

CHAPTER 1. INTRODUCTION

1.1. PUBLIC TRUST DOCTRINE

North Carolina state government applies the Public Trust Doctrine in management of its coastal lands, surface waters, and the resources in those waters. The Public Trust Doctrine states that “public trust lands, waters, and living resources in a State are held by the State in trust for the benefit of all the people, and establishes the right of the public to fully enjoy public trust lands, waters, and living resources for a wide variety of recognized public uses. The doctrine also sets limitations on the States, the public, and private owners, as well as establishing the responsibilities of the States when managing these public trust assets” (Coastal States Organization 1997).

The Constitution of North Carolina implements the Public Trust Doctrine in Article XIV, Section 5, which states: “It shall be the policy of this State to conserve and protect its lands and waters for the benefit of all its citizenry, and to this end it shall be a proper function of the State of North Carolina and its political subdivisions to acquire and preserve park, recreational, and scenic areas, to control excessive noise, and in every other appropriate way to preserve as a part of the common heritage of this State its forests, wetlands, estuaries, beaches, historical sites, open lands, and places of beauty.”

Public trust resources include the waters to the upstream extent of navigation, including navigation by small recreational boats, such as canoes or kayaks [North Carolina Supreme Court (*Gwathmey v. State of North Carolina*, 342 N.C. 287, 464 S. E. 2d. 674, 1995)]; submerged lands beneath the waters up to the normal high tide line (or normal water level in areas not subject to lunar tides); and the fisheries resources within those waters (see definition below). Common public trust uses include navigation and commerce, fishing, bathing (swimming), and hunting. Under certain circumstances, private entities may own submerged lands, but public trust rights in the waters over those lands are not affected by such ownership.

The State can restrict exercise of public trust rights in the overall public interest. Such restrictions can be in the form of laws enacted by the North Carolina General Assembly or rules adopted as part of the North Carolina Administrative Code (NCAC) by regulatory commissions established by the General Assembly. A variety of regulatory commissions and administrative agencies established by the General Assembly have authority for management of North Carolina’s coastal lands, waters, and fishes under state and federal laws. State authority generally applies within the boundaries of North Carolina, which extends from internal waters (creeks, rivers, and lakes) downstream through the coastal sounds, and into the Atlantic Ocean for three nautical (nm) or 3.45 statute miles from the state’s Atlantic Ocean shoreline. Federal jurisdiction applies from that point out to 200 nm (230.16 statute miles) from shore, an area called the Exclusive Economic Zone (EEZ). Several state and federal agencies conduct major regulatory, research, and educational programs that affect North Carolina’s coastal fisheries resources and their habitats (Appendix A).

1.2. THE FISHERIES REFORM ACT AND COASTAL HABITAT PROTECTION PLANS

On August 14, 1997, Governor James B. Hunt, Jr., signed the Fisheries Reform Act (FRA) into law, bringing to a close a three-year process of intense meetings, discussions and debates over the future of fisheries management in North Carolina. This far-reaching reform package was put together by a coalition of legislators, commercial and recreational fishermen, scientists, fisheries managers and conservationists, in order to ensure healthy fish stocks, the recovery of depleted stocks and the wise use of North Carolina’s fisheries resources. The FRA (S.L.1997-400, H.B. 1097) includes a provision [General Statute (G.S.) 143B-279.8] for preparation of Coastal Habitat Protection Plans (CHPPs) by the North Carolina Department of Environment and Natural Resources. This section of the FRA resembles the federal Magnuson-Stevens Fishery Conservation and Management Act reauthorization of 1996 [also known as the Sustainable Fisheries Act (SFA)]. The SFA requires the regional fishery management councils and

National Marine Fisheries Service (NMFS) to amend federal fishery management plans to include provisions for the protection of “Essential Fish Habitat” (EFH) from federally funded activities. *The legislative goal of the CHPPs is long-term enhancement of coastal fisheries associated with coastal habitats.* The CHPP is to identify threats and recommend management actions to protect and restore habitats critical to North Carolina’s coastal fishery resources. The plans must be adopted by the Coastal Resources (CRC), Environmental Management (EMC), and Marine Fisheries (MFC) commissions. Once adopted, the plans will help to ensure consistent actions among commissions, as well as their supporting Department of Environment and Natural Resources (DENR) agencies. The passage of the FRA and the initiation of the CHPP program demonstrated the public desire and political will to better manage North Carolina’s coastal fishery habitats.

Since the mid-1980s, the State of North Carolina, through the Governor and General Assembly, has convened several high level panels to examine coastal environmental and fishery management issues. Each has made numerous policy recommendations concerning improved management of fish habitat and water quality.

- The Final Report and Recommendations of the Governor's Blue Ribbon Panel on Environmental Indicators was published in December 1990 (C. Manooch, DMF, pers. com., 2004). This report provided guidelines for developing a set of indicators to evaluate the status and trends of environmental quality within North Carolina. Responsibility for the task was assigned to the state's Department of Environment, Health, and Natural Resources (now DENR). The report evaluates indicators in the following environmental areas: air quality, air radioactivity, and indoor radon; water quality, groundwater, and public water supplies; solid waste, hazardous waste, and low-level radioactive waste; marine fishery resources, shellfish growing areas, and wetlands.
- The Albemarle-Pamlico Estuarine Study (1987 – 1994) recommended numerous water quality, fishery management, and land use reforms in its Comprehensive Conservation and Management Plan, including retain, restore, and enhance water quality; conserve and protect vital fish and wildlife habitats; and restore or maintain fisheries (Waite et al. 1994).
- The North Carolina Coastal Futures Committee was established in recognition of the 20th anniversary of passage of the Coastal Area Management Act (CAMA), which established North Carolina’s coastal zone management system under the CRC. The Committee’s report cited the tremendous growth in population and use of coastal resources, and recommended a number of important actions, including restoration and protection of important fisheries habitats, the need to address nonpoint source pollution, restoration of impaired coastal waters, and protection of freshwater wetlands similar to existing protection of coastal wetlands (North Carolina Coastal Futures Committee 1994).
- The Blue Ribbon Advisory Council on Oysters recommended a major increase in planting of oyster cultch to help restore oyster resources as well as changes in management of oyster culture practices (Frankenberg 1995).
- Most of the recommendations of the Fisheries Moratorium Steering Committee were included in the FRA in 1997, including development of this CHPP. The report also recommended reform of North Carolina’s coastal fisheries management system through the development of state Fishery Management Plans (FMPs) (MSC 1996).
- The CRC convened the Estuarine Shoreline Protection Stakeholders in 1999 to examine impacts of estuarine shoreline uses and water quality. The group’s report included comprehensive recommendations to improve agency coordination, enhance basinwide water quality management, restoration of impaired waters, and reduction of point and nonpoint source pollution (North Carolina Estuarine Shoreline Protection Stakeholders 1999).

Thus, there is a rich history of citizen participation in examination of coastal habitat and water quality issues in recent years. Based on public comments received at 20 public CHPP meetings along the coast and inland during the summers of 2003 and 2004 (Appendix B1 and B2), results indicated considerable

frustration that many, repeated recommendations have not been implemented. Because the CHPP uniquely brings together three major regulatory commissions, the public has an expectation that positive actions will result from this effort.

While the MFC manages commercial and recreational fishing practices in coastal waters through rules implemented by the Division of Marine Fisheries (DMF), several other agencies directly and indirectly affect coastal fisheries and fish habitats. The EMC has wide-ranging authority over activities affecting water quality statewide. Rules adopted by the EMC govern point and nonpoint discharges, wastewater management, alteration of non-coastal wetlands, and stormwater management. The EMC is unique because its rules are implemented by several different DENR agencies, including the Division of Water Quality (DWQ), Division of Air Quality (DAQ), Division of Water Resources (DWR), and the Division of Land Resources (DLR). The DLR is also unique because it administers rules adopted by multiple regulatory commissions, including the EMC, Sedimentation Control Commission, and the Mining Commission. The CRC enacts rules to manage development and land disturbing activities along estuarine and ocean shorelines, shoreline stabilization, alteration of submerged bottoms and coastal wetlands, and marina construction. The Division of Coastal Management (DCM) implements rules adopted by the CRC. The N.C. Wildlife Resources Commission (WRC) has a direct role in the management of fisheries through the designation of primary nursery areas in Inland Waters, including many anadromous fish spawning areas, and regulation of fishing in those waters. There are a myriad of other state, federal, and interstate programs affecting coastal fisheries habitat in North Carolina (Appendix A).

This plan was written by DMF staff with assistance from the CHPP Development Team - scientists and planners from DMF, DCM, DWQ, Division of Environmental Health (DEH), and WRC (Appendix C). An Intercommission Review Committee (IRC), consisting of two members from each of the three commissions (Appendix C), provided policy oversight, reviewed this plan, and developed the management recommendations (Chapter 9.0).

1.3. PURPOSE AND ORGANIZATION OF DOCUMENT

The primary focus of this plan is describing habitats for coastal fisheries resources in eastern North Carolina, threats to those habitats, and management actions to address those threats. The CHPP identifies four goals for protection of coastal fisheries habitat:

- 1) Improve effectiveness of existing rules and programs protecting coastal fish habitats
- 2) Identify, designate, and protect all Strategic Habitat Areas
- 3) Enhance habitat and protect it from physical impacts
- 4) Enhance and protect water quality

The CHPP is built around six basic habitats utilized by coastal fishery species: water column, shell bottom, submerged aquatic vegetation (SAV), wetlands, soft bottoms, and hard bottoms. Within each of the following habitat chapters (Chapters 2 - 7), there is detailed information on the habitat's description, distribution, ecological role and functions for finfish and shellfish species (primarily fishery species, but also forage and protected species), status and trends, threats, and management needs. The term "management" is defined broadly to include regulatory, enforcement, research, monitoring, and restoration activities affecting coastal fish habitat. Management needs are based on documented inadequacies in the current management framework and are highlighted in the habitat chapters with *italics*. A summary highlighting the most pressing management needs is provided at the end of each habitat chapter. A chapter addressing strategic habitats (what they are and criteria for their designation) follows the habitat chapters (Chapter 8). The final chapter lists the most pressing management recommendations as developed by the IRC. Each of the Commissions will use the threats discussion, management needs, and recommendations to develop coordinated coastal habitat management strategies as provided in the Act. The DENR will also develop a coordinated strategy to implement the CHPP

recommendations.

1.4. AREA DESCRIPTION

The CHPP area includes all waters flowing into North Carolina's coastal waters and the watersheds they drain. Table 1.1 shows that the CHPP area is approximately 12% water (3,181,881 acres) and 88% land (24,229,770 acres). Maps 1.1a and 1.1b show this area, including water bodies, the main towns, roads and other local and regional features noted throughout the CHPP. Local and regional differences in habitat and associated fish species are determined by climate, geology, ground water and surface water hydrology, land use, and associated human population.

