CROSSROADS

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Monmouth University Honors School

Monmouth University
West Long Branch, NJ

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ABSTRACTS

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THESES

EDITOR'S NOTE

Crossroads is an interdisciplinary, undergraduate research journal published by the Honors School at Monmouth University. The contributors are Junior and Senior Honors thesis students whose work has been chosen by the Honors Council as representing the most original, thoroughly researched, and effectively argued theses in their fields.

Crossroads is made possible through the support of Monmouth University and the generosity of our benefactor Ms. Jane Freed, class of 1981. The articles in this volume include works in the fields of: Anthropology, Biology, Chemistry, English, & Fine Art.

Deep gratitude must also be given to the Chief Advisors and Second Readers. It is through their inspiration and support that our Honors School students succeed. Without their mentorship, the students would be missing out on a key component of their experience in the Honors School.

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CARBON SEQUESTRATION OF RHIZOPHORA MANGLE IN THE BAHAMAS

CHELSEA BARRETO

ABSTRACT

A solution to reduce the impacts of climate change caused by rising atmospheric carbon dioxide is to conserve and restore ecosystems that sequester carbon. Blue carbon ecosystems, which include, mangrove flats, salt marshes, and seagrass beds are coastal ecosystems that sequester carbon, which would otherwise remain in the atmosphere as carbon dioxide. While there is little known on the potential of these ecosystems to store carbon, early work suggests that they may store more carbon than terrestrial carbon ecosystems. Unfortunately, these ecosystems and mangrove flats in particular, are being destroyed at high rates for development. Should research show that mangrove flats serve as large carbon sinks then it becomes essential to conserve these ecosystems. The primary objective of this work was to determine how much carbon is currently stored in dwarf red mangrove, *Rhizophora mangle*, biomass in The Bahamas. In addition, site-to-site differences in carbon storage was compared and explained.

In October of 2012, four sites were selected on Eleuthera, The Bahamas attempting to maximize site variability. All sampling was done from six plots established at each site. The quantity of carbon stored in mangroves was determined from plant biomass, which was extrapolated from plant volumes. Mangrove volumes were determined from growth parameters of individuals. In each plot, leaf numbers were estimated, mangrove individuals were quantified, and soil depth was determined. It was observed that there were large differences from site to site in number of individuals, soil depth, biomass accumulation and carbon storage of mangroves. The site with the greatest primary productivity and carbon storage also had the greatest soil depth likely making it the greatest carbon sink. Regardless of the site to site variability, mangroves proved to be good stores for carbon. Future work should tie mangrove productivity to sediment accumulation and search for the factors that explain site to site variability.

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EFFECTS OF LIPOPOLYSACCHARIDE-INDUCED INFLAMMATION ON HYPOXIC AND INFLAMMATORY GENE EXPRESSION PATHWAYS IN THE RAT TESTIS

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Monmouth University
Biology

Chief Advisor: Dr. Michael A. Palladino
Second Reader: Dr. Ellen Doss-Pepe
Honors Advisor: Assistant Dean John Tiedemann

NOTE: This Honors Thesis is written according to School of Science guidelines for the Honors Thesis.

ABSTRACT

Microbes and the toxic molecules they produce are known to have negative impacts on reproductive physiology. Lipopolysaccharide (LPS) is an endotoxin that elicits a strong inflammatory response in most tissues. HIF-1α is a transcription factor considered the master regulator of oxygen homeostasis and controls the expression of a variety of genes such as those involved in angiogenesis, oxygen transport, and glucose metabolism. Previous work in our lab demonstrated that protein levels of HIF-1α are significantly elevated in the testis following LPS-induced inflammation, suggesting a role for HIF-1 in the inflammatory response. The goal of this project was to identify genes in the hypoxic and innate and adaptive immune response pathways that are up-regulated or down-regulated in the rat testis following LPS-induced inflammation and to determine the role of these genes in the overall molecular response to inflammation. Real time quantitative polymerase chain reaction (RT-qPCR) was utilized to detect changes in gene expression in the testis following intraperitoneal injection of LPS from *P. aeruginosa* in male retired breeder rats. Results demonstrated up-regulation of two subsets of genes from the hypoxic and inflammatory response pathways 3 or 6 hours following LPS- induced inflammation. Affected genes indicate a variety of functions, especially those in the hypoxic pathway, and reflect the complexity of the inflammatory response of the testis. Overall, this project provides a baseline understanding of hypoxic and inflammatory pathway gene expression changes that will be useful for future studies to elucidate the molecular response of the testis to inflammation.

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Rupert Brooke and Isaac Rosenberg:

Myth, Modernity, and the Destabilization of "Georgian War Poetry

Robert Magella

Abstract

Modernism is the dominant literary category by which English literature of the early twentieth century has come to be defined. This critical trend has perpetuated the marginalization of non-Modernist literatures of the time, initially carried out by the Modernists themselves. One of these literatures considered outside the span of "Modernism" was Georgian War Poetry of the First World War. The Modernists considered these poets too old-fashioned to be "modern," claiming that truly modern literature would not appear until the conventions in which these Georgians worked were shed by post-war poets like T.S. Eliot and W.B. Yeats. The dominance of English Modernism in the contemporary literary historical perspective means that, like the Modernists, most literary critics today would argue that Georgian War Poetry was more conventional, and therefore not as good or meaningful as the Modernists'. With this project I reclaim the reputations of the poets Rupert Brooke and Isaac Rosenberg, situating the stigma of archaic convention and patriotic fervor in the "war" poetry of Rupert Brooke, and simultaneously locating the innovation in the "Georgian" poetry of Isaac Rosenberg. Based on my reevaluations of these poets, I claim that the unity of Georgian War Poetry, a group of poets consistently defined by Brooke, Siegfried Sassoon, Wilfred Owen, and Rosenberg, falls apart upon closer inspection. This destabilization of Georgian War Poetry as a cohesive literary group opens the door for new evaluations of the poets involved with that group, specifically Isaac Rosenberg, in whom I see potential for constituting a transitional figure for Modernism between the pre-war Imagist movement and the post-war advances of Eliot, James Joyce, Ezra Pound, and others.

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SYNTHESIS OF A LIGAND-BRIDGED BIMETALLIC TEETER TOTTER COMPOUND TO PREPARE A MORE EFFICIENT CATALYST

HEATHER SIEBERT

Abstract

The work presented in this thesis focuses on studying a unique type of rearrangement called pseudorotation. In addition this work aims to synthesize a target molecule called a ligand bridged bimetallic teeter totter, which has the potential to be a more efficient catalyst. Pseudorotational rearrangements are atomic rearrangements which produce a new steric relationship without breaking or forming any new bonds. This type of rearrangement could be utilized to prepare a catalyst which has dynamic electronic and steric states which are dependent upon the position of bulky ligands during pseudorotation. The compounds synthesized in this thesis are dodecahedral rhenium(V) polyhydrides with various aromatic amine ligands. These compounds are synthesized under a nitrogen environment through melt or reflux reactions. Once the compounds are synthesized they are characterized with ^{1}H, $^{1}H\text{-}\{^{31}P\}$, $^{31}P\text{-}\{^{1}H\}$ NMR and IR. Throughout this project multiple compounds were synthesized, which to our best knowledge have never been made before. Preliminary results also suggest that the synthesis of the ligand bridged bimetallic teeter totter was successful. The ligand bridged bimetallic teeter totter compound, $ReH_5(PPh_3)_2(\mu\text{-pyrimidine})RhCl(CO)_2$ contains an eight coordinate rhenium center attached to a square planar rhodium center by a pyrimidine ligand bridge. In addition variable temperature NMR was run on the product $ReH_5(PPh_3)_2(pyr)$ and the activation energy (E_a), enthalpy of formation ($\Delta H^{\ddagger}$) and entropy of formation ($\Delta S^{\ddagger}$) were determined. The E_a for the compound is 14.9 kcal/mol·K, the $\Delta H^{\ddagger}$ is -50.96 kcal/mol and the $\Delta S^{\ddagger}$ -47 J/mol·.

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The Walls of Nevis:
A Geo-Military Analysis of the British Colonial Fortifications on the island of Nevis

Andrew Colucci
Dr. Edward Gonzalez-Tennant
Dr. Richard Veit
December 8, 2013

Chapter I - Introduction

Four hundred years ago, the British crown established an empire that encompassed the entire globe. From the spice ports of Asia to the uncharted New World in the Western hemisphere, Great Britain asserted its economic and military dominance over other nations in Europe and beyond. This empire was so immense that writers of the nineteenth century would say the sun never set on the British Empire. Where did this success come from? Indeed, the naval superiority of Great Britain was well known and could not be matched by other European nations. Its armies were well trained and experienced in nearly every theater of war. However, it can be argued that the secret to Great Britain's success lies in its surfeit of colonies around the globe and the trade network between them. These towns and cities provided the raw material and markets necessary to power Britain's industry and fuel its economy. Of all these colonies, few were as vital to Britain's global success as the Caribbean port of Nevis.

Today, Nevis, along with its larger neighboring island of St. Kitts, is a part of a two-island federation located in the Western Antilles. For three hundred years following the settlement of the island 1628, the island of Nevis was a British colony in the Caribbean. As with many other colonies established in the Caribbean, Nevis became a central British interest because of its sugar production, which was highly valued by European nations. What made Nevis such an essential port was its geographic location. For the early half of the colonial era, most European ships that traveled to the New World were at the mercy of the trade winds that blew southwest from Europe to the Caribbean Sea just south of North America. Nevis, being a part of the leeward islands of the Western Antilles[1], was directly in the path of this trade route. This made Nevis a primary port for most British ships entering the New World, allowing them to resupply after their arduous journey across the Atlantic and sell their goods as they resupplied. This key geographic

[1] Islands of the Lesser Antilles
Leeward Islands: Virgin Islands, Anguilla, Saint Marteen, Saba, Saint Eustatius, Saint Kitts, Nevis, Barbuda, Antigua, Montserrat, Guadeloupe

Windward Islands: Dominica, Martinique, Saint Lucia, Saint Vincent, Grenada.

(Curret and Hauser, 5: 2011)

advantage allowed the main trading port of Charlestown to expand rapidly and earned Nevis the title of "Queen of the Caribbees" (Machling 2012: 19). As a port of great importance, the colony constructed numerous defensive fortifications along the coast to deter and prevent enemy invasion. However, despite these protective measures, the island fell to invading French armies on two separate occasions. Why did the island of Nevis fall to invading French forces? Were the forts and batteries constructed on the island inadequate to serve in the defense of the colony? Or were the French forces that destroyed the colony simply too strong for the defenses to handle?

Starting in the sixteenth century and lasting until the eighteenth century, warfare in Europe had grown from feudal disputes between lords and kingdoms to full scale wars between nations. Many historians refer to this time period of European history as the "military revolution" (Guilmartin 2009: 129). Feudal armies of paid mercenaries were being replaced by professional standing armies. The wide spread use of handheld gunpowder weapons, such as the musket, allowed the peasant to combat the heavily armored feudal knight (Seymour 2004: 73-74). Powerful cannons had made the old medieval castles obsolete and the new Italian "Bastion System" of fortification had begun to surround nearly all major cities in Europe (Saunders 1989: 53). On the sea, larger ships with conical sails and naval artillery were creating new "ship-of-the-line" tactics that changed the rules of naval engagement (Guilmartin 2011: 137). These changes and innovations had given the European powers the tools and tactics to wage war on a massive scale and open new theaters of conflict around the globe.

One of the new theaters of European warfare, driven by imperial design, was the Caribbean (Duffy 1979: 224). During the colonial period, this region of the world was home to numerous military campaigns characterized by frequent naval battles and sea raids (Seymour 2004: 89). Many of the European conflicts followed the settlers to colonial locales. These developments also led to the rise of seventeenth and eighteenth century piracy, and the names of infamous pirates with names like Black Beard and Henry Morgan continue to inspire the modern imagination. These individuals were famous for raiding Caribbean ports, settlements, and ships. As a means of defense, European nations constructed fortifications to defend their island colonies from the conflicts that plagued the region (Duffy 1979: 224). On islands like Nevis, then a colony under the British crown, Europeans constructed large stone walls, armed with cannon and musket, in the hopes that such precautions would ward off invasion. Nevis, itself, would see the

construction of twelve individual fortifications (Machling 2012: 58), the descriptions of which seemed to be formidable enough to stop any advancing militant force in the region. Despite these fortifications, however, Nevis was sacked by French forces twice in 1706 and 1782 (Machling 2012: 79).

The central aim of my research is to further the study of Caribbean fortification through a systematic analysis of Nevis's network of forts, including examinations of fort design, armament, and garrison. This will include geospatial analysis and the use of geographic information systems (GIS) to fully explore the creation, management, and analysis of the island's military landscape. Such analyses are rare in Caribbean archeology (Torres and Ramos 2008, Singleton 2001) and will produce data crucial for the analysis of Nevisian defenses. This research is designed to serve as a pilot project for the investigation of other fortifications throughout the Caribbean. In many ways, this analysis will contribute unique interpretations of Caribbean fortifications, adding a more comprehensive method of analysis to be utilized at other sites.

The study and examination of military landscapes in Nevis are important for two reasons. These sites deserve study as part of the preservation of the past for future generations. The ruins of the old fortifications on Nevis are endangered by natural and manmade threats. Fortifications on Saddle Hill at the southern side of the island are gradually disappearing into the tropical forest. Sections of Saddle Hill's wall have also been torn down to create a road leading to a cell tower constructed on top of the hill. The ground underneath the walls of the largest fort on the island, Fort Charles, is rapidly eroding into the sea. As years pass increasingly more of Nevis's military sites are destroyed due to a variety of natural and manmade causes such as erosion, development and looting. These sites deserve systematic study and documentation, if not preservation, so that future generations of Nevisians can understand the history of their home, a history which has been built from the labor of their ancestors.

Furthermore, an analysis of these forts and their combat effectiveness will reveal important lessons regarding the significance of logistics in terms of present day military defense. Although more has changed in the history of warfare in the past few decades than in the precious centuries, these fortifications could reinforce the importance of logistics and communication with static defense. Whatever condition or situation that resulted in the capitulation of these colonial defenses to French assault could

still threaten defense networks in this modern era of warfare. Therefore, proper analysis of the fortifications would help educate people of the past and assist them in preparation for the future.

Research Questions

With the main purpose of this paper being an evaluation of the Nevisian defensive fortification system, the research will concentrate on three main aspects of fortification; design, armament, and garrison. Each of these aspects speaks to key factors that come into play during the hours of combat which these fortifications have seen. While other factors do exist, it is important to keep in mind that due to the scope of the project, the research will concentrate only on the defensive elements of the fortifications. Other elements, such as the offensive strength of the French forces on the surrounding islands and those brought to bear against the British fortifications, play a vital role in determining how effective the fortifications would have been. Again, due to the scope of this project, this factor had to be overlooked for now.

The first aspect of defense which this project will concentrate on is the design of the fortifications. This initial aspect encompasses many smaller factors which contribute to the overall effectiveness of the structures themselves. The exact location as to where the engineers planned to construct the defenses plays a critical part in the effectiveness of the fortifications. A small fort constructed atop a hill overlooking flat lands will serve much better in defense than a large fort built in a valley. Therefore, one of the questions regarding design is whether the engineers who built the fortification used the natural landscape in their design of the fortifications to add to their defensive capabilities. This project will also examine the construction design of the fortifications and compare them to leading European designs to determine if these fortifications were being constructed with the latest advances in European fort design. The effectiveness of the fortifications is also directly affected by the materials that the fortifications were made from. One last factor that will be examined under the aspect of design is communication. In order for a system of fortifications to be effective, they must work together; and in order for that system to work together, they must be able to communicate properly. Were these fortifications able to communicate with each other quickly? All of these factors will be examined to determine how well each of the structures was designed.

It is one thing to have a defensive structure in place, but it is a completely different story if one had a weapon to fight back with. The second aspect of defense with which this project is concerned is armament. Were these fortifications adequately armed to stave off a hostile force? This aspect will examine factors such as the condition of the weaponry kept at these fortifications. It is also important to see if the weapons kept here were up to date with the weapons used against them. The strongest walls and highest towers will not help a defender if he faces an army of muskets armed only with a sword.

Finally, the soldiers themselves will be examined in the final aspect of garrison. Our knowledge of the everyday life of Caribbean soldiers represents a poorly understood aspect of the region's history and represents a key contribution for archaeology (Watters 2001). This category looks into the quality of training and quality of living that the defenders of Nevis had. Were the Nevisian defenders professionally trained soldiers, or militia volunteers from the main town? Were soldiers regularly stationed at the fortifications, and, if they were, what quality of life did these soldiers have? All of these factors contribute greatly to the troop morale and combat effectiveness of the island's defenders.

As mentioned before, there are many other conditions that play into a battle to determine the outcome. This project simply examines the fortifications from the viewpoint of the defenders on the island; their positions, their weapons, and their condition. Due to the scope of the project, the offensive capabilities of the French had to be set aside. However, this does not mean that this was overlooked. Research concentrates on the island's defenses but the overall conclusion will, to some degree, acknowledge the offensive factors of the conflict and their role in the fall of Nevis.

