Echoes of the Hidden Graveyard: An Archaeological Reconnaissance Survey of Main Duck Island

A Thesis Submitted to the Committee of Graduate Studies in Partial Fulfillment of the requirements of the Degree of Master of Arts in the Faculty of Arts and Science

Trent University

Peterborough, Ontario, Canada

Anthropology M. A. Graduate Program

January 2026

Abstract

Echoes of the Hidden Graveyard: An Archaeological Reconnaissance Survey of Main Duck Island

Emmanuel Nii Amui Amui

This study explores the connection between the historical occurrences and the landscape changes on Main Duck Island, located at the eastern end of Lake Ontario. This research is conceptualized within the framework of Maritime Cultural Landscapes (MCL) to understand the relationship between the landscape and Lake Ontario. To explore this relationship, the study integrates spatial and archaeological methods such as GIS-based paleoshoreline modeling to understand the landscape change over time, analysis of air photographs, visibility analysis (viewshed) to understand island mobility, archaeological reconnaissance survey to discover and rediscover archaeological sites on the island, and ceramic analysis of surface finds to identify decorative motifs to establish cross cultural similarities between finds on mainland Canada and New York. This study is significant in contextualizing historical events such as Indigenous and non-Indigenous migration with landscape changes and archaeological data. Ultimately, the study corroborates past environmental conditions that have influenced the island's morphology with contemporary ones.

Keywords: Island Archaeology, Maritime Cultural Landscapes, GIS (Geographic Information Systems), Paleoshoreline Modelling, Viewshed Analysis, Archaeological Reconnaissance survey.

Acknowledgements

First, I would like to thank God for giving me the strength and perseverance to complete this work. I would like to sincerely thank my supervisor, Professor James Conolly. Your guidance has shaped this thesis and my academic experience. Special thanks for the biggest life jacket you provided during the trip to Main Duck. I also want to thank my committee members, Professor Gyles Iannone and Professor Jennifer Moore, for their insightful comments and review of the scope of this thesis. I am grateful to the Mohawks of Tyendinaga and the Mohawks of the Bay of Quinte for allowing the crew on their territory. I also appreciate Parks Canada for providing the permit to visit and conduct the reconnaissance survey on Main Duck. I want to thank the School of Graduate Studies for the International Graduate Scholarship Award. I am also grateful to the Department of Anthropology for the expert advice from faculty members, resources provided, and the funding I received. The seminars from the first year provided a firm foundation in the Anthropology Graduate Program. I would also like to thank Kate Hodge at Trent's Map, Data, and Government Information Center (MaDGIC) for the helpful session on understanding maps in GIS. To the 2023 Anthropology Graduate Program cohort, I would like to thank you for the kind words of encouragement and fun times during these two years. Indeed, I was not alone in this. Finally, I would like to thank my family for supporting me throughout this process and accommodating my annoying complaints. Your support and encouragement helped me complete this thesis.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AD	-	Anno Domini
BP	-	Before Present
DEM	-	Digital Elevation Model
DSM	-	Digital Surface Model
DTM	-	Digital Terrain Model
EODMS	-	Earth Observation Data Management System
ESRI	-	Environmental Systems Research Institute
GIS	-	Geographic Information System
LiDAR	-	Light Detection and Ranging
MaDGIC	-	Maps, Data and Government Information Centre
MASL	-	Meters Above Sea Level
MCL	-	Maritime Cultural Landscape
NAPL	-	National Air Photo Library
NOAA	-	National Oceanic and Atmospheric Administration
TBDEM	-	Topo Bathymetric Digital Elevation Model
UTM	-	Universal Transverse Mercator
WWII	-	World War II

Chapter 1: Goals and Objectives

1.1 Introduction

This research integrates geomorphological, environmental, and archaeological evidence to develop an understanding of the long-term history of Main Duck Island in Lake Ontario (Fig. 1.1). It does this from the perspective of maritime cultural landscape theory to contextualize the information within the broader patterns of interaction between communities facilitated by the island's maritime setting. This introductory chapter provides a comprehensive overview of the thesis, including the research context, aim, anticipated outcomes, and chapter organization.

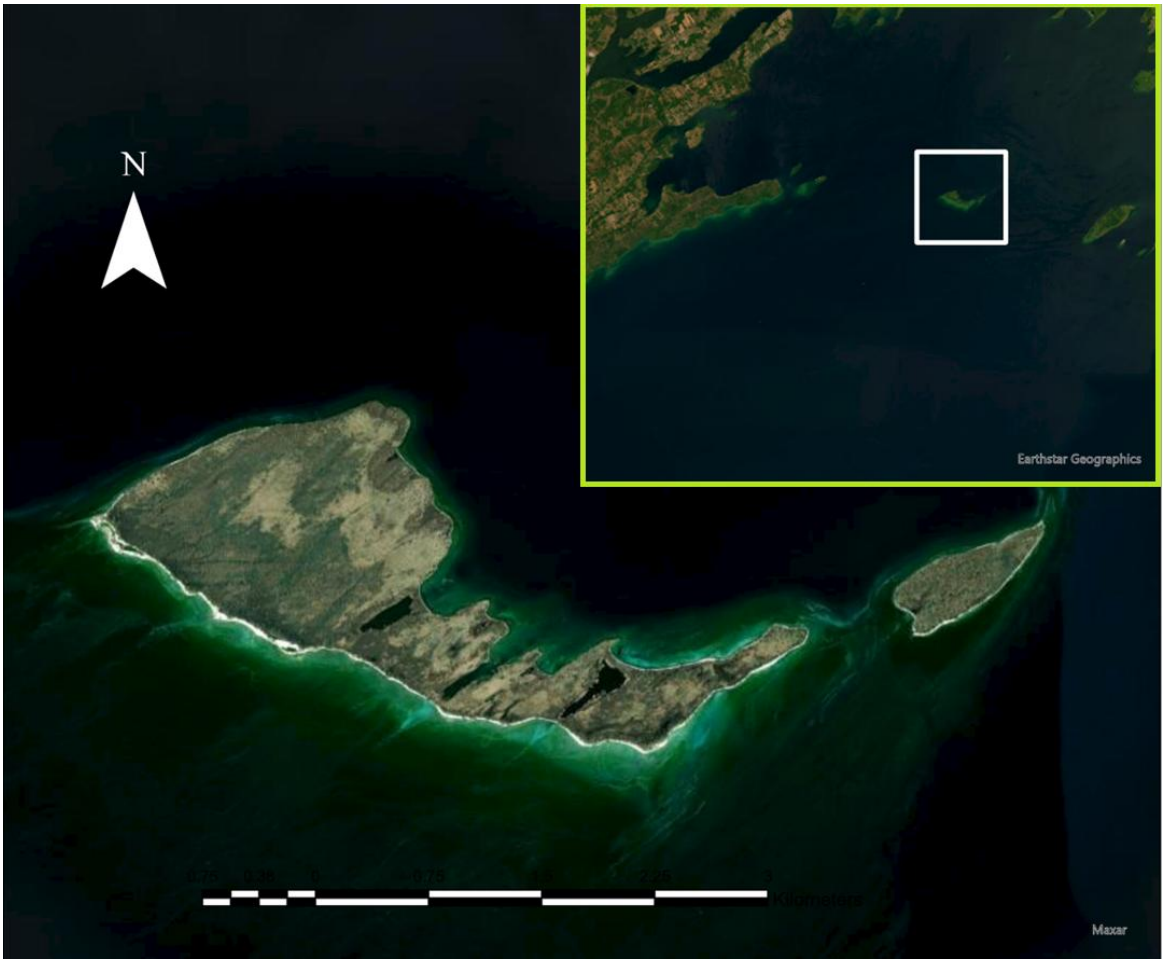

Figure 1.1 Satellite View of Main Duck Island.

1.2 Background to the Research Area

Main Duck Island is located in the eastern part of Lake Ontario. The island forms part of a cluster of islands near the Canadian border (Fig. 1.2) (Parks Canada Agency, 2013). The cluster of islands in this region includes those falling within the territories of both Canada and the United States of America. These islands include False Duck Island, Yorkshire Island, part of Prince Edward's County, and Wapoos Island, all located within Canada, and Little Galloo Island and Stony Island in the United States of America (USA). First Nations Peoples, especially the Mississaugas of Alnwick, are associated with the island in historical documents (Naval Marine Archives, 2016; Parks Canada, 2013; Simpson, 1953). The island is also tied to the historical narratives of Canada as a strategic naval location in British-French and British-United States conflicts, as well as an important timber and fishing location in the nineteenth century (Naval Marines Archive, 2016).

This research employed an interdisciplinary approach, integrating various fields of study to examine the island's history within the context of maritime cultural landscape theory. The research addresses the island's use by Indigenous communities from the perspective of island archaeology and visual connectivity. It incorporates a reconnaissance survey to build an understanding of known archaeological sites. In addition, it considers the island's geological history and formation processes.

1.3 Research Context

This thesis reviews and applies the framework of maritime cultural landscape theory to examine how the island's past inhabitants have been part of wider social, economic, and political relationships that extended between the northern and southern

shores of Lake Ontario. Currently, Main Duck is home only to wildlife, including various land and water snakes, and migratory birds. The island is uninhabited by humans and forms part of the St. Lawrence Island National Oar of Canada. The island is managed by Thousand Islands National Park and is classified as Zone 1. Zone 1, special preservation areas, is considered too sensitive to the development of extensive facilities. Hence, preservation is the primary management consideration (Parks Canada, 2022) (Fig. 1.3).

Figure 1.2 Old Photograph of the East End of Lake Ontario in 1815, Showing the Cluster of Islands in the Main Duck Region (From Melish, 2023).

Figure 1.3 Non-Venomous Snakes Beneath Rocks on Main Duck Island (From WomBom, 2010).

Oral accounts and historical literature provide information about the communities and types of cultural activities on this island. Various groups, including First Nations peoples, Euro-Canadian and American smugglers, fisherfolk, and, most recently, the Government of Canada, have utilized the island for different purposes (Parks Canada, 2013). This thesis thus adopts a long-term perspective, well-suited to archaeological data, that begins with Main Duck's formation, its intensive use as a strategic locale for a historical fishing community, and continues through to its contemporary role as a recreational destination and nature sanctuary within Parks Canada.

The long-term approach adopted in this research offers a perspective that views the island as dynamic and evolving, partly due to long-term environmental

changes and partly due to recent anthropogenic forces. Long-term change is impactful, as during a post-glacial low stand at 10,500 years BP, Lake Ontario's water level was approximately 50 meters lower than it is today (Anderson & Lewis, 2012). During this period, until approximately 7,000 cal BP, Main Duck was the central and highest portion of a land bridge connecting Prince Edward County to Cape Vincent. Inundation of the bridge began after 7,000 years BP and continued until the island's modern shorelines formed by approximately 5,000 cal BP (Anderson & Lewis, 2012). More recent observations yielded conflicting measurements of the total land area of Main Duck, which appear to result from changes in lake levels over the last 200 years. This has impacted the lower-lying areas of the island's topography (Fig. 1.4 and 1.5) (Naval Marines Archives, 2016; Parks Canada, 2013; Zerbisias, 2011), meaning the complexity of the shoreline configuration and its impact even on more recent human settlements needs to be considered. In recent years, deforestation for timber and agriculture, as well as industrial-scale fisheries and fish-processing facilities, have had a dramatic impact on the island's landscapes.

In addition to geological change, this thesis focuses on two aspects of the island's archaeological and historical past. First, archaeological data may have been lost due to submersion or erosion resulting from both ancient and more recent fluctuations in lake levels. Therefore, this thesis models the formation of the island's shorelines by considering the history of Lake Ontario's water levels over the last 10,000 years. Second, this thesis examines the existing terrestrial record and presents the results of a reconnaissance survey to identify and map archaeological sites located near the lake's shoreline. This research provides a chronologically and culturally precise inventory of both Indigenous and Euro-Canadian/American sites for addressing the more recent history of human use of the island.

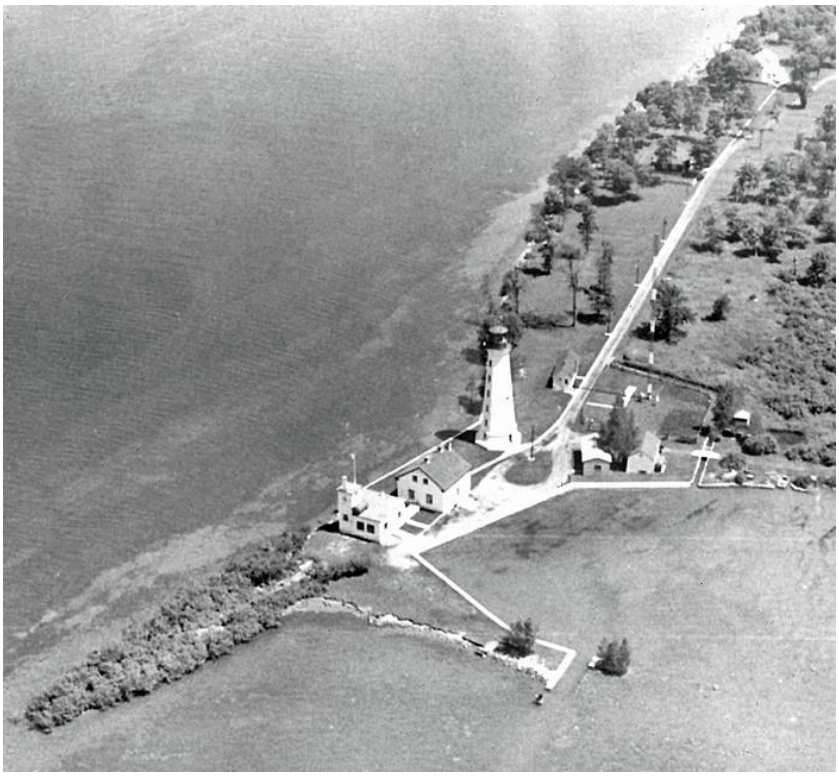

Figure 1.4 Aerial Photograph of the Light House Station Building in 1930, North-Western End of Main Duck Island (From Lighthouse Friends, n/d).

Figure 1.5 Aerial Photograph of Light House Station in 2019, North-Western End of Main Duck Island (From Lighthouse Friends, n/d).

1.4 Research Aims and Outcomes

In addition to the broader long-term perspective on the island's human history and its relationship to broader cultural context, this research also aims (a) to create a set of maps at specific time slices illustrating the location of submerged shorelines, and use these to predict locations for future underwater survey; (b) to use GIS methods to establish the visual relationships between adjacent islands and Main Duck to establish whether inter-visibility of islands and the mainland may have influenced accessibility and navigation decisions; and (c) to implement and report on the results of an archaeological reconnaissance survey to provide information about the use and role of the island in the more recent past.

The outcomes of the research are:

- An understanding of the formation of the island and the inundation of shorelines during the period 7,000 to 5,000 cal BP.
- An up-to-date inventory of archaeological sites on the island that informs understanding of the settlement, use, and importance of the island for both Indigenous and Euro-Canadian/American communities.
- An informed discussion about the island's importance in the broader context of Lake Ontario's human past, from the perspective of maritime cultural landscape theory.

1.5 Research Questions

The research addressed the following questions:

1. How did the Main Duck's formation and inundation of its shorelines shape the island's habitability, accessibility, and role within Lake Ontario's landscape?
2. What does the spatial and temporal distribution of archaeological sites reveal about settlement patterns and island use?
3. What does the integration of terrestrial and maritime evidence tell us about the broader regional interaction between the Sandbanks, Main Duck, and New York?

1.6 Research Approach

This study will employ a mixed-methods research approach. The mixed-methods approach utilizes both qualitative and quantitative research methods. Within the broader framework of maritime cultural landscape theory, which posits that water and water-based travel constitute an interactive medium rather than a barrier, this thesis seeks to understand how the communities on Main Duck were part of a larger cultural, economic, and political system. To do so requires information on the environmental and cultural history of the island from both a qualitative and quantitative perspective. Ground reconnaissance and aerial reconnaissance surveys will contribute to the qualitative perspective of this research. Further qualitative sources include historical photography and archival documents that record past human activities on Main Duck. The application of GIS will contribute to both quantitative and qualitative research. Quantitatively, it provides statistical data that could be measured and calculated (Esri, 2023). This includes shoreline history models and locational information about archaeological sites, as well as their relationship to environmental or natural factors (Hull, 2024).

Archaeological reconnaissance is a technique researchers use to systematically search, identify, and document potential archaeological sites. Through reconnaissance surveys, archaeologists can locate sites by examining surface scatters, distinctive surface indicators, and the landscape's features. Archaeologists can determine the boundaries of a site, identify areas with concentrated clusters of finds, and assess the relative distribution of archaeological materials within the site. Two reconnaissance methods will be used to undertake archaeological reconnaissance at Main Duck. These involve site visitation and the use of drones and satellite imagery to establish the situational context of sites and potential site areas. Visiting sites enables up-close distribution of cultural materials on the landscape (Fig. 1.6). This may be manifested through surface scatters of archaeological data or distinct features on the landscape.

Satellite and drone-based aerial reconnaissance enables the identification of archaeological sites from a distance above the ground (Fig. 1.7). Patterns on the ground are created through human activities that are not observable to the human eye due to their proximity to the ground. Through aerial reconnaissance surveys, archaeological sites can be revealed by identifying crop marks, earth marks, and soil marks (Paskey & Cisneros, 2020). Reconnaissance at Main Duck is used to contextualize archaeological sites from a distance, supplementing ground reconnaissance with different visual perspectives.

1.7 Ethical Considerations

Ethical considerations will be adhered to in this research. As required by the ethical requirements of anthropology and archaeology, permission and permits were obtained from Parks Canada, the custodian and national authority for archaeology on federal land in Canada, including Ontario. This institution holds the authority to issue

research permits before conducting any archaeological or anthropological research in the national park system. Permission was also sought through the Parks Canada consultation process from the Indigenous peoples within whose territory Main Duck is located, namely the Mohawk First Nation at Akwesasne.

Figure 1.6 Main Duck Archaeology Crew at the Opposite End of Schoolhouse Bay.

Figure 1.7 An Aerial Photograph of the Northern Coast of Main Duck Showing Duplex 1.

1.8 Organization of Chapters

The subsequent chapters of this thesis are structured as follows. Chapter 2 explains maritime cultural landscape (MCL) theory, which was used to study the maritime history of Main Duck and Lake Ontario. Chapter 3 examines the environmental and cultural background of Lake Ontario. Chapter 4 examines the environmental and cultural background of Main Duck Island and discusses Main Duck's archaeological and historical perspectives. Chapter 5 recaps the research questions and discusses the methods used to collect data for this study. Chapter 6 builds upon the data collected using the methods explained in Chapter 5, providing a detailed analysis and results of ground and aerial reconnaissance surveys, GIS modeling, and analysis of decorative motifs from mainland sites of similar age that can be compared to those recovered from Main Duck. Chapter 7 considers the observations and data collected from Main Duck in the context of the theoretical perspective presented in Chapter 2 on maritime cultural landscapes. Chapter 8 provides conclusions and recommendations for future work arising from the thesis.

Chapter 2: Background: Maritime Cultural Landscapes and Lake Ontario

2.1 Introduction

The purpose of this chapter is to establish the relevance of maritime cultural landscape (MCL) theory as a conceptual foundation for studying the maritime history of Main Duck Island and Lake Ontario. First, I provide a historical overview of the theory, outlining key contributions from scholars and methodological advancements that have shaped the discipline. I then examine the practical applications of MCL across diverse geographical and cultural contexts, demonstrating its utility for understanding maritime cultural heritage. The chapter further situates Lake Ontario within the MCL framework, discussing the natural and anthropogenic influences that have shaped its maritime landscape over time. Additionally, I highlight the Indigenous and colonial histories of the lake, emphasizing how human activities have transformed and interacted with the maritime environment

2.2 Maritime Cultural Landscapes (MCL)

2.2.1 MCL Concepts, History, and Definitions

The integration of environmental context into maritime archaeology began in the late 1970s with Keith Muckelroy's work, which emphasized the need to reflect on human interaction with maritime and terrestrial landscapes (Delgado, 2019). Christer Westerdahl first coined the theory of maritime cultural landscapes in the late 20th century during a maritime archaeological survey of the coast of Swedish Norrland between 1975 and 1980 (Westerdahl, 1978; 1980a, 1980b; 1991a). Westerdahl sought to understand the relationship between human societies and the marine environment (Benjamin et al., 2019; Biar, 2020; Ilves, 2004; Lehman, 2018; Stewart, 2007;

Westerdahl, 1992). Humans are social beings and interact with the environment both directly and indirectly. Westerdahl (1992) chose the term “maritime cultural landscapes” (MCL) because he wanted to collectively understand the “unity of the remnants of maritime culture on land as well as underwater” (Westerdahl, 1992, p. 5).

The importance of settling near maritime resources has been a recurring theme in human history. Westerdahl was concerned with the relationship between coastal terrestrial landscapes and the maritime environment, emphasizing the importance of water to the human community (Biar, 2020). Hence, there was a need for a term that captures the tangible and intangible relationships among humans, terrestrial landscapes, and the maritime environment. I use the term “tangible” to refer to cultural traits that are touchable, concrete, or physical. In contrast, intangible traits refer to non-physical aspects of culture that cannot be touched but shape cultural practices. Although intangible traits may be expressed through tangible materials, others may not leave tangible traces. Lofgren (1981) directly links the landscape to humans, introducing the term cognitive landscapes. Cognitive landscapes reveal the intangible and functional perspective ascribed to physical surroundings (Lofgren, 1981). When cognitive landscapes are incorporated into understanding the immediate coastal area, it is easier to visualize the spatial relationships and cultural significance of material data. It provides a comprehensive understanding of how historical events and natural phenomena have occurred (Lehman, 2018). Campbell shares a similar notion on cognitive landscapes. Cognitive landscapes are characterized by natural features, such as islands, wind, and water, as well as built features, including temples and other artificial structures. From these two features, mental maps and cultural functional aspects are created (Campbell, 2020).

Westerdahl (1992) explained the concept behind the MCL theory. It explores humans' relationship with the maritime environment and highlights the benefits humans derive from this natural resource. Overall, Westerdahl (2008) provides a simple expression that describes the relationship between the physical and cognitive landscapes to produce the cultural landscape of humans. This is represented by the concept of "Physical Landscape + Cognitive Landscape = Cultural Landscape" *(*Westerdahl, 2008, p. 213).

In summary, the theory and ideology of MCL may be applied to landscapes that have direct contact with seascapes or water resources. This theory's ideology concerns the interaction between humans and the natural maritime environment, which creates tangible and intangible culture. MCL may be characterized as a mid-level theory as it seeks to explain traits in a specific cultural context. In this regard, MCL attempts to explain the cultural landscapes in a coastal context. The primary objective is to understand how humans interact with maritime environments, and MCL may be applied across various contexts and geographic regions, as reviewed in the next section.

2.2.2 Application and Expectations of Maritime Cultural Landscapes

Maritime archaeology has evolved beyond the exclusive study of underwater archaeological data and now encompasses the contextualization of underwater sites with terrestrial data from coastal communities (Delgado, 2019; Westerdahl, 1992). Westerdahl (1992) argues that maritime cultural landscape theory focuses on the space between the maritime environment and the coastal landscape, thereby serving as a bridge between water and landscape. Hunter (1994) makes a case for incorporating

MCL more widely into maritime archaeology, postulating that the discipline "demonstrates that settlements situated along the coast and island shores are as maritime as they are terrestrial" (Hunter, 1994, p. 261). This means coastal areas cannot be adequately studied without taking into consideration the maritime environment. Ancient features on land were gradually incorporated into the intangible cultural heritage to support a deeper understanding of underwater sites. For example, the maritime investigation at the Akanthou site in Cyprus demonstrated a strong connection between the sea and the prehistoric settlers. The investigation unearthed tangible remains that shed light on trade, transport, and subsistence (Soyluoğlu, 2020). The author corroborated the tangible remains with the narratives through interviews. This led to the understanding of how the coastal area at Akanthou was used in the past.

An important application of MCL in African cultural perspectives is highlighted by Pollard (2017), who explains that interactions in the coastal Swahili states were crucial in shaping cultural identity. Pollard (2017) sought to determine when the Swahili state became a maritime society, as addressed in Elgidus Ichumbaki's reply to Fleisher et al. (2015). Fleisher et al. (2015) proposed that the Swahili coast's transformation into a maritime lifeway occurred in the early second millennium CE, based on long-distance eastern navigation that altered coral and lime architecture. However, Ichumbaki disagreed and argued that the notion is stunted and does not reflect the holistic interaction of the Swahili coast with the maritime environment, even on chronological grounds. He suggested that this interaction was more complex than it appeared, noting that the maritime cultural landscapes of the Swahili coast have evolved over time. The ancestors of the Swahili first appeared and settled along the coast around c. 30,000 BP (Pollard, 2017, p. 147). They then became

more pronounced in the second millennium. This resulted from the gradual direct and indirect contact between coastal and inland dwellers, contributing to the development of Swahili urbanism and maritime practices along the coast. Ichumbaki suggested that the relationship between the sea and the people was more complex (Ichumbaki & Polland, 2021), citing the development of traditional pottery because of interactions with world economies in the late first millennium CE. The concept of maritime cultural landscapes encompasses more than a sector of the people's culture (Pollard & Ichumbaki, 2021). Instead, it emphasizes the interconnectedness between maritime and terrestrial environments in the creation of culture. The application of MCL to African landscapes reveals the theory's limitations. This is because some African contexts have unpredictable environmental conditions and lack the institutional resources to undertake such research (Okonkwo, 2017).

Research by Stewart (2007) provides another perspective on the application of maritime cultural landscapes. This research was conducted across 17 seafaring centers in the United Kingdom and the United States. Stewart documented how maritime cultural landscapes unearth belief systems, as reflected in the memorials and monuments of Anglo-American mariners' gravestones in cemeteries from the 18th to 19th century. The study of memorials contributes to an understanding of belief systems and social relations, thereby advancing the primary goal of maritime cultural landscapes (Westerdahl, 1994). Stewart (2007) collected data on how these mariners were linked to the maritime environment through their memorial headstones. The memorials “speak the voices of seafaring communities, sailors, and maritime families whose professions included merchant shipping, naval seafaring, fishing, and whaling” (Stewart, 2007, p. 113). From these headstones, Stewart identified themes related to the Anglo-American lifestyle of the period. Dwelling more on individual memorials, it

was revealed that churches and cemeteries in coastal areas have been preferred as permanent resting places for mariners since the Middle Ages (Stewart, 2007). From these grave headstones, themes such as the dangers of the natural environment were reenacted in writing. These include sailors “lost at sea” (Stewart, 2007, p. 117), fear of sudden death (Stewart, 2007, p. 119), and the expression of religious sentimentality, which began in the mid-19th century (Stewart, 2007, p. 121). The memorial monuments erected by families of mariners went beyond representing their relationship with maritime landscapes. The headstones conveyed personal feelings, social relations, and belief systems associated with the mainland while at sea (Stewart, 2007, p. 123).

Another perspective from which maritime cultural landscapes can be understood is from the Western Arctic regions. Barr et al. (2016) conducted a study to search for whaling fleets submerged in 1871. Whaling was the focus of the north slope Inupiat culture (Jensen, 2012, p. 143). In efforts to locate the whaling fleets, primary accounts reported that environmental conditions trapped the ships (Barr et al., 2016). However, current climatic conditions have led to the melting of ice, exposing remote, submerged, and previously inaccessible sites. Archaeological research employed the theory of maritime cultural landscapes as the primary framework for locating the whaling fleet. This intangible cultural heritage was collected by the ONMS Maritime Heritage Program over 20 years to understand the significance of whaling and to identify additional wrecks associated with whaling along the shore (Barr et al., 2016, pp. 151-152).

Popta et al. (2018) published their research on the theory and practice of maritime cultural landscapes, conducted in the late medieval north-eastern Zuiderzee

region of the Netherlands, dating back to AD 1100-1400. The research, co-authored with Westerdahl, sought to understand how the physical environment, through various environmental conditions such as floods, rising sea levels, and erosion, altered and submerged the terrestrial and cultural landscapes of settlements in the area. The theory of maritime cultural landscapes was applied in this region because discussions on ships and shipwrecks were perceived as too narrow in scope. Hence, there was a need to involve shores, lakes, rivers, and terrestrial landscapes (Popta et al., 2018). The research was approached holistically, using the theory's cognitive and physical landscape approach. Manifestations of maritime cultural landscapes, in the form of maritime cultural centers such as harbors, coastal settlements, and seaports, were discovered in the northeastern Zuiderzee region (Popta et al., 2018).

Delgado (2024) sought to establish the national significance of the Blake Plateau, located off the southeastern coast of the United States from the shoreline of North Carolina to Florida, by examining known and suspected maritime sites. The primary theory used in this study was maritime cultural landscapes, specifically the creation of cultural landscapes by establishing the link between natural areas and human activities. A typical example of the relationship between people, the land, and the maritime environment is the spiritual and mental connection the Native Gullah have to the Sea Islands. The relationship between the Gullah, the sea islands, and the Blake Plateau was emphasized through "annual rituals and offerings to their ancestors" on the Atlantic coast (Delgado, 2024, p. 3). The Gullah settled in the coastal area and sea island region, just miles away from the plateau. Delgado (2024) also documented the relationship between the coastal Gulf Stream and external contacts. These contacts include Spanish, French, Dutch, and English. Using maritime cultural landscapes, the activities on land were linked to those in the maritime

environment, resulting in the development of maritime culture. These included trade at the ports, settlement, forced migration (enslavement), and warfare.

2.3. Conclusions

Maritime cultural landscape theory provides a set of guiding principles for examining the relationship between humans and water in the context of Lake Ontario, particularly regarding the subject matter of Main Duck Island. The three insights from MCL that guide this thesis are:

1. Maritime and terrestrial landscapes are integrated and not separate entities.

2. Maritime landscapes are dynamic.

3. Maritime environments have cultural meanings.

MCL elucidates the social dimensions and ideologies underlying the erosion and flooding of communities. It helps inform better choices regarding marine environments to avoid submerging sites. Technologically, the interaction between the land and sea opens up a deeper conversation about the relevance of underwater archaeology and the integration of multidisciplinary approaches to understanding the land and water. Conceptually, MCL redefines how we ought to approach cultural heritage in relation to maritime environments. It enables us to understand that land and water have an ongoing relationship that may be differently experienced. It helps decolonize the field by advocating an approach that equitably represents marginalized groups and prioritizes their voices. Understanding the interconnectedness of submerged maritime and terrestrial environments is the backbone on which this thesis stands. It shows a transdisciplinary and ontological approach to bridging the gap

between these two entities (tangible and intangible heritage). It adds to and provides a more comprehensive, evidence-based account of how prehistoric and historic events have shaped Main Duck's landscape.

In conclusion, maritime cultural landscapes are applied differently in various contexts. The above are just a few examples of contexts in which MCL was used. Diverse jurisdictions may have a far more intimate relationship with maritime landscapes than others. However, a similar ideology or notion exists across these geographical contexts: the understanding and preservation of the relationship between societies, past and present, and maritime environments.

Chapter 3: Lake Ontario Environmental and Cultural History

3.1 Environmental Background of Lake Ontario

Lake Ontario is one of North America's five Great Lakes. With a surface area of 19,000 km², it is the fifth largest of the Great Lakes and currently ranks 13th among the world's largest lakes (United States Environmental Protection Agency (EPA), 2011). Lake Ontario watershed covers 82,990 km², and its "bedrock consists mainly of Palaeozoic sedimentary bedrock formation, including sub-glacial and glacial lake sediments" (Anderson & Lewis, 2012, p. 514). However, the depth and elevation of the water level are uneven. This is caused by the uneven deposition of silt, clay, and sandy coastal sediments supplied through erosion and the transportation of these deposits by the lake's current (Anderson & Lewis, 2012). The geomorphological history of Lake Ontario is critical to this research because the water levels since the late glacial period mean that the islands (as high points on the Duck-Galloo Ridge) have been both connected to the mainland and underwater at differing periods over the last 12,000 years. Lake Ontario has been shaped by geological, ecological, and anthropogenic factors (Assani et al., 2016; Dreimanis, 1977; Guiry et al., 2020; Waldman et al., 2009).

