.
- **F** 0–60%: Very few or no water quality indicators meet desired levels. Quality of water in these locations tends to be very poor, leading to unacceptable habitat conditions for aquatic plants and animals.
- **ID** Insufficient Data (ID) is a designation used for areas where there is either insufficient or no data to give a grade on desired health levels.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