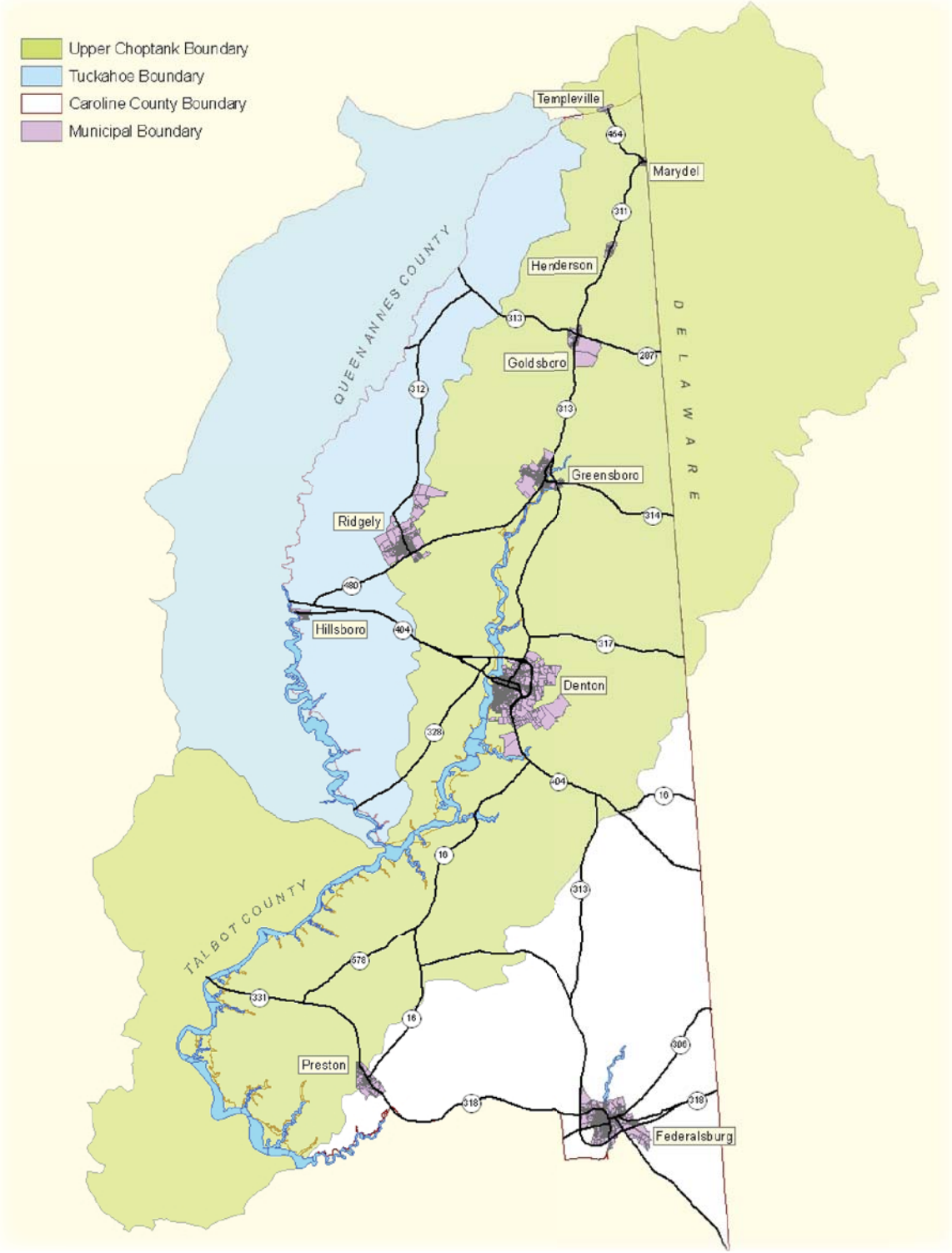

Upper Choptank River
&
Tuckahoe Creek
Watershed Characterizations

November 2007

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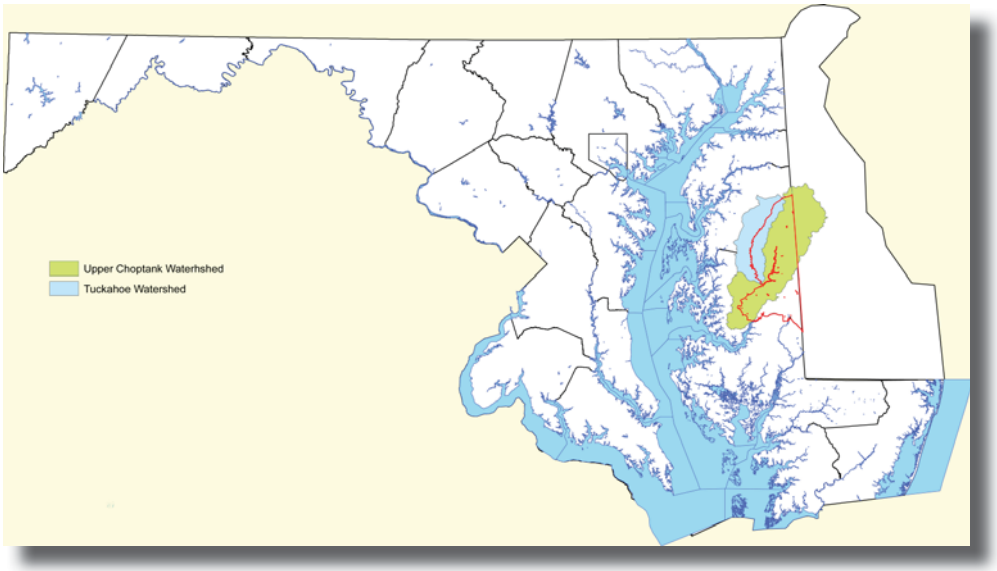
Cultural & Natural Resources

Introduction

Forces for change are blowing in the wind across the Tuckahoe Creek and Upper Choptank Watersheds on the Delmarva Peninsula. An increase in the number of people, growing concerns about the quality of the natural environment, shifts in food preferences, globalization, rising energy costs, and other forces are creating opportunities and threats for people who live in and care about the two watersheds. (See maps 1 & 2 in Section 4).



At the same time, Tuckahoe Creek, the Upper Choptank River and the lands they drain are filled with valuable cultural and natural assets:

- A natural history containing dramatic accounts about how the watersheds formed and provided habitat for life;
- Working landscapes employed for centuries as farms and forests;
- Scenic parks, recreation areas, and water trails;
- Diverse wetland ecosystems;
- A rich human history – much of it still evident in residential, commercial, and public buildings, at steam-boat-landing sites, in the "feel" of small town centers, and in the stories, still being told, of Native, African, and European Americans who have lived and died in the watersheds;
- Institutions of governance – municipalities, counties, state and federal agencies, and public advocacy groups – by which local residents, and others, decide how land and water will be used, how the local economy will evolve, the number of people who will settle in the watersheds, and where they will reside;
- Research and educational resources in the schools, colleges, and other organizations that serve watershed residents and the natural resources of the region.

Strong concerns exist among people who live in, work on, and care about the watersheds. They want to anticipate, shape, and adjust to forces for change in ways that protect, restore, and enhance the areas' assets.[1] One option, which will be advanced to meet those concerns, will be to shift governmental authority away from local citizens and authorities to regional, state, and federal levels of planning and government where, it will be argued, "The broadly felt impacts of local economic and political decisions can be guided." An alternative approach will be for local people in the watersheds to manage assets from the "grassroots level." This document advances the case for effective grassroots initiatives to manage the resources in ways that incorporate local values but, at the same time, meet the concerns of citizens and authorities based elsewhere.

1 See the Caroline County Anticipating and Adopting to Growth Pressures: Strategic Thinking for the Future of Caroline County to the Year 2025. College Park, Maryland: University of Maryland Institute for Governmental Service, 2005

Grassroots efforts will succeed, however, only through active participation in and the wise use of local and external resources and institutions by local citizens and their town and county authorities. To avoid the shift of governance responsibilities to elsewhere, local citizens and public officials in the watersheds must work across county and municipal boundaries to gather and share information, to create a common, detailed vision for the future, to partner with and access resources from external authorities and organizations, and to design and implement educational and legal tools for managing change.

A Natural History of the Watersheds

To understand the natural history of the watersheds, first look away to the West at the Appalachian Mountains. The Appalachians formed as the result of an intercontinental collision between North America and Africa. About 230 million years ago, the mountains reached their peak heights of 8,000 feet, or more. Through weathering – by which water, wind, and ice broke the face of the mountains into small pieces, and through erosion – by which streams carried those pieces down and eastward toward the edge of North America, layers of sediments from the Appalachians formed the Atlantic Coastal Plain, the land over which the Tuckahoe Creek and Choptank River now flow. As is revealed by layers of marine and land fossils under what is now the Delmarva Peninsula, sea rise and fall have submerged and exposed the plain many times.[2]

Watersheds Form and Reform

The fall and rise of sea level corresponded with the formation and retreat of glaciers on the northern portion of the North American Continent. During periodic cycles lasting tens-of-thousands-of-years, water successively evaporated from the sea to form clouds, fell to the earth as snow to form glaciers, and then melted again to reform seawater. As glaciers located in what is now Pennsylvania and New Jersey melted, run-off water formed two major river basins, now called the Susquehanna and Delaware Watersheds.

About 35 million years ago, near the southeast tip of the Delmarva Peninsula, the earth suffered a cataclysmic event that scientists call a “bolide.” At that time, a large meteor struck the earth. Evidence suggests the depression created by the event may have led the Susquehanna River to shift its path westward to what eventually became the Chesapeake Bay, thus allowing for the formation of the Tuckahoe Creek and Upper Choptank River Watersheds.[3]

As recently as 18,000 years ago, during the most recent ice age, an ice mass called the Wisconsin Glacier reached a thickness of several thousand feet and moved south into what is now Pennsylvania and New Jersey. Sea level at that time dropped more than 200 meters below what it is today. Around 10,000 years ago, the Wisconsin Glacier melted, raised the seas, “drowned” the Susquehanna and Delaware Rivers, formed the present-day Chesapeake and Delaware Bays, and gave their current form, partially tide-water and partially fresh, to what we know as Tuckahoe Creek and the Upper Choptank River.

2 Delaware Museum of Natural History A Delmarva Odyssey www.delmarvaodyssey.com/geology.html
3 United States Geologic Service Investigating the Chesapeake Bay Impact Crater http://woodshole.er.usgs.gov/epubs/bolide/

Ice-Age Fauna

Ice-age fauna on the Delmarva Peninsula included:

- Boreal species – such as lemmings and ground squirrels;
- Large mammals – such as musk oxen, mammoths, and mastodons;
- Familiar but now foreign animals – such as caribou, elk, and wolves;
- Familiar animals still found in the region – such as white-tailed deer, skunks, otters, weasels, and fox;
- Unusual animals now extinct, including giant beavers and bats.

With the end of the last ice age, Paleo-Indians followed their prey onto the peninsula. They were nomadic hunter-gathers, and they left little evidence of their presence on the Delmarva. They likely favored the midpeninsular-divide region, including the headwater areas of Tuckahoe Creek and the Upper Choptank River, because the "backbone" of the peninsula offered potable water and good hunting and fishing in freshwater lakes and wetlands.

The evolution of life forms on the Atlantic Coastal Plains, since the Wisconsin Glacier receded, involves adaptations to:

- Warmer soils;
- A longer growing season;
- Rising sea level;
- A severe, multiyear drought about 1,000 years ago;
- A relatively cool, wet period, beginning about 800 years ago, during which wildlife, much as we know it today, became established.

Wildlife Now

Wildlife exists within land and waterscape habitats. In a recently published plan for protecting and restoring wildlife diversity, the Maryland Department of Natural Resources (DNR) classified the state's land and waterscapes – using, primarily, soil types and underlying geologic features – into five physiographic provinces.[4] From west to east across Maryland, the provinces are: Allegheny Plateau; Ridge and Valley; Piedmont; Upper Coastal Plain; and Lower Coastal Plain. The Lower Coastal Plain Province, which extends across the Eastern Shore, south of the Elk River in Cecil County, incorporates the Tuckahoe Creek and Upper Choptank Watersheds.

The DNR plan notes that while some wildlife species are found in all five of the state's provinces, the distribution and abundance of Maryland's wildlife tend to vary by province. The plan provides observations about wild animals in Maryland by groups of organisms.

White Tail Deer, Photo Courtesy of USFWS

4 Maryland Department of Natural Resources. Maryland Wildlife Diversity Conservation Plan, September 2005.

Mammals

Most mammals are distributed statewide, but the western provinces contain the most diverse set. Citing the Natural Heritage Program (NHP), the DNR indicates there are 28 marine mammals and 75 land mammals, including native and introduced species, in the state. Land mammals include 12 shrews and moles, 11 bats, 3 rabbits and hares, 26 rodents, 17 carnivores, 2 deer, and the Assateague pony. Twenty one species are found exclusively in or near to the four western counties of the state. Only the Delmarva fox squirrel, sika deer, and Assateague pony are restricted to the Lower Coastal Plain. Exotic species, which were introduced intentionally or unintentionally in the Lower Coastal Plain, include the house mouse, Norway rat, black rat, sika deer, and nutria.

Delmarva Fox Squirrel, Photo Courtesy of USFWS

Birds

DNR quotes the Maryland Ornithological Society in noting 423 species of birds are on the "Official List of Birds of Maryland," including two extirpated species – trumpeter swan and greater prairie chicken, two extinct species – passenger pigeon and Carolina parakeet, and a large number of "accidental species," which have been observed only one or a few times in Maryland since 1804 when recordkeeping began. The Lower Coastal Plain is a transitional area for birds and contains species centered primarily in southeastern North America, and, with fewer numbers, in inland regions of the continent. Among birds that breed in the province, most are associated with water and wetland habitats, but they also include species of upland forests, shrublands, and grasslands. "Waterbirds" – including waterfowl, marsh birds, shorebirds, and colonial nesting species – are an important component of the province's avifauna. Perching birds of the region include the brown-headed nuthatch, marsh wren, Swainson's warbler, saltmarsh sharp-tailed sparrow, seaside sparrow, and brown-tailed grackle.

Reptiles

Maryland's native reptiles include 18 turtles, 7 lizards, and 24 snakes. The state manages, for commercial harvest, two turtle species commonly found in the Chesapeake Bay Watershed – the northern diamond back terrapin and the snapping turtle. The northern diamond back terrapin is the only truly estuarine reptile in Maryland.

The state's seven lizards are all small, four-legged, slender, and long-tailed. The common five-lined skink and the fence lizard are widespread, but the broad-headed skink is restricted, likely, to the eastern half of the state. In contrast to the lizards, snakes range in size from the tiny eastern wormsnake to the thick-bodied and heavy timber rattlesnake. About half of Maryland's snakes lay eggs and half are live-bearers, females retaining eggs during their development. All of Maryland's snakes are carnivorous, eating a variety of foods from invertebrates to small mammals. Most are terrestrial, but a few are semi-aquatic.

Amphibians

Amphibians in Maryland include 21 salamanders and 20 frogs and toads. Widespread and significant declines in amphibians have been observed, worldwide, since 1980. Declines in some species may result from over-exploitation and habitat loss, but the sharpest declines have no known cause. For unexplained reasons, the declines have been relatively slower and fewer in North America than elsewhere.

The 21 species of salamanders found in Maryland are sensitive to human sprawl and associated habitat fragmentation. Shortly after emerging from hibernation during late winter or early spring, many salamanders seek traditional breeding sites, and if habitats are fragmented, the sites may become difficult or impossible to reach. When the sites are destroyed, breeding becomes impossible unless alternatives sites can be found. Water temperature is critical to successful reproduction in many species; thus delays in finding breeding sites can result in failed reproduction.

Most of Maryland's frogs and toads belong to biologic families that are experiencing the sharpest worldwide declines. Although most species lay eggs in water, toads and some frogs are terrestrial as adults. Each species has a distinct mating call, which is usually made at night when breeding occurs. After breeding, most go silent and become difficult to detect.

The highest concentrations of amphibians is in Western Maryland, Southern Maryland, and the Lower Eastern Shore. Relatively high concentrations are found also, however, in the far upper reaches of the Tuckahoe Creek and Upper Choptank Watersheds. Some clusters of sites in those areas show concentrations at the 25 species level-of-richness.

Fishes

Maryland is home to many native freshwater and saltwater fish. Numerous species have also been stocked in the state's streams, including largemouth bass, trout, and carp. Others, such as the northern snakehead, a predatory fish from Asia, have been illegally introduced and are the object of eradication efforts.

Freshwater fishes total 121 species in the state. The most common are the blacknose dace, eastern mudminnow, creek chub, blue-ridge sculpin, mottled sculpin, and tessellated darter. About twenty introduced species inhabit Maryland's streams, including some that have acclimated well, like the popular largemouth bass and the less popular common carp. A map showing species richness for freshwater fish in Maryland illustrates the Tuckahoe Creek and Upper Choptank River Watersheds are at the highest level for the Lower Coastal Plains Province, with 30-39 species indicated.

Striped Bass, Image Courtesy of USFWS

The Chesapeake Bay hosts more than 140 species of finfish although some species are seriously depleted. For example, the Susquehanna River Restoration goal is for 2 million shad, but only about 3 percent of the goal has been achieved.[5] The Bay Program indicates that after harvest moratoria in Maryland (1985-1990) and Virginia (1989-

5 Chesapeake Bay Program Environmental Indicators, 2005.

1990) the Atlantic States Marine Fisheries Commission declared, in 1995, the striped bass fishery was restored.[6] From 1988 to 2005, construction of fishways and removal of dams have added more than 1,800 miles of historic habitat to migratory and resident fish in the bay. [7]

Invertebrates

Maryland's invertebrates are not as well studied as are the state's vertebrates. Some species are known enough, however, to be recognized as endangered, threatened, or in need of conservation. With its five diverse physiographic provinces, Maryland's invertebrate fauna are diverse. They include, for example, dragonflies and damselflies, butterflies and moths, and freshwater mussels and benthic marine species. Invertebrate species in Maryland include planarians (freshwater, non-parasitic flatworms), sponges, worms, mollusks (animals with shells), and arthropods (animals such as insects, with segmented bodies and appendages on each segment).

Several species are of high economic importance, either as commercially valuable species or as pest species. Commercially important species include the blue crab, horseshoe crab, and native pollinators – along with the honeybee. (See page 24 to learn about an investigation of native pollinators in the Tuckahoe Creek Watershed.) Blue crabs have the highest economic value of any commercial fishery in the Chesapeake Bay.

Some invertebrate species serve as indicators of environmental health. More than 350 types of benthic macroinvertebrates – that is, animals without backbones that are larger than ½ millimeter, the size of a pencil dot – are found in Maryland streams. These animals allow DNR to utilize an Index of Biotic Integrity to assess the health of stream communities.

Other invertebrates are considered pests. The Maryland Department of Agriculture (MDA) uses control programs to address agricultural and forest pest species. The gypsy moth, southern pine beetle, emerald ash borer, Asian longhorned beetle, and pine shoot beetle are all insect pest species the state monitors and tries to suppress. MDA also controls mosquitoes to prevent the spread of mosquito-borne disease in humans, pets, and livestock.

Rare-Plant Sites in Caroline County

In 2000, the Wildlife and Heritage Division of DNR conducted an investigation of rare, threatened, and endangered plant species in Caroline County and published information about the results.[8] The publication also provides suggestions for protecting habitat sites known to support such species.
The division focused on five types of habitats:

- Delmarva Bays (known also as "Whale Wallows"; see page 44);
- Mixed deciduous forests;
- Tidal freshwater marshes and swamp forests;
- Sand ridges;

6 Ibid.
7 Ibid
8 See Jason W. Harrison. Ecologically Significant Areas in Caroline County: Rare Plant Sites Newly Identified or Updated in 2000. Annapolis, Maryland: Maryland Department of Natural Resources, Coastal Zone Management Division, 2001. The section that follows draws on this study.

- Coastal Plain Bogs.

Examples of all five habitat types are found in the Tuckahoe Creek and Upper Choptank Watersheds.

Delmarva Bays

The division placed much emphasis on locating high quality Delmarva Bays because: (1) these seasonal ponds are unusual; (2) many have been destroyed because of hydrologic changes resulting from agricultural conversion, development, and logging; and (3) they are known to support several globally rare plant species and state endangered species. Globally rare species found in the Delmarva Bays in Caroline County include: Harper's fimbristylis; Creeping St. John's-wort; Rose coreopsis; and Torrey's dropseed. State-endangered species reportedly include: Featherfoil; Aster-like boltonia; and Walter's paspalum. For more information on Delmarva Bays see page 44.

The division investigated plant species in and wrote suggestions for protection of the following bays in the Tuckahoe Creek and Upper Choptank Watersheds:

- Baltimore Corner Preserve
- Bridgetown Ponds
- East Melville Pond
- Greer's Pond
- Hollingsworth Ponds
- Jackson Lane Site
- Mount Zion South Pond
- Persimmon Preserve Sites
- R & M Bay
- Schuyler Road Pond

A Delmarva Bay. Photo courtesy of Maryland Department of Natural Resrouces

Mixed Deciduous Forests

Mixed deciduous forests included in the DNR study are "large continuous tracts…containing steep ravines, seepage toeslopes, 'rich woods pockets,' and forested slopes and floodplains." Such forests are found in the Tuckahoe Creek and Upper Choptank Watersheds, as well as in other basins in Caroline County. Pockets of rich woods found in mixed deciduous forests are unusual on the Coastal Plain and may result from a combination of well-drained, high pH soils. The pockets support wildflowers, ferns, and trees typically found of the piedmont area of Central Maryland but rarely seen on the Coastal Plain.

High quality floodplain forests bordering the Tuckahoe Creek contain rich alluvial soils and flooding dynamics that support a diverse natural community, including rare plant species. The state endangered Upright burhead, the state threatened Deciduous holly, and the highly state rare Rough hedge-nettle occur in these forests.

Tidal Freshwater Marshes and Swamp Forests

The DNR investigation of ecologically-significant areas focused significant attention on tidal freshwater marshes and swamp forests found along the Tuckahoe Creek and Choptank River. This type of habitat is characterized by flooding of certain frequency and duration, and by periodic saltwater intrusion. Reportedly, such marshes and forests have a more diverse assemblage of plants than do estuarine marshes downstream. Freshwater marshes and swamp forests are known to support the state endangered Slender blueflag, state threatened Parker's pipewort, state threatened Lake-bank sedge, and state rare Salt-marsh bulrush.

Sand Ridges

DNR investigators examined sand ridges along the Tuckahoe Creek, Choptank River, and Marshyhope Creek. Dry openings along the ridge crests are comprised of sandy soils that, typically, are nutrient-poor and have low water retention capacity. The ridges are known to support rare and uncommon species.

Fire is a natural process that creates open habitats on the ridges. Modern fire suppression practices have resulted, however, in a few canopy openings. Consequently, plants that require the full sun in these naturally open habitats are becoming rare.

Plants adapted to the nutrient-poor and dry conditions of the sand ridges are, in most cases, leguminous species. Such plants have nitrogen-fixing bacteria living their roots. Species investigated by DNR on sand ridges in Caroline County were the globally rare, state endangered Cream-flowered tick-trefoil, the state threatened Wild lupine, and the state rare spurred butter-pea.

Coastal-Plain Bogs

A unique and uncommon set of natural plant communities on the Coastal Plain of Maryland is called "Coastal-Plain Bogs." Most are located, currently, in powerline right-of-ways. Maintenance in those locations minimizes woody plant succession and creates an open canopy. Historically, fire and beaver activity created the same environment. Many Coastal Plain Bogs contain significant areas of Sphagnum moss and other plants adapted to highly-acidic conditions. In addition, the diverse habitat of the bogs supports several types of carnivorous plant species that are rare in Maryland. Included are: Bladderworts, Sundews, and Northern pitcher-plants. Orchids, which often exhibit striking floral displays, are also known to inhabit Coastal Plain Bogs.

The Watersheds' Size and Land Uses

The Tuckahoe Creek and Upper Choptank Watersheds are unequal in size, They are similar, however, in the way the land is being used. The total area of the two watersheds is approximately 317,000 acres, of which about half is located in Caroline County. About 60 percent of the land is devoted to agriculture. Caroline County also has the most developed land of the jurisdictions containing the two watersheds, a fact that will be reconsidered in the discussion of "forces of change." A comparison of hte two watersheds can be seen in Table 1. (See map 3 in Section 4 for a map of land uses in these watersheds, and Maps 4 and 5 for sensitive areas in the watersheds)

Table 1: Comparison of the Watersheds		
	Upper Choptank*	**Tuckahoe Creek**
Jurisdictions	• 2 States • 3 Counties • 8 Municipalities	• 2 Counties • 2 Municipalities
Acres	219,984	97,339
Population	Approx. 33,000	Approx. 6,814
Agriculture	96,886 (59%)	62,624 (64%)
Forest	46,485 (29%)	21,292 (22%)
Developed	13,124 (8%)	845 (1%)
Wetlands	4,818 (3%)	13,465 (13-14%)
*Upper Choptank total acres include the portion of the watershed in the state of Delaware; however, specific distribution of acres is for Maryland portion only.		

Forces for change create opportunities and threats to the assets found in the Tuckahoe Creek and Upper Choptank Watersheds. The most salient force is population growth. (See Map 6 in Section 4 for growth boundaries)

Population Growth

Table 2 displays population figures, including both historic census data that begin in 1970 and projections that go to 2030, for the four county jurisdictions found in the Tuckahoe Creek and Upper Choptank River Watersheds. Table 3 indicates that Caroline County grew from 19,781 people in 1970, to 29,772 people in 2000. Queen Anne's County grew from 18,422 in 1970, to 40,563 in 2000. In Talbot County, the population growth was from 23,682 in 1970, to 33,812 in 2000. And in Kent County, Delaware, the population grew from 81,892 in 1970, to 125,396 in 2000.

Table 2: Historic and Projected Population								
Jurisdiction	Census 1970	Census 1980	Census 1990	Census 2000	2005	2010	2020	2030
Caroline	19,781	23,143	27,035	29,772	31,650	34,200	41,000	47,900
Queen Anne's	18,422	25,508	33,953	40,563	45,450	49,200	55,800	61,900
Talbot	23,682	25,604	30,549	33,812	35,550	37,050	40,050	42,100
Kent, Delaware	81,892	98,219	110,993	125,396	143,969	157,503	175,816	189,536
Source for Maryland Data: Maryland Department of Planning (September 2006) Source for Delaware Data: Delaware Population Consortium (October 2006)								

Table 3 provides historic and projected summary changes in population numbers and growth rates. Kent County, which has a population greater than the other three counties combined, grew by more than 43,000 people from 1970 to 2000 and is expected to add another 64,000 people from 2000 to 2030; in both periods, the growth rate for Kent County is about 33 percent. Talbot County, which added about 10,000 people in the last three decades of the 20th Century, is expected to reduce its rate of growth during the first three decades of the 21st Century and to add less than 10,000 people. Queen Anne's County grew rapidly in the last part of the 20th Century, increasing its population by more than 50% from 1970 to 2000, but that county is expected to slow its rate of growth and to add fewer people, about 21,000 individuals, from 2000 to 2030. Caroline added the fewest people from 1970 to 2000, about 10,000 individuals, but is expected to increase its rate of growth and add more than 18,000 people from 2000 to 2030.

Table 3: Historic and Projected Poulation Changes and Rates of Growth

Jurisdictions	Census 1970-2000		Projections 2000-2030	
	Popultaion Changes	Rates of Growth	Population Changes	Rates of Growth
Caroline	9,991	33.6%	18,128	37.8%
Queen Anne's	22,141	54.6%	21,337	34.5%
Talbot	10,130	30.0%	8,288	19.7%
Kent, Delaware	43,504	34.7%	64,140	33.8%
Totals	**85,766**		**111,893**	

Source for Maryland Data: Maryland Department of Planning (September 2006)
Source for Delaware Data: Delaware Population Consortium (October 2006)

Table 3 indicates, for the county jurisdictions that are located in the Tuckahoe Creek and Upper Choptank Watersheds, total population growth will be about 25,000 people more during the first three decades of the 21st Century than it was during the last three decades of the 20th Century. Only a portion of the population growth in the four jurisdictions will be in the Tuckahoe Creek and Upper Choptank River Watersheds, but the projections do imply that, under current policies, growth in the jurisdictions will remain robust and even increase.

Assuming the projections prove to be reasonably accurate, the relevant questions are:

- Where will more than 100,000 new people in the counties reside? Will they live near to municipalities where they can be served by public water and sewer systems? Or will their homes be scattered across the rural countryside where the new residents will require private wells and septic systems, fragment wildlife habitat, and make traditional agriculture more difficult to sustain?
- How much will new residential and commercial buildings add to the real property tax base of the jurisdictions?
- How much will the new residents and businesses contribute to the tax and fee revenues of the jurisdictions?
- How much will the new people add to the costs of public services?
- Which local jurisdictions, including municipal and county governments, will gain relatively more or less in tax increases, and which will bear more or less of the burdens for added services?
- How much will the new people contribute to the incomes of businesses and laborers in the counties?

- What contributions will new people make to the local quality of life and what will their addition to the counties take away from traditional life styles?
- What environmental consequences will adding more than 100,000 new residents create?

These questions make a case for multi-jurisdictional cooperation to coordinate population growth policies. The case is especially strong for Caroline County, which contains all nine of the municipalities located in the watersheds.[9] A base level of coordination would be the sharing of data on building permits and development activities. A higher level of coordination, also needed, would be to share visions and intentions of how and where the jurisdictions desire to grow. At the highest level of coordination, jurisdictions would jointly plan and implement land use policies. An institutional asset of the watersheds, the Caroline County Council of Governments, is an important tool for achieving multi-jurisdictional coordination and is moving forward toward all three levels of coordination.

As this assessment of the watersheds is being written, the Caroline County Government and municipalities in the northern region of that county are considering a plan to bring public waste-water disposal services to that region. The plan, if implemented, will bring public services to an area that has long experienced failing septic systems and public-infrastructure constraints on economic development. Implementation of the services will also create the potential for increased population growth in the region. Consideration of the plan increases the need for cross-governmental coordination of growth policies in Caroline County.

Increasing Environmental Concerns

The environmental consequences of population growth should be seen in the context of increasing concerns about the quality of the environment among the general population of the Chesapeake Bay Region and increasing initiatives by governments at the local and state levels. The icon for environmental interests and activities in the regional basin that contains the two watersheds is the Chesapeake Bay Program. Begun in 1983, that program links bay-basin states with federal authorities to fund research and provide cost-sharing and technical assistance for the reduction of point and nonpoint-source water pollution in the bay and its tributaries. Research indicates eutrophication, primarily from nitrogen and phosphorus loadings, is the key cause of decline in the bay's water quality. Despite its estimated cost – more than $19 billion to implement the most recent update of the agreement, signed in 2000 – the program continues to have widespread popular support in Maryland and other bay basin states.[10]

Because the Chesapeake Bay Program focuses on nutrient loading – including non-point source pollution from agriculture, the dominant land use of the Tuckahoe Creek and Upper Choptank River Watersheds – some advocates will press for more state authority over agricultural practices. Again, the alternative policy choice will be increased grassroots efforts to achieve local advances in water quality.

Both Delaware and Maryland have Choptank Tributary Teams, and the later organization contains both the Tuckahoe Creek and Upper Choptank Watersheds. These teams are institutional assets of the watersheds because they provide ongoing public-private communications and support local initiatives to meet the environmental concerns of residents for the watersheds and the wider basin.

9 The western edges of the towns of Easton and Trappe, in Talbot County, are located in the Upper Choptank River Watershed.

10 Karl Blankenship. Bay Journal (December 2002). See at www.bayjournal.com/article.cfm?article=919

Changing Food Preferences

Farmers market, photo courtesy of USDA.

The demand for food products is rapidly changing in the United States. In a recent study, the U.S. Department of Agriculture (USDA) identified three drivers – aging customers, a maturing market, and a more diverse population – for changes in American eating habits. The USDA study also suggests consequences those drivers imply for the future.[11] The "aging consumers" factor is based on the growing number of older baby boomers; it implies increased consumer demand for "healthy foods," especially fruits and vegetables. The "maturing market" involves the satiation of basic needs, higher standards of living, and an "upgrading" of food choices; it implies "more expensive cuts of meats, exotic vegetables, luxury food items, ready-to-eat meals, and higher priced restaurants." Finally, the "more diverse population" factor is based on the fact that the Hispanic population is expected to grow by 1.2 million annually, over the next two decades, compared with annual increases of 500,000 among non-Hispanic Whites and 400,000 each among Blacks and Asians. Hispanics are expected to increase from 12.6 percent of the U.S. population in 2000, to 18 percent by 2020; the implication of a more diverse population is that Americans are likely to eat relatively more fruit, eggs, fish, nuts, and seeds.

Agriculture is the predominant land use in the Tuckahoe Creek and the Upper Choptank River Watersheds. Most farm products from the watersheds do not ship directly to retail markets, however. Thus, in large part, the economic fortunes of farmers in the watersheds will be tied to the ability of others, such as leaders in the poultry industry, to make the adjustments to the changing food-consumer market. The three drivers also imply, however, that opportunities for farmers in the watersheds are growing for direct and niche retail marketing. Changing food preferences and growing demand for food products created by increases in the populations in the watersheds, elsewhere on the Delmarva Peninsula, and in the nearby Northeast Megalopolis, will create new marketing opportunities for local farmers.

Globalization

For residents of the Tuckahoe Creek and Upper Choptank Watersheds, globalization means increasing interdependence with people of other communities and nations. Such interdependence involves cooperation, competition, and, sometimes, unfortunately, violent conflict. Developing the capacity to avoid the threats and to take advantage of the opportunities created by globalization depends, fundamentally, on education. [12]

11 USDA *Amber Waves: The Economics of Food, Farming, Natural Resources and Rural America*, April 2003 www.ers.usda.gov/Amberwaves/April03/Features/ConsumerDrivenAg.htm

12 This section draws on Jacques Delores. "Education for Tomorrow," UNESCO Courier, April 1996.

Education is essential for building a creative workforce that can adapt to new technologies and take part in the "information age" that is driving economic growth. Education also advances knowledge about how to marry economic development with responsible management of the natural environment. And education, at its best, produces citizens rooted in their own cultures yet open to other cultures and to human progress.

If educational institutions are to succeed in their job of aiding adaptation, they must help people anticipate change, whether the change be in personal and social values, family structure, the potential contributions of women and minorities, or the challenges of achieving development while protecting the environment. To be successful, educational institutions must also adapt, so as to anticipate and respond to evolving relations among local, regional, state, and national authorities and between public and private institutions. And, finally, educational institutions must advance the values of openness and respect for others, of mutual understanding and collaborative problem solving; in a word, they must advance the values of "peace."

Educational institutions are active in the Tuckahoe Creek and Upper Choptank Watersheds. They include local primary and secondary school systems, a regional community college, a nearby four-year liberal arts college, universities in Maryland and Delaware, and various related organizations. By their participation in and support of these institutions, watershed residents will aid the adaptation to globalization.

Increasing Dependence on and Rising Prices for Fossil Fuels

As economies around the globe have rapidly grown during the last two centuries, they have done so largely by using fossil fuels as their energy sources. The primary fossil fuels – oil, coal, and natural gas – are stock resources, subject to being used up; as such, markets for these fuels are subject to rapid price increases. In addition, significant portions of U.S. oil and natural gas are imported from countries in unstable regions of the world. The prospect of such import dependence and potential price increases is creating significant pressure for change across the country and in the watersheds.

It is useful when discussing the future of energy to distinguish between "costs" and "prices." As the demand for oil, coal, and natural gas increases – while other factors remain the same – prices for those fossil fuels will rise and markets will react to that signal. In addition, however, there are non-market consequences – especially foregone political and environmental opportunities (i.e. social costs) – of an increasing demand for fossil fuels.

The economic consequences of increasing demand for oil, coal, and natural gas send a price signal to both consumers and suppliers. Consumers will attempt to adjust their behavior by cutting back on energy use – pooling car rides, making their homes more energy efficient, etc. – and by substituting alternative energy sources – for example, bio-fuels and solar power – for higher priced fossil fuels. Suppliers will invest in more costly exploration and resource recovery of fossil fuels, and in the production of alternative energy commodities. In the Tuckahoe Creek and Upper Choptank Watersheds, higher fossil fuel energy prices imply the following incentives, among others: employees attempting to reduce their commuting distances to work; farmers with energy-intensive operations attempting to find alternative energy sources to stay in business; farmers with potential for growing bio-fuel inputs, such as barley, soybeans, and switch grass, rethinking their crop options and, perhaps, investing in bio-fuel production.

The political consequences of increased dependence on imports of fossil fuels are costly. Oil imports make the

United States more subject to the influence of foreign governments, some of which may not share our interests. They require greater diplomatic skills and, as history demonstrates, when those skills fail, large expenditures to intervene militarily in other places. The watersheds have always been the source of military recruits – no less today with the War in Iraq than with the Revolutionary or Civil Wars.

The environmental costs of using oil, coal, and natural gas as primary energy sources are both global, such as climate change, and local, as in reduced air quality. As citizens of the world, residents of the watersheds are both part of the problem and part of the solution.

The total set of consequences in the watersheds of rising prices for and dependence on fossil fuels is mixed. Other things being the same, those forces for change imply: a slowing of residential development pressures; increased economic hardships, particularly for poorer homeowners and commuters; increased threats to farm supply budgets, but increased income opportunities for crop producers; increased risks to military volunteers and their families; and increased awareness that where the environment is concerned, we should be responsible for the consequences of our behavior.

Assets of the Watersheds

Assets in the Tuckahoe Creek and Upper Choptank River Watersheds play a dual role. First, forces for change, such as the five discussed above, create threats and opportunities for the protection, preservation, and enhancement of assets that are found in the watersheds. Second, watershed assets provide resources by which people can adjust to the change forces.

Assets of the watersheds are both natural and cultural. In reality, the two types are never mutually exclusive: nature affects human thought and behavior, just as humans affect nature. The natural resource "land," for example, has provided a medium for gathering and growing human food since the Delmarva Peninsula formed after the last ice age; and humans, since Paleo-Indians moved to the peninsula, have used fire, drainage ditches, and other techniques to "improve" the land. The assets are also both tangible – such as native plants, historic buildings, and public parks, and intangible – for example, laws to guide the development process, the history of African Americans in the watersheds, and local people's "sense of place."

African-American Legacy

The history of African Americans living in the Tuckahoe Creek and Upper Choptank Watersheds teaches hard lessons about the characteristics and legacy of slavery, but it also inspires hope for the future of the region and beyond. Beginning in the 17th Century, the watersheds have been home to people who were enslaved in Africa and transported to America, and to their descendants. Pre Civil War treatment of slaves as private property – to be bought, sold, worked and abused as owners preferred – is part of the story.

Out of such inhuman experiences, however, the human spirit has prevailed. Frederick Douglass, born in the Tuckahoe Creek Watershed, toiled as a slave there and in Baltimore before escaping and becoming a powerful spokesman against slavery prior to the Civil Way and an influential public official for reconstruction afterward. Harriet Ross Tubman, who also was born as a slave in the region, escaped from Maryland like Douglass and returned to the state many times to lead family members and others to freedom in the North, often using the

Upper Choptank Watershed as her escape route on the Underground Railroad. Tubman joined the Union Army to become a nurse, spy, and scout. She capped her long life of public leadership as a suffragist and humanitarian. And Bishop A.W. Wayman, another African-American hero of the region, became a national leader of the African Methodist Episcopal (AME) Church during and after the Civil War.

