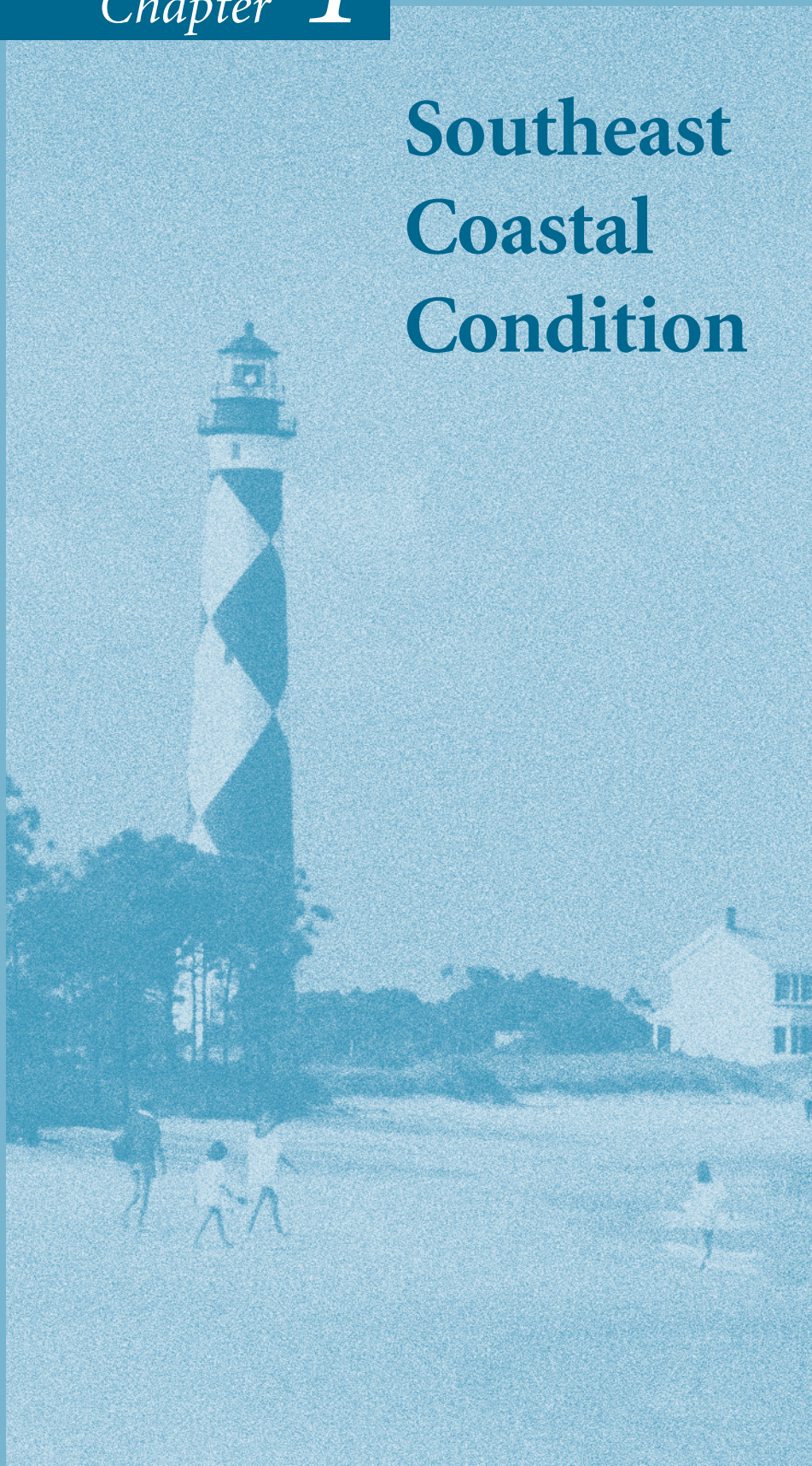


Chapter 4

**Southeast
Coastal
Condition**



Southeast Coastal Condition



The condition of southeastern estuaries is fair, although monitoring has shown evidence of human-induced stress in some areas (Figure 4-1). From 1994 to 1995, EMAP collected environmental stressor and response data from approximately 200 locations throughout southeastern estuaries. In 1996 and 1997, a smaller number of sites were examined in North Carolina. Approximately 54% of the estuarine area of the southeastern United States was in good ecological condition, meaning that, in the most stressful period of the year, neither environmental stressors (nutrients, contaminants, etc.) nor conditions for aquatic life showed any signs of impairment (Figure 4-2). Alternatively, 35% of the estuarine area showed indications of impaired aquatic life use and 17% showed impairments to human use.

The estuaries of the southeastern United States (Carolinian province) extend from Cape Henry, Virginia, through the southern end of the Indian River Lagoon along the east coast of Florida (Figure 4-3). Also included in southeastern estuaries is a region of the West Indian province from Indian River Lagoon through Biscayne Bay. The population of coastal counties along the Southeast Coast increased 64% from 1970 to 1990 (U.S. Bureau of the Census, 1996). The estuarine resources are diverse and extensive, covering an estimated 4,487 square miles.



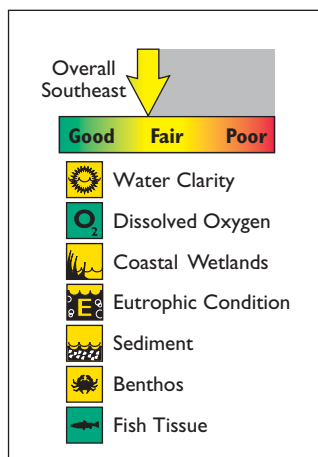


Figure 4-1. The overall condition of southeastern estuaries is fair.

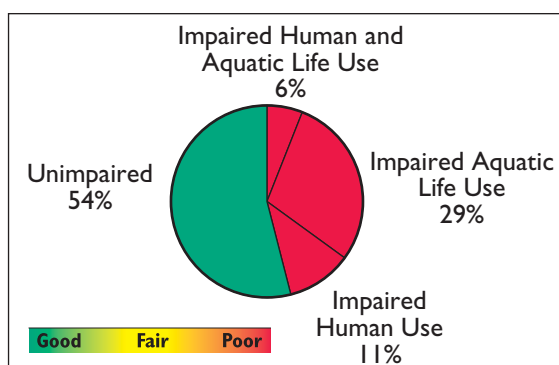


Figure 4-2. The condition of estuaries on the Southeast Coast; estimates are within $\pm 10\%$ based on 4 years of sampling (U.S. EPA/EMAP).

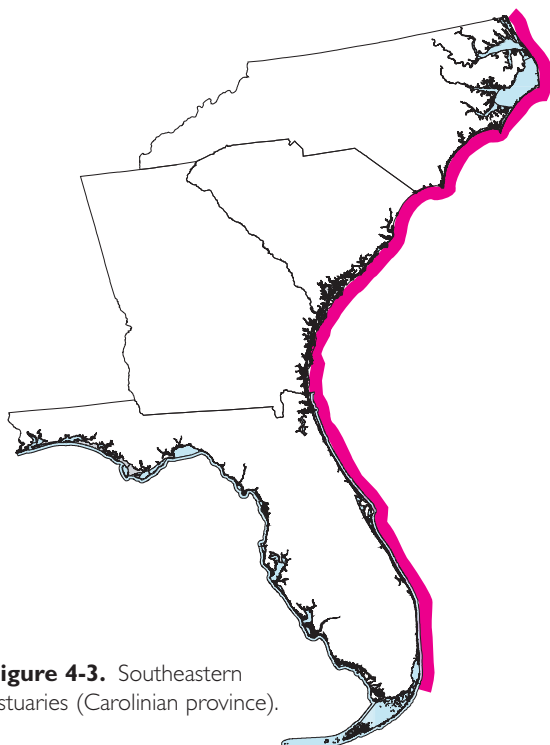


Figure 4-3. Southeastern estuaries (Carolinian province).

