

Chapter 14

Natural Resources in the Pasquotank River Basin

14.1 River Basin Hydrologic Units

Under the federal system, the Pasquotank 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 33).

Table 33 Hydrologic Subdivisions in the Pasquotank River Basin

Watershed Name and Major Tributaries	DWQ Subbasin 6-digit Codes	USGS 8-digit Hydrologic Units	USGS 14-digit Hydrologic Units Local Watersheds*
Albemarle Sound	03-01-50 03-01-51 03-01-52 03-01-53	03010205	010010, 010020, 020010, 020020, 030010, 040010, 050010, 060010, 060020, 070010, 080010, 080020, 085020, 090010, 090020, 090030, 100010, 110010, 130010, 130040, 140010, 150010, 170010, 180010, 190010, 210010, 210020, 210030, 220010
Pasquotank River	03-01-50	03010205	240050
Alligator River and Croatan Sound	03-01-51	03010205	240060
Perquimans, Little and Yeopim River	03-01-52	03010205	240030
Scuppernong River	03-01-53	03010205	240040
Phelps Lake	03-01-53	03010205	160010
Currituck Sound	03-01-54	03010205	230010, 240100
North River	03-01-54	03010205	240090
Roanoke Sound and surrounding area	03-01-56	03010205	230020
Pamlico Sound	03-01-55	03020105	090020, 090016, 090014

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

14.2 Water Resources and Water Supply Planning

NC DENR Division of Water Resources 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 Division also administers two environmental education outreach programs, Stream Watch and Project WET. For more information about the Pasquotank basin visit <http://www.ncwater.org/basins/Pasquotank/>.

14.3 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, particularly around lake shorelines. 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, algae blooms can also cause difficulty in water treatment resulting in taste and odor problems in finished drinking water.

14.4 Source Water Assessment of Public Water Supplies

14.4.1 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 new 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 SWAP 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>.

14.4.2 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 1986, 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://h2o.enr.state.nc.us/wswp/index.html>.

14.4.3 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, available sources of existing data at federal, state and local levels. The SWAP selected sixteen statewide databases that were attainable and contained usable geographic information related to PCSs.

14.4.4 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 the potential threat 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>.

14.4.5 Public Water Supply Susceptibility in the Pasquotank 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 different 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 Pasquotank River Basin, 355 public water supply sources were identified. One is a surface water source and 354 are groundwater sources. Of the 354 groundwater sources, 17 of them have a Higher, 312 have a Moderate and 25 have a Lower susceptibility rating. Table 34 identifies the surface water source and its overall 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.

Table 34 SWAP Results for Surface Water Source in the Pasquotank River Basin

PWS ID Number	Inherent Vulnerability Rating	Contaminant Rating	Overall Susceptibility Rating	Name of Surface Water Source	PWS Name
0428010	L	L	L	Fresh Pond	Town of Nags Head

14.5 Forestry

14.5.1 Forest Management

Approximately 44 percent of forestland in the Pasquotank basin is privately owned; 10 percent is owned by forest industry, and the remaining 46 percent is publicly owned. These ownership estimates comes 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 22,362 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 68,252 acres in the basin. This includes 1,384 plans, such as preharvest, rehabilitation and forest stewardship plans, that provide site specific guidance for water quality protection.

The DFR also 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 potential to negatively impact water quality. The DFR performs hazard reduction burns to reduce fuel load and therefore wild fire hazard. During the period covered by this Plan, approximately 3,055 acres were either prepared or burned for the reduction of hazardous fuels.

14.5.2 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 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://h2o.enr.state.nc.us/basinwide/SupplementalGuide.htm>.

The 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 portion of the Pasquotank basin north of Albemarle Sound has coverage by a Water Quality Forester, thanks to a new position that was established in 2005, which is assigned from the Elizabeth City District Office. Field foresters based in the Fairfield District Office work the southern portion of the basin. Water Quality Foresters conduct FPG inspections, survey BMP implementation, check for compliance with forest harvest requirements of state buffer rules, develop preharvest 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 Division of Forest Resources inspected 916 forestry sites for FPG compliance the basin; 97 percent of the sites inspected were in compliance. In addition, 181 re-inspections were performed to ensure that sites continued to be or were brought into compliance with the FPGs.

