



Virginia Resilient Coastal Forests

Benefits Report



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Project Overview

Coastal forests are important ecological, historical and cultural habitat that are imperiled by a wide range of threats that can impact their abundance, distribution, composition and intactness. Coastal forests are at risk from unprecedented challenges such as sea-level rise and climate change, but many of the U.S.'s coastal areas are experiencing high urban growth rates leading to forest clearing to make room for new housing and industry. Weather-related threats such as hurricanes, flooding and wildfire are increasing in intensity and frequency as global temperatures increase. Increasing global temperatures also influence the distribution and life cycles of plants, animals, pests and diseases causing unforeseen impacts to coastal forest quality. Even some widespread climate solutions to address greenhouse gas emissions, such as development of utility-scale solar energy, may conflict with coastal forests as land is sought for new solar farms.

The pressures facing coastal forests make it imperative that federal, state and local governments, nonprofits, universities, businesses, forest landowners and community members be informed about what is at stake and what could be lost. This pilot study was designed to create a landscape-scale conservation planning process unique to coastal forests of the southeast United States. The pilot study includes an inventory of coastal forest resources and assets, an analysis of the benefits these forests provide, an evaluation of the various threats and their level of risk to coastal forests, engagement of local and state stakeholders about these threats, prioritization of existing forests and the development of management strategies to mitigate or adapt to future impacts.



Project Area

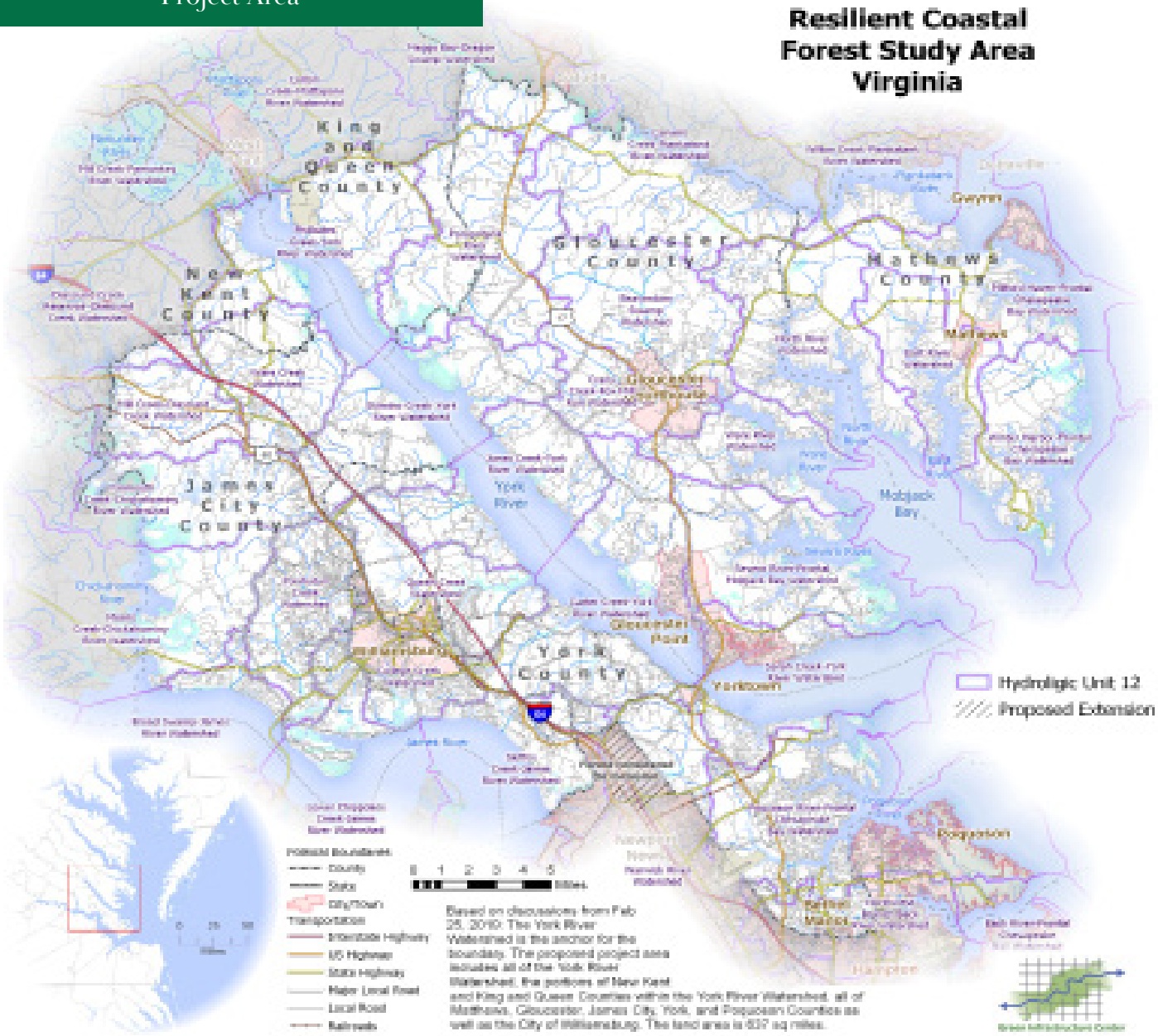


Figure-1: A map outlining the Virginia Resilient Coastal Forest study area.

The study area for Virginia is composed of 6 counties (Gloucester, James City, King and Queen, Mathews, New Kent, and York Counties) either entirely or partially and 8 towns or cities (Bethel Manor, Gloucester Courthouse, Gloucester Point, Gwynn, Mathews, Poquoson, Williamsburg and Yorktown) within the lower watershed of the York River. The study area boundary was chosen by staff with the Virginia Department of Forestry and contains a mix of rural, suburban and urban land uses. The counties and towns north of the York River are predominantly rural in character, while the counties, towns and cities south of the York River experience higher density and more urban growth patterns. A mix of land uses and urban growth patterns was chosen to evaluate different development pressures on coastal forests. This mix is intended to demonstrate the different opportunities and challenges to coastal forests and requires the engagement of diverse stakeholders and community types.

Introduction to Coastal Forest Benefits

This benefits’ report is a partial assessment of natural resource assets related to coastal forests. It analyzes the benefits coastal forests provide to the environment and communities that reside within and around those forests. By identifying and quantifying the role and benefits coastal forests play in a region, these data can be used by local stakeholders to understand the extent of services, justify decision-making when protecting or conserving forests, utilize data in local planning decisions, educate the public and build support and political will from the community to effect necessary change.

What do we mean by benefits?

Coastal forests provide valuable ecosystem services. These services are further classified into supporting services, regulating services, provisioning services, and cultural services. Each type of service is dependent on the functional role the forests play in the environment and human society. Supporting services are nutrient cycling, soil formation, pollination, and habitat, while regulating services are air and water purification, decomposition, carbon sequestration and storage, and flood protection. Provisioning services, oftentimes referred to as ecosystem goods, are tangible forest products, such as timber, paper, medicines, foods, biofuels, and genetic material. Cultural services examples are recreation, science and education, historical or natural heritage sites, and spiritual practices associated with natural places and symbolism.

This benefits report quantifies many of the services described, with a particular focus on the role of coastal forests in providing regulating, provisioning, and cultural services. The study area’s land cover was mapped using remote sensing techniques from aerial photographs and geographical information system (GIS) data layers publicly available or shared by committee partners

from national, state, and local groups. Rural areas were mapped at a 10-meter pixel resolution, while urban areas were mapped at a finer resolution of 1-meter pixels. Benefits’ calculations were derived from the land cover and by using published multipliers from the U.S. Forest Services i-Tree multipliers specific for the study region (i-Tree County multipliers). Other values were sourced from GIS datasets shared by local partners or published datasets.

237,501 acres of total forest cover

Total forest cover makes up 58% of land cover in the study area, with mixed forests being the predominant forest type in the region at 41% (see Table-1 below).

Table-1: Number of acres and percent land cover, by type.

Land Cover Type	Acres	Percent Cover
Evergreen Forest	34,201	8%
Mixed Forest	166,284	41%
Wooded Wetland	37,016	9%
Wetland	31,041	8%
Pervious	90,644	22%
Impervious	32,761	8%
Water	15,922	4%
Total	407,869	100%

Source: Virginia Geographic Information Network (VGIN) 2015.



