A vision for the

Gulf of Mexico Report Card

comprehensive

ecosystem health

Gulf-wide

science-based

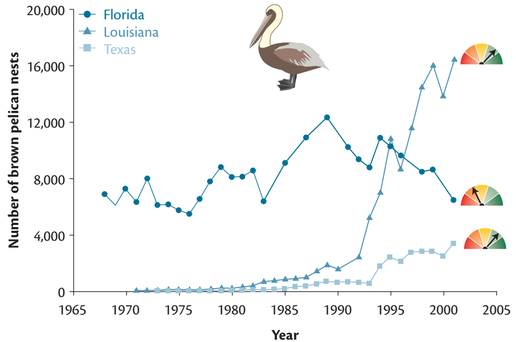
integrated assessment

Example component: *Birds*

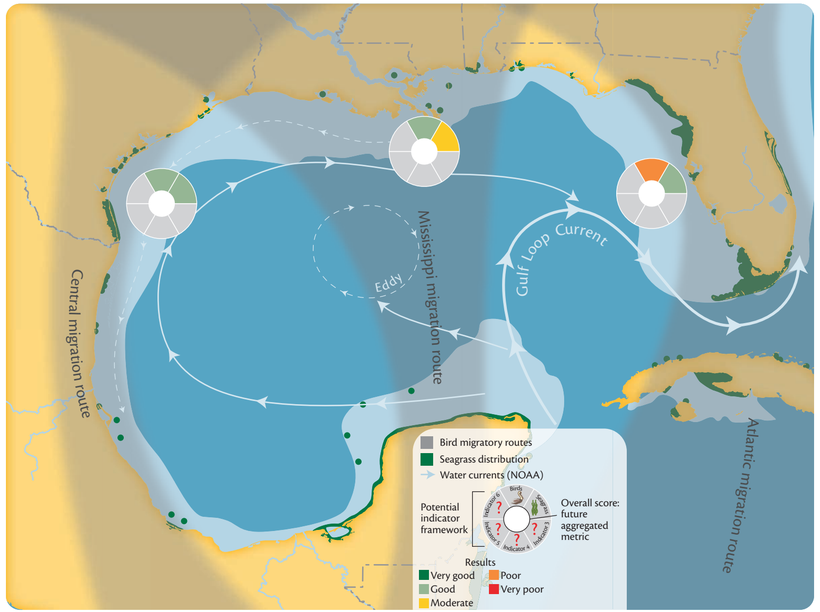
Report card prototype

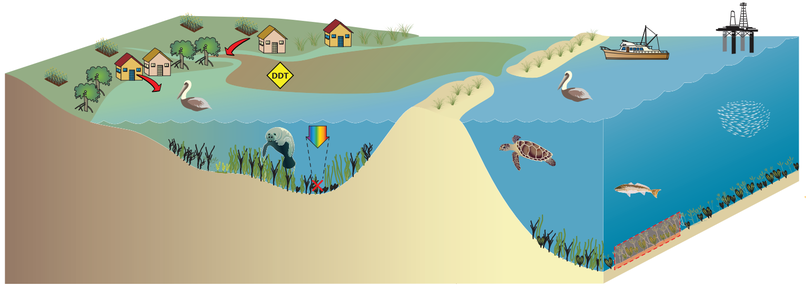
Example component: *Seagrass ecosystems*

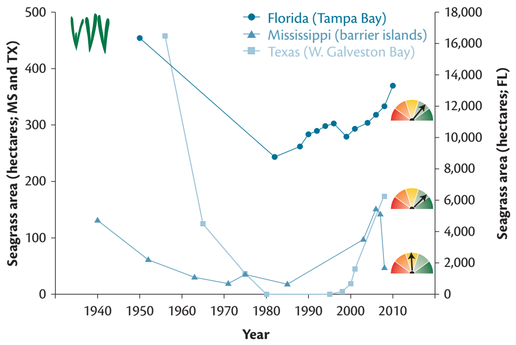
Dave & Liz Smith



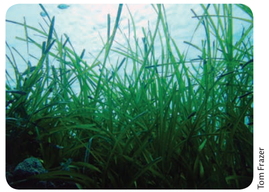
Brown Pelican populations over time in Florida, Louisiana, and Texas (Holm et al. 2003).