14.5.3 Forestry Best Management Practices

Implementing Forestry Best Management Practices is strongly encouraged by the Division of Forest Resources in order to efficiently and effectively protect the water resources of North Carolina and maintain compliance with the FPGs. During this reporting period, DFR provided 467 written or verbal BMP recommendations on tracts totaling 18,910 acres in the Pasquotank 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, 17 of those surveys were performed in the Pasquotank River Basin. On those sites, implementation of North Carolina's recommended BMPs was 83 percent. Two percent (2 percent) of the conditions on those sites had potential to be a risk to water quality. Forestry BMP implementation in the Pasquotank 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 additional 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.

14.5.4 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 harvest activities. Temporary bridges are usually the best 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. 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 Web site <http://www.dfr.state.nc.us/>.

14.5.5 Forest Products Industry

The forest industry is a vital economic driver throughout the Pasquotank River basin, with significant forest industry operations located in the basin. In the Pasquotank basin, 7 different businesses are considered “Primary Processors” of forest products raw material, which represents 3 percent of the total number of primary processors in the state. Examples of primary processors in this basin include several sawmills that produce products such as rough and dressed lumber, chips, bark and sawdust. 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-shared reforestation assistance for forest landowners.

14.6 Public Lands

The Embayed Region has large acreages in public ownership. Pocosin Lakes, Alligator River, Great Dismal Swamp, and Mackay Island National Wildlife Refuges; Dare Bombing Range; Dismal Swamp State Natural Area; Pettigrew State Park; and Northwest River and North River Game Lands protect large acreages of pocosin, nonriverine swamp, and marsh from development. Yet there are large, highly significant sites in this region that are in need of acquisition or other protection action. The series of sites along the Northwest River, the North River, the Scuppernong River, and a number of smaller sites have little or none of their area protected. Protection is particularly urgent for Nonriverine Wet Hardwood Forests and Peatland Atlantic White Cedar Forests. No examples of Nonriverine Wet Hardwood Forest are protected in the region, and only one small example is protected anywhere in the state.

14.7 Ecological Significance of the Pasquotank River Basin

The Pasquotank River basin has a large number of significant natural areas, including aquatic habitats. Coastal influence is prevalent in the basin. For instance, four of the five federally listed threatened and endangered aquatic species are predominantly marine species -- the American Alligator being the exception -- although the Shortnose Sturgeon is anadromous, spending some stages of its life in freshwater rivers. The Pasquotank River basin, which includes waterways that do not drain to the Pasquotank River, contains some extensive conservation lands, which correspond to a number of expansive natural features (swamps, marshes, pocosins, etc). Rare animal species and plants found in the Pasquotank River basin are listed in Table 35.

For more information on rare plant and animal species, visit the NC Natural Heritage Program (NHP) website at www.ncnhp.org.

14.7.1 Significant Natural Heritage Areas in the Pasquotank River Basin

The North Carolina Natural Heritage Program (NHP) compiles the list of Significant Natural Heritage Areas. The list is based on the program's inventory of natural diversity in the state. Natural areas are evaluated on the basis of the occurrences of rare plant and animal species, rare or high-quality natural communities, and geologic features. The global and statewide rarity of these elements and the quality of their occurrence at a site relative to other occurrences determines a site's significance rating. The sites included on this list are the best representatives of the natural diversity of the state, and therefore have priority for protection. Inclusion on the list does not imply that any protection or public access exists.

Certain sites that contribute to the maintenance of water quality in the Pasquotank River Basin are highlighted below. They are grouped by region, and the names of individual Significant Natural Heritage Areas that constitute the grouping are bulleted. More complete information on Significant Natural Heritage Areas may be obtained from the Natural Heritage Program.

Currituck Sound Significant Natural Heritage Areas

- * Buckskin Creek/Great Swamp
- * Church Island Marsh
- * Currituck Banks Corolla Natural Area
- * Currituck Banks/Swan Island Natural Area
- * Gibbs Woods/Tull Bay Marshes
- * Great Marsh
- * Nellie Bell Ponds, Marsh, and Cedar Swamp
- * Northwest Backwoods
- * Northwest River Marsh Game Land
- * Maple Swamp Gordonia Forest
- * Monkey Island Heronry
- * Pine Island/Currituck Club Natural Area
- * Troublesome Point/Gibbs Point Marshes
- * Upper Northwest River Marsh

The Currituck Sound region includes the Northwest River, North Landing River, and Currituck Banks. Many of the Significant Natural Heritage Areas in Currituck Sound are Tidal Freshwater Marsh and Nonriverine Swamp Forest/Nonriverine Wet Hardwood Forest communities surrounding the estuarine shoreline and drowned river mouths. Several of the sites in this region are extensive, such as Great Marsh (6,037 acres), Pine Island/Currituck Club Natural Area (11,709 acres), and Buckskin Creek/Great Swamp (5,044 acres). These high-quality natural areas provide water quality benefits as well as outstanding wildlife habitat. The Upper Northwest River Marsh contains the only example of the Estuarine Fringe Pine Forest in the state and one of only two known in the nation.