Table 1.1. The land and water areas for each North Carolina Coastal Habitat Protection Plan Management Unit. (Source: 1:100,000 scale USGS topographic quadrangle maps)

| Management Unit | Land area | | Water area | | Total area (acres) |
|--------------------|-------------------|------------|------------------|------------|--------------------|
| | Acres | % of total | Acres | % of total | |
| Albemarle | 1,669,684 | 72 | 658,400 | 28 | 2,328,084 |
| Cape Fear | 5,795,998 | 99 | 64,973 | 1 | 5,860,970 |
| Chowan | 3,183,877 | 98 | 51,691 | 2 | 3,235,568 |
| Coastal Ocean | 15,374 | 2 | 724,842 | 98 | 740,216 |
| Core/Bogue | 188,976 | 53 | 167,998 | 47 | 356,974 |
| Neuse | 3,466,244 | 96 | 135,571 | 4 | 3,601,815 |
| New/White Oak | 481,345 | 93 | 38,449 | 7 | 519,794 |
| Pamlico Sound | 394,337 | 27 | 1,061,613 | 73 | 1,455,950 |
| Roanoke | 6,118,980 | 98 | 140,827 | 2 | 6,259,807 |
| Southern Estuaries | 253,227 | 95 | 14,425 | 5 | 267,652 |
| Tar/Pamlico | 2,661,729 | 96 | 123,092 | 4 | 2,784,821 |
| Total | 24,229,770 | 88 | 3,181,881 | 12 | 27,411,651 |

To address local and watershed issues, the CHPP program will also produce Management Unit (MU) plans, after the CHPP development, based primarily on the same watershed boundaries used by DWQ for Basinwide Water Quality Plans. Since the CHPP is focused on fish and fisheries, some minor boundary changes were made to reflect similarities in fish habitats, or in estuarine and coastal water body dynamics. A watershed approach is necessary because many fisheries rely on the interconnectivity of waters within a watershed, and most pollutants are conveyed into estuarine waters via upstream conduits. The eleven MU areas and their boundaries approved by the IRC are shown on Map 1.2. The units are Chowan, Albemarle, Roanoke River, Pamlico Sound, Tar-Pamlico, Neuse, Core/Bogue, New-White Oak, Cape Fear, Southern Estuaries, and Coastal Ocean. Most of the Chowan and Roanoke River MUs, and part of the Albemarle MU, are located in Virginia. The Coastal Ocean MU includes North Carolina's territorial waters and ocean front beaches. Among MUs, the largest area of water (1,061,613 acres) is in Pamlico Sound, and the smallest area (14,425 acres) is in the Southern Estuaries (Table 1.1).

Climate and weather

Weather conditions, especially temperature, precipitation, wind, and storms, exert major influences on the coastal area and fishery resources of eastern North Carolina. The climate along the North Carolina coast is strongly influenced by the Atlantic Ocean. North Carolina's coastal ocean includes the convergence between two major oceanic currents: the warm, north-flowing Gulf Stream and the cool, south-flowing Virginia coastal current (also called the Labrador Current). The Gulf Stream current moves within 10 – 12 mi (16.1 – 19.3 km) of the coast at Cape Hatteras before turning northeast toward Europe, bringing southern species (such as brown, white, and pink shrimp; king and Spanish mackerel; snappers and groupers; and calico scallops) to North Carolina's waters. The Virginian (Labrador) Current ends at the

Gulf Stream, supplying northern oceanic species (such as Atlantic mackerel, Atlantic herring, and Atlantic cod) to North Carolina.

The works summarized in Orlando et al. (1994) closely examined coastal wind patterns. These winds vary at basically three time scales: seasonal (>1 month); synoptic (3-20 days) due to the passage of weather systems; and diurnal (<1 day) due to changes in local sea breezes. Seasonal winds blowing in the South Atlantic Bight (SAB) (area from Cape Hatteras, N.C. to Cape Canaveral, F.L.) originate either from the Bermuda-Azores High in the North Atlantic or from a smaller high pressure area centered over the Ohio Valley (Ohio Valley High). During winter (November – February), winds flowing from the northwest gradually shift to the north. Winds are stronger in North Carolina than in states to the south during this season. During spring and summer, the dominant influence of the Ohio Valley High is replaced by the Bermuda-Azores High, resulting in winds from the west and southwest. West and southwest winds cause offshore movement of surface water and inshore movement of bottom water along much of the North Carolina coast, resulting in upwelling in some near-shore areas. Autumn winds (September – October) flow more from the northeast.

Storms can have a significant impact on the geology of the coastal area. Tropical storms can bring storm surges over 16 ft (4.9 m) above sea level along the south Atlantic coast (VIMS 1974 in Orlando et al. 1994), causing coastal flooding. Between 1950 and 1996, 14 hurricanes struck the North Carolina coast. More recently, hurricanes Bertha and Fran hit North Carolina in 1996. In 1997 and 1998, two more hurricanes affected the coastal area: Danny in July 1997 and Bonnie in August 1998. Three sequential storms affected the North Carolina coast during late August - October 1999 (Hurricanes Dennis and Floyd, and Tropical Storm Irene), inundating the region with up to 3.3 ft (1m) of rainfall, resulting in several weeks of flooding and major environmental and economic damage (Bales et al. 2000; Paerl et al. 2001). Similarly, “nor’easter” storms during fall through spring also cause coastal flooding. For example, the Good Friday storm of 1962 was one of the most severe storms recorded to strike the United States' Atlantic coast, causing severe damage from North Carolina to New England.

Geology and hydrology

A chain of low-lying barrier islands extending from Virginia to Cape Fear dominates the geology and surface water hydrology of North Carolina's ocean coastline. Artificial barrier islands extending from the Cape Fear River to South Carolina were created by dredging the Atlantic Intracoastal Waterway (ICW) in the 1930s (Map 1.1b). The northern part of the natural barrier islands, the Outer Banks, separates the Albemarle-Pamlico sounds complex from the coastal ocean. Proceeding inland, eastern North Carolina's land area is divided between the Coastal Plain and Piedmont physiographic regions, with the majority of land in the Coastal Plain. These two regions are separated by the Fall Line (Map 1.3), where streams are characterized by falls and rapids. The Coastal Plain region extends from the seashore up to the Fall Line and varies in width from 120 to 160 mi (193.1 – 257.5 km). Streams in the western Coastal Plain have sandy bottoms. Going east, those sandy bottoms change to mud and clay in the eastern Coastal Plain, where there are extensive swamps and occasional large, shallow lakes (Menhinick 1991). The streams converge near the coast to form estuaries where fresh water mixes with salt water from the ocean. The Chowan, Roanoke, Tar-Pamlico, and Neuse rivers flow into the Albemarle-Pamlico estuarine system, the second largest estuary on the U.S. Atlantic coast. The Cape Fear River flows directly into the Atlantic Ocean.

The groundwater hydrology of coastal North Carolina is dominated by six major aquifers: the surficial, Yorktown, Black Creek, Castle Hayne, Cretaceous, and Peedee (Steel 1991; Giese et al. 1997). The various aquifers intersect the surface in zones running northeast to southwest. The Cretaceous aquifer is the most extensive and farthest west of Coastal Plain aquifers. The surficial and Yorktown are farthest east, and the Castle Hayne lies between the Yorktown and Cretaceous. The thickness of the aquifers varies from a several feet along the Fall Line, to more than 3000 m (9843 ft) at Cape Hatteras (Steel 1991).

Land use and human population

Estuarine and coastal areas contain some of the nation's most densely populated and rapidly growing areas (Beach 2002). Population density patterns reflect historical development and population pressures, location relative to transportation networks, and the natural resources of the coastal areas (NOS 1990). As population density increases, so does the potential for degradation of the natural environment by human activities (Cairns and Pratt 1992). In the year 2000, New Hanover County had the highest population density (803 persons/mi², Table 1.2) among the 20 coastal counties included in the Coastal Area Management Act (CAMA). Onslow, Pasquotank, Craven, Carteret, and Brunswick counties also had relatively high population densities (over 100 persons/mi²). However, the highest-density areas in North Carolina were in the Piedmont region (Map 1.4), suggesting that at least some of the problem from highly mobile pollutants may be traced upstream. The lowest population densities in eastern North Carolina (about 10 persons/mi²) were in Tyrrell and Hyde counties.

The human population of North Carolina's coastal area is growing rapidly. During the 1970s, counties within the Albemarle-Pamlico region grew at a rate below the statewide average, but in the 1980s, those counties exceeded the statewide average growth rate by 3.6% (Steel 1991). Growth rates were highest in oceanfront counties, except Hyde, in which all the oceanfront property is federally owned (Ocracoke Island lies within Cape Hatteras National Seashore). Combined population growth in the eight counties bordering the Atlantic Ocean (Currituck, Dare, Hyde, Carteret, Onslow, Pender, New Hanover, and Brunswick) has exceeded 20% per decade since 1970 (<http://data.osbm.state.nc.us/pls/linc>), 24 September 2003). During that period, population changes in those counties ranged from an increase of 91% (Dare County from 1970 to 1980) to a loss of 8% (Hyde County from 1980 to 1990). North Carolina's 44 Coastal Plain counties had a 16% population increase from 1990 to 2000 (1,919,186 to 2,229,888), compared to a 19% increase in non-Coastal Plain counties for the same time period. However, there was great variation among counties in the Coastal Plain (Map 1.5). As shown in Table 1.2, New Hanover, Pender, Currituck, Dare, and Brunswick counties had growth rates ranging from about 32 to 44%, while Onslow, Hertford, Washington, and Bertie counties had very low or negative growth rates (-3 to 1.3%).

The coastal counties of North Carolina experience tremendous seasonal population fluctuations due to the influx of tourists. The seasonal population of coastal cities and towns increased, on average, 54% from 1990 to 2000 (Table 1.3). These estimates do not include day visitors who come to the area, but do not stay overnight. The counties that border the ocean and sounds have the greatest population fluctuations due to tourism. In many of these counties, public facilities, including wastewater treatment systems, roads, and water supply systems, are being taxed to the limit (Steel 1991).