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



Tom Frazer

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.

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.

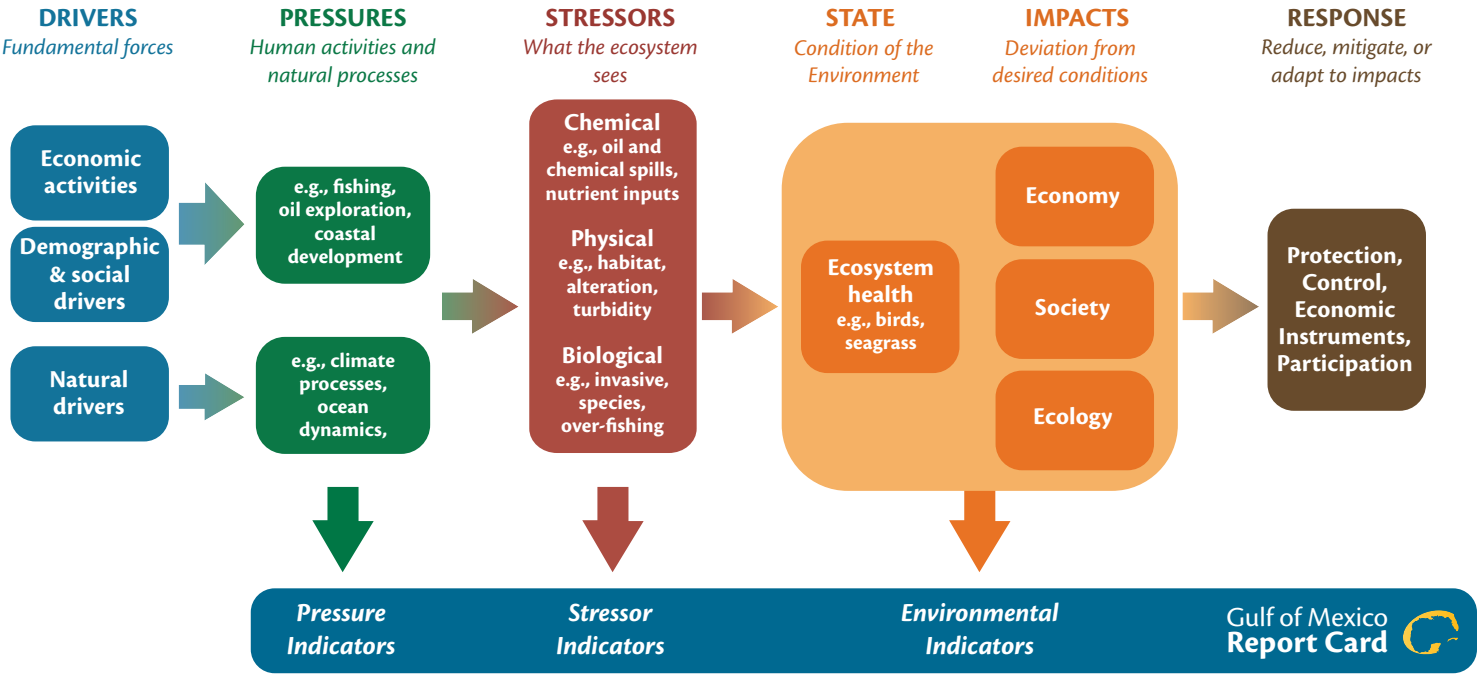
West Galveston Bay, Texas, also experienced seagrass decline and recovery. Declines began in the mid-1950s, particularly along the Galveston Island–Bay margin where most seagrasses occurred, with complete seagrass loss by 1979. This was attributed primarily to water quality degradation, dredging, and 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.

