2022

Sustaining The Shell Middens: A Coastal Vulnerability Assessment Of Shell Midden Sites Within The Nansemond River Tributary

Mary Lawrence Young
William & Mary - Arts & Sciences, mlyoung987@gmail.com

Sustaining the Shell Middens: A Coastal Vulnerability Assessment of Shell Midden Sites within the Nansemond River Tributary

Mary Lawrence Young

Henrico, Virginia

Bachelor of Arts, College of William & Mary, 2021

A Thesis presented to the Graduate Faculty of The College of William & Mary in Candidacy for the Degree of
Master of Arts

Department of Anthropology

College of William & Mary
August 2022

APPROVAL PAGE

This Thesis is submitted in partial fulfillment of
the requirements for the degree of

Master of Arts

____
Mary Lawrence Young

Approved by the Committee July 2022

____
Committee Chair
Martin Gallivan, Professor and Department Chair, Anthropology
College of William & Mary

____
Jessica Jenkins, Mellon Postdoctoral Fellow of Environmental Science and Policy, Anthropology
College of William & Mary

____
Mara Dicenta, Assistant Professor, Anthropology
College of William & Mary

____
Shannon White, Professor and GIS Certificate Coordinator, Center for Geospatial Analysis
College of William & Mary

ABSTRACT

Throughout history, coastlines have commonly drawn human settlements. However, modern environmental processes (i.e., shoreline erosion, sea-level rise, land subsistence, inundation) threaten to destroy much of our remaining global coastal heritage. To prevent the further loss of archaeological contexts, this study seeks to develop a coastal vulnerability index through geospatial analysis to assess the vulnerability of 35 precontact shell midden sites along the Nansemond River in Suffolk, Virginia. The Nansemond middens offer a long-term history of how coastal inhabitants interacted with their surrounding landscape, with occupation of the area ranging from the Early Archaic period through Contact. This research considers various environmental and cultural variables used to determine which archaeological sites are most threatened by environmental changes and offer the most significant addition to our understanding of the past.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

I owe a great deal of thanks to everyone who contributed to this project. First and foremost, I would like to thank my advisor, Dr. Martin Gallivan, for his guidance and support. Over the past five years, thanks to his continued encouragement, I have grown so much as a student. Next, I would like to offer an enormous thanks to Dr. Jessi Jenkins, most notably, for getting me started on oyster research and continuing to foster my interest in shell midden archaeology. She has been an irreplaceable mentor figure and support system this year. I would also like to thank Dr. Shannon White and the whole staff of the CGA for all their assistance as I troubleshot GIS questions with them every week. They always made the CGA a welcoming and encouraging environment. I would also like to thank Dr. White and Dr. Mara Dicenta for their support and willingness to sit on my thesis committee, taking the time to review my work and offering much-appreciated advice.

I would also like to thank the Chesapeake Archaeology Lab (CAL) for all the good times and shared interest in the shell midden archaeology. I do not think I will ever meet another group of people as interested in the oyster fishery. Additionally, I would like to offer an enormous thanks all my friends and fellow graduate students for their welcoming kindness, constant encouragement, and willingness to listen to me talk about oysters. I would especially like to thank my friend and roommate, Carol Oordt, for going through the first year of the Anthropology One-Year MA program with me. Lastly, I would like to thank my family, who have always supported me through all my endeavors. You have always encouraged me to pursue my passions, from digging up rocks in the backyard to conducting real archaeological field work. Again, thank you to everyone for their unwavering encouragement and support. I would never have made it this far without each and every person!

I. Introduction

The following study details the analysis of several archaeological sites within the Chesapeake Bay watershed to the threats of environmental change through techniques drawn from geospatial analysis. While most shoreline preservation research focuses on the effects of sea-level rise and erosion on current and future infrastructure, this project builds on and contributes to ongoing efforts by cultural resource managers to expand the concerns of environmental processes on coastal archaeological sites.

We live in an age characterized by increasing environmental, social, economic, and political instability. Climate change and its associated impacts on coastal zones are current issues of global magnitude and concern. Over the past century, global temperatures have risen 0.8 °C, while the rise in the past three decades was a staggering 0.6 °C at the rate of 0.2 °C per decade (Mahapatra et al. 2015). As a result, sea-level rise estimates predict increases between 15 and 95 centimeters (cm) by 2100, with best estimates at 50 centimeters (cm) (Thieler and Hammar-Klose 1999). Unbeknownst to most, climate change and sea-level rise threaten to destroy much of our archaeological heritage (Reeder et al. 2012). The archaeological record fundamentally enhances our understanding of human behavior, diversity, and ecology. As a non-renewable resource, the archaeological record is highly threatened yet rarely receives discussion in conversations regarding climate change and conservation (Erlandson 2008). The research developed here will underscore the intertwined fate of archaeological sites and their surrounding environment.

Archaeologists have long been concerned with the status of cultural heritage sites in coastal regions as coastal ecology is inextricably linked with human decisions. Habitable coastal zones comprise only 1.5% of Earth's landmass, yet 41% of the world's population and nine out of 10 of the most densely populated cities occur within 100 kilometers (km) of coastline (Reeder-Myers et al. 2012). Nevertheless, predictions tell us that with only one foot (0.3 meters [m]) of sea-level rise in the Chesapeake Bay watershed, nearly 800 of the 17,000 archaeological sites in Virginia would be destroyed (Lowery et al. 2012; Reeder-Myers 2015; Smith 2017).

Many of the richest deposits of human civilization rest just underneath these threatened shorelines. Archaeology provides the long-term historical perspective necessary to fully understand the complex relationship of human ecodynamics (i.e., the interactions between human social and cultural systems and climate and environmental change) (Rick and Sandweiss 2020). Through a historical ecological lens, archaeology is utilized to reveal these long-term histories within landscapes that are as cultural as they are ecological. Environmentally driven archaeology strengthens and reinforces the search for sustainable trajectories moving forward. However, before we can understand such resources, they must be protected and preserved for the future.

This project specifically seeks to understand environmental change's threat to coastal archaeological sites within the Nansemond River tributary (Figure 1). Four distinct sub-questions inform the larger analysis, each relating to more prominent cultural and environmental preservation themes.

1. How can we access the vulnerability of coastal shell midden sites as a means of cultural and historic preservation?
2. What environmental and/or cultural variables are most influential in determining vulnerability?
3. Which shell midden sites hold the highest level of shoreline vulnerability within the Nansemond River Tributary?
4. How can we develop effective management and testing programs for the most vulnerable sites?

II. Background

While all archaeological sites hold the potential for newfound understandings of the past, this analysis is focused explicitly on shell midden sites from the Nansemond River due to a combination of factors, including descendant community interest and resource availability. The remainder of this section outlines the theoretical paradigm employed in this research, followed by a history of shell midden studies in the Chesapeake region and a description of the coastal change processes, including erosion, sea-level rise, and land subsidence. The section ends with an explanation of how cultural heritage sites are managed.

a. Theoretical Paradigm

This research is informed by the ideas of historical ecology, focusing on how social practices have impacted and continue to influence human landscapes (Smith 2017). Historical ecology developed as a response to traditional frameworks regarding human-environmental relations and foregrounds agency as the driving force behind said interactions. The theory posits that landscapes are the product of human agency and intentional interactions within the environment. Interactions can be positive (e.g., resource management) or negative (e.g., resource depletion), yet all disturbances caused by human activities are critical to shaping biodiversity and environmental health (Erickson 2008).

A dualistic feedback loop exists between humans and their environments in which societies are both affected by environmental disturbances and cause ecological change (Balée 2006). Changes inscribed on the landscape—the medium created by humans freely acting within the environment—result from natural occurrences as much as human interactions (Erickson 2008). Landscapes, in a historical ecological sense, represent more than an environment in which organisms inhabit. While landscapes offer resources and shelter, they simultaneously collect the physical remains of long-term narratives as the human past becomes inscribed upon the landscape (Balée 2006).

The distinction between historical ecology and other ecological frameworks is the emphasis on human agency as a force working to actively modify the environment. For example, cultural ecology holds that the environment is not transformable; instead, people must change to suit their ecological surroundings better. Historical ecology combats this notion with the concept of a “landscape” being actively created and changed by people over long periods. These landscapes offer archaeologists a glimpse at the deep history of humankind engraved on the surrounding environment (Balée 2006).

Historical ecology challenges the age-old notion of the “noble savage” or “pristine primitive.” The Noble Savage thesis argues Indigenous people lived in harmony with the environment through a Eurocentric and homogenizing lens. Native people were the “original conservationists,” stewards of the environment whose ecological wisdom and spiritual connection to the landscape serve as inspiration for modern industrial societies looking for sustainable trajectories moving forward. Through these ancient environmental practices, Indigenous people were thought to be able to lead us off the path of environmental destruction. These images of ecological nobility have led environmentalists to not only aspire to "Indigenous standards of ecological” knowledge but also enlist indigenous people as prominent allies of environmental movements (Nadasdy 2005).

While seemingly positive, the narrative of the ecologically noble savage "denies the realities of native people’s lives, reducing the rich diversity of their beliefs, values, social relations, and practices to a one-dimensional caricature” (Nadasdy 2005: 293). It has long been proven that the image of the ecologically noble savage is unattainable. Instead of living in harmony with the environment, Indigenous people have permanently altered their environments according to their needs, for the better or worse, rather than let the environment determine their adaptive behaviors. The historical narrative of Westerners as the “destroyers of nature” and Indigenous people as the “protectors of nature” disavows the great diversity of peoples and communities and denies their narratives of resistant and resilience (Nadasdy 2005).

The ideas of conservation and environmentalism are of Euro-American origin, rendering attempts to classify indigenous knowledge and cultural practices within these systems problematic. Traditional, long-held beliefs marked non-Europeans as simple-minded and primitive peoples, a perspective rooted in the idea that Indigenous people were unchanged, or as Eric Wolf coined, "people without history" (Wolf 2010). That being said, many descendant communities willingly join forces with environmentalist organizations in equal partnerships with a dual purpose of conserving the environment and their ancestral landscape. For example, in 2020, the Nansemond Indian Nation joined the Chesapeake Oyster Alliance, a coalition of nonprofits, community organizations, oyster growers, and others committed to adding 10 billion oysters to the Bay by 2025. This was a decision made in an attempt of "healing our [Nansemond] ancestral homeland" (Bass 2021). Through their own decision and "ambition to preserve the environment," the Nansemond Indian Nation chose to take part in conservation initiatives as a partner and ally rather than a symbol of environmental harmony to strive towards (Bass 2021).

Through these partnerships, the historical ecology or environmental archaeology thesis offers methods to conduct Indigenous-influenced conversation work, emphasizing preserving cultural landscape while conserving environmental integrity. For example, recent research concerning resilient communities and sustainable historical trajectories (e.g., Jansen 2018; Reeder-Myer et al. 2016; Rick et al. 2016; Rick and Lockwood 2013; Thompson et al. 2020; Turck and Thompson 2016) has shown the immense impact Indigenous peoples had on their environment. Disciplines such as archaeology, paleobiology, cartography, and geology reveal long-hidden records of the ecological past and develop historical baselines that document processes responsible for changes in coastal ecosystems, including events such as the collapse of the Chesapeake Bay oyster fishery.

Drawing from a deep historical understanding, historical ecology combined with other fields (e.g., paleobiology, conservation biology, ecology, history) offers insight into ecosystem change that helps inform contemporary environmental management and challenge long-held assumptions about the limited influence of humans in the distant past (Rick and Lockwood 2013). Research has shown that native peoples heavily influenced most pre-Contact landscapes in one way or another, be it through land cultivation, prescribed fire, or overhunting. This implies that conservation strategies may need to consider not only current human disturbances but also cultural practices that were historically important in managing ecosystems (Bjorkman and Vellend 2010). The combined knowledge of past, present, and future environmental conditions allows archaeologists and geologists to disclose the landscape's narrative. Critical to these narratives is reconstructing historical baselines, or reference conditions, by identifying core social and environmental processes responsible for resource depletion over time (Rick and Lockwood 2013). While many disciplines offer ways to identify ecological causes, archaeology stands alone in its ability to "people the past." Archaeology informs the environmental as well as human social, political, and ceremonial processes that changed and shaped natural environments over millennia.

Environmental archaeology often draws on paleoclimatic proxies such as shells, pollen, wood charcoal, and tree rings when making conclusions about the environmental conditions of past societies (Balée 2006). The archaeological record can supplement paleoclimate data by humanizing landscapes and offering evidence of how past civilizations modified and adapted to the natural environment (Erlandson 2012; Erlandson and Rick 2010; Rick and Lockwood 2013). Insight from archaeological data can also inform researchers about how past societies adjusted to rapidly changing environments. Therefore, the archaeological record may hold vital insight to help mitigate contemporary environmental issues (e.g., climate change and sea-level rise) that threaten to destroy the remaining archaeological reserves. As Erlandson (2012:140) states: “Ironically, marine erosion is destroying the very coastal sites that can tell us how past societies adapted to earlier episodes of sea-level rise and coastal geographic change that had profound effects on human history.” Thus, we should be working to preserve sites threatened by environmental forces as sources of future research rather than let allow them to be destroyed. Environmental and cultural historical trajectories are undeniably linked, supporting the claim "there is no cultural landscape distinct from natural landscape in historical ecology—only landscape” (Gallivan 2016:11). To realize the natural environment, we must recognize and understand the historical narratives transpiring within the landscape, including the forced colonization and displacement of indigenous communities, erasure of Indigenous histories in education and public memory, economic marginalization, and violations of cultural and political rights (Whyte 2018).

Through a historical ecological lens, this project aims to discover archaeological sites with the potential to reveal cultural, environmental, and historical narratives and bring them to the forefront of conversations regarding conservation, mitigation, and climate change. Archaeological sites are long-term archives of the human past inscribed on the landscape, meaning their fate is tied to the ground on which they sit. Ergo, if the coastline is destroyed, so too is all the archaeological potential.

b. History of Shell Midden Archaeology in the Chesapeake Bay

Coastal environments offer unique perspectives on early human estuary usage and subsistence practices. They serve greater functions than merely resource procurement areas, influencing components of Indigenous life from long-term occupation, culture, kinship, political organization, and architecture to resilience and the experience of colonialism. This project specifically focuses on the coastlines of the Chesapeake Bay, the largest estuary in the continental United States and home to a once-thriving oyster fishery (Rick et al. 2016). The Chesapeake Bay is approximately 320 km long and bordered by over 7,400 km of shoreline. The Bay is categorized as an estuary due to the combination of freshwater from local tributaries mixed with the salt water of the Atlantic Ocean. This blend, referred to as brackish water, has allowed more than 2,000 aquatic and terrestrial species to thrive in and around the Bay, forming one of the most productive natural ecosystems in the area (Dent 1995).

While this study emphasizes the threats future environmental conditions pose to coastal archaeological sites, it is essential to discuss the temporality of the archaeological record in this region better to grasp the importance of the undocumented archaeological potential. Researchers have established that the Chesapeake Bay and its associated tributaries (e.g., the Nansemond River) are a relatively recent post-Pleistocene (2.58 million years ago [mya]–1,700 mya) phenomenon (Kusnerik et al. 2018). The estuary we know today only began to form circa 10,000 B.C. and was not completed until approximately 3,000 years ago. Altogether, the transformation of this area into its more-or-less present form required almost 7,000 years. Thus, it must be remembered that the land mass available for prehistoric occupation during the pre-Contact period drastically differed from what we understand as the modern Chesapeake Bay watershed (Dent 1995).

Geologically known as the Holocene (ca. 9700–5000 B.C.), this was a time of extreme climate change and increasing ecological complexity. As the last “ice age” was coming to an end, the climate was quickly warming, and sea levels were rising due to melted glacial ice flowing back into the ocean (Dame 2008). With rising sea levels, intertidal and shallow coastal habitats continually changed as they were submerged or forced up-slope. By about 6000 B.C., the sea-level rise had slowed, and deltas of accumulated sediment began to appear in submerged river valleys and drainage basins. As sea levels stabilized, modern coastlines started developing along the east coast of

North America (Thompson and Worth 2011). The freshly submerged areas transformed into estuaries, which became the habitats of thriving bivalve and shellfish populations (Dame 2008). The estuarine systems rapidly accumulated some of the most productive natural ecosystems on the planet, and the native people of the coastal mid-Atlantic region took full advantage of these resources. The rich estuaries of the Late Archaic fostered a complex food web centered on the presence of shellfish, like the Eastern Oyster (*Crassostrea virginica*) (Dame 2008).

The Chesapeake Bay holds a deep history of human settlement and subsistence with an archaeological record spanning as early as the Paleoindian period (B.C. 12,000 –8,000) through the twentieth century. With the Chesapeake Bay serving as an entry point for most early colonial endeavors, Indigenous coastal sites in the mid-Atlantic region have the potential to reveal evidence regarding complexity in nonagricultural societies and the experiences of Native Americans during the early days of colonization. The Chesapeake Bay functioned as Native Americans' primary estuarine resource along the mid-Atlantic coast for epochs due to its rich abundance of natural resources. Shellfish harvesting increased exponentially during the Late Archaic period (2500–1200 B.C.) as previously turbulent sea levels stabilized (Dame 2008). This resulted in the development of extensive shell midden deposits beginning to materialize in the archeological record (Thompson and Worth 2011). Intensive shellfish harvesting by Native populations living in the region continued for millennia.

With the onset of colonization and into the following centuries, anthropogenic habitat modification to the Chesapeake Bay (e.g., habitat destruction and removal, intensive harvesting and fishing practices, and nutrient runoff) fundamentally changed the ecosystem of the Bay (Harding et al. 2008). By the mid-to-late 1800s, oyster reefs from the Bay were heavily harvested for canning and commercial consumption, quickly depleting resources (Thompson et al. 2020). Barely 200 years following colonization, the once-thriving shellfish populations in the region had been reduced to a fraction of their historical abundance (Schulte 2017). These precipitous declines cause difficulty in establishing baselines for restoration, adding to the already complicated task of restoring a healthy and sustainable fishery with ever-present eutrophication, sedimentation, disease, and ongoing harvest (Rick et al. 2016).

Much Indigenous history from the mid-Atlantic region is found in or alongside shell middens (Gallivan 2011). Previous research and archaeological excavations (e.g., Jenkins and Gallivan 2019; Reeder-Myers et al. 2016; Rick et al. 2011; Rick et al. 2016; Thompson et al. 2020) reveal the abundance of oyster middens scattered throughout the Chesapeake Bay coastline, emphasizing the central role of oysters within the economic, social, and cultural systems of coastal peoples. Holmes (1907) estimated upward of 100,000 acres of shell middens in Virginia and Maryland alone. Due to their abundance and well-established preservation, shell middens can reveal much about pre-Contact Indigenous life.

Archeological studies of shell midden and coastal sites provide a deeper historical perspective of oyster collapse and can help inform policy makers about places to concentrate oyster fishery revitalization efforts (Jenkins 2017). The results of these archaeological studies can shed light on the variable ways humans have transformed natural landscapes during the Anthropocene (a term some researchers have proposed for the current geological age) (Crutzen and Stoermer 2000). Oysters, along with other shellfish and mollusks, act as valuable proxies for past human-induced and ecological change, even being utilized by some researchers as a marker of the Anthropocene (Thompson et al. 2020).

Previous research (e.g., Harding et al. 2008; Jansen 2018; 2016; Jenkins and Gallivan 2019; Lulewicz et al. 2017; Reeder-Myers et al. 2016; Thompson et al. 2020) has demonstrated that Native Americans in the Chesapeake harvested oysters sustainably, on a millennial time scale, a remarkable pattern considering that the nineteenth century Chesapeake oyster fishery collapsed following only 200 years of post-colonial harvesting (e.g., Kusnerik et al. 2018). Archaeological evidence demonstrates that the precontact oyster fishery fostered resilience through Native harvesting practices centered on oyster collection from shallow water nearshore reefs (Jenkins and Gallivan 2019).

Other studies have shown the inventiveness of Native coastal dwellers over time. Using height (the longest measurement of an oyster shell from the dorsal to the ventral) as a proxy for oyster health. Rick et al. (2016) suggest that Native Americans living in the Chesapeake watershed maintained a sustainable oyster harvesting system for millennia by demonstrating an increase in valve height through time. The work of Thompson and colleagues (2020) shows increased growth in oyster shell size from the Late Archaic period through the Mississippian period (ca. 1000–500 B.C.), implying localized increases in ecosystem productivity either through human management practices or environmental change. They suggest that when Native American usage of oyster reef ecosystems intensified, more territoriality of fishing rights developed to manage populations. Mississippian societies maintained considerable hierarchical control over oyster reef harvesting, acting as a management system for common-pool resources to reduce harvest threats by one person or group. These territorial practices may have started much earlier, perhaps parallel to ethnographic and archaeological evidence from fisher-hunter-gatherers elsewhere in the world (Thompson et al. 2020).

Jenkins and Gallivan (2019) also see an increase in mean oyster height from the Late Archaic through the Middle Woodland I period, evidence of possible oyster reef cultivation, and maricultural practices such as shelling (i.e., the practice of returning oyster shells to the water to build up reef habitat for future growth) and culling (i.e., the breaking apart oyster clumps, or burrs, keeping some oysters and discarding others back into the water [Jenkins 2017: 75-76]) (Jenkins and Gallivan 2019). They show that the state of the Native oyster fishery was not only sustainable but also resilient (i.e., "the capacity of a system to recover in size, structure, and diversity after strain caused by stress" [Jenkins and Gallivan 2019:18]) through a significant decrease in shell height from the Middle Woodland I period (500 B.C.–A.D. 200) to the Middle Woodland II period (A.D. 200–900) (Jenkins and Gallivan 2019). These trends coincide with substantial increases in population size, resource demands, and sedentism. With Native American management, oyster height increased again at the onset of the Late Woodland period, returning to previous measures and continuing to remain at a consistent size through European contact (Jenkins and Gallivan 2019).

Patterns show that oyster populations in the Chesapeake Bay remained relatively stable until the onset of colonization in the early 1600s. Harding et al. (2008) observed a decline in oyster shell height between oysters harvested by Jamestown settlers from 1611 to 1612 and modern oyster populations at the same age. They conclude that oysters at the onset of colonization were larger, in a better state of health, and had significantly faster growth than modern oyster populations. Unlike historic oyster populations, modern river oysters have faced severe degradation due to years of exposure to diseases such as Dermo and MSX and other chronic environmental stresses (e.g., pollution, dredging, eutrophication), negatively impacting growth and reproduction (Harding et al. 2008).

Previous studies centered on sea-level rise in the Chesapeake Bay watershed (e.g.., Erlandson 2012; Erlandson and Rick 2010; Reeder-Myers and Rick 2019; Rick and Lockwood 2013; Smith 2017) indicate that the two most at-risk archaeological sites in the region are Native American shell middens and residential settlements located in estuarine environments. Climate scientists have revealed that the Chesapeake Bay sea levels have already risen 0.9 m (3 feet [ft]) since John Smith first arrived in the early

1600s (Dame 2008). As demonstrated by the research potential exhibited above, shell midden sites are critical to preserving as their accumulation over an extensive period and ability to withstand poor preservation conditions render them long-term archives of cultural and environmental change (Smith 2017). In recent decades, the preservation of Indigenous knowledge and the protection of archaeological sites have become priorities in the nation's attempts at cultural conservation. The damage of such resources to the threats of climate change would be a tremendous loss of Indigenous knowledge about the region's past cultural and environmental processes (Smith 2017).

III. Coastal Change Processes

The environmental landscape of the Nansemond River has been affected by various natural and anthropogenic processes over thousands of years. In recent decades, there has been a resurgence of many threats due to climate change. The following section details the environmental processes most impactful to the Chesapeake Bay shorelines and underlying archaeological record. These include but are not limited to sea-level rise, shoreline subsidence, and coastal erosion.

a. Coastal Erosion

Coastal erosion is the process by which local seal level rise, strong wave action, tidal currents, coastal flooding, and in some cases, boat wakes and shoreline hardening, wear down or carry away rocks, soil, and sand from along the coast. All coastlines are affected by natural events that cause erosion, yet the severity of the problem is only worsening with global warming and climate change. Continually increasing sea-level rise causes waves to break at higher elevations along shorelines, inundating lower elevations more brutally and eroding sediment off the slope (Smith 2017).

The Nansemond River shoreline is currently experiencing low to medium erosion rates, meaning the coast is changing between -1 and -5 ft/year (Figure 2) (Hardaway et al. 2017). As a result, the shorelines along the Nansemond River with the highest historic rates of change have been hardened as a preventative measure. Shoreline hardening involves the installation of artificial structures such as concrete, rocks, or riprap borders consisting of large stones along the water's edge (Figure 3). This primarily involves placing broken concrete along the shoreline of the Nansemond River to prevent future erosion. Additionally, two headland breakwaters were built in the late 1990s to stabilize the beaches at the head of the river. Other areas along the shoreline are covered by marsh fringes of varying widths, acting as another barrier to the effects of erosion (Hardaway et al. 2014).

These shoreline arrangements mean that erosion rates vary significantly along the Nansemond River depending on such factors as shoreline type, the direction the shoreline faces, and whether it has a structure built on it or nearby (Hardaway et al. 2014). While some areas are experiencing low erosion rates (< 1 ft/year), others have medium erosion rates (2–5 ft/year). The areas around Chuckatuck Creek are some of the areas with the highest erosion rates, upwards of 3 ft/year (Figure 4). While the techniques historically applied for shoreline stabilization, such as hardening and headland breakwaters, are effective in the short term for decreasing shoreline erosion, they destroy the natural character of the shoreline and often their associated archaeological resources. This means if shoreline management methods do not change, we will lose the ability to properly preserve our coastal natural and cultural resources from erosion (Hardaway et al. 2014).

b. Sea Level Rise

Sea-level rise is measured by climate scientists in two ways: absolute sea-level rise and relative sea-level rise. Absolute, or global, sea-level rise is a measure of the increase in the volume of water in the world's oceans due to increasing temperatures and melting ice caps (Smith 2017). It refers to the height of the ocean surface above the center of the Earth without regard to whether nearby land is rising or falling

(Environmental Protection Agency 2021). Estimates place current global sea-level rise rates at approximately 3.4 millimeters (mm) per year (Weeman 2017). In contrast, relative sea-level rise calculates the change in ocean rise and fall relative to land at a particular location (Environmental Protection Agency 2021). As land sinks, the difference in vertical elevation between the land and surface increases. Relative sea-level rise tends to produce a higher rate of sea-level rise than absolute sea-level rise because the relative value accounts for the degree of land subsidence (Smith 2017). Relative sea-level rise is the calculation typically measured by National Oceanographic and Atmospheric Administration (NOAA) tidal stations. The closest gauge to the study area that provides water levels is at Sewell Point, Virginia, within the Norfolk Navy Station (Figure 5). The gauge currently reports an increase in relative sea level trend of 4.74 mm/year with a 95% confidence interval of +/- 0.21 mm/year based on monthly mean sea level data from 1927 to 2021 (Virginia Tidal Gauges 2021). Sewells Point actively projects a sea-level rise of 2.03 ft (0.62 m +/- 0.22 m) by 2050. This increase in sea-level warrants ongoing monitoring of shoreline conditions and attention to shoreline management planning (Hardaway et al. 2014).

Sea level rise is the biggest non-human threat to coastal archaeological sites. In the United States alone, almost 30% of the population lives in high-density coastal areas where sea-level rise plays a role in flooding, shoreline erosion, and storm hazards. Sea level rise is caused by various factors, including thermal expansion, land uplift and subsidence, and glacier and ice melt. As sea levels increase, archaeological sites along shorelines become further submerged underwater. The more a site is subject to inundation, the faster the site integrity is destroyed, and artifacts and cultural deposits washed away.

c. *Land Subsidence*

Land subsidence is the “gradual settling or sudden sinking of the Earth’s surface due to removal or displacement of subsurface earth materials” (Water Resources 2019). Today, more than 80% of known land subsidence in the US is a consequence of groundwater use—a primarily human-driven activity. Some primary causes include aquifer-system compaction associated with groundwater withdrawal, drainage of organic soils, underground mining, and natural compaction or collapse such as sinkholes or thawing permafrost. In coastal areas, groundwater is pumped to provide water supplies for localities and as a result, the surrounding sediment layers compact, making the ground surface lower than before (Smith 2017). The combined effects of sea-level rise and sinking and subsiding land have made the world’s coastal residents and resources disproportionately vulnerable to the effects of climate change. Current land subsidence rates for the southern Chesapeake Bay region place land decrease between 1.1 and 4.8 mm per year (Virginia and West Virginia Water Science Center 2018).

D. Summary

The drastic effect sea level rise has on much of the world’s populations results from the historical tendency of people to settle along easily navigable coastlines and productive river delta regions. Today, this leaves coastal inhabitants concentrated in rapidly subsiding areas, including sinking deltas, coastal cities, and coastal floodplains. If land subsidence continues at the current rate, significantly more coastal residents and resources will be at risk in the coming decades (Stone 2021). Various initiatives are in action to counteract the effects of ground water pumping, including a project through the Hampton Roads Sanitation District in Virginia. Through their *Sustainable Water Initiative for Tomorrow* program, plans exist to inject treated wastewater below the ground to raise groundwater pressures, potentially expanding the aquifer system, raising the land surface, and counteracting the land subsidence occurring in the Virginia Coastal Plain (Virginia and West Virginia Water Science Center 2018).

IV. Heritage Management Practices

Steps are being taken to preserve archaeological sites from human and environmental threats. However, historic preservation and cultural conservation come at both a high time and monetary commitment. Therefore, methods must be employed to filter out sites with the greatest cultural returns at the highest risk. The most well-established archaeological preservation program lies under the control of the National Park Service (NPS): the National Register of Historic Places (NRHP). The NRHP is the official list of the nation's historic places worthy of preservation. It acts as a national program to foster support for both private and public initiatives to identify, evaluate, and protect historic and archaeological resources. Listings on the NRHP widely vary from historic plantations and battlefields to pre-contact sites thousands of years old.

The NPS has established a four-part set of criteria historic sites must meet to qualify for the NRHP. The criteria aim to determine the quality of significance of historic resources, including buildings, archaeological sites, and cemeteries. The four-part criteria are as follows (National Park Service 2022):

A. If they are associated with events that have significantly contributed to the board patterns of history.
B. If they are associated with the lives of persons significant in our past.
C. If they embody distinctive characteristics of a type, period, or construction method.
D. If they have yielded or may be likely to yield, information important in prehistory or history.

Other archaeological site preservation and conservation methods relate to threats posed by environmental and anthropogenic forces. Under the National Historic Preservation Act (NHPA), archaeological sites are accessed on their significance and potential threat. The evaluation determines what mitigation tactics to proceed with going forwards, either data recovery and excavation prior to site destruction or preservation of the site *in situ* (Smith 2017).

The primary mitigation method for shorelines is stabilization to prevent the further eroding of archaeological potential. The shorelines of the Nansemond River fall within the City of Suffolk's Shoreline Management Program. The program confirms that many Suffolk shorelines are suitable for a "living shoreline" approach (Hardaway et al. 2014). Living shorelines are a shoreline management practice that addresses erosion in lower energy situations by offering long-term protection, restoration, and enhancement of vegetated shoreline habitats (Figure 6). There are many ways living shorelines can be put into place, such as the strategic placement of plants, stone, sand fill, and other structural and organic materials. Living shorelines maintain natural processes between intertidal and subtidal areas and allow native plant populations to flourish along coastlines. They provide valuable ecological services, including water quality improvement, aquatic habitats, tidal water exchange, sediment movement, wetland preservation, improved groundwater flow, and decreased erosion. These services reinforce archaeological site preservation by stabilizing shorelines without destroying the natural environment, unlike older shoreline management techniques (Center for Coastal Resources Management 2020).

Traditional management practices included the construction of bulkheads, concrete seawalls, stone revetments, and the use of miscellaneous material placed along shorelines to stimulate the function of bulkheads. The adverse effects of shoreline hardening on the natural integrity of shorelines are now understood, and while these techniques are effective at stabilizing eroding shorelines, they unfavorably alter habitats causing permanent loss in ecosystem function. For example, bulkheads constructed close to the water correlate with sediment loss and high temperatures in intertidal zones, impacting organisms living in the areas (Hardaway et al. 2014). Along the Nansemond River, approximately 12 miles of shoreline have been hardened. However, plans are now underway to continue the restoration of the Nansemond shoreline through the

Living Shorelines Program. More will be discussed about these initiatives and their effects on archaeological sites in the conclusion.

