*This document contains overall and specific condition of the Charlotte Harbor National Estuary Program from the National Estuary Program Coastal Condition Report. The entire report can be downloaded from http://www.epa.gov/owow/oceans/nepccr/index.html*

National Estuary Program Coastal Condition Report

Chapter 5: Gulf of Mexico National Estuary Program Coastal Condition, Charlotte Harbor National Estuary Program

June 2007

Charlotte Harbor National Estuary Program

Charlotte Harbor National Estuary Program
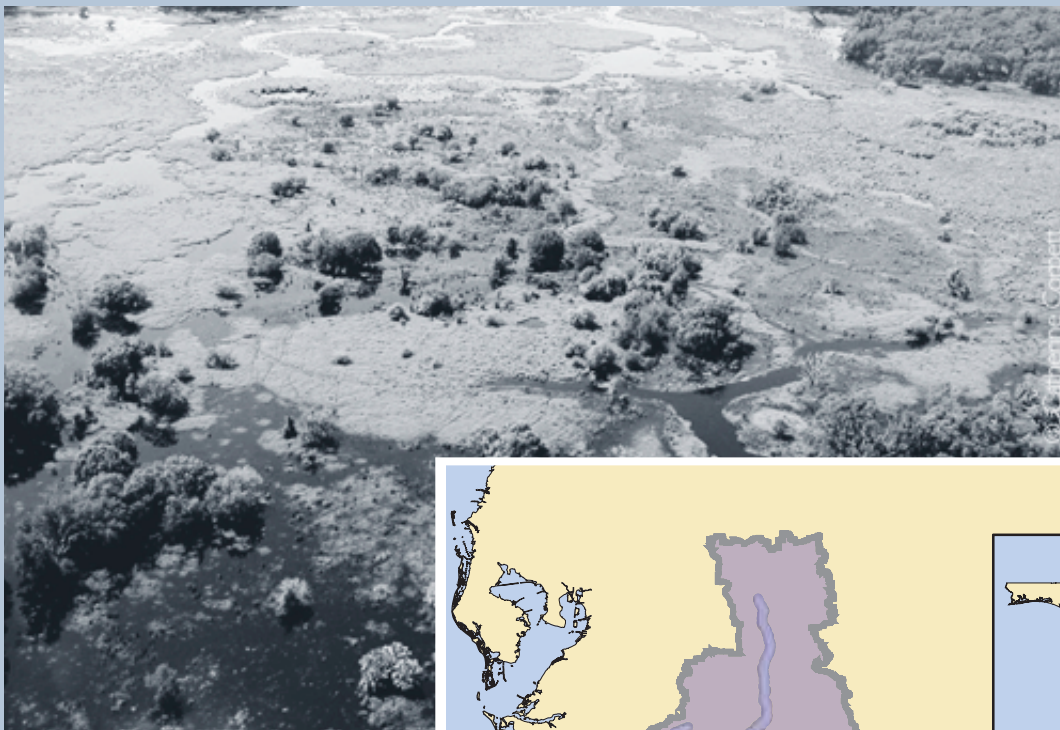
www.chnep.org

Background

Located on the west coast of Florida's peninsula, Charlotte Harbor is created by the inflow and confluence of the Myakka, Peace, and Caloosahatchee rivers and empties into the Gulf of Mexico via Boca Grande, Gasparilla Pass, and San Carlos Bay. The fluctuations of river flow between the wet (summer) and dry (winter) seasons affect the Harbor's salinity and dissolved oxygen levels (NOAA, 1985). The Harbor itself is 30 miles long and 7 miles wide, with a total area of 270 mi^2 (CHNEP, 2005a). The Charlotte Harbor watershed is home to a highly diverse natural ecology, as well as to a growing human population and a variety of economic activities, including phosphate mining, residential development, tourism, intensive agriculture, and commercial fishing. Population growth is a major concern in the Charlotte Harbor watershed because county populations are projected to grow by more than 33% between 2000 and 2020 (CHNEP, 2000).

