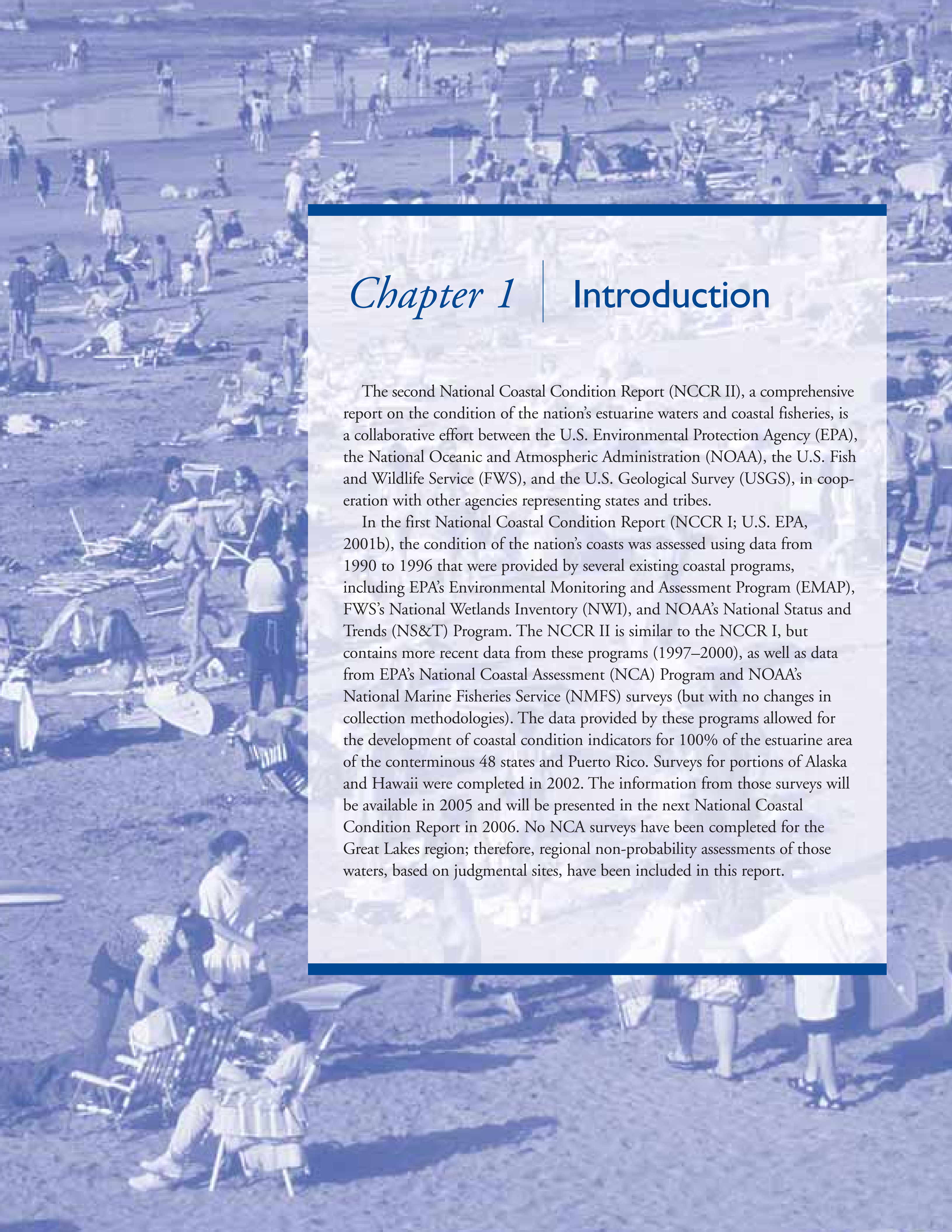


# *Chapter 1* | Introduction

The second National Coastal Condition Report (NCCR II), a comprehensive report on the condition of the nation's estuarine waters and coastal fisheries, is a collaborative effort between the U.S. Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Fish and Wildlife Service (FWS), and the U.S. Geological Survey (USGS), in cooperation with other agencies representing states and tribes.

In the first National Coastal Condition Report (NCCR I; U.S. EPA, 2001b), the condition of the nation's coasts was assessed using data from 1990 to 1996 that were provided by several existing coastal programs, including EPA's Environmental Monitoring and Assessment Program (EMAP), FWS's National Wetlands Inventory (NWI), and NOAA's National Status and Trends (NS&T) Program. The NCCR II is similar to the NCCR I, but contains more recent data from these programs (1997–2000), as well as data from EPA's National Coastal Assessment (NCA) Program and NOAA's National Marine Fisheries Service (NMFS) surveys (but with no changes in collection methodologies). The data provided by these programs allowed for the development of coastal condition indicators for 100% of the estuarine area of the conterminous 48 states and Puerto Rico. Surveys for portions of Alaska and Hawaii were completed in 2002. The information from those surveys will be available in 2005 and will be presented in the next National Coastal Condition Report in 2006. No NCA surveys have been completed for the Great Lakes region; therefore, regional non-probability assessments of those waters, based on judgmental sites, have been included in this report.

# Why Are Coastal Waters Important?

## Coastal Waters are Valuable and Productive Natural Ecosystems

Coastal waters include estuaries, coastal wetlands, seagrass meadows, coral reefs, mangrove and kelp forests, and upwelling areas. Critical coastal habitats provide spawning grounds, nurseries, shelter, and food for finfish, shellfish, birds, and other wildlife. The coasts also provide essential nesting, resting, feeding, and breeding habitat for 85% of U.S. waterfowl and other migratory birds.

Estuaries are bodies of water that receive freshwater and sediment influx from rivers and tidal influx from the oceans, thus providing transition zones between the fresh water of a river and the saline environment of the sea. This interaction produces a unique environment that supports wildlife and fisheries and contributes substantially to the economy of coastal areas.

Wetlands are the interface between the aquatic and terrestrial components of estuarine systems. Wetland habitats are critical to the life cycles of fish, shellfish, migratory birds, and other wildlife, and they help improve surface water quality by filtering residential, agricultural, and industrial wastes. Wetlands also buffer coastal areas against storm and wave damage; however, because of their close interface with terrestrial systems, wetlands are vulnerable to land-based sources of pollutant discharges and other human activities.

## Coastal Waters Have Many Human Uses

Coastal areas are the most developed areas in the nation. This narrow fringe—only 17% of total contiguous U.S. land area—is home to more than 53% of the nation's population (Figure 1-1). This means that more than one-half of the U.S. population lives in less than one-fifth of the total area of the conterminous 48 states (NRC, 2000). Further, this coastal population is increasing by 3,600 people per day, giving a projected total increase of 27 million people by 2015. This rate of growth is faster than that of the nation as a whole (Figure 1-2).

The Brown Pelican *(Pelecanus occidentalis)*, an endangered species, feeds on schooling fish near the ocean's surface by plunging beak-first from the air. In the 1960s, chemical dichlorodiphenyltrichlorethane (DDT) almost caused the demise of the brown pelican. Pelicans exposed to DDT laid eggs with thin or non-existent shells that broke during nesting, thus reducing the number of surviving offspring. Since DDT was banned in 1972, brown pelicans have made a remarkable recovery, and there are permanent brown pelican nesting colonies on both Anacapa and Santa Barbara Islands. (photo: Shane Anderson)

**Figure 1-1.** Population distribution in the United States, based on 2000 U.S. Census Bureau data.

In addition to being a popular place to live, the U.S. coasts are of great recreational value. Beaches have become one of the most popular vacation destinations in America, with 180 million people using the coast each year (Cunningham and Walker, 1996). Sport fishing, boating, and diving are enjoyed by millions, as is the simple pleasure of visiting the shore.

Human use of coastal areas also provides commercial services. Almost 31% of the U.S. gross national product (GNP) is produced in coastal counties, and roughly 85% of commercially harvested fish depend on estuaries and nearby coastal waters at some stage in their life cycle (NRC, 1997). Estuaries supply water for industrial uses; lose water to freshwater diversions for drinking and irrigation; are the critical terminals of the nation's marine transportation system and Navy; provide a point of discharge for municipalities and industries; and are the downstream end of nonpoint source runoff.

The average U.S. marine fisheries annual catch of 7 million metric tons (mt) is approximately 4.5% of the world's annual catch. The waters adjacent to the estuaries and wetlands of the United States, from 3 to 200 nautical miles, constitute the federal Exclusive Economic Zone (U.S. EEZ). The waters within and adjoining the U.S. EEZ have been designated as large marine ecosystems (LMEs), based on their distinct bathymetry, hydrography, productivity, and trophic relationships (NOAA, 1988b).

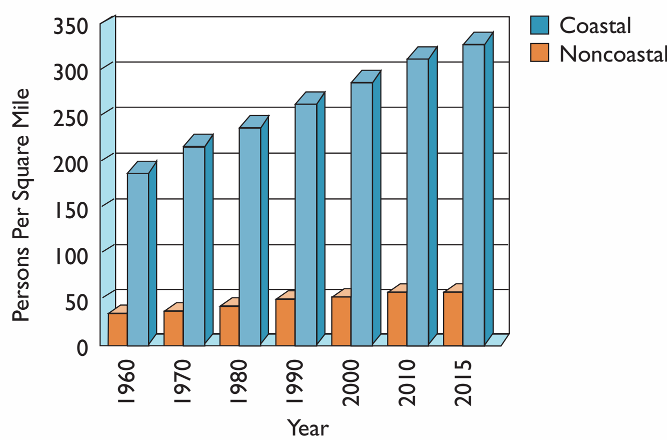



**Figure 1-2.** Population density from 1960 to 2015 (NOAA, 1998b).

# *Why Be Concerned about Coastal Condition?*

Because a disproportionate percentage of the nation's population lives in coastal areas, the activities of municipalities, commerce, industry, and tourism have created environmental pressures that threaten the very resources that make the coast desirable. Population pressures include increased solid waste production, higher volumes of urban nonpoint source runoff, loss of green space and wildlife habitat, declines in ambient water and sediment quality, and increased demands for wastewater treatment, irrigation and potable water, and energy supplies. Development pressures have resulted in substantial physical changes along many areas of the coastal zone. Coastal wetlands continue to be lost to residential and commercial development, and the quantity and timing of freshwater flow, critical to riverine and estuarine function, continue to be altered. In effect, the same human uses that are desired of coastal waters also have the potential to lessen their value. This report not only discusses indicators of coastal condition that gauge the extent to which coastal habitats and resources have been altered, but also addresses connections between coastal condition and the ability of coastal areas to meet human expectations for their use.