Chapter II - Previous Work in Caribbean

Before further discussion of the British colonial fortifications on the island of Nevis, it is important to explore previous archaeological work in the Caribbean to situate my investigation of military sites and Caribbean archaeology. Like archaeology conducted in other parts of the globe, Caribbean archaeology is divided into two major categories, prehistoric archaeology and historical archaeology. Prehistoric archaeology concentrates

on the era of human history before the arrival of the Spanish in 1492. Historic archaeology explores cultural material from the colonial period until the recent past, with specific interests being plantation and military sites. Each of these concentrations has their own specific research goals oriented towards understanding the cultural heritage of the Caribbean. However, with this project concentrating on military sites from the colonial era, this section simply provides an overview of the historical work in the Caribbean to outline previous research goals and sites. This category is explored chronologically, beginning with earlier work and moving to the recent era to better understand how the goals of historical archaeology in the Caribbean changed with time. This chapter also discusses recent research (e.g., Machling 2012) which sheds light on colonial fortifications and appropriate historical resources that are crucial to performing an accurate analysis of the island's defensive capabilities.

Historical Archaeology

As prehistorians explore contact era sites to define the boundaries of prehistory, the contact period, and the consequences of European colonization on local indigenous populations (Wilson: 2007), historians and historical archaeologists have spent time documenting structures of the colonial and industrial era. Work in documenting these historic structures started as early as the seventeenth century with the work of Hans Sloane. Sloane and other naturalists spent time recording the natural flora and fauna of the region while also making detailed observations of historic ruins. "With respect to formal archaeological investigations, other than for resolution of problems relation to prehistory and the demise of indigenous populations, focus on the documentation of colonial-era monuments, forts, and planter houses" (Armstrong and Hauser 587: 2009). As archaeology became its own discipline in the early twentieth century, many of the colonial era buildings were falling into disrepair and ruin. These locations soon became points of interest for European archaeologists and many came to document these locations to better understand the lifestyle of the people at the time. However, more attention was given to the European colonizers and planters of the era rather than the African slave laborers who worked in the fields. Over time, the European centered view of these sites would shift as interest grew within local populations to learn more about their cultural identity.

During the second half of the twenty-first century, as the island nations began to receive independence from their once colonial monarchies, local historical museums and conservation groups began to establish themselves on the islands. The creation of these local scientific institutions and associated publication outlets reflected a growing interest in the study of local historical contexts and a shift from the reliance upon distant, imperial, museums and toward a locally based focus on historical interpretation. For much of the Caribbean, the institution of slavery and the cultural and political infrastructure of forts and plantations were deteriorating. Many of the old fortifications that served as land bases for the European powers now stood as derelict structures that loomed over the landscape and the old plantations that were once the symbol of the foreign aristocracy were now succumbing to the environment around them. With the foreign powers gone from the islands, local historical conservation groups and archaeologists turn their attention to preserving and documenting these sites with a uniquely local interpretation.

Concentrations in Caribbean Archaeology

Historical archaeology in the Caribbean has concentrated one two types of sites, military fortifications and plantation archaeology, with most of the work concentrating on the former of the two. With the colonial powers and foreign archaeologists gone, the academia of the region began to reexamine plantation sites with a new focus. Whereas research centered on the life of the plantation owner and the social structure of plantation society in the past, archaeologists now explore these sites to better understand the life many slave workers endured and examine the African Diaspora in the Caribbean. This shift in focus resonated with much of the local population, for archaeology of the region was now studying the history of their ancestors and provided them with a sense of cultural identity. No longer was the research about the wealthy landowners and the comfortable lifestyle that they enjoyed in the plantation social system. Research now concentrated on the hardships that many of the islander's ancestors had endured and brought to light the history of many cultural practices that developed and survived the plantation system to become a main part of present day culture on the islands.

Examples of work in Caribbean Archaeology

Study into the Afro-Caribbean culture goes back into the nineteen-sixties with the work of J.S. Handler. Handler was interested in the ceramic tradition that many current day Caribbean potters followed on islands like Antigua, Nevis, and Barbados. These potters produced a ceramic made from locally collected clay known as coarse earthenware. By molding this clay and placing it into a low heat furnace, potters produced a thick based, low-fired, dark colored ceramic useful for domestic purposes. Examples of this pottery are not just found in modern day assemblages, but are also found at planation sites across the Caribbean. Despite the fact that many of these potters used European style methods of production, Handler attributed this style of pottery making to the slaves of African decent living in the Caribbean and defined the ceramic as "Colonoware". While the rest of the archaeological world was slow to accept "colonoware" as being a ceramic tradition of the Afro-Caribbean culture, this was the first time that a tradition had been traced back to the origins and fully attributed to the Afro-Caribbeans living in bondage on plantations (Armstrong and Hauser, 585: 2009).

Another example of the work done in plantation archaeology is the study of spatial dialectics and social control in the planation setting. With many people working in bondage at one place, forms of control must have been used on the planation to maintain order and keep the laborers working. One of the ways in which slave owners kept the slaves in check was to use the landscape to their advantage. Working on plantation sites in the Blue Mountains of Jamaica, James Delle began to notice a pattern in how plantations were set up. In many of the cases, the overseer's house was built on a centrally located hill which was able to overlook the fields in which the slaves worked and the quarters in which the slaves lived. This provided the illusion that the overseer was constantly watching every action that the slaves undertook and often made the slaves hesitate before any rebellious thoughts entered their minds (Delle: 1999). This Foucaultsian system was found to be employed on several other plantation sites located around the Caribbean, including planation sites of other nationalities. Following up on James Delle's work in Jamaica, Theresa Singleton studied the layout of planation lands in Cuba. Although the Spanish planters utilized walled enclosures to contain their slaves, they still utilized centrally located high grounds to construct planter houses in order to keep up the illusion of surveillance (Singleton: 2001). Such work with spatial dialectics added to the growing literature on plantation systems in the Caribbean and offered a greater

understanding of plantation layout and forms of social control used in the colonial time period.

With regards to the archaeology completed in the Caribbean, both historic and prehistoric, there is still much work that is to be completed. As mentioned before, there are several factors that must be changed in order for more archaeological work to be completed. Universities in the region must establish academic programs structured towards the teaching of archaeology and anthropology as a specific discipline, not just a derivative of another discipline such as history, so that new generations of trained archaeologists who are native to the area can go out and conduct research of their own. Although local governments already support archaeological research and historic conservation groups, increased government support, either through fiscal donations or policy creation, would go a long way to increasing the amount of work in the region.

Previous Work on Nevis

In terms of historic preservation and archaeology, the island of Nevis is a prime example of how archaeologists and government officials can work together to preserve the culture of an island. This is because Nevis has had relatively more work completed than most of the neighboring islands in the Caribbean. The people of Nevis have worked closely with professionally trained archaeologists from outside of the Caribbean in efforts to document decaying ruins and establish local museums showcasing the history and heritage of the island. However, the work completed on the island is a prime example of how well a non-governmental organization and coordinate the efforts of an island to preserving the heritage of their past.

Nevis Historical Conservation Society

Much of the work completed on the island can be attributed to the local historic group known as the Nevis Historical Conservation Society (NHCS). Founded in 1980, the NHCS is a prime example of the non-governmental organization mentioned before in the previous section. Originally consisting of a volunteer staff, the NHCS was a group concerned

with the preservation of the island's cultural heritage which quickly sought out guidance from other scholars in the area with regards to running a non-governmental, cultural preservation organization. Since 1984, the NHCS has hired outside archaeologists and historians to come to the island in order to document the historic landmarks around the island. These outside volunteers included David and Joan Robinson of the United States Peace Corps, who conducted a feasibility study commissioned by the NHCS, and Samuel Wilson, a professionally trained American prehistoric archaeologists who was interested in the pre-Columbian history of the island. The NHCS has also worked with local Nevisian architects to study the historic buildings of Nevis's main town, Charlestown, and created a basis for classifying buildings for inclusion in the historic district. Continuing to work with American archaeologists towards the common goal of historic preservation, the NHCS has also commissioned studies into the historic Jewish community that lived on the island during colonial times with the hopes of restoring the buildings in the near future. In the field of plantation archaeology, the organization supported a study of the economics of planation life at a local Nevisian planation, known as Coconut Walk, which has turned into the first large-scale research project at a Nevisian plantation. The research mandate of the NHCS also extends to the island's biodiversity ad natural environment, which later resulted in the creation of a botanical garden on the island (Watters 86: 2001).

In order to support these research projects on the island, the NHCS has worked to establish facilities that would allow for continued research and data collection on the island. With the success of the architectural, archaeological, and ecological programs on the island, the NHCS has established the Nevis Field research Center to facilitate studies by qualified researchers and to enhance the educational opportunities afforded to Nevisians. The organization also established a storage system for artifact collections and has set up museums around the island were these artifacts can be put on display in exhibits for locals to come see. Today, the NHCS has a membership of over 500 individuals, making the Nevisian Historical Conservation Society the largest non-governmental organization on Nevis. The organization has dramatically expanded the educational opportunities and research programs on the island (Watters 87: 2001).

Documentation of Nevisian Fortifications

The historical research completed on the island of Nevis is not simply limited to the work undertaken by the Nevis Historical Conservation Society. Other work by independent researchers with the similar research goals of preserving the island's history and heritage has been completed on the island as well (Meniketti: 2006). Particularly important to this project will be the work of Tessa C. Machling as it provides the historic background and literature for the analysis for these fortifications (Machling: 2005, 2012).

Machling's work on the island concentrates entirely on documenting the colonial fortifications built by the British to defend the island. Before this documentation of the fortifications, only a couple positions had been recorded. Most of the fortifications remained undocumented and were being destroyed by both the environment and tourism. This documentation does several things to record these defensive positions for future work on the island. Firstly, it brings together nearly all of the historical records regarding the historical fortifications. Machling explored archives in the Caribbean and England, finding sixteenth - nineteenth century shipping manifests to the islands, colonial maps, descriptions of Nevis during the eighteenth century, and even plans for fortifications on the island. Much of these documents, which had remained unseen for centuries, detail the construction methods of the fortifications, the changes in armament and garrison through their years of service, and record specific events which happened on the island regarding these fortifications including changes of command and the French attacks (Machling: 2012).

Machling also travels to the island of Nevis several times during her research to conduct field work and explore the ruined fortifications in person in the late 1990's. The main purpose of these trips was to record the current state of the fortifications. The first trip was to the island was to specifically explore the ruins of the old New Castle Redoubt built on the northern shore of the island. Development in the area called for the destruction of the Redoubt so a new airfield could be built. Archaeological excavations were carried on here for the first time before the Redoubt was destroyed, revealing a myriad of different ceramics both local and European in origin. Machling detailed the architecture of the structure as well, taking time to examine the composition of the walls and the design of the defensive positions. While the Redoubt was eventually destroyed in 1997, the records Machling made allow

for further analysis into the life and defensive capabilities of this fortification (Machling 2005). Later trips to the island continued this pattern of documentation and included the documentation of the island's remaining cannon. Several old rusted cannon still existed at these defensive locations around the island but were strewn about the sites. Machling recorded the information of these cannon including maker's marks, identification numbers, and measurements while also finding records of these cannon in the old documents she had gathered. From these records, Machling was able to tell where the cannon on the island were made, when they arrived on the island, and what happened to them following the French attacks. This level of documentation and detail of the fortifications had never existed before (Machling 2012).

Machling's work provides the historical background needed for the analysis of the defensive capabilities for these fortifications. This historical documentation will be frequently referenced and the historical documents will be used to better understand the conditions of the island's fortifications at the time of the French attack. However, this work does not provide any level of analysis. Therefore, the work completed in this project will go beyond Machling's work, providing a better understanding of the fortifications of the island, their defenders, their weaponry, and the efforts to defend the island during crisis.

Limiting Factors in Caribbean Archaeology

The Caribbean has seen over six thousand years of human habitation, yet much of this record remains unexplored. There are several reasons for this lack of archaeological study, including the lack of trained archaeologists in the area (Jiménez and Ramos 2008). For much of the recent history of the region, each island was controlled by a foreign colonial power. Therefore, much of the academic study of the islands during this time was conducted by researchers from these foreign powers as many of the locals were either enslaved or employed in labor for the imperial monarchies. As time progressed and many of these colonies gained their independence from their European overseers, the amount of study in the island decreased as the number of foreign archaeologists dwindled. More recently the area has begun producing native born archaeologists interested in learned more about the local history and heritage of the region, however, the subjects of

archaeology and anthropology are not seen as distinct areas of study in this region. As a result, few Universities in the Caribbean offer degrees or programs in which students learn gain degrees in these fields and the region does not produce as many native born archaeologists who can conduct systematic archaeological surveys.

Another reason why this region has received little in means of archaeological research is a matter of government support. In countries such as the United States, archaeological surveys are mandated by the government. Due to laws such as the National Historical Preservation Act of 1966, any land development projects which use federal money, lands or involve a federal organizations must complete historical surveys to check for any cultural material of historic significance before construction can proceed. These laws create the business of cultural resource management (otherwise known as CRM) and accounts for much of the archaeological exploration conducted in the United States. In other European countries, government grants fund academic archaeological projects around the country which are usually run by Universities. While there is an immense interest in archaeology for defining a national identity in the Caribbean, the governments of the area cannot supply the same amount of financial support to historical survey work that other countries can. As a result, much of the work must be completed by small, non-governmental organizations which are financed by donations and meager government grants (Watters 85: 2001).

Cultural heritage and historic preservation in particular have received more attention than the study of buried archaeological remains throughout the region. The stabilization of standing structures receives more support from government agencies and international organizations than the excavation of new archaeological sites, whether those sites be historical or prehistoric. Such historic constructions receive more attention simply because they are more readily visible on the landscape. "Such structures, however, also have much greater potential to characterize national patrimony, to help educate the citizens about their heritage, and to enhance tourism, which are prospects appealing to local governments with limited economic resources" (Watters 84: 2001). As a result, many historic structures, such as plantation houses and colonial military fortifications, have received a large amount of attention and are often restored to serve as cultural heritage sites. Efforts by the Society for the Restoration of Brimstone Hill on St. Kitts exemplify these endeavors (Matheson: 1982, 1987)

Chapter III - Methods

Analysis of the island's defensive capabilities will rely on two sources of data; historical documentation work and spatial analyses conducted using geographic information systems (GIS). While the historical documentation makes up a large part of the project, my contribution will concentrate on geospatial analysis as supported by GIS. I use these maps to examine placement of the fortifications, weapon ranges, visibility, and travel times across the island. Unlike the trowel, shovel and screen, GIS is a relatively new skill in the archaeologist's repertoire. With recent advances with the technology, more archaeologists have begun applying GIS to sites across the globe. This chapter explores geographic information systems technology, the advantages it grants archaeologists, and how each of these advantages has been applied in the field. This chapter also discusses the how maps for this specific project were made.

GIS and Archaeology

Digging in a certain location for evidence of human disturbance or cultural material has been the standard method for archaeological exploration for over a century. While archaeologists have always used maps to locate themselves and their sites relative to natural and cultural landmarks, the real tools of the trade were the trowel, shovel and screen. However, recovering large numbers of artifacts from different sites leads to a large amount of information that must be stored and this data must be analyzed for patterns which speak to human behavior. The best way to analyze this data is through applying statistics, which is difficult to learn and even more difficult to be confident in. Therefore, it is not surprising that, with the arrival of computer generated graphics and visualization software, many archaeologists are now turning to geographic information systems technology (GIS) to analyze their data for them (Kvamme, 153: 1999) (Ladeford and McCoy, 264: 2009). While it does not replace the shovel in the field, GIS has become a crucial tool for the archaeologist (Surface-Evans and White: 2012).

GIS is more than just mapping software used by archaeologists. GIS has been employed in several fields, from social science to physical science. It allows for the user to bring data together in one place and analyze the data for patterns. For geologists, GIS is used to locate deposits of minerals and resources which are exposed above ground or hidden beneath the surface. In

disciplines like criminal justice, statistics can be put onto a map and analyzed for correlations between crime rates and demographics in certain areas. Just as it is useful for these fields, GIS is useful for archaeology in that it allows the researcher to store data collected from the field, visualize that data all together in one location and analyze that data for patterns using algorithms and programs. In these three ways, GIS has revolutionized archaeology and allowed for better understanding and interpretation of archaeological sites.

Visualization

Among the other two advantages that GIS gives archaeologists, it allows the researcher to better visualize the data they collect. When an archaeologist is in the field, they are limited to a ground view of the site. This places a limit on the archaeologists understanding and interpretation of the site they are working on. While flagging certain features or artifacts may help, it does not compare to having the entirety of the site data displayed on a single map. Visualization refers to two different types of activities. First is data visualization, in which the goal is to discover new information, relationships or patterns among variables through exploratory analyses of spatial representations of data (Ladeford and McCoy, 264: 2009). With the arrival of GIS, such representations can be produced in multiple dimensions and can be compared by overlaying layers of data a top one another. From this overlaying of data, archaeologists are better able to visualize the entire site and pick out anthropogenic patterns among naturally occurring patterns.

