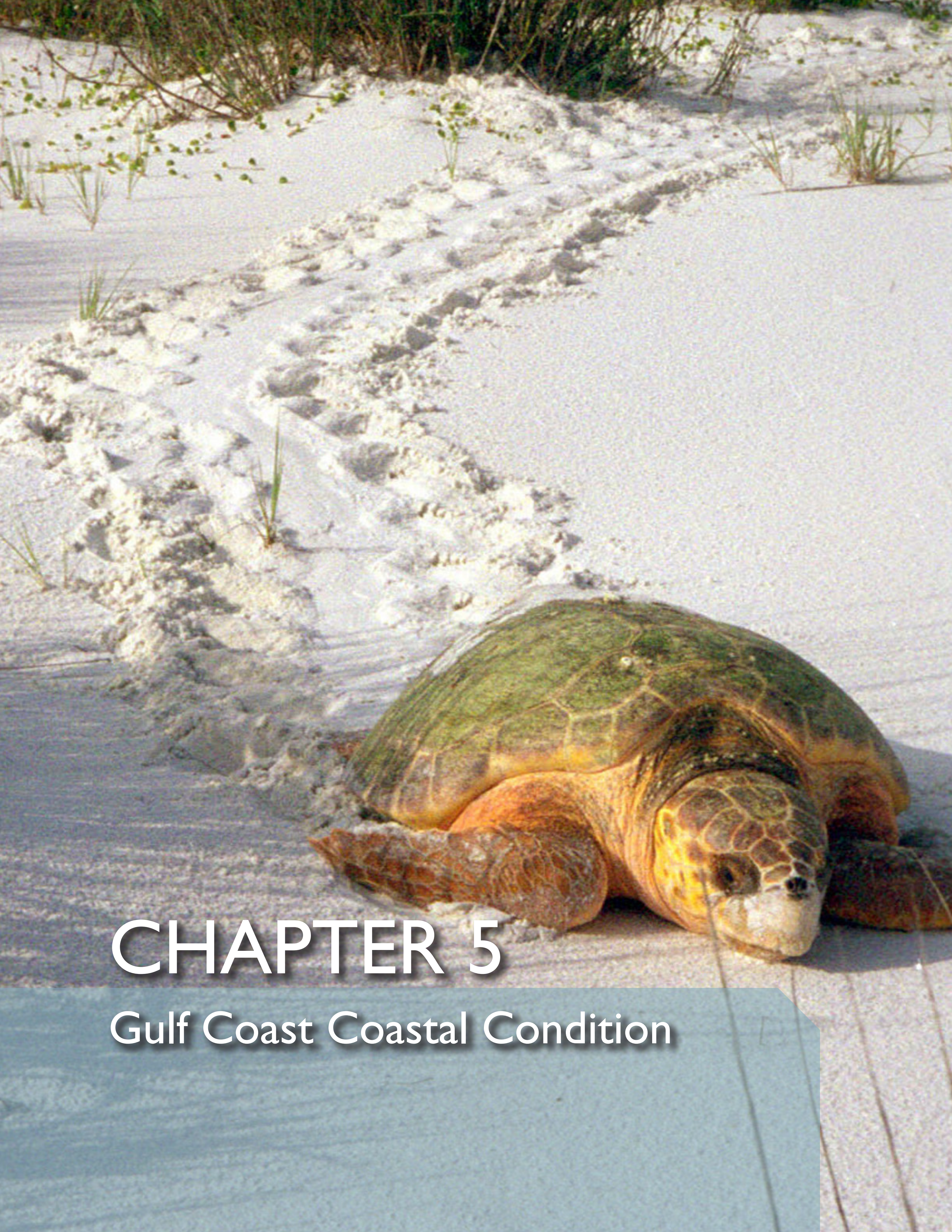

CHAPTER 5

Gulf Coast Coastal Condition

5. Gulf Coast Coastal Condition

As shown in Figure 5-1, the overall condition of the coastal waters of the Gulf Coast region is rated fair, with an overall condition score of 2.4. The water quality index for the region's coastal waters is rated fair; the benthic index is rated fair to poor; the sediment quality and coastal habitat indices are rated poor; and the fish tissue contaminants index is rated good. Figure 5-2 provides a summary of the percentage of the region's coastal area rated good, fair, poor, or missing for each index and component indicator. This assessment is based on environmental stressor and response data collected by the states of Florida, Alabama, Mississippi, Louisiana, and Texas from 879 locations, ranging from Florida Bay, FL, to Laguna Madre, TX, from 2003 to 2006. The hurricanes of 2005 (Katrina and Rita) significantly affected the data collected; Alabama, Mississippi, and Louisiana did not collect data in 2005 (except for water quality indicators in Mississippi).

Please refer to Chapter 1 for information about how these assessments were made, the cutpoints used to develop the rating for each index and component indicator, and the limitations of the available data.

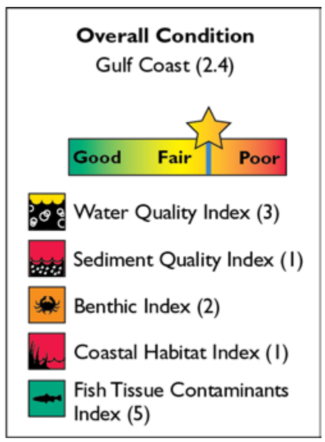

Figure 5-1. The overall condition of Gulf Coast coastal waters is rated fair (U.S. EPA/NCA).

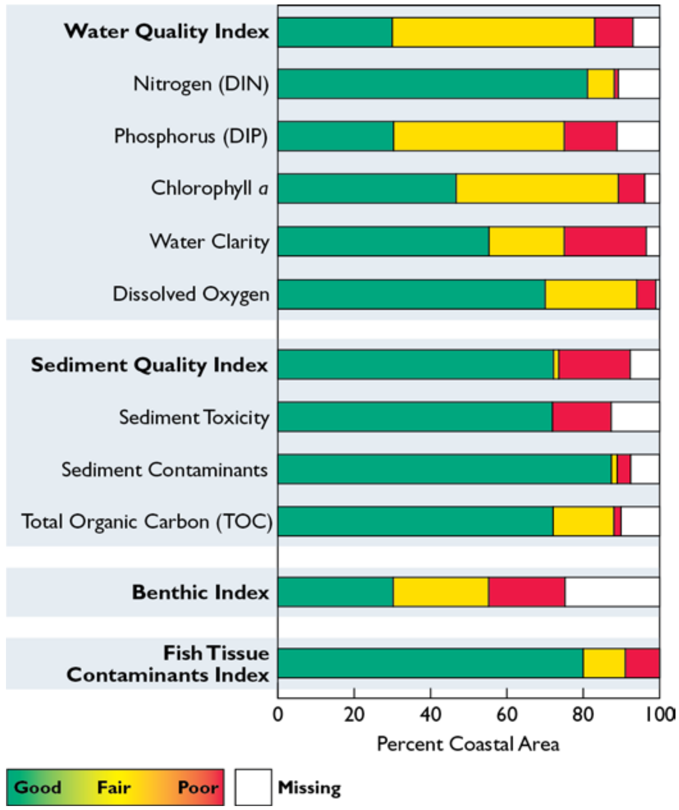

Figure 5-2. Percentage of coastal area achieving each ranking for all indices and component indicators— Gulf Coast region (U.S. EPA/NCA).

Uses of the National Coastal Condition Reports

This report is designed to help us understand the questions, "What is the condition of the nation's coastal waters, is that condition getting better or worse, and how do different regions compare?" This report, however, cannot represent all individual coastal and estuarine systems of the United States and is based on a limited number of ecological indices and component indicators for which nationally consistent data sets are available to support estimates of ecological condition. The assessments provided in this report, and more importantly, the underlying data used to develop the assessments, can provide a picture of historical coastal conditions at state, regional, or national scales. For example, the National Coastal Assessment (NCA) data have been used to provide insight into the conditions in the estuaries of Louisiana and Mississippi prior to Hurricane Katrina. These data may also be used to help us understand conditions in Gulf of Mexico estuaries prior to the Deepwater Horizon incident and subsequent BP Oil Spill. However, the methodology and data used in this report were not designed to asses impacts directly related to the BP Oil Spill. This report does not include, for example, indicators such as water chemistry, oil-related contaminants (i.e., oil, grease, alkylated PAHs, or volatile organic compounds), dispersant compounds, or other indicators of exposure that might be required in an environmental assessment. Any comparisons to environmental data collected to assess the impact of the BP Oil Spill on Gulf of Mexico estuaries should be limited to the indicators and methods presented in this report and to broad generalizations about coastal condition at state, regional, or national scales.

The Gulf Coast coastal area comprises more than 750 estuaries, bays, and sub-estuary systems that are associated with larger estuaries. The total area of the Gulf Coast estuaries, bays, and sub-estuaries is 10,538 square miles. Gulf Coast estuaries and wetlands provide critical feeding, spawning, and nursery habitat for a rich assemblage of fish and wildlife, including essential habitat for shorebirds, colonial nesting birds, and migratory waterfowl. The Gulf Coast is also home to an incredible array of indigenous flora and fauna, including endangered or threatened species such as the Kemp's ridley sea turtle, Gulf sturgeon, Perdido Key beach mouse, West Indian manatee, telephus spurge, and piping plover. This region's coastal waters also support vegetated habitats that stabilize shorelines from erosion, reduce nonpoint-source loadings, and improve water clarity.

Gulf Coast coastal waters are located in two biogeographical provinces: the Louisianian Province and the West Indian Province. The Louisianian Province extends from the Texas–Mexico border east to Anclote Key, FL. The West Indian Province extends from Tampa Bay, FL, on the Gulf Coast to the Indian River Lagoon, FL, on the Atlantic Coast; the portion of this province included in the Gulf Coast region extends from Tampa Bay to Florida Bay. The borders of the Gulf Coast region roughly coincide with the borders of the Gulf of Mexico LME.

The Gulf Coast is home to approximately 13% of the nation's coastal residents. Between 1980 and 2006, the population of coastal counties in the Gulf Coast region increased by 53% from 10.7 million to 16.3 million people (Figure 5-3). Population density also increased by 53% from 158 to 241 persons/square mile. Figure 5-4 presents population density data for Gulf Coast coastal counties in 2006 (NOEP, 2010).

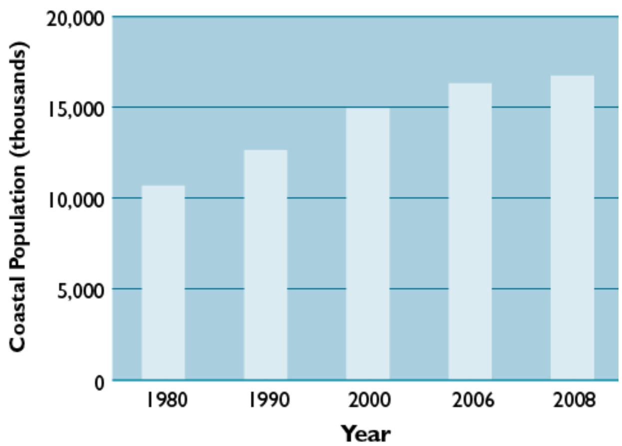

Figure 5-3. Population of coastal counties in Gulf Coast states from 1980 to 2008 (NOEP, 2010).

