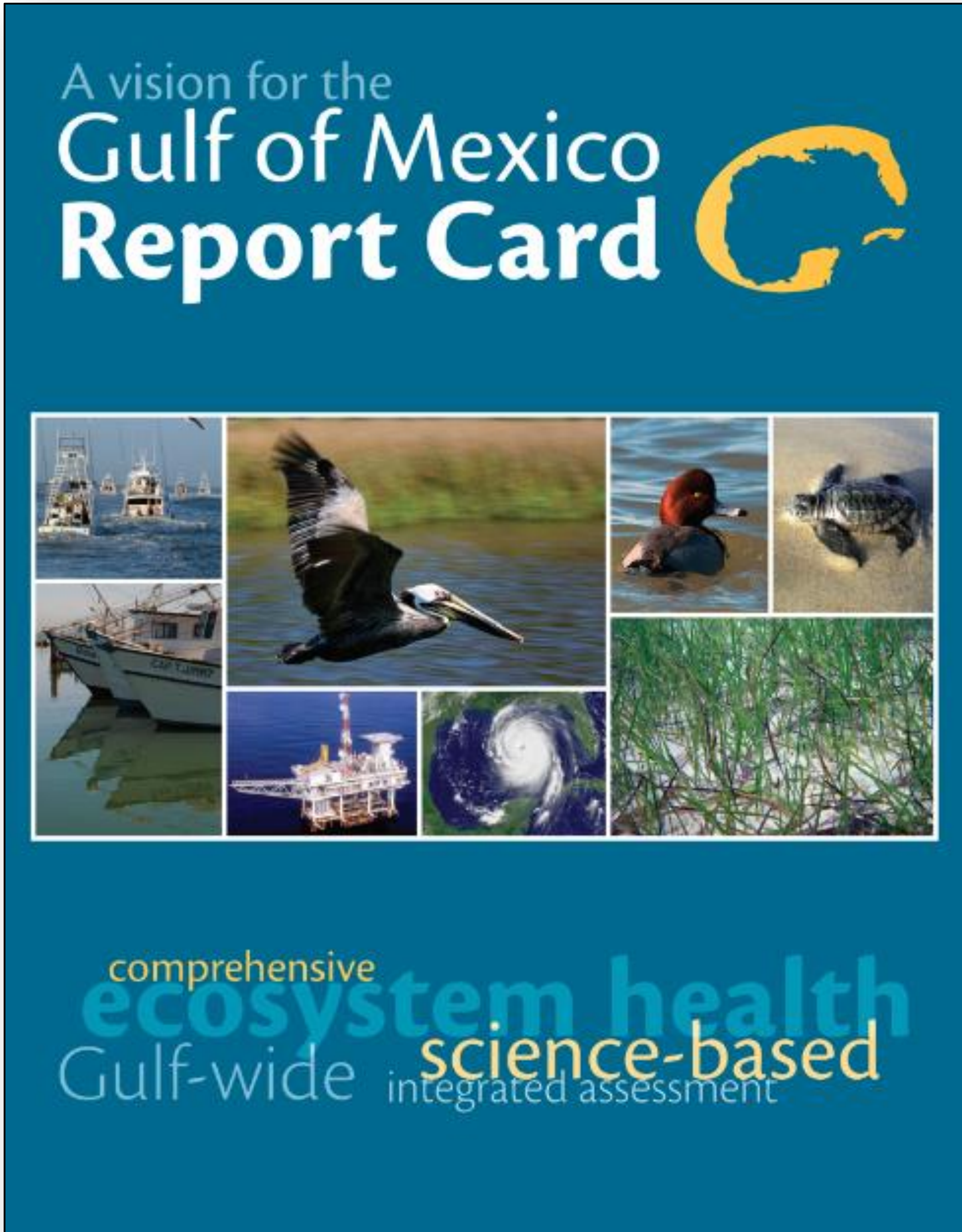

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A Report Card to Assess Ecosystem Health of the Gulf of Mexico

by **Wes Tunnell**
Harte Research Institute
for Gulf of Mexico Studies
Texas A&M University-Corpus Christi

5th National Conference on Ecosystem Restoration 1 August 2013, Chicago, Illinois

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

Harwell Gentile
& Associates, LC

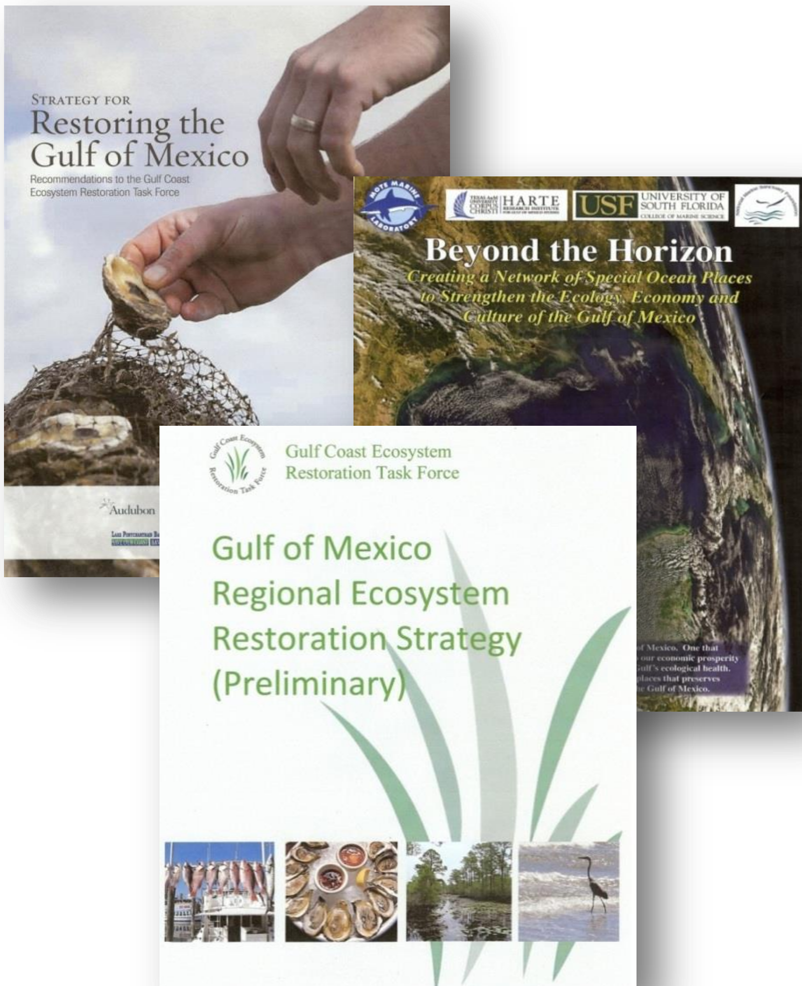
A Report Card for the Gulf of Mexico.

Why it should matter?

The Gulf of Mexico is a healthy and productive ecosystem, but there are many challenges to maintaining that status…

Over Fishing
Nutrient Over Enrichment
Habitat Loss
Water Quality
Freshwater Inflows
Climate Change

The Deepwater Horizon focused attention on the Gulf and its future as no other event ever has…



The challenge is to make sure that the funds and energy to be focused on the Gulf are effectively employed

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If you do not know where you came from, or where you are…

How will you know where you are headed and when you get there?

How do you get everyone on the same page…

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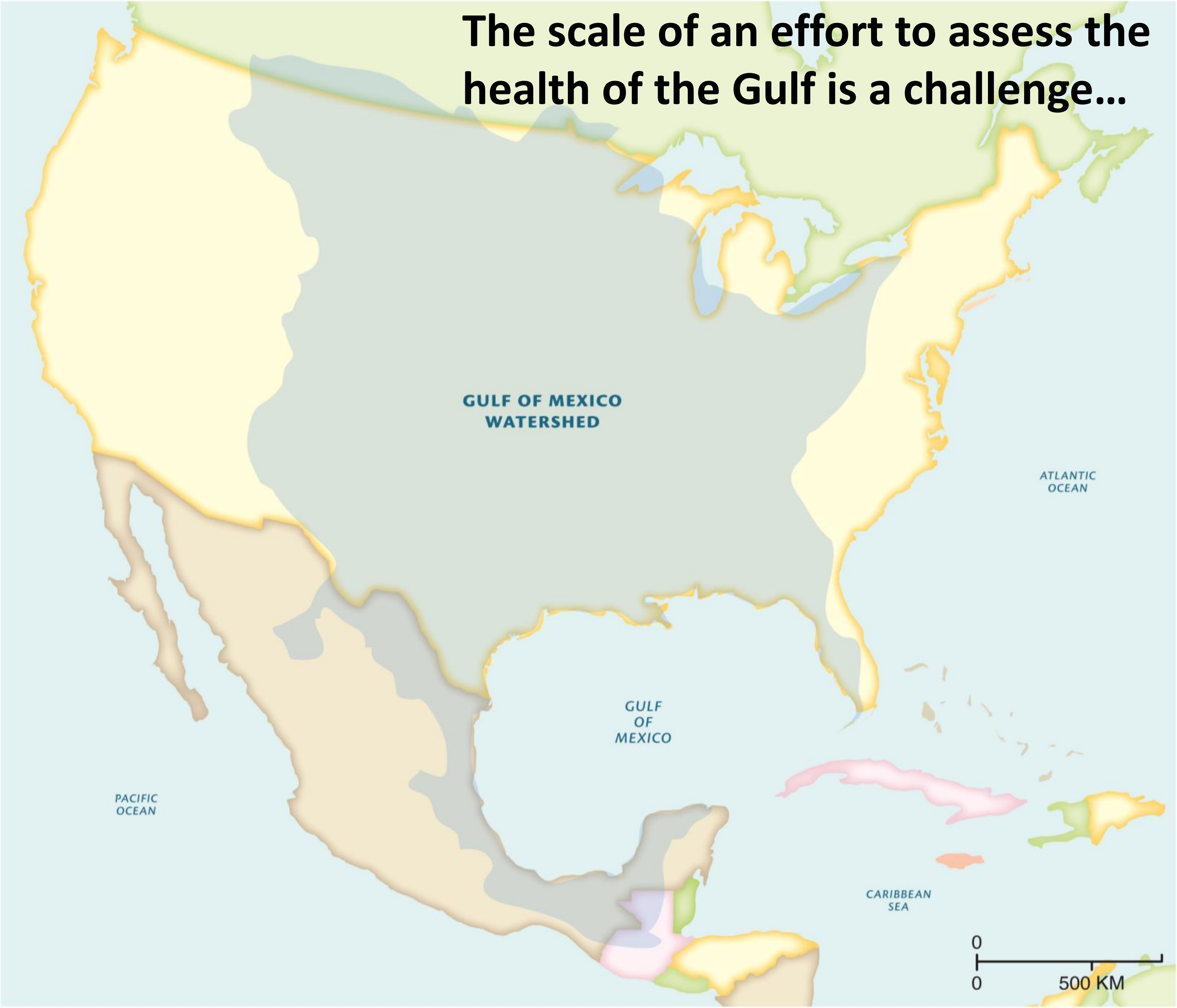
Moving in the same direction?