# Indices Used to Measure Coastal Condition

This report examines several available data sets from different agencies and areas of the country and summarizes them to present a broad baseline picture of the condition of coastal waters. Three types of data are presented in this report:

- Coastal monitoring data from programs such as EPA's EMAP and the NCA Program, NOAA's NS&T Program, FWS's NWI, and data from the Great Lakes National Program Office (GLNPO) have been analyzed for this report and used to develop indices of condition
- Fisheries data for LMEs from the NMFS
- Assessment and advisory data provided by states or other regulatory agencies and compiled in national databases.

Available coastal monitoring information is presented on a national scale for the conterminous 48 states and Puerto Rico; these data are then broken down and analyzed at six geographic levels: Northeast Coast, Southeast Coast, Gulf Coast, West Coast, Great Lakes, and Alaska, Hawaii, and Island Territories (Figure 1-3). These geographic regions are comparable to the LME classifications used by NOAA (Table 1-1). The assessment and advisory data are presented at the end of each chapter. Although inconsistencies in the way different state agencies collect and provide assessment and advisory data prevent their use for comparing conditions between coastal areas, the information is valuable because it helps identify and illuminate some of the causes of coastal impairment, as well as the impacts of these impairments on human uses.

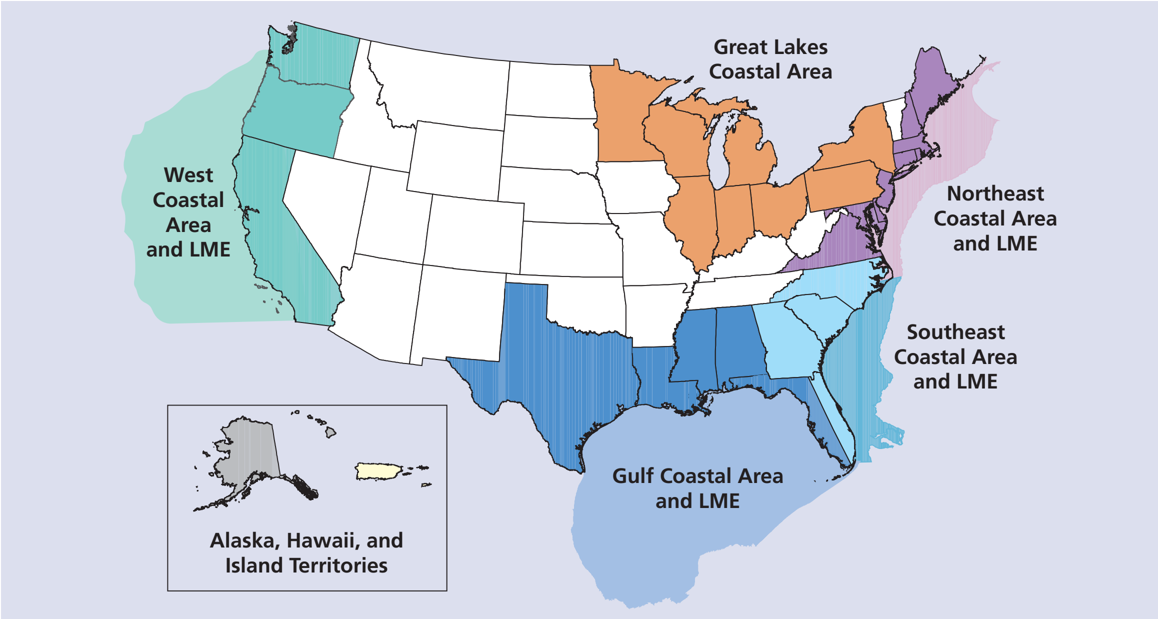



**Figure 1-3.** Coastal and large marine ecosystem areas presented in the chapters of this report.

**Table 1-1. Comparison of NCA's Reporting Regions and NOAA's Large Marine Ecosystems (LMEs)**

| NCA Reporting Regions | NOAA's LMEs |
|---|---|
| Northeast Coastal Area | Northeast U.S. Continental Shelf LME |
| Southeast Coastal Area | Southeast U.S. Continental Shelf LME |
| Gulf Coastal Area | Gulf of Mexico LME |
| West Coastal Area | California Current LME |
| Alaska, Hawaii, and Island Territories | East Bering Sea LME, Gulf of Alaska LME, Chukchi Sea LME, Beaufort Sea LME, Insular Pacific–Hawaii LME, Caribbean Sea LME |

Three sources of estuarine information use nationally consistent data-collection designs and methods—NCA, NS&T, and NWI. The NCA Program collects these data from all coastal areas in the United States, except the Great Lakes region, and the data are representative of all estuarine waters. The NS&T Program collects data from all coastal regions in the United States; however, the design of this survey does not permit extrapolation of the data to represent all coastal waters. The NWI provides estimates of wetland acreage (including coastal wetlands) by wetland type based on satellite reconnaissance of all U.S. states and territories.

## *Purpose of This Report*

The purpose of the NCCR II is to present a broad baseline picture of the condition of estuaries across the United States for 1997 to 2000 and, where available, snapshots of the condition of offshore waters. This report uses currently available data sets to discuss the condition of the nation's coasts, and it is not intended to be a comprehensive literature review of coastal information. Instead, the report uses NCA and other monitoring data on a variety of indicators to provide insight into current coastal condition. The NCCR II will serve as a continuing benchmark for analyzing the progress of coastal programs and will be followed in subsequent years by reports on more specialized coastal issues. It will also serve as a reminder of the data gaps and other pitfalls that assessors face and must try to overcome in order to make reliable assessments of how the condition of the nation's coastal resources may change with time. Chapter 9 explores the connections between the condition indicators and human uses of coastal areas. Although the type of assessment described in Chapter 9 cannot be conducted on scales larger than a single estuary, it is important to address coastal condition at several spatial scales (e.g., national, regional, state, and local). Chapter 9 provides an approach that complements the national/regional approach by examining the same national/regional monitoring information with additional site-specific information for a specific estuary, Galveston Bay, in order to evaluate conditions with regard to human uses.

This report also includes special highlight sections that describe several exemplary programs related to coastal condition at the federal, state, and local levels. These highlights are not intended to be comprehensive or exhaustive of all coastal programs, but are presented to show that information about the health of coastal systems is being collected for decision making at the local and regional levels.

## *Shortcomings of Available Data*

Estuarine condition in Alaska is difficult to assess because very little information is available to support the kind of analysis used in this report (i.e., spatial estimates of condition based on indicators measured consistently across broad regions). Nearly 75% of the area of all the bays, sounds, and estuaries in the United States is located in Alaska, and no national report on estuarine condition can be complete without information on the condition of living resources and use attainment of these waters. Similarly, information to support estimates of conditions based on the indicators used in this report is limited for Hawaii, the Pacific territories, and the U.S. Virgin Islands. Although these latter systems make up only a small portion of the nation's estuarine area, they represent a unique set of estuarine subsystems (such as coral reefs and tropical bays) that are not located anywhere else in the United States, with the exception of the Florida Keys and the Flower Gardens off the Texas/Louisiana coast.

Surveys of Puerto Rico were completed in 2000 and are also included in this report. Collection surveys were completed for Hawaii and portions of Alaska in 2002 and will be included in the next National Coastal Condition Report. In addition, new surveys of ecological coastal condition for Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and the Pacific territories were planned for 2004.

In order to attain consistent reporting in all of the coastal ecosystems in the United States, fiscal and intellectual resources need to be invested in the creation of a national coastal monitoring program. The conceptual framework for such a program is outlined in the National Coastal Research and Monitoring Strategy (http://www.epa.gov/owow/oceans/nccr/H2Ofin.pdf). This strategy calls for a national program that is organized at the state level and carried out by a partnership between federal departments and agencies (EPA, NOAA, DOI, and USDA) and state natural resource agencies, as well as academia and industry.

This monitoring program would provide the capability to measure, understand, analyze, and forecast ecological change at national, regional, and local scales. A first step in the development of this type of program was the initiation of EPA's NCA Program, a national estuarine monitoring program organized and executed at the state level. However, the NCA Program is merely a starting point for developing a comprehensive national coastal monitoring program that can offer a nationwide coastal assessment at all appropriate spatial scales. One approach for examining coastal data at a more local scale—an individual estuarine system—is presented in Chapter 9.

## Coastal Monitoring Data

A large percentage of the data used in this assessment of coastal condition comes from programs administered by EPA and NOAA. EPA's NCA Program provides representative data on biota (e.g., plankton, benthos, and fish) and environmental stressors (e.g., water quality, sediment quality, and tissue bioaccumulation) for all coastal states and Puerto Rico (except states in the Great Lakes region). NOAA's NS&T Program provides site-specific data on toxic contaminants and their ecological effects for all coastal regions and Puerto Rico. Coastal condition is also evaluated using information from the FWS's NWI, which provides information on the status of the nation's wetlands acreage.

Five primary indices were created using data available from national coastal programs: water quality index, sediment quality index, benthic index, coastal habitat index, and fish tissue contaminants index. These indices were selected because of the availability of relatively consistent data sets for these indicators for most of the country. These indices do not address all characteristics of estuaries and coastal waters that are valued by society, but they do provide information on both ecological condition and human use of estuaries.

