

Chapter 8

Population and Natural Resources in the Chowan River Basin

8.1 Population Growth and Development

North Carolina's coastal counties are some of the fastest growing areas in the state and the associated development is impacting water quality. Two of the five counties in the basin are expected to experience growth rates in excess of ten percent by 2020 (Table 15). As the counties in the Chowan River basin continue to grow along the inner waterways there will likely be a loss of natural areas and an increase in the amount of impervious surface associated with new homes and businesses.

County population data present projected county growth estimates based on Office of State Planning information (June 2006) (Table 15). Counties with the highest expected growth are associated with the largest municipal areas and the most densely populated subbasins within the basin.

Table 15 County Population and Growth Estimates

County	Percent of County in Basin ♦	1990 Population	2000 Population	Estimated % Growth 1990-2000	Estimated Population 2020	Estimated % Growth 2000-2020
Bertie	30	20,388	19,757	-3.2	18,668	-5.8
Chowan	67	13,506	14,150	4.6	15,154	6.6
Gates	80	9,305	10,516	11.5	12,962	18.9
Hertford	100	22,317	22,977	2.9	25,062	8.3
Northampton	65	21,004	22,086	4.9	25,062	11.9
Subtotals		86,520	89,486	20.6	96,908	39.9

♦ Source: North Carolina Center for Geographic Information and Analysis (CGIA), 1997.

Note: The numbers reported reflect county population; however, these counties are not entirely within the basin. The intent is to demonstrate growth for counties located wholly or partially within the basin.

Table 16 presents population data from Office of State Planning for municipalities located wholly or partly within the basin. Data presented by municipality summarize information on past growth of urban areas in the basin.

Table 16 Population Data by Municipality in the Chowan River Basin

Municipality	County	April 1980	April 1990	April 2000	Percent Change (1980-1990)	Percent Change (1990-2000)
Ahoskie	Hertford	4,887	4,535	4,523	-7.2	-0.3
Aulander*	Bertie	1,214	1,209	888	-0.4	-26.6
Cofield	Hertford	465	407	347	-12.5	-14.7
Colerain	Bertie	284	241	221	-15.1	-8.3
Como	Hertford	89	102	78	14.6	-23.5
Conway	Northampton	678	759	734	11.9	-3.3
Edenton	Chowan	5,357	5,268	5,394	-1.7	2.4
Gaston*	Northampton	883	1,003	973	13.6	-3.0
Gatesville	Gates	363	308	281	-15.2	-8.8
Harrellsville	Hertford	151	106	102	-29.8	-3.8
Jackson*	Northampton	720	592	695	-17.8	17.4
Lasker	Northampton	96	139	103	44.8	-25.9
Murfreesboro	Hertford	3,007	2,580	2,045	-14.2	-20.7
Powellsville	Bertie	320	279	259	-12.8	-7.2
Rich Square*	Northampton	1,057	1,058	931	0.1	-12.0
Seaboard	Northampton	687	791	695	15.1	-12.1
Severn	Northampton	309	260	263	-15.9	1.2
Winton	Hertford	825	796	956	-3.5	20.1
Woodland	Northampton	861	760	833	-11.7	9.6

* The numbers reported reflect municipality population; however, these municipalities are not entirely within the basin. The intent is to demonstrate growth for municipalities located wholly or partially within the basin

Population trends in the Chowan basin show a decline in rural areas and an increase in population and development along inland waterways. While in most towns population decreased between 1990 and 2000, the overall basinwide population is expected to increase. Planning for sustainable growth in the Chowan River basin requires awareness, understanding and implementation of sound design and management options. The natural resources and waterways contribute to our quality of life while supporting and promoting economic growth. Communities should anticipate growth while incorporating Low Impact Development technologies in their planning to promote long-term sustainability of our natural resources. The NC Division of Coastal Management with NC Sea Grant and NCSU College of Design developed *The Soundfront Series*, informational guides to assist property owners and community planners and managers. The guides are available in print and on the web. <http://www.ncseagrant.org/>.

8.2 River Basin Hydrologic Units

Under the federal system, the Chowan River basin is made up of hydrologic areas referred to as cataloging units (USGS 8-digit hydrologic units). Cataloging units are further divided into smaller watershed units (14-digit hydrologic units) that are used for smaller scale (Table 17).

