

CHAPTER 1. INTRODUCTION

habitat and water quality concerns

North Carolina has the largest estuarine system of any state along the Atlantic coast. The numerous estuarine rivers, creeks, large sounds, inlets, and ocean bays create a diverse aquatic system totaling over 2.3 million acres in size. North Carolina is located at the convergence of the mid-Atlantic and south Atlantic biogeographical provinces, supporting a mix of both northern and southern fish species in North Carolina's waters. Because of this, the extensive amount of estuarine and marine waters, and the diversity and abundance of habitats occurring there, North Carolina's coastal fisheries are among the most productive in the United States.

However, pressures from development, loss of habitat, and water quality degradation appeared to be taking a toll on North Carolina's estuaries in the late 1980s. Several major fish kills, associated with low oxygen events and diseases, such as *Pfeisteria*, occurred. Oysters were dying from diseases (Dermo and MSX). Sea turtle and marine mammal mortalities related to disease and fishing gear interactions were increasing. Several commercially and recreationally important fisheries were classified as overfished, including summer flounder, weakfish, river herring, and striped bass. All of these concerns resulted in conflicts between recreational and commercial fishermen and raised environmental concerns by the public.

Because of these concerns, the State of North Carolina, through the Governor and General Assembly, convened several high level panels during this period to examine coastal environmental and fishery management issues. Each has made numerous policy recommendations concerning improved management of fish habitat and water quality.

- The Governor's Blue Ribbon Panel on Environmental Indicators published a report and recommendations in December 1990 (C. Manooch/DMF, pers. com., 2004). This report, compiled by the Department of Environment, Health, and Natural Resources (now DENR) provided guidelines for developing a set of indicators to evaluate the status and trends of environmental quality within North Carolina.
- 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 to reevaluate coastal issues since the Coastal Area Management Act (CAMA), which established North Carolina's coastal zone management system under the CRC, was enacted 20 years ago. Recommendations of the report included restoration and protection of important fisheries habitats and impaired waters, the need to address nonpoint source pollution, 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).
- The Fisheries Moratorium Act, in 1994, established a steering committee to oversee study of fishery resources.

Up until this point, the majority of the panel recommendations were not implemented. However, most of the recommendations of the Fisheries Moratorium Act Steering Committee were included in the Fisheries Reform Act in 1997.

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 (G.S. 143B-279.8) requires preparation of Fishery Management Plans by the Division of Marine Fisheries and Coastal Habitat Protection Plans (CHPPs) by the North Carolina Department of Environment and Natural Resources. The goal of all Fishery Management Plans is to ensure the long-term viability of the State's commercially and recreationally significant species and fisheries. The Fishery Reform Act mandates that each plan include all pertinent fishery information as well as habitat and water quality considerations that are consistent with the Coastal Habitat Protection Plan. 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 CHPP is long-term enhancement of coastal fisheries associated with coastal habitats. The law specified that the CHPP 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. The intent of this tri-commission effort was to ensure consistent actions among commissions, as well as their supporting Department of Environment and Natural Resources (DENR) agencies. The public had become increasingly frustrated with the inability of multiple panels to successfully implement recommendations. However, the FRA clearly required that recommendations of the management plans be implemented. 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. Because the CHPP uniquely brings together three major regulatory commissions, the public has an expectation that positive actions would result from this effort.

1.3. Authority for management and protection of public trust resources

The Public Trust Doctrine provides the authority for the state to manage public trust resources. The 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 . . . 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).

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 NC 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).

1.4. CHPP PROCESS

DMF staff, with assistance from the CHPP Development Team, completed drafting of the first CHPP in 2004. The CHPP team includes scientists and planners from DMF, DCM, DWQ, Division of Environmental Health (DEH), and WRC. An Intercommission Review Committee (IRC), consisting of two members from each of three commissions, the Marine Fisheries, Coastal Resources, and Environmental Management commissions, provided policy oversight, reviewed this plan, and developed the management recommendations (Street et al. 2005). After the IRC and DENR reviewed the draft plan, the Marine Fisheries, Coastal Resources, and Environmental Management Commissions separately approved of the plan and recommendations. Following that, each division and the Department compiled bi-annual implementation plans to accomplish recommendations within their authority. The IRC was slightly reorganized to reflect their new charge – to meet quarterly to discuss implementation progress, cross-cutting issues and facilitate CHPP implementation actions, as well as review future CHPP updates. Changes included renaming the group to the CHPP Steering Committee (CSC) and asking the Wildlife Resources Commission to join the CSC in 2009 since many of the implementation actions affect resources under their jurisdiction (see Appendix B for current CSC membership). In addition, other DENR division staff, such as Division of Environmental Health, Division of Forestry, Division of Water

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Resources, Division of Land Resources, Division of Soil and Water Conservation, and Ecosystem Enhancement Program were invited to participate at CSC meetings.

1.4. Purpose and organization of document

The purpose of the CHPP is to assimilate information on the environmental requirements, spatial distribution, ecological value, overall condition, and threats to coastal fish habitats and ecosystems, so that management needs can be identified to protect, enhance, and restore associated fisheries. The 2005 CHPP identified four overarching 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 updated 2010 CHPP follows the same organizational format as the initial 2005 plan, with updated information and additional focus on ecosystem integrity and Strategic Habitat Areas. The CHPP is organized 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 or gaps in the current management framework and are highlighted in the habitat chapters with *italics*. The threat sections are followed by a listing of habitat-specific management needs from the 2005 and 2010 CHPP, with a brief narrative on progress to date. A summary highlighting the most pressing management needs is provided at the end of each habitat chapter.

Following the habitat chapters, there is a discussion of ecosystem management and Strategic Habitat Areas (Chapter 8). The ecosystem management chapter will provide a cross-reference for threat-based information and a synthesis of information and recommendations regarding ecosystem-level management issues (i.e., cross-cutting threats, habitat trade-offs). The chapter will also summarize Strategic Habitat Area assessments and their role in ecosystem management.

The final chapter covers recommendations organized by CHPP goals. This chapter revisits the 2005 CHPP recommendations in light of new information presented in the update and discussions among the commissioners on the CSC. Each of the Commissions and the Department will use the threats discussion, management needs, and recommendations to develop and update coordinated coastal habitat implementation plans as provided in the Act.

1.6. ACCOMPLISHMENTS

After the CHPP was formally adopted in December of 2004, the commissions, their administrative divisions, and DENR developed and adopted bi-annual implementation plans during the summer of 2005. The implementation plans detailed more than 100 specific steps the Department, its agencies and their respective commissions would take during the 2005/06 – 2006/07 fiscal years to implement the CHPP recommendations. Following that, a second two year implementation plan was developed and adopted by the CSC for the 2007/08-2008/09. Many of the 07-09 implementation actions were continuations of ongoing activity. The 2007-2009 implementation plan includes proposed implementation actions and is available on the DMF website.

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Over the past five years, implementation of the CHPP has been a significant part of the decision making process of DENR's divisions and regulatory commissions. All three commissions and their DENR agencies actively used the CHPP and its recommendations as guidance in their regulatory and operational programs. Numerous implementation actions were accomplished or are underway.

The CHPP Steering Committee concluded that the six most significant accomplishments and advancements of the CHPP in the first five years included:

- Interagency coordination/cooperation – CHPP coordinator position established, CHPP Steering Committee and interagency quarterly meetings
- Stormwater runoff management – adoption of EMC Phase 2 and coastal stormwater rules
- Habitat mapping – SAV due to APNEP workgroup, shellfish and shellfish closures due to new positions, SHA process to prioritize habitat areas, shoreline mapping through grant funding
- Compliance monitoring – new positions in multiple divisions, cross training marine patrol, increased permit fees and fines
- Oyster reef restoration – new positions and funding for sanctuary development and monitoring, funding for construction of a shellfish hatchery, and creation of an oyster shell recycling program
- Beach nourishment management – development of the Beach and Inlet Management Plan through grant funding, and adoption of CRC sediment criteria rules

A common thread to all of these accomplishments was support from the Department and the General Assembly to implement these actions.