V. Case Study: The Nansemond River Tributary

a. Environmental Context

To better understand the cultural landscapes of the study area, it is necessary to understand the underlying natural features that make up the environment in question. The study area is the Nansemond River and its associated shorelines and tributaries. The Nansemond River is a part of the larger Chesapeake Bay watershed (Figure 1). The river originates in downtown Suffolk, Virginia (upper Nansemond) and flows approximately 20 miles from the city center to the confluence of the James River. The river has no significant source of freshwater except storm water runoff from rain events, allowing for higher salinity values. At the mouth of the Nansemond, salinity averages 15 parts per thousand (ppt) (brackish water) and gradually decreases to 1 to 2 ppt by the time the river reaches downtown Suffolk. Tidal rise and fall average 3 ft (Nansemond River Preservation Alliance 2022). Suffolk has approximately 150 miles of main river and creek shoreline with elevations that range from about 3 ft in marsh regions to between 5 and 20 ft along the bluffed shoreline (Hardaway et al. 2014). The Nansemond River tributary was initially made up of three streams that formed its headwaters, then split into two separate tributaries, the Western Branch and Bennett's Creek. Manufactured dams have since impounded the three streams and now exist as Lake Cahoon, Lake Kilby, and Lake Meade (Bass 2021).

The Nansemond River watershed drains 161,358 acres of land throughout Suffolk and Isle of Wight Counties. This includes several smaller tributaries: Chuckatuck Creek, Bennett's Creek, Cedar Creek, Sleepy Hole Park, and Constant's Wharf. Much of the river is made up of shoals (i.e., accumulations of sediment in a river channel or on a continental shelf less than 10 m below water level at low tide) and bordered by numerous wetlands. The land surrounding the Nansemond River is made up of various urban developments, mainly residential areas, farm and agricultural land, and wetland vegetation (USGS 2019). Parts of the shoreline border environmentally protected land, including the Nansemond National Wildlife Refuge. The riparian zone (i.e., the area where the land and water meet) is home to a diversity of plant and animal species. Much coastal vegetation filters the land runoff and stabilizes the shoreline (Bass 2021).

Currently, the overall health of the waterway is declining. The river is impaired by excess bacteria, resulting in 60% of the Nansemond River being closed to shellfish harvesting. Additionally, sediment concentrations are rising rapidly due to increased runoff, impacting water clarity. Groups such as the Nansemond River Preservation Alliance (NRPA) and the Nansemond Indian Nation, along with many others, are actively working to raise public awareness and encourage environmental stewardship of the Nansemond River, its tributaries, and wetlands, with special attention given to the restoration of the oyster fishery (Nansemond River Preservation Alliance 2022).

b. Culture History of the Chesapeake

Native American habitation of the Chesapeake Region began somewhere between the Paleoindian period (15000–8000 B.C.) and the Early Archaic period (8000–6000 B.C.) (Dent 1995); however, archaeological remains of these periods are relatively scarce due to sea-level rise following the end of the Pleistocene Epoch (2.6 million–11,700 years ago) (Egloff and Woodward 2006). The precontact period, or time before European arrival in North America, is typically divided into three distinct periods: the Paleoindian (15000–8000 B.C.), the Archaic (8000–1200 B.C.), and the Woodland (1200 B.C.–A.D. 1600). The Archaic period is further divided into the Early (8000–6000 B.C.), Middle (6000–2500 B.C.), and Late (2500–1200 B.C.) subperiods. The Woodland period is similarly divided into Early (1200–500 B.C.), Middle (500 B.C –A.D. 900), and Late

(A.D. 900–1607) (VDHR 2018). The following section provides a general cultural history of the Nansemond and the larger Chesapeake landscape in relation to the oyster fishery.

It must be acknowledged that much of the regional history discussed below Is informed by work from the mid-to-late 1990s, especially Richard Dent's *Chesapeake Prehistory* (1995), one of this region's most prominent regional histories. Many of the assumptions and descriptions of the precontact Chesapeake come from old literature and require updates. With some exceptions (e.g., Egloff and Woodward 2006; Gallivan 2007; Gallivan et al. 2011; Gallivan 2016; Roundtree 2005; Thompson and Worth 2011), little has been done in the Middle-Atlantic region to refine and redefine historical and cultural descriptions, meaning that they largely remain functional and environmentally deterministic. Thus, many of the explanations regarding the actions of ancient people (i.e., the changing climate forced people to adapt) are in out of line with the theoretical stance taken in this thesis. However, it is not the goal of this study to discuss Chesapeake regional history through the lens of historical ecology, but rather to offer context into the occupational history of the Nansemond River landscape.

Archaeological evidence indicates Native American occupation of the region from the close of the last Ice Age (i.e., the Pleistocene Epoch) to the displacement of many Indigenous populations by colonization in the late 1600s. In recent years, many descendant communities, like the Nansemond Indian Nation, have worked to reclaim their ancestral lands (Bass 2021). The Chesapeake Bay watershed was first occupied during the Paleo-Indian period, between 12,000 and 9,000 years ago. These early people primarily lived in small bands with their nuclear or extended family as nomadic hunter-foragers who established small, short-term camps. Paleo-Indians were highly mobile people, transitioning across the ancient landscape throughout the seasons to follow the most abundant resources (Dent 1995).

Occupation of the Chesapeake region increased exponentially during the Archaic period. While specific data for the Archaic period is limited, general assumptions can be made regarding Archaic settlement and subsistence practices within the Chesapeake. The Archaic period was a time of adjustment to the rapidly changing landscape that culminated in a period defined by social experimentation and redirection of human prehistory. With climatic changes came a more significant seasonal availability of resources, allowing for a greater reliance on seasonal mobility (Dent 1995).

While the Early and Middle Archaic periods remain somewhat elusive, both began to see the development of projectile points with distinct stylistic patterns. Dent (1995) states that trends initiated during the Early Archaic period appear to continue into the Middle Archaic period. During both periods, Native people settled in interior wetland areas near stream junctions, tributary floodplains, or other areas that might offer resource concentrations. Generally, both periods can be categorized by many small sites scattered across the landscape (Dent 1995). While some sites indicate possible usage of shellfish and oyster harvesting during the Middle Archaic period, no well-dated shell middens have been found to support this claim. Many researchers state that the Susquehanna River was still progressing rapidly enough to preclude the establishment of sizable concentrations of oysters (Dent 1995).

At the onset of the Late Archaic period (2500–1200 B.C.), nomadic groups of forager-fishers followed distinct resources through strategic settlement shifts, moving from the interior Coastal Plain into the Piedmont region. Reoccupation of the sites every year was frequent, given the seasonal predictability of the resources, especially those related to coastal and marine settings (Dent 1995). During this time, sea levels began to stabilize, resulting in new estuaries and various unique marine resources available for exploitation (Dame 2008). Native American groups in the Chesapeake started to develop new adaptive strategies coinciding with population increases and mobility decreases. As the Late Archaic transitioned into the Early Woodland period, small hunting bands transitioned into larger, semi-sedentary groups (Gallivan 2011). The climate became hotter and drier during this period, and riverine and estuarine settings provided abundant new plants and animals to harvest. For example, previously submerged floodplains now provided coastal Native Americans with a regular supply of estuarine resources, especially shellfish.

Native Americans developed new technologies that enhanced their ability to collect and utilize food resources from riverine and estuarine environments. As a result of these new technologies and more ecologically rich environments, there was less need to travel long distances to collect resources. Instead, Native groups had the opportunity to remain in one area and more consistently harvest local resources. The Late Archaic period resulted in the intensified production of resources rather than previous efforts at maintenance (Dent 1995). During this time, Indigenous people began engaging in resource management practices (i.e., mariculture) that increased the abundance of their natural resources. For example, Jenkins (2017) discusses examples of marine management systems such as the intentional selection of shellfish by size and age, shelling (i.e., returning dead oyster shells to extant reefs to enhance substrate for larval settlement), and culling (i.e., breaking apart oyster clumps, or burrs, keeping some oysters and discarding others back into the water) (Jenkins 2017:75–76).

The intensification effort was a lifestyle change forged by new adaptational systems that took advantage of the more stabilized ecosystem. With these adaptations came many advances related to the abundant fisheries of the Chesapeake Bay, including increases in oyster collection techniques that allowed for the harvest of offshore oysters. Offshore oysters were frequently collected by specialized task groups traveling through deep water in canoes. They would either dive off the canoe side and swim to retrieve the oysters or utilize specialized tongs to pull them out of the reefs (Dent 1995).

During the Early Woodland, sites typically consisted of small to medium camps located along small bodies of water such as streams or rivers. Researchers have reported more Early Woodland sites west of the Chickahominy than to the east along the James-York Peninsula (Figure 7). This strongly supports the assumption that Native inhabitants migrated eastward as they shifted their dependence from forest resources in the Early Woodland to estuarine resources in the Middle Woodland period. The resource shift can be explained by the lower sea levels present during this period and the expansion of tidal wetlands and more saline water upriver, creating an ideal environment for shellfish (Smith 2017). During the Middle Woodland period, subsistence strategies emphasized hunting deer and other land mammals and gathering fish, shellfish, starchy roots, tubers, and other local plants (Stewart 1992). By this time, archaeologists speculate that many Native American groups had developed relatively sedentary settlement patterns, choosing to reside in moderately sized villages. Archaeologically, these sites manifest as low-density middens in coastal environments. Small groups, possibly family units or specialized task forces, would separate from the core aggregate for a short period (up to several weeks) and establish microband camps to collect resources to return to the village (Blanton 1992; Stewart 1992).

The Middle Woodland period marks a significant transformation of lifeways towards coastal resources—from "hunter-gatherer" to "fisher-forager." Settlements were established nearer to the shorelines to allow for shellfish harvest during the fall and winter and fish in the spring and summer (Smith 2017). These shifts coincide with the development of extensive shell middens throughout the mid-Atlantic (Dent 1995). Shell middens often represent the locations of Middle Woodland resource procurement sites inhabited by specialized task groups for a short period to collect a specific resource.

The sites were visited yearly on a seasonal basis (Binford 1980). However, more recent studies have considered shell middens part of a larger historical narrative inscribed on the landscape. Shell middens have been interpreted as the remains of large feasting events at ceremonial centers as well as the remnants of persistent places visited by indigenous groups over many generations (Gallivan 2016).

Gatherings were significant events that would bring together different groups for feasting and trade. Many interpretations regarding such gatherings center on adaptation to environmental settings through sharing ecological information and resources (Gallivan 2016). More recent work has shifted narratives to focus more on the historical development of forager-fishers rather than their adaptive behavior. Forager-fisher societies in the Chesapeake region regularly interacted within interior encampments and large estuarine settlements organized around expansive shell middens. The small aggregate sites produced by these societies offer a setting for considering mundane practices, cultural traditions, and in some cases, human agency (Gallivan 2016).

Some of the most prominent settlements throughout the Chesapeake region were situated around shell middens—accumulations of trash left behind after the harvesting and processing of shellfish (Gallivan 2016). Middens varied in pattern; for example, those clustered along the broad mouth of Indian Field Creek on the York River contained rich deposits of oysters and clam shells within deeply stratified deposits. Others, such as the Maycock's Point site on the James River, contained deep middens of freshwater shellfish, fish bones, and elaborate ceramics from feasting events (Gallivan 2016). The two types of midden deposits are suggestive of different occupation events, with the deeply stratified midden representing the long-term accumulation of shellfish harvesting in one location (i.e., as a persistent place) versus the midden resembling a shallow, short-term deposit site for a feasting event (Jenkins and Gallivan 2019).

The Middle Woodland period is known as an era of rapid population growth, political centralization, and increased sedentism (Gallivan 2016). Larger population sizes and the rise of sedentary lifestyles required a more abundant and reliable food source, causing Native populations to begin harvesting oyster reefs more intensively. In their work, Jenkins and Gallivan (2019) show a decrease in mean oyster height from the Middle Woodland I (B.C. 500–A.D. 200) to the Middle Woodland II (A.D. 200–900), following long-term trends of oyster height increase moving out of the Late Archaic period (Jenkins and Gallivan 2019: 15). They argue that the decrease in mean oyster height was in response to increased populations and human predation pressure during the Middle Woodland II as the Chesapeake shell middens were most intensively harvested during this period.

Transitioning into the Late Woodland period (A.D. 900–1600), sedentism continued to expand as maize agriculture increased in prominence throughout the Chesapeake region. In the early half of the Late Woodland period, intermediate-size sites are interpreted as semipermanent villages or hamlets. By about 1300 A.D., intermediate-size sites decreased in number as most of the population began to coalesce into large, dispersed, or nonnucleated villages. Many of the larger sites tended to be serviced by small satellite villages and outlaying hamlets. Archaeologists argue that the settlement patterns resulted from the need for close proximity to suitable soils for agriculture and settlement restrictions from other Indigenous groups. Native groups living in the Coastal Plains were highly constricted by one another and other more hostile groups in the west and north. Often unoccupied buffer zones existed between tribal boundaries as either game preserves or the accidental result of the chiefdom's tendency to nucleate populations for the purposes of control (Dent 1995). Oysters remained a heavily utilized resource for much of the Late Woodland period. They were routinely harvested, especially the nearshore oysters found on riverbanks (Dent 1995).

Waselkov (1982) even notes an intensification in oyster harvesting lasting through the early part of the Late Woodland period.

Following the transition into the Late Woodland period (900–1200 A.D.), Gallivan (2016) notes a reversal of the oyster consumption trends in the Middle Woodland period. A decreased number of oysters were regularly consumed, putting less pressure on oyster populations. In turn, oysters were allowed to live longer and grow larger. This pattern is observable by an increase in the average shell size of oyster shells recovered from Late Woodland period shell midden deposits (Gallivan 2016). The transition in subsistence practices and resilience displayed by the fishery is likely a result of the development of management practices by past people surrounding the oyster fishery. With growing population sizes and the onset of village life during the Middle and Late Woodland periods, common resource management likely intensified. Villages and other more extensive, sedentary groups were dependent, to a large extent, on local resources and likely enacted practices to encourage the health and productivity of nearby reefs. It is hypothesized that these practices included supplementing reefs with old oyster shells (i.e., mariculture) and/or shifting harvesting enterprises from offshore to nearshore reefs, fostering resilience within the oyster fishery (Thompson et al. 2020). By working together in harvesting endeavors, mass captures during the oyster season had the potential to finance collective rituals for the rest of the year (Thompson 2018).

The end of the Late Woodland period and the onset of the Protohistoric period (1200–1607 A.D.) is characterized by continual population increase as village life became more complex and hierarchical. Villages developed more permanent dwellings, such as longhouses or smaller oval-shaped buildings, often encircled by ditches or palisade lines (Dent 1995). Palisades served as symbolic enclosures rather than actual fortifications as they often separated a chief’s house or sacred space from the remainder of the village (Smith 2017).

At the time of European Contact (ca. 1607), the Powhatan chiefdom, an Algonquian-speaking political alliance, occupied most of the lower Chesapeake Bay. Their territory extended from the Rappahannock River in the north southward to the James River. Chief Powhatan, known as Wahunsenacah, inherited leadership over six tribes near Richmond from the upper James and York River basins (Roundtree 1989). Intent on expanding his reach of power, Powhatan moved eastward, conquering 25 new tribes, and building an extensive and well-developed chiefdom with himself as paramount chief (Smith 2017). At the time of European contact, the Powhatan territory was divided into numerous distinct sub-tribes led by a local chief, or *werowance*, who was often a relative of Chief Powhatan to ensure loyalty (Dent 1995). Powhatan safeguarded loyalty throughout his chiefdom through a complex gifting and redistribution network. This involved the promise of protection and prestige goods (e.g., ornaments, shell beads, and copper) to the *werowances* placed in power in exchange for their loyalty and tribute to Powhatan as the *Mamanatowick*, or paramount Chief (Roundtree 1989).

c. Culture History of the Nansemond River

The Nansemond Indian Nation, situated on the Nansemond River at the mouth of the James River in modern-day Suffolk, Virginia, was historically one of the sub-tribes within the larger Powhatan Chiefdom. Anthropologists, including Lewis Binford have argued that the Nansemond remained outside of the Powhatan chiefdom as they did not appear to participate in the "redistribution network of the Powhatan Chiefdom" (Roundtree 1989: 14). However, Roundtree (1989: 14) contends the Nansemond hosted an organizational structure that paralleled that of the Powhatan Chiefdom with a *werowance* in power along with his three sub-chiefs (Roundtree 1989). The early Nansemond people in the region lived as forager-fishers who fished, hunted, gathered, and harvested shellfish for hundreds of years (Neal 1959). They inhabited flat terraces that overlooked the Nansemond River on which they developed small riverfront settlements of approximately 100 people governed by an appointed *werowance* (Bottoms 1983). When John Smith first encountered the Nansemond people in 1608, he estimated the population at approximately 1,000 men, women, and children combined (Turner 1982). While the Nansemond people utilized the vast marine resources of their estuarine ecosystem, they were also fervent agriculturalists, confirmed by Smith's descriptions of cornfields along the shoreline. He described his observation of the Nansemond as follows:

> "This river is a musket shot broad, each side being should bayes; a narrow channel, but three fadom: his course for eighteene miles, almost directly South, and by West where beginneth the first inhabitnts: for a mile it turneth directly Earth; towards the West, a great bay, and a white chaukie Iland convenient for a Fort: his next course South, where within a quarter of a mile, the river divideth in two, the neck a plaine high Corne field, the wester bought a highe plaine likewise, the Northwest answerable in all respects. In these plains are planted an aboundance of houses and people; they may containe 1000. Acres of most excellent fertill ground: so sweete, so pleasant, so beautiful, and so strong a prospect, for an invincible strong City, with so many commodities that I know as yet I have not seene. This is within one daies journey of Chawwonocke, the river falleth into he Kings river, within twelve miles of Cape-hendicke" (Tyler 1907: 63).

Historically, the Nansemond River hosted thriving oyster populations, with nearshore oysters residing in shallow areas like Bennett's Creek and offshore oysters submerged in reefs such as the Nansemond Ridge at the mouth of the Nansemond River. The oyster was and remains a culturally and environmentally important species for the Nansemond people. Resulting from their long-term abundance, oysters have been a part of the Nansemond's diet for thousands of years (Bass 2021). In the winter, women and girls traveled through marshes in canoes to harvest nearshore oysters, while boys dove offshore to collect oysters and other shellfish from parent reefs (Bass 2021). The harvested oysters were shucked and dried to preserve or added to seafood soups and stews for year-round consumption. Oyster shells were also turned into tools used in various grooming, clothing, and construction. Sometimes shells were even used for adornments, such as shell beads made into necklaces or added to ceremonial dresses (Bottoms 1983).

At the time of contact, the Nansemond Tribe's primary village site and seat of their local *werowance* was located at what is now known as Dumpling Island. Strachey (1953: 66) provides the names of three Nansemond werowances, *Weyhohomo* "a great Weroance of Nansamund" *Annapetough* "another lesse Weroance of Nansamund" and *Weywingopo* "a third Weroance of Nansamun" (McDonald et al. 1996). The island was difficult to traverse, being in the center of the Nansemond River and surrounded by marshes on three sides (Roundtree 1989). Described by John Smith as "a white chaukie Iland convenient for a Fort" (Tyler 1907: 62), Dumpling Island is said to have hosted food storage for the Nansemond, resulting in a large shell midden. The site was also a sacred landscape where past rulers were laid to rest (Bottoms 1983). Roundtree reports that at least three large, dispersed villages were located on the mainland surrounding the island. These sites likely included large shell middens still present in the archaeological record. The villages resembled a dispersed collection of houses and gardens on three points adjacent to the junction of Exchange Branch and the Nansemond River. Rountree argues that while these may have looked like three distinct townships to the observing colonists, the Nansemond understood this collection of diffused settlements to be one "town" scattered around modern-day Dumpling Island (Roundtree 1989:154).

The Nansemond people had two notable interactions with the English colonists documented in the journals of John Smith. Their first meeting was in the spring of 1608. The interactions between the colonists and the werowance were said to be peaceful. Smith described said interactions as follows:

> "The King [werowance] at our arrival sent for me to come unto him. I sent him word what commodities I had to exchange for wheat, and if he would, as had the rest of his Neighbours conclude a Peace, we were contented. At last he came

> downe before the Boate which ride at anchor some fortie yards from the shore. He signified to me to come a shore, and sent a Canow with foure or five of his men: two whereof I desired to come aboard and to stay, and I would send two to talke with their King a shore. To this hee agreed. The King wee presented with a piece of Copper, which he kindly excepted, and sent for victuals to entertaine the messengers. Maister Scrivener and my selfe also, after that, went a shore. The King Kindly feasted us, requesting us to stay to trade till the next day. Which having done, we returned to the Fort" (Tyler 1907: 62).

The colonists and the Nansemond engaged in a peaceful exchange of corn, a necessary food supply for the colonists, for copper, a prestige good for the Powhatan chiefdom usually acquired from a rival tribe, the Monacan (Bottom 1983). This was the Nansemond's one and only known peaceful interaction with the colonists. In the summer of 1608, Smith recorded that the colonists were unexpectedly ambushed by members of the Nansemond Tribe while trying to trade for corn (Bottom 1983). Roundtree (1989) countered this claim, arguing that the English were forcing trade upon the unwilling Nansemond people. The colonists felt that as "visitors of superior intellect," they had a right to demand whatever they needed from the Nansemond Tribe, a mindset unsurprisingly met with resistance (Roundtree 1989). The Nansemond ended up killing two messengers from the colonial expedition, and the colonists retaliated by burning Nansemond *yohacan*, or houses and temples, and destroying mortuary sites on Dumpling Island. The violence ended all trade, and the colonists briefly vacated the Nansemond lands. This did not last as the Nansemond landscape was considered highly valuable. The dispute continued between the colonists, Nansemond Tribe, and the larger Powhatan chiefdom, including a series of conflicts between 1610 and1614, 1622 and 1626, and 1644 and1646 (Bass 2021).

By 1676, conflict had escalated so much that colonial powers saw the only solution was to remove or exterminate all Native people in the area. A bloody conflict between the Indigenous people and the colonists, known as Bacon's Rebellion, resulted in a peace accord called the Treaty of Middle Plantation. The accord united several tribes formerly part of the Powhatan chiefdom, including the Nansemond, under the authority of a Pamunkey chief as “tributary tribes” to the English crown in exchange for protection from the English and foraging and fishing rights on their ancestral lands. Even with the treaty, the colonists continued extricating Native populations from their ancestral lands. On a map of the Nansemond River from 1670, “Virginia and Maryland as it is planted and inhabited this present year 1670,” the Nansemond Tribe had been limited to merely the “Indian Branch” of the Nansemond River (Figure 8) (Herrman and Withinbrook 1673).

By the late 1600s to early 1700s, most Nansemond people had been displaced from their ancestral landscape. The remaining members split into two separate groups, with several families migrating east. Others migrated southwest towards the Nansemond Indian Town at the confluence of the Nottoway River, Blackwater River, and Chowan River near the Virginia and North Carolina border. The Great Dismal Swamp, situated in the middle of these two dispersal areas became a stronghold for the Nansemond and other tribes who had been scattered (Bass 2021). This dispersal marked the end of the traditional Nansemond occupation along the Nansemond River until the descendant community, the Nansemond Indian Nation, began work to reclaim their ancestral lands.

d. Selected Sites

Most of the shell middens within the study area are located within an arbitrary 500-m buffer of the Nansemond River and were identified and excavated as part of Phase I reconnaissance projects in the 1970s and 1980s by local cultural resource management (CRM) firms (Figure 9). Such work involved surface collection at sites where climatic events previously unearthed features and grid shovel tests on intervals of either 50 or 75 ft (VCRIS 2022). Unfortunately, few sites received more substantial Phase II excavations, meaning little of this work has led to well-examined assemblages that have been published and interpreted (Figure 10). Less than half of the sites have been revisited since their original excavation over 40 years ago when archaeologists lacked the precise stratigraphic control and chronological understanding of current projects. The temporality of the few sites reassessed in the past 20 years is typically reevaluated due to the availability of more accurate data (VCRIS 2022). A commonality within all the site records is that the archaeological remains were already succumbing to shoreline erosion at the time of original excavations; thus, conditions are only progressively worsening. Brief summaries of each site and their associated excavation history are provided in the following section. The information recorded below primarily comes from the Virginia Department of Historic Resource's (DHR) archaeological site records within the Virginia Cultural Resource Information System (VCRIS) or VDHR site reports (Figure 11; Table 1).

e. Site Summaries

44SK0001

Site 44SK0001, also known as Sleepy Hole Point or the Hewitt Site, is located on the eastern bank of the Nansemond River. The site, first described in 1890 by Gerard Fowke, was listed as being 15 acres covered by oyster shell with a depth of approximately 16 inches (in) at the deepest point. Within the shell deposits were scattered sherds of shell- and sand-tempered pottery, placing the site within the general pre-Contact period. No further known excavations have been carried out on the site since the partial excavations completed by the Archaeological Society of Virginia (ASV) in May of 1963.

44SK0003

Site 44SK0003, also known as the Chandler Site, is a long-term Native American village/town repeatedly occupied over several periods, including the Middle Archaic, Early Woodland, Middle Woodland, Late Woodland, and early contact. The site's boundaries extend beyond the project's limits to encompass most of the broad finger ridge fronting the Nansemond River. Cleve Hall first discovered the site in 1964. However, extensive excavations did not occur until the early 2000s. During these excavations, diagnostic artifacts were recovered, including two Morrow Mountain I projectile points and Popes Creek, Townsend, and Roanoke simple-stamped sherds.

WMCAR carried out phase II excavations as part of a project by the Virginia Department of Transportation (VDOT) (Moore et al. 2004). The most prominent feature identified during the survey was an extensive midden in the site's northeast corner. The feature extends beyond the CRM project corridor in the north, but within the project area, the midden measured approximately 130 ft by 320 ft. The midden was approximately 14 to 18 in deep with dark soil littered with oyster shell and rock (Moore et al. 2004). The size of the site and extensive shell midden suggest it was likely the location of a Nansemond village site during the Late Woodland or Contact period (Turner and Opperman 2000). The site has been proposed as eligible for the NRHP under Criterion D due to the potential to yield important information about Middle Archaic, Middle Woodland, and/or Late Woodland to Contact period components (Moore et al. 2004). This is based on the presence of intact midden deposits and potential information regarding resource exploitation and ceramic technology. Today the site is located within agricultural fields.

44SK0011

Site 44SK0011, also known as the Winslow or Wilson Point Site, is located on the southwestern edge of the Nansemond River. First recorded by Howard MacCord in 1971, it was revisited a few times following the site's first discovery. However, no extensive work was done until a Phase II investigation by the James River Institute for Archaeology (JRIA). Mitigation work included systematic screen shovel-testing and excavations of eight 5 ft by 5 ft test units within a site area measuring 100 ft by 200 ft (McDonald et al. 1996). Artifacts recovered from the site included Roanoke Simple Stamped sherds, shell beads, pipe fragments, and copper fragments. The site resembles a Late Woodland to early Contact agricultural village site with a cluster of dense artifacts and shell scatters punctuated by areas characterized by virtually no artifacts. Occupation of the site appears to extend through the Middle Woodland, Late Woodland, and Contact periods.

Site 44SK0011 offers a unique opportunity to study an early contact period Native American village site. As the site sits near Dumping Island, it can be assumed that much of the early contact between the colonists and the Native people in the area occurred within the landscape. The site also contains a high density of artifactual material and several undisturbed subsurface cultural features, implicating Site 44SK0011 as eligible for nomination to the NRHP Under Criterions A and D (McDonald et al. 1996).

44SK0012

Site 44SK0012, a shell midden located along the western bank of the Nansemond River, was first recorded by Howard MacCord in 1971. Upon first inspection, the site was described as a 2 to 3-acre “shellfield” with soil consisting of shell filled sandy clay dating to the general pre-Contact period. No further work has been recorded on the site since its first discovery.

44SK0013

Site 44SK0013, also known as Knob Hill, is a multi-occupation site consisting of a pre-Contact shell midden dating to the Early, Middle, and Late Woodland periods. The site was initially recorded by Howard MacCord in 1971, simultaneously with Site 44SK0012. However, the site was revisited a few times, including by MacCord again in 1982 and WMCAR in 1997 for further excavations. The site was categorized as a "shellfield" consisting of a scatter of Archaic artifacts along a river terrace and a dense deposit of shell eroding from the plowzone. The site has experienced some disturbance due to agricultural pursuits and plowing. However, reports disclose that even with plow disturbances, there is a strong possibility of deeper undisturbed features. In 2017, the records of Site 44SK0013 were reconsidered by Roger Kirchen, and the site was listed as potentially eligible for inclusion on the NRHP. However, no further investigation has been carried out regarding the site's NRHP status.

44SK0015

Site 44SK0015 is a shell midden along the southwestern bank of the Nansemond River with occupations spanning the Early, Middle, and Late Woodland periods. Along with several other shell middens, it was first recorded by Howard MacCord in 1976. The site was briefly revisited by Mark Wittkofski in August of 1979 when the site was described as a 50-in diameter area of oyster shell midden interpreted as related to a single Woodland period household. No further information exists on the site.

44SK0018

Site 44SK0018 is a shell midden located on the eastern bank close to the mouth of the Nansemond River. It was first recorded by Keith Egloff in 1977. The site was never visited in person, but it was pointed out on a map and described as a series of small shell middens in woods corresponding to the slight knolls in the area. Very little is known about the site, but it can be assumed that the shell middens relate to a pre-contact settlement.

44SK0020

Site 44SK0020 is a pre-Contact village site with an extensive shell midden and occupations spanning the Middle and Late Woodland through contact periods. The site sits along the eastern bank at the mouth of the Nansemond River and was first recorded by Howard MacCord in 1977 as a 300-m shell midden extending into the construction of the Route 17 bridge approach to the Nansemond River. Mitigation archaeology conducted in the 1970s revealed a shell midden approximately 140 m long sitting undisturbed adjacent to Route 17. Few artifacts were recovered from the midden (Egloff 1980); however, archaeologists Keith Egloff and MacCord argued the site was possibly eligible for inclusion on the NRHP.

The site was revisited in the late 1980s as part of a project to construct a second bridge across the Nansemond River. James Madison University Archaeological Research Center (JUMARC) carried out Phase II excavations. Excavations revealed abundant features and artifacts, including an extensive shell midden. A subsample of the oyster shell was collected from the site and analyzed for shell size, bore hole presence/absence, and bore hole size. Site 44SK0020 was classified as a deeply stratified pre-contact site containing subsurface features, possible post molds/holes, a fire hearth, a shell midden, and temporarily diagnostic pottery sherds. The site was concluded to be a prehistoric Woodland period occupation site dating from as early as A.D. 200 through the Historic period (Jefferson et al. 1989).

In 1993, the site underwent Phase II excavations by MAAR Associates, Inc. (MAI), as the site was impacted by further construction. The excavations focused on the Late Woodland period shell midden and the western extension of a large prehistoric site east of Route 17 (Traver 1994). The results indicate that the midden began during the Middle Woodland period but was most heavily utilized during the Late Woodland period. Site 44SK0020 has a very high research potential allowing the study of site utilization through time. Archaeologists during the 1993 excavations listed Site 44SK0020 as significant and eligible for inclusion on the NRHP (Traver 1994).

44SK0037

Site 44SK0037, also known as Holliday Point 13, is a pre-contact shell midden site along the Western bluff that spans the Middle Archaic, Middle Woodland, and Late

Woodland periods. Mark Wittkofski and Edward Bottoms first recorded the site as an Archaic shell midden in 1978. It was revisited in 1996 by Kenneth Stuck from WMCAR as part of a survey conducted for VDOT. Within the project area of Site 44SK0037, archaeologists identified a low-density Late Woodland occupation associated with a displaced midden of unknown age with approximately one meter of fill. Further excavations have revealed that a relatively undisturbed portion of 44SK0037, mainly outside the western edge of the CRM project area, is potentially eligible for the NRHP under Criterion D. The portion of Site 44SK0037 within the right-of-way (ROW) is not eligible for the NRHP.

