Submerged Evidence of Early Human Occupation in the New York Bight

A Dissertation Presented

by

Daria Elizabeth Merwin

to

The Graduate School

in Partial Fulfillment of the

Requirements

for the Degree of

Doctor of Philosophy

in

Anthropology

(Archaeology)

Stony Brook University

August 2010

Stony Brook University

The Graduate School

Daria Elizabeth Merwin

We, the dissertation committee for the above candidate for the

Doctor of Philosophy degree, hereby recommend

acceptance of this dissertation.

David J. Bernstein, Ph.D., Advisor
Associate Professor, Anthropological Sciences

John J. Shea, Ph.D., Chairperson of Defense
Associate Professor, Anthropological Sciences

Elizabeth C. Stone, Ph.D.
Professor, Anthropological Sciences

Nina M. Versaggi, Ph.D.
Department of Anthropology, Binghamton University

This dissertation is accepted by the Graduate School

Lawrence Martin
Dean of the Graduate School

Abstract of the Dissertation

Submerged Evidence of Early Human Occupation in the New York Bight

by

Daria Elizabeth Merwin

Doctor of Philosophy

in

Anthropology

(Archaeology)

Stony Brook University

2010

Large expanses of the continental shelf in eastern North America were dry during the last glacial maximum, about 20,000 years ago. Subsequently, Late Pleistocene and Early Holocene climatic warming melted glaciers and caused global sea level rise, flooding portions of the shelf and countless archaeological sites. Importantly, archaeological reconstructions of human subsistence and settlement patterns prior to the establishment of the modern coastline are incomplete without a consideration of the whole landscape once available to prehistoric peoples and now partially under water.

This dissertation addresses Early to Mid-Holocene (Archaic period) hunter-gatherer occupation of the coastal plain, both subaerial and now submerged, in and adjacent to the New York Bight coastal province, stretching between southern New Jersey to the eastern end of Long Island, New York.

The Hudson River slices through the apex of the New York Bight. Its banks have been the focus of human activity beginning approximately 12,000 years ago, and the archaeological potential of the estuary and surrounding lands is great. However, a portion of the prehistoric human record in the lower Hudson River is virtually invisible using traditional archaeological methods, as sea level rise has inundated portions of river valley on the continental shelf that likely witnessed prehistoric occupation.

This dissertation proposes that the coastal plain and its river valleys in the Mid-Atlantic, specifically the New York Bight and the Hudson, were utilized by prehistoric peoples throughout the entire Holocene, but significant evidence of this occupation is now under water due to post-glacial sea level rise. Cultural continuity is also proposed for the lengthy Holocene, and the traditional regional chronology (Paleoindian, Archaic, and Woodland periods) and its implications for marked economic, demographic, and social change is challenged.

Data from known Archaic period archaeological sites located on the subaerial coastal plain in the New York Bight are used to reconstruct settlement patterns and to determine high probability areas for underwater prehistoric sites. Analysis of a recently discovered submerged archaeological assemblage known as the Corcione collection and results of new underwater field work in the Hudson River Valley (offshore Sandy Hook and in Croton Bay) are discussed in the context of the terrestrial record.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

As I ebb'd with the ocean of life,
As I wended the shores I know,
As I walk'd where the ripples continually wash you Paumanok,
Where they rustle up hoarse and sibilant,
Where the fierce old mother endlessly cries for her castaways,
I musing late in the autumn day, gazing off southward,
Held by this electric self out of the pride of which I utter poems,
Was seiz'd by the spirit that trails in the lines underfoot,
The rim, the sediment that stands for all the water and all the land of the globe.

Fascinated, my eyes reverting from the south, dropt, to follow those slender windrows,
Chaff, straw, splinters of wood, weeds, and the sea-gluten,
Scum, scales from shining rocks, leaves of salt-lettuce, left by the tide,
Miles walking, the sound of breaking waves the other side of me,
Paumanok there and then as I thought the old thought of likenesses,
These you presented to me you fish-shaped island,
As I wended the shores I know,
As I walk'd with that electric self seeking types.

- Walt Whitman, from *Leaves of Grass* (1891-1892)

Starting from fish-shaped Paumanok (Long Island) where, like Walt Whitman, I was born, I worked as a field archaeologist for a year before entering the Nautical Archaeology Program at Texas A&M University. In that time, especially the months spent at the Eagles Nest prehistoric site overlooking Mount Sinai Harbor, a grain of an idea became lodged in my mind: given the abundance of fresh water, animals, plants, and mineral resources along the island's protected shoreline, it is hardly surprising to discover that Native Americans left a rich archaeological record documenting thousands of years of life along the coast. But these sites are relatively recent (at the time, Eagles Nest had yielded the oldest radiocarbon date for a Long Island site, 4850 years old). Were people here earlier? And if so, where are the sites? It seemed likely that some answers may lie under water.

Much like a speck of sand trapped in an oyster, the notion that there must be underwater archaeological sites around Long Island grew for years in my head. This dissertation is the resultant small pearl. Now, I imagine if one could ask, an oyster would not express much gratitude for the process. I, however, have many people to whom I am indebted.

First, I would like to thank the members of my dissertation committee for their insight, guidance, and encouragement: David Bernstein, John Shea, and Elizabeth Stone of Stony Brook University, and Nina Versaggi of Binghamton University. R. Michael Stewart provided thoughtful comments on an earlier draft. In addition to serving as my advisor, Dave has been not only a close friend, but also my boss at the Institute for Long Island Archaeology for many years. I am lucky to have him as my mentor.

I have benefitted from sharing work and ideas with various graduate student cohorts and field crews over the years. I am grateful for my time spent at Texas A&M, and especially for my friendships with Scott McLaughlin, David Stewart, and Matthew Pridemore. Michael Faught generously allowed me to tag along during two field seasons of his work in northern Florida, where I learned the nuts and bolts of conducting research under water. Thanks are also due to him for the idea of the air lift we built, tested, and refined with the 2004 Stony Brook field school students.

I've had the real pleasure of earnest conversation with coworkers over test units and over beers during my many years working at Stony Brook, and I would like to acknowledge Allison Manfra McGovern and Mark Tweedie in particular for their support. Most recently, Mark helped me with the artifact images in Appendix B. On the subject of graphics, nearly all of the artifact photographs were taken by the ever-talented Marylou Stewart, and the underwater photographs were taken by Martin Alvero. I sincerely thank Janet Masullo of the Anthropology Department at Stony Brook for the moral support she has so freely given me all these years.

The GIS modeling component of this project was funded by a Tibor T. Polgar Fellowship from the Hudson River Foundation, which I gratefully acknowledge. In addition, I am indebted to the Archaeological Society of New Jersey for a research grant.

None of my field research off the coast of New Jersey likely would have happened had it not been for two people, Helene Corcione and Dana Linck. Helene discovered the lithic artifacts documented in this study, and brought her remarkable finds to Dana, then Park Archeologist for Gateway National Recreation Area. Dana recognized the significance of the Corcione collection, and in the course of fishing for information about underwater prehistoric archaeology he hooked me. I thank Dana for his generosity, offering his time, resources, detailed knowledge of Sandy Hook, and the wide breadth of his archaeological expertise.

Thanks are also due John Killeen, formerly of the New York District U.S. Army Corps of Engineers, Greg Lattanzi of the New Jersey State Museum, Deborah Fimbel of the New Jersey State Historic Preservation Office, and Michael Schifferli of the New York State Office of Parks, Recreation, and Historic Preservation for their time and assistance. The National Park Service provided much appreciated support for field work offshore Sandy Hook, and I am particularly grateful for the help that Russ Wilson (former Superintendent, Sandy Hook Unit, Gateway National Recreation Area), Kathy Foppes (Chief of Cultural Resources, Gateway NRA), and Dave Conlin (Chief, Submerged Resources Center) provided.

Scott Horecky's enthusiasm for the archaeology of Croton Point runs deeply, and I thank him for sharing his South Beach finds and encouraging me to look for artifacts in Croton Bay. I also thank the Westchester County Department of Parks, the staff at Croton Point, and the Material Archives and Laboratory for Archaeology for their help during the 2004 field season.