There is an increasing need for effective management of these resources given the predicted influx of people and businesses to southeastern coastal states over the next few decades and the ensuing pressures on the coastal zone of this region. Culliton et al. (1990) estimated that the coastal population in the southeastern United States will have increased by 181% over the 50-year period from 1960 to 2010 (the largest percentage increase in the country).

To help support resource management needs, EPA and NOAA initiated a comprehensive study of the quality of southeastern estuaries in 1994 by coordinating components of two nationwide monitoring efforts, the EPA Environmental Monitoring and Assessment Program and the NOAA National Status and Trends Program. The southeastern study was designed to provide yearly estimates of the condition of estuaries based on a variety of biological, chemical, toxicological, and aesthetic indicators (see Hyland et al., 1996; Hyland et al., 1998). Prior to this study, there was no comprehensive regionwide ecological information available. In addition to this monitoring effort, the Coastal 2000 initiative includes follow-up monitoring in the four southeastern states (North Carolina, South Carolina, Georgia, and Florida). Also, since the late 1980s, NOAA's NS&T Program and its Intensive Bioeffects Surveys have collected contaminant bioavailability and sediment toxicity data from several southeastern locations (Long et al., 1996).

Coastal Monitoring Data



Water Clarity

Water clarity in southeastern estuaries is fair. Water clarity was estimated by light penetration through the water column using a Secchi disc. Poor water visibility was defined as a Secchi depth of less than 0.5 m. This is equivalent to 10% of surface light reaching 1 meter. About 4% of southeastern estuaries had a Secchi depth of less than 0.5 meter (Figure 4-4).

The presence of debris introduced by humans (“trash”) in surface and bottom waters provides an obvious sign of degradation. Floating debris was observed in about 2% of southeastern estuaries, and bottom debris was observed in about 17% (Figure 4-5). Two other indicators of human disturbance are the presence of oil and grease and the presence of noxious odors. Oil was observed in 4% of the sediments in southeastern estuaries, and noxious odors were detectable in 24% of these sediments.

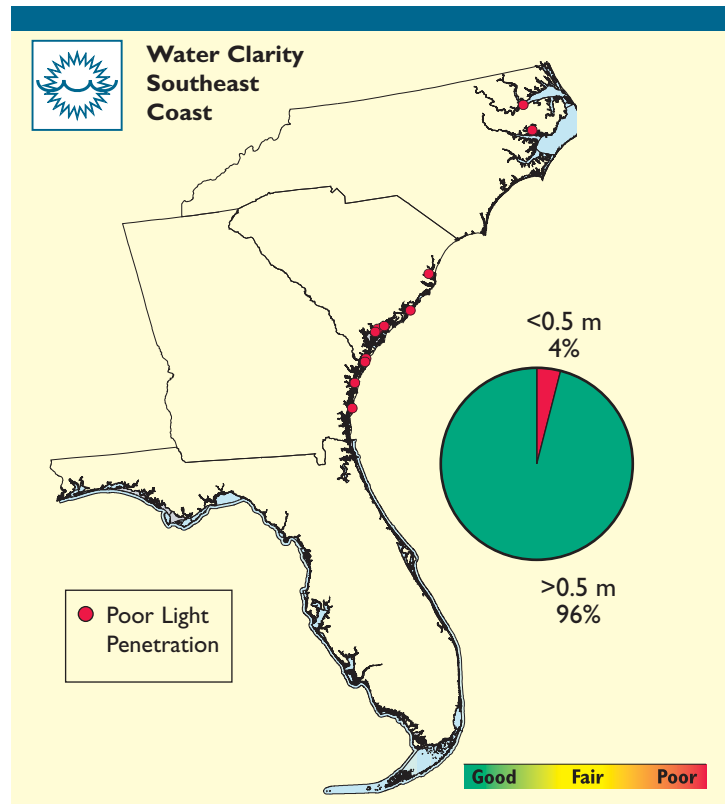


Figure 4-4. Light penetration data and locations for sites with a Secchi depth of <0.5 m (U.S. EPA/EMAP).



The sand makes a temporary rest in the broad deltas that form where the outflowing freshwater collides head-on with the incoming saltwater (Photo: Gray's Reef NMS).

Dissolved Oxygen

Dissolved oxygen conditions in southeastern estuaries are generally good. EMAP estimates for southeastern estuaries show that about 2% of the bottom waters in southeastern estuaries have low dissolved oxygen (less than 2 ppm) on a continuing basis in late summer (Figure 4-6). Most of this 2% is in the Neuse River and southern portions of Pamlico Sound.

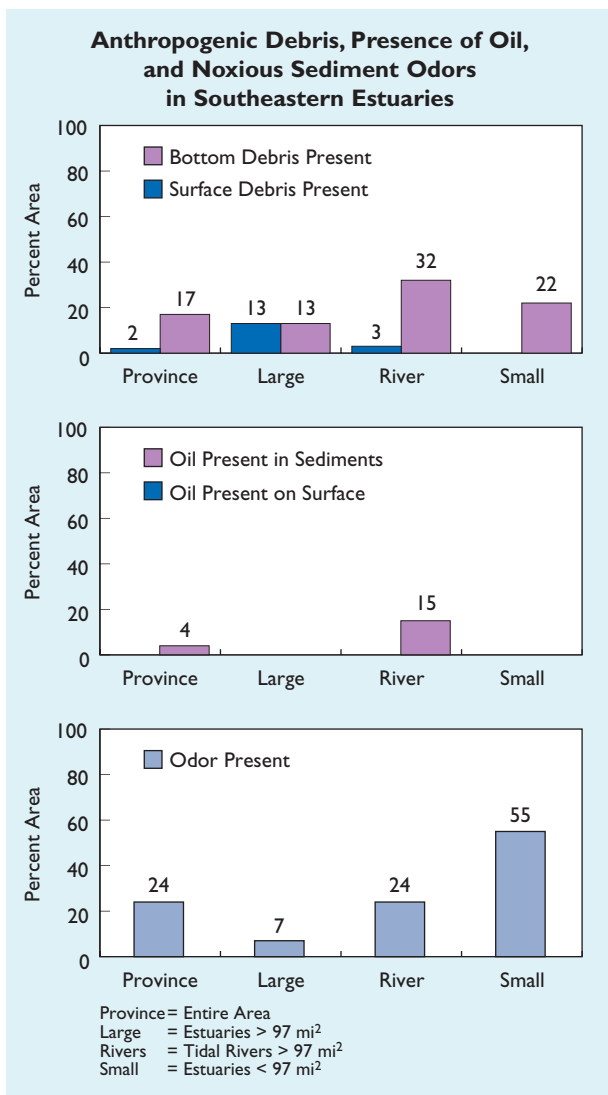


Figure 4-5. The presence of anthropogenic debris provides an obvious sign of degradation.

Coastal Wetland Loss

Wetland losses in the Southeast are high—40% of all wetlands existing in 1780 had disappeared by 1980 (Figure 4-7). Losses ranged from 23% in Georgia to nearly 50% in North Carolina (Dahl, 1990).