Table 1.2. Human population, density, and growth in Coastal Plain counties of North Carolina sorted by Coastal Area Management Act (CAMA) counties and other Coastal Plain counties, and growth during 1990 – 2000. (Source: North Carolina Office of State Budget and Management, unpub. data.)

| COUNTY | 1990 | | 2000 | | 1990-2000 | |
|-------------------------------------|------------|-----------------------------|------------|-----------------------------|-----------|----------|
| | Population | Persons/ mi ² | Population | Persons/ mi ² | Growth | % growth |
| CAMA counties | | | | | | |
| Brunswick | 50,985 | 82.33 | 73,143 | 118.10 | 22,158 | 43.5 |
| Pender | 28,855 | 33.16 | 41,082 | 47.22 | 12,227 | 42.4 |
| New Hanover | 120,284 | 602.85 | 160,307 | 803.44 | 40,023 | 33.3 |
| Currituck | 13,736 | 52.55 | 18,190 | 69.59 | 4,454 | 32.4 |
| Dare | 22,746 | 59.33 | 29,967 | 78.17 | 7,221 | 31.7 |
| Camden | 5,904 | 24.57 | 6,885 | 28.65 | 981 | 16.6 |
| Pamlico | 11,368 | 33.40 | 12,934 | 38.00 | 1,566 | 13.8 |
| Carteret | 52,407 | 101.13 | 59,383 | 114.59 | 6,976 | 13.3 |
| Gates | 9,305 | 27.29 | 10,516 | 30.84 | 1,211 | 13.0 |
| Craven | 81,812 | 115.12 | 91,436 | 128.66 | 9,624 | 11.8 |
| Pasquotank | 31,298 | 137.96 | 34,897 | 153.83 | 3,599 | 11.5 |
| Perquimans | 10,447 | 42.28 | 11,368 | 46.00 | 921 | 8.8 |
| Hyde | 5,411 | 8.75 | 5,826 | 9.43 | 415 | 7.7 |
| Chowan | 13,506 | 78.19 | 14,526 | 84.09 | 1,020 | 7.6 |
| Tyrrell | 3,856 | 9.84 | 4,149 | 10.58 | 293 | 7.6 |
| Beaufort | 42,283 | 50.83 | 44,958 | 54.05 | 2,675 | 6.3 |
| Hertford | 22,317 | 63.01 | 22,601 | 63.81 | 284 | 1.3 |
| Onslow | 149,838 | 195.37 | 150,355 | 196.04 | 517 | 0.3 |
| Washington | 13,997 | 40.44 | 13,723 | 39.65 | -274 | -2.0 |
| Bertie | 20,388 | 29.16 | 19,773 | 28.28 | -615 | -3.0 |
| Other Coastal Plain Counties | | | | | | |
| Johnston | 81,306 | 102.18 | 121,965 | 153.28 | 40,659 | 50.0 |
| Hoke | 22,856 | 102.56 | 33,646 | 150.98 | 10,790 | 47.2 |
| Harnett | 67,833 | 113.20 | 91,025 | 151.90 | 23,192 | 34.2 |
| Sampson | 47,297 | 49.96 | 60,161 | 63.55 | 12,864 | 27.2 |
| Pitt | 108,480 | 165.67 | 133,798 | 204.34 | 25,318 | 23.3 |
| Greene | 15,384 | 57.76 | 18,974 | 71.24 | 3,590 | 23.3 |
| Duplin | 39,995 | 48.82 | 49,063 | 59.89 | 9,068 | 22.7 |
| Nash | 76,677 | 141.28 | 87,420 | 161.08 | 10,743 | 14.0 |
| Bladen | 28,663 | 47.09 | 32,278 | 53.03 | 3,615 | 12.6 |
| Wilson | 66,061 | 176.54 | 73,814 | 197.25 | 7,753 | 11.7 |
| Jones | 9,361 | 19.75 | 10,381 | 21.90 | 1,020 | 10.9 |
| Columbus | 49,587 | 487.97 | 54,749 | 538.77 | 5,162 | 10.4 |
| Cumberland | 274,713 | 427.25 | 302,963 | 471.18 | 28,250 | 10.3 |
| Wayne | 104,666 | 187.92 | 113,329 | 203.47 | 8,663 | 8.3 |
| Northampton | 21,004 | 39.07 | 22,086 | 41.08 | 1,082 | 5.2 |
| Lenoir | 57,274 | 142.48 | 59,648 | 148.39 | 2,374 | 4.1 |
| Halifax | 55,516 | 76.39 | 57,370 | 78.94 | 1,854 | 3.3 |
| Martin | 25,078 | 54.23 | 25,593 | 55.34 | 515 | 2.1 |
| Edgecombe | 56,692 | 111.88 | 55,606 | 109.74 | -1,086 | -1.9 |

As population increases, so does the need for infrastructure (roads, schools, water and sewer facilities, electric transmission lines, etc.) to support those people, sometimes resulting in loss of important habitats and supporting areas, such as wetlands and riparian forests (see Water Column and Wetland chapters for more information on changes in land cover). Land cover data reported by the federal National Resource Inventory (D. Good, U.S. Department of Agriculture, Natural Resource Conservation Service, pers. com., 2001) show that urban/built-up land increased in coastal river basins by 83% from 1982 to 1997 (Appendix D and E).

Despite the growth in urban/built-up areas, land cover in coastal North Carolina is still primarily forest (53%) and cultivated crops (21.5%) (Appendix D). Beach (2002) showed that increases in developed areas have far outpaced population growth in coastal areas nationwide, resulting in a greater habitat impact than population data alone suggest. Beach (2002) concluded that conversion of land in the coastal zone from open space (forest and agricultural uses) to urban/suburban uses was the primary threat to coastal water quality. As of 1997, urban/built-up land covered 2.9-19.6% of the land area in North Carolina’s coastal river basins (Appendix D).

Table 1.3. Changes in permanent population, and seasonal population estimates for North Carolina’s barrier islands, 1970 - 2000. (Sorted in order of descending percent increase in permanent population. Sources: North Carolina Office of State Planning; North Carolina State Library; and town officials, pers. com., 2001)

| Municipality | Permanent population | | | | Seasonal population | |
|--------------------------------|----------------------|---------------|---------------|-----------------------------|---------------------------|---------------------------|
| | 1970 | April 1990 | April 2000 | Percent increase: 1990-2000 | Current seasonal estimate | Seasonal: permanent ratio |
| Sunset Beach | 108 | 311 | 1,824 | 486 | 15,000 | 8 |
| Kure Beach | 394 | 619 | 1,507 | 143 | 20,000 | 13 |
| Bald Head Island | * | 78 | 173 | 122 | 4,000 | 23 |
| Caswell Beach | 28 | 175 | 370 | 111 | * | * |
| Kitty Hawk | 0 | 1,937 | 2,991 | 54 | 19,759 | 7 |
| Southern Shores | 75 | 1,447 | 2,201 | 52 | 7,018 | 3 |
| Nags Head | 414 | 1,838 | 2,700 | 47 | 35,079 | 13 |
| Oak Island | 493 | 4,550 | 6,571 | 44 | 30,000 | 5 |
| Surf City | 166 | 970 | 1,393 | 44 | 20,000 | 14 |
| Emerald Isle | 122 | 2,434 | 3,488 | 43 | 35,000 | 10 |
| Kill Devil Hills | 357 | 4,238 | 5,897 | 39 | 40,473 | 7 |
| Topsail Beach | 108 | 346 | 471 | 36 | 1,500 | 3 |
| Unincorporated Bodie Island | * | 5,208 | 6,753 | 30 | 8,509 | 1 |
| Carolina Beach | 1,663 | 3,630 | 4,701 | 30 | 40,000 | 9 |
| Holden Beach | 136 | 626 | 787 | 26 | * | * |
| Pine Knoll Shores | 62 | 1,360 | 1,524 | 12 | 10,000 | 7 |
| Ocracoke Township | * | 690 | 769 | 11 | * | * |
| Unincorporated Hatteras Island | * | 3,833 | 4,001 | 4 | 24,901 | 6 |
| Atlantic Beach | 300 | 1,938 | 1,781 | -8 | 35,000 | 20 |
| North Topsail Beach | * | 947 | 843 | -11 | 4,800 | 6 |
| Wrightsville Beach | 1,701 | 2,937 | 2,593 | -12 | 40,000 | 15 |
| Ocean Isle Beach | 78 | 523 | 426 | -19 | 25,000 | 59 |
| Indian Beach | 48 | 153 | 95 | -38 | 5,000 | 53 |
| Total | 6,253 | 40,788 | 53,859 | 32 | 421,039 | 8 |

* Lack of data

Fisheries and protected species

Throughout this plan, the term “fish” is used to include, “All marine mammals; all shellfish; all crustaceans and all other fishes” [G.S. 113-129 (7)]. Coastal fish species are grouped into three overlapping classes based on management considerations: 1) fishery species, 2) forage species, and 3) protected species.

- Fishery species are those finfish, crustaceans, and mollusks that may be harvested in North Carolina's Coastal and Inland Fishing Waters (DMF 2003a) by commercial and recreational fishermen. Habitats supporting fishery species are the primary focus of the CHPP.
- Forage species make up a significant portion of the diet of fishery species (e.g., killifish, grass shrimp, menhaden, mullet).
- Protected species meet two criteria: 1) listed according to state law [G. S. 113-331] or through the federal Endangered Species Act by the relevant state or federal agency or protected under the federal Marine Mammal Protection Act, and 2) require aquatic or wetland habitat within North Carolina's coastal river basins or nearshore ocean waters at some point in their life cycle. Protected species are important in the CHPP process because they can be indicators of ecological stress (Ricklefs 1993). In addition, their habitat needs provide support for designating strategic habitat in locations where the distribution of fishery and protected species overlap, as well as in upstream areas important for maintaining estuarine water quality.

Fisheries

Coastal fisheries are defined as, "Any and every aspect of cultivating, taking, possessing, transporting, processing, selling, utilizing, and disposing of fish taken in coastal fishing waters, whatever the manner or purpose of taking..." [G.S.113-129 (2)]. North Carolina is one of the nation's leading coastal fishing states. Reported landings by both commercial and recreational fishermen in North Carolina generally rank among the top Atlantic coast states every year (Tables 1.4 and 1.5). More than 90% of North Carolina's commercial fisheries landings and over 60% of the recreational harvest (by weight) are comprised of estuarine-dependent species (from DMF annual commercial and recreational fisheries landings data). These species depend on North Carolina's coastal sounds and rivers to complete their life cycle.

North Carolina's fisheries productivity is attributable to several factors:

- Vast estuarine system, the largest (about 2.3 million acres) of any single Atlantic coast state, provides the basis for a wide variety of fish stocks and the fisheries that depend on them.
- Location at the convergence of the South Atlantic and mid-Atlantic biogeographic provinces, with important features from both, including habitats, fish stocks, and fishing methods.
- Wide variety of habitats that support various life history stages of fisheries stocks, such as:
 - Extensive seagrass meadows;
 - Ocean hard bottoms (natural rock outcrops, coral encrusted reefs, shipwrecks, and one of the largest state-managed artificial reef systems in the United States);
 - Shell bottoms, especially oyster reefs;
 - Vast areas of biologically productive shallow waters overlying mud and sand bottoms;
 - Extensive coastal marshes; and
 - Riverine systems with large areas of productive bottomland hardwood forest, as well as adjacent swamp forests.
- Flexible and responsive fisheries management processes that provide for harvest under a fisheries management plan (FMP) system with extensive data collection and public participation.
- Strong heritage of commercial and sport fishing, including recreational use of commercial gears, throughout eastern North Carolina.