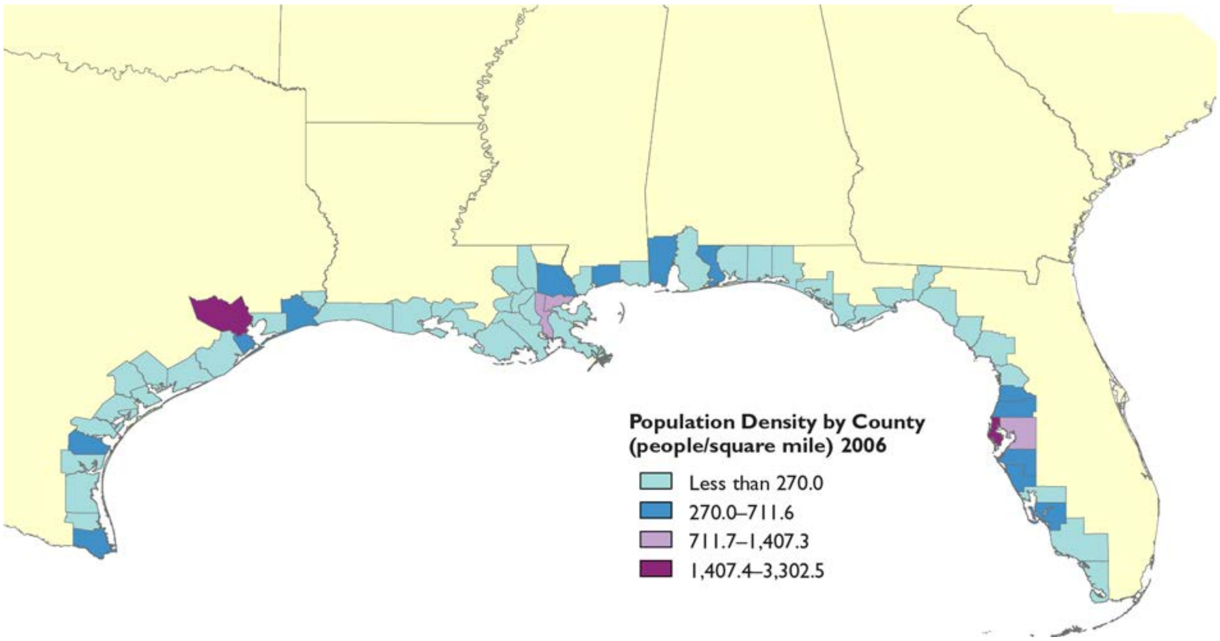

Figure 5-4. Population density in coastal counties in Gulf Coast states in 2006 (NOEP, 2010; U.S. Census Bureau, 2010).

The NCA monitoring data used in this assessment are based on single-day measurements collected at sites throughout the U.S. coastal waters (excluding the Great Lakes) during a 9- to 12-week period during the summer. Data were not collected during other time periods.

Coastal Monitoring Data—Status of Coastal Condition

A variety of programs have monitored the coastal waters of the Gulf Coast region since 1991. EMAP focused its coastal monitoring efforts on Gulf Coast coastal waters from 1991 to 1995 (Macauley et al., 1999; U.S. EPA, 1999). The Joint Gulf States Comprehensive Monitoring Program (GMP) began an assessment in 2000, in conjunction with EPA's Coastal 2000 Program (U.S. EPA, 2000). This partnership has continued as part of the NCA, with coastal monitoring being conducted by the five Gulf Coast states through 2006. In addition, NOAA's NS&T Program has collected contaminant bioavailability and sediment toxicity data from several Gulf Coast sites since the late 1980s (Long et al., 1996). Data from the NS&T Program Bioeffects Project are available at http://ccma.nos.noaa.gov/about/coast/nsandt/download.aspx.

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The sampling conducted in the EPA NCA survey has been designed to estimate the percent of coastal area (nationally or in a region) in varying conditions and is displayed as pie diagrams. Many of the figures in this report illustrate environmental measurements made at specific locations (colored dots on maps); however, these dots (color) represent the value of the index specifically at the time of sampling. Additional sampling would be required to define temporal variability and to confirm environmental condition at specific locations.

Water Quality Index

Based on the 2003 to 2006 NCA survey results, the water quality index for the coastal waters of the Gulf Coast region is rated fair, with 10% of the coastal area rated poor and 53% of the area rated fair for water quality condition (Figure 5-5). The water quality index was developed based on measurements of five component indicators: DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen. Estuaries with poor water quality conditions were found in all five states. Poor water clarity, high DIP concentrations, and high chlorophyll *a* concentrations contributed to poor water quality ratings. Only three sites in Louisiana had high concentrations of both DIN and DIP. Poor or fair conditions for the component indicators did not necessarily co-occur at the same station, resulting in a lower percentage of Gulf Coast coastal area rated good for the water quality index than for any of its component indicators (see Chapter 1 for more information). This water quality index can be compared to the results of NOAA's Estuarine Eutrophication Survey (Bricker et al., 1999), which rated the Gulf Coast as poor for eutrophic condition, with an estimated 38% of the coastal area having a high expression of eutrophication.

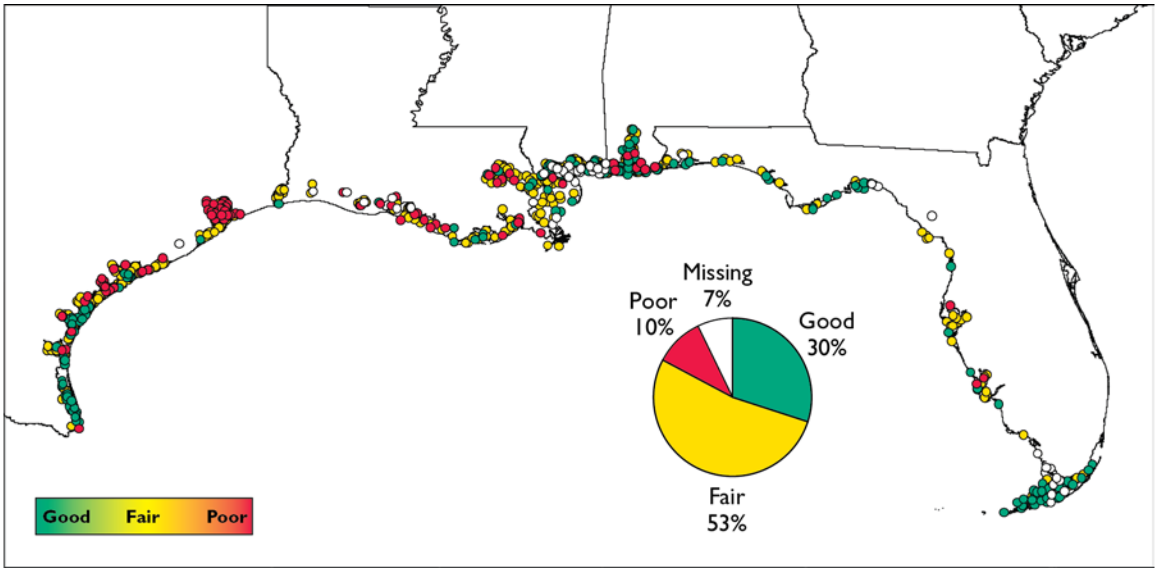

Figure 5-5. Water quality index data for Gulf Coast coastal waters (U.S. EPA/NCA).

Nutrients: Nitrogen and Phosphorus

The Gulf Coast region is rated good for DIN concentrations, but rated fair for DIP concentrations. It should be noted that different criteria for DIN and DIP concentrations were applied in Florida Bay than in other areas of the Gulf Coast region because Florida Bay is considered a tropical estuary. DIN concentrations were rated poor in 1% of the Gulf Coast coastal area, representing several sites in Louisiana and Texas, primarily from 2003 and 2004. Elevated DIN concentrations are not expected to occur during the summer in Gulf Coast waters because freshwater input is usually lower and dissolved nutrients are used more rapidly by phytoplankton during this season. DIP concentrations are rated poor in 14% of the Gulf Coast coastal area, which included sites in Tampa Bay and Charlotte Harbor, FL, where high DIP concentrations occur naturally due to geological formations of phosphate rock in the watersheds and artificially due to significant anthropogenic sources of DIP.

Potential for Misinterpretation of Conditions for States with Smaller Coastlines

Alabama and Mississippi resource agencies are concerned that the figures presented in the Coastal Monitoring Data section of this chapter could potentially represent their estuaries unfairly. Both states have at least 50 locations that were sampled each year in the NCA 2003–2006 survey; however, because of the high density of these sites and the small area of estuarine resources of these states, even one or two sites rated poor (red circles) give the appearance of poor condition dominating a large portion of the entire coast of these states. Although showing the entire Gulf Coast region in a single graphic is consistent with the goals of this report, these displays do not provide a detailed view of all data, particularly for Alabama, Mississippi, and eastern Louisiana.

Chlorophyll a

The Gulf Coast region is rated fair for chlorophyll *a* concentrations because more of the coastal area is rated fair and poor, combined, than is rated good for this component indicator. It should be noted that chlorophyll *a* concentrations were rated differently in Florida Bay than in other areas of the region because Florida Bay is considered a tropical estuary. High concentrations of chlorophyll *a* occurred in the coastal areas of all five Gulf Coast states.

Water Clarity

Water clarity in the Gulf Coast region is rated fair, with 21% of the coastal area rated poor for this component indicator. Lower-than-expected water clarity occurred throughout the Gulf Coast region, with poor conditions observed most frequently in Texas and Louisiana. The cutpoints used to assign water clarity ratings varied across Gulf Coast coastal waters (Figure 5-6) based on natural variations in turbidity levels, regional expectations for light penetration related to SAV distribution, and local waterbody management goals (see text box).

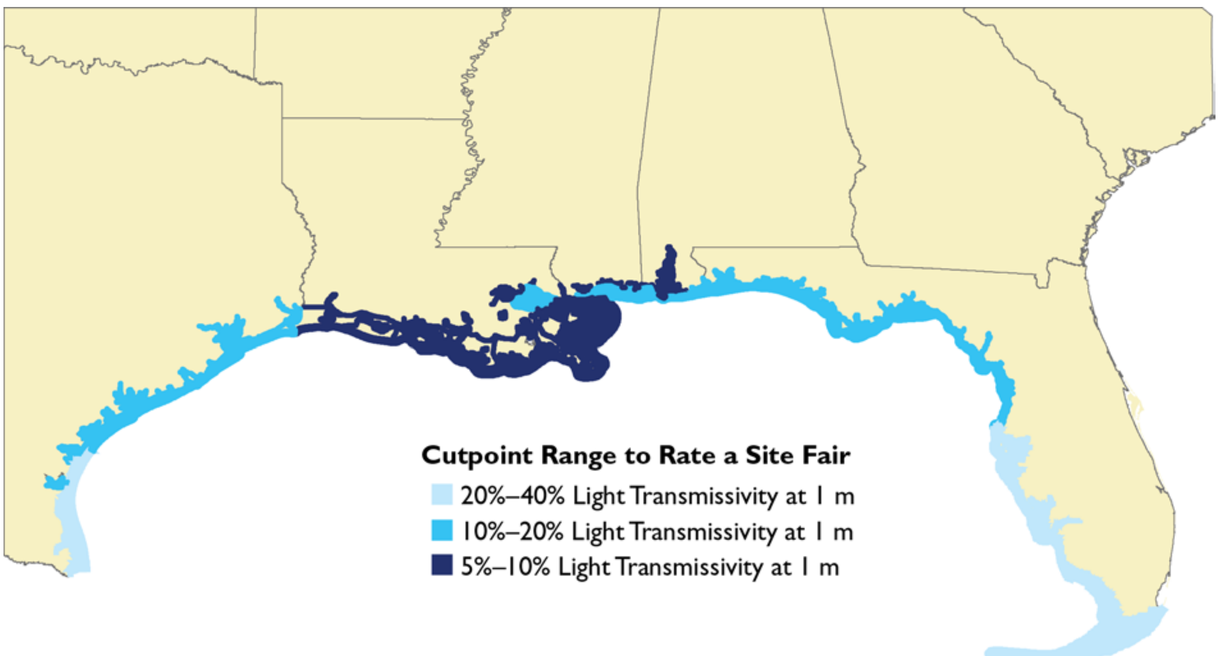

Figure 5-6. Map of water clarity cutpoints used in Gulf Coast coastal waters to rate a site fair (U.S. EPA/NCA).