From the 1970s to the 1980s, acreage of wetlands has continued to decline

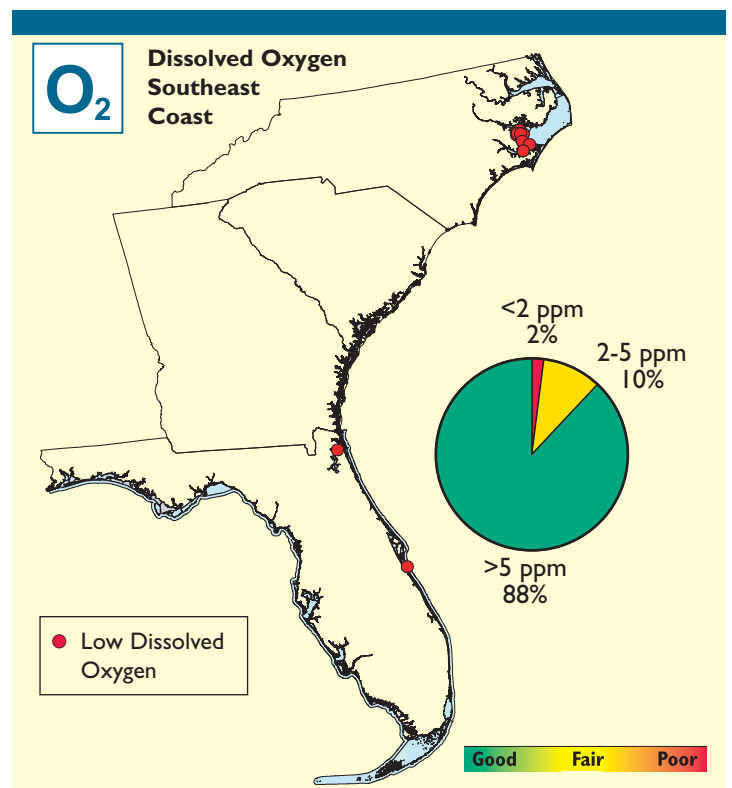


Figure 4-6. Dissolved oxygen data for sampled sites and locations for sites with less than 2 ppm for the Southeast Coast (U.S. EPA/EMAP).

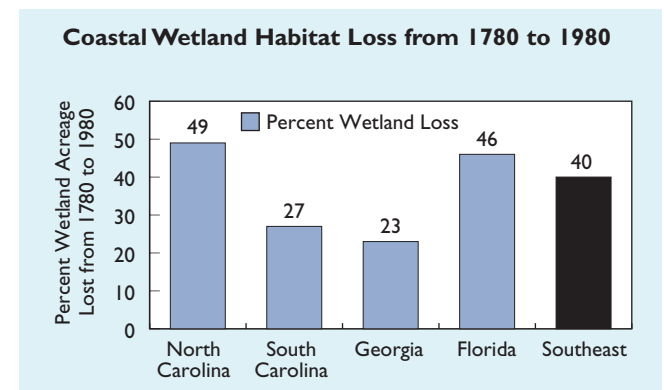


Figure 4-7. Percent wetland habitat lost from 1780 to 1980 by state and for the Southeast overall (Dahl, 1990; Turner and Boesch, 1988).

throughout all the states in the Southeast (Figure 4-8). These losses range from 1% decline in this decade for Georgia to a 16% decline in North Carolina.

Eutrophic Condition

The condition of southeastern estuaries as measured by eutrophic condition is fair. High eutrophic conditions were observed in only 13% of the area of southeastern estuaries (Figure 4-9). However, estimates predicted an expected increase in eutrophic condition in nearly all southeastern estuarine waters by 2020. Expression of eutrophic condition was high in four North Carolina estuarine river systems (Pamlico, Pungo, Neuse, and New Rivers) and in the St. Johns River in Florida. No estuarine systems in Georgia or South Carolina or the remainder of the east coast of Florida expressed high eutrophic conditions, although five others showed moderate conditions.

High expressions of chlorophyll *a* were observed during NOAA’s National Estuarine Eutrophication Assessment for about 14% of the area of southeastern estuaries. These high expressions were observed predominantly in estuaries in North Carolina and for a single estuary in Florida (Figure 4-10).

Coastal Wetlands Habitat Loss from 1970 to 1980

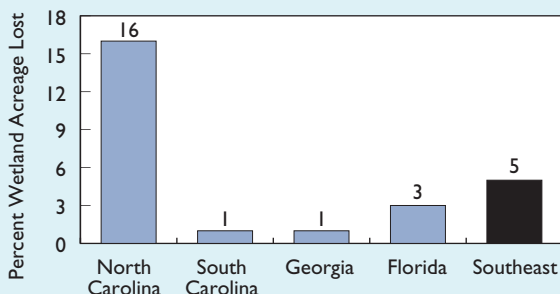


Figure 4-8. Percent decline in acreage of wetlands from 1970 to 1980 by state and for the Southeast overall (Hefner et al., 1994).

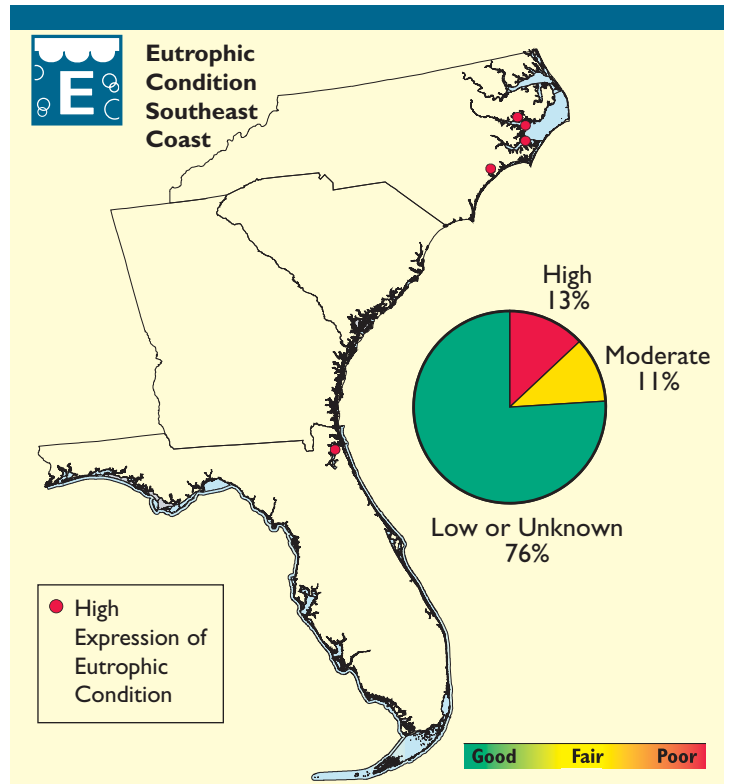


Figure 4-9. Eutrophic condition data and locations of estuaries with high expression of eutrophic condition along the Southeast Coast (NOAA/NOS).

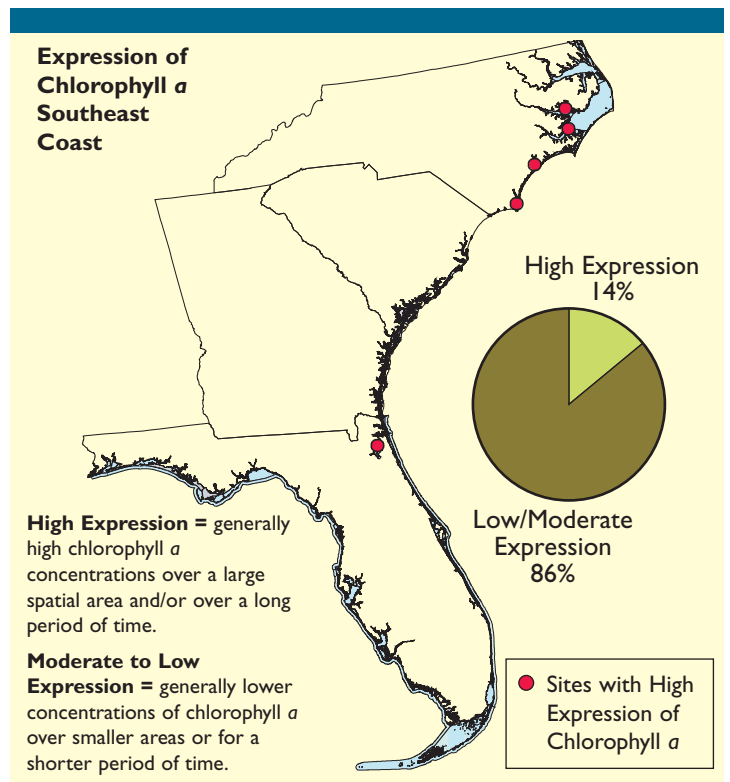


Figure 4-10. Chlorophyll *a* data for surveyed estuaries along the Southeast Coast and locations of estuaries with high expression of chlorophyll *a* (NOAA/NOS).