Coastal Forest Cores and Woodlands

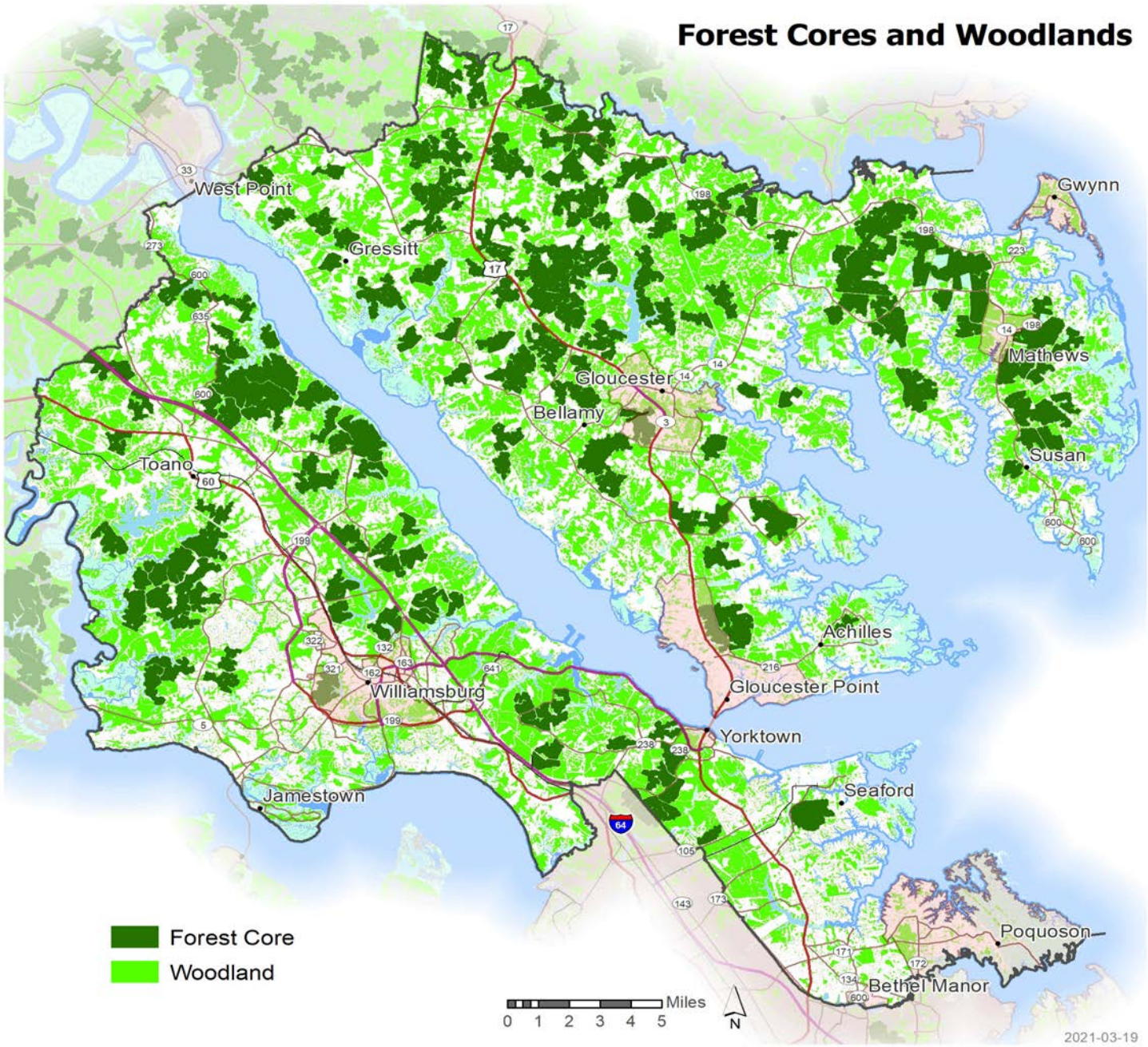


Figure-2: A map displaying the coastal forest cores (forests larger than 100 acres in size) and woodlands (forests smaller than 100 acres in size but larger than 10 acres).

Benefits of Urban Tree Canopy

As part of the analysis, GIC mapped tree canopy cover at 1-meter resolution for each of the cities and towns located within the study area. Tree canopy values for each city or town can be found in Table-3. In cities and towns, urban tree canopy provides many community health benefits by reducing air and water pollution, sequestering carbon, mitigating urban heat island effects and reducing standing water and stormwater runoff.

For this study, the reduction in air pollution and carbon sequestration and storage were calculated for the study area’s urban forests. Mitigating air pollution in urban settings is critical to avoid long-term health impacts to residents and to meet federal air-quality standards.

Many cities are developing Climate Action Plans to support sustainability measures, such as energy efficiency, urban cooling and reducing greenhouse gas emissions. Coastal forests, in both urban and rural settings, play a key role in mitigating greenhouse gas emissions. Forest land conversion accounts for 25% of global emissions.

Coastal forests sequester hundreds of thousands of tons of carbon dioxide from the atmosphere annually and play a significant role in mitigating future impacts of climate change on the surrounding communities (see Table-2). Trees sequester carbon which forms greenhouse gases such as sulphur dioxide and carbon dioxide, thereby reducing sources of global warming. Storing carbon and preventing its release is another way that trees mitigate the impacts of climate change. Coastal forests play an even larger role in preventing greenhouse gas formation by also sequestering carbon in the soil and thick organic layer of the forest floor.

Besides the role coastal urban forests play in regulating environmental impacts, these same forests directly and indirectly provide cultural services in the form of health benefits through

recreation and promoting behaviors that encourage physical activity in communities. Parks and green spaces account for a significant amount of a population’s moderate-to-vigorous physical activity, with an average of 5,300 hours per week spent on exercise in some neighborhood parks in the Los Angeles, CA, area. (Kim et al 2016). And it is not just greenspaces in communities that promote these behaviors. Tree canopy alone is shown to be an effective influencer on physical activity. A higher density of street trees (at the 75th vs 25th percentile) in low-income neighborhoods was associated with a 12% lower prevalence of obesity in children between the ages of 3-5 years in New York City (Lovasai et al 2013). Furthermore, a higher density of street trees was positively associated with longer walking times. Individuals walked a median

Table-2: Carbon sequestration and storage for each locality using U.S. Forest Service’s iTree County multipliers.

Localities	Tons/YR	Tons
County/City	CO2seq	CO2stor
Gloucester County	264,316	12,157,175
King and Queen County (partial)	37,254	1,421,294
Mathews County	115,588	3,700,984
Gwynn	2,231	71,437
Mathews	3,193	102,250
Gloucester Courthouse	8,292	381,372
Gloucester Point	5,968	274,484
James City County	186,093	6,787,884
New Kent County (partial)	20,704	734,206
York County	133,692	6,386,240
Williamsburg	9,561	344,981
Yorktown	668	31,886
Poquoson	2,114	114,317
Bethel Manor	83	3,969
Study Area Total	789,756	32,512,478

Source: i-Tree County, U.S. Forest Service

Benefits of Urban Tree Canopy

value of 32 minutes longer on streets with a high density of trees than on streets with a lower density (Vich et al 2019).

In addition to urban forests’ role in promoting physical activity, the scientific literature shows a correlation between tree canopy or greenspaces and improved mental health and faster healing from illnesses. Patients recovering from surgery in hospital rooms with views of nature have shorter hospital stays, receive fewer negative evaluations, and take fewer pain-relieving medicines than patients in rooms with windows facing a brick wall (Ulrich 1984). Visual exposure to settings with trees helps recovery from stress within five minutes, as indicated by changes in blood pressure and muscle tension (Ulrich 1984).

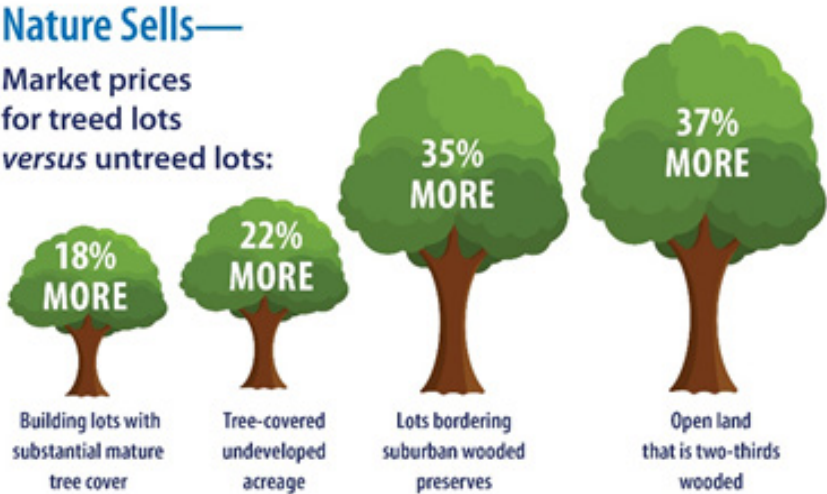
Finally, trees play a significant role in urban economies by increasing property values, which translates into a greater tax base for local governments. In one study, it was demonstrated that trees can increase residential property values by up to 37% (Foster et al 2011).