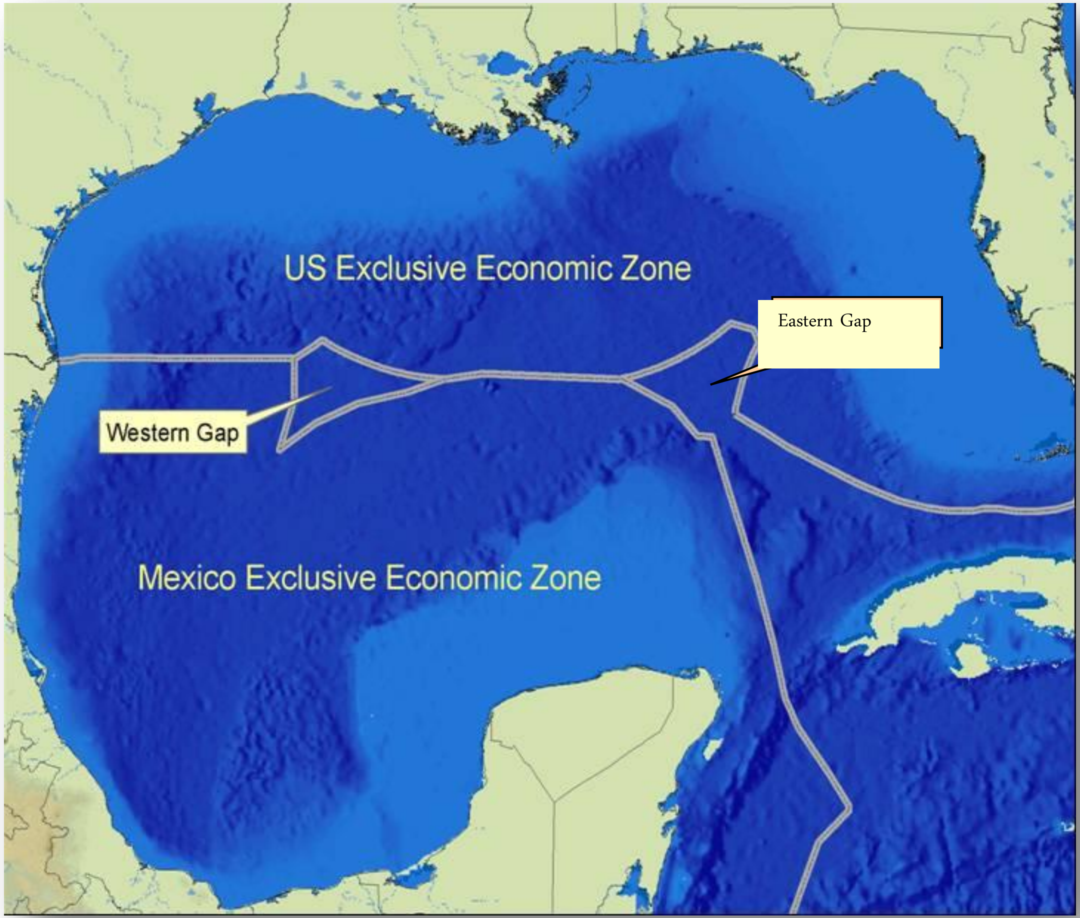
Gulf Stakeholders may have diverse goals…

But they share a common desire for a healthy and productive Gulf

The scale of an effort to assess the health of the Gulf is a challenge…



We need a Report Card that is also transboundry in scope and application

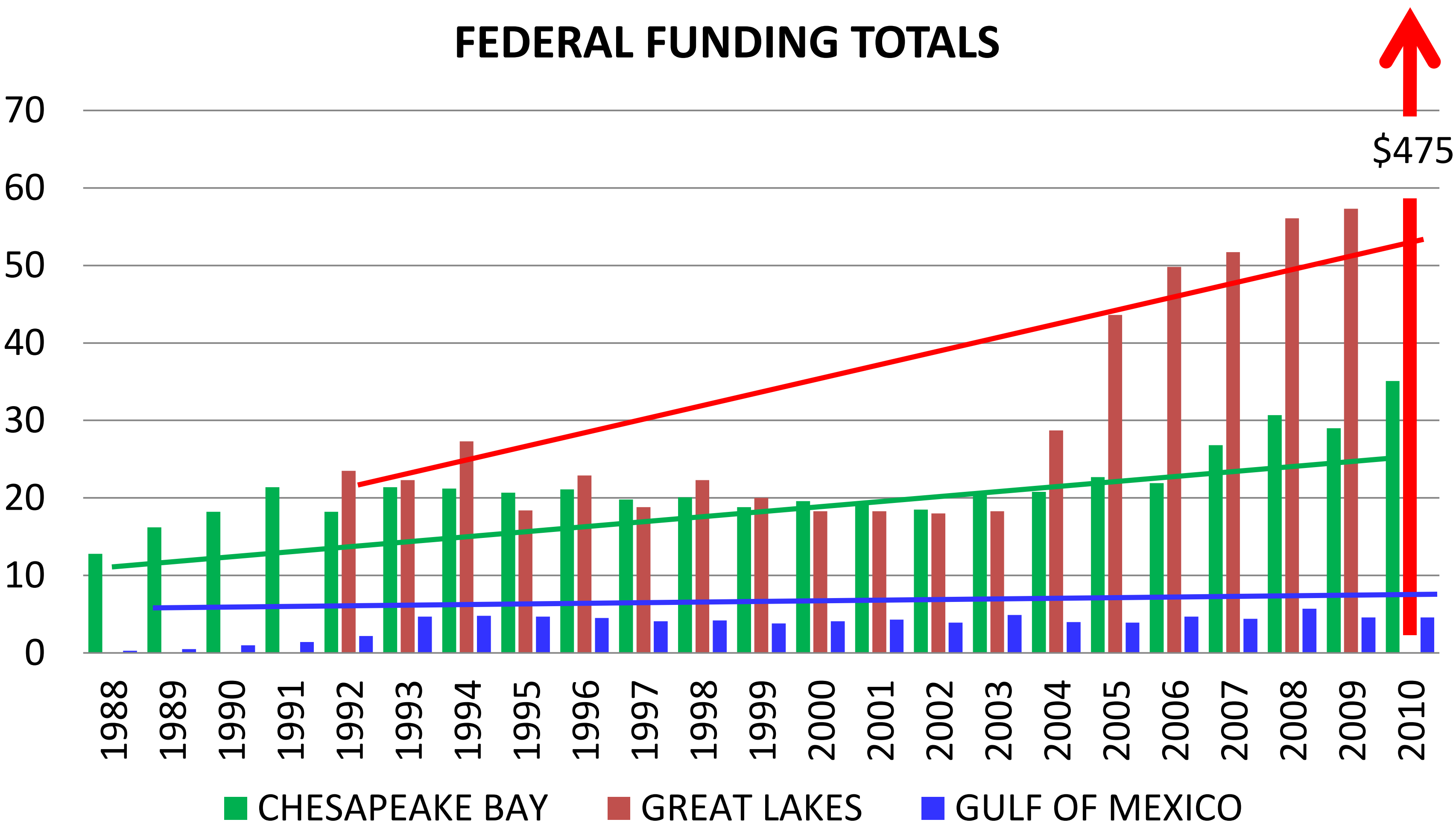


Mexico

United States

Cuba

FEDERAL FUNDING TOTALS



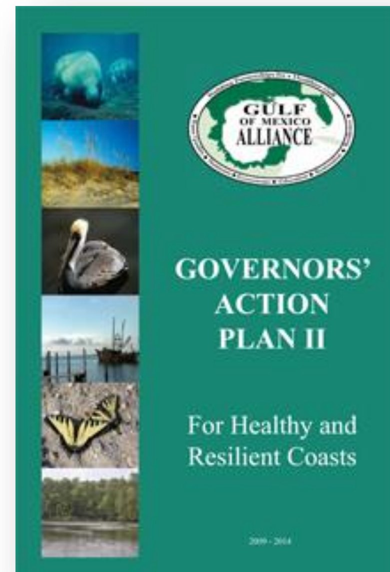
64,000 SQ MILES	***201,000 SQ MILES***	***596,000 SQ MILES***
$481.4 million	$1,010.6 billion	$86.3 million