North River Significant Natural Heritage Areas

- * Broad Creek Marshes
- * Hunting Creek Pocosin & Marsh
- * Indiantown Creek/North River Cypress Forest
- * North River/Deep Creek Marshes & Forest
- * North River/Crooked Creek Wetlands

Significant Natural Heritage Areas in the North River are characterized by vast, high-quality Tidal Freshwater Marshes and Cypress--Gum Swamps, as well as nonriverine wetland communities of Swamp Forest and Atlantic White Cedar. However, only a small fraction of the area is protected.

Great Dismal Swamp Significant Natural Heritage Areas

- * Dismal Swamp State Natural Area
- * The Green Sea
- * Great Dismal Swamp National Wildlife Refuge

The combined acreage of the Dismal Swamp State Natural Area and the Great Dismal Swamp National Wildlife Refuge is over 41,000 acres. This vast area extends into Virginia and consists mostly of Nonriverine Swamp Forest, High Pocosin, Atlantic White Cedar, and other associated nonriverine wetland communities. Together with the Green Sea, a 9,592-acre natural area to the east, the Great Dismal Swamp provides habitat for rare plant and animal species and is home to wildlife such as black bear that require large undeveloped areas for survival. Sizeable portions of the Dismal Swamp State Natural Area and the National Wildlife Refuge are Registered Natural Heritage Areas, yet drainage of adjacent lands has significantly affected the hydrology of these areas.

Albemarle Sound Significant Natural Heritage Areas

- * Albemarle Sound Low Shoreline
- * Harbinger Marshes
- * Big Flatty Creek Forests & Marshes
- * Little Flatty Creek Forests & Marsh
- * Bull Neck Swamp
- * Mamie Marshes & Ponds
- * Durant Island
- * Menzies Pond

The Significant Natural Heritage Areas that border Albemarle Sound are areas of high-quality Tidal Freshwater Marsh, Nonriverine Swamp Forest, Maritime Forests, and important Nonriverine Wet Hardwood Forests. These areas, though scattered, serve important roles as natural vegetated buffers for Albemarle Sound, in addition to providing habitat for wildlife. Completing protection of river buffers could improve water quality in Albemarle Sound.

East Dismal Swamp Significant Natural Heritage Areas

East Dismal Swamp is a 3,868-acre remnant of a Nonriverine Swamp Forest that once stretched over 100,000-acres in Washington and Beaufort counties. Certain old-growth forests characteristics of the East Dismal Swamp make it an attractive stop over for neotropical migrant birds. When protected, the East Dismal Swamp will contribute to the overall ecosystem function of natural areas in the region.

Scuppernong River/Lake Phelps Significant Natural Heritage Areas

- * Lake Phelps Aquatic Habitat
- * Pungo Lake Natural Areas
- * Palmetto-Peartree Swamp Forest
- * Scuppernong River Swamp Forest
- * Pettigrew State Park

Emptying into Albemarle Sound, the Scuppernong River drains northern Washington and Tyrrell counties. The high-quality communities bordering the river comprise over 14,000 acres and include Coastal Plain Small Stream Swamp (Blackwater Subtype), Cypress--Gum Swamp (Blackwater Subtype), Atlantic White Cedar, and Nonriverine Swamp Forest. Lake Phelps, one of the Coastal Plain's few natural lakes, drains into the Scuppernong River via canals. Lake Phelps is noteworthy for its unique shoreline community. Another natural lake, Pungo Lake, is one of the largest and most intact natural lakes in North Carolina, and it is a major concentration area for wintering waterfowl.