Trees also influence consumer spending patterns. They provide more attractive areas for development, and improve the character and charm of historic districts and commercial areas by giving

opportunities for people to interact with nature. A study by the University of Washington found that people shopped longer and more often in tree-lined retail areas and spent about 12% more money in large cities and 9% more in small cities (Wolf 2007). In addition, trees and areas of urban coastal forest cover contribute to the livelihood and economic well-being of cities and towns by drawing in tourists and indirectly supporting economic development in communities.

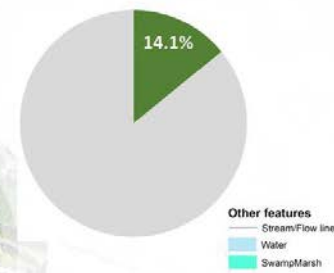


Businesses benefit from tree canopy by making shopping areas more aesthetically pleasing thereby attracting customers.



Source: Kathleen Wolf, 2007, City Trees and Property Values.

Bethal Manor, VA Tree Canopy

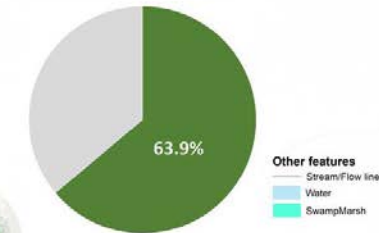


Other features
Stream/Flow line
Water
Swamp/Marsh

N 0.25 Miles

Figure-3: A map showing the extent of urban tree canopy for the town of Bethel Manor.

Gloucester Courthouse, VA Tree Canopy



Other features
Stream/Flow line
Water
Swamp/Marsh

N 0.5 Miles

Figure-4: A map showing the extent of urban tree canopy for the town of Gloucester Courthouse.

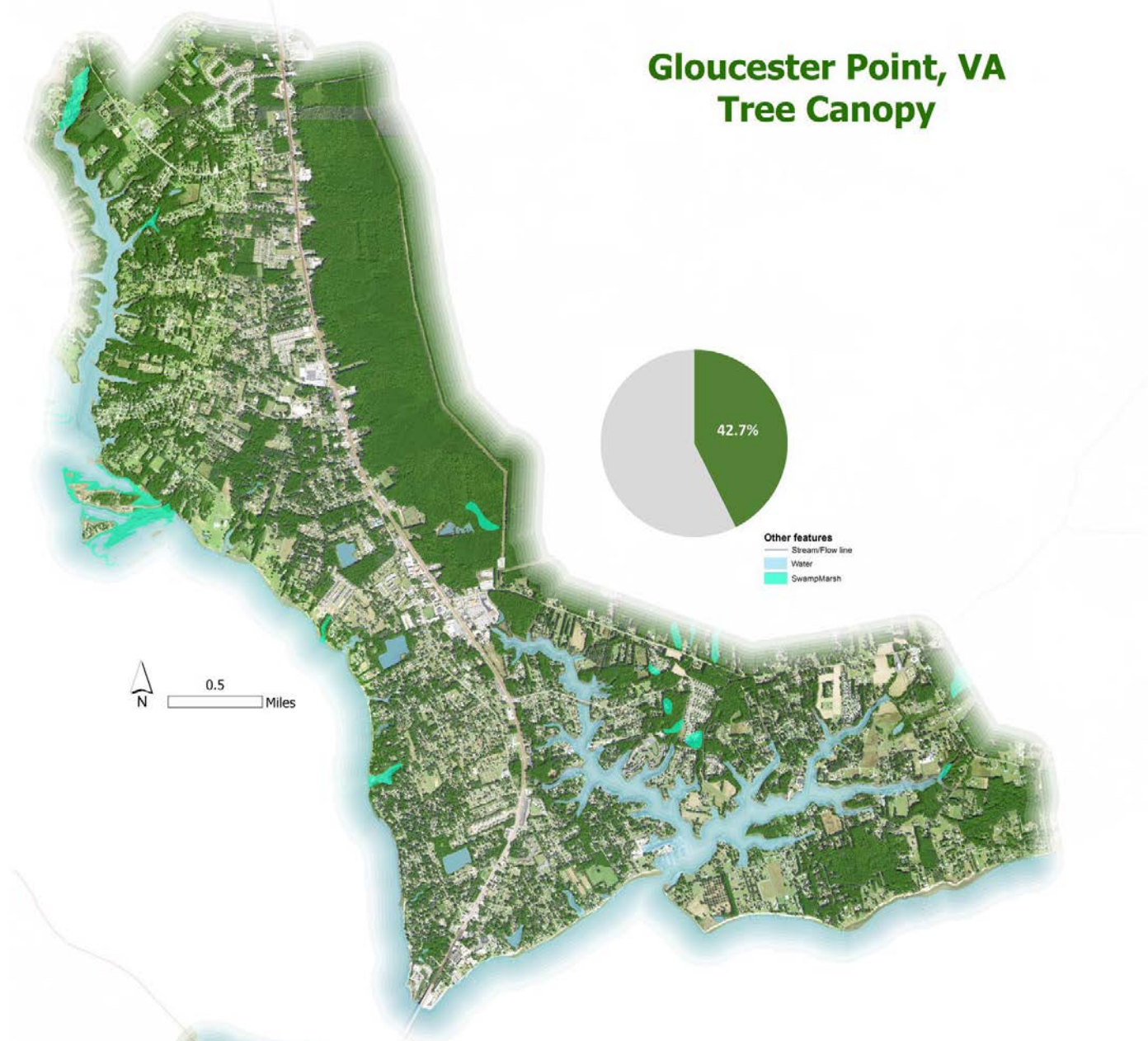


Figure-5: A map showing the extent of urban tree canopy for the town of Gloucester Point.

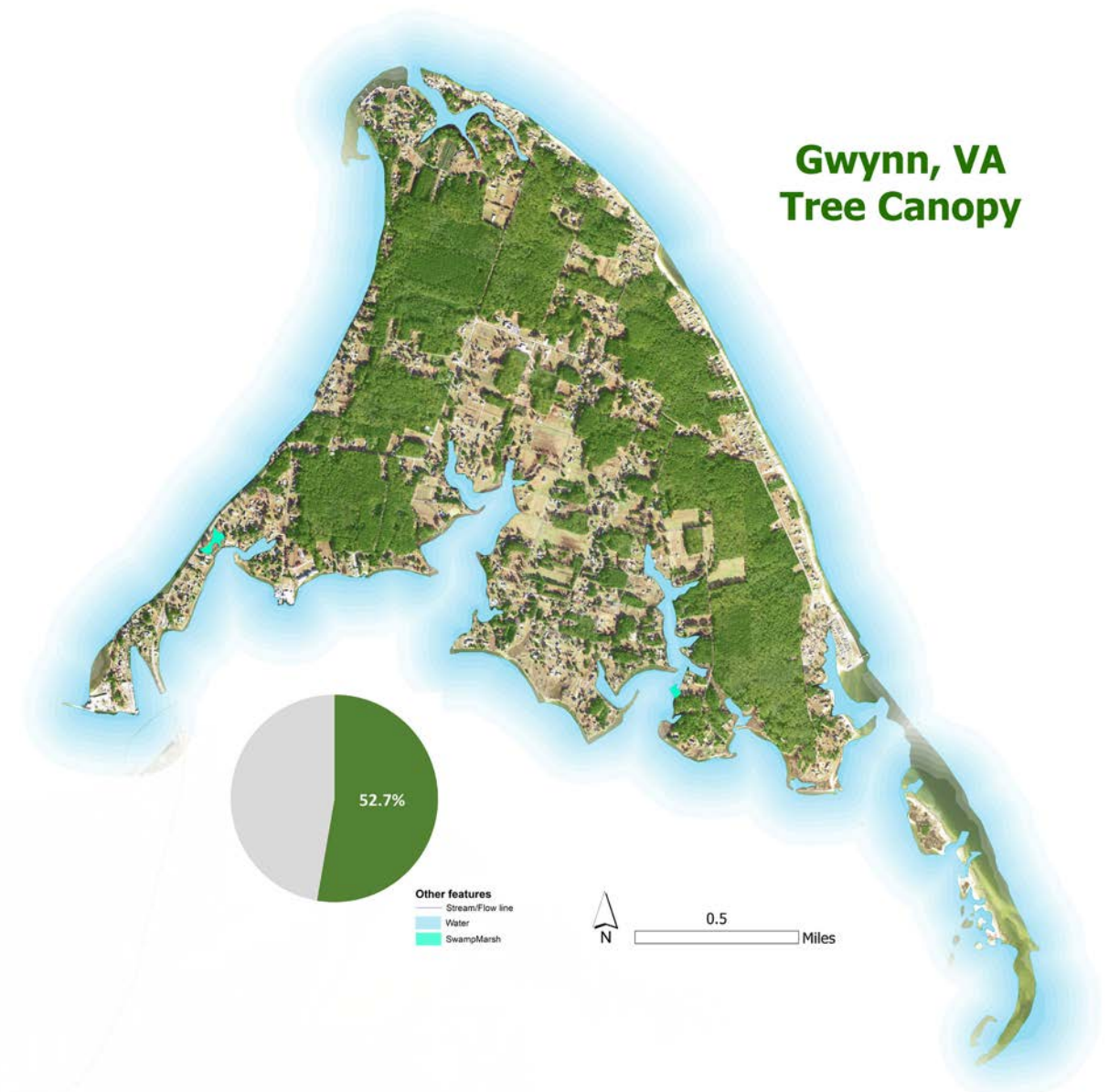


Figure-6: A map showing the extent of urban tree canopy for the town of Gwynn.