People of the watersheds and the region can be inspired by the history of African Americans in the Tuckahoe and Choptank Watersheds – exemplified by the lives of Douglass, Tubman, Wayman, and others.[13] The story of African Americans in the watersheds continues to unfold. A contemporary African-American observer, Erick Brown, wrote a reflection about the story at the conclusion of a recent voyage, across geography and through time, to investigate the places and meaning of slavery in the Chesapeake Bay Region. Brown's journey – which was organized for history teachers by the Starr Center at Washington College, began in the Tuckahoe Creek Watershed at the birthplace of Frederick Douglass, and occurred during the summer of 2007 – ended with these comments by Brown:

> *Let me say what a moving experience it was to see the places my ancestors lived, died, and (in some cases) overcame great obstacles to their prosperity and survival. I don't ever want to forget the stock I come from. I constantly want to remind myself that I come from a people who labored in chains but strived for perfection in music, dance, art, and literature. I want to remind myself that Africans refused to die here. Despite what many of us would judge to be a hopeless condition, they lived! They dreamed! They fought back in whatever way they could! They passed on to their future generations a legacy of hope and faith in God! Most importantly, when freed from their bondage, they forgave! The entire experience was an epiphany. The heat of the slave cabins, the oppressively hot sun, the sticky feel of the tobacco, the sounds of voices singing songs of hope and despair, the percussive rhythms of African drums, the view from the third floor of Mount Vernon, the luxury of the Douglass house. All of these experiences serve to remind me that when I stand, I stand in the shadow of greatness! When I walk, I walk in the footsteps of giants! If I could send my ancestors a message through time, it would be this. "Your legacy lives on. We remember, and we are grateful." (See http://news.washcoll.edu/events/2007/07/chesapeakejourney/ .)*

Framework of the African-American Heritage

National Park Service African American Heritage and Ethnography http://www.cr.nps.gov/enthography/aah/AAheritage/index.htm

A "self paced learning resource" for National Park Service Staff, this website offers information

13 The Caroline County Historical Society is actively documenting and publicizing the African-American experience in the watersheds and elsewhere in the county. For example, the society has:

- Hosted, in 2007, a one-man art exhibition of Mark Priest's paintings on the life of Harriet Tubman;
- Initiated efforts to restore the Webb-Fluharty home, occupied in the mid 1800s by James H. Webb, a free black man;
- Presented a lecture (by JOK Walsh) called "One More Soul Got Free" about Frederick Douglass, Harriet Tubman, and Jacob and Hannah Leverton, Quakers who operated a station on the Underground Railroad near Preston;
- Published illustrated maps of the lands of the Underground Railroad near Preston;
- Wrote and illustrated (by JOK Walsh) A Brief Overview of the Impact of the Chesapeake Bay on the Conduct of the Underground Railroad and An Outline of Sites in Caroline County, Maryland Related to the Period and Operation of the Underground Railroad, both copywritten in 2002.

about the history of African Americans in the Tuckahoe and Upper Choptank Watersheds. Included on the site are: (1) key concepts; (2) an ethnographic research center; (3) content modules; (4) a learning resource center; and (5) heritage preservation notes. The first module contains "Africans in the Chesapeake," which provides a detailed examination of life among slaves who were resident in Maryland and Virginia.

Public Broadcasting System The Africans in America Website
http://www.pbs.org/wgbh/aia/home.html

This website provides a historic review of African Americans in four periods: "The Terrible Transformation" (1450-1750); "Revolution" (1750-1805); "Brotherly Love" (1791-1831); and "Judgment Day" (1831-1865). Each review provides a narrative, resource bank, and teachers' guide. The last period contains a biography of Frederick Douglass, noting his birth on the Eastern Shore, experiences as a slave, escape to freedom, and development into an influential advocate for an end to slavery but without abandoning the American Constitution.

Maryland State Archives The Study of the Legacy of Slavery in Maryland
www.msa.md.gov

State Archives offers this resource "to preserve and promote the vast universe of experiences that have shaped the lives of Maryland's African American population." The website includes source documents and online presentations spanning the history of African Americans in Maryland. On an auxiliary website can be found an interactive map for Caroline and other counties; the county maps, based on property records, can be used to conduct searches for places and people in Antebellum Maryland.

Washington College A Chesapeake Journey: From Slavery to Freedom
http://news.washcoll.edu/events/2007/07/chesapeakejourney/

A group of history teachers, led by faculty from Washington College, took a journey in the summer of 2007, beginning on the banks of Tuckahoe Creek, to learn about slavery in the Chesapeake Bay Region, as told by the life of Frederick Douglass and others. Of particular interest are "Travel Blog" entries written by students, including the one by Erick Brown shown previously.

Frederick Douglass (1818-1895)

Fredrick Douglass. Narrative of the Life of Frederick Douglas, An American Slave
http://sunsite.berkeley.edu/Literature/Douglass/Autobiography/

Douglass began his autobiography by noting his birthplace – near Hillsboro in the Tuckahoe Creek Watershed – and went on to describe, in clear and compelling fashion, his life as a slave on the Eastern Shore and in Baltimore prior to his escape.

Public Broadcasting System People and Events: Frederick Douglass
http://www/pbs.org/wgbh/aia/part4/4p1539.html

Part of a large website devoted to "Africans in America" (use link to "Resource Book") this brief biography of Douglass highlights his indomitable spirit and life-long quest for learning and

teaching.

Frederick Douglass Memorial Action Coalition Memorial
http://frederickdouglasproject.org/index.html

A project is underway to create a memorial to Frederick Douglass on the Talbot County Courthouse lawn. This website, sponsored by the Frederick Douglass Memorial Action Coalition, provides via photographs and narrative, information about the design, location, and funding of the memorial. Also included are links to Frederick Douglass' papers, narratives, and materials. "What was possible for me is possible for you," Douglass is quoted as saying to a group of African-American school children in Easton, Maryland, in 1893.

Harriet Ross Tubman (1822-1913)

Kate Clifford Larson. Bound for the Promised Land. New York: Random House Publishing Group, 2004.

The focus of this biography of Harriet Tubman is on the "Moses of her People," but the book also provides detailed and well-documented information about the history of slavery in Dorchester and Caroline Counties, especially in the several decades leading up to the Civil War. That time period saw families arbitrarily and capriciously broken apart as "excess slaves" from Maryland were sold "down the river" to the Deep South. Tubman's mental, physical, and spiritual strength and courage make this scholarly work an enjoyable, even while a disturbing, read.

Kate Clifford Larson. Harriet Tubman Biography
http://harriettubmanbiography.com/_wsn/page8.html

Ms. Larson provides photographs, links, narratives, maps, and more, all of which illustrate the life and times of Harriet Tubman. The site complements and expands upon the author's biography of the Moses of her People.

Alexander Walker Wayman (1821-1895)

Choptank River Heritage Center Bishop Wayman Pilgrimage
www.riverheritage.org/RiverGuide/Trips/html/wayman_pilgrimage.html

Bishop Wayman was born in Tuckahoe Neck where his family owned farmland and Tuckahoe Creek-front property that included Wayman Wharf, the terminus for the Wheeler Transportation Line that served Hillsboro in the late 1800's. Wayman led the AME Church by preaching, writing (See his Cyclopedia of African Methodism.), and establishing new churches from Florida, to Minnesota, to California. The Choptank River Heritage Center provides a guide for a "pilgrimage" from the Talbot County steamboat stop at Covey's Landing, past Frederick Douglass' birthplace, to the ruins at Wayman Wharf.

Post Civil War African-American Communities on the Eastern Shore

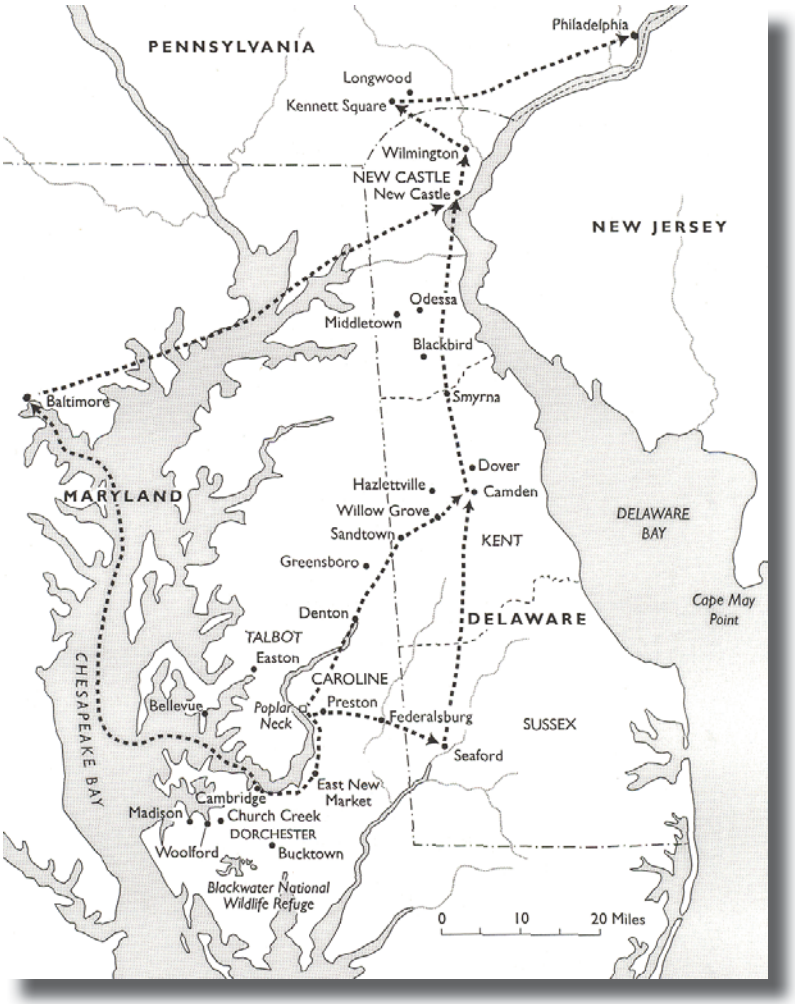
Talbot County *Unionville, Maryland*
http://www.tourtalbot.org/smalltowns.asp?tid=9

This website describes the history of African Americans on the Eastern Shore during the Civil War and afterwards when ex-slaves settled in small communities. There they built churches, homes, and businesses. The specific reference is to Unionville, which is located in Talbot County, but the history described on this site is relevant for small, rural, predominantly African-American communities such as Jonestown in Caroline County also.

Underground Railroad

The Internet provides many images, some with narratives, related to the Underground Railroad on Maryland's Eastern Shore. Some highlights of the images follow:

- Wright, Deborah L. "Being Harriet Tubman" The Bay Weekly, 12(6) February 5-11, 2005. Ms. Wright tells why and how she portrays Tubman in one-woman productions. See at www.bayweekly.com
- The C.V. Starr Center for the Study of the American Experience http://starrcenter.washcoll.edu
- This center, located at Washington College in Chestertown, provides Frederick Douglass Fellowships and student research opportunities for study of the African-American heritage on Maryland's Eastern Shore – including a current project on the Underground Railroad.
- Breaking the Silence www.antislavery.org This site provides illustrations and narratives about the origins of African Americans and about their history and prominent leaders, including Harriet Tubman.



Source: Larson, Kate Clifford. Harriet Tubman Biography. http://harriettubmanbiography.com/_wsn/page8.html See map 7 in Section 4 for a larger version of this map.

The Economy: Agriculture, Industry, and Transportation

The Tuckahoe Creek and Upper Choptank Watersheds are unique among America's stream basins because of the length of time during which agriculture has been their dominant economic activity.

Agricultural History

From tobacco production in Colonial Times, through grain farming during the fight for independence from England – when the Eastern Shore became known as the "bread basket of the Revolution" – through fruit and vegetable farming and canning in the 20th Century, to current days when many Shore farmers grow poultry, agriculture has driven the watersheds' economies. Agriculture is also tied to historical industries – milling and canning primarily – and to the growth and evolution of water, rail, and truck transportation.

Boom-to-bust cycles in agriculture – within the context of a continuous, 150-year exodus of people from farms to cities – have been significant factors in the history of the watersheds – thereby helping to explain, for example:

1. Human out-migration patterns, such as the tendency during bust years, for young men from the watersheds to join the military;[14]
2. Architectural styles in the watershed's towns, corresponding to boom times in agriculture.

Industrial History

An unusually-rich historic example of agricultural-related industry in the watersheds is the Linchester Mill Site, located near Hunting Creek, a tributary of the Choptank River. The mill contains German and French millstones, American Case roller mills, ten major pieces of process equipment, and a complete system of grain elevators and conveyers.[15] The mill site provides significant potential for educational purposes – including heritage preservation and environmental stewardship – and for recreational development.

Transportation History

The watersheds have important water-based transportation histories. For three centuries sailing vessels that were manufactured on Tuckahoe Creek and the Upper Choptank – sloops, schooners, shallops, scows, and various other vessel types (not all beginning with "s") – were built in Denton, Hillsboro, and, most frequently, Greensboro. These vessels sailed locally and the world over. For example: the Potter family ran sloops to Antigua and Rhode Island to trade for limes, rum, and pork in the 1740s; the schooners

Sloops. Image courtesy of NOAA.

14 The Caroline County Historical Society provides publications and lectures recalling the important role soldiers from the county have had in wars, beginning with the American Revolution. Examples include lectures with accompanying publications about the Campaign to Yorktown (1780-1781), Civil War, and World War II.

15 Caroline County Historical Society. A Proposal to Use the Linchester Mill Site for Environmental Stewardship, Heritage Preservation and Recreation Activities, 2006. The society also promotes the Friends of Linchester Mill and co-hosts programs with the friends group to increase local awareness of the value of the mill and the surrounding land and water area.

Comet, Hester, St. Peter and Eliza G. Potter, all built in Caroline County between 1798 and 1819, were used for trade in the West Indies and to respond to threats from British, Spanish, Danish and Haitian privateers; during the late 1700s, shallops, which were used where deep-water vessels could not go, were sailed on the Choptank upstream to the bridge at Greensboro; and, in the 1790s, Hillsboro merchant John Corrie used a scow to transport his goods on the Tuckahoe Creek.[16]

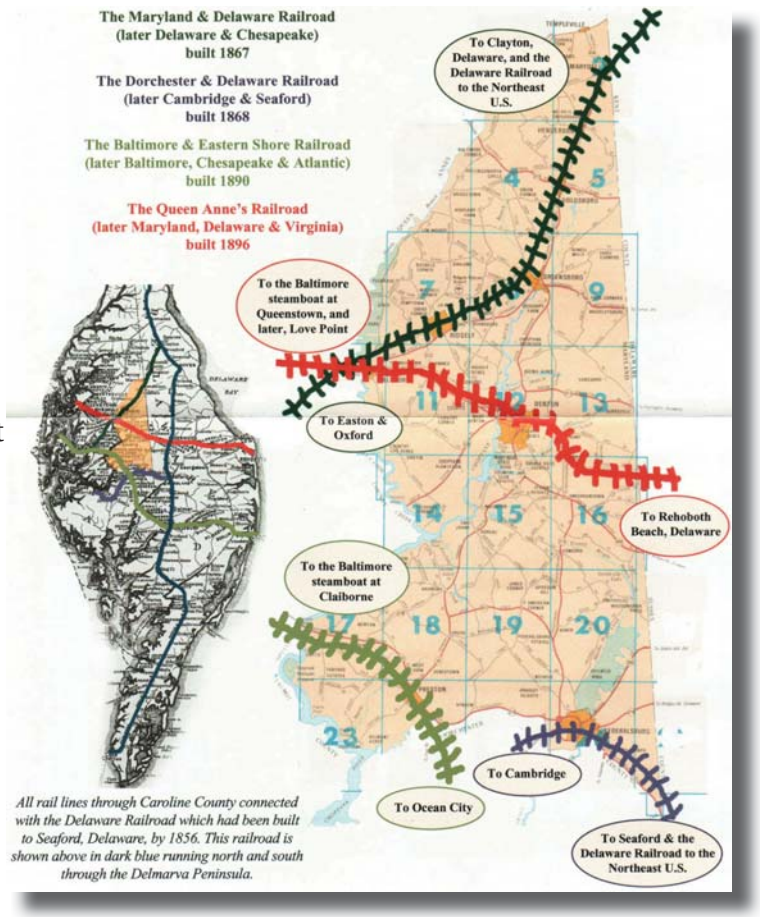
From the mid 19th to the early 20th Centuries steamboats joined sailboats on the Choptank River. Steamboats complemented schooners – which carried bulk freight like coal, fertilizer, and oyster shell – by carrying passengers and light freight. Railroads competed, eventually, with steamboats, but it was the popularization of cars and trucks, and public investments in road improvements that ended the steamboat age on the Choptank in the 1930s.[17]

To share this sailing and steamboat history among local residents and tourists, a group of public and private organizations have initiated "The Wharves at Choptank Crossing" to include a visitors center, nature walk, restaurant, and the existing Steamboat Wharf & Heritage Museum. The wharves will be located near Maryland Business Route 404 close to Denton.[18]

Three rail lines crossed the Tuckahoe Creek and Upper Choptank Watersheds. They were:

- The Maryland & Delaware built in 1867, which ran northeast to Clayton, Delaware and the Delaware Railroad to the Northeast U.S. and southwest to Easton and Oxford, Maryland;
- The Baltimore & Eastern Shore built in 1890, which ran northwest to the Baltimore steamboat at Claiborne, Maryland and southeast to Ocean City, Maryland;
- *The Queen Anne's* built in 1896, which ran northwest to Baltimore steamboat at Queenstown, Maryland and east to Rehoboth Beach, Delaware.

All lines connected to the east with the Delaware Railroad, which had been built, by 1856, to Seaford, Delaware. The railroad companies also built functionally useful and aesthetically pleasing railroad stations at Denton, Goldsboro, Greensboro, Henderson, Marydel, Preston, and Ridgely.[19] (See Map 8 in Section 4)



Courtesy of JOK Walsh

16 JOK Walsh. Three Centuries At Sea: The Sailing Vessels of Caroline County. Denton, Maryland: Caroline County Historical Society, 1998.

17 JOK Walsh. Steamboats on the Choptank. Denton, Maryland: Type-All Services, 2003.

18 Caroline County Historical Society. The Wharves at Choptank Crossing , Denton, Maryland (No Date).

19 JOK Walsh and Chrissie Barr, eds. Railroads: Caroline County, Maryland. Denton Maryland: Caroline County Historical Society, 2007.

Current and Future Agriculture

Public policies to influence the future of population growth and the location of new houses and other structures in the watersheds must take into consideration the large portion of land that is held as private farms. For example, Caroline County Government has created a "Transferable Development Rights" program and discussions are underway between the county and municipal governments to expand the program by creating growth "sending" and "receiving" areas that would preserve agricultural lands, provide payments to farm owners for forgoing development on their land, and concentrate growth in built areas around existing towns. (See Agricultural Land Conservation on page 23).

Agricultural practices are also important factors in environmental quality in the watersheds. Farm nonpoint source pollution combines with sewage-treatment-plant discharges, and other sources to create eutrophication in the Tuckahoe Creek and Upper Choptank River. Agriculture can also, however, be part of the solution to water quality problems. For example, consider the maintenance practices for local public drainage organizations. Such organizations, which are special-purpose taxing districts, manage about 800 miles of ditches draining more than 180,000 acres of land on Maryland's Eastern Shore. The ditches are part of the public infrastructure that serves the region's agricultural, transportation, commercial and residential land uses. Under a collaborative agreement created among environmental, agricultural, and other interest groups and public agencies in 2000, public drainage organizations are employing best-management-practices (BMPs) to maintain their ditches. (See Public Drainage on pages 31).

Stone is one of many BMP bank stabilizatio methods used to prevent blow-outs and channel obstructions for PDAs. Photo courtesy of the Caroline County SCD.

Of recent concern to farmers and home gardeners is the "colony collapse syndrome," a yet-to-be explained, sudden die-off of honeybee colonies. Research is underway in the Tuckahoe Watershed to investigate the presence and habitat needs of wild bees and other pollinators whose value has become more obvious to farmers and gardeners with the threat to domesticated honey bees. (See Pollinators on page X.)

The future of agriculture and related industries in the watersheds over the next several decades is largely unpredictable because it is subject to major factors that are themselves uncertain. Those factors include:

- The rate of local population growth, which itself is dependent on factors such as the price of gasoline, cost of housing on the Western Shore, and cross-bay transportation facilities;
- World prices for energy;
- The ability of the Delmarva poultry industry to continue to compete effectively in a global economy;

- The rate of advances in new farming technologies, such as in biotechnology;
- Changes in consumer preferences such as, for example, emerging consumer demand for local food products;
- Government programs such as public investments in conservation practices and land preservation.

Despite the uncertainties, several likely opportunities for agriculture in the watersheds are identifiable. They include:

- Increased production of bio-fuels to substitute for fossil-fuel products, especially those derived from oil imports;
- Advances in "integrated agriculture" whereby farmers receive income for protecting and enhancing natural systems that recharge ground water and recycle intermediate "wastes" into new products;
- Growth in local and regional retail markets whereby farmers in the watersheds take advantage of increased consumer demand, in the mid-Atlantic Region, for locally-grown retail food products.

Agricultural Statistics

Natural Resources Conservation Service (NRCS) Choptank Watershed
http://www.md.nrcs.usda.gov/programs/csp/2006/choptank.html

NRCS provides an overview of the Choptank River Watershed, including its geography (509,000 acres in Maryland and Delaware) and land-cover and land-use acreages (259,840 in agriculture, 147,840 forested, 40,320 urban, and 177,290 forestland/wetland). Also provided are two maps, one showing the watershed with state, county, and municipal overlays, and the second with an overlay of land uses in 2000.

National Agricultural Statistics Service *Agricultural Profile: Caroline County Maryland 2004*
www.nass.usda.gov/md/Caroline04

The profile indicates that over the decade 1992-2002: the number of farms in Caroline County declined from 588 to 506; average farm size increased from 216 to 227 acres; land in farms fell from 126,981 to 114,843 acres; and the average age of farm operators rose from 51.8 to 54.9 years. For Caroline County in 2002, the value of farm sales, for all products, stood at slightly over $100 million.

Additional References about Economic History

Chidester, Robert C. *A Historic Context for the Archeology of Industrial Labor in the State of Maryland*
www.heritage.umd.edu/CHRSWeb/AssociatedProjects/chidesterreport/Chapter%20v.htm

Chidester provides an interesting description of the history of industrial development on the Eastern Shore, with photographs and county-by-county details. The major epochs are Rural Agrarian Intensification, 1680-1815 (with grist mills, tanneries, and a plow factory in the watersheds), Agricultural-Industrial Transition, 1815-1870 (saw mills), Industrial/Urban Dominance, 1870-1930 (lumbering and food processing – with more than 150 canneries in

Caroline County), and Modern Period, 1930-Present (garment and sporting goods manufacturing, and food processing, primarily in the Greensboro area).

Eastern Shore Heritage Area. Stories of the Chesapeake
http://www.storiesofthechesapeake.org/agriculture.html

This website, written as part of a feasibility study, provides a succinct, yet detailed, description of the significance of agriculture for the Tuckahoe Creek and Upper Choptank Watersheds and other portions of the northern counties of the Eastern Shore: Caroline; Kent; Queen Anne's; and Talbot.

Sharrar, G. Terry *Maryland History and Culture Bibliography: Agriculture*
Maryland Humanities Council.
www.mdhc.org/.../search_essays.htm?essay1=28&essay2=hist&essay3=3&search3.x=14&search3.y=9 - 21k

Sharrar's essay on the history of agriculture in Maryland provides a short but broad and well-referenced overview of the subject. The author traces the ascendance and decline of a succession of major crops and animal products, beginning with tobacco, and including wheat (when Maryland was part of the first "wheat belt"), peaches, and various other products more common to the Western Shore. He ends with an optimistic note, suggesting the potential development of new products for local farmers as the result of biotechnological research and development being conducted in the state.

University of Maryland Library. *The Agricultural History of Maryland*
http://www.lib.umd.edu/agriculture/usain/mdhistory.html#top

As a general introduction to the history of Maryland agriculture, this website also provides an extensive bibliography about the subject. Of special interest is the description of "Movements, Institutions, and Societies" that have surrounded Maryland agriculture. Mentioned, for example, are: (1) the research and writings of John Beale Boardley, who lived in Talbot County; (2) Maryland Cooperative Extension, which serves citizens of the Tuckahoe Creek and Upper Choptank Watersheds; and (3) the University of Maryland Eastern Shore, which was created after passage of the second Morrill Act in 1890.

Agricultural Land Conservation

The Caroline County Planning and Codes Department website provides detailed information about land preservation, including descriptions of the county's transferable development rights program and Maryland's Agricultural Land Preservation Foundation. Also included on the land preservation portion of the site is a PDF file map of land preservation and conservation areas in Caroline County. The legend for the map indicates the county has a land preservation goal of 100,000 acres by 2020 of which 60,701 have been preserved. Land currently in Agricultural Preservation Districts totals 16,921 acres, and in Agricultural Preservation Easements the total is 26,363 acres. (See map 9 in Section 4 for AgriculturalLand Preservation)

Eastern Shore Land Conservancy http://eslc.org This organization has a vision for the year 2050 on the Eastern Shore where: (1) towns are vibrant and well defined; (2) farms, forests, and fisheries are thriving and scenic; and (3) historic, natural, and riverine landscapes are maintained. To accomplish this vision, the organization assists with land conservation through easement purchases and promotes land use planning by local governments in the region. The conservancy's website contains research reports on land protection, growth, and economic development as well as the Eastern Shore 2010 Agreement by which Caroline and other counties in the region pledged in 2002 to: (1) provide a minimum amount of funds for land protection; (2) implement economic development plans supporting the farming, fishing, and forestry industries; (3) direct 80 percent of new growth to villages and towns; (4) set a maximum annual growth rate; (5) create a plan for workforce housing; and (6) suggest alternatives to another Bay Bridge, including a public transportation plan.

Pollinators

Ted Suman, Research Associate, and Sylvan Kaufman, Conservation Curator, both at Adkins Arboretum, are studying pollinating insects in the Tuckahoe Creek Watershed. Suman and Kaufman wrote the following paragraphs about pollinators as assets in the watershed:

Photo by Scott Bauer, courtesy of USDA Agricutlural Research Service.

> "While many pollinating insects such as butterflies, beetles, wasps, and flies are found in the Tuckahoe River Watershed, the most important are the bees. Two species of bees are managed specifically for their pollinating activities. Honeybees are maintained by both commercial beekeepers and hobbyists for their pollinating activities and honey production. Bumblebees are used in at least one commercial greenhouse business for pollinating tomatoes. Two other groups of bees that occur in the watershed are also recognized as important pollinators. These include several species of native ground nesting bees and mason bees.
>
> A project begun this year (2007) at Adkins Arboretum involves, first, collecting and identifying all of the pollinating insects, particularly native bees, and then selecting those species that have shown potential for management. This includes determining and establishing supplemental nesting sites and food sources. This information will then be made available to area farmers, backyard gardeners, garden clubs, and other interested groups."

For additional information about pollinators and their value, see the following sources:

Sanford, M. Tom. *Pollination: The Forgotten Agricultural Input.*
apis.ifas.ufl.edu/papers/altpol.htm

Sanford, a University of Florida Extension Specialist in Apiculture, provides an introduction

to the subject by describing the all-too-easy-to-overlook significance of pollinator species for American Agriculture.

Ingram, Mrill, Gary Nabhan and Stephen Buchmann. *Our Forgotten Pollinators: Protecting the Birds and the Bees.*
www.pmac.net/birdbee.htm

The authors provide an overview of the ecological significance of pollinator services and threats to the various species that provide such services – particularly toxins and habitat loss for bees. An extensive bibliography is included.

Mid-Atlantic Agriculture Research and Extension Consortium. *Bee Aware: Notes and News on Bees and Beekeeping*
maarec.cas.psu.edu/Nov99_newsletter.html

This electronic newsletter has featured two editions that focus on bees and beekeeping on the Delmarva Peninsula and in the State of Maryland: July and September, 1999, respectively.

The Future of Agriculture

Talbot County Steering Committee *Growing Our Future*
http://ces.washcoll.edu/ruralcommunityleadership_avp.php

This vision plan for the future of agriculture in Talbot County, which was drafted in May 2007, identifies opportunities and threats to both conventional agriculture and to new small-scale farm enterprises in the county.

USDA/Agricultural Research Service *Integrated Farming*
www.ars.usda.gov/Main/docs.htm?docid=8519

The USDA provides a systems model available for computer download.

Pollin, Michael *The Omnivore's Dilemma*

Another name for "integrated farming" is "grass farming" as popularized by Pollin who describes an enterprise of this type in Virginia called "Polyface Farm." See http://polyfacefarms.com/index.html.

Agricultural Biotechnology

These three sources provide a balanced overview of questions about biotechnology at the farm level:

USDA www.usda.gov/agencies/biotech/
"AgBio World" www.agbioworld.org/
Dobbs, Thomas, et al) *Agricultural Biotechnology: Farm-Level, Market, and Policy Considerations* http://

agecon.uga.edu/~jab/Library/s02-04.pdf

1. Land Uses in Caroline County
2. Public drainage ditches in Caroline County or in the watersheds (SEE www.esrgc.org/tditches.htm for the Choptank River)
3. Land Preservation, from ESLC, for Caroline, Queen Anne's and Talbot Counties

Governance: Jurisdictions; Organizations; Legal Structures; and Planning Resources

Governance of land and water use in the watersheds is provided by local, state and federal jurisdictions, and their respective departments and agencies. Increasingly, governance of land and water also involves organizations that coordinate across jurisdictions and agencies – public-private groups, and stakeholder advocacy groups.

Organizations that coordinate across jurisdictions and agencies are the Caroline County Council of Governments, Mid Shore Regional Council, Chesapeake Bay Cabinet, and Chesapeake Bay Program. The States of Delaware and Maryland have also formed public-private groups, called "tributary teams," to assist in setting environmental policies for the Choptank and other watersheds. Advocacy organizations contribute to governance by raising issues, providing information, lobbying governments, and volunteering to assist in policy and program implementation. Each of the counties in the watersheds has, for example, a farm-bureau group that represents commercial agricultural interests. Likewise, the Delmarva Poultry Industry, Inc. represents that important sector of the regional economy. At the Chesapeake Bay watershed level, advocacy groups include the Chesapeake Bay Foundation and the Alliance for the Chesapeake Bay.

County Governments in Maryland and Delaware

For each county jurisdiction, an overview of the size and structure of government is offered. That is followed by descriptions of salient agencies and publications.

Caroline County, Maryland
www.carolinemd.org/

Size and Structure of Government

About half of the Tuckahoe Creek and Upper Choptank Watershed's total land area is located in this county. Caroline County, which also contains the Marshy Hope Watershed and a small portion of the Lower Choptank River Watershed, has an area of 326 square miles. The county's population, in 2000, was 29,772. Of the 10 municipalities found in Caroline, nine are located in the Tuckahoe Creek and Upper Choptank River Watersheds. The county's website contains the following statement about the jurisdiction's structure of governance: "In 1984, the citizens of Caroline County voted to establish Caroline as a Code Home Rule County. Home rule allows Caroline to exercise the power of self-government over purely local matters. The Maryland General Assembly retains the ultimate authority regarding maximum limits on property tax rates and the amount of indebtedness incurred by the county. Despite home rule, laws in certain areas, such as education, health, alcoholic beverages, and judicial

proceedings, and those establishing new types of taxes or fees, must by passed be the State."

Planning and Codes Administration
http://www.carolineplancode.org/

The department, created in 1985, administers, implements, and enforces county ordinances, regulations, and codes and state and federal laws as delegated related to land use, housing, excise tax assessments, and other matters. This website is thus a prime source of information about governance of the watersheds. Included are sections for:

- Building permits and zoning certificates;
- Review of plats for major and minor subdivisions, additions, and sewage reserve area relocations;
- Licensing of electricians, plumbers and salvage yards;
- The county's transferable development rights program;
- The Planning Commission, Board of Zoning Appeals, and four other boards and commissions;
- Monthly reports on permits issued and annual reports on new home construction, subdivisions, and other development activities.

Anticipating and Adapting to Growth Pressure
www.carolinemd.org/news/strategicplan.pdf

This document, which emphasizes a financial perspective and represents the view of a broad array of stakeholder groups, provides a strategic plan for coping with and managing population growth to the year 2025. Included are strategies for: land use; infrastructure; jobs for young people; financing school facilities; affordable housing; preservation and conservation of cultural and natural assets; and enhancement of health care services.

Queen Anne's County, Maryland
www.qac.org/

Size and Structure of Government

The western portion of the Tuckahoe Creek Watershed is located in Queen Anne's County. One municipality, Templeville, spans the Queen Anne's County – Caroline County boundary and is located in the Tuckahoe Creek basin. The county contains 510 square miles and, in 2000, had a population of 40,563 people. Like Caroline County, Queen Anne's has a Code Home Rule form of government.

Planning
www.qac.org/depts/planzone/planzonehome.htm

In Queen Anne's County, the Planning section includes the Departments of Economic Development & Agriculture and Land Use, Growth Management & Environment. The latter department contains three divisions: Community & Environmental Planning; Land Use & Zoning; and Zoning. A website for the Land Use, Growth Management & Environment Department provides access to a wide array of

documents, both current and historic, including the county's 2002 comprehensive plan, as amended.

Talbot County, Maryland
www.talbgov.org/

Size and Structure

Talbot County contains the southernmost portions of the Tuckahoe Creek and Upper Choptank Watersheds. None of Talbot's incorporated towns lie completely in those watersheds, although the western extremes of Easton and Trappe cross the watershed divide into the Upper Choptank River. Talbot's area is 477 square miles and, in 2000, the county's population totaled 33,812. Unlike Caroline and Queen Anne's Counties, Talbot has a Charter Home Rule form of government. A local charter, like a constitution, provides Maryland's Counties with the opportunity to create distinct legislative (council) and executive functions and authorities that may be more independent of the state government than is found in Code Home Rule Counties.

Department of Planning and Zoning

This department, along with six others, is located in the Land Management section of the Talbot County Government. This department's site contains the county's comprehensive plan (and maps), dated February 15, 2005, and an extensive set of links to codes, forms, processes, and sub-organizations. Departmental personnel indicated on the site include: a director and assistant director; long range, development review, and environmental planners; a zoning coordinator and a zoning enforcement officer; a housing coordinator; and three administrative assistants. See www.talbotcountymd.gov/index.php?page=Planning_and_Zoning .

Kent County, Delaware
www.co.kent.de.us/

Size and Structure

The northeast portion of the Upper Choptank Watershed lays in Kent County, Delaware – the middle jurisdiction of that state's three counties. Kent County contains 800 square miles and had a population of 126,697 in 2000. No Delaware incorporated municipalities are located in the Upper Choptank Watershed although the Town of Hartly, with a population of 107, sits on the watershed's northern boundary, about ten miles west of Dover.

Department of Planning Services
www.co.kent.de.us/Departments/Planning/index.htm
This department has responsibility for planning, inspections and enforcement, community development, historic preservation, manufactured housing, and mapping. The department provides an informative and interactive website with sections on the comprehensive plan, inspections and enforcement, community development, GIS mapping, historic preservation, manufactured housing, and planning & zoning.

Municipalities

The following descriptions of towns in the watersheds derive from the jurisdictions' websites, if available, and from the Maryland Municipal League website as found at www.mdmunicipal.org/cities/citiesweb.cfm .

Denton
www.dentonmaryland.com

Incorporated in 1802, by the year 2000 the Town of Denton contained 2,960 people. Denton relied on steamboat transportation until 1811 when the first of three bridges was built to span the Choptank River. Lamps from the second bridge now grace the downtown area. Denton has a town administrator and departments of finance, housing and community development, public safety and public works. Included on the Town's website are the comprehensive plan, an economic impact assessment of new developments (2006), and a publication about "Low Impact Development Techniques Applied to the Village at Watt's Creek Traditional Neighborhood Development." The Housing and Community Development Department of the town's government contains a director, two code enforcement officers, a property maintenance inspector, and an administrative aide. (See also Denton Pattern Book in Historic Properties.)

Goldsboro

Goldsboro dates from 1867 when the Delaware and Chesapeake Railroad arrived, and the community was called Oldtown. Canning became a major local industry in the first half of the 20th Century. Goldsboro incorporated as an official municipality in 1906 and, in 2000, had a population of 216. Land use planning in Goldsboro is provided by the Caroline County Government.

Greensboro
www.anywheregourmet.com/GreensboroMD/

Native Americans valued the southernmost point, on the Choptank River, where people could cross on foot. In transporting goods from the Chesapeake Bay to the Delaware Bay, European Americans saw the same value and built a town, originally called Bridgetown, and later Greensboro, at that point. The Maryland Colonial Legislature authorized Bridgetown in 1732. In 1826, Greensboro incorporated as a municipality of the State of Maryland. The town's population was 1,632 in 2000. Greensboro has a town manager, police chief, public works supervisor, and code enforcement officer.

Henderson

Henderson began as Meredith's Crossroads, a two-building farming village developed in the middle of the 19th Century. The town's present name comes from a director of the Delaware and Chesapeake Railroad, which arrived in 1868. Early in its development the village also boasted a grain mill, which was located about two miles away on the Choptank River. Henderson incorporated in 1949. In 2000, its population stood at 118. Land use planning in Henderson is done by Caroline County's Department of Planning and Codes.

Hillsboro

An early 18th Century bridge over the Tuckahoe Creek began the development of Hillsboro. The town became an incorporated municipality in 1853. In the 2000 census, its population was 163. More than one half of Hillsboro's area is located within 1000 feet of Tuckahoe Creek, which is tidal in that area, thus subjecting the municipality to development restrictions associated with Maryland's Chesapeake Bay Critical Area legislation. Land use planning in Hillsboro is provided by Caroline County Department of Planning and Codes.

Marydel

Incorporated in 1929, Marydel is unique among the municipalities of the watersheds in that the town spans the Delaware and Maryland State Boundary. The part of Marydel that is located in Maryland is incorporated while the portion located in Delaware is not. In 2000, the population of Marydel was 147. Land use planning for the town is provided by Caroline County Government.

Preston
www.prestonmaryland.us/

The Town of Preston incorporated in 1892, shortly after the Baltimore, Chesapeake, and Atlantic Railroad arrived to service the community with four passenger and two freight trains per day. During the early 20th Century, at harvest time, the Preston rail head commonly shipped twenty-five freight cars of canned tomatoes, apples, wheat, and watermelons per day. The 2000 U.S. Census indicated Preston contained 566 people. The town has a manager, police and public works departments, and grants and codes administrators. Town committees provide advice and assistance for planning and zoning, and for parks and recreation to the three town commissioners. At the town's website, the link "Permits and Zoning" provides a seven-step process for obtaining a building permit and additional links to a permit application form, the "Preston Planning and Zoning Code," and the "Preston Subdivision Regulation."