Table 17 Hydrologic Subdivisions in the Chowan River Basin

Watershed Name and Major Tributaries	DWQ Subbasin 6-digit Codes	USGS 8-digit Hydrologic Units	USGS 14-digit Hydrologic Units*
<i>Chowan River</i>		03010203	010010, 020010, 030010, 030020, 030030, 040010, 040020, 040040, 050010, 050011, 050012, 050020, 050030, 060010, 060011, 060012, 060020, 060030, 060040, 090010, 040030, 070010, 070020, 080020, 090015, 100010
Upper Chowan River and Ahoskie Creek	03-01-01		
Middle Chowan River and tributaries	03-01-03		
Lower Chowan and tributaries	03-01-04		
<i>Meherrin River and tributaries</i>	03-01-02	03010204	140010, 140020, 140030, 180010, 180020, 180030, 180040, 190010, 200010, 210010, 210020, 210030, 210040

*Numbers from the 8-digit and 14-digit column make the full 14-digit HU.

8.3 Water Resources and Water Supply Planning

NC DENR Division of Water Resources (DWR) administers programs for river basin management, water supply assistance, water conservation, and water resources development. The Division conducts special studies on instream flow needs and serves as the State liaison with federal agencies on major water resources related projects. The DWR also administers two environmental education outreach programs, Stream Watch and Project WET. For more information about the Chowan River basin visit <http://www.ncwater.org/basins/Chowan/>.

8.4 Water Quality Issues Related to Drought

Water quality problems associated with rainfall events usually involve degradation of aquatic habitats because the high flows may carry increased loadings of substances like metals, oils, herbicides, pesticides, sand, clay, organic material, bacteria and nutrients. These substances can be toxic to aquatic life (fish and insects) or may result in oxygen depletion or sedimentation. During drought conditions, these pollutants become more concentrated in streams due to reduced flow. Summer months are generally the most critical months for water quality. Dissolved oxygen is naturally lower due to higher temperatures, algae grow more due to longer periods of sunlight, and streamflows are reduced. In a long-term drought, these problems can be greatly exacerbated and the potential for water quality problems to become catastrophic is increased. This section discusses water quality problems that can be expected during low flow conditions.

The frequency of acute impacts due to nonpoint source pollution (runoff) is actually minimized during drought conditions. However, when rain events do occur, pollutants that have been collecting on the land surface are quickly delivered to streams. When streamflows are well below normal, this polluted runoff becomes a larger percentage of the water flowing in the stream. Point sources may also have water quality impacts during drought conditions even though permit limits are being met. Facilities that discharge wastewater have permit limits that are based on the historic low flow conditions. During droughts these wastewater discharges

make up a larger percentage of the water flowing in streams than normal and might contribute to lowered dissolved oxygen concentrations and increased levels of other pollutants.

As streamflows decrease, there is less habitat available for aquatic insects and fish. There is also less water available for irrigation and for water supplies. The dry conditions and increased removal of water for these uses further increases strain on the resource. With less habitat, naturally lower dissolved oxygen levels and higher water temperatures, the potential for large kills of fish and aquatic insects is very high. These conditions may stress the fish to the point where they become more susceptible to disease and where stresses that normally would not harm them result in mortality.

These are also areas where longer retention times due to decreased flows allow algae to take full advantage of the nutrients present resulting in algal blooms. During the daylight hours, algae greatly increase the amount of dissolved oxygen in the water, but at night, algal respiration and die off can cause dissolved oxygen levels to drop low enough to cause fish kills. Besides increasing the frequency of fish kills, algal blooms can also cause difficulty in water treatment resulting in taste and odor problems in finished drinking water.

8.5 Source Water Assessment of Public Water Supplies

8.5.1 Introduction

The Federal Safe Drinking Water Act (SDWA) Amendments of 1996 emphasize pollution prevention as an important strategy for the protection of ground and surface water resources. This focus promotes the prevention of drinking water contamination as a cost-effective means to provide reliable, long-term and safe drinking water sources for public water supply (PWS) systems. In order to determine the susceptibility of public water supply sources to contamination, the amendments also required that all states establish a Source Water Assessment Program (SWAP). Specifically, Section 1453 of the SDWA Amendments require that states develop and implement a SWAP to:

- Delineate source water assessment areas;
- Inventory potential contaminants in these areas; and
- Determine the susceptibility of each public water supply to contamination.

In North Carolina, the agency responsible for the PWS is the Public Water Supply (PWS) Section of the DENR Division of Environmental Health (DEH). The PWS Section received approval from the EPA for their SWAP Plan in November 1999. The SWAP Plan, entitled *North Carolina's Source Water Assessment Program Plan*, fully describes the methods and procedures used to delineate and assess the susceptibility of more than 9,000 wells and approximately 207 surface water intakes. To review the SWAP Plan, visit the PWS website at <http://www.deh.enr.state.nc.us/pws/index.htm>.