In the first fiscal year (2005-2006), most of the implementation measures were setting the stage to facilitate future actions. A CHPP coordinator position was created, the IRC was reorganized into the CHPP Steering Committee, and quarterly CHPP permit coordination meetings were established. Three DWQ, four DCM, three DEH-SS, and three DFR positions were funded by the General Assembly for compliance monitoring. Additionally, an agreement was established for Marine Patrol to regularly fly DCM compliance staff and to train officers how to report possible environmental violations. All of these actions were directed at improving effectiveness of existing rules and programs protecting coastal fish habitat (**Goal 1**). **Goal 2** called for identification and designation and protection of Strategic Habitat Areas. Before this could be done, mapping of CHPP habitats was needed. Three positions were appropriated to DMF to accelerate completion of shell bottom mapping. Elizabeth City State University, under a NOAA grant, began mapping SAV in Currituck Sound. CHPP staff, along with a SHA Advisory Committee, began developing the process to identify SHAs. To enhance habitat and protect it from physical impacts (**Goal 3**), DMF enhanced three existing oyster sanctuaries with more rock material and closed additional areas to mechanical shellfish harvesting. DCM began to formulate sediment compatibility rules, and NC Sea Grant formed a multi-slip docking facility advisory committee to discuss environmental issues related to multi-slip docking facilities and develop recommendations if needed to better protect fish habitat. To enhance and protect water quality (**Goal 4**), DWQ conducted a study, inspecting engineered stormwater structures, and surveyed stormwater outfalls draining into SA and ocean waters. In addition, DWQ, after hearing concerns of the CHPP Steering Committee and MFC Habitat and Water Quality Committee, began discussing the need for coastal stormwater rules.

In the second fiscal year (2006-2007), progress continued on the newly organized coordination meetings, and the appropriated positions were filled and began working. To further improve effectiveness of existing rules (**Goal 1**), CRC increased civil penalties to discourage violations. In addition NERRs hosted several workshops and outreach events on a variety of habitat and water quality protection topics. The major accomplishment toward identifying SHAs (**Goal 2**) was that an interagency SAV mapping workgroup was formed, with APNEP serving as the lead. An MOU was signed and the group began planning a coastwide mapping effort of SAV. Progress continued on shell bottom mapping and the SHA

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methodology process was completed and approved. For **Goal 3**, sediment compatibility rules were completed and approved, funding for the Beach and Inlet Management Plan was received, and the CRC Estuarine Shoreline Stabilization scientific work group completed a report including recommendations regarding the placement and suitability of hardened shoreline structures. DCM received funding to map the shoreline and structures on it, an important precursor to managing shorelines. The CRC Estuarine Shoreline Stabilization Subcommittee reviewed the report and considered possible rule changes. Toward protection and enhancement of water quality (**Goal 4**), Phase II stormwater rules became effective, and DWQ drafted coastal stormwater rules went through the public hearing process.

In the third fiscal year (2007-2008), coordination and educational outreach continued for **Goal 1** and several efforts underway previously were substantially completed. Under **Goal 2**, the Interagency SAV Mapping Partnership pooled funding to acquire aerial imagery of SAV and the imagery was taken. The analysis of SHA Region 1 was well underway. In terms of enhancing and protecting habitat (**Goal 3**), the benefits of the additional resources for DMF's Resource Enhancement Section were beginning to be seen, with increased mapping of shell bottom, collection of recycled oyster shell, and monitoring and research of oyster sanctuaries. The MFC and the WRC designated Anadromous Fish Spawning Areas, an important step in protecting anadromous fish habitat. DMF began spawning and stream obstruction surveys, critical for prioritizing future habitat restoration. DCM began drafting of the Beach and Inlet Management Plan and received a Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) multi-agency grant to study shoreline stabilization and marsh sills. The most visible accomplishment of 2007-2008 was the adoption of coastal stormwater rules which went into effect in October 2008, after a huge effort was made by the DWQ, EMC, and Department as well as other supporting state agencies to keep the rules from being overruled due to opposing development interests (**Goal 4**). Other accomplishments in protecting and enhancing water quality included the formation of the Community Conservation Assistance Program with the Soil and Water Conservation Districts. This is the only program designed to address stormwater retrofitting from existing development. Other efforts included expansion of the areas that qualify for CREP funding, completion of three additional lagoon conversion projects, continuation of the swine lagoon buyout program, and additional equipment purchases by DFR to enhance forestry BMPs.

In 2008-2009, budget shortfalls constrained implementation success. Funding for two DCM positions (compliance education coordinator and Clean Marina Program) was rescinded, and the CHPP quarterly interagency meetings were cancelled due to travel restrictions. Similarly, funding approved by the legislature in the previous year to greatly accelerate oyster reef restoration was partially rescinded. The gain in funding to the program balanced out losses from DMF's budget, with the final result being a small net gain in resources for oyster restoration. Shell bottom and SAV mapping was slower than expected due to vacancies and the inability to fill positions. However, progress was still made.

Toward improving effectiveness of existing rules (**Goal 1**), DMF received approval for two grant funded positions dedicated to coastal permit review, and MFC approved a revised definition of SAV habitat, to improve effectiveness in protecting this habitat. Agencies worked together to ensure consistency among rules with this definition change. DWQ began reviewing coastal CAMA land use plans, sponsored workshops for local government and developers on the new stormwater rules, and hosted a Water Quality Monitoring Forum aimed at coordinating monitoring efforts. Regarding **Goal 2**, analysis for Strategic Habitat Areas in Region 1 was completed, areas were identified and approved by the MFC, and are being incorporated into DENR's Conservation Planning Tool. DMF completed spawning and obstruction surveys on the majority of the Chowan River system. Regarding **Goal 3**, enhancing and protecting habitat, sanctuary monitoring work continued and DWQ worked with DOT on a SAV and oyster habitat restoration and mitigation project in Currituck Sound. DWQ also established a compensatory mitigation database. DMF incorporated results of EEP and university research on compensatory mitigation to develop a MFC policy on compensatory mitigation which will hopefully encourage compensatory

mitigation methods that successfully restore coastal watershed functions. DCM made major progress on drafting the Beach and Inlet Management Plan and delineating the coastal estuarine shoreline. Through CHPP discussions, plans are underway to assess the success of existing marsh sills as alternatives to vertical stabilization structures, provide tools to the general public to educate them on the effects of shoreline stabilization and a range of management options, and to then revisit rules related to estuarine shoreline stabilization. CRC approved rules to better protect marshes from mowing, and reduce impacts from docks and piers. In terms of enhancing and protecting water quality (**Goal 4**), DWQ has begun reviewing several rules such as ocean stormwater discharges and marinas for adequacy in water quality protection. DWQ conducted a smart sponge pilot study to examine new ways to clean up stormwater, constructed four low impact development projects, and is developing a mitigation policy for intermittent streams. Additional resources were also appropriated to the Soil and Water for the Lagoon Conversion Program.

In summary, relative to other past planning efforts to protect North Carolina's coastal environment, the CHPP has been largely successful in implementing plan recommendations. The greatest accomplishments of the CHPP have been non-regulatory. Prior to making large management changes, positions and funding were needed to assess compliance of existing environmental rules, complete mapping of fish habitats, and educate the public on environmental issues. Multiple large grants have been awarded to state agencies and universities to conduct research or projects in support of the CHPP. Examples include DCM receiving funding for the BIMP, shoreline mapping, and the CICEET project looking at shoreline stabilization; APNEP coordinating the pooling of resources to map SAV coastwide; and universities receiving Fishery Resource Grants (FRGs) and Coastal Recreational Fishing License (CRFL) grants to collect needed habitat information. Much has been done in those areas, but work still remains. The passing of the coastal stormwater rules marks the largest regulatory change that the CHPP influenced. It occurred through the hard work of numerous DENR staff, commissioners, and CHPP supporters such as environmental NGOs. With the exception of the EMC's coastal stormwater rules, rule changes for habitat protection occurred slowly and incrementally. Increased communication among divisions and commissions may have slowed down rule-making in some ways, but resulted in buy-in from other agencies and final products that are more consistent among divisions and commissions. Several large issues that involve regulations such as beach nourishment, estuarine shoreline stabilization, and protections for anadromous fish habitat are underway.