Table 1.4. Annual Atlantic coast commercial fisheries landings by state, 1997 - 2001 (thousands of pounds, sorted in descending order of average landings). (Source: National Marine Fisheries Service data)

| State | 1997 | 1998 | 1999 | 2000 | 2001 | Total | Average | % | Rank |
|----------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-----------|-----------|
| Virginia | 584,895 | 592,767 | 460,289 | 443,197 | 561,708 | 2,642,856 | 528,571 | 32 | 1 |
| Maine | 246,344 | 184,103 | 229,633 | 226,849 | 239,868 | 1,126,797 | 225,359 | 14 | 2 |
| Massachusetts | 229,915 | 257,438 | 198,877 | 187,861 | 242,066 | 1,116,157 | 223,231 | 13 | 3 |
| New Jersey | 175,172 | 197,550 | 168,974 | 171,804 | 168,403 | 881,903 | 176,381 | 11 | 4 |
| North Carolina | 228,433 | 180,238 | 153,310 | 155,214 | 139,277 | 856,472 | 171,294 | 10 | 5 |
| Rhode Island | 143,101 | 133,702 | 124,168 | 119,295 | 115,957 | 636,223 | 127,245 | 8 | 6 |
| Maryland | 76,599 | 61,479 | 66,419 | 48,913 | 55,536 | 308,946 | 61,789 | 4 | 7 |
| New York | 60,956 | 57,542 | 49,661 | 41,181 | 42,422 | 251,762 | 50,352 | 3 | 8 |
| Florida (east coast) | 32,719 | 29,959 | 30,417 | 40,607 | 37,130 | 170,832 | 34,166 | 2 | 9 |
| Connecticut | 19,072 | 17,625 | 18,430 | 19,563 | 18,687 | 93,377 | 18,675 | 1 | 10 |
| South Carolina | 17,350 | 17,653 | 18,574 | 15,835 | 14,111 | 83,523 | 16,705 | 1 | 11 |
| New Hampshire | 10,896 | 10,172 | 11,258 | 17,160 | 18,584 | 68,070 | 13,614 | 1 | 12 |
| Georgia | 14,511 | 13,196 | 12,250 | 9,694 | 9,036 | 58,687 | 11,737 | 1 | 13 |
| Delaware | 9,084 | 7,866 | 8,372 | 6,676 | 7,123 | 39,121 | 7,824 | 0 | 14 |
| Total | 1,849,047 | 1,761,290 | 1,550,632 | 1,505,849 | 1,671,909 | 8,334,726 | 1,666,945 | na | na |

Table 1.5. Annual Atlantic coast marine recreational fisheries harvest by state, 1997 - 2001 (thousands of pounds, sorted in descending order of descending average landings). (Source: National Marine Fisheries Service, Fisheries Statistics and Economics Division, pers. com., 2003)

| State | 1997 | 1998 | 1999 | 2000 | 2001 | Total | Average | % | Rank |
|----------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------|-----------|
| Florida (east coast) | 24,179 | 21,017 | 25,859 | 29,408 | 29,517 | 129,980 | 25,996 | 20 | 1 |
| North Carolina | 19,703 | 15,370 | 18,034 | 22,699 | 24,146 | 99,952 | 19,990 | 16 | 2 |
| New Jersey | 19,921 | 13,632 | 14,181 | 24,645 | 22,323 | 94,702 | 18,940 | 15 | 3 |
| Virginia | 16,835 | 13,993 | 11,507 | 13,112 | 17,732 | 73,179 | 14,636 | 11 | 4 |
| New York | 12,476 | 8,458 | 9,733 | 17,050 | 11,127 | 58,844 | 11,769 | 9 | 5 |
| Massachusetts | 9,865 | 9,252 | 7,626 | 15,538 | 15,984 | 58,265 | 11,653 | 9 | 6 |
| Maryland | 8,238 | 8,311 | 5,396 | 8,872 | 8,366 | 39,183 | 7,837 | 6 | 7 |
| Rhode Island | 3,225 | 3,567 | 3,817 | 7,020 | 4,457 | 22,086 | 4,417 | 3 | 8 |
| South Carolina | 4,492 | 3,356 | 2,628 | 2,834 | 3,156 | 16,466 | 3,293 | 3 | 9 |
| Connecticut | 3,228 | 3,424 | 2,575 | 3,029 | 3,432 | 15,688 | 3,138 | 2 | 10 |
| Delaware | 2,751 | 2,463 | 2,021 | 3,486 | 3,246 | 13,967 | 2,793 | 2 | 11 |
| Georgia | 1,339 | 1,049 | 1,772 | 2,202 | 2,017 | 8,379 | 1,676 | 1 | 12 |
| Maine | 1,516 | 705 | 802 | 1,571 | 1,964 | 6,558 | 1,312 | 1 | 13 |
| New Hampshire | 1,479 | 588 | 833 | 1,074 | 2,105 | 6,079 | 1,216 | 1 | 14 |
| Total | 129,247 | 105,185 | 106,784 | 152,540 | 149,572 | 643,328 | 128,666 | na | na |

Coastal North Carolina supports a vigorous commercial fishing industry. More than 7,500 licensed commercial fishermen sell their catches to over 800 dealers located throughout the coastal area. The annual ex-vessel value (paid to the fishermen, without any economic multipliers) is about \$100 million. Diaby (1999) estimated that the commercial fishing industry generated more than 27,000 jobs in North Carolina, with an annual payroll exceeding \$116 million. For 1994, Diaby (1997) estimated that commercial fishing supported about 4,900 jobs in Carteret County, with a total industry output of almost \$46 million. Licensed North Carolina resident and non-resident commercial fishermen can participate in any fishery, except that non-residents may not harvest molluscan shellfish commercially.

Virtually all licensed commercial fishermen in North Carolina participate in several different fisheries during the course of a year [an "annual round" of work that, in total, provides for a year's employment and income (Johnson and Orbach 1996)]. Few can count on a full year's work in a single fishery. Most

fishermen own a variety of fishing gears, and many own several vessels, each rigged for different fisheries. The nature of the target species (growth, seasonal migrations), weather variations, rule changes and restrictions, and other variables require that successful commercial fishermen exhibit great adaptability. Many fishermen hold non-fishing jobs as part of their annual work cycle. In fact, some persons with a commercial fishing heritage, who make very little money from commercial fishing, instead earning most of their income in non-fishing occupations, consider themselves to be commercial fishermen.

Recreational fishing is very important economically and culturally in coastal North Carolina. There are records of surf fishing from the early colonial period. Surf fishing along the Outer Banks for red drum and bluefish was the subject of articles in sporting magazines in the 1930s (Godwin et al. 1971). Tens of thousands of private recreational boaters fish the coastal waters, while thousands more fish from the shore, piers, and other structures. Since 1997, about 1.6 million anglers (64% non-residents) have made about 5.4 million fishing trips each year in coastal North Carolina. Diaby (1997) estimated that sport fishing contributed almost \$75 million to the Carteret County economy, supporting over 1,800 jobs.

Protected species

North Carolina state law [G.S. 113-331] protects endangered, threatened, and special concern species of mammals, birds, reptiles, amphibians, freshwater fishes, and freshwater and terrestrial mollusks under the jurisdiction of the North Carolina Wildlife Resources Commission (Appendix E). The North Carolina Natural Heritage Program (NHP) lists seven protected marine and estuarine fishes. The shortnose sturgeon (*Acipenser brevirostrum*) is listed as endangered at the state and federal levels. The Atlantic sturgeon (*Acipenser oxyrinchus*) is listed as Special Concern for state and federal protection. An MFC rule [15A NCAC 3M .0508] prohibits possession of any sturgeon in North Carolina's coastal waters. There are five marine and estuarine fishes listed as significantly rare: spinycheek sleeper (*Eleotris pisonis*), lyre goby (*Evorthodus tyrinus*), marked goby (*Gobionellus stigmaticus*), freckled blenny (*Hypsoblennius ionthas*), and opossum pipefish (*Microphis brachyurus*). All five of these species occur in marine and estuarine systems of the Cape Fear MU. Shortnose and Atlantic sturgeon occur in riverine, estuarine and marine systems within the CHPP management area. Other marine and estuarine species listed by NHP include Florida manatee (*Trichechus manatus*), loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), and Kemp's ridley sea turtle (*Lepidochelys kempii*). There are also numerous birds, reptiles, and mammals listed by NHP associated with salt marshes and other coastal wetlands [LeGrand and Hall 1999 (NHP animals); Amoroso 1999 (NHP plants)]. Listed estuarine species include the Carolina diamondback terrapin (*Malaclemys terrapin centrala*), Carolina salt marsh snake (*Nerodia sipedon williamglelsi*), and the federally listed piping plover (*Charadrius melodus*) inhabiting ocean beaches and inlet shorelines.

In addition to species listed by NHP, there are also species designated for protection under the Marine Mammal Protection Act (for example, bottlenose dolphin, *Tursiops truncatus*). Several species of marine mammals regularly utilize North Carolina's nearshore ocean waters as migratory corridors or nursery and feeding grounds. Northern right whales (*Balaena glacialis*), one of the world's most endangered species, migrate annually through North Carolina waters, between winter calving grounds along the Georgia coast and summer feeding areas from Cape Cod to the Bay of Fundy. Similarly, humpback whales (*Megaptera novaenagliae*) pass by offshore North Carolina during their annual journey between North Atlantic feeding grounds and winter calving areas off Hispanola. Bottlenose dolphins are year-round residents of the coastal ocean waters of North Carolina, and they utilize much of the estuarine system during the warmer months, going as far upstream as the lower Neuse River. Harbor porpoise (*Phocoena phocoena*) spend a part of each winter off the Outer Banks, as far south as Hatteras Bight, below Diamond Shoals. A number of other marine mammals occasionally utilize North Carolina's coastal waters, including pygmy sperm whales (*Kogia breviceps*) and pilot whales (*Globicephala melaena*).

1.5. STATUS OF FISHERIES

The current status of fisheries may be an indicator of the potential impacts of habitat degradation and loss. The status of North Carolina's coastal fishery resources is evaluated every year by DMF. Several pertinent definitions are provided for terms used in this section.

- Stock (<<http://www.ncdmf.net/resource.htm>>, 2002): A stock is a group of genetically similar fish that behave as a unit. Determining stock status requires long-term collection and subsequent analysis of data such as length, weight, age, catch, fishing effort, spawning stock biomass, juvenile abundance indices, fishing mortality, and natural mortality. All data are not available for all species, and there is no single measure or simple index that, by itself, describes the status of a given stock. Furthermore, information from a single year does not indicate stock status. Therefore, the stock status assigned for each coastal fishery stock is based on the available time-series of data.
- Fishery Management Plan (FMP): Plan for achieving specified management goals for a fishery. It includes data, analyses, and management measures for a fishery. The process for preparing FMPs in North Carolina was established by the FRA [G.S. 113-182.1]. The FRA states:
 - “[t]he goal of the plans shall be to ensure the long-term viability of the State's commercially and recreationally significant species and fisheries... Each plan shall...Contain necessary information pertaining to the fishery or fisheries, including... fishery habitat and water quality considerations consistent with Coastal Habitat Protection Plans ...”
- Stock status descriptors used by DMF (<<http://www.ncdmf.net/resource.htm>>, 2003):
 - **Viable:** Viable stocks exhibit stable or significantly increasing trends in average length and weight, catch-per-unit-effort (CPUE), spawning stock biomass, juvenile abundance indices based on historical averages, stable age structure that includes representatives of the older age classes, and stable or declining trends in fishing mortality.
 - **Recovering:** Recovering stocks are those stocks previously listed as Overfished or Concern that show marked and consistent improvement in the criteria listed for a Viable stock. A recovering stock may still be Overfished but would show measurable and consistent improvement toward the target(s) established in the applicable FMP.
 - **Concern:** Stocks designated as Concern are those for which an assessment is incomplete or unavailable, but data show increased effort and landings, and/or a truncated age distribution. The nature of a given fishery may also be a reason for concern (such as the roe fishery for striped mullet). Stocks especially affected by diseases or adverse natural events may also fall into this category (for example, oysters). Species designated Concern may be reasonable candidates for FMP development if the concern is well documented and justified.
 - **Overfished:** Overfished stocks are classified based on stock assessments conducted by the DMF or some other recognized fisheries management authority. Species designated as Overfished are priority candidates for FMP development.
 - **Unknown:** Stocks for which insufficient data are available to conduct a scientifically valid stock assessment are classified as Unknown. When data for species that have been designated Unknown are subsequently collected in DMF sampling programs and analyzed, a different status may be assigned.