An ecosystem level, science based Report Card for the Gulf of Mexico

The Gulf Report Card will…

Provide scientifically based metrics that guide future research

Support effective restoration efforts

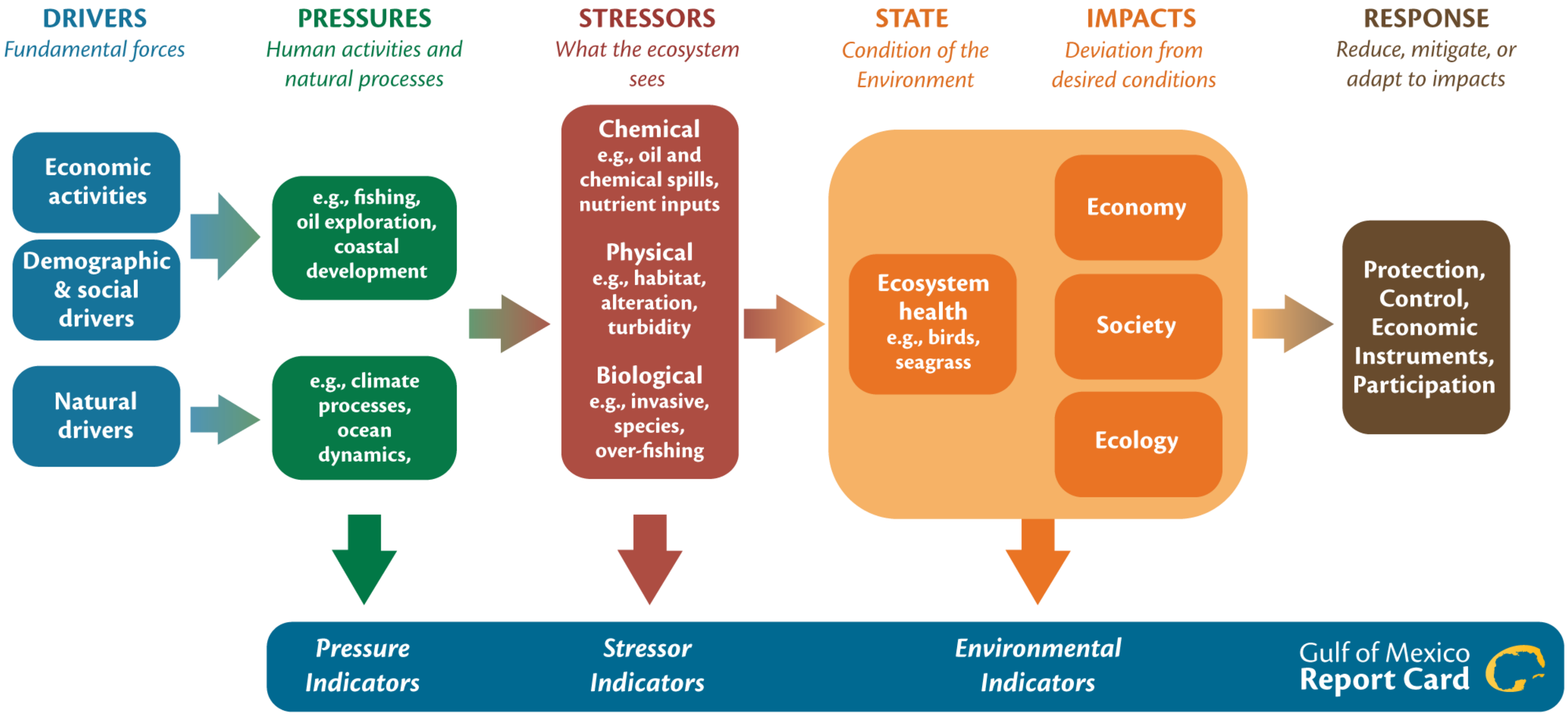


Be perceived as fair and objective

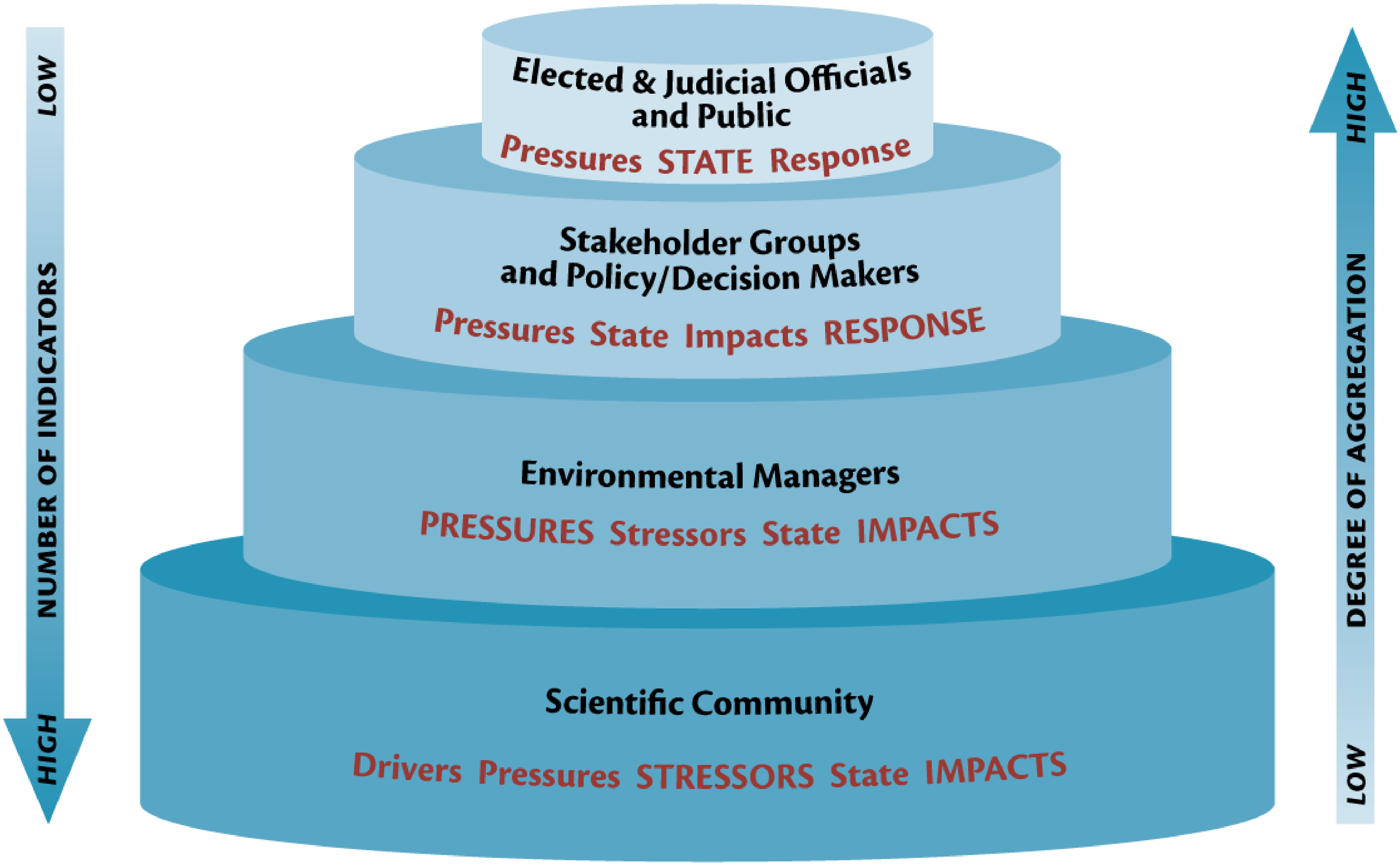
Build credibility and public support

Promote sound policy and decision-making

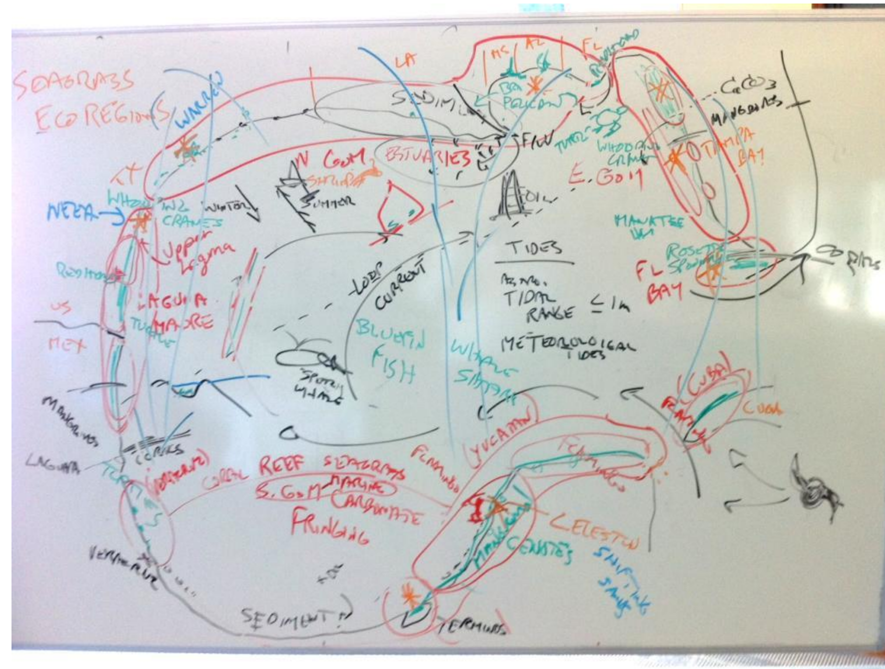
The Report Card foundation is a science-based conceptual framework



The Report Card is designed for multiple audiences and has a foundation in scientific data



The prototype was “hatched” at Harte Institute October 2011



Report Card Development Team

1. Larry McKinney, HRI, TAMUCC
2. Wes Tunnell, HRI, TAMUCC
3. Jack Gentile, Harwell Gentille & Assoc., LLC
4. Mark Harwell, Harwell Gentille & Assoc., LLC
5. Heath Kelsey, Univ. MD Center for Env. Sci.
6. William Dennison, Univ. MD Center for Env. Sci.