The estuarine area of the Charlotte Harbor NEP (CHNEP) contains waters listed as drinking water supplies (e.g., Shell and Horse creeks and parts of the Myakka River) and waters listed for shellfish propagation or harvesting (e.g., the tidal portion of the Myakka

and Peace rivers). The CHNEP estuarine area also includes most of the Peace River (U.S. EPA, 2005c). Those areas located within the Charlotte Harbor Aquatic and State Buffer Preserve and the Myakka River State Park have been designated as Outstanding Florida Waters. Charlotte Harbor and its contiguous coastal waters serve as a home, feeding ground, or nursery area for more than 270 resident, migrant, and commercial fish species of the Gulf of Mexico (CHNEP, 2005a). For numerous species, the most critical use of Charlotte Harbor is as a protected nursery area for both larval and juvenile stages of fish. Mangrove trees line the Harbor's shore and provide important habitat for plants, fish, birds, and other wildlife, such as manatees, sea turtles, wood storks, and dolphins.

Environmental Concerns

The environmental concerns of highest priority in Charlotte Harbor are hydrologic alterations, water quality degradation, and habitat loss. Management challenges for the CHNEP include protecting mangrove habitats; protecting seagrass areas from boat damage and water pollution; securing new water supply sources for the watershed's growing human populations and businesses; managing waste generated by septic tanks and sewer outfalls; protecting wetland areas for water retention, groundwater recharge, and wildlife habitat; and improving the overall efficiency of freshwater usage. Hydrologic alterations have occurred in the Harbor's three major tributary rivers, adversely effecting the location, timing, and volume of freshwater flows to this estuary (CHNEP, 2003a). The major causes of habitat loss in Charlotte Harbor include the degradation and elimination of headwater streams and other habitats by commercial development; the conversion of natural shorelines; the cumulative impacts of dock construction and boating; the invasion of exotic species; and other cumulative and future impacts of population growth (CHNEP, 2005a). In general, dissolved oxygen levels and surface water quality have declined in several areas of the Harbor's southern basins, including the Cape Coral peninsula south of Interstate 75, the north shore of the Caloosahatchee River, the coastal bays near Pine Island, and the Estero Bay watershed. Water quality in other areas of Charlotte Harbor is stable or improving (CHNEP, 2003b).

Population Pressures

The population of the 10 NOAA-designated coastal counties (Charlotte, Collier, DeSoto, Glades, Hardee, Hillsborough, Lee, Manatee, Polk, and Sarasota) coincident with the CHNEP study area increased by 251% during a 40-year period, from 0.8 million people in 1960 to 3.0 million people in 2000 (Figure 5-10) (U.S. Census Bureau, 1991; 2001). This rate of population growth for the CHNEP study area was almost double the growth rate of 133.3% for the collective Gulf Coast NEP-coincident coastal counties and was the second-highest rate of growth of all NEPs in the Gulf Coast region, behind Sarasota Bay. In 2000, the population density of these 10 coastal counties was 306 persons/mi^2, slightly higher than the population density of 287 persons/mi^2 for the collective Gulf Coast NEP-coincident coastal counties (U.S. Census Bureau, 2001). Development and population pressures are especially strong in NEP study areas that serve as major shipping ports and as centers for commercial and recreational fisheries and other activities.
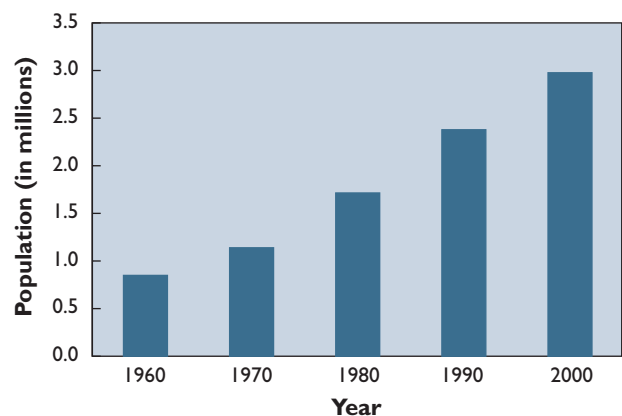

Figure 5-10. Population of NOAA-designated coastal counties of the CHNEP study area, 1960–2000 (U.S. Census Bureau, 1991; 2001).