44SK0040

Site 44SK0040, also known as Western Branch or Hillpoint Farm, is a shell midden located on the southwestern shoreline of the Nansemond River. The site was one of 11 first recorded by Wayne Clark in 1978. It was revisited by Theodore Reinhart in 1988 as part of a Phase I archaeological survey of the Hillpoint Farms property near Suffolk, Virginia. The site was described as a dense oyster shell midden on a bluff parallel to the Western Branch with scattered shells extending into the interior. Uncovered artifacts included Mockley and Townsend ceramic sherds, and the site is listed as having a series of pit features indicating pre-contact occupation presumed to date from the Middle Archaic to the Late Woodland period. The site report from the Phase I excavations indicated that 44SK0040 and several other sites deserved further archaeological attention at the Phase II level.

44SK0041

Site 44SK0041, also known as Teracosick Shell Midden, the Leonard Site, or the Aqueduct, is a Late Woodland village site associated with an extensive shell midden on the western bank of the Nansemond River. It was first recorded in 1978 by Wayne Leonard along with several other midden sites. The site was revisited by Theodore

Reinhard in 1988 and was identified as a village site referred to as Teracosick on John Smith's *Map of Virginia* (Figure 13). Site 44SK0041 was described as heavily eroded with a dense shell midden of oyster and periwinkle shell. The site sat within a mature soybean field during the assessment; therefore, artifact collection was not attempted. However, records claim intact subsurface deposits exist within the site boundaries.

The site underwent Phase I excavations during residential and commercial development of the surrounding property. Systematic shovel tests were placed across the site and unearthed evidence of a multicomponent occupation that was not only the site of the pre-contact Village of Teracosick but also an important Civil War fortification site. The site was recommended for further Phase II excavations and possibly eligible for the NRHP. The site was revisited in 1996 by the JRIA in response to a public utility expansion. Phase II excavations included visual surface inspection, shovel testing, and several strategically placed test units. The results produced artifact assemblages denoting significant Archaic, Middle Woodland, and seventeenth-century components. Interpretations from the Phase II excavations hypothesize the site to be the location of a Late Woodland/contact period village related to the *werowance* village described by Smith and Percy, potentially an outlying "suburb" of the *werowance* town of Nansemond or the village of Teracosick (McDonald et al. 1996).

The results of the Phase II excavation revealed that a large portion of the village site is likely still intact, including a possible hearth and structural postholes. The site offers researchers a unique and rare opportunity to intensively study a Native American village site with an intact stratigraphy. The site was revisited a final time in 2017 by Circa Cultural Resource Management, LLC, as part of a Phase I mitigation project. While most of the site is now a part of the Nansemond River Golf Course, a portion of the area is still evident along the edge of the coastline overlooking the river. This area will remain undeveloped, allowing the remains of intact features to be preserved. While the site may be potentially eligible for inclusion on the NRHP, the archaeologists in 2017 recommended no further work to be done at the site.

44SK0046

Site 44SK0046, also known as the Elizabeth Site, is a Late Woodland shell midden located on the eastern bank of the Nansemond River. First recorded by Wayne Clark in 1978, the site is described as a light scatter of oysters with lesser density around the fringe of the site. Recovered material includes oyster shells and diagnostic Rappahannock and Mockley ceramic sherds. The site was interpreted as representing a limited family occupation. No further work has been done at the site.

44SK0047

Site 44SK0047, also known as Little Shell Site, is situated within a cluster of sites along the eastern bank and represents a Middle Woodland shell midden. Wayne Clark first recorded the site in 1978, along with several other midden sites. The site had a very low artifact density (i.e., one Mockley sherd), and the presence of several oyster shells delineates the site boundaries. No further work has been done on this site.

44SK0048

Site 44SK0048, also known as the Abraham Midden, is located within a cluster of sites found along the southeastern coast of the Nansemond River. It was first recorded by Wayne Clark in 1978 as a large scatter of oyster shells intermixed with sandy soil. No subsurface excavation has taken place at the site. However, a single Mockley sherd has been located.

44SK0049

Site 44SK0049, or Midden Point, is a part of the cluster of shell middens along the southeastern coast recorded by Wayne Clark in 1978. The site received no subsurface excavations. However, records describe Midden Point as a low-density oyster shell midden extending in a circle around a distinct core area and blending into

Site 44SK53. The site had very few artifacts with limited finds, including sherds tempered with ribbed mussels (either of the Rappahannock or Currituck traditions).

44SK0050

Site 44SK0050, locally known as One Sherd, is a shell midden site first uncovered by Wayne Clark in 1978, along with a collection of other small middens on the southeastern bank of the Nansemond River. An informal survey of One Sherd revealed a slightly higher density of oyster shells than other nearby sites. The site was revisited by Matt Laird from the JRIA in 1996 as part of a CRM project. Phase II excavation yielded no further information, and the site was considered an ineligible nomination to the NRHP (McDonald et al. 1996).

44SK0051

Site 44SK0051, or the Margaret Midden, was discovered by Wayne Clark within a cluster of several other middens during work he conducted in 1978. Little was recorded about the site at that time. However, the site was revisited by WMCAR in 1997 as part of an extensive Phase II project and described as an Early to Middle Woodland shell midden with oyster shell scattered over the area lightly and a moderate density in the core area.

44SK0052

Site 44SK0052, referred to as the Tidal Flat site, is situated within a cluster of shell middens found on the southeastern coast and was first recorded by Wayne Clark in 1978. The site has had no subsurface excavations. Tidal Flat consists of a dense core area of shell with lighter scatter on the periphery in a circular shape. A few Rappahannock Plain ceramic sherds with a crushed mussel temper were uncovered, likely placing the site within the Late Woodland period. No further work has been done on the site.

44SK0053

Site 44SK0053, also known as Middle Shell, sits within the cluster of shell middens discovered by Wayne Clark in 1978. While no subsurface excavations were conducted at Middle Shell, it was described as a dense collection of oyster shells towards the center with lighter scatter towards the fringe. A few pieces of diagnostic Mockley ceramic sherds ware were uncovered during evaluation dating the site to the Middle Woodland period. No further work has been done at the site.

44SK0054

Site 44SK0054, given the appropriate name of Shell Midden, is also located within the cluster of sites discovered by Wayne Clark in 1978. The site dates to an unknown pre-contact period and consists of a very light scattering of oyster shells and artifacts. Artifacts were observed but not collected.

44SK0055

Site 44SK0055, named Wills Cove, is a shell midden on the southeastern coast of the Nansemond River first recorded by Keith Egloff and Edward Bottoms in 1978. No description of the site was provided. Bottoms reported finding 100 lithic flakes, polished axes, gorget fragments, a bannerstone, a concave-convex gouge, diagnostic Morrow Mountain points, and shell remains from four pits containing periwinkle and oyster. WMCAR revisited the site in 1997 before the land was built. No additional information was added regarding the site except a temporal designation of Middle Archaic to general Woodland period.

44SK0058

Site 44SK0058, known as Wilkinson's Landing, sits along the western bank of the river. The site was first surveyed by Coch and MacCord in 1963, who excavated a test pit containing shell, fire cracked rock (FCR), and quartzite flakes. Edward Bottoms and Keith Egloff revisited the site and several others in 1978. They describe the site as having heavy shell concentrations along the river's edge. No further work has been done at Wilkinson's Landing site.

44SK0062

Site 44SK0062 is a large pre-contact shell midden first observed by Howard MacCord in 1964. The ASV tested the site before the construction of a golf course destroyed it. No further information is available on the site, and it is no longer in existence.

44SK0080

Site 44SK0080, also known as Mintonville Point, is an extensive shell midden site located along the eastern coast of the Nansemond River. The site was first recorded by Howard MacCord in 1981 and was later revisited by WMCAR in 1997 as part of a mitigation project on land impacted by the construction of a power transmission line. Archaeologists at WMCAR conducted shovel tests and found dense concentrations of oyster shells and many brick fragments, indicating the site likely contained an oyster midden. Mintonville Point was not reassessed again until Jena Orlowski from Natural Resource Group, LLC, carried out Phase II excavations at the site in 2017 in response to a public utility expansion. The excavations included metal detecting, shovel tests, test units, and backhoe tripping of a few trenches.

Several diagnostic historic and precontact artifacts have been recovered from site 44SK0080, including historic artifacts dating to the Civil War, associating the site with the Suffolk II battlefield and the Siege of Suffolk, Fort Huger, and Hill's Point Battlefield. Diagnostic prehistoric artifacts recovered from the site included Yadkin, Kirk and Halifax halfed biface points, and Mockley, Yadkin, Mount Pleasant, Hanover I, Cashie, Colington, Hanover II and Townsend pottery sherds. These artifact types span from the Middle Archaic period to the Late Woodland period. The range of artifacts and features encountered at 44SK0080 suggests that the area was repeatedly inhabited throughout the Woodland and historic periods. During the precontact occupation at the site, a particular focus was placed on harvesting oysters from the surrounding tidal marshes.

The site represents a multicomponent prehistoric artifact scatter and shell midden site situated on Mintonville Point, a narrow peninsula that reaches into Wilroy Swamp (Eichmann et al. 2017). Marine shell was encountered throughout most areas within the original 44SK0080 boundary. Mollusks were presumably harvested from Oyster House Creek, which flows through the nearby Wilroy Swamp tidal marshes. Although only a sample was retained for analysis, over 60,000 shells and fragments (~ 40 kilograms [kg]) were found in shovel tests and test units, with the vast majority surfacing in the plowzone. Although most shell fragments appeared to be oysters, 51 clam and seven mussel fragments were also identified, as was one cockle and one periwinkle shell (Eichmann et al. 2017). The site has been recommended as eligible for inclusion on the NRHP under Criterion D due to the site integrity encompassing both precontact occupation and the military landscape associated with the Civil War Siege of Suffolk.

44SK0081

Site 44SK0081, or the Butler Site, is a Late Archaic to Early Woodland shell midden along the western edge of the Nansemond River. Howard MacCord first recoded the midden in 1981. It was later revisited by WMCAR in 1997 when the site was in the path of a proposed power line for VEPCO. Minimal damage was done to the site; however, the site sits amid a cultivated field, so much of the area has been plowed. Butler Site has been described as an area of sandy loam filled with oyster shells. The site lies approximately 200 ft north of another shell midden site, 44SK0012, suggesting they are likely related and/or contemporaneous. No further work has been done to confirm or deny the relation with 44SK0012.

44SK0091

Site 44SK0091 sits on the western bank of the Nansemond River. First recorded by Keith Egloff from the VDHR in 1983, the area has locally been known as "Shell Island" due to the large concentrations of oyster shell found in the area. Egloff also noted numerous examples of quartzite projectile points (mainly diagnostic Savannah River points) that had been collected and removed from the site. The site was recently revisited in 2021 by CRM firm Darby O'Donnell, LLC, as part of a Phase I cultural resource survey. Field techniques included shovel tests over 50-ft intervals, controlled surface collection of recently plowed fields on a 50 ft grid, and 25 ft metal detector transects. Diagnostic artifacts uncovered included a quartzite Piscataway projectile point (1,400–500 B.C.), one rhyolite Morrow Mountain I projectile point, a body fragment of Croaker Landing ware (1200–800 B.C.), and a few fragments of Mockley ceramics (200–900 A.D.) and Prince George ware (500 B.C.–300 A.D.). These artifacts dated the site to the Middle Archaic, Late Archaic, and general Woodland periods. The site has been recommended as potentially eligible for inclusion on the NRHP under Criterion D based on the interpretation of the site as being a Native American shell midden and hamlet associated with the Nansemond village of Teracosick as the Late Woodland period was ending (O'Donnell and Kirchen 2021).

44SK0093

Site 44SK0093, better known as Dumpling Island, is a Late Woodland shell midden and village site on the eastern bank of the Nansemond River. Dumpling Island is the most well-known archaeological site on the Nansemond River. While first noted in the 1960s, limited archaeological reconnaissance occurred in the area. The site was revisited and officially recorded by Keith Egloff from the VDHR in 1983 and was described as in an excellent state of preservation. Excavations at the site produced an abundance of diagnostic Roanoke ware, indicating that the occupation probably corresponded to the sprawling Nansemond village described by George Percy in 1609 (Turner and Opperman 2000). According to the records, the island was difficult to traverse even with a boat due to the surrounding marshes. The site is composed of dense deposits of oyster shells (Figure 12), likely representing the remains of a Nansemond village or ceremonial center at the time of contact. The site has been listed on the NRHP since 1998. Dumpling Island is further discussed in the cultural context section of this thesis.

44SK0170

Site 44SK00170 is a Middle Woodland shell midden site adjacent to Bennett's Creek. The site was excavated by the CRM firm MAI in 1987 as part of an archaeological survey of the area to be residentially developed. The site was described as an extensive, undistributed oyster shell midden away from the wooded creek margins of Bennet's Creek. Researchers believe the site may have represented Indigenous resource procurement camps. Diagnostic artifacts recovered from the shell midden include Popes Creek and Mockley ceramic sherds and a Potts Projectile Point.

44SK0191

Site 44SK0191 is a precontact shell midden thought to span from the Early Archaic period to contact, located at the southeastern head of the Nansemond River. First surveyed by Leigh and Luccketti of the JRIA in 1988, the site represents an extensive shell scatter with heavy concentrations in several ravines along the West Creek. Site 44SK0191 received more substantial excavations in 1991, and archaeologists at JRIA observed that the shell midden at the site extended to a depth of four inches below ground. Diagnostic artifacts included Popes Creek ceramic sherds, fire-cracked rock, quartz, quartzite, and Morrow Mountain and Halifax projectile points. Various historic artifacts were found as well.

44SK0212

Site 44SK0212 was part of a collection of sites excavated by Leigh and Luccketti from the JRIA in 1988 as part of a mitigation project on cultivated and developed land. The shell midden was found on the eastern bank of the river. It comprises many parts, including an exposed shell midden along the powerline, a midden area in the woods, and a large area of relatively dispersed artifacts and shell scatter in the field. The wooded area was shovel tested at 75-ft intervals and produced artifacts dating to the Early, Middle, and Late Woodland periods, including a shell-tempered fabric-impressed pottery sherd, FCR, quartzite and quartz lithic flakes, and a Prince George stylized ceramic sherd.

44SK0217

Site 44SK0217 was also a part of the VEPCO powerline excavation project by Leigh and Luccketti of the JRIA in 1988. This shell midden was described as a light shell and artifact scatter covering a small hilltop above a marshy creek with an oyster midden nestled along the side of a small basin. No pottery was uncovered, leaving the site to date to the general precontact period. No further work has been done at the site.

44SK0266

Site 44SK0266 is located in the wooded area near the VEPCO powerline construction project excavated by Leigh and Luccketti of the JRIA in 1988. The midden was found and exposed at ground level during a 75-ft interval shovel-test survey of the wooded area. The site includes a very dense concentration of oyster and periwinkle snail shells. No other artifacts were found or collected, dating the site to an unknown precontact period.

44SK305

Site 44SK0305 is a shell midden located adjacent to the eastern shore of the Nansemond River. It was discovered through a volunteer survey by Charles Manson of the ASV in 1989. Not much is known about the site other than it is an unknown precontact shell midden with a dense concentration (6 to 9 ft^2) of oyster shell remains on the surface. No further work has been done at the site.

44SK0306

Site 44SK0306 is a shell midden site discovered by Edward Bottoms of the ASV in 1989. He described the site as a shell midden eroding on the southwest shore of an island with the beach covered in oyster shells and a dense concentration of fractured quartz and quartzite. While part of the site has been destroyed, a portion of the site in the wooded area remains undisturbed. Pieces of diagnostic Townsend and Prince George ceramic sherds were found at the site, indicating a Late Woodland occupation date.

44SK0416

Site 44SK0416, also called Test Area 11, is a shell midden located on the southeastern bank of the Nansemond River. The site was discovered by Michael Timpanar from the CRM firm Ecology and Environment. The midden was described as a shell lens with artifacts in and below the shell. However, records state the midden was likely disturbed by earlier construction projects. No further work has been done at the midden site to date.

f. Summary of Sites

While all 35 sites considered in this study share the similarity of being pre-contact shell middens situated around the Nansemond River, the sites are diverse in many ways, including size, density, occupation, and previous archeological excavations. Many of the sites have had little more than surface-level artifact collection and site observations, especially the cluster of middens located on the southeastern corner of the river near the City of Suffolk (e.g., sites SK0046 to SK0051). Work at various other sites (e.g., SK0001, SK0062, SK0305, SK0306) was carried out by volunteer archaeologists from the ASV who had little professional training in artifact identification and regional history. Site SK0018 was never even visited by archeologists, and instead reported and described by Suffolk locals. On the other hand, some sites (e.g., SK0003, SK0011, SK0041, SK0080, SK0091) have been visited on multiple occasions as either part of CRM mitigation projects or small-scale research endeavors. For example, Site 44SK0041 is one of the most well-excavated sites on the Nansemond River, with at least three separate projects and respective site reports associated with the site. These extensive excavations have allowed archaeologists and historians to associate the site with the Nansemond village of Teracosick and list SK0041 as potentially eligible for the NRHP. It is important to note that many of these sites likely hold similar archaeological potential; however, the overwhelming lack of excavations have led to an incomplete modern understanding of the historic Nansemond landscape.

VI. Methodology

a. Coastal Vulnerability Index

A coastal vulnerability index (CVI) is used in this study to determine the vulnerability of the selected sites to the effects of erosion, sea-level rise, and land subsidence. Often used by coastal managers, CVIs use a range of variables to evaluate the threat environmental conditions pose to coastlines by assigning them a numerical ranking on a scale of 1 (least vulnerable) to 5 (most vulnerable). Indexes transform highly complex threats into easily understandable scales that compare quantitative and qualitative variables (Smith 2017). Other studies examining the vulnerability of coastal archaeological sites have calculated erosion rates on a site-by-site basis and used regression analysis to predict future erosion rates (Reeder et al. 2010). However, a CVI was selected for this study to allow the inclusion of more variables than just erosion—both cultural and environmental. This method reveals sites' significance to the archaeological records and their vulnerability to the physical environment (Smith 2017). Numerous studies worldwide have created environmentally driven CVIs ranging from

India (Mahapatra et al. 2015) and China (Hong et al. 2006) to the Mediterranean Sea (Anfuso and Martinez Del Pozo 2009). However, for this project, cultural factors are equally, if not more important, as the results derived here will influence future heritage management plans and initiatives.

The foremost CVI for the United States coast was carried out by the United States Geologic Survey (USGS) in 1999. Thieler and Hammar-Klose (1999) developed three different CVI's for the three coasts of the U.S. (e.g., the Atlantic, Pacific, and Gulf Coast). Six variables made up their CVI which was calculated as the square root of the geometric mean, or the square number of the variables:

$$CVI = \sqrt{\frac{a \cdot b \cdot c \cdot d \cdot e \cdot f}{6}}$$

where a = geomorphology, b = historical shoreline change, c = coastal slope, d = relative sea-level rise, e = wave action, and f = tidal range, equalized on a scale of 1 to 5 (Thieler and Hammar-Klose 1999). Their method produced a straightforward and easily transferable CVI based on available environmental data.

When beginning to factor in the specifics of developing a CVI equation targeted toward archaeological sites, advantages arise, such as providing a precise and spatially constricted target location. With such a study area for analysis, other variables that are not relevant for exclusively environmentally driven projects must be considered, including distance of the site to the nearest shoreline or eligibility for the NRHP. Reeder-Myers et al. (2012) attempted such work for archaeological sites along California's Santa Barbara Channel. Instead of developing a singular CVI scale considering both environmental and cultural aspects, they created two different values: first, a CVI determining the overall vulnerability of the shoreline; and second, a cultural resource vulnerability index (CRVI) that added human-centric aspects. Using weighted averages of four variables, the following CVI equation was used:

$$CVI = \frac{4(x_1 + x_2) + 3x_3 + 2x_4}{4}$$

where x_1 = relative geomorphology, x_2 = relative coastal slope, x_3 = relative historical erosion, and x_4 = relative wave height. For each calculated CVI, values for the site's distance to the shoreline, elevation above mean sea level (MSL), and relative human threat, were then factored into the CRVI equation. The final weighted CRVI equation was:

$$CRVI = \frac{4x_1 + 3x_2 + 2x_3}{3}$$

Where x_1= relative distance to coast, x_2= relative CVI, and x_3= relative human threat index (Reeder-Myers et al. 2012; Reeder-Myers 2015). Smith (2017) developed a singular equation for gauging the vulnerability of archaeological sites based on a combination of environmental and cultural variables. The final equation is as follows:

$$CVI = \frac{C + E + cs + er + NRHP + ar}{6}$$

where D = distance to shoreline, E = minimum elevation, cs = coastal slope, er = historic rate of erosion, NRHP = NRHP eligibility, and ar = area of the site (Smith 2017). This equation considers cultural variables by proxy through NRHP eligibility and site area (ar).

To avoid researcher subjectivity in the importance of each variable (McLaughlin and Cooper 2010), an unweighted equation was used in this study to calculate the CVI, rendering the cultural and environmental variables of equal value within the equation. The selected equation used here is:

$$CVI = \frac{DS + E + RE + CS + LU + G + A + NRHP + HR}{9}$$

Where DS = distance to shoreline, E = elevation, RE = historic rate of erosion, CS = coastal slope, LU = land use, G = geomorphology, A = site area, NRHP = NRHP eligibility, HR = historical reference (Table 2). Continuous numeric variables (i.e., historic rate of erosion, site area, elevation, distance to shoreline, coastal slope) were divided on a linear scale from 1 to 5 based on natural breaks or Jenks in the data. Nominal variables (geomorphology, land use, NRHP eligibility, historical references) were given integer values from 1 to 5 based on predetermined categories (Table 3; Table 4). All spatial analysis in this project was carried out in ArcGIS Pro.

b. Selection of Environmental Variables

The six most common variables used in past CVI studies were geomorphology, historic rate of shoreline erosion, coastal slope, relative sea-level rise, wave height, and tidal range (Thieler and Hammar-Klose 1999). Reeder-Myers et al. (2012), while considering the same variables, included additional values (distance to the shoreline, site elevation, and land use) specifically applicable to the analysis of archaeological sites. The following environmental variables are included in this study: distance to shoreline, elevation, historic rate of erosion, coastal slope, land use, and geomorphology.

The CVI used in this study was developed based on data specifically available for the Nansemond River tributary. Unfortunately, the small study area limited the availability of wave height, tidal range, and sea-level rise data. With only one NOAA tidal gauge recording sea-level trends near the study area (Sewell Point at the Norfolk Navy Station), the sea-level rise rate across the whole study area is calculated to be 4.73 mm/year. The available wave height and tidal range data were also uniform across the sites.

As discussed earlier, land subsidence is influential in calculating relative sea-level rise, as both rising water levels and subsiding land mass are considered (Smith

2017). In recognition of this, an attempt was made to calculate how much land subsidence had occurred across the study area by comparing the elevations between two digital elevation models (DEMs). However, finding two DEMs with a long enough timelapse and comparable resolution values (e.g., 10-m resolution compared to 1-m resolution) was not possible. Therefore, land subsidence was not factored into this study.

The final variables used in this research are the historic rate of erosion, coastal slope, elevation, distance to shoreline, geomorphology, and land use. They were equalized for each site on a scale of 1 (least vulnerable) to 5 (most vulnerable). The historic rate of erosion is used to predict future erosion rates at each site as it can be assumed that if a site has been eroding at a specific rate, it likely will continue to deteriorate at the same rate or higher (Smith 2017). The coastal slope provides insight into the inundation potential of a site, given that the shallower the slope of land along the shoreline, the more vulnerable it is to inundation during severe weather, and the faster the shoreline will retreat (Thieler and Hammar-Klose 1999). Geomorphology and land use inform on the status of the land each site sits atop. Finally, regarding coastal elevation and distance to the coastline, lower elevations and shorter distances render coastal sites more vulnerable (Reeder-Myers et al. 2012).

c. Selection of Cultural Variables

Three variables were selected to determine cultural significance: eligibility for the NRHP, site area, and historical references to Nansemond landscapes. Sites eligible for the NRHP have a high cultural significance as determined by the criteria for eligibility (NPS 2022). Each site was assessed based on the four-part criteria laid out by NPS and given a numeric ranking representing their NRHP status: 1 = ineligible, 2 = undetermined, 3 = possibly eligible, 4 = eligible, and 5 = listed. Site area is used as another proxy for site significance under the assumption that large village sites usually leave a more visible archaeological record than smaller sites. Thus, the larger the site, the more culturally significant (Smith 2017).

The final variable used is historical references, primarily from colonial accounts of interactions with the contact era Nansemond people. This included the writing of John Smith and George Percy and several maps dated to the early Contact period. An effort was made to locate references to locations and place names that matched with the descriptive records of the shell middens from VCRIS and various site reports. If multiple references to the site or site location were found, the site received a vulnerability score of 5, if only one reference a score of 4, and if there were no references a score of 1. It is important to note that this variable is biased towards a colonizer perspective, and in the future, effort should be made to include oral histories and records from members of the Nansemond Indian Nation.

d. Historical Reference Analysis

Firsthand accounts of John Smith and George Percy and several historic maps served as the principal descriptions of the Nansemond River landscape considered in this research. These accounts are used as directional references rather than an interpretation of Nansemond lifeways. Throughout the written records and maps, the number of times a site name or place was referenced was used to assign each a ranking, where zero references = 1, one reference = 3, and two or more references = 5.

As discussed in the cultural history section, John Smith first encountered the Nansemond in the late summer of 1608, when he and a small crew of men were on an exploratory trip around the Chesapeake Bay. They were caught in a squall and forced to find shelter, leading them to traverse the Nansemond River and come into contact with the Nansemond people. The description of the Nansemond River given by Smith (Tyler 1907: 63) during this encounter closely mirrors the modern appearance of the river, serving as a significant reference when trying to connect archaeological sites with historical locations. Continuing seven or eight miles up the Nansemond River, Smith recalls seeing “a little Iland, and in it was abundance of Corne” (Tyler 1907: 63). This is one of the very first historic references describing the Nansemond landscape, and it is clear that the island Smith described is archaeological site 44SK093, or Dumpling Island (McDonald et al. 1996).

Another resource critical for identifying the major historic Nansemond settlements was the transcripts of George Percy’s *A Twere Relacyon*. In 1609, when Jamestown was succumbing to hunger and diseases, Smith dispersed colonists into smaller congregate units to fend for themselves. John Martin and George Percy, along with a group of 60 men, were sent down the Nansemond River to establish themselves at Dumpling Island and enact trade with the Native people in the region. Percy claims that the colonist tried to trade copper for the Native’s settlement on Dumpling Island. However, the Nansemond refused and sacrificed the two colonists sent as messengers in retaliation. In response, the colonists attacked the settlement, burning down the Nansemond ceremonial center (McDonald et al. 1996). Regarding the interaction, Percy writes:

> “So Capte Martin did Apointe wth halfe of men to take the Island perforce…beinge Landed and acquainted with their Trechery we Beate the Salvages out of the Island burned their howses Ransaked their Temples Tooke downe the Corpes of their deade kings from their Toambes And caryed away their pearles Copper and bracelettes, wherewth they doe decore their kings funeralles” (Percy 1922: 263).

While Percy does not directly state this is the home of the Nansemond *werowance*, Smith recalled during Percy’s interactions with the Nansemond that he “did surprise this poor naked King, with his Monuments, houses, and the Isle he inhabited, and there fortified himself” (Smith 1986: 221). The ritualistic importance and historical abundance of Dumpling Island references in written records confirm that the island acted as the ceremonial center of the Nansemond landscape and the seat of their principle werowance. Considering Dumpling Island as the principal Nansemond settlement, Turner and Opperman (2000) could “map project” the locations of other Nansemond settlements in reference to archaeological sites. On John Smith’s *1612 Map of Virginia*, four Nansemond villages are listed: “Mattanock,” “Mantoughquemed,” “Nandsamund,” and “Teracosick.” He also labels an island called “Sharpes Ile” (Figure 13) (Smith 1612). Turner and Opperman (2000) describe the process as follows:

> “Ignoring the distances provided by Smith, the south-southwestern strike followed by a turn to the southeast corresponds with the approach to Dumpling Island which could therefore be identified as "Sharpes Ile" of Smith's map. Using Dumpling Island as a landmark, the village of Mantoughquemed could be located immediately east of Oyster House Creek on property adjacent to the U.S. Naval Transmitter Station. The location of the village of Nandsamund (depicted as a "Kings howse") can also be projected for the Hollidays Point area east of Cedar Creek corresponding to Smith's depiction of that settlement adjacent to the confluence of a smaller stream and the Nansemond River at a principal bend. The settlement of Mattanock, depicted as north of Nandsamund on the west bank of the river, however, cannot be projected with any accuracy given the absence of specific landmarks here. Finally, the village of Teracosick, depicted as south of Sharpes Ile (Dumpling Island) can be projected for the immediate environs of the confluence of Western Branch and the Nansemond River where a prominent bend to the east may correspond to a similarly depicted feature on Smith's map” (Turner and Opperman 2000: 2-9).

Another historic map from 1611 by Don Alonso de Velasco, the Spanish ambassador to England, identifies “Mattanock” and “Nandsamund” at an interior location on the east bank of the Nansemond River, consistent with Smith’s map (Figure 14). Additionally, Tyndall’s 1608 “Draught of Virginia” map places one settlement on the east bank of the Nansemond River called “Oriskoyek” (Figure 15) (Turner and Opperman 2000).

While numerous archaeological sites along the Nansemond River have been under-excavated, there has been some success with matching historical depictions and references of the contact era Nansemond landscape with archaeological knowledge. The most well-established connection names Site 44SK0093 as Dumpling Island. Excavations at the site have unearthed mortuary and ceremonial components in line with historical descriptions. Additionally, there is a vast shell midden at the site, matching

Smith's description of the site as "a white chaukie Iland" (Tyler 1907: 62). The Dumpling Island site is referenced repeatedly in historical literature regarding the Nansemond, placing it as the most historically significant site known within the Nansemond River landscape to date.

However, what the colonists understood to be the werowance village likely was not the extent of the whole settlement. Following Roundtree (1989: 154), the Nansemond "village" located on and around Dumpling Island would have consisted of a "dispersed collection of houses and gardens on the three points adjacent to the junction of the Exchange Branch and the Nansemond River." This means that what would have looked like three towns to the colonists would have been considered one scattered village to the Nansemond people. With this idea of the Nansemond werowance village being separated into three distinctive sites near Dumpling Island, site 44SK0093 likely represents one of three potential settlements making up the whole of the werowance village. Two other sites appear to line up with the written descriptions and understanding of the landscape: 44SK0011 and 44SK0210. Both sites and 44SK0093 date to the Late Woodland to early Contact periods and sit at three adjacent points (McDonald et al. 1996). As site 44SK0011 houses an identified shell midden, it receives acknowledgment of a historical reference in association with Dumpling Island. However, as the ceremonial center of the settlement was found to be associated with site 44SK0093, it is only given credit for one historical reference.

Three of the four Nansemond villages listed on John Smith's map have been associated with archaeological sites. Site 44SK0041, an extensive shell midden, has been correlated with the Late Woodland village of Teracosick. Turner and Opperman (2000) claim that Roanoke ware found at the site associates the settlement with the ethnic group settling on Dumpling Island, as Roanoke ware was heavily discarded at site 44SK0093 (McDonald et al. 1996). Nikki Bass, a member of the Nansemond Indian

Nation and environmental scientist, described Teracosick as “near the headwaters of the Nansemond River, around the present intersection of Williams Road & Wilroy Road in the Suffolk Borough” (Bass 2021). Smith’s map suggests that Teracosick was located at the southern end of the river, closer to the present urban limits of the City of Suffolk (Smith 1612). These descriptions and archaeological remains place site 44SK0041 as a strong contender for being associated with the remains of the village of Teracosick. Smith describes what is assumed to be the landscape of Teracosick as he sailed past Dumpling Island and the confluence of the Nansemond River and the Western Branch, recalling “plaines…planted aboundance of houses and people” (Tyler 1907: 62). Historical maps show these “plaines” lining up with the area around Brock Point and Thompson Landing on the west bank, and Abraham Point on the east side of the Nansemond River (McDonald et al. 1996).