8.5.2 Delineation of Source Water Assessment Areas

The SWAP Plan builds upon existing protection programs for ground and surface water resources. These include the state's Wellhead Protection Program and the Water Supply Watershed Protection Program.

Wellhead Protection (WHP) Program

North Carolinians withdraw more than 88 million gallons of groundwater per day from more than 9,000 water supply wells across the state. In 1996, Congress passed Amendments to the SDWA requiring states to develop wellhead protection programs that reduce the threat to the quality of groundwater used for drinking water by identifying and managing recharge areas to specific wells or wellfields.

Defining a wellhead protection area (WHPA) is one of the most critical components of wellhead protection. A WHPA is defined as “the surface and subsurface area surrounding a water well or wellfield, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield.” The SWAP uses the methods described in the state's approved WHP Program to delineate source water assessment areas for all public water supply wells. More information related to North Carolina’s WHP Program can be found at: <http://www.deh.enr.state.nc.us/pws/swap>.

Water Supply Watershed Protection (WSWP) Program

DWQ is responsible for managing the standards and classifications of all water supply watersheds. In 1992, the WSWP Rules were adopted by the EMC and require all local governments that have land use jurisdiction within water supply watersheds adopt and implement water supply watershed protection ordinances, maps and management plans. SWAP uses the established water supply watershed boundaries and methods established by the WSWP program as a basis to delineate source water assessment areas for all public water surface water intakes. Additional information regarding the WSWP Program can be found at <http://www.newwaterquality.org/wswp/>.

8.5.3 Susceptibility Determination – North Carolina’s Overall Approach

The SWAP Plan contains a detailed description of the methods used to assess the susceptibility of each PWS intake in North Carolina. The following is a brief summary of the susceptibility determination approach.

Overall Susceptibility Rating

The overall susceptibility determination rates the potential for a drinking water source to become contaminated. The overall susceptibility rating for each PWS intake is based on two key components: a contaminant rating and an inherent vulnerability rating. For a PWS to be determined “susceptible,” a potential contaminant source must be present and the existing conditions of the PWS intake location must be such that a water supply could become contaminated. The determination of susceptibility for each PWS intake is based on combining the results of the inherent vulnerability rating and the contaminant rating for each intake. Once combined, a PWS is given a susceptibility rating of higher, moderate or lower (H, M or L).

Inherent Vulnerability Rating

Inherent vulnerability refers to the physical characteristics and existing conditions of the watershed or aquifer. The inherent vulnerability rating of groundwater intakes is determined based on an evaluation of aquifer characteristics, unsaturated zone characteristics and well integrity and construction characteristics. The inherent vulnerability rating of surface water intakes is determined based on an evaluation of the watershed classification (WSWP Rules), intake location, raw water quality data (i.e., turbidity and total coliform) and watershed

characteristics (i.e., average annual precipitation, land slope, land use, land cover, groundwater contribution).

Contaminant Rating

The contaminant rating is based on an evaluation of the density of potential contaminant sources (PCSs), their relative risk potential to cause contamination, and their proximity to the water supply intake within the delineated assessment area.

Inventory of Potential Contaminant Sources (PCSs)

In order to inventory PCSs, the SWAP conducted a review of relevant and available sources of existing data at federal, state and local levels. The SWAP selected sixteen statewide databases that contained usable geographic information related to PCSs.

8.5.4 Source Water Protection

The PWS Section believes that the information from the source water assessments will become the basis for future initiatives and priorities for public drinking water source water protection (SWP) activities. The PWS Section encourages all PWS system owners to implement efforts to manage identified sources of contamination and to reduce or eliminate potential threats to drinking water supplies through locally implemented programs

To encourage and support local SWP, the state offers PWS system owners assistance with local SWP as well as materials such as:

- Fact sheets outlining sources of funding and other resources for local SWP efforts.
- Success stories describing local SWP efforts in North Carolina.
- Guidance about how to incorporate SWAP and SWP information in Consumer Confidence Reports (CCRs).

Information related to SWP can be found at <http://www.deh.enr.state.nc.us/pws/swap>.

8.5.5 Public Water Supply Susceptibility Determinations in the Chowan River Basin

In April 2004, the PWS Section completed source water assessments for all drinking water sources and generated reports for the PWS systems using these sources. A second round of assessments were completed in April 2005. The results of the assessments can be viewed in two ways, either through the interactive ArcIMS mapping tool or compiled in a written report for each PWS system. To access the ArcIMS mapping tool, simply click on the “NC SWAP Info” icon on the PWS web page (<http://www.deh.enr.state.nc.us/pws/swap>). To view a report, select the PWS System of interest by clicking on the “SWAP Reports” icon.