Charlotte Harbor National Estuary Program

NCA Indices of Estuarine Condition—Charlotte Harbor

The overall condition of Charlotte Harbor is rated fair based on three of the four indices of estuarine condition used by the NCA (Figure 5-11). The water quality index is rated poor, the sediment quality index is rated good, and the benthic index is rated fair; NCA data were unavailable to calculate a fish tissue contaminants index for Charlotte Harbor. Figure 5-12 provides a summary of the percentage of estuarine area rated good, fair, poor, or missing for each parameter considered. This assessment is based on data collected by the Florida Fish and Wildlife Research Institute, in partnership with the NCA, from 30 sites sampled in the CHNEP estuarine area in 2002. Please refer to Tables 1-24, 1-25, and 1-26 (Chapter 1) for a summary of the criteria used to develop the rating for each index and component indicator.
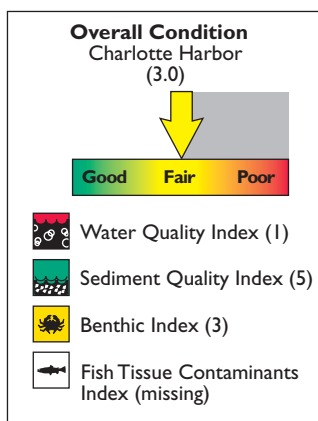

Figure 5-11. The overall condition of the CHNEP estuarine area is fair (U.S. EPA/NCA).

![icon] **Water Quality Index**

The water quality index for Charlotte Harbor is rated poor (Figure 5-13). This index was developed using NCA data on five component indicators: DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen. Elevated DIP concentrations and poor water clarity contributed to the Harbor's poor water quality condition. The NOAA's Estuarine Eutrophication Survey listed Charlotte Harbor as having low-to-high DIN concentrations, high DIP concentrations, and medium-to-hypereutrophic chlorophyll *a* levels (NOAA, 1997).
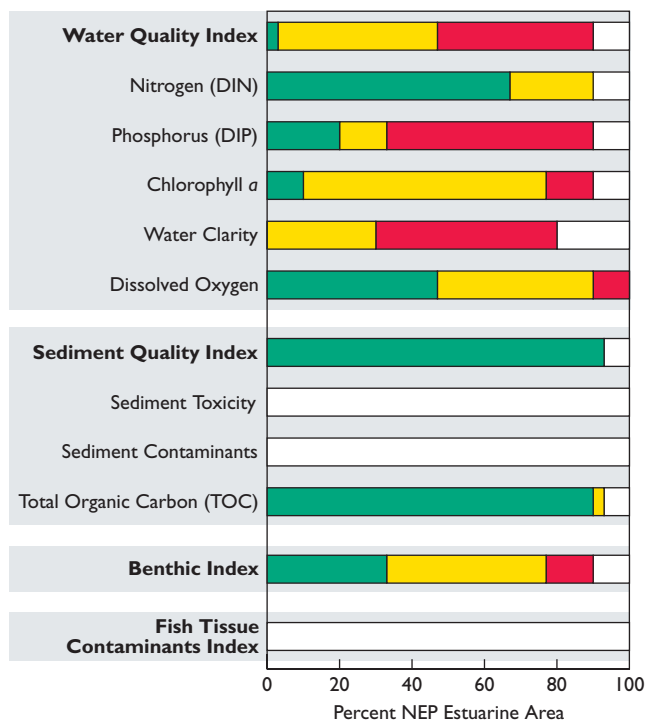

Figure 5-12. Percentage of NEP estuarine area achieving each rating for all indices and component indicators — Charlotte Harbor (U.S. EPA/NCA).

Dissolved Nitrogen and Phosphorus | The Charlotte Harbor is rated good for DIN concentrations. None of the estuarine area was rated poor for this component indicator, 23% of the area was rated fair, and 67% of the area was rated good. NCA data on DIN concentrations were unavailable for 10% of the CHNEP estuarine area. In contrast, DIP concentrations are rated poor for Charlotte Harbor; however, it should be noted that phosphorus levels in Charlotte Harbor are naturally high because of a commercially mined phosphate deposit, the Bone Valley deposit. Fifty-seven percent of the estuarine area was rated poor for DIP concentrations, 20% of the area was rated good, and 13% of the area was rated fair.

Chlorophyll a | Chlorophyll *a* concentrations in Charlotte Harbor are rated fair. Thirteen percent of the estuarine area was rated poor for this component indicator, 67% of the area was rated fair, and 10% was rated good. NCA data on chlorophyll *a* concentrations were unavailable for 10% of the CHNEP estuarine area.

Water Clarity | Water clarity in Charlotte Harbor is rated poor. Water clarity was rated poor at a sampling site if light penetration at 1 meter was less than 20% of surface illumination. Expectations for water clarity are high for Charlotte Harbor because one of the CHNEP's goals is to maintain SAV coverage and quality at levels of natural variability. Fifty percent of the estuarine area was rated poor for water clarity, 30% of the area was rated fair, and none of the area was rated good. NCA data on water clarity were unavailable for the remaining 20% of the CHNEP estuarine area.