1.5. Area description

North Carolina's coast is framed by a chain of low-lying barrier islands extending from Virginia to Cape Fear. The barrier islands create large and productive sounds and estuaries behind them. Southwest of the Cape Fear River, dredging of the Atlantic Intracoastal Waterway (ICW) in the 1930s created an artificial extension of these barrier islands (Map 1.1a-b). The northern part of the natural barrier islands, the Outer Banks, separates the Albemarle-Pamlico sounds complex from the coastal ocean. The topography of the three major capes has a major influence on adjacent ocean circulation.

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 ocean and estuarine 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.

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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 1.2), 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 CHPP area (coastal plain) includes all river basins flowing into North Carolina's coastal waters and the watersheds they drain. The Fall Line marks the upper extent of the CHPP area. The seaward extent of the CHPP area is the boundary of state territorial waters. In the 2005 CHPP, the coastal area was divided into 11 management units, closely following the river basin boundaries. The intent was to produce separate management plans for each of these units following completion of the CHPP. Subsequently, the CHPP Team and Steering Committee modified this organization into four management regions. These four regions were to be the basis for Strategic Habitat Area analyses to assess regional habitat condition and watershed issues. 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. Table 1.1 indicates the CHPP area is approximately 17% water (2,868,830 acres). Inlets at the boundaries between areas are shown separately since they influence both adjacent CHPP areas. 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 water area within CHPP management regions (based on USGS hydrologic unit boundaries and 1:24,000 scale shorelines).

| CHPP regions | Major water bodies | Total area (acres) | Water area (acres) | % water area |
|---------------------|--|---------------------------|---------------------------|---------------------|
| 1 | Albemarle/Currituck sounds, Chowan River | 5,688,749 | 767,002 | 13 |
| 1/2 | Oregon Inlet | 54,777 | 52,927 | 97 |
| 2 | Pamlico Sound, Neuse/Tar-Pamlico rivers | 6,372,286 | 1,362,795 | 21 |
| 2/3 | Ocracoke Inlet | 37,165 | 36,640 | 99 |
| 3 | Core/Bogue sounds, New/White Oak rivers | 1,138,266 | 423,117 | 37 |
| 4 | Cape Fear River, southern estuaries | 3,483,211 | 226,349 | 6 |
| Totals | | 16,774,455 | 2,868,830 | 17 |

To address local and watershed issues, a 2005 CHPP recommendation called for identification and designation of Strategic Habitat Areas. Four detailed regional analyses will be done to assess the condition and threats within these watersheds so that Strategic Habitat Areas can be identified at a landscape level for prioritized protection and restoration efforts. Boundaries of the four regional systems

were based primarily on USGS 14-digit hydrologic units comprising hydrologically connected receiving waters and watersheds. The regions represent a continuum of aquatic habitats extending from coastal plain rivers through estuarine waters and passing into coastal ocean waters through dynamic inlet systems. 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 four regional systems and their boundaries approved by the CHPP Steering Committee are shown on Map 1.2. The regions are generally referred to as: Northern (Region 1), North-Central (Region 2), South-Central (Region 3), and Southern (Region 4). Because major inlet flow influences adjacent CHPP regions, some overlap between regions exist. To take this into account, Oregon and Ocracoke inlets have been tallied separately. The total hydrologic unit area and water area of the regions is approximated in Table 1.1.

1.5.1. 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 jobs, and the natural resources of the coastal areas (NOS 1990). North Carolina's coast has historically consisted of small residential communities and beach towns, with a tourism and retirement component. Quaint towns like Edenton, Beaufort, and Southport remain small but are growing. While some island towns have retained their relatively small summer cottage character (Ocracoke Island, Topsail Beach), others have shifted to large scale homes and multi-unit housing (Carolina Beach, Atlantic Beach, Hatteras Island). The largest coastal cities include Wilmington, Jacksonville, and New Bern. Military bases contribute significantly to the economy of the latter two. Large industries are relatively uncommon, and are primarily located near the port of Wilmington along the Cape Fear River. Population growth in coastal North Carolina has been driven by tourism and retirement communities, due to the high quality of its coastal resources. As population density increases, so does the potential for degradation of the natural environment by human activities (Cairns and Pratt 1992).

Population, density, and change in population from 1990 to projected 2010 numbers are shown in Table 1.2. In the twenty coastal counties, New Hanover County, followed by Onslow County continue to have the largest populations and densities in 2010. Brunswick County followed by Craven and Carteret counties had the next highest populations. Pasquotank County has a modest population but is third in population density. In both 2000 and 2010 the lowest populations and densities in eastern North Carolina (about 10 persons/mi²) were in Tyrrell and Hyde counties, located on the Albemarle-Pamlico peninsula. This is about 100 times less dense than in New Hanover and about 20 times less than Onslow and Pasquotank counties. Although population density is increasing along the coast, many of the interior coastal plain counties like Cumberland, Pitt, and Johnston counties, had higher densities and similarly high growth rates (Map 1.4), suggesting that some coastal pollution may be derived from these upstream sources.

The coastal counties that have undergone the greatest population change in the past ten years are Brunswick, Camden, Pender, and Currituck counties (Table 1.2). Growth over the past ten years ranged from 21-34% in those counties and was primarily the result of urban sprawl since all are within commuting distance of larger municipalities such as Wilmington, Jacksonville, and Norfolk, VA. In the other coastal counties, population increased up to 18%, with the exception of Hyde, Washington, and Pamlico, where population declined slightly. For the past twenty years, the greatest population increases have occurred in the oceanfront counties. However, in the past ten years, the population increase in these areas slowed. The rate of county population change in the past ten years (2000-2010) was greater than the preceding ten years (1990-2000) in six counties, but slightly lower in fourteen. With the exception of Onslow County, which saw a major military base expansion, the other counties with greater population

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increases in the past ten years were located in non-oceanfront counties with relatively low populations on the north side of Albemarle Sound (Pasquotank, Perquimans, Camden, Hertford, and Bertie). This area and other western Albemarle-Pamlico counties have been marketed as the “Inner Banks” over the past five years by the real estate industry.

Municipalities on North Carolina’s barrier islands have experienced great increases in population along the coast in the past twenty years (Table 1.3). Population increased by as much as 100-486% in some beaches from 1990 to 2000. However, as these islands become more densely built-out, growth rates have slowed some. From 2000 to 2007, 69% was the maximum population increase. Brunswick County beaches accounted for the majority of the largest population increases, while some of the older established beach communities such as Wrightsville and Atlantic Beach showed minimal new growth. Overall, the permanent population of all oceanfront municipalities declined in the last ten years. However, permanent dwelling units may have converted to seasonal rentals. Influx of tourists on barrier island beaches results in tremendous seasonal population fluctuations. Seasonal population estimates at beach towns are 3 – 59 times greater than their permanent population. These estimates do not include day trippers. In many of these municipalities, public facilities, including wastewater treatment systems, roads, and water supply systems, are being taxed to the limit (Steel 1991).