Based on a combination of fishery landings and value, dependence (or association) of the stock on specific habitats, and importance of management and environmental issues associated with the fisheries, the primary coastal fisheries species in North Carolina and their status are listed in Table 1.6 (<<http://www.ncdmf.net/resource.htm>>, 2003). Of the more than 25 species and at least 24 fish stocks listed in Table 1.6, eight stocks are Viable (33%), two are Recovering (8%), eight are Concern (33%), three are Overfished (13%), and three are Unknown (13%), as of 2003. The status of most stocks has been evaluated since 1997. Some stocks have shown signs of improvement from 1997 to 2003, while others have declined (Table 1.7). For example, southern flounder status has gone from Viable in 1998, to

Concern from 1999 to 2001, to Overfished in 2002 and 2003. Bay scallop status has also declined from Viable (1997-1999) to Concern (2000-2003). There have also been some improvements in stock status; summer flounder, weakfish, and Albemarle Sound striped bass have gone from Concern to Viable. For more information on the status of individual fishery species, see the DMF website (<<http://www.ncdmf.net/stocks/index.html>>).

While much of the concern over declining fish stocks has been attributed to overfishing, habitat loss and degradation can make a stock more susceptible to overfishing. The effect of habitat loss and degradation could be indicated by the lack of recovery of certain stocks after fishing pressure is reduced. For example, river herring stocks have not recovered despite reduced fishing effort in recent years. Although the role of environmental factors in the river herring decline is uncertain, the center of river herring abundance (Chowan and Roanoke rivers) has suffered from water quality problems since the 1970s.

Several species/fisheries with high landings are not discussed because they occur primarily outside the areas emphasized in the CHPP program, such as wahoo, tunas, sharks, and dolphin, which live most of their lives in the ocean. Among MUs, the primary fisheries vary according to the range of salinity present. For example, Table 1.6 shows that the primary fisheries in low salinity estuaries (Albemarle, Chowan, and Roanoke MUs) include river herring, catfishes (*Ictalurus* and *Ameiurus*), striped bass, white perch (*Morone americanus*), American eel, and American shad. In areas with moderate salinities (Neuse, Tar-Pamlico, and Pamlico Sound MUs), species such as blue crab, shrimp, and spot are dominant. In higher salinity estuaries (i.e., Core/Bogue) and the near shore ocean, the primary fisheries include Atlantic menhaden, flounders, hard clams, and shrimp.

Table 1.6. Average annual fisheries landings, fishery management plan (FMP) authority, stock status, and importance in Coastal Habitat Protection Plan management units in coastal North Carolina. (Sorted by descending commercial fisheries landings. Source: Division of Marine Fisheries commercial and recreational fisheries landings data.)

| Species | Average commercial fisheries landings 1997-2002 (lb) | Average recreational fisheries landings 1997-2002 (lb) | Lead FMP agency | Stock status (2003)* | Management units | | | | | | | | | | |
|-----------------------------|--|--|--|--------------------------------|------------------|-----------|--------|---------------|------------|-------|---------------|---------|---------|--------------|-------------|
| | | | | | Albemarle | Cape Fear | Chowan | Coastal Ocean | Core/Bogue | Neuse | New/White Oak | Pamlico | Roanoke | S. Estuaries | Tar/Pamlico |
| Atlantic menhaden | 63,330,289 | Unknown | ASMFC | V | | | | X | X | X | | X | | | X |
| Blue crab | 47,673,736 | Unknown | DMF | C | X | X | | X | X | X | X | X | | X | X |
| Atlantic croaker | 10,692,337 | 276,740 | ASMFC | C | X | | | X | X | X | | X | | | X |
| Shrimp | 7,688,851 | Unknown | DMF out to 3 miles, NMFS beyond 3 miles | V | | X | | X | X | X | X | X | | X | X |
| Southern flounder | 3,523,763 | 134,186 | DMF | O | X | | | | X | X | X | X | | X | X |
| Bluefish | 3,240,218 | 838,102 | ASMFC/NMFS | R | | X | | X | X | | | X | | X | |
| Summer flounder | 2,938,425 | 381,729 | ASMFC/NMFS | V | | X | | X | X | | | X | | | |
| Spot | 2,563,527 | 1,028,822 | ASMFC | V | X | X | | X | X | X | X | X | | X | X |
| Weakfish | 2,531,015 | 116,632 | ASMFC/NMFS | V | X | | | X | X | X | | X | | | X |
| Striped mullet | 2,311,092 | Unknown | DMF | C | X | X | | X | X | X | X | X | | X | X |
| Snapper / grouper / seabass | 1,788,967 | 409,521 | NMFS | C | | | | X | | | | | | | |
| Hard clams | 671,716 | Unknown | DMF | ? | | X | | | X | | X | X | | X | |
| Striped bass | 555,421 | 663,626 | ASMFC - ocean, DMF/WRC - internal waters | V-Ocean, Albemarle O-elsewhere | X | | X | X | | X | | | | X | X |
| River herring | 352,364 | Unknown | ASMFC / DMF | O-Albemarle ?-elsewhere | X | X | X | | | X | | | | X | |
| Spotted seatrout | 290,303 | 419,273 | ASMFC | V | | X | | X | X | X | | X | | | X |
| Oysters | 234,445 | Unknown | DMF | C | | X | | | | X | X | X | | X | |
| American shad | 233,718 | Unknown | ASMFC | C | X | X | X | X | | X | | X | X | | X |
| Red drum | 203,537 | 255,884 | ASMFC/DMF | R | | X | | X | X | X | X | X | | X | X |
| Bay scallops | 39,903 | Unknown | DMF | C | | | | | X | | | | | | |

*Stock status: V = viable, R = recovering, C = concern, O = Overfished, ? = Unknown

Table 1.7. Trends in the stock status of species and stocks listed in Table 1.6. (1997 – 2003).

| | Overfished | Concern | Recovering | Viable | Unknown | | |
|---|------------|---------|------------|--------|---------|------|------|
| Species/stocks | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
| American shad | | | | | | | |
| Atlantic croaker | | | | | | | |
| Atlantic menhaden | | | | | | | |
| Bay scallops | | | | | | | |
| Black sea bass (North of Cape Hatteras) | | | | | | | |
| Black sea bass (South of Cape Hatteras) | | | | | | | |
| Blue crab | | | | | | | |
| Bluefish | | | | | | | |
| Gag | | | | | | | |
| Oysters | | | | | | | |
| Red drum (except Pamlico Sound) | | | | | | | |
| Red drum (Pamlico Sound) | | | | | | | |
| Reef fish | | | | | | | |
| River herring (Albemarle Sound) | | | | | | | |
| Shrimp | | | | | | | |
| Southern flounder | | | | | | | |
| Spot | | | | | | | |
| Spotted seatrout | | | | | | | |
| Striped bass (Albemarle Sound) | | | | | | | |
| Striped bass (except Ocean and Albemarle Sound) | | | | | | | |
| Striped bass (Ocean) | | | | | | | |
| Striped mullet | | | | | | | |
| Summer flounder | | | | | | | |
| Weakfish | | | | | | | |

1.6. HABITAT CONCEPTS AND TERMINOLOGY

The following habitat chapters contain numerous technical terms and acronyms that may not be familiar to the average reader. A complete list of terms and acronyms is found in Appendix H.

Habitat is simply the place where an organism lives (Odum 1959). Fish Habitat (FH) is hereby defined as freshwater, estuarine, and marine areas that support juvenile and adult populations of economically important fish species (commercial and recreational), as well as forage species important in the food chain. Fish habitat also includes land areas that are adjacent to, and periodically flooded by, riverine and coastal waters. Fish occupy specific areas or sites where the conditions are suitable for growth, protection, and/or reproduction. A species' use of specific areas can depend on various factors, including life stage, time of day, and tidal stage. Together, these habitat areas form a functional and connected system that supports the fish from spawning until death.

The upstream boundary of coastal fish habitat in North Carolina is approximately the Fall Line separating the Coastal Plain and Piedmont physiographic regions (Map 1.3) because only one coastal migratory species (American eel, *Anguilla rostrata*) has been reported significantly above the Fall Line (Menhinick 1991). Within North Carolina's coastal ecosystem, six habitat types were distinguished based on similar physical properties, ecological functions, and habitat requirements for living components:

- **Water column:** The water covering a submerged surface and its physical, chemical, and biological characteristics.
- **Shell bottom:** Intertidal or subtidal bottom composed of shell concentrations, including living oysters (*Crassostrea virginica*), hard clams (*Mercenaria mercenaria*), or other shellfish (such as whelks). Also referred to as oyster bars, oyster beds, oyster rocks, oyster reefs, clam beds, and shell hash.
- **Submerged aquatic vegetation (SAV):** Bottom recurrently vegetated by living structures of submerged, rooted vascular plants, (including roots, rhizomes, leaves, stems, propagules), as well as temporarily unvegetated areas between vegetated patches.
- **Wetlands:** Section 404 of the Federal Water Pollution Control Act defines wetlands as: “areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in wet soil conditions.” The CHPP will focus primarily on wetlands that are connected to coastal water bodies by surface water of sufficient depth to allow fish utilization. These “connected” wetlands are termed “riparian wetlands” in the CHPP because they border streams and other water bodies.
- **Soft bottom:** Areas of primarily unvegetated, unconsolidated sediment (particles smaller than rocks) beneath the water column, and not within other categories defined below.
- **Hard bottom:** Exposed areas of rock or consolidated sediments that may or may not be characterized by a thin covering of live or dead animals, generally located in the ocean rather than an estuary.

North Carolina’s coastal fishery resources (the “fish”) exist within a system of interdependent habitats that provide the basis for long-term fish production available for use by people (the “fisheries”). Most fish rely on different habitats throughout their life cycle (Figure 1.1); therefore, maintaining the health of an entire aquatic system is essential. The integrity of the entire system depends upon the health of areas and individual habitat types within the system. The areas that contribute most to the integrity of the system are another category of habitat termed Strategic Habitat Area. Strategic Habitat Areas (SHAs) are hereby defined as specific locations of individual fish habitat or systems of habitat that have been identified to provide critical habitat functions or that are particularly at risk due to imminent threats, vulnerability, or rarity. Criteria for delineation of SHAs are included in chapter 8.0 (Strategic Habitat Areas).