The framework in graphic form:
A conceptual diagram

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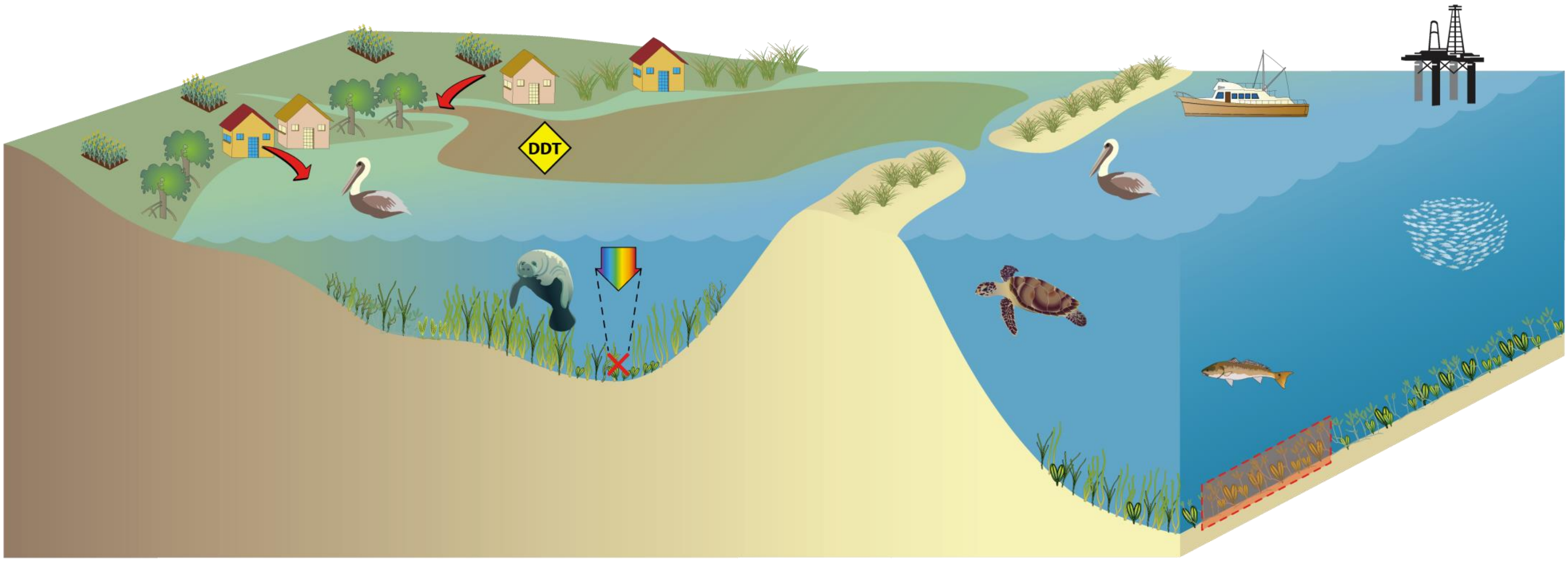
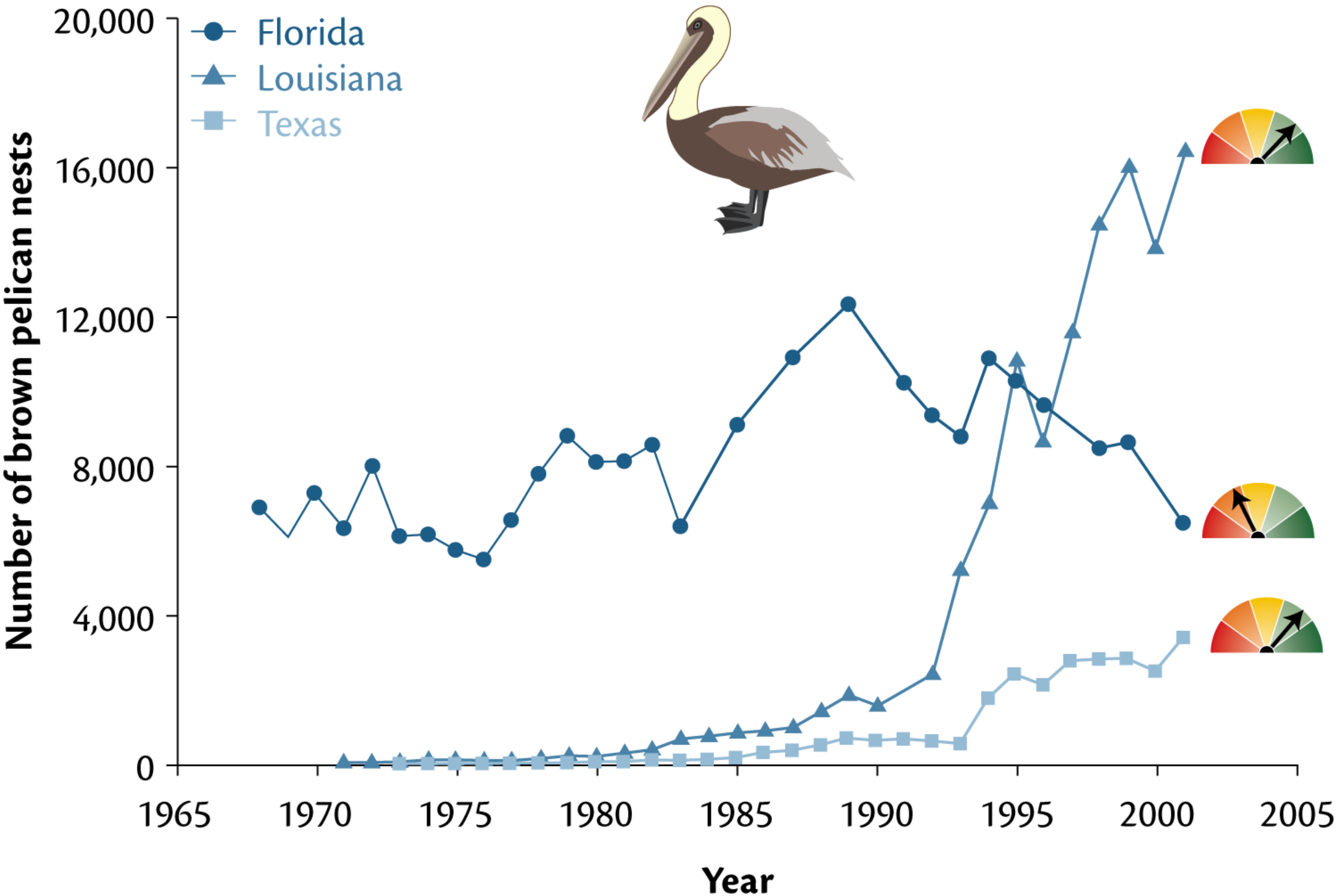


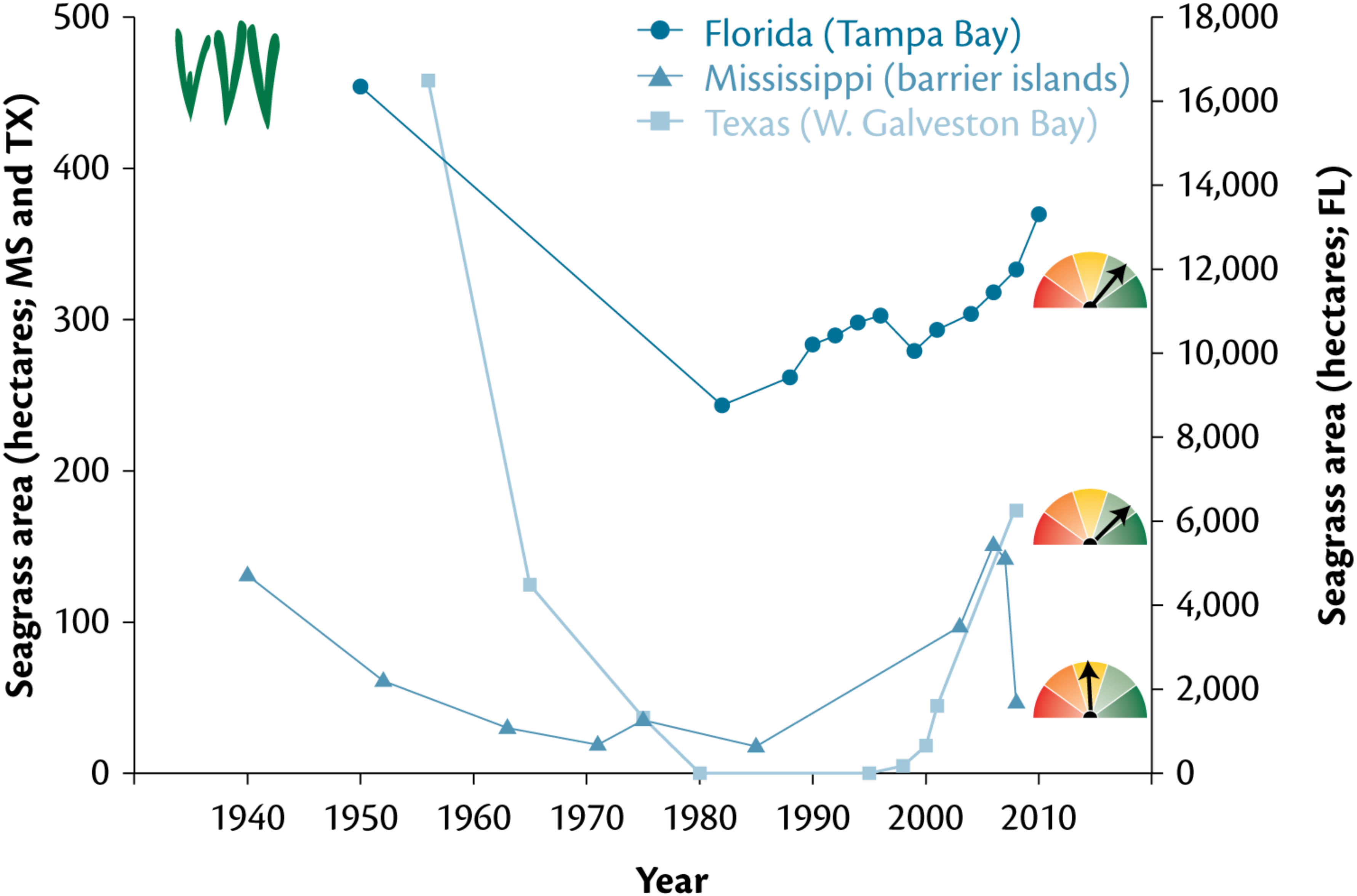
Contaminants, in particular DDT, reduced Brown Pelican populations prior to the chemical being banned in the USA in 1972. Brown Pelican populations rebounded but habitat alterations continue to be a threat to the population.