Since the 2005 CHPP was completed, patterns in coastal development have varied greatly. Prior to about 2002, coastal development appeared to be moderately increasing, primarily on the oceanfront communities, with some increase in the mainland communities as well. Between 2002 and 2006 a coastal boom in development escalated along the mainland waterfront as real estate prices rapidly increased. Termed as the “new waterfront” or the “Inner Banks”, developers targeted these areas for extremely large developments, where one subdivision could almost double a town’s population. In 2006, a survey by the News and Observer found that over 34,000 new homes in nearly 100 subdivisions and condominium projects were planned or under construction along the coast (<http://www.newsandobserver.com>, 2006). Pamlico, Chowan, Bertie, Washington, Brunswick, and Down East Carteret counties were among the coastal areas targeted for new large scale developments. Concerns rose over the potentially rapid change to rural coastal communities from the loss of farmland, fish houses, and public water access and the effect on the environment. Fish houses, struggling economically with falling seafood prices and rising fuel costs could sell their property for greater profits to developers. A study found that approximately one third of the fish houses open in 2000 had shut down by 2006 (Garrity-Blake and NC Sea Grant 2006). In 2008, sharply falling real estate prices and the recession lead to a major slow down in new development. Although some of the plans for property purchased by developers during the boom have been put on hold, land may have been zoned, platted, and/or permitted, allowing for future construction once economic conditions improve. The increase in population in these rural areas will require additional infrastructure (roads, schools, water and sewer facilities, electric transmission lines, etc.), which can result in loss or degradation 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).

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Table 1.2. Human population, density, and growth in Coastal Plain counties of North Carolina, 1990–2010. (Source: NC Office of State Budget and Management, unpub. data.)

| COUNTY | 1990 | | 2000 | | 2010 (projected) | | 1990-00 | 2000-10 |
|-------------------------------------|-----------|-----------------------------|-----------|------------------------------|------------------|------------------------------|-----------------------|-----------------------|
| | Pop. | Persons/ mi ² | Pop. | Persons / mi ² | Pop. | Person s/ mi ² | Pop. change (%) | Pop. change (%) |
| CAMA Counties | | | | | | | | |
| Brunswick | 50,985 | 82.33 | 73,143 | 118.10 | 110,293 | 130.23 | 43.5 | 33.7 |
| Camden | 5,904 | 24.57 | 6,885 | 28.65 | 9,919 | 41.23 | 16.6 | 30.6 |
| Pender | 28,855 | 33.16 | 41,082 | 47.22 | 55,188 | 63.45 | 42.4 | 25.6 |
| Currituck | 13,736 | 52.55 | 18,190 | 69.59 | 23,179 | 88.51 | 32.4 | 21.5 |
| New Hanover | 120,284 | 602.85 | 160,307 | 803.44 | 197,548 | 1031.34 | 33.3 | 18.9 |
| Onslow | 149,838 | 195.37 | 150,355 | 196.04 | 182,023 | 238.16 | 0.3 | 17.4 |
| Pasquotank | 31,298 | 137.96 | 34,897 | 153.83 | 41,529 | 183.04 | 11.5 | 16.0 |
| Perquimans | 10,447 | 42.28 | 11,368 | 46.00 | 13,461 | 54.48 | 8.8 | 15.5 |
| Gates | 9,305 | 27.29 | 10,516 | 30.84 | 11,828 | 34.74 | 13.0 | 11.1 |
| Dare | 22,746 | 59.33 | 29,967 | 78.17 | 33,073 | 86.26 | 31.7 | 9.4 |
| Craven | 81,812 | 115.12 | 91,436 | 128.66 | 99,211 | 139.89 | 11.8 | 7.8 |
| Carteret | 52,407 | 101.13 | 59,383 | 114.59 | 64,144 | 126.87 | 13.3 | 7.4 |
| Hertford | 22,317 | 63.01 | 22,601 | 63.81 | 23,663 | 67.02 | 1.3 | 4.5 |
| Beaufort | 42,283 | 50.83 | 44,958 | 54.05 | 46,877 | 56.18 | 6.3 | 4.1 |
| Tyrrell | 3,856 | 9.84 | 4,149 | 10.58 | 4,297 | 11.05 | 7.6 | 3.4 |
| Bertie | 20,388 | 29.16 | 19,773 | 28.28 | 20,152 | 28.82 | -3.0 | 1.9 |
| Chowan | 13,506 | 78.19 | 14,526 | 84.09 | 14,763 | 85.60 | 7.6 | 1.6 |
| Pamlico | 11,368 | 33.40 | 12,934 | 38.00 | 12,871 | 38.24 | 13.8 | -0.5 |
| Washington | 13,997 | 40.44 | 13,723 | 39.65 | 13,082 | 37.58 | -2.0 | -4.9 |
| Hyde | 5,411 | 8.75 | 5,826 | 9.43 | 5,448 | 8.89 | 7.7 | -6.9 |
| Total | 710,743 | | 826,019 | | 982,549 | | | |
| Other Coastal Plain Counties | | | | | | | | |
| Johnston | 81,306 | 102.18 | 121,965 | 153.28 | 174,876 | 221.02 | 50.0 | 30.3 |
| Hoke | 22,856 | 102.56 | 33,646 | 150.98 | 46,762 | 119.67 | 47.2 | 28.0 |
| Harnett | 67,833 | 113.20 | 91,025 | 151.90 | 116,342 | 195.54 | 34.2 | 21.8 |
| Pitt | 108,480 | 165.67 | 133,798 | 204.34 | 163,103 | 250.17 | 23.3 | 18.0 |
| Greene | 15,384 | 57.76 | 18,974 | 71.24 | 21,510 | 80.89 | 23.3 | 11.8 |
| Sampson | 47,297 | 49.96 | 60,161 | 63.55 | 67,493 | 71.44 | 27.2 | 10.9 |
| Duplin | 39,995 | 48.82 | 49,063 | 59.89 | 54,539 | 66.88 | 22.7 | 10.0 |
| Nash | 76,677 | 141.28 | 87,420 | 161.08 | 96,432 | 178.44 | 14.0 | 9.3 |
| Wilson | 66,061 | 176.54 | 73,814 | 197.25 | 81,097 | 220.27 | 11.7 | 9.0 |
| Cumberland | 274,713 | 427.25 | 302,963 | 471.18 | 323,472 | 496.13 | 10.3 | 6.3 |
| Wayne | 104,666 | 187.92 | 113,329 | 203.47 | 116,760 | 211.09 | 8.3 | 2.9 |
| Columbus | 49,587 | 487.97 | 54,749 | 538.77 | 55,430 | 59.14 | 10.4 | 1.2 |
| Bladen | 28,663 | 47.09 | 32,278 | 53.03 | 32,234 | 36.87 | 12.6 | -0.1 |
| Jones | 9,361 | 19.75 | 10,381 | 21.90 | 10,312 | 21.90 | 10.9 | -0.7 |
| Lenoir | 57,274 | 142.48 | 59,648 | 148.39 | 57,384 | 143.54 | 4.1 | -3.9 |
| Halifax | 55,516 | 76.39 | 57,370 | 78.94 | 55,053 | 76.03 | 3.3 | -4.2 |
| Northampton | 21,004 | 39.07 | 22,086 | 41.08 | 21,045 | 39.22 | 5.2 | -4.9 |
| Edgecombe | 56,692 | 111.88 | 55,606 | 109.74 | 51,552 | 102.02 | -1.9 | -7.9 |
| Martin | 25,078 | 54.23 | 25,593 | 55.34 | 23,694 | 99.16 | 2.1 | -8.0 |
| Total | 1,208,443 | | 1,403,869 | | 1,569,090 | | | |