Ridgely
www.ridgelymd.org/

Ridgely is a planned city, designed in grand style during the post Civil War railroad-boom era and meant to incorporate a busy waterfront along Tuckahoe Creek. Although the group that originally planned Ridgely failed in its financial ambitions, the town's wide streets and blend of commerce, industry, and residential development continue to reflect and build upon its early legacy. Ridgely, which incorporated in 1896, contained 1,352 people in the 2000 census. A five-member Planning and Zoning Commission, which is appointed by the Commissioners of Ridgely, reviews and recommends, requests changes in, or rejects all applications for subdivisions, renovations, demolitions and construction within the town.

Templeville

Templeville, once known as Bullock Town, incorporated in 1865, but a local cemetery demonstrates an earlier history as it contains graves of residents from the 18th Century, including members of the Temple

family for whom the town is named. Templeville offers a rural lifestyle with a local store and post office, nearby fishing, and picnicking in the town park. The town is unique in the watersheds in that its boundary spans the Caroline-Queen Anne's County line. In 2000, Templeville had a population of 80.

Public Drainage Associations

Public drainage ditches are common in the Tuckahoe Creek and Upper Choptank Watersheds and other basins on Maryland's Eastern Shore. Across the Eastern Shore, such ditches flow through about 821 miles of channel and drain 183,000 acres of crop land, forest land, roadways, commercial areas, and home sites. Public ditches on the Shore are organized into 101 Public Drainage Associations (PDAs) and four Public Watershed Associations (PWAs). The Tuckahoe Creek Watershed contains 21 PDAs, which have 83.1 miles of channel, and the Upper Choptank Watershed contains 29 PDAs, which have 158.5 miles of channel.[20] (See Map 10 in Sectoin 4 of PDAs in the watersheds)

According to State of Maryland law, PDAs and PWAs are independent units of government with rights-of-way and easements for ditch construction and maintenance. They may impose tax assessments on owners of benefited land for costs of maintenance services. Although designed originally for agricultural purposes, the associations are now providing significant stormwater drainage for towns, highways and roads, and commercial and residential developments. (See www.mda.state.md.us/resource_conservation/pda-pwa.php.)

Bell, Wayne and Philip Favero *Moving Water*, 2000
www.dnr.state.md.us/Bay/tribstrat/public_drainage_report.pdf

This publication records a process of conflict transformation among advocacy groups with commercial and environmental interests and provides a set of policy recommendations that acknowledge the need to protect the economic well-being of people who depend on land drainage, while at the same time protecting and enhancing the environment that is affected by public ditches.

Maryland Department of Agriculture "Cost-Share Assistance for Public Drainage Associations" www.mda.state.md.us/pdf/MDA_PDA_bro_proof2.pdf . This brochure provides information about Maryland's legal framework for drainage ditch maintenance and opportunities for cost-sharing monies, from the state to local associations. Cost-share funds are available to implement several types of best-management practices:

- Repair and stabilization of emergency blowouts and channel obstructions;
- Weirs or other water control structures;
- Outlet modifications and pipe replacements;
- Pocket wetland systems and re-flooding of wooded wetland areas;
- Water course enhancements;

Longmarsh PDA with BMP installed. Water control structures are built across drainage ditches to prevent gully erosion, reduce nutrient loadings, and maintain proper water table levels. Photo courtesy of Caroline County SCD.

20 Personal communication from Jade Phillips, PDA Coordinator, Caroline Soil Conservation on October 4, 2007.

- Expansion of vegetative buffers.

Cross-Jurisdictional Organizations

Three cross-jurisdictional assets are: an organization within Caroline County; another at the multi-county regional level; and a third at the multi-state level.

Caroline County Council of Governments (CCOG)
Begun as an outgrowth of a series of six "growth summit meetings," which the county and municipal governments of Caroline County convened in 2005, the CCOG formed officially the following year. Its mission is to promote intergovernmental communications, clarify issues, and encourage joint actions about population growth and other common interests. Logistical support for CCOG is provided by the Caroline County Government through its Department of Planning and Codes Administration.

Mid-Shore Regional Council
In response to recommendations made in a governor's task force, Caroline, Dorchester, and Talbot Counties formed the Mid-Shore Regional Council in 2001. The counties cooperate, via the council, for economic development and planning, with particular interests in physical infrastructure, economic diversification, regional planning, and creating a unified voice in the Maryland legislative process. See www.midshore.org/ .

The Chesapeake Bay Program
Since 1983 a regional partnership has led public efforts to restore the Chesapeake Bay. Included in the partnership are: the states of Maryland, Pennsylvania, and Virginia; the District of Columbia; the Chesapeake Bay Commission, a tri-state legislative body; the Environmental Protection Agency (EPA), representing the federal government; and participating citizen groups. See www.chesapeakebay.net/ .

Of particular relevance and value to people living in the Tuckahoe Creek and Upper Choptank Watersheds is the "Watersheds" link on the Chesapeake Bay Program website. This link provides information about watershed planning, grants and other resources, and search process for access to profiles about the Tuckahoe Creek and Upper Choptank Watersheds. Each profile includes area and regional maps, natural resource statistics, habitat and water quality information, and data concerning housing and population trends, pollution problems, and restoration programs.

State of Maryland Executive Agencies

Agencies and academic organizations with particular interest in the cultural-environmental nexus in the watersheds are grouped in the governor's Maryland Bay Cabinet. The cabinet is chaired by the Secretary of Natural Resources. Other members, all ex officio, are the Secretaries of Agriculture, Environment, and Planning, the Chancellor of the University System of Maryland (represented by the University of Maryland Center for Environmental Science), and the Dean of the College of Agriculture and Natural Resources at the University of Maryland College Park. See www.msa.md.gov/msa/mdmanual/26excom/html/07che.html .

A description of and link to each state agency in the cabinet is provided below. For descriptions of the two university organizations, see the Research and Education section.

Department of Agriculture
www.mda.maryland.gov/

Created in 1972, the Maryland Department of Agriculture has, as one of its three operating units, an Office of Resource Conservation. This office works with farmers in the watersheds and across the state to plan and implement conservation practices that integrate natural resource protection with crop and livestock production. The office administers Maryland's Nutrient Management Act of 1998 and provides cost-sharing programs to implement best management practices (BMPs). A special project of the office is the Tuckahoe Creek Targeted Watershed Grant Program, which utilizes an $800,000 grant received in 2006 to increase the installation of BMPs to reduce nutrient and sediment loads in the watershed. See the web site www.mda.state.md.us/pdf/tuckahoe_factsheet.pdf .

Department of the Environment
www.mde.maryland.gov/

The mission of the Maryland Department of the Environment (MDE) is "to protect and restore the quality of Maryland's air, water, and land resources, while fostering smart growth, economic development, healthy and safe communities, and quality environmental education for the benefit of the environment, public health, and future generations." MDE provides, on its website, information centers for citizens and businesses, and also a research center. Along with the Maryland Department of Planning, MDE has published a comprehensive overview of local planning tools and programs for Maryland's citizens and local governments, which can be found at www.mde.state.md.us/assets/documents/Planningtoolbox.pdf .

Department of Natural Resources
www.dnr.maryland.gov/

Maryland's Department of Natural Resources (MDNR) "preserves, protects, enhances and restores Maryland's natural resources for the wise use and enjoyment of all citizens." The department contains several distinct units, including research scientists, land managers, foresters, educators, and natural resource police. (See also Nature and Recreation, Martinak and Tuckahoe State Parks.)

Tools for Our Communities
Of particular significance to citizens and public officials concerned about the watersheds, the MDNR home page provides a link to "Tools for Our Communities." Clicking on "Tools…" allows you to "surf" the Tuckahoe Creek and Upper Choptank Watersheds for electronic and hard-copy information, view green building examples, low impact development and wetlands/forest restoration projects, and consider watershed assessment techniques.

Maryland Critical Areas Commission
In 1984, the State of Maryland enacted a law, and amended it in 2002, requiring the 16 counties and 44 municipalities surrounding the Chesapeake and Atlantic Coastal Bays to create a land use and resource management program designed to mitigate water pollution impacts and the loss of natural habitat, while accommodating future growth. The act designated all lands within 1000 feet of tidal waters or adjacent

tidal wetlands as the "Critical Area." As such, land adjacent to southern portions of the Tuckahoe Creek and Upper Choptank watersheds are within the critical area. To oversee implementation of the act, the state created a 29-member Critical Area Commission, whose website may be found at the following URL: www.dnr.state.md.us/criticalarea/ . This site provides practical information about the Critical Areas Act and links to "guidance publications."

Department of Planning
www.mdp.state.md.us/

The Maryland Department of Planning (MDP) has as it mission to promote "growth that fosters vibrant, livable communities, preserves and protects the environment, and makes efficient use of State resources." MDP provides data, research assistance, and policy development and implementation support for Maryland's public and private organizations. Highlights on the MDP website include links to the department's State Data Center, smart growth topics such as "Priority Places," land use topics such as recent legislation, mapping resources, and historical preservation. MDP contains the Maryland Historical Trust, www.maryalndhistoricaltrust.net/ , which formed in 1961 to assist the people of Maryland "in identifying, studying, evaluating, preserving, protecting, and interpreting" the state's prehistoric and historic assets. (See also, in Historic Properties, "Maryland Historical Trust Stories of the Chesapeake Area.")

State of Delaware

Delaware's Department of Natural Resources and Environmental Control (DNREC) is facilitating a Tributary Action Team; see Public-Private Watershed Organizations, Upper Chesapeake Bay Basin Tributary Action Team (Delaware) below. Information about all of Delaware's tributary teams may be accessed by the hyperlink "Watershed Teams" on the agency's home page (www.dnrec.delaware.gov/).

Federal Executive Agencies

Federal Agencies and organizations that are involved in the Chesapeake Bay Program have environmental interests in the watersheds. A complete list of federal agencies and organizations active in the bay program follows:

- Chesapeake Bay Environmental Enforcement Coalition
- U.S. Department of Agriculture (USDA)
    - National Resource Conservation Service (NRCS)
    - National Arboretum
    - U.S. Forest Service (USFS)
    - Farm Service Agency (FSA)
    - Cooperative State Research, Education and Extension Service
- U.S. Department of Commerce
    - National Oceanic and Atmospheric Administration (NOAA)
        - NOAA Chesapeake Bay Office
        - National Marine Fisheries Service
        - National Weather Service
        - National Ocean Service

        - NOAA Air Resources Laboratory
- U.S. Department of Defense (DOD)
    - U.S. Department of the Navy
        - U.S. Naval Academy
    - U.S. Department of the Army
        - U.S. Army Chesapeake Bay Program website
        - U.S. Army Environmental Center
        - U.S. Army Corps of Engineers - Baltimore District
        - U.S. Army Corps of Engineers - Norfolk District
        - U.S. Army Corps of Engineers - Philadelphia District
    - U.S. Department of the Air Force
    - Defense Logistics Agency
- U.S. Department of Education
- U.S. Department of the Interior
    - U.S. Geological Survey (USGS)
        - USGS Chesapeake Bay Information
        - USGS Patuxent Wildlife Research Center
    - National Park Service (NPS)
        - Chesapeake Bay Gateways Network
    - U.S. Fish and Wildlife Service (USFWS)
        - USFWS Chesapeake Bay Field Office
- U.S. Department of Transportation
    - U.S. Federal Highway Administration (FHA)
    - U.S. Coast Guard (USCG)
- U.S. Postal Service (USPS)
- U.S. General Services Administration (GSA)
- Environmental Protection Agency
- National Aeronautics and Space Administration (NASA)
- National Capital Planning Commission

EPA's Internet-Based Tools for Watershed Management

Of particular value to people living in the Tuckahoe Creek and Upper Choptank Watersheds is EPA's "Surf Your Watershed" website (http://cfpub.epa.gov/surf/locate/index.cfm). That site offers viewers opportunities to access information about building partnerships, characterizing a watershed, establishing goals, identifying solutions, and designing and implementing a program.

Public-Private Watershed Organizations

Both Maryland and Delaware have created public-private organizations with concerns about water quality and programs in the watersheds.

Choptank Tributary Team (Maryland)
www.dnr.state.md.us/bay/tribstrat/choptank/choptank_about.pdf

This geographically-oriented group is based on one of the ten major subwatersheds of the Chesapeake Bay that are located in Maryland. The Choptank Team's area of interest contains the Tuckahoe Creek and Upper Choptank Watersheds as well as the lower portion of the Choptank Basin. The group has about 30 members who are appointed by the Governor of Maryland and others who are active in the team. They focus their efforts on legislation and policy development, hands-on implementation, and public education. All ten Maryland Tributary Teams, including the Choptank group, have a "tributary strategy," which when implemented, would reduce nutrients in the Chesapeake Bay Watershed by 40%. The Choptank Team identified its major accomplishments, which included the following items of particular interest to the Tuckahoe Creek and Upper Choptank Watersheds:

- Championed the creation of the Public Drainage Task Force;
- Instigated an effort to expand Maryland's "Cover Crop Program";
- Initiated a state policy to create incentive payments for planting riparian buffers;
- Helped secure a Watershed Restoration Action Strategy for the Upper Choptank River.

Upper Chesapeake Bay Basin Tributary Action Team (Delaware)
www.dnrec.state.de.us/dnrec2000/admin/Press/Story1.asp?PRID=2613

The Upper Chesapeake Bay Basin Tributary Action Team, which formed in 2006, is working on the development of a pollution control strategy for the Upper Choptank Watershed and that portion of the Chester River that are located in Delaware. The team includes residents, business owners, farmers and others who live, work, and recreate in the watersheds. The team will recommend voluntary and regulatory actions to reduce phosphorus load by 40 percent. The time line is to develop a draft strategy by late 2007 and a final strategy by early 2008. For more information, contact Lyle Jones, Division of Water Resources at 302-739-9939.

Local Citizen-Stakeholder Advocates

A traditional organization found in all four of the counties in the watersheds, a new public figure with concerns for the Choptank River, and an advocacy group for the Upper Choptank are described below:

County Farm Bureaus
www.mdfarmbureau.com/ and www.defb.org

The Delaware and Maryland counties that are located in the Tuckahoe Creek and Upper Choptank Watersheds each has a farm bureau organization. Among other activities, the local farm bureau groups advocate, on a non-partisan basis, for agricultural interests in the watersheds. The county sites on the state-wide Maryland Farm Bureau website provide useful statistics about local agriculture.

Choptank Riverkeeper

Dick Tettlebaum, the Choptank Riverkeeper, is a new advocate for environmental quality in the Tuckahoe Creek and Upper Choptank River Watersheds as well as in other subwatersheds of the Choptank. He may be contacted by e-mail at choptankrk@goeaston.net and by telephone at 443-786-4799.

Friends of the Upper Choptank

This advocacy group has primary concerns about the quality of water in the Choptank River. They have conducted water quality sampling in past years and are now becoming involved in policy considerations to extend water and sewer services to communities in the northern portion of Caroline County.

Historic Properties

This section of assets focuses primarily on Caroline County where the most building in the watersheds has occurred. In addition, the section includes relevant Eastern Shore Region and State of Maryland organizations.

The State of Maryland created Caroline County out of parts of Dorchester and Queen Anne's Counties in 1774. In 1920 students and faculty of Caroline County Schools wrote a comprehensive history of the jurisdiction (History of Caroline County, Maryland From its Beginning www.rootsweb.com/~mdcaroli/history.html), in which they describe an initial political struggle between residents in the northern part of the county, who favored creating a county seat in Bridgetown (now Greensboro), and southern residents, who favored Pig Point (now Denton). The issue was resolved by popular referendum in favor of Denton and a court house was begun there in 1793. William Benson of Talbot County built the structure for £1800, in colonial-brick style, to resemble Independence Hall in Philadelphia. In the late 19th Century, County Commissioners decided the initial court house was too small. In 1895, they had the building razed and for the sum of $21,000 hired Slemmons & Lankford, of Salisbury, Maryland, to erect a new building. In 1966, the Commissioners of that time had an addition to the court house built, resulting in the structure that stands today. Although its first court house no longer exists, Caroline County contains many properties of historic value and potential interest to local citizens and visitors. A major effort is underway by the Caroline County Historical Society to protect, restore, and reuse old districts, buildings, sites, and objects.

Definitions

Historic Towson, Inc. Historic Designation Programs in Maryland
www.historictownson.org/programs.htm.
Local, state, and federal authorities all designate properties worthy of preservation for their historic and cultural significance. This quick reference defines the meaning of "a designation of eligibility" and distinguishes among the major programs in Maryland, which include: The National Register of Historic Places; The Maryland Register of Historic Properties; The Maryland Inventory of Historic Properties; and a Local Historic Designation. Federal, state, and local regulatory protections, grants, loans, and tax benefits are available through the programs.

Caroline County Heritage Efforts

Caroline County Historical Society Future Website www.carolinehistory.org/ This website of the society, which is under construction, will include information about the historic 1819 house – located at 16 North Second Street, Denton, Maryland – where the organization is headquartered and where the society displays its collections. The collections include portions of buildings, photographs, furniture, glassware, letters, diaries, documents and artifacts that illustrate the history of Caroline County. The site may also describe the significant

efforts being made by the society to preserve, protect, and make use of numerous historic properties.

Town of Denton Denton Pattern Book www.dentonmaryland.com/ A pattern book is an inventory of architectural and community-design forms that documents the inherited characteristics of "a place." A place may be defined as a single community, such as a town, or as a region that exhibits a common cultural inheritance, such as the Tuckahoe Creek and Upper Choptank Watersheds. Documents such as pattern books have been used since ancient Roman times, and the British brought the idea to the American colonies, where pattern books remained a common town-building tool through the first half of the 20th Century. The Denton Pattern Book is of value for all the jurisdictions, county and municipal, that have land-use authority in the Tuckahoe Creek and Upper Choptank Watersheds. (See Success Stories.)

Stories of the Chesapeake Heritage Area

Eastern Shore Heritage Inc. *Stories of the Chesapeake Heritage Area*
www.storiesofthechesapeake.org/

The Stories of the Chesapeake Heritage Area is a large part of the last great American colonial landscape – Maryland's Eastern Shore – and includes Caroline, Kent, Queen Anne's and Talbot Counties. The whole heritage area, like the Tuckahoe Creek and Upper Choptank Watersheds that it contains, is also a working landscape – a region where, in open spaces, people farm, create forest products, and commercially fish, and where, in the region's towns and villages, people produce commercial and government goods and services. The official site of the heritage area includes the organization's management plan.

Stories of the Chesapeake. Historic, Cultural, and Natural Sites of the Upper Eastern Shore Listed by Interpretive Theme
www.storiesofthechesapeake.org/downloads/FSAppendixA.pdf .

This site lists resources found on the Upper Shore, including those in the Tuckahoe Creek and Upper Choptank Watersheds. Resources listed, by category, in the two watersheds are:

African American History

- Frederick Douglass Birthplace (Tuckahoe Creek, Talbot County)
- Freedman's Bureau Site, 1865 (Denton, Upper Choptank)
- Marcy Fountain's House and Basement/dungeon, 19th c. (Bridgetown, Upper Choptank)

Agriculture

- Canneries (X 10) (Upper Choptank)
- Museum of Rural Life (Denton, Upper Choptank)
- Ridgely Railroad Station, 1892 (Ridgely, Tuckahoe Creek)

Colonial and Early National History

- Mason-Dixon Markers 1762 (Upper Choptank, Caroline County along Maryland/Delaware Boundary)

Nature

- Adkins Arboretum (Tuckahoe Creek, Caroline County)
- Idylwild Wildlife Management Area (Upper Choptank, Caroline County)
- Martinak State Park and Cabin, circa 1930 (Upper Choptank, Caroline County)
- Tuckahoe State Park (Tuckahoe Creek, Caroline County)

Religious Sites

- Bridgetown Chapel (Bridgetown, Upper Choptank)
- Christ Episcopal Church, 1874 (Denton, Upper Choptank)
- The Neck Meetinghouse and Yard (Denton, Upper Choptank)
- Quaker Meeting House, 1795 (Ridgely, Tuckahoe Creek)

Small Town

- Bridgetown School House, mid 19th c. (Bridgetown, Upper Choptank)
- Caroline County – 13 National Register Listings (Tuckahoe Creek and Upper Choptank)
- Caroline County Courthouse, 1791, 1895, 1966 (Denton, Upper Choptank)
- Denton – 25 sites documented in Inventory of Historic Sites in Upper Choptank, Caroline County
- Denton Historic District, National Register (Upper Choptank)
- Greensboro – 21 sites documented in Inventory of Historic Sites in Upper Choptank, Caroline County
- Greensboro Riverside Hotel (Upper Choptank)
- Hillsboro – 13 sites documented in Inventory of Historic Sites in Tuckahoe Creek, Caroline County
- Preston – 13 sites documented in Inventory of Historic Sites in Upper Choptank, Caroline County
- Ridgely – 17 sites documented in Inventory of Historic Sites in Tuckahoe Creek, Caroline County
- School House, Denton Women's Club, 1883 (Denton, Upper Choptank)

Water-Based

- Denton Ferry Landing, late 19th-20th c. (Denton, Upper Choptank)
- F. C. Lewis, Jr., Skipjack (West Denton, Upper Choptank)
- Greensboro Shipyard, 19th c. (Greensboro, Upper Choptank)
- Hillsboro Shipyard (Hillsboro, Tuckahoe Creek)
- Old Harford Town Maritime Center, Inc. (West Denton, Upper Choptank)
- Steamboat wharves (15) Choptank River (Upper Choptank, Caroline County)
- Unidentified shipwreck in Martinak State Park (Upper Choptank, Caroline County)
- West Denton (Harford) Shipyards, 18th c. (Upper Choptank, West Denton)

Maryland State Planning. Heritage Areas
www.mdisfun.org/planningamarylandvisit/heritage/HeritageAreas.html

This site provides information about twelve heritage areas across the State of Maryland, including the Stories of the Chesapeake.

Maryland Historical Trust. Stories of the Chesapeake Heritage Area
www.marylandhistoricaltrust.net/ha-carol.html

This site identifies the regional goals, quality of local resources, and management organization of Stories of the Chesapeake Area. Heritage tourism is viewed as a way to help diversify the area's economy "while protecting, preserving, and enhancing the coveted way of life, unique heritage and unmatched natural, cultural, and historic resources" of the region.

Historic Resources

Ralph E. Eshelman and Carl W. Scheffel, Jr. Maryland's Upper Choptank River and Tuckahoe River Cultural Resource Inventory, Choptank River Heritage Center, April 1999. www.riverheritage.org/Downloads/Choptank_Tuckahoe_Inventory.pdf This 141 page publication, which includes a brief history of the region, numerous photographs and maps, and an extensive bibliography, is an excellent source for detailed information about more than one hundred cultural resources extending northward along the Choptank River from Hunting Creek to the head of navigation near Greensboro and along the Tuckahoe Creek from that stream's confluence with the Choptank northward to Hillsboro – a total of over 40 miles of navigable riverine area. Included in the inventory are descriptions – some with photographs – of landings, wharves, canneries, bridges, shipyards, causeways, and the communities that contain these cultural resources. The publication provides a rich reference for cultural tourists who want to kayak or canoe the streams.

Choptank River Heritage Center www.riverheritage.org/ This website provides a treasure's chest of information. Included on the site, for example, are links to: historic places and people; a K-12 curriculum; exhibits at the Joppa Wharf Museum; and water trail guides for paddle trips. (See "Success Stories.")

Native Americans

Both "Choptank" and "Tuckahoe" are Native-American words. The Choptank People were an Algonquin-speaking, tribal group living along the river that took their name when English Settlers began arriving there in the early 1600s. Tuckahoe refers to a group of large, tuber-producing, edible, freshwater marsh plants of particular value to the Choptank Tribe and other native people because they emerged in the spring – the season of minimal food resources for native people living on the Delmarva Peninsula. Tuckahoe plants include arrow arum, duck potato, and golden club.

Like their Native Americans neighbors on the Delmarva – the Algonquin-speaking Nanticokes to the south and the Iroquois-speaking Susquehannas to the north – the Choptanks lived lightly on the land. Nevertheless, they worked the landscape – for example, by using fire to clear brush for planting gardens and hunting, and using ditching for water drainage. By the time the English Settlers arrived, the Choptank culture had evolved to a steady-state, hunting and gathering culture, which involved four activities for obtaining food: fishing – in shallow waters, primarily, for fish and shellfish; hunting – mostly in the upper part of the tributary, for fowl, small mammals, and deer; gathering – from uplands and wetlands, the edible nuts and plants found there; and gardening – by planting crops of beans, corn, and squash.

The Choptank People were relatively few in number, probably totaling less than one thousand individuals at the beginning of the 17th Century. Women, as well as men, were political leaders. The Choptanks were the indigenous tribe least hostile towards English settlement, in part, it seems, because the English were relatively slow to establish farms in the upper area of the watershed.

Like other native groups on the Maryland and Virginia Eastern Shore, however, the Choptank Tribe did not survive the 18th Century as an organized group. Communications between the English Settlers and the Native Americans on the Delmarva, as elsewhere in the American Colonies, were poor and prone to end in violent conflict. The English were uninterested in learning about Native-American cultural practices that we find valuable today – for example, the Choptank Tribe's practices of gender equality and sustainability. The Choptanks were victims of the philosophy that Europeans and their descendants – including the English and, eventually, the European-Americans – should, by right, extend their economic and political control over lands where Native People lived across North and South America.

Bell, Wayne. The Delmarva Bioregion. In a slide presentation, Bell emphasizes the interdependence of culture and nature, including the creation of working landscapes by Native Americans prior to English settlement on the peninsula.

Caroline County Historical Society. *Village of Choptank*. Denton, Maryland, 2004. At the southernmost tip of the Upper Choptank River Watershed is found the present-day (unincorporated) Village of Choptank. The historical society provided house and garden tours, a picnic barbeque, history perspectives, and an illustrated brochure for a public event held at the village on June 13, 2005.

Courtesy of JOK Walsh. See Map 11 in Section 4 for a larger version of this map.

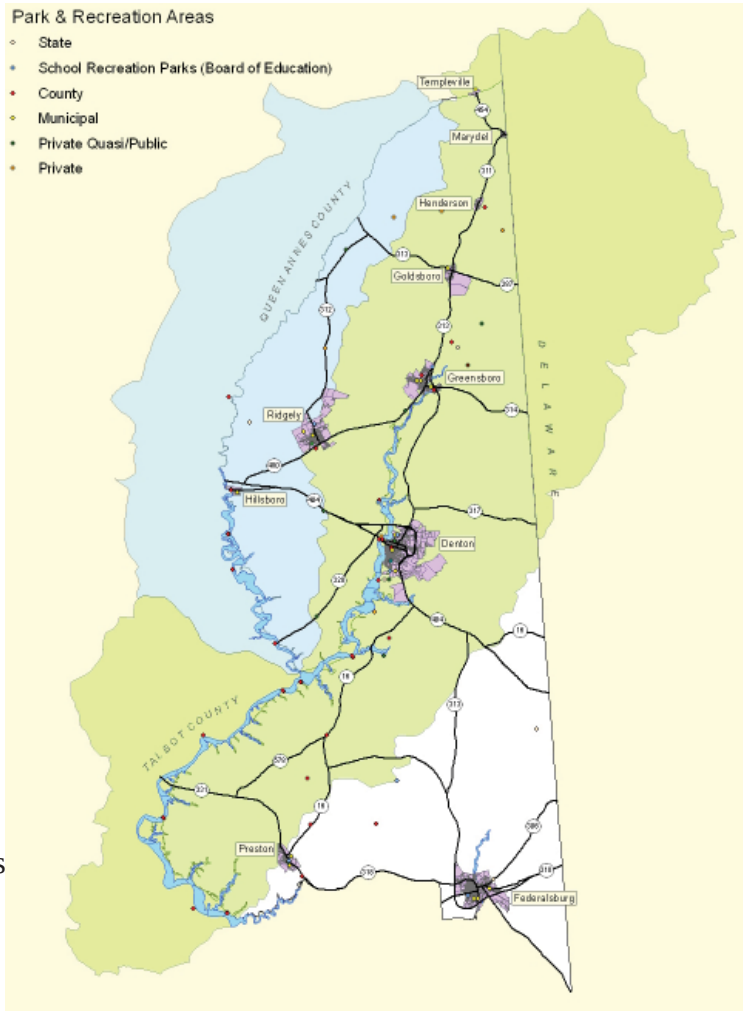
Rountree, Helen C. and Thomas E. Davidson. *Eastern Shore Indians of Virginia and Maryland*. Charlottesville, Virginia: University of Virginia Press, 1977. The single most important source of information about Native Americans of the Eastern Shore, this book describes, in detail, the geography, ecology, cultural world, and relations with English Settlers of the Eastern Shore of Native Peoples in the 17th and 18th Centuries. Included also are appendixes of major useful wild plants, fish, and shellfish.

Walsh, JOK. *Historic Footsteps: Indian Paths through Caroline County, Maryland*. Denton, Maryland: Type-All Services, 1999. This publication provides a map of major Indian trails across the Delmarva Peninsula and, in greater detail, a second map of trails across the Tuckahoe Creek and Upper Choptank Watersheds. Four major trails are shown: Choptank or Delaware Path; St. Jones Path; Wicommis or Whorekill Path; and Manticoke or Chicone Path. Of particular interest is a "trail hub" located on the Choptank River at Red Bridges, just north of Greensboro. The hub formed at Red Bridges because that is the southernmost "wading point" on the river.

Nature and Recreation

With outdoor recreation, the connection between culture and nature is obvious: people enjoy playing in their natural environment. Moreover, outdoor recreational experiences contribute to people's sense of place, to their interest about locations like the Tuckahoe Creek and Upper Choptank Watersheds, and to their willingness to invest their time, talent, and treasure in protecting and restoring cultural and natural assets they have learned to appreciate. (See Maps 12 and 13 in Section 4 for Parks and Recreation areas for these watersheds)

The Tuckahoe and Choptank Watersheds contain many outdoor recreational opportunities. People of varied ages, interests, and skills can enjoy boating, bicycling, bird watching, camping, fishing, horseback riding, learning about native plants, swimming and other activities at county, municipal, private and state parks, nature preserves, and recreation centers. And people who are interested in exploring nature can also investigate several examples of an unusual geologic/ecological formation, known as "Delmarva bays." These unique features were once referred to as "whale wallows" due to their appearance. An overview of natural and cultural attractions in the watersheds and across the bay basin may be viewed on the Chesapeake Bay Gateways Website at www.baygateways.net/ .



Caroline County Government Parks

Caroline County Department of Recreation and Parks www.carolinerecreation.org/index.html The department provides park and recreation services for the citizens of the county, thus contributing to the county government's vision to ensure a safe and vibrant community that preserves it rural heritage. Parks and recreation facilities include:

- A Recreation Center at the Denton Armory;
- Marina and boat ramps near or in Preston, Harmony, Greensboro and Hillsboro;
- School and community parks, provided with the Board of Education, at Denton Elementary, Lockerman School, Preston Elementary, and Ridgely Elementary;
- Community/Neighborhood parks in Greensboro, Ridgely, Harmony, Henderson and Jonestown;
- The South County Regional Park and Athletic Complex, planned for development on 73 acres at the corner of Seippes and American Corner Roads.

For additional information about the department, see the Caroline County 2006 Land Preservation, Parks and Recreation Plan at www.carolinerecreation.org/LPRP_plan.html.

Municipal Parks

Six municipalities in the watersheds provide community parks. The towns and their parks are:

- Coursey, Crouse Memorial, Fourth Street, and Wheeler Parks in Denton;
- Goldsboro Community Park in Goldsboro;
- Henderson Community Park in Henderson;
- James T. Wright Park in Preston;
- Martin Sutton Park in Ridgely;
- Ober Park in Greensboro.

Details about the parks are available from the respective municipal governments.

Private Parks and Recreation Centers

- Adkins Arboretum www.adkinsarboretum.org/ (See Research and Education.)
- Choptank River Heritage Center www.riverheritage.org/ (See Historic Resources.)
- Myrtle Simon Pelot Bird Sanctuary www.mdbirds.org/sanctuary/sanctuaries.html This sanctuary, owned by the Maryland Ornithological Society, includes about 60 acres of deciduous-swamp forest located in the Red Bridges area of the Choptank River Watershed near Greensboro. The sanctuary is described as "an oasis for flowers, birds, and other fauna in the midst of a predominantly agricultural area."
- Holiday Park Located on 200 acres bordered by the Choptank River near Greensboro, this park offers RV & tent camping, CATV, group facilities, and entertainment for children of all ages, including: a pool, playgrounds, gameroom, tennis and basketball courts, shuffleboard, volleyball, open sports field, river fishing, hayrides and trails for biking or hiking. The park offers planned activities on the weekends.
- Tuckahoe Equestrian Center www.tuckahoeequestriancenter.net/ This facility is a family and youth-oriented equestrian center located near Ridgely, but in Queen Anne's County. The center promotes 4-H and trail riding, driving, jousting, parades and horse shows, which include jumping, dressage, and English or Western equitation.

State of Maryland Parks

Martinak State Park www.dnr.state.md.us/publiclands/eastern/martinak.html Bordered by the Choptank River and Watts Creek, this recreational facility and natural area contains 107 acres of forests, field, and marshland. Cabins, campsites, boating access and picnicking facilities, hiking trails, a playground, shelters, and a nature center are available for public use.

Tuckahoe State Park www.dnr.state.md.us/publiclands/eastern/tuckahoe.html Tuckahoe Creek, with is characteristic border of wooded marshlands, runs through the length of this 3,800 acre park. Tuckahoe State Park also contains a 60-acre lake for boating and fishing, and 20 miles of hiking, biking, and equestrian trails. Picnicking, canoeing, and playground facilities are here too. Each weekend, Memorial Day though Labor Day, park staff offer free family activities.

Water and Hiking Trails

The Chesapeake Bay Gateways Website provides information and a map about "The Choptank and Tuckahoe Rivers Water Trail," an 80-mile water course on the two rivers that links numerous public access points, and natural and historic areas. View at www.baygateways.net/general.cfm?id=15 . The Maryland Department of Natural Resources provides a website with information about hiking and water trails for Caroline, Queen Anne's and Talbot Counties at www.dnr.state.md.us/greenways/counties.html.

Delmarva Bays

Delmarva Bays described previously as habitat for rare and endangered flora, are depressional, seasonal wetlands in the landscape. They may date to the origins of the Delmarva Peninsula, and they exist in an arced chain from New Jersey to Florida. Also called "whale wallows," "kettles," "sinks," and "vernal ponds" they typically range in size from one to fifteen acres and are nearly invisible for much of the year. In the spring, however, they fill with as much as four feet of groundwater, snowmelt, and rainwater to provide the habitat for many endangered and threatened amphibians and plants. Vegetation zones in the wallows usually consist of an outer perimeter of trees and shrubs, and an inner herbaceous plant community, where the rare plants are found. More than 2,000 delmarva bays may have once existed on the Eastern Shore, an uncounted number of which were located in the Tuckahoe Creek and Upper Choptank Watersheds. Agricultural and forestry practices and building developments have diminished their numbers. For additional information, including a description of a delmarva bay being protected by the Nature Conservancy in the Upper Choptank Watershed at the Jackson Lane Preserve, see the following sources:

Smithsonian Institution. *Whale Wallows*
www.serc.si.edu/education/resources/watershed/stories/whalewallows.jsp

Maryland DNR. *Delmarva Bays: Natural Enigmas*
www.dnr.state.md.us/naturalresource/spring2001/delmarvabays.html

Grant, Dave. *Disappearing Wetlands*
www.brookdale.cc.nj.us/staff/sandyhook/dgrant/field/Dis-wetland-text/Dis-wetland/Disappearing%20wetlands.htm

Nature Conservancy. *Largest Wetlands Preservation Project in Chapter History*
www.nature.org/wherewework/northamerica/states/maryland/press/press2026.html

Research and Education

Solving the important public issues of the watersheds – for example, deciding how to anticipate and shape population growth, maintain cherished qualities of life, improve the agricultural economy, increase human capital and opportunities, and protect and enhance the environment – will require knowledgeable citizens and public leaders. The genesis of knowledge is research and the sharing of it occurs through education.

Not all decisions about public issues in the watershed will be made locally. Some will be made in Annapolis,

in Washington, D.C., and elsewhere. And not all the research and education done for and about solving the watersheds' issues will be done in the local region.

If, however, local people – those who know the watersheds most intimately and, one could argue, have the most to gain or lose by public decisions – prefer to lead the process of solving watershed issues, their investments in and support of local and regional research and educational organizations is crucial. Fortunately, active in the watersheds and nearby are several outstanding research and educational institutions that local people can access and employ to increase their leadership capacity.

Adkins Arboretum
www.adkinsarboretum.org/

This 200-acre native garden and ecosystem preserve is located in the Tuckahoe Creek Watershed near Ridgely. The arboretum describes itself as "dedicated to promoting the appreciation and conservation of the region's native plants." Featuring more than 600 species of native shrubs, trees, wildflowers, and grasses, the arboretum contains four miles of paths along streams, through meadows and native plant gardens, and under the shade of a rich bottomland forest. (See Success Stories.)

Caroline County Public Library
www.caro.lib.md.us/library/

The vision of the Caroline County Public Library is to "empower customers to use information and ideas to enrich their lives." In addition to book circulation, the library accomplishes its mission through outreach, reference, children's services, and technical and computer services. Community groups are welcomed to meet in the library's facilities. The library has won citations for its innovative and effective services by the U.S Department of Education and the State of Maryland.

Caroline County Public Schools
http://cl.k12.md.us/

In the Tuckahoe Creek and Upper Choptank Watersheds, Caroline County Board of Education operates the following schools:

- Elementary facilities in Denton, Greensboro, Preston, and Ridgely;
- Two middle schools;
- Two high schools;
- A career and technology center.

The board newsletter, The Caroline Educator, indicates the 281 high school graduates of 2007, the largest number of graduates ever, earned more than $1 million in scholarships to further their education.

Center for Watershed Protection
www.cwp.org/

The Center for Watershed Protection (CWP), which is located in Ellicott City, Maryland, is a non-profit

corporation that provides information and technical tools about the protection of streams, lakes, and rivers. CWP staff recently presented information to the Caroline Council of Governments (CCOG) on how to gauge the heath of watersheds and have offered to address the CCOG again about designing local ordinances to protect the county's streams.

Chesapeake College
www.chesapeake.edu/

Located on a 170 acre campus near to the east side of the Tuckahoe Creek Watershed in Wye Mills, Maryland, Chesapeake College has served students, since 1965, from Caroline, Dorchester, Kent, and Queen Anne's Counties, with liberal arts, sciences, and career programs. In 2006, the college awarded credits to more than 3,300 students through the efforts of 132 full and part-time faculty members. The vision of the college is: "…to excel as a 21st Century learning community committed to the realization of the potential of each learner and to the promise of the region. Dedicated to the ideal that learning will not be limited by geography or circumstance, the College will provide residents with affordable access to a comprehensive array of career, transfer and lifelong learning opportunities of the highest quality."