In the Chowan River basin, 75 public water supply sources were identified, all of which are groundwater wells. Of the 75 groundwater sources, 4 of them have a Higher, 29 have a Moderate and 42 have a Lower susceptibility rating. It is important to note that a susceptibility rating of Higher does not imply poor water quality. Susceptibility is an indication of a water supply's potential to become contaminated by the identified PCSs within the assessment area.

8.6 Changes in Land Cover

Land cover can be an important way to evaluate the effects of land use changes on water quality. Unfortunately, the tools and database to do this on a watershed scale are not yet available. Land cover information from the National Resources Inventory (NRI) published by the Natural Resource Conservation Service (NRCS) is presented only at an 8-digit hydrologic unit scale. This information is presented to provide a picture of the different land covers and developing land use trends in the Chowan River basin, while noting that the data is outdated and does not reflect recent development along North Carolina's waterways.

Land cover information in this section is from the most current NRI, as developed by the NRCS (USDA-NRCS, June 2001). The NRI is a statistically based longitudinal survey that has been designed and implemented to assess conditions and trends of soil, water and related resources on the Nation's nonfederal rural lands. The NRI provides results that are nationally and temporally consistent for four points in time -- 1982, 1987, 1992 and 1997. The USDA is working to provide updates to land cover data in the near future.

In general, NRI protocols and definitions remain fixed for each inventory year. However, part of the inventory process is that the previously recorded data are carefully reviewed as determinations are made for the new inventory year. For those cases where a protocol or definition needs to be modified, all historical data must be edited and reviewed on a point-by-point basis to make sure that data for all years are consistent and properly calibrated. The following excerpt from the *Summary Report: 1997 National Resources Inventory* provides guidance for use and interpretation of current NRI data:

The 1997 NRI database has been designed for use in detecting significant changes in resource conditions relative to the years 1982, 1987, 1992 and 1997. All comparisons for two points in time should be made using the new 1997 NRI database. Comparisons made using data previously published for the 1982, 1987 or 1992 NRI may provide erroneous results because of changes in statistical estimation protocols, and because all data collected prior to 1997 were simultaneously reviewed (edited) as 1997 NRI data were collected.

Table 18 summarizes acreage and percentage of land cover from the 1997 NRI for the major watersheds within the basin, as defined by the USGS 8-digit hydrologic units, and compares the coverages to 1982 land cover.

Table 18 Land Cover in the Chowan River Basin by Major Watersheds: 1982 vs. 1997

LAND COVER	MAJOR WATERSHED AREAS *								
	Chowan River Watershed		Meherrin River Watershed		1997 TOTALS		1982 TOTALS		% change since 1982
	Acres (1000s)	%	Acres (1000s)	%	Acres (1000s)	% of TOTAL	Acres (1000s)	% of TOTAL	
Cultivated. Crop	142.4	30.3	119.6	35.8	262.0	32.6	264.1	32.8	-0.8
Uncultivated. Crop	1.5	0.3	0.0	0.0	1.5	0.2	0.0	0.0	150.0
Pasture	3.1	0.7	4.9	1.5	8.0	1.0	10.5	1.3	-23.8
Forest	266.7	56.7	174.8	52.3	441.5	54.9	445.9	55.4	-1.0
Urban & Built-Up	11.2	2.4	11.5	3.4	22.7	2.8	14.0	1.7	62.1
Federal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	45.7	9.7	23.2	6.9	68.9	8.6	70.3	8.7	-2.0
Totals	470.6	100.0	334.0	100.0	804.6	100.0	804.8	100.0	
Percent of Total Basin		58.5		41.5		100.0			
SUBBASINS	03-01-01 03-01-03 03-01-04 **		03-01-02						
8-Digit Hydraulic Units	03010203		03010204						

* = Watershed areas defined by the 8-Digit Hydraulic Units do not necessarily coincide with subbasin titles used by DWQ.

** A small portion of subbasin 03-01-04 is contained in hydrologic unit 03010205.

It is not currently feasible to estimate the land use in that portion to include the Chowan land cover estimates.

The hydrologic unit 03010205 is discussed in the Pasquotank River Basin Water Quality Plan.

Forest and wetlands (both private and federal forests) cover approximately 55 percent of the basin. Agriculture (including cultivated and uncultivated cropland and pastureland) covers approximately 34 percent of the land area. The urban and built-up category comprises roughly 3 percent. Cultivated cropland and forestland cover both decreased in the basin. Uncultivated cropland and pastureland cover had the most significant changes.