Mathews, VA
Tree Canopy

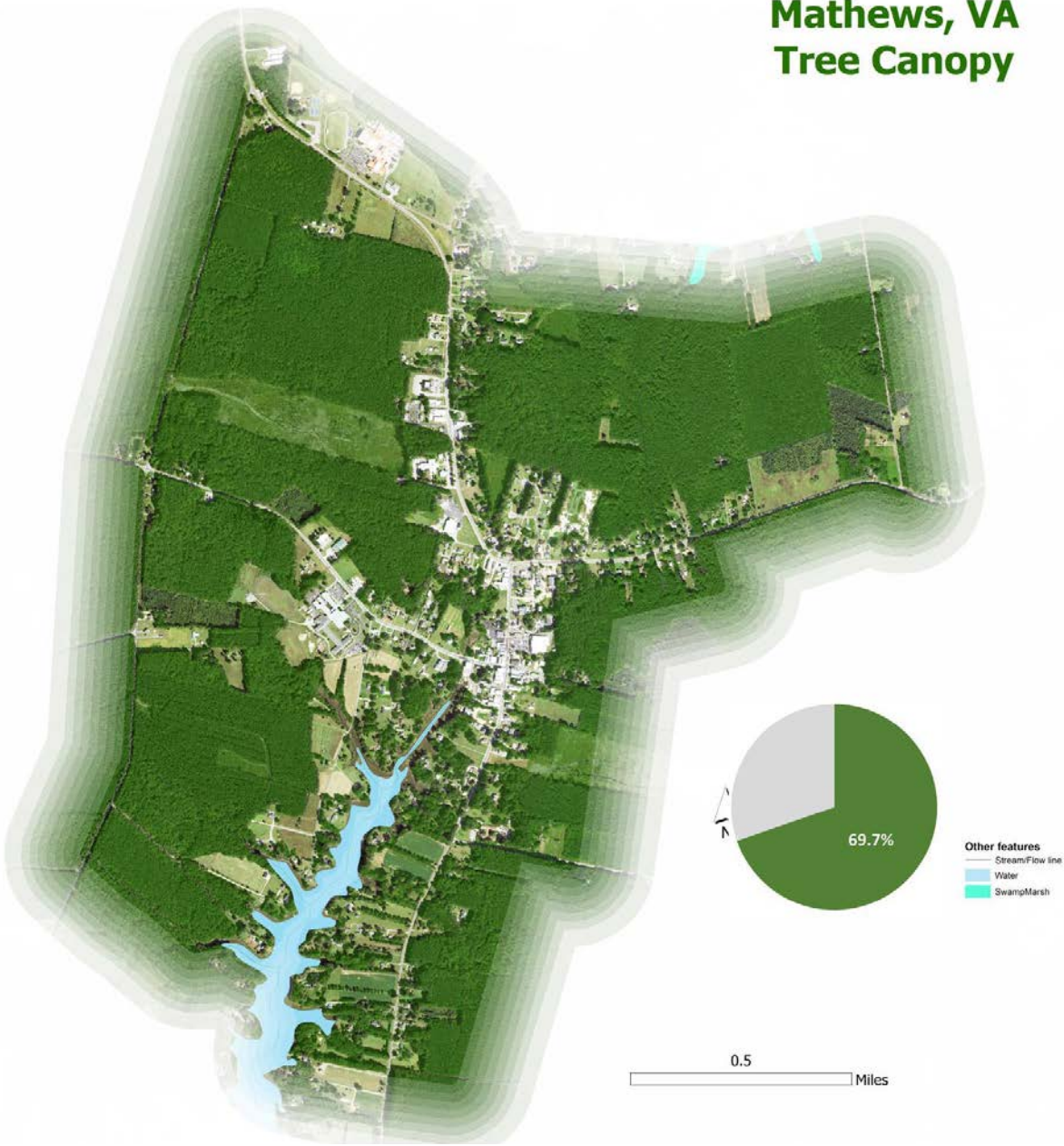


Figure-7: A map showing the extent of urban tree canopy for the town of Mathews.

Poquoson, VA
Tree Canopy

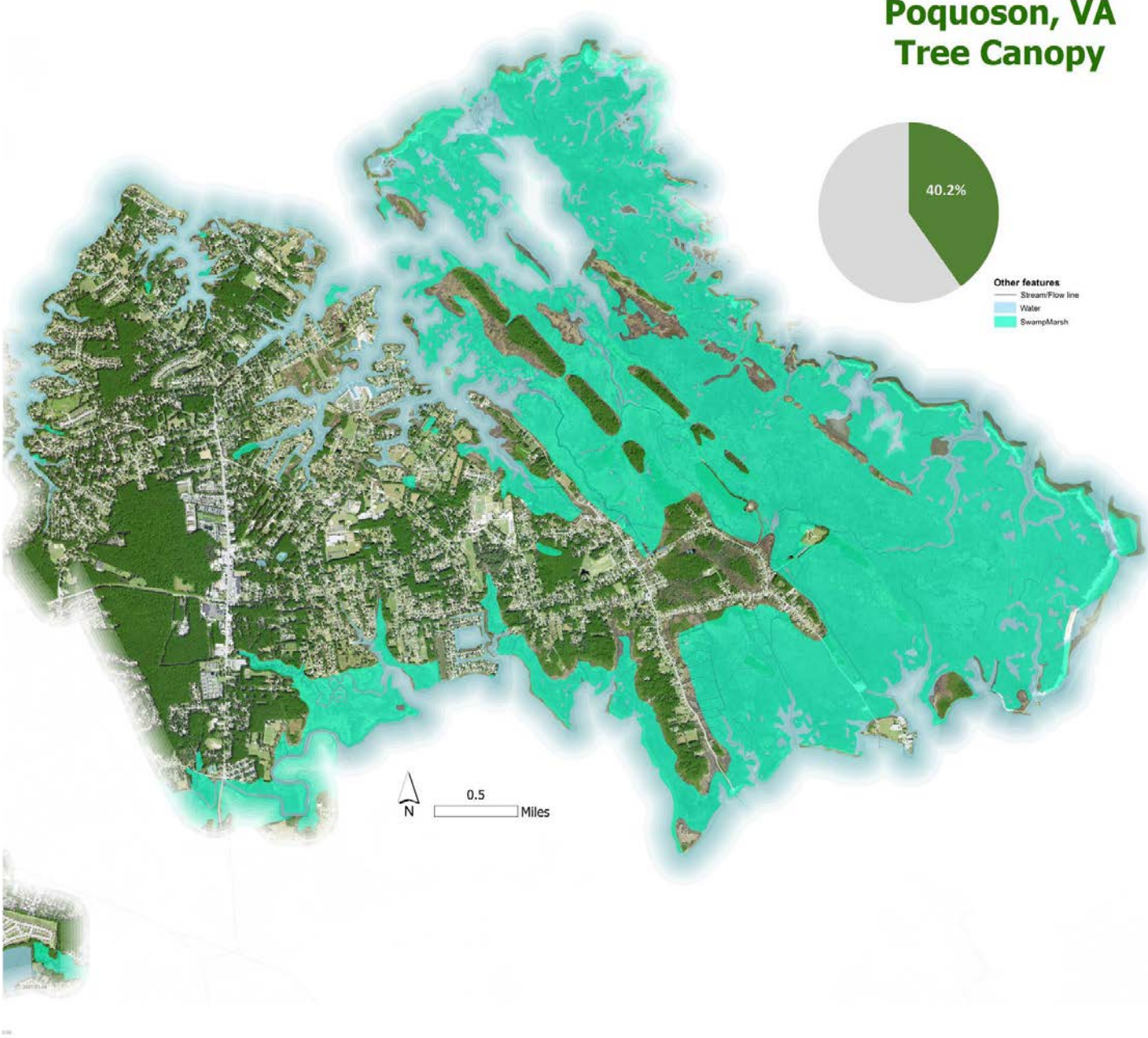


Figure-8: A map showing the extent of urban tree canopy for the town of Poquoson.