College of Agriculture and Natural Resources, University of Maryland College Park
http://agnr.umd.edu/

In addition to residential instruction, the college provides research, through the Maryland Agricultural Experiment Station, and adult and youth education, through Maryland Cooperative Extension, for the watersheds and elsewhere in Maryland. The watersheds are served, regionally, by the Wye Center for Research and Education, which is located in Talbot County (http://agresearch.umd.edu/RECs/WREC/index.cfm) and by local extension offices in Caroline (http://caroline.umd.edu/), Queen Anne's (http://queenannes,umd.edu/) and Talbot (http://talbot.umd.edu/) Counties. The College's disciplinary bases for research and extension education are:

- Animal and Avian Sciences
- Agricultural and Resource Economics
- Environmental Science and Policy
- Nutrition and Food Science
- Plant Science and Landscape Architecture
- Veterinary Medicine

See also the University of Delaware at http://ag.udel.edu/. This Land Grant University also provides research and extension programs for that portion of the Upper Choptank located in Kent County, Delaware.

Harry R. Hughes Center for Agro-Ecology
www.agroecol.umd.edu/

Created in 1999, the center gathers stakeholders from the agricultural, forestry, and environmental communities to retain Maryland's working landscapes and the industries they support, while protecting and improving the Chesapeake Bay and its tributaries. The center funds research projects to investigate institutional and technological options and their likely consequences, facilitates policy development processes, and conducts

education and outreach programs. Its website provides news, analytic documents, and other resources related to its mission and activities. In 2006, the center celebrated the 80th birthday and work of Harry R. Hughes – former Governor of Maryland and life-long-resident of the Upper Choptank Watershed – by naming itself for this outstanding leader for the Chesapeake Bay (www.bayjournal.com/article.cfm?article=2938).

Maryland Sea Grant College
www.mdsg.umd.edu/

Established in 1977 and administered by the University of Maryland Center for Environmental Science, Maryland Sea Grant College ties the state's universities and academic laboratories with the needs of people who manage, conserve, enjoy, or make their living from the Chesapeake Bay. For example, a Sea Grant Specialist for Coastal Communities works in the Tuckahoe Creek and Upper Choptank Watersheds to facilitate education and community action to protect cultural and natural resources in the region.

National Center for Smart Growth Research and Education
www.smartgrowth.umd.edu/

The center defines its mission as bringing "the diverse resources of the University of Maryland and a network of national experts to bear on issues in land development, resources preservation, and urban growth – the nature of our communities, our landscape, and our quality of life – through interdisciplinary research, outreach, and education." A component of the center is the Environmental Finance Center (EFC) at the University of Maryland (www.efc.umd.edu/), which provides communities in the Chesapeake Bay Region with tools and information to manage change for a healthy environment and an enhance quality of life. Current initiatives by EFC are in stormwater finance, agricultural land preservation, and financial systems management.

Salisbury State University
www.salisbury.edu/

Opened in Salisbury, Maryland in 1925, Salisbury University is a comprehensive unit of higher education offering education in undergraduate liberal arts, sciences, pre-professional and professional programs – including education, nursing, social work, and business – and a limited number of graduate programs. Of particular value to regional planning for the Tuckahoe Creek and Upper Choptank Watersheds is Salisbury University's "Eastern Shore Regional GIS Cooperative" (ESRGC), an organization that provides geographic information system (GIS) technology, data, technical support, and training to the local governments of Maryland's Eastern shore (www.esdrgc.org/).

United States Department of Agriculture: Agricultural Research Service

As part of a national assessment of the benefits of conservation practices used by farmers, in 2003 the Agriculture Research Service (ARS) of the United States Department of Agriculture initiated a project called the "Choptank River Watershed Project." The project, which involves multiple federal and Maryland public agencies, includes research about landscape/water quality modeling, the use of cover crops, controlled drainage, wetlands, and bioenergy production. Expected outcomes of the project are:

- New strategies to exploit the synergies between bioenergy production and water quality protection;

- New landscape management tools to optimize implementation of agricultural BMPs;
- Efficient monitoring technologies for cover crops;
- Improved management of drainage ditches to reduce export of nutrients;
- New tools to measure and to assess health of wetland ecosystems within the agricultural landscape.

For additional information and contacts, see ftp://ftp-fc.sc.egov.usda.gov/MD/web_documents/technical/ceap/Choptank_CEAP_overview_final_6_14_07.pdf .

ARS, along with researchers from Land-Grant Universities at several locations, is also doing research on the science, management, and policy of agricultural drainage ditches. As noted previously, such ditches, both public and private, are common and significant economic and environmental features of the landscapes of the Tuckahoe Creek and Upper Choptank Watersheds. A recent edition of the Journal of Soil and Water Conservation provides an extensive and detailed overview of the research. See Volume 62, number 4 (July/August 2007) pages 171-319.

University of Maryland Center for Environmental Science
www.umces.edu/

The University of Maryland Center for Environmental Science (UMCES) – which maintains a comprehensive program of environmental research, education, and service – represents the Chancellor of the University System of Maryland in the Chesapeake Bay Cabinet. One of UMCES' three laboratories is located near the mouth of the Choptank River at Horn Point. At the Horn Point Laboratory faculty members "conduct research on the biology, chemistry, physics, and ecology of organisms and ecosystems from wetlands and estuarine waters of the Bay to the continental shelf and open waters of the world's oceans…"

University Maryland Eastern Shore
www.umes.edu/

The University of Maryland Eastern Shore (UMES), founded in 1886 as Delaware Conference Academy, is now a land-grant, historically black college that provides research, classroom instruction, and extension outreach programs. As part of the UMES Extension Program, the university's Rural Development Center assists community groups, non-profit organizations, locally elected and appointed officials and private firms with plans, loans, grants, projects, and programs for community and county vitality on the nine-county Eastern Shore of Maryland (http://skipjack.net/le_shore/rural/).

Washington College
www.washcoll.edu/

Founded in 1782 as the tenth chartered college in the nation, Washington College offers 44 academic majors and programs, and two centers of excellence – the C.V. Starr Center for the Study of the American Experience, and the Center for Environment and Society . The Starr Center (http://starrcenter.washcoll.edu/); notes that it is interdisciplinary and encourages the study of traditional history alongside new approaches, as it seeks to bridge the divide between academic world and the public a large; the center does this especially by supporting and

fostering the art of written history. (See African Americans.) The Center for Environment and Society (http://ces.washcoll.edu/) has as its primary mission to "support the integration of ecological and social values." The center promotes interdisciplinary learning, research, and stewardship of natural and cultural resources.

Local Success Stories

Several assets, all of which have been identified previously, provide stories of significant success in the Tuckahoe Creek and Upper Choptank River Watersheds. Residents of the region can take pride in the accomplishments these assets provide and build on their understanding of why and how successes occurred.

Envisioning the Future by Remembering the Past

The *Town of Denton Pattern Book* is a richly illustrated, 100-page publication that documents the inherited characteristics of Denton and, with a little imagination, of other towns in the Tuckahoe Creek and Upper Choptank Watersheds Region. Available in Compact Disk form, the book provides practical tools and resources for builders, homeowners and suppliers, and is useful for conserving and restoring the sense of place in the region. The book includes information, illustrations, and suggestions for preserving and enhancing community characteristics, including state-of-the-art ideas for "green development."

The Indomitable Human Spirit

The African-American experience in the Tuckahoe Creek and Upper Choptank River Region and across the Delmarva Peninsula is an unfinished story. Rooted in slavery, suppressed by Jim Crow discrimination after the Civil War, and terrorized by lynchings in the 20th Century, the spirit of African Americans has proven impossible to subdue. As Erick Brown wrote about the Chesapeake Region, "…Africans refused to die here. Despite what many of us would judge to be a hopeless condition, they lived! They dreamed! They fought back in whatever way they could! They passed on to their future generations a legacy of hope and faith in God! Most importantly, when freed from their bondage, they forgave!" By employing personal qualities and leadership characteristics of heroes like Frederick Douglass, Harriet Tubman, and Quakers who provided stations on the Underground Railroad, people of the region can unite to build on the African-American legacy and encourage the vision of all people reaching their full potential across the watersheds.

Land Conservation

Maintaining the lands of Tuckahoe Creek and Upper Choptank River Watersheds in agriculture and forestry is essential to maintaining the sense of rural culture and, when coupled with conservation practices, to protecting and restoring natural ecosystems. Caroline County Government has been a state-wide leader in agricultural land preservation – employing the Maryland Agricultural Land Preservation Foundation to purchase permanent easements for nearly 30,000 acres of prime farmland and woodland, and leading the Eastern Shore in the portion of its operating budget allocated to land preservation. Efforts by Caroline County Government complement parallel efforts by the Eastern Shore Land Conservancy and Rural Legacy programs to purchase permanent easements on farmland and woodland. As the county government seeks to shape its future in the face of population growth pressures, it likely will: (1) reemphasize agriculture as the key component of economic development; (2) coordinate its transferable development rights program with the county's municipalities and

couple that program with more stringent rural zoning; and (3) work toward the goal of preserving contiguous areas of working landscapes and open spaces. The county coordinates with other counties on a regional basis through the Eastern Shore Land Conservancy, which also acts as an advocate for policies to preserve agriculture across the area.

Moving Water

Stemming from an initiative by the Choptank Tributary Team, incorporating recommendations by the State of Maryland Public Drainage Task Force, and using grant funds from the Chesapeake Bay Targeted Watersheds Grant Program and technical assistance from the Maryland Department of Agriculture and the National Resource Conservation Service, Public Drainage Associations in the watersheds are implementing best management practices (BMPs) for maintaining the region's public drainage ditches. The general purpose of the BMPs is to reduce nutrient pollution moving into the Chesapeake Bay and its tributaries, including Tuckahoe Creek and the Upper Choptank River. Information provided by the Maryland Department of Agriculture indicates 13 BMPs, each, have been implemented in the Tuckahoe Creek and Upper Choptank River watersheds. The experience of developing and implementing an innovative ditch-maintenance program illustrates how, by sharing information and clarifying common interests, agricultural and environmental groups can enhance environmental protection without jeopardizing the well-being of the region's economy.

Native Plants, Environmental Education, and Experiences of Nature

Adkins Arboretum hosts more than 16,000 visitors annually and "…strives to reach a broad audience – children, families, amateur and professional horticulturists, natural resource managers, land planners, the nursery industry and land developers – through guided walks, lectures, demonstrations, adult programs, children's programs, plant sales, art exhibitions, and seasonal community events." The arboretum is unique among public gardens and other arboretums in the region because it focuses solely on plants that are native to the Mid-Atlantic Coastal Plain. With its $5 million capital campaign, by 2008, Adkins Arboretum will build a new "green" arboretum center, entry, and parking area. The arboretum will also provide endowment funds to sustain the expansion and support additional programs. The new center will provide significant services and contribute to the "economic vitality and quality of life of the region."

Red Cardinal Flower, native species. Photo courtesy of USDA NRCS plants database.

The Choptank River Heritage Center – located in a historic schooner and steamboat warehouse at the Joppa Steamboat Wharf in West Denton – provides members, volunteers, and visitors with a rich menu of Choptank River experiences. The heritage center describes its mission as preserving and interpreting "the evolution and development of the land, its inhabitants, and their interrelationship with the Eastern Shore's noblest river" – the "Great Choptank River." The center is interested in cultural and natural heritage and provides activities in historic site and skipjack preservation, historical research and publishing, environmental curriculum development and education, water trail exploration, and heritage tourism development.

Parks and Recreation

The Tuckahoe Creek and Upper Choptank River Watersheds contain numerous, high-quality private, county, municipal, and state parks and recreation areas. Creation and effective management of these facilities constitutes a watersheds success story. Research indicates that people develop emotional attachments to outdoor places where they recreate. Attachments to such places, in turn, spur citizen involvement in land management issues (Eisenhauer B W.; Krannich R. S.; Blahna D.J. "Attachments to Special Places on Public Lands" Society and Natural Resources 13:5 July 2000, pp. 421-441). Moreover, outdoor recreation is increasingly viewed as a significant factor for human health (Killingsworth, R, et al. http://activelivingbydesign.org). Given the number and quality of park and recreational resources in the watersheds and the potential benefits they provide, the challenge is to increase the number of local people experiencing and enjoying the resources.

Preserving History and Marketing Culture

The Caroline County Historical Society, Inc. is ambitious and actively involved in historic preservation and the development of cultural tourism. Presently, the society is documenting, salvaging, stabilizing, and marketing 37 historic structures throughout the county. Some structures will be relocated to the Linchester Mill project and others to the new "Denton ArtsWay," both in the Upper Choptank River Watershed. In addition, the Historical Society is working with the county's tourism office to create a tourism infrastructure plan and to use one-room buildings as tourist information points such as kiosks and visitor reception buildings. The Museum of Rural Life, located on the court-house square in Denton, is operated by members of the society, contains: artifacts such as antique household items, diaries, and letters; and faculties, which include a house built in 1819, an exhibit gallery, a tourist reception area, and an audio-visual room.

Public Policy Coordination

Perhaps it seems presumptuous to select the Caroline County Council of Governments (CCOG) as a "success story." The organization, which includes Caroline County Government and all nine municipal governments in that jurisdiction, has only a brief life history, about 18 months, and has not made any significant policy impacts. Nevertheless, CCOG has created a forum for dialogue about policy issues, particularly issues related to development, increased communications, especially between the county and its municipalities, and set an agenda, which, if met, will create a base for collective action. At its meeting of July 2007, CCOG created a committee, co-led by county and municipal officials, to accomplish two tasks: (1) create a common data base, to be shared across all jurisdictions, about development activities; and (2) share information about development plans for each jurisdiction. If CCOG succeeds, it will increase trust, clarify development activities and intentions, set the stage for identifying common interests and the actions needed to achieve those interests, and thus provide a base for a third task: to coordinate planning and land-use policies in the county.

Research and Education

Several organizations are providing research and education services in the watersheds. All provide evidence of ongoing stories of success.

Chesapeake College, as previously noted, began in 1965 and serves students from Caroline, Dorchester, Kent, and Queen Anne's Counties. More than 3,300 students received credit at the college in 2006. Since its

beginning, the reputation of the college as an innovative leader in education and as a community partner for regional progress has grown. The 2004-2008 strategic plan for Chesapeake College contains the following initiatives: (1) provide students with an engaging learning experience both within and beyond the classroom; (2) ensure access and achievement for every student through innovative student-centered programs and services; (3) develop an organization that promotes "a community of learners" and reflects its core values in everyday operations; and (4) serve as a catalyst for regional economic, social, and cultural development.

Conservation Effects Assessment Project (CEAP) is the program title for "a multi-agency effort," begun in 2003, "to quantify the environmental benefits of conservation practices used by private landowners participating in selected Unites States Department of Agriculture conservation programs." One of the sites for CEAP research is the Choptank River. Project goals include:

- Determining more accurate nutrient reduction efficiencies for BMPs;
- Examining changes in environmental services as farmers increase bioenergy production;
- Developing innovative remote-sensing approaches for assessing wetland ecosystem health;
- Improving landscape decision support tools to optimize the effectiveness of BMPs;
- Fostering positive relationships among farmers, stakeholders, and customers to preserve natural resources.

Eastern Shore Regional GIS Cooperative (ESRGC) is the name for on organization housed at Salisbury University. ESRGC provides geographic information system (GIS) technology, data, technical support, and training to local government in the watersheds and across the Eastern Shore. Local governments in the watersheds are, with the help of ESRGC rapidly expanding their use of GIS to collect and analyze geographic data, and to use such analyses for making decisions. Applications in the watersheds include, for example, a traffic impact analysis for the Town of Denton, digitizing and annotating PDAs in Caroline County, and conducting flood vulnerability analyses for all of Maryland's counties. The ESRGC is a joint effort between the Mid-Shore Regional Council, the Tri-County Council of the Lower Eastern Shore of Maryland, and Salisbury University.

The **Harry R. Hughes Center for Agro-Ecology** is named for a native son of the Upper Choptank River, former governor, and leader for conservation, Harry Hughes. As previously described, the center, a 501 (c) 3 organization affiliated with the University of Maryland, convenes stakeholders, with the purpose of retaining working landscapes while improving water quality. Its mission includes research, policy analysis, and education and outreach components. Since its beginning in 1999, the center has, through grants and matching funds, invested more than $6 million in technical and institutional research efforts. Its policy analysis efforts have facilitated the development of a Statewide Plan for Agricultural Policy and Resource Management and Maryland's Strategic Forest Resource Plan, both completed in 2006. Education and outreach efforts include workshops for citizens, presentations to local government and community groups, and briefings for state lawmakers.

Ideas to Protect and Restore the Watersheds

Protection and restoration of assets in the Tuckahoe Creek and Upper Choptank River Watersheds means focusing attention, first, on the use of land in the region. Land provides the location for assets and its use determines the quality of water in the streams. The Maryland Annotated Code – in Article 66B, Article 25A, and Article 28 – provides legal authority to local governments for land use planning..

New State of Maryland Planning Elements

In the 2006 Session of the Maryland General Assembly, four new planning requirements became law. These elements, based on House Bill 1141/Senate Bill 5 and House Bill 2, require actions by Maryland counties and municipalities in Tuckahoe Creek/Upper Choptank River Region and, as such, they suggest ideas to protect and restore the watersheds. The elements and related ideas follow:

Water Resources Plan

All counties and municipalities must identify in their comprehensive plans, by October 1, 2009, drinking water and other water resources adequate for the needs of existing and future development and suitable receiving waters for wastewater and stormwater management to meet the needs of existing and projected development in the plans. Technical assistance will be available from the Maryland Department of the Environment (MDE).

Water resources do not conform to political boundaries. Aquifers underlie broad expanses of land and stream flows mean that one community's receiving water is another's source water. The water resources planning element will require greater attention, by counties and municipalities in the watersheds, to the characteristics of Tuckahoe Creek and the Upper Choptank River, to the relationship of those streams to the jurisdictions' development plans, and to the water-based interdependence of jurisdictions with their neighbors. The Maryland Departments of the Environment and Planning indicate that resource issues that they expect to be addressed in these elements include: "water resource protection areas, groundwater resources, water quality standards, and Total Maximum Daily Loads." This new element suggests the Maryland counties and municipalities in the watersheds should work together to obtain information and assistance from state agencies and others to create and coordinate their plans.

Municipal Growth

By October 1, 2009, all municipalities must identify areas for future growth consistent with a long-range vision for their future. This element will guide annexation proposals and plans after October 2009. Consultation with the county, in which a municipality is located, is required, and a joint planning agreement is encouraged.

As jurisdictions are interdependent because they share water resources, so too are they interdependent because they share citizen taxpayers. Maryland's method of local public finance makes county governments responsible for funding local public schools. Thus a decision by a municipality to grow, or not, will affect public-school-finance decisions by the host county government whose citizens include those in the municipality, in other municipalities in the county, and on county-governed property located outside of municipalities. Likely one municipality's growth policies will also affect the public finance of roads, public safety, parks and recreation, and other facilities and services provided by the county and neighboring municipalities.

For the watersheds, the situation of interdependence is most obvious in Caroline County where eight of that jurisdiction's nine municipalities lie in the Tuckahoe Creek and Upper Choptank River Watersheds and where a move to provide public drinking water and waste-water disposal for towns in the northern region of the county is currently under consideration. While the new element will require consultation by the county's municipalities

with the Caroline County Government, it only encourages joint planning agreements between municipalities and the county. The idea of creating a joint planning agreement among Caroline County Government and that jurisdiction's Municipal Governments seems well worth the effort and should be pursued.

Priority Preservation Area

Maryland counties with certified agricultural land preservation programs (Caroline, Queen Anne's and Talbot Counties are included) must – by July 1, 2008 – designate "Priority Preservation Areas" capable of supporting profitable agricultural and forestry enterprises, governed by policies that stabilize the land base so that development does not convert or compromise agricultural or forest resources, and large enough to support the kinds of agricultural operations that the county seeks to preserve.

The requirement to designate viable farming and forest enterprise areas and to establish policies to protect such areas suggests several ideas for watershed counties in Maryland. Purchase of conservation easements, a policy method that Caroline, Queen Anne's, and Talbot County have been implementing energetically, is one tool for protection. The new element also requires, however, concern for creating large tracts of integrated farm and forest lands. One idea that would move aggressively in that direction was advanced in Caroline County's Strategic Plan of 2005. The idea is to create a comprehensive County-Municipal Transferable Development Rights (C-MTDR) Program. Stakeholder group representatives who created the idea represented, among others, agriculture, municipal government, and the county government interests. The idea of a C-MTDR program is to compensate farmers who sell development rights in a sending area, which could be the county's "priority preservation" area, by requiring developers to purchase rights to build in municipal receiving areas.

Codes and Ordinances

Local government land use codes and ordinances are influential tools for preserving and restoring the environment and culture in the watersheds. Street, parking, driveway, sidewalk, and open-space designs, waterway buffers, land and tree conservation, and stormwater management all affect environmental quality. Design guidelines and regulations also can be used to affect the character, aesthetics, historic features, and architectural harmony of a place. The Denton Pattern Book offers a good example of how local communities can approach this issue. Ed McMahon and Sarah Hollberg provide a set of six "principles for better development" that encapsulate environmentally and culturally-sensitive codes and ordinances:[21]

1. Identify regional natural and scenic assets, particularly working landscapes such as farms and forests, and create policies to protect them.
2. Maintain a clear edge between town and countryside.
3. Build "livable communities," which rejuvenate downtowns and existing neighborhoods, encourage infill development, and emphasize close-in development with adequate concerns for location, siting and design decisions.
4. Preserve historic resources including building and sites.
5. Respect local character in new construction.
6. Reduce the impact of the car by:
    a. Encouraging walking and biking;

21 Adapted from Edward T. McMahon and Sarah S. Hollberg Better Models for Development in the Shenandoah Valley, www.theconservationfund.org.

b. Building transportation facilities that are beautiful as well as functional;
c. Slowing automobile traffic by narrowing road-width designs and using calming devises.

Workforce Housing

Counties and municipalities that decide to participate in a new state Workforce Housing Grant Program must assess workforce housing needs and determine goals, objectives, and policies that preserve or develop workforce housing. The workforce housing issue was also considered in the Caroline County Strategic Plan of 2005 where potential policy options were investigated.

When any new housing is developed in any town in the watersheds, preservation of the architectural heritage would be assisted by applying ideas from the Denton Pattern Book. In addition, the pattern book also provides suggestions for preserving and enhancing the overall sense of community and the environmental quality of new development.

Potential Workforce Housing Policy Options

The workforce housing issue was considered in the Caroline County Strategic Plan of 2005. Discussed below are some options for consideration for addressing workforce housing.

One option was found in Calvert County, Maryland. That county ties its affordable housing initiative to a TDR program to create incentives for developers to provide affordable housing.

Another example of an affordable housing initiative comes from Buncombe County, North Carolina, which rebates ½ the permit fees on homes that are built to meet state building code and sell for $135,000 or less.

The land development code for Pinellas County, Florida creates incentives for building of affordable housing in various ways:

- *Expedited permit processing;*
- *Relief of impact and review fees;*
- *Reduced parking requirements;*
- *Allowance for housing in commercial zones;*
- *Donation of publicly-owned land;*
- *Identification of qualified renters and buyers;*
- *Density bonuses;*
- *Construction of accessory structures;*
- *Reduced setbacks;*
- *Street design modifications;*
- *Zero lot lines.*

Advocacy Groups

Effective citizen and stakeholder group involvement in public policy development is the basis for democratic government. Some stakeholders in the watersheds, which have been described previously, seem to be effectively represented by their organizations. For example, agricultural interests in Caroline County are well represented by the county's Farm Bureau group. Likewise, historical preservationists in Caroline are represented, effectively, by the local Historical Preservation Society. Environmentally-oriented groups, however, do not have equivalent organizations. A "Friends of the Upper Choptank River" group exists, but has not been active in recent years. No equivalent group exists in the Tuckahoe Creek Watershed, although the potential for a "friends group" seems to exist in some active grassroots organizations in the watershed, including the Ruthsburg Community Club and the Tuckahoe Equestrian Center in Queen Anne's County, and Adkins Arboretum and an active citizenry in the Town of Ridgely in Caroline County. This situation may change with the recent creation of a new Choptank Riverkeeper.

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- Natalie Chabot
- Bill Collier
- Nancy Gearhart
- Jeff Ghrist (Co-chair)
- Amy Handen
- Wilber Levengood
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- John Ohler
- Sandi Olek
- Debbie Rowe
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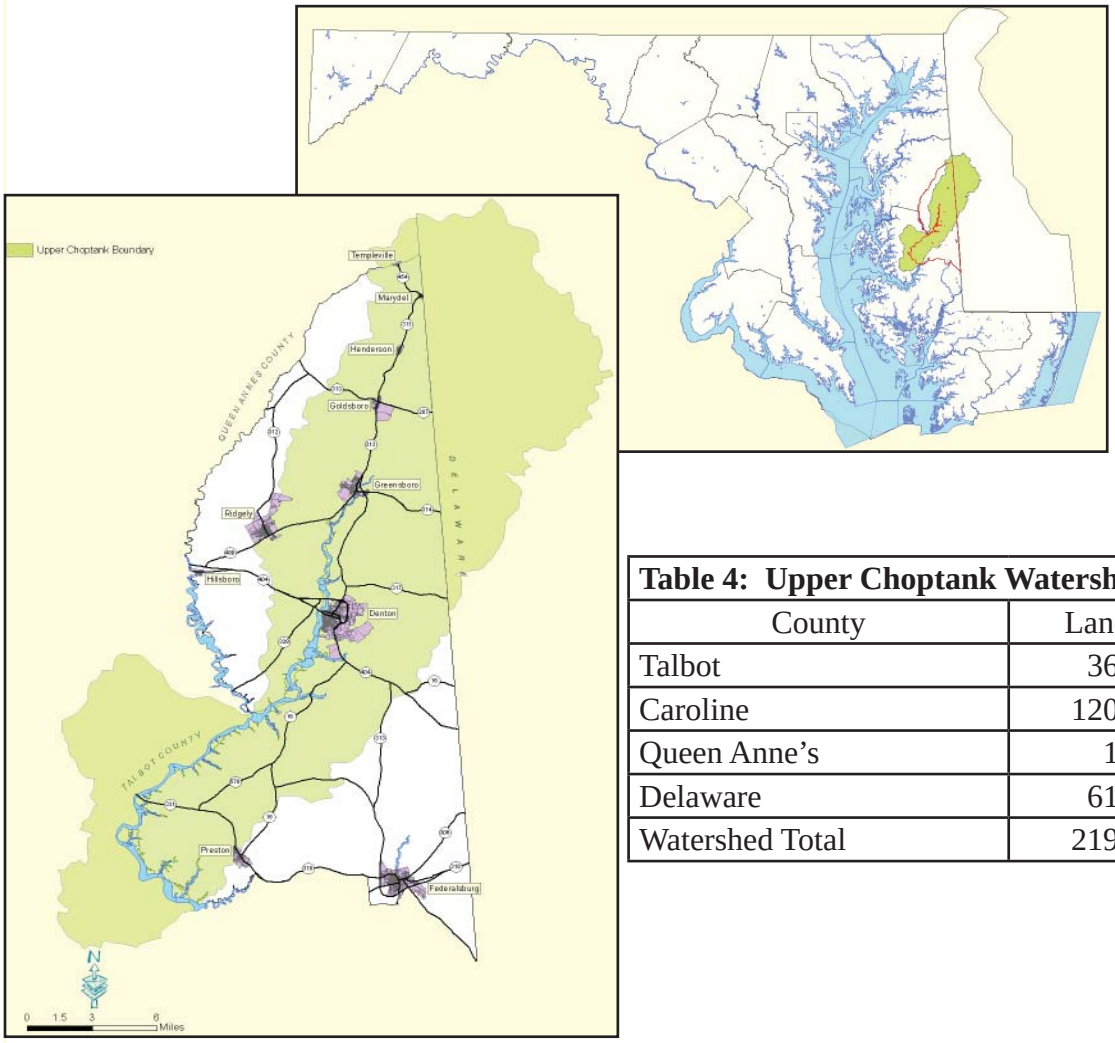
Philip Favero
Lead Author

Section 2: Upper Choptank Watershed Characterization

Introduction

The Upper Choptank Watershed is part of the Choptank River basin on Maryland's Eastern Shore as shown in Map 1. As shown in Map 2, the watershed extends into multiple jurisdictions including three Maryland counties and one Delaware county. As Table 4 indicates, the majority of the watershed is in Caroline County, followed by Delaware, Talbot County, and a small portion in Queen Anne's County. While the portion of the watershed that is in Caroline County is the focus of this characterization, data has been included from the other Counties where possible.

Upper Choptank Watershed



Upper Choptank Watershed

Table 4: Upper Choptank Watershed Acreage Summary

County	Land	Water	Total
Talbot	36,397	1,607	38,004
Caroline	120,655	3,133	123,788
Queen Anne's	1,932	0	1,932
Delaware	61,000	0	61,000
Watershed Total	219,984	4,740	224,724

In 2002 a watershed characterization was completed in partnership with Talbot County and the Maryland Department of Natural Resources. This section of the characterization is an update of the findings from the 2002 watershed characterization, and focuses more specifically on Caroline County.

State Priority for Restoration & Protection

The 1999 Maryland Clean Water Action Plan established priorities for watersheds in the State for water quality restoration and protection. In the Plan, the Upper Choptank River watershed was included in two categories for priority action:

- Category 1 Priority Watershed (highest priority for restoration)
- Category 3 watershed (indicates that protection is needed for identified resources)

As the basis for prioritization, indicators of water quality, landscape, and living resources were developed for all watersheds in the State. These indicators are described in greater detail in separate sections in this document.

Designated Uses

All waters of the State are assigned a "Designated Use" in regulation, COMAR 26.08.02.08, which is associated with a set of water quality criteria necessary to support that use. The designated uses may or may not be served now, but they should be attainable. All surface waters in the Upper Choptank River watershed are designated use I for Water Contact Recreation, and Protection of Aquatic Life.

A statewide assessment of water quality is required under Section 303(d) of the Federal Clean Water Act. As part of the assessment, Maryland tracks waterways that do not support their designated use in a list of "impaired waters" and a prioritized list of "Water Quality Limited Basin Segments" also known as the 303(d) priority list. Information considered in setting the 303(d) list priorities include, but is not limited to, severity of the problem, threat to human health and high value resources, extent of understanding the problem causes and remedies. Some Upper Choptank River watershed water bodies are identified as "impaired waters" on this list. A Total Maximum Daily Load (TMDL) allocation may be required to address the water quality and/or habitat impairment. A list of impairments requiring TMDL's in the Upper Choptank River can be found in Table 5.

Table 5: 2006 303(d) List of Impaired Waters Upper Choptank River Watershed Summary

Name	Impairment	Priority
Upper Choptank Watershed	Biological	Low
Upper Choptank Watershed	Bacteria-Fecal Coliform	Low
Upper Choptank Watershed	Nutrients	Low
Upper Choptank Watershed	Sediments	Low

Water Quality Indicators

The 1998 Clean Water Action Plan Unified Watershed Assessment established priorities for watersheds in the State for restoration and protection. In the Plan, the Upper Choptank River watershed was included in one category for priority action: highest priority for restoration.[1]

1 Maryland Clean Water Action Plan, Final 1998 Report on Unified Watershed Assessment, Watershed Prioritization and Plans for Restoration Action Strategies

As the basis for the prioritization, indicators of water quality, landscape and living resources were developed for all watersheds in Maryland. Other approaches to assessing water quality have been in use and are further described below. In general they do not look comparatively at watersheds as the Unified Assessment did in an effort to set priorities. The Unified Assessment also considered a range of living resource and landscape indicators described later. The findings for the water quality indicators are explained in the following text.

1. State 303(d) Impairment Number
The Upper Choptank River watershed appeared in the 303(d) list for four impairments, which means that the impairments need to be corrected. For this indicator, presence on the 303(d) list means that the watershed needs restoration.

2. Nontidal Total Phosphorus Index
In comparison to the other watersheds that drain to the Chesapeake Bay in Maryland, the Upper Choptank River watershed was among those with a lower total phosphorus (TP) concentration based on data from "core" nontidal stream monitoring stations in the watershed. Watersheds in Maryland that had this data available were ranked on a 1(worst) to 10 (best) scale to allow comparison of total phosphorus among them using the Tributary Team reporting methods for status/trends. The Upper Choptank River watershed was ranked "9" for TP.

To create a benchmark for this indicator, the TP scores for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the lowest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

3. Nontidal Total Nitrogen Index
In comparison to the other watersheds that drain to the Chesapeake Bay in Maryland, the Upper Choptank River watershed was among those with a lower total nitrogen (TN) concentration based on data from "core" nontidal stream monitoring stations in the watershed. Watersheds in Maryland that had this data available were ranked on a 1(worst) to 10(best) scale to allow comparison of total phosphorus among them using the Tributary Team reporting methods for status/trends. The Upper Choptank River watershed was ranked "8" for TN.

To create a benchmark for this indicator, the TN scores for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the lowest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

4. Tidal Habitat Index
Compared to other Chesapeake Bay watersheds in Maryland, the Upper Choptank River watershed ranked among those having better tidal habitat based on an index combining three measurements of water quality: surface chlorophyll a, secchi depth and summer bottom dissolved oxygen (July-Sept.). Using data collected 1994-1996, the Upper Choptank River watershed ranked "6.3" on a scale of 1(worst) to 10(best).

To create a benchmark for this indicator, the index scores for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the lowest quartile (25% of the watersheds) "exceeded" the benchmark. The

Upper Choptank River watershed did not exceed this benchmark.

5. Tidal Eutrophication Index
Compared to other Chesapeake Bay watersheds in Maryland, the Upper Choptank River watershed ranked among those having less eutrophication problems based on an index combining of three measurements of water quality (in surface mixed-layer water): total nitrogen, total phosphorus and total suspended solids. Using data collected 1994-1996, the Upper Choptank River watershed ranked "5.9" on a scale of 1(worst) to 10(best).

To create a benchmark for this indicator, the index scores for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the lowest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

6. Modeled Total Nitrogen Load
Compared to other Chesapeake Bay watersheds in Maryland, the Upper Choptank River watershed ranked among those transporting less total nitrogen (TN) to the Chesapeake Bay. The modeled TN load reaching the Chesapeake Bay from the Upper Choptank River was 9.21 lbs/acre. Nitrogen Load is a measure of how much of this important nutrient is reaching streams and other surface waters. For each type of land use in the watershed, on average, stormwater tends to carry or transport a characteristic amount of nitrogen from the land to nearby streams. Based on these averages, computers can be used to estimate (model) how much nitrogen is likely to be reaching Chesapeake Bay.

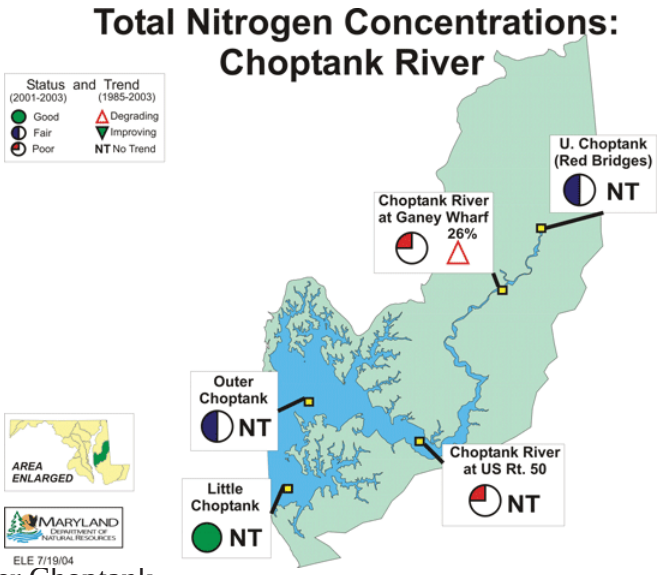
To create a benchmark for this indicator, the modeled TN loads for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

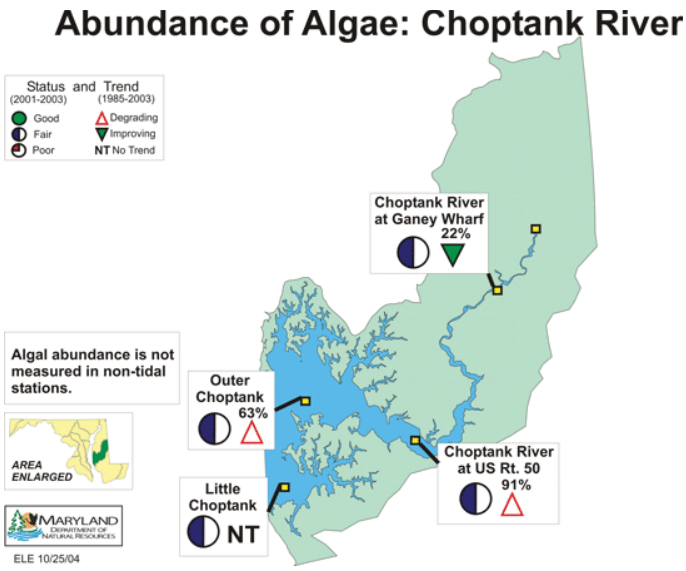
7. Modeled Total Phosphorus Load
Compared to other Chesapeake Bay watersheds in Maryland, the Upper Choptank River watershed ranked among those transporting excessive loading of total phosphorus (TP) to the Chesapeake Bay. The modeled TP load reaching the Chesapeake Bay from the Upper Choptank River was 0.75 lbs/acre. Total Phosphorus is a measure of how much of this nutrient is reaching streams and other surface waters. The ranking for modeled TP Load was performed in parallel to the ranking for modeled TN Load.

To create a benchmark for this indicator, the modeled TP loads for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark which included the Upper Choptank River watershed.