Dissolved Oxygen | The Charlotte Harbor is rated fair for dissolved oxygen concentrations. NCA estimates show that only 10% of the CHNEP estuarine area was rated poor for this component indicator, 43% of the estuarine area was rated fair, and 47% of the area was rated good.

Sediment Quality Index

The sediment quality index for Charlotte Harbor is rated good; however, this rating is based on measurements of sediment TOC only (Figure 5-14). Ninety-three percent of the estuarine area was rated good for sediment quality, with NCA data unavailable for 7% of the CHNEP estuarine area.

Sediment Toxicity | The NCA did not collect sediment toxicity data for Charlotte Harbor in 2002; therefore, sediment toxicity in the Harbor has not been rated for this report.

Sediment Contaminants | The NCA did not collect sediment contaminants data for Charlotte Harbor in 2002; therefore, sediment contaminant concentrations in the Harbor have not been rated for this report.

Total Organic Carbon | Charlotte Harbor is rated good for TOC concentrations, with 90% of the estuarine area rated good and 3% rated fair for this component indicator. NCA data on TOC concentrations were unavailable for 7% of the CHNEP estuarine area.
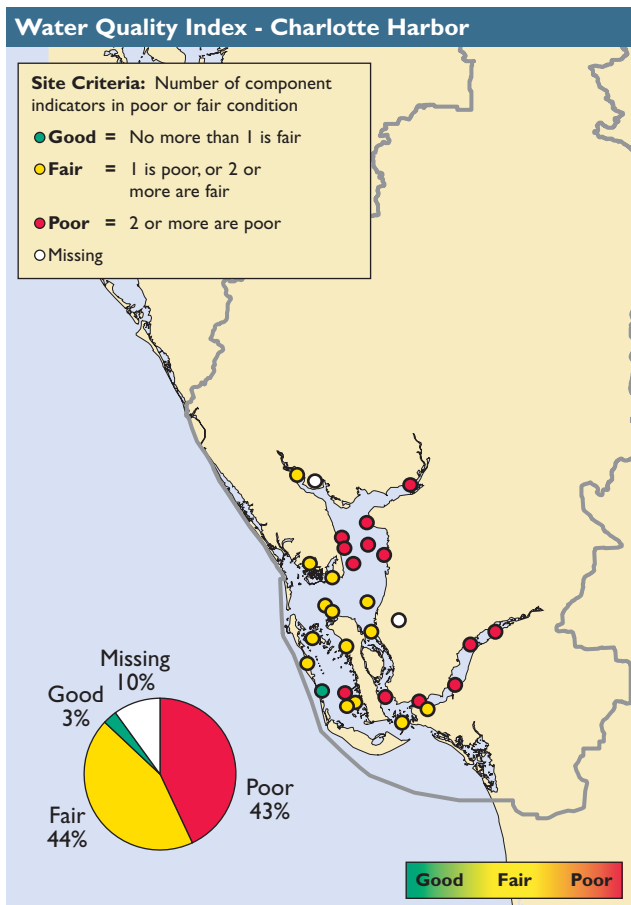

Water Quality Index - Charlotte Harbor

Site Criteria: Number of component indicators in poor or fair condition
- Good = No more than 1 is fair
- Fair = 1 is poor, or 2 or more are fair
- Poor = 2 or more are poor
- Missing

Good 3%
Missing 10%
Poor 43%
Fair 44%

Good Fair Poor

Figure 5-13. Water quality index data for Charlotte Harbor, 2002 (U.S. EPA/NCA).

Charlotte Harbor National Estuary Program

Benthic Index

The condition of benthic invertebrate communities in Charlotte Harbor is rated fair based on the Gulf Coast Benthic Index and data from the NCA. Benthic index estimates indicate that 13% of the Harbor's estuarine area was rated poor for benthic condition, 44% was rated fair, and 33% was rated good (Figure 5-15).

Fish Tissue Contaminants Index

The NCA did not assess the level of fish tissue contaminants in the CHNEP estuarine area in 2002; therefore, a fish tissue contaminants index for Charlotte Harbor was not developed for this report.