Characterizing coastal areas using each of the five indicators involves two steps. The first step is to assess condition at an individual site for each indicator. For each indicator, site condition rating criteria are determined based on existing criteria, guidelines, or the interpretation of scientific literature. For example, dissolved oxygen conditions are considered poor if dissolved oxygen concentrations are less than 2 mg/L (2 milligrams of oxygen per liter of water). This value is widely accepted as representative of hypoxic conditions; therefore, this benchmark for poor condition is strongly supported by scientific evidence (Diaz and Rosenberg, 1995; U.S. EPA, 2000a).

The second step is to assign a regional rating for the indicator based on the condition of individual sites within the region. For example, in order for a region to be rated poor with regard to the dissolved oxygen indicator, more than 15% of the coastal area in the region must have dissolved oxygen measured at less than 2 mg/L. The regional criteria boundaries (i.e., percentages used to rate each regional condition indicator) were determined as a median of responses provided through a survey of environmental managers, resource experts, and the knowledgeable public.

Scientists retrieve a Tucker net. A Tucker net is comprised of three nets to collect sample plankton from different water depths (Jamie Hall).

## Calculating Aquatic Life Use and Human Use Attainment

The results of the regional and national evaluations of estuarine condition were used to assess aquatic life use and human use attainment. If any of four indicators of condition—water quality condition, sediment quality, benthic condition, or habitat loss—received a poor rating at a given site, then the site was assessed as impaired for aquatic life use. Threatened aquatic life use was assessed as the overlap of fair conditions of these same indicators. For example, if two or more indicators were rated as fair and none as poor, then the site was listed as threatened (all sites had at least one fair rating because the regional ratings for coastal habitat loss were fair in all regions). A site was determined to be unimpaired for aquatic life use if all four indicators were rated good, or only one indicator was rated fair and no indicators were rated poor.

National and regional evaluations for fish tissue contaminants were used to assess human use attainment. If the fish tissue contaminant concentrations exceeded the concentration criteria ranges for risk-based consumption of four 8-ounce meals per month for any contaminant, the site was assessed as impaired for human use. A site was considered to be threatened for human use if the fish tissue contaminant concentrations fell within the criteria ranges for risk-based consumption of four 8-ounce meals per month. Sites were considered unimpaired for human use if fish tissue concentrations fell below the risk-based concentration guidance ranges for consumption for all contaminants.

All spatial areas in a region or the nation were assigned a category of (1) impaired for aquatic life use only, (2) impaired for human use only, (3) impaired for both aquatic life use and human use, (4) threatened (for one or both uses), or (5) unimpaired (for both uses).

## Aquatic Use Indices

The following indices examine coastal condition as it relates to use by aquatic organisms.

### Water Quality Index

The water quality index is made up of five indicators: nitrogen, phosphorus, chlorophyll *a*, water clarity, and dissolved oxygen. Some nutrient inputs to coastal waters (such as nitrogen and phosphorus) are necessary for a healthy, functioning estuarine ecosystem. When nutrients from various sources, such as sewage and fertilizers, are introduced into an estuary, the concentration of available nutrients will increase beyond natural background levels. This increase in the rate of supply of organic matter is called eutrophication, which may result in a host of undesirable water quality conditions (Figure 1-4). Excess nutrients can lead to excess plant

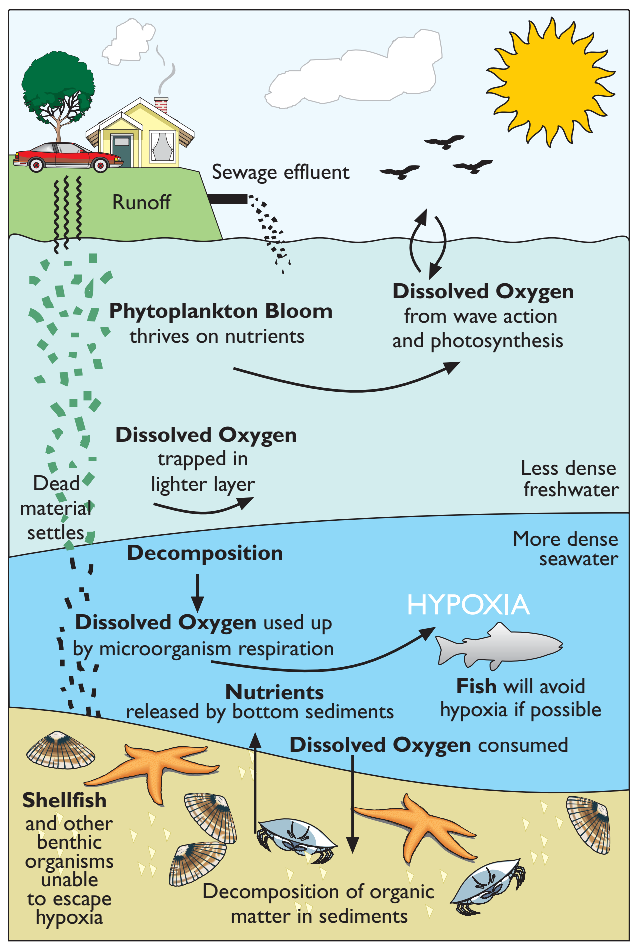



**Figure 1-4.** Eutrophication can occur when the concentration of available nutrients increases beyond normal levels.

production, and thus, to increased chlorophyll, which can decrease water clarity and lower concentrations of dissolved oxygen.

The water quality index used in this report is intended to characterize acutely degraded water quality conditions. It does not consistently identify sites experiencing occasional or infrequent hypoxia, nutrient enrichment, or decreased water clarity. As a result, a rating of poor for the water quality index means that the site is likely to have consistently poor condition during the monitoring period. If a site is designated as fair or good, the site did not experience poor condition on the date sampled, but could be characterized by poor condition for short time periods. In order to assess the level of variability in the index at a specific site, increased or supplemental sampling is needed.

### Nutrients: Nitrogen and Phosphorus

Dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) are necessary and natural nutrients required for the growth of phytoplankton. However, excessive DIN and DIP can result in large, undesirable phytoplankton blooms. For the NCCR I, DIN and DIP information was determined through a survey of estuarine experts conducted by NOAA (Bricker et al., 1999). In the NOAA report, surface maximum DIN values were assessed as high if they were equal to or greater than 1 mg/L; medium if they were less than 1 mg/L, but equal to or greater than 0.1 mg/L; and low if they were less than 0.1 mg/L. Surface maximum DIP values were assessed as high if they were equal to or greater than 0.1 mg/L; medium if they were less than 0.1 mg/L, but equal to or greater than 0.01 mg/L; and low if they were less than 0.01 mg/L. The NOAA report included data from all months of the year.

For the NCCR II, DIN and DIP were determined chemically through the collection of filtered surface water at each site. NCA surveys were conducted in late summer (not the most likely period for maximal nutrient values in East Coast and Gulf Coast estuaries, summer is the period of expected peak concentrations for West Coast estuaries). As a result, the DIN and DIP reference surface concentrations used to assess condition in this report are generally lower than those in the NOAA report because of the natural reduction in nutrient concentrations due to uptake by phytoplankton from spring to summer for the production of chlorophyll.

Coastal monitoring sites were rated good, fair, or poor for DIN and DIP using the criteria shown in Tables 1-2 and 1-3. These ratings were then used to calculate an overall rating for each region.

**Table 1-2. Criteria for Assessing Dissolved Inorganic Nitrogen**

| Area | Good | Fair | Poor |
|---|---|---|---|
| East/Gulf Coast sites | <0.1 mg/L | 0.1–0.5 mg/L | >0.5 mg/L |
| West Coast sites | <0.5 mg/L | 0.5–1.0 mg/L | >1 mg/L |
| Hawaii, Puerto Rico, and Florida Bay sites | <0.05 mg/L | 0.05–0.1 mg/L | >0.1 mg/L |
| **Regional Scores** | Less than 10% of the coastal area was in poor condition, and more than 50% of the coastal area was in good condition. | 10% to 25% of the coastal area was in poor condition, or more than 50% of the coastal area was in combined poor and fair condition. | More than 25% of the coastal area was in poor condition. |

**Table 1-3. Criteria for Assessing Dissolved Inorganic Phosphorus**

| Area | Good | Fair | Poor |
|---|---|---|---|
| East/Gulf Coast sites | <0.01 mg/L | 0.01–0.05 mg/L | >0.05 mg/L |
| West Coast sites | <0.01 mg/L | 0.01–0.1 mg/L | >0.1 mg/L |
| Hawaii, Puerto Rico, and Florida Bay sites | <0.005 mg/L | 0.005–0.01 mg/L | >0.01 mg/L |
| **Regional Scores** | Less than 10% of the coastal area was in poor condition, and more than 50% of the coastal area was in good condition. | 10% to 25% of the coastal area was in poor condition, or more than 50% of the coastal area was in combined poor and fair condition. | More than 25% of the coastal area was in poor condition. |

## Chlorophyll *a*

For this report, surface concentrations of chlorophyll *a* were determined from a filtered portion of water collected at each site and were rated good, fair, or poor using the criteria shown in Table 1-4. These ratings were then used to calculate an overall rating for each region.