A prime example of spatial analysis aiding archaeologists through visualization can be seen in James Delle's work on coffee plantations from Jamaica. While he did not specifically use GIS, Delle's study of coffee plantations in Jamaica is the most comprehensive analysis of spatial arrangements undertaken in Caribbean plantation archaeology. His work analyzes the placement of the overseer's house in relation to the placement of the many slave quarters around the plantation. Through the use of geographic information systems technology, Delle was able to view the all of the structures as well as the contour data from each plantation. This revealed that overseer's houses were built on specific hills which could overlook the fields in which the slaves worked and the quarters in which the slaves lived. This pattern appeared at nearly every plantation Delle studied in Jamaica but was

truly visible once the data from those plantations was combined through GIS (Delle: 1999).

Another example in which visualization of site data allows archaeologists to better understand archaeological patterns comes from the work by Theresa Singleton. Working on coffee plantations in Cuba, Singleton looked to expand upon the work by James Delle by examining the Spanish plantation system and its implementation of "barracones". While British plantation systems in the colonies used the surveillance system studied by James Delle, the Spanish plantations were using walled enclosures in certain areas of the plantations to control their laborers. Using geographic information systems technology, Singleton was able to locate the barracones in relation to the slave quarters and overseer's house and determine the overall effectiveness of these walled enclosures. Despite the added control that these walled enclosures gave the owners of these plantations, the most effective method of control that these plantations utilized was the positioning of the overseer's homes on hills at a central locations. Again, while Singleton did not specifically utilize GIS, these spatial dialectics are more easily viewed through the use of spatial analyses, a component of GIS.

In the field of battlefield archaeology, GIS often allows archaeologists to see large features in the landscape that have been covered over by the changing terrain. Trenches and other earth works were highly utilized in warfare during the nineteenth and twentieth centuries. These elongated ditches and mounds provided infantry with cover from incoming enemy fire and were often occupied by soldiers for days and even weeks. Therefore, these defensive works are often sought out by archaeologists who wish to better understand the lifestyle of these soldiers, but have difficulty coming across these positions. Outside of Petersburg, Virginia, archaeologists David Orr and Juliana Steele utilized geophysical survey work to locate certain terrain features which could be caused by underlying defensive positions. By mapping this data with geographic information systems technology, Orr and Steele were able to uncover a large network of trenches used in the defense of Petersburg during the American Civil War (Orr and Steele: 2011).

Representative Visualization

The second type of visualization, representative visualization, is "the production of either a direct representation of archaeological evidence - such

as maps of sites - or the reconstructions of past places or objects" (Ladeford and McCoy, 265: 2009). This form of visualization goes beyond simply placing data on a map by recreating the landscape as it was during a certain period. This could take the form of creating a static map of the area from a certain era or creating an interactive three dimensional representation of the landscape at the time. Both of these representations allow the researcher to better see the site in the context of the time period and get a sense of what life was like, something that is hard to achieve by standing in the present condition of the site.

Storage and Management of Data

The second advantage to using GIS for archaeological purposes is the ability to store and manage copious amounts of data. Geographic information systems have gradually become the platform that archaeologists use to store geographically and numerically large sets of information on artifact, feature, and site levels using its read-write capability" (Ladeford and McCoy, 266: 2009). For cultural resource management, which is much like the business form of archaeology, the ability to store information on multiple sites is crucial. This also allows researchers to send their site information and work they have completed to each other in a very short period. This ability can be compounded, allowing for multiple researchers to access the same information and allow them to work together based off of the same data. Therefore, the work completed by one researcher can be built upon by another researcher using the work previously completed. This allows for databases to be built up and shared by the academic community. For example, artifact distribution can be completed by a researcher using the data of a particular site. Once that researcher adds his contribution to the database, another researcher can use his work to explore patterns in the artifact distribution for certain human behaviors. This allows for work to be completed much quicker and with a higher degree of accuracy.

Spatial Analyses

The third advantage of using geographic information systems is the ability to conduct spatial analyses. Within the past decade, more spatial analyses have been applied to archaeological sites allowing archaeologists to

better understand the data and see patterns which would usually be missed. There are three major trends in the field of archaeology when it comes to spatial analyses: "prospecting for features and deposits, modeling with the goal of finding archaeological remains, and spatial analyses to learn more about past behavior" (Ladeford and McCoy, 268: 2009). The first major trend of archaeological prospecting is defined as the methods which past human activity is located and characterized. Prospecting commonly takes data from geo-physical surveys and analyses the data to detect patterns which would indicate human disturbance or behavior. Areas of cleared flat land in the middle of a jungle or terraced hillsides could indicate human habitation in the area and validate further archaeological survey work. However, prospecting still relies heavily on human judgment rather than computer processes to determine what areas are more likely to have cultural material.

In 2004, a team of archaeologists, including Kurt Rademaker, David Reid and Gorden Bromley, explored the southern highlands of Peru looking for Paleo-Indian sites. Within this region, several Paleo-Indian sites had already been discovered in the highlands and coastal areas in the west. However, the research goal of the archaeologists was to find new sites between the two areas. Knowing that there must have been travel between sites from the two areas, the researchers gathered geophysical survey data of the area and used least cost pathway analysis to look for possible routes between these coastal sites and the Peruvian highlands. Least coast analysis examines physical terrain data quantitatively and establishes pathways between two points which are physically less taxing and provide an easier route for travel. Using the possible pathways suggested by GIS, the archaeologists were able to narrow down which pathways were more likely than others based upon the presence of environmental dangers like flooding and rock slides. Once the unlikely pathways were weeded out of the suggested paths, the researchers again used GIS software to look for terrain which suggested human habitation, unusually flat land or strange environmental features. After this analysis was completed, the researchers traveled to these areas and conducted archaeological surveys to find a collection of Paleo-Indian artifacts and several possible campsites. Using the analyses provided by GIS, archaeologists were able to travel along the routes taken by prehistoric man thousands of years ago and better locate sites which could have remained hidden for thousands of years more (Rademaker et. al.: 2012).

The second trend in spatial analytics for archaeologists is the use of predictive models to find archaeological remains. Predictive modeling is much like archaeological prospecting in that it uses features of the environmental landscape to predict where human habitation once occurred. The main difference between the two is the scale of which the analysis takes place. Predictive modeling is usually a site level analysis. In other words, the analysis studies the terrain of a specific site using feature data and geographic data to determine what areas of a site are more likely to produce cultural material (Ladeford and McCoy, 270: 2009). This tool has enjoyed success in the field of cultural resource management in the United States simply because it is a cost effective way to determine presence or absence at a specific location (Verhagen and Whitley, 50: 2012). Instead of sending teams of archaeologists to dig up half of a site to determine whether an area had seen human habitation, a computer program can analyze the site and point out places of interest for smaller teams of archaeologists to concentrate their work.

The third trend of using spatial analyses to learn more about human behavior on a site encompasses a multitude of different methods. Each of these methods is used to better understand how people interacted with the site at the time of interest. One example is the least cost path analysis which was mentioned before. This analysis analyzes the terrain for pathways connecting a series of points. Keeping in mind environmental factors such as rivers, mountains, valleys, hills, and other landscape features, this analysis suggests paths between these points which would be less physically taxing on the travelers (Surface-Evans and White, 2: 2012). Analyses like this have been used to reveal pathways which are not so obvious to the human eye alone and explain trade networks which were once thought to be too difficult to establish. For example, in the mountains of northern Spain, archaeologist John Rissetto explored the pathways in which quarried rock was transported from coastal quarries nearly forty kilometers away back to campsites in the mountains (Rissetto: 2012).

Spatial analyses have also been used to provide insight on how people saw the environment around them as well. One type of analysis used towards this goal is the viewshed analysis. This analysis examines the relationship between a specific geographic point on a map and the area around it to determine how far a person can see before terrain obstacles obscure their view. This type of analysis is useful for understanding why a

specific site was chosen for habitation. It is possible that it was chosen because it allowed one to see far into the distance and detect approaching danger in time to move. One may also have been unable to see better settlement lands or approaching danger due to environmental obstructions such as mountains or hills which blocked their view. Viewshed analyses have also been used to better comprehend cultural beliefs as well. In their 2006 study, Patrick Willaims and Donna Nash used viewshed analysis of specific sites in the Andean Mountains to understand how the visibility of the mountains was an intricate component of ancient religious beliefs (Williams and Nash: 2006).

Spatial analyses also can be combined with one another to provide a more thorough investigation into human behavior. In the Jornada Mogollon Region of South-Central New Mexico, archaeologists Shaun Phillips and Phillip Leckman conducted archaeological research in an attempt to discover trading routes between pre-Columbian Native American pueblo sites. Previous work in the region had revealed areas of artifact concentrations that made somewhat linear patterns across the landscape. Using viewshed analyses, the researchers were able to decipher which areas where more visible to the inhabitants of the settlement where they conducted their survey work. From here, the researchers utilized least cost pathways analyses to reveal which areas were more easily traveled. The combination of the viewshed and least cost pathway analysis revealed pathways that lined up with several linear concentrations of artifacts on the landscape, giving more evidence to support what many had debated to be trade routes on the landscape. The combination of these analyses allow for a more in depth understanding of cultural practices of a region which would be missed if one viewed maps with just their eyes alone.

These advantages given to archaeologists by GIS technology are crucial for the interpretation of archaeological sites. GIS plays a central role in my analysis of Nevis's defensive capabilities. In terms of visualization, GIS allows for the relatively accurate mapping of the fortifications on more recent maps of the island. Data collected and created specifically for this project will also be stored and managed using GIS software for better organization and easy access for future work on the island. Finally, spatial analyses will be used to better understand the fortifications' relationships with the terrain around them. More specifically, viewshed and least cost pathway analyses will play a vital role in understanding the design and capabilities of the fortifications in the face of an attack. Such deep geo-

military analyses have not been completed in the Caribbean using geographic information systems technology. This project will not only be used to further demonstrate the advantages of using GIS technology on archaeological sites, but also demonstrate how GIS can prove useful in Caribbean archaeological studies.

Spatial Analysis

For this project, I have created several maps of the defensive works through the use of GIS technology to allow a more in-depth analysis of the fortifications. These maps are important to understanding the relationship the fortifications had with their surrounding environment. Factors such as weapon range, visibility, communication, and transportation are more easily understood with the aid of maps and spatial analyses. In order to carry out these analyses, an accurate map of the island's fortifications must be created using Machling's previous work on the island and modern maps of the island. Once an accurate map is created, recent topographic data will be overlaid onto the map to allow for spatial analyses of the island to be completed and viewshed, weapon range, and least cost pathway maps to be created.

Accurate Location of Fortifications

One of the most important tools utilized in this project is the mapping of the various fortifications on the island of Nevis. As mentioned in the previous chapter, the maps provided through geographic information systems technology allow one to better visualize the landscape surrounding the forts, which is key to understanding the weapon ranges and visibility factors for each position. However, while topographic and satellite imagery does exist, there are very few maps illustrating the island's fortifications. Maps created during the eighteenth and nineteenth centuries mark certain locations as defensive fortifications, but these locations are inconsistent with other contemporary drawings and the geographic features are not accurate enough to rely upon. During her documentation of the island's fortifications, Machling provides a small map where she plots the location of each fortification (Map 1). However, while this map may be more precise than its predecessors, this map is still inaccurate and does not detail the terrain or topography of the island. Therefore, georeferencing this map with present

day topographic data was completed to create an accurate model of the island.

In order for the proper analysis of the island, Machling's map was georeferenced with modern day maps of the island of Nevis to create a more accurate depiction of the locations of each of the fortifications. In other words, I have overlaid Machling's map onto an accurate topographic map of the island and formatted the coastline of Machling's map so that it matches the real coastline of the topographic map. Once Machling's map was georeferenced, I created a shapefile - quite literally a file containing a shape overlaid onto a map - containing the positions of all the fortifications on the island. This shapefile, when placed over a geographically accurate map of the island provides the position of every fortification relative to the coastline of the island. This is the accurate map of the island that this project needs in order to successfully conduct the analysis of the fortifications. This map and shape file are used throughout this project to analyze weapon ranges, visibility and troop mobility on the island. Once I created and stored this shapefile, I created separate shapefiles containing the position of each fortification alone. Later in this project, I use these individual viewshed analyses of each fortification to show the area visible from that specific location. With these shapefiles, an accurate present day map was created displaying the location of every fortification and road alongside present day topographic data.

Viewshed Analyses

Viewshed analyses allows for the visualization of how far defenders could see from each position. A viewshed analysis examines the elevation data around a single point on a map to determine how far one would be able to see before terrain features like hills and other obstacles obscure their vision. This analysis is crucial to understanding how well the fortifications could communicate. If one position was able to see another, then these two positions could communicate through the use of signaling lights of either fires or mirrors. The first viewshed analysis I completed was of the map containing all of the fortification positions. In other words, this map displays the area that is visible from the fortification network present on the island. However, this does not mean that each position can see the entire area highlighted in green. Each position has their own limiting factors that hinders their ability to see the rest of the island. For example, a fortification built on

the southern side of the island would have difficulty seeing the northern coast due to the undulating terrain and the large volcano that dominates the landscape. Therefore, separate viewsheds were created, each one from the position of a specific fortification.

The individual fortification viewsheds speak to the communication ability of the fortifications as well as the ability to spot hostile units. These analyses are important because they display the detection area around the fortifications where an enemy force would be noticed by that specific fortification. In other words, should an enemy ship or unit appear in any of the highlighted green area, it would be noticeable from the fortification symbolized by the red within the green area of the map. If any enemy unit were to stay outside of that highlighted green area, that unit would be difficult to see from the fortification and may remain undetected as long as it did not appear in the detection area of another fortification. These are later to be used in determining how the British militia responded to the French attack. If the French had landed outside of the visibility range of the fortifications, that it would be safe to assume that any offensive action taken by the French on the land would have had some element of surprise added to it. It is also important to note the element of communication these maps display. From the overall viewshed analysis map, we know that each fortification was viewable from some other position within the network. With these specific viewshed analysis maps, we are able to see which specific fortifications were in range of communication. With reference to the other individual viewshed analyses maps, one can see the specific fortifications that the one position would have been able to contact via signaling mirrors or smoke signals. This is important when examining the chain of communication between the fortifications.

Weapon Range Buffer Analysis

With the modern model produced from geo-referencing Machling's work, it is now possible to visualize how far the fortifications could have reached with their long range cannon. During the time period which these fortifications saw live conflict, nearly all cannon had the same range. At the furthest extent, these guns could reach about two-thousand to two-thousand five hundred feet. However, according to historic documentation of the island's weaponry, most of the fortifications were armed with eight-pound

sakers, a light field gun firing eight pound shots. Being light, field artillery pieces, these cannon were ineffective at ranges beyond fifteen hundred feet. In fact, these guns were typically used to hit targets within one thousand feet of the gun. At this range, the gun was much more accurate and could inflict maximum damage upon its target. In order to better visualize the furthest extent that these weapons could reach, buffer zones were created displaying the furthest range of the cannon and the range in which the guns could be fired for maximum effect. Firstly, I loaded the shapefile containing the total fortification positions onto a modern topographical map of the island (Map 2). On this map, I created buffer zones around each fortification. The inner most zone is the area of maximum effect. This is the area where the cannon could be fired accurately at a target and also cause maximum damage. The outer most ring is the area where the cannons could reach but not have much effect on its target. This map will prove important when analyzing the firing capabilities of each fortification.

Least Cost Analysis

Machling's work in documenting the fortifications of the island also provides a French map of the island, which describes the general location of the French landing force which attacked the island in 1706 (Map 5). With accurate contour data of the island and a several viewshed analyses already completed, this map provides the opportunity to map the possible route taken by the French on their march to attack Charlestown. In order to do this, the contour map of the island will be analyzed for the slopes of the changing landscape. Slopes from hills and mountains substantially slow travel on foot. A large military force would do their best to avoid as many steep slopes as possible in reaching their destination simply because it is faster to march on flat ground. Once the slopes of the island have been analyzed and highlighted, a cost distance map is created via the slope analysis and point at which the French land (Map 6). The cost-distance analysis examines the slopes of the island and calculates the cost of traveling over these slopes. Once a cost is determined for each slope of the island, the program then calculates how difficult it would be to travel from one point to another, coloring the map according to difficulty. Green areas took little time for the French to travel while red areas required some time to reach. This map, combined with the viewshed analyses will reveal how long the Nevisians had to react to the French attack.

With these maps created, it is now possible to interpret the data provided from historical documents and the GIS analysis. In the next chapter, each aspect of fortification will be analyzed for combat effectiveness based upon the data gathered and the maps created (See Map Appendix).