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Table 1.3. Changes in permanent population for barrier island municipalities, 1970-2007. (Sorted by percent increase in 2000-2007 population; Source: NC Office of State Planning)

| Municipality * | Permanent population | | | | | Percent increase: 1990-2000 | Percent increase: 2000-2007 |
|---------------------|----------------------|---------------|---------------|---------------|-----|-----------------------------|-----------------------------|
| | 1970 | April 1990 | April 2000 | July 2007 | | | |
| Sunset Beach | 108 | 311 | 1,824 | 3,090 | 486 | 69 | |
| Bald Head Island | * | 78 | 173 | 251 | 122 | 45 | |
| Kure Beach | 394 | 619 | 1,507 | 2,160 | 143 | 43 | |
| Caswell Beach | 28 | 175 | 370 | 488 | 111 | 32 | |
| Carolina Beach | 1,663 | 3,630 | 4,701 | 5,974 | 30 | 27 | |
| Surf City | 166 | 970 | 1,393 | 1,766 | 44 | 27 | |
| Oak Island | 493 | 4,550 | 6,571 | 8,261 | 44 | 26 | |
| Topsail Beach | 108 | 346 | 471 | 575 | 36 | 22 | |
| Ocean Isle Beach | 78 | 523 | 426 | 508 | -19 | 19 | |
| Southern Shores | 75 | 1,447 | 2,201 | 2,604 | 52 | 18 | |
| Holden Beach | 136 | 626 | 787 | 931 | 26 | 18 | |
| Kitty Hawk | 0 | 1,937 | 2,991 | 3,461 | 54 | 16 | |
| Kill Devil Hills | 357 | 4,238 | 5,897 | 6,820 | 39 | 16 | |
| Nags Head | 414 | 1,838 | 2,700 | 3,113 | 47 | 15 | |
| Emerald Isle | 122 | 2,434 | 3,488 | 3,855 | 43 | 11 | |
| North Topsail Beach | * | 947 | 843 | 898 | -11 | 7 | |
| Pine Knoll Shores | 62 | 1,360 | 1,524 | 1,601 | 12 | 5 | |
| Wrightsville Beach | 1,701 | 2,937 | 2,593 | 2,710 | -12 | 5 | |
| Atlantic Beach | 300 | 1,938 | 1,781 | 1,799 | -8 | 1 | |
| Indian Beach | 48 | 153 | 95 | 88 | -38 | -7 | |
| Total | 6,253 | 40,788 | 53,859 | 50,953 | | | |

* Excludes unincorporated townships, including Hatteras, Bodie, and Ocracoke Islands

The concern over loss of waterfront access led to a legislatively mandated Waterfront Access Study Committee which completed a report with recommendations in 2007 to examine the extent or potential of loss of diversity of uses and how those losses impact access to public trust waters, and recommendations to retain working waterfronts and public access, as well as to preserve North Carolina's coastal heritage. Some of those recommendations included extending eligibility of present use value taxation to working waterfront properties, increasing and utilizing funding from various existing programs to acquire and enhance public access, and establishing a Waterfront Access and Marine Industry (WAMI) Fund to purchase and develop working waterfronts. A \$20 million trust fund was established by the legislature and the acquisition process was begun in 2008, and other recommendations are underway. The need to preserve waterfront access will remain a high priority as long as development along the coast continues to increase.

1.5.2. 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.

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- 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, etc.).
- 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.

1.5.2.1. Fisheries

Authority to protect and conserve marine and estuarine resources and public trust resources resides in the Secretary of DENR (GS 143B-10) who has delegated it to the DMF director. The North Carolina MFC enacts rules to govern all fishing in coastal waters (GS 143B-279-8). 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 history of productive commercial and recreational fisheries is due not only to its large and diverse coastal ecosystem, but also to flexible and responsive management of coastal fisheries with extensive data collection and public participation, as well as a strong heritage of commercial and sport fishing throughout eastern North Carolina.

Coastal North Carolina has historically supported a vigorous commercial fishing industry. In the past five years, there has been a trend of declining numbers of commercial fishermen. Since 2000, the number of licensed commercial fishermen has declined by about 10% and the number of dealers by about 13%. In fiscal year 2008, there were 8711 commercial licenses issued with selling privileges (approximately 8565 commercial fishermen) and 738 licensed fish dealers throughout the coastal area. The annual ex-vessel value (paid to the fishermen, without any economic multipliers) has declined from about \$100 million in 2000 to \$82 million in 2008. The total economic impact from the commercial fishing industry in 2008 is still large however, estimated at \$144 million. Dare, Carteret, and Hyde counties had the highest seafood landings by weight and value in 2008 (DMF 2009a).

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Table 1.4. Annual Atlantic coast commercial fisheries landings by state, 1997-2007 (thousands of pounds, sorted by average landings). (Source: National Marine Fisheries Service data)

| State | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Average | % |
|----------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-----------|----|
| Virginia | 584,895 | 592,767 | 460,289 | 443,197 | 561,708 | 442,490 | 446,828 | 481,555 | 441,493 | 426,217 | 481,738 | 487,562 | 31 |
| Massachusetts | 229,915 | 257,438 | 198,877 | 187,861 | 242,066 | 243,824 | 295,439 | 336,948 | 337,214 | 383,466 | 303,006 | 274,187 | 17 |
| Maine | 246,344 | 184,103 | 229,633 | 226,849 | 239,868 | 197,057 | 224,106 | 208,405 | 214,820 | 234,275 | 176,006 | 216,497 | 14 |
| New Jersey | 175,172 | 197,550 | 168,974 | 171,804 | 168,403 | 162,175 | 170,132 | 185,615 | 156,961 | 175,759 | 153,965 | 171,501 | 11 |
| North Carolina | 228,433 | 180,238 | 153,310 | 155,214 | 139,277 | 159,557 | 139,215 | 136,444 | 79,154 | 68,641 | 62,900 | 136,580 | 9 |
| Rhode Island | 143,101 | 133,702 | 124,168 | 119,295 | 115,957 | 103,656 | 97,435 | 97,412 | 97,147 | 112,605 | 75,635 | 110,919 | 7 |
| Maryland | 76,599 | 61,479 | 66,419 | 48,913 | 55,536 | 53,185 | 49,350 | 49,507 | 67,460 | 51,216 | 50,102 | 57,251 | 4 |
| New York | 60,956 | 57,542 | 49,661 | 41,181 | 42,422 | 38,665 | 39,392 | 33,712 | 38,123 | 32,819 | 36,275 | 42,795 | 3 |
| Florida (east coast) | 32,719 | 29,959 | 30,417 | 40,607 | 37,130 | 32,221 | 34,855 | 41,824 | 23,113 | 26,342 | 24,483 | 32,152 | 2 |
| Connecticut | 19,072 | 17,625 | 18,430 | 19,563 | 18,687 | 16,177 | 16,420 | 21,150 | 13,628 | 11,746 | 10,263 | 16,615 | 1 |
| New Hampshire | 10,896 | 10,172 | 11,258 | 17,160 | 18,584 | 23,201 | 27,435 | 21,958 | 21,281 | 10,295 | 8,395 | 16,421 | 1 |
| South Carolina | 17,350 | 17,653 | 18,574 | 15,835 | 14,111 | 13,458 | 13,710 | 12,439 | 10,459 | 11,112 | 9,985 | 14,062 | 1 |
| Georgia | 14,511 | 13,196 | 12,250 | 9,694 | 9,036 | 9,563 | 8,942 | 6,341 | 9,697 | 7,747 | 7,180 | 9,832 | 1 |
| Delaware | 9,084 | 7,866 | 8,372 | 6,676 | 7,123 | 5,857 | 5,018 | 4,286 | 4,854 | 4,380 | 5,089 | 6,237 | 0 |
| Total | 1,849,047 | 1,761,290 | 1,550,632 | 1,505,849 | 1,671,909 | 1,501,086 | 1,568,277 | 1,637,596 | 1,515,404 | 1,556,620 | 1,405,022 | 1,592,612 | na |

*Source: National Marine Fisheries Service. Fisheries of the United States, annual reports.