The 2003 and 2004 field work would not have been possible without all of the wonderful students and volunteers: Martin Alvero, Bob Benson, Adina Buxbaum, James Caston, Dio Charvalos, Matt Conrad, Aaron Das, Matthew DeFelice (Dive Master), Bryan Frank, Amy Gusick, Erin Head, Charlotte Hjärthner-Agostini (Dive Master), Peter Leach, Ginessa Mahar, Matt Napolitano, Greg Porter, Franklin Price, Chris Reed, Erik Seadale, Rachel Scheckman, Harry Schreffer, Sparticus Shapiro, Ellen Valentino, Wyatt Yeager, Matthew Young, and Taylor Zaneri. I am especially grateful to Matthew DeFelice for his unflappable good nature and help that always went well above and beyond, and to Greg and Adina for returning the second season as field assistants. Captain Mick Trzaska embraced our non-traditional charter group, and made us feel at home aboard the *CRT II.* The staff at Dosil's Scuba Center provided greatly appreciated technical support.

Finally, I offer my heartfelt thanks to my family, especially my sisters Alicia Cacace and Alexandra Amon, my brother Hugh Merwin, and my Dad- and Mom-in-law, Will and Lee Schuler. My husband Mike Lenardi has been my best friend, true partner, companion, and rock solid foundation for many years now. I am deeply grateful that he has remained by my side through the good, the bad, and the sadly ugly. My mother lost her fight against cancer not long after I returned to Long Island from Texas A&M, and as I write these acknowledgments it has been just one week since I buried my father.

I remember a lunch I shared with my Dad at a small seafood place overlooking the Great South Bay where Hugh ran the kitchen, back in 2003. My Dad presented me with a gift box, and inside was a lovely gold bracelet composed of tiny overlapping oyster shells. Pleased, but a bit confused, I asked what was the occasion? Beaming, Dad said it was to celebrate completion of the first season of my very own underwater archaeological field project. He was proud, and said Mom would've been too. Thanks, Dad. I wish I could have shown you this pearl.

INTRODUCTION

Archaeology is the study of the past that uses material remains to reconstruct human behavior. As archaeologists, we seek to understand the similarities and differences within and between groups, often over large distances in both time and space. Our attempts to understand the human past are often framed by "big questions": how and when did hunter-gatherer groups spread across the globe? What are the origins and repercussions of plant and animal domestication? Why did social complexity develop in some places and not others?

The answers to these questions lie in the archaeological record, the tangible remains of past human activities. However, the data set is far from complete. Many aspects of human behavior simply do not leave material traces, from the mundane (e.g., daily social interaction between members of a family) to the life-altering (e.g., childbirth). Other clues to the past, such as fragile organic materials (e.g., everyday clothing made from animal or plant materials), typically do not survive in the ground for centuries, let alone millennia. Still others are virtually invisible using traditional archaeological methods. Until relatively recently, submerged archaeological deposits were invisible to researchers, but modern technology now allows us to explore what has been described as one of "the precious few frontiers left in the field" (Blanton 1996:217). Underwater archaeology has the potential to greatly expand our knowledge of the past.

A Very Brief History of Underwater Archaeology

The ability to conduct true scientific research under water was dependent on the development of suitable technology, but undersea exploration has a surprisingly ancient history. Alexander the Great could be credited as the first documented underwater explorer. During the late fourth century B.C., he was said to have had a glass barrel built to be towed beneath a boat in which a person could sit and observe the sea floor (Marx 1980). In his 360 B.C. *Problematum,* Aristotle described a crude diving bell used by free divers as an air source while working underwater. The history of free diving for pearls, sponges, and other marine resources is thousands of years old in the Mediterranean Sea and Asia. Diving to salvage material from shipwrecks may be as old as seafaring itself, and was the impetus for the eighteenth century invention of metal diving helmets with surface-supplied breathing air.

Technological innovations in diving suit design were made over the course of the eighteenth and nineteenth centuries in Europe and the United States, with several fatalities along the way. It was not until the twentieth century, however, that the tools and knowledge for underwater exploration became safe and widely available. An important development resulted from research in hyperbaric physiology. Essentially, the deeper a diver descends, the greater the pressure under which the gasses in his body (including the lungs and bloodstream) are compressed. Should a diver spend too long at depth, or ascend too fast, the compressed air may expand too quickly and embolize, leading to severe bodily harm and even death. In the early twentieth century "dive tables" were published by John Haldane and colleagues, providing a guide to safe dive times per depth (Boycott et al. 1908). Similar dive tables are still in use today.

Another important innovation was the invention of what is commonly called scuba, or self-contained underwater breathing apparatus, to replace diving suits and metal helmets. In 1943, Frenchmen Jacques Cousteau and Emile Gagnan assembled portable cylinders of compressed air with regulators and demand valves, the first modern scuba kit (Throckmorton 1987). Refinements improved on Cousteau and Gagnan's design, leading to modern equipment, and opening the undersea realm to exploration by masses of both recreational and scientific divers.

While the technology has continued to advance, underwater survey and excavation are typically far more expensive and logistically more complex than comparable archaeological projects conducted on dry land. Underwater conditions can vary widely from site to site, or even hour to hour at the same site, and all work is constrained by safety and time factors (generally, the deeper the site, the less time a scuba diver can remain at that depth). Water currents, temperature, and visibility frequently are important variables affecting our ability to undertake underwater field work. In addition to diving, remote sensing technology, including sonar systems and magnetometers, are routinely used by archaeologists to search for underwater sites.

The field of underwater archaeology is less than fifty years old, but in that time considerable advances have been made in both method and theory (Gould 2000). George Bass is generally credited as the first "underwater archaeologist" because of his explicit use of modern (albeit terrestrial) archaeological field methods to map and excavate a three thousand year old shipwreck off Cape Gelidonya, Turkey in 1960 (Throckmorton 1987). While many early important research projects were undertaken in the Mediterranean Sea and northwestern Europe, in the United States underwater archaeology grew not only through academic inquiry, but also in response to site destruction by treasure hunters and by offshore construction. By the early twenty-first century, six United States universities had underwater archaeology programs and at least eight state historic preservation offices had underwater archaeology branches (Elliott et al. 2000). An informal survey of journal articles and conference abstracts suggests that roughly half of all underwater archaeological work conducted today in the United States is done in advance of proposed construction and half consists of academic undertakings. Regardless of the reason, the overwhelming majority of underwater archaeology projects in the United States concern shipwreck sites.

Archaeology of Drowned Landforms

Shipwreck sites have been the traditional focus of underwater archaeological investigations (Bass 1972; Muckleroy 1978) and continue to dominate the field in the twenty-first century. However, the study of submerged land forms and drowned human occupation sites has substantial potential to increase our knowledge of the distant past (Bailey and Flemming 2008; Flemming 1983a; Stright 1990).

Research on underwater sites has made important contributions to the archaeology of Mesolithic sites in Northwest Europe (Aberg and Lewis 2000; Andersen 1987; Fischer 1995), Neolithic sites in the Mediterranean Sea (Flemming 1983b; Gifford 1990), Epipaleolithic and Neolithic sites off the Levant coast (Galili and Weinstein-Evron 1985; Galili et al. 1993), and even Aboriginal sites in Australia (Dortch 1997). A recent discovery of two stone Acheulean handaxes in Table Bay, South Africa suggests that at least some prehistoric deposits are able to weather several fluctuations in sea level and remain relatively intact (Werz and Flemming 2001).

In North America, large expanses of the continental shelf were dry during the last glacial maximum, about 20,000 years ago. During the Late Pleistocene and Early Holocene, large volumes of water from melting glaciers caused global (eustatic) sea level rise, flooding portions of the continental shelf. Over the course of the last 15 to 18,000 years, global seas have risen as much as 90 to 130 meters, drowning what was once inhabitable land and presumably countless archaeological sites. Rising seas have covered land that stretched seaward as much as 150 kilometers from the modern coastline. Sea level rise rates have varied considerably through both time and space, but slowed by 6000 to 3000 years ago, when shorelines were close to their modern positions in eastern North America (Fleming et al. 1998; Pirazzoli 1991; Stright 1995:131). Sea levels continue to rise today, accelerating as a consequence of global warming and drowning littoral archaeological sites.