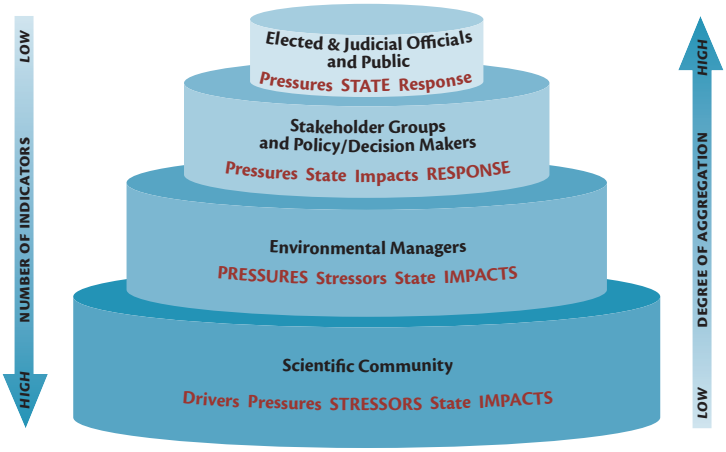
Report card process



The vision for a Gulf of Mexico Report Card is to develop a graphical representation of the environmental health of the Gulf that will be scientifically based, widely accessible, and readily understandable by policy-makers, stakeholders, scientists, and, most importantly, the American public. This Report Card will provide the scientific information and understanding necessary to evaluate the health of the Gulf, clearly demonstrate how well it is or is not progressing towards desired long-term goals, and inform the decision-making process on the policies and resources needed to achieve sustainability of a healthy Gulf of Mexico.

The newly developed framework for this Report Card (illustrated above) characterizes societal ***drivers***, ***pressures*** from human activities and natural processes, and ***stressors*** that directly affect the ecosystem. The ***state*** of the system and ***impacts*** are compared with desired conditions and lead to societal ***responses*** to improve environmental health. This comprehensive framework provides the scientific foundation to collect, organize, and report information across the broad spectrum of needs for regional-scale environmental management.

A critical objective of the Report Card is reaching the breadth of audiences with interests in the health of the Gulf. Different layers in the conceptual framework address a variety of targeted audiences (illustrated below). The highest level, aimed at decision-making officials and the general public, emphasizes indicators that characterize the state of the environment, i.e., the bottom-line conclusions about the health of the environment. Policy/decision-makers and stakeholders, shown at the second level, would consider a broader variety of indicators, emphasizing management responses. More hands-on environmental managers, such as in state-level environmental agencies, would focus on pressures and impacts, with interest in stressors and state of the environment. And scientists focus particularly on the causal relationships between stressors and impacts within the context of the drivers and pressures. This hierarchy provides the structure for most effectively integrating data to create indicators that synthesize information as one moves up the tiers, plus effectively organize and communicate information to stakeholders and the public as needed to explain grades. Finally, the Report Card is designed to maximize the growing opportunities for Citizen Science, demonstrated by the eBird dataset (*www.eBird.org*) and Seagrass Watch (*www.seagrasswatch.org*), in which thousands of trained volunteers collect useful environmental data that can show important patterns in environmental health.



Next steps

The Gulf of Mexico Report Card Team, with assistance from workshop participants, has developed prototypes for two components of a larger Gulf of Mexico Report Card, shown here for birds and seagrass ecosystems. These prototypes were developed to provide a concrete illustration of what the Report Card will entail. To fully develop the Gulf of Mexico Report Card, the Team will next convene a major workshop to decide how to divide the Gulf into manageable components, based on habitats, geographical and/or political boundaries. The Team will then lead scientists in fully developing the Report Cards for each component, following the conceptual and hierarchical frameworks presented here. Each Report Card will be fully vetted in the scientific and policy communities to ensure both scientific rigor and utility for environmental decision-making. Once these Report Card structures are created, existing and newly acquired data will be used to identify the metrics most useful for reporting, define specific thresholds for each grade level, assess environmental health, and graphically report the results to the diverse audiences (process described below). The Harte Research Institute for Gulf of Mexico Studies is committed to sustaining this Report Card effort by providing the scientific and technical analyses necessary for creating the Report Card, communicating results to decision-makers and the public, and advancing a long-term understanding of the health of the Gulf of Mexico.

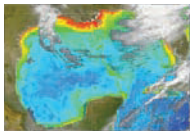
Create a conceptual framework

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

Choose indicators

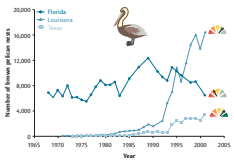
Step 2—Select indicators that convey meaningful information and can be measured reliably.

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

Gulf of Mexico Report Card

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

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