**Table 1-4. Criteria for Assessing Chlorophyll *a***

| Area | Good | Fair | Poor |
|---|---|---|---|
| East/Gulf, West Coast sites | <5 µg/L | 5–20 µg/L | >20 µg/L |
| Hawaii, Puerto Rico, | <0.5 µg/L | 0.5–1 µg/L | >1 µg/L |
| Florida Bay sites | <1 µg/L | 1–5 µg/L | >5 µg/L |
| **Regional Scores** | Less than 10% of the coastal area was in poor condition, and more than 50% of the coastal area was in good condition. | 10% to 20% of the coastal area was in poor condition, or more than 50% of the coastal area was in combined poor and fair condition. | More than 20% of the coastal area was in poor condition. |

## Water Clarity

Clear waters are valued by society and contribute to the maintenance of healthy and productive ecosystems. Light penetration into estuarine waters is important for submerged aquatic vegetation (SAV), which serves as food and habitat for the resident biota. The NCA estimates water clarity using specialized equipment that compares the amount and type of light reaching the water surface to the light at a depth of 1 meter, as well as by using a Secchi disk. Water clarity varies naturally among various parts of the nation; therefore, the water clarity indicator (WCI) is based on a ratio of observed clarity to regional reference conditions: WCI = (observed clarity at 1 meter)/(regional reference clarity at 1 meter). The regional reference conditions were determined by examining available data for each of the U.S. regions. Conditions were set at 10% of incident light available at a depth of 1 meter for normally turbid locations (most of the United States), 5% for naturally highly turbid conditions (Louisiana, South Carolina, Georgia, and Delaware Bay), and 20% for regions of the country with significant SAV beds or active programs for SAV restoration (southern Laguna Madre, the Big Bend region of Florida, the region from Tampa Bay to Florida Bay, the Indian River Lagoon, and portions of Chesapeake Bay). Table 1-5 summarizes the rating criteria for water clarity for each monitoring station and for the regions.

**Table 1-5. Criteria for Assessing Water Clarity**

| Area | Good | Fair | Poor |
|---|---|---|---|
| Individual sampling sites | WCI ratio is greater than 2. | WCI ratio is between 1 and 2. | WCI ratio is less than 1. |
| **Regional Scores** | Less than 10% of the coastal area was in poor condition, and more than 50% of the coastal area was in good condition. | 10% to 25% of the coastal area was in poor condition, or more than 50% of the coastal area was in combined poor and fair condition. | More than 25% of the coastal area was in poor condition. |

WCI= (observed clarity at 1 meter)/(regional reference clarity at 1 meter)

## Dissolved Oxygen

Dissolved oxygen is necessary for all estuarine life. Many states use a threshold average concentration of 4 to 5 mg/L to set their water quality standards. Concentrations below approximately 2 mg/L are thought to be stressful to many estuarine organisms (Diaz and Rosenberg, 1995; U.S. EPA, 2000a). These low levels most often occur in bottom waters and affect the organisms that live in the sediments. Low levels of oxygen (hypoxia) or lack of oxygen (anoxia) often accompany the onset of severe bacterial degradation, sometimes resulting in the presence of algal scums and noxious odors. In some estuaries, however, low levels of oxygen occur periodically or may be a part of the natural ecology. Therefore, although it is easy to show a snapshot of the conditions of the nation's estuaries concerning oxygen concentrations, it is difficult to interpret whether this snapshot is representative of all summertime periods (e.g., representative of variable daily conditions in Narragansett Bay) or the result of natural physical processes. Unless otherwise noted, the dissolved oxygen data presented in this report were collected under the NCA Program. Dissolved oxygen was rated good, fair, or poor using the criteria shown in Table 1-6.

**Table 1-6. Criteria for Assessing Dissolved Oxygen**

| Area | Good | Fair | Poor |
|---|---|---|---|
| Individual sampling sites | > 5 mg/L | 2–5 mg/L | < 2 mg/L |
| **Regional Scores** | Less than 5% of the coastal area was in poor condition, and more than 50% of the coastal area was in good condition. | 5% to 15% of the coastal area was in poor condition, or more than 50% of the coastal area was in combined poor and fair condition. | More than 15% of the coastal area was in poor condition. |

## Calculating the Water Quality Index

Once DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen were assessed for a given site, the water quality index rating was calculated for the site based on these five indicators. The index was rated good, fair, or poor using the criteria shown in Table 1-7.

**Table 1-7. Criteria for Determining the Water Quality Index Rating by Site**

| Rating | Criteria |
|---|---|
| Good | A maximum of one indicator is fair, and no indicators are poor. |
| Fair | One of the indicators is rated poor, or two or more indicators are rated fair. |
| Poor | Two or more of the five indicators are rated poor. |
| Missing | Two components of the indicator are missing, and the available indicators do not suggest a fair or poor rating. |

The water quality index was then calculated for each region using the criteria in Table 1-8.

**Table 1-8. Criteria for Determining the Water Quality Index Rating by Region**

| Rating | Criteria |
|---|---|
| Good | Less than 10% of coastal waters are in poor condition, and less than 50% of coastal waters are in combined poor and fair condition. |
| Fair | 10% to 20% of coastal waters are in poor condition, or more than 50% of coastal waters are in combined fair and poor condition. |
| Poor | More than 20% of coastal waters are in poor condition. |

## Sediment Quality Index

Another issue of major environmental concern in estuaries is the contamination of sediments with toxic chemicals. A wide variety of metals and organic substances, such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides, are discharged into estuaries from urban, agricultural, and industrial sources in the watershed. The contaminants adsorb onto suspended particles and eventually accumulate in depositional basins where they can disrupt the benthic community of invertebrates, shellfish, and crustaceans that live in or on the sediments. To the extent that the contaminants become concentrated in the organisms, they pose a risk to organisms throughout the food web—including humans.

Several factors influence the extent and severity of contamination. Fine-grained, organic-rich sediments are likely to become resuspended and transported to distant locations and are also efficient at scavenging pollutants. Thus, silty sediments high in total organic carbon (TOC) are potential sources of contamination. Conversely, organic-rich particles bind some toxicants so strongly that the threat to organisms can be greatly reduced. The NCA Program measured the concentrations of 91 chemical constituents in sediments and evaluated sediment toxicity by measuring the survival of the marine amphipod *Ampelisca abdita* following exposure to the sediments. The results of this research may be used to identify the most polluted areas and give clues regarding the sources of contamination.

The physical and chemical characteristics of surface sediments are the result of interacting forces that control chemical input and particle dynamics at any particular site. In assessing coastal condition, researchers measure the potential for sediments to affect bottom-dwelling organisms. The sediment quality index is based on three indicators of sediment condition: direct measures of sediment toxicity, sediment contaminants, and the sediment TOC concentration.

Some researchers and managers would prefer that the sediment triad (sediment chemistry, sediment toxicity, and benthic communities) be used to assess sediment condition (poor condition would require all three elements to be poor), or that poor sediment condition be determined based on the joint occurrence of elevated sediment contaminant concentrations and high sediment toxicity (see text box). Benthic community attributes are included in this assessment of estuarine condition as an independent variable rather than as a component of sediment quality.

In this report, the focus of the sediment quality index is on sediment condition, not just sediment toxicity. Attributes of sediments other than toxicity can result in unacceptable changes in biotic communities. For example, organic enrichment through wastewater disposal can have an undesired effect on biota, and elevated contaminant levels can have undesirable ecological effects (e.g., changes in benthic community structure) that are not directly related to acute toxicity (as measured by the *Ampelisca* test). For these reasons, the sediment quality index used in this report uses the combination of sediment toxicity, sediment contaminants, and sediment TOC to assess sediment condition. The condition of estuarine sediment is assessed as poor (high potential for exposure effects on biota) if any one of the elements is categorized as poor; condition is assessed as fair if the sediment contaminants indicator is fair; and condition is assessed as good if all three indices are at levels that would be unlikely to result in adverse biological effects due to sediment quality.

**Alternative Views for a Sediment Quality Index**

Some resource managers object to using effects range median (ERM) and effect reange low (ERL) values to calculate the NCCR II sediment quality index because the index is also based on actual measurements of toxicity. Because ERMs are acknowledged to be no greater than 50% predictive of toxicity, these managers believe that the same weight should not be given to a nontoxic sample with an ERM exceedance as is given to a sample that is actually toxic. O'Connor et al. (1998), using a 1,508-sample EPA and NOAA database, found that 38% of ERM exceedances coincided with amphipod toxicity (i.e., were toxic), 13% of the ERL exceedances (no ERM exceedance) were toxic; and only 5% of the samples that did not exceed ERL values were toxic. O'Connor and Paul (2000) expanded the 1,508-sample data set to 2,475 samples, and the results remained relatively unchanged (41% of the ERM exceedances were toxic, and only 5% of the nonexceedances were toxic). As a result, these researchers and managers believe that the sediment quality index used in this report should not result in a poor rating if sediment contaminant criteria are exceeded, but the sediment is not toxic.

## Sediment Toxicity

Researchers applied a standard direct test of toxicity at thousands of sites to measure the survival of amphipods (commonly found, shrimp-like benthic crustaceans) exposed to sediments for 10 days under laboratory conditions. As in all tests of toxicity, survival was measured relative to that of amphipods exposed to reference sediment. The criteria for rating sediment toxicity based on amphipod survival for each sampling site are shown in Table 1-9. Table 1-10 shows how these site data were used to evaluate the region.

**Table 1-9. Criteria for Assessing Sediment Toxicity by Site**

| Rating | Criteria |
|---|---|
| Good | The amphipod survival rate is greater than or equal to 80%. |
| Poor | The amphipod survival rate is less than 80%. |

**Table 1-10. Criteria for Assessing Sediment Toxicity by Region**

| Rating | Criteria |
|---|---|
| Good | Less than 5% of coastal areas are in poor condition. |
| Poor | More than 5% of coastal areas are in poor condition. |

## Sediment Contaminants

There are no absolute chemical concentrations that correspond to sediment toxicity, but ERL and ERM values are used as guidelines in assessing sediment contamination (Table 1-11). ERM is the median concentration of a contaminant observed to have adverse biological effects in the literature studies examined. A more protective indicator of contaminant concentration is the ERL criteria, which is the 10th percentile concentration of a contaminant represented by studies demonstrating adverse biological effects in the literature. Ecological effects are not likely to occur at contaminant concentrations below the ERL criterion. The criteria for rating sediment contaminants at individual sampling sites are shown in Table 1-12. Table 1-13 shows how these data were used to create a regional rating.