While sites 44SK0093 and 44SK0041 are the most readily associated with historic records, a few other sites within this study set strongly resemble locations on historic maps. Site 44SK0037, as well as a few other sites not included in this study, located at Hollidays Point to the North of the Dumpling Island settlement, mimic the location of the settlement of “Mattanock” on Smith’s map, as both locations are situated on the western side of Cedar Creek (Turner and Opperman 2000). Additionally, Bass (2021) describes the location of the village site as “halfway up the Nansemond River, just north of many of the best corn-growing soils…near what is now called Campbell Creek (off of Crittenden Road) in the Chuckatuck Borough.” These descriptions lead to similar locations between Cedar Creek and Campbell Creek near the shell midden remains at site 44SK0037. Archaeological excavations have also identified 44SK0037 as a Late Woodland site consistent with the occupation period of Teracosick.

Sites 44SK0093, 44SK0041, and 44SK0081 produce extensive collections of Roanoke ware, causing Turner and Opperman (2000) to associate these archaeological sites with the numerous Nansemond settlements scattered around Dumpling Island. These shell middens likely represented satellite settlements from the principal settlement of “Nandsamund,” as they are situated east of Cedar Creek in the Reid’s Ferry area described by Nikki Bass (2021). The village of Nandsamund on Smith’s map is represented by the longhouse glyph, symbolic of the werowance village site. The location of the werowance house at the village of Nandsamund on the western shore of the river contradicts other assumptions of the chiefdom being based on Dumpling Island, or site 44SK0093, on the eastern bank. However, Roundtree’s (1989) description of the Nansemond village site helps us understand that the village of the werowance, Weyhohomo, was made up of several smaller, dispersed village congregations that may have included sites 44SK0093, 44SK0011, and 44SK0081. Regardless, it is assumed here that all three sites are in some way related to the village of Nandsamund or the Dumpling Island settlement.

Two huge shell middens on the eastern bank of the Nansemond River, 44SK0018 and 44SK0191, have been pinpointed as the remains of the village of Oriskoyek identified on Tyndall’s 1608 “Draught of Virginia” map. The location also corresponds with one of two unnamed Nansemond sites that appear on either side of the mouth of the Nansemond River on John White’s 1585 map. While archaeological evidence typically dates these sites to the Middle Woodland period, the remains still highlight a Late Woodland to early contact period occupation. White’s “La Virginea Pars” map displays two unnamed Native American settlements on either side of the mouth of the Nansemond River (Figure 16). One reflects the location of Oriskoyek from Tyndall’s map, while the other is located on the eastern bank. The village correlates with the location of the Nansemond community of Crittenden. Bass (2021) describes the site as being located at the “confluence of the James and Nansemond Rivers and Chuckatuck Creek…being lined with oysters.” The village of Crittenden likely was related to the extensive shell midden at site 44SK0062. However, this assumption can never be proven as the site has since been destroyed and turned into a golf course.

The final village on Smith’s map, Mantoughquemed, poses more difficulty to place on the Nansemond landscape as it is the only village he lists on the eastern bank of the Nansemond River. Turner and Opperman (2000) claim Smith’s map places the site at the mouth of Oyster House Creek near the U. S. Naval Transmitter Station, situated in the area west of Mintonville Point (McDonald et al. 1996). This description would strongly associate the village location with Site 44SK0080, an extremely dense shell midden with occupations dating to the Late Woodland period. However, Bass (2021) describes the village as “near the present Suffolk-Chesapeake line, on what is now called Goose Creek in the Western Branch Borough of Chesapeake.” The location Bass describes falls outside of the 500-m study area buffer used for this project. For the purposes of this research, the village of Mantoughquemend is associated with site 44SK0080. However, further work needs to be done to confirm this statement.

In summary, through the analysis of Contact-era historical written records and maps of the Virginia landscape, it is possible to associate present archaeological sites with areas of importance on the historic Nansemond landscape. This included seven primary locations referenced on historical maps and written accounts: Dumpling Island, Mattanock, Mantoughquemed, Nandsamund, Teracosick, Crittenden, and Oriskoyek. In the above section, a best effort was made to associate archaeological shell middens with notable Nansemond sites based on the historical records available at this time. In the future, the voices of the Indigenous community should be better considered, as the interpretations of cultural significance presented here are primarily based on the perspectives and assumptions of white colonizers.

VII. Analysis and Results Environmental Variables

a. Distance to the Nearest Shoreline

Distance to the nearest shoreline is a variable that becomes necessary when working with archaeological sites rather than a continuous shoreline. Regardless of the elevation, sites closer to the shoreline are more at risk than those further away due to sea-level rise and wave action (Reeder et al. 2010; 2012). The selected sites sit a variety of distances away from the main shoreline of the Nansemond River. While some sites are located directly on the central coast, others sit further removed along a creek or tributary of the Nansemond River. Assessing the distance of each site to the nearest shoreline sheds light on how direct the threats of sea-level rise, wave, and tidal action are to each site individually, as the closer a site sits to the shoreline, the more intense and frequent the effects. Therefore, the selected sites are evaluated based on their distance to the nearest shoreline (Nansemond River or Creek outlet).

To determine the distance of each archaeological site to the shoreline, the most recent Nansemond shoreline data from the Virginia Institute of Marine Science's (VIMS) Shoreline Studies Program was used (Milligan et al. 2010). The VIMS shoreline data and the 35 site polygons (acquired from VDHR) were added to a new ArcGIS Pro project. The Generate Near Table tool was used to determine the point within each midden site closest to the 2009 VIMS shoreline data. The locations were exported into points using the XY Table to Point function. This generated points within each midden displaying the point's coordinates and the distance in meters to the shoreline. The data from the new points were spatially joined into the shell midden layer to associate each site with the area in which they were closest to the shoreline, representing the shortest distance of each archaeological site to the shoreline (Figure 17). The distances were classified into five categories based on natural breaks in the data and given a vulnerability ranking (Table 5). The closer the site to the shoreline, the higher the vulnerability rank. The results placed sites 44SK0011, 44SK0020, 44SK0037, 44SK0058, 44SK0062, and 44SK0170 at the highest risk by sitting directly on the coastline. Most sites sat adjacent to the Nansemond shoreline or a minor tributary. While sites on both the tributaries and the main shoreline of the Nansemond River used the same criteria to determine distance to the nearest drainage, it can be assumed that sites along the primary waterway will feel the effects of sea-level rise and wave/tidal action to a more substantial degree than those on smaller, more protected bodies of water.

b. Historic Rate of Erosion

Historic rate of erosion was selected as a variable to gauge future rates of erosion at each site under the assumption that if a site has been eroding at a specific rate without intervention, it will likely continue to erode at that rate or a higher rate (Smith 2017; Thieler and Hammar-Klose 1999). The data used to determine historic rates of erosion were acquired from the Shoreline Studies Program at the VIMS. VIMS calculated shoreline erosion (i.e., loss) and accretion (i.e., addition) by comparing aerial imagery between 1937 and 2009 (Milligan et al. 2010). The analysis produced two different statistics, net shoreline movement (NSM) and end point rate (EPR). NSM is the amount of distance between the two shorelines at every measured point. EPR represents the NSM divided by the number of years between the two shoreline measurements, which for all 35 shell middens was 72 years (Smith 2017). This provided a measure of shoreline change per year, with positive values meaning accretion and negative values indicating erosion.

Using the data provided by VIMS, a spatial join between the EPR spanning the shoreline and the 35 shell midden polygons was conducted to determine the point along the shoreline closest to each midden. This allowed for the association of the given EPR and NSM with each midden to represent historical erosion rates. The NSM (total erosion) values ranged from a very high accretion rate of 46.08 m to an erosion rate of

54.72 m, and the EPR values ranged from an accretion rate of 0.64 m per year to erosion of 0.76 m per year. The values for EPR were broken down into five categories by natural breaks in the data and symbolized accordingly. Values with the highest erosion rates were assigned a vulnerability of 5, and sites displaying accretion were assigned a ranking of 1 (Figure 18; Figure 19; Table 6).

c. Coastal Slope

Coastal slope is employed to measure the future erosion rate and the inundation potential of each site. The shallower the slope adjacent to the coastline, the more vulnerable it is to inundation and the faster its rate of shoreline retreat (Smith 2017; Thieler and Hammar-Klose 1999). In contrast, shorelines with very intense slopes are in danger of being undercut by wave action, causing the bluff's base to erode and sites to lose their structural integrity (Smith 2017). This leaves coastlines with slopes at either extreme at risk from environmental processes. In this study, shallower slopes were selected to represent a higher threat due to the nature of the lower-lying coasts of the Nansemond River.

To calculate the coastal slope of each site, the DEM from the USGS and the polygon feature for the 35 shell middens were added to a new ArcGIS Pro file. Then, using the slope function found in the Spatial Analyst tool kit, the slope was determined in both percent rise and degrees (with geodics in meters). This action produced a new raster file that gave a slope value between every pixel in the DEM of the study area (Figure 20). The raster file indicated the steepest and shallowest parts of the shoreline but did not allow a quantifiable comparison between sites. Therefore, the maximum, minimum, and mean slope was calculated with the zonal statistics table and exported to each midden polygon. The measurement chosen to distinguish ranking values was the minimum slope represented in percent rise. Thus, the values for minimum slope were divided into five categories based on natural breaks. Slope values presented an extensive array of diversity, with the highest value of 19.35% and the lowest totaling 0.000734%. Lower slope values seem to congregate around the southwestern end of the Nansemond River, but overall, slopes ranged wildly from site to site (Figure 21; Table 7).

d. Elevation

In determining site vulnerability, lower elevations are more likely to face the threat of inundation and flooding, leading to increased erosion and shoreline disturbance. Thus, minimum elevation was taken to represent the elevation criteria. To calculate the minimum elevation of each site, a 30-m digital elevation model (DEM) of the Nansemond River from the USGS was used.

The Zonal Statistics tool from ArcGIS Pro was used to calculate elevation and generate a new raster that changed all the cell values in each shell midden polygon feature to the lowest elevation value within that polygon feature. The Raster Calculator identified which cells contained the minimum values, which were exported into points. The points allowed for elevation attributes to be added to each polygon. Two sites (i.e., 44SK0053 and 44SK0217) did not produce minimum elevations because the polygon sizes were smaller than the 30-m raster pixels of the DEM layer, requiring the elevation values for these two sites to be manually determined and input.

The lowest elevations were assigned a vulnerability ranking of 5 and higher elevations of 1 (Figure 22; Table 8). There was a wide variety of elevation values, with the lowest being below sea level at -2 m and the highest elevations on a bluff at 11 m. Elevation was highly correlated to distance from the shoreline, with elevations rising the further one moved from the Nansemond River. Six selected sites (i.e., SK62, SK191, SK91, SK80, SK41, and SK40) had elevations of 0 or below; these areas generally were the middens extending directly to the shoreline and are currently at the highest risk of erosion.

e. Land Use

Reeder-Myers et al. (2010, 2015) included land use as a variable to determine modern-day human impacts on each site. Sites within developed urban areas face anthropogenic consequences to a higher degree than those located on protected public (i.e., Park Service) or private land. The land use in the Nansemond landscape varies significantly from open agricultural fields and urban housing developments to park land and recreational areas. To facilitate the use of this variable, Land Cover data from 2019 provided by the USGS offered a grid-by-grid layout of land use across Virginia. Each midden contained a certain number of grid cells based on the size and expanse of the midden. Most of the time, the land use assigned to the grid cell within the midden polygons varied. Therefore, the number of cells of each distinct land use classification was counted, and the land use category with the highest count was taken to represent the most abundant land use within the associated shell midden. Using Reeder-Myer's (2015) model, the results were sorted into five classifications, with shell middens on protected public land ranked as least vulnerable and middens on medium to high intensity developed land as most vulnerable (Figure 23; Table 9). Most of the sites fell within areas designated as open space agricultural fields, meaning there were not currently at risk of development. However, farming and plows can be determinantal to the stratigraphy and integrity of archaeological site preservation, meaning even if the site still exists, it may not provide valid information.

f. Geomorphology

Geomorphology is used to measure the erodibility of the shoreline based on the type of natural features each site sits atop; for example, a sandy beach will be much more prone to erosion than a rocky one (Smith 2017). The Nansemond River tributary sits above two distinct geologic deposits: the Tabb Formation described as "Pebbly to bouldery, clayey sand and fine to medium, shelly sand that grades upward into sandy and clayey silt" (USGS 2021); and an Alluvium deposit consisting of fine to coarse gravelly sand and sandy gravel. The spatial range for each geologic deposit was determined by the USGS Mineral Map (Figure 24) (USGS 2021). Most shell middens fall within one of the two deposits; however, a few consist of a mixture. Using Reeder-Myer's (2015) geomorphology scale, shell middens atop alluvium deposits were assigned a vulnerability rank of 5, middens atop the mixture a ranking of 4, and the Tabb Formation assigned a 3 (Figure 25; Table 10).

g. Summary of Environmental Variables

In the above section, the methods and results of each environmental variable (distance to the shoreline, erosion, coastal slope, elevation, land use, geomorphology) were detailed and summarized. All analyses of environmental variables were carried out using geoprocessing tools from ArcGIS Pro. The first variable calculated was the distance to the nearest shoreline, which informed how each site was affected by sea-level rise, wave action and tidal action under the assumption that the closer a site to the shoreline, the greater the effect. Distance to the nearest shoreline placed six sites (SK0011, SK0020, SK0037, SK0058, SK0062, SK0170) directly on the shoreline (distance = 0 m) at the highest risk. Several sies were over 100 m away from the shoreline, but 44SK0217 was furthest away at a distance of 549.71 m. Elevation also related to sea-level rise, wave action, and tidal action effects on each site. At higher elevations, sites are at less risk of environmental processes, placing site 44SK0054 at the lowest risk with a high elevation of 11 m. Several sites sat below sea level, making them incredibly vulnerable. However, sites 44SK0040 and 44SK0041 ranked at the highest risk under the elevation category due to their position resting two meters below sea level.

The following variable calculated was the historic rate of erosion. This looked at how the shorelines each archaeological site rested upon had changed over 72 years and was used as a base proxy to determine possible future shoreline erosion rates at the sites. Site 44SK0062 had the highest rate of shoreline erosion with an EPR of -0.61 m/yr. This ranked as medium erosion on VIMS's erosion scale. The lowest rate of shoreline erosion for sites within the study set was experiencing a low rate of shoreline accretion with an EPR of 0.08 m/yr. Most of the shorelines on which the archaeological sites sat were experiencing a low erosion rate of approximately -0.27 m/yr. The coastal slope was another variable used to inform each site's erosion rates and inundation potential. Shallower slopes allow for a faster rate of shoreline retreat placing sites SK0011, SK0050, SK0080, and SK0191 currently at the highest risk, with minimum slope values at 0%. Most sites maintained relatively low minimum slope values. However, site SK0051 revealed an abnormally high slope value at 19.35%, offering ample protection from environmental processes.

The final two environmental variables considered were land use and geomorphology. Land use utilized Land Cover data from 2019 to associate the land classification most abundant within each shell midden to the general land use of the site. The midden site at the highest risk was found to be site 44SK00212 as it is currently classified on medium to high intensity developed land. The least at-risk site is 44SK0416, located on protected public land. However, most sites are classified as being on developed open space or agricultural land, which means they are at moderate risk from plowing and potential future construction. The final variable was geomorphology, which informed the coastline's geologic integrity and erosional potential. With only three categorizations for the geomorphology variable, each site was considered at least at moderate risk. However, the 13 sites atop the alluvium deposit were deemed most at-risk due to the runoff potential of alluvium. All of the above information combined with the results of the cultural variables informed the final CVI results discussed below.

VIII. Analysis and Results of Cultural Variables

a. Site Area

Smith (2017) used site area as a proxy for artifact abundance on the assumption that a large village site with broad temporal depth would house greater and more abundant cultural resources than a small, dispersed scatter of artifacts (Smith 2017: 43). Thus, site area was calculated in meters squared (m^2) using the Calculate Geometry function in ArcGIS Pro. The results were divided into five categories based on natural breaks in the data and assigned a rank from 1 (smallest sites) to 5 (largest sites) (Figure 26; Table 11). Areas ranged from 202,151 m^2 (44SK0011) to 254 m^2 (44SK0217). While there was a large divide between the largest and smallest sites, most areas fell between 500 m^2 and 25,000 m^2.

b. Eligibility for the National Register of Historic Places

The most easily accessible variable to establish cultural significance was eligibility for the NRHP. As discussed earlier, the NRHP is a government-sponsored effort to identify, evaluate, and protect America's historic and archeological resources. Using the Virginia Cultural Resource Information System (VCRIS) records, all sites previously evaluated for the NRHP were identified and their status assigned. One site was already listed, 44SK0093 or Dumpling Island (Figure 28). Three sites were listed as eligible (44SK0003, 44SK0011, 44SK0020), and five sites were listed as potentially eligible (44SK0013, 44Sk0037, 44SK0041, 44SK0080, 44SK0091). All these sites were considered eligible or potentially eligible under Criteria D. Finally, only one site was listed as not eligible (44SK0050), as the site had previously been destroyed in a construction project. The remainder of the sites had not been assessed and received the status unknown. Each category (not eligible, unknown, potentially eligible, eligible, and listed) was given numeric rankings, with 1 representing not listed and 5 representing listed. As NRHP eligibility acts as a proxy of site significance, the sites that are eligible or already listed on the NRHP are assumed to be more culturally and historically significant. Thus, making them the most important sites to preserve (Figure 27; Table 12).

c. Historical References

The final cultural variable is based on historical references to Nansemond scared landscapes. As discussed in detail in a previous section, the two sources most critical for the historical references were John Smith's journals written during his Virginia explorations and George Percy's *A Twere Relacyon*. Within the written records, site 44SK0093 or Dumpling Island was the most explicitly referenced, allowing the site to receive a rank of 5 for historical significance (Figure 28). While no other site was as thoroughly documented, several site names were referenced in the historical literature or depicted on Contact-era maps. These sites all received a ranking of 4 for historical significance (44SK0011, 44SK0018, 44SK0037, 44SK0041, 44SK0062, 44SK0080, 44SK0081, 44SK0191). The remainder of the sites receiving no historical references obtained rankings of 1 because they did not offer any historical context (Figure 29; Table 13).

d. Summary of Cultural Variables

Three variables (site area, eligibility for the NRHP, and historical references) were used as proxies for the cultural and historical significance of each site. Site area was assumed to represent artifact abundance, with larger sites having more archaeological deposits than smaller ones. The results displayed an extensive range of site areas, with the smallest site, 44SK0217, measuring 254.80 m^2. The largest site area was 202,150.31 m^2 at site 44SK0011. Under the assumptions presented here, SK0011 would have the highest artifact abundance. The following variable considered was eligibility for the NRHP. This served as a proxy for site significance based on the criteria laid out by the NPS. According to this variable, the most at-risk site is 44SK0093, Dumpling Island, as the site was already listed on the register. The least at-risk site is 44SK0050 which is ineligible as the site had been previously destroyed. The remaining sites were classified based on their previous assessments in VCRIS.

The final variable considered within the cultural section was references within historical documentation. This variable, like NRHP, acted as a proxy for historical significance based on the number of references given in relevant literature and documents. As expected, site 44SK0093, or Dumpling Island, collected the most significant number of historical references earning the classification as most at-risk. Most sites received a low ranking due to a lack of references. However, eight other sites (SK0011, SK0015, SK0037, SK0041, SK0062, SK0080, SK0081, and SK0191) had at least one reference within the Contact-era documentation and maps, earning a higher at-risk value. The three variable results, combined with the environmental variable results, inform the final CVI calculations discussed below.

IX. Coastal Vulnerability Index (CVI) Results and Discussion

Once each variable had been determined and individually assigned a ranking, each sites' overall coastal vulnerability ranking was calculated. The rankings for each site were plugged into the CVI equation, and the arithmetic mean (i.e., average) was taken for each site to produce a final overall vulnerability score,

$$\mathrm{CVI} = \frac{DS + E + RE + CS + LU + G + A + NRHP + HR}{9}$$

where: DS = distance to shoreline, E = elevation, RE = historic rate of erosion, CS = coastal slope, LU = land use, G = geomorphology, A = site area, NRHP = NRHP eligibility, HR = historical reference. This allowed the sites to be compared to one another to ascertain which sites were at the greatest risk (Figure 30; Figure 31; Table 14).

While all the sites considered in this project deserve archaeological preservation and mitigation, only the three most at-risk will be addressed in the discussion as they are in the most immediate need of assistance. Based on the results of the CVI, sites SK0011 (CVI = 4.11), SK0191 (CVI = 4.00), and SK0080 (CVI = 3.89) displayed the highest risk based on the criteria employed in this study. All three sites are symbolized as red points on the final CVI ranking map in spatially diverse areas, insinuating little spatial continuity between high-risk sites (Figure 30).

Site SK0011 sits directly along the western edge of the Nansemond River near the City of Suffolk, making it highly threatened by sea-level rise and shoreline erosion. While the site does not have the highest historic erosion rates, the proximity of the shoreline makes the site especially vulnerable. Although site SK0011 appears somewhat removed from the shoreline on the maps provided here, the site has the largest area, and the point used to represent it does not account for the total spatial extent. The large surface area of this site invites interpretations of high artifact and feature densities. However, that can only be a hypothesis without further archaeological investigations. While site SK0011 sits atop the Tabb Formation on agricultural land like the majority of the sites, what sets it apart is SK0011's presumed association with the Dumpling Island village complex and its established eligibility for the NRHP under both Criteria A and D.

The next most at-risk site, SK0191, sits at the opposite end from the other two on the eastern shore close to the mouth of the Nansemond River. While site SK0191 rests further offshore than SK0011, it sits at an elevation below sea level, making it very sensitive to sea-level rise. Additionally, the site holds the highest risk of human interference through development by being the only site on land categorized as medium to high-intensity development. One of the most surprising factors of the results of the CVI for site SK0191 is that while the site has been attributed back to a Nansemond village listed on Tyndall's map, Oriskoyek, it has not yet been assessed for eligibility to the NRHP. This is likely due to the lack of archaeological excavations carried out at the site as well as its location in a highly populated urban area.

Site SK0080 ranked high on the CVI as the site had previously been listed as potentially eligible for the NRHP and had a reasonably extensive excavation history. The site covers a large area on the eastern shoreline of the Nansemond River, near the City of Suffolk. Site SK0080 is situated at a low elevation and close to the coastline, making it vulnerable to coastal erosion and sea-level rise. The site has been spatially associated with the Nansemond village of Mantoughquemend, yet further work needs to be done to confirm this assumption and establish whether the site is eligible for the NRHP.

The Dumpling Island complex ranks as the seventh most at-risk site. This result was unexpected, given that the site is historically and archaeologically significant. However, as the site is listed on the NRHP and located on private, protected land, the site and its surrounding landscape are well monitored for environmental damage and preserved from human development. While the landscape may be well managed, it can be argued that the site has been thoroughly under-excavated, considering the area's cultural significance to the descendant community and its abundant references within historical literature. The excavation records of the site are sorely lacking interpretation; there is not even a site report associated with the excavations at Dumpling Island (VCRIS 2022). However, it must be kept in mind that the Nansemond Indian Nation may not want to disturb the sacred site any further through development or even archaeological excavation.

A cluster of very low-risk sites is located within bracket B on the final CVI ranking map (Figure 30). The nine sites within the B bracket share most of the same characteristics due to their proximity. Additionally, they have high elevations as they sit atop the terraces John Smith references when sailing down the Nansemond River. This feature protects the sites from many environmental processes, including sea level rise, erosion, and wave and tidal action. The nine distinct shell middens may represent one large, continuous midden or a cluster of households. However, there is no concrete proof, and further archaeological excavations must be carried out to confirm. While these results have highlighted sites at the most immediate risk according to the criteria laid out above, all of the middens within the study area have the potential to add to conversations surrounding shell midden archaeology within the mid-Atlantic region.

X. Conclusion

This study has assessed the vulnerability of archaeological shell middens situated around the Nansemond River. The results indicate which sites are at most significant risk from environmental processes such as erosion and sea level rise, and which sites have the greatest potential for future research. These results can assist the descendant community, the Nansemond Indian Nation, archaeologists, and coastal managers in developing future research and conservation initiatives centered around both cultural and environmental preservation. Through geospatial analysis and the methodological study of the archaeological site records and historical documentation, this project was able to showcase a systematic ranking of 35 shell midden along the Nansemond River at varying levels of vulnerability.

The mid-Atlantic region was once home to a rich Indigenous cultural heritage. Nevertheless, resulting from colonization, much of the living cultural history has been displaced and whipped away. However, human history remains inscribed on the landscape through the intentional actions of people actively managing their surrounding environment and its associated resources (Erickson 2008). The fields of archaeology and geology are uniquely suited to explore the long-term archives left inscribed on the landscape. This work can be excruciatingly difficult in the Chesapeake region due to the poor preservation conditions maintained by the region's humid climate and naturally acidic soil. Researchers often find the archaeological record lacking, resulting in many remains' tendency to decay and decompose. Shell middens exist in abundance within this region and, as discussed in an earlier chapter, play a distinctive role in archaeological studies of the Chesapeake Region as long-term archives of cultural and environmental knowledge. They can unearth information ranging from Native American maricultural techniques and resource management practices (i.e., Jenkins 2017; Jenkins and Gallivan 2019) to environmental proxies used to reconstruct past climates (i.e., Kusnerik et al. 2018; Rick and Lockwood 2013; Rick et al. 2016).

This project assessed the vulnerability of the Indigenous Nansemond landscape through the thesis of historical ecology. Much of the discussion centers on the importance of shell middens as long-term archives of Indigenous knowledge, emphasizing that Native people actively managed a sustainable and thriving oyster fishery until the onset of colonization. However, while at times potentially true, this narrative reinforces the notion of the Ecologically Noble Savage, with high ecological biodiversity being strongly associated with the presence of Native peoples and low biodiversity associated with nonnatives (Hames 2007). Research has instead provided well-documented counterexamples of Indigenous peoples’ environmental indifference or destruction. For example, as discussed in an earlier section, Jenkins and Gallivan (2019) offer evidence of oyster overharvesting based on a decrease in mean shell size from the Middle Woodland I (500 B.C.–A.D. 200) to Middle Woodland II (A.D. 200–900) period. These trends highlight an increase in oyster harvesting intensity by forager-fisher populations living along the York River at the onset of the Middle Woodland II period. The intensive harvesting was enough to impact the once healthy oyster fishery by causing a statistically noticeable decline in oyster shell size, a proxy often used for oyster health (Jenkins and Gallivan 2019).

In the centuries following the size decrease, oyster height rebounded, despite growth in population sizes and sedentary life within Native communities. Jenkins and Gallivan (2019) have suggested this is due to a resilient oyster fishery being actively managed by Native people who were apt enough to recognize a harmful practice and make dynamic changes to adjust the outcome. The resilience displayed by the precontact oyster fishery results from both ecological and social factors. This reinforces the notion that not all interactions Native peoples living in the mid-Atlantic region had with the environment produced sustainable and enhancing effects. As Hames (2007: 179) declares, "the idea of deliberate conservation by native peoples was a myth." Instead, through the narrative of historical ecology, we can see Native peoples could fundamentally shape their environment both positively and negatively. Historical ecology emphasizes the interactions between societies and the environment over long periods by looking at the consequences of these interactions, gaining insight into past cultures and landscapes leading to the formation of contemporary society.

Regardless of the effect Indigenous people had on the oyster fishery's health, the shell middens' archaeological remnants offer crucial knowledge regarding Native lifeways and social practices well-worth preserving. The value of shell middens is often overlooked in studies of the mid-Atlantic region. However, as one of the most abundant archaeological resources in the region, attention needs to be drawn to the threats they face as coastal resources. One of the primary goals of this study was to join conversations regarding the vulnerability shell middens face to rapidly changing environmental processes while providing examples of techniques to monitor and/or mitigate the rising threat. The United States has approximately 142,641 km of tidal shoreline spread throughout 24 states, presenting a difficult and time-consuming challenge for protecting cultural heritage along coastlines (Reeder-Myers 2015). To put this into perspective, the Nansemond River tributary maintained as the study area in this project makes up a mere 31.9 km of the total shoreline, emphasizing a long road ahead in archaeological preservation. Using readily available data, studies (Reeder et al. 2010; Reeder-Myers 2015; Smith 2017), including the one detailed above, have shown the promise of GIS technology and spatial analysis to monitor at-risk archaeological and identify areas under exceptionally high threat from climate change and human development to prioritize for future research and mitigation initiatives.

Developing CVIs has broad applications both in the field of archaeology and shoreline management. They are very adjustable depending on the criteria under assessment and the data available for the proposed study area. CVIs can be applied to small areas such as a collection of archaeological sites displayed within this study or over a shoreline spanning thousands of kilometers. Working with a more extensive study area offers more available data yet provides a macro-scale view of environmental trends, whereas the smaller study site applied here offers a case-by-case assessment of individual archaeological sites. While different in their target strategy, both produce results drawing the attention of coastal resource managers and archaeologists alike to the most vulnerable areas. These results assist the relevant parties in developing efficient and effective preservation and mitigation strategies for high-risk areas.

While providing valuable insight into archaeological site vulnerability, CVIs are not always perfect. For example, they produce static results, meaning the rankings do not automatically change as environmental processes shift. They are bounded by the data used at the time of their calculation. The second downside would be the data available; open-source, available data is highly variable, meaning the quality and quantity of accessible data is inconsistent. For example, when initially looking for data, the highest resolution DEM available was 30-m which was not detailed enough to conduct some of the intended analysis. Despite the downsides, CVI rankings offer an accessible, low-cost, and non-invasive option for assessing shoreline vulnerability and archaeological site risk.

Within this CVI, the decision to utilize an unweighted equation or equal-weighted index offered its own set of challenges. With this method, all variables, regardless of meaning, have equal sway on the final index values. While this removes the risk of research bias in the selection of weights, it normalizes all variables to the same importance level of importance. Doing so increased the overall influence of variables such as historical references above the weight it should have been given, considering the results spawned from a Eurocentric, colonizer perspective of the landscape.

An alternative option to the unweighted equation could have been a value-weighted index where each of the nine variables was assigned a coefficient to multiply against each variable’s final ranking value. The higher the coefficient, the more impact the associated variable would have on the movement of the index and the final CVI value. The final calculation produced in the value-weighted index would be an average based on arbitrary index weights assigned by a human, making the results more prone to human error. In contrast to an unweighted equation, the formula would allow the subjective perspective of historical references to receive a lower weight than a variable such as a shoreline erosion or the potential inclusion of Indigenous perspectives. However, to carry out a weighted index calculation, experts in the fields such as environmental science, geology, urban planning, and archaeology would have to be consulted to gather the necessary perspectives to weigh each variable properly. An interesting direction for future research would be to determine appropriate weights for each variable and recalculate the CVI index to see how the results change. However, currently, the unweighted CVI results serve this project's original intent—to produce a best-guess ranking of the most at-risk archaeological shell middens along the Nansemond River to act as a guide to begin future excavation and mitigation work.

The next steps on this project include using the calculated information to begin the excavation and mitigation work of the shell middens. Mitigation work should include constructing shoreline bluffs or planting spartina grass to reinforce marshes, positively affecting the shorelines' environmental integrity and the cultural resources' safety (Smith 2017). Additionally, further spatial analysis (i.e., cluster testing) and regression analysis can be carried out in smaller clusters of sites, such as brackets A and B, to better determine the spatial relationship between sites. Moving forward, these studies need to be applied to more and broader study areas to further assess the risk climate change poses to cultural resources across Virginia and the broader Chesapeake region. The resulting information can guide and direct future research in coastal settings to the areas that need work most promptly. This would serve a dual purpose of adding to the pool of knowledge regarding coastal inhabitants and Indigenous history while working on excavating and mitigating high-risk sites from future destruction before they are gone forever.

Overall, this research aims to bring attention to climate change’s threat to cultural heritage. Historical sciences like archaeology provide essential perspectives on past climate and environmental change necessary for future restoration work. Archaeology highlights how past developments can inform and contextualize current and projected conditions. While geologists and paleontologists reconstruct ancient ecological and climatic changes, archaeologists humanize the landscape. Looking to our past and learning how previous humans responded to change magnifies our interpretation of human history and offers lessons for future generations. This project assists with efforts to preserve archaeological sites with such potential by outlining reproducible techniques for monitoring and mitigating at-risk archaeological sites before it is too late.