Lake Ontario has seen significant shoreline evolution due to isostatic rebound and changes in the outflow locations (Anderson & Lewis, 2012; O'Shea & Meadows, 2009). Following the Late Glacial Maximum at approximately 18,000 cal BP, melting of ice led to the emergence of pro-glacial waterbodies with high stands many meters above the current Great Lakes. Glacial Lake Iroquois encompassed both Lake Ontario and Rice Lake, with shorelines tens of kilometres inland from where they currently sit (Fig. 3.1).

Lake Ontario and Lake Erie were “separated until approximately 11,800 years ago, when the Niagara River Formed” (Hoffman et al., 2018, p. 83). By about 10,500 cal BP, following the retreat of the ice sheet north, draining through the Ottawa River shifted the flow away from the St Lawrence, leading to the creation, by about 9,500 cal BP, of a Lake Ontario low stand. After this date, inflow from the upper lakes into Lake Erie and thence into Lake Ontario started rising water levels, which led to the submerging of archaeological sites on the coast (Halligan, 2011, p. 45).

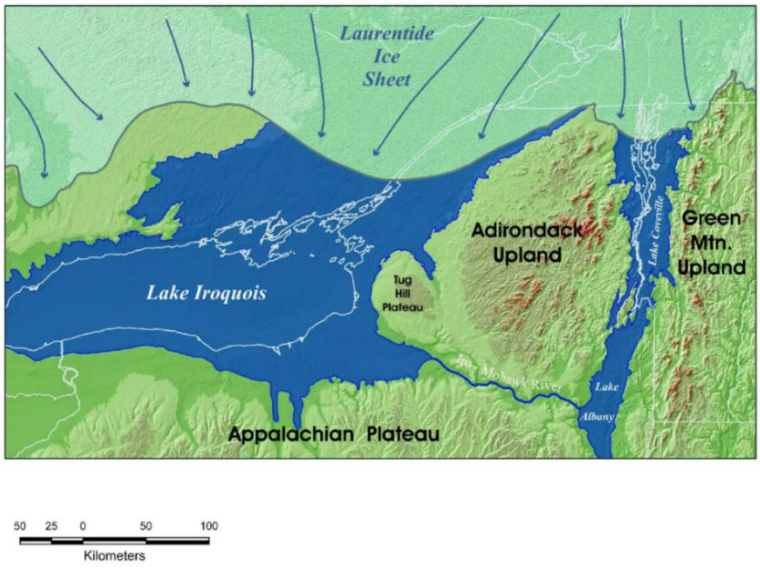

Figure 3. 1 Lake Iroquois Encompasses Lake Ontario and Rice Lake with Ice Sheets to the North (From Franzi, n.d).

It is worth noting that although Anderson and Lewis (2012) argue that Lake Ontario's water level stabilized about 3700 years ago, it still fluctuates. The US Army Corps of Engineers (2024) has monitored Lake Ontario’s water level fluctuations from 1918 to 2024 (Fig. 3.2). According to them, the Long-Term Average Annual water level was between 74.50 and 75 meters (Fig. 3.3) (US Army Corps of Engineers, 2024).

Prior to European settlement, the region of Lake Ontario was “deglaciated, with dense forest and clear streams” (Waldman et al. 2009, p. 1194). Lake Ontario's landscape underwent drastic changes when Europeans settled there. According to them, these changes included deforestation, drainage of swamps, construction, and agricultural development.

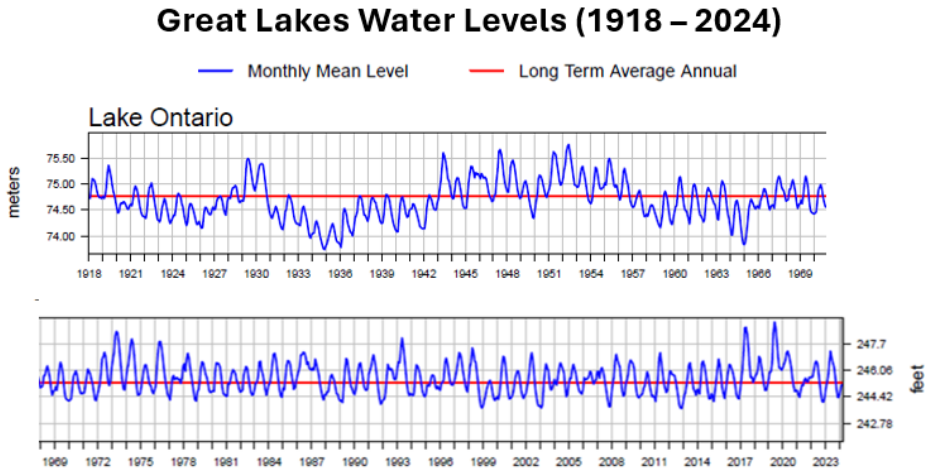

Figure 3. 2 Lake Ontario Water level (1918 – 2024) (From US Army Corps of Engineers Detroit District, 2024).

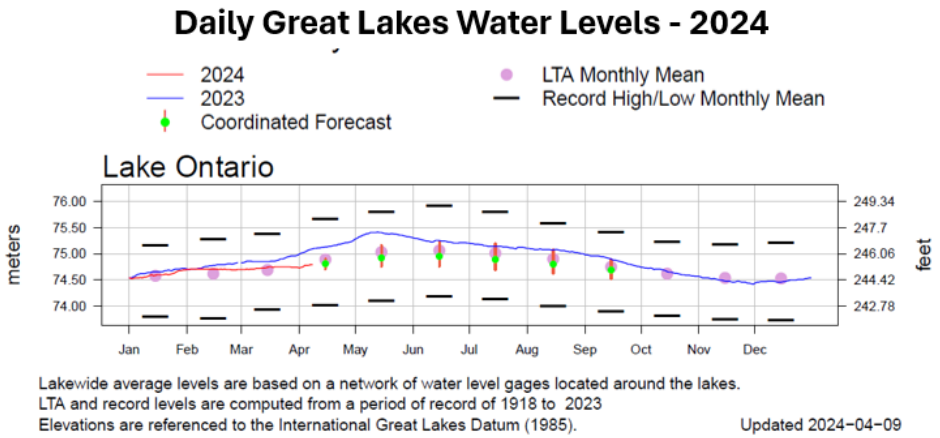

Figure 3. 3 Monthly Water Level of Lake Ontario for 2024 (From US Army Corps of Engineers Detroit District, 2024).

From about 9,500 cal BP, water inflow from the upper lakes via Lake Erie and the Niagara River increased water depth on the eastern part of Lake Ontario, where Main Duck Island is found (Anderson & Lewis, 2012). This eventually flooded the land in the Kingston Basin and led to the creation of Main Duck Island by about 7,500 cal BP (Anderson & Lewis, 2012; Estepp & Reavie, 2015). The depth and shoreline history change using spill heights calculated in calibrated years until the early 21st century. They incorporated the use of isostatic rebound models to understand how ice blocking of the St. Lawrence River Valley led to the overflow of the southeastern part of Lake Ontario (Anderson & Lewis, 2012). Anderson and Lewis's diagram portray the elevation of Lake Ontario between 14,000 years (cal BP) and the present day (Fig. 3.4). They incorporated a post-glacial uplift (Rebound response) model to achieve the diagram shown in Figure 3.5. It is worth noting that Lake Ontario's history is deeply rooted in the ecological, geographical, and anthropogenic activities that have shaped it since its formation. For instance, Eshenroder (2014) and Hoffman et al. (2018) note that the natural one-way barrier of Niagara Falls that blocked Lake Ontario’s connection to the other Great Lakes was breached by the creation of the Welland Canal in 1829. The theory of maritime cultural landscapes situates this history within a context where understanding how these three major factors interact can reveal these historical narratives.

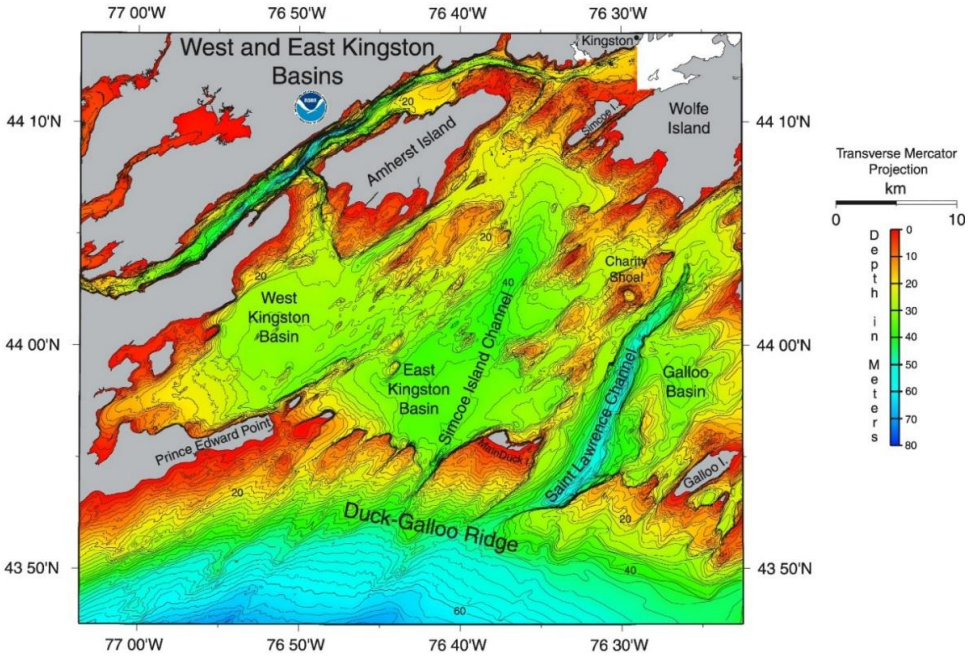

Figure 3. 4 Bathymetric Map of Eastern Lake Ontario (From NOAA, N/D).

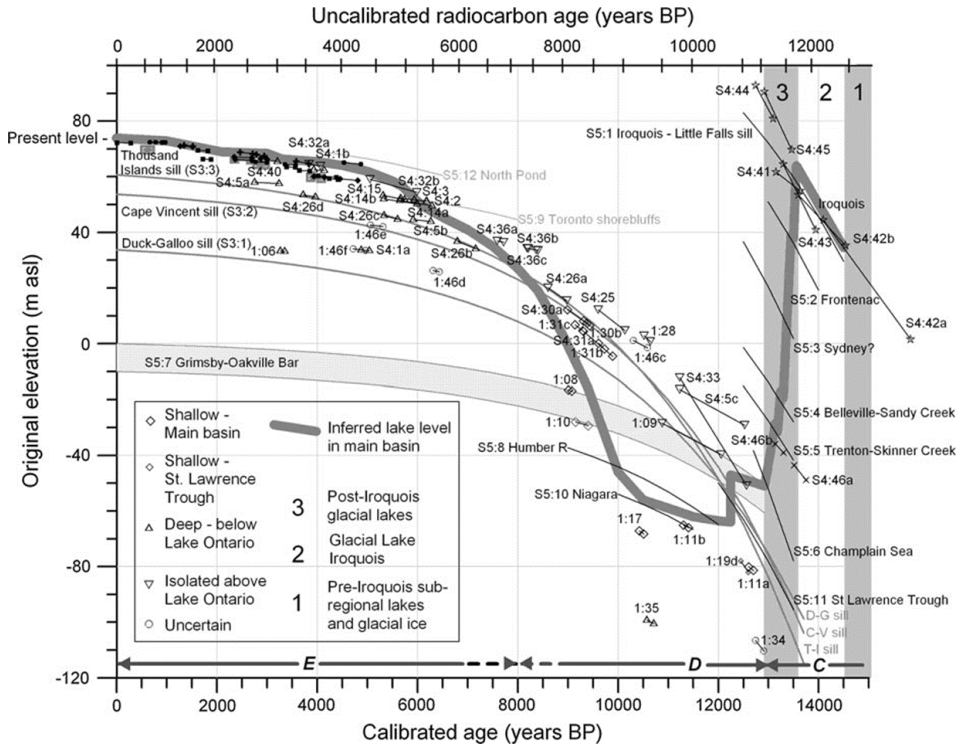

Figure 3. 5 Lake Ontario Water Level (14000 -2000 BP) (From Anderson & Lewis, 2012).

3.2 Indigenous History of Lake Ontario

The Indigenous heritage of Lake Ontario offers a timescale for understanding how cultures expanded and evolved. These cultures exhibit unique cultural heritages, manifesting in social, economic, and environmental interactions. The periodization of these cultures can be broadly categorized into different phases, with significant characteristics derived from their settlement cultures and advancements in toolmaking. These divisions result from material cultural remains that depict intangible cultural heritages preserved through various means. These cultural periods include the First Peoples/Paleoindians (between 13,500 BP and 12,500 BP), the Early Archaic People, and the Middle Archaic People (between 10,000 and 5,500 BP), the Laurentian Archaic People (between 6,000 and 4,300 BP), and the Early, Middle, and Late Woodland People (between 1500 BC and AD 1450).

The Paleoindian cultures of the Lake Ontario region date between approximately 13,500 BP and 12,500 BP. The period of the Paleoindians has been poorly understood due to the low water stage of Lake Stanley and the rarity of intact sites with evidence of Paleoindians, such as the Sheguiandah site (O'Shea & Meadows, 2009). They assert that the Paleoindians were the earliest humans to occupy the Upper Great Lakes region. Sites found in these regions of Lake Ontario yielded possible caribou hunting, suggesting that the Paleoindians in the Lake Ontario region were early hunters. This assertion was also documented by Sonnenburg et al. (2011), categorizing the Paleoindians and Early Middle Archaic people as hunter-gatherers. The fluted-point Paleoindian tradition characterized the Paleoindian tradition (O'Shea & Meadows, 2009). These tools are described as having "high angularity, sharp, thinned edges and unweathered surface with abundant conchoidal fractures and flake

scars typical of mechanical percussion" (Sonnenburg et al., 2011, p. 633). The connection and relationship between the Paleoindians and the Great Lakes are evident in the location of some sites, such as those in the Rice Lake region that have been submerged. These areas were known to be colonized by about 11,000 cal. BP, by the Paleoindians along the glacial lake, following the routes of herds of caribou (Sonnenburg et al., 2011, p. 633; 2013, p. 77).

The Early and Middle Archaic periods, spanning approximately 10,000 to 5,500 years BP, are marked by post-glacial environmental changes and a shift in the cultural and technological practices of Indigenous groups in Lake Ontario (Daniel, 2001, p. 237; Janetski et al., 2012, p. 127). Bebber et al. (2022) agreed that the Early and Middle Archaic period dates between 10,000 BP and 5,500 BP. They also share the notion that archaeological evidence, in the form of tool production, specifically stone projectile points, was associated with both the Paleoindians and the Early Archaic period. This period is characterized by a change in stone tool technology and subsistence (Janetski et al., 2012, p. 127). The change in projectile points changed from "stemmed styles early to notched forms late." This assertion is shared by Bebber et al. (2022), who suggest that this period was characterized by "Stemmed and notched bifacial flint tools," as noted by Janetski et al. (2012). Both the Early and Middle Archaic periods were characterized by a unique mortuary behavior (Pagoulatos, 2009, p. 332). The Laurentian Archaic period was sandwiched between the Early and Middle Archaic periods and the Late Archaic Period (Conolly, 2018). This period spans between 6,000 and 4,300 BP (Pagoulatos, 2009, p. 222). The Laurentian tradition was characterized by Brewerton points, Vosburg, Otter Creek, Kittatinny, and Normanskill biface forms, as well as narrow points.

The Late Archaic (5000 BP to 3200 BP) was considered a period of increased population, more complex settlement and socioeconomic structures, greater craft specialization, and increasingly complex mortuary behaviour compared to the Early and Middle Archaic (Pagoulatos, 2009, p. 332). The Late Archaic period was characterized by the domestication of native plants, which may have led to an increase in population (Tatarek & Sciulli, 2000, p. 365). The introduction of copper and small points characterized the Late Archaic period (Bebber et al., 2022). The "old copper industry" dated between 6780 and 3100 BP, and archaeological evidence placed these sites on the western side of the Great Lakes (Bebber et al., 2022, p. 4).

The Woodland period in the Lake Ontario region lasted from 1500 BC to AD 1450. It is categorized into three broad divisions: the Early Woodland period, the Middle Woodland period, and the Late Woodland period. Research into the Early Woodland periods only began a decade before Crawford et al. (2018) published their article, underscoring the need for further investigation. The Early Woodland people interacted with and adapted to their maritime environments. They "exchanged marine shell gorgets, copper tools, bracelets, beads, and galena," which were part of their burial culture (Crawford et al., 2018, p. 145). The Early Woodland people were egalitarian and had evidence of domesticating plants, specifically "chenopod (goosefoot)", which was also prevalent in the Late Archaic period (Crawford et al., 2018, p. 145). Side-notched projectile points and biface fragments characterized their tool technology. This period also yielded evidence of Vinette 1 pottery, characterized by undecorated vessels with conical bases (Crawford et al., 2018, p. 148).

The improvement of tool technology and cultural interaction necessitates a distinction between the Middle and Late Woodland dates. Like the Vinette pottery 1

from the Early Woodland period, the Middle Woodland period was characterized by the Vinette pottery 2. However, this pottery had dentate and cord wrap stick techniques used to make their decorative motifs. Both the Middle and Late Woodland periods were characterized by an increase in population, which led to the establishment of a more complex society (Lovis et al., 2001, p. 628). These two periods were also characterized by "transient hunting and fishing." This is evident in the introduction of maize in the Late Woodland period (Crawford et al. 2018, p. 144; Lovis et al., 2001, p. 630).

3.3 European History of Lake Ontario

The presence of Europeans in the Lake Ontario region has significantly shaped cultural narratives and histories. The arrival of Europeans also introduced new diseases, such as smallpox and measles, to the indigenous population, who had no immunity (Beeton, 2025). The arrival of Europeans also led to the invasion of Indigenous territories. Three groups are recognised as having settled and controlled the area of Lake Ontario: the British, the Americans, and the French. The first Europeans to have travelled through Ontario were the French in 1610 (Ewen & Wise, 2025). The French explorers Étienne Brûlé and Samuel de Champlain are acknowledged as having travelled to southern Ontario. Samuel de Champlain reached Lake Huron in 1615 and is regarded as the first to see the Great Lakes (Beeton, 2025). During this period, the Iroquois controlled Lake Ontario and had allied themselves with the British, who hindered the French movements. The French and British were rivals who vied for control of the natural resources in Southern Ontario. The contention between the two led to a series of wars fought between the 1600s and 1754.

The end of the wars marked the beginning of the American Revolution, which started in 1775 (Beeton, 2025).

In the War of 1812 between the British and Americans, the Great Lakes played a vital role because they served as routes that facilitated travel and transportation, protected colonies, and provided waterpower for development. For instance, the Niagara River, Detroit River, Lake Erie, and Lake Ontario were used as routes for invasion attempts by United States forces (Beeton, 2025). The War of 1812 is significant to Main Duck Island because it produced two important rival figures: Commodore Isaac Chauncey and Sir James Yeo. Commodore Isaac Chauncey was a naval officer who led U.S naval forces in the war of 1812 and other campaigns on Lake Ontario. He played an important role in disrupting British supply lines and controlled strategic areas on Lake Ontario. Sir James Luca Yeo was a British naval officer and leader of the British Royal Navy. He was appointed by British Admiralty to strengthen British naval presence. Both figures contested for dominance on Lake Ontario. Dominance on Lake Ontario was important because the lake proved to be an important route for the supply of resources and transportation. Both figures utilized Lake Ontario to their strategic advantage. These figures are important because soldiers from the British side of the war sought refuge on Main Duck to ensure their survival, a strategy like that employed by French soldiers earlier in the 18th century. A historian, Pierre Berton, made a note about these two figures: The rivalry between Commodore Chauncey and Sir Yeo was centered on how quickly they could construct superior vessels as both leaders aimed to assemble the most powerful fleet Lake Ontario had ever seen (Berton, 1981).

The relationship between Lake Ontario and the Europeans resulted in cultural and natural changes over time (Estepp and Reavie, 2015, p. 672). In a broader sense, Lake Ontario served as a means of transportation for trade, war, migration, and a vital resource for biodiversity.

3.4 Conclusion

By framing Main Duck Island within this broader theoretical perspective, this chapter has established a foundation for further analysis. Subsequent chapters will apply the principles of MCL to specific archaeological findings, mapping how past societies engaged with the maritime environment. This approach will offer insights into the cultural and economic significance of Main Duck Island, situated within the wider maritime history of Lake Ontario.

Chapter 4: Main Duck Island Environmental and Cultural History

4.1 Introduction

Main Duck is the largest island in the chain of islands in the eastern region of Lake Ontario. It has an approximate land area of 230 hectares (570 acres) and is 17.7 km away from Point Traverse south of Prince Edward County (Fig. 4.1) (McLeod, 2016; Naval Marines Archives, 2016; Parks Canada, 2013; Zerbisias, 2011). Various environmental and anthropogenic effects have contributed to the contemporary character of Main Duck. This chapter examines the island's environmental and cultural history. It also discusses issues related to the island's interconnectivity with the mainland.

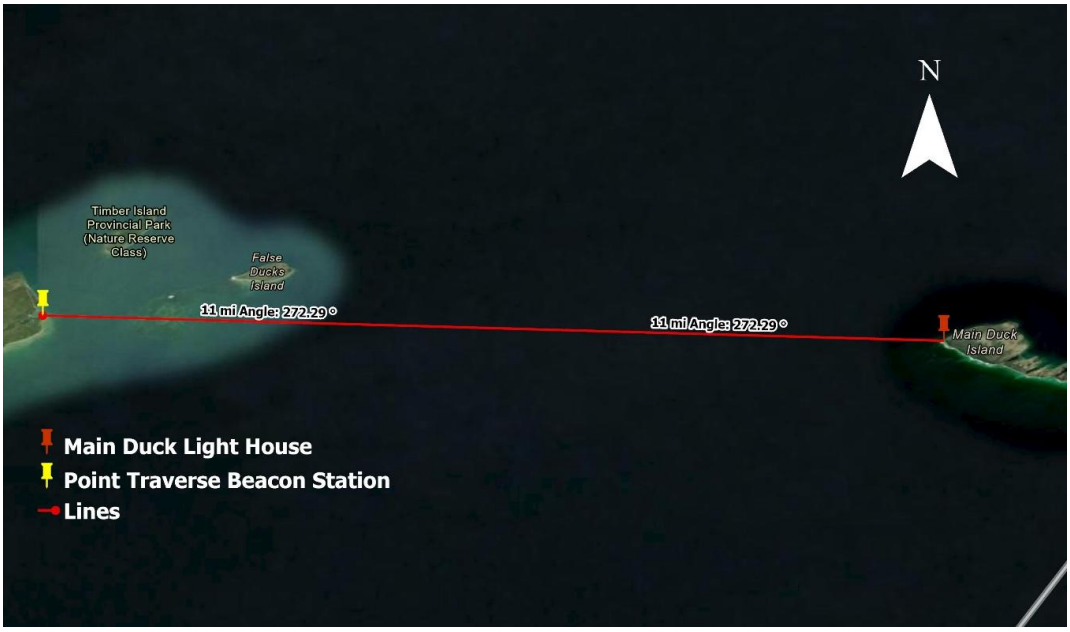

Figure 4. 1 Distance Between Point Traverse Beacon Station (Prince Edward County) and Main Duck Island.

4.2 Geographical Background

Main Duck slopes gently from north to south, with the eastern shoreline covered with massive Palaeozoic bedrock of Ordovician age (Fig. 4.2) (Conolly, 2024, p. 7) and zebra mussels covering the western shoreline. The increased lake level has encroached on the limestone bedrock of Main Duck.

Figure 4. 2 Rocky North Shore of Main Duck Island.

The gentle sloping of Main Duck from north to south results in a change in shoreline and encroachment of Lake Ontario on the land area. The island is characterized by a “high Ordovician limestone bluff covered by a mixed deciduous forest vegetation cover that changes to open meadow grasses and marsh reeds along the edge of the shore, cliffs, and overhanging ledges to the north and extensive pebble beaches that have developed along the shores of the lower portion of the island” (Ross and D’Annibale, 2001, p. 2).

Gateley (2012) also provided a detailed geomorphological description of Main Duck Island, offering contextual information on how the geomorphological setting of Main Duck Island contributes to the occurrence of shipwrecks. Reporting on the nature of the Main Duck coast provided by mariners, Gateley describes the shoreline of Main Duck as fragile and unpredictable, owing to the change in Lake Ontario's current and water level. Mariners explained that none of Main Duck's coves were good anchorages, recounting vessels blown ashore due to heavy winds (Gateley, 2012). Sprague (2009) claims that the shallow bedrock caused issues for previous people, leading to shipwrecks.

In more recent years, zebra mussels have impacted the island. Zebra mussels, also known as *Dreissena polymorpha*, are a freshwater clam invasive species originating from Eurasia. They were first discovered in Lake St. Clair in 1988 (Watersheds Canada, 2006). Like the quagga mussel, the zebra mussel was introduced "via ship ballast water to the Great Lakes in the 1980s" (Watershed Canada, 2006). Zebra mussels are highly adaptable to a wide range of environmental conditions, which has facilitated their survival in the Great Lakes. They reproduce rapidly, producing about one million eggs each year and secreting sticky fibers which they use to attach to hard surfaces of boats, aiding their transportation to different areas (Watershed Canada, 2006). The western shore of Main Duck is now covered with zebra mussel shells deposited there by the waves hitting the western part of the island (Fig. 4.3). The number of zebra mussels has only increased, which is suspected to have caused an outbreak that killed many birds on Main Duck. Some fish species eat the zebra mussel (Gateley, 2012).

The soil composition on Main Duck is shallow, allowing for limited vegetation growth. But in the interior, a test pit of 25 centimetres of soil indicates moderate pedogenesis (Adams, 2008, p. 8; Conolly, 2024, p. 7). The contemporary landscape is the product of historical anthropogenic activities, including farming and grazing by herds, which denuded what was likely a more forested landscape to one that is more savannah-like. According to historical sources, nineteenth-century activities on Main Duck included farming and the introduction of sheep, cattle, hogs, and horses by Captain John Walters (Naval Marine Archives, 2016), grazing herds of bison and cattle by Claude Cole, and building structures to house island users and the smuggling of alcohol (McLeod, 2016). These historical activities led to changes in the island's vegetation. These changes include patches of an open savannah plain to the northeast and a denser vegetative cover to the northwest (Fig. 4.4 and 4.5). Main Duck Island's current vegetation consists of marshland plants, coastal vegetation, and grassland shrubs. Following Parks Canada's purchase of the island in 1977, human activity has been restricted, and the island has been undergoing a process of rewilding.

Figure 4. 3 West Shoreline of Main Duck Covered with Zebra Mussels (the white outline on the shore).

Figure 4. 4 Open Area on Main Duck Island.

Figure 4. 5 Open Savanna Area on Main Duck.

4.3 Historical Background of Main Duck Island

4.3.1 Indigenous History of Main Duck

Archaeological evidence indicates that the Middle Woodland People first used the island between 450 BC and AD 450 (2400 BP – 1500 BP) and by the Early Late Woodland People from AD 850 to AD 1450 (1100 BP – 500 BP) (Parks Canada, 2013). On a general scale, the Early, Middle, and Late Woodland traditions appeared in southern Ontario around 1000-1300, 1300 -1400, and 1400-1650, respectively (Wright, 1996). These groups' occupation and lifestyle left tangible traces of their culture in the form of pottery. Summaries of Early and Middle Woodland archaeology, including those by Ferris and Spence (1995) and Fox et al (1992), state that the Early Woodland people were present in Ontario between 600 BC and AD 700. The Early Woodland people were hunter-gatherers and introduced ceramics to the Ontario region (Ferris & Spence, 1995). They highlighted that the ceramic vessels had decorations on the interior and exterior of the rim down to the neck (Ferris & Spence, 1995, p. 107). After about AD 500, Early Late Woodland peoples appeared in the archaeological record with larger and often palisaded villages, representing more sedentary communities (Fox et al., 2023). Williamson (1990) asserts that the Early Late Woodland communities maintained a diverse subsistence strategy but underwent a gradual shift to an agriculturally based society (Williamson, 1990, p. 312). Through the first part of the Late Woodland, Indigenous people were predominantly hunters and gatherers, although in later centuries, they increased their use of maize (Ferris & Spence, 1995). Late Woodland communities with even larger villages develop through the thirteenth and fourteenth centuries, initially close to the shoreline of Lake Ontario but moving inland over the course of the fifteenth century (Conolly et al., 2025).

Archaeological data recovered from Main Duck corroborated that Middle Woodland people settled on Main Duck. Evidence of this is seen in the recovery of pottery sherds at Schoolhouse Point dating to periods between 450 BC and AD 450 (2400 BP – 1500 BP) (Adams, 2008, p. 4). It is unclear whether the dates were established using radiocarbon or typological dates. Evidence of the Early Late Woodland people was also recovered from Chimney Bay as evidenced by potsherds dating from AD 850 to 1050 and AD 1350 to 1450 (Adams, 2008, p. 4),

4.3.2 European Settlement

Two groups of European or non-Indigenous groups, the French and the English, had contact with Main Duck from the mid-1700s until the early 20th century. However, there is more historical data on the English than the French. The Naval Marines Archive (2016) documented that French survivors of a marine battle against the English got to the island using rafts but were stranded on the island in the mid-1700s (Naval Marines Archive, 2016). In agreement with this assessment, other authors, peg the date of the French's arrival to Main Duck in the 1760s and documented the demise of the French on Main Duck to before the 1800s (Rick, 1974; Ross and D'Annibale, 2001; Naval Marines Archive, 2016; Townsend, n/d).

In the run-up to the war, the Embargo Act of 1807 prohibited the French from trading with England. However, it was repeatedly violated by many smugglers across Lake Ontario (Gateley, 2012). During hostilities, British Commodore Sir James Lucas Yeo sought shelter on the island after a battle against Chauncey, an American commodore, between 1812 and 1814 (Gateley, 2012; Townsend, n/d). The battle in 1812 was rumored to have resulted in 120 fatalities, was known as the "forgotten

war," whose outcome was claimed by both sides (Gateley, 2012). Gateley (2012) was the only authority to mention a series of naval engagements in 1813. These engagements occurred in the summer and led to two small naval vessels sinking in Lake Ontario. In 1966, John Rick led the first archaeological expedition to the shore of Main Duck to locate this shipwreck. This expedition produced evidence of a shipwreck of a French battle vessel on the coast of Main Duck. The chronology of this shipwreck was dated to around 1741 (Rick, 1970).

After the war, the ownership of the island was transferred to Captain John Walters. Captain Walters, who was also a farmer, owned Main Duck from 1848 to 1892 (Naval Marines Archive, 2016; McLeod, 2016; Townsend, n/d). Before selling the island, Sir John Walters introduced about 400 sheep on Main Duck and 200 at Yorkshire Island, as well as cattle, hogs, and horses (Fig. 4.6) (Gateley, 2012; Naval Marine Archives, 2016; Sprague, 2009). The ownership of the island was then transferred to Claude Cole in 1892 (Naval Marine Archives, 2016). In contrast, McLeod (2016) writes that in 1904, the Government of Canada sold the island to Claude W. Cole. To add to the confusion, documents from the Naval Marines Archive (2016) mention that the island was deeded to private ownership in 1892 by the same buyer, Claude W. Cole, who retained ownership until his death in 1938 (Naval Marines Archives, 2016; Townsend, n/d).