> Although the current NCA approach used to assess water clarity is an improvement over the previous effort, it still may reach inappropriate conclusions regarding water clarity for parts of the Gulf Coast region. Many of the areas of the Gulf Coast region have naturally high silt and suspended sediment loads. To modify the water clarity approach for this natural condition, researchers adjusted the approach by decreasing the "expected" water clarity levels to lower levels for much of the Gulf Coast region. Although this adjustment appears to have been successful for much of the Florida, Alabama, Mississippi, and Louisiana coasts, further adjustments may be necessary for Mississippi Sound and the Texas coast.

Dissolved Oxygen

The Gulf Coast region is rated good for dissolved oxygen concentrations, with less than 5% (4.8%) of the coastal area rated poor for this component indicator. Hypoxia in Gulf Coast waters generally results from stratification, eutrophication, or a combination of these two conditions. Mobile Bay, AL, experiences regular hypoxic events during the summer that often culminate in "jubilees" (i.e., when fish and crabs try to escape hypoxia by migrating to the edges of a waterbody); however, the occurrence of jubilees in Mobile Bay has been recorded since colonial times, and these occurrences are most likely natural events for this waterbody (May, 1973).

Although hypoxia is a relatively local occurrence in Gulf Coast estuaries, the occurrence of hypoxia in the Gulf Coast shelf waters is much more significant. The Gulf of Mexico hypoxic zone is the second-largest area of oxygen-depleted waters in the world (Rabalais et al., 2002a). This zone, which occurs in waters on the Louisiana shelf to the west of the Mississippi River Delta, was not assessed by the NCA survey. The area of the Gulf of Mexico hypoxic zone varied from 3,305 square miles in 2003 to 6,670 square miles in 2006 (Figure 5-7) (LUMCON, 2003, 2006). In 2004 and 2006, the hypoxic zone area was greater than the long-term average of 5,000 square miles (LUMCON, 2006). Current hypotheses speculate that the hypoxic zone results from water column stratification that is driven by weather and river flow, as well as from the decomposition of organic matter in bottom waters (Rabalais et al., 2002a). River-borne organic matter, along with nutrients that fuel phytoplankton growth in the Gulf waters, enters the Gulf of Mexico from the Mississippi River. Annual variability in the area of the hypoxic zone has been related to the flows of the Mississippi and Atchafalaya rivers and, by extension, to the precipitation levels that influence these flows. Sediment cores from the hypoxic zone show that algal production in the Gulf of Mexico shelf was significantly lower during the first half of the twentieth century, suggesting that anthropogenic changes to the basin and its discharges have resulted in the increased hypoxia (CENR, 2000). Estimates of hypoxia for the Gulf of Mexico shelf have not been included in the NCA estimates of hypoxia for Gulf Coast estuaries; consequently, the good rating for dissolved oxygen concentrations in the Gulf Coast region provided in this report should not be considered indicative of offshore conditions.

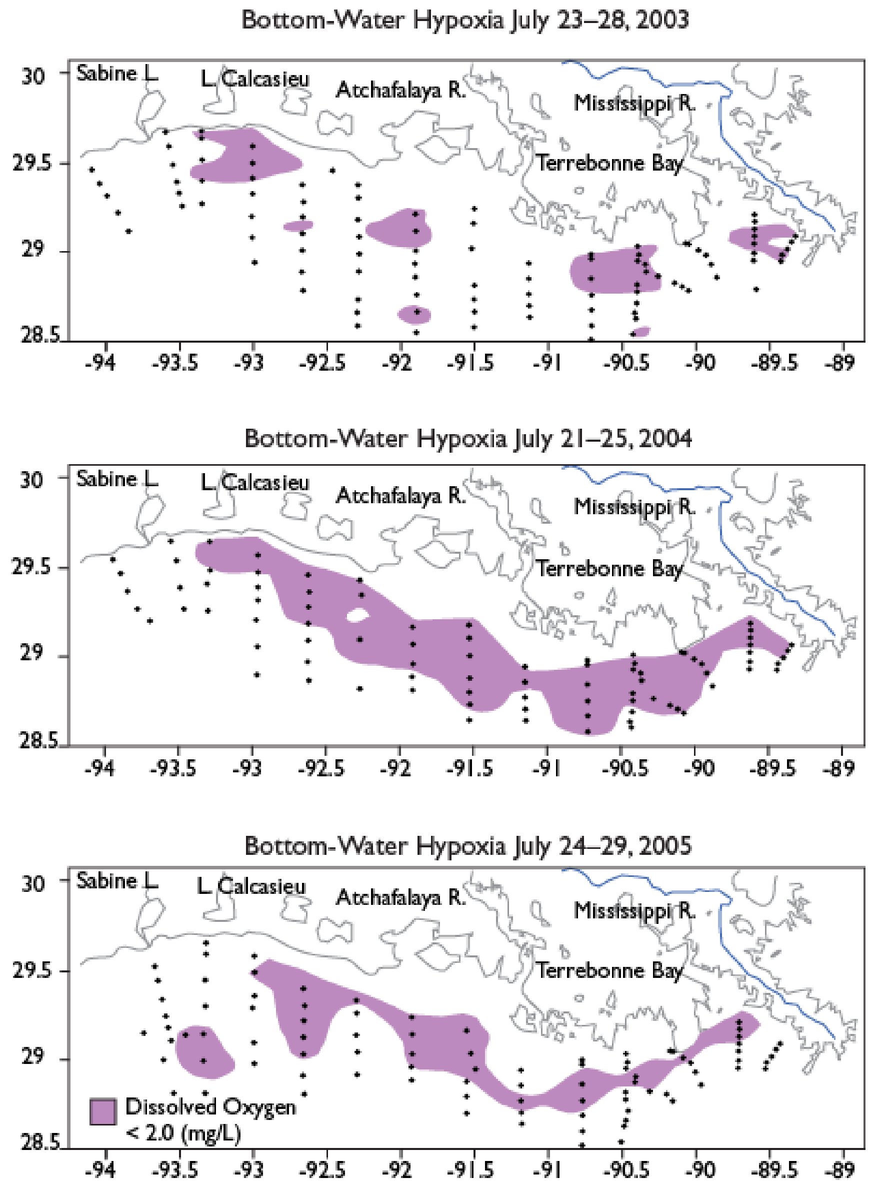

Figure 5-7. Spatial extent of the Gulf Coast hypoxic zone during July, 2003–2005 (U.S. EPA/NCA, based on data provided by NOAA, 2010a).

The cutpoint used in the NCA analysis for poor dissolved oxygen condition is a value below 2 mg/L in bottom waters. The majority of coastal states either use a different criterion, ranging from an average of 4 to 5 mg/L throughout the water column to a specific concentration (usually 4 or 5 mg/L) at mid-water, or include a frequency or duration of time that the low dissolved oxygen concentration must occur (e.g., 20% of observed values). The NCA chose to use 2 mg/L in bottom waters because this level is clearly indicative of potential harm to estuarine organisms. Because so many state agencies use higher concentrations, the NCA evaluated the proportion of waters that have dissolved oxygen concentrations between 5 and 2 mg/L in bottom waters as being in fair condition (i.e., threatened).

Sediment Quality Index

The sediment quality index is based on the rating scores for the sediment toxicity, sediment contaminants, and sediment TOC component indicators. In the Gulf Coast, the sediment quality index is rated poor because 19% of the coastal area was rated poor for at least one of the component indicators. However, these conditions rarely co-occurred in Gulf Coast sediments from the same sampling station, and the poor rating for the sediment quality index resulted primarily from the high percentage of coastal area rated poor for the sediment toxicity component indicator. Poor ratings for the sediment toxicity and sediment contaminants component indicators co-occurred at only three stations in Florida Bay, which had high concentrations of silver. The remaining stations with poor ratings for the sediment toxicity component indicator did not have high concentrations of sediment contaminants. The sediment toxicity at these sites may have been caused by naturally high levels of hydrogen sulfide (e.g., Florida Bay), high salinity (greater than 55 practical salinity units [psu]; e.g., Laguna Madre), sediment grain-size, or persistent levels of contaminants that were not measured by the NCA.

Sediment toxicity results do not always reflect sediment contaminant concentrations because toxicity also depends on contaminant bioavailability, which is controlled by pH, sediment grain-size, and organic content. Although sediment contaminant concentrations and sediment toxicity tests can be useful screening tools, it is not unusual to find a lack of correlation between the results of these component indicators because some toxic contaminants may not be bioavailable, some contaminants are not lethal to test organisms, and not all potentially toxic contaminants are analyzed. These points underscore the utility of a combined approach to assess the condition of sediment quality in coastal waters.

In 2010, the NCCA changed the sediment toxicity test protocols to conduct estuarine assays with the amphipod, *Leptocheirus plumulosus*, instead of *A. abdita*. The advantages of using *L. plumulosus* include the organism's tolerance to a wider range of salinities and sediment grain-size (*A. abdita* is sensitive to low salinity [< 10 psu] and to coarse-grained sediments). The use of *L. plumulosus* is hoped to reduce the occurrence of poor ratings for the sediment toxicity component indicator as a result of naturally occurring conditions. The NCCA is also reviewing the current NCA sediment quality index to determine the best approach to evaluate the component indicators and the cutpoints used to rate them. The next report, *National Coastal Condition Report V*, will reflect these modifications to the sediment quality index.

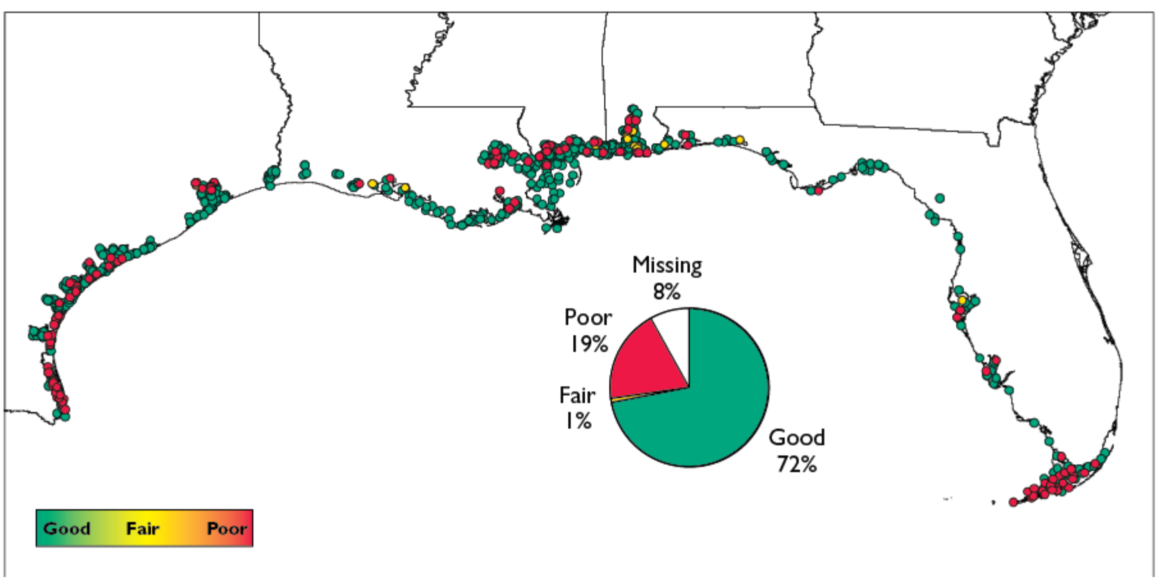

Figure 5-8. Sediment quality index data for Gulf Coast coastal waters (U.S. EPA/NCA).

Sediment Toxicity

The Gulf Coast region is rated poor for sediment toxicity, with 15% of the coastal area rated poor for this component indicator. Previous bioeffects surveys by NOAA (Long et al., 1996) and the results reported in the NCCR II (U.S. EPA, 2004a) showed less than 1% toxicity in large estuaries of the Gulf Coast region.