XI. Figures and Tables

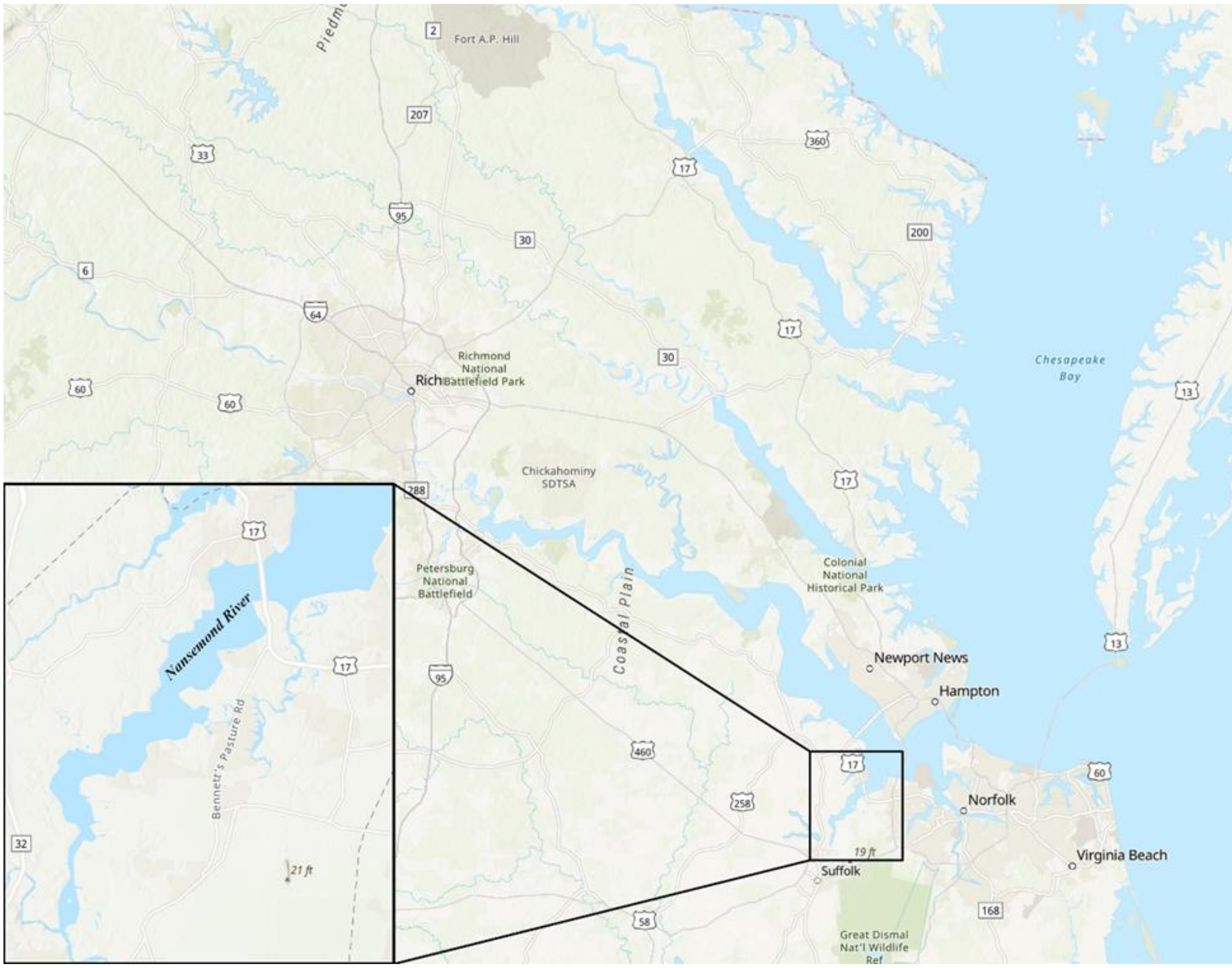

Figure 1. Location of Nansemond River and associated tributaries.

Figure 2. Eroding shell midden along the York River.

Figure 3. Shoreline hardening at Yorktown Beach, photo from VIMS.

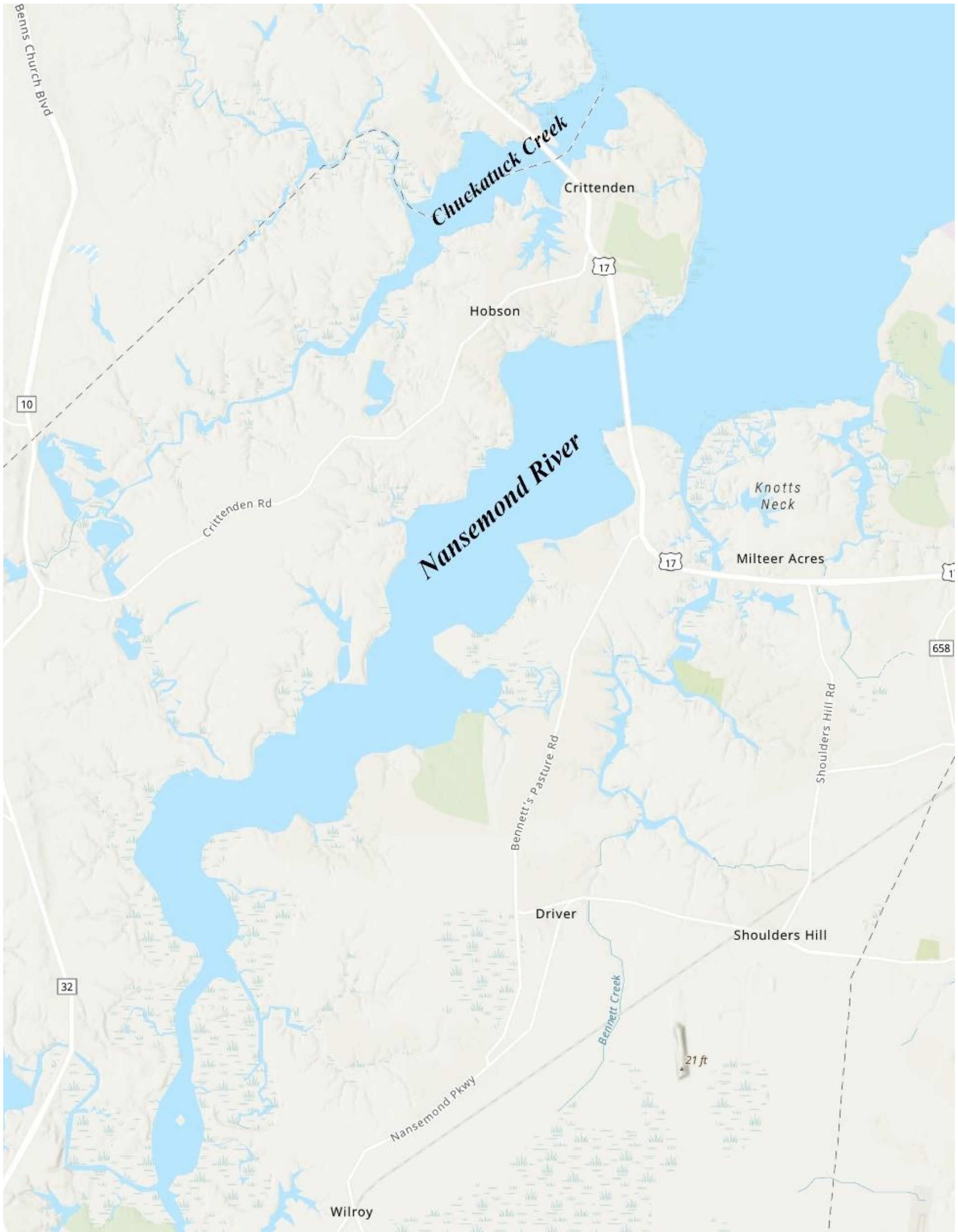

Figure 4. Map locating Chuckatuck Creek along Nansemond River.

Figure 5. Location of NOAA Tidal Gauge at Sewell Point, from NOAA tidal gauge map.

Figure 6. Example of living shoreline on the Nansemond River planted by the Nansemond River Preservation Alliance.

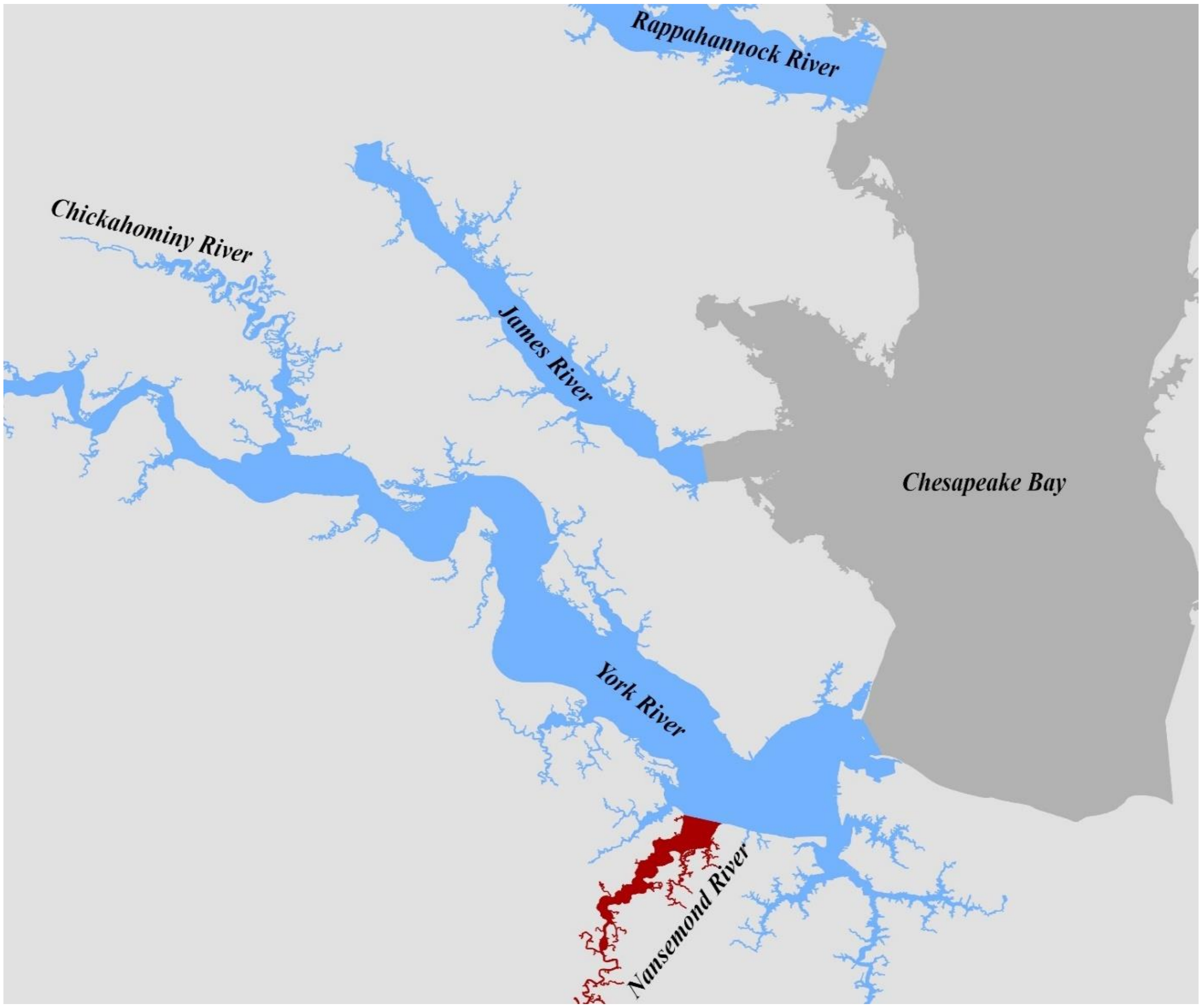

Figure 7. Major Virginia River, including the James, Rappahannock, York, and Chickahominy is relation to the Nansemond River (pictured in red).

Figure 8. "Virginia and Maryland as it is planted and inhabited this present year 1670" by Augustine Herrman and Thomas Withinbrook (Bass 2021).

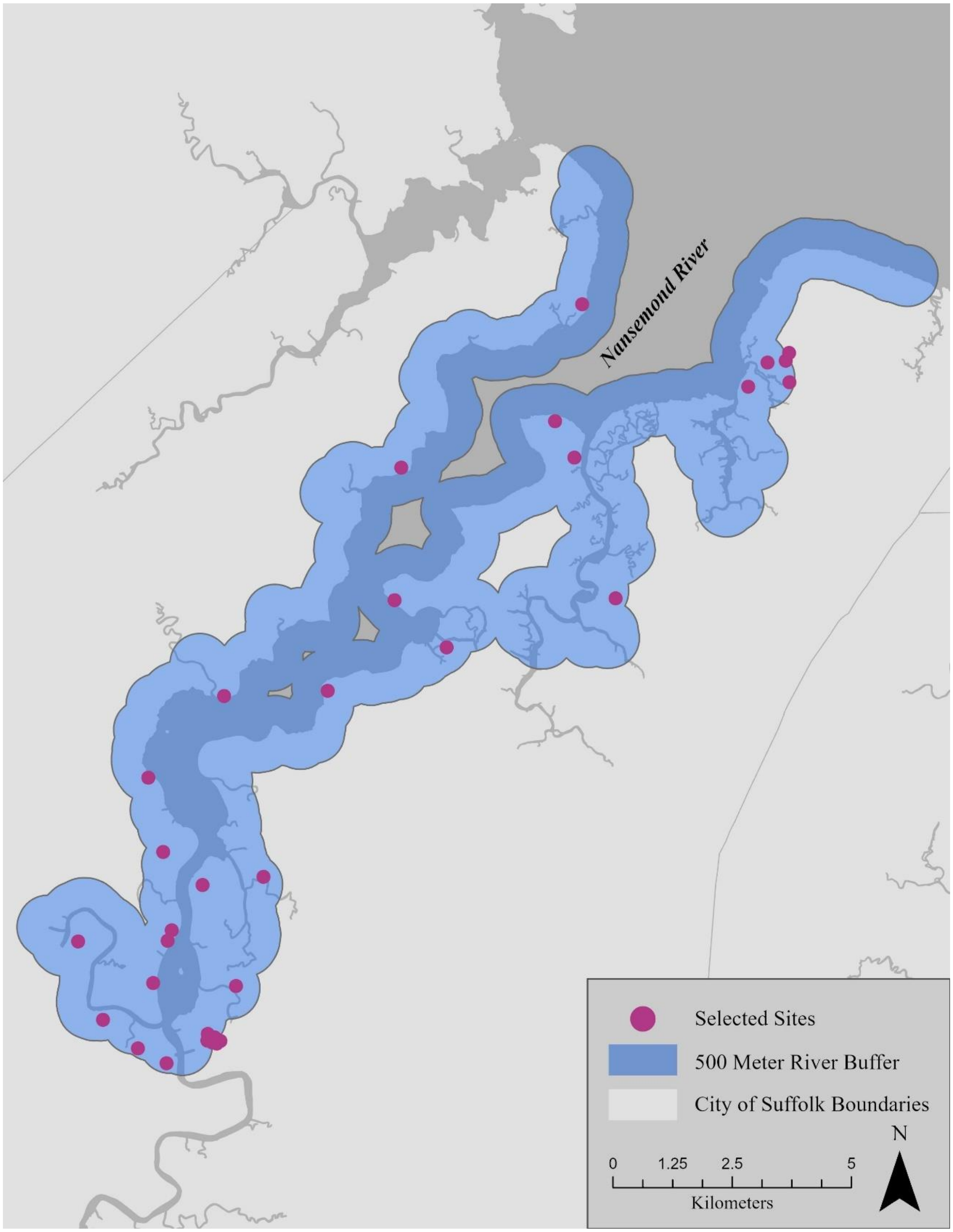

Figure 9. Selected sites within the arbitrary 500 meter buffer, sites represented as points rather than polygon shapes for privacy matters.

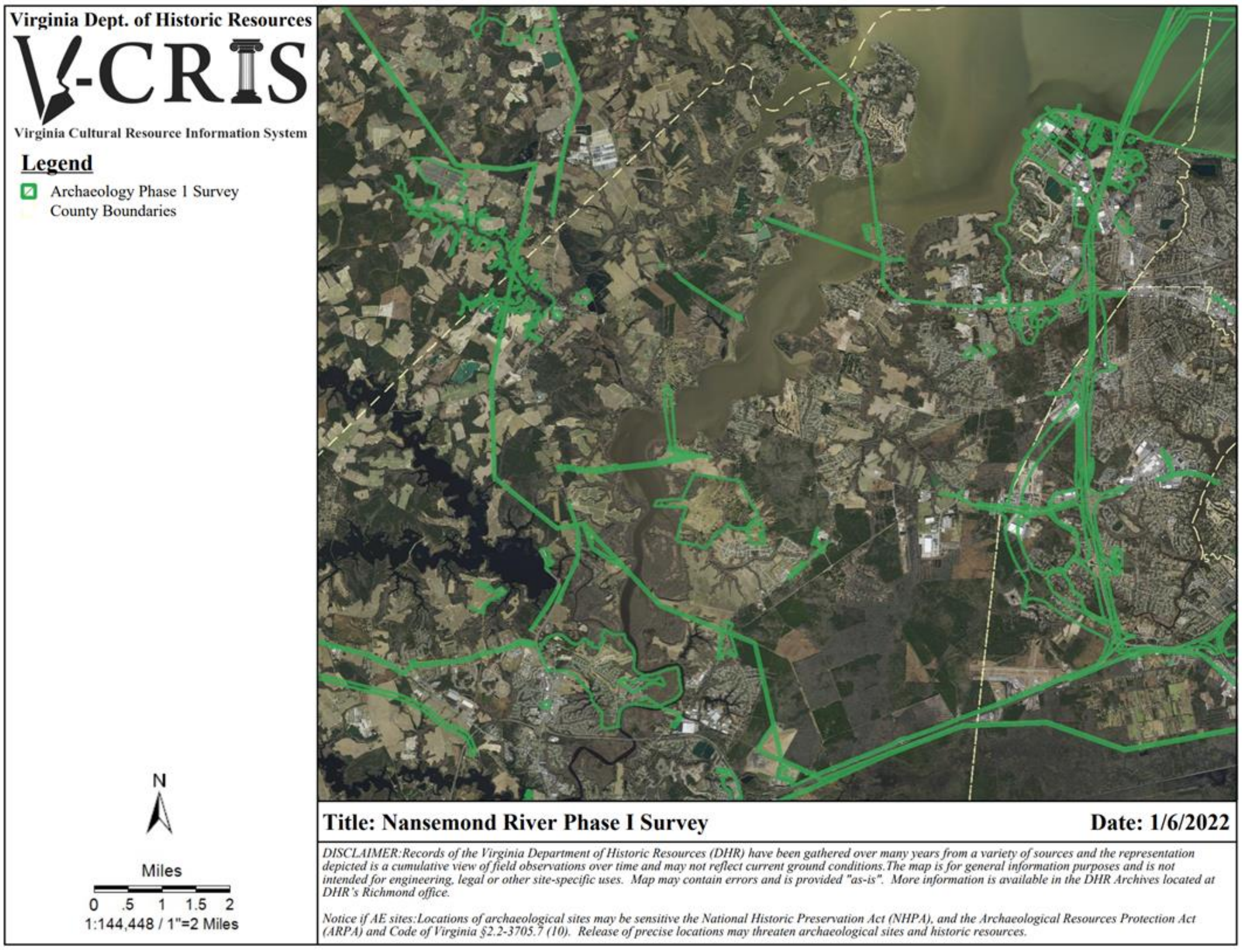

Figure 10. Boundaries of Phase I archaeological surveys within the Nansemond River tributary.

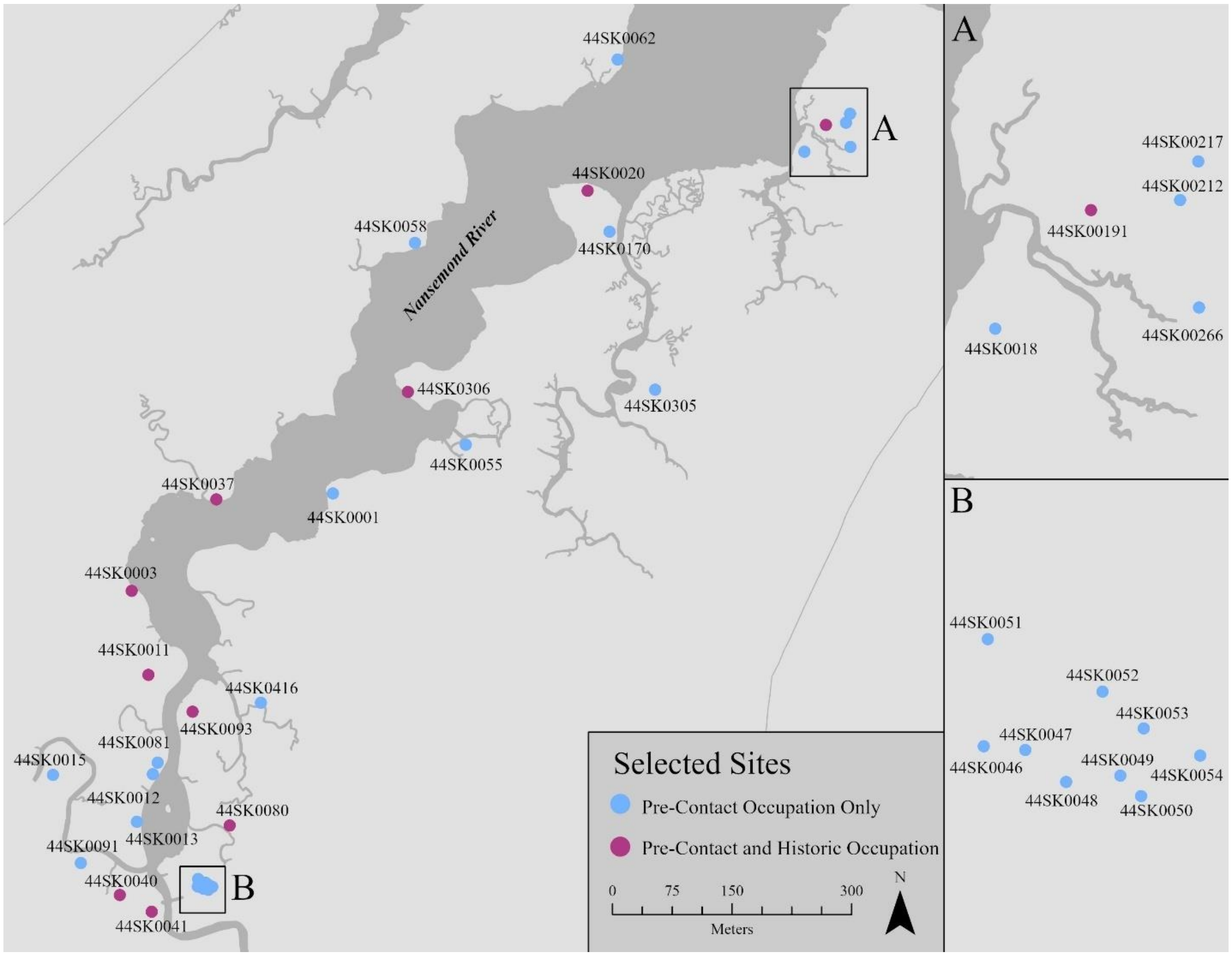

Figure 11. Selected Sites based on pre-Contact and historic occupations, site locations from VDHR.

Figure 12. Test unit from excavations at Dumpling Island, original photo from Virginia Department of Historic Resources Dumpling Island Historic Registry.

Figure 13. John Smith's 1612 "Map of Virginia" clipped to the Nansemond River, original image from the Library of Congress.

Figure 14. Don Alonso de Velasco's 1611 Map of Virginia, left displays clipped map of the Chesapeake region, right displays names of Native villages along major rivers and associated number.

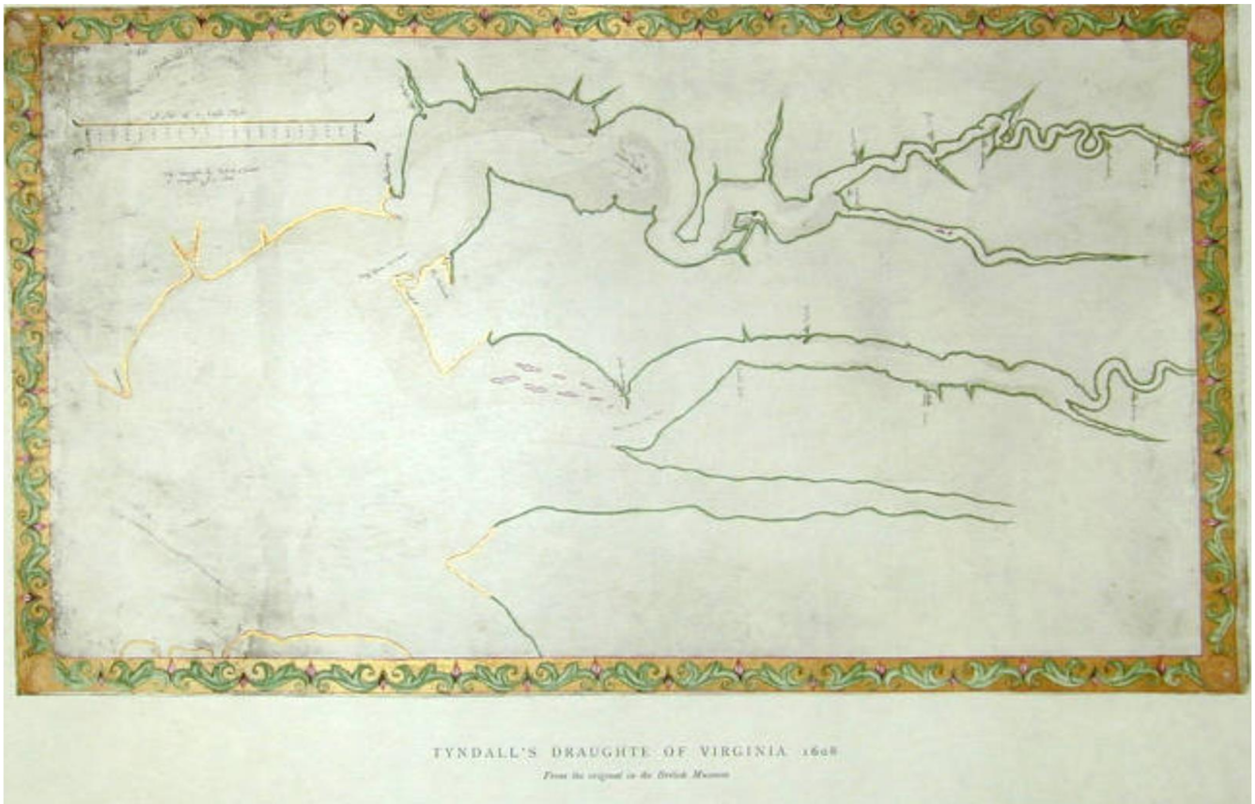

Figure 15. Robert Tyndalls' "Draught if Virginia" Map, from the Huntington digital library.

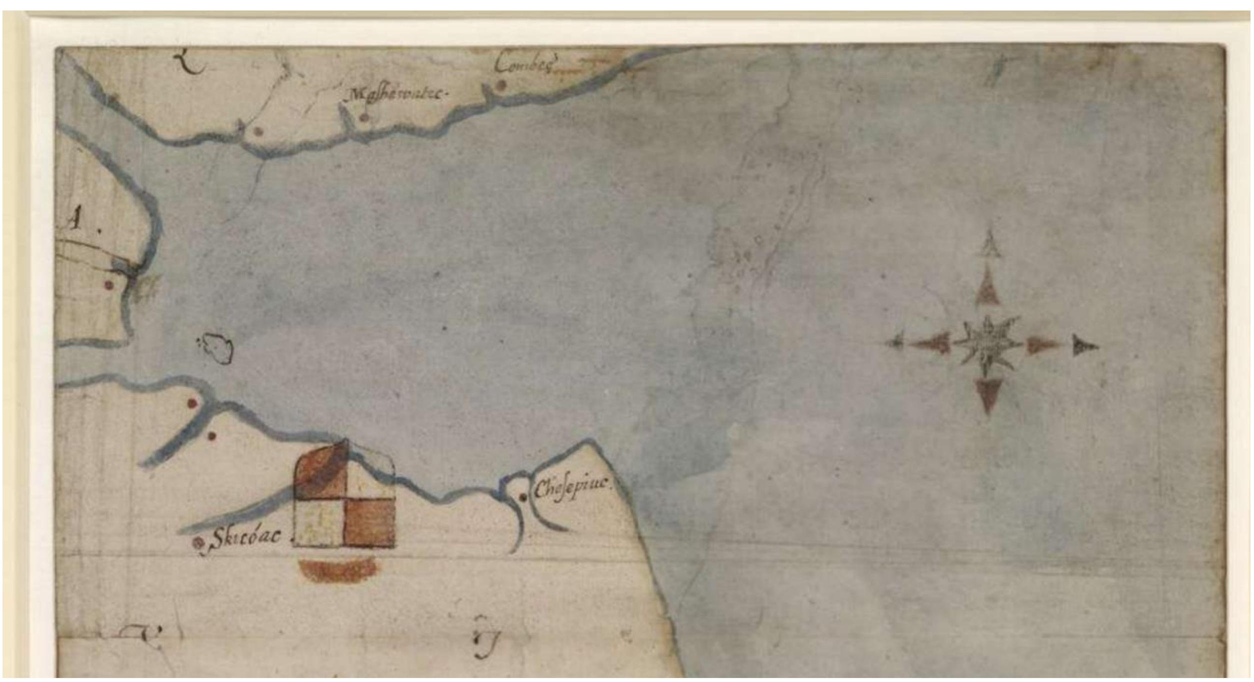

Figure 16. John White's 1585 "La Virginea Pars" Map, cropped to the Chesapeake Bay region, original from the British Museum.

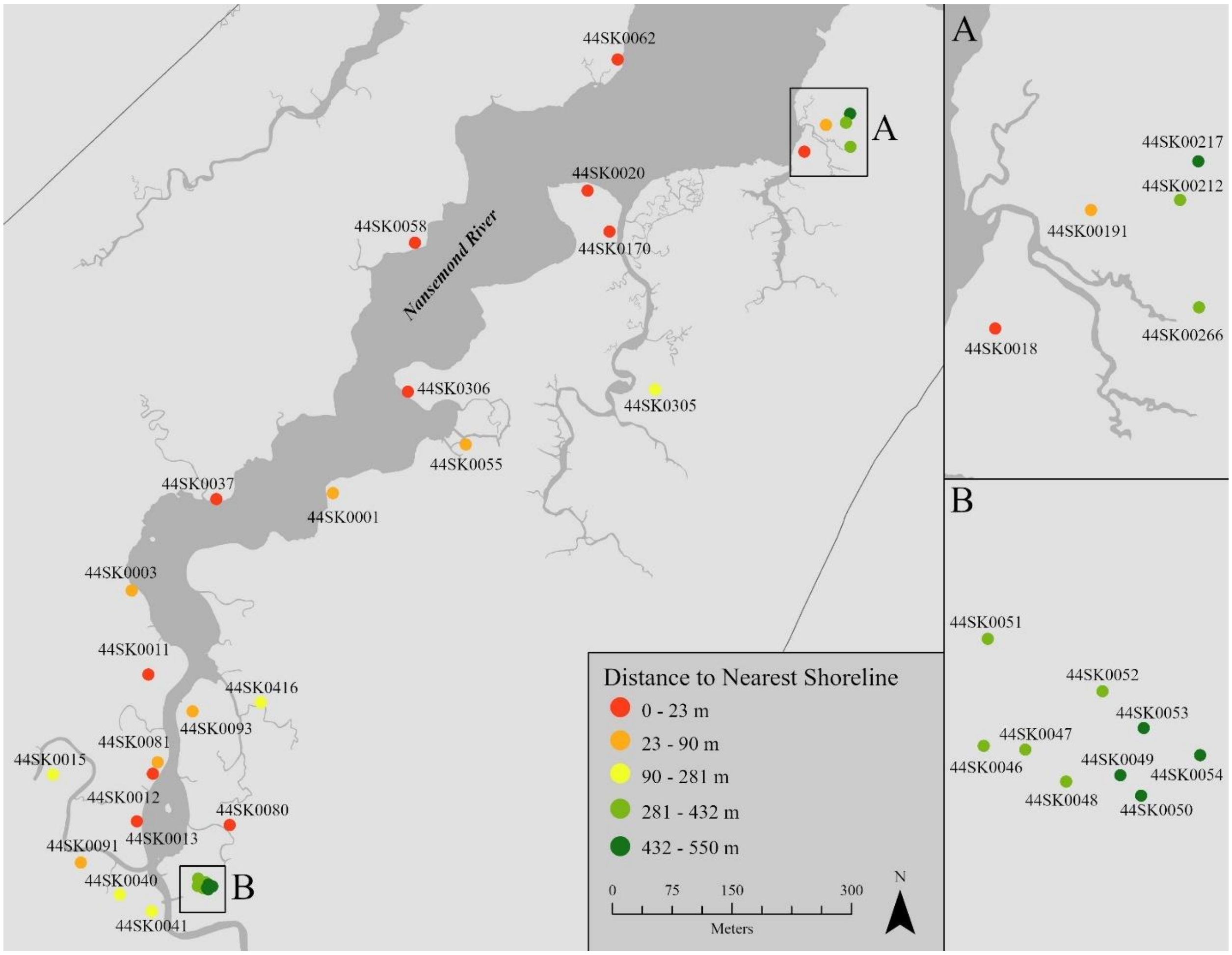

Figure 17. Selected sites displaying distance to the nearest shoreline, points in red represent high risk, points in green represent low risk.