Sediment Contaminants

The condition of southeastern estuaries as measured by sediment contamination is fair. Sediment contaminants have been estimated by EMAP and NOAA (bioeffects surveys) for the estuaries of the southeastern United States. Sediment contaminant concentrations measured by NOAA NS&T bioeffects surveys rarely exceeded ERM guidelines (Long et al., 1996), with exceedances occurring only for pesticides in two estuarine systems (Mud River and Cumberland River, Georgia, Figure 4-11). EMAP reported that ERL guidelines were exceeded for all of the major groups of sediment contaminants, albeit at low rates (5% of area) for PAHs and PCBs. There were greater ERL exceedances for pesticides (33%) and heavy metals (39%), although most of the pesticide ERL exceedances were for DDT metabolites, dieldrin, and lindane. Total DDT (DDT plus metabolites DDE and DDD) exceeded 6 ppm in nearly 27% of estuarine sediments and ranged from 0 to 214 ppm. Lindane exceeded its ERL value in 12% of sediments. Concentrations of some chemicals (pyrene, chlordane, DDT and its metabolites, dieldrin, and lindane) were found in the EMAP survey in excess of upper-level ERM guidelines in a few places (similar to the low incidence of ERM exceedances found in NOAA's NS&T bioeffects surveys). While concentrations of most sediment contaminants are relatively low, enrichment rates for southeastern estuarine sediments range from 11% (PCBs) to nearly 99% (PAHs) (Figure 4-12). Only three contaminants (total DDT, arsenic, and nickel) exceeded ERL guidelines for more than 15% of the southeastern estuarine sediments. Therefore, sediment contamination is rated fair for the Southeast.

Sediment Contaminant Criteria

ERM (Effects Range Medium) – The concentration of a contaminant that will result in ecological effects approximately 50% of the time based on literature studies.

ERL (Effects Range Low) – The concentration of a contaminant that will result in ecological effects about 10% of the time based on literature studies.

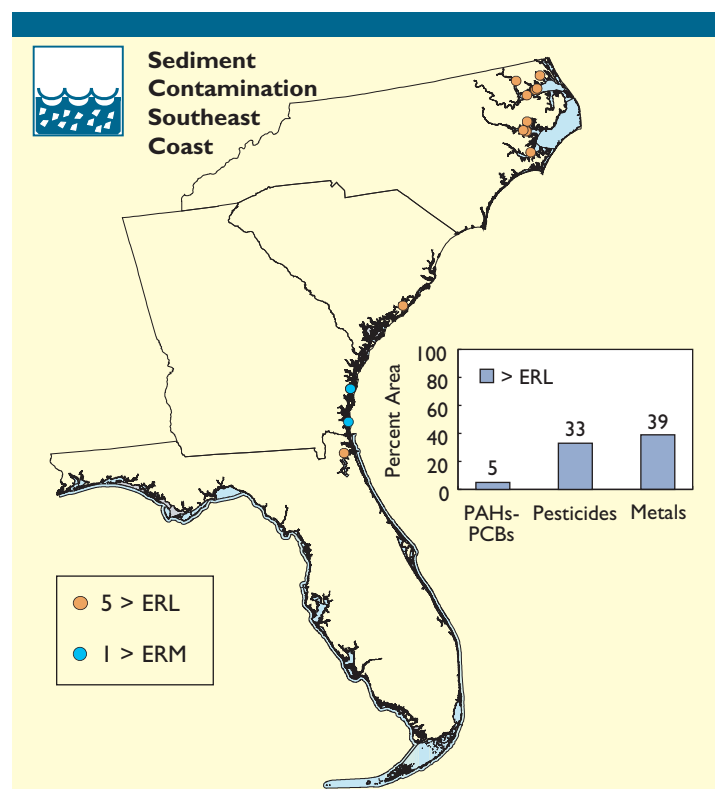


Figure 4-11. Sediment contamination for sampled sites and locations of sites with 5 > ERL along the Southeast Coast (U.S. EPA/EMAP).

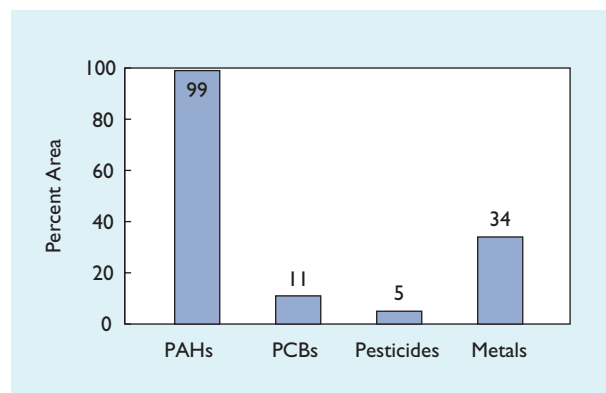


Figure 4-12. Percentage of estuarine sediments in southeastern estuaries that are enriched and range from 11% (PCBs) to nearly 99% (PAHs) (U.S. EPA/EMAP).



Benthic Condition

Benthic indicators in southeastern estuaries are fair. Benthic index estimates (Hyland et al., 1996; Hyland et al., 1998; Van Dolah et al., 1998), based on EMAP surveys, indicate that 17% of the estuarine area has highly degraded benthic resources (Figure 4-13). Of the 4,487 square miles in the Carolinian province, nearly 772 square miles were ecologically degraded with respect to benthos. Examination of the distributions of the benthic index in the three sampling strata within the southeastern United States (large estuaries, large rivers, and small estuaries/rivers) showed that large tidal rivers (Neuse and Pamlico Rivers and Indian River Lagoon) had the largest proportion of their estuarine bottom area represented by poorer than expected benthic communities (about 70%), while large estuaries (open areas such as Pamlico Sound) had the smallest proportional representation (about 5%). Degraded benthic conditions were observed throughout the Southeast.

Sediment toxicity from EMAP and NOAA NS&T bioeffects data show that small proportions of southeastern sediments are toxic based on bioassays with the marine amphipod *Ampelisca abdita* (Figure 4-14). NOAA bioeffects surveys of Winyah Bay, Charleston Harbor, Leadonwah Creek, Savannah River, and St. Simons Sound showed 0 to 1.2% of their sediments to be toxic. EMAP surveys generally confirm these findings, but show no toxicity associated with sediments from Savannah River or St. Simons Sound. In addition, EMAP surveys showed significant sediment toxicity associated with the Chowan River, some small estuaries in North Carolina, and Newfound Harbor on the Indian River Lagoon in Florida.

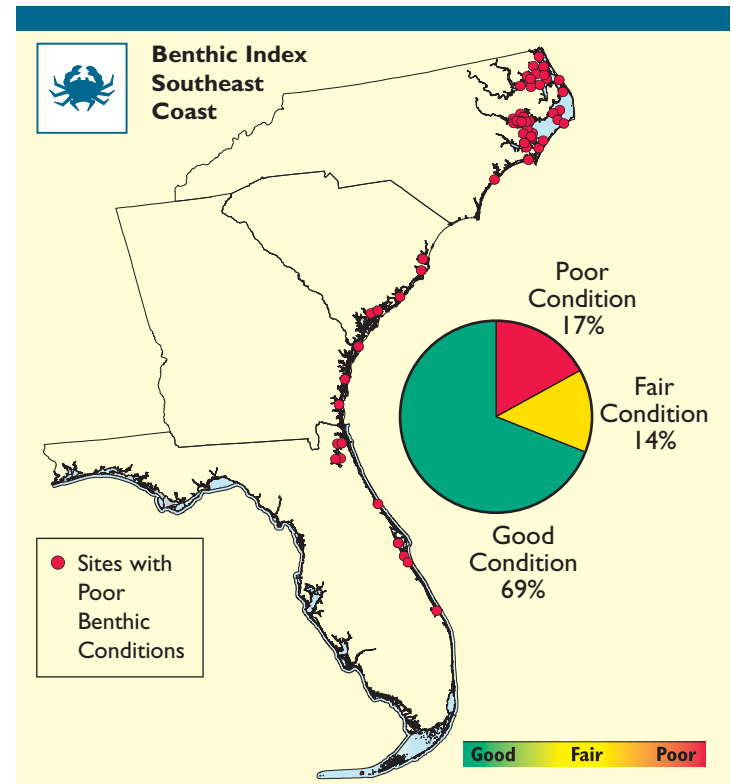


Figure 4-13. Benthic index condition data and locations with poor benthos along the Southeast Coast (U.S. EPA/EMAP).