Alligator River, Dare/Tyrrell/northern Hyde counties Significant Natural Heritage Areas

- * Alligator River/South Lake Swamp Forest
- * Alligator River/Swan Creek Swamp Forest
- * Alligator Creek/Second Creek Forest
- * Alligator River Swamp Forest
- * Alligator River Refuge/Central Section
- * Alligator River Refuge/Southeast Marshes
- * Upper Alligator River Marshes & Forests
- * Upper Alligator River Pocosin
- * US 264 Low Pocosin
- * Taylor Road Natural Area
- * Dare County Pocosin
- * Buck Island Bay Forest
- * Harvester Road Tall Pocosin
- * Faircloth Road Pond Pine Pocosin
- * Mashoes Marshes
- * New Lake Fork Pocosin
- * Pine Road Swamp
- * Roper Island
- * Roanoke/Stumpy Point Marshes & Pocosin

This large area is made up of extensive peatlands on either side of Alligator River. This region has the greatest extent of peatland communities in North Carolina, and probably in the whole eastern United States. Specifically, the Dare County Pocosin is one of the best Low Pocosin communities globally, one of the most extensive and one of the best Pond Pine Woodland occurrences globally, as well as one of the most outstanding peatland complexes. Nonriverine communities -- Swamp Forests, Pocosins, Pond Pine Woodland, Atlantic White Cedar Forests -- dominate the landscape here, although they are quite rare outside the Pasquotank basin. Some areas along the shores of the Albemarle Sound and the Alligator River support marshes and Tidal Cypress--Gum Swamps. Much of the land in this region is publicly-owned. Protection of Roper Island, Buck Island Bay Forest, and Alligator River/Swan Creek Swamp Forest in southern Tyrrell and northern Hyde counties could add significantly to the ecological integrity of the area by acting as a link between protected natural areas on either side of Alligator River.

Coastal Region Significant Natural Heritage Areas

- * Cape Hatteras Point
- * Colington Woods
- * Bodie Island Lighthouse Pond
- * Buxton Woods
- * Fort Raleigh Maritime Forest
- * Hatteras Island Middle Section
- * Hatteras Inlet Bird Nesting Islands
- * Hatteras Sand Flats
- * Jockey's Ridge State Park
- * Kitty Hawk Woods
- * Nags Head
- * Oregon Inlet/Roanoke Sound Bird Nesting Islands
- * Pea Island National Wildlife Refuge
- * Roanoke Island Juncus Marsh
- * Southern Shores Cypress Swamp

The Coastal Region includes the barrier islands and peninsulas, along with their associated marshes. These narrow ridges of unconsolidated sediment are among the most dynamic environments in the state, subject to reworking by erosion and overwash by storms as well as the more regular effects of tides, surf, salt spray, and wind. Significant Natural Heritage Areas in the coastal region of the Pasquotank basin include communities of Maritime Grassland, Maritime Forest, Sand Flats, and Salt Marshes. Protection exists for portions of several of these sites, such as Buxton Woods, Jockey's Ridge State Park, Pea Island National Wildlife Refuge, Nags Head Woods, and part of Kitty Hawk Woods. Because of the extreme rarity of these barrier island communities, protection should be a priority for the unprotected Significant Natural Heritage Areas.

14.7.2 Wetland Communities in the Pasquotank River Basin

The Pasquotank River basin constitutes a significant portion of the North Carolina Coastal Plain known as the Embayed Region. The name Embayed Region refers to the prominence of drowned river valleys, which form the large sounds and many bays. The land in the Embayed Region is universally low and flat, and most is poorly drained. This region contains the largest acreage and proportion of wetlands in the state. The extensive reach of the Pasquotank River basin -- from the coastal environment of the outer banks, across estuaries, to embayed rivers and natural lakes -- captures many types of wetland communities. Vast peatlands occupy the centers of peninsulas between the drowned rivers. On the fringes of the peatlands are flat mineral soil wetlands which are kept saturated primarily by rainfall and sheet flow. Additional large areas of organic and mineral soil swamps and marshes lie adjacent to the sounds and tidally-influenced rivers.

