This document contains the regional discussion of the Southeast estuaries, from the National Estuary Program Coastal Condition Report. The entire report can be downloaded from
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National Estuary Program Coastal Condition Report

Chapter 4: Southeast National Estuary Program Coastal Condition

June 2007

CHAPTER 4

SOUTHEAST NATIONAL ESTUARY PROGRAM COASTAL CONDITION

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Background

The Southeast Coast region extends from southern Virginia to Florida and includes two NEP estuaries: the Albemarle-Pamlico Estuarine Complex in North Carolina and Virginia and the Indian River Lagoon in Florida (Figure 4-1). Both estuarine systems are characterized by shallow lagoons located behind extensive barrier island chains that are punctuated with one or more narrow inlets or channels to the ocean. The flat coastal plain, small tidal range, and barrier islands that typify the Southeast Coast combine to minimize the influence of tides on water circulation in the region's two NEP estuaries; therefore, circulation within these systems is driven by different factors than in the river-dominated or tidally dominated estuaries found in other regions of the United States (NOAA, 1985).

Figure 4-1. The Southeast Coast region is home to two NEP estuaries.

Due to the vast forested acreage that dominates the Southeast region's coastal drainage areas, freshwater inflow to the NEP estuaries typically brings only small to moderate amounts of sediment; however, sediment loading to these estuaries can be higher in areas where land use is dominated by intensive agriculture and where soils that are subject to erosion are farmed. Precipitation patterns also influence freshwater input from rivers flowing into these estuaries. The region's annual average precipitation of about 40 inches decreases slightly from the north to the central portion of the region, and then increases to up to 64 inches in southern Florida. The Southeast Coast NEP estuaries contribute about 35% of all freshwater discharges to East Coast waters (NOAA, 1985).

Population Pressures

The population of the 41 NOAA-designated coastal counties coincident with the NEP study areas of the Southeast Coast region increased by more than 131.4% during the past 40 years, from 1.4 million people in 1960 to 3.2 million people in 2000 (Figure 4-2) (U.S. Census Bureau, 1991; 2001). This increase resulted in a population density of 168 persons/mi^2 in 2000 for these coastal counties; however, the population densities of the region's individual NEP study areas varied considerably in 2000, from a high of 308 persons/mi^2 for the Indian River Lagoon to 125 persons/mi^2 for the

Albemarle-Pamlico Estuarine Complex (U.S. Census Bureau, 2001). Development and population pressures are especially strong surrounding these NEP estuaries, which are centers of commercial fishing and recreational activity for the coastal communities of the Southeast Coast region.

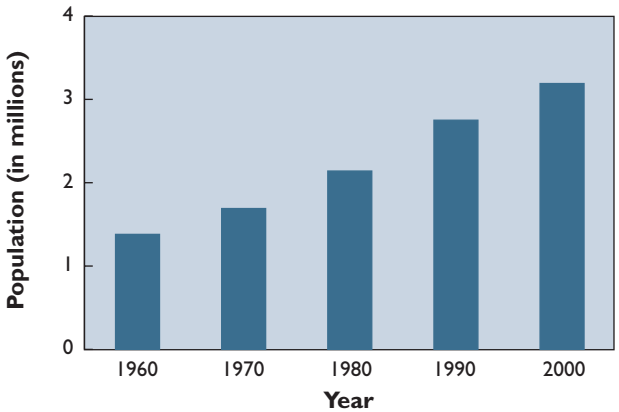

Figure 4-2. Population of the 41 NOAA-designated coastal counties of the Southeast Coast NEP study areas, 1960–2000 (U.S. Census Bureau, 1991; 2001).