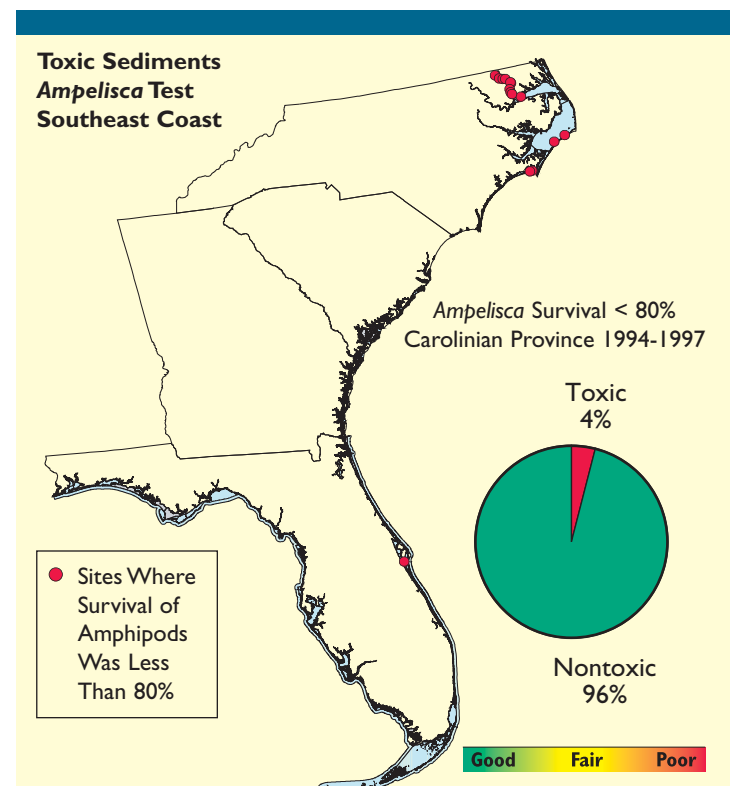


Figure 4-14. Amphipod data and locations with toxicity > 20% along the Southeast Coast (U.S. EPA/EMAP).

For the locations that showed poor benthic community quality, the co-occurrence of poor environmental quality (exposure) is shown in Figure 4-15. Of the 20% of the southeastern estuarine area that had impaired benthic assemblages, 61% also showed contaminated sediments, 1% showed sediment toxicity, 17% showed hypoxia, and 1% showed poor light conditions (high levels of total suspended solids). Of the locations that showed poor benthic community conditions, 20% had no sediment or water quality degradation (as measured by the EMAP program). Locations without obvious associations between adverse biological and exposure conditions occurred primarily in Pamlico Sound and Indian River Lagoon. Recently, Pamlico Sound has displayed some tendencies to hypoxic conditions in late summer, and Indian River Lagoon has shown increasing nutrient concentrations.



Fish Tissue Contaminants

The condition of southeastern estuaries as measured by fish tissue contaminants is good. Samples of spot, Atlantic croaker, blue crab, and penaeid shrimp were analyzed for presence of contaminants in edible tissues. All measured analytes in these samples were below corresponding Food and Drug Administration action levels for PCBs, pesticides, and mercury. Using international guidelines for other metals and pesticides, it was shown that arsenic guidelines were exceeded at 16% of sampled locations or in about 8% of the fish population examined (Figure 4-16). Arsenic found in fish and shellfish is almost completely altered into organic arsenobetaines that are not toxic to humans. Thus, only one location (about 1% of fish examined) showed elevated levels of nonarsenical contaminants in edible tissues.

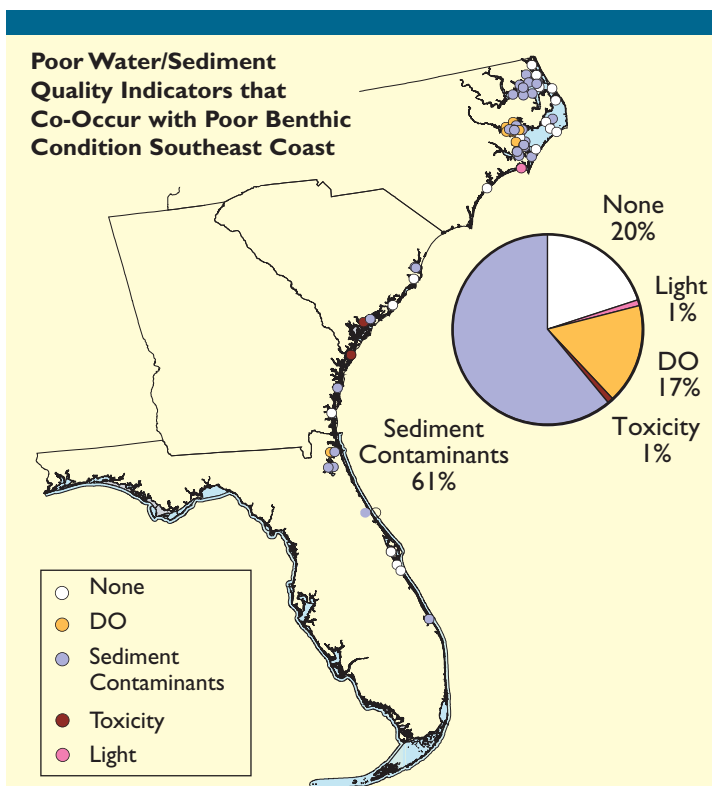


Figure 4-15. Indicators of poor water/sediment quality that co-occur with poor benthic condition in southeastern estuaries (U.S. EPA/EMAP).

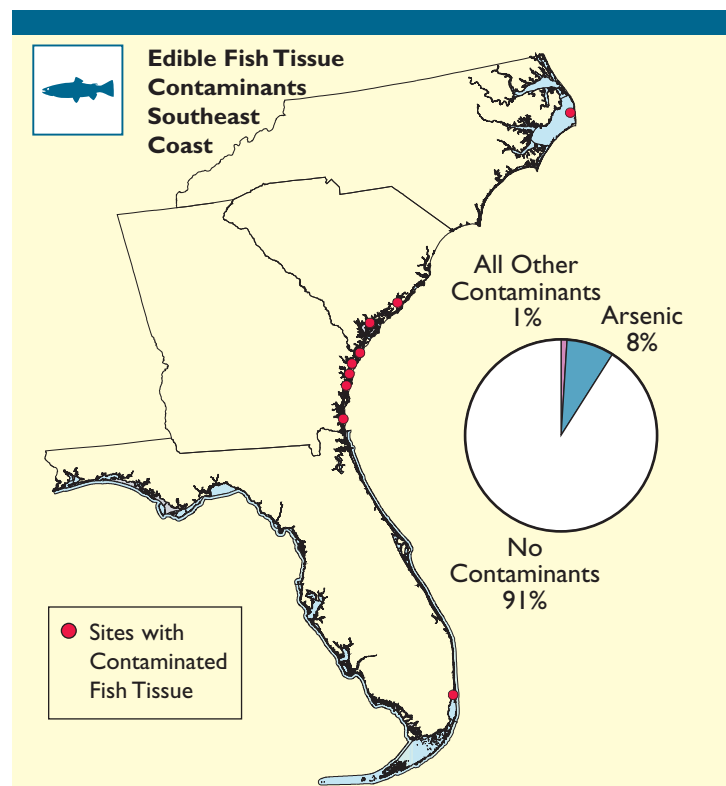


Figure 4-16. Contaminants in edible fish tissues in sampled sites along the Southeast Coast (U.S. EPA/EMAP).