Sediment toxicity is commonly associated with high concentrations of metals or organic chemicals with known toxic effects on benthic organisms; however, most of the sites sampled during this survey that were rated poor for sediment toxicity did not have high sediment contaminant concentrations. The toxicity at these sites may have been caused by naturally high levels of hydrogen sulfide (e.g., Florida Bay), high salinity (greater than 55 psu; e.g., Laguna Madre), or persistent levels of contaminants that were not measured by the NCA.

Guidelines for Assessing Sediment Contamination (Long et al., 1996)

ERM (Effects Range Median)—Determined values for each chemical as the 50th percentile (median) in a database of ascending concentrations associated with adverse biological effects.

ERL (Effects Range Low)—Determined values for each chemical as the 10th percentile in a database of ascending concentrations associated with adverse biological effects.

Sediment Contaminants

The sediment contaminants component indicator for the Gulf Coast region is rated good, with 3% of the coastal area rated poor for this component indicator. Most of these sites were located in Florida Bay, with sediment concentrations of silver that exceeded the ERM guideline. In addition, 2% of the coastal area was rated fair, primarily due to sites located in Mobile Bay, AL. The sediment contaminants measured in Gulf Coast waters included elevated levels of metals, pesticides, PCBs, and, occasionally, PAHs.

Sediment TOC

The Gulf Coast region is rated good for sediment TOC, with 16% of the coastal area rated fair for this component indicator and only 2% of the area rated poor.

Benthic Index

The condition of benthic communities in Gulf Coast coastal waters is rated fair to poor, with 20% of the coastal area rated poor for benthic condition (Figure 5-9). Benthic community data were not collected (missing) in 25% of the estuarine area in the Gulf Coast. This was primarily due to the impacts of Hurricanes Katrina and Rita, which prevented Louisiana, Mississippi, and Alabama from conducting the NCA survey in 2005. This rating is borderline, as the criterion for a poor rating is more than 20% of the coastal area in poor condition. This assessment is based on the Gulf Coast Benthic Index (Engle and Summers, 1999), which integrates measures of diversity and populations of indicator species to distinguish between degraded and reference benthic communities. Most Gulf Coast estuaries showed some level of benthic degradation.

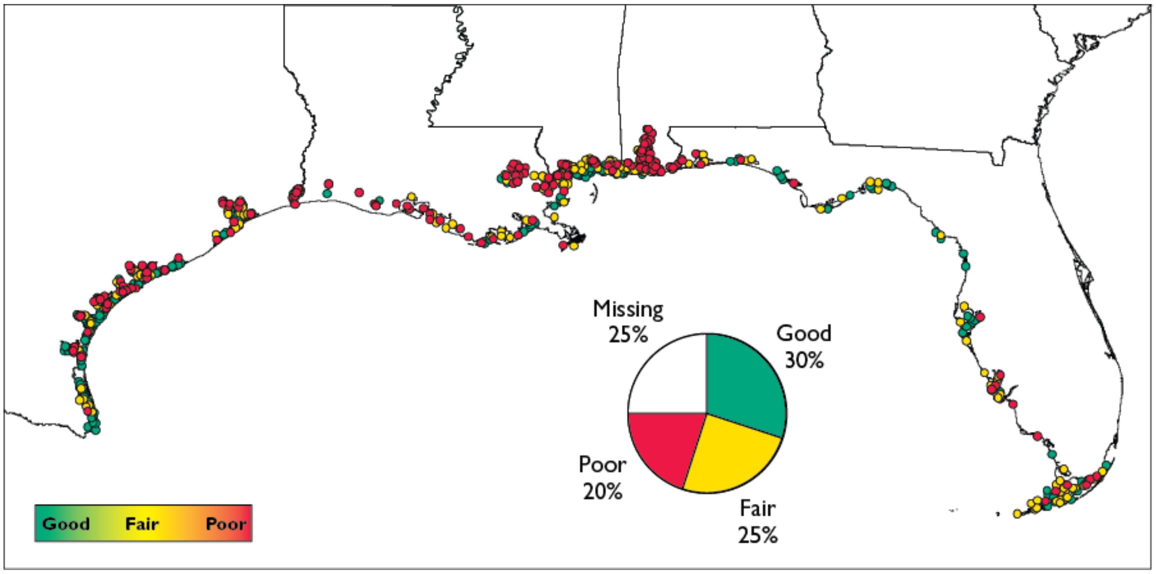

Figure 5-9. Benthic index data for Gulf Coast coastal waters (U.S. EPA/NCA).

Coastal Habitat Index

The coastal habitat index for the coastal waters of the Gulf Coast region is rated poor. The Gulf Coast region experienced a loss of 41,800 acres (1.2%) of coastal wetlands from 1998 to 2004 (Stedman and Dahl, 2008), and the long-term, average decadal wetland loss in coastal states is 2.4%. This estimate does not include the substantial losses of coastal wetlands in the Gulf Coast that occurred as a result of Hurricanes Katrina, Rita, and Wilma in 2005. In Louisiana alone, Hurricanes Katrina and Rita impacted more than 64,000 acres of coastal forested wetlands and more than 135,000 acres of coastal marshes (NMFS, 2007b). In Mississippi, 1,890 acres of coastal wetlands were impacted by Hurricane Katrina, while in Florida, mangrove wetlands were extensively damaged by Hurricane Wilma (NMFS, 2007b). Coastal wetlands in the Gulf Coast region constitute 66% of the total coastal wetland acreage in the conterminous 48 states (Dahl, 2003). Although the Gulf Coast region sustained the largest net loss of coastal wetland acreage during the past decade compared with other regions of the country, the region also had the greatest total acreage of coastal wetlands in 2004 (3,508,600 acres). While coastal development and interference with normal erosional/depositional processes contributes to wetland losses along the Gulf Coast, significant losses also result from climatic changes that affect sea-level rise, subsidence, and the frequency and severity of hurricanes.

Fish Tissue Contaminants Index

The fish tissue contaminants index for the coastal waters of the Gulf Coast region is rated good, with 9% of all sites where fish were sampled rated poor for fish tissue contaminant concentrations (Figure 5-10). Contaminant concentrations exceeding EPA advisory guidance values in Gulf Coast samples were observed primarily in Atlantic croaker and hardhead catfish. Commonly observed contaminants included total PAHs, PCBs, DDT, mercury, and arsenic. Although many of the Gulf Coast estuarine and coastal areas do have fish consumption advisories in effect, that advice primarily concerns recreational game fish such as king mackerel, which are not sampled by the NCA program.

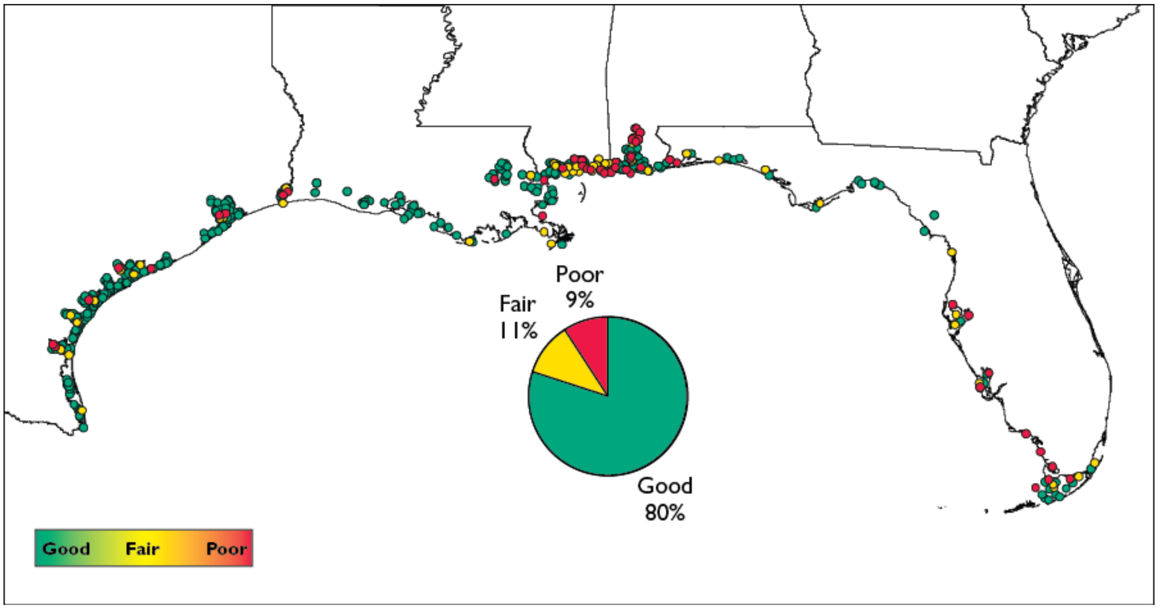

Figure 5-10. Fish tissue contaminants index data for Gulf Coast coastal waters (U.S. EPA/NCA).

Trends of Coastal Monitoring Data—Gulf Coast Region

Temporal Change in Ecological Condition

EMAP/NCA initiated annual surveys of coastal condition in the Gulf of Mexico in 2000, and these data were reported in the NCCR II. Data from 2001 and 2002 were assessed in the NCCR III, and data from 2003–2006 are assessed in this current report (NCCR IV). Seven years of monitoring data from Gulf Coast coastal waters provide an ideal opportunity to investigate temporal changes in ecological condition indices and component indicators. These data can be analyzed to answer two basic types of trend questions based on assessments of ecological indicators in Gulf Coast coastal waters: what is the interannual variability in proportions of area rated good, fair, or poor, and has there been a significant change in the proportion of poor area from 2000 to 2006?

With the exception of the fish tissue contaminants index, all of the condition indices and component indicators can be compared over time (2000–2006) because data supporting these parameters were collected using similar protocols and QA/QC methods. NCA implemented probability-based surveys that support estimations of the percent of coastal area in good, fair, or poor condition based on the indices and component indicators. Standard errors for these estimates were calculated according to methods listed on the EMAP Aquatic Resource Monitoring Web site (http://www.epa.gov/nheerl/arm). The cutpoints listed in Chapter 1 were used to determine good, fair, or poor condition for each index and component indicators. Inter-annual variation was evaluated by comparing annual estimates of percent area in poor condition for each indicator and the associated standard error. A 2-year survey design was implemented for 2005–2006; therefore, this was treated as a single "year." Trends in the percent area in poor condition for each indicator were evaluated using the Mann-Kendall test.

Neither the water quality index nor any of its component indicators showed a significant linear trend over time in the percent area rated in poor condition (Figures 5-11 through 5-16). The percent area in poor condition for the water quality index increased from 2000 to 2004 and then decreased (Figure 5-11), although there were no statistically significant differences between any of the years. The change in percent area in poor condition for DIP, chlorophyll *a*, and dissolved oxygen showed a similar pattern (Figures 5-13, 5-14, 5-16). The percent area with poor DIN ratings did not change over time (Figure 5-

12), while there was a slight, but not statistically significant, decrease in the percent area with poor water clarity over time (Figure 5-15).

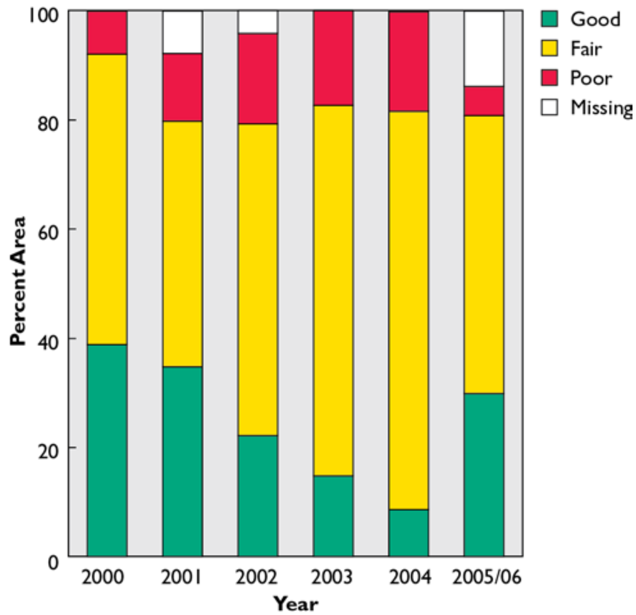

Figure 5-11. Percent area of Gulf Coast coastal waters in good, fair, poor, or missing categories for the water quality index measured from 2000–2006 (U.S. EPA/NCA).