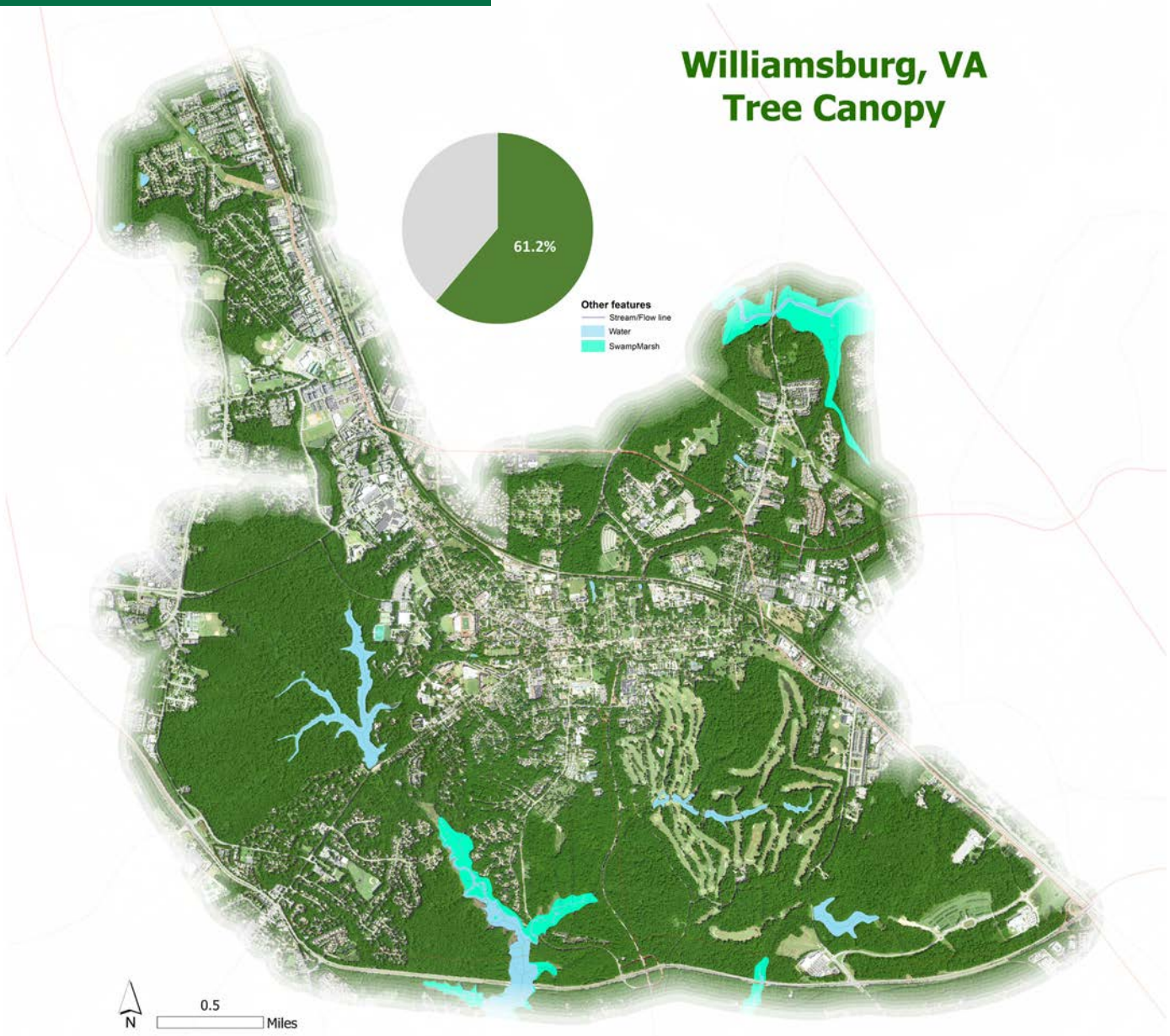


Figure-9: A map showing the extent of urban tree canopy for the City of Williamsburg.

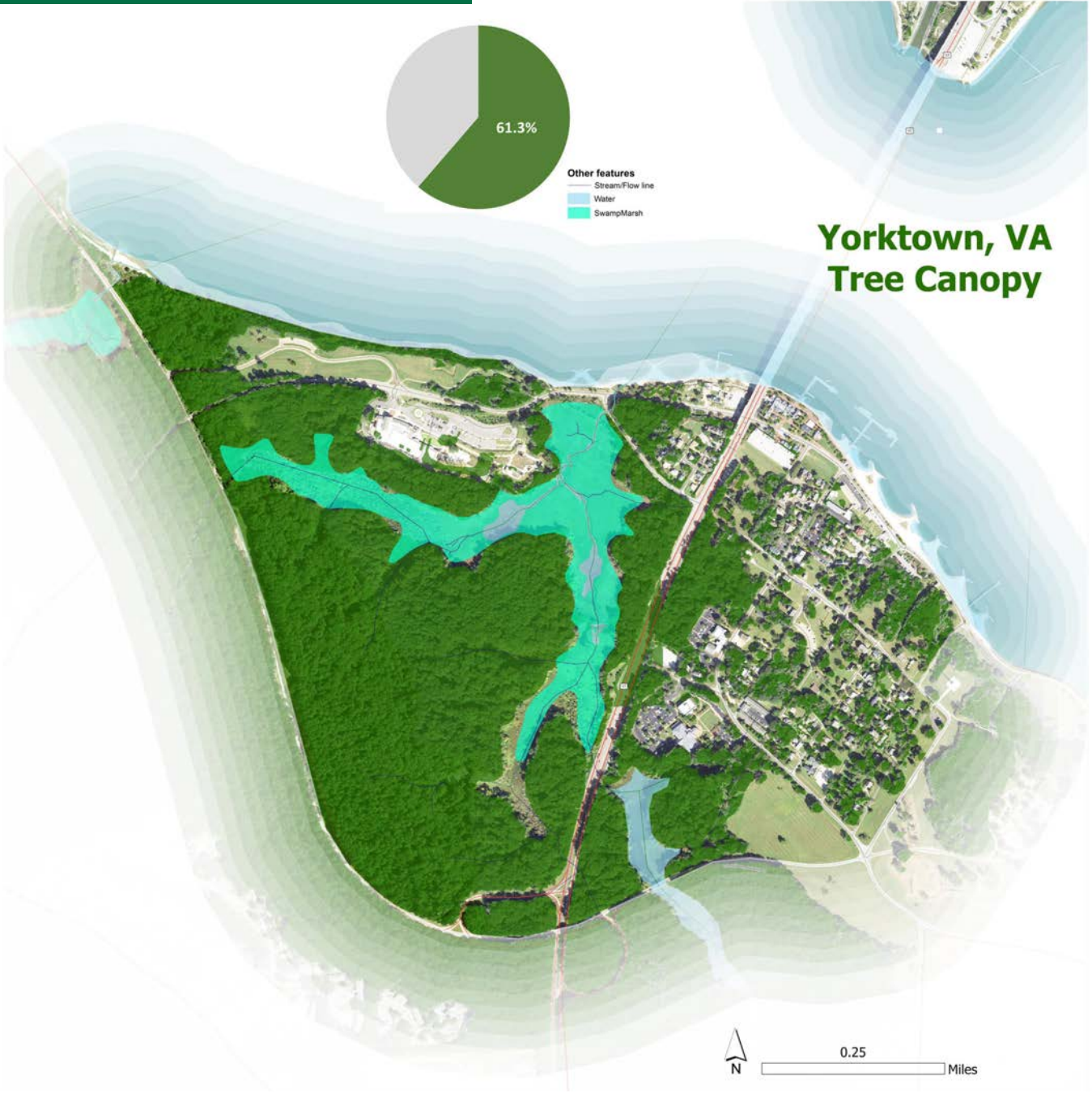


Figure-10: A map showing the extent of urban tree canopy for the town of Yorktown.

Benefits to Air Quality

For this study, the reduction in air pollution and carbon sequestration and storage were calculated for the study area’s urban forests. Mitigating air pollution in urban settings is critical to avoid long-term health impacts to residents and to meet federal air-quality standards.