Chapter IV - Interpretation

My goal of determining the effectiveness of Nevis's fortifications required the analysis of three aspects of defense; design, armament and garrison. The historical documentation and resulting spatial analysis supports the investigation of fortification effectiveness. In regards to design, most of the fortifications were constructed in good positions but were poorly planned out and constructed. The armaments utilized by the island were standard for the time period and provided a solid defensive range against potential enemies. However, many of these these weapons were not combat ready at any given time. Historical records also describe the defenders of the island as mere militia men with little combat training or experience. Overall, while the island's defensive capabilities may have looked good paper, the reality was that these fortifications, as well as the weapons they employed and men who defended the island, were not capable of defending against a minor attack, much less than a full scale French invasion. With a close examination of each defensive aspect, the reasons for the French victories is apparent.

Design

Before creating a defensive position to hold off an enemy attack, military planners/engineers must take note of the surrounding terrain. The natural terrain on which a fight takes place clearly impacts the tide of any battle or military engagement. The placement of a defensive position is crucial. A defensive position must be able to hold ground and defend a position. If this position is easily surrounded or circumvented, then that position is does not offer a proper defense. Should a defensive position be working with other positions in a network of defensive works, than a clear line of communication is vital for effective combined defense. Should a position be created at a location that is hard to see from other allied positions, than communication via signal mirrors, flags, or smoke signals will be difficult and the combined effort will collapse (Duffy: 1979, 1985) (Black: 2007). In these ways, the fortifications on the island of Nevis were properly designed.

Location of Defensive Works

With only one exception, each of the fortifications on the island of Nevis were constructed in easily defendable positions. Most of the fortifications were constructed along the coastline of the island (Map 3). While individually this may not allow for easy defense from land units, this provides excellent protection against enemy naval units. Seeing that Nevis is a small island, the only way to take the island is to land soldiers on the shore and take the main town. While this seems to give the advantage to the defenders of the island, this gives the defenders the heavy burden of fortifying the entire coastline. However, for the island of Nevis, the defenders seemed to have done just that. With the line of coastal artillery batteries, there are few places where landing operations can take place without encountering heavy resistance from the defenders. Not only are the Nevisian's defensive positions close enough on the coast where they can prevent enemy landing parties from hitting the beach, these fortifications were put in locations where they can fire at nearly every angle. Fort Charles, along with the fortifications at Long Point and hurricane hill, was built on a peninsula that jutted out into the Caribbean sea (Maps 4A, 4E). This allowed for the guns of the fortification to cover more coastline than just simply putting the fortification on the beach. Working together, these positions were able to cover a large portion of the islands coastline, preventing any foreign forces from landing on the beach (Map 2).

Communication was also bolstered by the defensive positions taken up by the fortificationsThe artillery batteries on the southern side of the island were unable to see signals from the northern artillery batteries. This was partly circumvented because each position was able to see one or more nearest forts. This would allow a message from one position to spread from one location to each of the fortifications until each position received the initial message. The viewshed analyses confirmed that much of the island was visible from each position (Map 3). Signals sent from one fortification would have no issue reaching any other allied fortification on the island.

Position of Saddle Hill Artillery Battery

The majority of Nevis's fortifications were built at locations were terrain gave an advantage to the defender; there is one position that is

different from the rest of the network. The artillery emplacement on the southern slope of Saddle Hill is built several hundred feet above sea level and about a mile inland (Map 4N). Being so far away from the coastline puts this position out of range of any naval gun of the time period, giving the defenders the advantage of not taking any enemy fire. However, this also means that this fortification, which is clearly marked on many historic maps as an artillery battery, would not be able to attack any ships that approach the coastline. Additionally, this position was so far inland that it would not have been able to attack any enemies landing on the coast either. Even if the enemy had landed on the beach directly in front of the position at Saddle Hill, the slope may have been too steep for an infantry brigade to approach. Therefore, there would not have been any targets for the artillery to fire upon. Thus it appears that the colossal fortification on Saddle Hill is a waste of valuable time and resources. However, what this position lacks in firing abilities, Saddle Hill makes up for in visibility. On the viewshed analysis map, the position of Saddle Hill appears as three dots instead of just one. This is because Saddle Hill has three peaks, each of which is a short walk from the fortification on the southern slope. During the time in which this position would have been in operation, the defenders would have taken full advantage of these peaks by creating clear pathways to each of the three points. From these points, the fortification at Saddle Hill can see the entire southern half of the island, including the eastern coast where the artillery position at Indian Castle is located and Charlestown itself. This position proves to be the outlier for several aspects and will be returned to in future analyses.

Individual Design

The aspect of design does not simply stop at location for each of the positions, but also takes into account how each of the fortifications were planned out and built. During the time period where these fortifications appeared on the island of Nevis, Europe was undergoing a revolution in fortress building. In past centuries, large stone castles with high walls served in the defense of medieval armies. The introduction of the cannon and gunpowder small arms heralded a new fortification design. Starting on the Italian peninsula, these fortifications were shorter with sloped walls that jutted out in triangular shapes, allowing for maximum firepower to be put down upon the enemy. In effect, these new designs maximized the killing potential of each fortification. However, the designs of the fortifications

called for precise angled measurements, and builders had to be skilled in mathematics to create effective defensive positions. Great European engineers and mathematicians, such as Vauban and Coehoorn, continuously added layers of defense to these defensive fortifications until a frontal assault was nearly impossible. In the Caribbean, European colonizers applied these new defensive designs when constructing their own defensive positions. However, these colonial defensive works did not always resemble the precise angled fortifications of Europe.

On the island of Nevis, the fortifications were individually designed in an inconsistent manner. Firstly, the fortifications on Nevis were not planned out by military engineers. Although the Nevisian planters requested a military engineer to plan the defense of the island, the British government did not send any trained engineer to the island. Instead, the local planters paid craftsmen and stone masons to construct fortifications to the best of their ability (Machling 69: 2012). The money for these fortifications came directly from the islanders themselves, not the British government. For this reason, construction of the fortifications was sporadic. During times of war, the planters paid large sums of money to hastily construct the defenses. In times of peace, construction slowed to a crawl as planters looked to save money on unnecessary precautions. After decades of construction, nine fortifications on the island had been completed by 1705 (Machling 70: 2012). However, it would still take another decade for other fortifications, including the artillery position of Saddle Hill to be completed. Once these fortifications were constructed, it was obvious to see that these were not well planned.

Design of Fort Charles

The main defensive position of the island of Nevis was to be Fort Charles, the large fort built on the peninsula overlooking the harbor just south of Charlestown (Machling, 59: 2012). This fortification was to be built following the plans of the most advanced fortifications of Europe with angled walls and jutting bastions. However, as mentioned before, no military engineers were sent to the island. Instead, inexperienced civil engineers hastily constructed the fortification. As a result, the walls of this fortification are not angled properly and the bastions are poorly designed. With the European design, should the walls take any direct cannon fire, the angle of the walls should be able to deflect the oncoming projectile without causing

significant structural damage to the wall. However, the walls of Fort Charles are too steep and, while the walls are strong enough to stand for hundreds of years, they lack the defensive characteristics of contemporary European fortifications. The bastions are also small and are not angled enough to provide covering fire for the entrance of the fort. These are severe liabilities in the defense of the fortification when facing land based artillery. Within the fortification, there was no space allotted for a garrison of soldiers. As with the other fortifications on the island, Fort Charles was not built with a barracks to house the soldiers who defended the walls. The other fortifications on the island also suffer from poor designs and construction methods.

Overall Design

For the aspect of design, the fortifications on the island of Nevis are well positioned but poorly planned. Placed along the coastline, each of the fortifications would hinder any enemy landing operations by providing constant coastal cannon fire. These fortifications were also located where they had clear line of sight along the coast and inland areas of the island. This would allow for easier communication between the fortifications and combined defensive efforts in case of an attack. However, the fortifications were not built to the European standards for fortress design. The most formidable fortification on the island, Fort Charles, was planned with shallow walls and small bastions . Although it was formidable defensive position against naval attacks, Fort Charles was at risk from land attacks, poorly designed eastern walls did not allow defenders to place effective fire upon attackers targeting the fort's entrance. The artillery position at Saddle Hill was also poorly designed. Although its location allowed for good visibility of the island, the location put the fortification out of range of coastal defense. In effect, the position of the fortifications made the island seemed formidable on paper, but cracks in the islands defense would appear should the island suffer from sustained attack due to the design of the islands fortifications.

Armament

The defensive aspect of armament is a crucial concern during any combat situation. Without proper weapons, even the most fortified positions would be simple stone obstacles to an attacking army. In this portion of the analysis, armament simply describes the types of weaponry used at the

fortifications and the condition they were kept in during their service on the island. Weaponry of the time period came in two forms, small arms and artillery. While both types of these weapons were used against different targets, the combination of these weapons on a battlefield proved devastating to an enemy. Most of the information for this aspect of defense will come from the historical documents gathered by Tessa Machling as there is little evidence of weaponry from the archaeological record recovered from the island so far.

Small Arms in European Warfare

Small arms refers to the weapons carried and operated by the infantry. Compared to the heavier artillery, these weapons were light, both in weight and in the damage they inflicted upon the enemy. During the seventeenth through nineteenth centuries, the time in which the Nevisian fortifications were constructed and served in the defense of Nevis, muskets were the preferred weapon of the infantry man. Becoming popular around the sixteenth century, the musket was a muzzle-loaded, smoothbore, black powder fire arm fired from the shoulder. Its cheap design and ease of use made it the ideal weapon for the average infantry man who received little training before being put on the front line. Specifically, the flint lock musket, utilizing the spark created from striking a metal plate with a flint flake to ignite the black powder, had become the premier firearm of the infantry man. With this weapon in their arsenal, European powers were able to quickly raise large armies and spread their influence across the globe. With the popularity of this Ordnance weapon, it makes sense to find this weapon in the historical records of the island.

Shipment of Small Arms

The movement and supply of armament from Europe to the Caribbean proved to be an issue throughout the service period of the fortifications (Seymour, 79: 2004). The transportation of weaponry from the British isles to the colonies in the new world was handled by the British Ordnance Office. This bureaucratic office of the British government regulated the weaponry utilized by the British military and distributed supplies to the colonies around the globe. With Britain's empire reaching

across six continents, the task faced by the office was enormous and it often failed to meet the demand of the colonies. Records kept by the Ordnance Office show that many requests for military personnel and weapons often went unfulfilled. Shipments that were sent were often in poor condition or contained out of date weaponry (Parnell: 1997). Examples of this can be seen in the records and accounts gathered by Machling. On numerous occasions, the residents of Nevis sent requests for more guns, both small arms and artillery. Despite their pleas and petitions, they were rejected on multiple times. It often took the work of the regional governor to acquisition such weaponry for the island's defense (Machling, 71: 2012). This lack of supply from the British government would have caused shortages in not only ammunition and powder for the guns, but a shortage in guns themselves. However, the problems for the Nevisians did not stop with the Ordnance Office. Once the weapons received the approval from the office and set sail for Nevis, they often failed to reach their destination.

Government bureaucracy not the only hindrance to the transportation of arms to Nevis, greed was also a factor. Many of the weapon shipments sent to the Caribbean often went through nearby Antigua or Barbados before reaching Nevis. The arrival of the weapons at these ports often meant that the best, and sometimes all, of the weapons were taken for defense of that specific island. Records from Antigua and Barbados mention several times how weaponry from Nevis was taken for the defense of their own port. As a result, Nevis was often left with a small number of outdated weapons in poor condition.

While the records of small arms in Nevis are few and far between, Machling complies a number of accounts detailing the presence of small arms on the island. At the time, the standard small arm was the smooth bore, muzzle-loading, black powder, flint-lock musket. These weapons, created only a century before the colonization of Nevis, were the premier firearm for the standard infantry man. Light, small, and easy to use, the flint-lock musket allowed the European nations to place a musket in the hands of a farmer and turn him into a soldier in a matter of weeks (Seymour, 65: 2004). This allowed for European nations to raise armies quickly (Wagner 120: 1979). In Nevis, there were requests for hundreds of these weapons for the defense of the island. However, for reasons mentioned before, only small numbers of these weapons reached the island. On several occasions, several outdated match-lock muskets were sent to the island instead of the requested flint-lock muskets. While these match-lock muskets were replaced, the flint-lock

muskets sent to replace them were often in terrible condition. One account from the early eighteenth century reports that the governor tried to rectify the situation by hiring a gunsmith to work on the island, fixing the weapons so that they were combat ready (Machling, 72: 2012). However, in the face of bureaucratic opposition from home and poor supply rates, many of the island's defenders often bought their own private muskets rather than rely on the crown to provide for their defense. Personal firearms, including pistols, often became the weapon of choice for the resident Nevisians who were unable to acquire steady military aid from their mother country.

Artillery on Nevis

Artillery on the island of Nevis suffered a slightly better fate than the small arms used by the residents. Construction of the fortifications on Nevis required that artillery be sent to the island in order for the fortifications to defend themselves. Artillery pieces are much stronger weapons than small arms. Larger, heavier, and requiring a few soldiers to operate, these weapons could deal massive damage to enemy ships and troop formations over a thousand feet away. These pieces often came in different weight classes. Heavier cannons, with their longer effective range, were used against fortifications and enemy naval units while lighter guns were more maneuverable on the field and served better against infantry formations. While being less effective than the other specialized cannons, medium cannons served a multirole purpose, firing both at naval units and infantry formations. However, these weapons required a team of trained individuals in order to be effective and had a slower rate of fire than the smaller muskets. As a result, these weapons were often contained behind fixed earthen works for offensive maneuvers or stone fortifications for defensive actions (Wagner 136: 1979). Nevis completed most of the fortifications by 1706, shortly before the first French invasion. Up until this point, Nevis had made several requests for artillery pieces to occupy the fortifications they were constructing. However, unlike the several requests for small arms shipments, the Nevisians had more success early on in obtaining these artillery pieces. Artillery pieces sent to Nevis were often in better condition but were in random groupings. Nevis never received a standard shipment of guns, but would often get an assortment of medium and light cannons. In contrast, the neighboring colony of Antigua received standard compliments of heavy

artillery complete with carriages and plenty of ammunition. By 1706, the governor reported that Nevis had in its procession over ninety cannons, however, other accounts reveal the actual number to be half that with each fortification on the island containing less than half of the artillery pieces they were designed to hold. During the French invasion of 1706, many of the cannon were captured or destroyed by the French. Following the defeat, the island petitioned to replace the lost cannon with more heavy artillery. However, from this point forward, the island received fewer and fewer combat ready cannon for the fortifications. By the mid eighteenth century, Nevis had only forty-five cannon of which only twenty-nine were serviceable. In contrast, the island of Antigua had over one hundred and thirty cannon, including heavy guns. After the second French attack of 1782, the island was left with only two '"dependable" guns, a number which only rose to twenty before the fortifications were abandoned by the end of the nineteenth century (Machling 72-74: 2012).

Overview of Armament

Armament is crucial to any type of military action, whether it be offensive or defensive. Obtaining and maintain the proper weaponry for combat is the difference between a complete victory and a devastating loss. In terms of armament, the island of Nevis suffered poorly. Small arms were hard to come by as shipments from the British Ordnance Office were scarce and those shipments that did make it to Nevis were often picked apart by the neighboring islands of Antigua and Barbados. As a result, many of the residents of Nevis took to purchasing their own personal firearms, which may be cost effective but are no substitute to a steady supply of military grade hardware and ammunition. Artillery for the island was more easily obtained and maintained by the Ordnance Office, but early shipments were often a mix match of different cannon. As time went on, the island continued to receive only small shipments of lighter artillery while the neighboring island Antigua received more powerful cannons in higher quantity. These lighter cannons, while effective against infantry formations, would not have had enough firepower to ward off a French fleet. In the end, the weaponry and supply rate of Nevis was subpar. The British government simply did not supply the adequate weaponry needed for the defense of the island.

Garrison

The third aspect which this analysis will examine is the garrison of defenders which occupied and protected the island of Nevis. Without a garrison, the walls and weapons on the island of Nevis would had had little meaning to an attacking force. Men were needed to man the walls and fire back at approaching hostile forces if there was to be any chance of defeating the enemy. Much like the armament aspect of the analysis, much of the data here will come from the historical sources gathered by Tessa Machling. These accounts of the island will be examined for hints as to who exactly served in the defense of Nevis, how these individuals were trained, and in what conditions they lived. The combination of these variables could lead to different outcomes in a battle and would give an indication as to what kind of soldier guarded the walls of Nevis.

Infantry in European Warfare

European infantry at the time of these Nevisian fortifications had undergone serious changes. In previous centuries, infantry were usually farmers and peasants taken form the surrounding countryside, given a simple pike, and forced to fight for their monarch during war (Wagner: 1979). Over time, however, advances in weapon technology and tactics evolved the soldier. By the time Nevis was colonized by the British, the European nations had established standing armies of professional soldiers armed with standard issue muskets and uniforms. These men were trained and paid to be soldiers in the service of the king, fighting in campaigns during war time and remaining in military garrisons to maintain law and order during times of peace (Seymour 68, 2004). Relative to the standards of modern infantry, their training was less intense, but constant drills and military maneuvers keep these men ready for combat. However, while their training and experience made these men the best choice for any sort of combat situation, the costs of feeding and equipping these soldiers were very high. While European governments could afford to support regular soldiers, colonial governments looked elsewhere for their defense.