NCA Indices of Estuarine Condition—Southeast Coast Region

Based on data collected by the NCA, the overall condition of the collective NEP estuaries of the Southeast Coast region is rated good to fair (Figure 4-3). Due to the rotating basin-monitoring schedule for Florida, the NCA sampled only the northern portion of the Indian River Lagoon for this assessment (approximately 230 mi^2). Because of their size, the estuaries of the Albemarle-Pamlico Estuarine Complex generally drive the coastal condition estimates for the Southeast Coast NEP estuarine area. The ratings for the NCA indices of estuarine condition (water quality, sediment quality, benthic, and fish tissue contaminants) for the Southeast Coast NEP estuaries ranged from good to fair, and neither estuary received a poor rating for any of the component indicators. Figure 4-4 shows the percentage of the Southeast Coast NEP estuarine area rated good, fair, poor, or missing for each parameter considered. 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.

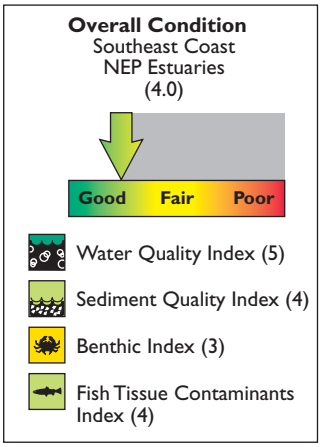

Figure 4-3. The overall condition of the Southeast Coast NEP estuarine area is good to fair (U.S. EPA/NCA).

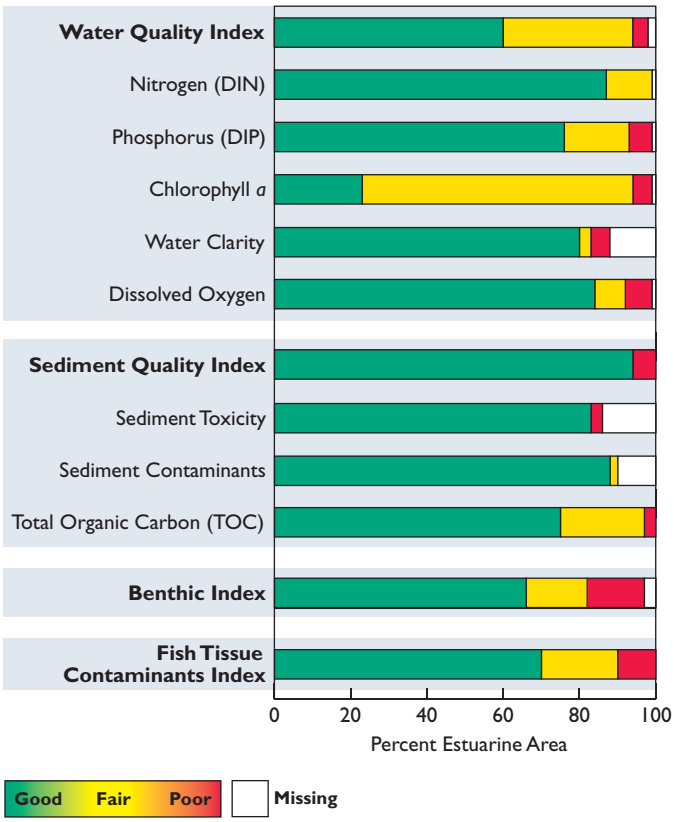

Figure 4-4. Percentage of NEP estuarine area achieving each rating for all indices and component indicators — Southeast Coast region (U.S. EPA/NCA).

Water Quality Index

The water quality index for the collective NEP estuaries of the Southeast Coast region is rated good (Figure 4-5). This index was developed using NCA data on five component indicators: DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen. Thirty-five percent of the region was rated fair for this index, indicating that some vigilance may be required regarding DIP and chlorophyll *a* concentrations.

Dissolved Nitrogen and Phosphorus | The Southeast Coast region is rated good for DIN concentrations because 12% of the region's NEP estuarine area was rated fair for this component indicator and none of the area was rated poor. The Southeast Coast region is also rated good for DIP concentrations, with 17% of the region's NEP estuarine area rated fair and 6% of the area rated poor. NCA data on DIN and DIP concentrations were unavailable for 1% of the Southeast Coast NEP estuarine area.