Changing sea levels have significant implications for archaeological research. Most importantly, any reconstruction of subsistence strategies and settlement patterns for years prior to the establishment of the modern coastline is not complete without a consideration of the total exposed land mass. Further, our knowledge of early regional cultural groups, their interactions, and means of expressing and maintaining territoriality, is limited without data from the now-submerged coast. Archaeology of drowned prehistoric sites is the best way to examine issues such as the origin of aquatic adaptations, settlement and mobility strategies at the coast versus interior, and seasonal subsistence patterns in eastern North America prior to the establishment of the present coastline.

Underwater Archaeology in the New York Bight

Several authors have noted the high archaeological potential of the Mid-Atlantic continental shelf (Edwards and Merrill 1977; Emery 1966; Emery and Edwards 1966; Hoyt et al. 1990; Kraft et al. 1983; Stright 1990), and specifically, portions of the shelf adjacent to major estuaries, including the drowned portion of the Hudson River (also known as the Hudson Shelf Valley or Hudson Canyon) (Edwards and Emery 1977; Salwen 1962, 1975). The research described in this dissertation addresses Early to Mid-Holocene (the Archaic period, approximately 10,000 to 3000 years ago) hunter-gatherer occupation of the coastal plain, both subaerial and now submerged, in and adjacent to the Hudson River Valley. For the purposes of this study the coastal plain archaeological unit is defined by the New York Bight coastal province, stretching between southern New Jersey to the eastern end of Long Island, New York (Figure 1). The term bight refers to a bend in an open coastline. The New York Bight is near the middle of the larger Mid-Atlantic Bight, the portion of the eastern North American coast between the Chesapeake Bay and Cape Cod. The term Mid-Atlantic as used herein encompasses what are today generally thought of as the Middle Atlantic states (Virginia, Maryland, Delaware, New Jersey) as well as southern New England (coastal New York, Connecticut, Rhode Island, and Massachusetts), reflecting the bounds of the Mid-Atlantic Bight.

The Hudson River, both subaerial and submerged, slices through the apex of the New York Bight (Figure 1). Its banks have been the focus of human activity for millennia, from the earliest colonization by Native American peoples approximately 12,000 years ago to modern times. The archaeological resources of the estuary and surrounding lands are rich, diverse, and have significant research potential. Several authors have developed cultural historical frameworks for understanding human adaptations to the changing Hudson River landscape through time based on extensive archaeological surveys and excavations along the river's banks (Brennan 1974; Claassen 1995; Eisenberg 1978; Funk 1976; Kraft 1991; Ritchie and Funk 1973; Salwen 1975). However, a portion of the prehistoric human record of the lower Hudson River Valley is virtually invisible using traditional archaeological methods. Sea level rise has inundated portions of the continental shelf that are likely to have witnessed early prehistoric occupation, especially in the New York Bight and areas of the Atlantic sea floor adjacent to the Hudson Canyon.

Despite the problems of site identification and the technological issues associated with conducting research under water, the potential to recover significant archaeological data from the sea bed is high. Information from prehistoric sites dating to the Late Pleistocene through Mid-Holocene now submerged in the New York Bight region will contribute to our knowledge of prehistoric Native American settlement, and possibly subsistence and even social, patterns. In addition, preservation of organic materials such as bone, wood, leather, textiles, and basketry is often better in waterlogged deposits (Coles 1988) than is typical for the acidic, sandy soils that characterize much of the coastal plain in the Mid-Atlantic. Another potential benefit of submerged prehistoric material, especially artifact scatters lacking temporally diagnostic tools or dateable deposits, is that a relative date for which the site must be older can be determined based on water depth and local sea level curves (plots of water depth versus time which indicate the rate of marine transgression).

Much of what is known regarding prehistoric lifeways on the coastal plain surrounding the New York Bight draws upon data from archaeological sites dating from the Late Archaic and subsequent periods (after roughly 6000 B.P.). The start of the Late Archaic period has been perceived as a time of human population growth in the region, suggested by an increase in the number of known sites, as well as an increase in both site size and diversity (Ritchie 1980; Snow 1980). Importantly, the Late Archaic period coincides with slowing sea level rise and the establishment of the modern coastline. Late Archaic period sites along the coast here often have an aquatic or maritime component, often characterized by the presence of shell middens, especially towards the latter part of the period when sea levels were closest to current positions (Braun 1974; Brennan 1968, 1974; Lavin 1988; Wyatt 1977). The coastal settlement patterns reconstructed for the Late Archaic period may well have an earlier origin, but the evidence is now under water.

In this dissertation I propose that the coastal plain and its river valleys in the Mid-Atlantic, specifically the New York Bight and the Hudson, were utilized by prehistoric peoples throughout the entire Holocene, but significant evidence of this occupation is now under water due to post-glacial sea level rise. Cultural continuity is also proposed for the lengthy Holocene, and the traditional regional chronology (Paleoindian, Archaic, and Woodland periods) and its implications for marked economic, demographic, and social change is challenged (cf. Bernstein 2006).

Data from known Archaic archaeological sites located on the subaerial coastal plain in the New York Bight are used to reconstruct settlement patterns and to determine high probability areas for underwater prehistoric sites. Analysis of a recently discovered submerged archaeological deposit known as the Corcione collection and results of new underwater field work in the Hudson River Valley (offshore Sandy Hook and in Croton Bay) are discussed in the context of the terrestrial record.

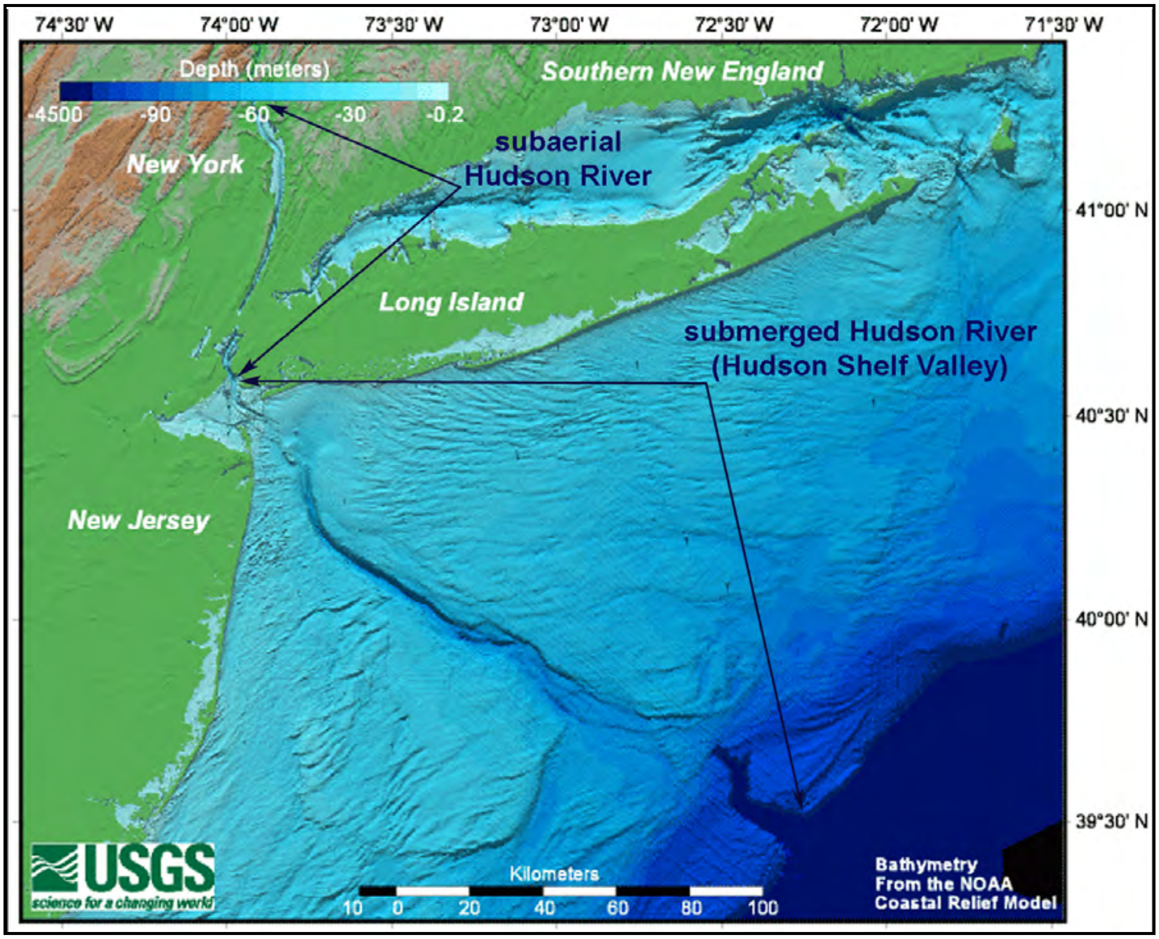


Figure 1. Location of the New York Bight study area. Bathymetry is based on the NOAA Coastal Relief Model, and the background image is from the USGS Studies in the New York Bight online report (http://woodshole.er.usgs.gov/project-pages/newyork/index.html).