On the European mainland, monarchies were able to raise massive armies of infantry, artillery and supporting cavalry. However, the distance between the European monarchies and their colonies proved sending large

armies to defend their colonies difficult. Instead of large armies, colonial powers normally maintained small expeditionary forces at home and only sent these forces to protect the colonies in time of war (Seymour 65-67: 2004). As a result, colonial governments looked to create their own soldiers in the form of militias. Militias were military units raised up from the local residents of a colony. The militia man was often a farmer who, in times of crisis, would gather up his own weapons and ammunition before joining others in the center of town to form a loosely organized military unit. Militia units in the colonies were cheap to maintain as they usually owned their own firearms and did not receive a formal salary. However, these troops lacked formal training. Hunting was often the closest experience to war that these men would have, which may helped the men familiarize themselves with loading a firing a musket but did not teach the men how to move and fight as a group. (Seymour 69: 2004). All in all, militia units were cost effective defensive troops and meant to be the backbone of Caribbean defense (Machling, 87: 2012), but their lack of formal training and weaponry meant that these soldiers were no replacement for regular infantry (Seymour, 68: 2004).

Professional Infantry on Nevis

Historical documents from the island of Nevis document the presence of both militia units and regular troops. From the accounts gathered by Machling, it seems regular infantry regiments were sent to the Caribbean to serve two purposes. The first regiments ,sent to the Caribbean in the mid seventeenth century, were to see that British laws were upheld. As the seventeenth century drew to a close and war with France seemed to become more of a possibility, more regiments of soldiers were sent to the West Indies to defend the colonies from French raids. Several accounts testify to the presence of three regular infantry regiments being present on the island before the attack of 1706, totaling about two hundred men. However, these accounts also detail the deplorable condition these soldiers served in. Many of the regiments which were sent to Nevis often did not have a place to live. As mentioned before, the fortifications on the island were not constructed with barracks in which soldiers could live. As a result, soldiers were forced to find quarters with the local residents of the island (Machling, 86: 2012). On many occasions, these soldiers were often denied quarters by the residents they were meant to protect. Several accounts discuss a lack of pay. Soldiers

would often go years without receiving money for their services, forcing them to work as labor for the local plantation owners. Another problem faced by these soldiers was the climate. Used to fighting in more temperate climates, these soldiers wore heavier cotton uniforms and hats which often lead to heat exhaustion and fatigue. Disease was also an issue for the soldiers. Malaria, small pox, and other illnesses reduced the average number of men in a regiment from eighty men to about fifty. Conditions for these soldiers was so bad that the commanding officer wrote a letter to the governor pleading for better pay and supplies. In his letter, the officer reported that the living condition of the rival French soldiers were far better than the condition of his own soldiers. By 1705, a year before the French attack, the remaining men of the regiments, with their numbers below one hundred, disbanded due to the lack of pay and presence of disease. Following the French attack in 1706, Only one regiment of regular soldiers was sent to the island for defense. However, payment issues and disease, again, wreaked havoc on the men, forcing them to disband before 1750. By the time of the second French attack in 1782, there were no British regulars able to defend the island (Machling, 87: 2012).

Nevisian Militia

Horrible living conditions, lack of pay, and disease made the regular soldiers on the island of Nevis virtually useless in the defense of Nevis. As a result, the defense was left to the island's militia. Early in the colonization of the island, the island militia was a very formidable force, with the number of militia men constantly increasing to fourteen hundred men in 1689. Around this time, accounts describe regular training exercises taking place on the island, including military maneuvers and shooting practice (Machling, 87;2012). These training sessions were unusual for their type of unit and would have made these men a stronger fighting force then the average colonial militia at the time. However, as the seventeenth century drew to a close, the numbers of the militia began to decline. Laws against the selling and breaking of personal weapons suggest that many planters were looking to get out of the militia. The real threat to the militia was disease. At the end of the 1690's, the same wave of diseases that decimated the regular infantry regiments cut the number of available militiamen from fourteen-hundred to

five hundred men. Attempts were made to restore the militia to fighting strength, including training sessions on how to man artillery pieces. However, by the time of the first French attack in 1706, the number of available militia men had only declined further to about four hundred and fifty men. After the attack, accounts of poor leadership from the militia officers increased and the number of available militia men decreased to about three hundred. From the 1830's, no more than one hundred militia men stood ready for the island's defense (Machling, 88: 2012).

Overview of Garrison on Nevis

Overall the Nevisian garrison in charge of defense was appalling. While regular soldiers were posted on the island, poor living conditions and the lack of pay drove many men to desert from the regiments. By the time of the French attacks, the regular infantry on the island were either disbanded or not a factor in the defense of the island. Real defense was left to the militia, which started off strong in the latter half of the seventeenth century but declined after disease ravaged their ranks. These men were unfit and undersupplied for combat. Leadership within the militia also contributed to the defeat at the hands of the French, with many commanders either not reporting for duty or discouraging their men during combat. In total, the Nevisian defenders never measured more than six hundred combat-capable men when attacked by the French in 1706 and 1782.

Chapter 5 - Conclusion

The importance of the island of Nevis to the British Empire's holding in the new world cannot be over stated. The island's central location in the West Indies as well as its location at the end of the trade winds made this island the primary stopping point for European shipping entering the new world. Settlers looking to create colonies on the North American mainland often traveled through this area before founding new colonies. Merchants looking to trade resources necessary for survival had to resupply on Nevis before they could reach any other colony in the seventeenth century. Being an island of such importance, it would seem only logical to fortify this island to prevent any other European nation from possessing this vital port. However, after a close examination of these colonial fortifications, negligence in the island's defense caused the island's capitulation to French forces in 1706 and 1782.

Where the fortifications were well placed, they were poorly designed compared to the contemporary fortifications at the time. Of the fourteen defensive positions on the island, thirteen were located along the coastline of the island, allowing defenders to fire upon the enemy before they could make landfall. All fourteen locations of the defensive works afforded the defenders excellent visibility. Being placed along the coastline, most of the fortifications were able to see miles out to see as well as other friendly positions along the coastline. Some fortifications, such as Saddle Hill and Hurricane Point, were built atop hills that allowed the defenders to see much of the island from one point. The positioning of these fortifications allowed for communication and support between the defenders of the island. However, despite their placement, the fortifications were not designed by experienced military engineers. Despite several attempts to secure military engineers to design the fortifications, the islanders were forced to rely on civil engineers to construct the fortifications. While these engineers oversaw the proper construction of these fortifications, they did not plan these positions in a way which optimized their defensive capabilities.

To make matters worse for the defenses of the island, the defenders received few weapons to protect their island. Weapons used on the island came from the gunsmiths, foundries, and arsenals of England. In order to requisition these weapons, orders were placed with the British Office of Ordnance, the bureaucratic branch of the British military charged with the

distribution of weapons and ammunition among the Empire's colonies. While the island's planter population and provincial government placed several orders for weapons, the Office of Ordnance, for whatever reason, denied most of the orders. Weapon shipments which were accepted by the Office of Ordnance were often full of guns in terrible condition or obsolete weaponry. Unfortunately for the island defenders, problems with weapon procurement did not stop with the "red-tape" and bureaucracy of the British government. Once the weapons left Europe, these weapons traveled across the Atlantic Ocean, stopping at other Caribbean colonies along the way. These colonies, such as Antigua and Barbados, would often take some weapons out of the shipments meant for Nevis. This left the Nevisian defenders with few weapons of poor condition. As a result, many of the island's defenders resorted to buying their own weapons with their own money.

Finally, in respect to the defenders of the island themselves, few individuals on the island were capable of defending the colony from any sort of attack. While the island did have a contingent of two hundred professional soldiers stationed on the island, the conditions these soldiers lived kept them from properly performing their duty. These soldiers were not provided housing on the island, as no fortification was designed big enough to include barracks to house soldiers. These men were also undersupplied, with many men not receiving pay checks for years at a time. However, the most devastating condition for the soldiers was the tropical climate itself. Unused to the region, the soldiers suffered from many diseases that swept through the ranks in waves of epidemics on the island. By the first French attack in 1706, the number of soldiers fit for duty fell drastically from two hundred to fifty. The island defenders did not just consist of professional soldiers, even the farmers of the island would take up arms as militia men when the island was threatened. Though untrained and inexperienced, these militia men provided the numbers needed to man the walls and protect the island. Yet, despite their familiarity with the island, these militia men were also greatly affected by the tropical climate and the diseases of the new world. After several epidemics on the island, the number of militiamen fell drastically. Following the first French attack, the numbers only continued to fall as men avoided mandatory service in the militia and the islanders lost interest in defending the territory of the British crown.

In each aspect of defense, the local residents and British monarchy failed to provide adequate effort. The combination of these factors leads to

the conclusion that, while they may seem strong on paper, the fortifications on the island of Nevis were in reality never fit for combat of any kind.

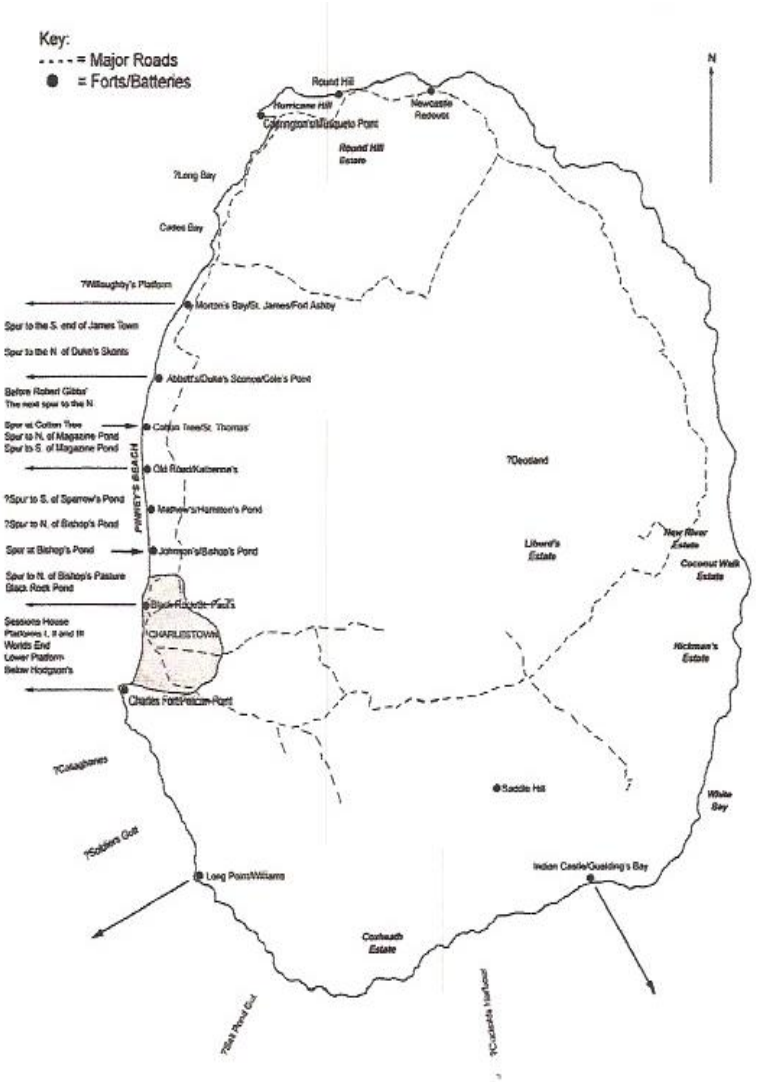
However, the study does not end here. Further work should still be completed into the construction methods of the fortifications. A more detailed analysis of the mortar composition and materials used to create the fortifications could tell more about the island's economy as well as the structural strength of the fortifications. Another area of exploration should be the workers who built these fortifications. Little is said about who built each defensive position, but literature of the time period suggests that planters would have used their own slaves to construct the forts. To learn about the men and women who built these forts under bondage is a crucial part of the island's heritage as these laborers have an important story which has yet to be told. While this project utilized GIS mapping in depth to explore themes of design and placement, more exact analyses can be conducted on weapon ranges taking into account the starting height of the cannon, which could increase weapon range and accuracy. Finally, a more in-depth study into the life of the soldiers would reveal a large amount behind the human aspect of these fortifications. Most accounts of the soldier's lives were written by officers, planters, and the governors of the island, not the soldiers themselves. There is still much that is left unsaid about how the soldiers lived their daily lives and survived on the island. While the historical documents do not mention it, there is also the possibility of a slave militia serving in the defense of the colony as well. All of these topics are important points which can be built upon to further the understanding of the fortifications and the culture surrounding them. Much of this work will be continued in the upcoming summer of 2014, as the primary researcher of this project will return to the fortifications for more in-depth research as a part of a Master's thesis. However, more work in this area is encouraged in order to better preserve the island's heritage and recover the story of the past.

Beyond Nevis, this project also demonstrates the advantages of using geographic information systems technology to analyze archaeological sites in the Caribbean. As discussed earlier in this project, many of the sites in the Caribbean have not been fully explored, much less analyzed. As a result, there are several aspects of the region's history which remain poorly understood. Applying the methods of this analysis to the region's other archaeological sites, both historic and prehistoric, would produce data not normally collected through the average archaeological excavation.

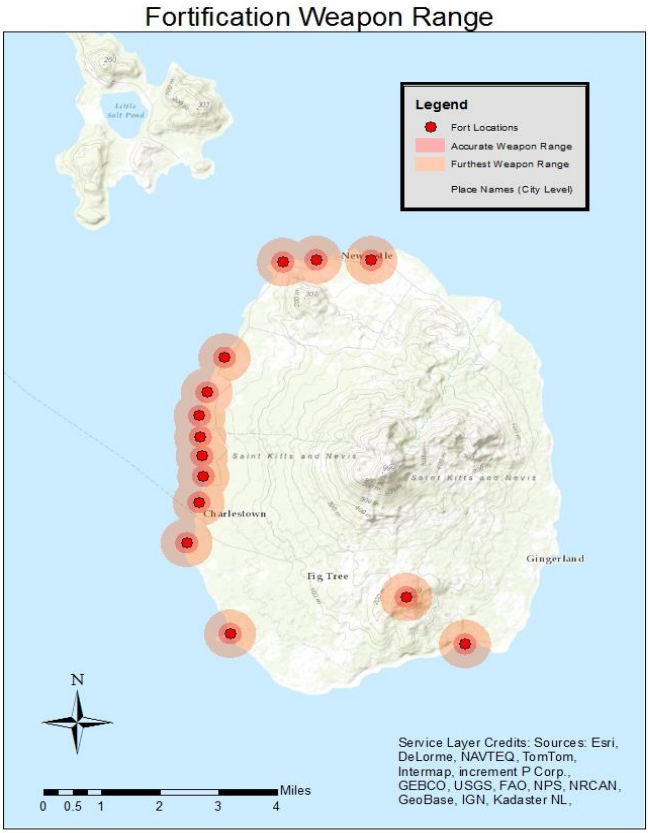
Georeferencing old colonial maps on top of more accurate modern maps could provide archaeologists and historians the general locations of long lost historical sites. Buffer analyses could be used with other fortifications in the region to calculate weapon ranges and defensive capabilities of those positions. Viewshed analyses can be used in both military and plantation sites to provide a better understanding of what was visible from the areas during the times of their occupation. Much of the history of the region remains unexplored, but, through the application of these spatial analyses along with historical documentation, the Caribbean's heritage can be fully recorded and understood, allowing the present and future generations to interpret and learn from our ancestors.

Map Appendix

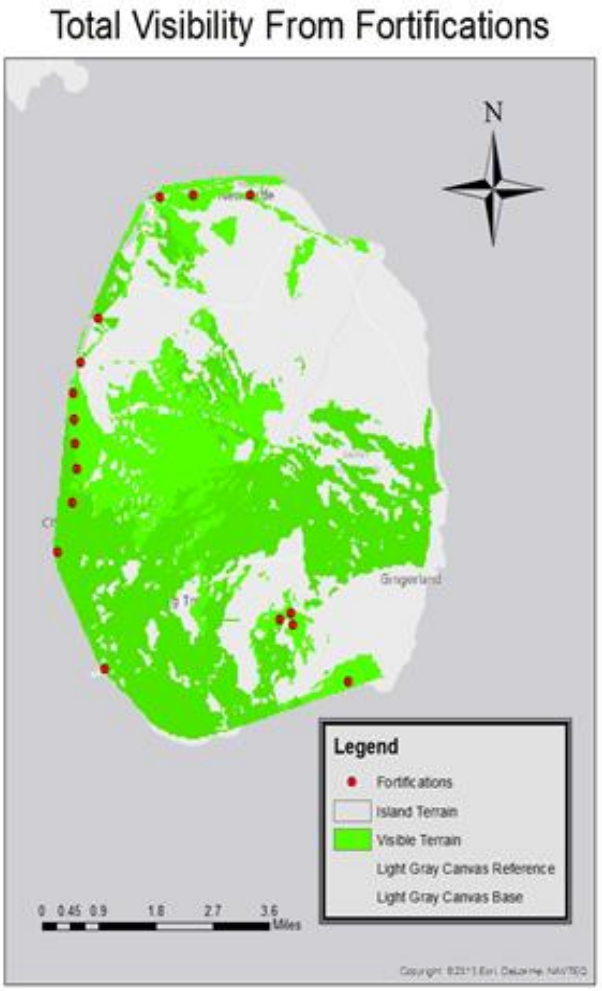
Map 1: This map was provided my Tessa Machling in her work *Protected Interests?* and shows the location of each fortification on the island of Nevis.