8.7 Forest Management

Approximately 86 percent of forestland in the Chowan River basin is privately owned; 12 percent is owned by forest industry and the rest is publicly owned. These ownership estimates come from the most recent Forestry Inventory and Analysis data published by the USDA-Forest Service (*Forest Statistics for North Carolina, 2002*. Brown, Mark J. Southern Research Station Resource Bulletin SRS-88. January 2004).

At least 44,933 acres of land were planted or regenerated with forest trees across the basin from September 1, 2000 through August 31, 2005. During this same time period, the North Carolina Division of Forest Resources (DFR) provided individual forest plans for landowners that encompassed over 83,959 acres in the basin. This includes 2,078 plans, such as pre-harvest, rehabilitation and forest stewardship plans, which provide site specific guidance for water quality protection.

The DFR operates a 700+ acre tree nursery in Goldsboro. The nursery grows 9 species of conifers and 51 species of hardwoods that are available for forest management and stream/wetland restoration projects. There is a distribution center located in Edenton where these seedlings can be picked up once they are purchased. Call 1-888-NC TREES (628-7337) for more information or visit the Web site noted above.

Uncontrolled high intensity fires can combust excessive amounts of ground cover and vegetation and have the potential to negatively impact water quality. DFR performs hazard reduction burns

to reduce fuel load and therefore wild fire hazard. During the period covered by this Plan, nearly 3,000 acres of land were either prepared or burned for the reduction of hazardous fuels.

8.7.1 Forest Practices Guidelines Related to Water Quality (FPGs)

The DFR is delegated the authority to monitor and evaluate forestry operations for compliance with laws and/or rules. Forestry operations in North Carolina are subject to regulation under the Sedimentation Pollution Control Act (SPCA) of 1973. However, forestry operations are exempt from the permit and plan requirements of the SPCA if the operations meet the compliance standards outlined in the Forest Practices Guidelines Related to Water Quality (FPG) and General Statutes regarding stream obstruction. For more information regarding forest practices guidelines related to water quality please visit Chapter 7 in the *Supplemental Guide to North Carolina's Basinwide Planning: Support Document for Basinwide Water Quality Plans*: <http://www.newaterquality.org/basinwide/SupplementalGuide.htm>.

DFR has personnel in all 100 counties who perform FPG inspections and handle other basic water quality related tasks on a daily basis. In addition, ten of its thirteen Districts across the State also have specialists known as Water Quality Foresters. The entire Chowan River basin now has coverage by Water Quality Foresters, thanks to a new position that was established in 2005, which is based out the Elizabeth City District Office. Water Quality Foresters conduct FPG inspections, survey BMP implementation, check for compliance with forest harvest requirements of state buffer rules, develop pre-harvest plans, provide training opportunities for landowners, loggers, and the public regarding water quality issues related to forestry, and assist other DFR staff with more technical water quality issues.

During the period September 1, 2000 through August 31, 2005 the DFR inspected 1,400 forestry sites for FPG compliance in the basin; 96 percent of the sites inspected were in compliance. In addition, 121 re-inspections were performed to ensure that sites continued to be or were brought into compliance with the FPGs.

8.7.2 Forestry Best Management Practices

Implementing Forestry BMPs is strongly encouraged by DFR in order to efficiently and effectively protect the water resources of North Carolina and help maintain compliance with the FPGs. During this Plan's reporting period, DFR provided 700 written or verbal BMP recommendations on tracts totaling 32,733 acres in the Chowan River Basin. To further assess BMPs, the DFR conducted a detailed, statewide BMP Implementation Survey from March 2000 through March 2003 to evaluate Forestry BMPs on active harvest operations. During that time period, 23 of those surveys were performed in the Chowan River basin. On those sites, implementation of recommended BMPs was 83 percent. Eight percent of the conditions on those sites had potential to degrade water quality. Forestry BMP implementation in the Chowan River basin was close to the statewide survey average of 82 percent. The problems most often cited in this survey relate to stream crossings, skid trails, and site rehabilitation. This survey, and future surveys to be conducted, will serve as a basis for focused efforts in the forestry community to address water quality concerns through better and more effective BMP implementation and training.

8.7.3 Bridgemats

To help prevent water quality problems associated with stream crossings, the DFR has been loaning bridgemats to loggers for establishing temporary stream crossings during harvesting activities. Temporary bridges are usually the preferred solution for stream crossings instead of culverts or hard-surfaced ‘ford’ crossings. Bridgemats are available upon request from any District Office. In 2005, the Albemarle-Pamlico National Estuary Program provided grant funding for the purchase of two steel sets of 30-foot bridgemats for use in northeastern North Carolina, with one set dedicated specifically to the Chowan River basin. There may be situations whereby the bridgemats are used in neighboring river basin areas, if the customer demand warrants. More information about using bridgemats, and the above noted BMP survey, is available on the ‘Water Quality’ section of the DFR’s website: <http://www.dfr.state.nc.us/>.