PREHISTORIC CONTEXT OF THE NEW YORK BIGHT REGION

Ancestors of historically known Algonquian-speaking Native Americans lived in the New York Bight region for more than ten thousand years. The archaeology of southeastern New York State and northern New Jersey has a history dating back to the nineteenth century (Cantwell and Wall 2001; Mounier 2003). During the twentieth century, archaeological investigations were conducted by avocational excavators, as part of cultural resource management projects, and to a lesser degree, as traditional academic endeavors. These activities continue today, with most of the work being done in advance of construction.

Surveys of regional prehistory are provided in Custer (1984), Kraft (1986, 2001), Mounier (2003), Ritchie (1980), Salwen (1978), and Snow (1980). Archaeologists working around the New York Bight and elsewhere in the Mid-Atlantic have traditionally employed a system of three periods (Paleoindian, Archaic, and Woodland) to divide the span of time between the first settlement of the region by Native Americans and the arrival of the European explorers in the sixteenth century. The Paleoindian period spans roughly 12,500 to 10,000 years before present (B.P.). It is followed by the Archaic, divided into four periods: Early Archaic (10,000 to 8000 years B.P.), the Middle Archaic (8000 to 6000 B.P.), the Late Archaic (6000 to 3000 B.P.), and the Terminal Archaic (sometimes referred to as the Transitional, 3000 to 2700 B.P.). The Woodland period is typically divided into the Early Woodland (2700 to 2000 B.P.), the Middle Woodland (2000 to 1000 B.P.), and the Late Woodland (1000 to 500 B.P.) (Table 1; these dates follow the chronology used by Cantwell and Wall [2001] and others). The work reported in this dissertation focuses on the Archaic period. All dates presented here, unless noted otherwise, are given as uncalibrated years B.P.

Many prehistoric archaeological sites in the region lack organic material suitable for radiocarbon dating, largely due to very poor preservation in sandy, acidic soils typical of the Atlantic coastal plain. As a result, archaeological deposits are often dated by relying on artifact (especially projectile point) styles (Figure 2). Points are classified based on morphology, and the contexts from which they were recovered are then assigned the absolute dates that have been obtained for similar materials in the region (Table 1). The chronological resolution of typological cross-dating is often broad, and not always adequate for sorting out remains into contemporary components or making comparisons among sites (Miroff et al. 2008). Despite these drawbacks, artifact typologies are helpful in ordering the prehistoric past, and they are used to organize the discussion that follows, except in those cases where specific radiocarbon dates are mentioned.

Prehistoric temporal divisions coincide roughly with the environmental changes that occurred from the end of the Late Pleistocene through the Early and Mid-Holocene to the present (Late Holocene) (Table 1). However, note that the divisions among Paleoindian, Archaic, and Woodland are largely the construction of archaeologists working during the first half of the twentieth century. Initially, the divisions seem to have reflected marked subsistence and technological changes. Problems with this temporal framework, and especially the invention of the Archaic period, are discussed in the next chapter.

Table 1. Prehistoric chronology for the New York Bight region. Dates are uncalibrated years before present.

Cultural Period	Dates	Comments
Late Woodland	1000 - 500 B.P. Late Holocene	modern sea level; triangular projectile points (Levanna, Madison, Potomac, Roanoke)
Middle Woodland	2000 - 1000 B.P. Late Holocene	sea level very close to modern position; points include Jack's Reef, Selby Bay, Fox Creek
Early Woodland	2700 - 2000 B.P. Late Holocene	sea level close to modern position; points include Adena, Calvert, Rossville
Transitional	3000 - 2700 B.P. Late Holocene	sea level within 2-3 meters of modern position; small stemmed, Orient fishtail points
Late Archaic	6000 - 3000 B.P. Mid-Holocene	sea levels between 3 and 15 meters lower; variety of side-notched (Brewerton, Halifax, Otter Creek) and stemmed (Bare Island, Lackawaxen, Lamoka), broad (Savannah River, Susquehanna), and triangular (Squibnocket) points
Middle Archaic	8000 - 6000 B.P. Mid-Holocene	sea levels between 15 and 25 meters lower; stemmed (Morrow Mountain, Neville, Stanly, Stark) points
Early Archaic	10,000 - 8000 B.P. Early Holocene	sea levels between 25 and 40 meters lower; corner-notched (Kirk, Palmer) and bifurcate base (LeCroy, St. Albans) points
Paleoindian	12,500 - 10,000 B.P. Late Pleistocene	sea levels more than 40 meters lower; fluted projectile points (Clovis, Cumberland, Dalton, Hardaway)

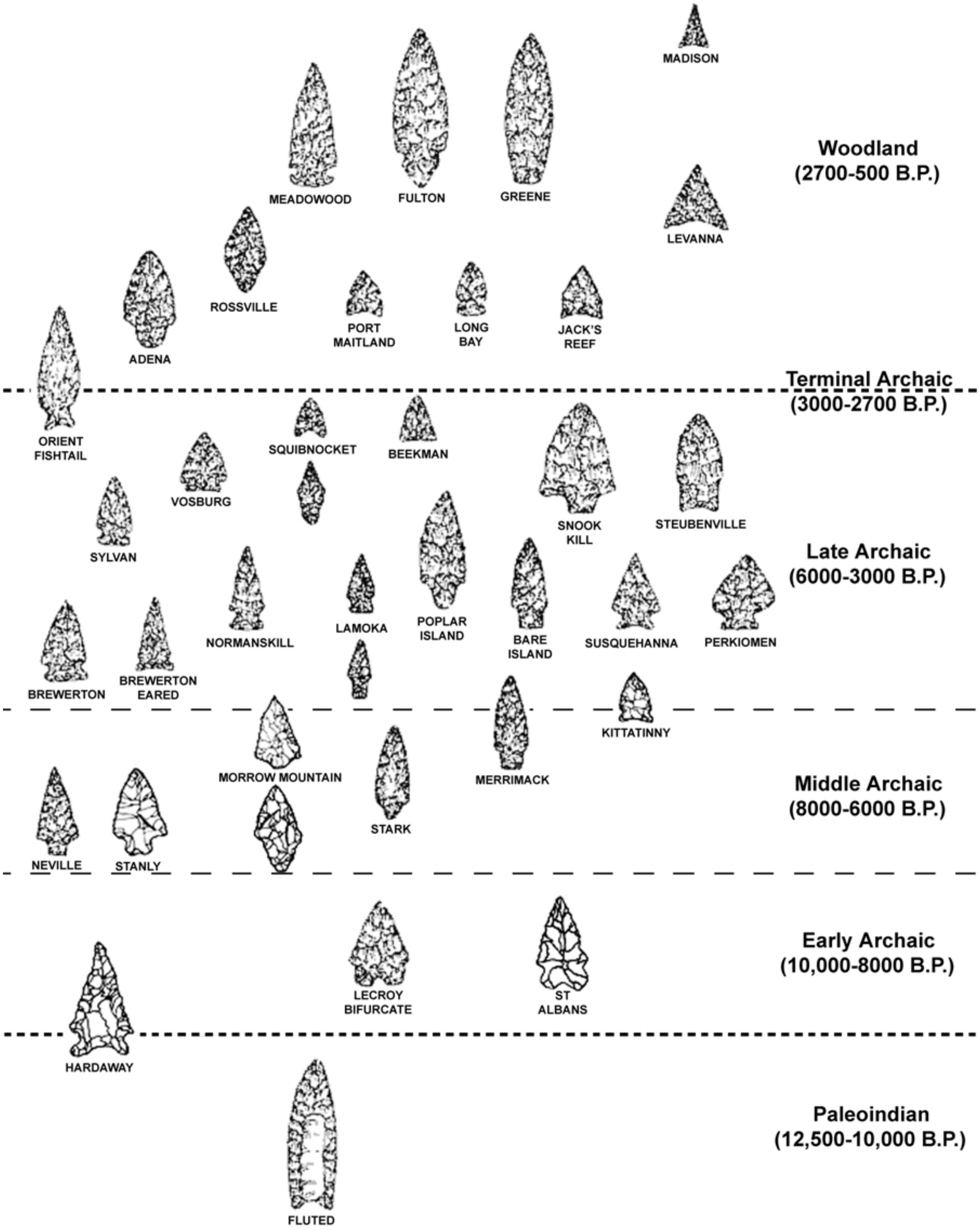


Figure 2. Projectile point chronology for the New York Bight region (Mid-Atlantic/ southern New England) (drawings after Justice 1987 and Ritchie 1971).