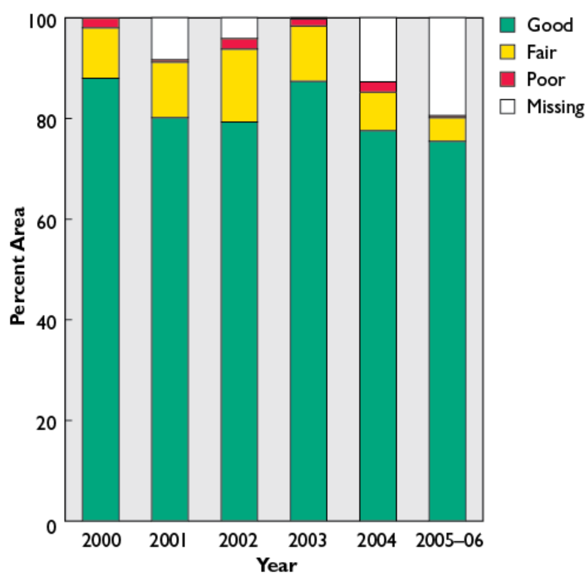

Figure 5-12. Percent area of Gulf Coast coastal waters in good, fair, poor, or missing categories for DIN measured from 2000–2006 (U.S. EPA/NCA).

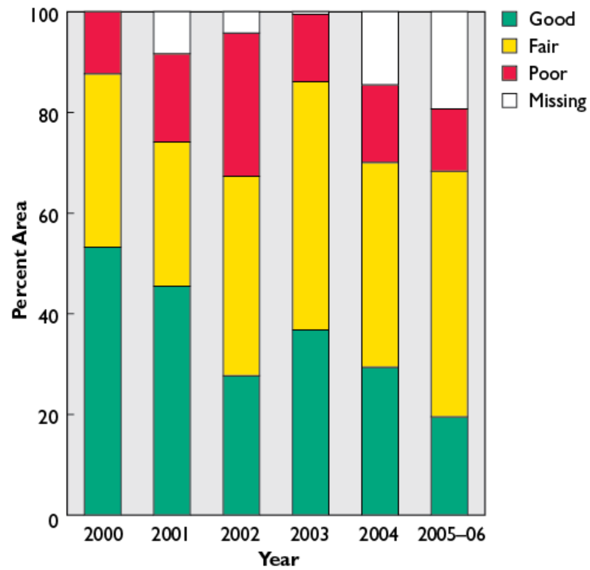

Figure 5-13. Percent area of Gulf Coast coastal waters in good, fair, poor, or missing categories for DIP measured from 2000–2006 (U.S. EPA/NCA).

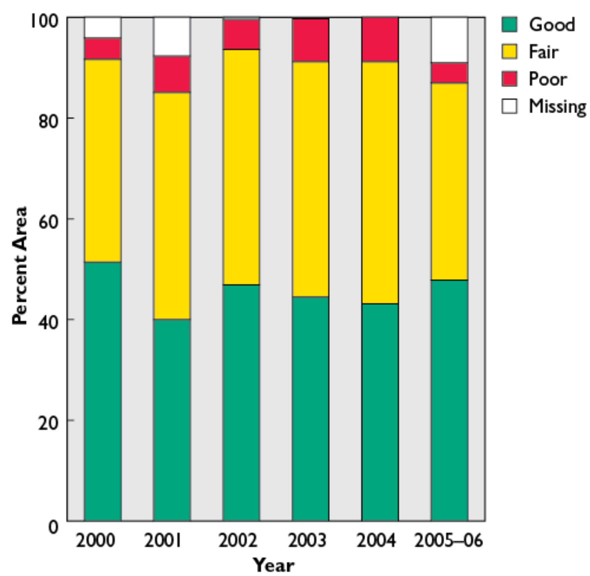

Figure 5-14. Percent area of Gulf Coast coastal waters in good, fair, poor, or missing categories for chlorophyll *a* measured from 2000–2006 (U.S. EPA/NCA).

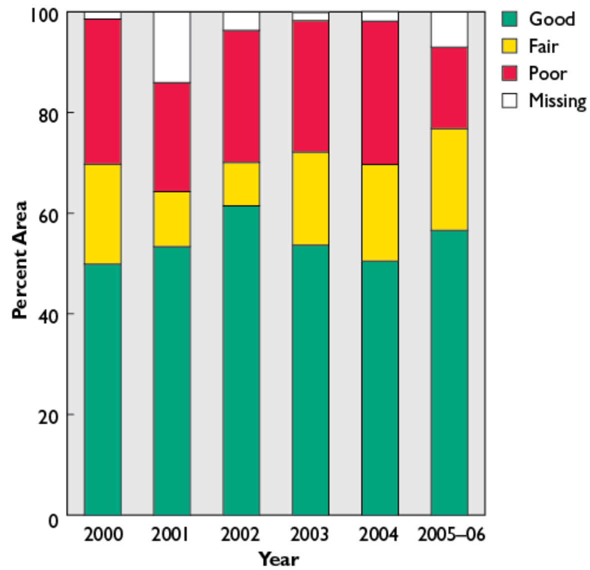

Figure 5-15. Percent area of Gulf Coast coastal waters in good, fair, poor, or missing categories for water clarity measured from 2000–2006 (U.S. EPA/NCA).

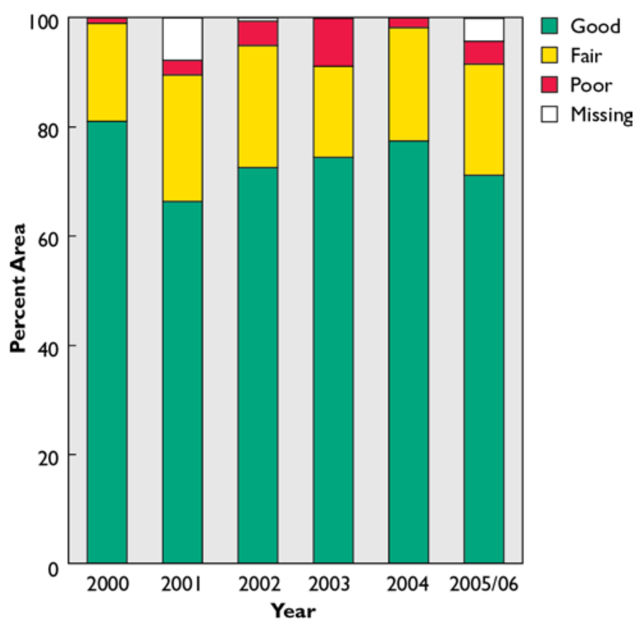

Figure 5-16. Percent area of Gulf Coast coastal waters in good, fair, poor, or missing categories for bottom-water dissolved oxygen measured from 2000–2006 (U.S. EPA/NCA).

The sediment quality index and its component indicators (i.e., sediment toxicity, sediment contaminants, and sediment TOC) were compared over time. Only the percent area with poor ratings for the sediment toxicity component indicator showed a significant positive trend from 2000–2006 ($p < 0.10$; Figure 5-18). Although there were no statistically significant differences in the percent area rated poor for sediment contaminants, TOC, or the sediment quality index from 2000–2002 (Figures 5-17 through 5-20), the percent area rated poor for the sediment contaminants component indicator decreased from 13% in 2000 to 0% in 2004–2006 (Figure 5-19).

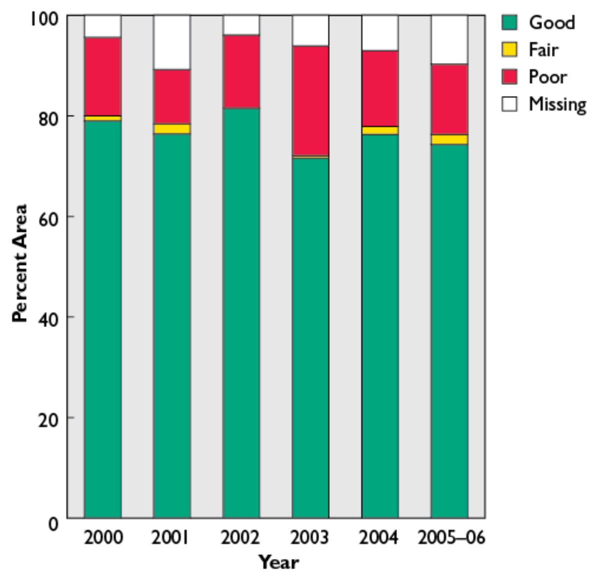

Figure 5-17. Percent area of Gulf Coast coastal waters in good, poor, or missing categories for the sediment quality index measured from 2000–2006 (U.S. EPA/NCA).

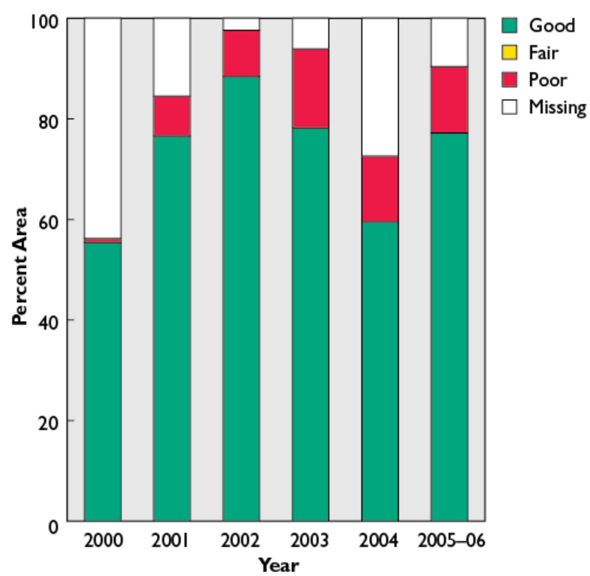

Figure 5-18. Percent area of Gulf Coast coastal waters in good, poor, or missing categories for sediment toxicity measured from 2000–2006 (U.S. EPA/NCA).

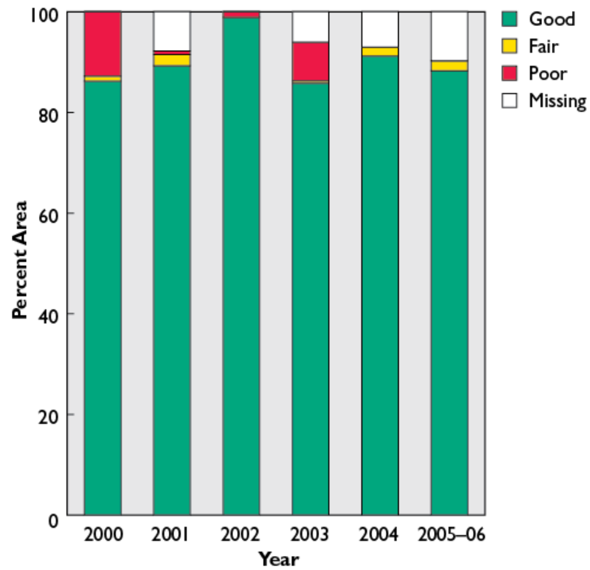

Figure 5-19. Percent area of Gulf Coast coastal waters in good, fair, poor, or missing categories for sediment contaminants measured from 2000–2006 (U.S. EPA/NCA).