Figure 4. 6 Livestock on Main Duck Island (From Osborne, 1983)

Claude Cole, also known as "King Cole," engaged in various activities on Main Duck. Cole controlled Main Duck from 1892, although there are discrepancies on the exact date, as mentioned earlier, until he died in 1938. Cole's contribution to the history of Main Duck stems from his involvement in illegal activities, including the smuggling of alcohol. According to one timeline, from the mid-1800s until July 14th, 1905, the island fell within the jurisdiction of the Department of Indian Lands (Naval Marine Archives, 2016). In 1905, the island was apparently sold to Claude Cole for twelve hundred dollars ($1200). Sprague also documented the purchase of Main Duck by Cole, but dated the transfer of ownership to 1904, citing the same prise of $1200. There is no documentation on whether Cole met Walters before purchasing the island. Cole's impulse to purchase the land was related to his desire to rule the island as a sovereign or a King. Hence, the alias "King Cole.” Cole believed he was destined to own Main Duck, saying that “it was in the blood” because his grandfather owned

three Indian islands and that “An island is where a man’s soul may breathe” (Naval Marine Archives, 2016; Lighthouse Friends, n/d).

Cole had a small farm on the 230-hectare island. He kept racehorses, sheep, hogs, cattle, and buffalo which he allowed to roam free on the island (McLeod, 2016; Naval Marine Archives, 2016; Sprague, 2009). In addition to his livestock, there were apparently wild cattle, which Cole had to eradicate; these may have been the ones introduced to the island by Captain Walters. He later introduced bulls, but the investment in the bulls did not yield as much as expected, as the buffalo herd easily tossed timber and logs, and were hostile to the horses. Cole ended the bulls and buffalo by shooting them (McLeod, 2016). Cole apparently used to hunt wild deer on the island (Naval Marine Archives, 2016). Other observed wild animals included a fox that crossed to the island over the winter ice and fed on turtle eggs (Sprague, 2008).

Cole was known as the proprietor of the Duck Island Dairy. It was believed that the butter produced from Main Duck was the finest sold in Canada. Bread and ice were delivered to Main Duck addition to smuggling (Gateley, 2012). However, traders and fishing parties plying the chain island route during the summer months distracted the monotony of Cole’s dairy business (Gateley, 2012). Main Duck Island was the hub for viable fishing to the extent that a settlement known as “Fisherman’s Cove,” also known as “Village Cove,” on Main Duck Island housed about 60 people (other sources cite 70 people) (Adams, 2008, p. 4). It is believed that Captain Harry Randall sought refuge on Main Duck in 1920 en route from New York to Belleville (Lighthouse Friends, n/d). The change in tide and the current of Lake Ontario led the captain and his men (four people, the captain included) to remain on Main Duck,

where they met the family of Fred Bongard, the second lighthouse keeper (1915-1921).

Cole was popularly known as the Notorious Rum Runner and had a soft spot for other bootleggers, allowing them to stay on the island (Fig. 4.7). The strategic location of Main Duck, along with its environmental advantages, helped Cole accumulate more wealth. Rum runners frequently harbored on Main Duck in 1920. Sheltering rum runners and harboring many cases of alcohol led the police to invade Main Duck on 11th May 1921 (Sprague, 2009). Cole defended himself, claiming that the alcohol, with the label "Kentucky Bourbon," was part of his personal cellar supply and not for export. Amidst vivid evidence that the rum was intended for export, Cole was acquitted, and all the rum was returned to him (McLeod, 2016). He turned Main Duck's shore into a frequent stop for patrons of the rum-running and smuggling before continuing their route to the American Shore (Sprague, 2009). Rum runners stored and waited on Main Duck until it was safe to deliver their goods across the American border (McLeod, 2016). Cole also distributed some of the alcohol to the fisherfolk to circumvent the United States Coast Guard (McLeod, 2016).

Notable and famous rum runners include Ben Kerr, Bruce Lowery, Gentleman Charlie Mills, and Wild Bill Sheldon. Gentleman Charlie Mills and Ben Kerr were frequent visitors to Main Duck and were popular exporters. The three bootleggers had a close relationship, as Kerr once departed for Belleville with cargo and disappeared, leaving his wife to ask for help from Cole. However, it later turned out that Kerr and his crew may have been victims of a shipwreck in Lake Ontario (Gateley, 2012). Between 1920 and 1933, the prohibition of alcohol in the United States meant "an increased interest in Canadian booze." Cole used this opportunity and geographical

advantage, as mentioned above, to facilitate rum-running, bootlegging, or, simply put, alcohol smuggling (Fig. 4.8).

Figure 4. 7 Claude “King” Cole (Right) and His Friend Mac Howell on Main Duck Island in 1925 (From Osborne, 2019).

Figure 4. 8 Protest to End Prohibition, 1931 (From Minnesota History Centre, 2019).

Main Duck had its share of superstitious beliefs and myths. According to myths, scaly serpents were frequently found in the Great Lakes (VanVlack, 2021). This legend was rooted in the belief systems of the Algonquin and Iroquois people. There are accounts of captains who had sailed past Main Duck and reported having seen an enormous serpent in its rocky crevices. These accounts described the serpent as “sound asleep, fifty feet long, dull brown with a dragon-like head, scales on its back, and a tail resembling a harpoon head” (VanVlack, 2021). It is no coincidence that different snake species overrun Main Duck. Although these accounts may be biased, there is some truth to the presence of snakes on the island. These snakes were most likely water snakes, some of which can grow to approximately 2 meters in length. Renoy (2020), a child of one of the lighthouse keepers, mentions that Cole Main, in 1964, was able to "drastically reduce the snake population on the island."

Ownership of the island was transferred to John Foster Dulles in 1941. Dulles was a successful Wall Street Lawyer who bought the island around the time of the Second World War (WWII) (Gateley, 2012; Naval Marines Archives, 2016; Parks Canada, 2013). Dulles and his family frequented the island for their summer vacation. He had selected the destination of Main Duck long ago, when he was a young boy who visited Main Duck with his friends on a catamaran (Gateley, 2012). Later, Dulles served as US Secretary of State and was described as a Cold War warrior against the Soviets (1953-1959) under US President Dwight D. Eisenhower (Gateley, 2012). He is credited with hiring Moses Muskrat Marsden, of Alderville First Nation, to build the cabin at the highest point of the island, at its northeastern end (Township of Selwyn, n/d) (Fig. 4.9)

Figure 4. 9 Cabin of John Foster Dulles (From Getty Images).

The structure had a sculpted chimney and a stone foundation (Sprague, 2009). Today, the only remains of the cabin are part of the chimney, the outline of the foundation of the cabin, and a galvanized drum west of the site (Conolly, 2024, p. 36; Ross & D'Annibale, 2001, p. 9) (Fig. 4.10).

Robert F. Hart Junior inherited the island from Dulles (Naval Marine Archives, 2016). Robert Hart Jr. and John Foster Dulles were friends (The New York Times, 1950). Other sources claim that Robert Hart Jr. bought the island for an undisclosed sum and promised to keep it safe (Time, 1964). Robert Hart Jr. ran a hunting lodge at Main Duck (Gateley, 2012). This cottage, which was owned by Robert Hart Jr. and built in the 20th Century (Ross & D'Annibale, 2001, p. 7), was also mentioned.

Main Duck was transferred to Parks Canada in 1977 (Parks Canada, 2013). In 1985, Main Duck had magnificent sights of "well-kept lawns and gardens" west of the

island in addition to the automated lighthouse (Gateley, 2012). However, feasibility studies of the island indicated that it is now overgrown with weeds and other vegetation. Between 1977 and 1998, the island was formally incorporated into the St. Lawrence Islands National Park, now Thousand Islands National Park. This formed part of the aim to preserve and protect natural sanctuaries for wildlife (Parks Canada, 2022). Main Duck became part of Thousand Islands National Park in 1998 (Parks Canada, 2013). The Thousand Islands National Park was established in 1904 by the Mallory family (Government of Canada, n.d).

Figure 4. 10 The Current State of the Dulles Buff Chimney.

4.3.3 The Lighthouse

Main Duck's Lighthouse was built in 1914 (Lighthouse Friends, n/d). It was established to aid vessels in navigating safely through eastern Lake Ontario from the United States to False Duck Island (Fig. 4.11). The decision to begin the construction of the Main Duck Lighthouse was made in 1908 and was debated until 1910 by the Lake Carriers' Association and the Lake Ontario Coal Carriers Association (Lighthouse Friends, n/d). The lighthouse's construction began in 1913 and was completed in 1914 by A.T.C McMaster of Toronto (Lighthouse Friends, n/d). The Lake Carriers' Association described the Main Duck Island Lighthouse as:

> " an octagonal tower with sloping sides. It is of reinforced concrete construction, having a height of 80 feet from its base to the vane of the lantern, and supports a polygonal iron lantern with a red roof. The light is of the third dioptric type of 100,000 candlepower, is displayed at an elevation of 74 feet, and shows one bright flash every 10 seconds. Petroleum vapor, burned under an incandescent mantle, serves as an illuminant. The light station is in latitude north 43 degrees 55 minutes 52 seconds, longitude west 76 degrees 38 minutes 19 seconds, and the light is visible 14 miles from all points of approach by water" (Lighthouse Friends, n/d).

The keepers of the lighthouse, according to lighthouse friends (n/d), were as follows:

- James Clark (1914 – 1915)
- Fred Bongard (1915 – 1921)
- Wesley Earl Thomas (1921 – 1953)
- Harold Dunn (1954 – 1958)
- Coleman Main / Frank Pitts (1959 – 1976)
- Kenneth McConnell (1976 – 1978)

Upgrades to the lighthouse, such as a fog alarm in 1915 and a radio beacon in 1929, were implemented to help sailors navigate Lake Ontario safely. The fog alarm and radio beacon systems provided mariners with real-time georeferenced information, helping them determine their location away from Main Duck's shores. The fog alarm was approved on February 18, 1913 (Government of Canada, n.d.). Before its automation and "de-staffing" in 1978, the lighthouse was manually run by the lighthouse keepers mentioned above on kerosene and a clock weight. The clock weights worked using gravity-powered gears to turn the lens at a precise speed. The lighthouse keeper's job was to regularly rewind the weights, clean the lens and keep the lamp burning all night. Fran Renoy (2020) mentions that her father, Frank Pitts, who managed the lighthouse together with Cole Main during the 1960s and 1970s, played a significant role in automating the lighthouse. Frank Pitts was a technician who worked on automating other lighthouses throughout Ontario. He was later transferred to the Department of Transport Marine Depot in Prescott (Renoy, 2020). Renoy (2020) recounts that her father, the lighthouse keeper, lived in the duplex with another assistant. She mentioned that the second duplex was built for the lighthouse keeper Cole Main and his family.

The switch to electricity enabled the remote operation of the lighthouse. The last lighthouse keeper, Kenneth McConnell, according to the lighthouse friends (n/d), recounted extreme weather conditions when discharging his duty of running the lighthouse and keeping it lit. He recounted waves of up to 55 miles an hour, climbing up to 15 feet high.

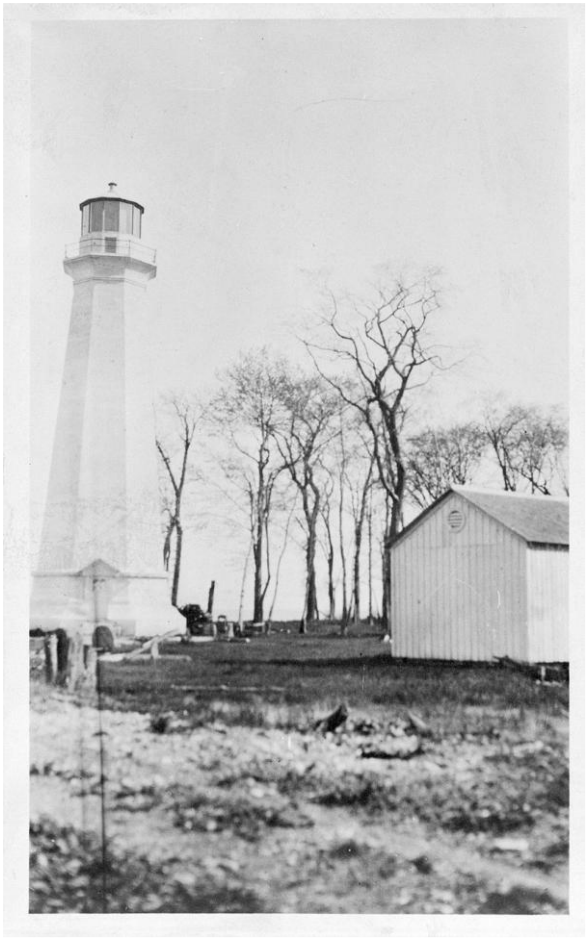

Figure 4. 11 Lighthouse Tower and Shed (1916) (From Canada Marine Aids Division / Library and Archives Canada / PA-148104).

The narratives of the lighthouse keepers assert the island's reputation as "the graveyard of Lake Ontario" (Gateley, 2012). The lighthouse on Main Duck Island was designated a Recognized Federal Heritage Building on August 24, 1989, due to its critical role in providing safety to mariners.

The catalogue of Brian Osborne's pictures, located at Queen's University Library, features eighty-two vintage images of Main Duck Island (Fig. 4.12). These pictures provide a pictorial representation and contextual data on Main Duck between 1910 and 2000.

Figure 4. 12 Lighthouse on Main Duck Island (From Queens University Library, Digital Collection, 2024).

4.4 Previous Archaeological Studies

The presence of humans on Main Duck has led to the creation of archaeological sites on the island. However, little archaeological research has been conducted on Main Duck (Conolly, 2024, pers. comm). Excavations were carried out by John Rick in 1966 and Ross and D'Annibale in 2000. There were also impact studies by Trillium Power Wind Corporation in advance of a power installation. However, the project was halted (Dino, 2023). An impact assessment or study is a process to identify, predict and evaluate the potential environmental effects of a proposed project (Government of Canada, 2025). My archaeological reconnaissance survey project was conducted in June 2024. Visual observations of these sites were highlighted in a feasibility study conducted by James Conolly on the shores of Main Duck earlier in the same year. Feasibility studies are conducted before conducting full-scale research. It provides information on the context within which the

archaeologist will be studying (Gadke et al., 2021). My research aims to understand whether Main Duck was always an island, examine the shoreline history in relation to the rising lake levels, and uncover the maritime cultural landscape narratives of the island.

Ross and D'Annibale (2001) highlighted the archaeological research conducted at Main Duck by John Rick in 1966. His work is regarded as the first archaeological research on the island. He investigated the 1741 shipwreck of a French battle vessel on the eastern shore of Main Duck Island. The French battleship had been "on its way from Cataraqui (now Kingston) to Fort Niagara laden with trade goods and military supplies" (Ross & D'Annibale, 2001, p. 3). The cause of the wreck was attributed to a storm on Lake Ontario. However, no evidence of the ship was found. Nonetheless, archaeological materials dating to the 18th century were recovered within the cracks of the limestone at the bottom of the lake. In their survey. Eight archaeological sites were identified during the survey of Main Duck, 5 of the 8 were considered historical (Adams, 2008; Ross & D'Annibale, 2001). Three dated to what he termed "pre-contact aboriginal occupation" (Adams, 2008, p. 3). These sites, discovered by Ross and Annibale, are Village Cove, Schoolhouse Point, Schoolhouse Bay, Hart's Cottage, Chimney Bay 1, Chimney Bay 2, Dulles Bluff, and Lighthouse Complex (Fig. 4.13). Adams (2008) undertook the Trillium Power Wind Corporation project on Main Duck Island in 2008. This project gathered data and tested for the presence of archaeological sites. The excavations undertaken on the island were hand-dug test pits. Unfortunately, the research did not identify any archaeological sites (Adams, 2008).

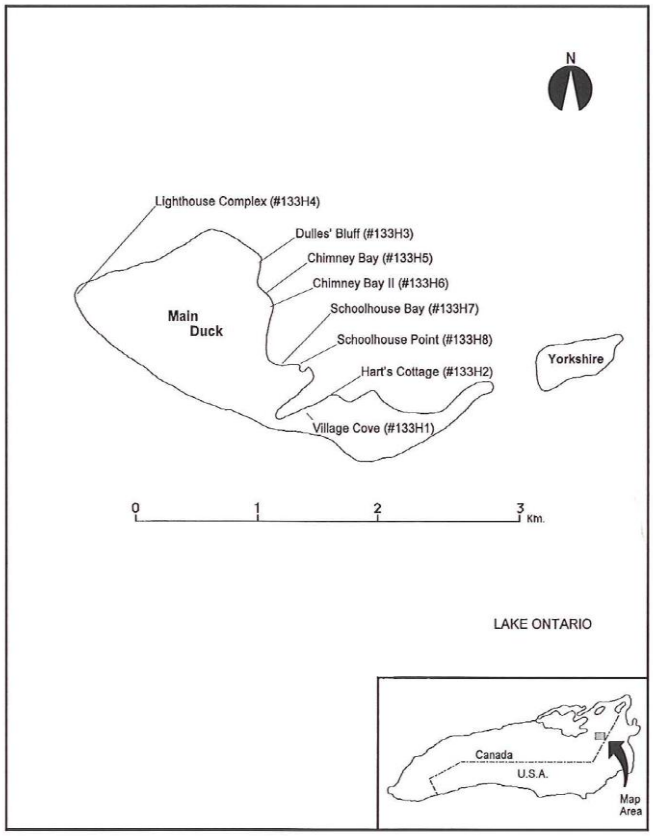

Figure 4. 13 Archaeological Sites on Main Duck. (From Ross and D'Annibale, 2001).

4.5 Conclusion

This chapter established a comprehensive foundation for understanding the multifaceted history, cultural significance, and geological background of Main Duck Island. It also explained the research questions and goals of the study. By setting the stage with these goals and research questions, a clear direction for the subsequent chapters is provided, where these questions will be explored in greater depth, These research questions explore the natural processes that have shaped the island over time, providing insights into how its physical form has influenced maritime culture. By addressing these questions, I aim to construct a detailed and comprehensive narrative that captures the island's unique heritage and its connections to the surrounding regions.

Chapter 5: Research Questions and Methods

5.1 Introduction

In this chapter, I start by defining my research questions and study goals. I then explain the various techniques employed to meet the study's objective of building an understanding of the long-term history of Main Duck's landscape and human history. This study employs three GIS-based analytical methods as outlined below: (1) paleoshoreline modelling; (2) visualization of spatially referenced data, and (3) line-of-sight (or visibility) analysis. This chapter also explains the methods used in conducting archaeological reconnaissance surveys and ceramic analysis.

5.2 Research Questions and Study Goals

This study applies maritime cultural landscape (MCL) theory to investigate the cultural and environmental history of Main Duck Island. The research explores the island's formation processes, Indigenous and European histories, and its present status as a protected Parks Canada site.

The overarching goal of this research is to understand how maritime cultural processes shaped the natural and cultural development of Main Duck Island. The central research questions are:

1. How did Main Duck Island's geological formation and the inundation of its shorelines influence its habitability, accessibility, and role within the broader Lake Ontario landscape?

2. What does the spatial and temporal distribution of archaeological sites reveal about patterns of settlement and island use?

3. How does the integration of terrestrial and maritime evidence inform our understanding of regional interactions among the Sandbanks, Main Duck Island, and the New York shoreline?

The specific objectives of this study are:

- To reconstruct the island's environmental transformation, including formation processes and shoreline changes between 10,000 and 4,000 BP.

- To compile a comprehensive inventory of archaeological sites on Main Duck Island.

- To evaluate the island's significance within the broader context of Lake Ontario's maritime cultural landscape.

- To investigate the nature and extent of human interactions with the island over time.

This research contributes to a deeper understanding of how natural and cultural processes interact in shaping island landscapes, offering new insights into the historical and archaeological significance of Lake Ontario's maritime environments.

5.3 Paleoshoreline Modeling

To answer my first question, methods of paleoshoreline modelling are appropriate. These are methods used for reconstructing ancient shorelines to understand past sea levels and landforms that have been subject to change due to water level change. Paleoshoreline reconstruction helps archaeologists identify ancient, inundated

shorelines, providing models of where former terrestrial settings have been inundated from rising sea or lake water levels (Laws et al., 2020, p. 18). The concept of maritime cultural landscapes is seen within this method through the integration of terrestrial and maritime landscapes to model the location of ancient shorelines and aid in the discovery of archaeological data in inundated shoreline areas.

Anderson and Lewis (2012) applied an empirical model of isostatic adjustment to reconstruct former lake levels in the Great Lakes basin. They identified early low-water phases characterized by exposed shore deposits such as woody detritus, peat, sand, and gravel. By integrating sedimentation rates and other water-level indicators, they developed a revised history of Lake Ontario's water-level fluctuations. Their method allowed the reconstruction of past lake levels and outlet sill elevations, the latter defining the lake's threshold and determining how much water it could retain before overflowing. Re-examination of core sediments revealed shallow-water and terrestrial organic deposits indicating that "closed-basin conditions existed," reflecting a drier phase (between 10.4 and 7.5 ka BP) in the region (Anderson & Lewis, 2012, p. 514). Subsequent transitions to peat and gyttja signaled rising water levels and flooding of surrounding grasslands around 6080 BP (Anderson & Lewis, 2012, p. 518). Anderson and Lewis (2012) further attributed these changes to differential isostatic rebound and variations in temperature and precipitation.

Anderson and Lewis (2012) calculated past water-level changes using the equation $E_t = E_p - A(e^{t/\tau} - 1)$ for any given location in the Great Lakes region, where E_t is the modelled elevation at time *t*, E_p the present elevation, and A (amplitude factor) the maximum uplift at that location (provided in Anderson and Lewis as a map), with $\tau = 3{,}700$ years representing the time at which uplift

effectively ceases. As noted by Lewis et al. (2005), the uplift component is based on an isostatic response surface of former shorelines. This equation was used to reconstruct Lake Ontario's water-level history from 14,000 BP to the present (Anderson & Lewis, 2012, p. 523).

To generate paleoshoreline models, the empirical isostatic adjustment equation for the Great Lakes is derived for a suite of different times (for example, 1000-year intervals) to produce a time series of lake-level changes. The resulting data are applied to a topobathymetric digital elevation model (TBDEM) of Lake Ontario, setting lake levels to the corresponding meters above sea level (MASL). The output raster is then reclassified to distinguish land areas from former shorelines. Worked examples of such models for archaeological purposes are provided in Sonnenburg et al. (2012) and Conolly (2020).

Paleoshoreline modeling is important to understanding the landscape of Main Duck because it produces a set of maps for any given time of how Lake Ontario's water level has increased over the years and how this increase has submerged formerly terrestrial land in eastern Lake Ontario, leading to the formation of islands, including Main Duck. This method is critical for answering the question of how contemporary islands were once connected to the mainland. It provides an avenue to calculate the amount of land area submerged by Lake Ontario. The time series generated through paleoshoreline modeling also provides dates that can be corroborated with historical documents about human activities on the coast of Main Duck, essentially providing information about archaeological sites that may have been submerged or are at risk of being submerged.

5.4 Visibility: Viewshed Analysis

Clifford Tandy, a surveyor and landscape architect, coined the term "viewshed" (Inglis et al., 2022, p. 2), which is the extent of a visible area or a terrain from a specified viewpoint or viewpoints (Rosa, 2011, p. 293). One of the first computational methods was called "Viewit", a computer-based program developed by the U.S Forest Service that computed observable geographical areas based on gridded elevation cells (Inglis et al., 2022, p. 2).

Viewshed analysis is used to identify areas on the terrain's surface that are visible to an observer from a given location (Brughmans et al., 2017; Fisher, 1996; Rosa, 2011; Sobala et al., 2020). This analysis forms the quantitative part of this research because it is a computer-generated program that calculates visibility on a landscape using parameters such as distance between the observer and the target, height of the observer, and the curvature of the earth (Rosa, 2011). These parameters are expressed in Digital Elevation Models (DEMs), which represent the earth's surface terrain through interpolations of elevations measured from the points on the ground by satellites (Dou et al., 2019; Rosa, 2011). Conducting a viewshed analysis produces representational maps of intervisibility. That is, the various parts of the landscape that are visible to the observer from a given location. This is important because visual information shapes people's movement as they tend to move through areas that have clear lines of sight to their destination (Brughmans et al., 2017). Visible islands and rocky outcrops are perfect markers used by land seekers, emphasizing that these visible areas affect navigation and may encourage directional travel (Brughmans et al., 2017, pp. 479-480). Gillings (1998) describes viewshed analysis as one of the more significant tools in GIS (p. 118).

Figure 5.1 illustrates a two-dimensional raster data map showing the input surface of the earth's surface with an observer point (left) and a generated viewshed analysis map showing suitable areas (right). The result of this computation is represented in a binary raster data map containing zeros (0s) and ones (1s) (Petrasova et al., 2015, p. 77). The "0" values indicate the not visible areas. In comparison, the "1" value indicates visible areas.

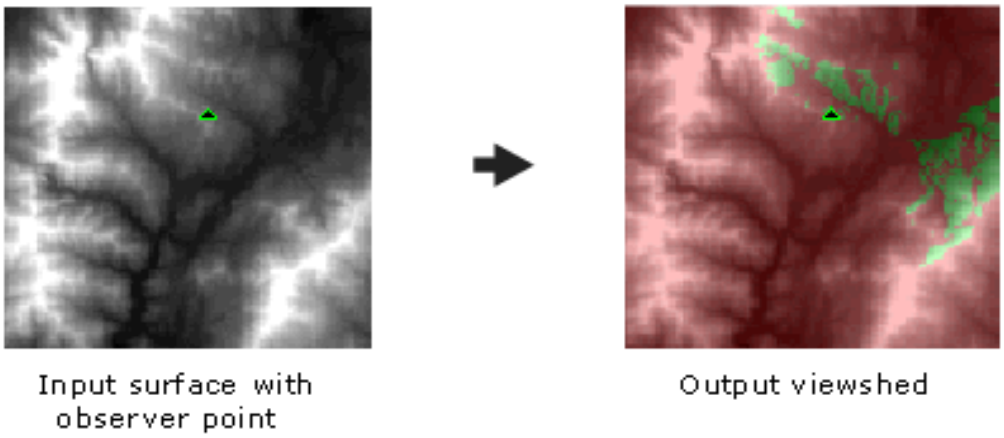

Figure 5. 1 Cells in Green are Visible from the Observation Tower, while Cells in Red are not (From ESRI,2023).

The concept of viewshed works with the analytical method called line-of-sight analysis. Line-of-sight analysis is based on the extent to which the observer may see and the various structures that may obstruct the extent of sight (Petrasova et al., 2015). Figure 5.2 explains the concept of line-of-sight. Observer point A would not see B due to the obstruction caused by C. However, the whole area within the range of A and C is observable. The line of sight is broken when the observer at point A wishes to view the slope on the unseen side of point C. From this viewpoint, viewshed analysis identifies areas that are seen as visible and in the line of sight, and areas that are unseen or cannot be seen are regarded as invisible, obstructed, or out of the line of

sight. The height of observer A above the terrain significantly influences the viewshed extent. The observer height can be changed to “model the view of a standing person, the view from a multi-story building, or the view from the top of a cell tower” (Petrasova et al., 2015, p. 77).

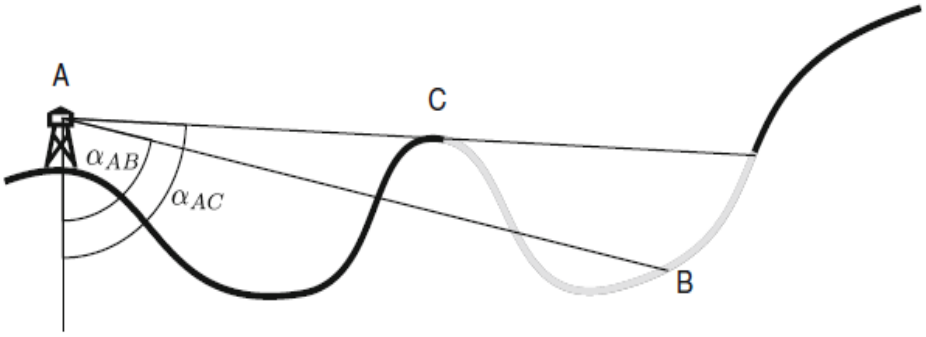

Figure 5. 2 Demonstration of Line of Sight (From Petrasova et al., 2015).

Lake and Woodman (2003) provide an example of the application of visibility analysis to establish the settlement pattern of a group. They categorize visibility studies in archaeology into two main types: non-GIS visibility studies and GIS visibility studies. The former pertained to what they termed “informal studies, statistical studies, and humanistic studies” (Lake & Woodman, 2003, p. 690). They provide a typical example of the former by referring to the construction of Neolithic long mounds on False Crest in East Sussex (Lake & Woodman, 2003, p. 690). This work posited that the Neolithic long mounds provided an excellent view of the river valley and the Weald (Drewett, 1982, pp. 49–50). In contrast, the oval mounds provided a limited view because these mounds were situated “at the heads of dry valleys or on river valley edge locations” (Drewett, 1982, pp. 49-50; Lake & Woodman, 2003, p. 690). Drewett (1982) concluded that the long mounds represent the primary settlement, while the oval mounds represent a secondary settlement.

An application of viewshed analysis explores how the Wari empire in the Middle Horizon of Peru distributed sites across the settlement landscape (Marsh & Schreiber, 2015). According to them, areas with more defensible landscapes were seen as places where sacred landmarks or direct surveillance outposts were constructed (Marsh & Schreiber, 2015, p. 54). To the Wari, visibility played an important part in development. They used this to develop a major road, agricultural terraces, and imperial sites (Marsh & Schreiber, 2015, p. 54). Wari also had a substantive military that conquered other provinces based on local conditions and strategic locations (Marsh & Schreiber, 2015, p. 55).

Similarly, Nutsford et al. (2015) discussed the importance of visual access to surrounding terrains. They specifically emphasised how the significance of a terrain is influenced by the "vertical dimension and distance from the observer (Nutsford et al., 2015, p. 1). According to them, closer visible objects or terrains have more significance than distant ones. However, these factors are influenced by the relative size of the observer (Nutsford et al. 2015, p. 2), directly affecting anthropogenic activities in the landscape.

Viewshed provides information on the decision-making associated with establishing settlements (Zheng et al., 2020). They aimed to evaluate how viewshed could be used to identify or simulate the settlement locations in the metropolitan area of the Oyo Empire in Nigeria between AD 1570 – 1830 (Zheng et al., 2020, p. 1). The study revealed that the movement and settlement of the Oyo Empire rested on two factors. First were biophysical drivers, which include elevation and slope, and secondly human drivers, which include population size (Zheng et al., 2020, p. 2). Results from the viewshed showed that the settlements had a higher probability of

being established in areas with elevation between 233 and 297 meters. The viewshed also revealed that settlements were small, closer to bodies of water, and in some instances, people occupied settlements at the base of hills where water bodies settled.

Viewshed analysis is an important component of maritime cultural landscape approaches, particularly in island settings, as it helps explain why certain islands were chosen for travel or settlement. It provides insight into how past groups perceived and navigated their environment by addressing the question, “What do I see?” By transforming raw geographic data into information about visual experience, viewshed methods help reconstruct patterns of movement across landscapes.

In this study, viewshed analysis is used to assess the role of visibility in travel and settlement decisions related to Main Duck Island. The analysis evaluates whether sightlines between Main Duck, nearby islands, the Ontario mainland, and the New York shoreline could have served as reliable visual markers for canoe navigation. Specifically, it examines whether an observer could move between islands north of Point Traverse and south toward New York while maintaining visual contact with the previous landmass. The resulting viewsheds for the Galloo Island region reveal the extent to which Main Duck and neighbouring islands were visible from one another, providing clues to possible routes and inter-island connectivity on Lake Ontario.