Environmental Setting

Before turning to an overview of the prehistoric period in the New York Bight and surrounding region, the natural environment (both ancient and modern) must be considered. An evaluation of the environment, including climate, hydrography, soils and minerals, is essential to understanding past land use, as well as to determining the likelihood of encountering prehistoric archaeological sites. Hunter-gatherer groups locate their settlements to best take advantage of the characteristics of the landscape. Thus, knowledge of a region's environmental features is important for reconstructing past behavior and assessing the probability of locating evidence of early activities.

The New York Bight is within the Atlantic Coastal Plain physiographic province, characterized by a 300 kilometer wide gently sloping surface that extends beneath the ocean, where it is known as the continental shelf. Several glacial moraines run roughly east-west across the coastal plain. The southernmost moraine marks the maximum extent of the Wisconsinan ice sheet, where it reached northern New Jersey and the middle of Staten and Long islands in New York approximately 21,750 B.P. (Isachsen et al. 2000:178) (Figure 3). Moraines in the New York Bight consist of poorly-sorted glacial till, sometimes containing lithic material suitable for stone tool manufacture (e.g., jasper nodules found on Staten Island), while areas south of the moraines are made up of outwash sediments. Thus, the surficial sediments of northeastern New Jersey, and parts of Staten Island and Long Island are essentially composed of mud, sand, gravel, and boulders transported from the north by glacial advances. Bedrock in the New York Bight generally consists of Mesozoic and Cenozoic age sedimentary rocks, though it is deeply buried through most of the region (Isachsen et al. 2000:169; Minard 1969).

Post-Glacial Environment. Deglaciation and associated sea level rise had a significant impact on the eastern North American landscape at the close of the Pleistocene. The fluctuating edge of the ice sheet in particular would have been a very dynamic zone, as shifting meltwater channels cut deltaic fans of outwash sediments and kames of till were dumped at the melting ice margin, only to be reworked during the next cold season and readvance of the ice (Isachsen et al. 2000). The maximum advance of the Wisconsinan glacier bisected modern Illinois, Indiana, and Ohio, and continued through northern Pennsylvania, northern New Jersey, and southern New York (Figure 3).

In the New York Bight region, the ice sheet was largely responsible for surficial topography and the location of fresh water resources such as proglacial lakes, meltwater streams, and kettle ponds. The presence of a massive ice sheet could have had a moderating effect near the edge of the glacier, blocking cold Arctic air in the winter and lowering temperatures in the summer (Martin et al. 1985:18). The interpretation that recently deglaciated landscapes at the end of the Pleistocene were harsh and desolate (e.g., Sirkin 1977) is not substantiated by soil chemistry. Plant growth is greatly influenced by three major nutrients: nitrogen, potassium, and phosphate. In areas which had been glaciated or were located near the edge of the ice sheet, nitrates present in

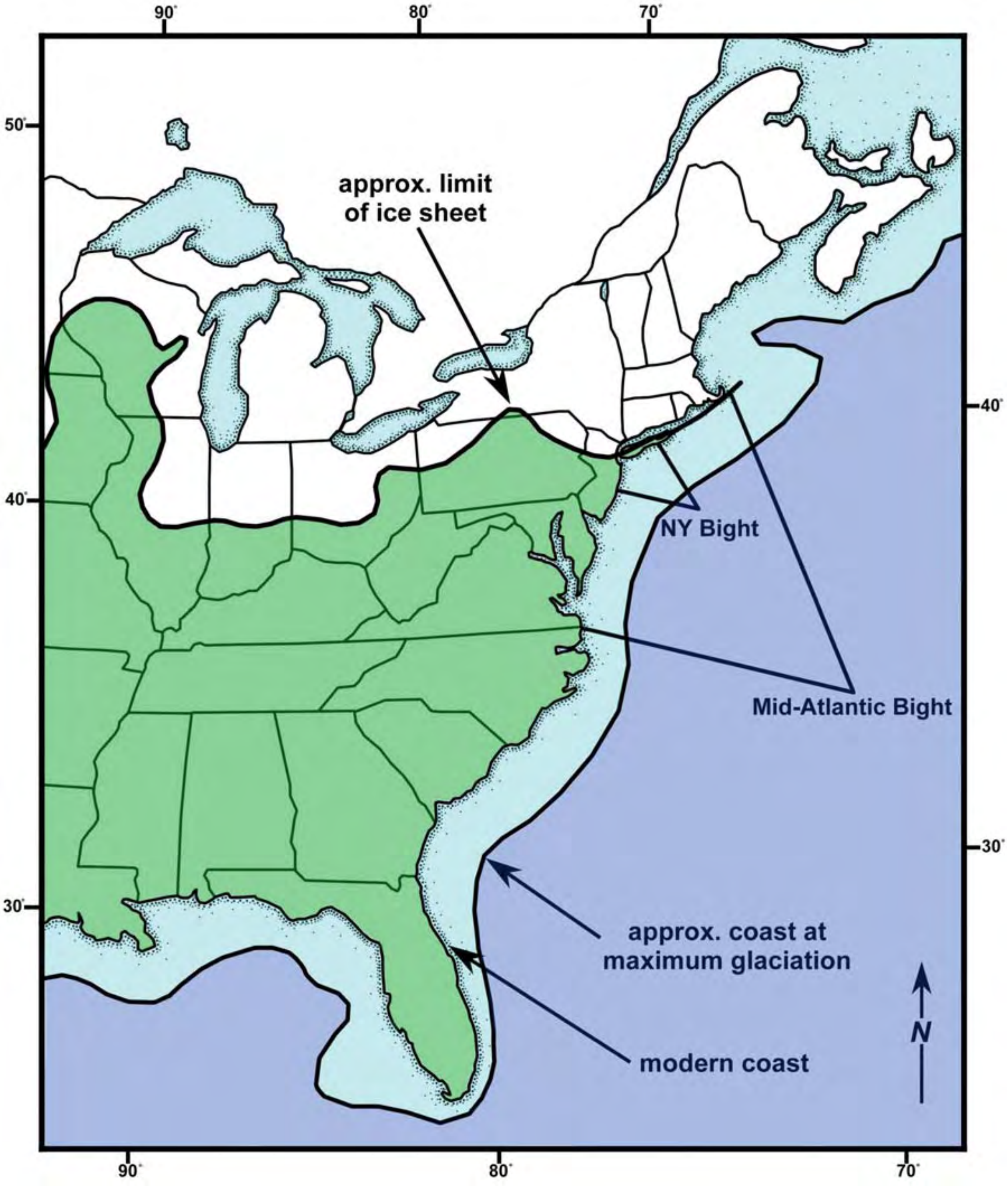


Figure 3. Map of the New York Bight showing the approximate southern limit of the Wisconsin ice sheet and the exposed portion of the continental shelf at the end of the last glacial maximum, approximately 21,750 B.P.

glacial ice would have been released in meltwater runoff. Further, glaciated landscapes with igneous or metamorphic terrain (e.g., much of the Northeast) would have witnessed an influx of potassium and phosphate released by the mechanical breakage of rock under the ice sheet (Bonnichsen and Turnmire 1999:6). These nutrients most likely sustained young, productive ecosystems in deglaciated areas, while Late Pleistocene cycles of low solar input resulted in the spread of grasslands, which could have supported large mammals, such as woolly mammoth, mastodon, bison, equines, reindeer, and musk ox (Bonnichsen and Turnmire 1999:6-7).