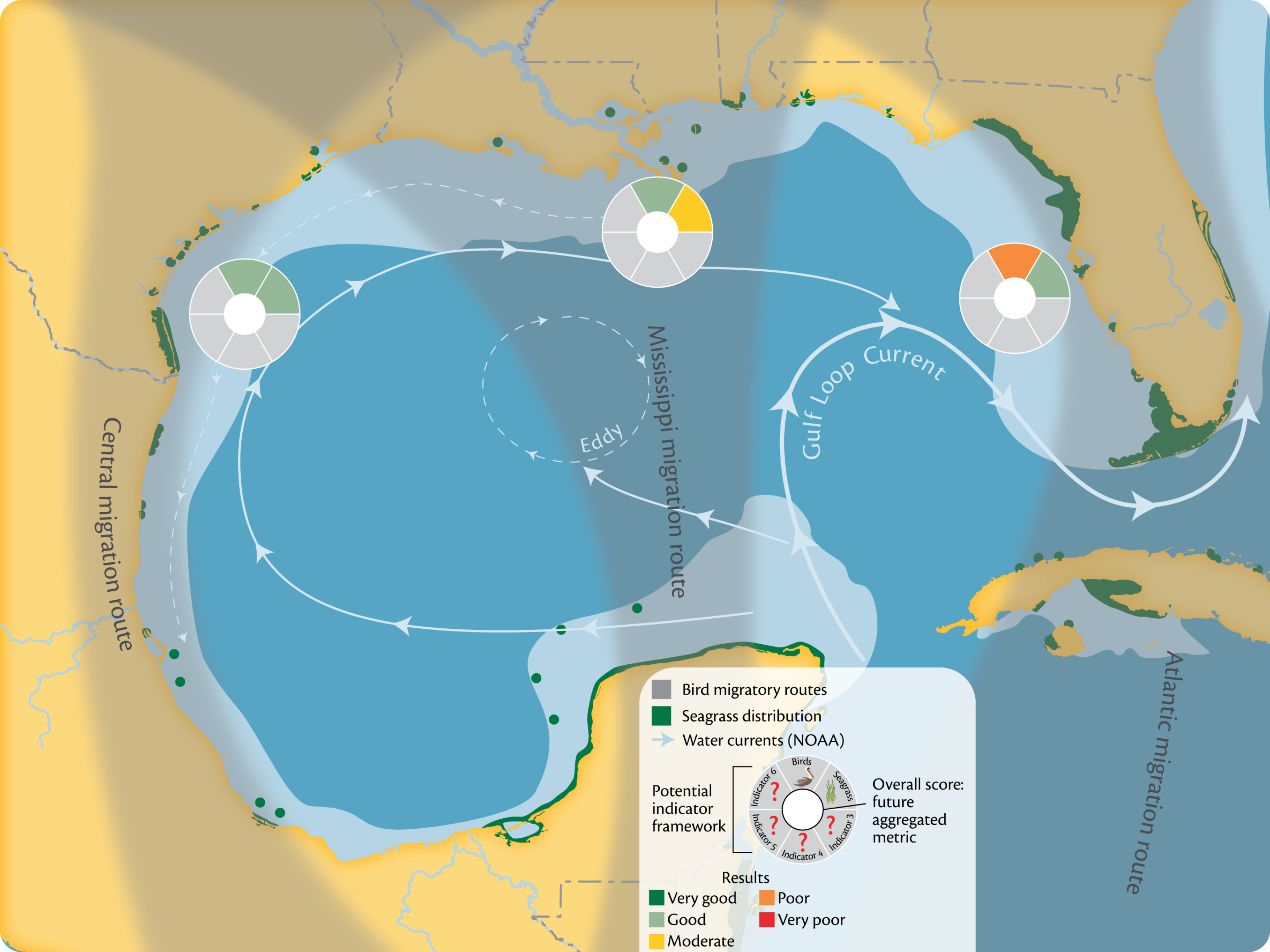
Urban development and agriculture runoff lead to turbidity and nutrient inputs into shallow coastal waters. Various seagrass species are adversely affected by reduced light, reducing seagrass area.

Brown Pelican is an iconic, colonial nesting shorebird

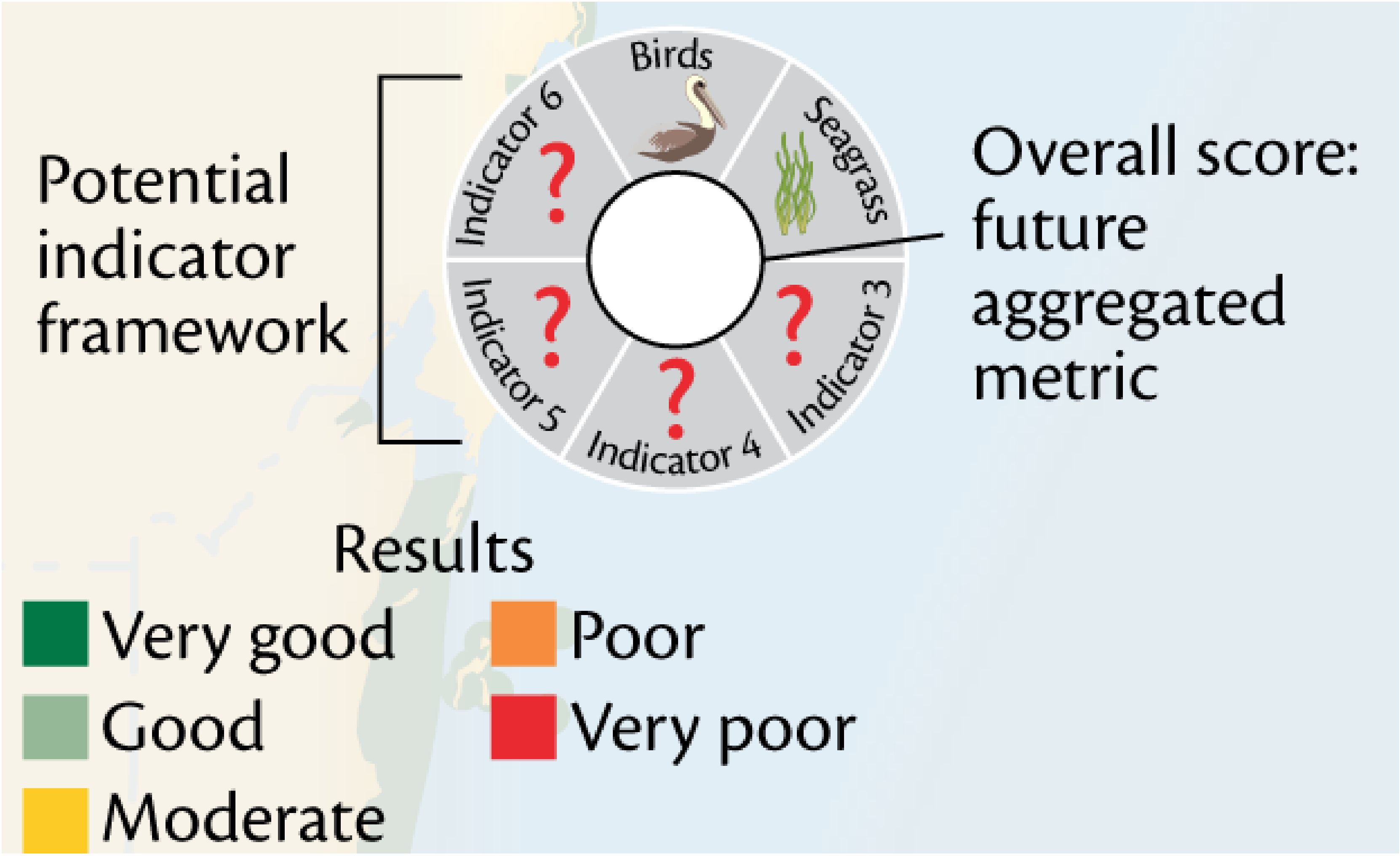


Seagrass is an essential shallow water habitat




Central migration route
Mississippi migration route
Atlantic migration route
Gulf Loop Current
Eddy
Bird migratory routes
Seagrass distribution
Water currents (NOAA)
Potential indicator framework
Birds
Seagrass
Indicator 3
Indicator 4
Indicator 5
Indicator 6
Overall score: future aggregated metric
Results
Very good
Good
Moderate
Poor
Very poor

Results are represented clearly



The five steps for creating a report card

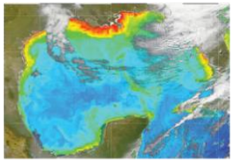
Create a conceptual framework

Step 1—Create new indicators and novel techniques for effective reporting and rigorous spatial analysis.

Choose indicators

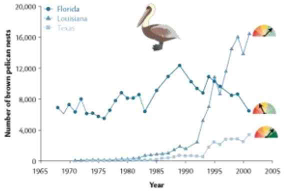
Step 2—Select indicators that convey meaningful information and can be measured reliably.

Define thresholds



Step 3—Define thresholds, reporting regions, and method of measuring threshold attainment.

Calculate scores



Step 4—Calculate indicator scores and combine into index grades.

Communicate results

Step 5—Communicate results using a variety of visual elements, such as photos, maps, figures, and conceptual diagrams.

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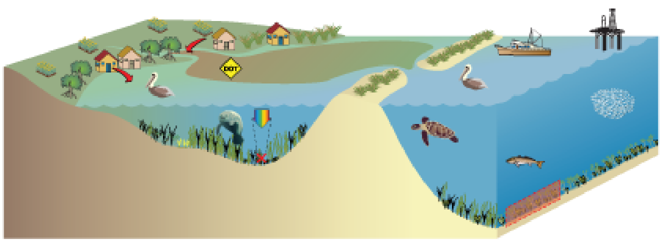
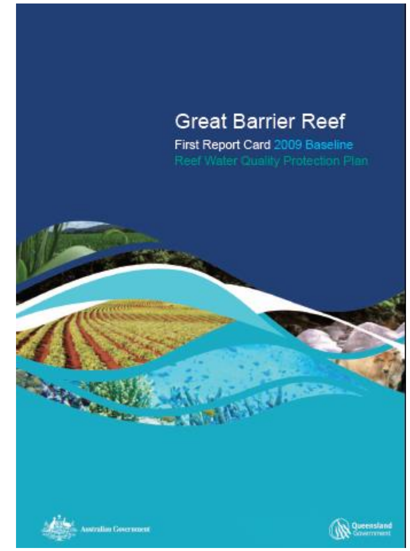
Step 1