Table 1.5. Annual Atlantic coast marine recreational fisheries harvest by state, 1997-2007 (thousands of pounds, sorted by average landings). (Source: National Marine Fisheries Service data.)

| State | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Average | % |
|----------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----|
| Florida (east coast) | 24,179 | 21,017 | 25,859 | 29,408 | 29,517 | 22,080 | 25,948 | 22,379 | 20,925 | 25,381 | 27,986 | 24,971 | 19 |
| North Carolina | 19,703 | 15,370 | 18,034 | 22,699 | 24,146 | 17,879 | 22,010 | 25,352 | 23,933 | 24,878 | 23,349 | 21,578 | 16 |
| New Jersey | 19,921 | 13,632 | 14,181 | 24,645 | 22,323 | 15,541 | 17,152 | 17,879 | 19,033 | 20,596 | 16,654 | 18,323 | 14 |
| Virginia | 16,835 | 13,993 | 11,507 | 13,112 | 17,732 | 14,861 | 13,506 | 14,800 | 15,737 | 17,131 | 15,529 | 14,977 | 11 |
| New York | 12,476 | 8,458 | 9,733 | 17,050 | 11,127 | 12,467 | 18,770 | 12,325 | 13,155 | 14,097 | 17,665 | 13,393 | 10 |
| Massachusetts | 9,865 | 9,252 | 7,626 | 15,538 | 15,984 | 14,197 | 13,896 | 14,995 | 14,351 | 15,728 | 13,428 | 13,169 | 10 |
| Maryland | 8,238 | 8,311 | 5,396 | 8,872 | 8,366 | 7,102 | 10,622 | 5,293 | 8,608 | 8,306 | 9,302 | 8,038 | 6 |
| Rhode Island | 3,225 | 3,567 | 3,817 | 7,020 | 4,457 | 4,063 | 4,412 | 4,409 | 4,072 | 3,721 | 4,596 | 4,305 | 3 |
| South Carolina | 4,492 | 3,356 | 2,628 | 2,834 | 3,156 | 1,794 | 3,781 | 4,402 | 3,120 | 4,132 | 4,234 | 3,448 | 3 |
| Connecticut | 3,228 | 3,424 | 2,575 | 3,029 | 3,432 | 4,024 | 6,026 | 4,339 | 4,837 | 5,629 | 6,139 | 4,244 | 3 |
| Delaware | 2,751 | 2,463 | 2,021 | 3,486 | 3,246 | 3,486 | 1,827 | 1,801 | 2,213 | 2,569 | 1,823 | 2,517 | 2 |
| Georgia | 1,339 | 1,049 | 1,772 | 2,202 | 2,017 | 1,101 | 2,203 | 1,931 | 1,641 | 1,747 | 2,096 | 1,736 | 1 |
| Maine | 1,516 | 705 | 802 | 1,571 | 1,964 | 1,801 | 748 | 1,274 | 1,377 | 1,077 | 1,653 | 1,317 | 1 |
| New Hampshire | 1,479 | 588 | 833 | 1,074 | 2,150 | 1,104 | 1,451 | 869 | 1,726 | 1,714 | 1,512 | 1,318 | 1 |
| Total | 129,247 | 105,185 | 106,784 | 152,540 | 149,617 | 121,500 | 142,352 | 132,048 | 134,728 | 146,706 | 145,966 | 133,334 | na |

*Source: National Marine Fisheries Service. Fisheries of the United States, annual reports.

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. Other commercial fishermen have transitioned away from selling their catch, but continue to fish with a Recreational Commercial Gear License (RCGL) for personal pleasure. In 2008, there were 5113 RCGL licenses sold.

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 as far back as the 1930s (Godwin et al. 1971). While commercial fishing has declined in recent years, recreational fishing has increased as North Carolina's resident and visitor population has grown. Tens of thousands of private recreational boaters fish the coastal waters, while thousands more fish from the shore, piers, and other structures. In 2007, it was estimated that about 1.9 million anglers went fishing in coastal North Carolina, with a total of approximately 6.9 million recreational fishing trips (DMF 2008). This includes trips from land, private boat, headboats, and both resident and non-resident fisherman. Diaby (1997) estimated that sport fishing contributed almost \$75 million to the Carteret County economy, supporting over 1,800 jobs. In January 2007, GS 113-174 required establishment of a coastal recreational fishing license. This will allow better estimates of recreational fishing effort. In 2007, approximately 470,000 recreational fishing licenses were issued, of which approximately one third were for out-of-state visitors. Wake, New Hanover, Onslow, Carteret, and Brunswick counties accounted for the greatest number of licenses.

1.5.2.2. Protected species

North Carolina state law [G.S. 113-331] protects endangered, threatened, and special concern species of mammals, birds, reptiles, amphibians, freshwater fishes, freshwater and terrestrial mollusks, and freshwater and terrestrial crustaceans under the jurisdiction of the North Carolina Wildlife Resources Commission. 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 at the state level and as a candidate for listing at the federal level. A MFC rule [15A NCAC 3M .0508] prohibits possession of any sturgeon in North Carolina's coastal waters. Shortnose sturgeon and Atlantic sturgeon occur in riverine, estuarine, and marine systems within the CHPP management area.

Beginning in 2004, the NC NHP decided to no longer track marine and estuarine fishes due to insufficient data, and difficulty of surveying and protecting fish species that occur in salt and brackish waters (LeGrand et al. 2008). The North Carolina Natural Heritage Program (NHP) had previously tracked five marine and estuarine fishes considered as significantly rare: spinycheek sleeper (*Eleotris pisonis*), lyre goby (*Evorthodus lyricus*), 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.

Other marine and estuarine species tracked 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, mollusks, and mammals tracked by NHP associated with salt marshes and other coastal wetlands [LeGrand et al. 2008 (NHP animals); Buchanan and Finnegan 2008 (NHP plants)]. Tracked estuarine species include the Carolina diamondback terrapin (*Malaclemys terrapin centrala*), Carolina salt marsh snake (*Nerodia sipedon williamenglelsi*), and the federally listed piping plover (*Charadrius melodus*), which inhabit ocean beaches and inlet shorelines.

In addition to species tracked 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 novaeangliae*) 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 long-finned pilot whales (*Globicephala melas*).

1.6. Status of fisheries

The current status of fisheries may in part be an indicator of habitat conditions or indicate the fisheries for which it would be particularly important to minimize habitat degradation due to an already stressed fish population. The status of North Carolina's coastal fishery stocks are evaluated every year by DMF. A stock is defined as 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. This information is incorporated into MFC Fishery Management Plans to determine appropriate management actions and goals for a fishery.

Table 1.6 lists 5-year average landings in pounds of commercially and recreationally important fishery species during the previous CHPP cycle and in the last five years. Commercially, Atlantic menhaden, blue crab, Atlantic croaker, shrimp, and flounder have accounted for the most landings during both time periods. In the past five years, average landings of Atlantic menhaden greatly declined due to the closure of the single menhaden plant in North Carolina. Blue crab and shrimp landings declined, while Atlantic croaker slightly increased. Commercial catch of thirteen of the nineteen fishery species listed declined in the past five years. Recreationally, striped bass, spot, bluefish, snapper-grouper, and spotted seatrout accounted for the most landings in the past decade. Of the ten species listed with recreational data, landings of seven fishery species have increased in the past five years, including all of the most abundant. Summer flounder, Atlantic croaker, and red drum landings decreased slightly.