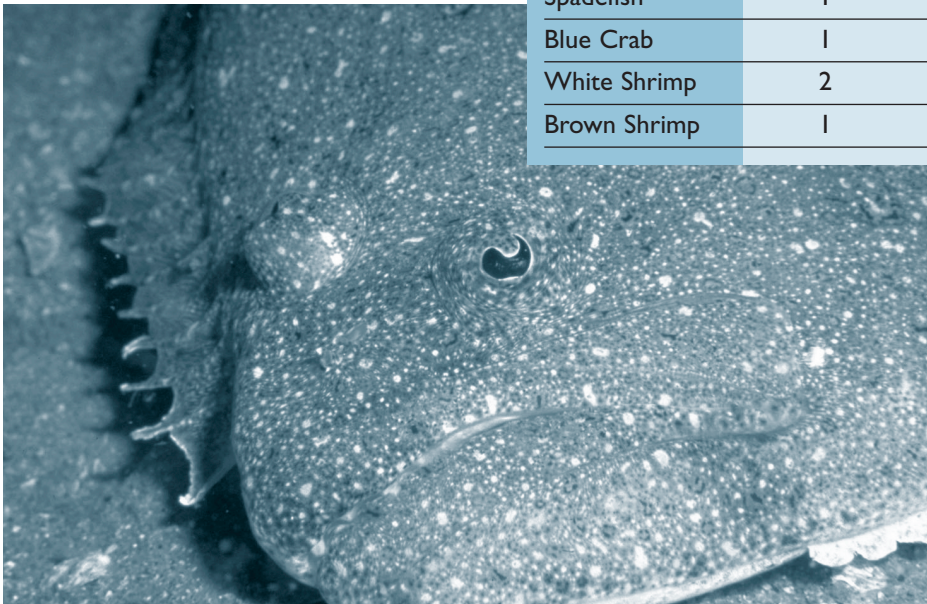
Less than 0.1% of the approximately 14,586 fish and shellfish examined from the region in 1995 had visible pathologies (Hyland et al., 1998) (Table 4-1). Growths, ulcerations, and fin rot were observed in 0.2% of fish, with white perch showing the highest incidence (3.4%). Shellfish showed shell disease in 0.2% of blue crabs and cotton disease in 0.07% of white and brown shrimp.

In summary, available data show that about 54% of southeastern estuaries are in good condition. The remaining 46% are showing some signs of environmental stress, although no obvious connections between adverse biological and exposure conditions related to human activities could be detected throughout much of this area. For example, co-occurrences

of degraded benthos and adverse exposure conditions (high sediment contamination in excess of sediment bioeffects guidelines and/or significant sediment toxicity based on standard assays) were much less extensive, occurring in only about 12% of the total area of these estuaries. While the overall level of degradation in southeastern estuaries is moderate, it occurred frequently enough, with respect to spatial extent and number of indicators, that condition should be measured periodically to ensure that increasing degradation does not occur. Programs like the Coastal 2000 Program implemented throughout North Carolina, South Carolina, Georgia, and Florida will provide this continuing surveillance.

Table 4-1. Number of Fish and Shellfish with Gross Pathologies in Southeastern Estuaries

Species	Number of Pathologies	Number of Fish	Percent with Pathologies	Standard Error of Estimate
Atlantic Croaker	1	3,564	0.03	0.01
White Perch	5	146	3.40	0.10
Spadefish	1	74	1.40	0.30
Blue Crab	1	483	0.20	0.03
White Shrimp	2	3,390	0.10	0.01
Brown Shrimp	1	543	0.20	0.02



The dusky flounder (*Syacium papillosum*) is usually left unnoticed buried and camouflaged by sand (Photo: Dean De Phillipa/ Passage Productions).

Assessments and Advisories

Clean Water Act Section 305(b) and 303(d) Assessments

The states on the Southeast Coast assessed 5,616 (63%) of their 8,956 estuarine square miles for their 1998 305(b) reports. Of the assessed estuarine waters on the Southeast Coast, 74% fully support their designated uses, 4% are threatened for one or more uses, and the remaining 22% are impaired by some form of pollution or habitat degradation (Figure 4-17). Individual use support for assessed estuaries is shown in Figure 4-18. The states on the Southeast Coast did not assess

any of their 9,070 shoreline miles. Although Florida reports water quality information for coastal waters for 305(b), it is not possible from that report to distinguish between Atlantic Coast and Gulf Coast listings. So 305(b) assessment information for Florida is included in its entirety in this section.

Table 4-2 shows individual use support reported by states for their assessed estuarine and coastal waters.

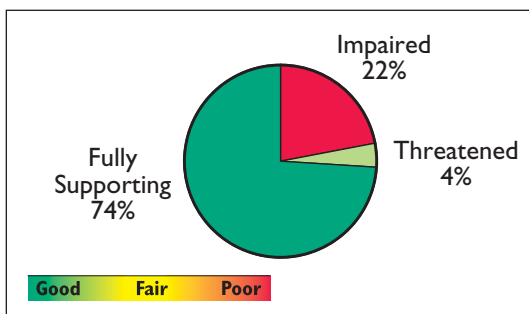


Figure 4-17. Water quality in assessed estuaries on the Southeast Coast (U.S. EPA).

Individual Uses	Estuaries Assessed as Impaired (mi ²)	Percent of Total Area Assessed
Aquatic Life	504	30%
Fish Consumption	340	29%
Shellfish Harvesting	874	34%
Swimming	361	22%
Secondary Contact	333	23%

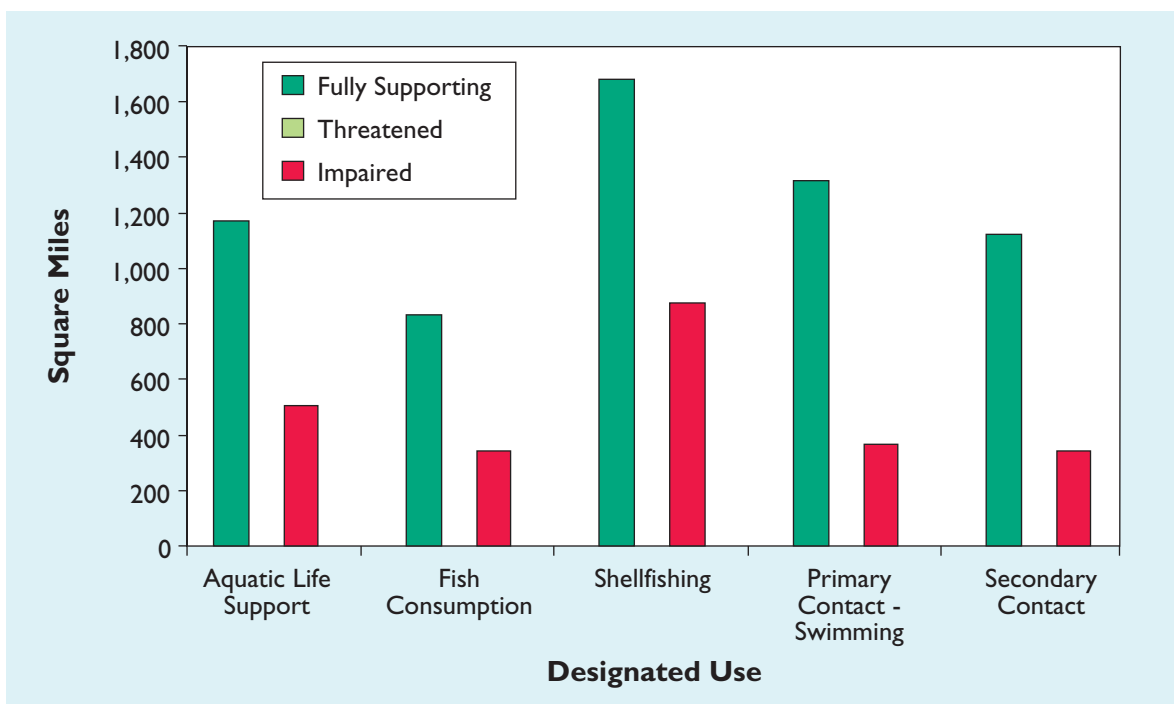


Figure 4-18. Individual use support for assessed estuaries on the Southeast Coast (U.S. EPA).