Trees mitigate the impacts of air pollution through a number of different mechanisms. For

example, they cool surface temperatures, by shading impervious surfaces that hold and radiate heat, thereby reducing the conversion of some air pollutants, such as nitrogen dioxide, into ground-level ozone. Trees also capture small particulate matter on their leaves or sequester pollutants through gas exchange, effectively removing these substances from the atmosphere. Even at the neighborhood level, trees reduce pollutants. Well-treed neighborhoods suffer less respiratory illnesses, such as asthma (Meenakshi et al 2014).

Table-3: Air quality pollutant reductions for each locality using U.S. Forest Service’s i-Tree County multipliers.

		LB/YR	LB/YR	LB/YR	LB/YR	LB/YR	LB/YR
County/City	Canopy Area (Acres)	CO Carbon monoxide	NO2 Nitrogen dioxide	O3 Ozone	PM2.5 Particulate Matter (2.5 microns)	PM10 Particulate Matter (10 microns)	SO2 Sulphur dioxide
Gloucester County	83,936	24,460	511,993	4,893,911	203,262	1,037,591	669,406
King and Queen County	12,535	12,606	55,697	789,513	35,960	135,227	46,357
Mathews County	32,073	6,002	150,378	2,298,648	104,273	411,499	473,479
Gwynn	619	116	2,903	44,369	2,013	7,943	9,139
Mathews	886	166	4,155	63,507	2,881	11,369	13,081
Gloucester Courthouse	2,633	767	16,061	153,522	6,376	32,549	20,999
Gloucester Point	1,895	552	11,560	110,494	4,589	23,427	15,114
James City County	53,048	14,028	292,500	2,895,034	109,439	621,896	384,014
New Kent County	5,663	6,273	23,735	342,813	15,375	59,975	19,605
York County	39,484	9,345	204,818	2,614,970	96,354	418,971	474,558
Williamsburg	2,845	752	12,688	13,0842	3,830	26,107	16,978
Yorktown	197	47	1023	13,056	481	2,092	2,369
Poquoson	1,578	295	5,879	94,428	3,443	14,418	19,568
Bethel Manor	25	6	127	1,625	60	260	295
Study Area Total	237,417	75,415	1,293,516	14,446,733	588,336	2,803,323	2,164,962

Source: i-Tree County, U.S. Forest Service

Benefits to Water Resources

Forests provide numerous services for the regulation of flooding and provisioning of clean and safe drinking water to communities. Forest buffers along riparian corridors filter out sediment and nutrients that contribute to poor water quality, while shading and cooling water for aquatic life. Tree roots and the forest duff layer soak up rainfall and infiltrate water into the ground, preventing it from becoming surface flow runoff. By infiltrating rainfall into the ground, forests play a vital role in groundwater recharge, replenishing aquifer systems that communities rely on for drinking water sources. Coastal forests and forested wetlands capture and store flood waters and slowly infiltrate it back into the ground, acting as reservoirs that regulate flooding.

Coastal forested wetlands or “swamps” possess thick, nutrient rich organic soils that support flood tolerant tree species such as pumpkin ash, swamp tupelo, red maple and bald cypress. Forested wetlands play a critical role as habitat for a variety of plants, wildlife and aquatic organisms such as fish, clams and crayfish. Many of the



Wetlands provide numerous water quality benefits, habitat and shoreline protection in coastal zones.



In the background a “ghost forest” is beginning to form.

forested wetlands are located at the boundaries of high water along the coast or concentrated along tributaries or on floodplains of headwaters.

Some isolated forested wetlands are scattered across the landscape as well. Approximately 72% of wetlands are located within the Coastal Plain of Virginia (Augustine 2004) and wetlands are at risk from conversion to urban development and agriculture or degradation from salt inundation and invasive species. Salt inundation is a particular concern as sea-level rise encroaches into forested areas and more powerful storm surge pushes saltwater and salt spray further inland. Salt creates toxic conditions in the soil which leads to water stress for trees ill-adapted to high concentrations of salt, resulting in “ghost forests”, large swaths of dead standing and often bleached trees. With tree cover loss and higher water tables, marshes are able to migrate further inland eroding the extent of forest habitat. In addition, some invasive species such as phragmites colonize and form dense thatch which reduces native plant competition, decreases habitat quality and elevates wildfire risk to adjacent homes and properties.

Benefits to Water Resources in the Study Area at a Glance....

Coastal Forests in the study area capture and infiltrate 2.5 billion gallons of stormwater per 2 inch rain fall event.

Pollution loading levels (Nonpoint sources) reduced pollutants such as nitrogen, phosphorus, sediment and reduced loadings to waterways by:

- 731,000 lbs per year of avoided nitrogen runoff
- 46,600 lbs per year of avoided phosphorous runoff
- 17,900 tons per year of avoided sediment runoff

Miles of streams that have a forested buffer = 761 miles or 68% of stream miles.

Miles of stream listed as impaired (section 303-d listed) = 71.6 miles or 6.4% of stream miles.

Of those 761 forested stream miles, 89% have at least a 100 ft buffer and 75% have at least a 600 ft buffer.

A 100 foot buffer removes the majority of N, P, S from overland runoff, while a 600 foot buffer is wide enough to also serve as a corridor for many species of wildlife.

Wetlands = 31,041 acres

Forested wetlands = 37,016 acres

Note that wetlands data are from the National Wetlands Inventory and overlaid with forest cover. Wetlands are difficult to pick out with aerial mapping when covered by dense canopy. The extent of forested wetlands in the study area may be far greater.



Benefits to Water Resources

Water

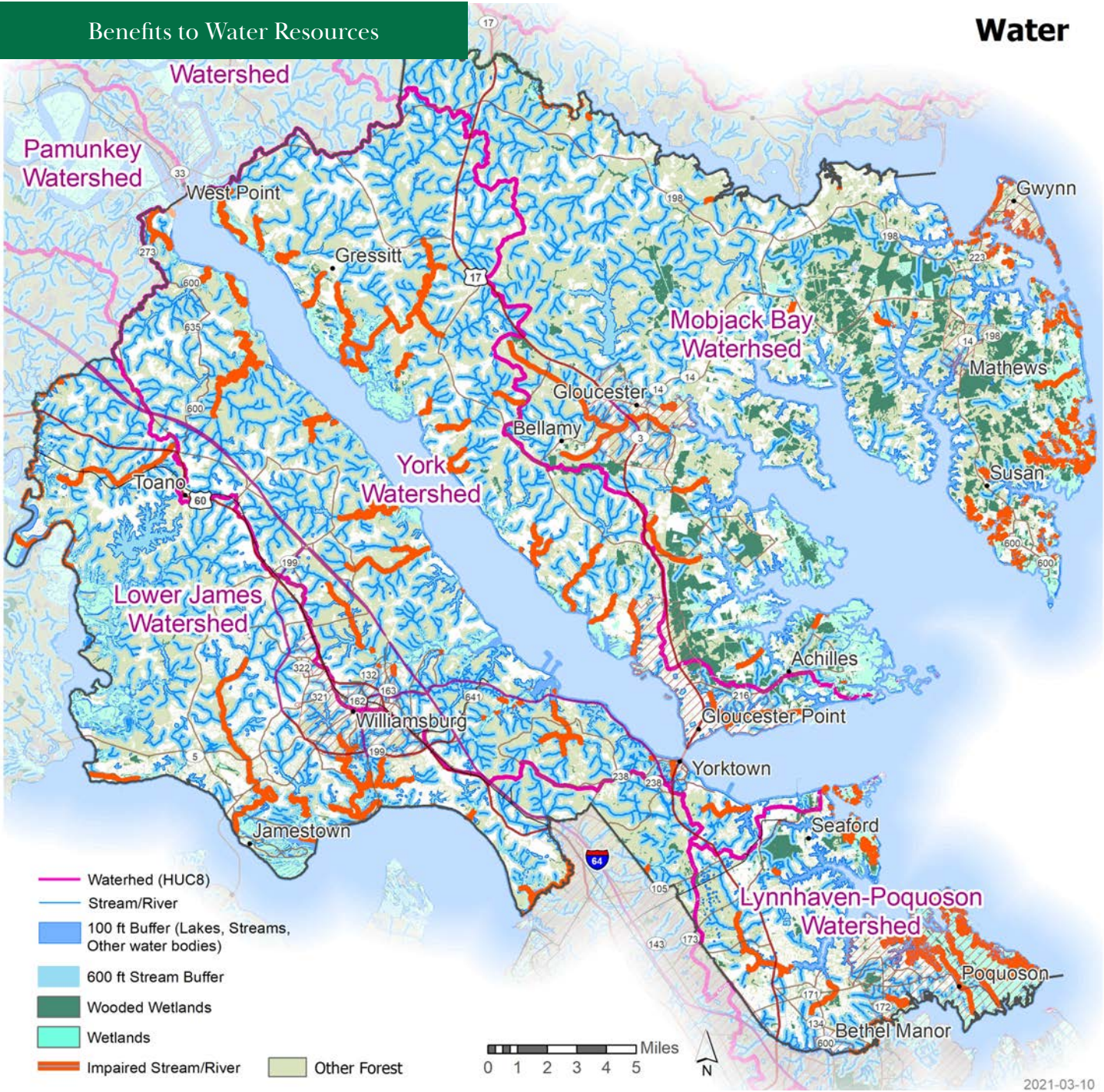


Figure-11: A map displaying the water resources within the project study area including 100 ft and 600 ft stream buffers, wooded wetlands, and non-forested wetlands. 100 ft forested buffers protect water quality and 600 ft forested buffers were mapped as possible wildlife corridors.