While relatively few Pleistocene faunal remains have been found on land around the New York Bight, several stream beds in Monmouth County, New Jersey contain bedded Pleistocene deposits from which fossils have been recovered, and finds have also been made by fishermen in the Atlantic Ocean (Jepsen 1964; Parris 1983; Whitmore et al. 1967). The paleontological record of Pleistocene fauna from Monmouth County include extant (white-tailed deer [*Odocoileus virginianus*], muskrat [*Ondatra zibethica*], raccoon [*Procyon lotor*], fox [cf. *Urocyon* sp.]), extirpated (gray wolf [*Canis lupus*], mountain lion [*Felis concolor*], elk [*Cervus canadensis*], caribou [*Rangifer tarandus*], beaver [*Castor canadensis* and *Castoroides ohioensis*]), and extinct (crane [*Grus proavus*], ground sloth [*Megalonyx* sp. and *Eremotherium mirabile*], elk-moose [*Cervalces* sp.], mastodon [*Mammut americanum*]) animals (Parris 1983). Mastodon finds in northeastern Monmouth County (near Sandy Hook) include part of a tibia found before 1818 in Navesink Hills, and a nearly complete skeleton (1824) and tooth (1882) from Long Branch (Jepsen 1964). Bergen County, New Jersey (northwest of New York City, on the west side of the Hudson River) has also yielded mastodon remains (Parris 1983).

Many species of megafauna present in the New York Bight region were extinct by the end of the Late Pleistocene. Their presence on the now-submerged continental shelf is known, however, from several finds. Virtually all of the bones were recovered by fishermen from the surface of the sea floor (the bite of shellfish dredges is no deeper than eight centimeters into the surface) (Gallagher et al. 1989). Whitmore et al. (1967) documented 19 mastodon and mammoth finds (virtually all teeth) in the Atlantic Ocean in and around the Hudson Canyon and along the New Jersey shore between Sandy Hook and Atlantic City. They also report on the recovery of a metacarpal from an extinct elk-moose (*Cervalces scotti*) dredged from the Hudson Canyon off New York in 160 meters of water. Jepsen's inventory (1964) adds another six mastodon specimens, and Gallagher et al. (1989:104) add two more teeth to the inventory. Parris (1983) makes note of a horn core, likely aurochs (*Bos primigenius*), found in peats off Brigantine. Finally, Gallagher et al. (1989) report on two caribou antlers from southern New Jersey waters and part of the left radius from a ground sloth (*Megalonyx* sp.) from the Atlantic Ocean off Sandy Hook. These faunal finds are summarized in Table 2. Many of the finds have been made adjacent to the Hudson Shelf Valley, roughly between 40°30'/74°00' and 40°00'/73°00' (Figure 1). Whitmore et al. (1967:1477) attribute the concentration along the Hudson Canyon at least in part due to the intensity of effort by trawling vessels in this area, while the preponderance of teeth found by fishermen is likely because they survive well and are large and easily recognized. Other skeletal elements likely have been thrown back into the ocean (Gallagher et al. 1989:102).

One of the problems with understanding human adaptations to the Late Pleistocene/Early Holocene landscape in eastern North America is that there are no modern analogs for the biotic communities which existed in the past. For example, Late Pleistocene vegetation distributions no longer exist, even though there were essentially no extinctions of plant species. Pollen from cores and other data indicate that in the past there were associations of plants which either do not occur today, or if they do, are of very limited geographic extent (Martin et al. 1985:25).

In the past, researchers (e.g., Fitting 1968; Sirkin 1977; Snow 1980:111-117) concerned with reconstructing the paleoenvironment in eastern North America tended to take a rather general approach, attempting to characterize regions by forest type based on ideas of vegetative succession and climax. In glaciated areas of the New York Bight, the broad pattern following the retreat of the Wisconsinan ice sheet consisted of first tundra grassland, replaced by taiga (or the "spruce parkland zone" [Fitting 1968]) with coniferous trees including spruce and pine, followed by boreal forest with some deciduous species, and finally a mixed hardwood forest dominated by oak. These vegetative communities were transgressive over time and space.

Table 2. Faunal finds made in the Atlantic Ocean in and around the New York Bight.

Location	Water Depth	Species, Element	Year Collected	Comments,* Source
40°16'30"/73°54'30"	19 m	ground sloth, radius	1980s	found by fish trawler off Sandy Hook; Gallagher et al. 1989
40°16'/73°54'	20 m	mastodon, 3 molars	1966	Whitmore et al. 1967
~40°10'/73°20'	40 m	mastodon, 2 molars		AMNH; Whitmore et al. 1967
~40°08'/73°20'30"	30 m	mastodon, teeth	1951	Jepsen 1964
~40°06'30"/74°	20 m	mastodon, tusk and bones	1882	Jepsen 1964
40°03'/73°50'	26 m	mastodon, molar	1967	Whitmore et al. 1967
~40°/74°	20 m	mastodon, molar	1962	Whitmore et al. 1967
~40°/73°	30 m	mastodon, molar		AMNH, Whitmore et al. 1967
39°52'/73°58'	20 m	mammoth, molar	1962	USNM, Whitmore et al. 1967

~39°50'/73°30'	40 m	mastodon, teeth	1948, 1953	Jepsen 1964
~39°50'/73°15'	50 m	mastodon, 2 molars		AMNH, Whitmore et al. 1967
39°50'/73°05'	60 m	mastodon, molar	1948	AMNH, Whitmore et al. 1967
39°46'/73°56'	20 m	mastodon, molar	1965	USNM, Whitmore et al. 1967
~39°45'/74°	20 m	mastodon tooth	1951	Jepsen 1964
~39°45'/73°30'	40 m	mastodon, molar	1948	Whitmore et al. 1967
~39°45'/73°30'	40 m	mastodon, molar	1954	Whitmore et al. 1967
~39°45'/73°30'	40 m	mastodon, molar	1954	Whitmore et al. 1967
~39°45'/73°30'	40 m	mastodon, molar	1950	Whitmore et al. 1967
39°43'/73°12'	46 m	mastodon, molar		AMNH, found by scalloper, Whitmore et al. 1967
39°42'/72°47'	~60 m	mastodon, molar		AMNH, Whitmore et al. 1967
39°40'/73°50'	~20 m	mastodon, molar		found by clam dredge, Whitmore et al. 1967
39°37'55"/73°57'23"	27 m	mastodon, molar	1987	found by clammer; Gallagher et al. 1989
~39°35'/74°05'	14 m	mastodon, long bone	1957	Jepsen 1964
~39°35'/74°	20 m	mastodon, molar		AMNH, Whitmore et al. 1967
39°35'/72°40'	75 m	mammoth, molar		AMNH, Whitmore et al. 1967
~39°35'/72°10'	160 m	elk-moose, metacarpal	1950	Whitmore et al. 1967
~39°30'30"/74°06'	15 m	caribou, antler	1988	Gallagher et al. 1989
~39°30'/72°30'	40 m	mastodon, tusk fragment	1950	Whitmore et al. 1967
~39°25'/74°20'	10 m	aurochs, horn	1980	Parris 1983
~39°25'/74°	38 m	mastodon, premolar	1980s	Gallagher et al. 1989
~39°25'/74°	38 m	caribou, antler	1987	Gallagher et al. 1989

*AMNH=collections, American Museum of Natural History, USNM=U.S. National Museum (now the Smithsonian Institution, National Museum of Natural History)

While this reconstruction has generally been upheld, there has been some rejection of the succession-to-climax model for explaining shifts in vegetative communities (Blumler 1996). A complete picture of past landscapes is still being developed, and there is a need for fine-grained environmental data in order to understand early Native American lifeways (Gaudreau 1988; McWeeney 1994; Newby et al. 2001). Pollen data and macrobotanical remains are most compelling when supported by faunal data. Past landscapes in eastern North America were probably more complex, heterogeneous, and potentially more productive, than evidence from one source alone would suggest.