Chlorophyll a | The Southeast Coast region is rated fair for chlorophyll *a* concentrations because 71% of the region's NEP estuarine area was rated fair for this component indicator and 5% of the area was rated poor. NCA data on chlorophyll *a* concentrations were unavailable for 1% of the Southeast Coast NEP estuarine area.

Water Clarity | Water clarity in the collective NEP estuaries of the Southeast Coast region is rated good. Three percent of the region's NEP estuarine area was rated fair for this component indicator, and only 6% of the area was rated poor.

Dissolved Oxygen | The Southeast Coast region is rated fair for dissolved oxygen concentrations because 8% of the region's NEP estuarine area was rated fair for this component indicator and 7% of the area was rated poor.

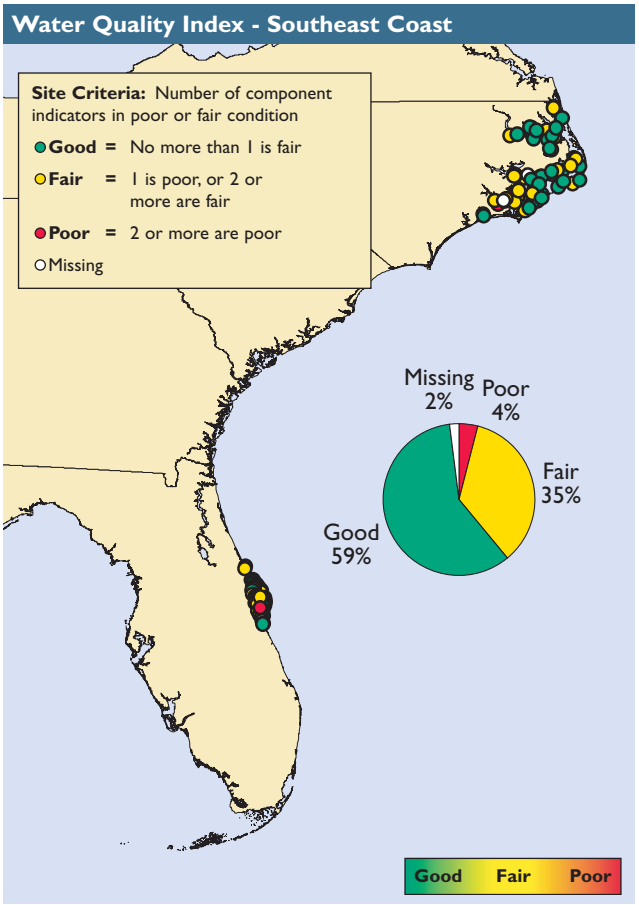

Figure 4-5. Water quality index data for the Southeast Coast NEP estuarine area, 2000–2002 (U.S. EPA/NCA).

Sediment Quality Index

The sediment quality index for the Southeast Coast region is rated good to fair because 6% of the region's NEP estuarine area was rated poor for sediment quality condition (Figure 4-6). This index was developed using NCA data on three component indicators: sediment toxicity, sediment contaminants, and sediment TOC.

This report discusses two different approaches for characterizing estuarine condition:

Approach 1 – The NCA provides unbiased, quality-assured data that can be used to make consistent "snapshot" comparisons among the nation's NEP estuaries. These comparisons are expressed in terms of the percent of NEP estuarine area in good, fair, or poor condition.

Approach 2 – Each individual NEP collects site-specific estuarine data in support of local problem-solving efforts. These data are difficult to compare among NEPs, within regions or nationally, because the sampling and evaluation procedures used by the NEPs are often unique to their individual estuaries. However, these evaluations are important because NEP-collected data can evaluate spatial and temporal changes in estuarine condition on a more in-depth scale than can be achieved by the NCA snapshot approach.