Benefits to Wildlife & Biodiversity

One of the biggest supporting services provided by coastal forests is the amount of habitat they provide to forest-dependent species. Forest-dwelling species, such as the red-cockaded woodpecker are dependent on large tracts of intact forests for habitat. Without protected forestlands, these species would be extirpated from the region. Forest cores and corridors also provide connectivity for wildlife across the landscape, which allow animals to migrate and adapt to immediate (fire) and long-term (climate change) threats. The Virginia study area contains 237,501 acres of total forest cover; however, large intact tracts of forests (100+ acres in size) make up only 68,417 acres or 28% of total forest cover.

Table-4 below shows the breakout of intact forest tracts by size and count within the study area. There are 12 intact forest tracts that are larger than 1000 acres in size, and the acreage across class sizes is evenly split, but the largest intact forested tracts (greater than 1000 acres in size) made up 8.7% of total forest cover in the region. This means there is a lack of large intact forested habitat in the region which can limit some species of wildlife that require large blocks of contiguous forest.

Table-4: Number of acres of forest cores, by size class, in the study area.

Size Class	Count	Total Acres
100 – 500 acres	83	24,982
501 – 1000 acres	33	22,771
1000+ acres	12	20,664
Total	128	68,417

Source: Green Infrastructure Center’s intact cores model using VaNLA modified land cover.

The coastal forests of Virginia are rich in tree diversity, with over 88 species of trees making up the forests. There is a total of 330 species of terrestrial vertebrates within the study area. Birds are the most “species rich” of any of the groups, at 212 species (see Table-5).

Table-5: Species richness of terrestrial vertebrates, by taxonomic group.

Taxonomic Group	Species Richness
Amphibians	31
Birds	212
Mammals	46
Reptiles	41
Total	330

Source: Biodiversity Mapping.org



Great blue heron along the York River.

Benefits to Wildlife & Biodiversity

The region is also home to several federal- and state-listed threatened and endangered species (Table-6). Ten species within the study area are either federally or state listed (or both) as endangered or threatened. Several species, such as Mabee’s salamander and the barking treefrog are associated with vernal pools in pine savannas or forests, while the small-whorled pogonia, a small forest-dwelling herb, is found in older, larger diameter, mixed deciduous upland forests. Coastal forests not only provide critical habitat for these rare species, but serve as refugia for hundreds of species that support the many ecosystem services and functions upon which communities rely.



Tiger Salamander, Photo credit: Glenn Bartolotti

Table-6: A list of federal- and state-threatened and endangered species within the study area. LT = Listed Threatened; LE = Listed Endangered.

Common Name	Scientific Name	Taxonomic Group	Federal Listing	State Listing
Cape Fear spatterdock	<i>Nuphar sagittifolia</i>	Vascular Plant	-	LT
Sensitive joint-vetch	<i>Aeschynomene virginica</i>	Vascular Plant	LT	LT
Peregrine falcon	<i>Falco peregrinus</i>	Bird	-	LT
Atlantic sturgeon	<i>Acipenser oxyrinchus</i>	Fish	LE	LE
Small whorled pogonia	<i>Isotria medeoloides</i>	Vascular Plant	LT	LE
Mabee's salamander	<i>Ambystoma mabeei</i>	Amphibian	-	LT
Harper's Fimbry	<i>Fimbristylis perpusilla</i>	Vascular Plant	-	LE
Tiger salamander	<i>Ambystoma tigrinum</i>	Amphibian	-	LE
Barking treefrog	<i>Hyla gratiosa</i>	Amphibian	-	LT
Northeastern beach tiger beetle	<i>Cicindela dorsalis dorsalis</i>	Insect	LT	LT

Source: Virginia Department of Natural Resources

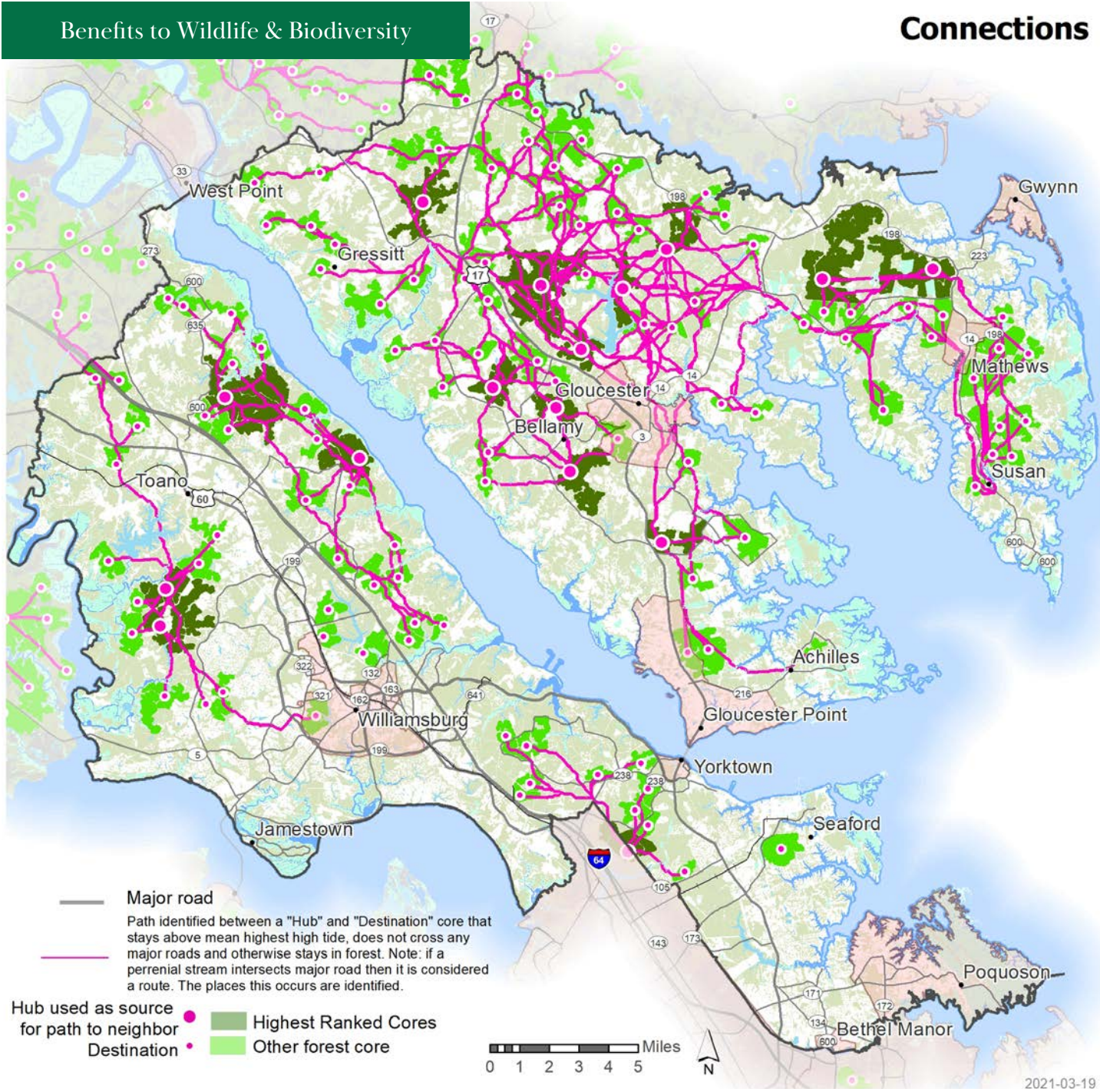


Figure-12: A map showing forest corridors and connections across the study area.