There are 134 waters on the Southeast Coast that are listed as impaired under Section 303(d) of the Clean Water Act. The percentage of listed waters impaired by each of the major pollutant categories is shown in Figure 4-19.

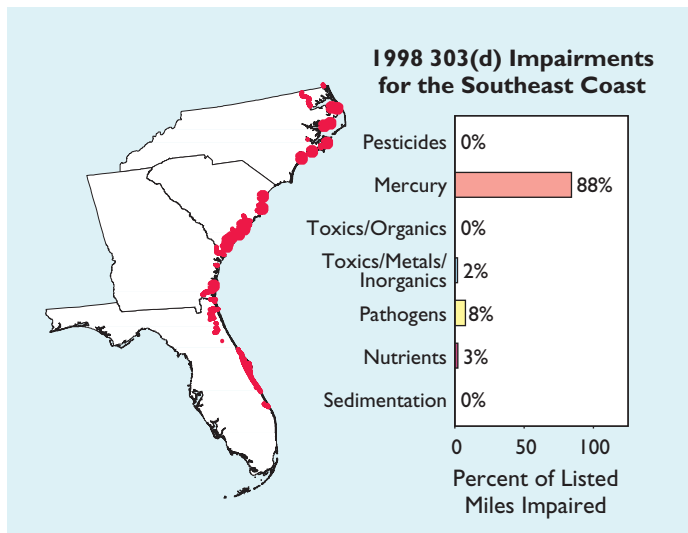


Figure 4-19. 303(d) listed waters on the Southeast Coast and the percentage of listed waters impaired by the major pollutant categories (note that a listing may be impaired by multiple pollutants) (U.S. EPA).

State Fish Consumption Advisories

Eight fish consumption advisories were active in the coastal waters of the Southeast in 2000 (Figure 4-20). All four coastal states had statewide advisories covering all coastal waters and estuaries to warn citizens against consuming large quantities of king mackerel because of potential mercury contamination. Because of these statewide advisories, 100% of the total coastline miles of the Southeast were under advisory.

The following species were under advisory for at least some portion of the Southeast Coast during 2000:

Spotted sea trout	Mussels	Clams
Largemouth bass	Silver perch	Blue crab
Atlantic croaker	Jack crevalle	Oysters
Red drum	Flounder	King mackerel
Black drum	Ladyfish	

The majority of fish consumption advisories on the Southeast Coast (64%) were the result of mercury contamination (Figure 4-21). Advisories were only issued for two other pollutants, PCBs and dioxins. All PCB advisories were in Georgia, and the one dioxin advisory was in North Carolina's Albemarle Sound.

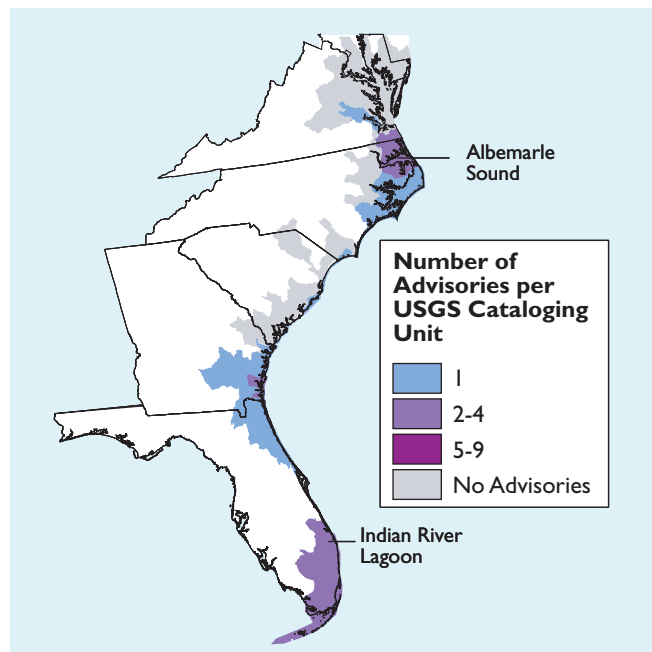


Figure 4-20. The number of fish consumption advisories per USGS Cataloging Unit in southeastern coastal waters. These data are for 2000 (U.S. EPA NLFWA, 2000c).

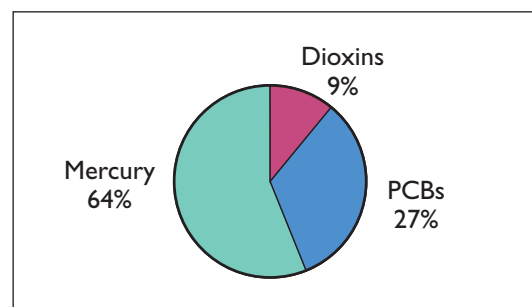


Figure 4-21. Pollutants responsible for fish consumption advisories in coastal waters of the Southeast (percent of 2000 advisories issued for each pollutant) (U.S. EPA NLFWA, 2000c).

Classified Shellfish-Growing Waters

Shellfishing plays an important role in the ecology and economy of southeastern states. In the Southeast, 3.9 million acres were classified for shellfish harvest in 1995. Of these, 71% of waters were approved, 16% were harvest-limited, and 13% were unclassified (Figure 4-22). Nationally, the Southeast Coast ranks second in the percentage of approved waters. Of the classified acreage, 64% is located in estuarine waters and 36% in nonestuarine waters. The top three pollution sources affecting harvest limitation are wildlife, urban runoff, and agricultural runoff.

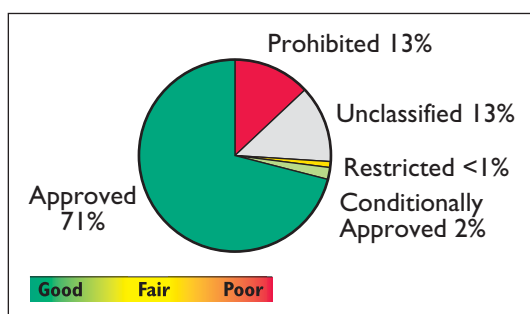


Figure 4-22. Classification of shellfish-growing waters for the Southeast (1995 Shellfish Register, NOAA, 1997).

The top two shellfish species (rated high or medium in abundance) in the Southeast are hard clams (463,711 acres) and eastern oysters (417,483 acres). Hard clams and eastern oysters are found at high or medium relative abundance in 11% of the region's shellfish-growing waters. Nine percent (43,179 acres) of hard clams and 27% (111,327 acres) of eastern oysters are located in waters that do not allow direct harvesting (i.e., restricted, conditionally restricted, and/or prohibited).

Beach Closures

A total of 127 beaches in the Southeast reported information to EPA's BEACH Program on beach monitoring activities and beach closings during 1999. The only beach closings reported on the Southeast Coast (seven beaches) occurred in Florida (Figure 4-23). All of the reported beach closings resulted from elevated bacteria levels due to storm water runoff, pipeline breaks, and boat discharges.

All of the beaches reporting information in North Carolina, South Carolina, and Georgia had monitoring programs in 1999. However, only 61% of beaches reporting from the east coast of Florida had monitoring in place for bacteria levels. None of the beaches in Georgia contributed information to the EPA survey because the state did not have a monitoring or beach closure program; however, Georgia began a monitoring program in 1999 and reported monitoring information from four beaches.