Freshwater tidal wetlands are an important component of the landscape in the Pasquotank River basin, especially along Currituck Sound and the North and Northwest Rivers. Along the Albemarle Sound, the land-water interface is characterized by Tidal Cypress-Gum Swamp communities. Nonriverine wetland communities in the Pasquotank River basin include Nonriverine Swamp Forest, Nonriverine Wet Hardwood Forest, High Pocosin, Low Pocosin, Pond Pine Woodland, Peatland Atlantic White Cedar Forest, and Bay Forest. Both the Dismal Swamp and the Dare mainland contain extensive Nonriverine Swamp Forest, and they also support patches of Atlantic White Cedar, Pocosin, and Pond Pine Woodland. The extent of the natural areas in both the Dismal Swamp and the Dare mainland allows for the natural 'shifting mosaic' pattern of these wet peatland communities. The Nonriverine Wet Hardwood Forest community, which is dominated by oaks, is not part of the 'shifting mosaic' pattern, being associated more with mineral soils than organic soils and peatlands. The high productivity of the Nonriverine Wet Hardwood wetland community soils when cleared for agriculture has led to a drastic decline in the acreage of this community type across the state.

Natural Lake Shoreline is a wetland community type composed of the vegetated shoreline zone of large natural lakes. The vegetation may include emergent graminoids and other herbs, shrub thickets, Cypress--Gum Swamps, or various bottomland species. The Natural Lake Shoreline of Phelps Lake in Washington County is a high-quality example of this wetland community type which is protected within Pettigrew State Park.

Nontidal coastal fringe wetlands occur primarily on the outer banks. Wetland communities on the outer banks include Maritime Swamp Forest and Maritime Shrub Swamp, examples of which are protected at Nag's Head Woods; Maritime Wet Grassland, an example of which is found in the Pine Island Audobon Sanctuary in Currituck County; and Interdune Pond, a protected example of which is found at Cape Hatteras National Seashore.

14.7.3 Rare Aquatic and Wetland-Dwelling Species

The influence of the coastal location of the Pasquotank River basin is reflected in the rare aquatic species. Most of the species found on this basin's list are associated with marine and estuarine environments, such as the Manatee, the sea turtles (Loggerhead, Hawksbill, and Northern Diamondback Terrapin), and the fishes Lyre Goby and Shortnose Sturgeon. Even the American Alligator lives in fresh to slightly brackish lakes, ponds, rivers and marshes.

While there are other rare mammals in the Pasquotank basin, the Manatee (*Trichechus manatus*) is the only rare aquatic mammal. A migratory animal that typically lives in the warmer waters of Florida and other Gulf states, manatees occasionally inhabit North Carolina's inlets, estuaries and rivers from June to October. Manatees rest near the surface of the water, which makes them vulnerable to motorboat propellers and discarded trash.

Table 35 List of Rare Aquatic Species in Pasquotank River Basin

Scientific Name	Common Name	State Status	Federal Status
Animals			
<i>Acipenser brevirostrum</i>	Shortnose Sturgeon	E	LE
<i>Alligator mississippiensis</i>	American Alligator	T	T(S/A)
<i>Caretta caretta</i>	Loggerhead	T	LT
<i>Chelonia mydas</i>	Green Turtle	T	LT
<i>Eretmochelys imbricata</i>	Hawksbill	E	LE
<i>Evorthodus lyricus</i>	Lyre Goby	SR	
<i>Fundulus confluentus</i>	Marsh Killifish	SR	
<i>Fundulus cf. diaphanus</i>	Lake Phelps Killifish	SR	FSC
<i>Malaclemys terrapin terrapin</i>	Northern Diamondback Terrapin	SC	FSC
<i>Trichechus manatus</i>	Manatee	E	LE
Plants			
<i>Amaranthus pumilus</i>	Seabeach Amaranth	T	LT
<i>Ceratophyllum australe</i>	Southern Hornwort	SR	
<i>Didiplis diandra</i>	Water Purslane	SR	
<i>Eriocaulon perkeri</i>	Estuary Pipewort	SR	
<i>Heteranthera multiflora</i>	Multiflowered Mud-plantain	SR	
<i>Lilaeopsis carolinensis</i>	Carolina Grasswort	T	
<i>Myriophyllum tenellum</i>	Leafless Watermilfoil	SR	
<i>Ranunculus ambigens</i>	Water-plantain Spearwort	SR	
<i>Sphagnum torreyanum</i>	Giant Peatmoss	SR	
<i>Torreyochloa pallida</i>	Pale Mannagrass	SR	
<i>Utricularia macrorhiza</i>	Greater Bladderwort	SR	
<i>Utricularia resupinata</i>	Northeastern Bladderwort	SR	

SR = Significantly Rare; T = Threatened; SC = Special Concern; FSC = Federal Species of Concern; E = Endangered