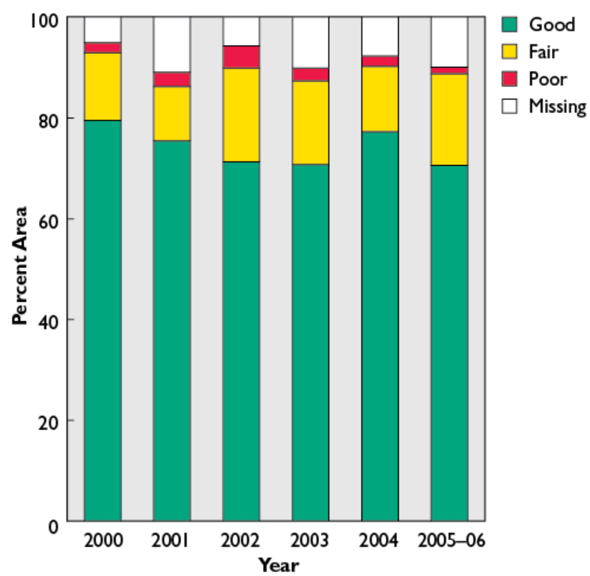

Figure 5-20. Percent area of Gulf Coast coastal waters in good, fair, poor, or missing categories for sediment TOC measured from 2000–2006 (U.S. EPA/NCA).

The benthic index for Gulf Coast coastal waters is a multimetric indicator of the biological condition of benthic macroinvertebrate communities. Biological condition indicators integrate the response of aquatic organisms to changes in water quality and sediment quality over time. There was no statistically significant trend in the percent area with poor benthic condition from 2000–2006. The percent area with poor benthic condition increased from 2000 to 2002 and then decreased (Figure 5-21). More than 50% of the area had missing benthic data in 2005–2006; this was, in part, due to difficulties in obtaining samples after the hurricanes of 2005 (e.g., Katrina and Rita).

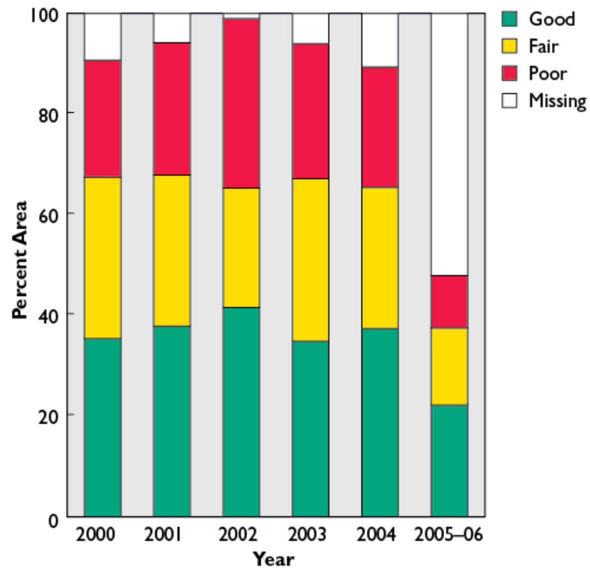

Figure 5-21. Percent area of Gulf Coast coastal waters in good, fair, poor, or missing categories for the benthic index measured from 2000–2006 (U.S. EPA/NCA).

In summary, there were no statistically significant trends in water quality, sediment quality, or benthic condition in the Gulf Coast estuaries from 2000–2006.

Large Marine Ecosystem Fisheries—Gulf of Mexico LME

The Gulf of Mexico LME extends from the Yucatan Peninsula, Mexico, to the Straits of Florida, and is bordered by the United States and Mexico (Figure 5-22). In this LME, intensive fishing is the primary driving force of biomass change, with climate as the secondary driving force. The Gulf of Mexico LME is considered a moderately productive LME based on global estimates of primary production (phytoplankton) (NOAA, 2007a). The LME is partially isolated from the Atlantic Ocean, and the portion located beyond the continental shelf is a semi-enclosed oceanic basin connected to the Caribbean Sea by the Yucatan Channel and to the Atlantic Ocean by the Straits of Florida. Through the narrow, deep Yucatan Channel, a warm current of water flows northward, penetrating the Gulf of Mexico LME and looping around or turning east before leaving the Gulf through the Straits of Florida. This current of tropical Caribbean water is known as the Loop Current, and along its boundary, numerous eddies, meanders, and intrusions are produced and affect much of the hydrography and biology of the Gulf. A high diversity of fish eggs and larvae are transported in the Loop Current, which tends to concentrate and transport early life stages of fish toward estuarine nursery areas, where the young can reside, feed, and develop to maturity.

Figure 5-22. The Gulf of Mexico Large Marine Ecosystem (NOAA, 2010a).

From 2003 to 2006, commercial fisheries in the Gulf of Mexico LME generated over $2.6 billion in revenue, dominated by the white and brown shrimp fisheries, which generated over $677 million and $650 million during this period, respectively. The next-highest grossing fishery, the Eastern oyster (*Crassostrea virginica*), yielded over $240 million (NMFS, 2010). The other top-grossing fisheries include menhaden, blue crab, and pink shrimp. Most of the commercial fishery revenue within this LME is generated by Louisiana and Texas. See Figure 5-23 for revenues and landings of the top Gulf of Mexico LME commercial fisheries. As in other LMEs, the fisheries are managed through a combination of federal and state regulatory regimes, the latter playing an especially large role because invertebrates tend to occur within state waters. Recreational fishers target red drum and spotted seatrout, as well as pelagic (water-column dwelling) species such as mackerel, dolphinfish, and cobia.

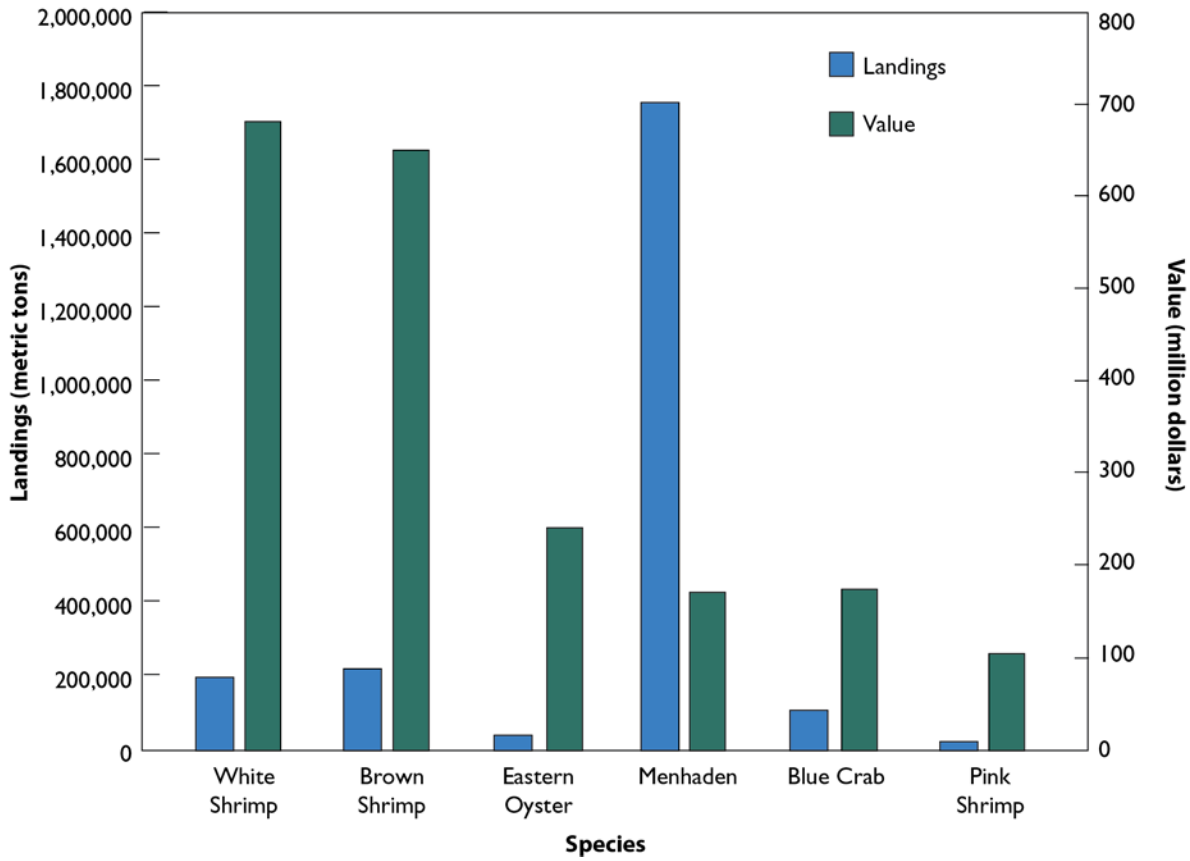

Figure 5-23. Top commercial fisheries for the Gulf of Mexico LME: landings (metric tons) and value (million dollars) from 2003–2006 (NMFS, 2010).

Invertebrate Fisheries

In the Gulf of Mexico LME, the most important commercial fisheries are invertebrates (shrimp, oysters, and crab), which represent five of the six top-grossing fisheries. Shrimp fisheries in this LME are some of the most valuable U.S. fisheries based on ex-vessel revenues (pre-processing value) and are fished using a twin-trawl system that allows the towing of four trawls simultaneously. Brown, white, and pink shrimp account for over 99% of the total Gulf of Mexico LME shrimp catch. In 2006 alone, these three important species produced approximately 129 metric tons valued at more than $388 million in ex-vessel revenues. They are typically found in all U.S. Gulf of Mexico LME waters shallower than 395 feet. Most of the offshore brown shrimp catch is taken at 130- to 260-foot depths; white shrimp are caught in waters 66 feet deep or less; and pink shrimp in waters of 130–200 feet. Brown shrimp are most abundant off the Texas–Louisiana coast, and the greatest concentration of pink shrimp is in waters off southwestern Florida. Between 2004 and 2006, the average annual yield for brown shrimp (53,500 metric tons), pink shrimp (6,500 metric tons), and white shrimp (52,000 metric tons) was below maximum sustainable yield levels (NMFS, 2009b).

Catch levels in 2006 were excellent for brown and white shrimp, with white shrimp reaching an all time high at approximately 59,500 metric tons, while pink shrimp have shown a moderate declining trend in recent years (Hart and Nance, 2007). For each species, the number of young shrimp entering the fisheries has generally reflected the level of catch, with harvesting occurring at maximum levels. The number of young brown shrimp produced per parent increased significantly until about 1991—most likely in relation to marsh habitat alterations—and has remained near or slightly below that level during most years.

Coastal sinking and sea-level rise in the northwestern Gulf of Mexico LME inundate intertidal marshes, allowing the shrimp to feed for longer periods within the marsh area. Both factors have also expanded estuarine areas, created more marsh edges, and provided more protection from predators. However, continued coastal sinking will lead to marsh deterioration and an ultimate loss of supporting wetlands, and current high fishery yields may not be indefinitely sustainable.

In the Gulf of Mexico LME, harvesting is regulated under the Gulf of Mexico Fishery Management Council's Shrimp FMP (GMFMC, 2011), which restricts shrimping by closing two shrimping grounds—a seasonal closure of fishing grounds off Texas for brown shrimp and a closure off Florida for pink shrimp. The harvesting of small shrimp is sacrificing the yield and value of the catch by cutting short future population growth (Caillouet et al., 2008); therefore, size limits also exist for white shrimp caught in federal waters and landed in Louisiana. Because shrimp are a short-lived species (with life spans only up to 1.5 years), they can quickly benefit from management practices.

Until very recently, the shrimp fisheries were overcapitalized, with more fishing effort being expended than was needed to sustainably harvest the resource (Nance et al., 2006). Lower-than-average ex-vessel prices for shrimp and higher-than-average fuel prices over the past few years have stemmed this trend. As in the Southeast U.S. Continental Shelf LME, another management concern is the use by shrimp fisheries of small-mesh trawl nets that catch non-target species, including species at low stock levels; commercially fished species such as red snappers, croakers, and seatrouts; and protected resources such as sea turtles. All sea turtle species are listed as endangered or threatened under the Endangered Species Act, and shrimp vessels have been required to use turtle-excluder devices in their nets since 1988 to avoid capturing sea turtles. The NMFS and the fishing industry are working together to continue development of bycatch-reduction gear to address the problems of finfish by-catch in shrimp fisheries of the Gulf of Mexico and Southeast U.S. Continental Shelf LMEs.