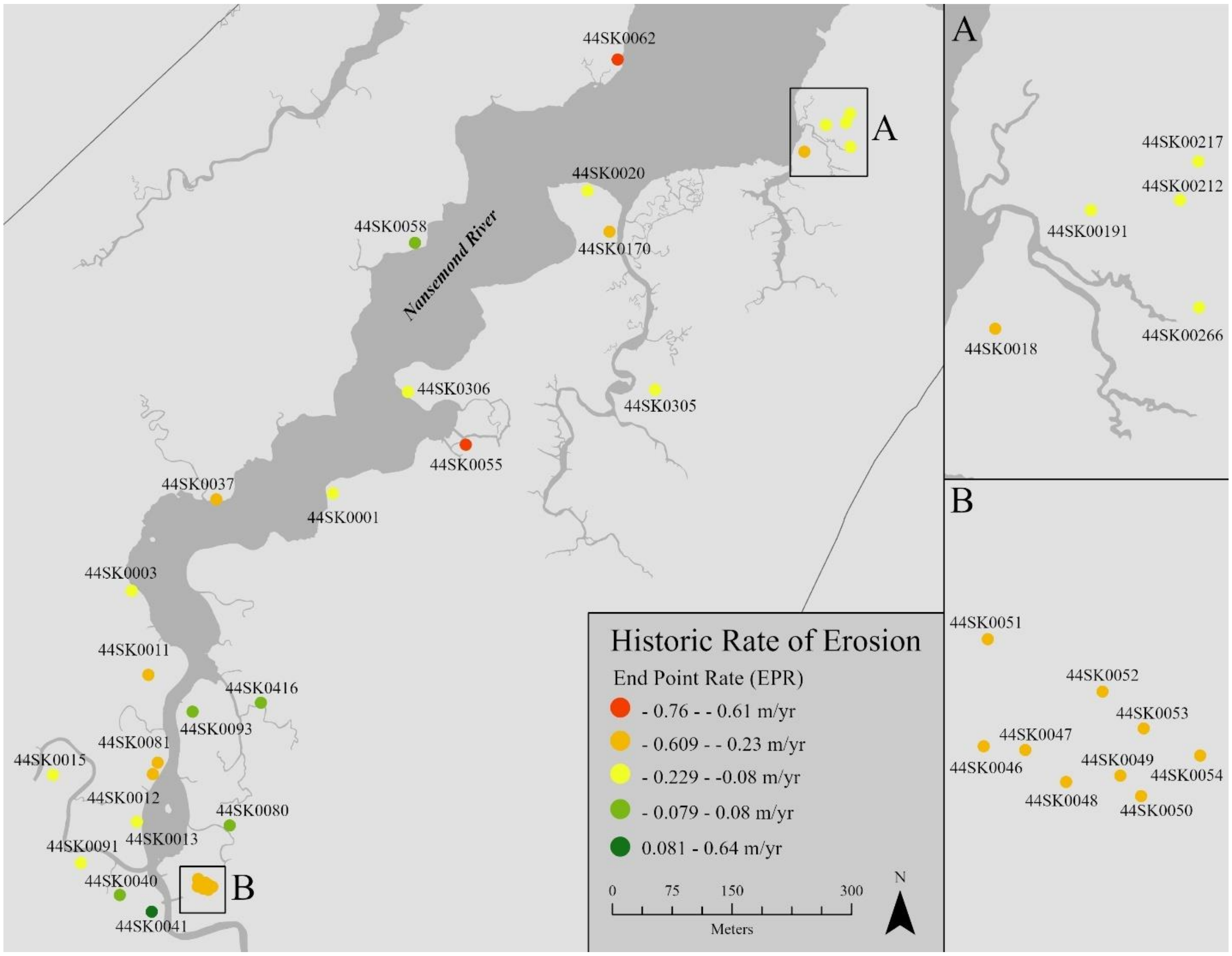

Figure 18. Historic rates of shoreline erosion as end point rate (i.e., rate of erosion per year).

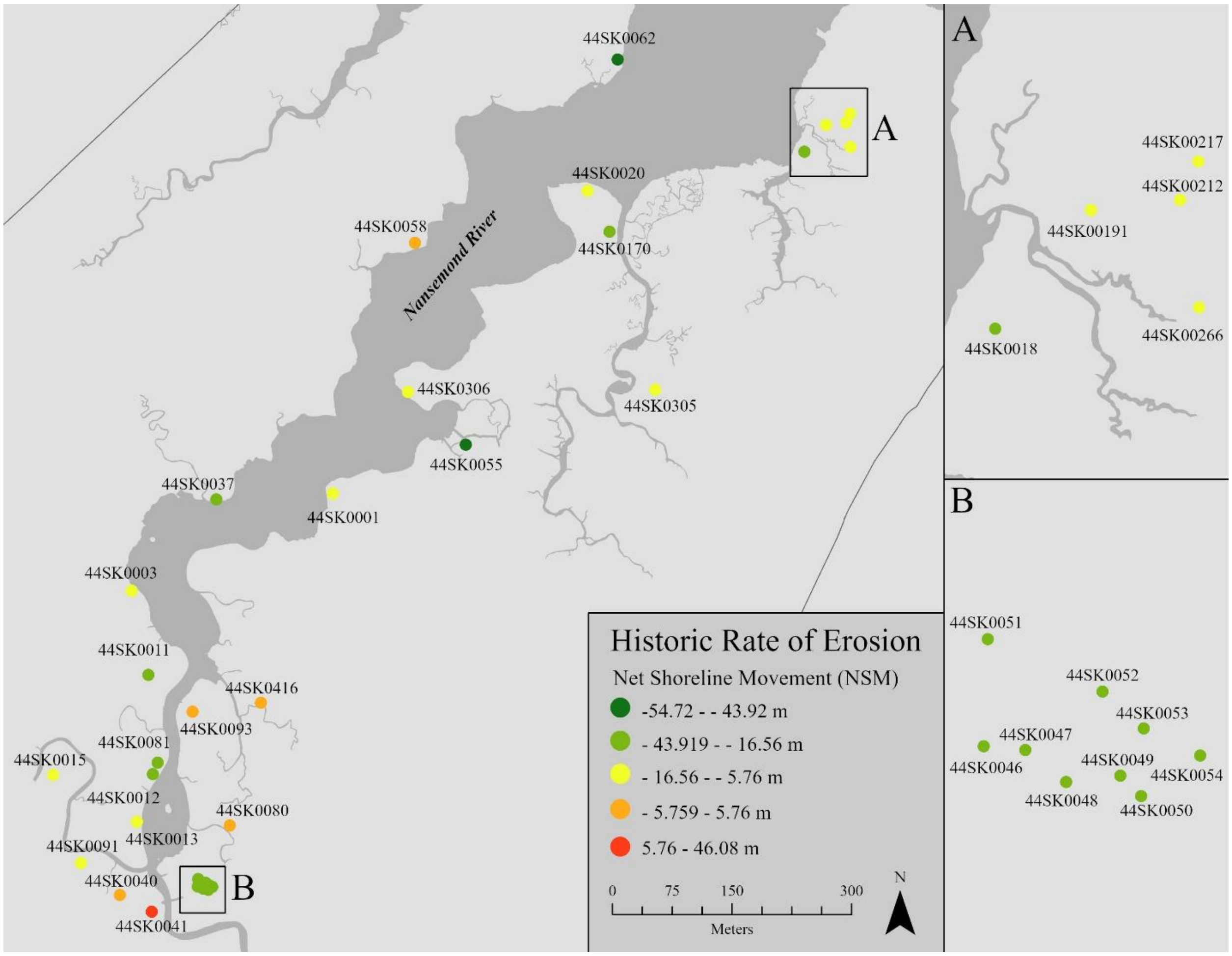

Figure 19. Historic rate of shoreline erosion shown as net shoreline movement, distance between the shoreline in 1937 and 2009.

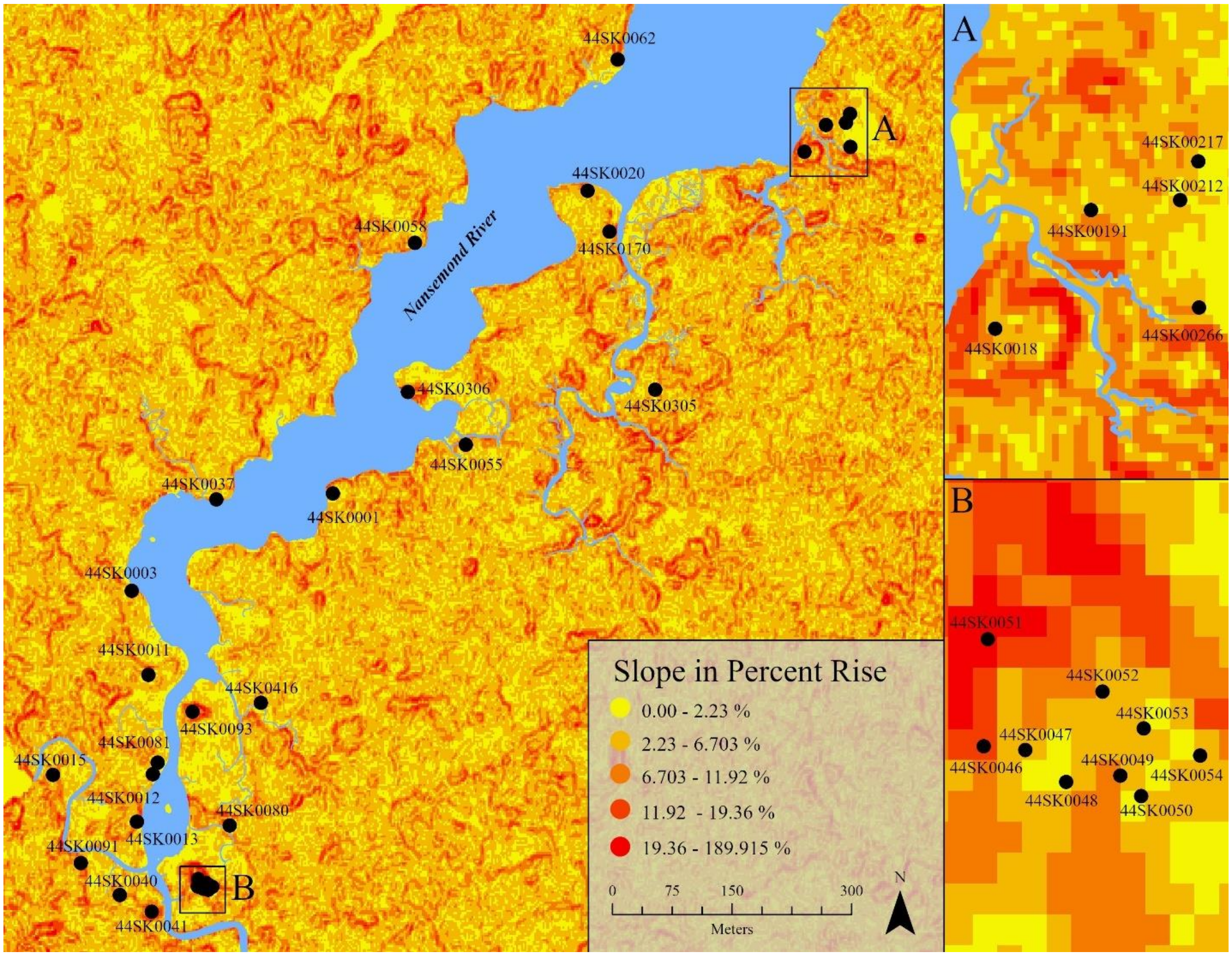

Figure 20. Overall slope values for the land surrounding the Nansemond River in percent rise, red areas display steeper slopes, while yellow areas display shallower slopes.

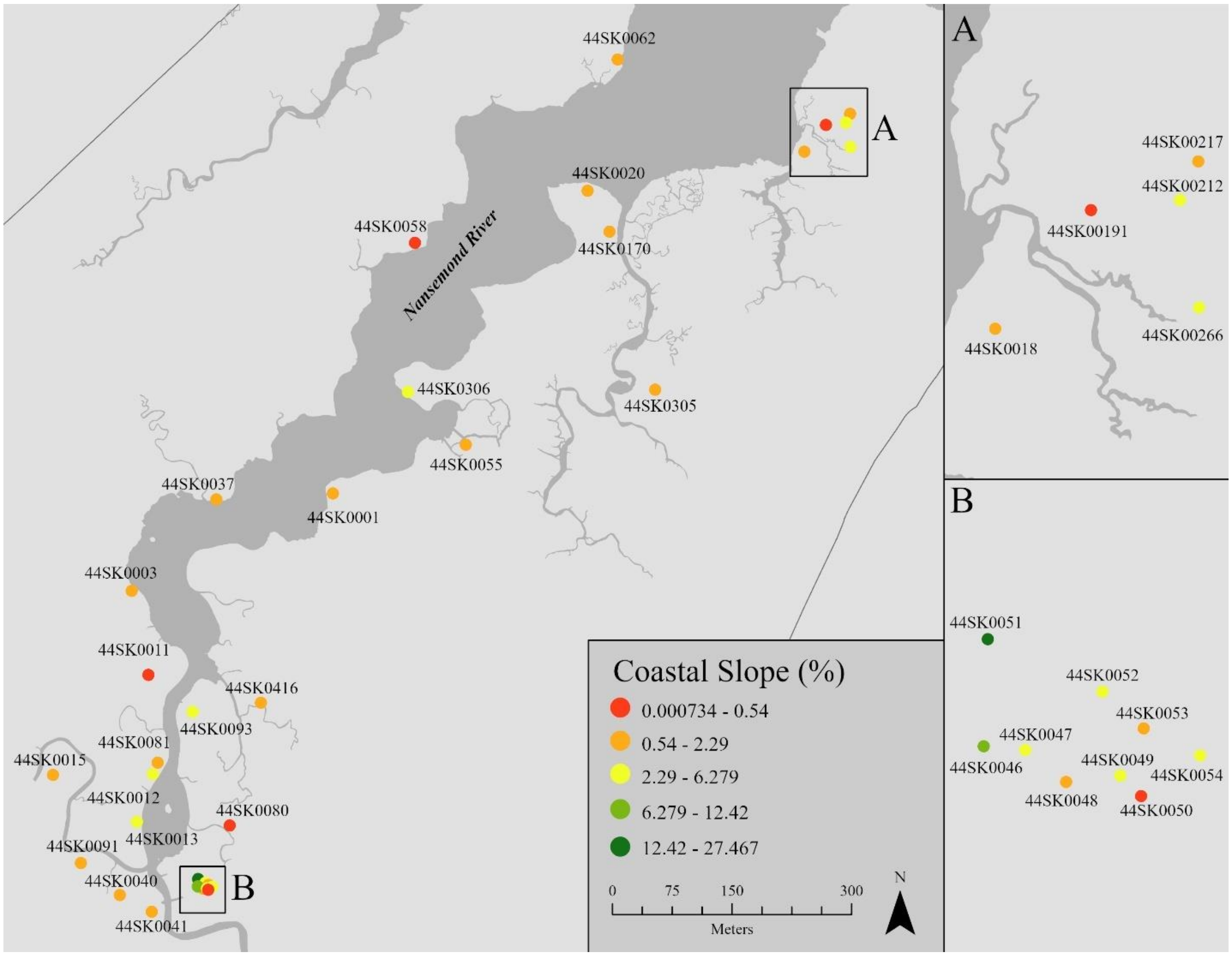

Figure 21. Minimum slope values for selected sites in percent rise, steeper slopes in green, shallower slopes in red.

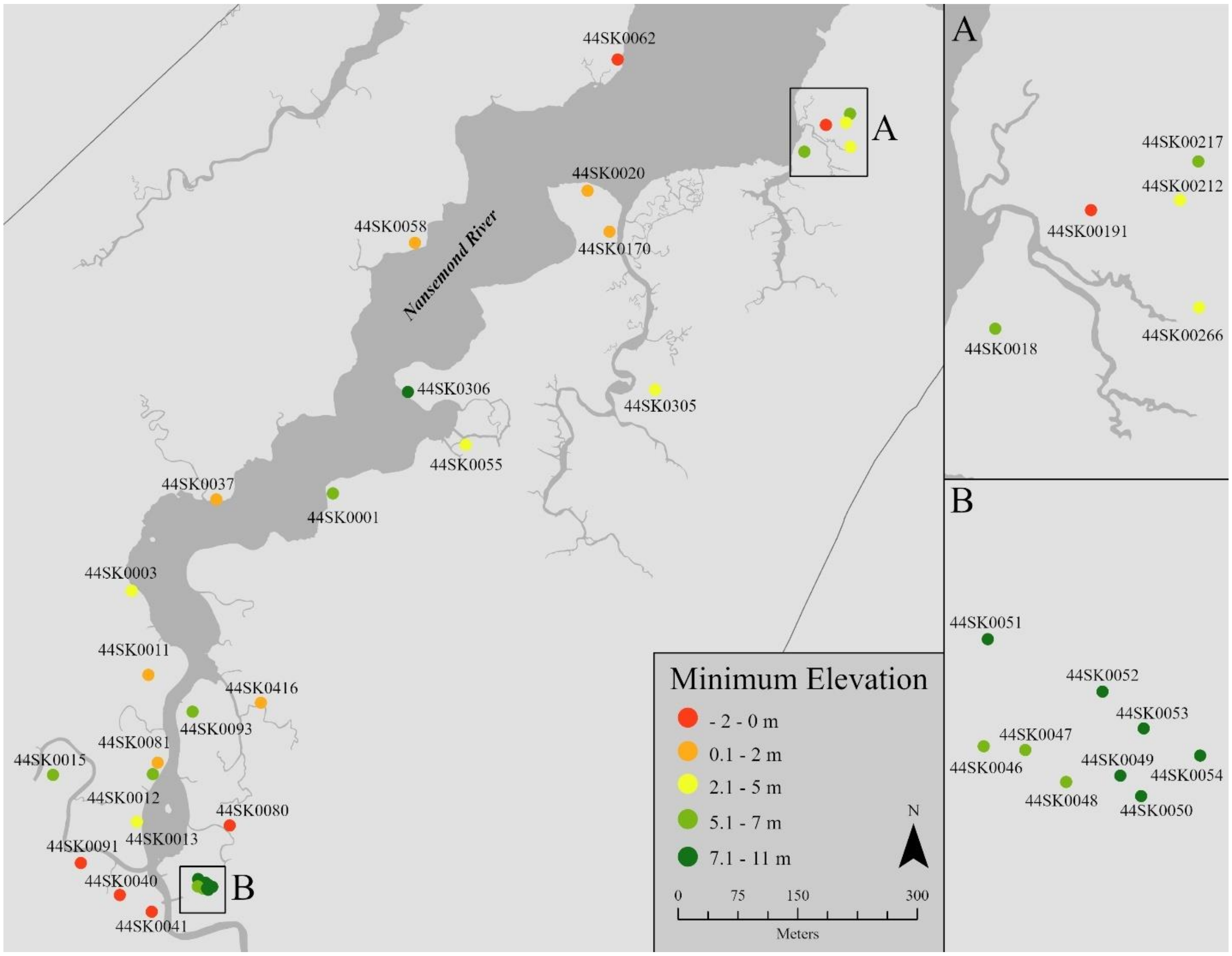

Figure 22. Minimum elevation of each selected site in meters.

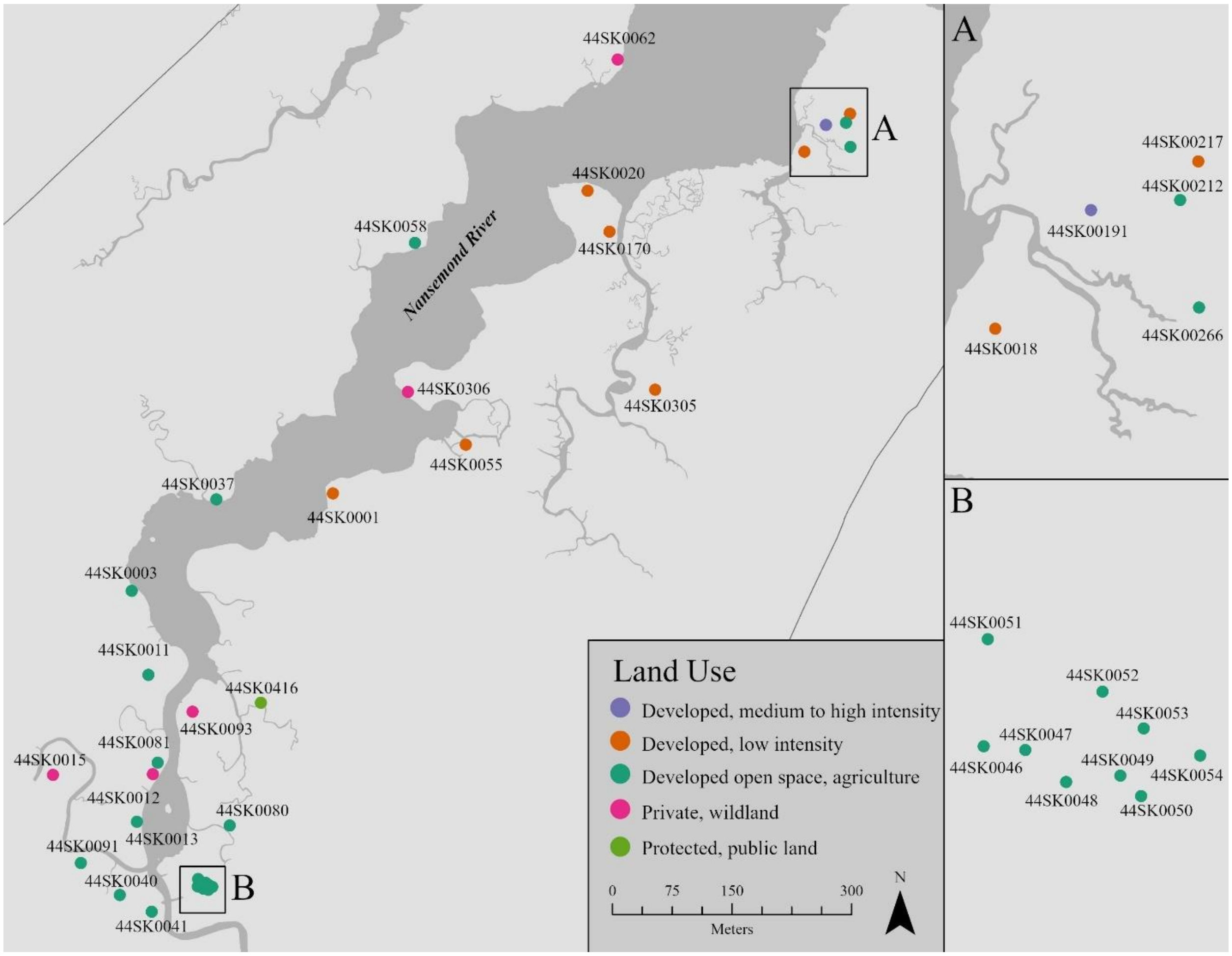

Figure 23. Land use for each selected site, where purple represents most at-risk and green represents least at-risk.

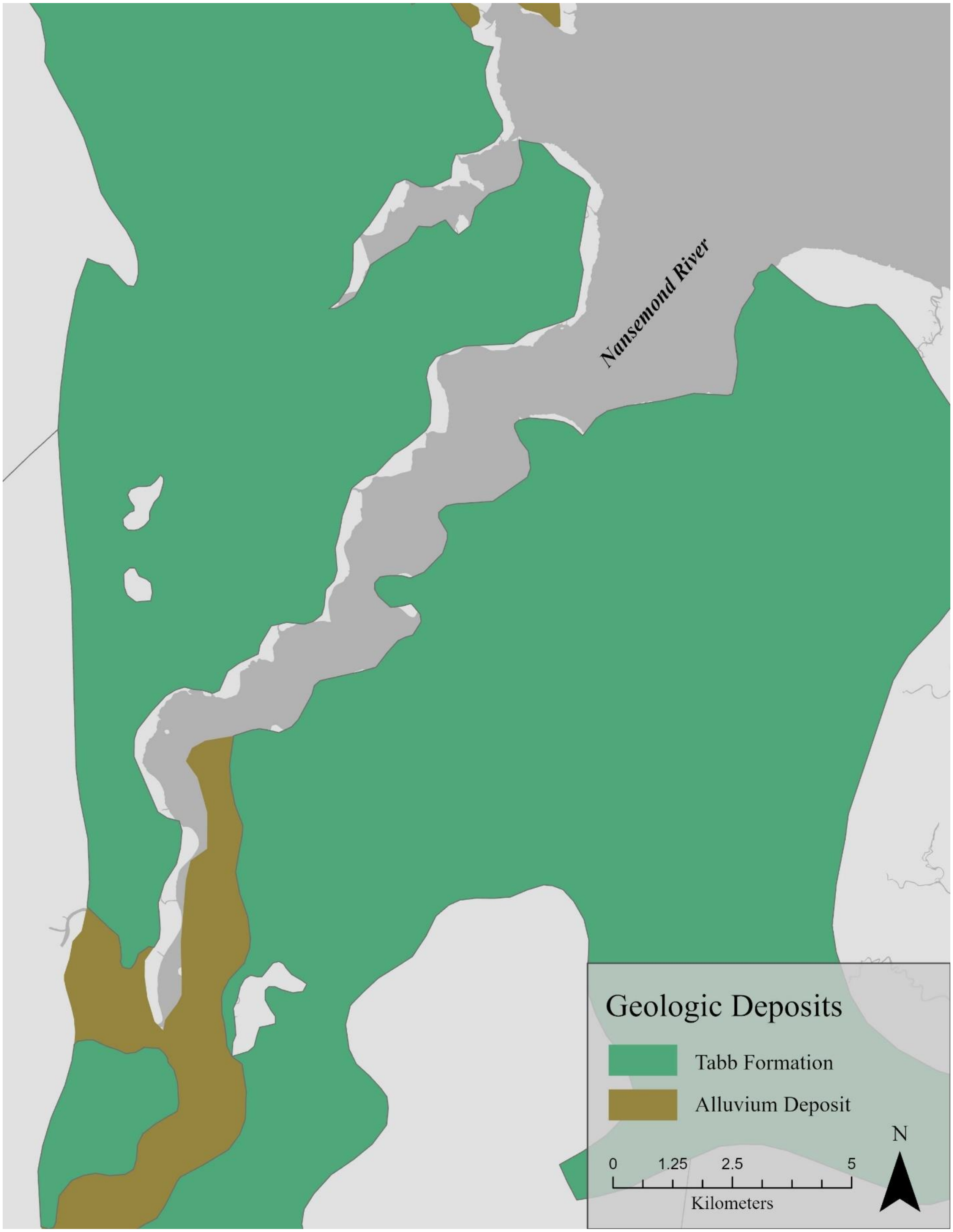

Figure 24. Spatial layout of the alluvium deposit and Tabb Formation.

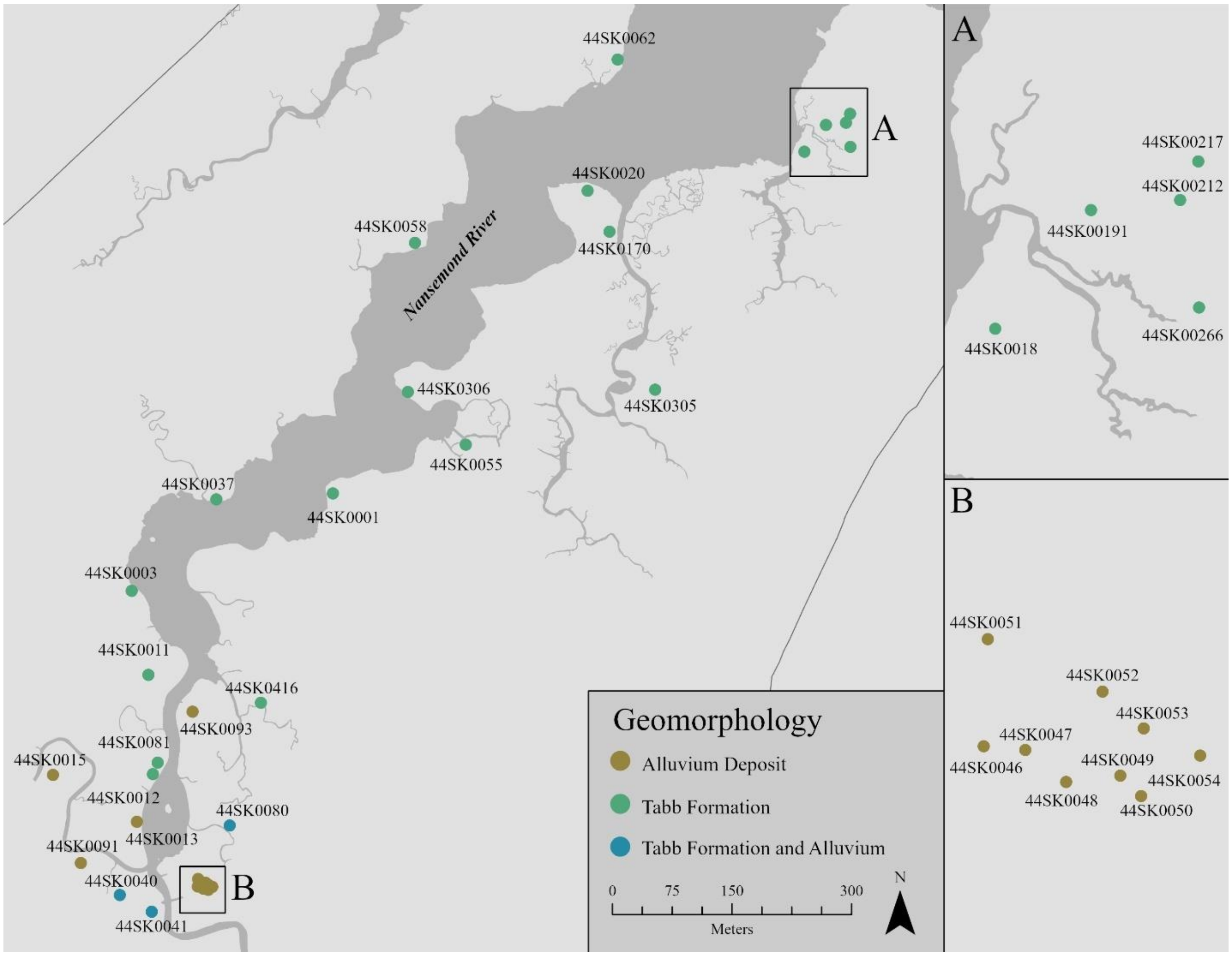

Figure 25. Geomorphology for selected sites.