8.7.4 Forest Products Industry

The forest industry is a vital economic driver throughout the Chowan River basin, with significant forest industry operations located in the basin. In the Chowan River basin, seven different businesses are considered “Primary Processors” of forest products raw material, which represents three percent of the total number of primary processors in the state. While one of the state’s five pulp/paper mills is located in Plymouth, just beyond the boundary of the Chowan River basin, the economic importance of the mill’s demand for raw materials and its employment value circulates across river basin boundaries, throughout northeastern North Carolina. Other examples of primary processors in this basin include pine sawmills operated by Weyerhaeuser, International Paper and Georgia Pacific. All primary processors pay an assessment to the State, which is then combined with annual legislative appropriations to fund the “Forest Development Program - FDP”, which provides cost-share reforestation assistance for forest landowners.

8.8 Public Lands

A small percentage (1.2 percent) of the Chowan River basin is publicly-owned conservation land. The Chowan Swamp State Natural Area, administered by the Department of Parks and Recreation, protects more than 6,000 acres. Merchants Millpond State Park encompasses about 3,300 acres, and offers an excellent natural experience with a wide variety of plant and animal life. Wildlife Resources Commission has two small game lands within the basin: the Chowan Game Lands and the Chowan Swamp Game Lands.

8.9 Ecological Significance of the Chowan River Basin

The Chowan and Meherrin rivers still reflect the rural character of the basin. The Chowan River is known for some of the best fishing in the state, with largemouth bass, bluegill, chain pickerel, black crappie, perch and herring being some of the most sought after species. However, the Chowan River is noteworthy for more than good fishing with approximately 100 stream miles of the Chowan River are considered an Aquatic Significant Natural Heritage Areas by the North Carolina Natural Heritage Program (NHP). The NHP is working to catalog North Carolina’s Aquatic Significant Natural Heritage Areas, identifying stretches of river and streams that contain viable populations of rare aquatic species. The Chowan River receives this designation because of the diversity of its freshwater mussel populations, many of which are rare and vulnerable.

8.9.1 Significant Natural Heritage Areas in the Chowan River Basin

The NHP inventories areas for natural diversity, and catalogs rare plant and animal species and natural communities. As previously mentioned, the Chowan River is for much of its length in North Carolina considered a state significant Aquatic Significant Natural Heritage Area. There are a number of other significant natural areas in the Chowan River basin, some of which are described below. Inclusion on the list does not imply that protection or public access exists. More complete information on natural areas may be obtained from the NHP.

A number of identified natural areas contribute to water quality, including wetland natural communities adjoining tributary streams and the mainstem rivers. Perhaps the most important wetland community in this basin is the Tidal Cypress-Gum Swamp, which is found along much of the shoreline of the Chowan River, extending as far upriver as the Chowan Swamp area of southern Gates County. Tidal swamps are distinguished by flooding caused primarily by regular or irregular (such as wind) tides rather than seasonal river flooding. This situation modifies the water quality of both brownwater and blackwater rivers and produces a different hydrologic regime (Schafale and Weakley 1990).

The **Chowan Swamp/Bennetts Creek/Catherine Creek Swamps** natural area contains some of the largest areas of Tidal Cypress-Gum Swamp in the state. The natural area consists of approximately 16,000 acres along the northern floodplain of the Chowan River.

The **Colerain/Cow Island Swamp and Slopes** natural area is similar to the Chowan Swamp, in that it lies in the floodplain of the Chowan River and features Tidal Cypress-Gum Swamp along the shoreline, as well as other wetland communities farther from the river. This natural area is located downstream from the Chowan Swamp, on the western shore of the river in Hertford and Bertie Counties.

The **Rocky Hock Swamp Forest** contains remnants of an Atlantic White Cedar Forest community. It is significant for having the only population of whisk-fern (*Psilotum nudum*) in North Carolina and represents a major range extension for this species.

The **Chinkapin Creek Hardwood Forest**, is over three square miles in area, contains one of the most extensive areas of mature upland hardwood forest natural communities remaining in the Coastal Plain of North Carolina. It also contains one of the few remnants in the state for Pine/Scrub Oak Sandhill (Northern Subtype).

The **Reedy Point Swamp** is a good example of Pond Pine Woodland, and is among the best in the region north of Albemarle Sound.