5.5 Landscape Change

Air photographs are the products of aerial photography. Aerial photograph of Stonehenge in 1906 is considered the first archaeological aerial photograph (Bewley et al., 2005, p. 274). The recognition of the value of air photographs to archaeology is credited to O. G. S. Crawford (Bewley et al., 2005, p. 275). Air photographs are useful

for looking at land cover change because they assess the long-term change of the landscape over time. It provides a pictorial view of the landscape over a period and helps identify sections of the landscape affected by the change. Aerial photography produces advanced photogrammetric 3D information, such as Digital Terrain Model (DTM) and Digital Surface Model (DSM), that provide accurate height information that could be used to take measurements of a large area (Pahava & Kaur, 2020). Archaeologists can use this information to measure the foundations of structures whose outlines are visible from an aerial perspective. Many countries used this method to understand enemy terrains during conflicts such as wars and to produce maps (Pahava & Kaur, 2020). Typical examples are online maps used for various purposes in the contemporary world.

Analysis of land cover using aerial photography produces high-quality orthorectified imagery and photomosaics that provide spatially accurate representations of the landscape (Pahava and Kaur, 2020). The use of aerial photography or air photos reveals contextual information about a given area. This helps the appropriate authorities identify the agents of change and provide resources where necessary for remediation, preservation, or conservation (National Collection of Aerial Photography, n/d). Aerial photography may reveal two types of landscape change. These changes may be immediate or over a short period of time or gradual over or more subtle over a longer period. These are termed land cover conversion and land cover modification (Turner & Meyer, 1994). Land cover conversion happens over a short period of time, changing the land cover of specific areas. Processes that may result in this form of change include agriculture and urban expansion. Land cover modification may result from gradual natural processes that may affect a larger area.

These may include the invasion of plant species in a new environment over a period (Hudak & Wessman, 1998).

Research conducted by Hudak and Wessman (1998) focused on bush encroachment in South Africa, which reduced the grazing capacity for animals and led to loss of income for rangers. The study revealed the extent to which these bushes have invaded viable land for crop production, the density of the bushes, and how these affected the production of grains. Hudak and Wessman (1998) found that the woody plant densities provided a map of the distribution of these densities through the reclassification of pixel values over the landscape. Singh (1989) documents that these pixels are distributed within bands that test for change in the landscape. "Pixels showing radiance change are found in the tails of the distribution while pixels showing no radiance change tend to be grouped around the mean" (Singh, 1989, p. 992).

I evaluated changes to Main Duck Island's landscape using air photographs taken at various times in the last sixty-five years (1930-1995). Digital air photographs were retrieved from the National Air Photo Library (NAPL) and Trent University's Maps, Data and Government Information Centre (MaDGIC). The National Air Photo Library is a subsidiary of Natural Resources Canada that archives over 6 million aerial photographs of various areas in Canada. These air photographs were searched and requested through the online search portal called the Earth Observation Data Management System (EODMS). This online search platform aided in the search and requests for air photographs of Main Duck Island. Within the EODMS database, the National Air Photo Library is selected since it archives a huge number of aerial photographs.

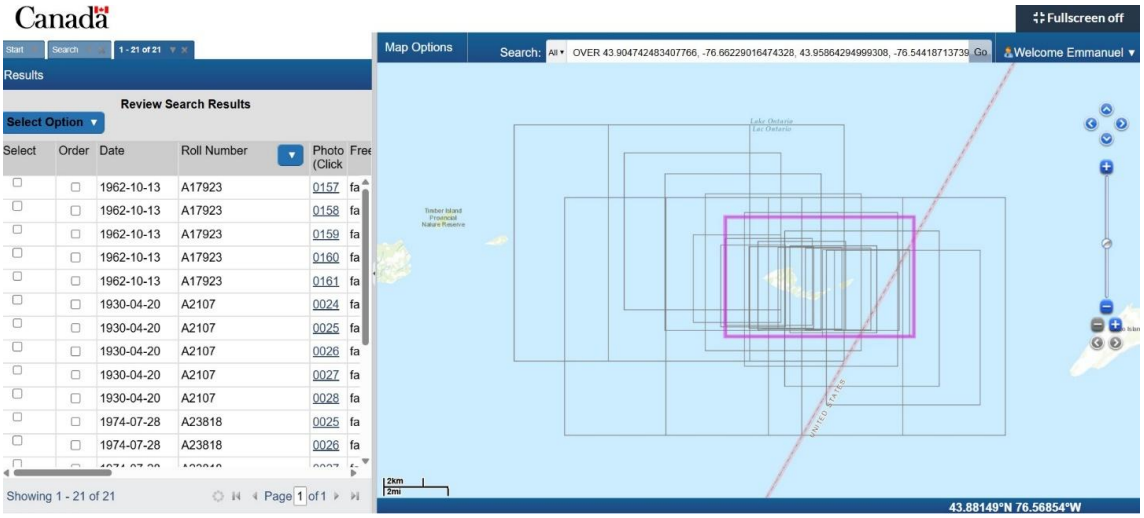

Figure 5. 3 Main Duck Air Photographs in the EODMS Database (From: EODMS, n/d).

Using control points in the form of UTM coordinates, interpolations were made in ArcGIS Pro to resample the air photo and calculate real-world coordinates. Air photos were retrieved from the National Air Photo Library (NAPL) (Fig. 5.3) and Trent University's Maps, Data and Government Information Centre (MaDGIC).

Landscape change maps were derived through a series of analyses in ArcGIS Pro (version 3.5.3). To arrive at these maps, air photographs had to be digitized manually. Manual digitalization included integrating Main Duck's air photos into the base map and tracing out the island's land area. Since the air photographs were taken over a period of 65 years, the difference in lenses may contribute to a significant difference in image properties. Hence, these air photographs were georeferenced using ground control points to fit the scale of the base map and other historical air photographs. It is also worth noting that the air photographs were taken between April and October in the various years. This places the time these air photographs were taken between summer and fall. Air photos from 1930, 1962, 1974, and 1995 were integrated into

Main Duck's basemap (Figs. 5.4, 5.5, 5.6, and 5.7). The air photographs from the National Air Photo Library (NAPL), 1930, 1974, and 1995 had to be resampled to fit Main Duck's geographical area. In contrast, the 1962 air photographs from MaDGIC were already georeferenced. Resampling and georeferencing were important because these photographs were taken over a period of 65 years using different lenses and different geographical scales. There is a total of 21 air photographs of Main Duck in the National Air Photo Library archives. Amongst these, three air photographs were requested from the National Air Photo Library and one air photograph from MaDGIC (Table 5.1).

Table 5. 1 Main Duck archived air photographs (From: NAPL via EODMS, N/D).

Dates	**Number of photographs in the archive**	**Roll number**
20th April 1930.	5 photographs	A2107
13th October 1962.	5 photographs	A17923
28th July 1974.	6 photographs	A23818
14th April 1976.	3 photographs	A24316
7th April 1995.	2 photographs	A28172

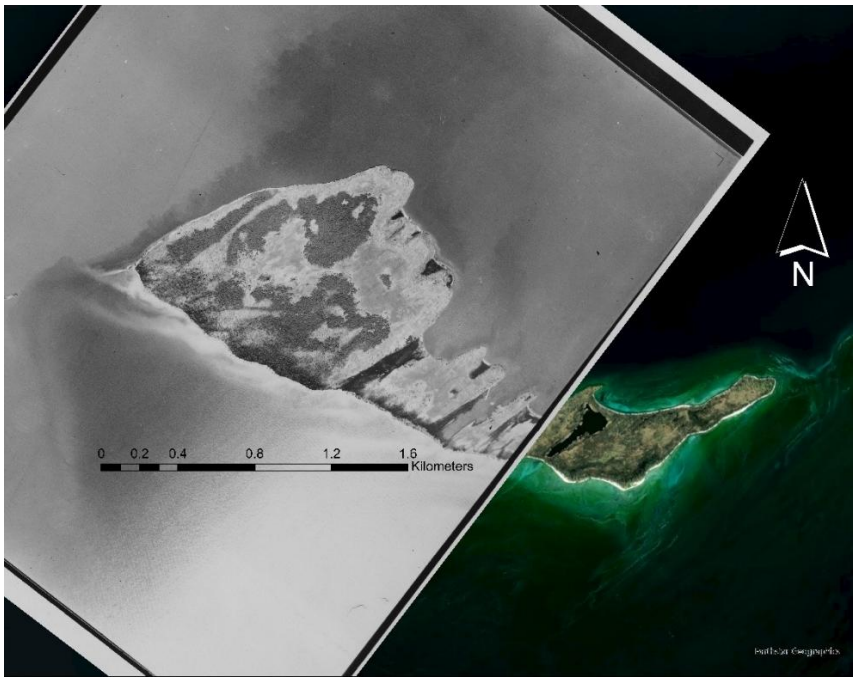

Figure 5.4 Air Photography from 1930 Integrated into a Topographic Map of Main Duck.

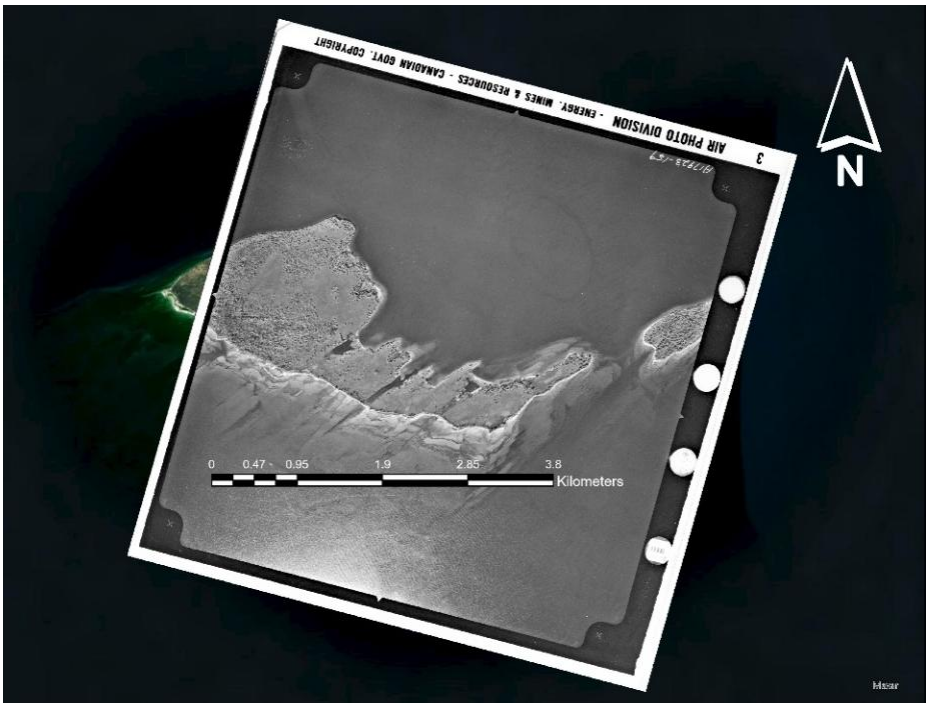

Figure 5.5 Air Photography from 1962 Integrated into a Topographic Map of Main Duck.

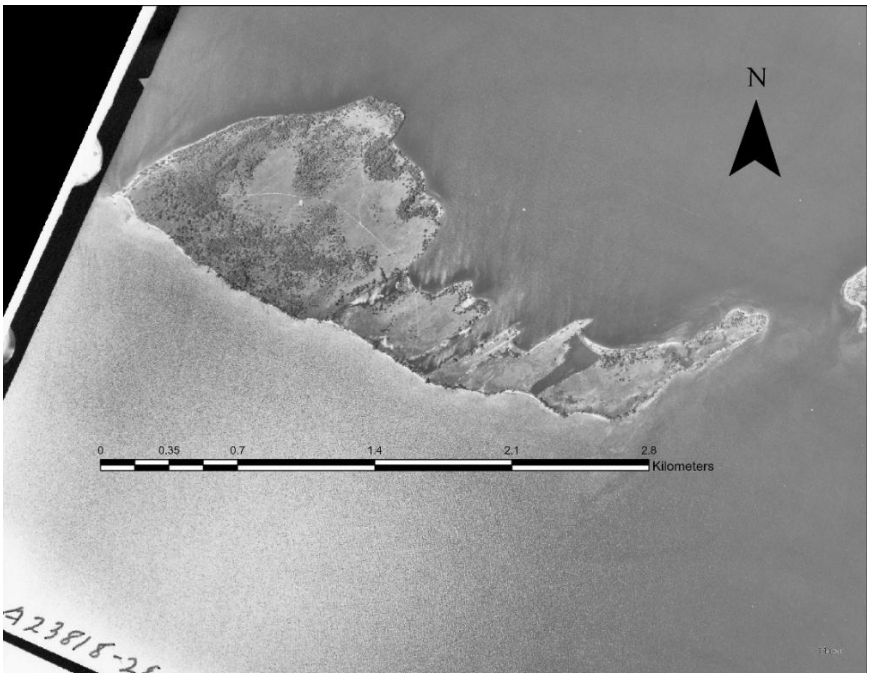

Figure 5.6 Air Photography from 1974 Integrated into a Topographic Map of Main Duck.

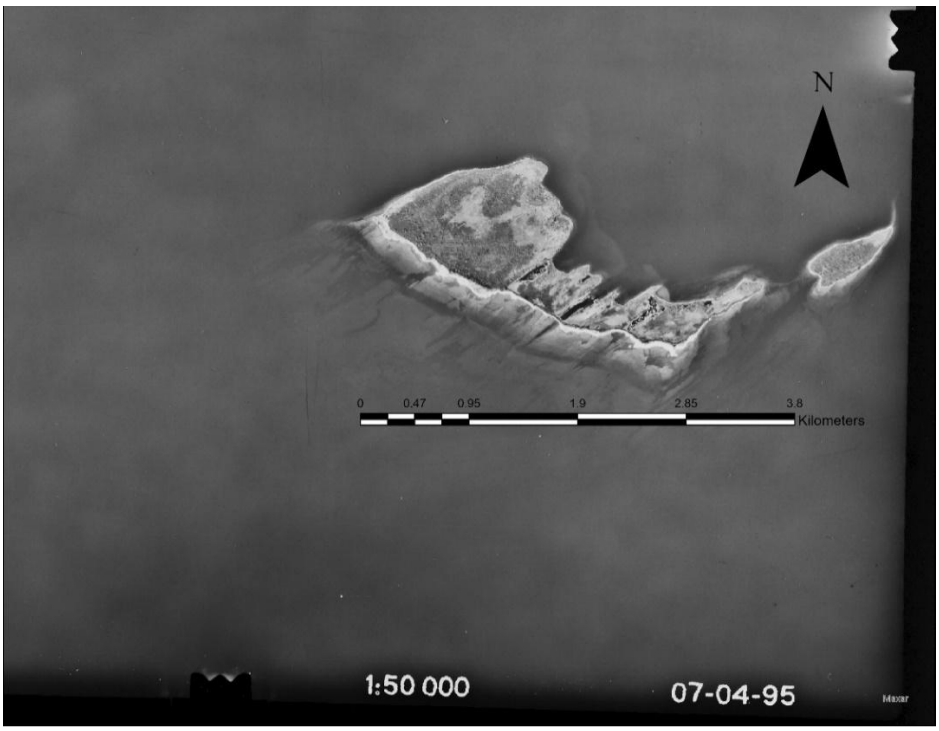

Figure 5.7 Air Photography from 1995 Integrated into a Topographic Map of Main Duck.

The method of analysis was as follows. First, each digital air photographs was reclassified to isolate land from water. To do this, I digitized the outline of the island to make a vector polygon. I used this to remove areas of the photograph that captured water, because water has a different pixel value that may influence land cover analysis. Masking the island enables the concentration on areas of high relevance and reliance (Roy et al., 2014). The new island polygon is created by creating a new polygon feature class, which provides editing tools to trace landscape surfaces. The island vector polygon is converted into a raster using the "Polygon to Raster" tool in ArcGIS Pro.

Second, each photograph of the island was converted to a raster and reclassified to reveal the various pixel values showing a shallow or dense vegetation area. The reclassification of air photographs was undertaken using natural breaks to separate into two categories. Natural breaks are used to rank numerical values (pixels) of non-uniform distribution, providing an unequal class based on varying frequency of observation per class (ArcGIS Pro, version 3.5.3). Two categories were used because the analysis aimed to group the pixels of the air photographs into two different land classes. The reclassification is important because it demarcates the areas with higher pixel values (denser vegetation areas) and lower pixel values (less dense vegetation areas).

The purpose of this analysis is to understand whether Main Duck's landscape has changed over the years. The analysis of air photographs helps identify these changes and specific locations where these changes have occurred. This analysis will also suggest whether these landscape changes were caused naturally or through

anthropogenic activities. The generation of these maps can also suggest various locations on the island where archaeological investigations ought to be intensified.

5.6 Archaeological Reconnaissance Survey

A reconnaissance survey is a conscious effort to gather relevant data from the field. A reconnaissance survey, as explained by Sharer and Ashmore, is a systematic attempt to identify or locate archaeological sites (Sharer & Ashmore 1993, p. 187). Brian Fagan, in his definition of reconnaissance survey, agrees with Sharer and Ashmore by explaining that "reconnaissance survey also involves a preliminary examination of the area to identify sites, to assess the potential, and to establish tentative site distributions" (Fagan & DeCorse, 1999, p. 160).

5.6.1 Ground Reconnaissance Survey

For Main Duck, the type of ground reconnaissance survey that was conducted was a surface survey. The surface survey is an archaeological exploration conducted on the ground surface. Instructions and restrictions from Parks Canada only permitted non-destructive archaeological surveys, a testament to our respect for the island's cultural integrity. Hence, test pitting and excavations were not conducted on the Main Duck. Surface survey, also known as field walking, is a visual search method in which archaeologists carefully inspect the ground for traces of human activity (Gruškovnjak, 2019). The archaeologist is also responsible for documenting and recording information on artifacts found during the ground survey.

The ground reconnaissance survey was conducted using both random and systematic techniques. A random survey, as the name suggests, involved choosing

sites without any specific guidance from grids. This technique was employed to cover various sites and discover traces of human activities. On the other hand, a systematic survey focused on specific areas, such as the shoreline, is known to contain traces of past human activities. This technique was akin to the judgmental sampling technique used to discover sites. The systematic technique employed in known sites involved surveying from one end to the other, providing a comprehensive and strategic approach to our research. Ground reconnaissance brings both the archaeologist and the site into direct contact. Through this method, archaeologists can understand the minute details of material remains on the site. The specificity of the ground reconnaissance survey enables the archaeologist to interpret how the inhabitants conceived their environment. Through a ground reconnaissance survey, the archaeologist can identify the delimitation of surface scatters, and the distribution of material remains on the site.

5.6.2 Aerial Reconnaissance

Aerial reconnaissance refers to the remote survey of an archaeological site from above. This method of reconnaissance survey is conducted using equipment such as drones, planes, or other equipment that can capture the site without requiring ground contact. The importance of this method rests in the ideology that it produces a more widespread view of the site. This reconnaissance survey may generate pictures or videos from various heights above the site. Aerial reconnaissance may be used to identify the extent of the site. This method may also reveal larger foundations buried beneath vegetation, which an archaeologist may not detect through ground reconnaissance. Aerial reconnaissance may also be used to identify crop and soil marks. These show the nature of the soil and vegetation based on whether traces are

buried underneath a site. Patterns created on sites that may not be noticed at ground level are easily captured from aerial reconnaissance surveys (Paskey & Cisneros, 2020, p. 6).

This method produces results in the form of air photographs. Air photographs are used to identify features such as crop marks and landmarks that may not be visible from the ground (Kadhim & Abed, 2021, p. 2). Kadhim and Abed (2021) approached the use of aerial photographs from the perspective of Light Detection and Ranging (LiDAR). Typical examples where aerial photographs were used include research in the Solway Plain, where square enclosures thought to be Romano-British farmsteads were uncovered (Bewley et al., 2005, p. 281). Another study that employed this technique was the Yorkshire Dales Project, which investigated the coaxial field systems and their changes over time (Bewley et al., 2005, p. 281).

5.7 Ceramic Analysis

The purpose of this analysis is to find out if the material archaeological data discovered on Main Duck is similar to that found on the north shore of Lake Ontario or in the New York region. This answers the question of relationship between the island's Woodland period inhabitants and the surrounding region. The revelation of these materials places historical narratives and prehistoric notions within context, allowing other methods of research, such as dating methods, to provide more information about the archaeological data and the settler group at a given time.

Cultural relationships among Indigenous communities around the eastern part of Lake Ontario can be explored through the analysis of ceramic decorative motifs. The objective of ceramic analysis within this study was to determine whether

Indigenous ceramics found on Main Duck Island share closer stylistic affinities with assemblages from Ontario or from New York. Decorative motifs provide valuable indicators of cultural affiliation and interaction, reflecting how communities expressed identity and transmitted tradition through material culture. Variations in motif design, execution, and frequency can signal shifts in social networks, exchange, or influence across regional boundaries.

Within this framework, the analysis of ceramic surface finds from Main Duck Island and comparative collections from Sandbanks and other Lake Ontario sites focuses on identifying motif types and vessel parts that may reveal patterns of stylistic continuity or divergence. This approach aims to assess the extent of cultural interaction and mobility across the lake and to clarify the temporal and social context of occupation on Main Duck Island. Although extensive excavations are necessary to determine the range of variation of Indigenous pottery on Main Duck, reconnaissance surveys have unearthed pottery pieces with elaborate decorative motifs. The decorated sherds found during the reconnaissance survey at Main Duck were compared to decorative motifs from the Sand Banks (A1Gh-32) and sites from New York (Fig. 5.8). SandBanks was selected as it is the closest well-documented Indigenous site with Middle and Late Woodland ceramic artifacts that can be compared to those recovered on Main Duck. The Sand Banks excavation was undertaken by Sheryl A. Smith and a crew of three between July and August 1981, at the request of the Ministry of Natural Resources and with the co-operation of the office of the Eastern Region Archaeologist, Ministry of Culture and Recreation (Smith, 1981, p. 2). The research at Sandbanks had four objectives. First, to determine the boundaries of the prehistoric archaeological site discovered by Mr. Jim Ives of the Park staff; second, to define the cultural sequence and chronology at the site, that is, who lived there and when; third,

to investigate the nature of the materials and determine the function (s) of the site; and fourth, to provide direction to the Ministry of Natural Resources concerning the archaeological resource management (Smith, 1981, p. 7). The archaeological excavations were divided into two distinct areas, Area A and Area B. Pot sherds from both areas were analysed. The sites in New York include the Kipp Island, located in the Seneca River County, north of Cayuga Lake, and the Kelso site in the Onondaga County, located in the Town of Elbridge (Hart et al., 2011; Seneca County, 2019; Town and Villages Offices of Public Historian & Elbridge Historical Archives, 1963). These sites in New York were selected for this research because both sites produced similar decoration to that found on Main Duck and in SandBanks. The exact location of the Kelso site is not shared. Although the site was archaeologically investigated in the 1960s, there is concern that giving out the site's location will lead to looting and loss of the site's context. However, the site generally falls within the Town of Elbridge (Town and Villages Offices of Public Historian & Elbridge Historical Archives, 1963).

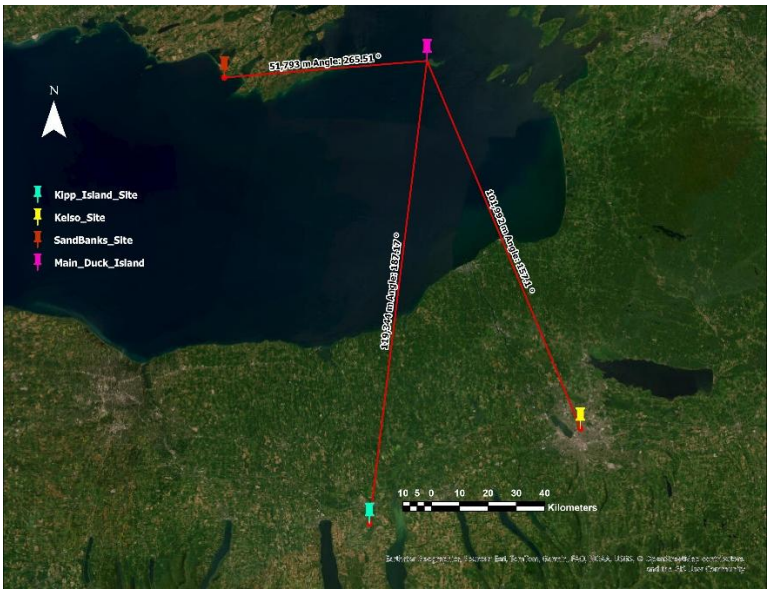

Figure 5. 8 Map Showing Kipp Island (Turquoise), Kelso Site (Yellow), SandBanks Site (Red), and Main Duck (Pink).

Chapter 6: Results

6.1 Introduction

This chapter provides the results of paleoshoreline modeling, visibility, landscape change, archaeological reconnaissance survey, and ceramic analysis. These methods contribute to a deeper understanding of how natural and cultural processes interact in shaping island landscapes, offering new insights into the historical and archaeological significance of Lake Ontario's maritime environments.

6.2 Paleoshoreline Modeling

Reconstruction of Main Duck's shoreline is crucial for understanding how the island was connected to the mainland of Canada to the north and to New York to the south when it emerged as an isolated landmass, and how its size and configuration changed, thereby informing future surveys of submerged shorelines.

Using the methods described in the previous chapter and the outlet sills generated by Anderson and Lewis (2012), I generated a time series of paleoshoreline change between 10,000 BP and 4,000 BP for Main Duck Island and the surrounding area of eastern Lake Ontario (Figs. 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, and 6.7). These time slices show the ancient shorelines, the increase of Lake Ontario water levels, and how Main Duck became an island.

Reconstruction of the shorelines revealed the rate at which Main Duck's land mass was lost to Lake Ontario (Fig. 6.9 and Table 6.1). According to the generated GIS models, Main Duck became an island about 8000 years BP. The island's land area has changed substantially since then (Fig. 6.10 and Table 6.2). The west shore of the

island has lost more land overall due to gradual change (Fig. 6.8). Consequently, any traces of human use of the island along the shoreline in the more distant past will have been submerged. These issues are discussed more fully in the discussion presented in Chapter 7.

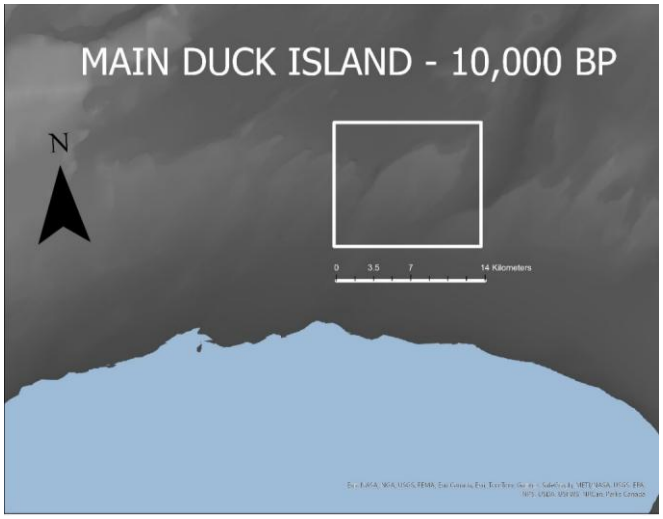

Figure 6. 1 Paleoshoreline of Eastern Lake Ontario at 10,000 BP With Main Duck in the Outlines Box.

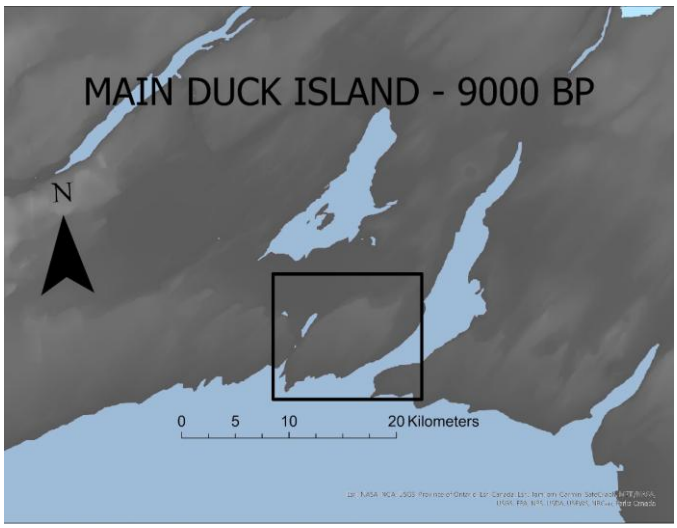

Figure 6. 2 Paleoshoreline of Eastern Lake Ontario at 9000 BP With Main Ducks South Shore Detached from New York.

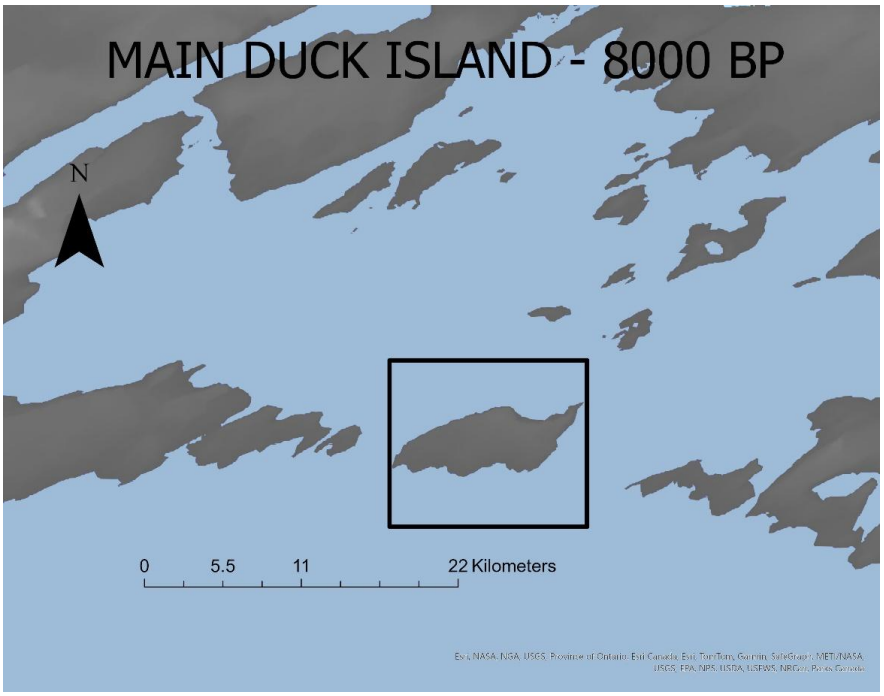

Figure 6. 3 Paleoshoreline of Eastern Lake Ontario at 8000 BP With Main Duck as an Island.