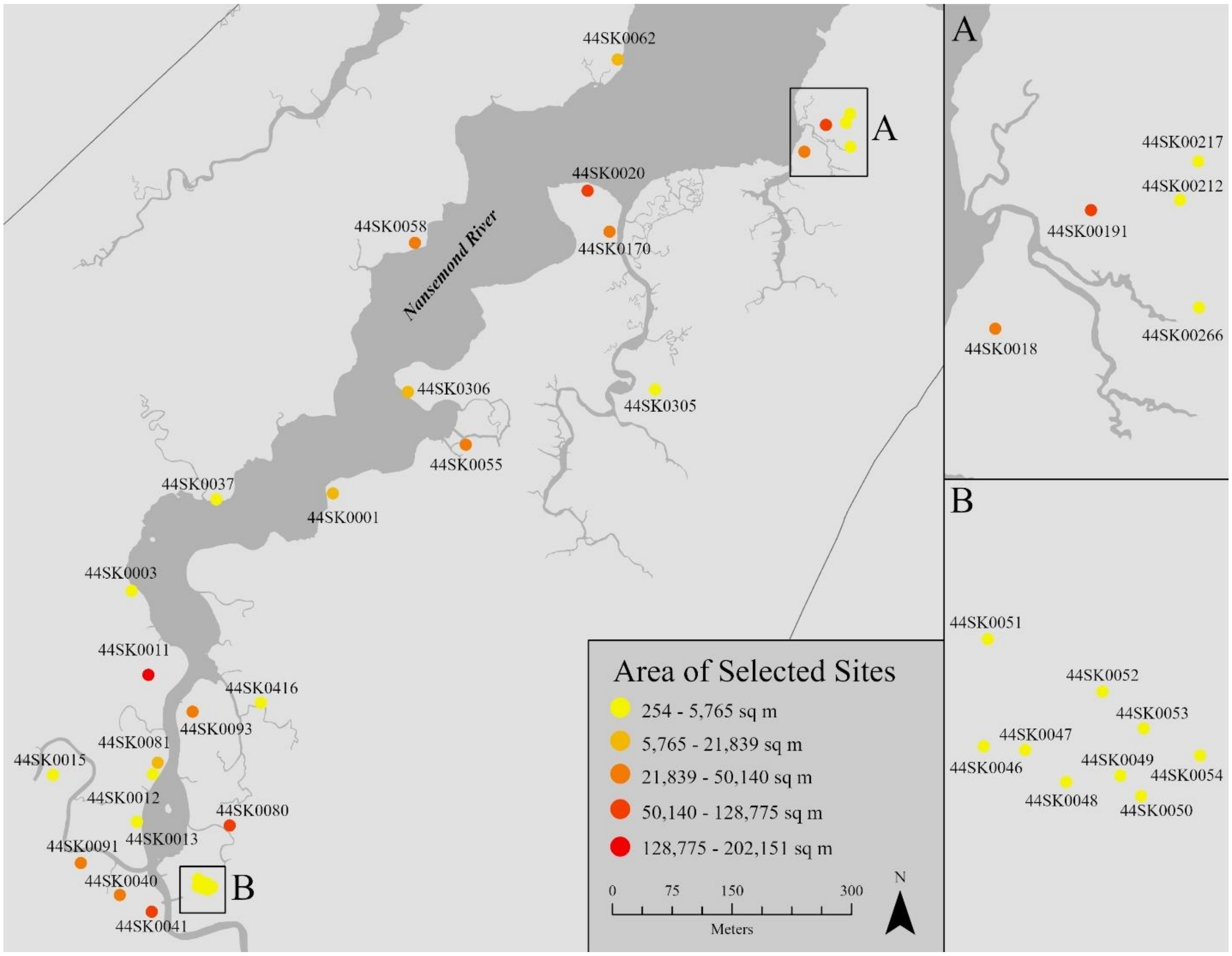

Figure 26. Site area for selected sites.

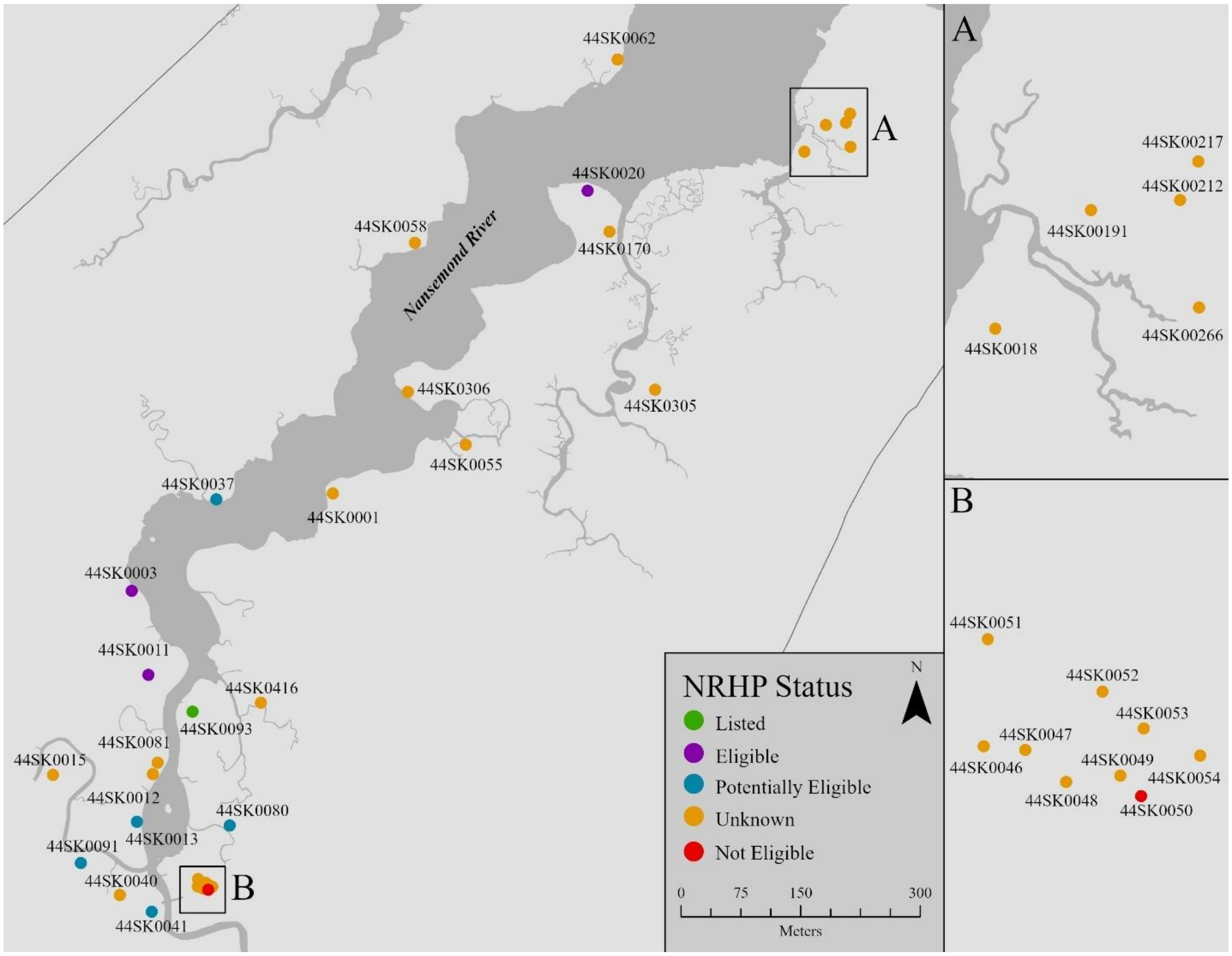

Figure 27. NRHP status for each site.

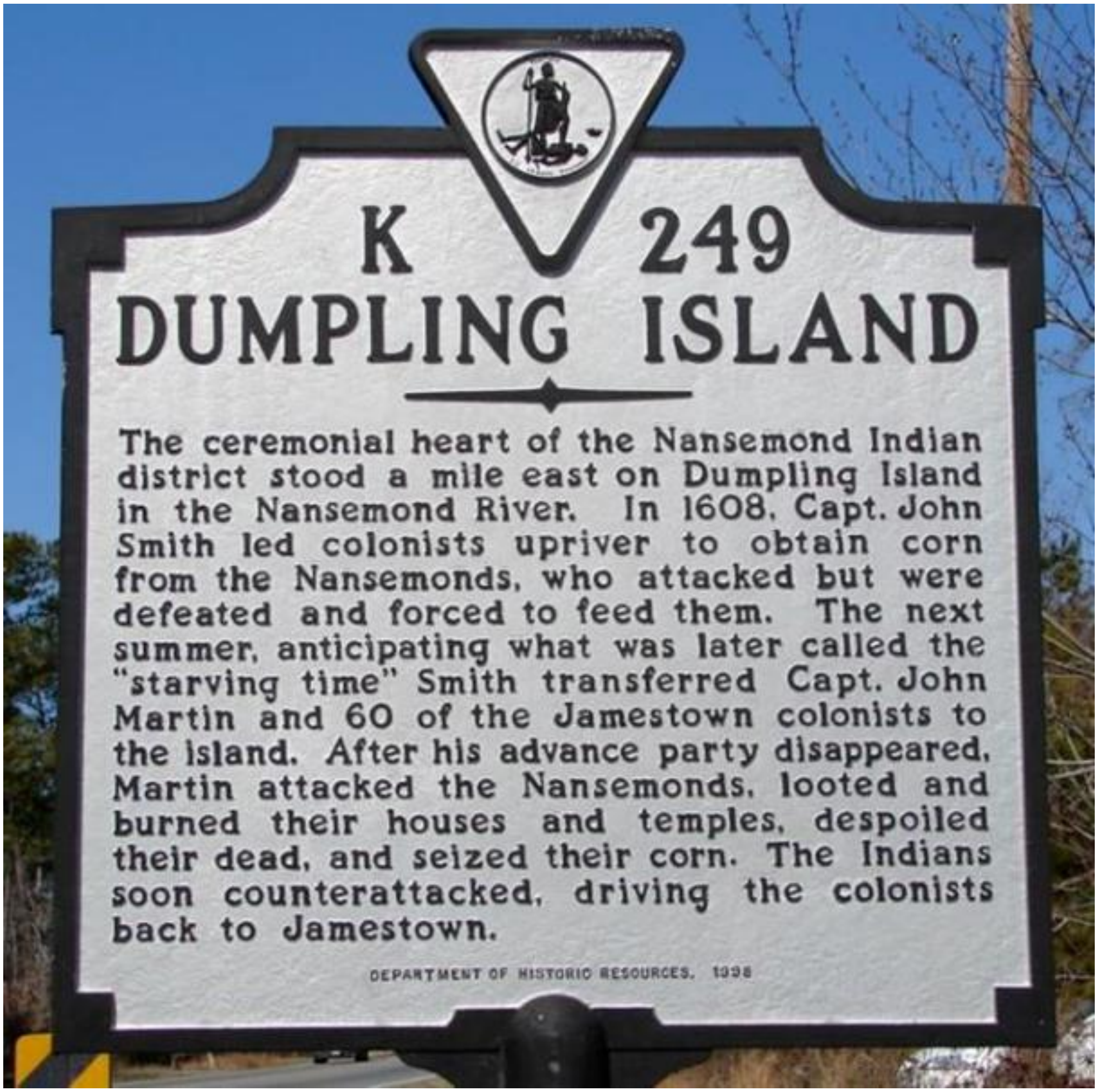

Figure 28. Dumpling Island's historical sign, original photo from Virginia Department of Historic Resources Dumpling Island Historic Registry.

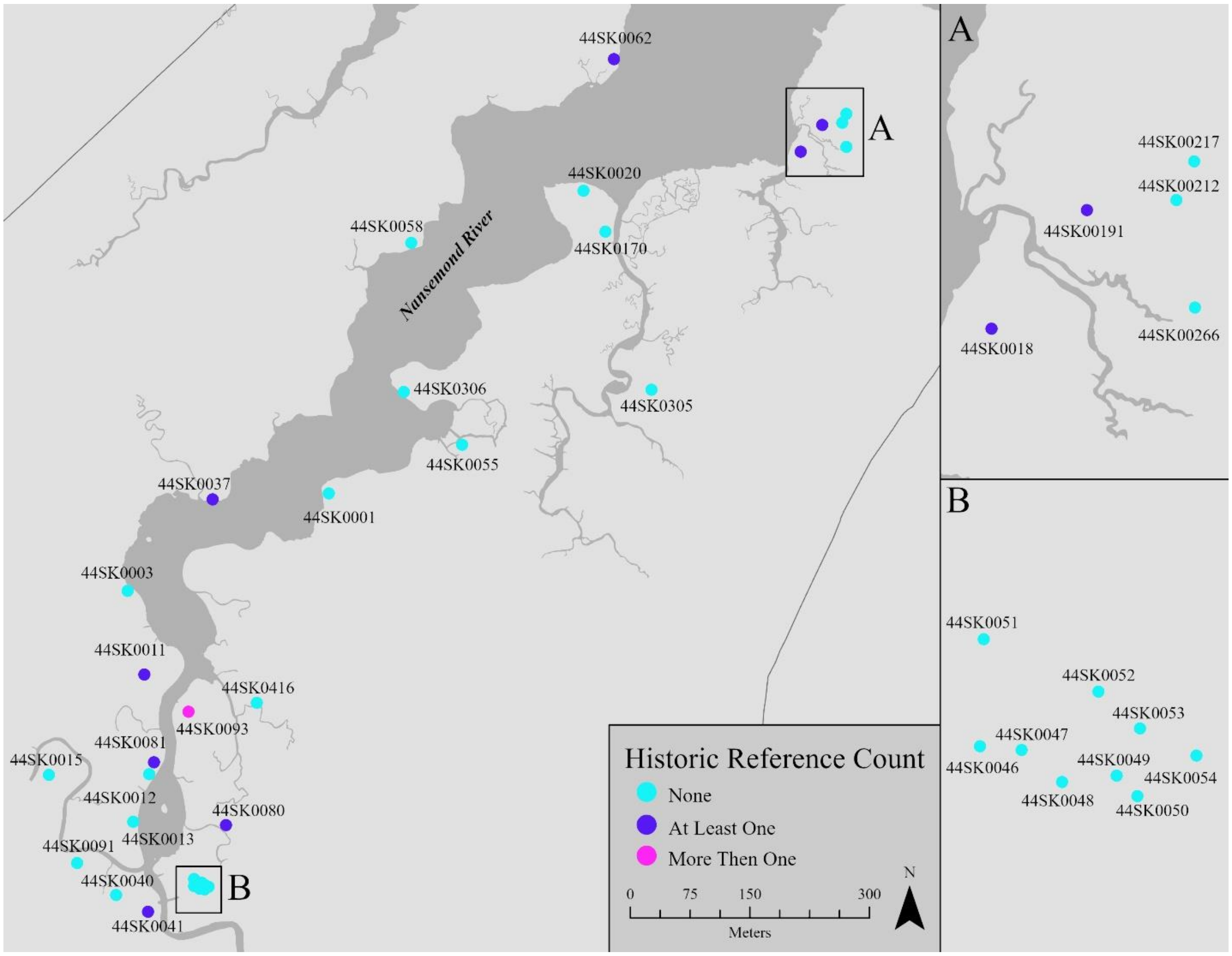

Figure 29. Historical reference ranking for selected sites.

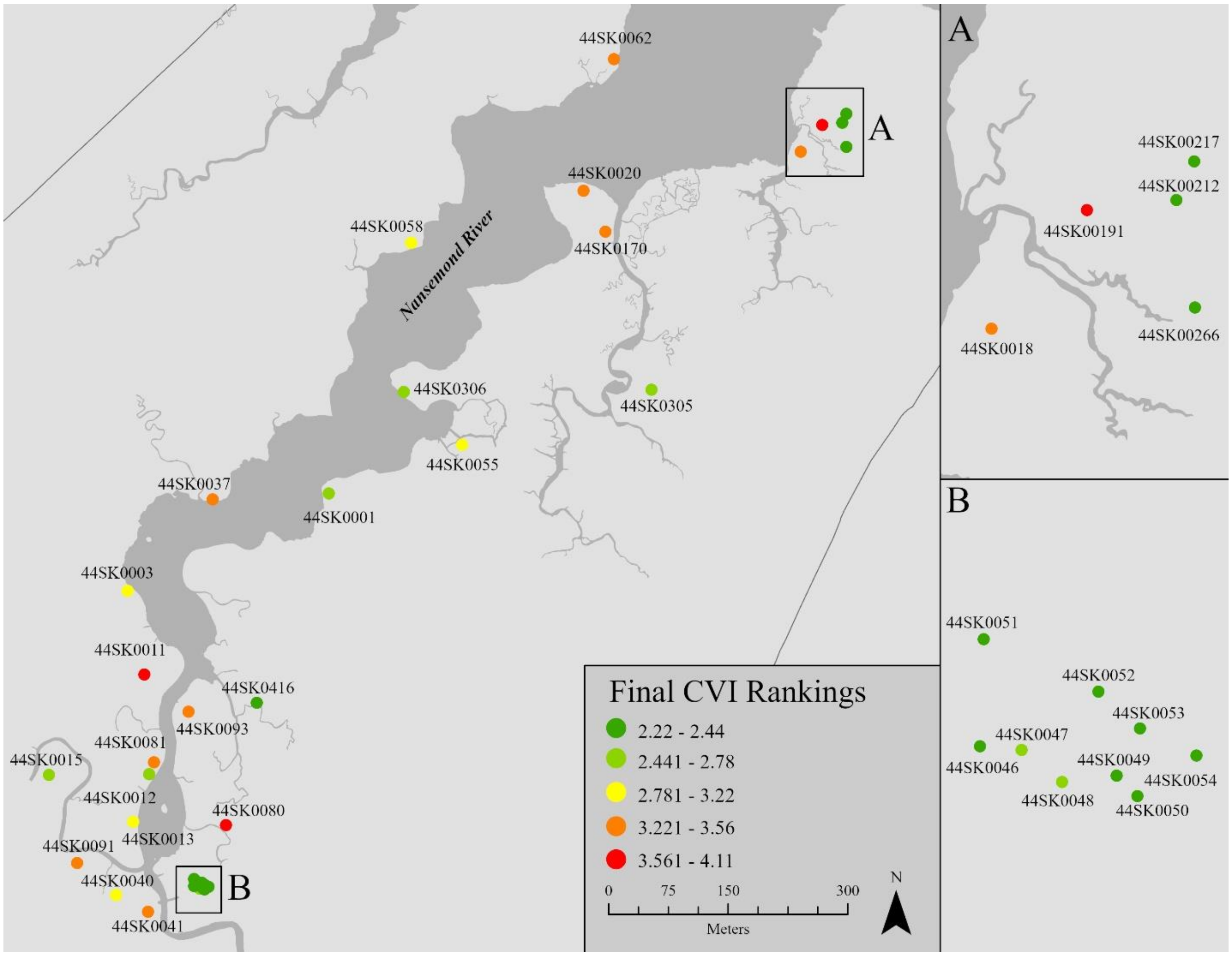

Figure 30. Final CVI rankings.

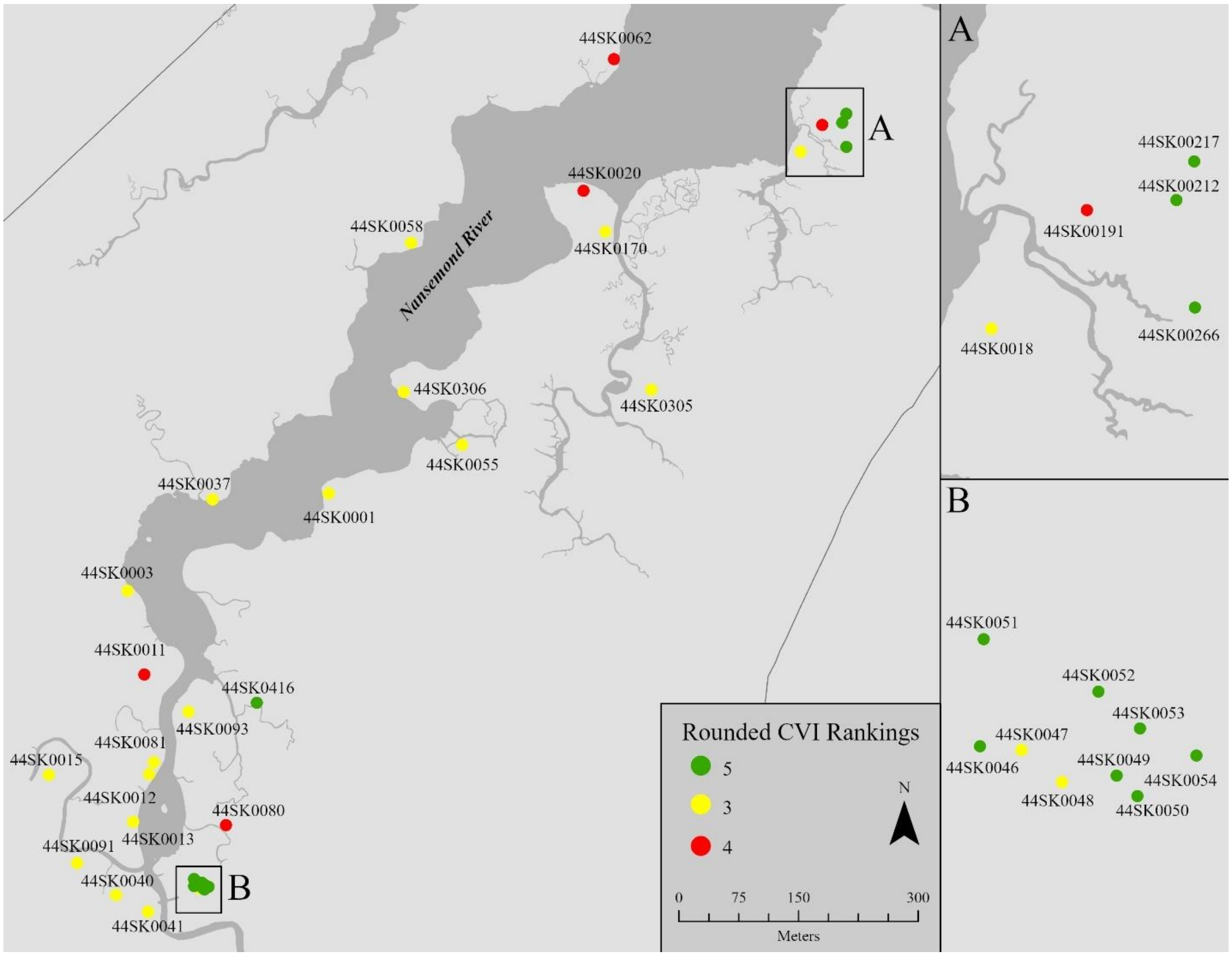

Figure 31. Final CVI ranking rounded to the nearest whole number.

Site Number	Periods of Occupation
44SK0001	Unknown Pre-contact
44SK0003	Middle Archaic, Early Woodland, Middle Woodland, Late Woodland, Contact
44SK0011	Middle Woodland, Late Woodland, Contact
44SK0012	Unknown Pre-contact
44SK0013	Early Woodland, Middle Woodland, Late Woodland
44SK0015	Early Woodland, Middle Woodland, Late Woodland
44SK0018	Unknown Pre-contact
44SK0020	Middle Woodland, Late Woodland, Contact
44SK0037	Middle Woodland, Late Woodland
44SK0040	Middle Archaic, Middle Woodland, Late Woodland
44SK0041	Late Woodland
44SK0046	Late Woodland
44SK0047	Middle Woodland
44SK0048	Unknown Pre-contact
44SK0049	Late Woodland
44SK0050	Unknown Pre-contact
44SK0051	Early Woodland, Middle Woodland, Late Woodland
44SK0052	Late Woodland
44SK0053	Middle Woodland
44SK0054	Unknown Pre-contact
44SK0055	Middle Archaic, Early Woodland, Middle Woodland, Late Woodland
44SK0058	Early Woodland, Middle Woodland, Late Woodland
44SK0062	Unknown Pre-contact
44SK0080	Early Archaic, Middle Archaic, Middle Woodland, Late Woodland
44SK0081	Late Archaic, Early Woodland
44SK0091	Middle Archaic, Late Archaic, Early Woodland, Middle Woodland, Late Woodland
44SK0093	Late Woodland, Contact
44SK0170	Middle Woodland
44SK0191	Unknown Pre-contact
44SK0212	Early Woodland, Middle Woodland, Late Woodland
44SK0217	Unknown Pre-contact
44SK0266	Unknown Pre-contact
44SK0305	Unknown Pre-contact
44SK0306	Late Woodland
44SK0416	Unknown Pre-contact

Table 1. Selected sites and their associated period.

Variable	Definition	Source
Geomorphology	Geologic landform type and erodibility	USGS Geologic Map
Land Use	Current usage and management of land	USGS Protected Areas Database; US 2019 MLCD Land Cover (CONUS) Data:
NRHP Eligibility	Determined eligibility of each site for NRHP	Virginia Cultural Resource Information System (VCRIS)
Site Area (m^2)	Geometric area of each site	VCRIS; Site Reports
Distance to Shoreline (m)	Shortest distance from center of site to the nearest shoreline	Digital Elevation Model (DEM) from USGS
Historic Rate of Erosion (m/year)	Shoreline change during the twentieth century	Virginia Institute of Marine Science (VIMS)
Coastal Slope	Elevation change across area 30 km landward and seaward	DEM from USGS
Historical References	Historical references of site locations, names or importance	John Smith's Journals; George Percy excepts; Contact era maps
Elevation	Height of shoreline above sea level	DEM from USGS

Table 2. List of all variables, including definition and data source.

Ranking	Geomorphology	Land Use	NRHP Eligibility	Historical References
1 (Very Low)	-	Protected, Public Land	Ineligible	None
2 (Low)	-	Private, Wildland	Undetermined	-
3 (Moderate)	Tabb Formation	Developed, Open Space and/or Agriculture	Potentially Eligible	-
4 (High)	Tabb Formation and Alluvium	Developed, Low Intensity	Eligible	One
5 (Very High Risk)	Alluvium	Developed, Medium to High Intensity	Listed	More than one

Table 3. Nominal Variable Classifications.

Ranking	Site Area (m^2)	Distance to Shoreline (m)	Elevation (m)	Erosion (m/year)	Coastal Slope (%)
1 (Very Low)	254 – 5,765	432 – 550	7.1 – 11	0.081 – 0.64 m/yr	12.42 – 27.467
2 (Low)	5,765 – 21,839	281 – 432	5.1 – 7	- 0.079 – - 0.08 m/yr	6.279 – 12.42
3 (Moderate)	21,839 – 50,140	90 – 281	2.1 – 5	- 0.229 – - 0.08 m/yr	2.29 – 6.279
4 (High)	50,140 – 128,775	23 – 90	0.1 – 2	- 0.609 – -s 0.23 m/yr	0.54 – 2.29
5 (Very High Risk)	128,775 – 202,151	0 – 23	- 2 – 0	- 0.76 – - 0.61 m/yr	0.000734 – 0.54

Table 4. Numeric Variable Classifications

Site Number	Distance to Shoreline (m)	Ranking
44SK0001	27.11	4
44SK0003	32.26	4
44SK0011	0.00	5
44SK0012	16.89	5
44SK0013	22.17	5
44SK0015	129.97	3
44SK0018	21.57	5
44SK0020	0.00	5
44SK0037	0.00	5
44SK0040	248.27	3
44SK0041	152.43	3
44SK0046	349.29	2
44SK0047	394.89	2
44SK0048	431.73	2
44SK0049	488.27	1
44SK0050	520.04	1
44SK0051	314.87	2
44SK0052	427.57	2
44SK0053	485.17	1
44SK0054	545.15	1
44SK0055	32.44	4
44SK0058	0.00	5
44SK0062	0.00	5
44SK0080	4.42	5
44SK0081	43.89	4
44SK0091	40.67	4
44SK0093	89.76	4
44SK0170	0.00	5
44SK0191	41.99	4
44SK0212	425.75	2
44SK0217	549.71	1
44SK0266	400.24	2
44SK0305	280.06	3
44SK0306	6.07	5
44SK0416	165.24	3

Table 5. Distance from each site to the nearest shoreline in meters.

Site Number	EPR (m)	NSM (m)	Ranking
44SK0001	-0.15	-10.8	3
44SK0003	-0.12	-8.64	3
44SK0011	-0.23	-16.56	4
44SK0012	-0.47	-33.84	4
44SK0013	-0.22	-15.84	3
44SK0015	-0.15	-10.8	3
44SK0018	-0.39	-28.08	4
44SK0020	-0.09	-6.48	3
44SK0037	-0.28	-20.16	4
44SK0040	-0.03	-2.16	2
44SK0041	0.64	46.08	1
44SK0046	-0.27	-19.44	4
44SK0047	-0.27	-19.44	4
44SK0048	-0.27	-19.44	4
44SK0049	-0.27	-19.44	4
44SK0050	-0.27	-19.44	4
44SK0051	-0.27	-19.44	4
44SK0052	-0.27	-19.44	4
44SK0053	-0.27	-19.44	4
44SK0054	-0.27	-19.44	4
44SK0055	-0.76	-54.72	5
44SK0058	-0.03	-2.16	2
44SK0062	-0.61	-43.92	5
44SK0080	0.08	5.76	2
44SK0081	-0.42	-30.24	4
44SK0091	-0.15	-10.8	3
44SK0093	0.04	2.88	2
44SK0170	-0.29	-20.88	4
44SK0191	-0.17	-12.24	3
44SK0212	-0.17	-12.24	3
44SK0217	-0.17	-12.24	3
44SK0266	-0.17	-12.24	3
44SK0305	-0.16	-11.52	3
44SK0306	-0.08	-5.76	3
44SK0416	-0.02	-1.44	2

Table 6. Historic rate of erosion as EPR and NSM, along with the associated vulnerability ranking.

Site Number	Minimum Slope (%)	Maximum Slope (%)	Mean Slope (%)	Ranking
44SK0001	0.86	9.17	3.97	4
44SK0003	1.45	5.09	3.66	4
44SK0011	0.00	13.10	4.51	5
44SK0012	3.73	11.56	7.38	3
44SK0013	3.82	8.91	7.34	3
44SK0015	1.27	8.89	4.43	4
44SK0018	1.27	19.90	7.89	4
44SK0020	0.67	13.41	5.14	4
44SK0037	1.27	2.69	2.27	4
44SK0040	0.67	13.41	6.42	4
44SK0041	0.67	18.01	9.05	4
44SK0046	7.41	12.42	12.42	2
44SK0047	4.31	5.41	4.31	3
44SK0048	1.34	8.14	1.34	4
44SK0049	3.51	7.44	5.47	3
44SK0050	0.00	3.51	1.76	5
44SK0051	19.35	27.47	27.47	1
44SK0052	5.91	6.28	6.28	3
44SK0053	1.34	4.67	3.01	4
44SK0054	1.72	4.38	4.38	4
44SK0055	0.86	8.02	3.96	4
44SK0058	0.54	12.51	5.58	5
44SK0062	2.29	16.86	5.15	4
44SK0080	0.00	12.60	4.84	5
44SK0081	1.34	11.44	6.03	4
44SK0091	0.87	17.23	5.65	4
44SK0093	2.74	13.71	8.13	3
44SK0170	0.86	16.40	5.15	4
44SK0191	0.00	14.38	5.42	5
44SK0212	2.55	2.55	2.55	3
44SK0217	1.76	3.81	2.79	4
44SK0266	3.31	7.31	3.31	3
44SK0305	2.02	6.08	4.05	4
44SK0306	3.84	35.88	19.32	3
44SK0416	0.67	5.48	3.46	4

Table 7. Minimum, maximum and mean slope values for selected site, along with ranking.

Site Number	Elevation (m)	Ranking
44SK0001	6	2
44SK0003	4	3
44SK0011	2	4
44SK0012	6	2
44SK0013	4	3
44SK0015	7	2
44SK0018	7	2
44SK0020	1	4
44SK0037	2	4
44SK0040	-2	5
44SK0041	-2	5
44SK0046	6	2
44SK0047	6	2
44SK0048	6	2
44SK0049	8	1
44SK0050	9	1
44SK0051	8	1
44SK0052	10	1
44SK0053	8	1
44SK0054	11	1
44SK0055	4	3
44SK0058	2	4
44SK0062	-1	5
44SK0080	0	5
44SK0081	2	4
44SK0091	0	5
44SK0093	7	2
44SK0170	2	4
44SK0191	-1	5
44SK0212	3	3
44SK0217	6	2
44SK0266	5	3
44SK0305	4	3
44SK0306	8	1
44SK0416	1	4

Table 8. Minimum elevation values and associated vulnerability rankings for each site.