The other major invertebrate fisheries in the Gulf of Mexico LME are the blue crab and Eastern oyster. The Eastern oyster is a mollusk native to the U.S. eastern seaboard and the Gulf of Mexico. As a filter feeder, this oyster provides a critical ecosystem function by cleaning the water of plankton and detritus. Oysters build reef-like structures and are harvested using dredges, which scrape sea bottoms and haul the specimens into a basket. From 2003 to 2006, the Eastern oyster fishery in the Gulf of Mexico LME provided over $241 million in total ex-vessel revenues (see Figure 5-23) (NMFS, 2010). This species is also heavily harvested in the Chesapeake Bay. Both areas now supplement natural production by farming oysters, a process that induces oyster reproduction in controlled environmental conditions.

The crab fisheries include blue and stone crab, which provide differing economic values for Gulf states. The biology and harvesting specifications for the blue crab are described within the Southeast U.S. Continental Shelf LME section (Chapter 4), where this is the top-grossing fishery and an iconic species. Although less well known in the Gulf, the blue crab fishery generated over $165 million in total ex-vessel revenues from 2003 to 2006 for this area, providing many of the crabs served on the East Coast market (NMFS, 2010).

Menhaden Fishery

Menhaden, a herring-like fish, are found in coastal and estuarine waters of the Gulf of Mexico, Southeast U.S. Continental Shelf, and Northeast U.S. Continental Shelf LMEs. They form large schools at the surface, which are located by aircraft and harvested by purse seines to produce baitfish; fishmeal; fish oil; flavoring for pet food; protein in animal feed; and fertilizer. Menhaden are prey for many fish, marine mammals, and sea birds, and, as filter feeders, minimize algal blooms, all of which are important functions within coastal ecosystems. Gulf menhaden (*Brevoortia patronus*) play a greater role in U.S. commercial fisheries than their Atlantic relative, Atlantic menhaden (*Brevoortia tyrannus),* generating

$168.6 million in total ex-vessel revenues from 2003 to 2006 within the Gulf (mostly by Louisiana) (see Figure 5-23) (NMFS, 2010). In both the Gulf and the Atlantic, menhaden are largely harvested by one company, Omega Protein of Houston, which owns reduction factories along the Gulf Coast and one in Virginia.

Gulf menhaden are most abundant in the north-central portion of the Gulf of Mexico, though they are present throughout the Gulf. They form large surface schools that appear in nearshore Gulf waters from April to November. Although no extensive coast-wide migrations are known, some evidence suggests that older fish move toward the Mississippi River delta. In 2005, Hurricanes Katrina and Rita did considerable damage to the four Gulf menhaden reduction factories (which process the fish into fertilizer, feed stock, and fish oil); two closed for the remainder of the fishing season after the storms and faced major difficulties re-opening in 2006. Because Gulf of Mexico LME menhaden have a short life cycle and a high natural mortality, overfishing has not been a management concern. Management is coordinated through the Gulf States Marine Fisheries Commission and consists of an approximate 28-week fishing season from April to October. Menhaden in the Atlantic are largely managed by the Atlantic States Marine Fisheries Commission and the states.

Fishery Trends and Summary

Figure 5-24 shows landings of the menhaden fishery in the Gulf of Mexico LME since 1950. The menhaden and the other top fisheries in this LME are displayed on separate graphs because catches of menhaden are too large to demonstrate on the same scale as the rest of the Gulf of Mexico fisheries. Landings in the menhaden fishery increased steadily from 1950, peaked at nearly 1 million metric tons in the mid-1980s and declined to present-day levels of 400,000 metric tons. In addition to changes in fishing effort, the variations in landings are largely attributable to altered environmental conditions that affect recruitment of gulf menhaden, including adverse meteorological events such as hurricanes. Increased tropical activity also leads to decreased fishing effort and, coupled with lower recruitment level, results in a negative impact on fishery landings.

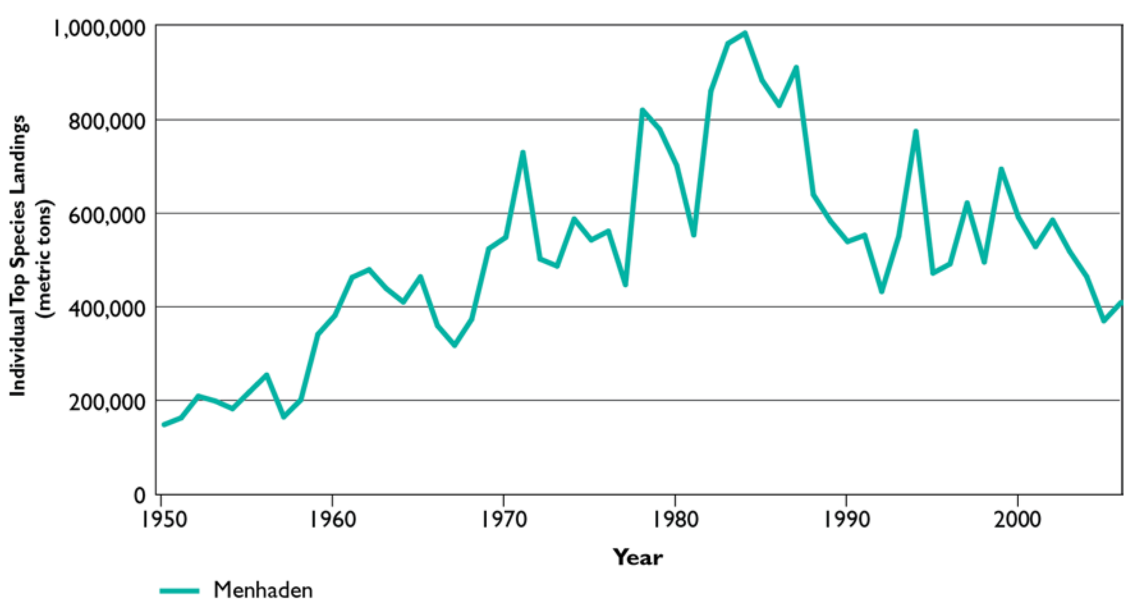

Figure 5-24. Landings of the menhaden fishery in the Gulf of Mexico LME from 1950 to 2006, metric tons (NMFS, 2010).

Landings in the invertebrate fisheries, which generate the largest revenues for the Gulf of Mexico LME, are presented in Figure 5-25. Since 1950, the blue crab has steadily increased from 10,000 metric tons to present-day landings of 30,000 metric tons. Landings in the Eastern oyster fishery have consistently fluctuated around 10,000 metric tons over the past five decades. Data for the shrimp fisheries was not available prior to 1961, and landings from 1972 to 1977 were reported as combined totals rather than as separate species. Nevertheless, with the data that are available, there is evidence of considerable fluctuation in landings over the past several decades for all three shrimp species. During this time, both the white and brown shrimp fisheries landings have increased to just over 60,000 metric tons, with catches in the white shrimp fishery steadily increasing since the late 1990s. Landings in the brown shrimp fishery had been declining since 2000, though a recent spike brought catches up to average levels. The pink shrimp fishery, which yields much lower catches than the other two shrimp species, declined from a peak of 25,000 metric tons in the mid-1960s to less than 5,000 metric tons in 2006 (NMFS, 2010).

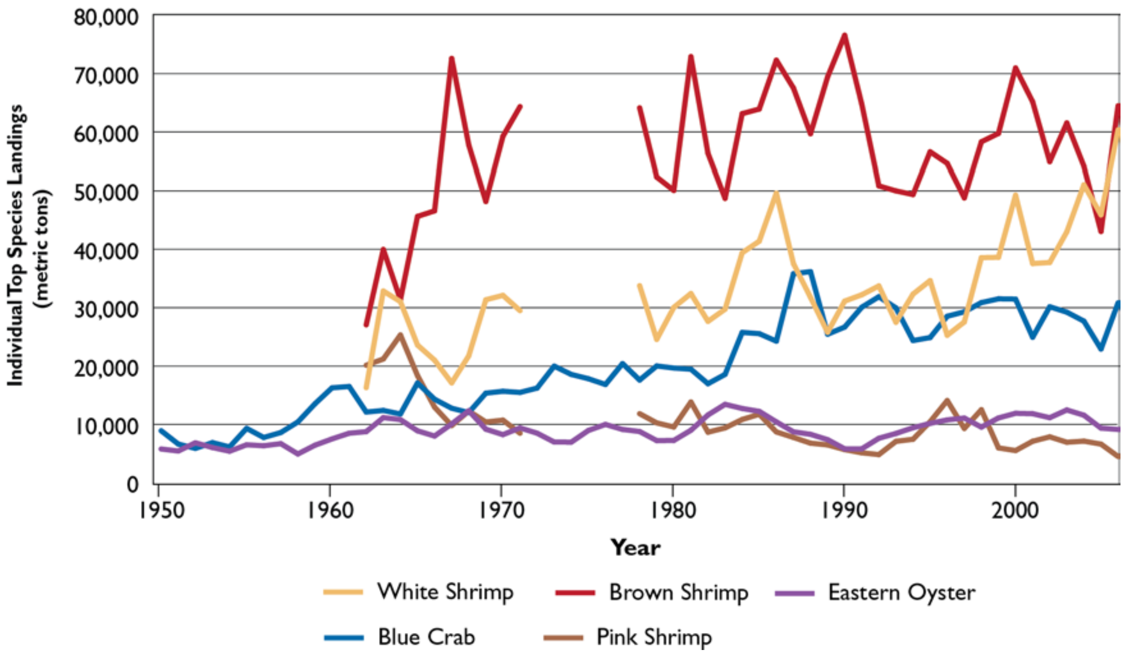

Figure 5-25. Landings of the top commercial fisheries in the Gulf of Mexico LME from 1950 to 2006, metric tons (NMFS, 2010).

The Gulf of Mexico LME provides significant commercial and recreational fisheries opportunities. The top commercial species are invertebrate species of white, brown, and pink shrimp. These species accounted for over $350 million in 2006 alone. From 2003 to 2006, Eastern oyster catches provided over $240 million, and blue crab generated $165 million for commercial fisheries. The menhaden fishery generated $165 million from 2003–2006 from approximately 400,000 metric tons per year (NMFS, 2010). Interestingly, and unlike most other Gulf fisheries, the menhaden catch far exceeded its market value. Menhaden are used in a variety of industries such as fertilizer production, protein in animal feed, and flavoring in pet foods.

In addition to the substantial market value of these commercial fisheries, they support other related industries, such as boat construction, fuel for vessels, fishing gear and nets, shipboard navigation and electronics, and ship repair and maintenance. Similarly, recreational fish such as grouper, snapper, and amberjack drive an economic engine that supports tourism, bait and tackle shops, recreational boating and much more, all contributing significantly to the value derived from the ecosystem service of fishery production. This "coastal economy" (Yoskowitz, 2009) of the Gulf of Mexico LME provides fish and shellfish for food, but that is not the only ecosystem service or function it offers. Fish and shellfish are part of complex ecosystems that rely on various species interactions for the maintenance of necessary ecosystem functions. For instance, invertebrates and pelagic (water-column dwelling) species provide sustenance for larger fish, which themselves are prey for marine mammals and seabirds, which can also support tourism and coastal development. Many functions performed by species in the LME also indirectly benefit humans, such as water purification by bivalves such as scallops, clams, and oysters that filter the water constantly while feeding, helping to clean the water of algae, detritus, and toxics, which results in a more enjoyable beach or boating experience for humans.