In general, vegetation in the New York Bight region during the Late Pleistocene consisted largely of boreal forest dominated by coniferous species, particularly spruce (*Picea* sp.). Based on arboreal pollen studies in southern New England, spruce accounted for more than 40 percent of the trees on the landscape 12,000 years ago (Gaudreau 1988: Figure 4). Other trees in a mixed conifer/hardwood forest in southern New England, the lower Hudson River Valley, and northern New Jersey around 12,000 B.P. included white pine (*Pinus strobus*), fir (*Abies* sp.), and larch (*Larix* sp.) (McWeeney 1999:7). Pollen cores indicate that spruce had dropped to less than 40 percent by the start of the Holocene at 10,000 B.P., while the percentage of oak trees (*Quercus* sp.) made up roughly 20 percent of regional woodlands (Gaudreau 1988; Jacobson et al. 1987). Spruce drops out of the pollen record for the New York Bight area after 8000 years ago, and is replaced by pines (*Pinus* sp.), indicative of a warmer climate (Gaudreau 1988). By 4000 B.P., deciduous forests had expanded such that regional pollen data indicates oaks made of 50 percent of the forest and pines only 20 percent (Bernabo and Webb 1977), similar to modern conditions. These changes in biotic communities occurred somewhat earlier in the southern portion of the Mid-Atlantic region. Analysis of pollen from the Dill Farm archaeological site in coastal Delaware showed a pine-dominated forest (with hemlock, birch, and oak) by roughly 9950 B.P. (Custer 1989:50). Temporal and spatial shifts in faunal communities likely followed the changing floral patterns, but these shifts are not well documented.

The Mid-Atlantic coastline has been progressively inundated since the last glacial maximum (ca. 21,750 B.P.; Isachsen et al. 2000:178). As the glacier melted, water which previously had been locked up as ice filled oceans, resulting in a world-wide rise in sea level, ranging from 95 to 130 meters depending on the locality (Kraft et al. 1983). Phenomena relating to sea level rise include the elevation of ground water table levels (which generally resulted in an increase of fresh water resources over time on the coastal plain) and isostatic rebound (uplifting of land relieved of glacial overburden, most notably in northern areas such as coastal Maine). Major river valleys, including the Hudson, Delaware, and ancestral Susquehanna (now Chesapeake Bay), were gradually inundated.

The rate of sea level rise has fluctuated over the past 20,000 years. In general, rates in eastern North America were as high as ten meters per thousand years during the Late Pleistocene, and slowed to about three meters per thousand years with the onset of modern climatic conditions in the Mid-Holocene around 7000 B.P. (Fleming et al. 1998). Sea levels continued to rise at a rate of about three meters per thousand years until around 5000 to 6000 years ago. At this time, seas were within seven or eight meters of their current levels. After around 5000 years ago, sea level rise slowed even further, to about one meter per thousand years, a rate which has lasted until fairly recently (Pirazzoli

1991). The rate of sea level rise has accelerated in the past four hundred years, jeopardizing archaeological sites on the modern coast (Blanton 1996).

Climatic swings, local coastal morphology, isostatic rebound, and other factors will result in different sea level curve plots, even over relatively short distances (Oldale 1986; Donnelly 1998). Because of this variation, it is best to use local (not continental) sea level curves for environmental reconstruction. Sea level curves for New York Harbor (summarized in Pirazzoli 1991:192-193) suggest that water levels were approximately 30 meters lower 10,000 years ago, 22 meters lower 8000 years ago, around 15 meters lower 6000 years ago, 8 meters lower 4000 years ago, and 4 meters lower 2000 years ago (Figures 4 and 5). Thus, sea level curves can be used to give a relative date for cultural deposits found under water. For example, an artifact recovered from an undisturbed context in a water depth of 23 meters is most likely more than 8000 years old, the last time that portion of the continental shelf was dry land.

The formation of the Hudson River is linked with glacial processes. As the climate warmed after the last glacial maximum, meltwater from the receding ice sheet became trapped north of the end moraine, and glacial Lake Hudson was formed (Weiss 1974). Lake Hudson drained prior to 12,500 B.P., after which the ancestral Hudson River was confined to its bedrock channel. Salt water entered the lower Hudson River around 12,000 B.P., creating estuarine conditions, and rising sea levels during the Holocene resulted in widening the river to its current size (Weiss 1974).

Like the variable rates of sea level change, global climate has not been constant over the past several thousand years. When the first known people entered eastern North America at the end of the Pleistocene, the climate was dry compared to modern conditions. Much of the earliest occupation coincides with an episode known as the Younger Dryas interval (approximately 11,300 to 10,000 B.P.), when temperatures dropped to cold glacial levels. The termination of the Younger Dryas marked the onset of comparably stable, moist and warm Holocene conditions (Mayewski and Bender 1995). In general, while climatic swings during the Holocene are small in magnitude compared with those documented for the Pleistocene, there have been periods of marked change. For example, during the span between approximately 7000 to 5000 years ago, known as the Mid-Holocene hypsithermal, temperatures in the Northern Hemisphere were warmer in the summer and colder in the winter than they are now (Kerwin et al. 1999). The Mid-Holocene hypsithermal roughly coincided with the Middle Archaic period. More pronounced differences in seasonal temperatures may have been met with a cultural response during the Middle Archaic period, such as higher residential mobility.

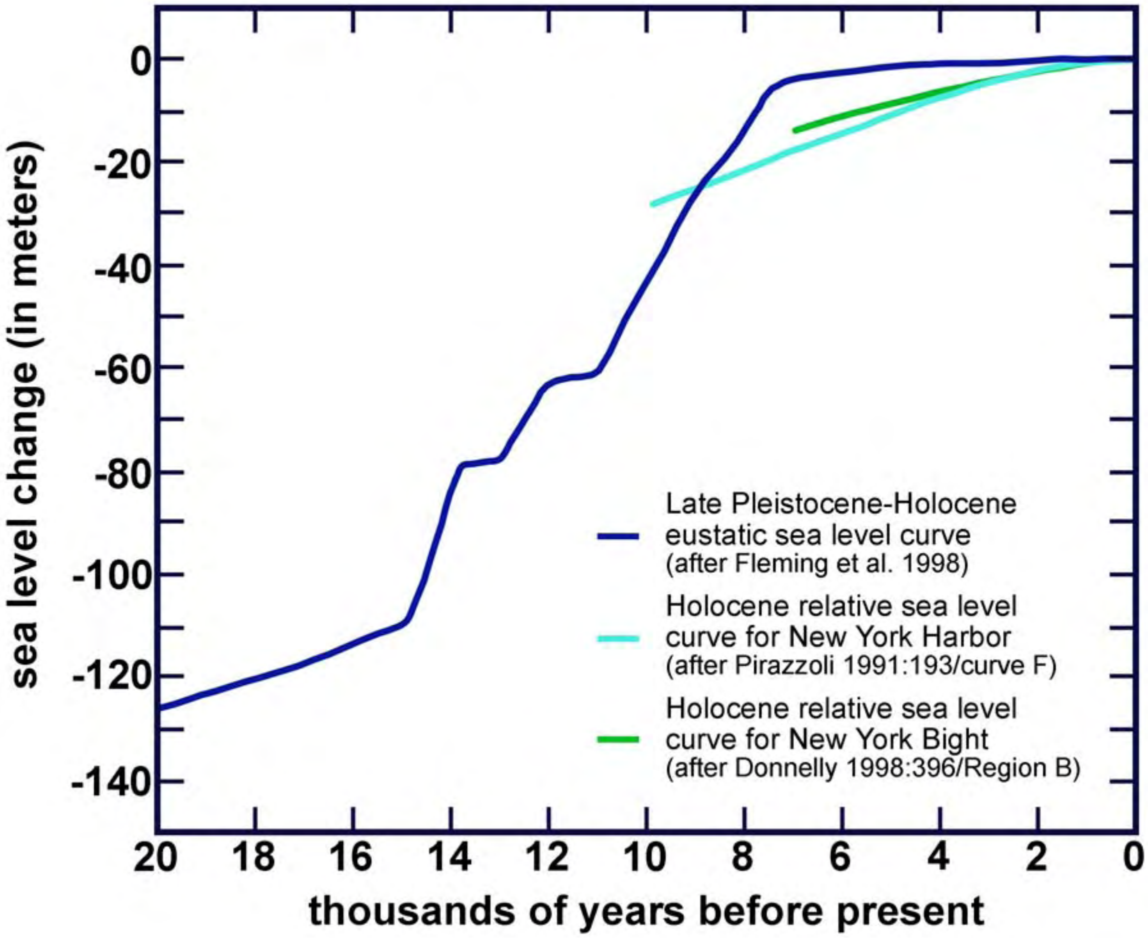


Figure 4. Sea level curves for the New York Bight. The dark blue line represents eustatic (global) sea level change from after the Last Glacial Maximum through the present (after Fleming et al. 1998), while the light blue line represents local relative sea level rise over the course of the Holocene for New York Harbor (Inner New York Bight; after Pirazzoli 1991), and the green line is relative sea level rise in the New York Bight (after Donnelly 1998).