The **Wiccacon River Bluffs and Swamp** consists of a series of bluffs and dissected lands along the lower Wiccacon River. The spectacular bluffs support a band of mesic forests, and while no rare plant species are known, the Basic Mesic Forest supports a large number of species that are typical of the Piedmont and even Mountains but are quite rare in the Coastal Plain.

There are six natural areas identified as significant along the Meherrin River. The entire portion of the Meherrin River in North Carolina is also considered a regionally significant Aquatic Significant Natural Heritage Area, primarily due to high quality habitat for rare mussels. Those Significant Natural Heritage Areas important to water quality include the **Meherrin River**

Swamp in Hertford County and the **Meherrin River Slopes and Swamp** in Northampton County.

The **Meherrin River/Banks Creek Natural Area** contains one of the best occurrences of mature mesic mixed hardwood forest in the region. In addition, two outcrops of Yorktown fossil deposits occur in the bluffs.

The **Chowan River/Bartonsville Natural Area** is a State-Significant site that is located along the western margin of the Chowan River floodplain, just north of the confluence with the Meherrin River. The natural area includes representative examples of mature, old-growth swamp forest (with cypress and gum) and upland loblolly pine plant communities. Old-growth examples of these communities are rare on the coastal plain, and within the natural area one can find the former National Champion loblolly as well as significant wildlife habitat. A portion of the site was protected by a 1965 agreement with the Society of American Foresters.

Merchants Millpond was constructed in 1811 as a source of waterpower, but has not been used as such for a long time. Now Merchant's Millpond State Park's shallow pond supports an excellent Piedmont/Coastal Plain Semi-permanent Impoundment community, believed to resemble those in the large, mature beaver ponds that were eliminated from the state when beavers were extirpated. The pond has an open canopy of stunted cypress and tupelo trees, and supports a diverse assemblage of aquatic herbs. Several rare species are present: yellow water-crowfoot (*Ranunculus flabellaris*), American featherfoil (*Hottonia inflata*), pale mannagrass (*Torreyochloa pallida*), and conferva pondweed (*Potamogeton confervoides*). Upstream of the pond, in Lassiter Swamp, is an excellent quality blackwater Cypress--Gum Swamp, including an area of virgin water tupelo. The state champion water tupelo can be found in this area. The diversity of habitat supports a tremendous variety of animal life. Over 190 species of birds have been recorded in the park. Diverse populations of reptiles and amphibians and numerous mammals such as beaver, mink and river otter are also found here.

The **Wyanoke Sandhills** natural area is the northernmost longleaf pine community in the state, unusual in that it lies north of the range of wiregrass (*Aristida stricta*), which is a groundcover commonly associated with longleaf pine communities. The site also contains good examples of other uncommon natural communities, including wetlands, and a significant historical site containing Civil War earthworks.

8.9.2 Rare Aquatic and Wetland-Dwelling Animal Species

Table 19 below lists the rare aquatic species found in the Chowan River basin. For more information on rare plant and animal species, visit the NHP website: www.ncnhp.org.

Table 19 List of Rare Aquatic Species in the Chowan River Basin

Scientific Name	Common Name	State Status	Federal Status
Animals			
<i>Acipenser brevirostrum</i>	Shortnose Sturgeon	E	LE
<i>Alasmidonta undulata</i>	Triangle Floater	T	
<i>Anodonta implicata</i>	Alewife Floater	T	
<i>Lampsilis radiata radiata</i>	Eastern Lampmussel	T	
<i>Leptodea ochracea</i>	Tidewater Mucket	T	
<i>Ligumia nasuta</i>	Eastern Pondmussel	T	
<i>Orconectes virginienensis</i>	Chowanoke Crayfish	SC	FSC
Plants			
<i>Hottonia inflata</i>	Featherfoil	SR	
<i>Bacopa innominata</i>	Tropical water-hyssop	SR	
<i>Potamogeton confervoides</i>	Conferva Pondweed	SR	FSC
<i>Torreyochloa pallida</i>	Pale Mannagrass	SR	

Listing Abbreviations: SR = Significantly Rare; T = Threatened; SC = Special Concern; FSC = Federal Species of Concern; E and LE = Endangered

An endangered taxon is in danger of extinction throughout all or a significant portion of its range. A threatened taxon is likely to become an endangered species within the foreseeable future. Special concern species require monitoring, but may be taken or collected under specific regulations. A significantly rare species is rare in North Carolina, but has no official state status. Federal species of concern refers to a taxon under consideration for listing, but at present there is insufficient information to support listing.