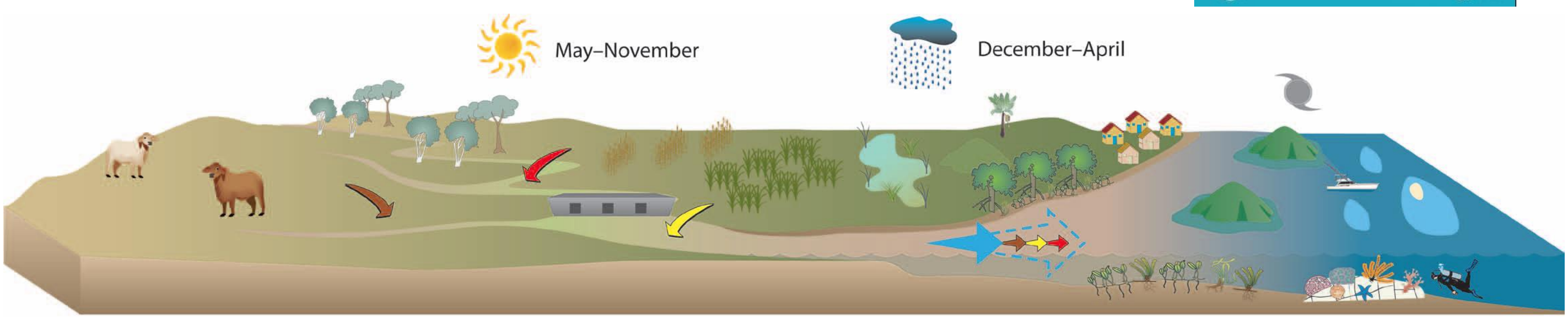
Create a conceptual framework



Step 1—Create new indicators and novel techniques for effective reporting and rigorous spatial analysis

Example





The Great Barrier Reef catchments are largely rural and dominated by summer monsoonal rains and occasional cyclones delivering sediments, nutrients and pesticides to the inshore and sometimes offshore portions of the reef in pulsed flows, which can be affected by water reservoirs and dams. Grazing is the largest single land use, and sugarcane, horticulture and other cropping make up other agricultural land uses. Small urban centres are located on the coastal strip. Habitats include wetlands, reef, seagrass and mangroves, and continental and coral islands are present. Reef-based tourism, as well as commercial and recreational fisheries, are an important part of the regional economy.

Step 2

Choose indicators

Step 2—Select indicators that convey meaningful information and can be measured reliably

Example

MTAC Mid-Atlantic Tributary Assessment Coalition

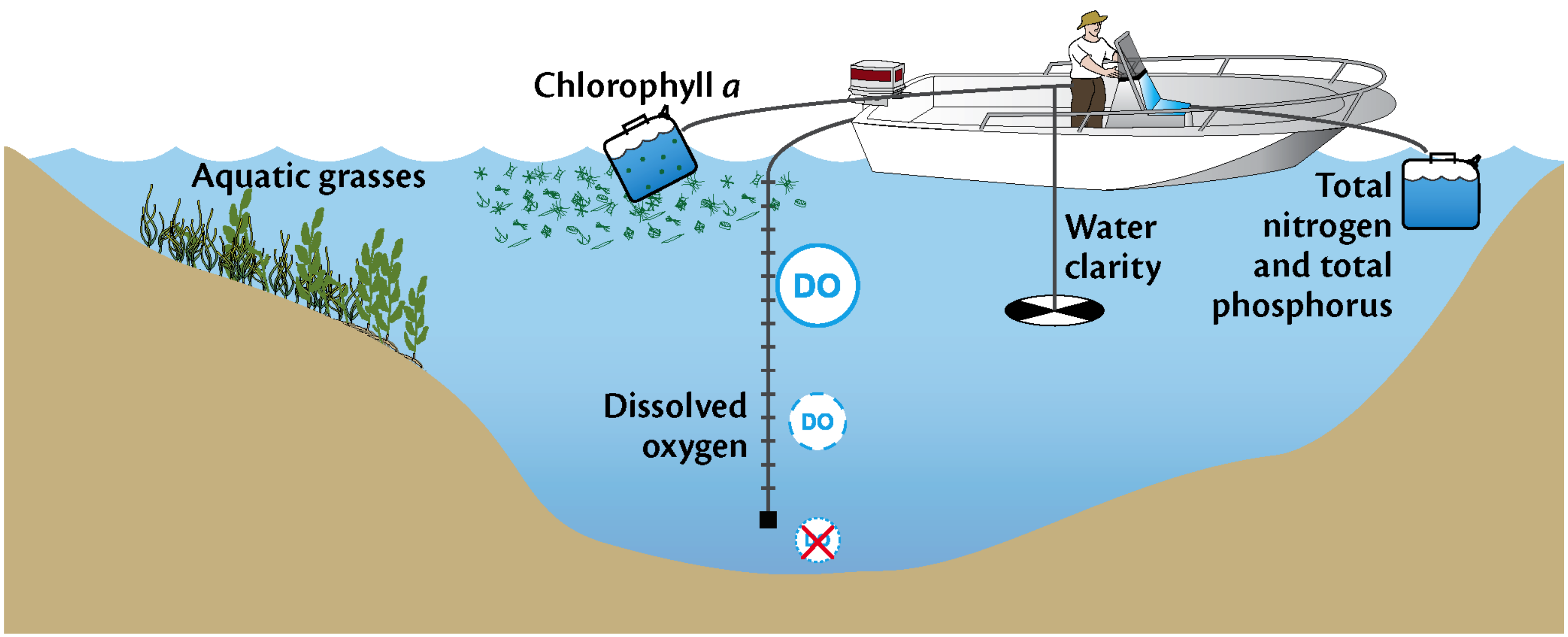
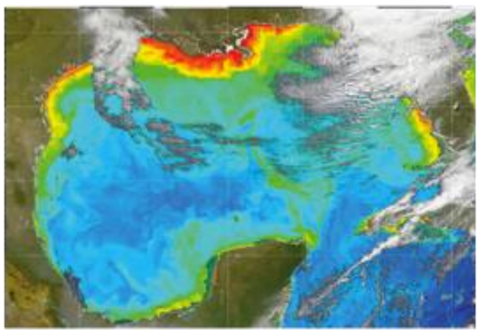


Figure 4.1. This conceptual diagram illustrates the six core indicators discussed in this document. Most indicators are measured by monitoring programs, although aquatic grasses in the Chesapeake Bay are also measured and provided to groups, by the Virginia Institute of Marine Sciences. Water samples are collected at sites so that chlorophyll *a*, total nitrogen, and total phosphorus can be analyzed in the lab.

Step 3

Define thresholds

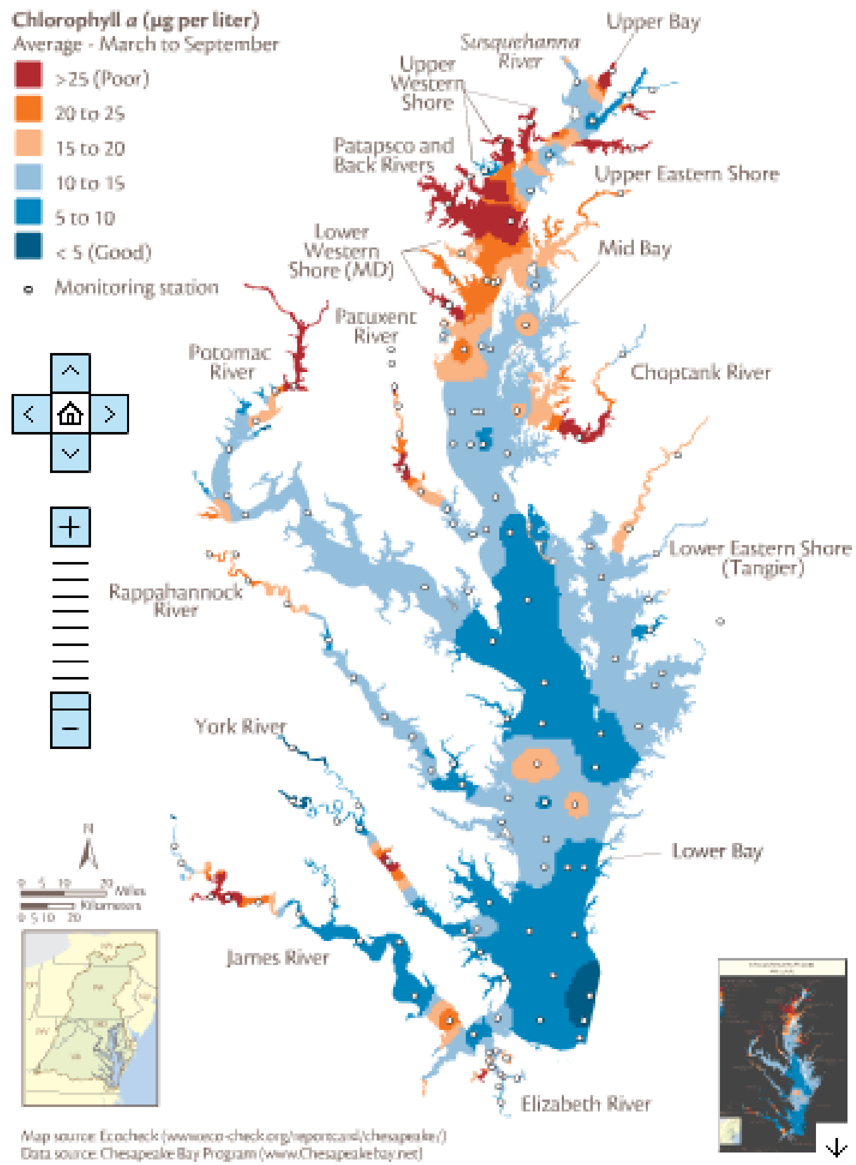


Step 3—Define thresholds, reporting regions, and method of measuring threshold attainment.