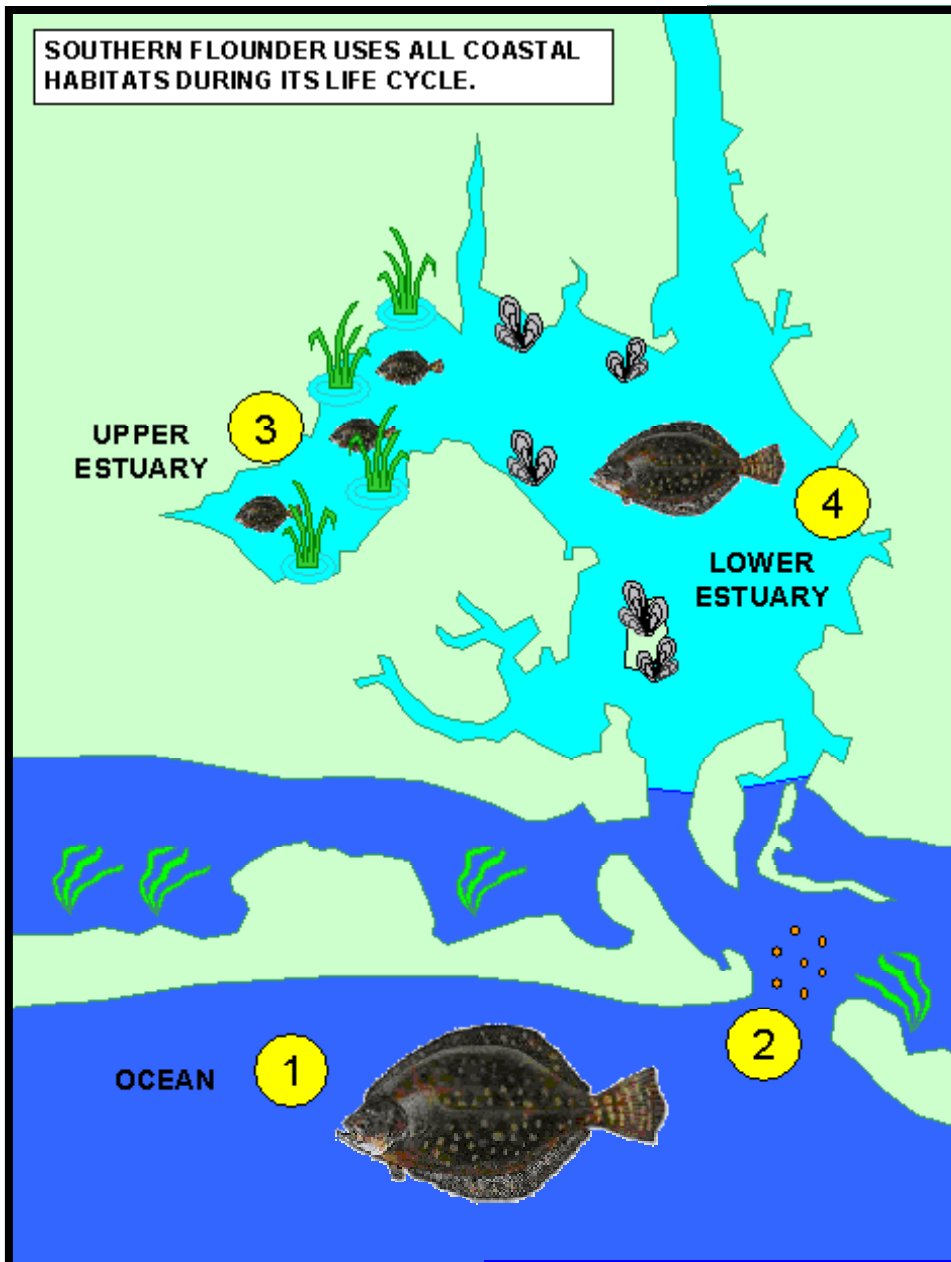


Figure 1.1. Life cycle of the southern flounder.

- 1 - Adults spawn in nearshore ocean waters during late winter months.
- 2 - Larvae drift inshore on currents, eventually passing through inlets and to the estuary beyond.
- 3 - Small juveniles settle out of the water column in upper, low-salinity estuaries containing marsh wetlands and shallow soft bottom habitat.
- 4 - As flounder grow, they begin to occupy deeper channels and the lower portion of the estuary. Juvenile flounder also move throughout the estuary, foraging on crabs and small fish living in oyster reefs and along the marsh edge. Once the juvenile flounder recruit to the adult population, the cycle is continued.

Ecological role and functions

The ecological role of each habitat is discussed in the habitat chapters that follow in terms of productivity and effect on overall water quality and quantity in an ecosystem. That discussion is followed by information on specific fish habitat functions. The general functions of habitat for fishery and forage species are grouped into the following categories:

- Refuge: Properties of the habitat that provide cover for organisms at various life stages to escape from predators and adverse environmental conditions. Structural refuge can also encourage attachment of colonizing sessile (stationary or non-mobile) organisms.
- Spawning: Properties of the habitat that provide the necessary conditions (substrate, temperature, flow, structure, etc.) for successful spawning of adults.
- Nursery: Properties of the habitat that provide a combination of refuge and foraging habitat resulting in successful development of subadult life stages of aquatic organisms. Nursery habitat can be further defined as habitats that contribute disproportionately to the production of individuals that recruit to adult populations (Beck et al. 2001).
- Foraging: Properties of the habitat that enhance growth of species' life stages through the presence, accessibility, and vulnerability of prey organisms.
- Corridor: Properties of the habitat that allow relatively safe passage (either active or passive) of species' life stages among foraging, spawning, and refuge areas. This function also addresses the connectivity of aquatic habitat and its effect on aquatic organisms.

Spatial scales

In ecological terms, spatial scales are differentiated by the variable resolution and extent of landscape features (such as a forest to a tree to an individual branch) and the manifestation of different biological, chemical, or physical patterns at those scales. For example, individual oyster shells, the spaces between them, and the water surrounding them could define a very fine scale. Small organisms relate to these crevices by selecting them over the surrounding unstructured bottom. The small organisms are relatively separate from what is happening in the entire watershed, although watershed patterns can affect them through the surrounding water. The entire watershed occupies a much larger scale in which anadromous fish, for example, require different areas depending on time of year and life stage. Regional scales encompass multiple watersheds and affect individual watersheds with similar climatic patterns and other large-scale phenomena. Highly migratory organisms like tunas, whales, and sea birds relate to habitat at regional scales while at the same time selecting fine-scale habitat characteristics at any specific point in time. There are basically three larger scales used to describe habitat and ecosystem organization and function in this document: regional, watershed, and site-specific.

- Regional scale is defined by large biogeographic regions, such as the mid-Atlantic and South Atlantic Bights or the Coastal Plain and Piedmont physiographic regions of eastern North America.
- Watershed scale is defined by CHPP management units or by other hydrologic units based on DWQ or U.S. Geological Survey (USGS) delineations. Nationally, the typical watershed covers 40,000 to 250,000 acres (USGS 2001).
- Site-specific scale is defined by DWQ as water bodies delineated on 1:24,000 scale hydrographic maps or by features named on NOAA nautical charts. Within a given area, a given habitat type may be dominant, but not continuous, such as patchy distribution of SAV. Specific habitat features change continually, especially at their edges. Beds of SAV expand and contract. Thus there is a high degree of natural variability within habitats.

Impacts, sources, and threats

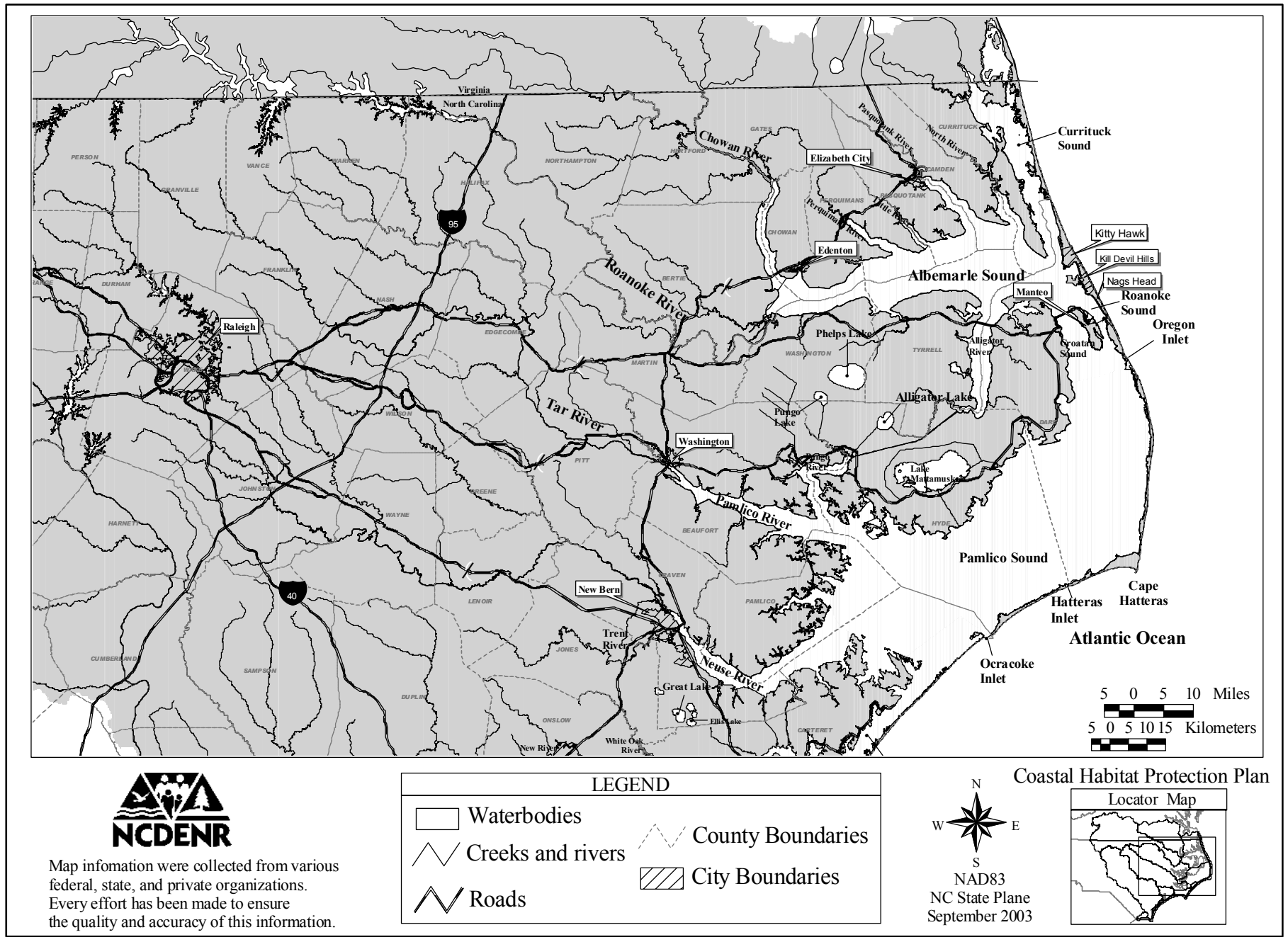
Coastal fisheries resources in North Carolina have evolved over geologic time to live within their existing conditions. Thus, they have adapted to the gradual climate shifts and episodic storm events that have

occurred through time. But these natural and gradual changes did not include the host of artificial chemicals, deforestation of riparian lands, stormwater runoff, nutrient enrichment, destruction of habitats, and highly effective fishing practices that have developed during the last century, and are so pervasive today. These threats to coastal fish habitat can be characterized by impacts types and sources.