Charlotte Harbor National Estuary Program Indicators of Estuarine Condition

The major indicators of estuarine condition used by the CHNEP are species composition and coverage of SAV; coverage and quality of fish and wildlife habitat; quantity and timing of freshwater flows and groundwater levels; and water quality conditions that lead to or are indicative of eutrophication. The CHNEP manages an interagency monitoring program that collects data on a variety of parameters, including Secchi disk, temperature, salinity, specific conductance, dissolved oxygen, pH, color, turbidity, total suspended solids, chlorophyll *a*, total nitrogen, total Kjeldahl nitrogen, total ammonia nitrogen, total nitrite+nitrate nitrogen, dissolved orthophosphate, total phosphorus, and TOC.
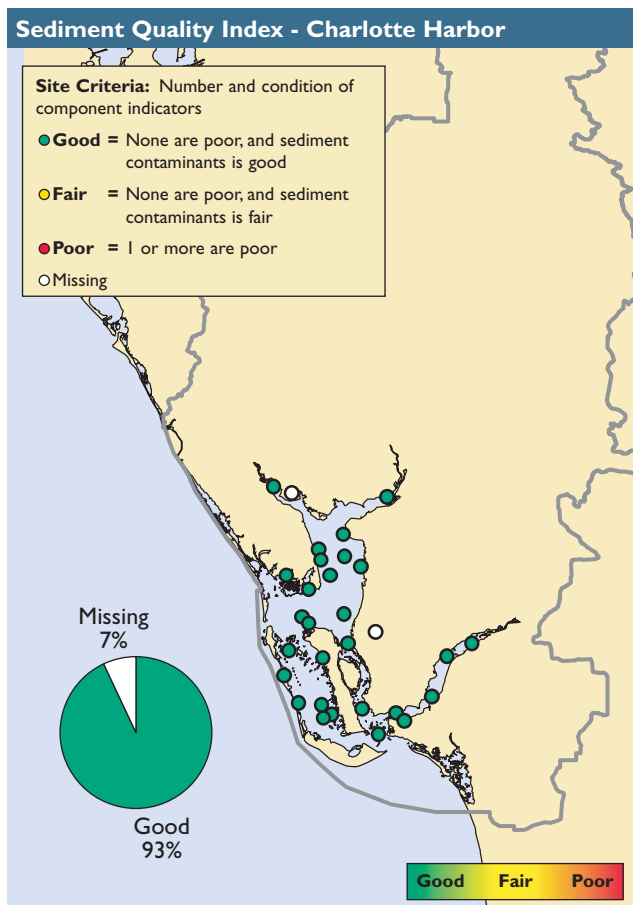

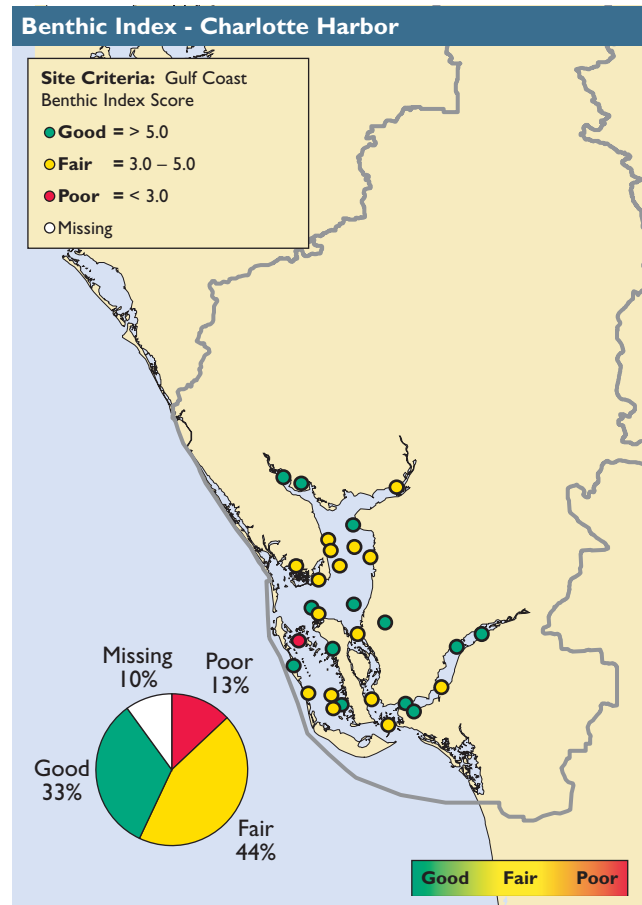**Figure 5-14.** Sediment quality index data for Charlotte Harbor, 2002 (U.S. EPA/NCA).