Example

Chesapeake Bay Health: 2010

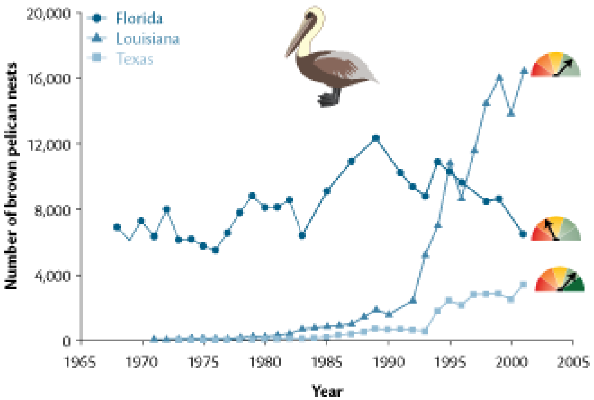
Chlorophyll *a*



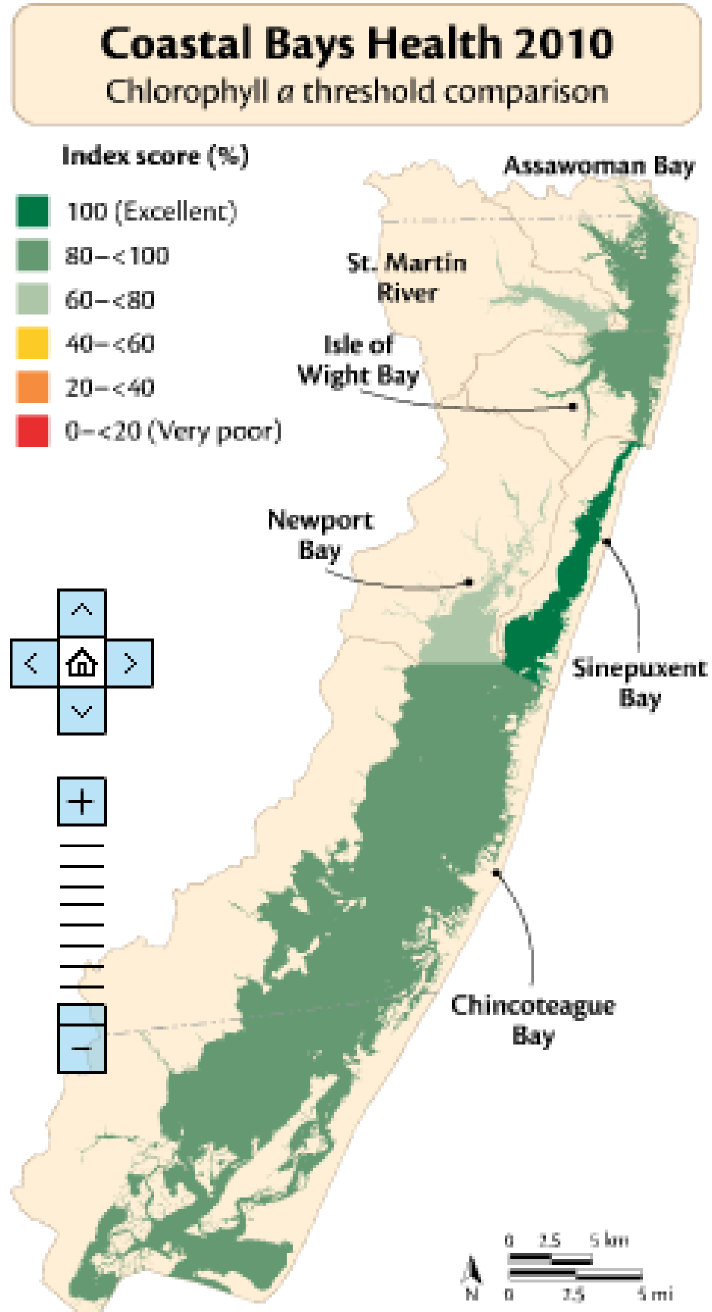
Example

Step 4

Calculate scores



Step 4—Calculate indicator scores and combine into index grades.



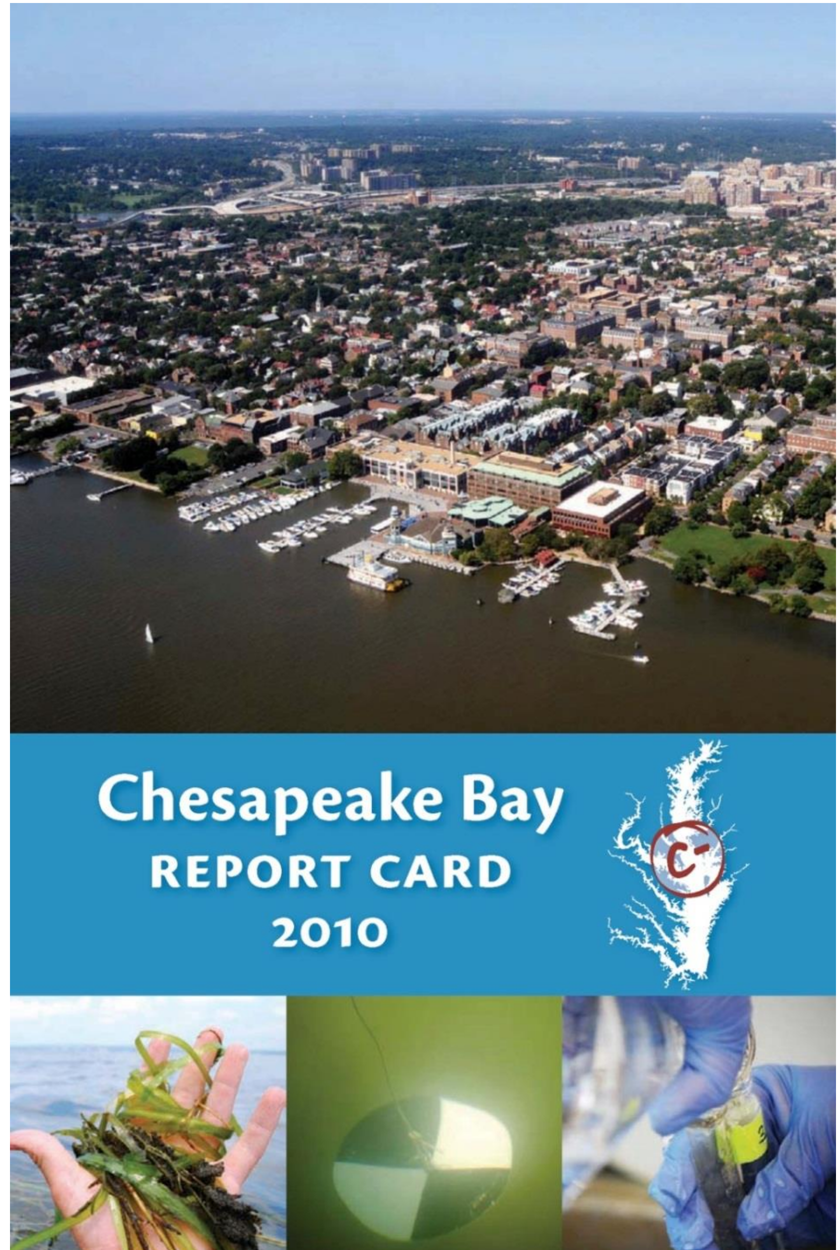
Example

Step 5

Communicate results

Gulf of Mexico Report Card

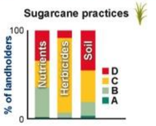
Step 5—Communicate results using a variety of visual elements, such as photos, maps, figures, and conceptual diagrams.

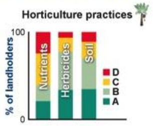


Communicate results

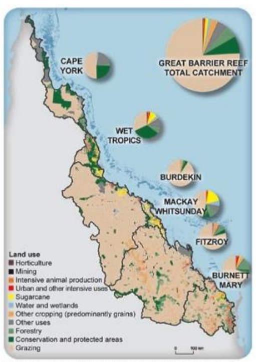
Land practice results

Adoption of improved management practices varies by industry and practice. The adoption of improved management practices for sugarcane and horticulture as at 2008–2009 is presented using the following framework:
A – Cutting-edge practices, B – Best practices, C – Common practices, D – Unacceptable practices.





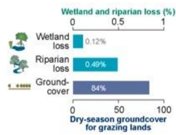
- Cutting-edge (A) or best management (B) practices are used by 36 per cent of sugarcane growers for nutrients, seven per cent for herbicides and 19 per cent for soil.
- Practices considered unacceptable by industry or community standards (D) are used by 34 per cent of sugarcane growers for nutrients, eight per cent for herbicides and 45 per cent for soil.
- Cutting-edge (A) or best management (B) practices are used by 39 per cent of horticulture producers for nutrients, 78 per cent for herbicides and 70 per cent for soil.
- Practices considered unacceptable by industry or community standards (D) are used by 24 per cent of horticulture producers for nutrients, six per cent for herbicides and 11 per cent for soil.
- Fifty per cent of graziers across the Burdekin and Fitzroy regions are using (A or B) management practices that are likely to maintain land in good to very good condition or improve land in lesser condition.
- Twelve per cent of graziers in the Burdekin and Fitzroy regions are using (D) management practices that are likely to degrade land to poor condition.

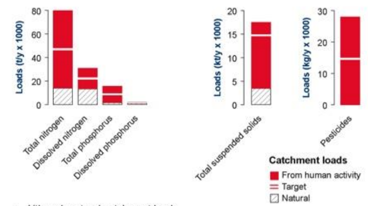


Land use map of the Great Barrier Reef catchment.

Catchment results

Catchment results include wetland and riparian loss, groundcover and catchment loads. Confidence in catchment load estimates differs across regions due to varying levels of data availability.



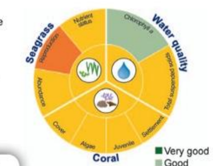


- Wetland loss from 2001 to 2005 was 883 hectares (0.12 per cent), with greater losses occurring in smaller coastal catchments. Wetland loss since pre-European times is 14 per cent.
- There has been a loss of 30,000 hectares (0.49 per cent) of riparian vegetation between 2004 and 2008.
- Dry season groundcover for grazing lands is high (84 per cent), well above the 50 per cent target and likely due to high rainfall.
- Although natural catchment loads occur, most of the loads to the Great Barrier Reef are from human activities.
- Annual total suspended solid loads are 17 million tonnes, of which 14 million tonnes are from human activity.
- The largest contribution of total suspended sediment load is from the Burdekin and the Fitzroy regions (4.7 and 4.1 million tonnes respectively), mainly derived from grazing lands.
- Agricultural fertiliser use is a key source of dissolved nitrogen and phosphorus runoff; annual loads of dissolved nitrogen are 31,000 tonnes.
- All pesticides are from human activities. The total annual pesticide loads are approximately 28,000 kilograms and the highest loads are from the Mackay Whitsunday and Wet Tropics regions (approximately 10,000 kilograms each per year).

Marine results

The effects of river discharge into the Great Barrier Reef are largely concentrated into inshore areas up to 20 kilometres from shore. Higher than average wet season rainfall in the Great Barrier Reef catchment occurred between 2007 and 2009, particularly in the Burdekin River catchment. Marine results for 2008–2009 are presented for seagrass, water quality and coral.