Impacts are specific effects on habitat such as extremely low flow, nutrient enrichment, or erosion. These impacts have corresponding effects on living resources, which can be both positive and negative. Positive impacts can result from habitat preservation, enhancement, and restoration efforts. Negative impacts can result from habitat degradation and loss. Cumulative impacts are the combined outcome of numerous actions and stresses that alone may have relatively minor effects, but together lead to substantive habitat degradation or loss. Restoration of specific degraded habitats may cumulatively benefit dependent organisms.

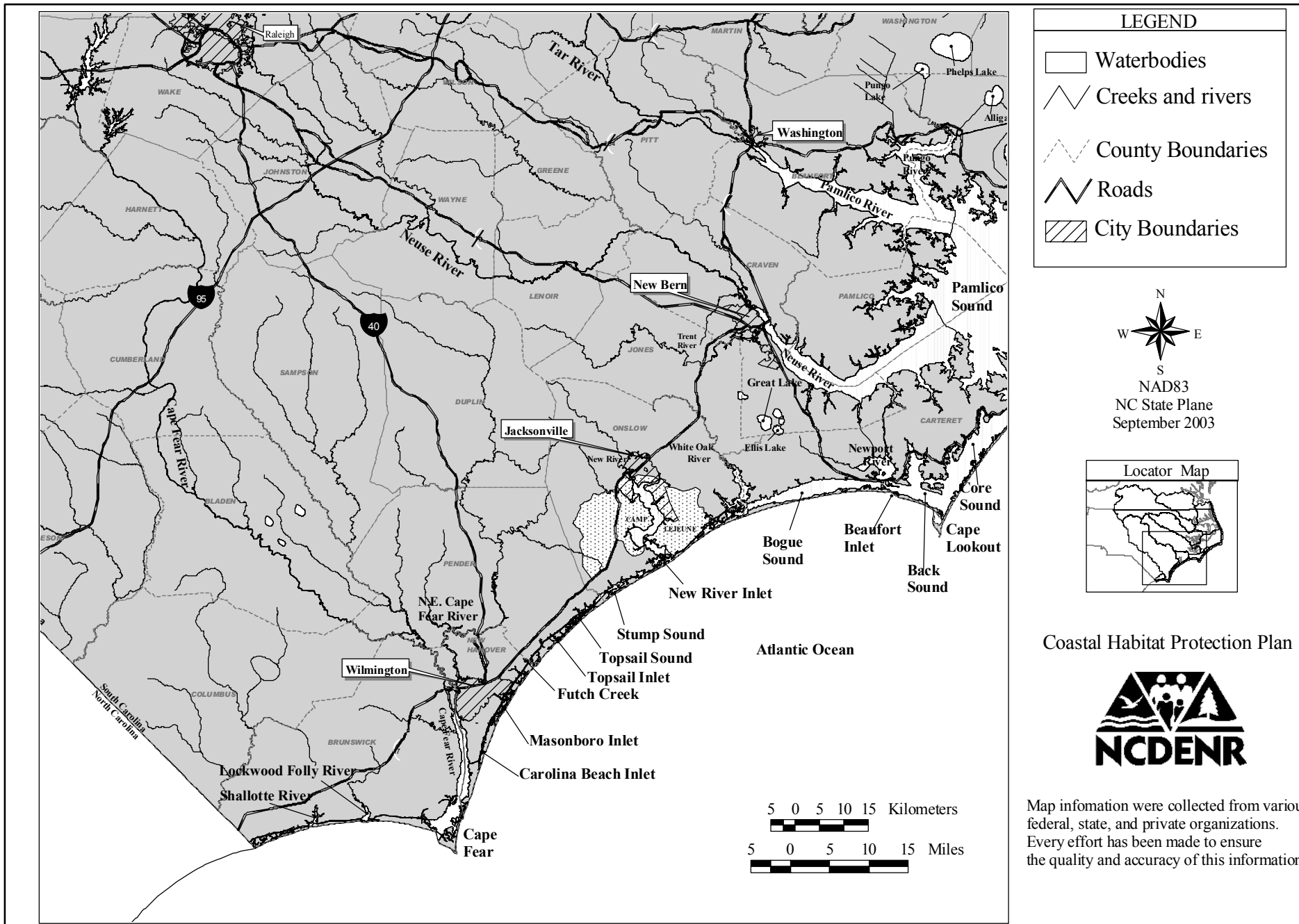
The overall effect of human-induced, habitat impacts on living resources has been expanding areas of low dissolved oxygen, coupled with nutrient enrichment and suspended sediment. Species that can tolerate the low dissolved oxygen, algae growth, and excess sediment thrive in degraded areas. These species include smaller, less desirable organisms such as comb jellies (Breitburg 1992; Breitburg et al. 1994) and toxic algae (Paerl 1982; Tester and Fowler 1990). In areas where there is no oxygen, only a few bacteria species can survive. Degraded areas not only impair fishery resources, but also impair other human uses such as swimming and drinking water supply.

Impact sources are natural events or human activities that can have individual or multiple effects. Impact from pollution originates from both point (outfall pipes, ditches) and nonpoint sources (stormwater runoff), primarily affecting water quality (the biological, chemical, and physical suitability of water relative to standards that support desirable living communities). Natural events and human activities also affect the physical habitat through storms, floods, construction activities, land clearing, and fishing.



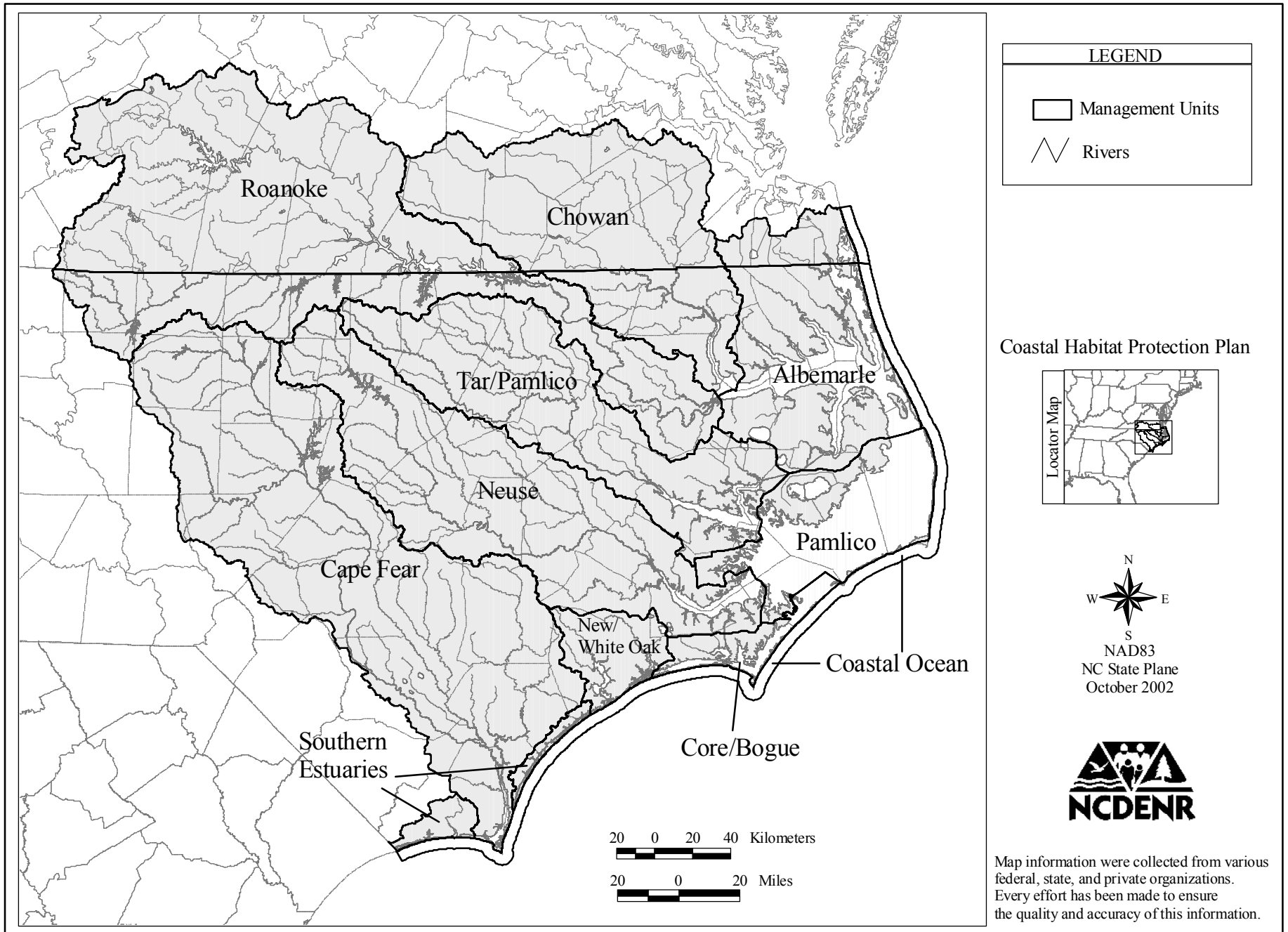
Map 1.1a. Hydrographic features in coastal North Carolina. (Data from 1:100,000 scale USGS topographic maps).