Figure 5-15. Benthic index data for Charlotte Harbor, 2002 (U.S. EPA/NCA).

The results from this monitoring program can be found at the following NEP-supported Web sites: http://www.checflorida.org and http://ws13.ipowerweb.com/checflor/chec/waterquality_home.htm.

Water and Sediment Quality

The presence of algal blooms; high concentrations of DIN, DIP, and chlorophyll *a*; and low levels of dissolved oxygen are the key indicators of potential eutrophic conditions in Charlotte Harbor. In recent decades, population growth, stormwater runoff from residential and commercial development, agricultural and industrial practices, and the burning of fossil fuels have been major sources of increased inputs of nutrients to Charlotte Harbor. Results from March 2004 show elevated levels of DIN and slightly higher than normal DIP concentrations in the Harbor, but normal chlorophyll *a* levels. Dissolved oxygen and turbidity values were rated better than normal by the CHNEP. The Caloosahatchee River basin has ongoing water quality problems, with excess nutrients, low dissolved oxygen, and noticeable increases in levels of copper and lead (CHNEP, 2005a). Recent maps of water and sediment quality indicators, as reported by the CHNEP on a monthly basis, can be found at http://www.chnep.org.

Declines in dissolved oxygen levels and worsening surface water quality were observed in the southern basins of Charlotte Harbor. Overall, there have been major increases in total suspended solids in the entire southern portion of the CHNEP estuarine area, including the full extent of Charlotte Harbor. Florida surface water standards have been exceeded frequently for dissolved oxygen (both instantaneous readings and daily average readings) and ammonia in many basins, and to a lesser extent, for chlorophyll *a* and bacteria levels (CHNEP, 2003b).

Habitat Quality

The natural habitats of the Charlotte Harbor estuarine area span a wide range of environments, from xeric oak scrubs to subtidal soft-bottoms to mangrove forests. Mangrove forests provide habitat for more than 2,300 species of animals, including at least 42 federally listed and state-listed endangered or threatened animal species, such as the Florida black bear, manatee, bald eagle, wood stork, Florida scrub jay, and American crocodile. In Charlotte Harbor, the acreage, type, and health of seagrass systems are monitored as one of the major indicators of estuarine condition. Informal habitat indicators monitored by the CHNEP include shellfish-area closures, number of fish kills, presence of fish lesions, acres of stable seagrass areas, and presence or lack of HABs (red tides). Some other useful response indicators include the effectiveness of riprap under docks, the effectiveness of artificial reefs in enhancing habitat value along seawalls, the length of shoreline restored, and the effectiveness of exotic vegetation removal (CHNEP, 2005a).

Seagrasses within the northern portion of the CHNEP study area have been found to be stable, and analysis is still being conducted on the southern portion of the area (CHNEP, 2005a). Seagrass habitats exist throughout all of the riverine and estuarine regions of the CHNEP study area, providing food sources, solid foundations, and protective structures for living resources. Historically, dredge-and-fill activities within coastal bottom and wetland areas have reduced the extent of these habitats. One specific goal of the CHNEP is to reduce propeller damage to SAV by 2010 (CHNEP, 2000). At the present time, the CHNEP's data is sufficient to evaluate significant losses of SAV acreage due to direct impacts, such as water management (e.g., losses in the Caloosahatchee River's *Vallisneria americana*) and channel and causeway island construction (e.g., losses in IntraCoastal Waterway and Sanibel Causeway). Dissolved and suspended matter within the water column, rather than chlorophyll *a*, largely limit light availability for seagrass beds in Charlotte Harbor, and water clarity in the Harbor increases with salinity and distance from the tributaries (McPherson and Miller, 1987; McPherson and Miller, 1994; Dixon and Kirkpatrick, 1999; Doering and Chamberlain, 1999; Tomasko and Hall, 1999); thus, seagrass coverage shows inter-annual variability largely due to inter-annual freshwater flow changes (Corbett et al., 2005). In some areas of Charlotte Harbor, unrestricted development has resulted in large losses of habitats, such as high marshes and salterns.