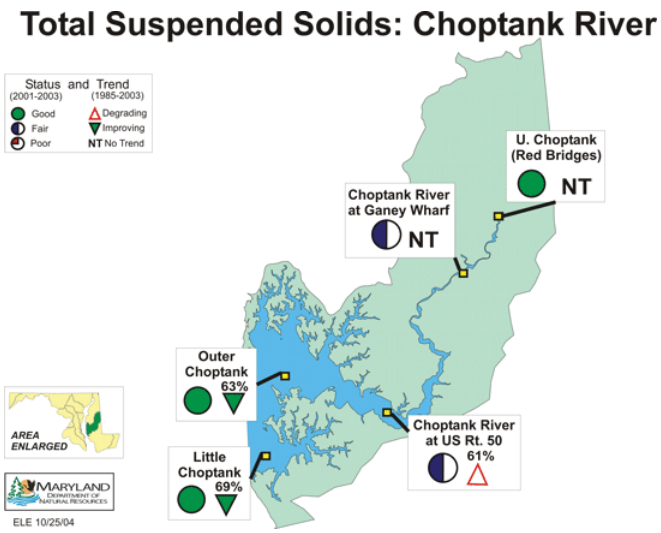
Tributary Team Water Quality Characterization

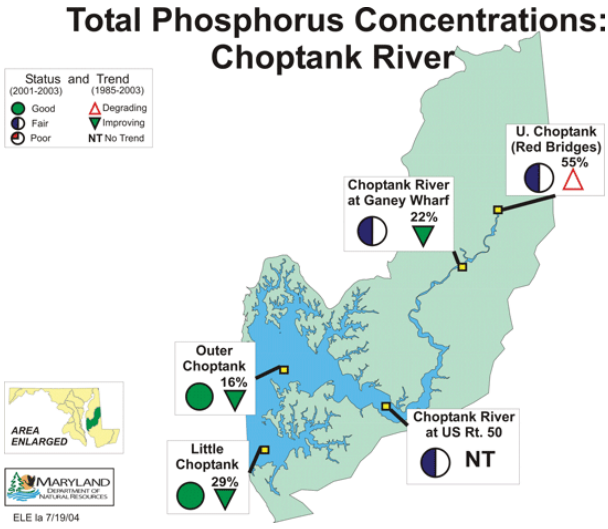
As part of the work of the Choptank Tributary Team, water quality is routinely characterized for several parameters at two monitoring sites in Caroline County, Ganey Wharf and Red Bridges. The following maps show water quality status and trends for 1985-2003 for the entire Choptank River watershed, including the

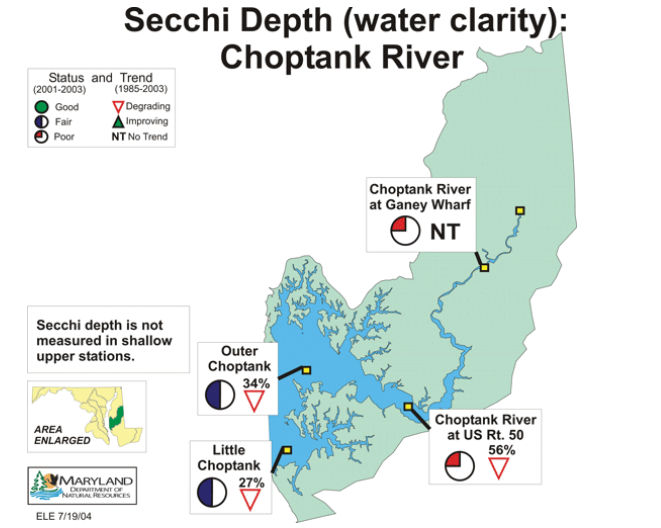


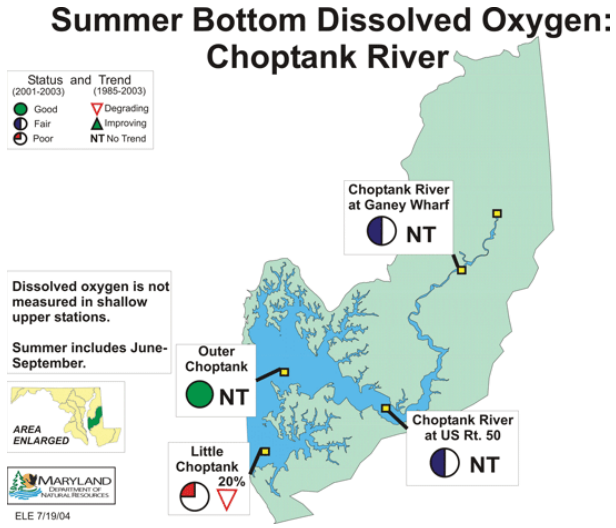


Upper Choptank.









Specific Water Quality Parameters

1. Salinity[2]

Salinity levels are an important water quality parameter and help to define which aquatic resources will live in the area. The salinity ranges change with the season and rainfall, and a general overview is shown in Table 6.

Table 6: Salinity in the Upper Choptank River	
Choptank River Location	Salinity in parts per thousand (ppt)
Bow Knee Point to the Choptank Wetlands Preserve	Highly variable ranging from 0.1 to over 8.0 ppt, i.e. from nearly fresh to slightly brackish (low mesohaline).
Choptank Wetlands Preserve to Tuckahoe Creek	Tends to be in the .1 to 3.0 ppt range, but periods of salinity slightly higher than 7.0 have been measured.

2. Dissolved Oxygen

Dissolved oxygen (DO) is microscopic bubbles of oxygen that are mixed in the water and occur between water molecules. Dissolved oxygen is necessary for healthy lakes, rivers, and estuaries. Most aquatic plants and animals need oxygen to survive. Fish will drown in water when the dissolved oxygen levels get too low. The absence of dissolved oxygen in water is a sign of possible pollution.

Current state water quality standards generally require 5 mg/l DO throughout all of the Bay's waters – from the deep trench near the Bay's mouth to the shallows at the head of the bay. Recent DO data for the Upper Choptank River is available from EPA water quality monitoring stations at Red Bridges and Ganey Wharf and is shown in Charts. At these two stations, summer time DO levels range from 2.7 to 9.1 mg/l. While most DO samples are above 5.0 mg/l, several samples during the summer months fail to meet the standard.[3]

Chart 1: Upper Choptank River at Red Bridges

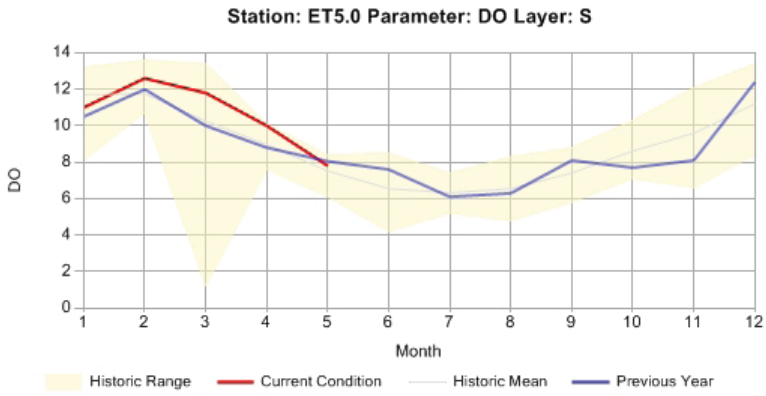
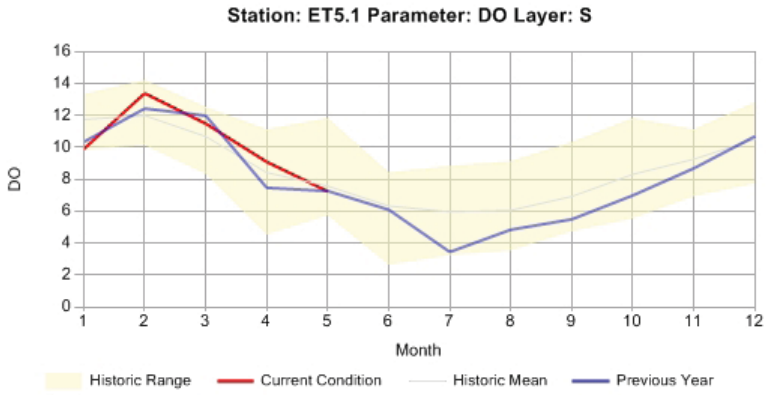


Chart 2: Upper Choptank River at Ganey Wharf



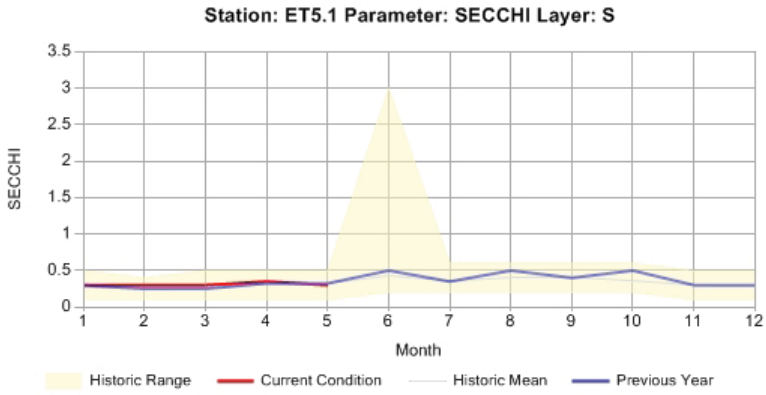
2 2002 Upper Choptank River Watershed Characterization, p. 13

3 Data source and charts from EPA Chesapeake Bay Program Website

3. Secchi Depth

Secchi depth is a measurement that indicates water clarity. The water clarity of a is measured by using an 8-inch diameter disc called a "Secchi disc." The disc is lowered into the water to find the depth at which it first appears to vanish from the observer's sight. A secchi depth of less than 1 meter indicates poor water clarity which tends to inhibit the growth of submerged aquatic vegetation.

Chart 3: Upper Choptank River at Ganey Wharf



Recent secchi depth measurements for the Upper Choptank River are limited to the Ganey Wharf water quality monitoring station, and are shown in Chart 3. Average secchi depth measurements are .3m to .4m; well below the 1 meter standard.[4]

4. Total Suspended Solids (TSS)

High concentrations of suspended solids can make streams unusable in many ways. Organic contaminants (e.g., pesticides) and bacteria can attach to the suspended solids making them more readily transportable. This can affect downstream water uses by closing bathing areas and delivering toxic contaminants to biota. In addition, excessive suspended solids can smother stream bottom life by settling out in pools. Total suspended solids Concentrations of 15 mg/l or greater for total suspended solids is believed to generally inhibit the growth of submerged aquatic vegetation because light cannot penetrate to the plants' leaves.

Chart 4: Upper Choptank River at Red Bridges

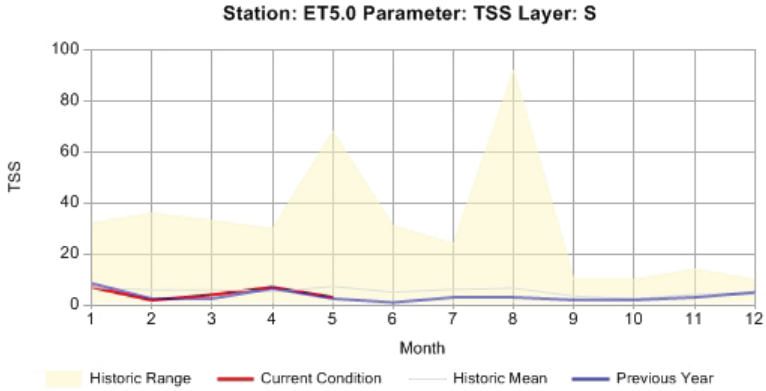
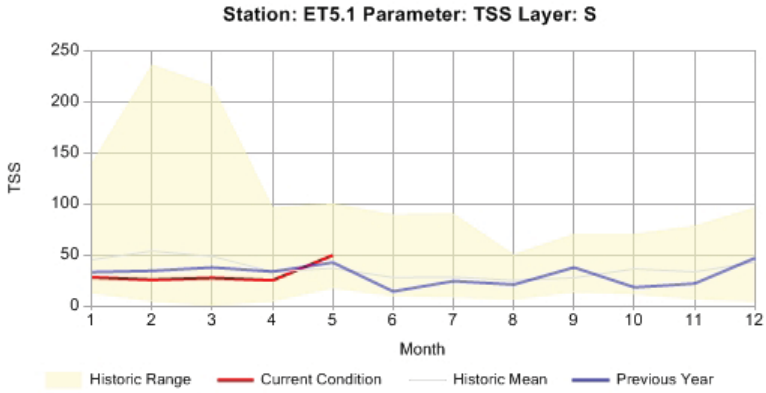


Chart 5: Upper Choptank River at Ganey Wharf



Recent TSS measurements for the Upper Choptank River are available for both the Ganey Wharf and Red Bridges water quality monitoring stations. Generally, TSS concentrations at the Red Bridges station meet the 15 mg/l standard while TSS concentrations at the Ganey Wharf station routinely do not meet the standard.[5]

4 Data source and charts from EPA Chesapeake Bay Program Website
5 Data source and charts from EPA Chesapeake Bay Program Website

5. Chlorophyll A

Algal abundance is estimated based on chlorophyll A measurements. High algal abundance can harm living resources such as bay grasses (SAV) and aquatic animals. Excess algae in the water column or growing on bay grasses can shade out the grasses. In addition, excess algae can cause reduced dissolved oxygen levels during the night (when they respire) and after they die (as they sink and are decomposed). Resulting low or no oxygen conditions can harm or kill aquatic animals, such clams and fish.

There is no standard set in Maryland for Chlorophyll A measurements. For purposes of establishing TMDLs, 50 mg/l is often used as a threshold. Chlorophyll A is measured at both the Ganey Wharf and Red Bridges monitoring stations. Measurements are generally higher at Ganey Wharf with some measurements in excess of 50 mg/l throughout the year.[6]

Chart 5: Upper Choptank River at Red Bridges

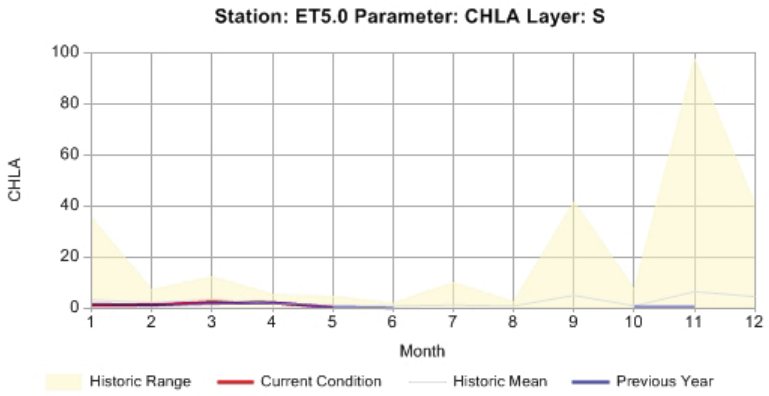
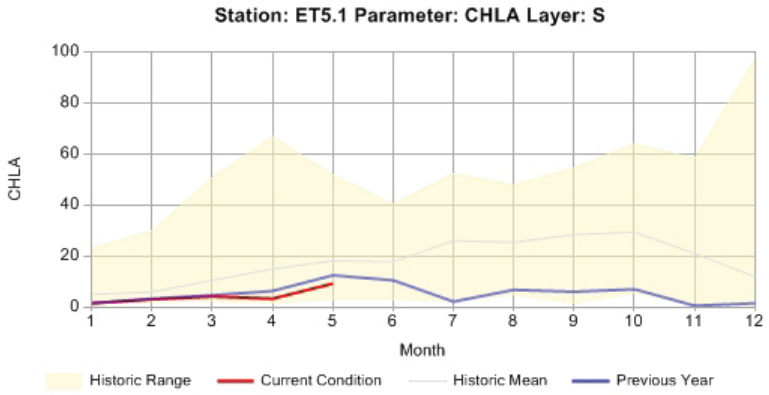


Chart 6: Upper Choptank River at Ganey Wharf



Point Sources

Discharges from discrete conveyances like pipes are called "point sources." Point sources may contribute pollution to surface water or to groundwater. For example, waste water treatment discharges may contribute nutrients or microbes that consume oxygen (measured as Biochemical Oxygen Demand). This process reduces oxygen available for aquatic life. Stormwater discharges may contribute excessive flow of water and/or seasonally high water temperatures. Industrial point sources may contribute various forms of pollution. Some understanding of point source discharges in a watershed targeted for restoration is useful in helping to prioritize potential restoration projects.

According to the Maryland Department of the Environment Permit database as summarized in Table 7, there are 26 permitted surface water discharges and three permitted groundwater discharges in the Upper Choptank River Watershed.[7]

Table 7: MDE Permit Summary
Upper Choptank River Basin in Maryland

County	Surface Discharge	Groundwater Discharge
Caroline	5	0
Talbot	21	3
Queen Annes	0	0

6 Data source and charts from EPA Chesapeake Bay Program Website

7 2002 Upper Choptank Watershed Characterization, p. 15.

NonPoint Sources

A quantitative estimate of nonpoint source loads (surface water or groundwater) is not available for the Upper Choptank River watershed. However, nutrients and sediments are a significant issue in the watershed based on two sources:

- The 303(d) listing of the watershed for nutrients, sediments, and fecal coliform bacteria is believed to be associated with nonpoint sources
- Long term water quality monitoring data from Ganey Wharf indicates that nitrogen and suspended sediment concentrations are poor and phosphorus concentrations are fair. Upstream of this point in the river, point source loads are probably small compared to nonpoint source loads. Therefore, it is likely that nonpoint sources are the primary causes of degraded water quality at this location.
- Long term water quality monitoring data from Red Bridges indicates that nitrogen and phosphorous concentrations are fair. Upstream of this point in the river, point sources are not significant. Consequently, nonpoint sources are the likely reason that water quality is not good at this location.
- Modeled phosphorus load in the Water Quality Indicators section in this document indicates that a combination of factors in the watershed, including land use, would generally lead to excessive phosphorus transport.

The Maryland Tributary Strategy Choptank Basin Summary Report for 1985-2003 Data estimates that in 2002 91.7% of nitrogen, 89.3% of phosphorus, and 100% of sediment contributions into the Choptank River are from nonpoint sources.[8] There is no specific information for the Upper Choptank subwatershed, however the estimates are worth noting. Categories for nonpoint sources include urban, agriculture, forest, mixed open, and atmospheric deposition. While agriculture remains the dominant land use and contributor, urban and point sources have increased since 1985.

Chart 7: Nitrogen Sources

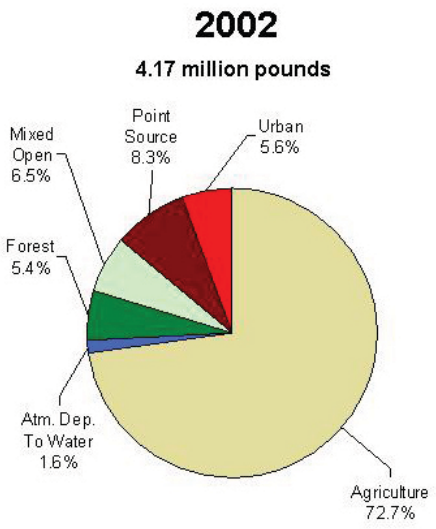


Chart 8: Phosphorus Sources

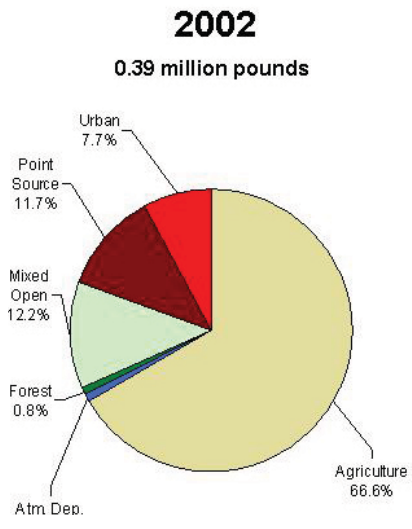
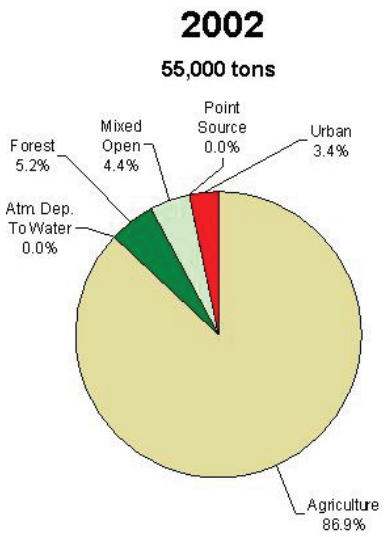


Chart 9: Sediment Sources



8 Maryland Tributary Strategy Choptank Basin Summary Report for 1985-2003, pages 7-9

Shoreline Erosion

Wherever land and open water meet, change in the form of erosion or accretion of land is typically the inevitable result of natural processes. Human activity in these areas either tends to inadvertently accentuate these natural processes or purposefully attempts to control movements of water and/or loss of land. Erosion of shorelines can contribute significant amounts of nutrients and sediment.

Watershed specific erosion rates are not available, but County-wide shoreline erosion is summarized in Table 8.[9]

Table 8: Shore Erosion Rate by County (Miles of Shoreline)

County	Total Shoreline	Total Eroding Shoreline	Erosion Rate		
			0-2 ft/yr	2-4 ft/yr	4 and greater ft/yr
Caroline	120	30 (25%)	24	4	2
Talbot	605	316 (52%)	281	27	8

The shoreline erosion rates listed in the table for Caroline County account for most of the Choptank River shoreline in the Upper Choptank watershed. These erosion rates are probably also indicative of Talbot County's shoreline in the watershed. The majority of Talbot County's shoreline, as listed in the table above, is outside of the Upper Choptank River watershed along the Lower Choptank River and the Chesapeake Bay where erosion rates are generally higher.

Maps of historic shoreline changes were produced in 1999 by the Maryland Geologic Survey (MGS) in a cooperative effort between DNR and the National Oceanic and Atmospheric Administration (NOAA). These maps include digitized shorelines for several years in Talbot and Caroline Counties. The maps also show relatively little change adjacent to smaller water bodies that are typical along the Choptank River in the Upper Choptank River watershed. Copies of these maps are available from the MGS.

Water Supply

The Upper Choptank River watershed has only one type of public water supply system. There are at least 24 public community groundwater systems in the watershed that use wells as their water source. These community water supply wells tend to draw from deep aquifers as summarized in Table 9. These deep aquifers are relatively distinct from surface water and shallow groundwater. They are relatively unaffected by the water quality issues discussed elsewhere in this watershed characterization.

Table 9: Public Water Supply Systems

Categories of Water Supply Systems	Upper Choptank Watershed
Surface Intakes (source water from rivers or streams)	None
Community Surface Water Systems (source from impoundments)	None
Community Groundwater Systems (source water from wells)	Yes
Well Head Protection (active protection efforts)	None

Aquifers used by the Community Groundwater Systems in Maryland's portion of the Upper Choptank River

9 From http://shorelines.dnr.state.md.us/edu.asp, Shoreline Change Fact Sheet Series.

watershed are listed below:

- Aquia Formation
- Cheswold Aquifer
- Federalsburg Aquifer
- Frederica Aquifer
- Piney Point Formation

Land Use & Land Cover

Landscape Indicators

Water quality, particularly in streams and rivers, is affected by the land in the riparian zone and the land use throughout the watershed. In an effort to gauge the effects of land use on water quality, and to allow comparison between watersheds, DNR has developed a series of Landscape Indicators. These indicators can be used to portray landscape conditions on a watershed scale that tend to support good water quality or that tend to degrade water quality.

The Maryland Clean Water Action Plan published in 1998 listed landscape indicators for the Upper Choptank River as summarized in the sections that follow.

1. Impervious Surface

On average across the entire Upper Choptank River watershed, 1.55-2.1% of surface cover is impervious.[10] This average imperviousness compares well with similar watersheds in Maryland.

Roads, parking areas, roofs and other human constructions are collectively called impervious surface. Impervious surface blocks the natural seepage of rain into the ground. Unlike many natural surfaces, impervious surface typically concentrates stormwater runoff, accelerates flow rates and directs stormwater to the nearest stream. Watersheds with small amounts of impervious surface tend to have better water quality in local streams than watersheds with greater amounts of impervious surface. Side effects of impervious surfaces become increasingly significant and negative as the percentage of impervious area increases. Examples of related problems include reduction of groundwater infiltration, increased soil and stream bank erosion, sedimentation, destabilization or loss of aquatic habitat, and “flashy” stream flows (reduced flow between storms and excessive flows associated with storms.) The Maryland Biological Stream Survey has related the percent of impervious surface in a watershed to the health of aquatic resources. For areas with less than 4% impervious cover, streams generally rate “Fair” to “Good” for both fish and in-stream invertebrates. Beyond about 12% impervious surface, streams generally rate “Poor” to “Fair” for both.

The impervious surface estimate used for this indicator was generated for the 1998 Maryland Clean Water Action report. Each land use type in the 1994 Maryland State Planning land use data was assigned an estimated imperviousness taken from the TR-55 manual used by the former Soil Conservation Service.

10 1998 Maryland Clean Water Action Report (est. 2.1% impervious surface)
Mid-Atlantic Region Earth Science Application Center, University of Maryland, 2000 (est.1.55% impervious surface)

To create a benchmark for comparing impervious area among Maryland watersheds, the percent of impervious area for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

2. Population Density

The population density in the Upper Choptank River watershed is about 0.15 people per acre using 2000 Census data. This density compares well with similar Maryland watersheds.

To create a benchmark for comparing population density among Maryland watersheds, the people per acre for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

As human population increases, effects of human activity that tend to degrade, displace, or eliminate natural habitat also tends to increase. Watersheds with higher populations, assuming other factors are equal, tend to exhibit greater impacts on waterways and habitat. However, growth can be directed in ways to reduce negative impacts.

3. Historical Wetland Loss

According to the 1998 Clean Water Action Plan, the historical loss of wetlands in the Upper Choptank River watershed is estimated to be 48,169 acres which is a relatively large loss of wetlands compared with other similar Maryland watersheds.

This interpretation is based on the assumption that the hydric soils in the watershed were all, at one time, wetlands. In most of Maryland's watersheds, extensive wetland areas have been converted to other uses by draining and filling. This conversion unavoidably reduces or eliminates the natural functions that wetlands provide.

To create a benchmark for comparing historic wetland loss area among Maryland watersheds, the historic wetland loss acreage for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed exceeded the benchmark because it is in the highest quartile.

4. Unbuffered Streams

Approximately 49% of streams in the Upper Choptank River watershed were not buffered with trees based on 1998 information. This finding compares well with other similar Maryland watersheds. It is important to note that Caroline County has an extensive network of ditches that are often characterized as streams which likely skews the stream buffer information. Best Management Practices are applied to many of these ditches in lieu of forested buffers. These ditches, referred to a Public Drainage Associations (PDAs), are discussed in greater

detail elsewhere in this document.

DNR recommends that forested buffer 100 feet wide, i.e. natural vegetation 50 feet wide on either side of the stream, is typically necessary to promote high quality aquatic habitat and diverse aquatic populations. In most of Maryland, trees are key to healthy natural streams. They provide numerous essential habitat functions: shade to keep water temperatures down in warm months, leaf litter "food" for aquatic organisms, roots to stabilize stream banks, vegetative cover for wildlife, etc. In general, reduction or loss of riparian trees / stream buffers degrades stream habitat while replacement of trees / natural buffers enhances stream habitat. (For this indicator only "blue line streams" were included. Intermittent streams were not considered.)

This estimate of streams lacking forested buffer was generated for the 1998 Maryland Clean Water Action Plan by using Maryland Department of State Planning GIS data for streams and for 1994 land use.

To create a benchmark for comparing unbuffered streams among Maryland watersheds, the percent of unbuffered streams for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed the benchmark.

5. Soil Erodibility

The average soil erodibility of lands within 1000 feet of streams in the Upper Choptank River watershed is 0.28 value/acre. This suggests that control of soil erosion is particularly important here.

Watersheds with more highly erodible soils are naturally more susceptible to surface erosion, sedimentation, streambank erosion and other problems related to soil movement. These negative effects of soil erodibility on water quality can be minimized through careful management. The soil erodibility indicator accounts for natural soil conditions but not for management of the land. (Existing crop land management was not considered). The naturally erodible soils in the watershed are addressed by techniques called Best Management Practices (BMPs) to prevent soil loss from practices that are typically in use on local farms. BMPs like no-till, reduced till, cover crops, field strips, and others significantly reduce erosion and sediment movement. These BMPs can be seen in use in many places in the watershed.

This estimate of soil erodibility was generated through an analysis of GIS data that incorporated the soil erodibility factor (K), slope steepness, land area within 1000 feet of streams and cropland within that 1000 feet buffer based on 1994 Maryland Department of State Planning land use data.

To compare Maryland watersheds for this index, the benchmark of 0.275 value/acre was used, i.e. less than 0.275 was considered relatively beneficial for water quality and 0.275 or greater was considered to be a likely factor for water quality problems.

2002 Land Use/Land Cover

Table 7 summarizes 2002 land use for the Upper Choptank Watershed in Maryland. Based on this information, the watershed is dominated by agriculture (59%) and forest (29%). The remaining approximately 12% of the

land in the watershed was mostly developed lands with small amounts of tidal and emergent wetlands and other land uses.

Viewing these land uses as potential nonpoint sources of nutrients, agricultural lands are likely to dominate loads to local waterways.

Table 7: 2002 Land Use Upper Choptank Watershed			
Category	**Description**	**Acres**	**%**
Agriculture	Field, Pasdture, Ag Buildings	96,886	59.16%
Forest	All woodlands and brush	46,485	29.29%
Developed Lands	Residential, Commercial, etc.	13,124	8.27%
Wetlands	Tidal marsh, Emergent wetlands	4,818	3.04%
Other	Extractve and bare ground	395	.25%
Watershed Total for Land Use (excl. open water)		158,708	
Watershed Total including open water		163,449	

Green Infrastructure

An additional way to interpret land use / land cover information is to identify "Green Infrastructure." In the GIS application developed by Maryland DNR and its partners, Green Infrastructure refers to areas of natural vegetation and habitat that have statewide or regional importance as defined by criteria developed by DNR. The criteria for identifying of lands as Green Infrastructure is limited to considering natural resource attributes currently found on those lands. One example of the criteria is that interior forest and wetlands complexes at least 250 acres in size are considered as part of Green Infrastructure. As a second example, sensitive species habitat that is located within areas of natural vegetation at least 100 acres in size is also counted as Green Infrastructure. Other potential attributes of Green Infrastructure lands, such as ownership or if the current natural conditions are protected in some way, are not criteria for Green Infrastructure but they may be considered independently.

Within the Green Infrastructure network, large blocks of natural areas are called hubs, and the existing or potential connections between them, called links or corridors. Together the hubs and corridors form the Green Infrastructure network which can be considered the backbone of the region's natural environment.

In 2007, the Green Infrastructure Tool was updated to include Rare Species Habitat, Aquatic Hot Spots, and areas important for Water Quality Protection. This Updated Green Infrastructure will serve as the basis for targeting of State land preservation resources to the ensure the protection of the most valuable lands. With this protocol in place, Green Infrastructure lands will be protected through various existing programs including Rural Legacy, Program Open Space, conservation easements and others.

- A significant number of Green Infrastructure hubs are found in the Upper Choptank River watershed. Many, but not all of these hubs are along the Choptank River and its tributaries. Also, many of these areas of natural vegetation have some association with wetlands and/or wet soils.
- Many corridors selected by the computer analysis have significant amounts of agricultural land shown within the potential corridor. In general, viability of these corridors for protection or restoration requires local on-the-ground assessment to provide additional information regarding site conditions, land owner preferences and potential viability of projects.

Protected Lands

As used in the context of this watershed characterization, "protected land" includes any land with some form of long term limitation on conversion to urban/developed land use. This protection may be in various forms: public ownership for natural resource or recreational intent, private ownership where a third party acquired the development rights or otherwise acquired the right to limit use through purchase of an easement, etc. The extent of "protection" varies greatly from one circumstance to the next. Therefore, for some protected land, it may be necessary to explore the details of land protection parcel by parcel through the local land records office to determine the extent of true protection.

Knowledge of existing protected lands can provide a starting point in prioritizing potential restoration activities. In some cases, protected lands may provide opportunities for restoration projects because owners of these lands may value natural resource protection or enhancement goals.

Protection of agricultural land is the most active form of land conservation in the watershed. As Table 8 shows, agricultural easements encompass about 19,100 acres covering 12% of the watershed in Caroline County. Agricultural districts encompass an additional 11,400 acres beyond the acreage under easements. This is an additional 7% of the watershed.

Conservation easements cover about 5,150 acres (3.2% of the watershed) including over 2600 acres in Caroline County. These figures include easements held by private organizations and by the Maryland Environmental Trust.

Government owned land in the Upper Choptank watershed amounts to less than half of one percent

Table 8: Protected Land Summary By County Upper Choptank Watershed in Maryland

Category	Talbot (2006)		Caroline (2006)		Queene Annes (2002)	
Area Category	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Agriculture Easement	5,009	13.7	14,046	11.6	84	4
Agricultural District	3,445	9.4	7,947	6.6	0	--
Conservation Easement: MET	2,221	6.1	1,986	1.6	0	--
Conservation Easement: Private	300	.8	641	.5	0	--
County Parks	7	--	178	.1	0	--
DNR Land	130	.4	448	.4	0	--
Total Protected Land in County/Watershed	**11,112**	**30.4**	**25,246**	**20.8**	**84**	**4**
Total County Land in Watershed	**36,575**	**100**	**120,982**	**100**	**1,937**	**100**

of the watershed. No federal land is identified. Caroline County has about 178 acres of park land in the watershed. DNR land in the watershed encompasses 460 acres including about 300 acres recently acquired form Chesapeake Forest, Inc. Other DNR land in the watershed includes a small portion of Seth Forest in Talbot County and Martinak State Park in Caroline County.

Smart Growth

Maryland's Smart Growth Program was initiated in 1997 with the primary goal of working with local governments to strengthen and invest in Maryland's existing communities, save taxpayers money, while at the same time protect natural resources from development. The Smart Growth Program partners with local governments to designate Priority Funding Areas (PFA's) which are existing communities targeted for development. These locally designated PFA's are eligible for State infrastructure funding to support development and re-development, whereas areas outside of the PFA are not eligible for the funding.

Protecting Maryland's most critical and valued natural resources is a main goal of the Smart Growth Program. A keystone program of the program is the Rural Legacy Program. The Rural Legacy Program directs funding towards local designated areas to protect land from future development through purchase of easements (or in fee simple) is promoted. This unique program works to protect large contiguous blocks of valuable open space and resource lands. The Priority Funding Areas can be seen on Map 6 in Section 4 of this document.

Rural Legacy Areas in the Upper Choptank watershed are concentrated near Tuckahoe Creek. A little over 5400 acres of the Tuckahoe Rural Legacy area are in the watershed. State funding for the Tuckahoe Rural Legacy area was appropriated in State fiscal years 1999 and 2000.

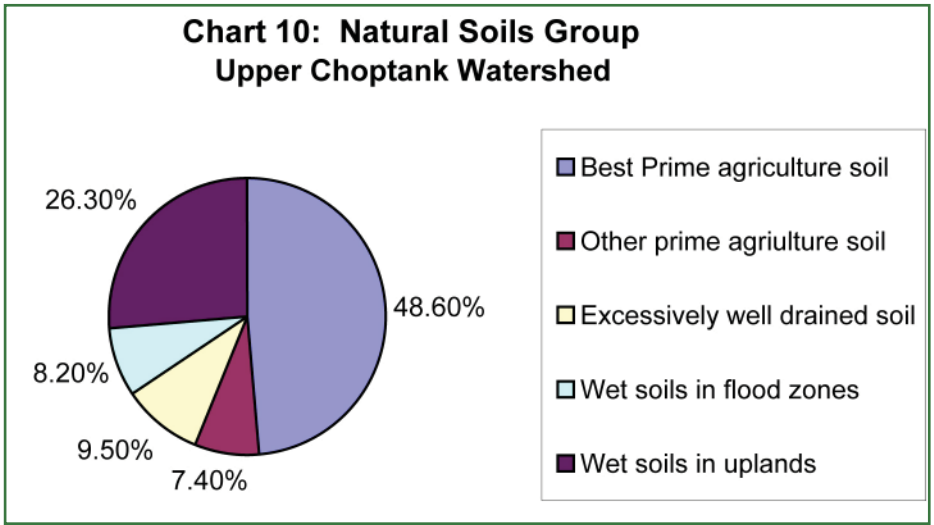
Soils

1. Interpreting Local Conditions with Natural Soil Groups

Soil conditions, like soil type and moisture conditions, greatly affect how land may be used and the potential for vegetation and habitat on the land. Soil conditions are one determining factor for water quality in streams and rivers. Local soil conditions vary greatly from site to site as published information in the soil surveys for Talbot and Caroline Counties show. This complicated information can be effectively summarized using Natural Soil Groups to help identify useful generalizations about groups of soils.

About 56% of the Upper Choptank Watershed in Maryland is prime farmland based on the list shown in Chart 10.

Chart 10: Natural Soils Group
Upper Choptank Watershed



2. Soils and Land Uses

Local soil conditions are a useful element in watershed planning and for targeting restoration projects. Soils with limitations related to wetness or slope naturally inhibit active use for farming or development. Land owners in the watershed have tended to leave many of these areas in natural vegetation or other low intensity use. By comparing the general land use, soil, and green infrastructure maps, several tendencies can be seen. Green infrastructure and forest in general tends to coincide with soils that are either hydric and poorly drained, or with soils that are excessively well drained. Additionally, development, which often relies on septic systems, tends to be concentrated on excessively well drained soils and not on hydric soils.

Wetlands

1. Introduction to Wetland Categories

The Eastern Coastal Plain Province likely has the highest diversity of emergent estuarine and palustrine wetland communities relative to other Maryland physiographic regions because both tidal and nontidal freshwater marshes occur here. Wetlands are most abundant in the Coastal Plain due to the low topographic relief and high groundwater table characteristic of the region. (See Map 4 in Section 4 for wetlands in these watersheds)

Estuarine Wetlands. Estuarine wetlands are abundant throughout the Coastal Plain. These systems consist of salt and brackish tidal waters and contiguous wetlands where ocean water is at least occasionally diluted by freshwater runoff from the land. These wetlands may extend far upstream in tidal rivers to freshwater areas. Differences in salinity and tidal flooding within estuaries have a significant effect on the distribution of these wetland systems. Salt marshes occur on the intertidal shores of tidal waters in areas of high salinity. Brackish marshes are the predominant estuarine wetland type in Maryland. They are found along the shores of Chesapeake Bay, mostly on the Eastern Shore, and for considerable distance upstream in coastal rivers. Estuarine shrub swamps are common along the Maryland coastal zone. Aquatic beds, comprised mostly of submerged aquatic vegetation, are abundant in shallow water zones of Maryland's estuaries, especially Chesapeake Bay and its tributaries.

Palustrine wetlands. Forested wetlands are the most abundant and widely distributed palustrine wetland type on the Coastal Plain. These wetlands are found on floodplains along the freshwater tidal and nontidal portions of rivers and streams, in upland depressions, and in broad flat areas between otherwise distinct watersheds. Tidal freshwater swamps occur along coastal rivers in areas subject to tidal influence. Scrub-shrub swamps are not abundant on the Eastern Shore but are represented in the Upper Choptank River watershed. Emergent wetlands on the Coastal Plain are characterized by a wide range of vegetation, depending on water regime.[11]

2. Tracking Wetlands

Oversight of activities affecting wetlands involves several regulatory jurisdictions. The Maryland Dept. of the Environment (MDE) is the lead agency for the State and cooperates with DNR, the Army Corps of Engineers and other Federal and local agencies. As part of its responsibility, MDE tracks State permitting and the net gain or loss of wetlands over time.

11 Adapted from *Wetlands of Maryland*, Tiner and Burke, 1005.

As Table 9 shows, changes tracked in the State regulatory program show a net increase of nearly 90 nontidal wetland acres and approximately 1 tidal wetland acre has occurred in the Upper Choptank River watershed over the past 10-14 years.

Table 9: Tidal & Nontidal Wetland Changes Upper Choptank Watershed

	Nontidal*	Tidal**
Impacts	-7.27	-.048
Permittee Mitigation	2.33	.075
Programmatic Mitigation	80	.8256
Other Gains	12.59	-
Net Change	**87.65**	**.8526**

*1991-2006
**1996-2006

Regulatory tracking for authorized nontidal wetland losses began in 1991. Comprehensive tracking of voluntary wetland gains began in 1998. From 2005-2006, approximately 55 wetland acres were restored in the Upper Choptank watershed, including phragmites control, emergent wetland creation, and forested wetland creation. This acreage is not included in the table.