Site Number	Classification	Ranking
44SK0001	Developed, low intensity	4
44SK0003	Developed open space, agriculture	3
44SK0011	Developed open space, agriculture	3
44SK0012	Private, wildland	2
44SK0013	Developed open space, agriculture	3
44SK0015	Private, wildland	2
44SK0018	Developed, low intensity	4
44SK0020	Developed, low intensity	4
44SK0037	Developed open space, agriculture	3
44SK0040	Developed open space, agriculture	3
44SK0041	Developed open space, agriculture	3
44SK0046	Developed open space, agriculture	3
44SK0047	Developed open space, agriculture	3
44SK0048	Developed open space, agriculture	3
44SK0049	Developed open space, agriculture	3
44SK0050	Developed open space, agriculture	3
44SK0051	Developed open space, agriculture	3
44SK0052	Developed open space, agriculture	3
44SK0053	Developed open space, agriculture	3
44SK0054	Developed open space, agriculture	3
44SK0055	Developed, low intensity	4
44SK0058	Developed open space, agriculture	3
44SK0062	Private, wildland	2
44SK0080	Developed open space, agriculture	3
44SK0081	Developed open space, agriculture	3
44SK0091	Developed open space, agriculture	3
44SK0093	Private, wildland	2
44SK0170	Developed, low intensity	4
44SK0191	Developed, medium to high intensity	5
44SK0212	Developed open space, agriculture	3
44SK0217	Developed, low intensity	4
44SK0266	Developed open space, agriculture	3
44SK0305	Developed, low intensity	4
44SK0306	Private, wildland	2
44SK0416	Protected Public Land	1

Table 9. Land use categorization for each site, along with vulnerability rank.

Site Number	Geomorphology	Ranking
44SK0001	Tabb Formation	3
44SK0003	Tabb Formation	3
44SK0011	Tabb Formation	3
44SK0012	Tabb Formation	3
44SK0013	Alluvium	5
44SK0015	Alluvium	5
44SK0018	Tabb Formation	3
44SK0020	Tabb Formation	3
44SK0037	Tabb Formation	3
44SK0040	Tabb Formation and Alluvium	4
44SK0041	Tabb Formation and Alluvium	4
44SK0046	Alluvium	5
44SK0047	Alluvium	5
44SK0048	Alluvium	5
44SK0049	Alluvium	5
44SK0050	Alluvium	5
44SK0051	Alluvium	5
44SK0052	Alluvium	5
44SK0053	Alluvium	5
44SK0054	Alluvium	5
44SK0055	Tabb Formation	3
44SK0058	Tabb Formation	3
44SK0062	Tabb Formation	3
44SK0080	Tabb Formation and Alluvium	4
44SK0081	Tabb Formation	3
44SK0091	Alluvium	5
44SK0093	Alluvium	5
44SK0170	Tabb Formation	3
44SK0191	Tabb Formation	3
44SK0212	Tabb Formation	3
44SK0217	Tabb Formation	3
44SK0266	Tabb Formation	3
44SK0305	Tabb Formation	3
44SK0306	Tabb Formation	3
44SK0416	Tabb Formation	3

Table 10. Geomorphology categorization and vulnerability ranking for selected sites.

Site Number	Site Area (m2)	Ranking
44SK0001	21838.80	2
44SK0003	3696.95	1
44SK0011	202150.31	5
44SK0012	4410.68	1
44SK0013	5764.07	1
44SK0015	5234.03	1
44SK0018	50139.24	3
44SK0020	90761.91	4
44SK0037	4384.53	1
44SK0040	42721.45	3
44SK0041	76836.52	4
44SK0046	702.07	1
44SK0047	451.97	1
44SK0048	1207.59	1
44SK0049	651.19	1
44SK0050	384.95	1
44SK0051	936.09	1
44SK0052	929.83	1
44SK0053	669.91	1
44SK0054	725.27	1
44SK0055	31592.80	3
44SK0058	45623.02	3
44SK0062	10691.42	2
44SK0080	128774.73	4
44SK0081	9159.90	2
44SK0091	36848.82	3
44SK0093	28472.23	3
44SK0170	43095.19	3
44SK0191	108780.87	4
44SK0212	545.71	1
44SK0217	254.80	1
44SK0266	590.98	1
44SK0305	1531.75	1
44SK0306	9551.83	2
44SK0416	5409.00	1

Table 11. Site area and associated vulnerability ranking for selected sites.

Site Number	NRHP Eligibility	Ranking
44SK0001	Unknown	2
44SK0003	Eligible	4
44SK0011	Eligible	4
44SK0012	Unknown	2
44SK0013	Potentially eligible	3
44SK0015	Unknown	2
44SK0018	Unknown	2
44SK0020	Eligible	4
44SK0037	Potentially eligible	3
44SK0040	Unknown	2
44SK0041	Potentially eligible	3
44SK0046	Unknown	2
44SK0047	Unknown	2
44SK0048	Unknown	2
44SK0049	Unknown	2
44SK0050	Not eligible	1
44SK0051	Unknown	2
44SK0052	Unknown	2
44SK0053	Unknown	2
44SK0054	Unknown	2
44SK0055	Unknown	2
44SK0058	Unknown	2
44SK0062	Unknown	2
44SK0080	Potentially eligible	3
44SK0081	Unknown	2
44SK0091	Potentially eligible	3
44SK0093	Listed	5
44SK0170	Unknown	3
44SK0191	Unknown	3
44SK0212	Unknown	3
44SK0217	Unknown	3
44SK0266	Unknown	3
44SK0305	Unknown	3
44SK0306	Unknown	3
44SK0416	Unknown	3

Table 12. NRHP status and vulnerability ranking for selected sites.

Site Number	Ranking	Place Name
44SK0001	1	
44SK0003	1	
44SK0011	4	Dumpling Island
44SK0012	1	
44SK0013	1	
44SK0015	1	
44SK0018	4	Oriskoyek
44SK0020	1	
44SK0037	4	Mattanock
44SK0040	1	
44SK0041	4	Teracosick
44SK0046	1	
44SK0047	1	
44SK0048	1	
44SK0049	1	
44SK0050	1	
44SK0051	1	
44SK0052	1	
44SK0053	1	
44SK0054	1	
44SK0055	1	
44SK0058	1	
44SK0062	4	Crittenden
44SK0080	4	Mantoughquemend
44SK0081	4	Nandsamund
44SK0091	1	
44SK0093	5	Dumpling Island
44SK0170	1	
44SK0191	4	Oriskoyek
44SK0212	1	
44SK0217	1	
44SK0266	1	
44SK0305	1	
44SK0306	1	
44SK0416	1	

Table 13. Historical reference ranking for selected sites.

	Distance to Shoreline (m)		Elevation		Historic Rate of Erosion		Coastal Slope	
Site Number	Distance (m)	Distance Rank	Minimum Elevation (m)	Elevation Rank	EPR (m/yr)	Erosion Rank	Minimum Slope (%)	Slope Rank
44SK0001	27.1080	4	6	2	-0.15	3	0.86	4
44SK0003	32.2627	4	4	3	-0.12	3	1.45	4
44SK0011	0.0000	5	2	4	-0.23	4	0.00	5
44SK0012	16.8886	5	6	2	-0.47	4	3.73	3
44SK0013	22.1713	5	4	3	-0.22	3	3.82	3
44SK0015	129.9738	3	7	2	-0.15	3	1.27	4
44SK0018	21.5694	5	7	2	-0.39	4	1.27	4
44SK0020	0.0000	5	1	4	-0.09	3	0.67	4
44SK0037	0.0000	5	2	4	-0.28	4	1.27	4
44SK0040	248.2664	3	-2	5	-0.03	2	0.67	4
44SK0041	152.4263	3	-2	5	0.64	1	0.67	4
44SK0046	349.2859	2	6	2	-0.27	4	7.41	2
44SK0047	394.8935	2	6	2	-0.27	4	4.31	3
44SK0048	431.7254	2	6	2	-0.27	4	1.34	4
44SK0049	488.2732	1	8	1	-0.27	4	3.51	3
44SK0050	520.0413	1	9	1	-0.27	4	0.00	5
44SK0051	314.8681	2	8	1	-0.27	4	19.35	1
44SK0052	427.5715	2	10	1	-0.27	4	5.91	3
44SK0053	485.1672	1	8	1	-0.27	4	1.34	4
44SK0054	545.1490	1	11	1	-0.27	4	1.72	4
44SK0055	32.4446	4	4	3	-0.76	5	0.86	4
44SK0058	0.0000	5	2	4	-0.03	2	0.54	5
44SK0062	0.0000	5	-1	5	-0.61	5	2.29	4
44SK0080	4.4238	5	0	5	0.08	2	0.00	5
44SK0081	43.8851	4	2	4	-0.42	4	1.34	4
44SK0091	40.6687	4	0	5	-0.15	3	0.87	4
44SK0093	89.7595	4	7	2	0.04	2	2.74	3
44SK0170	0.0000	5	2	4	-0.29	4	0.86	4
44SK0191	41.9928	4	-1	5	-0.17	3	0.00	5
44SK0212	425.7460	2	3	3	-0.17	3	2.55	3
44SK0217	549.7073	1	6	2	-0.17	3	1.76	4
44SK0266	400.2385	2	5	3	-0.17	3	3.31	3
44SK0305	280.0614	3	4	3	-0.16	3	2.02	4
44SK0306	6.0735	5	8	1	-0.08	3	3.84	3
44SK0416	165.2355	3	1	4	-0.02	2	0.67	4

Site Number	Classification	Land Use Rank	Geologic Deposit	Geomorphology Rank	Area (m2)	Area Rank	NRHP Status	NRHP Rank	Rank	Final CVI
44SK0001	Developed, low intensity	4	Tabb Formation	3	21838.80	2	Unknown	2	1	2.78
44SK0003	Developed open space, agriculture	3	Tabb Formation	3	3696.95	1	Eligible	4	1	2.89
44SK0011	Developed open space, agriculture	3	Tabb Formation	3	202150.31	5	Eligible	4	4	4.11
44SK0012	Private, wildland	2	Tabb Formation	**3**	4410.68	1	Unknown	2	1	2.56
44SK0013	Developed open space, agriculture	3	Alluvium	5	5764.07	1	Potentially eligible	3	1	3.00
44SK0015	Private, wildland	2	Alluvium	5	5234.03	1	Unknown	2	1	2.56
44SK0018	Developed, low intensity	4	Tabb Formation	3	50139.24	3	Unknown	2	4	3.44
44SK0020	Developed, low intensity	4	Tabb Formation	3	90761.91	4	Eligible	4	1	3.56
44SK0037	Developed open space, agriculture	3	Tabb Formation	3	4384.53	1	Potentially eligible	3	4	3.44
44SK0040	Developed open space, agriculture	3	Tabb Formation and Alluvium	4	42721.45	3	Unknown	2	1	3.00
44SK0041	Developed open space, agriculture	3	Tabb Formation and Alluvium	4	76836.52	4	Potentially eligible	3	4	3.44
44SK0046	Developed open space, agriculture	3	Alluvium	5	702.07	1	Unknown	2	1	2.44
44SK0047	Developed open space, agriculture	3	Alluvium	5	451.97	1	Unknown	2	1	2.56
44SK0048	Developed open space, agriculture	3	Alluvium	5	1207.59	1	Unknown	2	1	2.67
44SK0049	Developed open space, agriculture	3	Alluvium	5	651.19	1	Unknown	2	1	2.33
44SK0050	Developed open space, agriculture	3	Alluvium	5	384.95	1	Not eligible	1	1	2.44
44SK0051	Developed open space, agriculture	3	Alluvium	5	936.09	1	Unknown	2	1	2.22
44SK0052	Developed open space, agriculture	3	Alluvium	5	929.83	1	Unknown	2	1	2.44
44SK0053	Developed open space, agriculture	3	Alluvium	5	669.91	1	Unknown	2	1	2.44
44SK0054	Developed open space, agriculture	3	Alluvium	5	725.27	1	Unknown	2	1	2.44
44SK0055	Developed, low intensity	4	Tabb Formation	3	31592.80	3	Unknown	2	1	3.22
44SK0058	Developed open space, agriculture	3	Tabb Formation	3	45623.02	3	Unknown	2	1	3.11
44SK0062	Private, wildland	2	Tabb Formation	3	10691.42	2	Unknown	2	4	3.56
44SK0080	Developed open space, agriculture	3	Tabb Formation and Alluvium	4	128774.73	4	Potentially eligible	3	4	3.89
44SK0081	Developed open space, agriculture	3	Tabb Formation	3	9159.90	2	Unknown	2	4	3.33
44SK0091	Developed open space, agriculture	3	Alluvium	5	36848.82	3	Potentially eligible	3	1	3.44
44SK0093	Private, wildland	2	Alluvium	5	28472.23	3	Listed	5	5	3.44
44SK0170	Developed, low intensity	4	Tabb Formation	3	43095.19	3	Unknown	3	1	3.44
44SK0191	Developed, medium to high intensity	5	Tabb Formation	3	108780.87	4	Unknown	3	4	4.00
44SK0212	Developed open space, agriculture	3	Tabb Formation	3	545.71	1	Unknown	3	1	2.44
44SK0217	Developed, low intensity	4	Tabb Formation	3	254.80	1	Unknown	3	1	2.44
44SK0266	Developed open space, agriculture	3	Tabb Formation	3	590.98	1	Unknown	3	1	2.44
44SK0305	Developed, low intensity	4	Tabb Formation	3	1531.75	1	Unknown	3	1	2.78
44SK0306	Private, wildland	2	Tabb Formation	3	9551.83	2	Unknown	3	1	2.56
44SK0416	Protected Public Land	1	Tabb Formation	3	5409.00	1	Unknown	3	1	2.44

Table 14. Individual values and rankings for each variable leading to the final CVI calculation for each selected site.

XII. Bibliography

Anfuso, Giorgio, and Jose Angel Martinez Del Pozo
2009 Assessment of coastal vulnerability through the use of GIS tools in South Sicily (Italy). Environ Manage 43(3):533–545

Bass, Nikki
2021 Indigenous Life on the Nansemond River. StoryMap. https://storymaps.arcgis.com/stories/efa89a87874044328af43b7a4357bb04.

Balée, William
2006 The Research Program of Historical Ecology. Annual Review of Anthropology 35:75-98.

Bjorkman, Anne D., and Mark Vellend
2010 Defining Historical Baselines for Conservation: Ecological Changes Since European Settlement on Vancouver Island, Canada: Historical Vegetation on Vancouver Island. *Conservation Biology* 24(6): 1559–1568.

Binford, Lewis R.
1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1):4–20. DOI:10.2307/279653.

Blanton, Dennis B.
1992 Middle Woodland Settlement Systems in Virginia. In Middle and Late Woodland Research in Virginia: A Synthesis, Theodore R. Reinhart and Mary Ellen N. Hodges (Eds). *The Archeological Society of Virginia*, Courtland, Virginia. 29(1): 65-96.

Bottoms, Emmett Edward
1983 Seventeenth Century Settlement of the Nansemond River in Virginia. *Old Dominion University Libraries*.

Center for Coastal Resources Management
2020. Living Shorelines Overview. Virginia Institute for Marine Science. https://www.vims.edu/ccrm/outreach/living_shorelines/ls_brochure_updated2020.pdf

Crutzen, Paul and E. F. Stoermer
2000 The Anthropocene. *IGBP Newsletter* 41(17): 17–18.

Dame, Richard F.
2009 Shifting Through Time: Oysters and Shell Rings in Past and Present Southeastern Estuaries. *Journal of Shellfish Research* 28(3): 425–430

Dent, Richard J., Jr.
1995 Chesapeake Prehistory: Old Traditions, New Directions. *Plenum Press*, New York, NY.

Earth Explorer
2022. United States Geologic Survey. https://earthexplorer.usgs.gov/.

Eichmann, William, William Stanyard, David Franz, Edward Schneider, and Larissa Thomas
2017 Phase II Investigations for the Atlantic Coast Pipeline Project: Virginia Sites 44AU0024, 44CS0346, 44GV0388, 44SK0080/0608, and 44SK0612. VA-143. Virginia: Environmental Resources Management.

Egloff, Keith
1980 Phase I Test of 44SK20 at the Bridge Approach of Route 17 to the Nansemond River. Archaeology. Suffolk, VA: Virginia Department of Historic Resources.

Egloff, Keith T., and Deborah Woodward
2006 First People: The Early Indians of Virginia. Second edition. Virginia Department of Historic Resources, Richmond, VA.

Environmental Protection Agency
2021. Report on the Environment. https://www.epa.gov/roe.

Erickson, Clark L.
2008 Amazonia: The Historical Ecology of a Domesticated Landscape. In *The Handbook of South American Archaeology*, Helaine Silverman and William H. Isbell (eds). *Springer* New York, New York, NY 157–183.

Erlandson, Jon McVey
2012 As the world warms: rising seas, coastal archaeology, and the erosion of maritime history. *Journal of Coastal Conservation* 16(2): 137-142.

Erlandson, Jon M., and Torben C. Rick
2010 Archaeology meets marine ecology: the antiquity of maritime cultures and human impacts on marine fisheries and ecosystems. *Annual Review of Marine Science* 2: 231-251.

Erlandson, Jon. M.
2008 Racing a rising tide: Global warming, rising seas, and the erosion of human history. *Journal of Island & Coastal Archaeology* 3:167–169.

Gallivan, Martin
2007 Powhatan's Werowocomoco: Constructing Place, Polity, and Personhood in the Chesapeake, C.E. 1200 – C.E. 1609. *American Anthropologist* 109(1):85-100.

Gallivan, Martin
2016 *The Powhatan Landscape: An Archaeological History of the Algonquin Chesapeake*. University Press of Florida, Gainesville.

Gallivan, Martin, Danielle Moretti-Langholtz and Buck Woodard
2011 Collaborative Archaeology and Strategic Essentialism: Native Empowerment in Tidewater Virginia. *Historical Archaeology* 45(1):10-23.

Hames, Raymond.
2007 The Ecologically Noble Savage Debate. *Annual Review of Anthropology*, 9[0t]h ser 36(177): 178-190. DOI:10.1146/annurev.anthro.35.081705123321

Hardaway, Scott., Donna Milligan, Christine Wilcox, Marcia Berman, Tamia Rudnicky, Karinna Nunez, and Sharon Killeen
2014 City of Suffolk Shoreline Management Plan. Virginia Institute of Marine Science, William & Mary. https://doi.org/10.21220/V5Q60Z

Hardaway, Scott, Donna Milligan, and Christine Wilcox.
2017 Shoreline Studies Program shoreline evolution database 1937-2009. Retrieved from http://www.vims.edu

Harding, Juliana M., Roger Mann, and Melissa J. Southworth
2008 Shell Length-at-age Relationships in James River, Virginia, Oysters (Crassostrea virginica) Collected Four Centuries Apart. *Journal of Shellfish Research* 27(5):1109–1115. DOI:10.2983/0730-8000-27.5.1109.

Herrman, Augustine, and Thomas Withinbrook
1673 Virginia and Maryland as It Is Planted and Inhabited This Present Year 1670.

Holmes, William Henry
1907 Aboriginal Shell-heaps of the Middle Atlantic Tidewater Region. *American Anthropologist*, n.s. 9:114.

Hong, H., S. Cui, and L. Zhang
2006 A coastal vulnerability index and its application in Xiamen, China. *Aquatic Ecosystem Health Manage* 9 (3):333–337

Jansen, Alex
2018 Shell middens and human technologies as a historical baseline for the Chesapeake Bay, USA. *North American Archaeologist* 39(1):25–50. DOI:10.1177/0197693117753333.

Jefferson, Norman
1989 The Archaeological Investigations of a Portion of Site 44SK20 Prior to the Widening of Route 17, Suffolk, Virginia. Archaeology, SK-024. Suffolk, VA: James Madison University Archaeological Research Center.

Jenkins, Jessica A., and Martin D. Gallivan
2019 Shell on Earth: Oyster Harvesting, Consumption, and Deposition Practices in the Powhatan Chesapeake. *The Journal of Island and Coastal Archaeology*:1–23. DOI:10.1080/15564894.2019.1643430

Jenkins, Jessica A.
2017 Methods for inferring oyster mariculture on Florida's Gulf Coast. *Journal of Archaeological Science* 80:74–82. DOI:10.1016/j.jas.2017.02.001.

Kusnerik, Kristopher M., Rowan Lockwood, and Amanda N. Grant
2018 Using the Fossil Record to Establish a Baseline and Recommendations for Oyster Mitigation in the Mid-Atlantic U.S. In *Marine Conservation Paleobiology*, edited by Carrie L. Tyler and Chris L. Schneider, pp. 75–103. Springer International Publishing, Cham.

Lowery, Darrin L., Michael A. O'Neal, Sebastian Carisio, and Tessa Montini
2012 Sea Level Rise in Coastal Virginia: Understanding Impacts to Archaeological Resources. University of Delaware. Manuscript presented to Virginia Department of Historic Resources, Threatened Sites Program.

Lulewicz, Isabelle H., Victor D. Thompson, Justin Cramb, and Bryan Tucker
2017 Oyster paleoecology and Native American subsistence practices on Ossabaw Island, Georgia, USA. *Journal of Archaeological Science: Reports* 15:282–289. DOI:10.1016/j.jasrep.2017.07.028.

Mahapatra, Manik, Ratheesh Ramakrishnan, and A. S. Rajawat
2015 Coastal Vulnerability Assessment of Gujarat Coast to Sea Level Rise Using GIS Techniques: A Preliminary Study. *Journal of Coastal Conservation* 19(2): 241–256.

McDonald, Bradley, Matthew Laird, and Paul Johnson
1996 Nansemond River Archaeology: Phase II Archaeological Significance Evaluation of Sites 44SK11, 44SK41, 44SK50, and 44SK210 and a Phase I Archaeological Survey of 2,000 Feet Along the Nansemond River 42" and 48" Utility Line Replacement, City of Suffolk, VA. Archaeology, SK-123. Suffolk, VA.

McLaughlin, Suzanne and J. Andrew G. Cooper
2010 A multi-scale coastal vulnerability index: A tool for coastal managers? *Environmental Hazards* 9: 233-248.

Moore, William, Dane Magoon, Susan Bamann, Bill Hall, and Loretta Lautzenheiser
2004 Archaeological Survey Proposed Relocation of Kings Highway Bridge, Route 125, Suffolk, Virginia. Archaeology, SK-080. Suffolk, VA: Coastal Carolina Research.

Nansemond River Preservation Alliance
2022. River and Tributary History. https://www.cleanmyrivers.com/river-history.

Nansemond Shell Midden Polygons
2021 Virginia Cultural Resource Information System: Virginia Department of Historic Resources.

Nadasdy, Paul
2005 Transcending the Debate over the Ecologically Noble Indian: Indigenous
75 Peoples and Environmentalism. Ethnohistory, 52(2), 291-331. doi:10.1215/00141801-52 2-291

National Park Service
2022. The National Register of Historic Places. http://npshistory.com/brochures/national-register-rc.pdf.

Neal, Peter R
1959 A History of the Nansemond River, Virginia. Honors Theses. 604.

O'Donnell, Darby, and Kristin Kirchen
2021 Phase I Cultural Resource Identification Survey of 50 Acres within the 120-Acre Brady Marina Tract, City of Suffolk, Virginia. Archaeology. Suffolk, VA: Darby O'Donnell, LLC.

Reeder-Myers, Leslie A., and Torben C. Rick
2019 Kayak Surveys in Estuarine Environments: Addressing Sea-Level Rise and Climate Change. *American Antiquity* 93(370): 1040–1051.

Reeder-Myers, Leslie, Torben Rick, Darrin Lowery, John Wah, and Gregory Henkes
2016 Human Ecology and Coastal Foraging at Fishing Bay, Maryland, USA. *Journal of Ethnobiology* 36(3):595–616. DOI:10.2993/0278-0771-36.3.595.

Reeder-Myers, Leslie A.
2015 Cultural Heritage at Risk in the Twenty-First Century: A Vulnerability Assessment of Coastal Archaeological Sites in the United States. *The Journal of Island and Coastal Archaeology* 10(3): 436–445.

Reeder, Leslie A., Torben C. Rick, and Jon M. Erlandson
2012 Our Disappearing Past: A GIS Analysis of the Vulnerability of Coastal Archaeological Resources in California's Santa Barbara Channel Region. *Journal of Coastal Conservation* 16(2): 187–197.

Reeder, Leslie A., Torben C. Rick, and Jon M. Erlandson
2010 Our disappearing past: a GIS analysis of the vulnerability of coastal archaeological resources in California's Santa Barbara Channel region. *Journal of Coastal Conservation* 16(2): 187-197.

Rick, Torben C., and Daniel H. Sandweiss
2020 Archaeology, Climate, and Global Change in the Age of Humans. Proceedings of the National Academy of Sciences 117(15): 8250–8253.

Rick, Torben C., Leslie A. Reeder-Myers, Courtney A. Hofman, Denise Breitburg, Rowan Lockwood, Gregory Henkes, Lisa Kellogg, Darrin Lowery, Mark W. Luckenbach, Roger Mann, Matthew B. Ogburn, Melissa Southworth, John Wah, James Wesson, and Anson H. Hines
2016 Millennial-scale sustainability of the Chesapeake Bay Native American oyster fishery. *Proceedings of the National Academy of Sciences* 113(23):6568–6573. DOI:10.1073/pnas.1600019113.

Rick, Torben C., and Rowan Lockwood
2013 Integrating Paleobiology, Archeology, and History to Inform Biological Conservation: Paleobiology, Archeology, and History. *Conservation Biology* 27(1):45–54. DOI:10.1111/j.1523-1739.2012.01920.x.

Roundtree, Elizabeth C.
2005 *Pocahontas, Powhatan, Opechancanough: Three Indian Lives Changes by Jamestown*. Charlottesville: University of Virginia Press.

Roundtree, Elizabeth C.
1989 *The Powhatan Indians of Virginia: Their Traditional Culture.* Norman: University of Oklahoma Press.

Schulte, David M.
2017 History of the Virginia oyster fishery, Chesapeake Bay, USA. *Frontiers in Marine Science*. doi:10.3389/fmars.2017.00127.

Smith, John
1612 Map of Virginia. Library of Congress.
https://www.loc.gov/resource/g3880.ct000377/?r=-0.009,0.32,0.3,0.222,0.

Smith, Erica
2017 High Place at The Water's Edge: A Coastal Vulnerability Assessment Of The Kiskiak Landscape. College of William and Mary - Arts & Sciences.

Stewart, Michael
1992 Observations on the Middle Woodland Period of Virginia: A Middle Atlantic Region Perspective. In Middle and Late Woodland Research in Virginia: A Synthesis, Theodore R. Reinhart and Mary Ellen N. Hodges (eds). *The Archeological Society of Virginia*, Courtland, Virginia (29):1-38

Strachey, William
1953 *The Historie of Travell Into Virginia Britania*. Hakluyt Society, London.

Stone, Madeleine
2021 Sinking Land and Rising Seas: The Dual Crises Facing Coastal Communities. National Geographic.

Smith, Bruce D
1987 "Independent Domestication of Indigenous Seed-Bearing Plants in Eastern North America. 11 In Emergent Horticultural Economies of the Eastern Woodlands, edited by William F. Keegan, pp. 3-47, Southern Illinois University, Center for Archaeological Investigation, Occasional Paper 7, Carbondale.

Percy, George
1922 "A Trewe Relacyon." Tyler's Quarterly Magazine. 3:4.

Thieler, E. Robert, and Hammar-Klose, Erika S.
1999 *National Assessment of Coastal Vulnerability to Future Sea-Level Rise: Preliminary Results for the US Atlantic Coast*. US Geological Survey, Open-File Report 99-593. A

Thompson, Victor D., and John E. Worth
2011 Dwellers by the Sea: Native American Adaptations along the Southern Coasts of Eastern North America. *Journal of Archaeological Research* 19(1):51–101. DOI:10.1007/s10814-010-9043-9.

Thompson, Victor D
2018 Collective Action and Village Life during the Late Archaic on the Georgia Coast. In *The Archaeology of Villages in Eastern North America* P. 14. DOI:10.5744/florida/9781683400462.003.0002

Thompson, Victor D., Torben Rick, Carey J. Garland, et al.
2020 Ecosystem Stability and Native American Oyster Harvesting along the Atlantic Coast of the United States. *Science Advances* 6(28):96-52.

Traver, Jerome
1994 Phase II Archaeological Investigations of Sites 44SK20, 44SK391, & 44SK393, City of Suffolk, Virginia & 44IW115 and 44IW148, Isle of Wight County, Virginia, Includes Additional Phase I Survey: Cypress Creek. Archaeology, SK-039. Suffolk, VA.

Turner, Randolph, and Antony Opperman
2000 Searching for Virginia Company Period Sites: An Assessment of Surviving Archaeological Manifestations of Powhatan-English Interactions, A.D. 1607-1624. Archaeology, VA-069. Virginia: Virginia Department of Historic Resources.

Thompson, Victor D., and John A. Turck
2009 Adaptive Cycles of Coastal Hunter-Gatherers. *American Antiquity* 74(2): 255–278.

Turck, John A., and Victor D. Thompson
2016 Revisiting the Resilience of Late Archaic Hunter-Gatherers along the Georgia Coast. *Journal of Anthropological Archaeology* 43: 39–55.

Turner, E. Randolf
1982 A Re-examination of Powhatan Territorial Boundaries and Population, ca. AD 1607. *Quarterly Bulletin*, Archeological Society of Virginia, 37: 56.

Tyler, Lyon
1907 Narrative of Early Virginia: 1606-1625. Lyon Tyler, ed. New York: Barnes and Noble.

Tyndall, Robert
1608 Draughte of Virginia. British Museum. https://hdl.huntington.org/digital/collection/p15150coll4/id/3895/

United States Geologic Survey (USGS)
2021 Mineral Resources Online Spatial Data. https://mrdata.usgs.gov/geology/state/map-us.html?x=-78.846415&y=37.516574&z=7#home.

United States Geologic Survey (USGS)
Multi-Resolution Land Characteristics (MRLC) Consortium
2019 Multi-Resolution Land Characteristics (MRLC) Consortium. ttps://www.mrlc.gov/.

United States Geologic Survey (USGS)
2021 Virginia National Hydrography Dataset. Virginia Geographic Information Network. ftp://rockyftp.cr.usgs.gov/vdelivery/Datasets/Staged/Hydrography/NHD/State/HighResolution/GDB/NHD_H_Virginia_State_GDB.zip.

Virginia Cultural Resource Information System (VCRIS)
2022. Virginia Department of Historic Resources. https://www.dhr.virginia.gov/v-cris/.

Virginia Department of Historic Resource (VDHR)
2018 Native American Comparative Collections: Projectile Points and Lithic Types. Virginia Department of Historic Resources, Richmond, Virginia. http://www.dhr.virginia.gov/arch_DHR/archaeol_lpc.htm

Virginia Tidal Gauges
2021. National Oceanographic and Atmospheric Administration. https://tidesandcurrents.noaa.gov/map/index.html?region=Virginia.

Virginia and West Virginia Water Science Center
2018 Monitoring Land-Surface Deformation in the Virginia Coastal Plain ACTIVE. https://www.usgs.gov/centers/virginia-and-west-virginia-water-science-center/science/monitoring-land-surface-deformation#overview.

Waselkov, Gregory A.
1982 Shellfish Gathering and Shell Midden Archaeology. ProQuest Dissertations Publishing.

Water Resources
2019. Land Subsidence. United States Geologic Survey. https://www.usgs.gov/mission-areas/water-resources/science/land-subsidence#:~:text=collapse%2C%20or%s20subsidence.-,Land%20subsidence%20is%20a%20gradual%20settling%20or%20sudden%20sinking%20of,%2C%20sinkholes%2C%20and%20thawing%20permafrost.

Weeman, Katie, and Patrick Lynch
2018 New Study Finds Sea Level Rise Accelerating. National Aeronautics and Space Administration. https://climate.nasa.gov/news/2680/new-study-finds-sea-level-rise-accelerating/.

White, John
1585 *La Virginea Pars*. British Museum. https://www.britishmuseum.org/collection/object/P_1906-0509-1-3.

Whyte, Kyle Powys
2018 “White Allies, Let’s Be Honest About Decolonization.” *Yes! Solutions Journalism*. https://www.yesmagazine.org/issue/decolonize/2018/04/03/white-allies-lets-be-honest-about-decolonization

Wolf, Eric. R.
2010 Europe and the People without History. *University of California Press*.