**Sediment Contaminant Criteria**
(Long et al., 1995)

**ERM (Effects Range Median)**—Determined 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.

**Table 1-11. ERM and ERL Guidance Values in Sediments (Long et al., 1995)**

| Metal[a] | ERL | ERM |
|---|---|---|
| Arsenic | 8.2 | 70 |
| Cadmium | 1.2 | 9.6 |
| Chromium | 81 | 370 |
| Copper | 34 | 270 |
| Lead | 46.7 | 218 |
| Mercury | 0.15 | 0.71 |
| Nickel | 20.9 | 51.6 |
| Silver | 1 | 3.7 |
| Zinc | 150 | 410 |
| **Analyte[b]** | **ERL** | **ERM** |
| Acenaphthene | 16 | 500 |
| Acenapthylene | 44 | 640 |
| Anthracene | 85.3 | 1,100 |
| Flourene | 19 | 540 |
| 2-Methyl napthalene | 70 | 670 |
| Napthalene | 160 | 2,100 |
| Phenanthrene | 240 | 1,500 |
| Benz(a)anthracene | 261 | 1,600 |
| Benzo(a)pyrene | 430 | 1,600 |
| Chrysene | 384 | 2,800 |
| Dibenzo(a,h)anthracene | 63.4 | 260 |
| Fluoranthene | 600 | 5,100 |
| Pyrene | 665 | 2,600 |
| Low molecular weight PAH | 552 | 3,160 |
| High molecular weight PAH | 1,700 | 9,600 |
| Total PAHs | 4,020 | 44,800 |
| 4,4'-DDE | 2.2 | 27 |
| Total DDT | 1.6 | 46.1 |
| Total PCBs | 22.7 | 180 |

[a] Units are ug/g dry sediment, equivalent to ppm.
[b] Units are ng/g dry sediment, equivalent to ppb.

**Table 1-12. Criteria for Assessing Sediment Contaminants by Site**

| Rating | Criteria |
|---|---|
| Good | No ERM concentrations are exceeded, and less than five ERL concentrations are exceeded. |
| Fair | Five or more ERL concentrations are exceeded. |
| Poor | An ERM concentration is exceeded for one or more contaminants. |

**Table 1-13. Criteria for Assessing Sediment Contaminants by Region**

| Rating | Criteria |
|---|---|
| Good | Less than 5% of coastal sediments are in poor condition. |
| Fair | 5% to 15% of coastal sediments are in poor condition. |
| Poor | More than 15% of coastal sediments are in poor condition. |

## Sediment Total Organic Carbon

Sediment contaminant availability or organic enrichment can be altered in areas where there is considerable deposition of organic matter. Sediment toxicity from organic matter is assessed by measuring TOC. The criteria for rating TOC for individual sampling sites are shown in Table 1-14. Table 1-15 shows how these data were used to create a regional ranking.

**Table 1-14. Criteria for Assessing Sediment TOC by Site (concentrations on a dry-weight basis)**

| Rating | Criteria |
|---|---|
| Good | The TOC concentration is less than 2%. |
| Fair | The TOC concentration is between 2% and 5%. |
| Poor | The TOC concentration is greater than 5%. |

**Table 1-15. Criteria for Assessing Sediment TOC by Region**

| Rating | Criteria |
|---|---|
| Good | Less than 20% of coastal areas are in poor condition. |
| Fair | 20% to 30% of coastal areas are in poor condition. |
| Poor | More than 30% of coastal areas are in poor condition. |

### Calculating the Sediment Quality Index

Once sediment toxicity, sediment contaminants, and sediment TOC were assessed for a given site, the sediment quality index rating was calculated for the site based on these three indicators. The sediment quality index was rated good to poor for each site using the criteria shown in Table 1-16.

**Table 1-16. Criteria for Determining the Sediment Quality Index by Site**

| Rating | Criteria |
|---|---|
| Good | None of the individual components are poor, and the sediment contaminants indicator is good. |
| Fair | No measures are poor, and the sediment contaminants indicator is fair. |
| Poor | One or more of the component indicators is poor. |

The sediment quality index was then calculated for each region using the criteria shown in Table 1-17.

**Table 1-17. Criteria for Determining the Sediment Quality Index by Region**

| Rating | Criteria |
|---|---|
| Good | Less than 5% of coastal sediments are in poor condition, and less than 50% of coastal sediments are in combined poor and fair condition. |
| Fair | 5% to 15% of coastal sediments are in poor condition, or more than 50% of coastal sediments are in combined poor and fair condition. |
| Poor | More than 15% of coastal sediments are in poor condition. |

## Benthic Index

The worms, clams, and crustaceans that inhabit the bottom substrates of estuaries are collectively called benthic macroinvertebrates, or benthos. These organisms play a vital role in maintaining sediment and water quality and are an important food source for bottom-feeding fish, shrimp, ducks, and marsh birds. Benthos are often used as indicators of disturbances in estuarine environments because they are not very mobile and thus cannot avoid environmental problems. Benthic population and community characteristics are sensitive indicators of contaminant and dissolved-oxygen stress, salinity fluctuations, and sediment disturbance and serve as reliable indicators of estuarine environmental quality. EMAP and NCA have developed regional (Northeast, Southeast, and Gulf coasts) benthic indices of environmental condition for estuaries that reflect changes in diversity and population size of indicator species to distinguish degraded benthic habitats from undegraded benthic habitats (Engle et al., 1994; Weisberg et al., 1997; Engle and Summers, 1999; Van Dolah et al., 1999). These indices reflect changes in benthic community diversity and the abundance of pollution-tolerant and pollution-sensitive species. A high benthic index rating for benthos means that samples taken from an estuary's sediments contain a wide variety of species, a low proportion of pollution-tolerant species, and a high proportion of pollution-sensitive species. A low benthic index rating indicates that the benthic communities are less diverse than expected, are populated by more pollution-tolerant species than expected, and contain fewer pollution-sensitive species than expected. The benthic condition data presented throughout this report were collected by the NCA Program unless otherwise noted. Indices vary with region because species assemblages depend on prevailing temperatures, salinities, and the silt-clay content of sediments. Benthic index was rated poor when the index values for the Northeast, Southeast, and Gulf coasts' diversity or species richness, abundance of pollution-sensitive species, and abundance of pollution-tolerant species fell below a certain threshold.

Not all regions included in this report have developed benthic indices. Indices for the West Coast and Puerto Rico, as well as Alaska and Hawaii, are being developed and are not available for reporting at this time. As a surrogate for a benthic index, benthic community diversity was determined for each site. Values for community diversity were examined regionally to determine if diversity varied directly with either salinity or sediment silt-clay content (the two natural variables most likely to influence estuarine benthic diversity). If there was no significant relationship between diversity and these natural gradients in the region (as in Puerto Rico), then a surrogate benthic index was used based on the lower 95% confidence limit for the mean benthic diversity measures. If there was a significant relationship between diversity and either of these natural gradients in the region (as in the West Coast), then a surrogate benthic index was used based on the ratio of observed to expected diversity. Expected diversity was determined based on the statistical relationship of site diversity to site salinity (or silt-clay content). Poor condition was defined as less than 75% of the expected benthic diversity at a particular salinity (expected diversity was determined by a regression between diversity and salinity). More detailed descriptions of these surrogate analyses are provided in the West Coast chapter (Chapter 6) and the Puerto Rico chapter (Chapter 8). Table 1-18 shows the good, fair, and poor rating criteria for the different regions of the country. These ratings were used to calculate an overall rating for each region.

The relationship between poor benthic condition (poor index values) and environmental stressors (i.e., water quality and sediment quality indices and their component measurements) is examined using the co-occurrence of these factors in each region. In all regions, some sites with poor benthic community condition did not co-occur with high levels of environmental stressors measured by NCA. The sites that do not co-occur with the poor water quality and sediment quality indices may be the result of physical habitat degradation (not measured by NCA).

## Coastal Habitat Index

Coastal wetlands are the vegetated interface between aquatic and terrestrial components of estuarine ecosystems. Wetland habitats are critical to the life cycles of fish, shellfish, migratory birds, and other wildlife. These habitats also filter and process residential, agricultural, and industrial wastes, thereby improving surface water quality, and buffer coastal areas against storm and wave damage. An estimated 95% of commercial fish and 85% of sport fish spend a portion of their life cycles in coastal wetland and estuarine habitats. Adult stocks of commercially harvested shrimp, blue crabs, oysters, and other species throughout the United States are directly related to wetland quality and quantity (Turner and

**Table 1-18. Criteria for Assessing Benthic Index**

| Area | Good | Fair | Poor |
|---|---|---|---|
| Northeast Coast | Benthic index score is greater than 0.0. | N/A | Benthic index score is less than 0.0. |
| Southeast Coast | Benthic index score is greater than 2.5. | Benthic index score is between 2.0 and 2.5. | Benthic index score is less than 2.0. |
| Gulf Coast | Benthic index score is greater than 5.0. | Benthic index score is between 3.0 and 5.0. | Benthic index score is less than 3.0. |
| West Coast (compared to expected diversity) | Benthic index score is more than 90% of the lower limit (lower 95% confidence interval) of expected mean for a specific salinity. | Benthic index score is between 75% and 90% of the lower limit of expected mean diversity for a specific salinity. | Less than 75% of observations had expected diversity. |
| Puerto Rico (compared to upper 95% confidence interval for mean regional benthic diversity) | Benthic index score is more than 90% of the lower limit (lower 95% confidence interval) of mean diversity in unstressed habitats in Puerto Rico. | Benthic index score is between 75% and 90% of the lower limit of mean diversity in unstressed habitats in Puerto Rico. | Benthic index score is less than 75% of the lower limit of mean diversity for unstressed habitats in Puerto Rico. |
| Regional Scores | Less than 10% of coastal sediments have a poor benthic index score, and less than 50% of coastal sediments have a combined poor and fair benthic index score. | 10% to 20% of coastal sediments have a poor benthic index score, or more than 50% of coastal sediments have a combined poor and fair benthic index score. | More than 20% of coastal sediments have a poor benthic index score. |

Boesch, 1988). Wetlands throughout the United States have been and are being rapidly destroyed by human activities (e.g., flood control, agriculture, waste disposal, real estate development, shipping, commercial fishing, oil/gas exploration and production) and natural processes (e.g., sea level rise, sediment compaction, droughts, hurricanes, floods). In the late 1970s and early 1980s, the country was losing wetlands at an estimated rate of 300,000 acres per year. The Clean Water Act, state wetland protection programs, and programs such as Swampbuster (USDA) have helped decrease wetland losses to an estimated 70,000 to 90,000 acres per year. Strong wetland protection must continue to be a national priority; otherwise, fisheries that support more than a million jobs and contribute billions of dollars to the national economy are at risk (Turner and Boesch, 1988; Stedman and Hanson, 2000), as are the ecological functions provided by wetlands (e.g., nursery areas, flood control, and water quality improvement).