Charlotte Harbor National Estuary Program

HIGHLIGHT

Hurricanes and Hypoxia in 2004

Over a two-month period in 2004, four major hurricanes and five named tropical storms battered Florida, with three hurricanes directly impacting the CHNEP study area (CHNEP, 2005b; Everham 2005). On August 13, 2004, Hurricane Charley—the strongest hurricane to hit the United States since Hurricane Andrew in 1992—passed through the heart of Charlotte Harbor (Pasch et al., 2005). The destruction from Hurricane Charley was not limited to the land and homes of the Charlotte Harbor watershed, but included damage to the Harbor and its rivers, creeks, and tributaries. Many of Charlotte Harbor's local islands, man-made canals, tributaries, and other waterways are lined with homes and boat docks. In calm weather, these settings provide an idyllic existence and magical vistas; however, the scenario changed in the face of Hurricane Charley, as waterways were made impassable by fallen trees, uprooted vegetation, and enormous quantities of debris (Fletcher, 2005).

One week after Hurricane Charley moved through Florida, state agencies began receiving complaints of foul-smelling water, prompting an unscheduled sampling effort that measured low dissolved oxygen levels for many areas of the estuary. Although the sampling found that turbidity and total suspended solid values for the estuary were not unusual, and that color was typical of values normally found during the wet season the biological oxygen demand (BOD) for the estuary was very high. The low dissolved oxygen values in Charlotte Harbor were associated with the decomposition of large amounts of dissolved organic matter that resulted in the high levels of BOD (see bar graph) (Tomasko et al., 2005b). Although hypoxia is a normal, wet season phenomenon in the Harbor (Camp Dresser & McKee, 1998) and a hypoxic zone was apparent in Charlotte Harbor two weeks after Hurricane Charley passed through the area (see map), hypoxia has never been recorded over such an extensive area of the Charlotte Harbor watershed (Tomasko et al., 2005b).

Satellite image of Hurricane Charley at landfall (NOAA National Climatic Data Center).

Subsequently, Hurricane Frances passed through Florida over the Labor Day weekend. Three weeks later, on National Estuary Day, Hurricane Jeanne followed Frances over the Peace River basin. The impacts of this string of hurricanes on the water quality of Charlotte Harbor were felt for months following the storms. Water quality characteristics in Charlotte Harbor, such as dissolved oxygen and water clarity, were degraded into the fall of 2004, but were showings signs of recovery by 2005 (Beever, 2005).
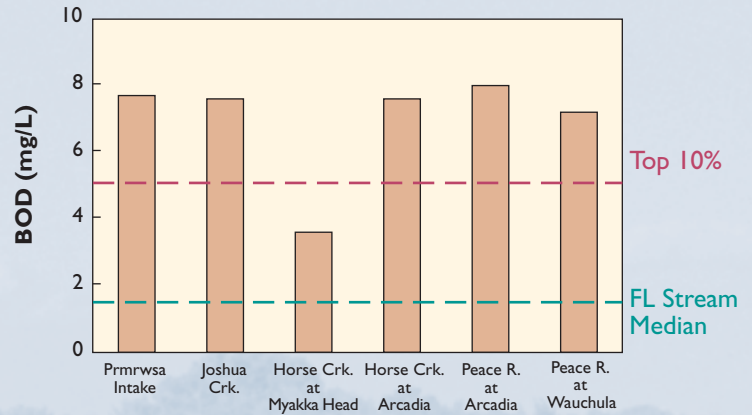
Five-day BOD values one week after Hurricane Charley (Tomasko et al., 2005a).

Large hypoxic zone (ca. 30 mi²) apparent two weeks after Hurricane Charley. BLUE TRIANGLE: Sites with no hypoxia (DO < 2 mg/L) in surface or bottom waters. RED TRIANGLE POINTING UP: Sites with hypoxia in bottom waters only. RED TRIANGLE POINTING DOWN: Sites with hypoxia in both bottom and surface waters. YELLOW TRIANGLE: Sites not visited due to an oncoming storm. The red line delimits area believed to exhibit hypoxia for this event, based on event data and historical monitoring data demonstrating that hypoxia is associated with flows out of the Peace River and along the western "wall" of Charlotte Harbor. Some smaller areas (unknown in size) exhibited hypoxia in both bottom and surface waters (Tomasko et al., 2005a).

Living Resources

Charlotte Harbor provides habitat for 39 species of mammals, 331 species of birds, 67 species of reptiles, 27 species of amphibians, and 452 species of fish (CHNEP, 2005a); however, the growing human population and increasing urban development have resulted in habitat loss throughout the study area. This loss of habitat can negatively affect plant communities and wildlife. For example, since the 1920s, pine flatwoods habitat acreage has decreased; communities of pines, wax myrtle, and saw palmetto have been lost; and animals, including pileated woodpeckers, American kestrels, sandhill cranes, black bears, panthers, indigo snakes, and gopher tortoises, have been displaced (CHNEP, 2000).