3. Interpreting Wetland Distribution

Wetlands in most of the Upper Choptank River watershed tend to occur along waterways as shown in the maps. However, the map also shows that wetlands in the northern end of the watershed tend to be more diffuse, and they are less likely to be associated with waterways.

Table 10: National Wetlands Inventory Acreage Summary

Wetland Classification	Acres
Lacustrine	0
Riverine	151
Palustrine	29,029
Estuarine	3646
Total	**32,826**

In comparing the Wetlands map to Generalized Land Use map, it can be seen that much of the forested land in the watershed is found in association with wetlands or adjacent to them. Additionally, comparing the maps shows that many of the nontidal wetland areas on the wetland maps are depicted as forest on the land use map. This difference is simply the result of two differing views of the landscape. For example, wooded nontidal wetlands can be viewed as "wetlands" from a habitat / regulatory perspective and they can be viewed as "forest" from a land use perspective. Wetlands serve valuable water quality and habitat functions that may not be provided by other land uses. Table 10 shows the types and amounts of wetlands present in the Upper Choptank watershed.[12]

Public Drainage Associations

Public Drainage Associations (PDA's) were created by state law more than half a century ago in recognition of their many public benefits. Proper drainage of frequently saturated soils helps create more productive farmland, reduces flooding, protects public health, improves the transportation infrastructure, and supports local economies. One the downside, agricultural drainage systems can accelerate the delivery of nutrients to nearby waters, disturb wildlife habitat, and contribute to erosion and sediment losses. In Caroline County there are

12 U.S. Fish and Wildlife Service, National Wetland Inventory. Data summarized by the Chesapeake Bay Program

approximately 368 miles of PDA's. These ditches are necessary for both agriculture and development on the Eastern Shore. (See Map 10 in Section 4)

Some PDA's are considered "blue line" streams by the USGS. It is important to note that the general nature of PDA's necessitates treating them differently than natural streams even though they may be included in stream mile calculations. Forested buffers along both sides of PDA's, for example, are not feasible for a functioning PDA because access is needed for ditch maintenance. As previously mentioned, forested buffers along streams are desirable for providing habitat and improved water quality and are used as quantifiable indicators of watershed health.

Heightened concerns over the environmental impacts have prompted PDAs to seek new solutions to ditch maintenance. PDA managers are being asked to perform an environmental balancing act that seeks to keep ditch channels functioning properly and protect waterways from agricultural runoff containing sediments and nutrients, while holding the line on association fees. Best management practices (BMPs) combined with cost-share grants have been identified to facilitate this effort.

Floodplains

The 100-year floodplain extends far up tributaries to the Choptank River. The extent of potential flood areas in the Upper Choptank River watershed has significant implications for land use decisions and watershed management including potential restoration projects. (See Map 4 in Section 4)

In recent years, stormwater management requirements have provided a means to limit impacts of new development and impervious area that would otherwise contribute to stream degradation and flooding. However, these new projects may not significantly improve water quality or quantity that are driven by systemic watershed factors.

For existing development and impervious area, retrofitting controls to enhance water quality and limit peaks in stormwater runoff may offer an additional way to protect waterways. However, consideration of retrofits must take into account at least two local issues:

- Land owner interests and preferences.
- Management directions already established by Public Drainage Associations (PDAs)

Low Elevation Areas Subject to Sea Level Rise

Most areas of the Upper Choptank River watershed have sufficient elevation to be unaffected by any potential for sea level rise in the next 50 to 100 years. However, marshes and other low-lying wetlands are at risk for inundation. The potential for sea level rise impacts need to be considered as part of any comprehensive watershed management effort. For example, the identification and prioritization of potential WRAS projects will take into account the risk of inundation during the life of the project.

As a gauge of potential sea level rise risk, a Maryland-wide assessment of land with an elevation of 1.5 meters or less was first published in 1998 and then repackaged in a 2000 State report. At this statewide scale, the

general area at risk to inundation from sea level rise is limited to marsh/wetland areas along the Choptank River. The area of concern in the Upper Choptank River watershed extends from Bow Knee Point to Barker Creek just upstream of the Choptank Wetlands Preserve. A significant portion of the Choptank Wetlands Preserve is at risk for inundation.

LIVING RESOURCES AND HABITAT

Overview

Living resources, including all the animals, plants and other organisms that call the land and waters of the Upper Choptank River watershed home, are being affected by human activity. The information summarized here suggests that some of the significant stresses on living resources in the watershed are manipulation of habitat, excessive movement of sediment and excessive availability of nutrients.

Living Resource Indicators

Aquatic organisms are sensitive, in varying degrees, to changes in water quality and aquatic habitat. This association offers two perspectives that are important for watershed restoration. First, improvements for living resources offer potential goals, objectives and opportunities to gauge progress in watershed restoration. Second, the status of selected species can be used as to gauge local conditions for water quality, habitat, etc. This second perspective is the basis for using living resources as an "indicator."

The Maryland Clean Water Action Plan published in 1998 listed the following living resource indicators for the Upper Choptank River Watershed. Several of these indices rely on index rankings generated from a limited number of sampling sites which were then generalized to represent entire watersheds. Considering this limitation on field data, it may be beneficial to conduct additional assessments to provide a more complete understanding of local conditions:

1. SAV Abundance Index

For tidal areas of the Upper Choptank River watershed, the abundance of submerged aquatic vegetation (SAV) scored "1.5" for the Abundance Index which means that SAV covered about15% of the potential SAV habitat. This index is designed to allow comparison of watersheds based on actual SAV acreage versus potential SAV acreage. To generate the score for this index, two measurements of SAV area were estimated: 1) area covered by SAV in the year 1996 was measured using aerial survey data, and 2) the potential SAV area was measured based on water depth (up to two meters deep), physical characteristics and historic occurrence of SAV.

The benchmark used for the SAV Abundance Index was 10%. If less than 10% of the potential SAV area in a watershed was covered by SAV in 1996, then the watershed was listed in the category "needs improvement". If more than 10% of the potential SAV area in a watershed was covered by SAV in 1996, then the watershed was listed in the category "needs preventative action" to protect or enhance SAV abundance. No watershed in the State scored higher than 2, reflecting a maximum observed coverage of 20%.

2. SAV Habitat Requirements Index

For tidal areas of the Upper Choptank River watershed, the abundance of submerged aquatic vegetation (SAV) scored "5.0" for the Habitat Requirement Index which means that SAV habitat requirements were not met based on 1994-1996 data. This index is designed to allow comparison of watersheds based on several measurements of habitat conditions: secchi depth, dissolved inorganic nitrogen where applicable, dissolved inorganic phosphorus, Chlorophyll a and total suspended solids.

The benchmark used for the SAV Habitat Requirements Index was 7. A score of 7 or higher means that 1994 through 1996 data showed that habitat conditions for SAV in a watershed were sufficient and the watershed was listed in the category for "restoration needed". A score less than 7 means that the watershed's habitat conditions were not favorable for SAV and the watershed was listed in the category for "needs preventative action".

3. Nontidal Benthic Index of Biotic Integrity

For this index, an average score for an 8-digit watershed less than 6.0 means that restoration is needed and a score of 8.0 or greater means that protection is recommended. To generate this index, each stream site that is assessed is compared to reference conditions that were established for comparable streams that are minimally impacted. Nontidal rivers (streams seventh order and larger) are not incorporated into this index.

When the *Maryland Clean Water Action Plan* was published in 1998, the Upper Choptank River was generally found to be in poor condition on average based on assessment of benthic macroinvertebrate communities (stream bugs). In 2000, three sites were sampled by the Department of Natural Resources Maryland Biological Stream Survey in the Upper Choptank resulting in one "poor" and two "good" stream characterizations. This does not necessarily indicate that the stream has improved since the 1998 *Clean Water Action Plan,* it could be indicative of better data or different data analyses.

4. Nontidal Fish Index of Biotic Integrity

For this index, an average score for an 8-digit watershed less than 6.0 means that restoration is needed and a score of 8.0 or greater means that protection is recommended. In each stream site where fish are surveyed, the makeup of the overall fish population is measured in nine distinct ways such as the number of native species, number of benthic fish species, percent of individuals that are "tolerant" species, etc. These nine scores are then integrated to generate an index ranking for the survey site. To generate the index for the watershed, the scores for all the stream sites assessed within the 8-digit watershed are averaged together.

Photo courtesy of DNR Maryland Biological Stream Survey.

When the *Maryland Clean Water Action Plan* was published in 1998, the Upper Choptank River scored 6.5 on a scale of 1 (worst) to 10 (best) indicating a fair/good condition on average. In 2000, three sites were sampled by the Department of Natural Resources Maryland Biological Stream Survey in the Upper Choptank resulting in one "poor" and two "good" stream characterizations.

5. Nontidal In-Stream Habitat Index

This index allows comparison of streams based on habitat for fish and benthic organisms as measured by in-stream and riparian conditions. For each stream site that was assessed, visual field observations are used to score the site for substrate type, habitat features, bank conditions, riparian vegetation width, remoteness, aesthetic value, etc. For each site, the individual scores are integrated to generate a single score for each stream site. The index score reported for each stream site is a relative score to the maximum attainable score for comparable streams. The watershed index is created by averaging the scores for all the sites that were assessed in the watershed.

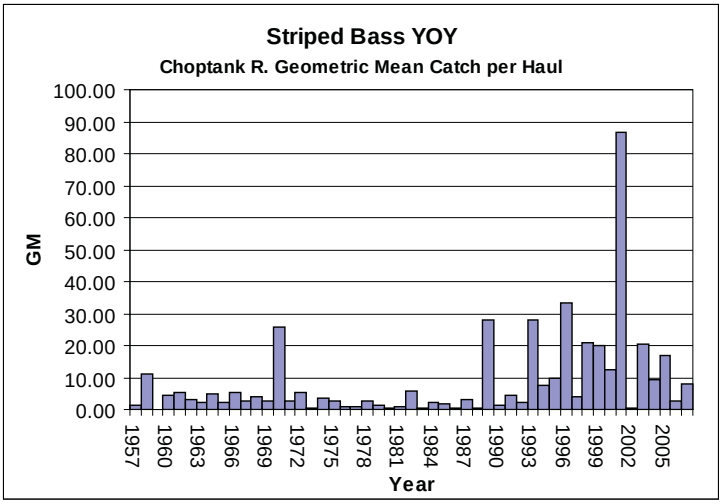
When the *Maryland Clean Water Action Plan* was published in 1998, the Upper Choptank River scored an average of 4.9 on a scale of 1 (worst) to 10 (best) indicating conditions were generally fair on average. In 2000, three sites were sampled by the Department of Natural Resources Maryland Biological Stream Survey in the Upper Choptank resulting in poor, marginal, and sub-obtimal stream characterizations.

Fish

1. Striped Bass Spawning and Nursery

The Upper Choptank River is one of the most important spawning and nursery areas for striped bass (rock fish) in the Chesapeake Bay watershed. In terms of size and productivity, the Upper Choptank ranks third (behind the Upper Chesapeake Bay and the Potomac River). Within the Upper Choptank River, the area most used by striped bass for spawning and nursery extends from near Denton to approximately Bow Knee Point. Chart 11 shows juvenile striped bass survey results from the Department of Natural Resources.

Chart 11: Juvenile Striped Bass Survey



2. Juvenile Fish Survey

DNR Fisheries Service conducts numerous surveys to gauge the condition of fisheries and some of the sampling sites have been located in the Upper Choptank River. The Bay-wide Estuarine Juvenile Finfish Survey samples 22 sites each year including one in the Upper Choptank River near Denton and three other sites downstream in the Choptank River. Additionally the annual Blue Crab Survey includes five stations in the Choptank River. For additional information see http://www.dnr.state.md.us/fisheries/juvindex/index.html.

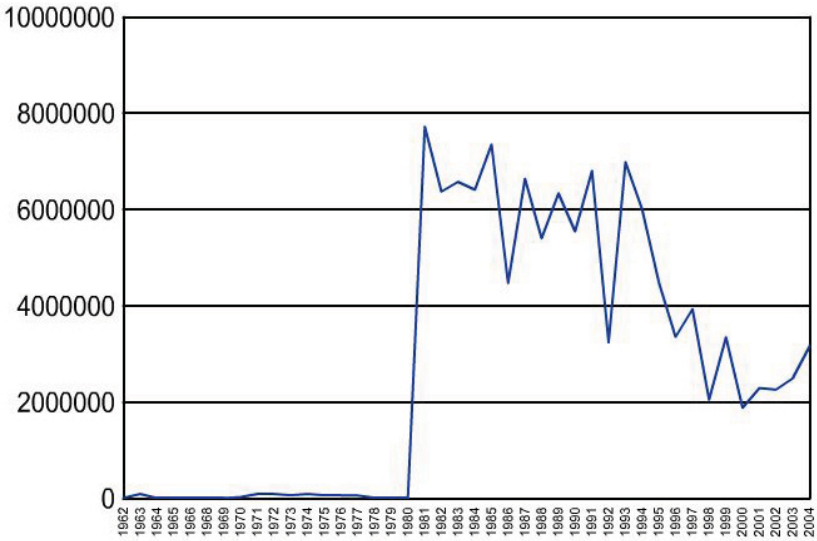
3. Tidal Largemouth Bass Studies 1998-2001

The Eastern Regional Staff of Freshwater Fisheries has sampled the Upper Choptank for largemouth bass abundance since the 1980's. In 1999, the survey techniques were changed to increase overall precision, and to better address the correlation between largemouth bass abundance and habitat quality. Roughly forty 250m stations representing prime, average and marginal habitats were sampled each year using an electrofishing boat to collect data on largemouth bass and other recreationally important species. The results of these data were encouraging; the bass population in the Upper Choptank appears to be stable or slowly increasing over the three-year study period. Catch-per-unit effort (CPUE) for all bass collected per 100m increased over time from 1.52 in 1999, 1.69 in 2000 to 2.25 in 2001. Similarly, CPUE of young-of-year bass has increased as well from 1999-2001. Overall, when compared to other fisheries, the Upper Choptank River supports an excellent fishery for tidal largemouth bass. It is described by consistent reproduction and a balanced age and size structure of bass in optimal physical condition. Bass abundance was highest in areas of prime habitat characterized by areas with an abundance of structure, adjacent deep water and tidal current breaks.

4. Commercial Fisheries

Commercial fisheries harvest information for the Choptank River is tracked by DNR Fisheries Service. While this information aggregates Upper Choptank River information into the Choptank River-wide information, it provides some indication of local conditions. Also see http://mddnr.chesapeakebay.net/mdcomfish/mdcomfishery.html .

Chart 12: Blue Crab Harvest Data for the Choptank River



- Blue Crabs: For the entire Choptank River, the annual commercial harvest ranged from 6 million pounds in 1994 to 3,162,271 pounds in 2004.
- Striped Bass: The commercial harvest data for the entire Choptank River extends all the way back to 1929. Over the 70-year period from 1929 to 1999, the annual striped bass harvest in the Choptank River occasionally exceeded 200,000 pounds prior to 1976. Since that time, the annual harvest has been significantly smaller. 1998 was the highest harvest year during the 1990s yielding around 135,000 pounds. Since then, the annual harvest has continued to decline. In 2004, the harvest yielded about 33,532 pounds.

5. Recreational Fish Stock Assessment

During 2000, DNR Fisheries Service conducted an extensive effort across the Chesapeake Bay to assess the status of selected fish species that are important for recreational activities. Part of this effort involved sampling of Upper Choptank River fish in the vicinity of the Tuckahoe Creek confluence using experimental fyke nets at five locations. The report on this work, released in 2001, included several findings that may be relevant:

- Channel Catfish recruitment in the Choptank River may have improved recently. A higher percentage of 2 to 5 year years amoung the population was found in 1999 and the absolute numbers of channel catfish between 200 mm and 310 mm length increased substantially in 1999 and 2000. From 1993 to 1998 the most frequently found length among channel catfish was consistently increasing. While 1999 and 2000 recruitment declined, subsequent years have improved in "young-of-the-year" (YOY) surveys.
- White Catfish populations in the Choptank River may be expanding based on trends toward increasing length and increasing pre-recruit abundance. Their numbers counted during 2000 were greater than any year since 1993. The fyke net catches in the Choptank River were nine times the level in 1998.
- White Perch populations appear to be stable (based on relatively constant length frequencies).
- Yellow Perch netted in the 2000 survey indicated continuing strong recruitment in the Choptank River in recent years. The 1996 year-class accounted for 60% of the yellow perch population.

6. Fish Consumption Advisory

In late 2001, MDE issued revised fish consumption advisories. The advisory recommended limiting consumption of channel catfish and white perch caught in the mainstem of the Choptank River due to PCB and/or pesticide contamination. This recommendation remained in effect in the 2007 Statewide fish consumption advisory. The complete advisory list is available at http://www.mde.state.md.us/CitizensInfoCenter/Health/fish_advisories/index.asp.

MDE cited changes in the EPA's recommended daily consumption estimates, new sampling data and improved analytical techniques, which led to the revised advisory to limit consumption of 13 species of fish recreationally caught in 14 Maryland waterways. While contaminant levels have not changed, the consumption advisories are especially important for children and women of child-bearing age who are or may become pregnant or are nursing.

Sensitive Species

Sensitive species are most widely known in the form of Federally-listed Endangered or Threatened animals such as the bald eagle. In addition to these charismatic rare animals, both US EPA and Maryland DNR work through their respective Federal and State programs to protect numerous endangered, threatened, or rare species of plants and animals and the habitats that support those species.

For the purposes of watershed restoration, it is valuable to account for known locations of habitat for these species. These places are often indicators, and sometimes important constituents, of the network of natural areas or "green infrastructure" that are the foundation for many essential natural watershed processes. Protecting these species and/or promoting expansion of their habitats can be an effective foundation for a watershed restoration program.

DNR's Wildlife and Heritage Division uses three designations for areas providing habitat for sensitive species. These designations are: Sensitive Species Project Review Areas, Natural Heritage Areas, and Wetlands of Special State Concern. As shown on Map 5 in Section 4, two of the three sensitive species designations are found in the Upper Choptank watershed. The purpose of these designations is to help protect sensitive species and their habitat through the review of applications for State permits or approvals, and review of projects that

involve State funds. For the types of projects potentially described above, DNR makes recommendations and/or requirements to protect sensitive species and their habitat.

These categories do not place requirements on any activities that do not require a permit/approval or do not involve State funds. However, there are State and Federal restrictions that address "takings" of protected species that apply more broadly. In addition, many counties have incorporated safeguards for these areas into their project and permit review processes. In all instances, property owners are encouraged to seek advice on protecting the sensitive species / habitat within their ownership. More details and guidance can be requested from DNR Natural Heritage Division staff.

Submerged Aquatic Vegetation

SAV beds in the Upper Choptank River watershed are small and limited to narrow areas along the shoreline. This is, in part, due to the depth of the river channel which limits the area of potential physical habitat in the Upper Choptank River. These areas are too small to be identified in the remote sensing data that is publicly available via DNR's MERLIN Internet mapping tool which shows data for each year from 1984 through 1999. (Also see www.vims.edu/bio/sav/ for extensive information or www.mdmerlin.net for annual distribution maps 1984 through 1996).

Next Steps

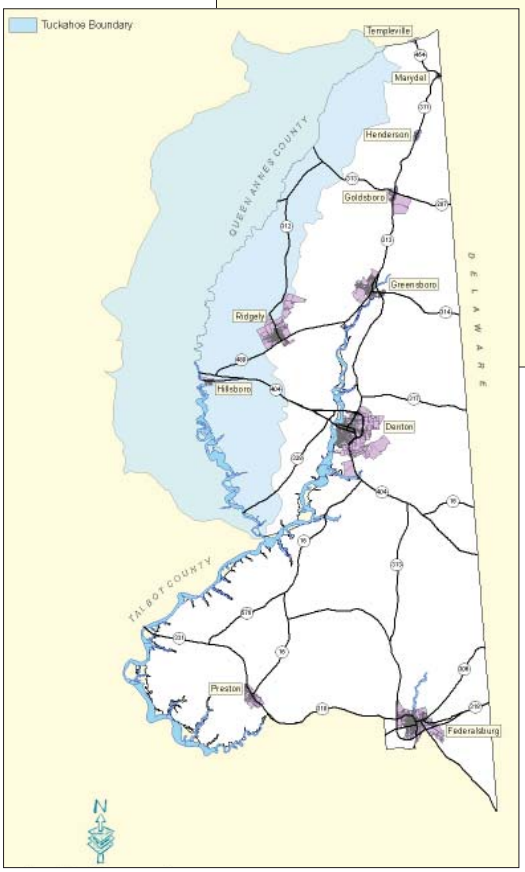
As Map 24 in Section 4 shows, there are 38 12-digit subwatersheds within the 8-digit Upper Choptank watershed. As a next step, the Caroline County Planning & Codes Administration will begin working with its partners to develop subwatershed plans for each of these smaller scale watersheds. Through this effort, the Administration hopes to address potential TMDLs, the State Tributary Strategies, and other State and County planning requirements.

Section 3: Tuckahoe Creek Watershed Characterization

Introduction

The Tuckahoe Creek Watershed is a sub-basin of the Choptank River basin as shown in Map 2 Regional Context. It extends through three Maryland counties: Queen Anne's, Caroline and Talbot Counties (Map 2 County Context) As Table 14 indicates, the majority of the Tuckahoe Creek watershed is in Queen Anne's County, followed closely by Caroline County, and a smaller portion in Talbot County. This document is a watershed characterization, similar to ones done for various Maryland watersheds, with assistance from Maryland Department of Natural Resources. While portion of the watershed in Caroline County is the focus of this characterization, data has been included from the other Counties where possible. Larger versions of these maps can been found on Maps 1 and 2 in Section 4 .

Tuckahoe Creek Watershed



Tuckahoe Creek Watershed

Table 14: Tuckahoe Creek Watershed Acreage Summary

County	Land	Water	Total
Caroline	35,920	n/a	n/a
Queen Anne's	45,960	n/a	n/a
Talbot	15,459	n/a	n/a
Watershed Total	97,339	1,280	98,619

State Priority for Restoration & Protection

The 1999 Maryland Clean Water Action Plan established priorities for watersheds in the State for water quality restoration and protection. In the Plan, the Tuckahoe Creek watershed was included in two categories for priority action:

- Category 1 Priority Watershed (highest priority for restoration)
- Category 3 watershed (indicates that protection is needed for identified resources)

As the basis for prioritization, indicators of water quality, landscape, and living resources were developed for all watersheds in the State. These indicators are described in greater detail in separate sections in this watershed characterization.

Designated Uses

All waters of the State are assigned a "Designated Use" in regulation, COMAR 26.08.02.08, which is associated with a set of water quality criteria necessary to support that use. The designated uses may or may not be served now, but they should be attainable. All surface waters in the Tuckahoe Creek watershed are designated use I, for Water Contact Recreation and Protection of Aquatic Life.

Table 15: 2006 303(d) List of Impaired Waters Tuckahoe Creek Watershed Summary

Name	Impairment	Priority
Tuckahoe Creek Watershed	Biological	Low
Tuckahoe Creek Watershed	Nutrients	Low
Tuckahoe Creek Watershed	Sediments	Low
Tuckahoe Creek Watershed	Metals*	High

*Mercury in fish, MDE submitted in 2002. Approved in 2004. Castro et al. 2001 Hg - Largemouth Bass (289; n = 15)

A statewide assessment of water quality is required under Section 303(d) of the Federal Clean Water Act. As part of the assessment, Maryland tracks waterways that do not support their designated use in a list of "impaired waters" and a prioritized list of "Water Quality Limited Basin Segments" also known as the 303(d) priority list. Information considered in setting the 303(d) list priorities include, but is not limited to, severity of the problem, threat to human health and high value resources, extent of understanding the problem causes and remedies. Some Tuckahoe Creek watershed water bodies are identified as "impaired waters" on this list. A Total Maximum Daily Load (TMDL) allocation may be required to address the water quality and/or habitat impairment. A list of impairments requiring TMDL's in the Tuckahoe Creek can be found in Table 5.[1]

Water Quality Indicators

The 1998 Clean Water Action Plan Unified Watershed Assessment established priorities for watersheds in the State for restoration and protection. While the Upper Choptank watershed was selected as a Category 1 Priority

1 Castro, M.S., McLaughlin, E.N., Davis, S.L., and Morgan II, R. 2002. Total Mercury Concentrations in Lakes and Fish of Western Maryland, USA. Arch. Environ. Contam. Toxicol. 42: 454-462.

Watershed, which calls for highest priority for restoration, the Tuckahoe Creek Watershed was not selected.

As the basis for the prioritization, indicators of water quality, landscape and living resources were developed for all watersheds in Maryland. Approaches to assessing water quality have been in use for several years and are further described below. In general they do not look comparatively at watersheds as the Unified Assessment did in an effort to set priorities. The Unified Assessment also considered a range of living resource and landscape indicators described later. The findings for the water quality indicators are explained in the following text.

1. State 303(d) Impairment Number
The Tuckahoe Creek watershed appeared in the 303(d) list for four impairments, which means that the impairments need to be corrected. For this indicator, presence on the 303(d) list means that the watershed needs restoration.

2. Modeled Total Nitrogen Load
Compared to other Chesapeake Bay watersheds in Maryland, the Tuckahoe Creek watershed ranked among those transporting less total nitrogen (TN) to the Chesapeake Bay. The modeled TN load reaching the Chesapeake Bay from the Tuckahoe Creek was 9.66 lbs/acre. Nitrogen Load is a measure of how much of this important nutrient is reaching streams and other surface waters. For each type of land use in the watershed, on average, stormwater tends to carry or transport a characteristic amount of nitrogen from the land to nearby streams. Based on these averages, computers can be used to estimate (model) how much nitrogen is likely to be reaching Chesapeake Bay.

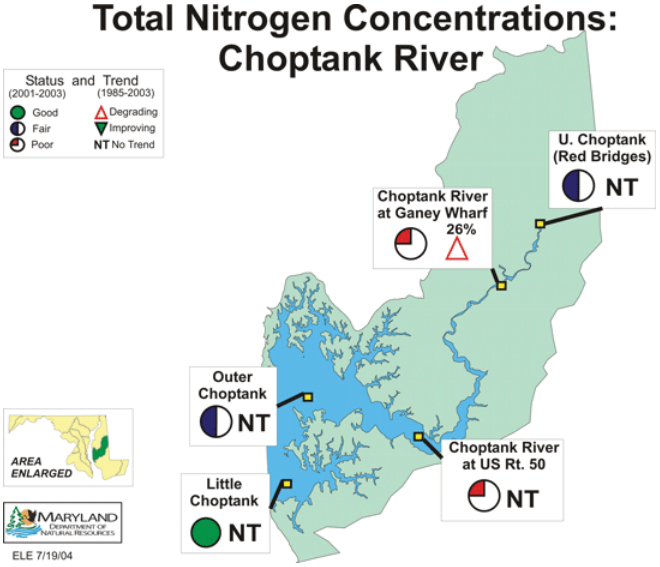
To create a benchmark for this indicator, the modeled TN loads for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds. The watersheds in the highest quartile (25% of the watersheds) “exceeded” the benchmark.

3. Modeled Total Phosphorus Load
Compared to other Chesapeake Bay watersheds in Maryland, the Tuckahoe Creek watershed ranked among those transporting excessive loading of total phosphorus (TP) to the Chesapeake Bay. The modeled TP load reaching the Chesapeake Bay from the Tuckahoe Creek was 0.75 lbs/acre. Total Phosphorus is a measure of how much of this important nutrient is reaching streams and other surface waters. The ranking for modeled TP Load was performed in parallel to the ranking for modeled TN Load above.

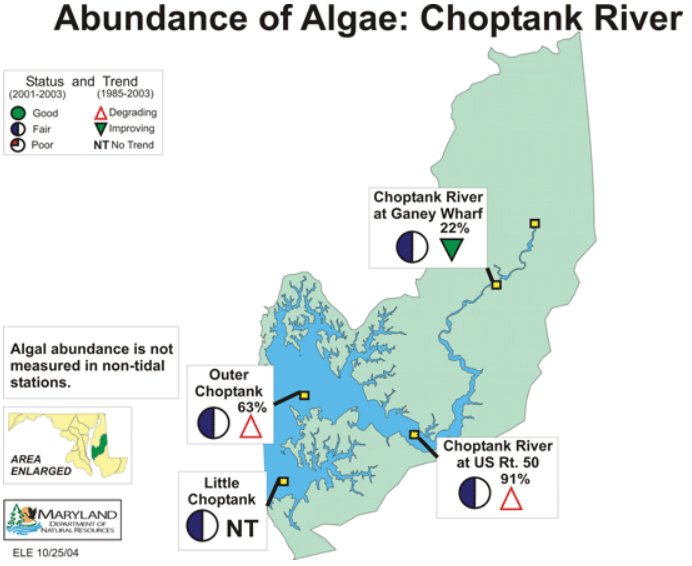
To create a benchmark for this indicator, the modeled TP loads for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) “exceeded” the benchmark which included the Tuckahoe Creek watershed.

Tributary Team Water Quality Characterization
As part of the work of the Choptank Tributary Team, water quality is routinely characterized for several parameters at two monitoring sites in Caroline County, Ganey Wharf and Red Bridges. The following maps show water quality status and trends for 1985-2003, for the entire Choptank Watershed, including Tuckahoe Creek watershed. Ganey Wharf is located at a point on the Choptank River that includes water from Tuckahoe Creek, and therefore has the most relevant data for Tuakchoe Creek and its watershed.

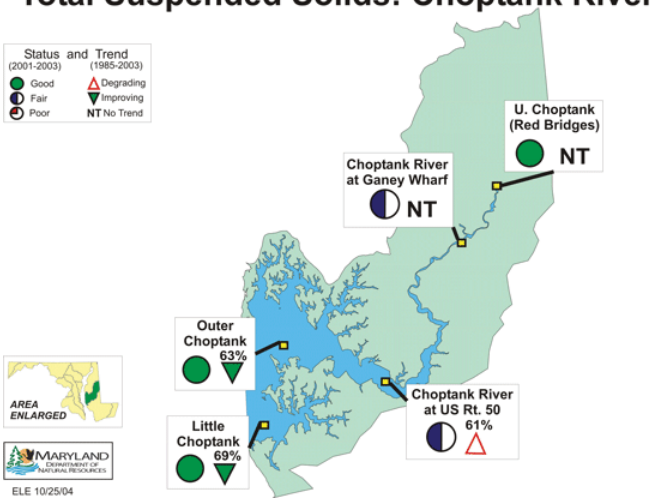
Total Nitrogen Concentrations: Choptank River



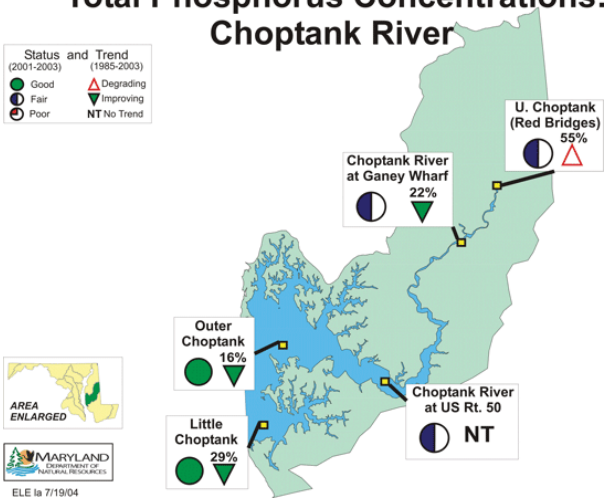
Abundance of Algae: Choptank River



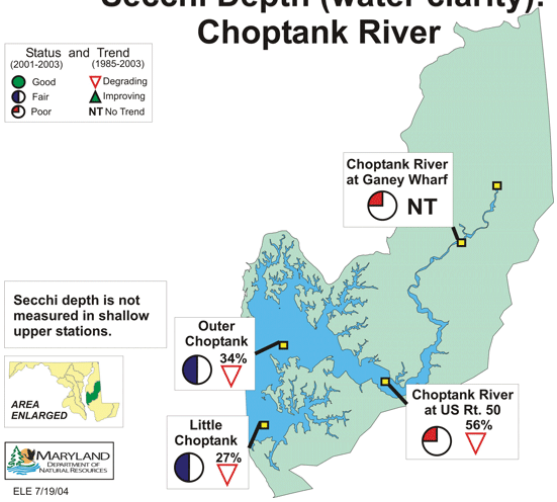
Total Suspended Solids: Choptank River



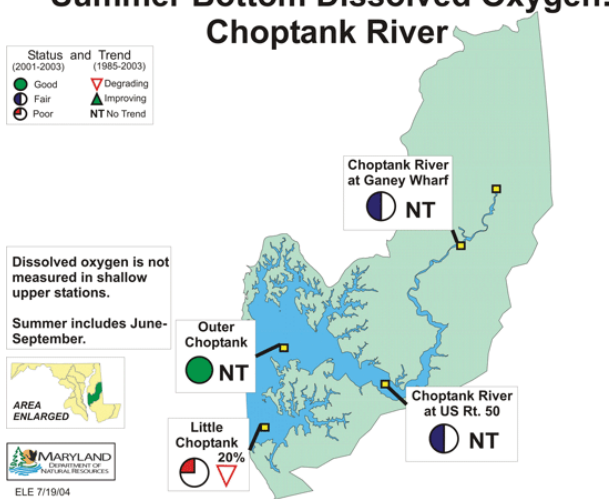
Total Phosphorus Concentrations: Choptank River



Secchi Depth (water clarity): Choptank River



Summer Bottom Dissolved Oxygen: Choptank River



Specific Water Quality Parameters

1. Salinity[2]

Salinity-Salinity levels are an important water quality parameter and help to define which aquatic resources will live in the area. The salinity ranges change with the season and rainfall however, typical levels for Talbot County waters is around 15 ppt (or 1.5%) which is about half the salinity of the ocean. A general overview is shown in Table 16.

Table 16: Salinity in the Tuckahoe Creek	
Choptank Wetlands Preserve to Tuckahoe Creek	Tends to be in the .1 to 3.0 ppt range, but periods of salinity slightly higher than 7.0 have been measured.
Upstream of Tuckahoe Creek	Generally less than 1.0 ppt.

2. Dissolved Oxygen

Dissolved oxygen (DO) is microscopic bubbles of oxygen that are mixed in the water and occur between water molecules. Dissolved oxygen is necessary for healthy lakes, rivers, and estuaries. Most aquatic plants and animals need oxygen to survive. Fish will drown in water when the dissolved oxygen levels get too low. The absence of dissolved oxygen in water is a sign of possible pollution.

Current state water quality standards generally require 5 mg/l DO throughout all of the Bay's waters – from the deep trench near the Bay's mouth to the shallows at the head of the bay. Recent DO data for the Tuckahoe Creek is not available. However, EPA water quality monitoring stations at Red Bridges and Ganey Wharf, which are both in the Upper Choptank River watershed, show data that during the summer time, DO levels range from 2.7 to 9.1 mg/l. While most DO samples are above 5.0 mg/l, several samples during the summer months fail to meet the standard.

3. Secchi Depth

Secchi depth is a measurement that indicates water clarity. The water clarity is measured by using an 8-inch diameter disc called a "Secchi disc." The disc is lowered into the water to find the depth at which it first appears to vanish from the observer's sight. A secchi depth of less than 1 meter indicates poor water clarity which tends to inhibit the growth of submerged aquatic vegetation.

Secchi depth measurements for the Tuckahoe Creek are not available for this report, but data from various sources, such as Horn Point Lab, or other scientists is forthcoming.

4. Total Suspended Solids (TSS)

High concentrations of suspended solids can make streams unusable in many ways. Organic contaminants (e.g., pesticides) and bacteria can attach to the suspended solids making them more readily transportable. This can affect downstream water uses by closing bathing areas and delivering toxic contaminants to biota. In addition,

2 2002 Upper Choptank River Watershed Characterization, p. 13

excessive suspended solids can smother stream bottom life by settling out in pools. Total suspended solids Concentrations of 15 mg/l or greater for total suspended solids is believed to generally inhibit the growth of submerged aquatic vegetation because light cannot penetrate to the plants' leaves.

Recent TSS measurements for the Tuckahoe Creek were not found, but data is available for both the Ganey Wharf and Red Bridges on the Upper Choptank River monitoring stations. Generally, TSS concentrations at the Red Bridges station meet the 15 mg/l standard while TSS concentrations at the Ganey Wharf station routinely do not meet the standard.

5. Chlorophyll A

Algal abundance is estimated based on chlorophyll A measurements. High algal abundance can harm living resources such as bay grasses (SAV) and aquatic animals. Excess algae in the water column or growing on bay grasses can shade out the grasses. In addition, excess algae can cause reduced dissolved oxygen levels during the night (when they respire) and after they die (as they sink and are decomposed). Resulting low or no oxygen conditions can harm or kill aquatic animals, such clams and fish.

There is no standard set in Maryland for Chlorophyll A measurements. For purposes of establishing TMDLs, 50 mg/l is often used as a threshold. Chlorophyll A is measured at both the Ganey Wharf and Red Bridges monitoring stations. Measurements are generally higher at Ganey Wharf with some measurements in excess of 50 mg/l throughout the year.

Point Sources

Discharges from discrete conveyances like pipes are called "point sources." Point sources may contribute pollution to surface water or to groundwater. For example, waste water treatment discharges may contribute nutrients or microbes that consume oxygen (measured as Biochemical Oxygen Demand). This process reduces oxygen available for aquatic life. Stormwater discharges may contribute excessive flow of water and/or seasonally high water temperatures. Industrial point sources may contribute various forms of pollution. Some understanding of point source discharges in a watershed targeted for restoration is useful in helping to prioritize potential restoration projects.

Maryland Department of the Environment Permit keeps track of both surface discharge and groundwater discharge permits. Characteristics of these permitted discharges (volume, temperature, pollutants, etc.) are tracked by MDE through the permit system. Most of this information is accessible to the public and can be obtained from MDE.

NonPoint Sources

A quantitative estimate of nonpoint source loads (surface water or groundwater) is not available for the Tuckahoe Creek watershed. However, nutrients and sediments are a significant issue in the watershed based on two sources:

- The 303(d) listing of the watershed for nutrients, sediments, and mercury is believed to be associated with

nonpoint sources

- Modeled phosphorus load in the Water Quality Indicators section in this document indicates that a combination of factors in the watershed, including land use, would generally lead to excessive phosphorus transport.

The *Maryland Tributary Strategy Choptank Basin Summary Report for 1985-2003 Data* estimates that in 2002 91.7% of nitrogen, 92.7% of phosphorus, and 100% of sediment contributions into the Choptank River are from nonpoint. Categories for nonpoint sources include urban, agriculture, forest, mixed open and atmospheric deposition. While agriculture remains the dominant land use and contributor, urban and point sources have increased since 1985.