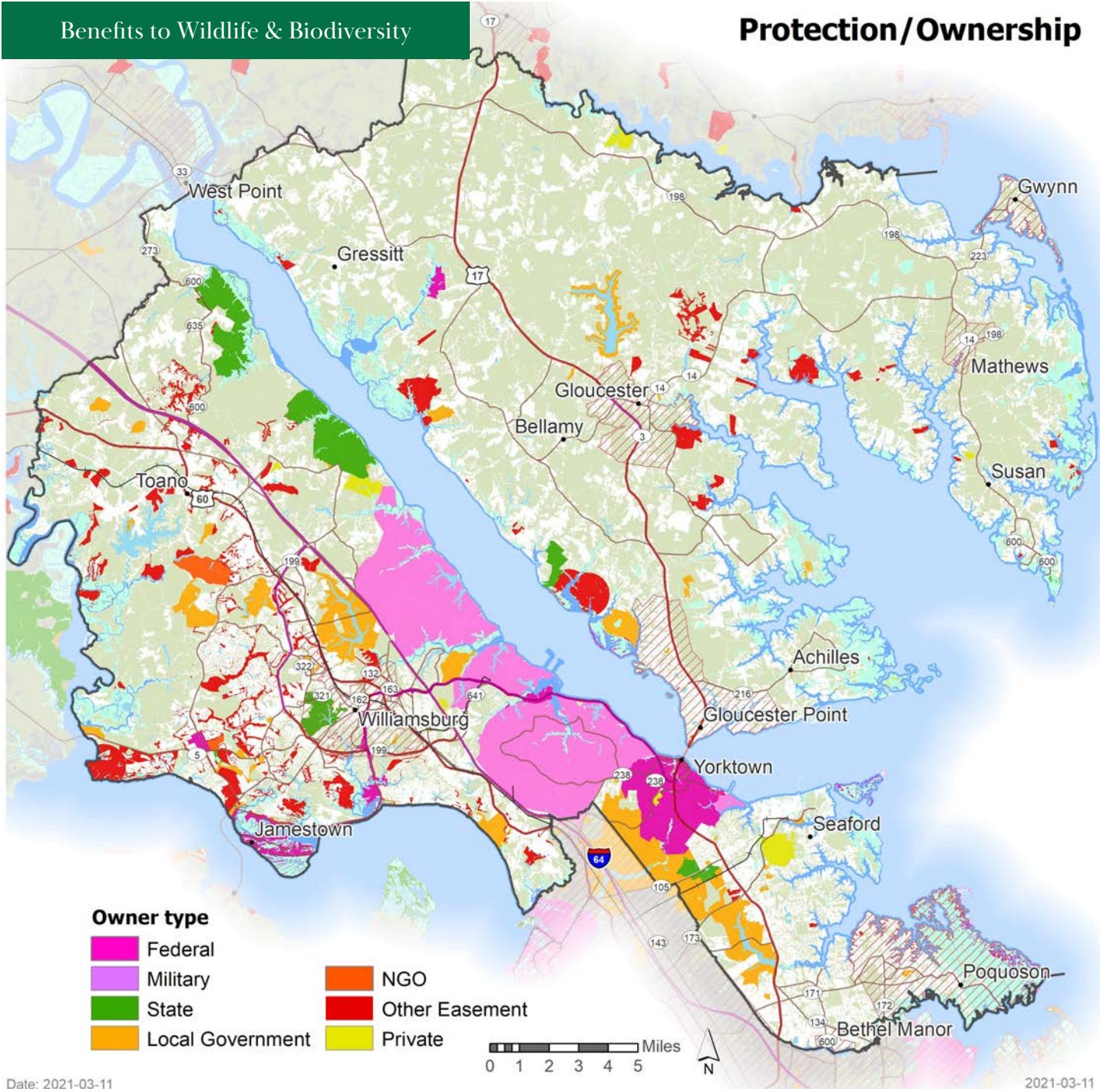


Figure-13: A map showing protected areas by ownership status.

Benefits to Forest Economy

The forest sector contributes to regional and local economies through resource production, taxes, and direct jobs in the industry (lumber, milling) and indirectly through supporting jobs. In 2015, the forest products industry ranked number three in Virginia in overall economic output and employed more than 108,000 people across the state. In the Virginia Resilient Coastal Forest study area and nearby, 24,610 cubic feet of volume was harvested in 2018, with a value of \$10,425,295 (VA DOF 2020).

The forest sector is dependent on the availability and abundance of forestland and the economies of scale for production, harvesting, and processing. As coastal forests are converted into non-forest uses, markets that rely on a steady supply of timber and non-timber products are jeopardized, along with those jobs and tax revenue streams upon which communities rely.



The forest economy is dependent on available land for forests to regenerate and replace harvested trees.



A truck transports logs to a local processing facility. The forest economy creates many direct and indirect jobs in rural communities.

Table-7: Value of timber production by county and total for study area.

County	2018 Harvest Values (USD)	2018 Harvest Cu ft Volume
James City	\$73,560	199
York	\$165,530	737
Mathews	\$372,378	1,228
New Kent	\$2,533,003	4,857
King and Queen	\$6,180,470	15,712
Gloucester	\$1,100,354	1,876
Total	\$10,425,295	24,610

Source: Virginia Department of Forestry

Benefits to Recreation & Tourism

Recreation is a cultural and provisioning service coastal forest provide to communities. Recreation, in the form of hiking trails, greenways, lakes and rivers for fishing, birding, and more, brings valuable active pursuits to communities. Virginians visiting natural areas was the top recreation activity in the state in 2017 (71%, up from 50% in 2011) and this figure will likely be higher for 2020 when many recreation activities were limited to the outdoors.

These outdoor enthusiasts also spend money in the local economy on products such as food, gas, and lodging. In fact, American consumers spend more money on outdoor recreation than on fuel and pharmaceuticals combined (OIA 2017). Nature-based outdoor recreation, which includes activities such as hiking, camping, and hunting, all of which take place in a natural setting, contributed \$2.45 billion to Virginia’s Gross Domestic Product (GDP) in 2019 (BEA ORSA 2019). These amenities attract employers and employees alike, making the region desirable for businesses and workers to relocate and revitalize a local or regional economy. One study demonstrated a strong positive correlation between the growth of entrepreneurial and creative class industries and rural counties that ranked very high in outdoor amenities (McGranahan et al 2010).

Economic Value of Tourism Industry For Virginia

Employment: **123, 369** outdoor recreation jobs in all industries

Nature Based GDP: **\$2.45 Billion**

Source: Bureau of Economic Analysis (BEA), Outdoor Recreation Satellite Account (ORSA), 2019



A sign greets visitors to Bethel Beach Natural Area Preserve.

Acres of protected areas: 72,257 acres or 18% of the study area

- Federal: 16,419 acres
- Military: 21,681 acres
- State: 6,965 acres
- Local: 13,861 acres
- Nongovernmental org. (NGO): 1,099 acres
- Private: 1,874 acres
- Other easements: 14,126 acres

Source: Virginia Department of Natural Resources and local sources.



Forests contribute to an immersive outdoor experience for a variety of recreational activities.

Benefits to Cultural Heritage

Number of historical and cultural sites in the study area

70 historical and cultural sites* are located in the study area.

**Source: National Register of Historic Places, National Park Service*

61 of those sites are within 200 meters of a forest.

Landscape context is important for historic sites. Forested backdrops, large trees and scenic vistas are all provided by the landscape. As much of the study area contains significant federal, state and local historic assets, the landscape’s role in adding to that setting cannot be underestimated. Forests form the cultural landscape for many of Virginia’s historic sites.

A cultural landscape is defined as “a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values.” (National Park Service Preservation brief 36).

Conclusions

This report highlights the many environmental, economic, social and cultural benefits coastal forests provide to the Lower York River watershed and surrounding communities. This analysis will be used to inform the next stages of the Resilient Coastal Forests Project where local stakeholders and the public will evaluate coastal forest threats, their extent and discuss subsequent management strategies to protect, adapt and mitigate risks. The stakeholders will prioritize what forests are most important using the inventory and asset data and discuss ways to maintain forest integrity, connectivity on the landscape and maximize forest benefits into the future through



Tree canopy provides context to important cultural sites.



Historic trees lend a backdrop to sites and often tell their own story about significant events.

conservation management strategies. Knowing the benefits that coastal forests provide to the community helps local stakeholders build support for forestland conservation in urban, suburban and rural landscapes and to plan for a resilient future for Virginia’s trees.

Benefits to Cultural Heritage

Cultural/Historic



Figure-14: A map displaying the cultural and historical resources in the study area.

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