Advisory Data

Fish Consumption Advisories

In 2006, 11 fish consumption advisories were in effect for the estuarine and marine waters of the Gulf Coast region. Most of the advisories (9) were issued for mercury, and each of the five Gulf Coast states had one state-wide coastal advisory in effect for mercury levels in king mackerel. The statewide king mackerel advisories covered all coastal and estuarine waters in Florida, Mississippi, Louisiana, and Alabama, but covered only the coastal shoreline waters in Texas. As a result of the statewide advisories, 100% of the coastal miles of the Gulf Coast and 76% of the estuarine square miles were under advisory in 2006 (Figure 5-26) (U.S. EPA, 2007c). Table 5-1 lists the species and/or groups under fish consumption advisory in 2006 for at least some part of the coastal waters of the Gulf Coast region.

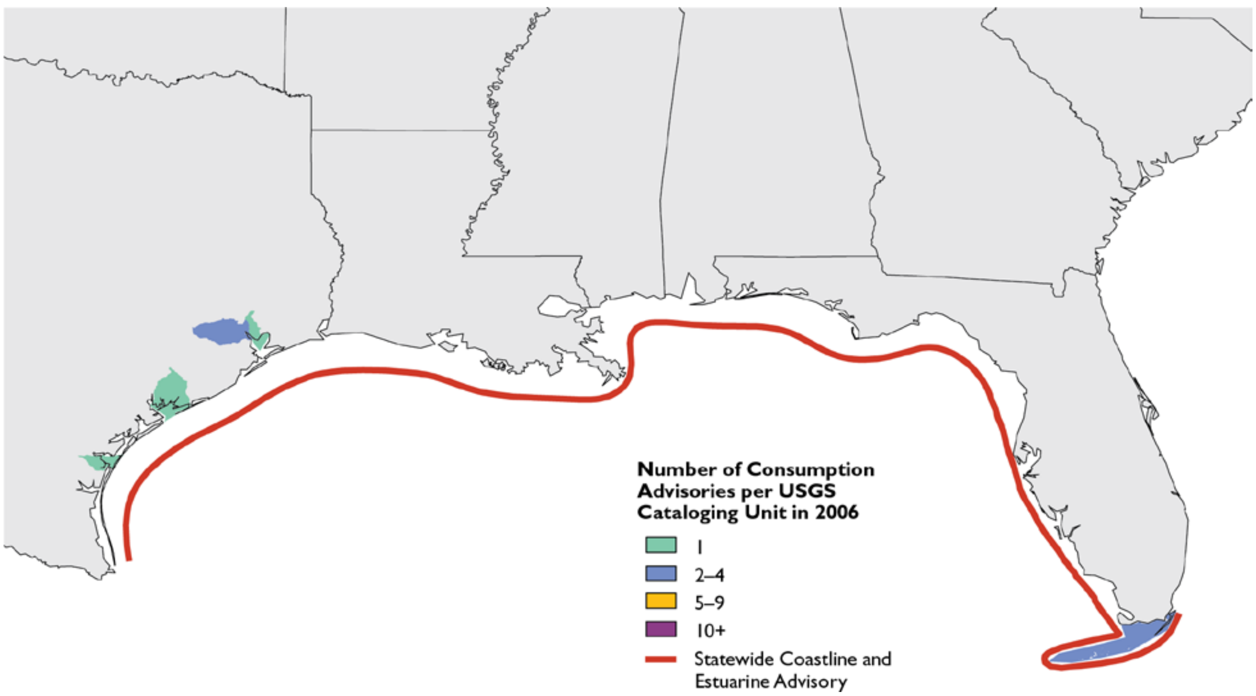

Figure 5-26. The number of fish consumption advisories active in 2006 for the Gulf Coast coastal waters (U.S. EPA, 2007c).

Table 5-1. Species and/or Groups under Fish Consumption Advisory in 2006 for at Least Some Part of the Coastal Waters of the Gulf Coast Region

Species and/or Groups under Fish Consumption Advisory		
Almaco jack	Atlantic croaker	Atlantic spadefish
Atlantic stingray	Atlantic thread herring	Barracuda
Black drum	Black grouper	Blackfin tuna
Blue crab	Bluefish	Bluntnose stingray
Bonefish	Catfish	Cobia
Crab	Crevalle jack	Dolphin
Fantail mullet	Florida pompano	Gafftopsail catfish
Gag grouper	Gray snapper	Greater amberjack
Gulf flounder	Hardhead catfish	Hogfish
Lane snapper	King mackerel	Ladyfish
Little tunny	Lookdown	Mutton snapper
Oysters	Pigfish	Pinfish
Red drum	Red grouper	Red snapper
Sand seatrout	Scamp	Shark
Sheepshead	Silver perch	Skipjack tuna
Common Snook	Snowy grouper	Southern flounder
Southern kingfish	Spanish mackerel	Spot
Spotted seatrout	Tarpon	Striped mojarra
Striped mullet	Wahoo	Tripletail
Vermillion snapper	White mullet	Weakfish
White grunt	Yellowtail snapper	Yellowedge grouper
Yellowfin tuna		

Source: U.S. EPA, 2007c

In addition to the statewide coastal advisory, Florida had two mercury advisories in effect for a variety of fish. In Texas, the Houston Ship Channel continued an advisory for all fish species because of the risk of contamination by chlorinated pesticides and PCBs. In addition, the advisory was expanded to include potential dioxin contamination for all fish in the Houston Ship Channel. Figure 5-27 shows the number of advisories issued along the Gulf Coast for each contaminant (U.S. EPA, 2007c).

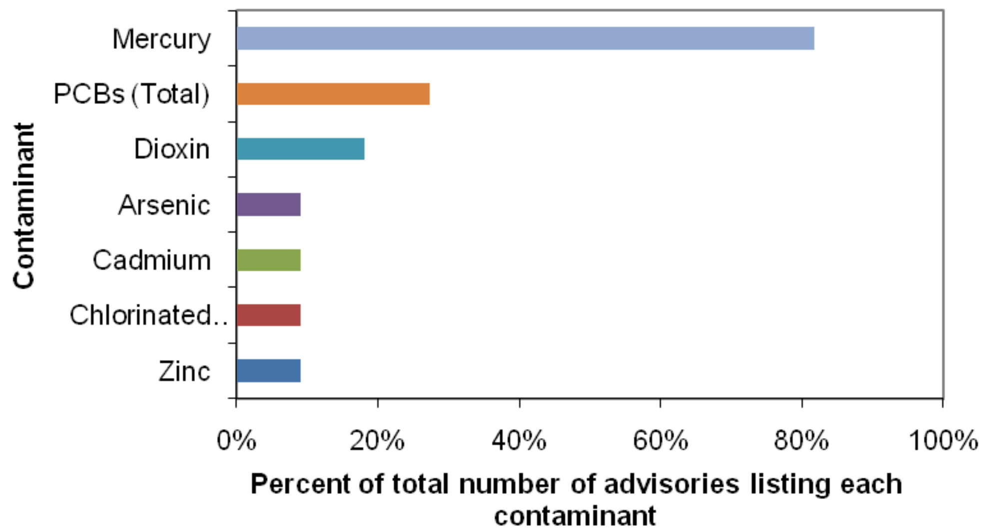

Figure 5-27. Pollutants responsible for fish consumption advisories in Gulf Coast coastal waters. An advisory can be issued for more than one contaminant, so percentages may add up to more than 100 (U.S. EPA, 2007c).

Beach Advisories and Closures

How many notification actions were reported for the Gulf Coast between 2004 and 2008?

Table 5-2 presents the number of total and monitored beaches, as well as the number and percentage of monitored beaches affected by notification actions from 2004 to 2008 for the Gulf Coast (i.e., Florida's Gulf Coast beaches, Texas, Louisiana, Mississippi, and Alabama). Data from Florida were not included in 2004 and 2005, nullifying comparison with the 2006 to 2008 information. Nevertheless, there is an increase of 32 monitored beaches for those years amongst the other three states. From 2006 to 2008, the percentage of monitored beaches affected by notifications increased demonstrably from 48% to 54% (U.S. EPA, 2009d). Annual national and state summaries are available on EPA's Beaches Monitoring site: http://www.epa.gov/waterscience/beaches/seasons/.

Table 5-2. Beach Notification Actions, Gulf Coast, 2004–2008 (U.S. EPA, 2009d)

Numbers and Percentages	2004[a]	2005[a]	2006	2007	2008
Total number of beaches	241	242	651	649	650
Number of monitored beaches	100	132	316	323	323
Number of beaches affected by notification actions	65	67	152	164	176
Percentage of monitored beaches affected by notification actions	65%	51%	48%	51%	54%

[a] Data for Florida's Gulf Coast beaches is not included for 2004 and 2005 because the state did not differentiate between its Southeast and Gulf coast beaches in its state summary.

What pollution sources impacted monitored beaches?

Table 5-3 presents the numbers and percentages of monitored Gulf Coast beaches affected by various pollution sources for 2007. Unknown, unidentified, and uninvestigated pollution sources contributed to over 85% of beach notifications on the Gulf Coast. The other major pollution sources affecting Gulf Coast beaches in 2007 were boat discharges (22%), storm-related runoff (28%), and wildlife (22%) (U.S. EPA, 2009d).

Table 5-3. Reasons for Beach Advisories, Gulf Coast, 2007 (U.S. EPA, 2009d)

Reason for Advisories	Total Number of Monitored Beaches Affected	Percent of Total Monitored Beaches Affected
Other and/or unidentified sources	92	41%
Pollution sources not investigated	73	33%
Storm-related runoff	62	28%
Wildlife	50	22%
Boat discharge	49	22%
No known pollution sources	30	13%
Agricultural runoff	19	9%
Septic system leakage	19	9%
Sanitary/combined sewer overflow	15	7%
Sewer line leak or break	11	5%
Publicly owned treatment works	1	< 1%

Note: A single beach advisory may have multiple pollution sources.

How long were the 2007 beach notification actions?

In 2007, nearly 90% of beach notifications on the Gulf Coast lasted up to a week, with most (70%) in the 3- to 7-day duration period. Another 19% were either 1 day (4%) or 2 days (15%), and the remaining 11% were of the 8- to 30-day duration (9%) and over 30-day duration (2%) (U.S. EPA, 2009d). For more information on state beach closures, please visit EPA's Beaches Web site: http://water.epa.gov/type/oceb/beaches/beaches_index.cfm.

Summary

Based on the indices used in this report, the overall condition of Gulf Coast coastal waters is rated fair. The coastal wetland and sediment quality indices are rated poor in Gulf Coast coastal waters for 2003–2006, while water quality and benthic condition were also of concern (rated fair and fair to poor, respectively). Benthic index values were lower than expected in 20% of the Gulf Coast estuaries. Although elevated sediment contaminant concentrations were found in only 3% of the coastal area, sediments were toxic in 15% of the coastal area. Poor water clarity was observed in 21% of the coastal area, elevated levels of DIP were observed in 14% of the area, and dissolved oxygen concentrations were rated poor in less than 5% (4.8%) of the area. DIN concentrations rarely exceeded guidelines. The overall condition rating of 2.4 in this report represents no significant change from the ratings of 2.4 and 2.2 observed in the previous reports (NCCR II and III), but still represents an improvement in overall condition since the early 1990s.

NOAA's NMFS manages several fisheries in the Gulf of Mexico LME, including reef fishes, mackerel, and shrimp. The top commercial species are invertebrate species of white, brown, and pink shrimp; oysters; and blue crabs. The menhaden stock in this LME is healthy, but in 2005, Hurricanes Katrina and Rita did considerable damage to the four Gulf menhaden reduction factories. Continued coastal sinking and sea-level rise in the northwestern Gulf of Mexico LME may lead to shrimp habitat deterioration, and current high fishery yields may not be indefinitely sustainable.

Contamination in Gulf Coast coastal waters has affected human uses of these waters. In 2006, 100% of the coastal miles of the Gulf Coast and 76% of the estuarine square miles were under fish consumption advisories, primarily due to mercury contamination. In addition, approximately 48% of the region's monitored beaches were closed or under advisory for some period of time during 2006.

Increasing population pressures in the Gulf Coast region warrant additional monitoring programs and increased environmental awareness to correct existing problems and to ensure that indicators that appear to be in fair condition do not worsen.