This Page was Intentionally Left Blank



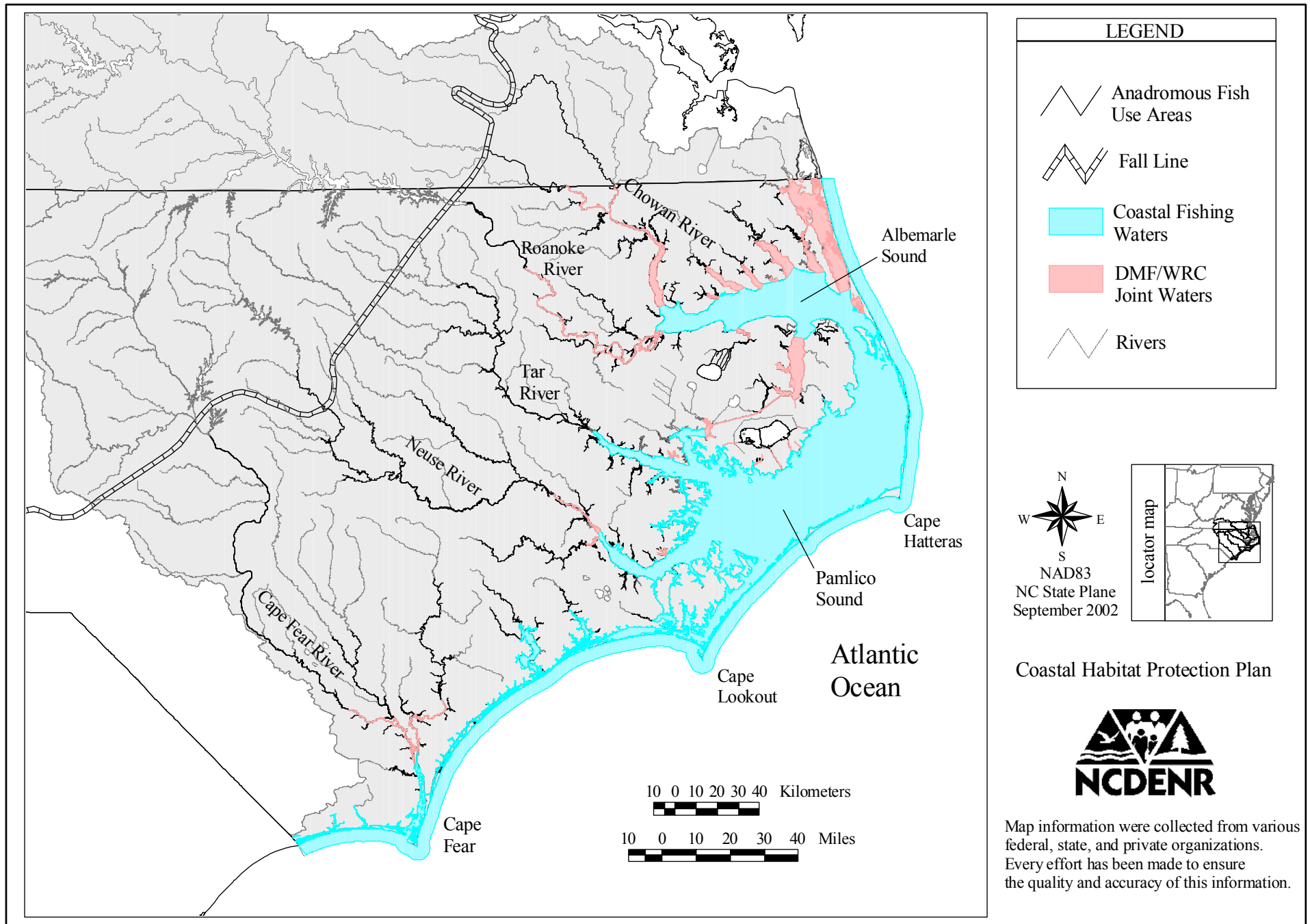
Map 1.1b. Hydrographic features in coastal North Carolina. (Data from 1:100,000 scale USGS topographic maps).

This Page was Intentionally Left Blank



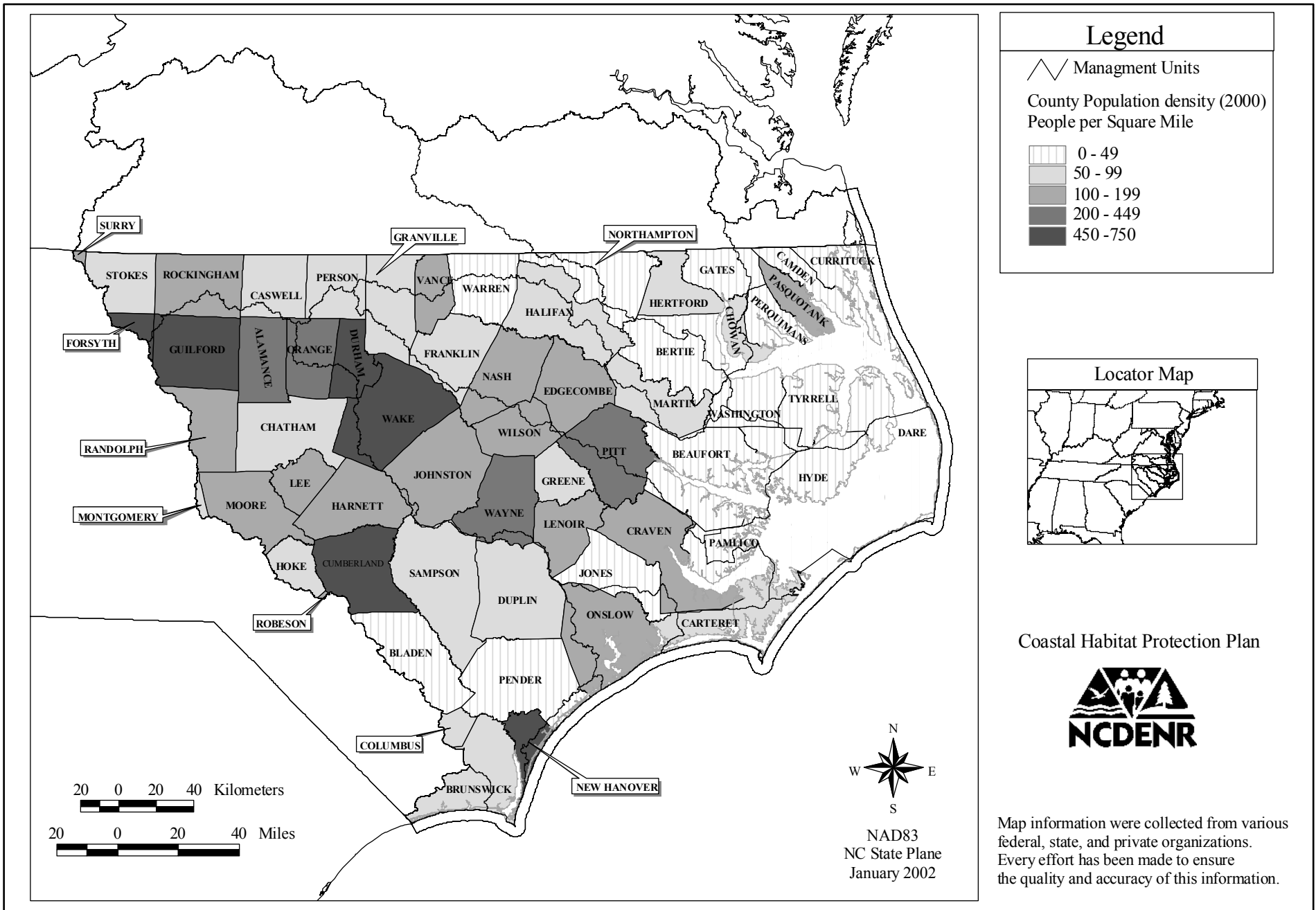
Map 1.2. North Carolina Coastal Habitat Protection Plan management unit boundaries

This Page was Intentionally Left Blank



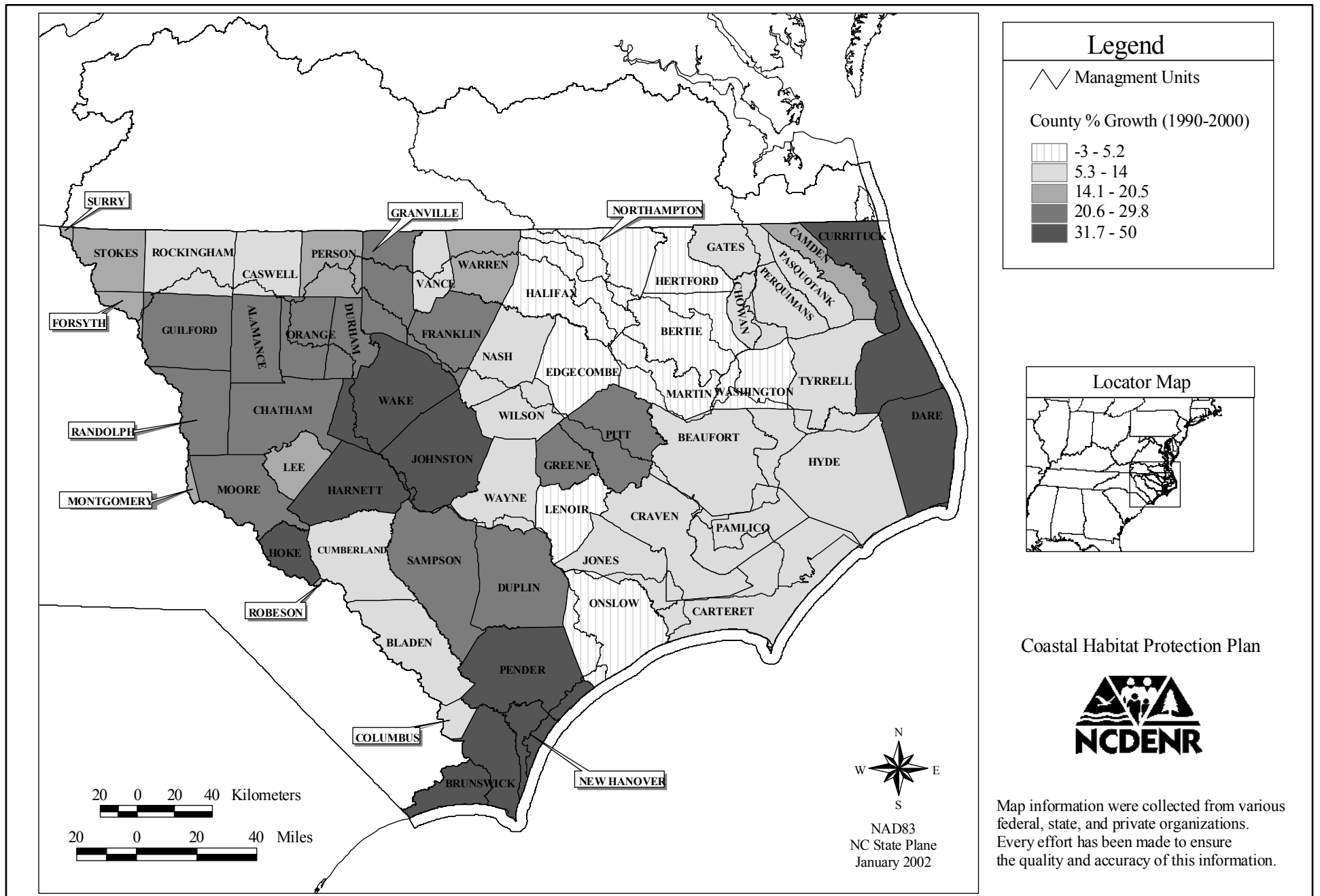
Map 1.3. Jurisdictional and effective boundaries of coastal fish habitat in North Carolina. [Anadromous fish use areas from North Carolina Division of Marine Fisheries data and Baker (1968), and fall line from Menhinick (1991)].

This Page was Intentionally Left Blank



Map 1.4. Density of human population in the Coastal Habitat Protection Plan area of North Carolina (2000). (Data from the North Carolina Office of State Budget and Management (August 2001). Persons/mi² includes only land areas.)

This Page was Intentionally Left Blank



Map 1.5. Percent growth in human population by county in the Coastal Habitat Protection Plan area during 1990-2000. [Data from the North Carolina Office of State Budget and Management (August 2001)].

This Page was Intentionally Left Blank