Chart 13: Nitrogen Sources

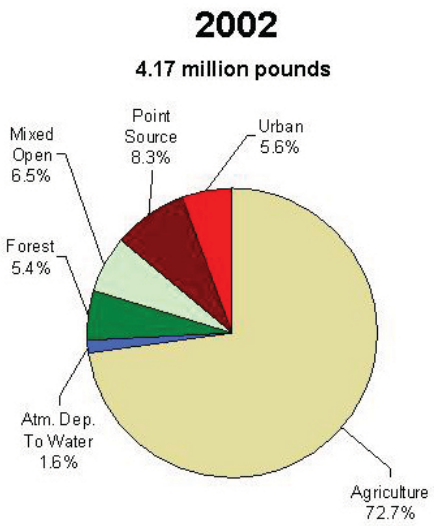


Chart 14: Phosphorus Sources

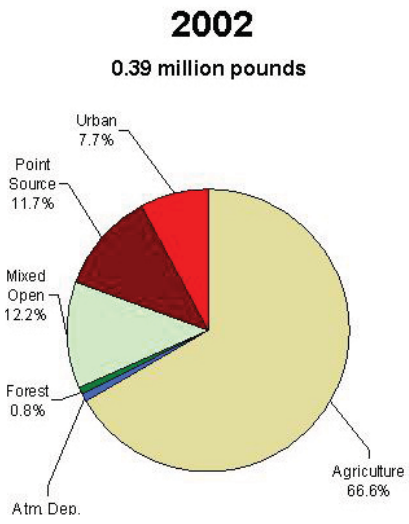
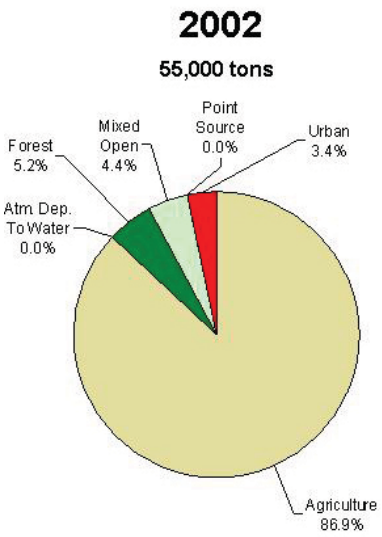


Chart 15: Sediment Sources



Tuckahoe Lake, which is an impoundment located near Ridgely in southwestern Caroline County, is located in a watershed in which the mercury impairment is dominated by nonpoint source mercury contributions (via atmospheric deposition). Although some sources of atmospheric deposition are located in Maryland, many are located outside of the state and even beyond the region. The EPA considers coal-fired electric power generating plants to be the largest anthropogenic source of mercury emissions in the nation (EPA 2000).

Trophic level 4 fish (Largemouth Bass) were harvested from Tuckahoe Lake and were analyzed for mercury tissue concentrations.

Shoreline Erosion

Wherever land and open water meet, change in the form of erosion or accretion of land is typically the inevitable result of natural processes. Human activity in these areas either tends to inadvertently accentuate these natural processes or purposefully attempts to control movements of water and/or loss of land. Erosion of shorelines can contribute significant amounts of nutrients and sediment.

Countywide shoreline erosion is summarized in the following table. The data comes from a compilation of data from 2003 study, and found with Maryland Shorelines Online, and USGS.[3]

Table 17: Shore Erosion Rate by County (Miles of Shoreline)

County	Total Shoreline	Total Eroding Shoreline	Erosion Rate		
			0-2 ft/yr	2-4 ft/yr	4 and greater ft/yr
Caroline	120	30 (25%)	24	4	2
Talbot	605	316 (52%)	281	27	8
Queen Anne's	414	217 (52%)	180	27	10

The shoreline erosion rates listed in Table 17 for Caroline County account for most of the Choptank River shoreline in the Upper Choptank Watershed. These erosion rates are probably also indicative of Talbot County's shoreline in the watershed. The majority of Talbot County's shoreline, as listed in the table above, is outside of the Tuckahoe Creek watershed along the Lower Choptank River and the Chesapeake Bay where erosion rates are generally higher.

Maps of historic shoreline changes were produced in 1999 by the Maryland Geologic Survey (MGS) in a cooperative effort between DNR and the National Oceanic and Atmospheric Administration (NOAA). These maps include digitized shorelines for several years in Talbot and Caroline Counties. Copies of these maps are available from the MGS.

Land Use & Land Cover

Landscape Indicators

Water quality, particularly in streams and rivers, is affected by the land in the riparian zone and the land use throughout the watershed. In an effort to gauge the affects of land use on water quality, and to allow comparison between watersheds, DNR has developed a series of Landscape Indicators. These indicators can be used to portray landscape conditions on a watershed scale that tend to support good water quality or that tend to degrade water quality.

The Maryland Clean Water Action Plan published in 1998 listed landscape indicators for the Tuckahoe Creek watershed as summarized in sections that follow

1. Impervious Surface

On average across the entire Tuckahoe Creek watershed, 0.8- 0.9% of surface cover is impervious.[4] This average imperviousness compares well with similar watersheds in Maryland.

Roads, parking areas, roofs and other human constructions are collectively called impervious surface. Impervious surface blocks the natural seepage of rain into the ground. Unlike many natural surfaces, impervious

3 From http://shorelines.dnr.state.md.us/edu.asp, Shoreline Change Fact Sheet Series.

4 1998 Maryland Clean Water Action Report (est. 2.1% impervious surface)
Mid-Atlantic Region Earth Science Application Center, University of Maryland, 2000 (est.1.55% impervious surface)

surface typically concentrates stormwater runoff, accelerates flow rates and directs stormwater to the nearest stream. Watersheds with small amounts of impervious surface tend to have better water quality in local streams than watersheds with greater amounts of impervious surface. Side effects of impervious surfaces become increasingly significant and negative as the percentage of impervious area increases. Examples of related problems include reduction of groundwater infiltration, increased soil and stream bank erosion, sedimentation, destabilization or loss of aquatic habitat, and "flashy" stream flows (reduced flow between storms and excessive flows associated with storms.) The Maryland Biological Stream Survey has related the percent of impervious surface in a watershed to the health of aquatic resources. For areas with less than 4% impervious cover, streams generally rate "Fair" to "Good" for both fish and in-stream invertebrates. Beyond about 12% impervious surface, streams generally rate "Poor" to "Fair" for both.

The impervious surface estimate used for this indicator was generated for the 1998 Maryland Clean Water Action report. Each land use type in the 1994 Maryland State Planning land use data was assigned an estimated imperviousness taken from the TR-55 manual used by the former Soil Conservation Service.

To create a benchmark for comparing impervious area among Maryland watersheds, the percent of impervious area for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Tuckahoe Creek watershed did not exceed this benchmark.

2. Population Density

The population density in the Tuckahoe Creek watershed is about 0.07 people per acre (or 44.24 persons per square mile) using 2000 Census data (summarized by Chesapeake Bay Program Office). This density is relatively low compared to the Upper Choptank watershed.

To create a benchmark for comparing population density among Maryland watersheds, the people per acre for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Tuckahoe Creek watershed did not exceed this benchmark.

As human population increases, effects of human activity that tend to degrade, displace or eliminate natural habitat also tends to increase. Watersheds with higher populations, assuming other factors are equal, tend to exhibit greater impacts on waterways and habitat. However, growth can be directed in ways to reduce negative impacts.

3. Historical Wetland Loss

According to the 1998 Clean Water Action Plan, the historical loss of wetlands in the Tuckahoe Creek watershed is estimated to be 35,689 acres.

In most of Maryland's watersheds, extensive wetland areas have been converted to other uses by draining and filling. This conversion unavoidably reduces or eliminates the natural functions that wetlands provide.

To create a benchmark for comparing impervious area among Maryland watersheds, the historic wetland loss acreage for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark.

4. Unbuffered Streams

Approximately 60% of streams in the Tuckahoe Creek watershed were not buffered with trees based on 1998 information. This finding is higher than that for the Upper Choptank watershed. It is important to note that Caroline County has an extensive network of ditches that are often characterized as streams which likely skews the stream buffer information. There are a significant number of these ditches located in the Tuckahoe Creek watershed. Best Management Practices are applied to many of these ditches in lieu of forested buffers. These ditches, referred to a Public Drainage Associations (PDAs), are discussed in greater detail elsewhere in this document.

DNR recommends that forested buffer 100 feet wide, i.e. natural vegetation 50 feet wide on either side of the stream, is typically necessary to promote high quality aquatic habitat and diverse aquatic populations. In most of Maryland, trees are key to healthy natural streams. They provide numerous essential habitat functions: shade to keep water temperatures down in warm months, leaf litter "food" for aquatic organisms, roots to stabilize stream banks, vegetative cover for wildlife, etc. In general, reduction or loss of riparian trees / stream buffers degrades stream habitat while replacement of trees / natural buffers enhances stream habitat. (For this indicator only "blue line streams" were included. Intermittent streams were not considered.)

This estimate of streams lacking forested buffer was generated for the 1998 Maryland Clean Water Action Plan by using Maryland Department of State Planning GIS data for streams and for 1994 land use.

5. Soil Erodibility

The average soil erodibilty of lands within 1000 feet of streams in the Tuckahoe Creek watershed is 0.30 value/acre which suggests that control of soil erosion is particularly important here.

Watersheds with more highly erodible soils are naturally more susceptible to surface erosion, sedimentation, stream bank erosion and other problems related to soil movement. These negative effects of soil erodibility on water quality can be minimized through careful management. The soil erodibility indicator accounts for natural soil conditions but not for management of the land. (Existing crop land management was not considered.) The naturally erodible soils in the watershed are addressed by techniques called Best Management Practices (BMPs) to prevent soil loss that are typically in use on local farms. BMPs like no-till, reduced till, cover crops, field strips, and others significantly reduce erosion and sediment movement. These BMPs can be seen in use in many places in the watershed.

This estimate of soil erodibility was generated through an analysis of GIS data that incorporated the soil erodibility factor (K), slope steepness, land area within 1000 feet of streams and cropland within that 1000 feet buffer based on 1994 Maryland Department of State Planning land use data. To compare Maryland watersheds for this index, the benchmark of 0.275 value/acre was used, i.e. less than 0.275 was considered relatively

beneficial for water quality and 0.275 or greater was considered to be a likely factor for water quality problems.

2002 Land Use / Land Cover

Table 18 summarize land use and land cover for the Tuckahoe Creek Watershed in Maryland.[5] The size of this watershed is approximately 153 square miles, or 97,900 acres. Based on land cover information, the watershed is dominated by agriculture (64%) and forest (22%). The remaining approximately 14% of the land in the watershed was mostly tidal and emergent wetlands. Little percentage of the watershed is currently developed. The principal towns on the Tuckahoe River are located eleven miles up the river from its confluence with the Choptank. These towns include Hillsboro and Ridgely on the eastern side of the Tuckahoe in Caroline County and Queen Anne on the western shore of the Tuckahoe and situated in Queen Anne's County. (Map 3 in Section 4 shows land use in the watershed)

Table 18: 2002 Land Use
Tuckahoe Creek Watershed

Category	Description	Acres	%
Agriculture	Field, Pasdture, Ag Buildings	62,624	64
Forest	All woodlands and brush	21,292	22
Developed Lands	Residential, Commercial, etc.	845	1
Wetlands	Tidal marsh, Emergent wetlands	13,465	13-14
Other	Extractve and bare ground	5	<1
Watershed Total for Land Use (excl. open water)		158,708	
Watershed Total including open water		163,449	

Green Infrastructure

An additional way to interpret land use / land cover information is to identify "Green Infrastructure." In the GIS application developed by Maryland DNR and its partners, Green Infrastructure refers to areas of natural vegetation and habitat that have statewide or regional importance as defined by criteria developed by DNR. The criteria for identifying of lands as Green Infrastructure is limited to considering natural resource attributes currently found on those lands. One example of the criteria is that interior forest and wetlands complexes at least 250 acres in size are considered as part of Green Infrastructure. As a second example, sensitive species habitat that is located within areas of natural vegetation at least 100 acres in size is also counted as Green Infrastructure. Other potential attributes of Green Infrastructure lands, such as ownership or if the current natural conditions are protected in some way, are not criteria for Green Infrastructure but they may be considered independently.

Within the Green Infrastructure network, large blocks of natural areas are called hubs, and the existing or potential connections between them, called links or corridors. Together the hubs and corridors form the Green Infrastructure network which can be considered the backbone of the region's natural environment.

In 2007, the Green Infrastructure Tool was updated to include Rare Species Habitat, Aquatic Hot Spots, and areas important for Water Quality Protection. This Updated Green Infrastructure will serve as the basis for targeting of State land preservation resources to ensure the protection of the most valuable lands. With this

5 Land cover data based on 1991-1993 LandSat Thematic Mapper satellite imagery, compiled by Chesapeake Bay Program.

protocol in place, Green Infrastructure lands will be protected through various existing programs including Rural Legacy, Program Open Space, conservation easements and others. Map xx Green Infrastructure shows several significant local characteristics of Green Infrastructure:

- A significant number of Green Infrastructure hubs are found in the Tuckahoe Creek watershed. Many of these areas of natural vegetation have some association with wetlands and/or wet soils.
- Many corridors selected by the computer analysis have significant amounts of agricultural land shown within the potential corridor. In general, viability of these corridors for protection or restoration requires local on-the-ground assessment to provide additional information regarding site conditions, land owner preferences and potential viability of projects.

Protected Lands

As used in the context of watershed restoration, "protected land" includes any land with some form of long term limitation on conversion to urban / developed land use. This protection may be in various forms: public ownership for natural resource or recreational intent, private ownership where a third party acquired the development rights or otherwise acquired the right to limit use through the purchase of an easement, etc. The extent of "protection" varies greatly from one circumstance to the next. Therefore, for some protected land, it may be necessary to explore the details of land protection parcel by parcel through the local land records office to determine the true extent of protection. (Map 9 in Section 4 shows land preservation in the watershed)

Knowledge of existing protected lands can provide a starting point in prioritizing potential restoration activities. In some cases, protected lands may provide opportunities for restoration projects because owners of these lands may value natural resource protection or enhancement goals.

Table 19: Protected Land Summary By County Tuckahoe Creek Watershed in Maryland

Category	Talbot (2006)		Caroline (2006)		Queene Annes (2002)	
Area Category	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Agriculture Easement	1,980	13	5,528	15	2,667	6
Agricultural District	926	6	2,394	7	9,015	20
Conservation Easement: MET	302	2	200	1	n/a	n/a
Conservation Easement: Private	107	1	n/a	n/a	n/a	n/a
County Parks	3	-	-	-	n/a	n/a
DNR Land	-	-	-		3,800	8
Total Protected Land in County/Watershed	**3,318**	**22**	**8,122**	**23**	**15,482**	**34**
Total County Land in Watershed	**15,459**	**100**	**35,920**	**100**	**45,960**	**100**

Smart Growth

Maryland's Smart Growth Program was initiated in 1997 with the primary goal of working with local governments to strengthen and invest in Maryland's existing communities, save taxpayers money, while at the same time protect natural resources from development. The Smart Growth Program partners with local governments to designate Priority Funding Areas (PFA's) which are existing communities targeted for development. These locally designated PFA's are then eligible for State infrastructure funding to support development and re-development, whereas areas outside of the PFA are not eligible for State infrastructure funding.

Protecting Maryland's most critical and valued natural resources is a main goal of the Smart Growth Program. A keystone program of the program is the Rural Legacy Program. The Rural Legacy Program directs funding towards local designated areas to protect land from future development through purchase of easements (or in fee simple) is promoted. This unique program works to protect large contiguous blocks of valuable open space and resource lands. The Priority Funding Areas are shown on Map 6 in Section 4.

Many Rural Legacy Areas are within the Tuckahoe Creek watershed A little over 5400 acres of the Tuckahoe Rural Legacy area are in the watershed. State funding for the Tuckahoe Rural Legacy area was appropriated in State fiscal years 1999 and 2000.

Soils

1. Interpreting Local Conditions with Natural Soil Groups

Soil conditions, like soil type and moisture conditions, greatly affect how land may be used and the potential for vegetation and habitat on the land. Soil conditions are one determining factor for water quality in streams and rivers. Local soil conditions vary greatly from site to site as published information in the Soil Surveys for Talbot and Caroline Counties show.

2. Soils and Land Use

Local soil conditions can be a useful element in watershed planning and for targeting restoration projects. Soils with limitations related to wetness or slope naturally inhibit active use for farming or development. Land owners in the watershed have tended to leave many of these areas in natural vegetation or other low intensity use. Green Infrastructure and forest in general tends to coincide with soils that are either hydric & poorly drained or with soils that are excessively well drained. Additionally, development, which often relies on septic systems, tends to be concentrated on excessively well drained soils and not on hydric soils.

Wetlands

1. Introduction to Wetland Categories

The Eastern Coastal Plain Province likely has the highest diversity of emergent estuarine and palustrine wetland communities relative to other Maryland physiographic regions because both tidal and nontidal freshwater

marshes occur here. Wetlands are most abundant in the Coastal Plain due to the low topographic relief and high groundwater table characteristic of the region. (Map 4 in Section 4 shows wetlands in the watershed)

Estuarine Wetlands. Estuarine wetlands are abundant throughout the Coastal Plain. These systems consist of salt and brackish tidal waters and contiguous wetlands where ocean water is at least occasionally diluted by freshwater runoff from the land. These wetlands may extend far upstream in tidal rivers to freshwater areas. Differences in salinity and tidal flooding within estuaries have a significant effect on the distribution of these wetland systems. Salt marshes occur on the intertidal shores of tidal waters in areas of high salinity. Brackish marshes are the predominant estuarine wetland type in Maryland. They are found along the shores of Chesapeake Bay, mostly on the Eastern Shore, and for considerable distance upstream in coastal rivers. Estuarine shrub swamps are common along the Maryland coastal zone. Aquatic beds, comprised mostly of submerged aquatic vegetation, are abundant in shallow water zones of Maryland's estuaries, especially Chesapeake Bay and its tributaries.

Palustrine wetlands. Forested wetlands are the most abundant and widely distributed palustrine wetland type on the Coastal Plain. These wetlands are found on floodplains along the freshwater tidal and nontidal portions of rivers and streams, in upland depressions, and in broad flat areas between otherwise distinct watersheds. Tidal freshwater swamps occur along coastal rivers in areas subject to tidal influence.

2. Tracking Wetlands

Oversight of activities affecting wetlands involves several regulatory jurisdictions. The Maryland Dept. of the Environment (MDE) is the lead agency for the State and cooperates with DNR, the Army Corps of Engineers and other Federal and local agencies. As part of its responsibility, MDE tracks State permitting and the net gain or loss of wetlands over time.

Table 9: Tidal & Nontidal Wetland Changes Tuckahoe Creek Watershed

	Nontidal*	**Tidal****
Impacts	-1.89	-0.001
Permittee Mitigation	1.57	-
Programmatic Mitigation	2.3	0.007
Other Gains	0	-
Net Change	**1.98**	**0.006**

*1991-2006
**1996-2006

As Table 9 shows, changes tracked in the State regulatory program shows a net increase of nearly 2 nontidal wetland acres and a very small amount of tidal wetland change Tuckahoe Creek watershed over the past 10-14 years.

Regulatory tracking for authorized nontidal wetland losses began in 1991. Comprehensive tracking of voluntary wetland gains began in 1998. Wetland acres restored in the Tuckahoe watershed, if any, including phragmites control, emergent wetland creation, and forested wetland are not included in the table.

3. Interpreting Wetland Distribution

Wetlands in most of the Tuckahoe Creek watershed tend to occur along waterways as shown on maps XXXX.

In comparing the wetlands map to the generalized land use map, it can be seen that much of the forested land in

the watershed is found in association with wetlands or adjacent to them.

Additionally, comparing the maps shows that many of the nontidal wetland areas on the wetland maps are depicted as forest on the land use map. This difference is simply the result of two differing views of the landscape. For example, wooded nontidal wetlands can be viewed as "wetlands" from a habitat / regulatory perspective and they can be viewed as "forest" from a land use perspective.

Wetlands serve valuable water quality and habitat functions that may not be provided by other land uses. Table 10 shows the types and amounts of wetlands present in the Tuckahoe Creek watershed.[6]

Table 10: National Wetlands Inventory Acreage Summary

Wetland Classification	Acres
Lacustrine	0
Riverine	299.3
Palustrine	12,262
Estuarine	41.78
Total	**12,603.08**

Public Drainage Associations

Public Drainage Associations (PDA's) were created by state law more than half a century ago in recognition of their many public benefits. Proper drainage of frequently saturated soils helps create more productive farmland, reduces flooding, protects public health, improves the transportation infrastructure, and supports local economies. One the downside, agricultural drainage systems can accelerate the delivery of nutrients to nearby waters, disturb wildlife habitat, and contribute to erosion and sediment losses. In Caroline County there are approximately 368 miles of PDA's. These ditches are necessary for both agriculture and development on the Eastern Shore. (Map 10 in Section 4 shows PDA's in the watershed)

Some PDA's are considered "blue line" streams by the USGS. It is important to note that the general nature of PDA's necessitates treating them differently than natural streams even though they may be included in stream mile calculations. Forested buffers along both sides of PDA's, for example, are not feasible for a functioning PDA because access is needed for ditch maintenance. As previously mentioned, forested buffers along streams are desirable for providing habitat and improved water quality and are used as quantifiable indicators of watershed health.

Heightened concerns over the environmental impacts have prompted PDAs to seek new solutions to ditch maintenance. PDA managers are being asked to perform an environmental balancing act that seeks to keep ditch channels functioning properly and protect waterways from agricultural runoff containing sediments and nutrients, while holding the line on association fees. Best management practices (BMPs) combined with cost-share grants have been identified to facilitate this effort.

Floodplains

The 100-year floodplain extends far up tributaries to the Choptank River. The extent of potential flood areas in the Tuckahoe Creek watershed has significant implications for land use decisions and watershed management

6 U.S. Fish and Wildlife Service, National Wetland Inventory. Data summarized by the Chesapeake Bay Program

including potential restoration projects. (Map 4 in Section 4 shows floodplains in the watershed)

In recent years, stormwater management requirements have provided a means to limit impacts of new development and impervious area that would otherwise contribute to stream degradation and flooding. However, these new projects may not significantly improve water quality or quantity that are driven by systemic watershed factors.

For existing development and impervious area, retrofitting controls to enhance water quality and limit peaks in stormwater runoff may offer an additional way to protect waterways. However, consideration of retrofits must take into account at least two local issues:

- Land owner interests and preferences.
- Management directions already established by Public Drainage Associations (PDAs)

Low Elevation Areas Subject to Sea Level Rise

Most areas of the Tuckahoe Creek watershed have sufficient elevation to be unaffected by any potential for sea level rise in the next 50 to 100 years. However, marshes and other low-lying wetlands are at risk for inundation. The potential for sea level rise impacts need to be considered as part of any comprehensive watershed management effort..

As a gauge of potential sea level rise risk, a Maryland-wide assessment of land with an elevation of 1.5 meters or less was first published in 1998 and then repackaged in a 2000 State report. At this statewide scale, the general area at risk to inundation from sea level rise is limited to marsh/wetland areas along the Choptank River, but don't include areas in the Tuckahoe Creek.

Living Resources and Habitat

Overview

Living resources, including all the animals, plants and other organisms that call the land and waters of the Tuckahoe Creek watershed home, are being affected by human activity. The information summarized here suggests that some of the significant stresses on living resources in the watershed are manipulation of habitat, excessive movement of sediment and excessive availability of nutrients.

Living Resource Indicators

Aquatic organisms are sensitive, in varying degrees, to changes in water quality and aquatic habitat. This association offers two perspectives that are important for watershed restoration. First, improvements for living resources offer potential goals, objectives and opportunities to gauge progress in watershed restoration. Second, the status of selected species can be used as to gauge local conditions for water quality, habitat, etc. This second perspective is the basis for using living resources as an "indicator."

The *Maryland Clean Water Action Plan* published in 1998 listed the following living resource indicators for the Tuckahoe Creek Watershed. Several of these indices rely on index rankings generated from a limited number of

sampling sites which were then generalized to represent entire watersheds. Considering this limitation on field data, it may be beneficial to conduct additional assessments to provide a more complete understanding of local conditions:

Nontidal Benthic Index of Biotic Integrity

For this index, an average score for an 8-digit watershed less than 6.0 means that restoration is needed and a score of 8.0 or greater means that protection is recommended. To generate this index, each stream site that is assessed is compared to reference conditions that were established for comparable streams that are minimally impacted. Nontidal rivers (streams seventh order and larger) are not incorporated into this index.

When the Maryland Clean Water Action Plan was published in 1998, the Tuckahoe Creek watershed score a 5.5, based on assessment of benthic macroinvertebrate communities (stream bugs).

Nontidal Fish Index of Biotic Integrity

For this index, an average score for an 8-digit watershed less than 6.0 means that restoration is needed and a score of 8.0 or greater means that protection is recommended. In each stream site where fish are surveyed, the makeup of the overall fish population is measured in nine distinct ways such as the number of native species, number of benthic fish species, percent of individuals that are "tolerant" species, etc. These nine scores are then integrated to generate an index ranking for the survey site. To generate the index for the watershed, the scores for all the stream sites assessed within the 8-digit watershed are averaged together.

When the Maryland Clean Water Action Plan was published in 1998, the Upper Choptank River scored 8.1 on a scale of 1 (worst) to 10 (best) indicating a good condition on average.

Nontidal In-Stream Habitat Index

This index allows comparison of streams based on habitat for fish and benthic organisms as measured by in stream and riparian conditions. For each stream site that was assessed, visual field observations are used to score the site for substrate type, habitat features, bank conditions, riparian vegetation width, remoteness, aesthetic value, etc. For each site, the individual scores are integrated to generate a single score for each stream site. The index score reported for each stream site is a relative score to the maximum attainable score for comparable streams. The watershed index is created by averaging the scores for all the sites that were assessed in the watershed.

When the Maryland Clean Water Action Plan was published in 1998, the Tuckahoe Creek Watershed scored an average of 6.1 on a scale of 1 (worst) to 10 (best) indicating conditions were generally fair on average.

Species Habitat (Aquatic and other)

Tuckahoe Creek provides habitat to diverse fauna and fish. Maryland Department of Natural Resources has identified many portions of the Tuckahoe Creek between Hillsboro and the mouth of the Tuckahoe as an important area for protection, due to many marshes and habitat for fish.

Species found throughout Tuckahoe Creek include striped bass, otters, wood duck, osprey, shad, and herring. Specific fish species, such as the hickory shad (Alosa mediocris), which are members of the herring family of fishes, can be found in some areas along the creek near Tuckahoe State Park.

In a 1999 report done by the Fish Passage Workgroup of the Chesapeake Bay Program's Living Resources Subcommittee (LRSc), the following species were found in sampled sites, during a Fish Passage program: Alewife herring, blueback herring, American
shad, white perch, yellow perch, gizzard shad,and bluegill.
Source: http://www.chesapeakebay.net/pubs/99fishpass_annrept.pdf

Other studies have shown, for instance that the Ironcolor shiner (Notropis chalybaeus) has also been found in Tuckahoe Creek. (McInich 1994).

Source: McIninch S.P. 1994. The freshwater fishes of the Delmarva peninsula. Unpubl. Ph.D. diss., Univ. of Maryland, Eastern Shore, Princess Anne.

Juvenile Fish Survey

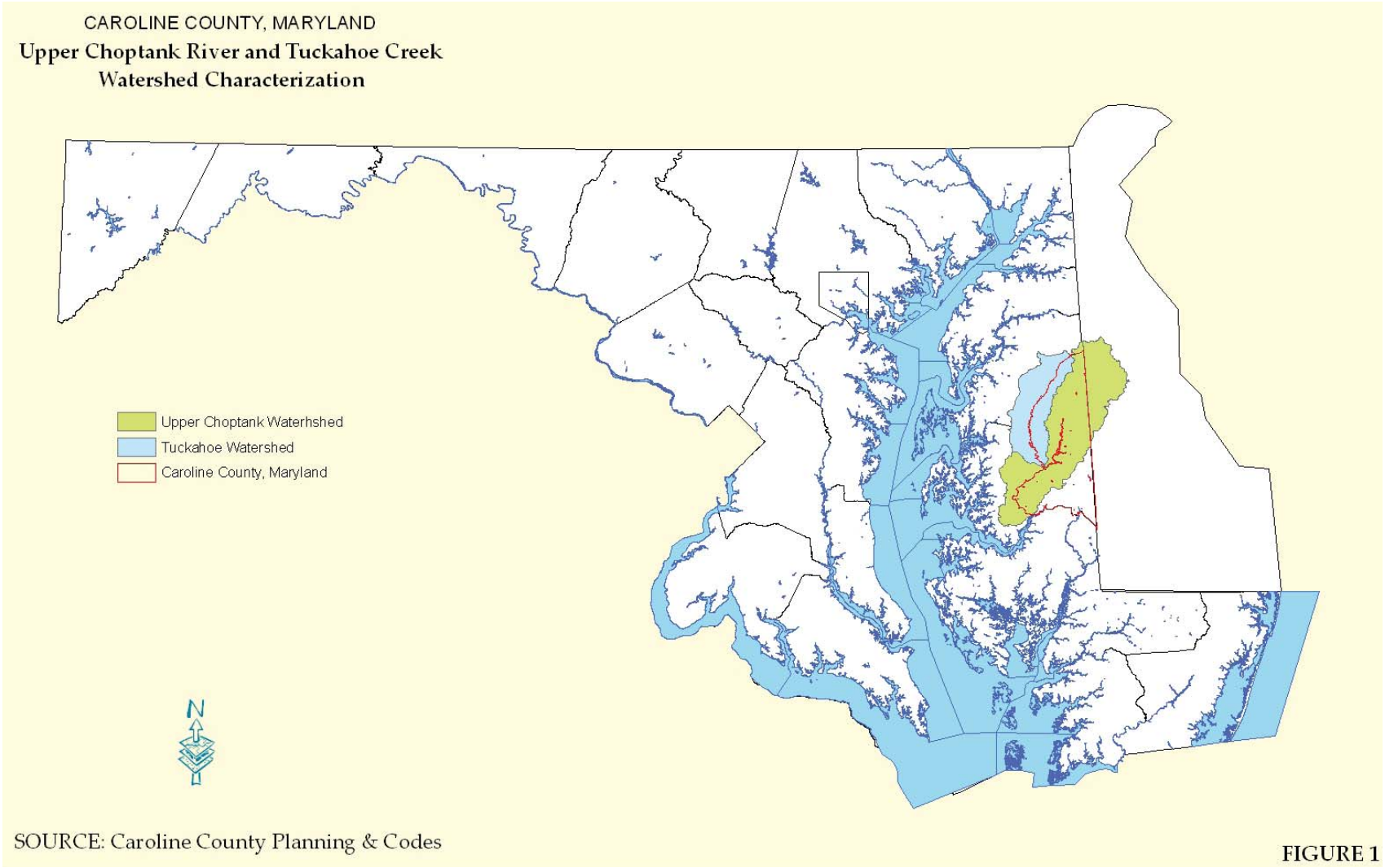
DNR Fisheries Service conducts numerous surveys to gauge the condition of fisheries and some of the sampling sites have been located in the Choptank River watershed, but not necessarily on Tuckahoe Creek. The Bay-wide Estuarine Juvenile Finfish Survey samples 22 sites each year including one in the Choptank River near Denton and three other sites downstream in the Choptank River. Additionally the annual Blue Crab Survey includes five stations in the Choptank River. Since they sample various fish, in addition to striped bass, a few species were selected, which are know to be found in Tuckahoe Creek, to address in this characterization. For example, 2001 was an excellent year for young-of-year white perch, as seen on graph 1 below. White perch is known to occur in Tuckahoe Creek as well. For Alewife Herring (Graph 2), 2003 was a good year for this specific species. (Durrell and Weedon, DNR, 2007)

For additional information see http://www.dnr.state.md.us/fisheries/juvindex/index.html

Next Steps

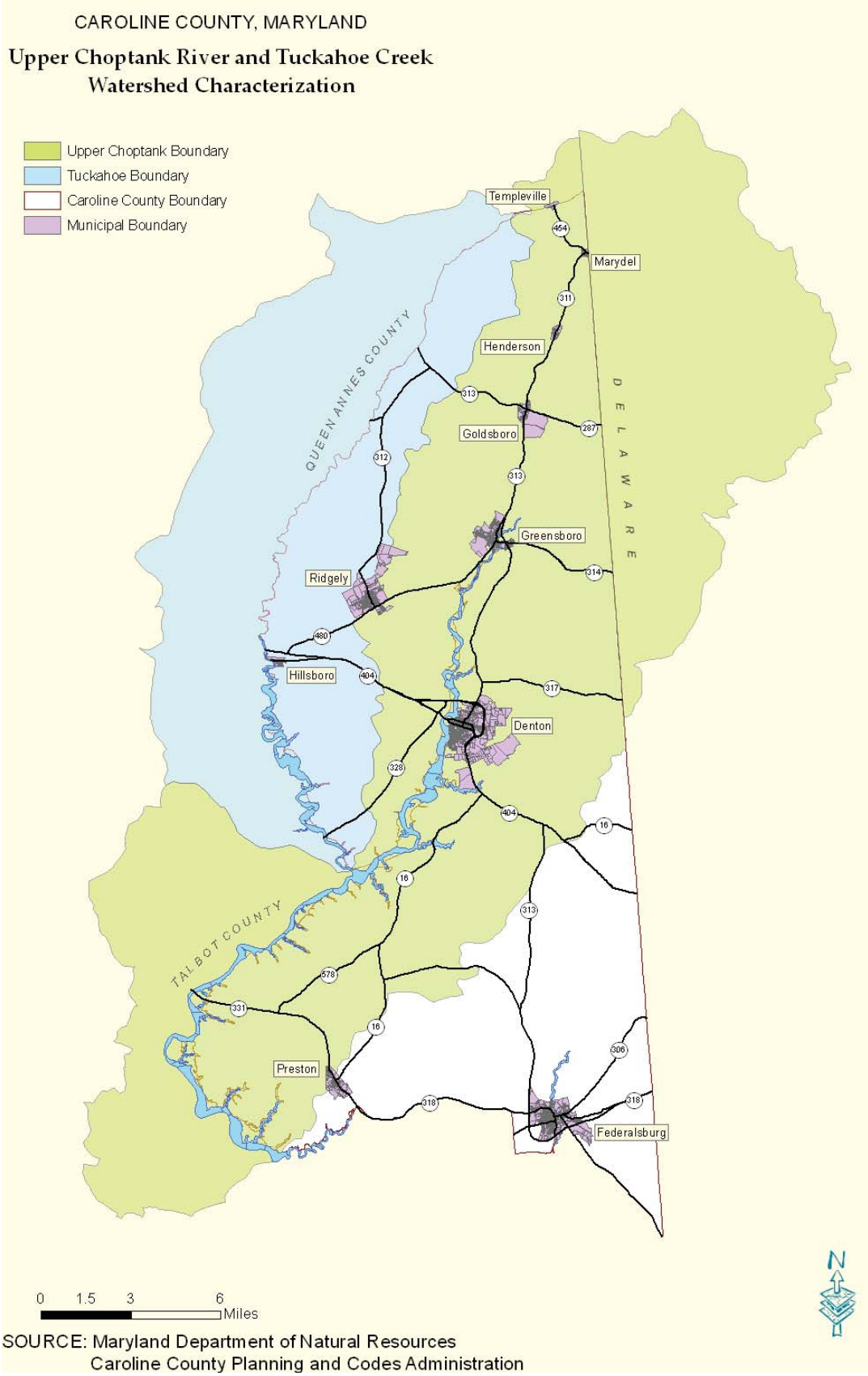
As Map 14 shows, there are 24 12-digit subwatersheds within the 8-digit Upper Choptank watershed. As a next step, the Caroline County Planning & Codes Administration will begin working with its partners to develop subwatershed plans for each of these smaller scale watersheds. Through this effort, the Administration hopes to address potential TMDLs, the State Tributary Strategies, and other State and County planning requirements.

List of Maps



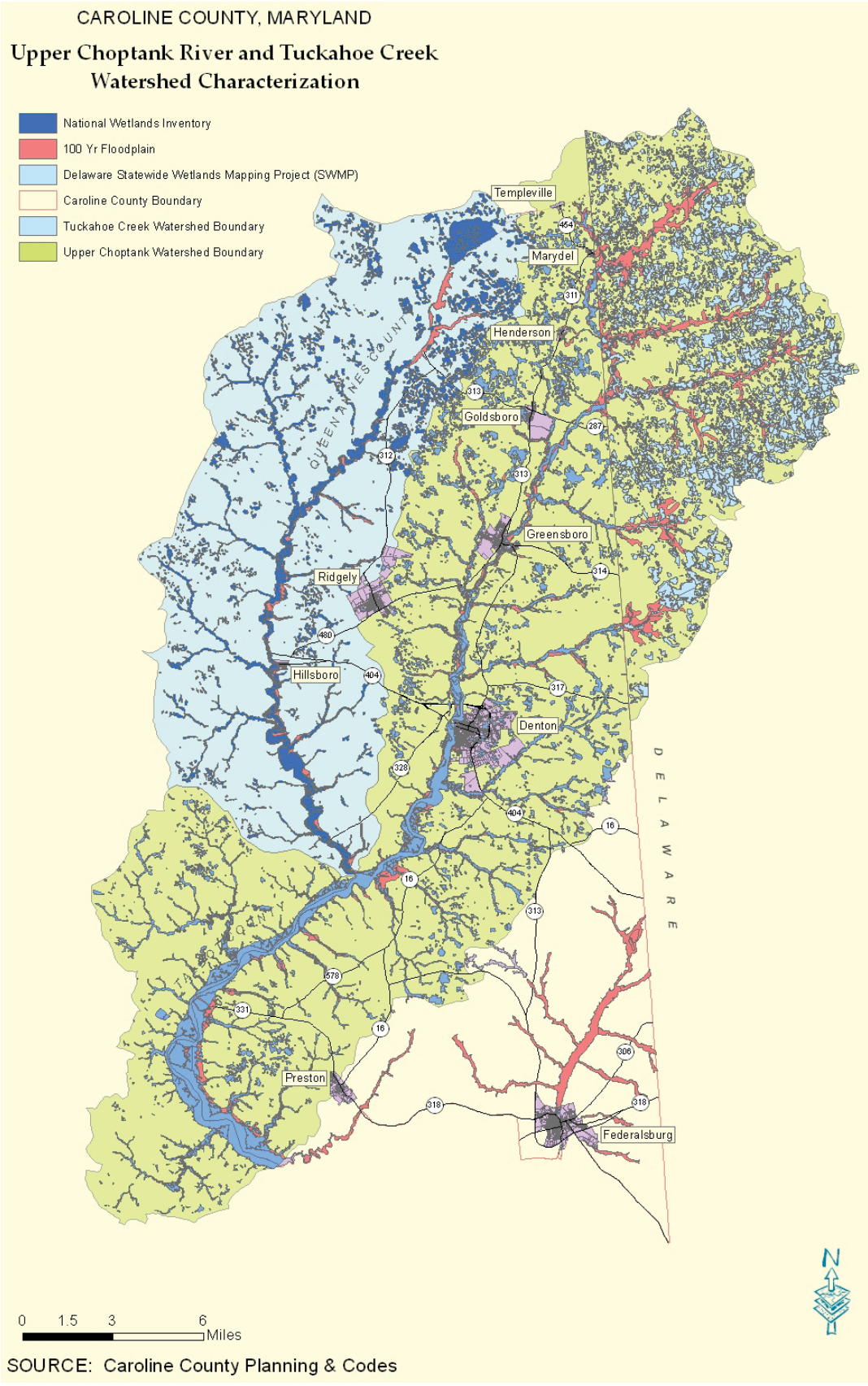
Map 1: Upper Choptank and Tuckahoe Creek Watersheds in the State Context.