Five of the rare aquatic animals – the Triangle Floater, Alewife Floater, Eastern Lampmussel, Tidewater Mucket, and Eastern Pondmussel – are species of freshwater mussels. Freshwater mussels have an interesting life cycle, with many of them dependent on specific fish to act as hosts for their larvae. Freshwater mussels have surprisingly long life spans – with thicker-shelled river species living 20-40 years, and some up to 100 years. Freshwater mussels are imperiled nationwide, due to degraded physical habitats (e.g. sedimentation) and reduced water quality, as well as declining populations in certain fish species that act as hosts.

The Triangle Floater (*Alasmidonta undulata*) formerly inhabited virtually every North Carolina river system that drained to the Atlantic. However, the populations of this small mussel are declining, and it is not found in many of the locales where it was once collected. It prefers slow moving streams rather than rapids or riffles. The Alewife Floater (*Anodonta implicata*) is usually found in more northern areas, ranging from Nova Scotia to the Potomac River in Virginia and Maryland. The population found in the Chowan River basin appears to be a disjunct. The Alewife Floater gets its name from its association with its main host fish, the alewife. The Eastern Lampmussel (*Lampsilis radiata*) is usually found in medium to coarse sand habitats. Like the Alewife Floater, the Eastern Lampmussel is generally considered a northern species, with a discontinuous range from the Pee-Dee Drainage Basin north to the St. Lawrence Drainage Basin. Little is known about its fish hosts. The Tidewater Mucket (*Leptodea ochracea*) is known from only a few locations within North Carolina, including a large population in Lake Waccamaw, populations in the Tar and Roanoke Rivers, and much smaller populations in the Chowan and Meherrin Rivers. Although not truly restricted to tidal portions of rivers, the Tidewater Mucket is never found far from the Atlantic coast. This suggests that, like the Alewife

Floater, its dominant or preferred fish host is anadromous. The Eastern Pondmussel (*Ligumia nasuta*) reaches its southern range limit in North Carolina. This species is known from the Chowan, Roanoke, and Pamlico drainage basins. Like the other freshwater mussel species discussed, its population appears to be declining, probably due to poor water quality. In North Carolina, this species is known from the Chowan, Roanoke, and Cape Fear River basins. The species has been recently extirpated from the Pamlico River basin.

The Shortnose Sturgeon (*Acipenser brevirostrum*) is a large, anadromous fish that once was common in North Carolina waterways. The shortnose sturgeon may live for up to 30 years, and inhabits the lower sections of larger rivers and estuaries along the Atlantic coast. The species has suffered from excessive harvesting and habitat degradation, and is now in danger of extinction. The fish has not been recorded from the Chowan River for over one hundred years.

Not much is known about the natural history of the Chowanoke Crayfish (*Orconectes virginianus*). This crustacean reaches the southern end of its range in North Carolina and the only other place it occurs is Virginia. It lives in sluggish streams flowing through woodlands with sandy or gravelly substrates, and is considered one of North Carolina's rarest crayfish.

8.10 Fisheries

8.10.1 River Herring Fisheries Management Plan

The Chowan River and its tributaries provide critical habitat for the anadromous fish species. Good water quality is an essential habitat element and has been identified as a limiting factor in fish stock recovery if water quality does not improve. The draft 2007 River Herring Fisheries Management Plan (FMP) provides an assessment of habitat conditions, recent studies, and recommendations to improve stock conditions. The FMP for the river herring advocates for multi-agency natural resource conservation and preservation. The FMP recommends that agencies collaboratively work to 1) develop stricter nutrient discharge limits to reduce eutrophication, 2) develop sediment discharge limits to protect spawning habitats, 3) reevaluate the oxygen budget in coastal waters to account for low DO waters draining from swamps and 4) require dischargers meet compliance with BOD limitations. The FMP supports the need for improved stormwater management plans and developing requirements for establishing and protecting riparian buffers and wetlands. The FMP discourages interbasin water transfers to prevent exacerbation of existing water quality conditions. The FMP also calls for an assessment of potential contaminants and by-products of reverse osmosis plants. More information on fish habitat requirements, water quality needs and specific recommendations can be found in the draft river herring FMP on the Division of Marine Fisheries website: <http://www.ncfisheries.net/fmps/index.html>.

8.10.2 Fish Kill Summary

DWQ has systematically monitored and reported fish kill events across the state since 1996. From 2000 to 2005, field investigators reported seven fish kill events in the Chowan River basin. Stagnant water, shallow water, low dissolved oxygen, and possible chemical contamination may have contributed to these fish kill events. Annual fish kill reports can be found at DWQ's Environmental Sciences website <http://www.ncwaterquality.org/esb/Fishkill/fishkillmain.htm>.