The NWI (2002) contains data on estuarine emergent and tidal flat wetland acreage for all coastal states for 1990 and 2000 except Hawaii and Puerto Rico. Data for Hawaii and Puerto Rico are available for 1980 and 1990. The proportional change in regional coastal wetlands over the 10-year time period was determined for each region of the United States (Northeast Coast, Southeast Coast, Gulf Coast, West Coast, and Alaska, Hawaii, and Puerto Rico) and combined with the long-term decadal loss rates for the period 1780 to 1990. The average of these two loss rates (historic and present) multiplied by 100 is the regional value of the coastal habitat index. The national value of the coastal habitat index is a weighted mean that reflects the extent of wetlands existing in each region (different than the distribution of the extent of estuarine area). Table 1-19 shows the rating criteria used for the coastal habitat index.

The NWI estimates represent regional assessments and do not apply to individual sites or individual wetlands. Before individual wetland sites can be assessed, rigorous methodologies for estimating the quantity and, particularly, the quality of wetlands must be developed. Until these methods are available and implemented, only regional assessments of quantity losses can be made. Although a 1% loss rate per decade may seem small (or even acceptable), continued wetland losses at this rate cannot be sustained indefinitely and still leave enough wetlands to maintain their present ecological functions.

**Table 1-19. Criteria for Determining the Coastal Habitat Index**

| Rating | Criteria |
|---|---|
| Good | The index score is less than 1.0. |
| Fair | The index score is between 1.0 and 1.25. |
| Poor | The index score is greater than 1.25. |

## Human Use Indices

Human use attainment is assessed using the national and regional evaluations for fish tissue contaminants; however, the fish tissue contaminant data used in the assessment are not always from fish species that are widely consumed and that are of market length. If the available fish tissue contaminant values from the NCA surveys exceed the risk-based concentration guidance ranges for consumption of four 8-ounce meals per month for any contaminant (U.S. EPA, 2000c), the site is assessed as impaired for human use. A site is considered threatened for human use if the available fish tissue contaminant information falls within the guidance ranges for consumption of four 8-ounce meals per month. Sites are considered unimpaired for human use if fish tissue concentrations are less than the risk-based guidance concentration range.

### Fish Tissue Contaminants Index

Chemical contaminants may enter a marine organism in several ways: direct uptake from contaminated water, consumption of contaminated sediment, or consumption of previously contaminated organisms. Once these contaminants enter an organism, they tend to remain in the animal tissues and may build up with subsequent feedings. When fish consume contaminated organisms, they may “inherit” the levels of contaminants in the organisms they consume. This same “inheritance” of contaminants occurs when humans consume fish with contaminated tissues. Contaminant residues can be examined in the fillets, whole-body portions, or specific organs of target fish and shellfish species and are compared with risk-based EPA fish contaminant guidance values (U.S. EPA, 2000c).

For the NCA surveys, target fish were collected from all sites where fish were available, and whole-body contaminant burdens were determined. No EPA Guidance criteria exist to assess the ecological risk of whole-body contaminants for fish, but the EPA Advisory Guidance can be used as a basis for estimating advisory determinations, even if the data are based on whole-fish or organ-specific body burdens (U.S. EPA, 2000c)(Table 1-20). The whole-fish contaminant information collected by NCA for U.S. estuaries was compared with risk-based thresholds based on the consumption of four 8-ounce meals per month for selected contaminants (approach used by most state advisory programs) and assessed for noncancer and cancer health endpoints (U.S. EPA, 2000c). Table 1-21 shows the rating criteria for the fish tissue contaminants index for each site. Table 1-22 shows how these data were used to create a regional rating.

**Table 1-20. Risk Guidelines for Recreational Fishers (U.S. EPA, 2000c)**

| Contaminant | Screening Value[a] (ppm) | Concentration Range[b] (ppm) (noncancer) | Concentration Range[c] (ppm) (cancer) |
|---|---|---|---|
| Arsenic (inorganic)[d] | 1.2/0.026[e] | 3.5–7.0 | 0.008–0.016 |
| Cadmium | 4.0 | 0.35–0.70 | |
| Mercury | 0.4 | 0.12–0.23 | |
| Selenium | 20.0 | 5.9–12.0 | |
| Chlordane | 2.0/0.114 | 0.59–1.2 | 0.03–0.07 |
| DDT | 2.0/0.117 | 0.059–0.12 | 0.035–0.069 |
| Dieldrin | 0.2/0.0025 | 0.059–0.12 | 0.00073–0.0015 |
| Endosulfan | 24.0 | 7.0–14.0 | |
| Endrin | 1.2 | 0.35–0.70 | |
| Heptachlor epoxide | 0.052/0.00439 | 0.015–0.031 | 0.0013–0.0026 |
| Hexachloro-benzene | 3.2/0.025 | 0.94–1.9 | 0.0073–0.015 |
| Lindane | 1.2/0.0307 | 0.35–0.70 | 0.009–0.018 |
| Mirex | 0.8 | 0.23–0.47 | |
| Toxaphene | 1.0/0.0363 | 0.29–0.59 | 0.011–0.021 |
| PAH (Benzo(a)pyrene) | 0.00547 | | 0.0016–0.0032 |
| PCB | 0.08/0.02 | 0.023–0.047 | 0.0059–0.012 |

[a] Screening value for recreational fishers.
[b] Range of concentrations associated with noncancer health endpoint risk for consumption of four 8-ounce meals per month.
[c] Range of concentrations associated with cancer health endpoint risk for consumption of four 8-ounce meals per month.
[d] Inorganic arsenic estimated as 2% of total arsenic.
[e] 1.2 and 0.026 are the screening values for inorganic arsenic for noncancer and cancer health endpoints, respectively.

**Table 1-21. Criteria for Determining the Fish Tissue Contaminants Index by Site**

| Rating | Criteria |
|---|---|
| Good | The index score falls below the range of the Guidance criteria for risk-based consumption associated with four 8-ounce meals per month. |
| Fair | The index score falls within the range of the Guidance criteria for risk-based consumption associated with four 8-ounce meals per month. |
| Poor | The index score exceeds the maximum value of the range of the Guidance criteria for risk-based consumption associated with four 8-ounce meals per month. |

**Table 1-22. Criteria for Determining the Fish Tissue Contaminants Index by Region**

| Rating | Criteria |
|---|---|
| Good | Less than 10% of estuarine sites are in poor condition, and less than 50% are in combined fair and poor condition. |
| Fair | 10% to 20% of estuarine sites are in poor condition, or more than 50% are in combined fair and poor condition. |
| Poor | More than 20% of estuarine sites are in poor condition. |

## Summary of Rating Criteria

The rating criteria used in this report are summarized in Tables 1-23 (index indicators) and 1-24 (index components).

**Table 1-23. Indicators Used to Assess Coastal Condition (NCA)**

| Icon | Ecological Condition by Site | Ranking by Region |
|---|---|---|
| Water Quality Index | **Water Quality Index** is an index that is based on five water quality measurements (dissolved oxygen, chlorophyll *a*, nitrogen, phosphorus, and water clarity). | |
| | **Good:** No measures are rated poor, and a maximum of one is rated fair.<br>**Fair:** One measure is rated poor, or two or more measures are fair.<br>**Poor:** Two or more measures are rated poor. | **Good:** Less than 10% of coastal waters are in poor condition, *and* less than 50% of coastal waters are in combined poor and fair condition.<br>**Fair:** Between 10% and 20% of coastal waters are in poor condition, *or* more than 50% of coastal waters are in combined fair and poor condition.<br>**Poor:** More than 20% of coastal waters are in poor condition. |
| Sediment Quality Index | **Sediment Quality Index** is an index that is based on three sediment quality measurements (sediment toxicity, sediment contaminants, and sediment TOC). | |
| | **Good:** No measures are rated poor, and the sediment contaminants indicator is rated good.<br>**Fair:** No measures are rated poor, and the sediment contaminants indicator is rated fair.<br>**Poor:** One or more measures are rated poor. | **Good:** Less than 5% of coastal sediments are in poor condition, *and* less than 50% of coastal sediments are in combined poor and fair condition.<br>**Fair:** Between 5 and 15% of coastal sediments are in poor condition, *or* more than 50% of coastal sediments are in combined poor and fair condition.<br>**Poor:** More than 15% of coastal sediments are in poor condition. |
| Benthic Index | **Benthic Index** (or a surrogate measure) is an indicator of the condition of the benthic community (organisms living in estuarine sediments) and can include measures of benthic community diversity, the presence and abundance of pollution-tolerant species, and the presence and abundance of pollution-sensitive species. | |
| | **Good**, **fair**, and **poor** were determined using regionally dependant benthic index scores. | **Good:** Less than 10% of coastal sediments have a poor benthic index score, *and* less than 50% of coastal sediments have a combined poor and fair benthic index score.<br>**Fair:** Between 10% and 20% of coastal sediments have a poor benthic index score, *or* more than 50% of coastal sediments have a combined poor and fair benthic index score.<br>**Poor:** More than 20% of coastal sediments have a poor benthic index score. |
| Coastal Habitat Index | **Coastal Habitat Index** is evaluated using the data from the NWI (NWI, 2002). The NWI contains data on estuarine-emergent and tidal flat acreage for all coastal states (except Hawaii and Puerto Rico) for 1780 through 2000. | |
| | The average of the mean long-term, decadal wetland loss rate (1780–1990) and the present decadal wetland loss rate (1990–2000) was determined for each region of the United States and multiplied by 100 to create a coastal habitat index score. | **Good:** The coastal habitat index score is less than 1.0.<br>**Fair:** The coastal habitat index is between 1.0 and 1.25.<br>**Poor:** The coastal habitat index is greater than 1.25. |
| Fish Tissue Index | **Fish Tissue Contaminants Index** concentrations are an indicator of the level of chemical contamination in target fish/shellfish species. | |
| | **Good:** Composite fish tissue contaminant concentrations are below the EPA Guidance concentration range.<br>**Fair:** Composite fish tissue contaminant concentrations are in the EPA Guidance concentration range.<br>**Poor:** Composite fish tissue contaminant concentrations are above the EPA Guidance concentration range. | **Good:** Less than 10% of estuarine sites are in poor condition, *and* less than 50% are in combined fair and poor condition.<br>**Fair:** From 10 to 20% of estuarine waters are in poor condition, *or* more than 50% are in combined fair and poor condition.<br>**Poor:** More than 20% of sites have poor condition. |