Stock status terms were modified by DMF in 2007 to better address the assignment of a status to stocks that have unapproved or no stock assessment, or whose stock assessments are too unreliable to determine a status. In addition, the term "Overfished" was changed to "Depleted" to address those stocks that may have other factors besides fishing contributing to low population abundances. Categories now include:

- **Viable** - Viable stocks exhibit stable or increasing trends in average length and weight, catch per unit effort, spawning stock biomass, juvenile abundance indexes based on historical averages, stable age structure that includes representatives of the older age classes, and stable or declining trends in fishing mortality. Stocks deemed recovered by a Division of Marine Fisheries (DMF), Atlantic States Marine Fisheries Commission (ASMFC), or regional Council fishery management plan (FMP) would be considered "viable". A stock is considered "recovered" when it has reached the target(s) for sustainable harvest, spawning stock biomass, spawning potential ratio, fishing mortality, size/age structure, or any other biological target required in an approved DMF, ASMFC and/or regional Council FMP. (No Overfishing; Not Overfished)¹
- **Recovering** - Recovering stocks are those stocks that show marked and consistent improvement in the criteria listed for a "viable" stock. A "recovering" species may still be depleted but would be defined as one that, under a current plan, shows measurable and consistent improvement but has not yet reached the target(s) of a specific FMP. (No Overfishing; Overfished)*

¹ Overfishing/overfished designations result from completed stock assessments.

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- **Concern** - Stocks designated as “concern” are those stocks that exhibit increased effort, declining landings, truncated age distribution, or are negatively impacted by biotic and/or abiotic factors that cannot be controlled (example: water quality, habitat loss, disease, life history, predation, etc). Stocks with or without an approved stock assessment or FMP but are exhibiting declining trends may be classified as “concern”. (Overfishing; Not Overfished)* Stocks whose assessments have unreliable benchmarks may also be classified as “concern” (Example: Overfishing cannot be determined)
- **Depleted** – Depleted stocks are those stocks where the spawning stock abundance is below a predetermined threshold or where low stock abundance precludes an active fishery. Factors that can contribute to “depleted” status include but are not limited to fishing, predation, competition, water quality, habitat loss, recruitment variability, disease, or a combination of these factors. Determination is based on approved DMF, ASMFC, and/or regional Council FMPs and/or stock assessments. Species designated as “depleted” would be priority candidates for FMP development.
- **Unknown** - Stocks for which insufficient data are available to determine trends in effort, landings, age distribution, recruitment, etc. are classified as “unknown”. Many stocks that have been designated as “unknown” have been picked up in DMF sampling programs that may result in sufficient data to designate a status in the future.

Of the fishery species listed in Table 1.6, comprising at least 25 fish stocks, eight stocks are Viable (32%), two are Recovering (8%), eight are Concern (33%), six are Depleted (24%), and one is Unknown (4%), as of 2008 (Table 1.7). Depleted stocks include black sea bass south of Hatteras, bay scallop, river herring (Albemarle stock), southern flounder, and striped bass (central/southern stock). Species that have demonstrated a decline in their stock status since the last CHPP include bay scallop, weakfish, spot, summer flounder, gag, and black sea bass north of Hatteras. Species with improved stock status include Atlantic croaker, bluefish, and striped mullet. Others remained the same. For more information on the status of individual fishery species, see the DMF website at <http://www.ncdmf.net/stocks/index.html>.

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Table 1.6. Average annual North Carolina landings for important commercial and recreational fishery species reported during the first (1997-2002) CHPP cycle and last five years. (Sorted alphabetically; Recreational landings include a+b1 landing type; Source: DMF fisheries landings data)

| Species | Average commercial fisheries landings | | | Average recreational fisheries landings | | | Lead FMP agency |
|----------------------------|---------------------------------------|----------------|-------------|---|----------------|-------------|---|
| | 1997-2002 (lb) | 2003-2007 (lb) | 5 yr Change | 1997-2002 (lb) | 2003-2007 (lb) | 5 yr Change | |
| American shad | 233,718 | 268,359 | + | Unknown | Unknown | | ASMFC |
| Atlantic croaker | 10,692,337 | 11,782,240 | + | 276,740 | 193,490 | - | ASMFC |
| Atlantic menhaden | 63,330,289 | 17,812,110 | - | Unknown | Unknown | | ASMFC |
| Bay scallops | 39,903 | 2,855 | - | Unknown | Unknown | | DMF |
| Blue crab | 47,673,736 | 29,819,727 | - | Unknown | Unknown | | DMF |
| Bluefish | 3,240,218 | 3,038,788 | - | 838,102 | 1,141,502 | + | ASMFC/NMFS |
| Hard clams | 671,716 | 467,317 | - | Unknown | Unknown | | DMF |
| Oysters | 234,445 | 379,268 | + | Unknown | Unknown | | DMF |
| Red drum | 203,537 | 137,249 | - | 255,884 | 202,314 | - | ASMFC/DMF |
| River herring | 352,364 | 149,845 | - | Unknown | Unknown | | ASMFC / DMF |
| Shrimp | 7,688,851 | 5,738,901 | - | Unknown | Unknown | | DMF < 3 mi, NMFS > 3 mi |
| Snapper/grouper / sea bass | 1,788,967 | 1,792,935 | + | 409,521 | 757,759 | + | NMFS |
| Southern flounder | 3,523,763 | 2,178,931 | - | 134,186 | 349,569 | + | DMF |
| Spot | 2,563,527 | 1,663,773 | - | 1,028,822 | 1,404,384 | + | ASMFC |
| Spotted seatrout | 290,303 | 225,873 | - | 419,273 | 618,003 | + | ASMFC |
| Striped bass | 555,421 | 639,960 | + | 663,626 | 2,364,036 | + | ASMFC - ocean, DMF/WRC - internal waters |
| Striped mullet | 2,311,092 | 1,649,147 | - | Unknown | Unknown | | DMF |
| Summer flounder | 2,938,425 | 3,826,534 | + | 381,729 | 209921 | - | ASMFC/NMFS |
| Weakfish | 2,531,015 | 498,949 | - | 116,632 | 171,598 | + | ASMFC/NMFS |

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 and a fishing moratorium. Although the role of environmental factors in the river herring decline is uncertain, the center of river

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herring abundance (Chowan and Roanoke rivers) has suffered from water quality problems since the 1970s and stream obstructions and flow alterations.

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, 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 1.7. Trends in the stock status of important fishery species and stocks listed in Table 1.6. (1998–2010).

| Species/stocks | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|------|------|------|------|------|------|------|------|------|------|------|------|------|
| American shad | ? | ? | ? | | | | | | | | | | |
| Atlantic croaker | | | | | | | | | | | | | |
| Atlantic menhaden | | | | | | | | | | | | | |
| Bay scallops | | | | | | | | | | | | | |
| Black sea bass (N. of Hatteras) | | | | | | | | | | | | | |
| Black sea bass (S. of Hatteras) | | | | | | | | | | | | | |
| Blue crab | ? | | | | | | | | | | | | |
| Bluefish | | | | | | | | | | | | | |
| Gag | ? | | | | | | | | | | | | |
| Oysters | | | | | | | | | | | | | |
| Red drum | | | | | | | | | | | | | |
| Reef fish | | | | | | | | | | | | | |
| River herring (Albemarle) | | | | | | | | | | | | | |
| Shrimp | | | | | | | | | | | | | |
| Southern flounder | | | | | | | | | | | | | |
| Spot | | | | | | | | | | | | | |
| Spotted seatrout | | | | | | | | | | | | | |
| Striped bass (Albemarle) | | | | | | | | | | | | | |
| Striped bass (except Ocean and Albemarle) | ? | ? | ? | | | | | | | | | | |
| Striped bass (Ocean) | | | | | | | | | | | | | |
| Striped mullet | ? | | | | | | | | | | | | |
| Summer flounder | | | | | | | | | | | | | |
| Weakfish | | | | | | | | | | | | | |