Seagrass: Inshore seagrasses are in moderate condition. Seagrass abundance is moderate and has declined over the past five to 10 years, associated with excess nutrients. The number of reproductive structures is poor or very poor in four of the six regions, indicating limited resilience to disturbance.

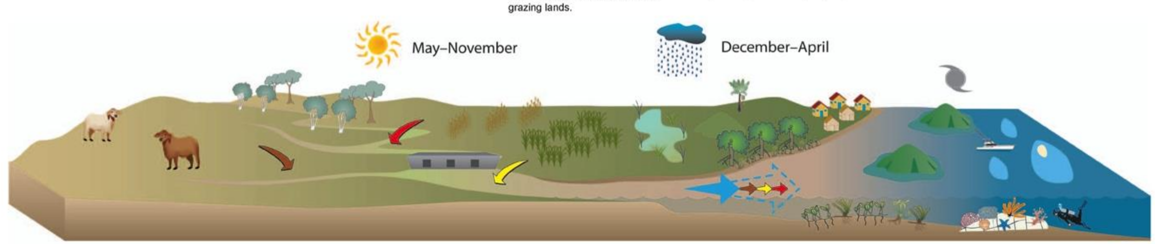


Water quality: Inshore water quality is moderate overall. Concentrations of total suspended solids range from poor (Burdekin and Mackay Whitsunday regions) to very good (Burnett Mary region).

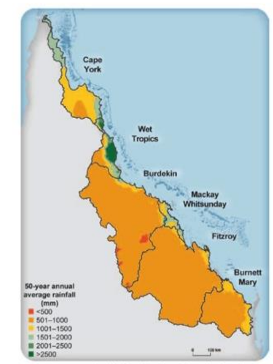
Waters within 20 kilometres of the shore are at highest risk of degraded water quality. These waters are only approximately eight per cent of the Great Barrier Reef Marine Park, but support significant ecosystems as well as recreation, tourism and fisheries.

Coral: Most inshore reefs are in good or moderate condition, based on coral cover, macroalgal abundance, settlement of larval corals and numbers of juvenile corals. Most inshore reefs have either high or increasing coral cover; however, corals in the Burdekin region are mostly in poor condition.

Pesticides: Pesticides, even at low concentrations, are a significant cause for concern. Of particular concern is the potential for compounding effects that these chemicals have on the health of the inshore reef ecosystem, especially when delivered with other water quality pollutants during flood events.



The Great Barrier Reef catchments are largely rural and dominated by summer monsoonal rains and occasional cyclones delivering sediments, nutrients and pesticides to the inshore and sometimes offshore portions of the reef in pulsed flows, which can be affected by water reservoirs and dams. Grazing is the largest single land use, and sugarcane, horticulture and other cropping make up other agricultural land uses. Small urban centres are located on the coastal strip. Habitats include wetlands, reef, seagrass and mangroves, and continental and coral islands are present. Reef-based tourism, as well as commercial and recreational fisheries, are an important part of the regional economy.



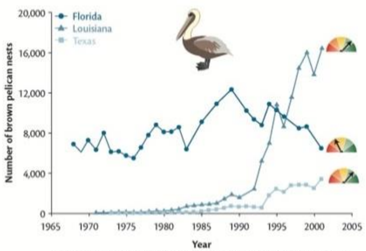
Average annual rainfall in the Great Barrier Reef catchment (1950–2000).

Communicate results

Example component: *Birds*

Report card prototype

Example component: *Seagrass ecosystems*



Brown Pelican populations over time in Florida, Louisiana, and Texas (Holm et al. 2003).

Gulf of Mexico birds

The Gulf of Mexico is a major flyway for migratory birds that provides essential stopover habitat along three migratory pathways. The Gulf has large, undisturbed, and diverse areas of coastal habitats that provide breeding and wintering habitat for shore birds, marsh birds, forest birds, and waterfowl. These habitats support internationally significant populations of birds including Brown Pelican, American Flamingo, Redhead, Whooping Crane, Sooty Tern, and Snowy Plover. Representative bird species associated with different habitats can be effective indicators of Gulf ecosystem health.

Brown Pelican trends

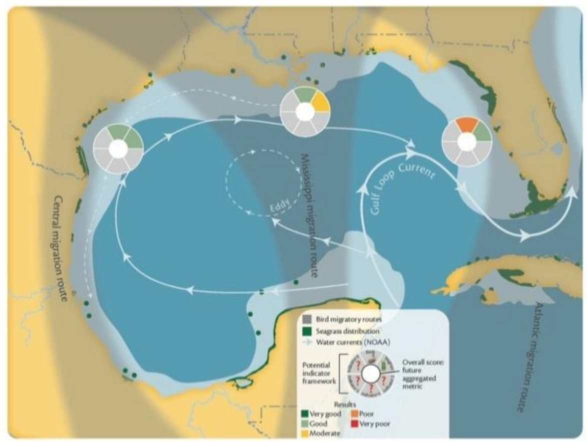
The Brown Pelican is an iconic symbol of the Gulf of Mexico and important indicator of the effects of human activities on Gulf ecosystem health. An estimated 25,000 Brown Pelicans nested along the Gulf Coast in the early 20th Century but populations began declining in the 1920s because of human disturbances. By the end of the 1960s, direct and indirect effects of DDT and dieldrin had resulted in catastrophic population declines, with Florida having the only remaining significant breeding population in the Gulf of Mexico.

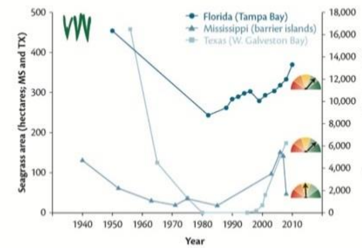
With the listing as an endangered species (1970), the ban on DDT (1972), and effective management, the number of breeding pairs in the northern Gulf increased to 20,000–25,000 by the end of the 1990s. Brown Pelicans were removed from the endangered species list in Alabama and Florida in 1985, and in Mississippi and Texas in 2009. However, Brown Pelicans continue to be adversely impacted by human activities which have resulted in the decline of the Florida population in since 1989 to levels approaching those seen in the 1960s, although the specific causes are presently unknown. The fully developed Report Card will provide indicators of both the ecological health of the Brown Pelican and the human activities and stressors affecting them. This Brown Pelican example illustrates the importance of the Gulf of Mexico Report Card in characterizing the causal links between human activities and ecological heath and thereby informing decisions to achieve sustainability.

Birds as indicators

Population patterns of bird species can be effective indicators of environmental health because they utilize a wide range of habitats within the Gulf of Mexico. With input from the avian science community, we envision developing indicators for key species representing colonial water birds, waterfowl, marsh, beach, shore, wading, and pelagic sea birds. These key species will serve as indicators for health of their particular habitats by reflecting the pressures and stressors acting upon them, such as coastal development and habitat alteration, human disturbance of nests and colonies, food availability, hunting, and contaminants. Metrics describing the health of bird populations will expand upon those described here for the Brown Pelican, and new indicators will be developed. Finally, a key element of the Gulf of Mexico Report Card framework is to develop new, integrative metrics that characterize the pressures and stressors impinging on birds and their habitats.

Contaminants, in particular DDT, reduced Brown Pelican populations prior to the chemical being banned in the USA in 1972. Brown Pelican populations rebounded but habitat alterations continue to be a threat to the population.





Seagrass area over time in Mississippi, Texas, and Florida (Handley et al. 2007, Carter et al. 2011, W. Pulich pers comm).

Gulf of Mexico seagrass ecosystems

Seagrass ecosystems are a dominant habitat in shallow waters throughout the Gulf of Mexico and are essential to its health and integrity. Expansive seagrass meadows provide an important refuge and foraging habitat for many species, supporting recreational and commercial fisheries. Unfortunately, seagrass ecosystems are often threatened by increased nutrient inputs and other stressors, e.g., dredging, coastal development. Thus the health of seagrass ecosystems provides an important indicator of the health of the Gulf of Mexico at both local and Gulf-wide scales.

Seagrass trends

Progressive deterioration of seagrass beds has occurred around the Gulf but notable recoveries exist in some areas (illustrated above). For example, seagrass coverage on the Mississippi barrier islands significantly declined during the 1940s–1970s, but substantially recovered by mid-2000s. This reversal in trends began in 1971 when the Gulf Islands National Seashore was established and development ceased, and protected since 1995 from the destructive impacts of shrimp trawling.

Urban development and agriculture runoff lead to turbidity and nutrient inputs into shallow coastal waters. Various seagrass species are adversely affected by reduced light, reducing seagrass area.

West Galveston Bay, Texas, also experienced seagrass decline and recovery. Declines began in the mid-1950s, particularly along the Galveston Island–Bay margin where most seagrasses occurred, with complete seagrass loss by 1979. This was attributed primarily to water quality degradation, dredging, and shoreline development. After absence for two decades, seagrasses were re-introduced through transplanting. Because dredging and development were moderated and water quality significantly improved, transplanted seagrasses became established and subsequently spread around the Bay.

Similarly, Tampa Bay, Florida, seagrasses experienced a widespread loss in a rapidly urbanized watershed post World War II. The critical stressor was excessive nitrogen inputs from sewage discharges into Tampa Bay but beginning in the 1970s, major improvements to sewage treatment plants reduced nitrogen inputs by 90%, leading to clearer water and ongoing recovery of seagrasses. At present, nitrogen inputs come from stormwater runoff and air pollution from power plants and automobiles. The Tampa Bay National Estuary Program was established in 1991 to further improve seagrass ecosystem health, focusing not only on nitrogen inputs but also reducing toxic pollutants, restoring and protecting seagrass habitats, and reducing dredging and other physical stressors.

Seagrass ecosystems as indicators

Many features of seagrass ecosystems can serve as indicators in addition to areal coverage. Seagrass species composition can be an indicator, e.g., comparing a single-species meadow like turtle grass to a mixture that includes other Gulf of Mexico species. Animals using seagrasses as a habitat (e.g., shellfish, redfish) or food source (e.g., manatees, waterfowl) can be indicators. Because seagrasses are closely linked to water quality, particularly the underwater light regime, water quality metrics like chlorophyll and turbidity can be appropriate indicators. Seagrass ecosystems provide important services that also could be indicators, including primary and secondary production, carbon and nutrient sequestration, erosion protection, and recreational fishing.

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University of Maryland CENTER FOR ENVIRONMENTAL SCIENCE