Shellfish are a reliable measure of the environmental health of an estuary. Because they feed by filtering estuary water, shellfish assimilate and concentrate the materials carried in the water in their tissues. More than 275 species of shellfish are found throughout the waters of Charlotte Harbor. People have been harvesting shellfish in the area since the Calusa Indians of southwest Florida gathered enormous amounts of shellfish by digging canals and constructing immense shell mounds. In the more recent past, oysters, clams, and scallops have been harvested commercially and recreationally throughout Lemon Bay, Gasparilla Sound, Charlotte

Harbor, and Pine Island Sound. The height of the shellfish industry in the Charlotte Harbor area occurred during the 1940s, and the commercial harvest of shellfish has declined since that time (CHNEP, 2000).

Environmental Stressors

Adverse changes in the location, timing, and volume of freshwater flows; overall function of flood plain systems; and natural river flows are the major hydrologic concerns in Charlotte Harbor. Man-made canals and waterfront lots are two major developments that alter surface water hydrology and degrade estuarine conditions in Charlotte Harbor. The construction of drainage channels for transportation, agricultural activities, urbanization, and hurricane flood relief have been just as prevalent. Although changes to groundwater systems in the Charlotte Harbor watershed have been less obvious, the increased drainage of surface systems reduces recharge to groundwater, altering the general flow of underground aquifers. Saltwater intrusion is an indicator of these changes.

Hydrologic alterations have occurred in many regions of the Charlotte Harbor area. For example, the Caloosahatchee River was channelized and artificially connected to Lake Okeechobee in the late 1800s and early 1900s to provide flood protection, serve as a navigational channel, and supply water for agricultural and

Prop roots of mangrove trees below the water surface provide substrate for many other organisms (CHNEP).

urban use. Three locks and dams have been constructed along the Caloosahatchee River, one of which artificially truncates the river's estuarine system by blocking the natural gradient of fresh water to salt water that historically had extended upstream during the dry season. The flow through this river is highly manipulated because water management juggles the often conflicting needs of estuary resources, public water supply, and agricultural uses (CHNEP, 2003a). In addition, the upper Peace River has changed from a gaining stream with flow all year long to a losing stream with river flows being lost in sinkholes along the upper Peace River. Kissingen Springs, located along the upper Peace River, ceased flowing in the early 1950s, which is a sign of a lowered groundwater table in the Charlotte Harbor watershed (Corbett, 2003). The Myakka River flows have been artificially augmented because of the overland surface flow of groundwater pumped for agricultural use in the dry season. Also, the upper Myakka River demonstrates an increasing trend in specific conductivity (sulfate and calcium levels), and an extensive tree die-off has occurred in this area due to hydrologic stress (CHNEP, 2003b; Minnis, 2003).

Current Projects, Accomplishments, and Future Goals

The CHNEP set a variety of goals in *Committing to Our Future: A Comprehensive Conservation and Management Plan for the Greater Charlotte Harbor Watershed, Volume 1* (CHNEP, 2000). A goal of the CHNEP is to increase conservation, preservation, and stewardship lands by 25% by the year 2018. To combat hydrological alterations, the CHNEP plans to improve waterbodies affected by artificial structures by the year 2020. To help improve water quality, the program will gather information for the State of Florida to use in developing TMDLs (except for mercury) for high-priority, 303(d)-listed water segments by 2004 and for all remaining 303(d) waters in the CHNEP estuarine area by 2009. The CHNEP also plans to develop a sense of stewardship by providing information on living resources and water quality to the public, as well as by maintaining environmental education efforts with partners (CHNEP, 2000).

Conclusion

Urban development in the Charlotte Harbor study area has been rapid and has contributed to water quality degradation, habitat loss, and hydrologic changes. In addition, there have been ongoing declines in water quality in many of the Charlotte Harbor basins. NCA data classify the overall condition of Charlotte Harbor as fair. Water quality in the Harbor is rated poor, with DIN concentrations rated good; chlorophyll *a* and dissolved oxygen concentrations rated fair; and DIP concentrations and water clarity rated poor. Sediment quality in the Harbor is rated good; however, this rating is based only on measurements of one sediment quality component indicator (sediment TOC). The benthic index is rated fair, and 2002 NCA data were unavailable to develop a fish tissue contaminants index for Charlotte Harbor.

A young student conducts water quality tests in Charlotte Harbor (CHNEP).