Three rare fishes currently occur in the Pasquotank basin. The Shortnose Sturgeon (*Acipenser brevirostrum*) is a large, anadromous fish that once was common in North Carolina waterways. A distinctive fish with five rows of bony plates running the length of the body (giving it a rather prehistoric look), 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 fish moves from the ocean and estuaries into freshwater rivers to spawn between February and May. Juveniles may remain upriver for up to five years after birth before migrating to the ocean. The species has suffered from excessive harvesting and habitat degradation, and is now in danger of extinction. Current distribution is not well known, and the shortnose sturgeon has not been reported from the Pasquotank basin for more than 20 years. The Lyre Goby (*Evorthodus lyricus*), so named for the lyre-shaped marking on its caudal fin, is a small fish limited to coastal areas in North Carolina. It is found in the Cape Fear River estuary, tidepools at Wrightsville Beach, and Bogue and Pamlico sounds. It prefers shallow, muddy tidepools dominated by smooth cordgrass. Human impacts to smooth cordgrass marshes place constant pressures on the natural habitat of the lyre goby. The third rare fish found in the Pasquotank basin is the Lake Phelps Killifish (*Fundulus cf. diaphanus*), and is endemic to North Carolina.

Several rare reptiles are found in the Pasquotank basin. Three species of sea turtles have been identified in the basin: the Loggerhead Turtle (*Caretta caretta*), the Green Turtle (*Chelonia mydas*), and the Hawksbill Turtle (*Eretmochelys imbricata*). A fourth turtle, the Northern Diamondback Terrapin (*Malaclemys terrapin terrapin*), is basically restricted to estuarine situations, and lives in coastal marshes, tidal flats, coves, estuaries, and lagoons behind barrier beaches. It is intolerant of long-term exposure to freshwater or 100 percent seawater. The American Alligator (*Alligator mississippiensis*), lives in slow moving coastal rivers, canals, lakes, marshes and estuaries and is a state and federally threatened species. The American Alligator has recovered from the low populations of the past century, and is no longer biologically threatened or endangered under the Endangered Species Act. However, it retains the federally threatened status due to its similarity of appearance to other rare crocodilians, and commercial hunting and trade are regulated.

14.8 Fisheries

14.8.1 River Herring Fisheries Management Plan

Within the Pasquotank River basin exists 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>.

14.8.2 Fish Kill Summary

DWQ has systematically monitored and reported fish kill events across the state since 1996. From 2000 to 2005, field investigators reported eleven fish kill events in the Pasquotank River basin. Low dissolved oxygen, high water temperatures 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://h2o.enr.state.nc.us/esb/Fishkill/fishkillmain.htm>.

14.9 Submerged Aquatic Vegetation

Submerged Aquatic Vegetation (SAV) is a fish habitat dominated by one or more species of underwater vascular plant. These vegetation beds occur in both subtidal and intertidal zones and may occur in isolated patches or cover extensive areas. Fresh water vegetation may also grow in SAV beds. In North Carolina, SAV usually occurs in water less than 6 ft deep because of light

limitations. SAV is valued as a Critical Habitat Area under Marine Fisheries Commission rules. Over 150 fish and invertebrate species are known to use SAV as adults or juveniles, of which about 30 are important commercial fishery species. SAV beds provide an excellent nursery area for many species, including blue crabs, red drum, pink shrimp, spotted seatrout, and gag. SAV blades provide a surface for post-larval shellfish attachment, especially bay scallops, and refuge for small fish like mummichogs, pipefish, and grass shrimp. Large predators like flounders, rays, and red drum forage around SAV. SAV produces oxygen and detritus that is exported to other habitats, and reduces moderate turbidity and turbulence.

SAV coverage has declined and currently there are about 200,000 acres of SAV in coastal North Carolina. Aerial and ground surveys of SAV condition and growth provide baseline maps for future management actions are being coordinated through Albemarle Pamlico National Estuary Program, National Oceanic Atmospheric Association and local universities. SAV areas in Currituck Sound have been mapped. SAV is an environmental indicator and responds to water quality conditions. SAV is extremely dependent on clarity of the water column for its existence. Reduced light availability from nutrient and sediment loading is thought to be the primary cause of losses. Efforts need to continue to support SAV research to promote restoration and to identify water quality conditions that are limiting growth.