Map 2: Upper Choptank and Tuckahoe Creek Watersheds in the Regional Context.

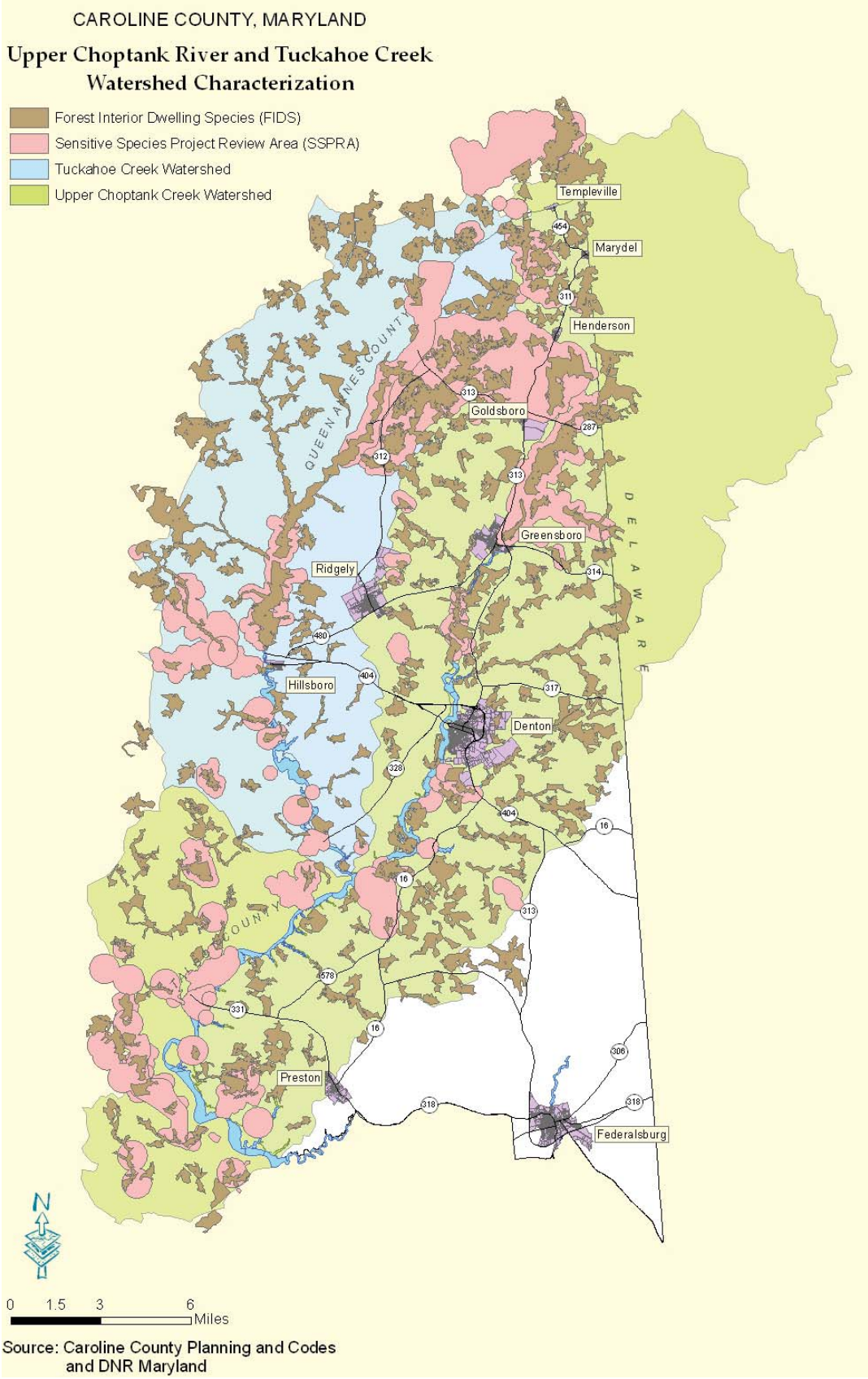


Map 3: Upper Choptank and Tuckahoe Creek Land Use.

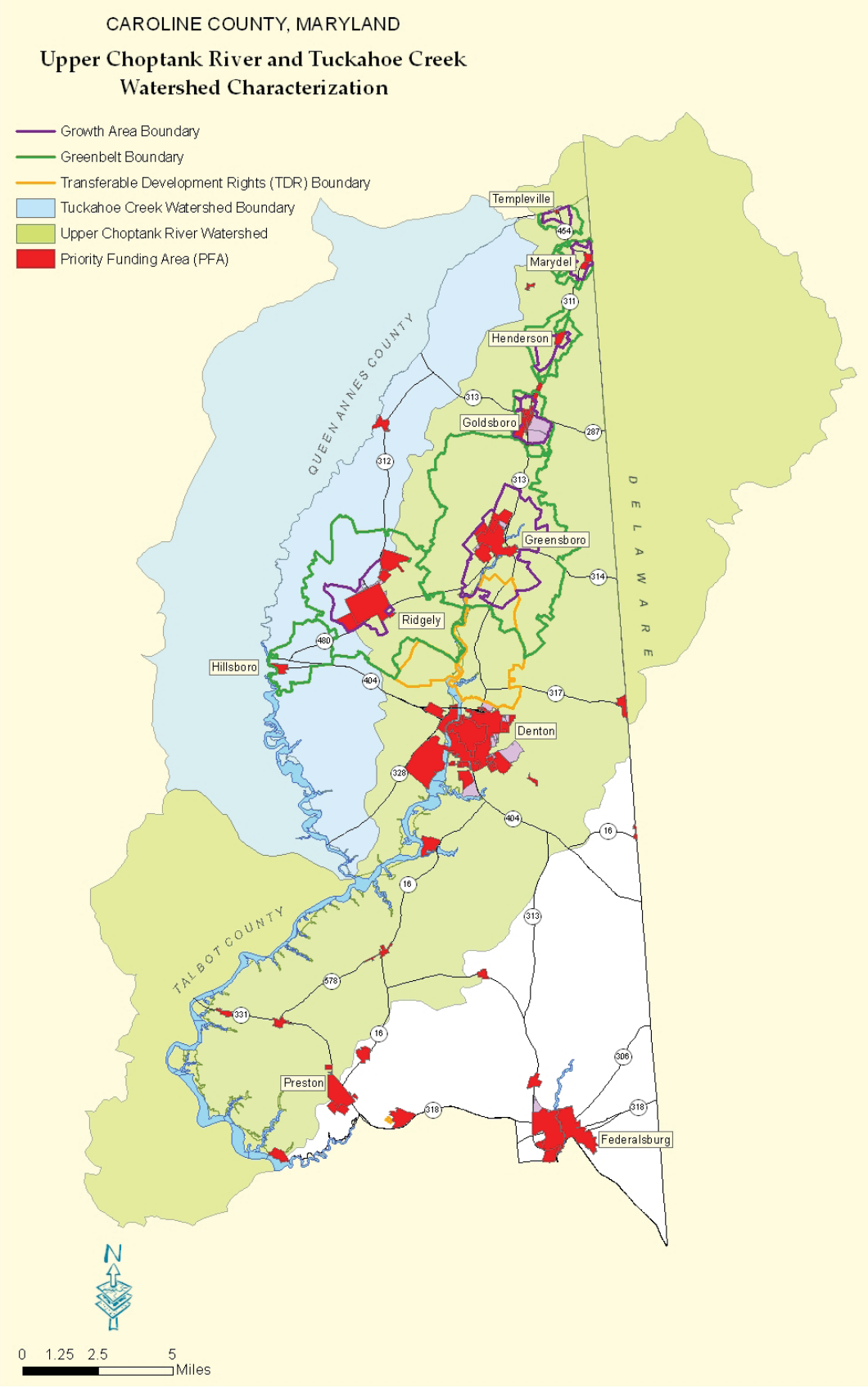
Map 4: Upper Choptank and Tuckahoe Creek Watersheds Wetlands.



Map 5: Upper Choptank and Tuckahoe Creek Watersheds Sensitive Species & Forest Interior Dwelling Species.



Map 6: Upper Choptank and Tuckahoe Creek Watersheds Growth Areas, Priority Funding Areas, Greenbelts, and Transfer of Development Rights (TDR) Areas.

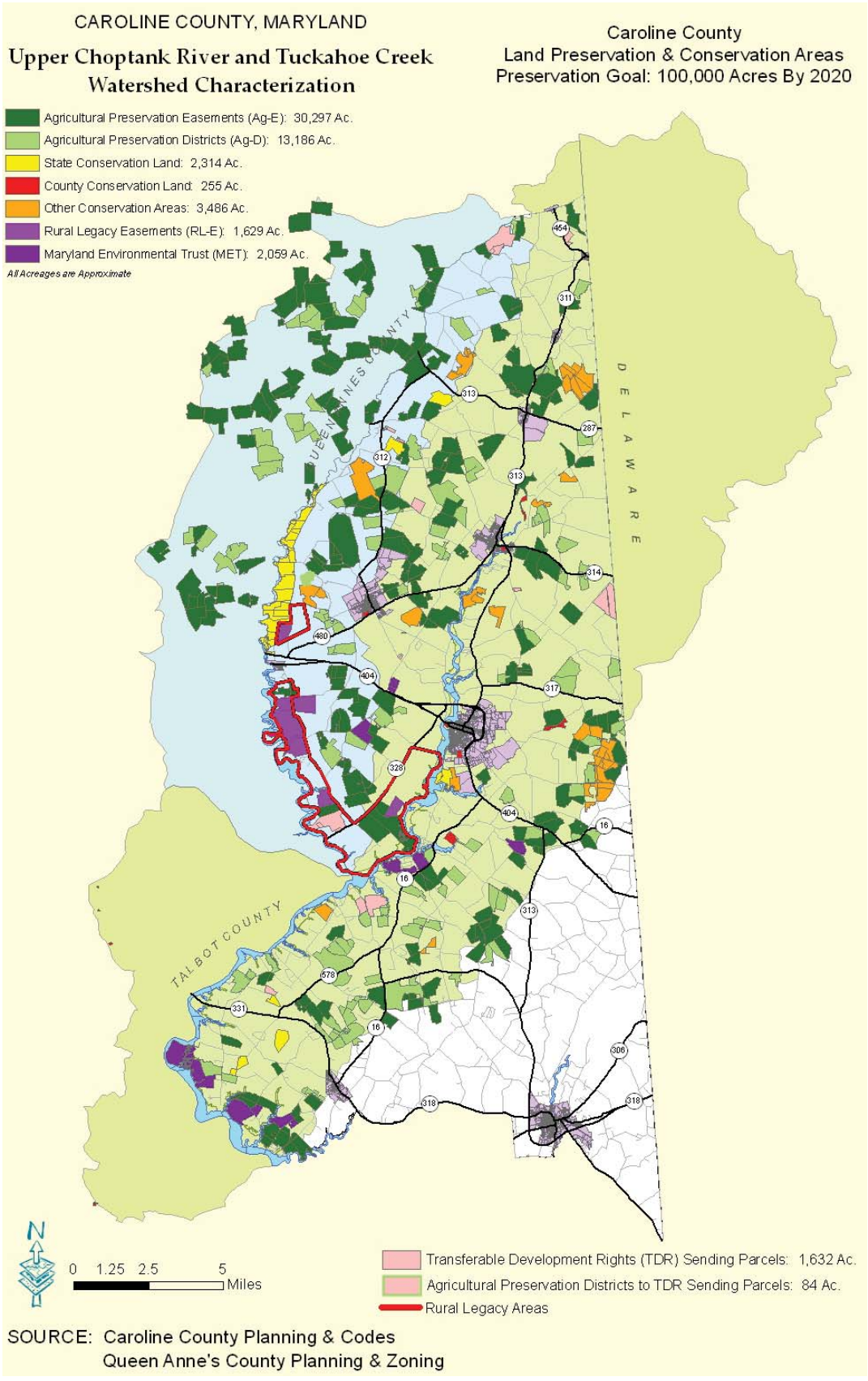


Map 7: Regional map showing Underground Railroad routes. Source: Larson, Kate Clifford. *Harriet Tubman Biography.* http://www.harriettubmanbiography.com.

Map 8: Historic Railroads in Caroline County. Courtesy of JOK Walsh.

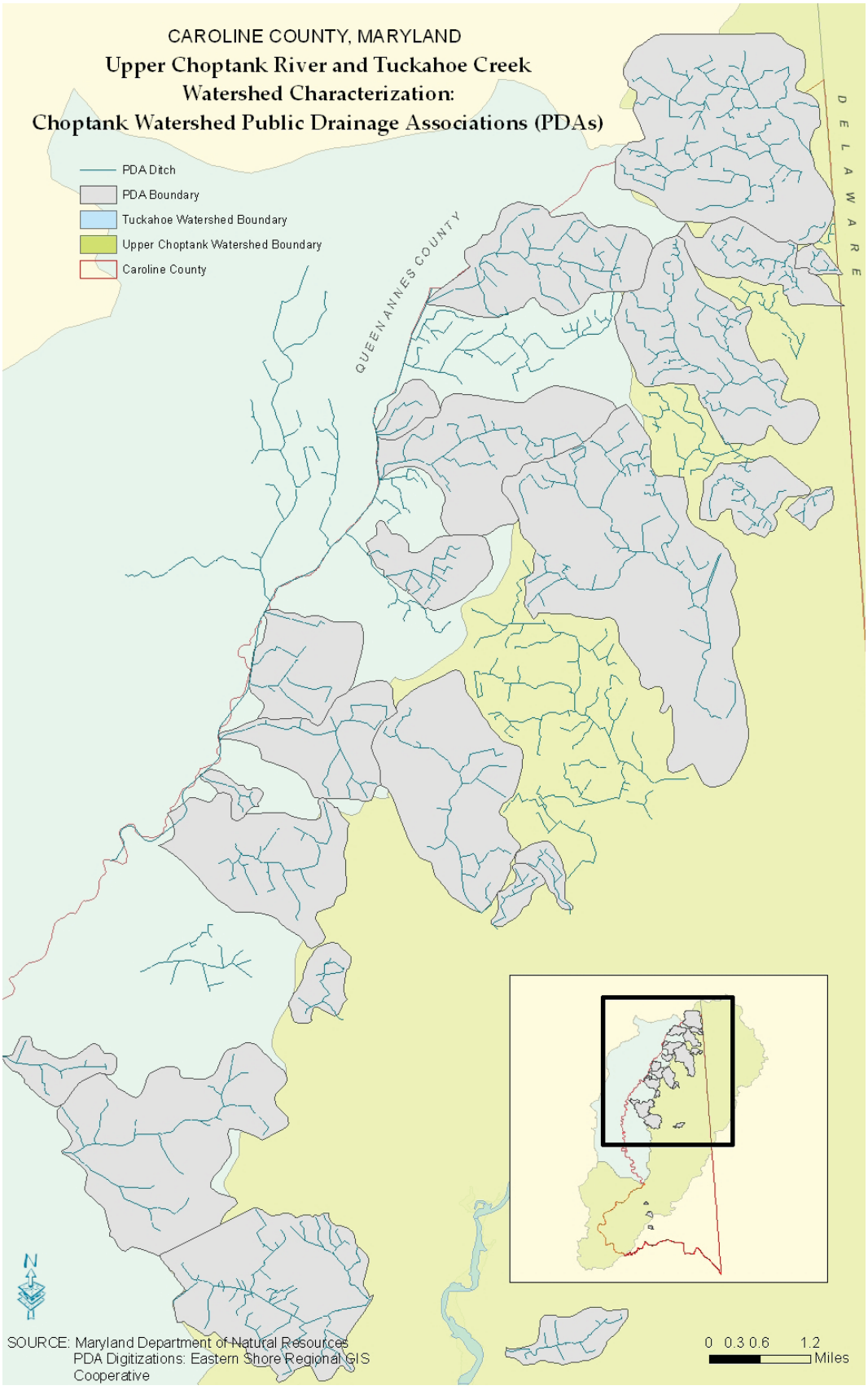
All rail lines through Caroline County connected with the Delaware Railroad which had been built to Seaford, Delaware, by 1856. This railroad is shown above in dark blue running north and south through the Delmarva Peninsula.

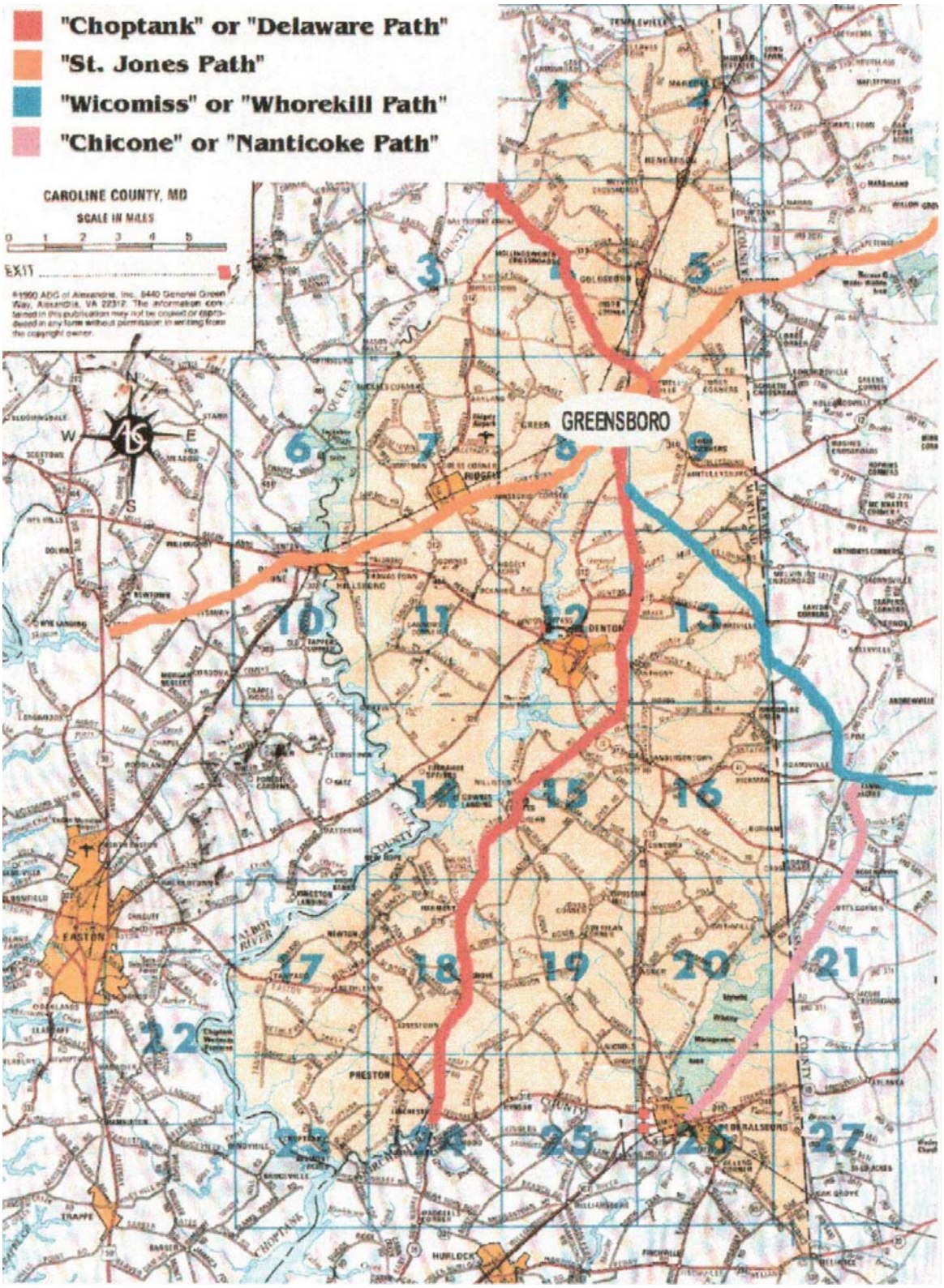
Map 9: Upper Choptank and Tuckahoe Creek Watersheds Land Preservation.



Map 10: Upper Choptank and Tuckahoe Creek Watersheds Public Drainage Associations.

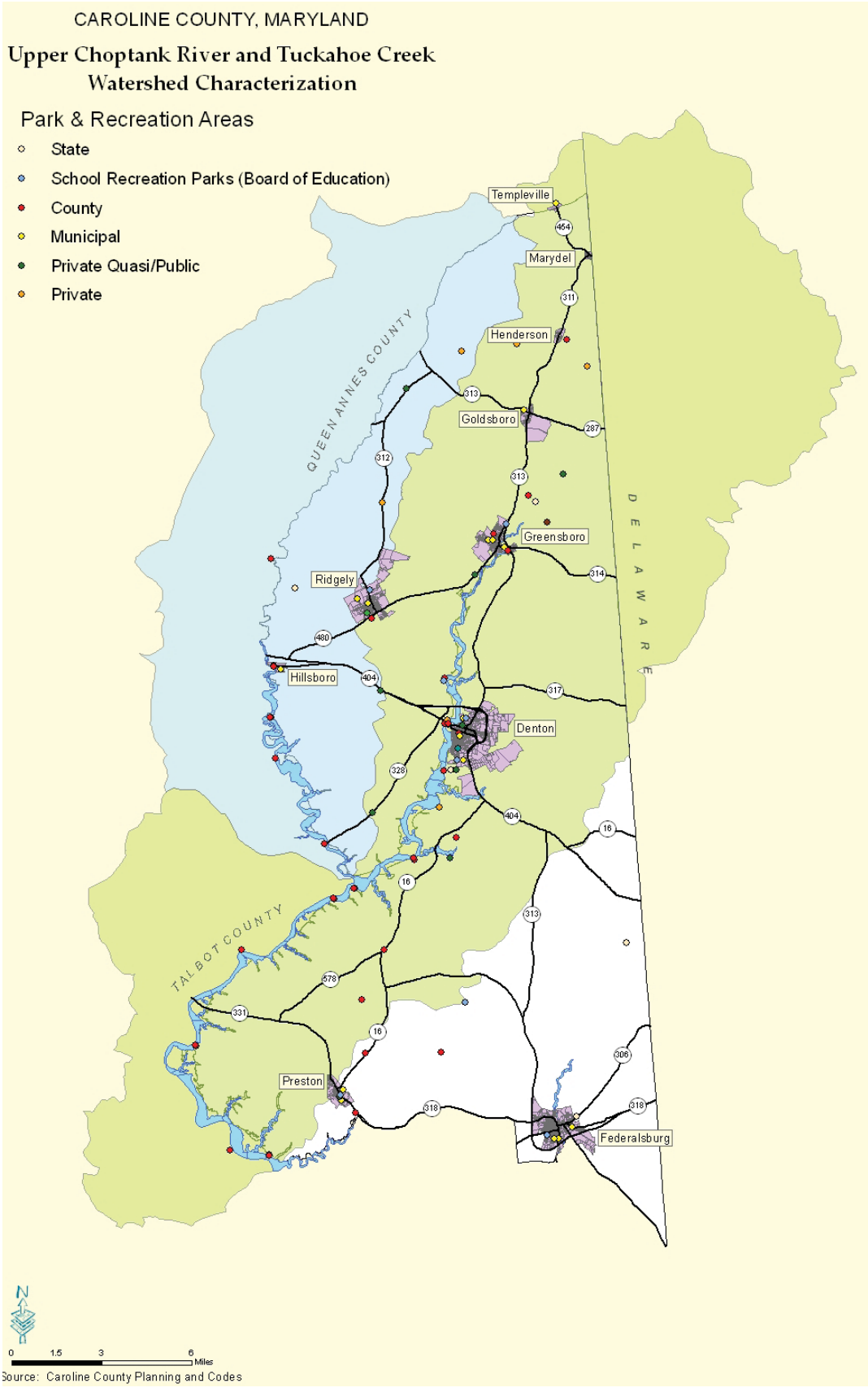
Public Drainage Associations are most heavily concentrated in the Northern section of Caroline County. Best Management Practices are utilized to help limit pollutant loads from entering the County's waterways.



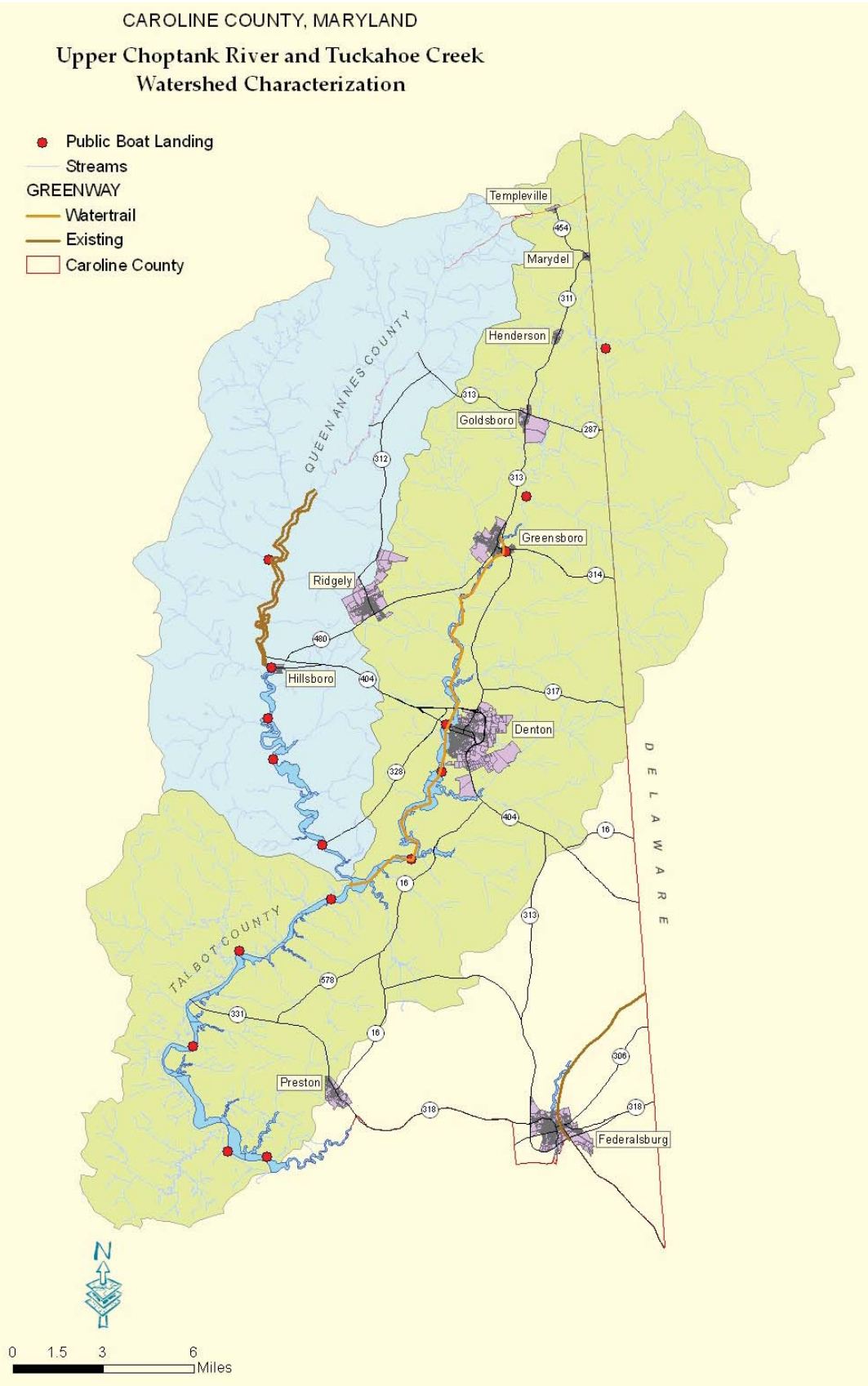


Map 11: Upper Choptank and Tuckahoe Creek Watersheds Native American Paths. Courtesy of JOK Walsh.

Map 12: Upper Choptank and Tuckahoe Creek Watersheds Park & Recreation Sites.

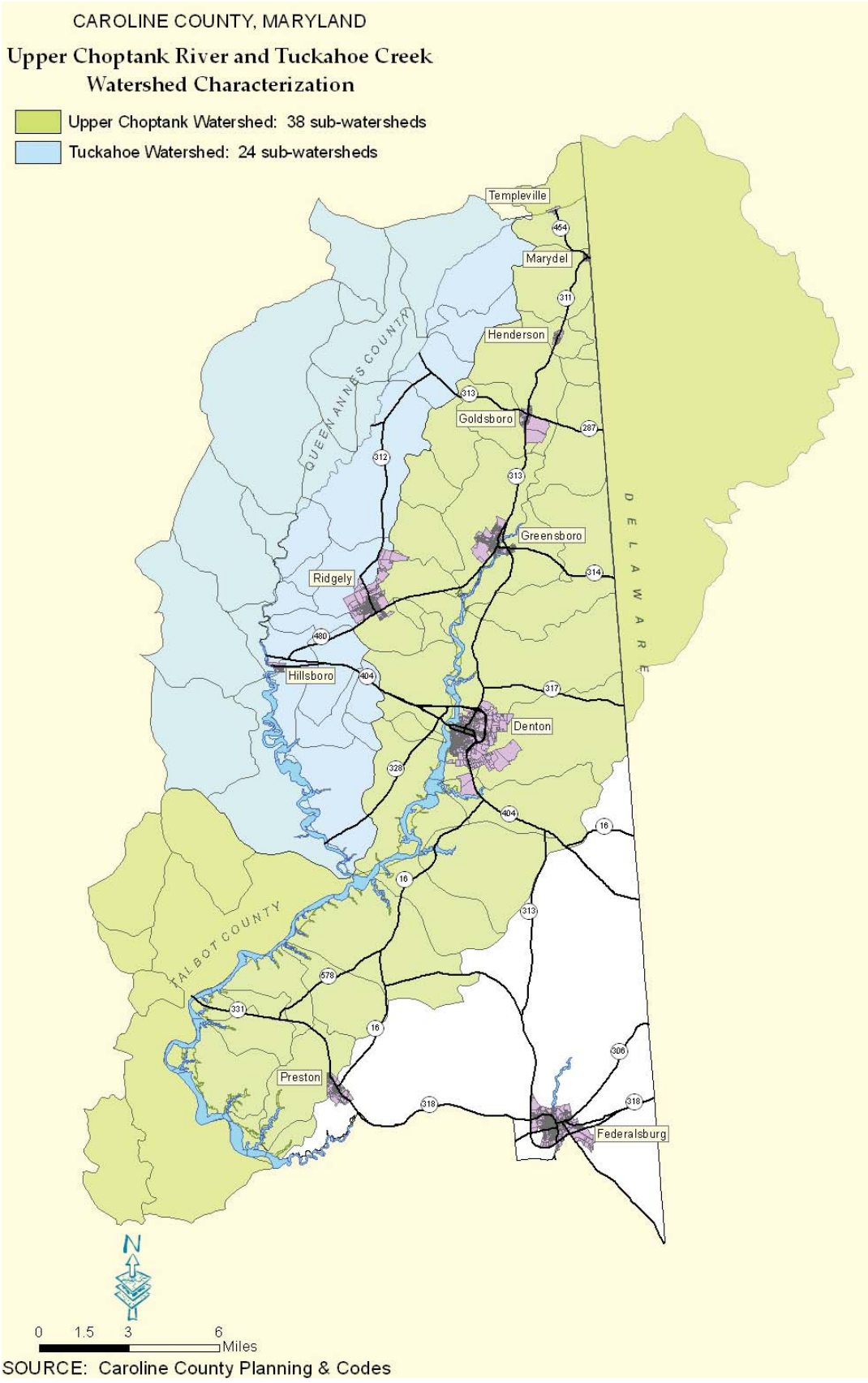


Map 13: Upper Choptank and Tuckahoe Creek Watersheds Public Boat Landings and Trails.



Map 14: Upper Choptank and Tuckahoe Creek Watersheds 12-digit subwatersheds.

Using the basic information from this watershed characterization document, each of these 12-digit subwatersheds will be further studied to assist the County and its partners in addressing State planning requirements, TMDLs, and Tributary Strategies.



SOURCE: Caroline County Planning & Codes

Glossary

303(d) A section of the federal Clean Water Act requiring the states to report which waters of the state are considered impaired for the uses for which they have been designated, and the reasons for the impairment. Waters included in the "303(d) list" are candidates for having TMDLs developed for them.

319 A section of the federal Clean Water Act dealing with non-point sources of pollution. The number is often used alone as either a noun or an adjective to refer to some aspect of that section of the law, such as grants.

8-digit watershed Maryland has divided the state into 138 watersheds, each comprising an average of about 75 square miles, that are known as 8-digit watersheds because there are 8 numbers in the identification number each has been given. These nest into the 21 larger 6-digit watersheds in Maryland which are also called Tributary Basins or River Basins. Within the Chesapeake Bay drainage, 8-digit watersheds also nest into 10 Tributary Team Basins.

Anadromous fish Fish that live most of their lives in salt water but migrate upstream into fresh water to spawn.

Benthic Living on the bottom of a body of water.

CBIG Chesapeake Bay Implementation Grant Program, a DNR-administered program that awards grants from the Chesapeake Bay Program to reduce and prevent pollution and to improve the living resources in the Chesapeake Bay.

CBNERR The Chesapeake Bay National Estuarine Research Reserve in a federal, state and local partnership to protect valuable estuarine habitats for research, monitoring and education. The Maryland Reserve has three components: Jug Bay on the Patuxent River in Anne Arundel and Prince Georges' Counties, Otter Point Creek in Harford County and Monie Bay in Somerset County.

CCWS Chesapeake and Coastal Watershed Service, the unit in DNR that works with local governments and other interested parties to develop restoration strategies and projects.

COMAR Code Of Maryland Regulations (Maryland State regulations)

CREP Conservation Reserve Enhancement Program, a program of MDA. CREP is a federal/state and private partnership which reimburses farmers at above normal rental rates for establishing riparian forest or grass buffers, planting permanent cover on sensitive agricultural lands and restoring wetlands for the health of the Chesapeake Bay.

CRP Conservation Reserve Program, a program of Farm Service Agency in cooperation with local Soil Conservation Districts. CRP encourages farmers to take highly erodible and other environmentally-sensitive farm land out of production for ten to fifteen years.

CWAP Clean Water Action Plan, promulgated by EPA in 1998. It mandates a statewide assessment of watershed conditions and provides for development of Watershed Restoration Action Strategies (WRASs) for priority watersheds deemed in need of restoration

that, among other things, supports the Coastal Zone Management program, a source of funding for some local environmental activities, including restoration work.

NPS Non-Point Source, pollution that originates in the landscape that is not collected and discharged through an identifiable outlet.

NRCS Natural Resources Conservation Service, formerly the Soil Conservation Service, an agency of the US Department of Agriculture that, through local Soil Conservation Districts, provides technical assistance to help farmers develop conservation systems suited to their land. NRCS participates as a partner in other community-based resource protection and restoration efforts.

PDA Public Drainage Association

Palustrine Wetlands Fresh water wetlands, including bogs, marshes and shallow ponds.

RAS Resource Assessment Service, a unit of DNR that carries out a range of monitoring and assessment activities affecting the aquatic environment.

Riparian Area 1. Land adjacent to a stream. 2. Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e. a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines. (National Research Council, Riparian Areas: Functions and Strategies for Management. Executive Summary page 3. 2002) SAV Submerged Aquatic Vegetation, important shallow-water sea grasses that serve as a source of food and shelter for many species of fin- and shell-fish.

SCA[M] Stream Corridor Assessment is an activity carried out by CCWS in which trained personnel walk up stream channels noting important physical features and possible sources of problems.

SCD Soil Conservation District is a county-based, self-governing body whose purpose is to provide technical assistance and advice to farmers and landowners on the installation of soil conservation practices and the management of farmland to prevent erosion.

SSPRA Sensitive Species Protection Review Area, an imprecisely defined area in which DNR has identified the occurrence of rare, threatened and/or endangered species of plants or animals, or of other important natural resources such as rookeries and waterfowl Staging areas.

Synoptic survey A short term sampling of water quality and analysis of those samples to measure selected water quality parameters. A synoptic survey as performed by DNR in support of watershed planning may be expanded to include additional types of assessment like benthic macroinvertibrate sampling or physical habitat assessment.

Glossary

CWiC Chesapeake 2000 Agreement watershed commitments. CWiC is a shorthand phrase used in the Chesapeake Bay Program.

CZARA The Coastal Zone Reauthorization Amendments of 1990, intended to address coastal non-point source pollution. Section 6217 of CZARA established that each state with an approved Coastal Zone Management program must develop and submit a Coastal Non-Point Source program for joint EPA/NOAA approval in order to "develop and implement management measures for NPS pollution to restore and protect coastal waters".

CZMA Coastal Zone Management Act of 1972, establishing a program for states and territories to voluntarily develop comprehensive programs to protect and manage coastal resources (including the Great Lakes). Federal funding is available to states with approved programs.

Conservation Easement A legal document recorded in the local land records office that specifies conditions and/or restrictions on the use of and title to a parcel of land. Conservation easements run with the title of the land and typically restrict development and protect natural attributes of the parcel. Easements may stay in effect for a specified period of time, or they may run into perpetuity.

DNR Department of Natural Resources (Maryland State)

EPA Environmental Protection Agency (United States)

Fish blockage An impediment, usually man-made, to the migration of fish in a stream, such as a dam or weir, or a culvert or other structure in the stream

GIS Geographic Information System, a computerized method of capturing, storing, analyzing, manipulating and presenting geographical data.

MBSS Maryland Biological Stream Survey, a program in DNR that samples small streams throughout the state to assess the condition of their living resources.

MDA Maryland Department of Agriculture

MDE Maryland Department of the Environment

MDP Maryland Department of Planning

MET Maryland Environmental Trust, an organization that holds conservation easements on private lands and assists local land trusts to do similar land protection work.

MGS Maryland Geological Survey, a division in DNR.

NHA Natural Heritage Area, a particular type of DNR land holding, designated in COMAR.

NOAA National Oceanic and Atmospheric Administration, an agency of the US Department of Commerce

TMDL Total Maximum Daily Load, a determination by MDE of the upper limit of one or more pollutants that can be added to a particular body of water beyond which water quality would be deemed impaired.

Tributary Teams Geographically-focused groups, appointed by the Governor, oriented to each of the 10 major Chesapeake Bay tributary basins found in Maryland. The teams focus on policy, legislation, hands-on implementation of projects, and public education. Each basin has a plan, or Tributary Strategy.

USFWS United States Fish and Wildlife Service, an agency of the Department of Interior.

USGS United States Geological Survey

Water Quality Standard Surface water quality standards consist of two parts: (a) designated uses of each water body; and (b) water quality criteria necessary to support the designated uses. Designated uses of for all surface waters in Maryland (like shell fish harvesting or public water supply) are defined in regulation. Water quality criteria may be qualitative (like “no objectionable odors”) or quantitative (toxic limitations or dissolved oxygen requirements).

Watershed All the land that drains to an identified body of water or point on a stream.

WSSC Wetland of Special State Concern, a designation by MDE in COMAR.