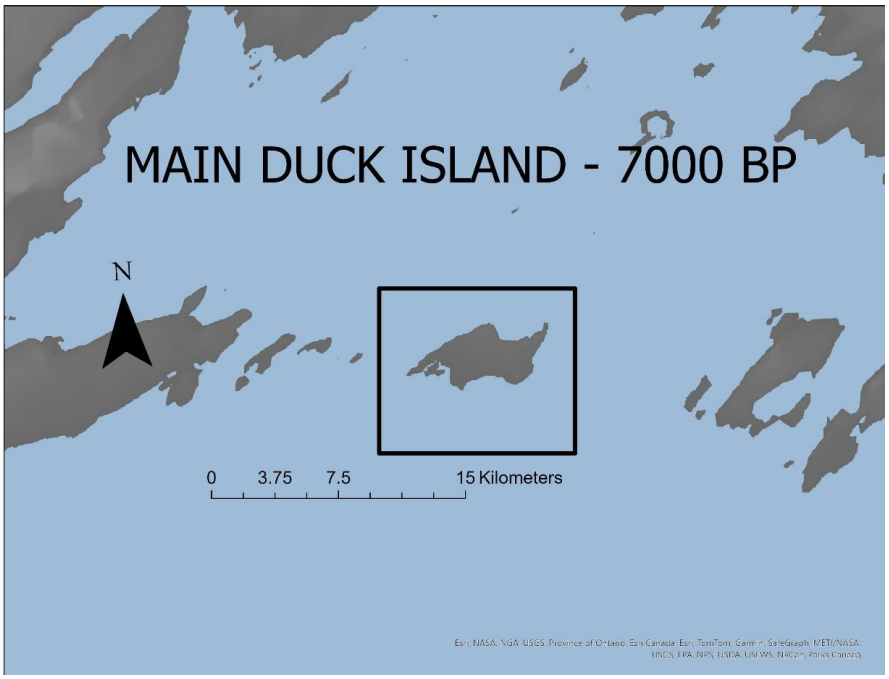

Figure 6. 4 Paleoshoreline of Eastern Lake Ontario at 7000 BP Showing a Reduced Land Area Size of Main Duck.

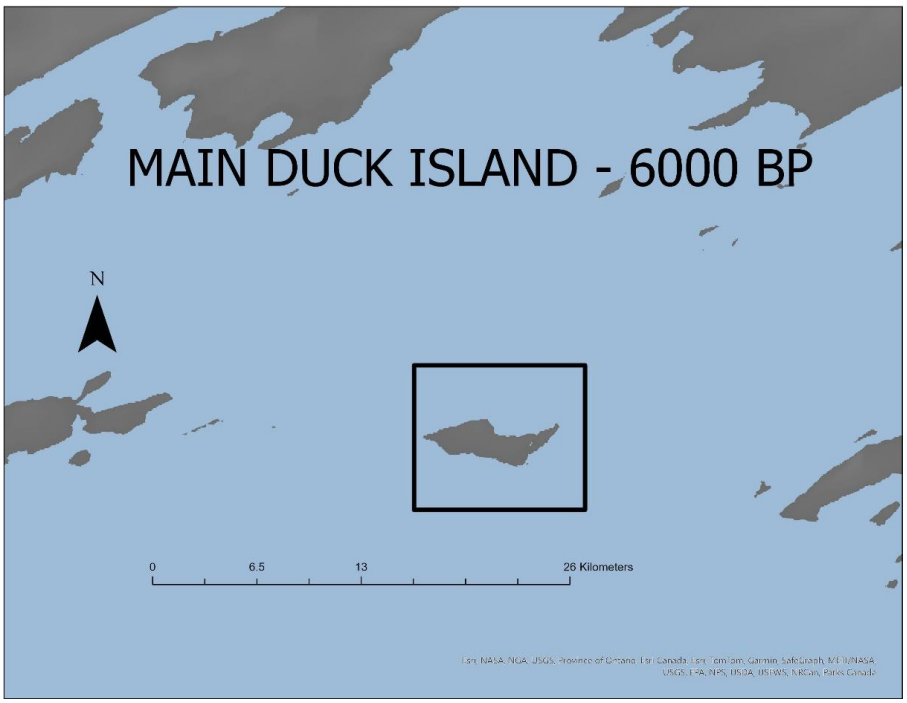

Figure 6. 5 Paleoshoreline of Eastern Lake Ontario at 6000 BP Showing Further Reduction in Main Duck's Land Size.

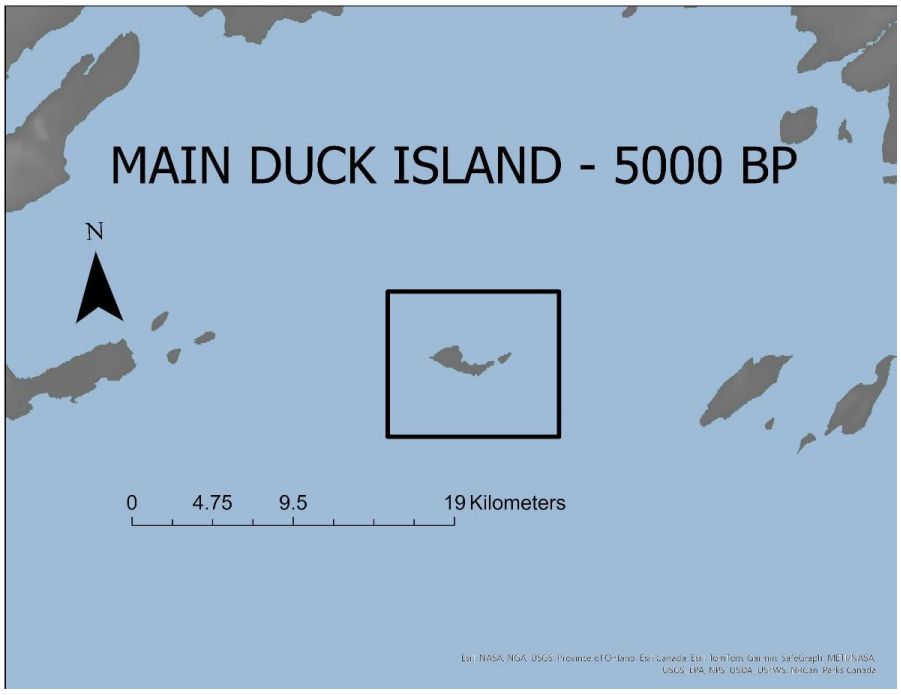

Figure 6. 6 Paleoshoreline of Eastern Lake Ontario at 5000 BP Showing Yorkshire Island Detached From Main Duck.

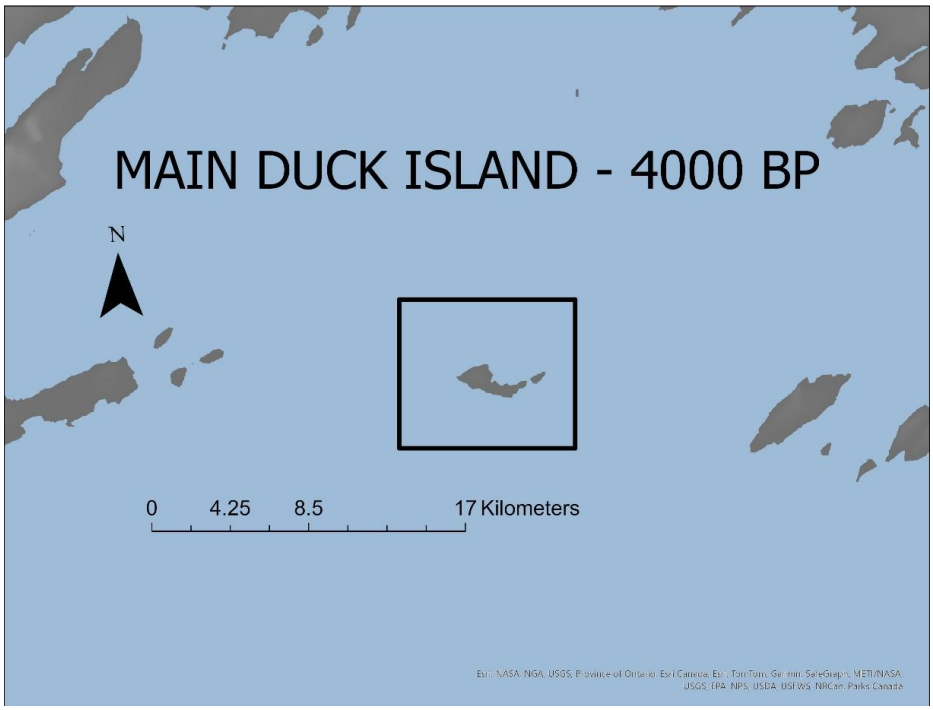

Figure 6. 7 Paleoshoreline of Eastern Lake Ontario at 4000 BP Showing the Land Size of Main Duck When Lake Ontario Stabilized.

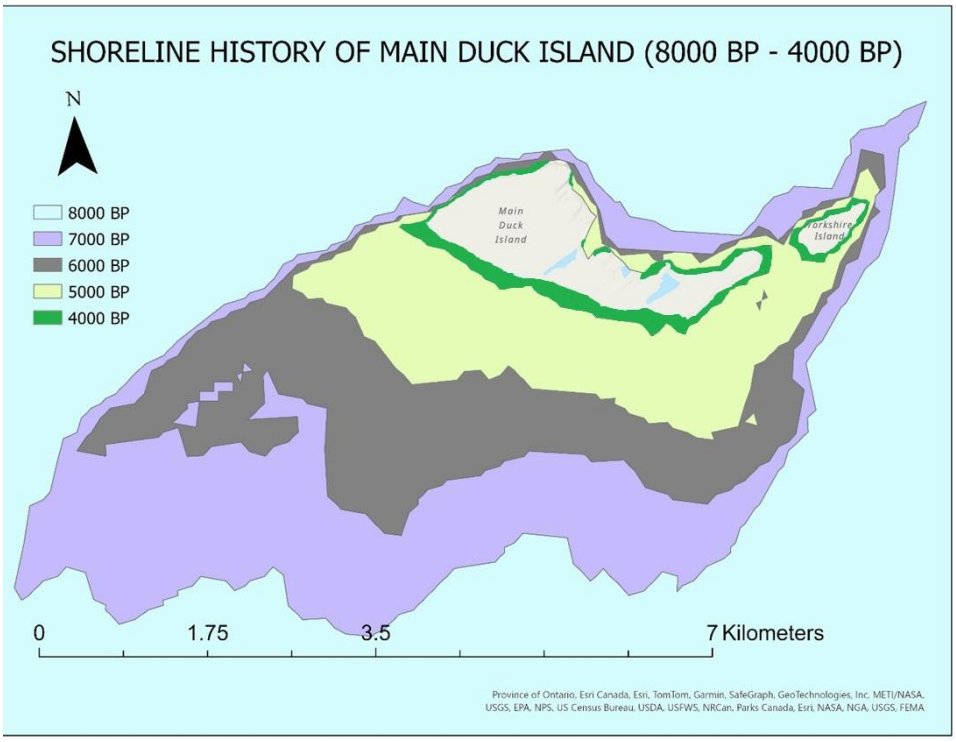

Figure 6. 8 Shoreline History Showing Land Loss at the Western Shoreline.

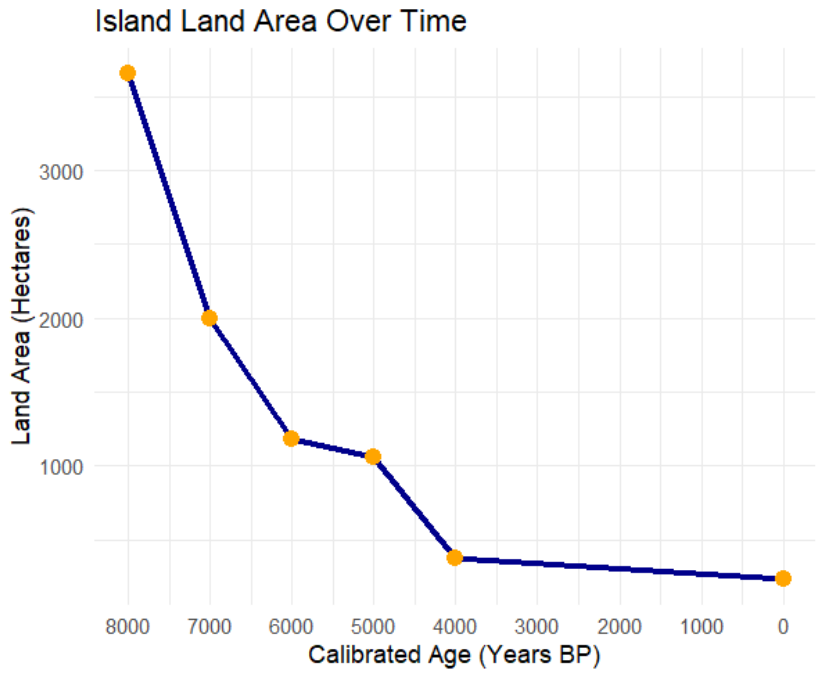

Figure 6. 9 Graph Showing the Loss of Land Area to Lake Ontario Over Time.

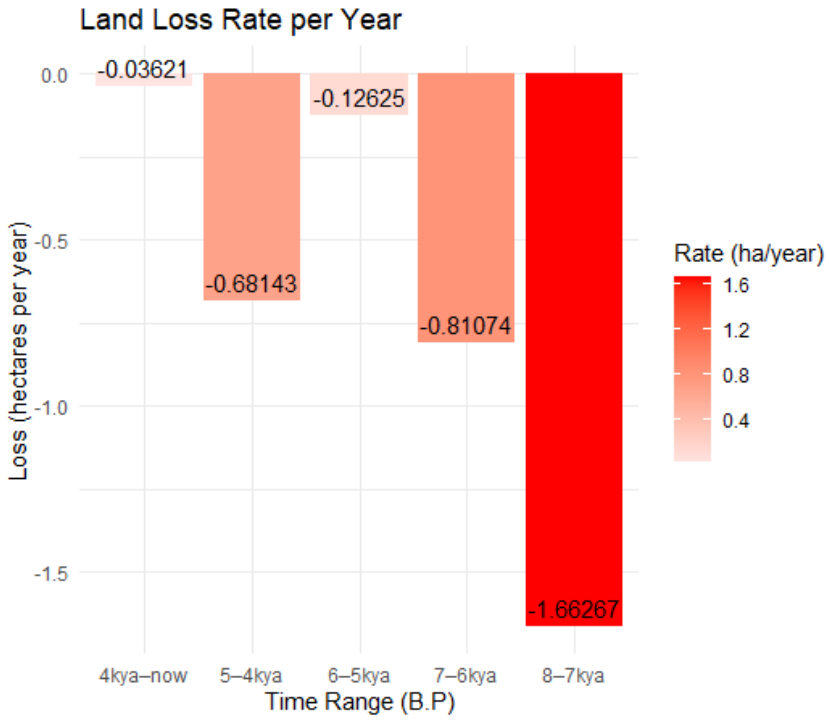

Figure 6. 10 Bar Chart Showing the rate of Land Loss per year.

Table 6. 1 Table Showing Elevation Level, Approximated Land Area, and Rate of Land Loss Per Year.

Calibrated age (years bp)	Original elevation (masl)	Approximate land area (ha)	Loss of land area per year (ha)
10,000	-48	Connected to Mainland	
9,000	0	Connected to Mainland	
8,000	24	3656	-1.66
7,000	40	1993	-0.81
6,000	50	1183	-0.12
5,000	55	1056	-0.68
4,000	64	375	-0.14
Present	75	230	-1.66

Table 6. 2 Table showing the land area lost to Lake Ontario between 8000 BP. to date.

Date Range	Land Area Lost in ha
8000 – 7000 BP	1663
7000 – 6000 BP	811
6000 – 5000 BP	126
5000 – 4000 BP	681
4000 - present	145
TOTAL	3426

6.3 Visibility

Viewshed analysis was conducted using the June 2025.2 ArcGIS online software. This analysis aimed at establishing whether a traveller in a canoe will be able to move between the island chain without losing sight of the islands ahead and behind them. Viewshed analysis was conducted from the north and south of Main Duck. Multiple observer points were placed on each island. Each island had points on its coast to aid bearing; a traveller in the canoe will want to move to the next island without losing sight of the previous island. This will allow the traveller in the canoe to fall within the visibility range of more than one island while moving towards the next island. These points were placed on Main Duck's north and south coasts. With the observer's height of 1.5 m, assuming the observer is standing in the canoe, and the target (island) height of 0 m, meaning the observer would see at ground level, and a maximum distance of 15 kilometres, the visibility in Figure 6.11 was produced. A maximum distance of 15 kilometres was selected because the average water level of Lake Ontario is 75 meters above sea level, while the highest point on Main Duck is about 85 meters above sea level, making the target, Main Duck, approximately 10 meters high.

Conroy (n/d) explains and breaks down the formula for how far a person could see the horizon from the shore using Pythagoras' theorem. That is, the height of the observer (h), the radius of the earth (R), the length of the line connecting the observer and the horizon (l), and the arc (s), which is the distance along the surface of the earth to the horizon. According to Conroy (n/d), $l = s$, and since the height of the observer is very small, it can be ignored, producing the formula $s = l = \sqrt{2Rh}$. Since the earth's

radius is about 6371km, R=6371 and 6.371,000 in meters. Hence, s = l = √2(6371000) h. This ultimately is simplified to provide the final formula s = l = 3.6√h.

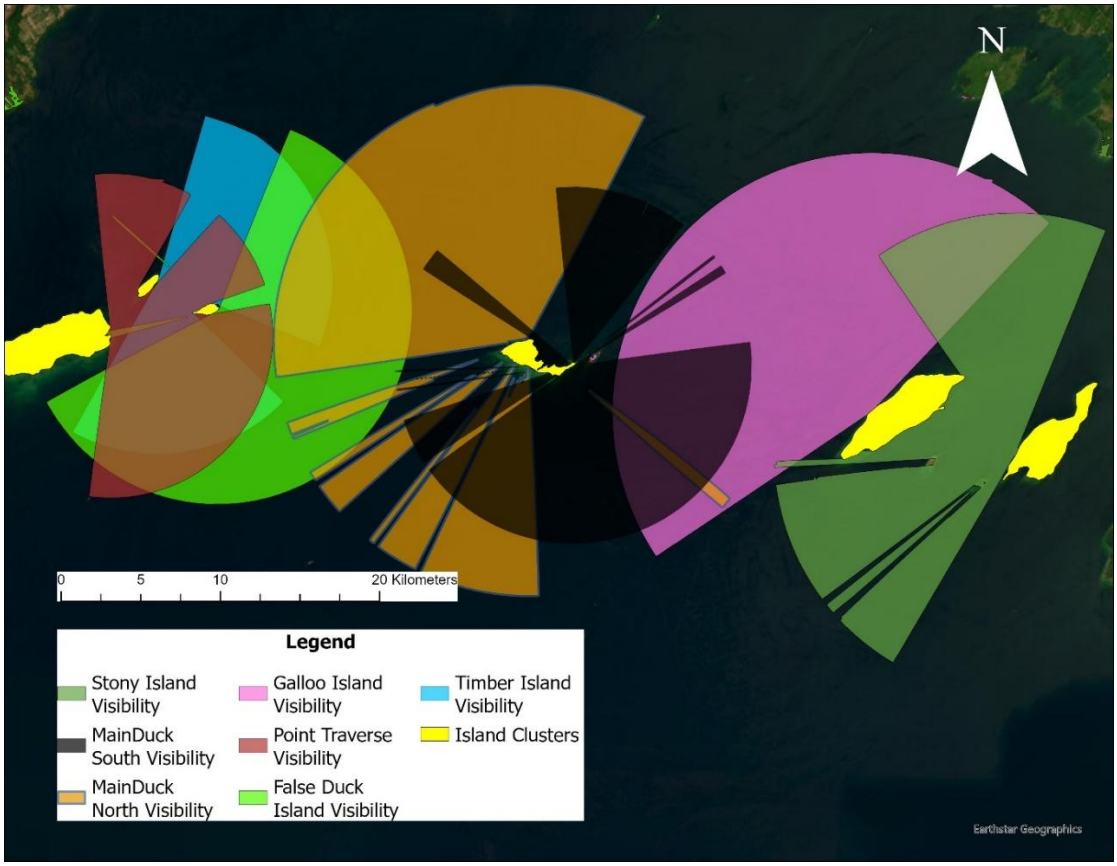

Figure 6. 11 Visibility from Main Duck and Point Traverse (Mainland Canada).

Per the formula used to calculate the maximum distance to see a target (3.6 x √h), the heights of the observer and the target are multiplied by the formula, and the products are added. Thus:

Maximum distance for observer (D_1): 3.6 x √1.5 = 4.4 km

Maximum distance for target (D_2): 3.6 x √10 = 11.4 km

Therefore $D_1 + D_2$ = 15.8 km

Viewshed is an important tool for understanding intervisibility in the context of islands. It provides information regarding movement patterns due to spatial orientation during crucial seasons such as colonization or a quest for new resources. To address limitations in viewshed analysis, a cumulative viewshed analysis may be employed. Cumulative viewshed combines multiple visibility models to represent diverse environments to understand visibility networks (Chapman, 2003). Incorporating anthropogenic elements, such as human alterations, such as buildings, or a seasonal growth of flora, provided real-world scenarios on how the island may be used presently.

From the viewshed, it was observed that Point Traverse's visibility overlaps with both False Duck and Timber Island, while the visibility from False Duck overlaps with the visibility from Main Duck.

6.4 Landscape Change

Based on analysis of air photographs, it can be stated that Main Duck has undergone significant landscape change in the last 90 years. The maps from 1930, 1974, and 1995 produce similar vegetative structures with dense vegetation abounding along the northwestern shoreline (Figs. 6.12, 6.14, and 6.15). The landscape analysis from 1962 showed that the dense vegetation of Main Duck remained the same, but had more patches of dense vegetation of trees throughout the landscape (Fig. 6.13).

These patterns suggest both anthropogenic and natural changes in vegetation. The fluctuating nature of the vegetation corroborates the historical accounts documented about land use on the island. Historical accounts peg land use on the island to the northwestern shoreline around the lighthouse complex, the northeastern

highland around the Dulles Buff chimney, the middle eastern shoreline in the schoolhouse bay and point area, and the village cove region of Main Duck. Land use patterns included the use of the island for farming and animal husbandry by Captain John Walters between 1848 and 1892 (Naval Marine Archives, 2016). Grazing on the island was critical in shaping the island's vegetative cover because Captain John Walters owned 400 sheep, 200 cattle, 60 hogs, and 30 horses. The use of the island by Claude Cole between 1904 and 1938 is also critical in explaining the changing vegetation. Cole's use of the island for smuggling on Main Duck's eastern shoreline around the schoolhouse bay sites and his introduction of bulls and a herd of buffalo (grazing in Main Duck's open areas) altered the landscape of Main Duck during his ownership of the island (Townsend, n/d). The natural change of the island's landscape is seen from after ownership of the island was transferred to Parks Canada in 1977, at which point activities on the island were limited to scientific research. The maps from 1974 and 1995 shows the decrease in dense vegetation on the western shoreline and mid-section of Main Duck. This may not be attributed to anthropogenic activities since the island has not been inhabited.

Analysis of the air photograph from 1930 revealed two building-like structures west of the Village Cove barn (Fig. 6.16). A screenshot of Main Duck's current aerial view was taken using google to provide context as to where these building structures would have been. However, the ground reconnaissance survey revealed that the area containing the building structures have been overtaken by vegetation.

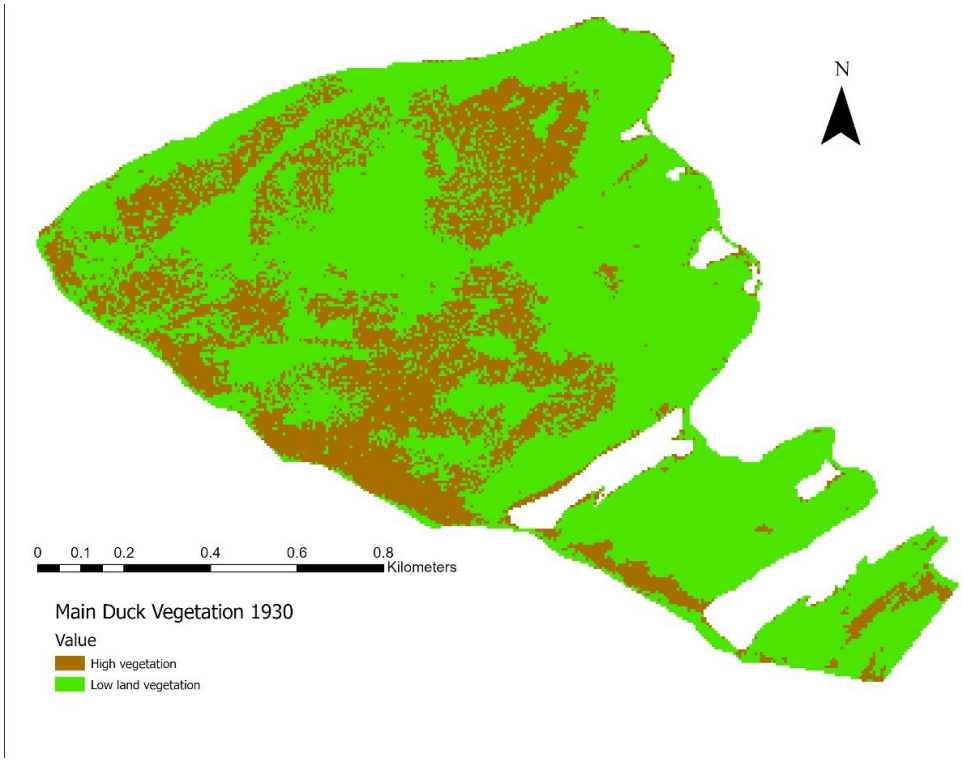

Figure 6. 12 Main Duck Island Landscape in 1930.

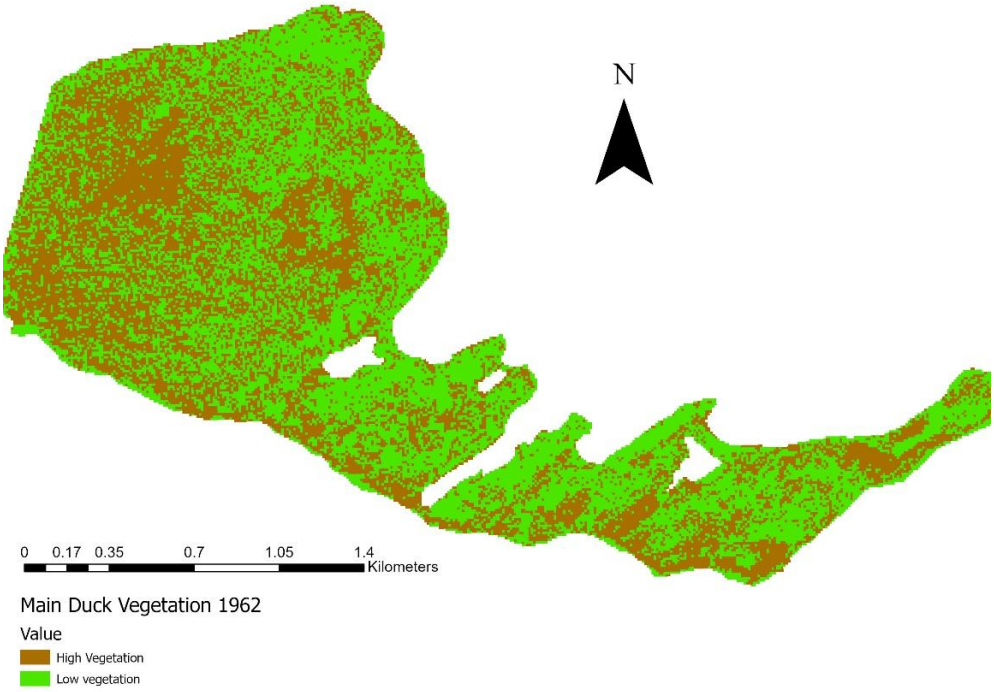

Figure 6. 13 Main Duck Island's Landscape in 1962.

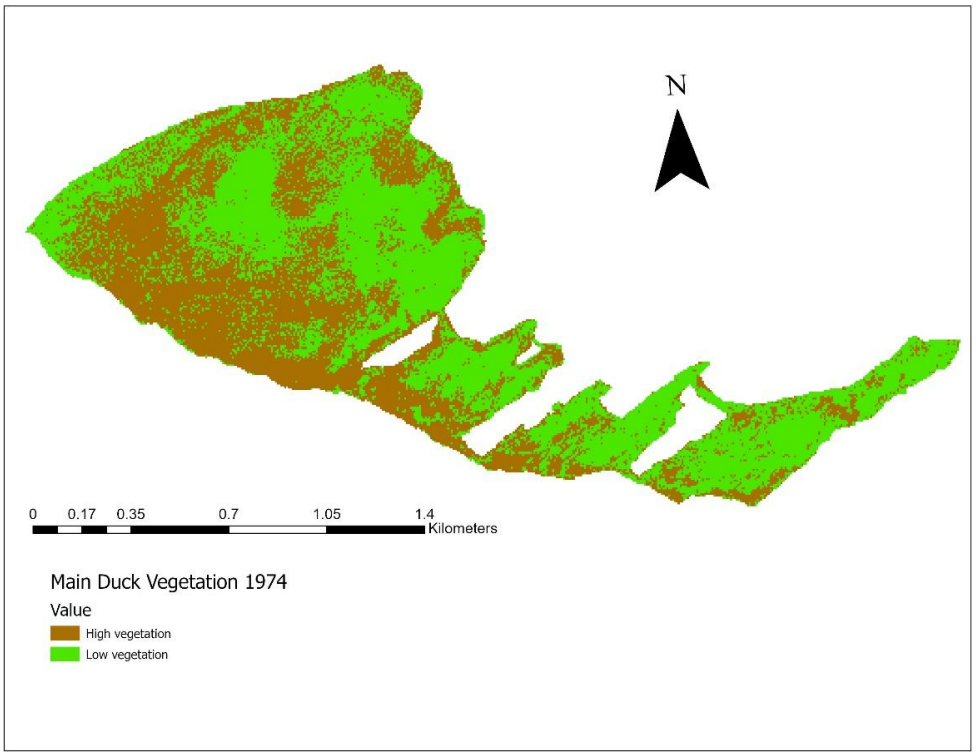

Figure 6. 14 Main Duck Island's Landscape in 1974.

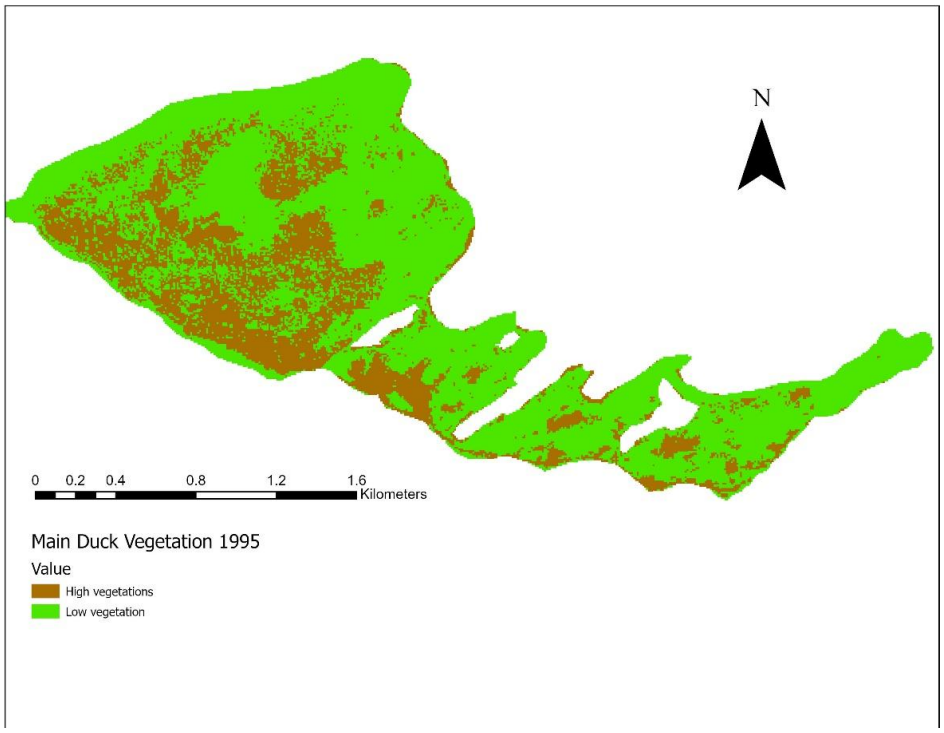

Figure 6. 15 Main Duck Island's Landscape in 1995.