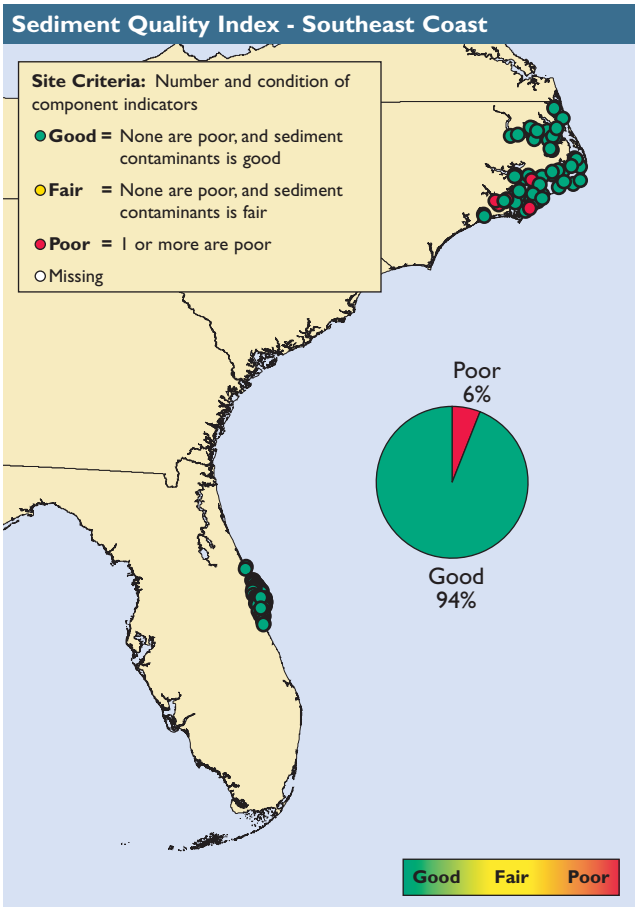

Figure 4-6. Sediment quality index data for the Southeast Coast NEP estuarine area, 2000–2002 (U.S. EPA/NCA).

TOC concentrations were the only sediment quality component indicator measured in the Indian River Lagoon; therefore, the sediment quality index for the Southeast Coast NEP estuarine area is not based on a full assessment of sediment toxicity or sediment contaminant concentrations in all of the region's NEP estuaries.

Sediment Toxicity | The Southeast Coast region is rated good for sediment toxicity; however, this assessment is based solely on data collected for the Albemarle-Pamlico Estuarine Complex because NCA data on sediment toxicity were unavailable for the Indian River Lagoon. Eighty-three percent of the Southeast Coast NEP estuarine area was rated good for sediment toxicity, and only 3% of the area was rated poor, with poor samples collected at one site in Currituck Sound and one site in Pamlico Sound. NCA data on sediment toxicity were unavailable for 14% of the Southeast Coast NEP estuarine area.

Sediment Contaminants | The Southeast Coast region is rated good for sediment contaminant concentrations; however, this assessment is based solely on data collected for the Albemarle-Pamlico Estuarine Complex because NCA data on sediment contaminants were unavailable for the Indian River Lagoon. Based on these parameters, 88% of the Southeast Coast NEP estuarine area was rated good for sediment contaminant concentrations, 2% of the area was rated fair, and none of the area was rated poor. NCA data on sediment contaminant concentrations were unavailable for 10% of the Southeast Coast NEP estuarine area.

Total Organic Carbon | The Southeast Coast region is rated good for TOC concentrations. TOC concentrations were rated good in 75% of the region's NEP estuarine area, fair in 22% of the area, and poor in only 3% of the area, with the sites rated poor located in North Carolina's Little Alligator River, Slocum Creek, and Neuse River.

Benthic Index

The benthic index for the collective NEP estuaries of the Southeast Coast region is rated fair. The Southeast Coast Benthic Index, developed by Van Dolah et al. (1999), integrates measures of species diversity and populations of indicator species to distinguish between degraded (poor) and reference benthic communities. Fifteen percent of the Southeast Coast NEP estuarine area was rated poor for benthic condition, 66% was rated good, and 16% was rated fair (Figure 4-7).