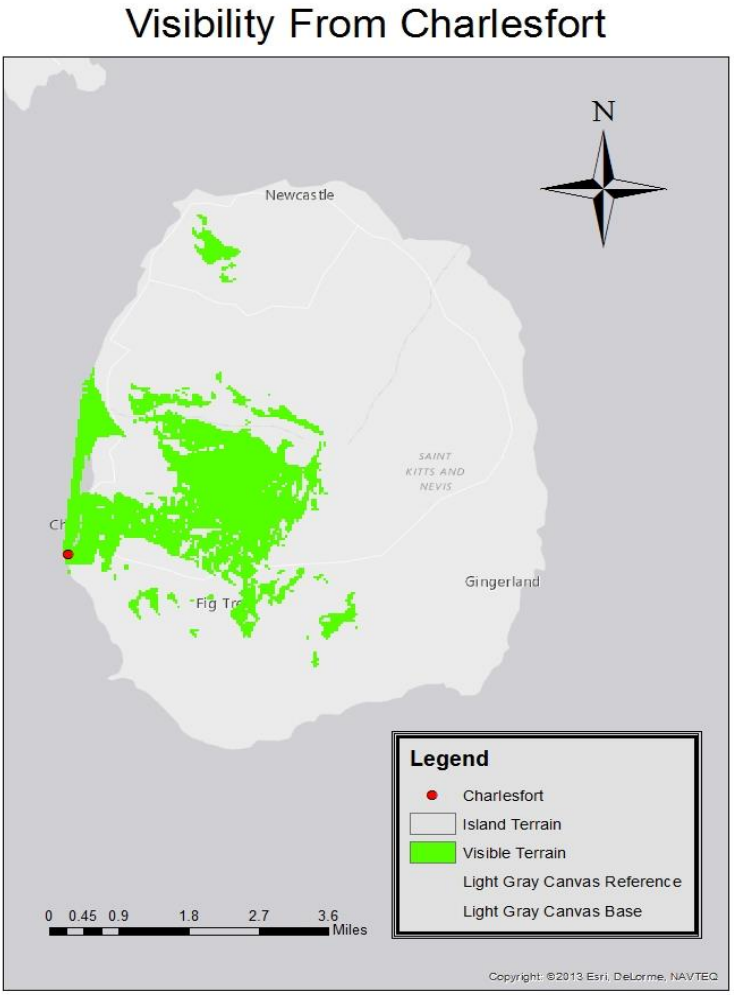
Map 2: This map displays the weapon ranges of each fortification. The average cannon range at the time was about 2500 feet with accurate fire, displayed in darker red, being about 1200 feet.



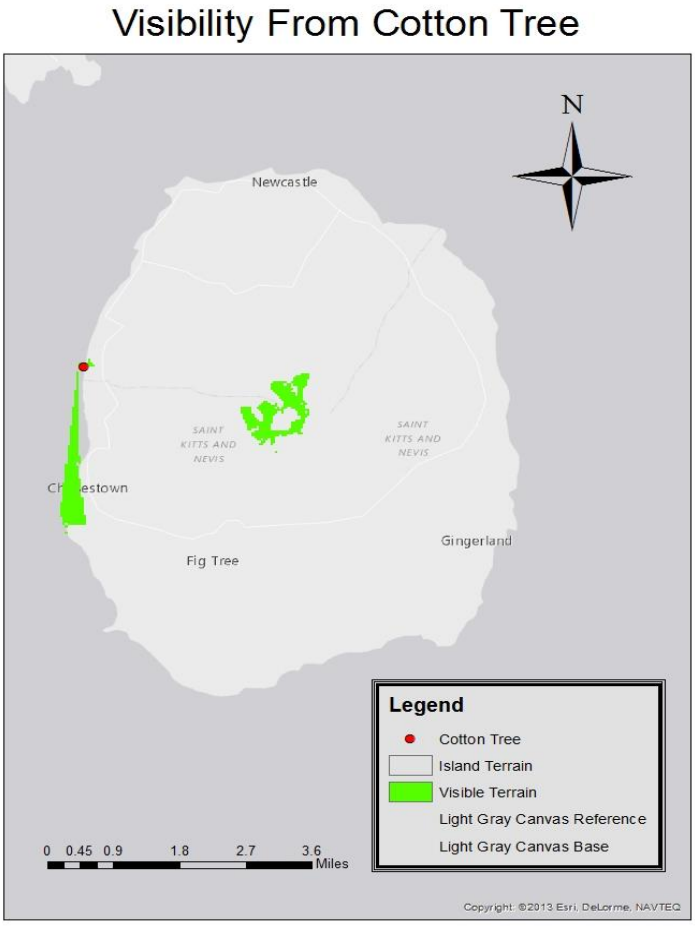
Map 3: This map displays the total visibility of the island from the fortifications. Any area in green is visible from one of the fourteen defensive positions on the island.



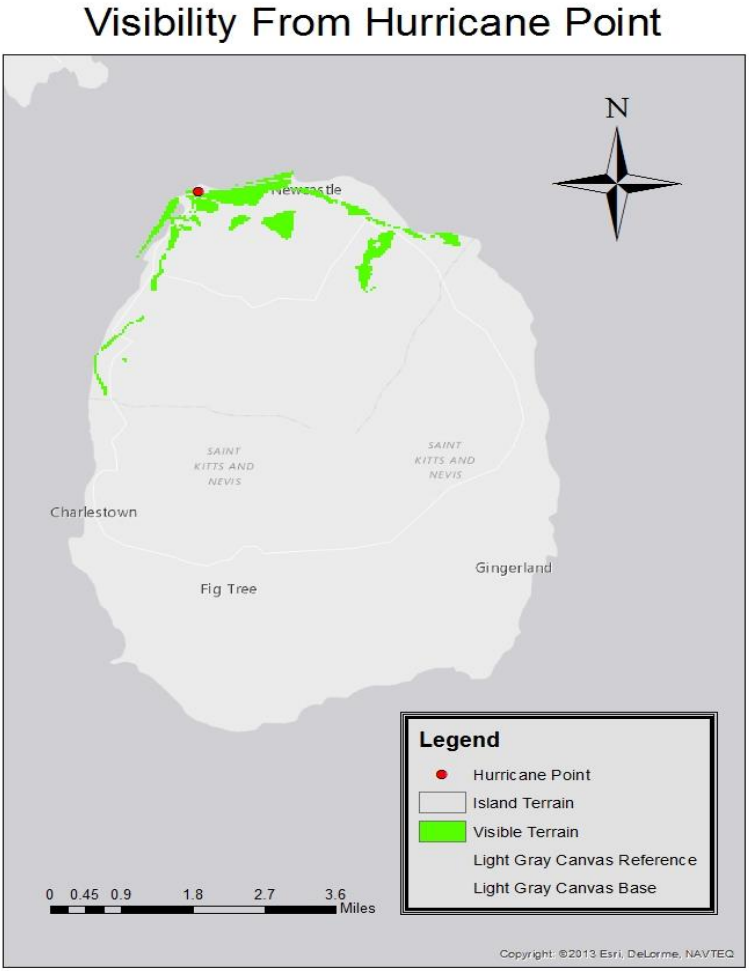
Map 4A: This map displays the total visible area from Fort Charles.



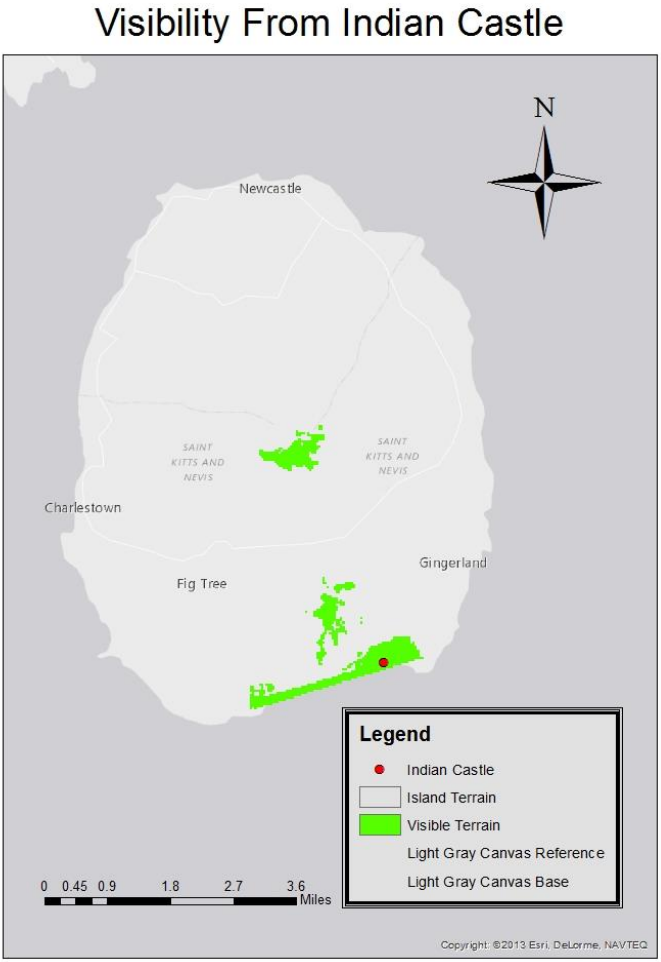
Map 4B: This map displays the total visible area from the Cotton Tree artillery battery.



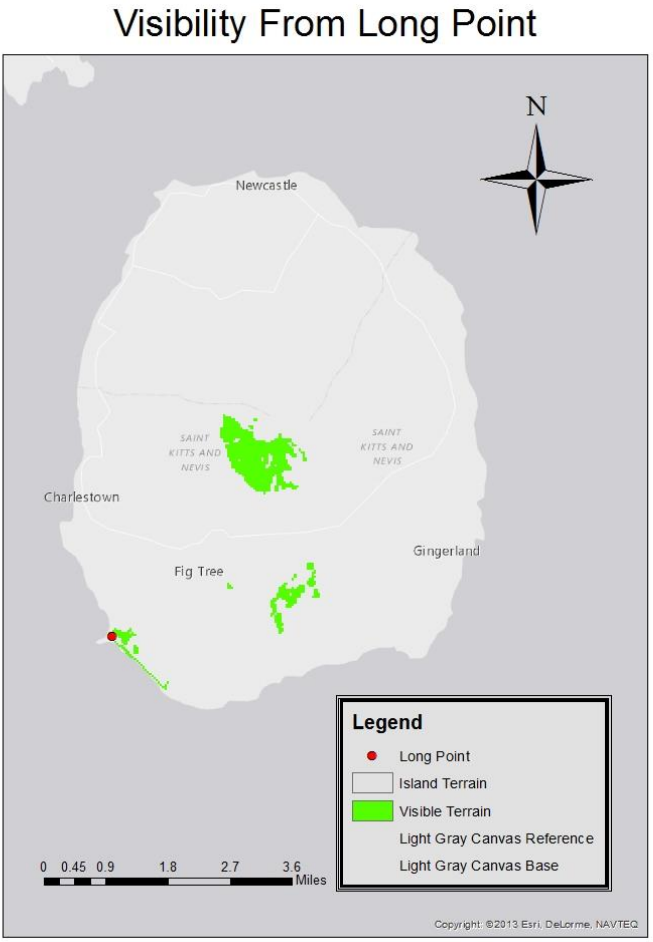
Map 4C: This map displays the total area visible from the coastal artillery position at Hurricane Point.



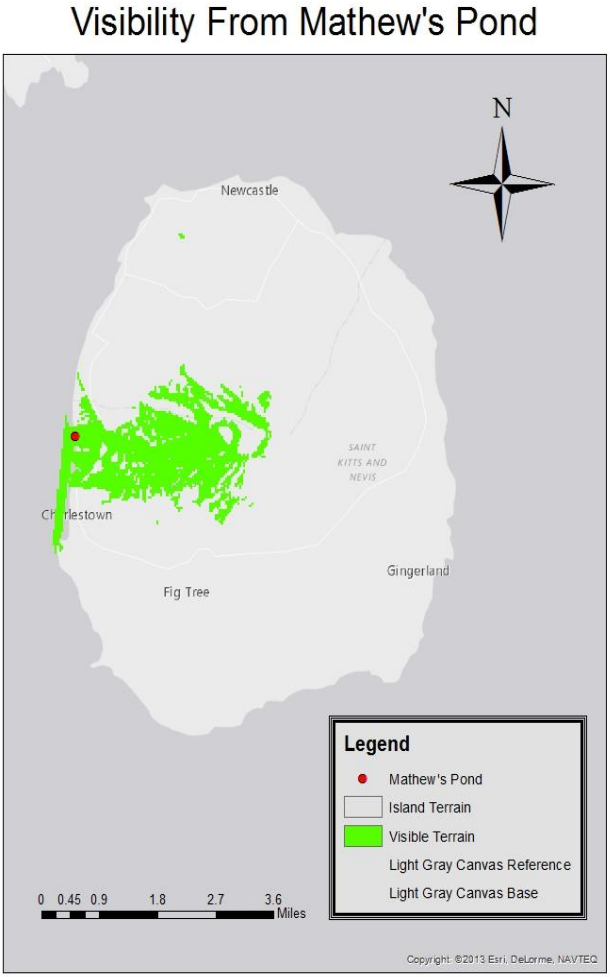
Map 4D: This map displays the total visible area from the Indian Castle artillery battery.



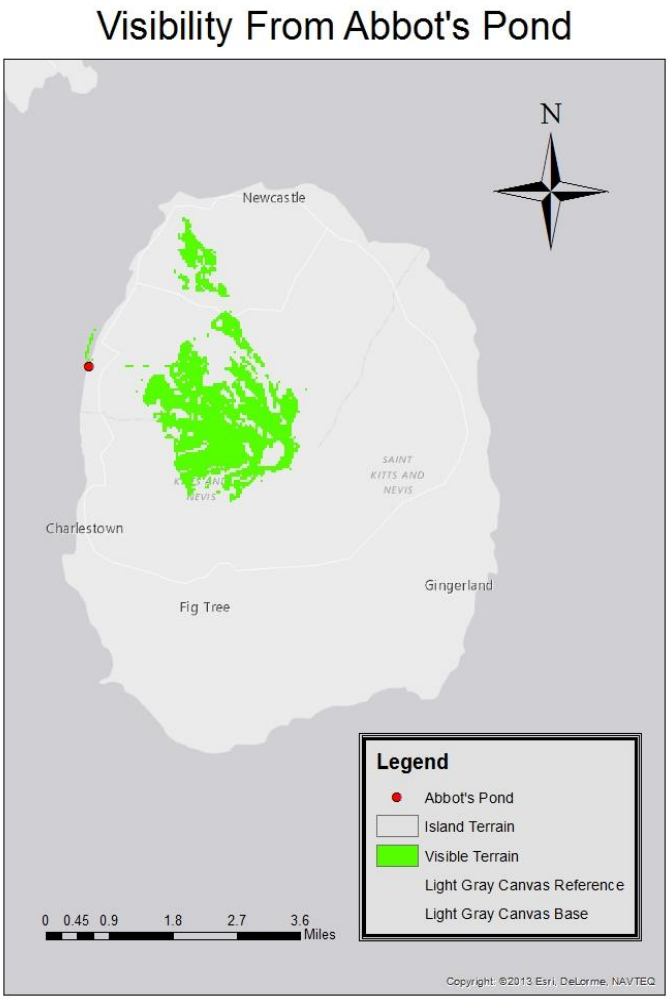
Map 4E: This map displays the total visible area from the Long Point artillery battery.