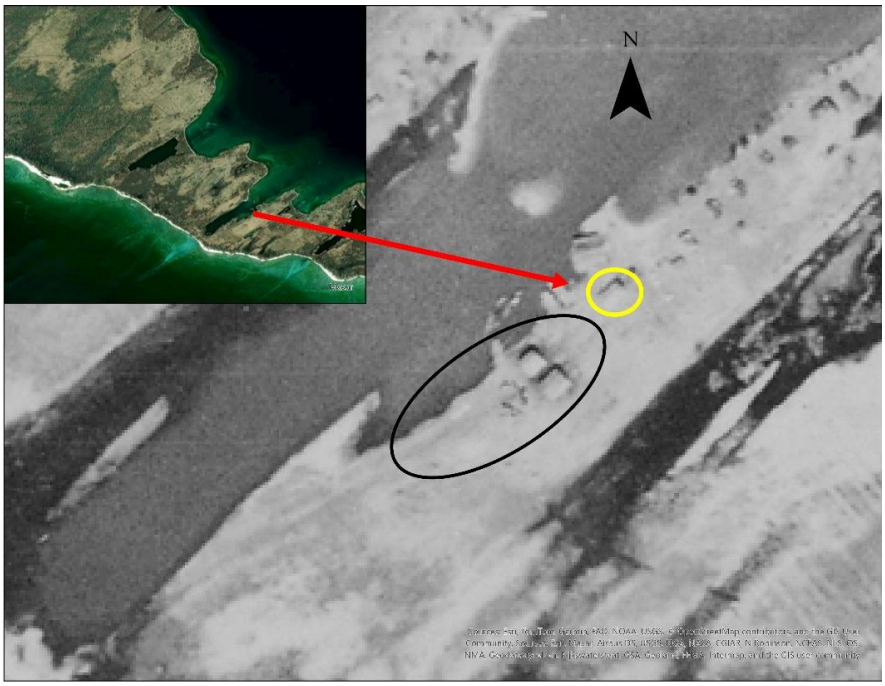

Figure 6. 16 Air Photograph (Top) Showing the Village Cove Barn (Yellow) and Other Buildings on Main Duck (Black).

Figure 6. 17 A Picture from 1930 Showing the Barn as the Last Structure (Queens University Archives, n/d).

The first photograph (Fig. 6.16) shows the building structures in the Village Cove area, with the last structure, circled in yellow, being the barn, the only surviving structure on the Village Cove site. The barn provided the context needed to place the building structures within the area west of Village Cove. The second photograph (Fig. 6.17) provides a ground-level shot of the area from the west, showing the east. In this photograph, the barn is circled in red and is seen as the last structure after the building structures (Fig. 6.17). These photographs were taken in the 1930s.

6.5 Archaeological Reconnaissance Survey

Ground reconnaissance survey on Main Duck revealed 10 new archaeologically significant places. The survey was also used to redocument previously identified sites. A reconnaissance survey is important, especially for sites such as Main Duck, because the nature of the landscape is constantly changing due to various factors and conditions. It was imperative to conduct an archaeological reconnaissance survey because it forms part of the non-destructive methods of doing archaeological research.

6.5.1 Results of Reconnaissance Survey: Site Descriptions

A prior reconnaissance survey conducted on Main Duck in 2001 by Parks Canada archaeologists (Ross & D'Annibale, 2001) led to the documentation of six sites. These sites are listed in Table 6.3.

Table 6. 3 Main Duck Sites and coordinates.

Site	**Coordinates**	
	Longitude	**Latitude**
Schoolhouse Bay	-76.617676	43.926795
Schoolhouse Point	-76.618638	43.926914
Chimney Bay 1	-76.619287	43.932804
Chimney Bay 2	-76.619275	43.932813
Dulles Buff Chimney	-76.620739	43.934422
Remains of a Car	-76.634834	43.933105

Table 6. 4 Table showing the clusters and coordinates of the new sites.

Category	**Location**	**Clusters**	**Coordinates**	
			Longitude	**Latitude**
Schoolhouse Sites	Schoolhouse Point	Concrete slab	-76.616000	43.927405
		Cluster of broken bottles	N/A	N/A
	Schoolhouse Bay	Cluster of Metals	-76.618638	43.926914
		Mooring rings	-76.619130	43.928394

	Opposite Schoolhouse Bay		-76.619057	43.928449
Lighthouse and duplex Sites	Adjacent duplex 1	Demolished foundation	-76.635141	43.933009
		Remains of metal signpost	-76.634670	43.933261
		Midden	-76.634571	43.933263
	Infront of duplex 2	Partially Eroded Stone and Concrete Stairway	-76.636885	43.932235
	Adjacent the Lighthouse	Well	-76.636452	43.932351
West Shoreline Sites	West shoreline	Metal frame	-76.621215	43.924164

Figure 6. 18 Map of Main Duck Showing Indigenous and Historical Sites.

Our re-visitation of these locations was an important goal in the 2024 season, as the previous survey had been conducted two decades ago. Archaeological reconnaissance survey was used to re-document known sites, as some geographical coordinates were inaccurate. The 2024 reconnaissance survey also discovered ten (10) new places that contained remains of past lifeways (Table 6.4). These sites are categorized into three site clusters, as follows:

1. Schoolhouse sites
2. Lighthouse and Duplex sites
3. West Shoreline sites

All identified sites, both previously known and newly recorded, were classified as either Indigenous or Historical. Indigenous sites are those containing material culture predating European settlement, whereas Historical sites include evidence associated with the documented or written record (Fig. 6.18).

6.5.2 Rediscovered sites

6.5.2.1 Schoolhouse Bay

The Schoolhouse Bay site was the first site to be rediscovered (Fig. 6.19). The area of the schoolhouse bay had a "small cabin on one of the highest points of the shoreline" (Gateley, 2012; Sprague, 2009). Sprague further mentions that the schoolhouse bay cabin was built when John Foster Dulles bought Main Duck in 1941 (Sprague, 2009). It is approximately 77.74 ± 3.37 meters above sea level. The Schoolhouse Bay site stretches about ten meters wide and approximately five (5) meters inland. The concrete feature stretched about five (5) meters inland from the shore. It was also observed that the Schoolhouse Bay site had a gently sloping shore,

which Lake Ontario would overrun should the water levels rise. Watermarks on the roots of short trees showed that the lake's water reached the site during high tides. The cluster of metals containing the wrought and iron nails was approximately seventy-eight meters from the Schoolhouse Bay site.

Figure 6. 19 Schoolhouse Bay Site.

6.5.2.2 Schoolhouse Point

Schoolhouse Point is located 150 meters away from Schoolhouse Bay. The site was found on a raised platform with a rocky base (Adams, 2008; Ross & D'Annibale, 2001). Ground reconnaissance survey was conducted five meters inland and covered about 150 meters along the Schoolhouse Point site, northward. A two-meter interval was used between two archaeologists to cover the land area. However, the dense nature of the vegetation restricted the movement of crew members to a one-meter ground reconnaissance survey from the coastal shoreline of Schoolhouse Point. Ground reconnaissance survey was conducted on Schoolhouse Point until reaching a concrete slab dug into the ground within the rocks. Before conducting a ground

reconnaissance survey at Schoolhouse Point, we undertook a preliminary survey by walking the low coastal shoreline adjacent to Schoolhouse Point. The survey yielded no results, as no archaeological site was found.

6.5.2.3 Chimney Bay 1

Chimney Bay 1 site is located south of the Dulles Buff Cliff and the eastern shoreline of Main Duck before the raised rocky Dulles Buff Cliff. The Chimney Bay site shoreline is covered with pebbles and small rocks. Ground reconnaissance at the Chimney Bay 1 site extended fifty meters north and south from its documented location. Ground reconnaissance revealed 5 local ceramic sherds (4 decorated, 1 undecorated). These local ceramics had multiple incisions drawn in a criss-cross pattern. The sherds measured approximately 2 cm in length and about 0.5 cm thick (Fig. 6.20).

Figure 6. 20 Potsherd Found at the Chimney Bay 1 site.

6.5.2.4 Chimney Bay 2

Chimney Bay 2 is approximately fifty meters away from Chimney Bay 1. Chimney Bay 2 is also located south of the Dulles Buff Cliff and the eastern shoreline of Main Duck before the raised rocky Dulles Buff Cliff. However, Chimney Bay 2 is characterized by a rocky shoreline as opposed to Chimney Bay 1's pebble and small rock shoreline. This site is on a raised elevation above Lake Ontario's water level. Reconnaissance survey of the site revealed traces of faunal remains and pottery sherds. Five sherds (all decorated) and one bone were discovered. The sherds discovered measured between 3cm and 5 cm. The decorative motifs on these sherds resembled comb stamp impressions of short dashes. The sherds were about 3 cm thick and had a smudged internal surface finish. The outer surface area had an unburnished-smudged surface finish on which the impressions were made (Figs. 6.21 and 6.22).

Figure 6. 21 Chimney Bay 2 Site.

Figure 6. 22 Sherds and faunal remains from Chimney Bay 2.

6.5.2.5 Dulles Buff Chimney

The Dulles Buff Chimney is located at the northeastern cliff of Main Duck. The name "Dulles Buff Chimney" was given to the site because it was believed that John Foster Dulles, who owned Main Duck from 1941 to 1959, built the chimney in 1941 (Ross & D'Annibale, 2001). The cabin was constructed with yellow brick in the firebox, mortared field stones, red brick on the back, and topped with ceramic chimney pots (Conolly, 2024, p. 32). He also described the remnant of the chimney, "the chimney's hearth, concrete embedded with beach pebbles (and a large herbivore tooth), is centered between the east and west (side) walls but sits about 5.4 meters (18 feet) from the main door, corresponding to the change in roof pitch. The chimney is 2.7 meters in length (9 feet) and 1.8 meters wide (6 feet)" (Conolly, 2024, p. 2).

Figure 6. 23 Aerial view of the Dulles Buff Chimney.

Figure 6. 24 Front (right) and Back (left) view of the Dulles Buff Chimney.

In association with the Dulles Buff chimney were other artifacts, such as a metal tank, pieces of recently broken glass bottles, and a rectangular concrete structure, which was speculated to be the floor of the chimney site. The concrete floor was constructed approximately five meters away from the chimney, surrounding it. The chimney was partly destroyed, exposing the consolidated work of the people who had maintained it. The chimney was made of burnt bricks, stones, and concrete. The internal part of this structure was approximately five meters wide, and the external part was between seven and eight meters wide. According to the decade-old archaeological survey report by Ross and D'Annibale (2001), the chimney was considered visible from the shoreline. However, the dense vegetation made it impossible to see the structure from the shore during our survey (Figs. 6.23 and 6.24).

6.5.2.6 Remains of a vehicle

The remains of the vehicle were found about fifty meters northeast of duplex 1. It was critical to document this site because past documentation described the metal

remains of the car as wood. However, the remains of the vehicle were metal. The car had been transported to Main Duck by boat (Fig. 6.26).

Figure 6. 25 Remains of the Vehicle, Northeast of Duplex 1.

Figure 6. 26 John F. Dulles Vehicle Being Transported to Main Duck by boat. (From Osborne, 2024).

The remains included two tires connected by a metal rod measuring approximately 1.4 meters in length, and a metal frame measuring about one meter in

length and between 60 and 70 cm in width, located about 1.5 meters away from the tires (Fig. 6.25).

6.5.3 New Sites

Reconnaissance surveys revealed three new site clusters. All the new sites were along the shoreline of Main Duck. Some of these sites may extend about ten meters inland, as they contain traces of human activities.

6.5.3.1 Schoolhouse Sites

The new cultural features discovered at Schoolhouse Bay and Point included a concrete slab, a cluster of broken glass bottles at Schoolhouse Point, and a cluster of metals at Schoolhouse Bay (Fig. 6.27). The concrete slab is 53.79 meters west of the Schoolhouse Point site,79.42 ± 3.31 meters above sea level, and 8.75 meters away from the shoreline. The remains of the glass are twenty-five meters away from Schoolhouse Point. Three pieces of glass, about five inches long and two inches wide, were discovered. The pieces of glass were narrow-necked and widened at the body. The glass did not have labels or maker's marks. These plain glass pieces were the only artifacts discovered in that area until the discovery of the concrete slab. Ground reconnaissance began at Schoolhouse Point and moved westward until the slab was exposed. Initial ground reconnaissance was conducted at 4 meters from the rocky shoreline. However, the dense vegetation and short trees limited the ground survey to two meters from the edge. The concrete slab was approximately three meters long, 50 to 60 cm wide, 20 cm thick, and divided into sections 60 cm apart.

Figure 6. 27 Concrete Slab and Wrought Nail at the Schoolhouse Point and Bay.

The cluster of metal was found on the rocky shoreline. The new site is 78.36 meters away from the Schoolhouse Bay site. Material data discovered included pieces of metal, including wrought and iron nails. The other metal objects were undiagnostic.

6.5.3.2 Mooring Rings

Mooring rings were discovered at two different locations. The first pair of mooring rings was located opposite Schoolhouse Bay, while the second pair was in front of the partially eroded stone and concrete stairway in front of duplex 2. The rings are 9.27 meters apart and 210.1 meters across the Schoolhouse Bay site. The second pair of mooring rings were five meters apart and approximately 8 meters in front of the partially eroded stone and concrete stairway in front of duplex 2 (Fig. 6.28).

Figure 6. 28 Mooring Rings Opposite the Schoolhouse Bay and Adjacent Duplex 2.

6.5.3.3 Lighthouse and Duplex cluster

The lighthouse and duplex cluster include the foundation adjacent to duplex 1, the remains of a metal signpost, a possible midden, the partially eroded stone and concrete stairway adjacent to duplex 2, and the concrete well (Fig. 6.29). All these sites were located on the northern shoreline of Main Duck. The foundation extended about five meters inland. Reconnaissance survey conducted around the foundation failed to identify the remnants of the demolished site. However, broken parts of the concrete and rock structure suggested a building's demolition. In front of the demolished site, a concrete and rock platform with a staircase on the right side of the structure had been laid. The platform is situated above the rocks and measures approximately 1.2 meters in height, 2 feet in width, and 3 to 4 feet in length.

It was unclear whether the metal piece found in the same context as the signpost was connected to the post. However, the shaft of the signpost is metallic and was firmly driven into place, while the piece of metal was loosely laid on the rocks of the northern edge. The height of the signpost is approximately 2.5 meters (Fig. 6.30).

Figure 6. 29 Concrete Foundation Northeast of Duplex 1.

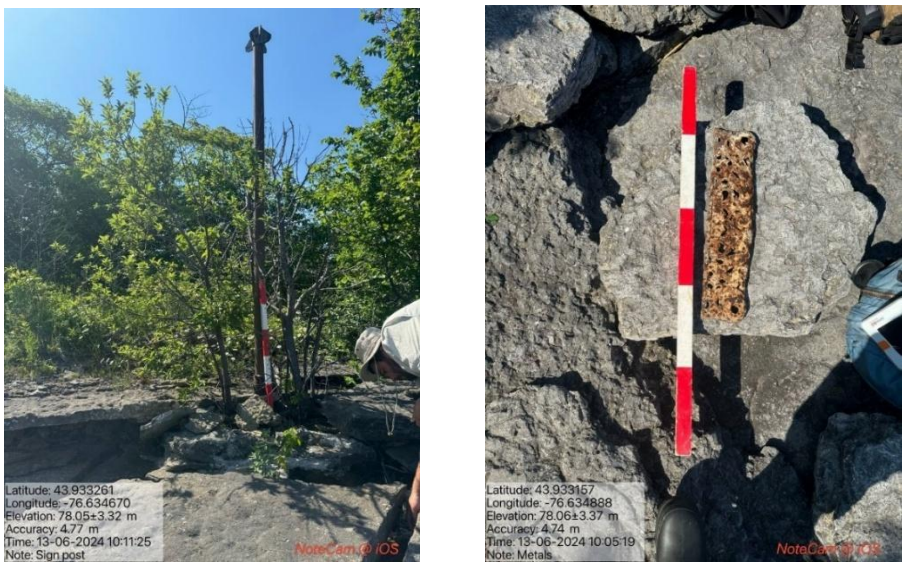

Figure 6. 30 Remains of a Signpost and Metal on the Rocky North Shoreline.

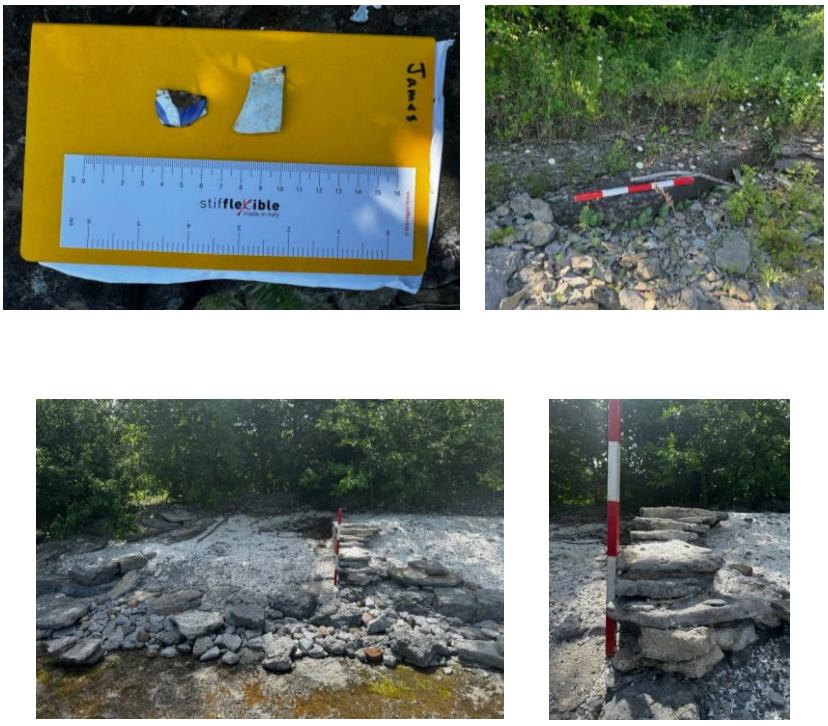

Figure 6. 31 Hand-Painted Creamware, a Midden and Partially Eroded Stone and Concrete Stairway on the North Shoreline.

An eroded patch of land East of duplex 1 indicated evidence of a possible midden (Fig. 6.31). This was found in the sandy shore area east of duplex 1, after the rocky shoreline. Ground reconnaissance revealed traces of broken ceramics. The ceramics had fabrics most likely to be creamware. One sherd was a body sherd, while the other was a rim with a neck and part of the body. One sherd had hand-painted decoration and a plain white interior on its outer body area. On-site analysis revealed that the rim sherd had a short neck and a rounded lip. The sherd was also plain white inside and outside. Both sherds measured between 2cm and 3cm in length.

The partially eroded stone and concrete stairway was discovered on the northwestern side of duplex 2. This was made of uneven rocks and concrete stacked

on top of each other. It extended about seven meters to the left and right. The stairway was about 2.5 meters wide and about 50 cm high.

Figure 6. 32 A Concrete Well Close to the Lighthouse on Main Duck.

The well located in the region of the lighthouse is incorporated into the wall of the lighthouse and measures about 1.2 meters by 1.4 meters (Fig. 6.32). It was not possible to determine the depth of the well because it was filled with sand and zebra mussels. The well was made with the same building materials (rocks and concrete) used for the stairway west of duplex 2.

6.5.3.4 West Shoreline Cluster

Ground reconnaissance on the western shoreline of Main Duck revealed remains of a metal frame under a tall tree about ten meters away from the current shoreline. The initial stages of the ground reconnaissance revealed part of the metal frame that protruded from the ground. The metal frame became clearer after zebra mussel shells were removed. The frame measured approximately two meters in length and almost a meter in width (Fig. 6.33).

Figure 6. 33 Metal Remains Under a Tree on the West Shoreline.

Although pedestrian surveys and excavations are fundamental methodologies for reconstructing past human activities, they are not without limitations that may significantly affect their accuracy. Limitations of this methodology include spatial and temporal constraints, destruction of the earth's crust, artefact recovery limitations, accessibility, and logistics.

Ground reconnaissance survey conducted on Main Duck covered a limited section of the island. This limitation was compounded by time constraints, as the crew had only a limited period to conduct a series of archaeological investigations on the island. Human effort and natural vegetative cover limited the coverage of the field survey. That is, the vegetative cover prevented the crew from reaching deep into some sites on Main Duck. Also, the permit granted by Parks Canada was for a non-invasive reconnaissance survey, therefore, it did not permit the use of larger and more sophisticated logistics on the island. Logistics also entails funding and requires trained personnel, which would directly affect the project's finances. This affected artefact recovery. That is, because ground reconnaissance identified few new sites, the few

artefacts recovered do not accurately reflect the distribution of archaeological sites on the island.

6.6 Ceramic Analysis

My analysis of Sandbanks decorative motifs yielded numerical values comparable to those of Smith (1981) (Table 6.5) and revealed a decorative motif similar to that of Main Duck Island. The graphs show the distribution of decorative motifs and vessel parts of pottery from the SandBanks. Although the analysis of the sherds from Sandbanks primarily focused on decorative motifs, I also examined vessel parts and the placement of decorative motifs on the sherds (Fig. 6.34, 6.35, and 6.36)

Table 6. 5 Table showing Pottery Analysis from Sandbanks.

SANDBANKS POTTERY SHERDS ANALYSIS		
Analysis type	Vessel specifics	N=
Quantity		824
Vessel parts	Lip/rim	72
	Neck	19
	Body	628
	Unidentified	105
Decorated sherds		196
Motif location	Internal	1
	External	167
	Both	28

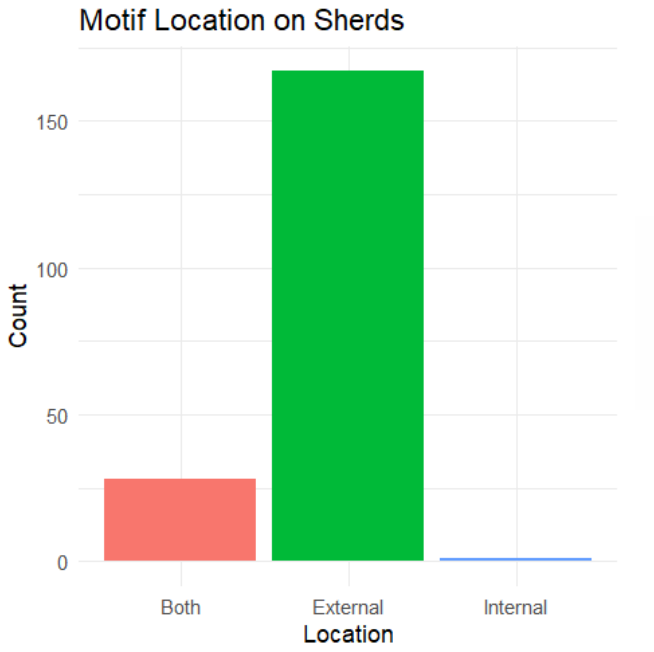

Figure 6. 34 Bar Chart Showing the Location of Decorative Motifs From SandBanks.

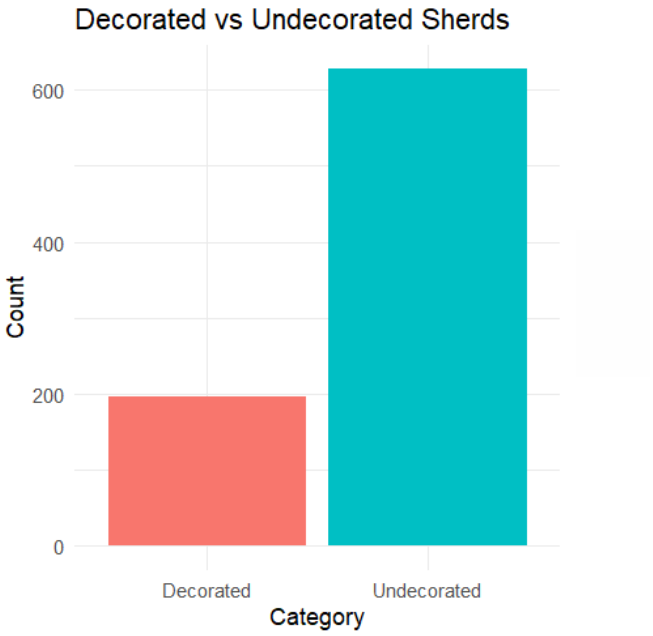

Figure 6. 35 Bar Chart Showing the Distribution Between Decorated and Undecorated Sherds From SandBanks.

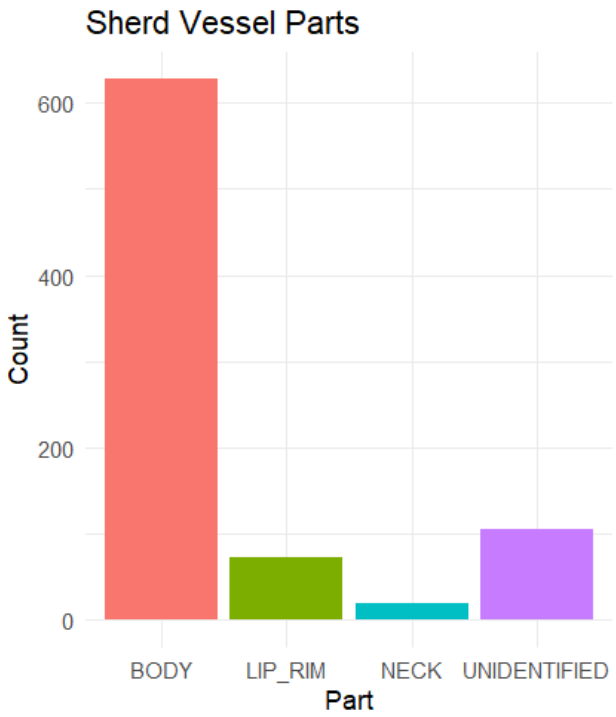

Figure 6. 36 Bar Chart Showing the Distribution of Vessel Parts From SandBanks.

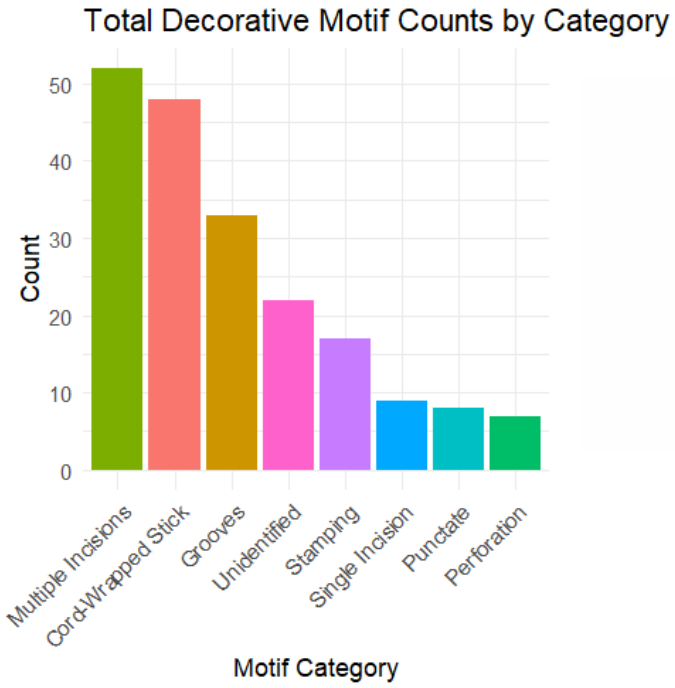

Figure 6. 37 Bar Chart Showing the Distribution of Decorative Motifs From SandBanks.

Table 6. 6 Decorative Motifs from Sandbank.

Decorative Motifs		**Count**
Cord-Wrapped Stick (CWS) and Related	Cord Wrapped Stick	31
	Oblique Cord Wrapped Stick and rows of punctate	4
	Oblique Cord Wrapped Stick	13
	Total	**48**
Single Incision	Single Incision	3
	Single incision under lip	1
	Short incisions on rim and lip	1
	Short Dashes	4
Multiple Incisions	Multiple Incisions	10
	Multiple short irregular incisions	21
	Multiple wavy incisions	3
	Multiple incisions on lip	2
	Multiple incisions in arrow form	10
	Multiple diagonal shallow incisions	1
	Cris-cross short incisions	2
	Multiple rows of incisions and criss-cross incisions	3
	Total	**61**
Grooves	Single Groove	9

	Multiple Grooves	3
	Multiple Groove and Punctate	2
	Multiple Zig Zag Grooves	2
	Shallow diagonal grooves	3
	Multiple shallow horizontal and vertical grooves	10
	Multiple shallow vertical grooves	4
	Total	**33**
Punctate	Punctate	4
	Multiple horizontal punctates	2
	Punctate and multiple short stabs	2
	Total	**8**
Stamping	Stamping	9
	Rocker Stamp	2
	Triangular Stamping	4
	Roulette	2
	Total	**17**
Perforation	Perforation	7
	Total	**7**
Unidentified	Undecorated Ceramic Pipe	1
	unidentified	21
	Total	**22**

The decorative motifs were analyzed and categorized into seven main groups (Table 6.6). These groups are based on incision type, groove type, punctate or stamping techniques, the use of tools such as cord-wrapped sticks, and other uncategorized forms (Fig. 6.37). The sherds found during the Main Duck reconnaissance survey numbered ten in total. Among the ten, nine sherds were decorated while one was undecorated. The sherds were found at the Chimney Bay 1 (5 sherds) and Chimney Bay 2 sites (5 sherds) (Figs. 6.38, 6.39, 6.40, and 6.41). Table 6.7 provides a breakdown of decorative motifs discovered on Main Duck.

Figure 6. 38 Cord-Wrapped Stick Impressions Found at Chimney Bay 2 (left) and Undecorated Sherd found at Chimney Bay 1(right).

Figure 6. 39 Multiple Criss-Cross Incisions on Sherd from Chimney Bay 1.

From my analysis, all the decorative motifs identified on Main Duck's surface finds were present on finds from both Sandbanks and New York. That is, the Middle to Late Woodland sites in New York had evidence of cord-wrapped stick impressions, multiple incisions, and other decorative techniques characteristic of Middle to Late Woodland ceramics (Ritchie & MacNeish, 1949; Hart & Brumbach, 2009, p. 376). The New York sites that contained these decorative motifs include Kipp Island in the Seneca County and the Kelso site in Onondaga County. Decoration in the Kipp Island area included linear stamping, cord-wrapped stick impressions, incising, and punctations (Gates, 2001). Decoration in the Kipp Island area included linear stamping, cord-wrapped stick impressions, incising, and punctations (Grossman et al., 2015).

Figure 6. 40 Horizontal Incisions on Sherd From Chimney Bay 1.

The location of the motifs, on the external part of the sherd, also aligns with the stylistic traditions of Sandbanks and New York. Since these sherds correspond to that stylistic range of Sandbanks and New York, they date between 2500 BP and 1500 BP. The tool traditions that characterised this region were the Cord Wrapped Stick technique (where a stick wrapped with a cord is pressed into the clay to make impressions), dentate stamps (which used notched tools to make patterned

impressions), and pottery decorative motifs from the middle upward to the neck and lip, almost like those of Vinette 2 made with coils. Taken together, these traits provide an understanding of the Woodland period under consideration.

Figure 6. 41 Horizontal Impressions and Short Vertical Comb Stamps From Chimney Bay 2.

Table 6. 7 Pot sherds recovered during the Main Duck Reconnaissance Survey.