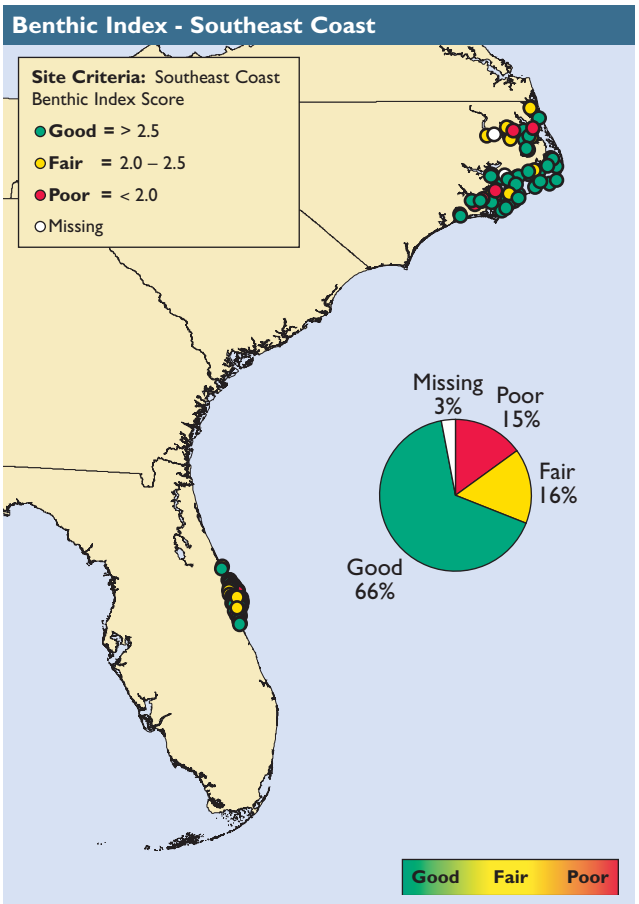

Figure 4-7. Benthic index data for the Southeast Coast NEP estuarine area, 2000–2002 (U.S. EPA/NCA).

Although only 15% of the Southeast Coast NEP estuarine area had degraded benthic resources, 80% of the sampling sites representing this degraded area were geographically correlated with some measure of poor water or sediment quality (Figure 4-8). Poor benthic condition co-occurred with equal frequency for degraded sediment quality and water quality (60% of the sites with poor benthic condition).

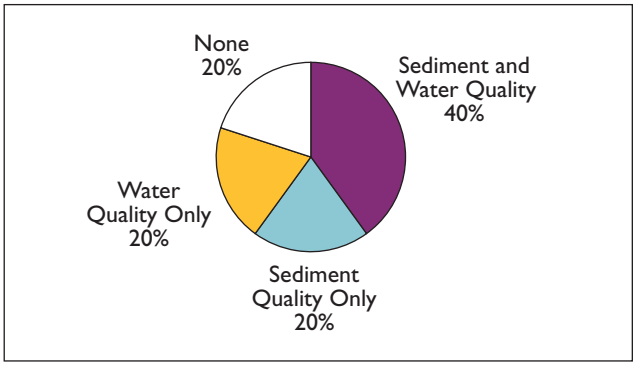

Figure 4-8. Percent of sampling sites in the Southeast Coast NEP estuaries where poor benthic condition overlaps with other indices rated poor (U.S. EPA/NCA).