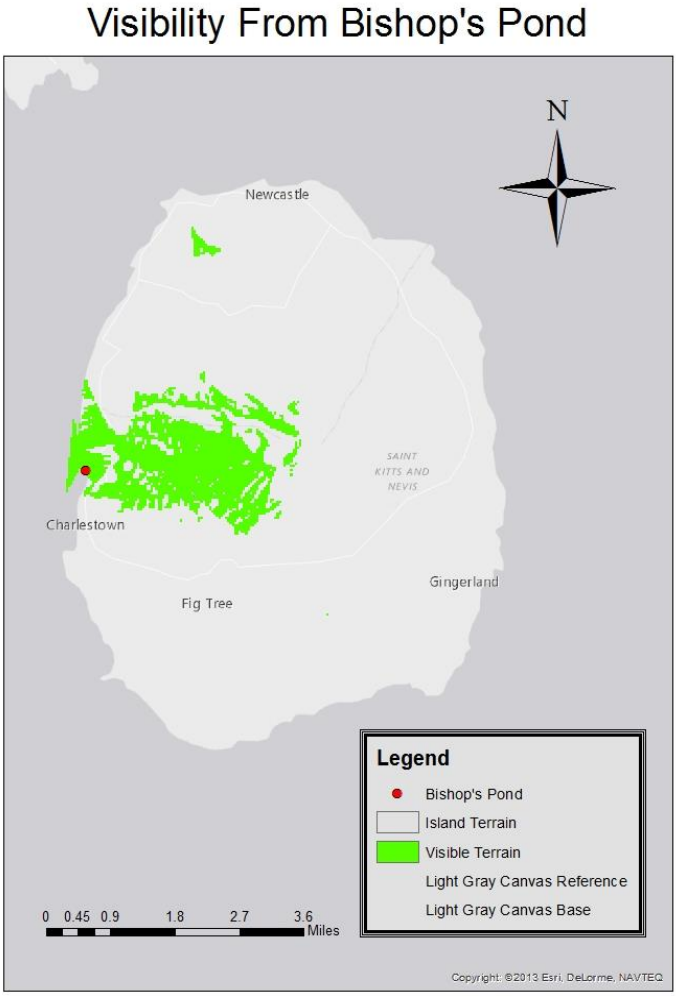
Map 4F: This map displays the total visible area from the artillery battery at Mathew's Pond.



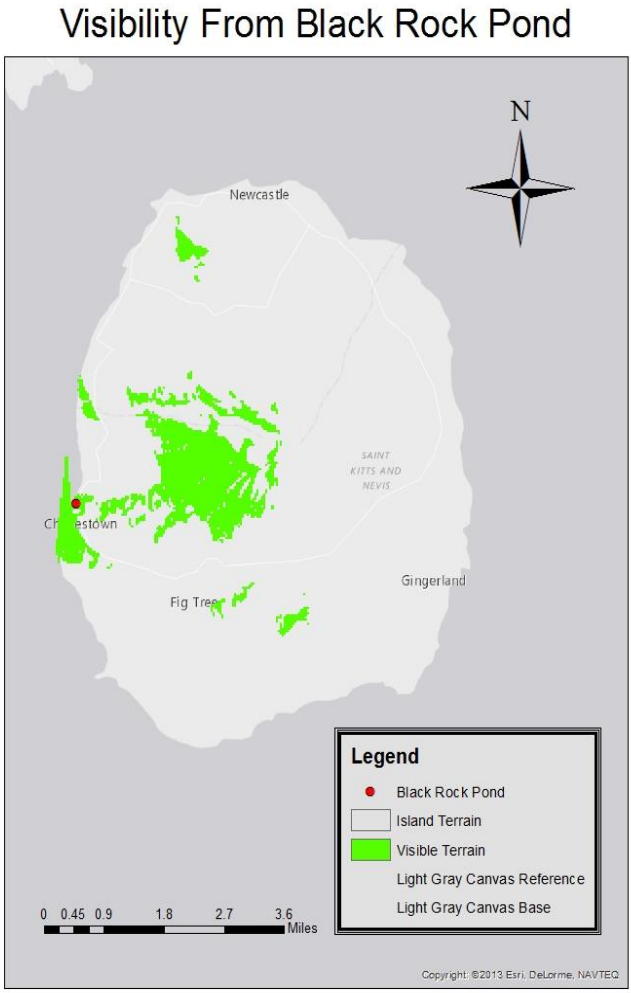
Map 4G: This map displays the total visible area from the artillery battery at Abbot's Pond.



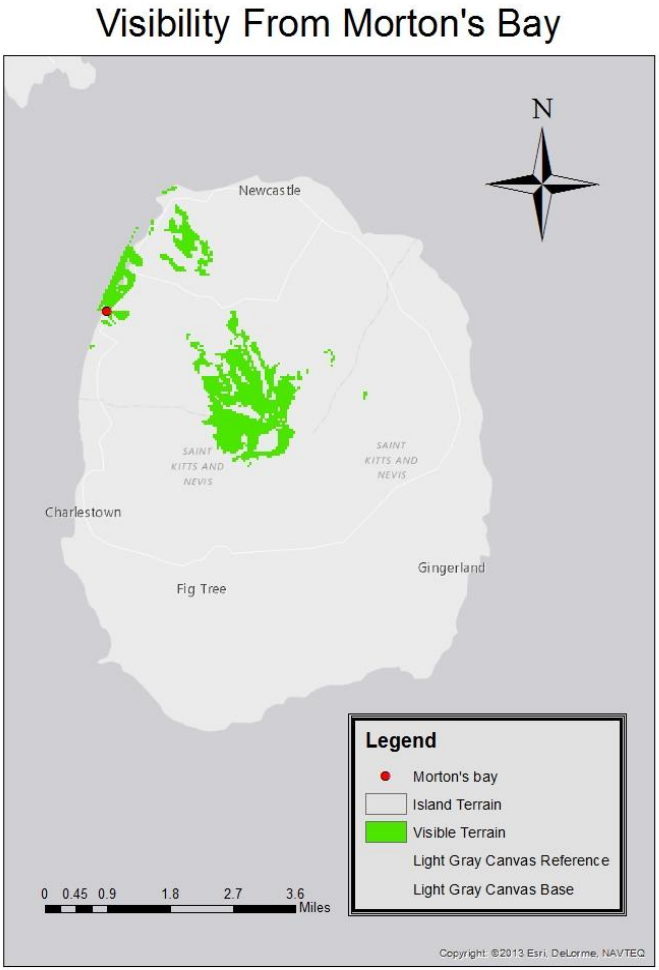
Map 4H: This map displays the total visible area from the artillery battery at Bishop's Pond



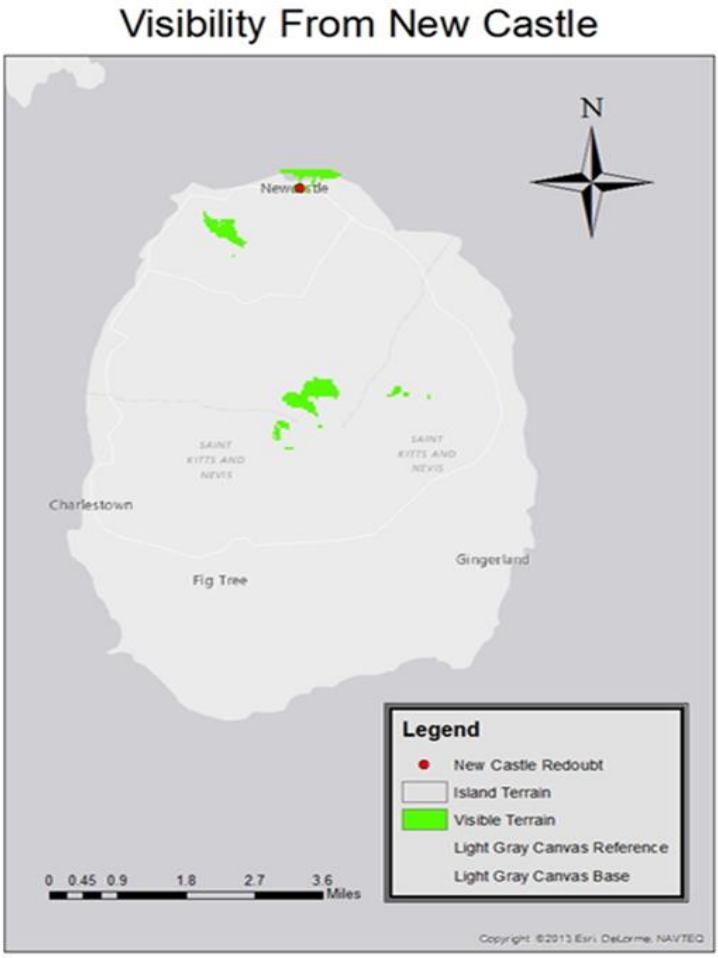
Map 4I: This map displays the total visible area from the defensive position at Black Rock Pond.



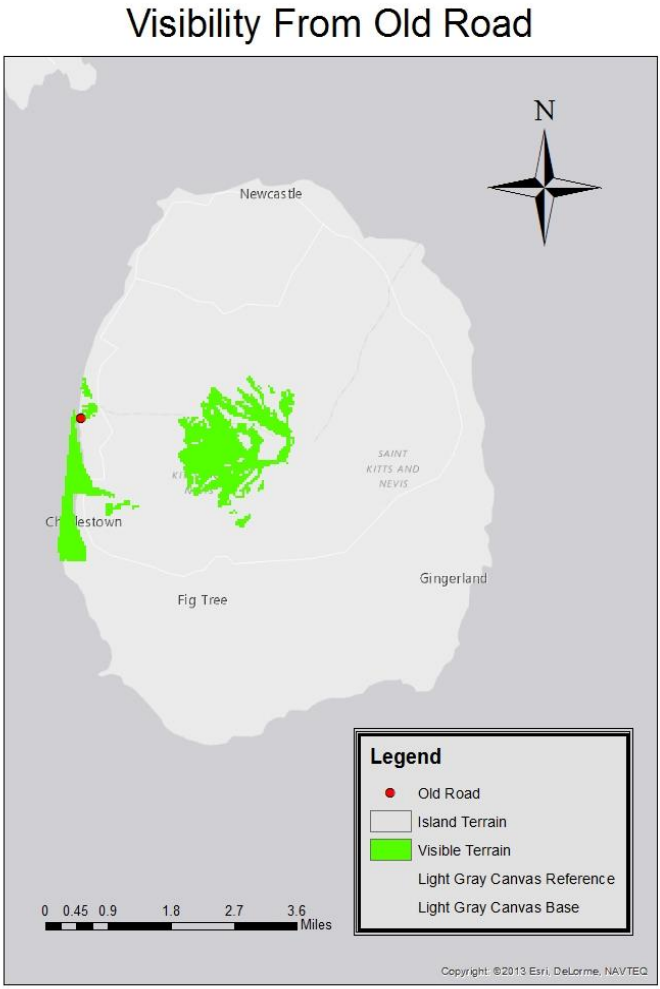
Map 4J: This map displays the total visible area from the artillery battery at Morton's Bay.



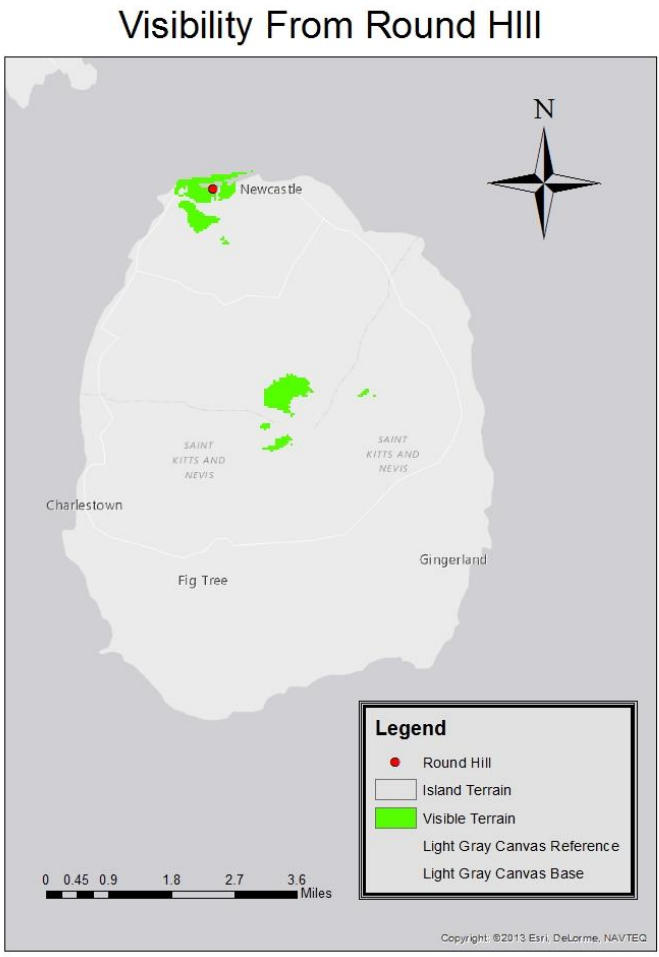
Map 4K: This map displays the total visible area from the New Castle Redoubt .



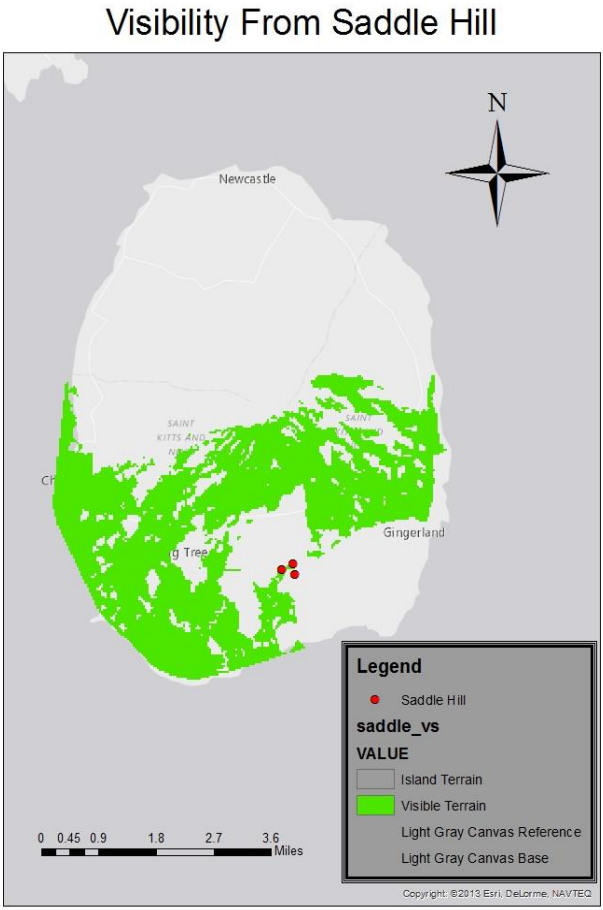
Map 4L: This map displays the total visible area from the Old Road artillery battery.



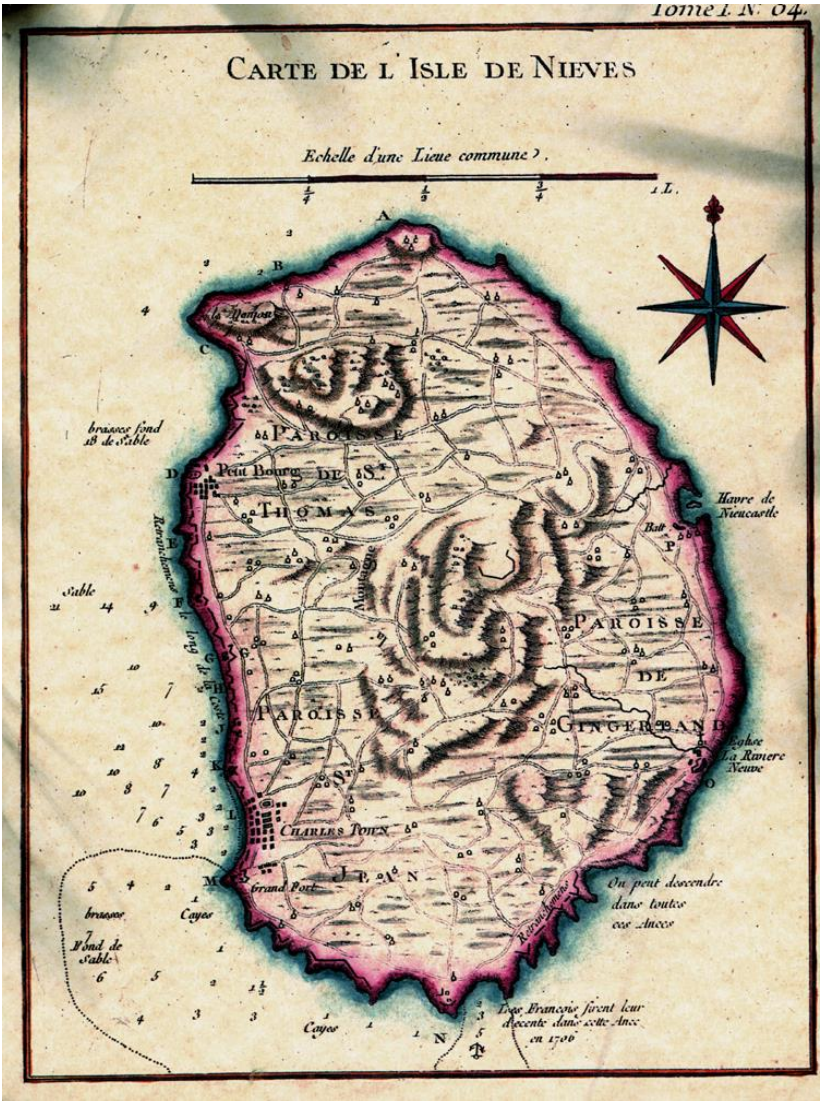
Map 4M: This map displays the total visible area from the artillery battery at Round Hill



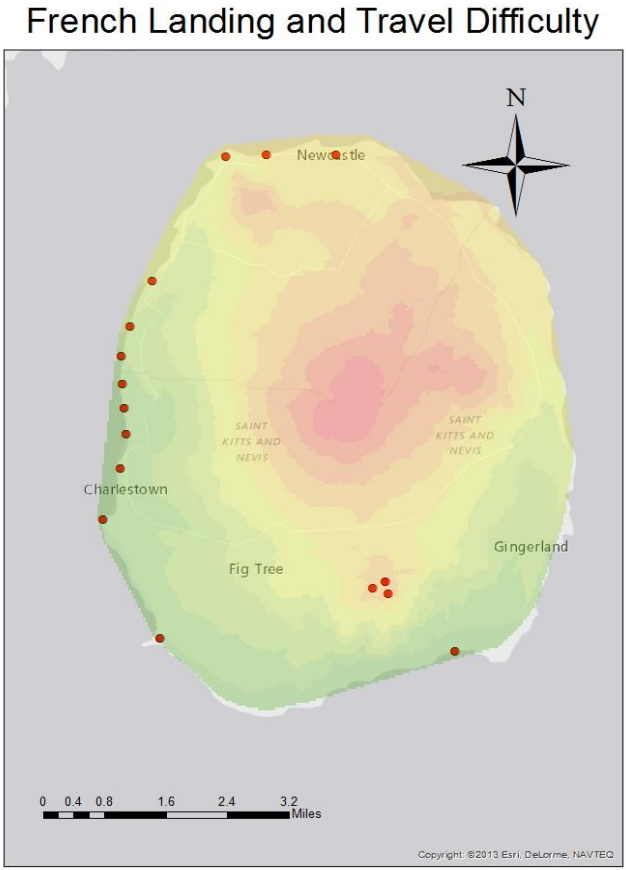
Map 4N: This map displays the total visible area from the three hilltops of Saddle Hill. While the artillery battery was built on the southern slope, sentries would have been on each hilltop.