MAIN DUCK SURFACE SHERDS		
Decorative Motif	**Quantity**	**Location of Motif**
Cord Wrapped Stick	2	External
Multiple Incisions	3	External
Undecorated	1	
Horizontal impressions and Short vertical comb stamps	4	External
Total	**10**	

Indigenous and historic sites on Main Duck differ in terms of distribution due to the island's use at various times, historical contexts, environmental and preservation factors. Indigenous sites would be rather concentrated in a certain location, rather than a historical site whose settlement may be dispersed over a wider area. This is reflected in Main Duck's known indigenous site, limited to the area of the Schoolhouse Point and Chimney Bay, as opposed to its historical sites in the Village Cove, the Dulles Buff Chimney area, and the Lighthouse region (northwestern Main Duck). Historical contexts play an important role because historical sites are documented, and their location is known. However, indigenous sites on Main Duck need intensive survey methods since the location may be generalized to a setting covering a vast area. In terms of preservation, an indigenous site may contain archaeological data that relates poorly with the natural environment, mostly because these materials are either made natural and may not survive the archaeological record or may deteriorate faster with their exposure to natural elements. Historical materials may have the ability to withstand these conditions.

6.7 Conclusion

This chapter summarised the results of a range of different analyses of Main Duck, beginning with its paleoshoreline history, visibility, landscape change, archaeological reconnaissance survey, and ceramic analysis. The identification of archaeological sites on Main Duck has unearthed possible sites for archaeological excavations. Redocumentation of archaeological sites provides an overview and updated records of the location of cultural sites on Main Duck. With this backdrop, the next chapter discusses how the concept of maritime cultural landscapes fits into Main Duck’s historical and archaeological perspectives.

Chapter 7: Discussion

7.1 Introduction

In this chapter, I discuss critical topics deduced from previous chapters and analysed data. The approach used in this research is based on maritime cultural landscapes (MCL), which explains the relationship between human societies, marine and terrestrial environments. This archaeological investigation uses MCL to understand how environmental conditions and maritime and terrestrial environments intersect with anthropogenic uses of the island of Main Duck. I will discuss two major themes, land use and Main Duck as a transitional land, which address my research questions:

1. How did the Main Duck's formation and inundation of its shorelines shape the island's habitability, accessibility, and role within Lake Ontario's landscape?
2. What does the spatial and temporal distribution of archaeological sites reveal about settlement patterns and island use?
3. What does the integration of terrestrial and maritime evidence tell us about the broader regional interaction between the Sandbanks, Main Duck, and New York?

Against this backdrop, the integration of methods developed in the previous chapters will reveal the relationships between Main Duck's landscape, the maritime environment, and how it influenced human activities.

7.2 Land Use: Temporary or Permanent Settlement

Main Duck Island was used for various activities at different times. The island's cultural usage could be divided into three main categories: Indigenous use, strategic location in warfare, and economic and personal use.

7.2.1 Indigenous Use

The Middle to Late Woodland peoples were the first known occupants of Main Duck Island (Parks Canada, 2013). They likely migrated from the eastern end of Lake Ontario, and their complex social organization influenced subsistence practices that supported temporary settlement and small-scale cultivation (Martin, 2008). Ecological factors such as bird migration routes, biodiversity, and the island's natural barriers may have drawn these groups to Main Duck through a combination of "push" and "pull" dynamics (Breivik, 2016). Pull factors such as resource abundance, secure landing places, or ambition to find new land, and favourable environmental conditions contrast with push factors like depleted resources, conflict, or climatic stress elsewhere. Main Duck may therefore have served as a temporary habitation area or a waypoint in seasonal movements between the Ontario and New York shores. Archival research has provided additional context for the Indigenous groups who occupied the island, their subsistence strategies, and their role within the broader Galloo Island region.

Visibility also played an important role in understanding how people reached Main Duck Island. Viewshed analysis was used to model how intervisibility among islands may have influenced navigation and settlement choice. The analysis shows that a traveller moving toward Main Duck could maintain visual contact with

successive islands by following a route from Point Traverse to False Duck Island, then south to Main Duck. From the south, visibility between Stony Island, Little Galloo Island, and Main Duck overlapped, allowing continuous sightlines between islands. There is no line of visibility from the shores of Stony Island at the coast of New York through to Main Duck. This will only be possible should the observer enter Main Duck's visibility through that of Little Gallo Island. This overlapping visibility would have provided navigational bearings, enabling travellers to move safely across Lake Ontario to Main Duck without losing sight of Little Galloo Island and Stony Island. Such visual continuity would have been critical for small watercraft, allowing travellers to orient themselves and return to the previous island if necessary.

Depending on the observer's location, removing obstructions, such as trees, from the line of sight may affect visibility. However, visibility from Point Traverse, Main Duck, and New York was undertaken from the shores of the locations mentioned. Vegetation may limit visibility and is critical in accounting for vegetation density in the overall viewshed calculations (Nutsford et al., 2015). Removing trees may alter the digital elevation model (DEM), thereby directly affecting viewshed calculations. Removing trees also leads to significant landscape changes. It may increase erosion by displacing soil, accelerating land loss. This may directly affect biodiversity on the island, including the nesting patterns of seasonal migratory birds and turtles that frequent it.

Reconnaissance survey and ceramic analysis further confirmed the Indigenous occupation of the island. A total of ten ceramic sherds were recovered from the Chimney Bay 1 and 2 sites, nine of which displayed decorative motifs. These included cord-wrapped stick impressions, multiple incisions, horizontal impressions, and short

vertical comb stamps. Comparative analysis with ceramics from the Sandbanks site revealed similar decorative techniques, consistent with those reported by Smith (1981), and suggestive of shared stylistic traditions. The motifs also resemble assemblages from Middle to Late Woodland sites in New York, including Kipp Island, and the Kelso site (Hart & Brumbach, 2009; Ritchie & MacNeish, 1949). These parallels indicate widespread stylistic connections across the eastern Lake Ontario basin, reflecting regional interaction and mobility.

Based on these comparisons, I concur with previous interpretations that date the Middle to Late Woodland occupation of Main Duck Island to between 450 BC and AD 1450 (Parks Canada, 2013; Naval Marine Archives, 2016). After this period, the island entered a new phase of non-Indigenous occupation. Ceramic analysis thus provides a key line of evidence for situating Main Duck within the broader cultural and environmental history of Lake Ontario, linking changes in settlement and mobility to fluctuations in water levels and shoreline configuration.

7.2.2 Strategic Location in Warfare

Warfare on Main Duck began in the mid-1700s. The French sought refuge on Main Duck in their war against the English (Naval Marine Archives, 2016). Main Duck's use as a strategic location during warfare was due to its natural barriers. The island was regarded as invincible by armies and patrons (used for defence and commers), and its surrounding coast is considered hostile by fisherfolk who use the route due to the lake currents of Lake Ontario. Ground reconnaissance survey on the island discovered that the northern coast of the island sloped gently to the west. The northeastern side of the island is the highest side of the island and is mainly formed by

huge layers of rock. The rocky shoreline of Main Duck also extended down along the eastern shoreline. This is why the change in land area affected the west shoreline more than the east shoreline. Due to the increase in Lake Ontario's water level, areas once considered land are now submerged. These submerged land areas also contain huge rocks hidden beneath the water. Ground reconnaissance survey on the northwestern shoreline of the island exposed some rocks whose tips stuck out of the water. To a sailor who does not know the terrain, they risk wrecking.

Numerous shipwrecks have occurred around the island due to the lake's current and the nature of the island's underwater rocks (Ford, 2017). In his Main Duck investigation, Rick (1960) revealed a shipwreck off the east coast of Main Duck, adjacent to the Schoolhouse Bay site. Since visibility of the island is poor, sailors use this as a defensive strategy to either escape or wreck ships. Rick (1961) documented that battered French soldiers used the island as a refuge or shelter after being defeated by the English, until their eventual demise in the early 18th century. This is because without accurate navigation, it is difficult to locate the island.

Visibility analysis undertaken with an observer height of two meters revealed that an observer standing at Point Traverse Light Station (on mainland Canada, north of Main Duck) will not be able to see Main Duck. However, if an observer with a height of 1.5m in a canoe enters the area of Main Duck's visibility, the observer may be able to see Main Duck within a 15 km maximum distance since Main Duck's highest point is 10 m above Lake Ontario's water level. However, the observer also ought to consider the environmental conditions, since factors such as humidity, distance to horizon, and the height of the observer all influence what one may see. This, coupled with rough waves, suggests the reason why the battered French soldiers

met their demise on Main Duck, as there may not have been any form of rescue to reach them, or efforts to reach them on the island may have been met by unfortunate wrecks.

7.2.3 Personal and Economic Use

Main Duck Island was periodically occupied and used for both personal and economic purposes by a succession of private owners. Various accounts (McLeod, 2018; Miller, 2002; Naval Marine Archives, 2016) document its use by Captain John Walters, Claude Cole, John Foster Dulles, and Robert Hart Jr.

Between 1848 and 1890, Captain John Walters used the island for agriculture, livestock grazing, and fishing (McLeod, 2016; Naval Marine Archives, 2016; Townsend, n.d.). His activities likely introduced domesticated animals to Main Duck for the first time. Ground reconnaissance indicates that the island's mid-section consists of open fields interspersed with swamps and low vegetation, suggesting a suitable area for grazing animals, such as the bison Walters was said to have brought to the island. Although aerial photographs do not reveal the exact location of his residence, the open central area remains the most plausible setting for his agricultural operations.

Claude Cole, who owned the island between 1892 and 1938, appears to have exploited it most intensively (Sprague, 2009). He operated a large-scale alcohol smuggling enterprise throughout the Galloo Islands region during Prohibition (Naval Marine Archives, 2016; Sprague, 2009). Cole is also reported to have hosted family members, and fisherfolk, hunted imported game, and maintained a dairy operation on the island. Analysis of 1930 aerial photographs reveals two structures west of the

existing Village Cove barn, which still stands. These buildings may have been erected to provide accommodation for the various calibers of people who frequented Main Duck. However, these buildings no longer appear in subsequent aerial imagery from 1962, 1974, or 1995, suggesting their abandonment or removal after Cole's tenure.

John Foster Dulles, a Wall Street lawyer and later U.S. Secretary of State, owned Main Duck from 1941 to 1959 and used it as a private retreat for his family (Gateley, 2012). One of the island's most recognizable features, the Dulles Bluff Chimney, marks the remains of his cabin, constructed on the island's highest point. Ground reconnaissance on the northeastern side of the island identified the chimney base and associated concrete foundations.

Robert Hart Jr., who owned Main Duck from 1959 to 1976, operated a hunting lodge on the island (Gateley, 2012). Ross and D'Annibale (2001) noted that this cottage was built in the twentieth century, although its precise location is unknown. It is possible that Hart used the existing Dulles cabin facilities during his ownership.

Main Duck Island has also played a role in broader economic and political contexts, owing to its position near the Canada–United States boundary. Its location made it a waypoint for trade and navigation during periods of unstable lake conditions, as sailors familiar with the island chain used it for shelter and orientation. A shipwreck off the east coast, dated to between 1650 and 1700, provides archaeological evidence of this strategic function and may represent a military vessel carrying ammunitions (Rick, 1960). Dulles's later ownership (1941–1959) coincided with a period when the Galloo Islands region transitioned from military to civilian use (Cooper, 2006). As U.S. Secretary of State (1953–1959), Dulles also linked the island

to Cold War political history through his diplomatic activities between the United States and the Soviet Union (Gateley, 2012; Naval Marine Archives, 2016; Parks Canada, 2013).

These successive occupations illustrate the diverse and changing uses of Main Duck Island over time. Together they reflect the island's shifting role from a productive agricultural and smuggling outpost to a private retreat , a site of broader economic and political significance and, ultimately, a protected land by Parks Canada. This history establishes a foundation for understanding the island's environmental and cultural transformations, which are examined in the following section.

7.3 The Transitional Land

Main Duck Island's transitional concept is derived from three distinct areas.

1. The reconstruction of the shoreline of eastern Lake Ontario from 10,000 BP to when the lake levels stabilized at 4000 BP.
2. Documented narratives and accounts about Indigenous and non-indigenous settler contact with the Galloo cluster of islands.
3. Similarity established between decorative motifs from surface-collected local pottery at Main Duck Island and Sand Banks on the mainland, Canada, to the north, and publications of indigenous Middle-Late Woodland pottery in New York to the south.

7.3.1 Paleoshoreline modelling

Reconstruction of Main Duck's shoreline was crucial to understanding whether the island was connected north to mainland Canada and south to New York.

Reconstruction of the shorelines revealed changes to Main Duck's land size and changes to the water level of Lake Ontario. According to the GIS models generated, Main Duck became an island about 8000 years BP, beginning its island status with 3656 hectares of land and its disconnection from the land area north of the island. The south coast of Main Duck had already disconnected at 9000 years BP, but was still connected to the mainland to the north. This shows the increase in water level of Lake Ontario, leading to the submerging of Main Duck's coastal areas and the loss of land as a result. The GIS models revealed the rate at which Main Duck lost land area to Lake Ontario. According to measurements from these paleoshorelines, it was revealed that Main Duck lost much of its land area to Lake Ontario between 9000 and 8000 years BP. It lost 1663 hectares of land, translating to 1.66 hectares a year within the period. Subsequent years saw a reduction in the loss of land area at a reduced rate. That is, land loss fluctuated between 0.81 and 0.14 between 7000 BP and 4000 BP. The lake's current water level averages between 74 and 75 meters, bringing the rate of land loss to Lake Ontario back to 1.6 hectares a year. But this time, the calculation is based on the already reduced land area of the island. Land loss to Lake Ontario during its stabilized period (4000 BP) was pegged at 0.14484 hectares per year. This means that every year, Main Duck is at risk of losing part of its shores, together with its archaeological sites, to Lake Ontario. In total, Main Duck has lost about 3456 Hectares of land to Lake Ontario. At this rate, Main Duck will lose about 1.6 hectares (3.95 acres) of land every year to Lake Ontario. Although this size may seem small, the constant erosion of the coast over time may lead to a more detrimental loss of land if this is accumulated over many years. This is a phenomenon that, through this study, is proven to be ongoing. This means that the coastal area of the Main Duck is under constant threat of being submerged over a period.

7.3.2 Cultural Historical Narratives

The transitional nature of Main Duck Island is reflected both in its cultural narratives and in the distribution of tangible heritage across its landscape. These lines of evidence complement one another, collectively supporting accounts of migration and movement between mainland Canada, Main Duck, and the New York shore through the Galloo Islands region. My reconstruction of Main Duck's paleo-shoreline indicates that the island became isolated from the mainland approximately 8,000 years BP. Indigenous oral traditions identify the Middle to Late Woodland peoples as the first inhabitants of the island, dating from about 450 BC to AD 1450 (approximately 2,400–500 BP) (Adams, 2008). This suggests that Main Duck was already insular before its initial settlement. These dates align with the Woodland period as documented by Crawford et al. (2018), Parks Canada (2013), Adams (2008), and Fiedel (1987). When first occupied, the island's land area was approximately 375 hectares, compared with about 230 hectares today.

Subsequent non-Indigenous use by the French and later by private owners such as Captain John Walters, Claude Cole, John Foster Dulles, and Robert Hart Jr. further contributed to the formation of archaeological sites and vegetation change. The intermittent presence of these settlers, many of whom used the island seasonally or temporarily, illustrates a continued pattern of transience and adaptation.

From a maritime cultural landscape perspective, this interplay between human activity and environmental setting defines Main Duck's long-term character. The island's physical features influenced how its occupants made use of it. The rocky

northern shoreline, with two mooring rings opposite the duplex, likely served as a docking area, while the eastern coves provided sheltered docking areas suitable for concealment or protection from wind and waves. Although much of the coastal zone contains archaeological remains, evidence of inland structures suggests that the island's interior open areas were preferred for habitation. Documentary and field sources (Adams, 2008; Gateley, 2012; McLeod, 2016; Naval Marine Archives, 2016; Sprague, 2009) identify structural remains west of Village Cove, near the lighthouse and duplex in the northwest, and around Dulles Bluff in the northeast. The 1930 aerial photographs show buildings in the Village Cove area, consistent with the period of Claude Cole's ownership, when the island supported family members, fishers, and rum-running operations (Gateley, 2012).

These anthropogenic activities demonstrate how successive occupants of Main Duck Island understood and responded to the opportunities and constraints of their environment. The resulting archaeological record preserves material evidence of these interactions, reflecting both the island's environmental dynamics and its enduring role as a place of movement, adaptation, and continuity within the Lake Ontario cultural landscape.

7.3.3 Analysis of Archaeological Data

Archaeological evidence, including locally - produced ceramics, reinforces the interpretation of Main Duck Island as a transitional and connective landscape. The island served as a passageway for both Indigenous and non-Indigenous peoples traveling between mainland Canada and New York (McLeod, 2016; Naval Marine Archives, 2016). Historical sources (Sprague, 2009; Gateley, 2012) document

successive changes in ownership and use, from Indigenous occupation to private proprietorship, and ultimately to its protection under Parks Canada. Paleoshoreline reconstructions discussed earlier indicate that the island chain was once connected, facilitating human movement across the region. However, radiocarbon and typological data, combined with reconstructed shoreline models presented in this study, demonstrate that Main Duck was already insular when it was first occupied. This suggests that early inhabitants reached the island by water, highlighting sustained connections among mainland Canada, Main Duck, and the New York shore. These connections are further reflected in similarities in material culture, particularly ceramic decorative motifs.

The decorative motifs identified on pottery from Main Duck correspond closely with those from the Sandbanks site in Ontario and several New York State sites, including Kipp Island (Seneca County), and Kelso (Onondaga County). Comparative analysis of these assemblages shows consistent use of cord-wrapped stick impressions, multiple incisions, and other decorative techniques characteristic of Middle to Late Woodland ceramics (Hart & Brumbach, 2009; Ritchie & MacNeish, 1949). These stylistic parallels indicate cultural interaction and diffusion across Lake Ontario, reflecting shared technological traditions and aesthetic conventions. The transition from coiling to modeling observed in these assemblages further marks a chronological and technological shift within the Woodland sequence. The recovery of local ceramics at the Schoolhouse Point and Chimney Bay sites provides evidence of prehistoric habitation on the island. Unfortunately, dense vegetation hindered an in-depth ground reconnaissance survey. However, subsurface detection at these two known prehistoric sites may reveal their extent and lead to the discovery of new ones.

Initial dates for local ceramics recovered from Main Duck were determined through typological analysis. Although this dating technique was relative, it provides evidence of decorative motifs similar to those found at sites in SandBanks, on the mainland of Canada, at Kipp Island, and at the Kelso sites in New York. Until absolute dating is undertaken on these archaeological data, it is speculative to provide conclusive date ranges of a few years. I used the date range up to 1450 AD because documented sources place the Late Woodland people in occupation of Main Duck until then.

The quantity of local ceramics recovered during ground reconnaissance at Main Duck cannot be used to accurately establish cultural attributions and chronology for prehistoric sites and people on the island. These archaeological data were discovered at the surface level. These materials may have been affected by environmental conditions, leading to changes in the primary and secondary context. The presence of local ceramics may only indicate the presence of indigenous groups reported to have used the island in the past. However, much more archaeological data is needed to establish accurate site function or chronological placement

Evidence of movement and cultural exchange continue into the historic period with non-Indigenous use of the island. Activities associated with rum-running under Claude Cole, naval engagements during the War of 1812, and the presence of fisherfolk all demonstrate the island's enduring role in cross-lake mobility (Gateley, 2012; Townsend, n.d.). Archival photographs document these later occupations, including the transport of John Foster Dulles's vehicle to the island, images of Cole and his guests, Dulles's cabin, the lighthouse complex, and the Village Cove settlement. Claude Cole's smuggling operations between New York and mainland

Canada exemplify the island's continued use as a transit hub, while later owners such as Robert Hart Jr. (1959–1976) perpetuated its identity as a site of cross-border engagement.

Together, these archaeological and historical records reveal how successive occupants, Indigenous and non-Indigenous, have transformed Main Duck's cultural landscape. The tangible remains they left behind, from ceramic sherds to architectural features, preserve traces of the island's intangible heritage of movement, adaptation, and exchange across Lake Ontario.

7.4 Present-Day Use by Parks Canada

Since Parks Canada purchased Main Duck Island from Robert Hart Jr. in 1977, the agency has maintained responsibility for its protection and management. The acquisition aimed to preserve both the island's intangible cultural identity and its diverse natural environment. Today, Main Duck supports a range of wildlife, including several snake species, seasonal populations of turtles and migratory birds, and a rich variety of native vegetation.

Preserving the island's intangible cultural heritage is especially important because the Mohawks of the Bay of Quinte and Tyendinaga regard Main Duck as a place of ancestral and cultural significance. The island holds a unique connection to its origin stories and historical migrations (Parks Canada, 2013). Protecting this heritage is also essential for interpreting the material culture left behind by the island's former inhabitants. The use of maritime cultural landscape theory in this research provides a framework for understanding these relationships by examining how Indigenous peoples' connections to the land and water shaped their identity and sense of place.

The conservation of Main Duck's ecological systems is equally significant. The island provides seasonal nesting grounds for migratory birds and supports a relatively undisturbed habitat for numerous plant and animal species. It has become an important destination for visitors to the Galloo Islands and a site of continuing scientific interest. Parks Canada regularly facilitates ecological and archaeological research on the island, including studies on biodiversity, species coexistence, and habitat change.

Archaeological investigations, such as those conducted by John Rick (1960) and by Ross and D'Annibale (2000), have helped document both tangible and intangible aspects of Main Duck's heritage. Ongoing research contributes to a more comprehensive understanding of the island's environmental and cultural history and the ways in which human activity has shaped its landscape over time.

7.5 Conclusion

Main Duck Island has fulfilled many roles over time. Archaeological, historical, and environmental evidence demonstrate its long-standing importance to diverse groups and its continuing significance today. The concept of the maritime cultural landscape provides a framework that links terrestrial Main Duck, Lake Ontario, and the human activities that have shaped them. Throughout its history, people have adapted their practices to engage with the island's maritime setting and changing environment. Owing to its strategic position, Main Duck has served as a temporary refuge, a seasonal resource base for fishers and smugglers, a military asset, and later as a protected island within the St. Lawrence Islands National Park of Canada.

Analyses of land use, material culture, and surviving built features complement the island's intangible heritage, revealing the depth of human connection to this landscape. The reconstruction of its paleoshoreline and the study of ceramic assemblages further illustrate enduring relationships between the island, mainland Canada, and New York State. Today, under the stewardship of Parks Canada, Main Duck continues to support a thriving ecosystem while remaining a focus of cultural and scientific research. Together, these findings highlight the island's enduring role within the broader maritime landscape and underscore the importance of preserving its cultural and natural heritage.

Chapter 8: Recommendation and Conclusion

8.1 Summary of The Study

This chapter concludes the research. It summarizes the goals of the research and recaps the answered research questions. It employed the concept of maritime cultural landscapes to understand how the marine environment, terrestrial land, and anthropogenic activities have shaped and been shaped by Main Duck. The research addressed three questions interrelated through the analysis of archaeological data, historical records, and GIS paleoshoreline modeling. The addressed research questions are:

1. How did the Main Duck's formation and inundation of its shorelines shape the island's habitability, accessibility, and role within Lake Ontario's landscape?

The above question was addressed through paleoshoreline modelling. The reconstruction of the shoreline history revealed how the rise of Lake Ontario's water level transitioned Main Duck into an island approximately 8000 years BP. The shoreline changes directly influenced how the island's landscape ought to be used for activities such as farming and settlement. Its natural barriers offered a strategic advantage in terms of defence in the time of war, concealment during smuggling, and the habitability of people.

2. What does the spatial and temporal distribution of archaeological sites reveal about settlement patterns and island use?

The spatial and temporal distribution of archaeological sites was addressed through an archaeological reconnaissance survey and analysis of air photographs. The

survey revealed archaeological data, including surface finds of decorated pot sherds. Other features, such as the chimney, duplex, and lighthouse, amongst others, suggest that the island was a destination for a group of people either temporarily or permanently. Since most archaeological sites were found in the coastal areas, this shows the interaction between the land and lake, suggesting activities such as fishing, transportation, and communication. Air photography revealed the area where a purported settlement site used to be around the Village Cove, suggesting that permanent and temporary buildings characterised the island.

3. What does the integration of terrestrial and maritime evidence tell us about the broader regional interaction between the Sandbanks, Main Duck, and New York?

The integration of the terrestrial and maritime evidence was answered by combining the analysis of local pottery, paleoshoreline modelling, and historical records within the concept of maritime cultural landscape. The concept was used to establish the link between the historical records and the paleoshoreline history of Main Duck. This provided critical information through ceramic analysis and corroboration of historical data to establish the period of the arrival of the island's first settlers and how their tool tradition and tangible data linked to sites on mainland Canada and New York. The concept was also used to reveal the relationship that existed between subsequent non-indigenous patrons and the island. It suggested land use through agriculture, animal husbandry, a vacation destination, and illicit trade.

This chapter also recommends solutions from an archaeological perspective that could help preserve the cultural sites for many years to come. It provides realistic

solutions to real-world problems. In the context of Main Duck, these recommendations suggest ways to preserve Main Duck's remaining cultural features and protect its intangible heritage and biodiversity.

8.2 Recommendation from the Study

8.2.1 Extensive Ground and Subsurface Survey of Discovered Sites.

The discovery of new sites and the rediscovery of old sites on Main Duck place the island within the area of a cultural landscape. Meaning that people used the island in the past, and evidence of this abounds in the material remains left behind. To recover more information about the island, non-destructive archaeological research should be conducted to generate additional data on the island. These non-destructive archaeological investigations include subsurface detection techniques and a more extensive ground reconnaissance survey.

The reconnaissance survey conducted in this study is an introductory one, which builds on previous reconnaissance surveys conducted by other researchers. The reconnaissance survey undertaken in this study aimed to locate previously documented old sites and identify new sites in their vicinity. The ground reconnaissance survey was conducted solely by walking. This survey was conducted by a small crew that worked for a limited number of days in unpredictable environmental conditions. An extensive ground reconnaissance survey is necessary because the entire island needs to be searched to locate archaeological sites. This will provide a more complete picture of the distribution of material culture on the site.

Subsurface detection is also very important because it does not harm or destroy the site in any way. The subsurface detection will help archaeologists or researchers locate material culture with precision. This will conserve a lot of energy, time, and money. Subsurface detections, such as those using ground penetrating radar (GPR), magnetometers, and resistivity meters, can help reveal features like buried structures, metal objects, building foundations, and many more.

8.2.2 Contemporary Ways to Protect Main Duck

Critically assessing the rate at which Main Duck's coastal sites and the island are under constant threat to the natural environment, it is important to enact contemporary ways to protect the island, its inhabitants, and the archaeological site. Although Main Duck's landscape is predominantly bedrock, parts of Main Duck are very shallow and fall under the threat of Lake Ontario's water level. Specifically, the west coast of Main Duck lacks the rocky cover, unlike the island's northeast and eastern shore. The GIS models produced revealed that changes in the island's land area predominantly occurred from the west coast. Aside from archaeological processes such as excavation and digital documentation to salvage cultural remains and store archaeological data, other drastic measures could be implemented to minimize the impact of Lake Ontario on the island.

Parks Canada has protected the island since its purchase in 1977. Conducting regular scientific studies to protect plant and animal species unique to the island. However, some engineering solutions, such as building sea walls along the west coast and shallow areas, would limit flooding on the island. To achieve this, geologists may use the models generated, along with the air photograph analyses, to identify low-

lying coastal areas where sea defence could be established. This is critical because Lake Ontario poses the greatest threat to the island. In that, the coastal archaeological sites that were once considered land are now found underwater. This will lead to the gradual displacement of archaeological data, as artifacts are shifted and relocated from their primary location to a secondary one. In some instances, artifacts are lost altogether.

An extensive underwater archaeological investigation should be undertaken on specific parts of the island. Since more sites on the West Coast and the northwest are underwater, extensive underwater archaeological surveys should be conducted to locate artifacts that may be hidden in rock crevices. The growth of underwater archaeology has seen tremendous development. The use of high-definition cameras to capture underwater sites unearths how the maritime environment interacts with the terrestrial environment. Investigating areas that may contain shipwrecks and conducting a shallow-water survey along the west coast will reveal new underwater sites that were once considered terrestrial.

In future research, I would like to address the distribution of indigenous sites along the coastline of Main Duck. I would also like to understand the role Parks Canada is playing in protecting Main Duck's land area since the island is home to diverse species of birds and snakes. Examining anthropogenic changes to Main Duck is important because these activities lead to the creation of archaeological sites. It provides a social perspective on the relationship between Lake Ontario and Main Duck. These activities help understand how humans relate to the environment, settlement patterns, and land use. Anthropogenic changes could provide useful

datasets that offer a better understanding through predictive modelling and other GIS techniques.

8.2.3 Digital Documentation of Landscape and Archaeological Data

Digital documentation is important to the study of archaeology. This form of documentation has transformed how researchers record, analyze, and share information about the past, present, and build models to reflect the future. Digital documentation, including the use of Geographic Information Systems, drones, and aerial imaging, as well as digital databases and, to some extent, virtual reality, has transformed the realm of archaeological analysis, capture, and preservation. Digital documentation helps with accuracy and precision, accessibility, and preservation. Digital documentation, such as photography, stores pictorial information of various archaeological investigations on the site. This is a form of complementing excavations, as the different processes and stages of the excavation are recorded to provide a pictorial context for the materials from the site. New technology has led to the preservation of information even in harsh conditions and in distant or remote areas.

8.2.4 Excavations

Excavation, although important, should be the last resort to unearth archaeological remains on Main Duck. Although this may seem impossible, Primary observations, coupled with documented data from scientists, have indicated that Main Duck Island is characterized by a considerable amount of bedrock, leaving a thin layer of soil at its surface. Hence, excavating certain areas may leave the soil loose, which can initiate a cycle of erosion. Already, the island's coastal monuments and total land

area are under an imminent threat of being encroached upon by the increasing water level of Lake Ontario. Excavations ought to be conducted in a controlled manner, providing solutions such as photographs and documentation in field notes to compensate for lost data by removing the earth's crust. A judgmental sampling technique should be used to locate an excavation site. This will inform archaeologists on the exact places to excavate, thereby avoiding digging amiss. When excavations are conducted under the right conditions, the data is salvaged, and the soil is backfilled.

8.3 Conclusion

All in all, Main Duck Island remains vital to understanding the history of southeastern Lake Ontario. Events that occurred on the island have altered and shaped our understanding of its geographical location, identity, and continuity. Main Duck is not merely another island in Lake Ontario. It defines cultural identities of indigenous groups, island users, and narratives of the past. This research has unearthed Main Duck's cultural sites. This research uses the theory of maritime cultural landscapes to understand the intangible heritage that explains tangible evidence. This research forms part of the introductory archaeological research to unearth Main Duck's narratives. Main Duck is not just an island; it is a place between the land and water, between past and present, and between nations and people.

Bibliography

Abel, T. J., & Fuerst, D. N. (1999). Prehistory of the St. Lawrence River Headwaters Region. *Archaeology of Eastern North America*, 27, 1–53. http://www.jstor.org/stable/40914426

Adams, N. (2008). *An archaeological assessment of areas to be affected by the installation of a meteorological tower, Main Duck Island, St. Lawrence Islands National Park* (Archaeological Research Permit #SLI-2008-1963; Application #2482). Adams Heritage, on behalf of AMEC Earth and Environmental for Trillium Power Wind Corporation.