| | | | | |
|--|--|--|--|---|
| | | | | ? |
|--|--|--|--|---|

Depleted

Concern

Recovering

Viable

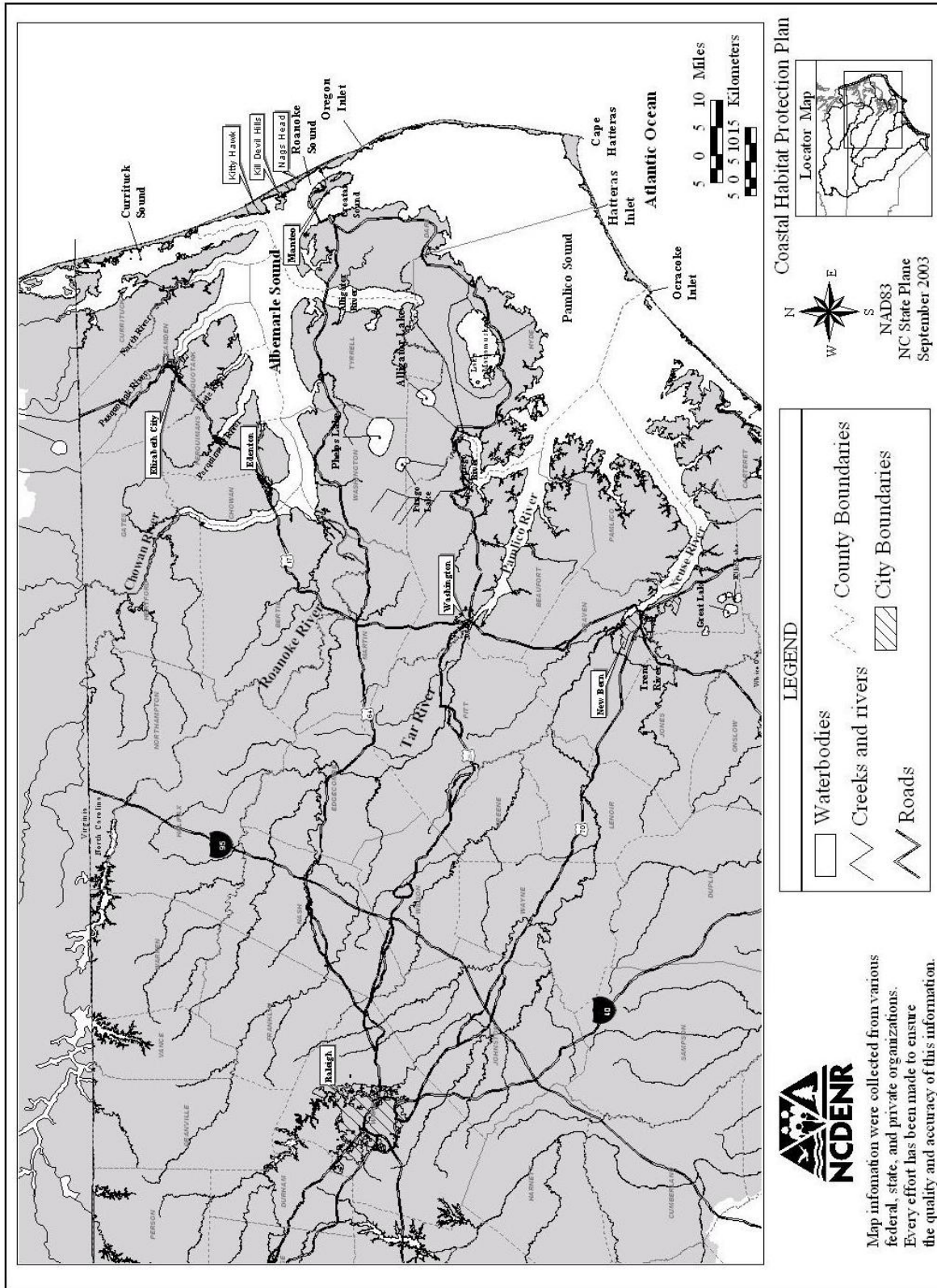
Unknown

1.7. Habitat concepts and terminology

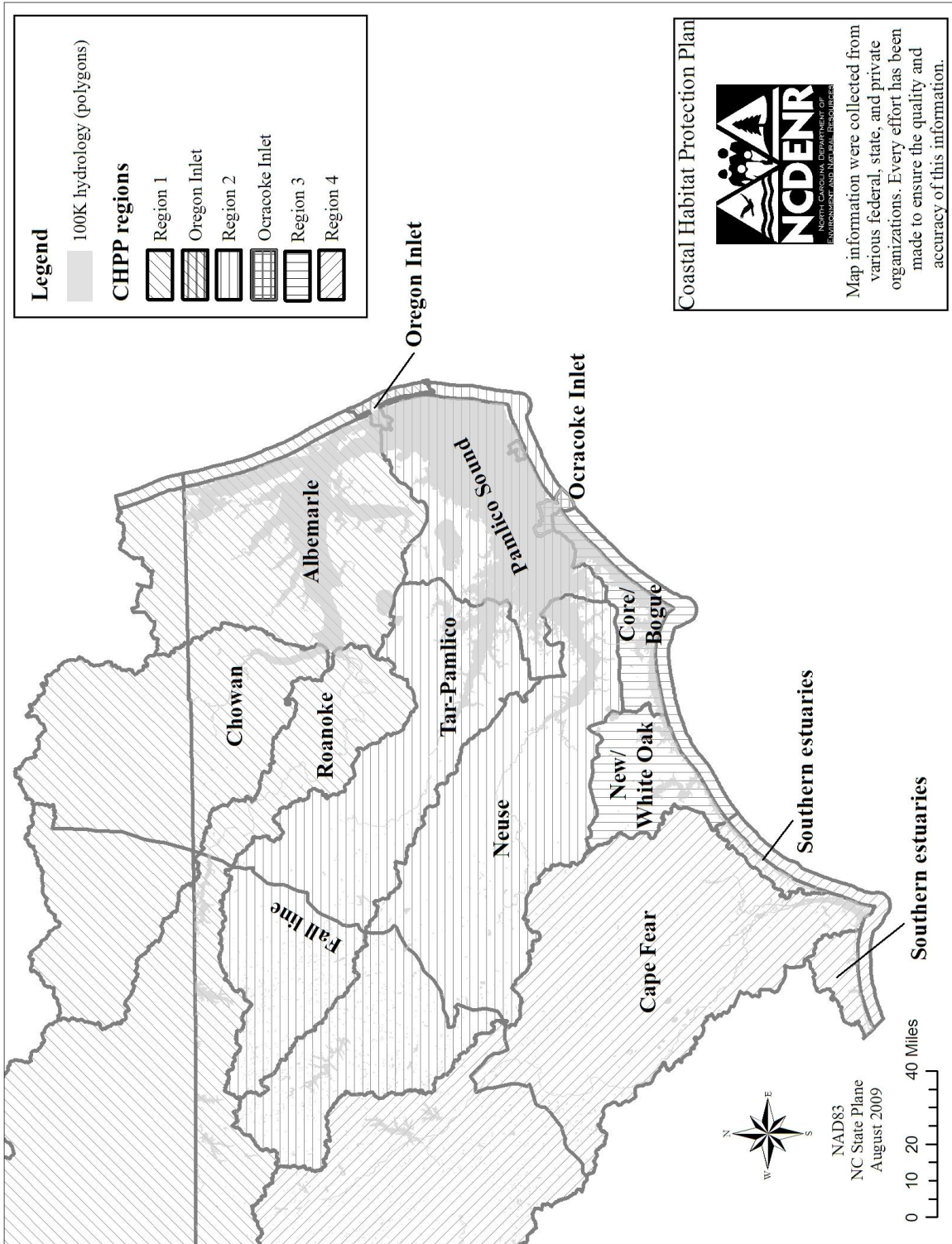
The following habitat chapters contain numerous technical terms and acronyms that may not be familiar to the average reader. A complete list of terms and acronyms is found in Appendix C.

Habitat is simply the place where an organism lives (Odum 1959). Fish Habitat (FH) is 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. 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, shell bottom, submerged aquatic vegetation (SAV), wetlands, and hard bottom.

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.



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



Map 1.2. The CHPP region and subregion boundaries (based on USGS hydrologic units), along with the fall line separating Coastal Plains and Piedmont physiographic regions.