**Table 1-24. Criteria for Measurements Used as Components of Index Indicators Used To Assess Coastal Condition (NCA)**

**Dissolved Inorganic Nitrogen (DIN)** levels are measured as part of the water quality index.

| Ecological Condition by Site | Ranking by Region |
|---|---|
| **Good:** Surface concentrations are less than 0.1 mg/L (NE, SE, Gulf), 0.5 mg/L (West), or 0.05 mg/L (tropical). | **Good:** Less than 10% of coastal area is in poor condition, *and* less than 50% of coastal waters are in combined poor and fair condition. |
| **Fair:** Surface concentrations are 0.1–0.5 mg/L (NE, SE, Gulf), 0.5–1.0 mg/L (West), or 0.05–0.1 mg/L (tropical). | **Fair:** From 10% to 25% of coastal area is in poor condition, *or* more than 50% of coastal area is in combined fair and poor condition. |
| **Poor:** Surface concentrations are greater than 0.5 mg/L (NE, SE, Gulf), 1.0 mg/L (West), or 0.1 mg/L (tropical). | **Poor:** More than 25% of coastal area is in poor condition. |

**Dissolved Inorganic Phosphorus (DIP)** levels are measured as part of the water quality index.

| Ecological Condition by Site | Ranking by Region |
|---|---|
| **Good:** Surface concentrations are less than 0.01 mg/L (NE, SE, Gulf), 0.01 mg/L (West), or 0.005 mg/L(tropical). | **Good:** Less than 10% of coastal area is in poor condition, *and* less than 50% of coastal area is in combined poor and fair condition. |
| **Fair:** Surface concentrations are 0.01–0.05 mg/L (NE, SE, Gulf), 0.01–0.1 mg/L (West), or 0.005–0.01 mg/L (tropical). | **Fair:** From 10% to 25% of coastal area is in poor condition, *or* more than 50% of coastal area is in combined fair and poor condition. |
| **Poor:** Surface concentrations are greater than 0.05 mg/L (NE, SE, Gulf), 0.1 mg/L (West), or 0.01 mg/L (tropical). | **Poor:** More than 25% of coastal area is in poor condition. |

**Chlorophyll *a*** is one of the measurements used in the water quality index.

| Ecological Condition by Site | Ranking by Region |
|---|---|
| **Good:** Surface concentrations are less than 5 µg/L (less than 0.5 µg/L for tropical ecosystems*, except to less than 1.0 µg/L for Florida Bay). | **Good:** Less than 10% of coastal area is in poor condition, *and* less than 50% of coastal area is in combined poor and fair condition. |
| **Fair:** Surface concentrations are between 5 µg/L and 20 µg/L (between 0.5 µg/L and 1 µg/L for tropical ecosystems, except to between 1.0 to 5.0 µg/L for Florida Bay). | **Fair:** From 10% to 20% of coastal area is in poor condition, *or* more than 50% of coastal area is in combined fair and poor condition. |
| **Poor:** Surface concentrations are greater than 20 µg/L (greater than 1 µg/L for tropical ecosystems, except to greater than 5 µg/L for Florida Bay,). | **Poor:** More than 20% of coastal area is in poor condition. |

*Tropical ecosystems include Hawaii, Puerto Rico, and Florida Bay sites.

**Water Clarity** is part of the water quality index. A water clarity indicator (WCI) is calculated by dividing observed clarity at 1 meter by a regional reference clarity at 1 meter. This regional reference is 10% for most of the United States, 5% for areas with naturally high turbid conditions, and 20% for areas with significant SAV beds or active SAV restoration programs.

| Ecological Condition by Site | Ranking by Region |
|---|---|
| **Good:** WCI ratio is greater than 2. | **Good:** Less than 10% of coastal area is in poor condition, *and* less than 50% of coastal area is in combined poor and fair condition. |
| **Fair:** WCI ratio is between 1 and 2. | **Fair:** From 10% to 25% of coastal area is in poor condition, or more than 50% of coastal area is in combined fair and poor condition. |
| **Poor:** WCI ratio is less than 1. | **Poor:** More than 25% of coastal area is in poor condition. |

*(continued)*

**Table 1-24. Criteria for Measurements Used as Components of Index Indicators Used To Assess Coastal Condition (NCA) (continued)**

| Ecological Condition by Site | Ranking by Region |
|---|---|
| **Dissolved Oxygen** is one of the measurements used in the water quality index. | |
| **Ecological Condition by Site** | **Ranking by Region** |
| **Good:** Concentrations are greater than 5 mg/L. | **Good:** Less than 5% of coastal area is in poor condition, *and* less than 50% of coastal area is in combined poor and fair condition. |
| **Fair:** Concentrations are between 2 mg/L and 5 mg/L. | **Fair:** From 5% to 15% of coastal area is in poor condition, *or* more than 50% of coastal area is in combined fair and poor condition. |
| **Poor:** Concentrations are less than 2 mg/L. | **Poor:** More than 15% of coastal area is in poor condition. |
| **Sediment Toxicity** is evaluated as part of the sediment quality index using a 10-day static toxicity test with the ampiphod *Ampelisca abdita*. | |
| **Ecological Condition by Site** | **Ranking by Region** |
| **Good:** Mortality* is less than or equal to 20%. | **Good:** Less than 5% of coastal sediments have greater than 20% mortality in toxicity tests. |
| **Poor:** Mortality is greater than 20%.<br>*Test mortality is adjusted for control mortality. | **Poor:** More than 5% of coastal sediments have greater than 20% mortality in toxicity tests. |
| **Sediment Contamination** is evaluated as part of the sediment quality index using ERM and ERL guidelines. | |
| **Ecological Condition by Site** | **Ranking by Region** |
| **Good:** No ERMs are exceeded, and fewer than five ERL guidelines are exceeded. | **Good:** Less than 5% of coastal sediments are in poor condition. |
| **Fair:** No ERMs are exceeded, and five or more ERL guidelines are exceeded. | **Fair:** From 5% to 15% of coastal sediments are in poor condition. |
| **Poor:** One or more ERM guidelines are exceeded. | **Poor:** More than 15% of coastal sediments are in poor condition. |
| **Sediment Total Organic Carbon** is measured as part of the sediment quality index. | |
| **Ecological Condition by Site** | **Ranking by Region** |
| **Good:** The TOC concentration is less than 2%. | **Good:** Less than 20% of coastal sediments are in poor condition. |
| **Fair:** The TOC concentration is between 2% and 5%. | **Fair:** From 20% to 30% of coastal sediments are in poor condition. |
| **Poor:** The TOC concentration is greater than 5%. | **Poor:** More than 30% of coastal sediments are in poor condition. |

The picturesque wetlands of Tomales Bay, California, stretch inshore and provide important habitat for birds on the Pacific flyway (Dan Howard).

## How the Indices Are Summarized

Overall condition for each region was calculated by summing the scores for the available indicators and dividing by the number of available indicators (i.e., equally weighted), where good = 5; fair = 4, 3, or 2 (based on position in percent range); and poor = 1. The Southeast Coast, for example, received the following scores:

| Indicator | Score |
|---|---|
| Water Quality Index | 4 |
| Sediment Quality Index | 4 |
| Benthic Index | 3 |
| Coastal Habitat Index | 3 |
| Fish Tissue Contaminants Index | 5 |
| ***Total Score Divided by 5 = Overall Score*** | 19/5 = 3.8 |

To create the national indicator numbers, a weighted average was calculated for each of the five indicators. The indicator scores were weighted by the percentage of total area of estuaries contributed by each geographic area (Figure 1-5). For example, the weighted average for the water quality index was calculated by summing the products of the regional water quality index scores and the area contributed by each region. These weighting factors are used for all indicators except the coastal habitat index, which uses the geographic distribution of total area of coastal wetlands (Figure 1-6). The overall national score was then calculated by summing each national indicator score and dividing by five.