Map 5: Provided by Machling, this French map of the island of Nevis details the 1706 landing area of the French army which captured Nevis.



Map 6: Utilizing the French map provided by Machling, this cost-distance analysis displays the travel difficulties encountered by the French army moving across Nevisian landscape. Greener areas would have been reached quickly with relative ease while red areas were difficult to reach and required hours of travel



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Influencing Environmental Sustainability through Graphic Design

Senior Honors Thesis: Graphic Design
Olivia Greco

G.R.I.D.

Graphic design is an outlet to engage others in change through visual communication, and it is a tool for social innovation, specifically in promoting a new understanding of sustainability. Through the following series of designed materials, I created a system of visual learning that promotes environmental sustainability within a small, connected community: Monmouth University's campus. The series is appropriately named "G.R.I.D.," standing for "Green Resources in Design." I began with a series name, logo, typefaces and color palette to set the groundwork for my visual series and executed the system in two parts. First, a three-part poster series that illustrates through information graphics the ways in which Monmouth currently addresses environmental sustainability, and how it could be addressed in the future. Second, I have created a packaging component that could be used to directly engage students, faculty and staff in one of Monmouth's existing sustainability initiatives, the MU Community Garden.

Through this system of informational design and packaging materials, I hope to model a successful method of promoting social change. Executed through a multi-faceted campaign, G.R.I.D. uses tools in art and design to unite efforts for promoting sustainability and creates real, tangible solutions on a manageable scale.

G.R.I.D.

GREEN RESOURCES IN DESIGN

The word "grid" lends itself to graphic design as well as the environment. Defined as a structure made up of a series of intersecting curved guide lines, a grid structures design elements the same way that it structures a garden or solar panels. In design, a grid organizes graphic elements in relation to a page & other elements. It promotes consistency and organization. In terms of sustainability, "living off-the-grid" means living sustainably and independently of public systems. More literally, a grid lends itself visually to the shape and pattern of such objects as a grid garden or solar panel arrangement.

I chose to use G.R.I.D. as an acronym to explain its relevance and connection to the MU community as a series of Green Resources In Design.

Logo Design

The typeface used for G.R.I.D. is geometric, minimalistic, bold

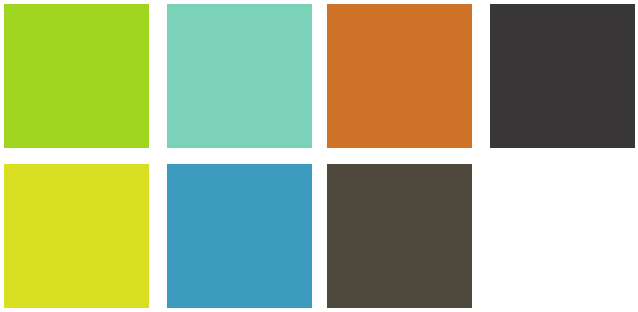
And influenced by technology.

QUICKSANDQUICKSANDQUICKSANDQUICKSAND

The typeface “Quicksand” was used for all other typesetting. Quicksand is a sans serif type family with three weights and a dash version for headings. It is influenced by popular early 1900s geometric-style sans serif typefaces based on geometric forms and is legible and friendly.

Color Palette

I created the master palette of muted, yet energizing colors to reflect elements of nature and to create a consistent, engaging mood for the following pieces. I utilized levels of transparency to add variation without losing consistency throughout the series.

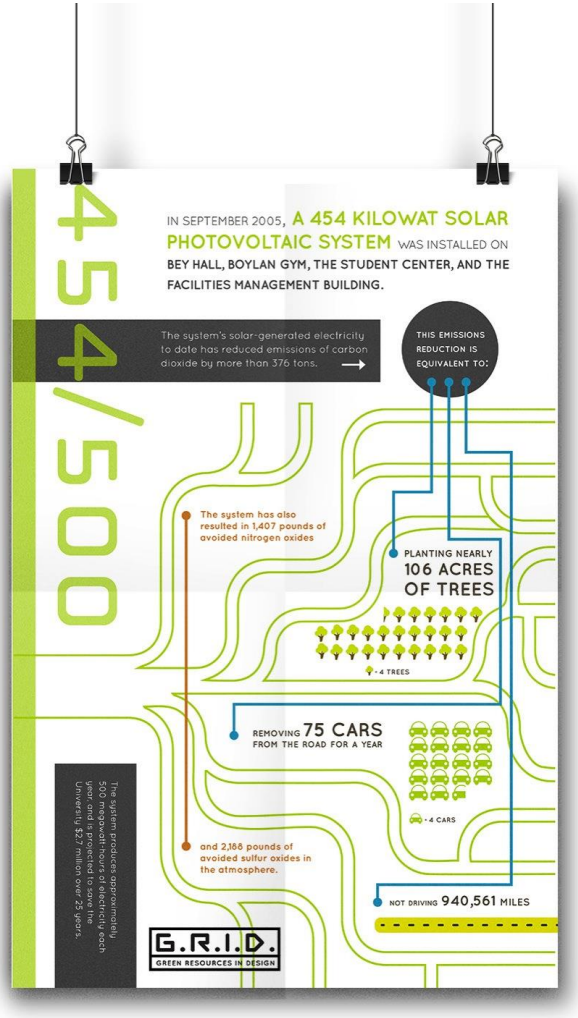


Poster Series

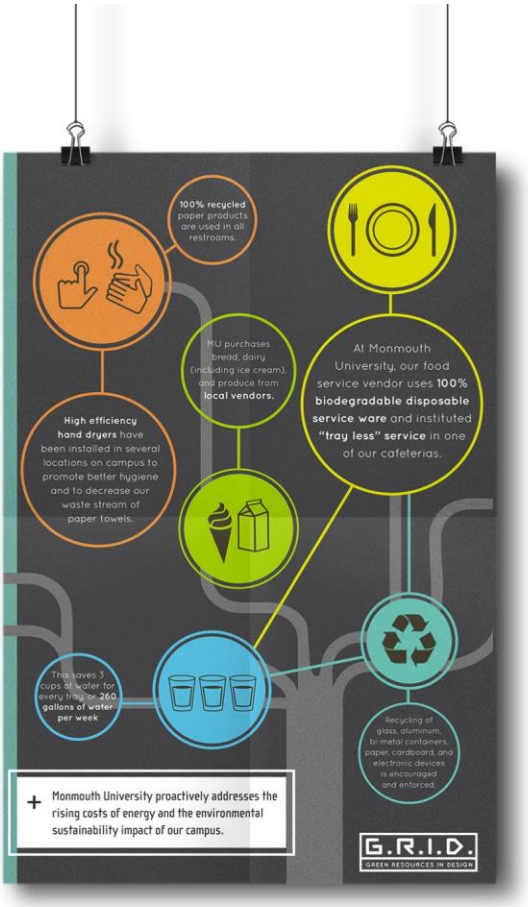
MU Green Energy
Adobe Illustrator
Through information graphics, this poster illustrates the ways that Monmouth addresses energy use by highlighting the installation of solar panels on four main buildings on campus. Symbols and icons are used in numerical equivalents to explain the effects and savings of the solar panels.

MU Waste
Adobe Illustrator
Similarly, this poster illustrates the ways that Monmouth addresses the rising costs of energy and the environmental sustainability impact of our campus. Through infographics and icons, I have communicated existing efforts on campus that address waste management and sustainability, specifically in food and water supply and paper use, and visually draw connections between these initiatives.

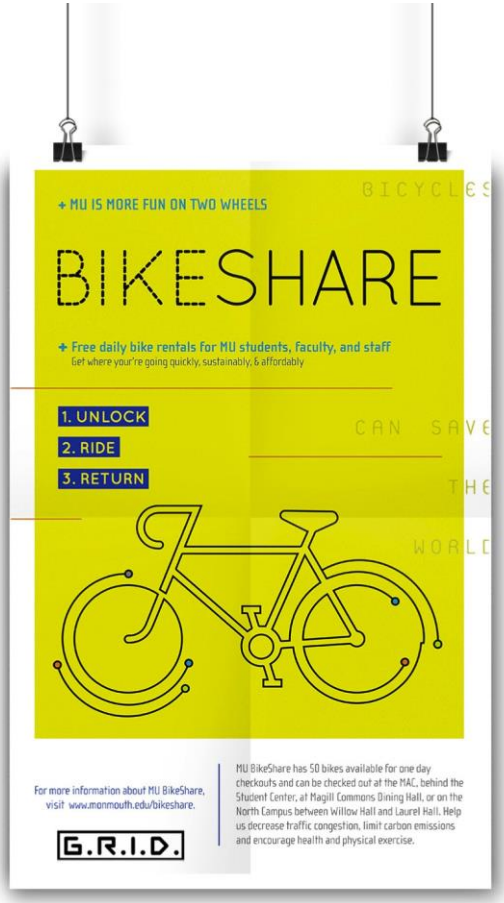
MU Bike Share
Adobe Illustrator
This poster introduces a new concept. Here, I created a poster promoting a campus bike share that students, faculty and staff could utilize on and around campus. Instead of driving from the library to Bey Hall, participants could unlock and ride a bike on campus to reduce traffic as well as carbon emissions in the immediate area.



MU Green Energy
Adobe Illustrator



MU Waste
Adobe Illustrator



MU Bike Share
Adobe Illustrator

MU Harvest
Packaging Design

I wanted to continue promoting existing sustainability initiatives at Monmouth by re-designing and rebranding The Monmouth University community garden. The MUCG is an incredible resource that we have, and most of the information is accessible through their website. The website has all necessary information, but is not highly not visible to students unless they are actively looking for it. I wanted to put the community garden in the hands of our campus community by re-designing resources and information to make signing up and getting involved easy, engaging, and fun.

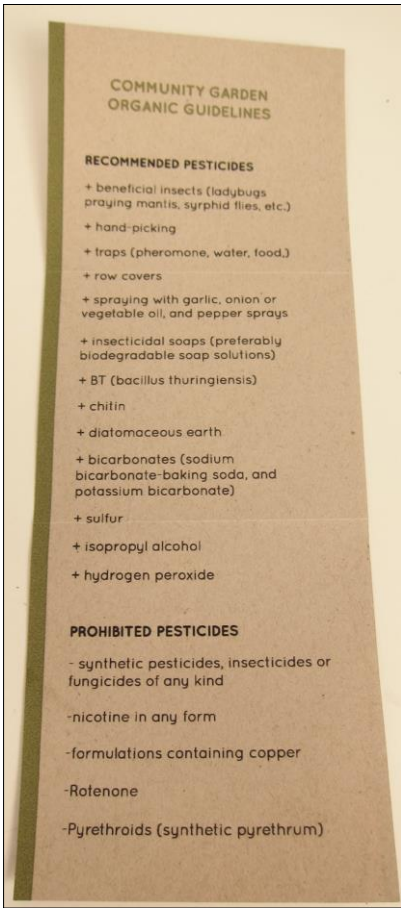
I re-branded the community garden as "MU Harvest," and created an all-inclusive package to help new gardeners get off to a good start.

MU Harvest
Package Design
This custom-designed packaging contains two main components: a seed pod containing starter seeds to begin a plot in the community garden as well as a packet of instructions, guidelines, and list of best practices.

MU Harvest: seed packaging

Each biodegradable seed pod contains two organic seeds as well as organic compost. The front label shows contents description and labels the type of seed. The front flap lifts up to reveal specific growing information about the plant: size, hardiness, sun and water needs, days to germination.

MU Harvest: instructions packet
Resting in the packet under the seed pod is a packet of instructions. Printed inside of the folded envelope is the mission statement of MU's community garden as well as tips to get started and general rules of the garden.



COMMUNITY GARDEN
ORGANIC GUIDELINES

RECOMMENDED PESTICIDES

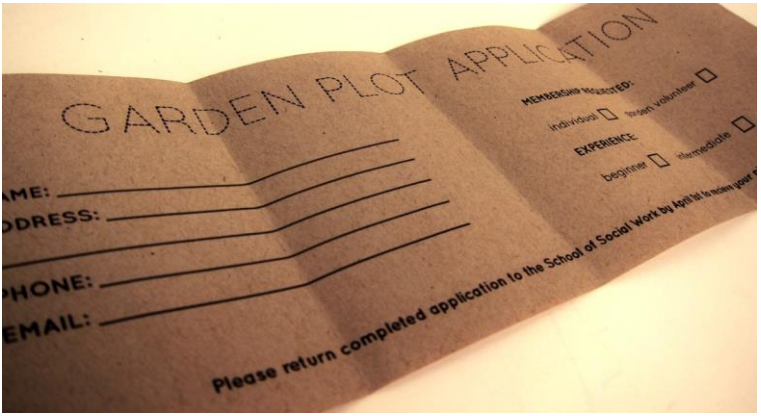
+ beneficial insects (ladybugs praying mantis, syrphid flies, etc.)
+ hand-picking
+ traps (pheromone, water, food,)
+ row covers
+ spraying with garlic, onion or vegetable oil, and pepper sprays
+ insecticidal soaps (preferably biodegradable soap solutions)
+ BT (bacillus thuringiensis)
+ chitin
+ diatomaceous earth
+ bicarbonates (sodium bicarbonate-baking soda, and potassium bicarbonate)
+ sulfur
+ isopropyl alcohol
+ hydrogen peroxide

PROHIBITED PESTICIDES

- synthetic pesticides, insecticides or fungicides of any kind
-nicotine in any form
-formulations containing copper
-Rotenone
-Pyrethroids (synthetic pyrethrum)

MU Harvest: recommended and prohibited pesticides and fertilizers

Included in the envelope is a double - sided insert listing recommended and prohibited pesticides and fertilizers to be used in the garden.



MU Harvest: plot application
The redesigned plot application consolidates information and is easy to fill-out and understand.

MU Harvest: Paper Use

A large part of this process was researching the most sustainable paper choices to use in my designs. All materials were printed on recycled, Environment Grade uncoated paper by Neenah paper company. Neenah's environment grade paper is made from fibers sourced using sustainable practices that are local to the manufacturing facilities.

MU Harvest: reusable bag

For the final packaging component, I moved away from the computer to screen print by hand reusable bags with the Grid logo design. Starting with a canvas bag, I hand-cut a stencil of the Grid logo design and used an aluminum screen printing screen and water-soluble ink to transfer the design onto the bag.

The future of G.R.I.D.

G.R.I.D. models a designed system that could feasibly be adopted on a small scale to influence environmental consciousness and an understanding of sustainability. This project is not only an exploration of my interest in graphic design, packaging design and branding but an extension of my interest in environmental sustainability and my desire to influence change as an artist. I designed this system with the Monmouth University community in mind, but it creates a basis for engaging groups of individuals on a small scale to encourage systems-based thinking.

The G.R.I.D. series can be viewed at www.oliviagreco.com/grid.