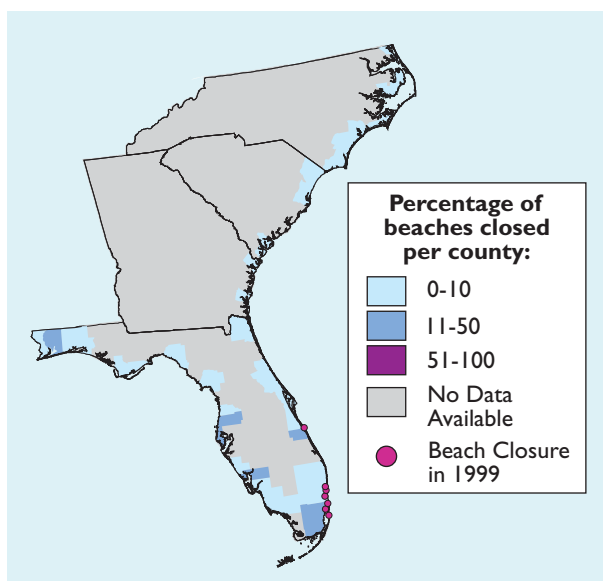
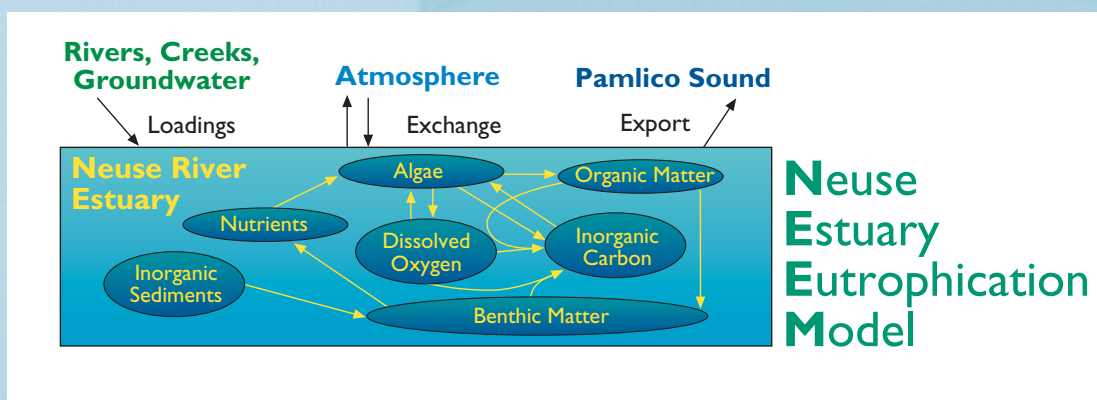
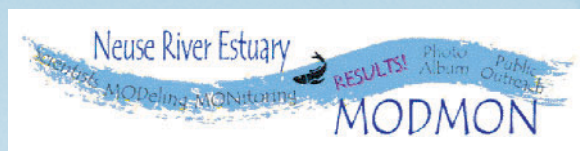


Figure 4-23. The only beach closings in 1999 reported to EPA for the Southeast Coast occurred in Florida. Other closings may have occurred but were not reported to EPA.

Eutrophication Studies in the Neuse River Estuary

The Neuse River Estuary is home to some of North Carolina's most economically valuable commercial and recreational fish and shellfish, in addition to being a highly valued recreational and industrial resource. However, the slow-flowing waters of the estuary provide near perfect conditions for algal blooms and eutrophication when combined with the increased nitrogen loading that has taken place in the last 3 to 4 decades. Recently, the state legislature mandated a 30% reduction in nitrogen loading to reduce the unwanted symptoms of eutrophication (nuisance algal blooms, hypoxia, fish kills). Because it is often difficult to predict or identify the effects of water quality management decisions, the plan to reduce nitrogen loading by 30% has created an opportunity for scientists to conduct a large-scale experiment using data collected before, during, and (eventually) after the reduction.

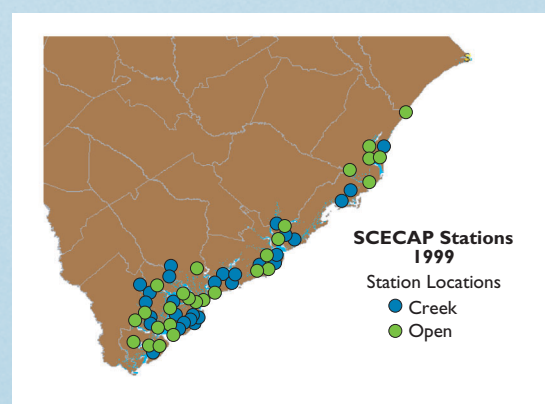
The multidisciplinary Neuse Modeling and Monitoring (MODMON) project was designed to collect monitoring data to establish the status and trends of water, sediment, and habitat quality in the estuary. Another aspect of MODMON was to create short-term and long-term water quality models such as the Neuse Estuary Eutrophication Model (see figure). Results of different model scenarios can be found on the Internet: <http://www.marine.unc.edu/neuse/modmon>.



This model simulates the processes used to predict water quality in the Neuse River for various nutrient loading and hydrologic scenarios.

South Carolina Estuarine and Coastal Assessment Program

In 1999, the South Carolina Department of Natural Resources (SCDNR) and the South Carolina Department of Health and Environmental Control (SCDHEC) initiated a major new collaborative coastal monitoring program. The goal of the South Carolina Estuarine and Coastal Assessment Program (SCECAP) is to monitor the condition of the state's estuarine habitats and associated biological resources annually. This program significantly expands current ongoing monitoring efforts being conducted by SCDNR and SCDHEC by drawing upon the expertise of both in a cooperative effort. SCECAP integrates measures of water and sediment quality with multiple measures of biological condition at a large number of sites throughout the state's coastal zone. It also expands historical monitoring activities that have focused primarily on open water habitats (e.g., bays, sounds, tidal rivers) to include an assessment of conditions in tidal creeks, which serve as important nursery habitat for most of the state's economically valuable species (see figure). Many of these tidal creeks are also the first point of entry for nonpoint source runoff from upland areas and, therefore, can provide an early indication of anthropogenic stress.



Sampling sites for SCECAP in 1999.

Summary

Ecological conditions in southeastern estuaries are fair (Figure 4-24). The primary problem in southeastern estuaries in the 1990s has been wetland loss and sediment contamination. Sediment contamination received a rating of fair, with high levels of contaminants being detected over moderate areas, but with additional low-level contamination detected over broader areas (particularly for pesticides and metals). Resulting health of resident benthic fauna was considered fair, with evidence of impaired benthic assemblages detected in about 17% of these estuaries. Wetland losses in the Southeast are substantial and receive a fair rating. Dissolved oxygen conditions are considered good and the condition of fish is also considered good, based on the low occurrence of contaminated tissues in fish sampled in southeastern estuaries. Increasing population pressures in this region of the country will require additional programs and increasing environmental awareness in order to correct existing problems and ensure that indicators that appear to be in fair condition do not worsen.

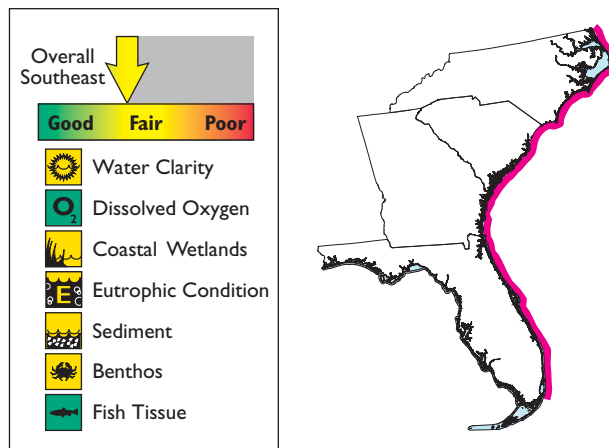


Figure 4-24. Ecological conditions in southeastern estuaries are fair.