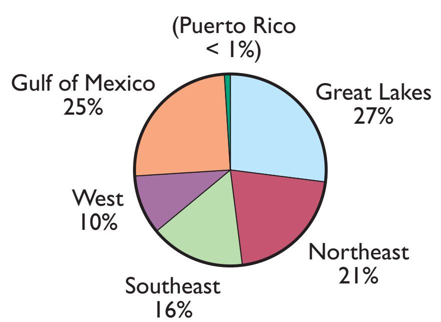



**Figure 1-5.** Percentage of estuarine area contributed by each geographic region assessed in this report.

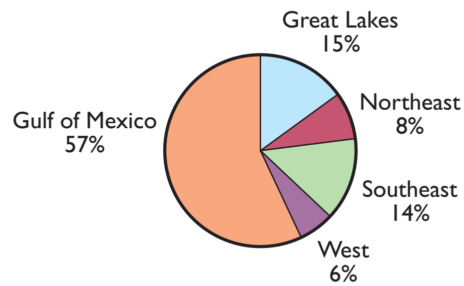



**Figure 1-6.** Percentage of coastal wetland area contributed by each geographic region assessed in this report.

## *Large Marine Ecosystem Fisheries Data*

In addition to coastal monitoring data, a second type of data used to assess coastal condition in this report is LME fisheries data from the NMFS. The waters adjacent to the estuaries and wetlands of the United States, from 3 to 200 nautical miles offshore, constitute the U.S. EEZ. Waters within and adjoining the U.S. EEZ have been designated as LMEs, based on their distinct bathymetry, hydrography, productivity, and trophic relationships (NOAA, 1988). The NMFS regulates fisheries on the Atlantic, Pacific, and Gulf of Mexico coasts. Information on the status of the fish stocks comes from NMFS assessment data for the Northeast Shelf LME, the Southeast Shelf LME, and the Gulf of Mexico LME. Ultimately, the Secretary of Commerce has management responsibility for most marine life in the U.S. waters. Fishery resources are managed largely by fishery management councils through extensive consultation with state and federal agencies, affected industry sectors, public interest groups, and in some cases, international science and management organizations. Information provided for this report on U.S. living marine resources and the three Atlantic LMEs was compiled from NMFS productivity data and

*Our Living Oceans* (NMFS, 2003), a report issued periodically by NMFS covering most living marine resources of interest for commercial, recreational, subsistence, and aesthetic or intrinsic reasons to the United States.

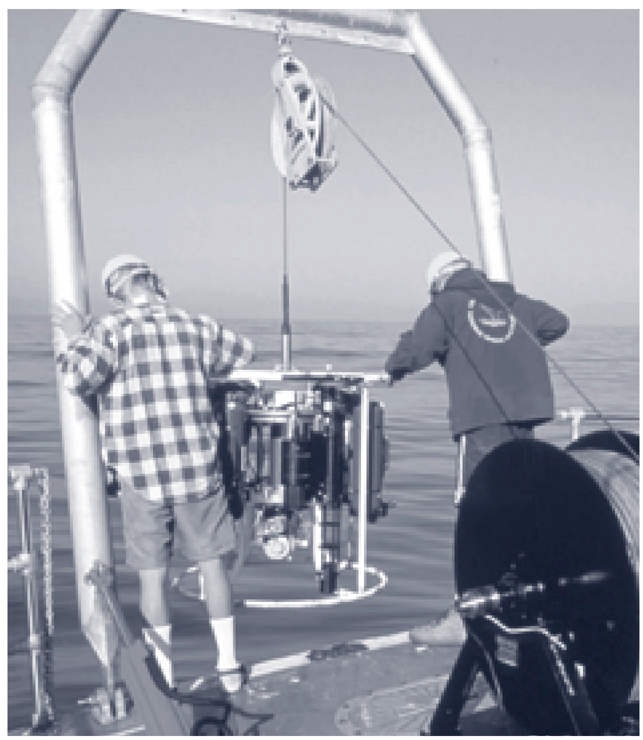
**Marine Fisheries Fuel the U.S. Economy**

More than one-fifth of the world's most productive marine waters lie within the LMEs of the U.S. EEZ. The value of both commercial and recreational fishing is significant to the U.S. economy, to thousands of private firms, and to individuals, families, and communities.

- More than 170,000 people and 123,300 commercial fishing vessels are employed by the commercial fishing industry in the United States, the world's fifth largest seafood-producing country.
- In 2001, U.S. commercial fishermen landed 9.8 billion pounds of fish and shellfish, valued at $3.3 billion.
- The industry contributed an estimated $28.6 billion (in value added) to the U.S. GNP.
- Recreational fishing added another $25 billion to the U.S. GNP.

## Assessment and Advisory Data

Assessment and advisory data provided by states or other regulatory agencies are the third set of data used in this report to assess coastal condition. Several EPA programs, including the Clean Water Act Section 305(b) Assessment Program, the National Listing of Fish and Wildlife Advisories (NLFWA) Program, and the Beaches Environmental Assessment, Closure, and Health (BEACH) Program, maintain databases that are repositories for information about how well coastal waters support their designated or desired uses. These uses are important factors in public perception of the condition of the coast and also address the condition of the coast as it relates to public health. The data for these programs are collected from multiple state agencies, so data collection and reporting methods differ among states. Because of these inconsistencies, data generated by these programs are not included in the estimates of coastal condition.



The Channel Islands National Marine Sanctuary (CINMS) partnered with scientists from the University of California at Santa Barbara to study impacts of the El Niño Storms. The project, named "Plumes and Blooms", investigates the nutrient-rich brown sediment plumes that, in turn, produce green marine algal blooms. (photo: Channel Islands NMS)

## Clean Water Act Section 305(b) Assessments

States report water quality assessment information and water quality impairments under Section 305(b) of the Clean Water Act. States and tribes rate water quality by comparing measured values to their state and tribal water quality standards. Water quality standards include narrative and numeric criteria that support specific designated uses and also specify goals to prevent degradation of good-quality waters. States and tribes use their numeric criteria to determine how well the designated uses assigned to waterbodies are supported. The states then consolidate their more detailed uses into general categories so that EPA can summarize state and tribal data. The most common designated uses are

- Aquatic life support
- Drinking water supply
- Recreation, such as swimming, fishing, and boating
- Fish consumption.

After comparing water quality data to the criteria set by water quality standards, states and tribes classify their waters into the following categories:

| | |
|---|---|
| **Fully Supporting** | These waters meet applicable water quality standards, both criteria and designated use. |
| **Threatened** | These waters currently meet water quality standards, but states are concerned that they may degrade in the near future. |
| **Not Supporting** | These waters do not meet water quality standards. |

The 305(b) assessment data (submitted by the states in 2000) are stored in EPA's National Assessment Database and are summarized in the *National Water Quality Inventory 2000 Report* (U.S. EPA, 2002). These data are useful for evaluating the success of state water quality improvement efforts. Unfortunately, each state monitors water quality parameters differently, so it is difficult to make generalized statements about the condition of the nation's coasts based on these data alone.

## National Listing of Fish and Wildlife Advisories

States, U.S. territories, and tribes have primary responsibility for protecting their residents from the health risks of consuming contaminated, noncommercially caught fish and shellfish. (Sale of commercial fish in interstate commerce is regulated by the U.S. Food and Drug Administration [FDA].) Resource managers protect residents by issuing consumption advisories for the general population, including recreational and subsistence fishers, as well as for sensitive groups (e.g., pregnant women, nursing mothers, children, and individuals with compromised immune systems). These advisories inform the public that high concentrations of chemical contaminants (such as mercury and PCBs) have been found in local fish and shellfish. The advisories include recommendations to limit or avoid consumption of certain fish and shellfish species from specific waterbodies or, in some cases, from specific waterbody types (e.g., all coastal waters within a state).

The 2002 NLFWA is a database— available from EPA and searchable on the Internet at http://www.epa.gov/waterscience/fish— that contains fish advisory information provided to EPA by the states and tribes. The NLFWA database can generate national, regional, and state maps that illustrate any combination of advisory parameters.

## Beach Advisories and Closures

There is growing concern in the United States about public health risks posed by polluted bathing beaches. Scientific evidence documenting the rise of infectious diseases caused by microbial organisms in recreational waters continues to grow; however, not enough information is currently available to define the extent of beach pollution throughout the country. EPA's BEACH Program, established in 1997, is working with state and local governments to compile information on beach pollution that will help define the national extent of the problem.

A few states have comprehensive beach monitoring programs to test the safety of water for swimming. Many other states have only limited beach monitoring programs, and some states have no monitoring programs linked directly to water safety at swimmable beaches. The number of beach closings and swimming advisories that continue to be issued annually, however, indicate that beach pollution is a persistent problem. In 2002, there were 529 beach closures and advisories in coastal and Great Lakes waters.

## Connections with Human Uses

The water quality index, sediment index, benthic index, and coastal habitat index are all measures of ecological condition. The fish tissue contaminants index directly affects human uses of coastal waters and is also a measure of the condition of estuarine fish populations. The final chapter of this report (Chapter 9: Health of Galveston Bay for Human Use) presents a case study that outlines how these indicators of coastal condition connect with human uses. Although this report does not address bacterial contamination as a condition indicator, it does present the areal extent of shellfishing restrictions and swimming advisories based on exceedances of indicator bacteria concentrations in coastal waters. The type of assessment described in Chapter 9 cannot be done on scales larger than a single estuary; however, it is important to address coastal condition at several spatial scales (e.g., national, regional, state, and local). Chapter 9 provides an assessment approach that complements the national/regional approaches by examining the same national/regional monitoring information, as well as additional site-specific information for an individual estuary (Galveston Bay) in order to evaluate conditions with regard to human uses.

## Appendices

Three appendices are provided at the end of this report. Appendices A and B assess the quality of data from EPA's NCA Program, the primary source of information for this report. These appendices evaluate the planning, sampling collection, laboratory processing, and auditing aspects of the program, as well as list the uncertainty levels for the estimates provided in Chapters 2 through 8. The appendices also compare these levels with the desired levels of certainty developed through the data quality objective (DQO) process.

Appendix C compares the results of the NCCR I (covering the period 1990 to 1996) with the results of this report (1997–2000). Because of changes in indicators and the availability of different types of data, the comparison cannot be as straightforward as the reader might desire (i.e., direct comparison of the ranking in NCCR I to the ranking in NCCR II). In Appendix C, the estimates and ranking for NCCR I are recalculated using the approaches and methodologies developed in NCCR II. This recalculation allows for a more direct comparison of the two reports.

Giant sea bass *(Stereolepis gigas)* are mainly bottom dwellers, but will come into mid-waters when searching for food. This species was once abundant throughout Southern California, before it was overfished. The giant sea bass eats spiny lobsters, rock crabs, and squid (Mark Conlin).