Fish Tissue Contaminants Index

Fish tissue contaminants data for the Southeast Coast NEP estuarine area were collected for the Albemarle-Pamlico Estuarine Complex; however, data were not collected for the Indian River Lagoon. Figure 4-9 shows that only 10% of all stations sampled where fish were caught exceeded the EPA Advisory Guidance values used in this assessment, resulting in a rating of good to fair for the region's fish tissue contaminants index (70% of the stations were rated good). These contamination estimates are an approximation because they are based on the analysis of whole-body samples, rather than fillets only. For mercury, which has a high affinity for muscle tissue, these data may be an underestimation; however, for the chemical contaminants that concentrate in fish organs and fatty tissues, the data may be an overestimation. Although the fish sampled may not represent the same species sought by commercial fishermen and consumers, the analysis does represent the potential for accumulation of contamination in these estuarine environments.

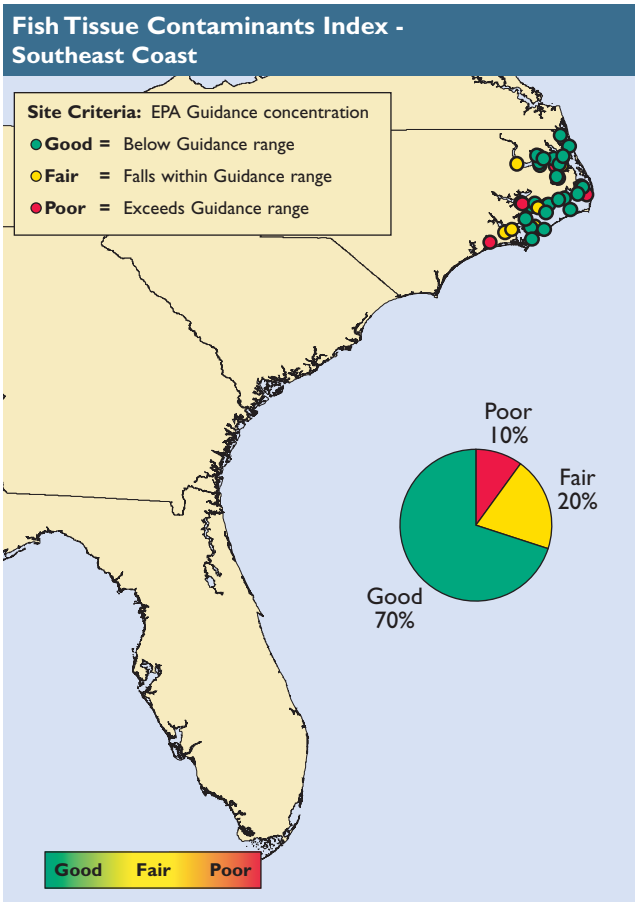

Figure 4-9. Fish tissue contaminants index data for the Southeast Coast NEP estuarine area, 2000–2002 (U.S. EPA/NCA).

NEP Estuaries and the Condition of the Southeast Coast Region

The purpose of the NEP is to identify, restore, and protect the nationally significant estuaries of the United States. The Southeast Coast region supports diverse agricultural activities such as large-scale agriculture production and aquaculture and is home to two NEP estuaries: the Albemarle-Pamlico Estuarine Complex and the Indian River Lagoon. The Albemarle-Pamlico Estuarine Complex NEP study area contains large tracts of forested and undeveloped land, including 11 National Wildlife Refuges (e.g., Great Dismal Swamp, Back Bay, Mackay Island, Currituck, Roanoke River, Alligator River, Pocosin Lakes, Pea Island, Mattamuskeet, Swan Quarter, and Cedar Islands). The Complex's watershed also contains the Cape Lookout and Cape Hatteras national seashores; the Croatan National Forest; and many state-owned parks, forests, and research reserves (Martin et al., 1996). In addition, several U.S. Department of Defense (DoD) lands are located in this watershed. Similar to the Albemarle-Pamlico Estuarine Complex, portions of the Indian River Lagoon NEP study area have escaped much of the urbanization that has overrun other portions of Florida's coastal areas, and the estuarine area of the Lagoon includes the Merritt Island National Wildlife Refuge, Canaveral National Seashore, Hobe Sound National Wildlife Refuge, Pelican Island National Wildlife Refuge, and several state parks. The citrus industry is a dominant agricultural land use within the Indian River Lagoon study area.