Anderson, T. W., & Lewis, C. F. (2011). A new water-level history for Lake Ontario Basin: Evidence for a climate-driven early Holocene Lowstand. *Journal of Paleolimnology*, 47(3), 513–530. https://doi.org/10.1007/s10933-011-9551-8

Aryani, D., Pandanwangi, A., & Effendi, I. (2021). *Multiculturalism of mythological images in batik motifs*.. https://doi.org/10.2991/assehr.k.210615.096

Assani, A. A. (2016). *Relationship between Water Levels in the North American Great Lakes and Climate Indices*. IntechOpen. https://doi.org/10.5772/63383

Barr, B., Delgado, J., Lawrence, M., & Tilburg, H. (2016). The search for the 1871 whaling fleet of the western arctic: writing the final chapter. *The International Journal of Nautical Archaeology*, 46(1), 149-163. https://doi.org/10.1111/1095-9270.12205

Bebber, M. R., Buchanan, B., & Holland-Lulewicz, J. (2022). Refining the chronology of North America's copper using traditions: A macroscalar approach via Bayesian modeling. *PloS One*, *17*(4), e0266908–e0266908. https://doi.org/10.1371/journal.pone.0266908

Beeton, A.M. (2025). *Great Lakes*. Encyclopedia Britannica. https://www.britannica.com/place/Great-Lakes

Bel, M. (2009). The palikur potters: an ethnoarchaeological case study on the palikur pottery tradition in french-guiana and amapá, brazil. *Boletim Do Museu Paraense Emílio Goeldi Ciências Humanas,* 4(1), 39-56. https://doi.org/10.1590/s1981-81222009000100005

Benjamin, J., McCarthy, J., Wiseman, C., Bevin, S., Kowlessar, J., Astrup, P., & Hacker, J. (2019). *Integrating aerial and underwater data for archaeology: digital maritime landscapes in 3d*., 211-231. https://doi.org/10.1007/978-3-030-03635-5_14

Berton, P. (1981). *The invasion of Canada: 1812–1813*. McClelland and Stewart.

Bewley, R. H, Crutchley, S. P., Shell, C. A. (2005). New light on an ancient landscape: lidar survey in the Stonehenge World Heritage Site. *Antiquity*. 2005;79(305):636-647. https://www.semanticscholar.org/paper/New-light-on-an-ancient-landscape%3A-lidar-survey-in-Bewley-Crutchley/c25ea800c1e36c5b7ccae0a4b7241809a4676378

Biar, A. (2020). A lacustrine cultural landscape in the prehispanic basin of mexico. *The International Journal of Nautical Archaeology*, 49(2), 341-356. https://doi.org/10.1111/1095-9270.12424

Breivik, H. M. (2016). *Dynamic relations between humans and environment in the earliest settlement phase of Norway (9500-8000 cal BC).* Retrieved March 13, 2022, from https://ntnuopen.ntnu.no/ntnu-xmlui/handle/11250/2424884

Brughmans, T., de Waal, M. S., Hofman, C. L., & Brandes, U. (2017). Exploring transformations in Caribbean indigenous social networks through visibility studies: The case of late pre-colonial landscapes in East-Guadeloupe (French West Indies). *Journal of Archaeological Method and Theory, 25*(2), 475–519. https://doi.org/10.1007/s10816-017-9344-0

Bursey, J. A., & Bursey, J. A. (2012). Early Archaic Lithic Technology: A Case Study from Southern Ontario. *Archaeology of Eastern North America*, 40, 107–130. http://www.jstor.org/stable/23265138

Campbell, P. B. (2020). The Sea as a Hyperobject: Moving beyond Maritime Cultural Landscapes. *Journal of Eastern Mediterranean archaeology & heritage studies*, *8*(3–4), 207–225. Pennsylvania State University Press.

Chapman, H. (2003). Rudston 'Cursus A'– Engaging with a Neolithic Monument in Its Landscape Setting Using GIS. *Oxford Journal of Archaeology*, 22(4), 345-356. https://doi.org/10.1046/j.1468-0092.2003.00192.x

Conolly, J. (2018). Revisiting the Laurentian Concept: Evaluating the Contribution of Isolation By Distance and Biogeography on the Morphological and Geospatial Variation in Laurentian Archaic Biface Forms. *Archaeology of Eastern North America*, 46.

Conolly, J. (2024). *Thousand Islands National Park, Main Duck Island archaeological survey report in fulfilment of Parks Canada research and collection permit TINP-2024-45822*. Trent University.

Conolly, J., Fox, W., Birch, J. (2025). A Revised Chronology for the Emergence and Expansion of Late Woodland Villages along the North Shores of Lake Erie and Lake Ontario and Evidence for a Rapid Increase in Fortified Settlements in the Thirteenth Century AD. *Canadian Journal of Archaeology/Journal canadien d'archéologie* 48:52–84 (2024).

Conroy, J. (n.d.). *How far away is the horizon?* University of Washington. https://sites.math.washington.edu/~conroy/m120-general/horizon.pdf

Crawford, G. W., Lytle, J. L., Williamson, R. F., & Wojtowicz, R. (2019). An Early Woodland Domesticated Chenopod (Chenopodium Berlandieri Subsp. Jonesianum) Cache From The Tutela Heights Site, Ontario, Canada. *American Antiquity*, *84*(1), 143–157. https://doi.org/10.1017/aaq.2018.75

Daniel, I. R. (2001). Stone Raw Material Availability and Early Archaic Settlement in the Southeastern United States. *American Antiquity*, *66*(2), 237–265. https://doi.org/10.2307/2694607

De'Scathebury, E. (2011). *Theory 101.* Retrieved from https://www.theposthole.org/issues/18/6 on 15th December 2023.

Delgado, J. (2024). Blake plateau: cultural connections and the national significance of an offshore maritime cultural landscape. *Journal of Maritime Archaeology*. https://doi.org/10.1007/s11457-024-09429-z

Delgado, J. P. (2019). *War at Sea: A Shipwrecked History from Antiquity to the Twentieth Century***.** Oxford University Press.

Dino, A. (2023). Ontario deliberately destroyed evidence in Wind Power Project Lawsuit: Ontario Court of Appeal. Law Times. https://www.lawtimesnews.com/practice-areas/environmental/ontario-deliberately-destroyed-evidence-in-wind-power-project-lawsuit-ontario-court-of-appeal/377706

Dou, W., Li, Y., & Wang, Y. (2019). An equal-area triangulated partition method for parallel Xdraw viewshed analysis. *Concurrency and Computation: Practice and Experience, 31*(1), e5216. https://doi.org/10.1002/cpe.5216

Dreimanis, A. (1977). Correlation of Wisconsin glacial events between the Eastern Great Lakes and the St. Lawrence Lowlands. *Géographie Physique et Quaternaire*, *31*(1–2), 37–51. https://doi.org/10.7202/1000053ar

Drewett, P., ed (1982). The Archaeology of Bullock Down, Eastbourne, East Sussex: The Development of a Landscape. *The Sussex Archaeological Society*, Lewes.

Environmental Systems Research Institute [Esri] (2023). *Using viewshed and observer points for Visibility Analysis*. Using Viewshed and Observer Points for visibility analysis- ArcGIS Pro | Documentation. (n.d.-a). https://pro.arcgis.com/en/pro-app/latest/tool-reference/3d-analyst/using-viewshed-and-observer-points-for-visibility.htm

Eshenroder, R. L. (2014). Role of the Champlain Canal and Erie Canal as Putative Corridors for Colonization of Lake Champlain and Lake Ontario by Sea Lampreys. *Transactions of the American Fisheries Society (1900)*, *143*(3), 634–649. https://doi.org/10.1080/00028487.2013.879818

Estepp, L. R., & Reavie, E. D. (2015). The ecological history of Lake Ontario according to phytoplankton. *Journal of Great Lakes Research*, 41(3), 669–687. OXFORD: Elsevier B.V.

Ewen, G., Horn, M., Wise, S. (2025). Ontario. *Encyclopedia Britannica*. https://www.britannica.com/place/Ontario-province

Eyles, N., Eyles, C., Menzies, J. and Boyce, J. (2011). End moraine construction by incremental till deposition below the Laurentide Ice Sheet: Southern Ontario, *Canada. Boreas*, 40: 92-104. https://doi.org/10.1111/j.1502-3885.2010.00171.x

Fagan B.M. & DeCorse C.R. (1999). *In The beginning: An Introduction to Archaeology*. Prentice Hall, 160.

Fiedel, S. J. (1987). Algonquian Origins: A Problem in Archeological—Linguistic Correlation. *Archaeology of Eastern North America*, *15*, 1–11. http://www.jstor.org/stable/40914351

Fisher, P. F. (1996). Reconsideration of the viewshed function in terrain analysis. *Journal of Archaeological Science, 25*(1), 27–38

Fleisher, J., Lane, P., LaViolette, A., Horton, M., Pollard, E., Morales, E. M. Q., & Wynne-Jones, S. (2015). When did the swahili become maritime?. *American Anthropologist*, 117(1), 100-115. https://doi.org/10.1111/aman.12171

Ford, B. (Ed.). (2011). The archaeology of maritime landscapes. *Springer*. https://doi.org/10.1007/978-1-4419-8210-0

Franzi, D. A. (n.d.). *Maximum extent of Lake Iroquois* [Map]. Science Education Resource Center at Carleton College. https://serc.carleton.edu/details/images/12601.html

Gadke, D. L., Kratochwill, T. R., & Gettinger, M. (2021). Incorporating feasibility protocols in intervention research. *Journal of School Psychology*, Volume 84, Pages 1-18, ISSN 0022-4405, DOI: 10.1016/j.jsp.2020.11.004. https://pubmed.ncbi.nlm.nih.gov/33581765/

Gagné, M. (2024). Culture of Early Indigenous Peoples in Canada. In *The Canadian Encyclopedia*. Retrieved from https://thecanadianencyclopedia.ca/en/article/palaeoindian

Garcia, G. & Grohmann, C. (2019). Dem-based geomorphological mapping and landforms characterization of a tropical karst environment in southeastern Brazil. *Journal of South American Earth Sciences,* 93, 14-22. https://doi.org/10.1016/j.jsames.2019.04.013

Gateley, S. P. (2012). *Maritime tales of Lake Ontario* (ISBN 978-1609496845). Arcadia Publishing.

Gates S. C. (2001). Two sites but two phases? Revisiting Kipp Island and Hunter's Home. *Northeast Anthropology* 62, 31–53.

Gillings, M. (1998). Embracing Uncertainty and challenging dualism in the GIS-based Study of a palaeo-flood plain. *European Journal of Archaeology*. *1*(1), 117–144. doi:10.1179/eja.1998.1.1.117. https://www.cambridge.org/core/journals/european-journal-of-archaeology/article/abs/embracing-uncertainty-and-challenging-dualism-in-the-gisbased-study-of-a-palaeoflood-plain/690C16B77C0B6C7D3DC612ED341A4155

GISGeography. (n.d.). What is map algebra? Global, zonal, focal, local raster operations. *GISGeography*. https://gisgeography.com/map-algebra-global-zonal-focal-local/

González, S., Huddart, D., Alcántara, I. I., Domínguez-Vázquez, G., Bischoff, J. L., & Felstead, N. J. (2015). Paleoindian sites from the basin of mexico: evidence from stratigraphy, tephrochronology and dating. *Quaternary International*, 363, 4-19. https://doi.org/10.1016/j.quaint.2014.03.015

Government of Canada. (2025). *Basics of Environmental Assessment under the Canadian Environmental Assessment Act, 2012*. Retrieved from https://www.canada.ca/en/impact-assessment-agency/services/policy-guidance/basics-environmental-assessment.html, on July22, 2025

Government of Canada. (n.d.). *Thousand Islands National Park: History*. Parks Canada. Retrieved August 21, 2025, from https://parks.canada.ca/pn-np/on/1000/culture/histoire-history

Grossman, J., Johnson, L. & Peteet, D. (2015). *The Archaeology Of Little Wood Creek: New Chronometric Evidence*. https://www.researchgate.net/publication/343135433_THE_ARCHAEOLOGY_OF_LITTLE_WOOD_CREEK_NEW_CHRONOMETRIC_EVIDENCE

Gruškovnjak, L. (2019). Visibility of Archaeological Record on the Surface. *Proceedings From the 5th Scientific Conference Methodology and Archaeometry*, 57-79. https://doi.org/10.17234/9789531757799.5

Guiry, E. J., Buckley, M., Orchard, T. J., Hawkins, A. L., Needs-Howarth, S., Holm, E., & Szpak, P. (2020). Deforestation caused abrupt shift in Great Lakes nitrogen cycle. *Limnology and Oceanography*, 65(8), 1921–1935. Hoboken, USA: John Wiley and Sons, Inc.

Halligan, J. (2011). Lake Ontario Paleoshorelines and Submerged Prehistoric Site Potential in the Great Lakes. In: Ford, B. (eds) *The Archaeology of Maritime Landscapes. When the Land Meets the Sea*, vol 2. Springer, New York, NY. https://doi.org/10.1007/978-1-4419-8210-0_3

Hart, P, Anderson, L. M. & Feranec, R. S. (2011). *Additonal Evidence for Cal, Seventh-Century A. D. Maize Consumption at the Kipp Island Site, New York*. Retrieved from https://nysm.nysed.gov/sites/default/files/nysmrecord-vol2_0-3.pdf

Hart, P. & Brumbach, H. J. (2009). On pottery change and northern iroquoian origins: an assessment from the finger lakes region of central new york. *Journal of Anthropological Archaeology,* 28(4), 367-381. https://doi.org/10.1016/j.jaa.2009.07.001

Hoffman, J. R., Morris, T. J., & Zanatta, D. T. (2018). Genetic evidence for canal-mediated dispersal of Mapleleaf, Quadrula quadrula (Bivalvia:Unionidae) on the Niagara Peninsula, Canada. *Freshwater Science*, *37*(1), 82–95. https://doi.org/10.1086/696127

Hudak, A. T., & Wessman, C. A. (1998). Textural analysis of historical aerial photography to characterize woody plant encroachment in South African savanna. *Remote Sensing of Environment*, 66(3), 317–330. https://doi.org/10.1016/S0034-4257(98)00078-9

Hunter, J. R. (1994). 'Maritime Culture': notes from the land. *IJNA* 23.4: 261–264.

Ichumbaki, E. & Pollard, E. (2021). *The Swahili civilization in eastern Africa*. https://doi.org/10.1093/acrefore/9780190854584.013.267

Ilves, K. (2004). The seaman's perspective in landscape archaeology landing sites on the maritime cultural landscape. *Estonian Journal of Archaeology*, 8(2), 163. https://doi.org/10.3176/arch.2004.2.04

Inglis, N., Vukomanovic, J., Costanza, J., & Singh, K., (2022). From viewsheds to viewscapes: Trends in landscape visibility and visual quality research. *Landscape and Urban Planning.* 224. https://www.sciencedirect.com/science/article/abs/pii/S0169204622000731

Janetski, J. C., Bodily, M. L., Newbold, B. A., & Yoder, D. T. (2012). The Paleoarchaic to Early Archaic Transition on the Colorado Plateau: The Archaeology of North Creek Shelter. *American Antiquity*, *77*(1), 125–159. https://doi.org/10.7183/0002- 7316.77.1.125

Jensen, A., (2012). The Material Culture of I ˜nupiat Whaling: An Ethnographic and Ethnohistorical Perspective. *Arctic Anthropology 49,143–161*

Kadhim, I. & Abed, F. M. (2021). The potential of lidar and uav-photogrammetric data analysis to interpret archaeological sites: a case study of chun castle in south-west england. *ISPRS International Journal of Geo-Information*, 10(1), 41. https://doi.org/10.3390/ijgi10010041

Lake, M.W. & Woodman, P. E. (2003). Visibility Studies in Archaeology: a Review and Case Study. *Environment and Planning B: Planning and Design* 30:689-707.

Laws, A. W., Maloney, J. M., Klotsko, S., Gusick, A. E., Braje, T. J., & Ball, D. (2020). Submerged paleoshoreline mapping using high-resolution Chirp sub-bottom data, Northern Channel Islands platform, California, USA. *Quaternary Research, 93*(1), 1– 22. https://doi.org/10.1017/qua.2019.34

Lehman, J. (2018). Marine cultural heritage: frontier or centre?. *International Social Science Journal*, 68(229-230), 291-301. https://doi.org/10.1111/issj.12155

Lighthouse Friends. (n.d.). *Main Duck Island Lighthouse*. Lighthouse Friends. https://www.lighthousefriends.com/light.asp?ID=1446

Lofgren, *O.* (1981), Manniskan i landskapet- landskapet i manniskan. In Honko, L. & Lofgren, 0. (Eds), *Tradition och miljii, 235-61.* Lund.

Lovis, W. A., Egan-Bruhy, K. C., Smith, B. A., & Monaghan, G. W. (2001). Wetlands and Emergent Horticultural Economies in the Upper Great Lakes: A New Perspective from the Schultz Site. *American Antiquity*, *66*(4), 615–632. https://doi.org/10.2307/2694176

Marsh, E. J., & Schreiber, K. (2015). Eyes of the empire: A viewshed-based exploration of Wari site-placement decisions in the Sondondo Valley, Peru. *Journal of Archaeological Science, Reports*, 4, 54–64. https://doi.org/10.1016/j.jasrep.2015.08.031

Martin, S. W. J. (2008). Languages Past and Present: Archaeological Approaches to the Appearance of Northern Iroquoian Speakers in the Lower Great Lakes

Region of North America. *American Antiquity*, *73*(3), 441–463. https://doi.org/10.1017/S0002731600046813

McLeod, S. (2016). "*Island has unique heritage*". Kingston Whig-Standard. Archived from the original on 2017-12-04

Melish, J. (1815). *East End of Lake Ontario [Map*]. Internet Archive. https://archive.org/details/dr_east-end-of-lake-ontario-0495006

Miller, R. M. (2002). *Pennsylvania: a history of the Commonwealth*. Pennsylvania State University Press. pp. 20–23. ISBN 978-0-271-02214-7

Morrison, B. P., & Peiman, K. S. (2022). The role of hatcheries in the decline of Lake Ontario Atlantic salmon. *Canadian Journal of Fisheries and Aquatic Sciences*, *79*(6), 994–1002. https://doi.org/10.1139/cjfas-2021-0253

National Center for Applied Transporation (NCAT). (n.d.*). Land use change and transportation: Case studies*. National Center for Applied Transportation. https://www.ncap.org/case-studies/land-use-change

National Oceanic and Atmospheric Administration, National Geophysical Data Center. (n.d.). *Bathymetry of Lake Ontario [Image]*. Retrieved August 21, 2025, from https://www.ngdc.noaa.gov/mgg/image/images/ontario_300.pdf

Naval Marine Archive. (2016). *Main Duck, part of the "Graveyard of Lake Ontario."* Retrieved from

https://navalmarinearchive.com/research/docs/main_duck.html#fn2 on 27th February 2024.

Nutsford, D., Reitsma, F., Pearson, A. L., & Kingham, S. (2015). Personalising the viewshed: Visibility analysis from the human perspective. *Applied Geography (Sevenoaks),* 62, 1–7. https://doi.org/10.1016/j.apgeog.2015.04.004

O'Shea, J. M., & Meadows, G. A. (2009). Evidence for early hunters beneath the Great Lakes. *Proceedings of the National Academy of Sciences - PNAS*, *106*(25), 10120–10123. https://doi.org/10.1073/pnas.0902785106

Okonkwo, T. (2017). Maritime boundaries delimitation and dispute resolution in Africa. *Beijing Law Review*, 08(01), 55-78. https://doi.org/10.4236/blr.2017.81005

Osborne, B. (1983). "Human Presence on Main Duck Island", *Rideau Canal Reports*, Ontario Region. Ottawa: Parks Canada.

Pagoulatos, P. (2009). An Ideological Derivative toward the Origins of Territoriality and Early Sedentism in the Northeastern United States. *North American Archaeologist*, *30*(4), 331–360. https://doi.org/10.2190/NA.30.4.a

Pahava, H., & Kaur, D. (2020). *Role of historical aerial photographs in assessing land-use/land-cover changes*. RMSI Blog. https://www.rmsi.com/blog/2020/12/role-of-historical-aerial-photography-in-assessing-land-use-land-cover-changes/

Parks Canada Agency, G. of C. (2013). *Parks Canada - Thousand islands national park of Canada - new land acquisitions for St. Lawrence Islands National Park of Canada.* https://web.archive.org/web/20160306034042/http://www.pc.gc.ca/eng/pn-np/on/lawren/natcul/natcul1/a.aspx#main

Parks Canada Agency, G. of C. (2022). *Thousand islands national park of canada management plan, 2022*. Thousand Islands National Park. https://parks.canada.ca/pn-np/on/1000/info/plan/plan-2022#map-9

Paskey, A. W., & Cisneros, A. B. (2020). *Digging into archaeology*. Retrieved from https://asccc-oeri.org/wp-content/uploads/2020/06/OERI-Archaeology_Final_4_29.pdf on March 26 2024

Petrasova, A., Harmon, B., Petras, V., & Mitasova, H. (2015). *Viewshed Analysis.* 10.1007/978-3-319-25775-4_6. https://link.springer.com/chapter/10.1007/978-3-319-25775-4_6

Pfeiffer, S., Sealy, J. C., Williamson, R. F., Needs-Howarth, S., & Lesage, L. (2016). Maize, Fish, and Deer: Investigating Dietary Staples among Ancestral Huron-Wendat Villages, as Documented from Tooth Samples. *American Antiquity*, *81*(3), 515–532. https://doi.org/10.1017/S0002731600003978

Pollard, E. (2018). Lynn Harris (Ed.): Sea Ports and Sea Power: African Maritime Cultural Landscapes. *The African archaeological review*. Dordrecht: Springer Nature B.V.

Popta, Y., Westerdahl, C., & Duncan, B. (2018). Maritime culture in the Netherlands: accessing the late medieval maritime cultural landscapes of the north-eastern zuiderzee. *The International Journal of Nautical Archaeology*, 48(1), 172-188. https://doi.org/10.1111/1095-9270.12333

Pramono, P., Bahren, B., Hidayat, H., Wasana, W., & Syahrani, A. (2019). *Creating batik motifs from minangkabau manuscript illumination*. https://doi.org/10.4108/eai.29-8-2019.2288993

Renoy, F. (2020). Letter: Fran Renoy recalls first visit to Main Duck Island. *The Picton Gazette*. Retrieved February 6, 2025, from https://pictongazette.ca/post/letter-fran-renoy-recalls-first-visit-to-main-duck-island

Rick, J. H. (1974). *Archaeological investigations of the National Historic Sites Service, 1962–1966* (Occasional Papers in Archaeology and History). Parks Canada. https://publications.gc.ca/site/eng/9.842691/publication.html

Ritchie, W. A., & MacNeish, R. S. (1949). The Pre-Iroquoian Pottery of New York State. *American Antiquity*, *15*(2), 97–124. https://doi.org/10.2307/276387

Roberts, A. (1984). Paleo indian on the north shore of Lake Ontario. *Archaeology of Eastern North America,* 12, 248–265. http://www.jstor.org/stable/40914242

Rosa, D. L. (2011). The observed landscape: map of visible landscape values in the province of enna (italy). *Journal of Maps*, 7(1), 291-303. https://doi.org/10.4113/jom.2011.1183

Ross, B. & D'Annibale, C. (2001). *Preliminary Assessment of the Archaeological Potential at Main Duck Island (133H), St. Lawrence Islands National Park*. Parks Canada Report in Fulfilment of Archaeological Research Permit #2000-18H.

Roy, D. P., Wulder, M. A., Loveland, T. R., Woodcock, C. E., Allen, R. G., Anderson, M. C., Helder, D., Irons, J. R., Johnson, D. M., Kennedy, R., Scambos, T. A., Schaaf, C. B., Schott, J. R., Sheng, Y., Vermote, E. F., Belward, A. S., Bindschadler, R., Cohen, W. B., Gao, F., Hipple, J. D., Hostert, P., Huntington, J., Justice, C. O., Kilic, A., Kovalskyy, V., Lee, Z. P., Lymburner, L., Masek, J. G., McCorkel, J., Shuai, Y., Trezza, R., Vogelmann, J., Wynne, R. H., & Zhu, Z. (2014). Landsat-8: Science and product vision for terrestrial global change research. *Remote Sensing of Environment*, 145, 154–172. https://doi.org/10.1016/j.rse.2014.02.001

Seneca County. (2019). *Chapter One – original inhabitants and the Iroquois the original inhabitants*. http://www.senecacountyny.gov/wp-content/uploads/2019/12/Chap-1-Original-Inhabitants-the-Iroquois-ADA.pdf

Sharer, R. J., & Ashmore, W. (1993). *Archaeology: Discovering the past*. Mountain View, CA: Mayfield, p 187 &197.

Simpson, E. (1953). *A history of the Rice Lake Indians*. https://www.ricelakereserves.com/

Singh, A. (1989). Review Article Digital change detection techniques using remotely-sensed data. International Journal of Remote Sensing, 10(6), 989–1003. https://doi.org/10.1080/01431168908903939

Smith, S. A. (1981). *The Lakeshore Lodge site (A1Gh-32): A multi-component Woodland fishing station in Sandbanks Provincial Park* (Report prepared under the auspices of the Ministry of Culture and Recreation for the Ministry of Natural Resources, Napanee District).

Sobala, M., Myga-Piątek, U., & Szypuła, B. (2020). Assessment of changes in a viewshed in the western carpathians landscape as a result of reforestation. *Land*, 9(11), 430. https://doi.org/10.3390/land9110430

Sonnenburg, E, Boyce, J & Reinhardt, E. (2011). Quartz flakes in lakes: Microdebitage evidence for submerged Great Lakes prehistoric (Late Paleoindian-Early Archaic) tool-making sites. *Geology*. 39. 631-634. 10.1130/G31964.1. https://pubs.geoscienceworld.org/gsa/geology/article/39/7/631/130588/Quartz-flakes-in-lakes-Microdebitage-evidence-for

Soyluoğlu, M. (2020). *Underwater cultural heritage protection in cyprus and its contribution to roman archaeology*. https://doi.org/10.33583/mags2020.05

Sprague, T. (2009). *Ghosts of Main Duck Island past*. Nature Stuff. Retrieved February 5, 2025, from Ghosts of Main Duck Island Past – Nature Stuff

Stewart, D. (2007). Gravestones and monuments in the maritime cultural landscape: research potential and preliminary interpretations. *The International Journal of Nautical Archaeology,* 36(1), 112-124. https://doi.org/10.1111/j.1095-9270.2006.00107.x

Storck, P. L. (1982). Palaeo-Indian Settlement Patterns Associated with the Strandline of Glacial Lake Algonquin in Southcentral Ontario. *Canadian Journal of Archaeology / Journal Canadien d'Archéologie*, 6, 1–31. http://www.jstor.org/stable/41102233

Tatarek, N. E., & Sciulli, P. W. (2000). Comparison of population structure in Ohio's late archaic and late prehistoric periods. *American Journal of Physical Anthropology*, *112*(3), 363–376. https://doi.org/10.1002/1096-8644(200007)112:3%3C363::AID-AJPA7%3E3.0.CO;2-Y

Thatcher, C. A., Brock, J. C., Danielson, J. J., Poppenga, S. K., Gesch, D. B., Palaseanu-Lovejoy, M. E., Barras, J. A., Evans, G. A., & Gibbs, A. E. (2016). Creating a Coastal National Elevation Database (CoNED) for Science and Conservation Applications. *Journal of Coastal Research*, 76(sp1), 64–74. https://doi.org/10.2112/SI76-007

The New York Times. (1950). *Yachtsman's Wife, Infant Die in Fire; Early Morning Blaze Razes Robert F. Hart Jr. Home on Lake Ontario*. Retreived from https://www.nytimes.com/1950/01/15/archives/yachtsmans-wife-infant-die-in-fire-early-morning-blaze-razes-robert.html

Time. (1964). People: Feb. 7, 1964. Retrieved from https://time.com/archive/6808294/people-feb-7-1964/

Town and Villages Offices of Public Historian & Elbridge Historical Archives (1963). *Press Photograph of Excavated Cooking Pit/Hearth from Kelso Archaeological Dig in Elbridge NY*. Retreived from https://considerthesourceny.org/document/press-photograph-excavated-cooking-pithearth-kelso-archaeological-dig-elbridge-ny#:~:text=The%20Kelso%20site%20is%20one,kept%20secret%20to%20protect%20them.

Townsend, R. B. (n.d.). *Main Duck Island history*. Lake Ontario Offshore Racing (LOOR). Retrieved February 10, 2025, from https://www.loor.ca/history-mainduckisland

Township of Selwyn. (n.d.). *Moses Muskrat Marsden (1871–1968)*. Retrieved October 1, 2025, from https://www.selwyntownship.ca/media/0een5mkd/muskrat-marsden-qr-text.pdf

Turner, B. L., & Meyer, V. (1994), Global land-use and land cover change: an overview. In *Changes in Land Use and Land Cover: A Global Perspective* (W. B. Meyer and B. L.Turner, Eds.), Cambridge University Press, Cambridge, pp. 1–9

U.S. Army Corps of Engineers, Great Lakes and Ohio River Division. (n.d.). *Great Lakes water level data*. U.S. Army Corps of Engineers. Retrieved from Water Level Data.

United States Environmental Protection Agency (EPA). (2011). *Great Lakes Atlas: Factsheet #1.* Retrieved from EPA Archive https://www.nrc.gov/docs/ML0710/ML071000471.pdf on January 20th, 2025.

VanVlack, A. B. (n.d.). *Rescued by destiny: A love story anchored in history*. Prince Edward County Moments. Retrieved February 6, 2025, from https://2022.countymoments.ca/from-disaster-to-love-on-lake-ontario/

Waldman, J., Daniels, R., Hickerson, M., & Wirgin, I. (2009). Mitochondrial DNA Analysis Indicates Sea Lampreys Are Indigenous to Lake Ontario: Response to Comment. *Transactions of the American Fisheries Society (1900)*, *138*(5), 1190–1197. https://doi.org/10.1577/T08-035R.1

Westerdahl, C. (1992). The maritime cultural landscape. *International Journal of Nautical Archaeology* 21(1):5–14. https://doi.org/10.1111/j.1095-9270.1992.tb00336.x

Westerdahl, C. (2008). Boats apart. building and equipping an iron-age and early-medieval ship in northern Europe. *International Journal of Nautical Archaeology* 37(1):17–31. https://doi.org/10.1111/j.1095-9270.2007.00170.x

Westerdahl, C. (1978), Marinarkeologisk inventering med utgdngspunkt frdn eft norrlandrkr exempel. C-uppsats,arkeologi. Unpublished graduation thesis, 103 pp., University of Stockholm.

Westerdahl, C. (1980a). On oral tradition and place names. *International Journal of Nautical Archaeology* 9 31 1-29.

Westerdahl, C. (1980b). *NAgot om aldre maritim kultur. In Meddelande XLI-XLII 1978- 80. Vhterbottens norrafornminnesforening*, Skellefted museum: 7-2 I. SkellefteA

Westerdahl, C. (1991a), Norrlandsleden: The maritime cultural landscape of the Norrland sailing route. In Crumlin Pedersen, 0. (Ed.), *Aspects **of** Maritime Scandinavia AD 200-1200. Proceedings **of** the Nordic Seminar on Maritime Aspects **of** Archaeology, 13-15th March 1989.* Roskilde.

Westerdahl, C. (1994). Maritime cultures and ship types: brief comments on the significance of maritime archaeology. *International Journal of Nautical Archaeology* 23.4, 265–270.

Williamson, R.F. (1990). "The Early Iroquoian Period of Southern Ontario," in: *The Archaeology of Southern Ontario to A.O. 1650*, edited by C. Ellis and N. Ferris, Occasional Publications of the London Chapter, OAS No. 5:291-320

WomBom. (2010). *Main Duck Island_6176* [Photograph]. Flickr. https://www.flickr.com/photos/wombom/4807145486

Wright, J. V. (1966). *The Ontario Iroquois Tradition*. National Museum of Canada Bulletin 210. National Museum of Canada, The Queen's Printer, Ottawa.

Zerbisias, A. (2011). *"Lake Ontario's cleanest spot: An island nature preserve sheltered by rocky channels".* Toronto Star. Archived from the original on 2017-06-22.

Zheng, M., Tang, W., Ogundiran, A., & Yang, J. (2020). Spatial Simulation Modeling of Settlement Distribution Driven by Random Forest: Consideration of Landscape Visibility. *Sustainability,* 12(11), Article 4748. https://doi.org/10.3390/su12114748