Because the areas surrounding the Southeast Coast NEP estuaries have not been developed as major metropolitan urban centers, a key question when assessing these two estuaries is whether their condition accurately reflects the condition of all Southeast Coast estuaries (both NEP and non-NEP). A comparison of NCA data from the two Southeast Coast NEP estuaries and all Southeast Coast estuaries reveals that the two groups of estuaries have similar overall condition ratings, as well as similar ratings for most of the NCA estuarine indices.

Based on the NCA survey results, both the collective Southeast Coast NEP estuaries and all Southeast Coast estuaries combined are rated good to fair for overall condition, with both groups receiving an overall condition score of 4.0 (Figure 4-10). A comparison of NCA data for both groups of estuaries shows that the collective Southeast Coast NEP estuaries are rated good for the water quality index, good to fair for the sediment quality index, fair for the benthic index, and good to fair for the fish tissue contaminants index. The group of all Southeast Coast estuaries combined are rated good to fair for the water quality and sediment quality indices, fair for the benthic index, and good for the fish tissues contaminants index. With respect to the water quality and sediment quality component indicators, both groups of estuaries are rated good for DIN concentrations and all three sediment quality component indicators (sediment toxicity, sediment contaminants, and sediment TOC) and fair for chlorophyll *a* concentrations. The collective Southeast Coast NEP estuaries are rated good for DIP concentrations and water clarity and fair for dissolved oxygen concentrations, whereas the group of all Southeast Coast estuaries

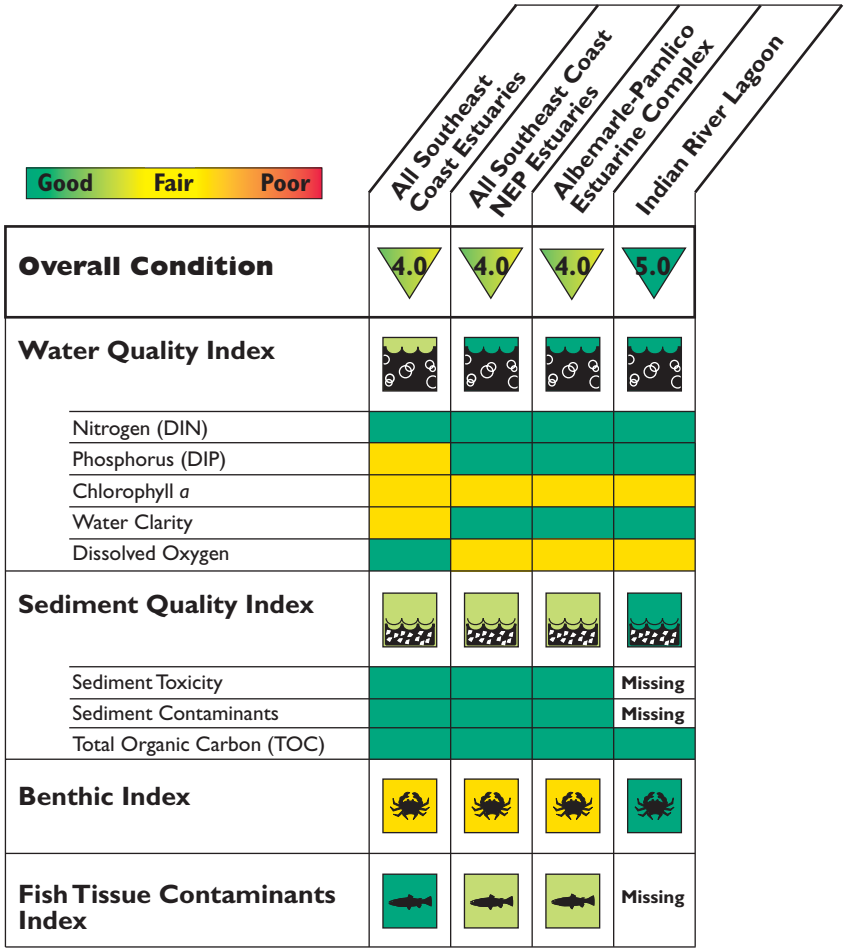

Figure 4-10. Comparison of NCA results for Southeast Coast NEP estuaries and all Southeast Coast estuaries (U.S. EPA/NCA).

combined are rated fair for DIP concentrations and water clarity and good for dissolved oxygen concentrations.

With respect to the two Southeast Coast NEP estuaries, both estuaries received higher or comparable overall condition scores to the overall condition score for the collective Southeast Coast NEP estuaries (4.0, rated good to fair). The Indian River Lagoon (5.0) is rated good for overall condition, whereas the overall condition rating for the Albemarle-Pamlico Estuarine Complex (4.0) is good to fair. It should be noted, however, that the NCA survey data for the Indian River Lagoon are incomplete because NCA data were not available to assess the fish tissue contaminants index or the sediment toxicity and sediment contaminants component indicators for this estuary. In addition, only the northern portion of the Indian River Lagoon was surveyed by the NCA in 2000 and 2001. Much of this area is included within the federally protected National Aeronautics and Space Administration (NASA)/Kennedy Space Center/Merritt Island Wildlife Refuge complex and the Canaveral National Seashore and remains relatively undeveloped. In contrast, much of the southern portion of the Indian River Lagoon (which was not surveyed by NCA) is suburban or urban in character; includes extensive agricultural areas; and continues to experience rapid development. An assessment that includes all indices and component indicators and that assesses both the northern and southern portions of the Lagoon may have resulted in a different overall condition rating for the Indian River Lagoon.

The NCA survey data show that the two NEP estuaries of the Southeast Coast are both rated good for the water quality index and that the ratings for all five of

the water quality component indicators are comparable between the two estuaries. For both the Albemarle-Pamlico Estuarine Complex and the Indian River Lagoon, DIN and DIP concentrations and water clarity are rated good, and chlorophyll *a* and dissolved oxygen concentrations are rated fair.

The sediment quality index ratings differ slightly between the Albemarle-Pamlico Estuarine Complex and the Indian River Lagoon. The sediment quality index for the Albemarle-Pamlico Estuarine Complex is rated good to fair, with all three component indicators (sediment toxicity, sediment contaminants, and sediment TOC) also rated good. The sediment quality index for the Indian River Lagoon is rated good; however, this rating is based only on measurements of one component indicator (sediment TOC, rated good) collected in the northern part of the Lagoon.

The benthic index, which denotes the health of an estuary's benthic community, is rated fair for the Albemarle-Pamlico Estuarine Complex and good for the Indian River Lagoon.

The fish tissue contaminants index is rated good to fair for the Albemarle-Pamlico Estuarine Complex. The NCA did not collect data on fish tissue contaminant concentrations for the Indian River Lagoon; therefore, a fish tissues contaminants index for this estuary was not developed for this report.

Nationally, the overall condition score (4.0) for the collective NEP estuaries of the Southeast Coast region ranked highest when compared to the Gulf Coast (2.75), West Coast (2.5), Northeast Coast (1.5), and Puerto Rico (1.5) NEP regions. Population pressures, measured as population density (number of persons/mi^2), did not correlate well with the overall condition ratings for the Southeast Coast NEP estuaries. For example, although the Albemarle-Pamlico Estuarine Complex has a lower calculated population density of 125 persons/mi^2, this estuary is rated good to fair for overall condition, with an overall condition score of 4.0. In contrast, the Indian River Lagoon, with a higher population density (305 persons/mi^2), is rated good for overall condition, with a overall condition score of 5.0; however, inclusion of the missing data for two of the sediment quality component indicators (sediment toxicity and sediment contaminants) and for the fish tissue contaminants index may have resulted in a lower overall condition score for the Indian River Lagoon.