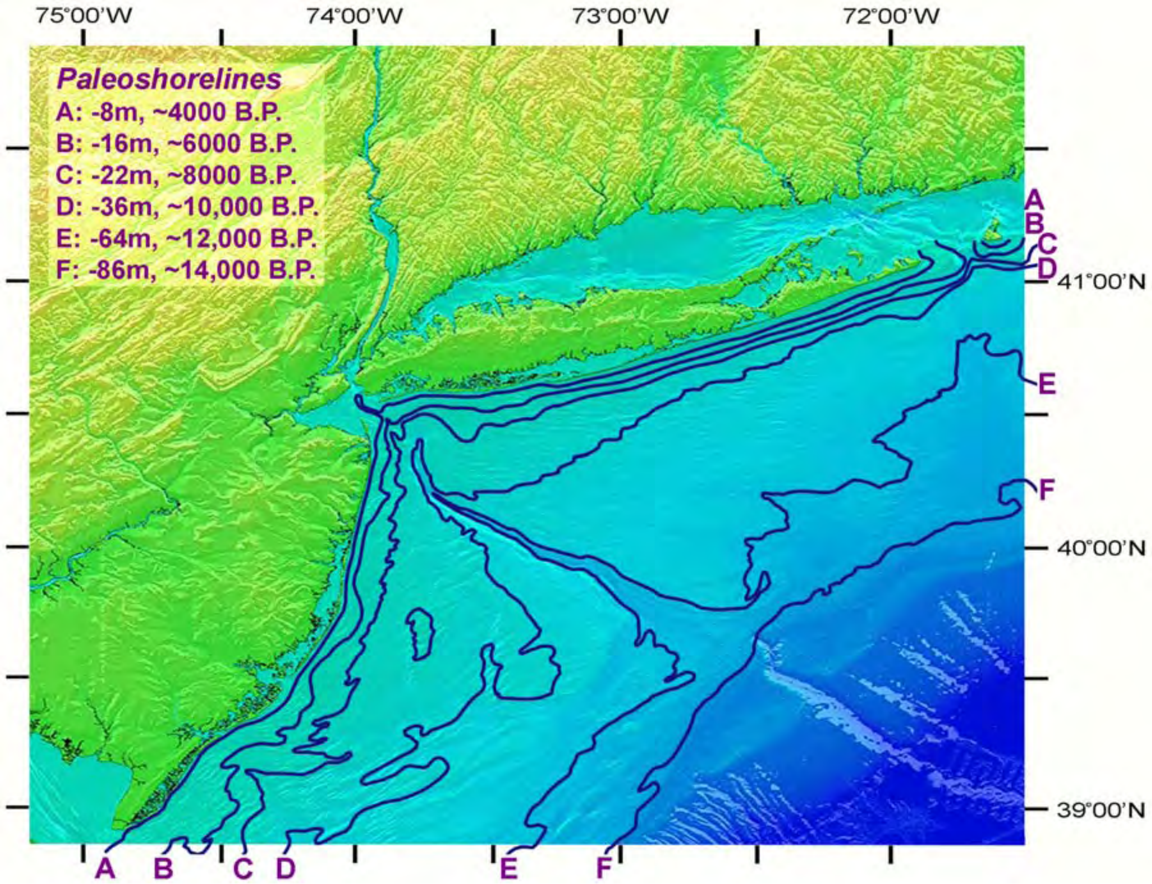


Figure 5. Generalized shorelines in the New York Bight, 4000 to 14,000 years ago. Note that these paleoshorelines are based on modern bathymetry (data from the NOAA Coastal Relief Model), which in turn has been influenced by modern deposition, erosion, dredging, and other factors. Thus, the reconstructed shorelines are approximate.

Culture History and Chronology

Despite the thousands of archaeological surveys and excavations undertaken on terrestrial prehistoric sites in the New York Bight region, many important research issues remain unresolved. The paucity of radiocarbon dates has hampered reconstruction of subsistence and settlement patterns (Bernstein 2006; Cantwell and Wall 2001). In the majority of cases, sites have been dated solely on the basis of artifact styles, especially projectile point morphology (Table 1; Figure 2). Artifacts believed to be diagnostic of particular prehistoric periods are referenced in the following overview of culture history, except in those cases where specific radiocarbon dates are available. As noted above, unless otherwise stated, these radiocarbon dates are in uncalibrated years B.P. Sites mentioned in the text are shown in Figure 6.

The coastlines of the New York Bight have been progressively inundated since the retreat of the Late Pleistocene glaciers. Although sea level continues to rise today, most shorelines attained their approximate modern positions by 3000 B.P. During the last three to five thousand years of the prehistoric era (and most likely earlier), the mouths of estuaries were particularly attractive to hunter-gatherers, and many of the larger sites dating to the Late Holocene have been identified in these settings (Bernstein 2006).

The Paleoindian period dates from the first arrival of humans into the region until around 10,000 B.P. Settlement here, like all of the Americas, took place at the end of the Pleistocene glacial epoch as human populations radiated out from Asia across the exposed Bering Sea land bridge and/or by boat across the northern Pacific (Anderson and Gillam 2000; Dixon 1999; Fiedel 2000; Fladmark 1979; Meltzer 1988, 2004).

Recently, a perceived similarity between Paleoindian and European Solutrean toolkits has prompted some archaeologists to speculate about a northern Atlantic coastal migration route (Sellet 1998; Stanford and Bradley 2005). However, the logistical problems a founding population would have encountered traversing the North Atlantic Ocean, the lack of human occupation sites above about 48 degrees north latitude, and a gap of at least 5000 years between Solutrean sites in Iberia and early sites in eastern North America, suggest that any resemblance in bone and lithic tools between the two cultures is coincidental, and not necessarily indicative of a migration (Kornfeld and Tubarev 2009; Straus 2000). Still, should the North Atlantic migration route be shown to have been viable, the continental shelf off the northeastern United States (especially the paleocoastline of the New York Bight and Hudson Canyon, Figure 3) would be a logical place to search for evidence (Stright 2004).

Only a few sites dating to the Paleoindian period are known from the New York Bight region, while the presence of early peoples is implied from the occasional find (almost always on the surface) of characteristic fluted projectile points that were presumably used to hunt Late Pleistocene/Early Holocene fauna (Anderson and Faught

1998). The relative scarcity of early sites along the modern coast is to be expected. Even if the region was well-populated prior to 10,000 B.P., most of the evidence for early human presence has been destroyed or hidden by natural processes. Foremost among these forces is the post-glacial rise in sea level. During the initial settlement of the region, sea level was roughly one hundred meters lower than today, meaning that, for example, the south shore of Long Island was located as much as 160 kilometers south of its present position (Sirkin 1995). What is now lower New York Harbor would have been exposed land, cut by stream channels of the Hudson and Raritan rivers.

Sea level rise has significant implications for understanding early human subsistence and settlement patterns, as large expanses of theoretically inhabitable land have since been drowned (Kraft et al. 1983). The archaeological potential of the continental shelf off eastern North America is largely undetermined, although a few studies have successfully demonstrated the high likelihood for the presence of early prehistoric sites (e.g., Dunbar et al. 1992; Hoyt et al. 1990; Stright 1986). Until more data are collected from submerged archaeological deposits, the extent to which Paleoindians used the coastal plain in eastern North America will remain unknown.

A number of early Native American sites have been found on land in the region. The first reported Paleoindian habitation site in eastern North America was at Shoop, Pennsylvania (Witthoft 1952). This discovery was soon followed by the Reagan site in Vermont (Ritchie 1953) and the Bull Brook site in eastern Massachusetts (Byers 1954). The Bull Brook site is still the largest known early site in the Northeast, with 42 loci containing over 8,000 stone tools. Radiocarbon dates on charcoal from hearth features at Bull Brook range between 8720 and 9300 B.P., while faunal remains include beaver, caribou, and other cervid bones (Spiess et al. 1998:208, 224).

Meadowcroft Rockshelter probably has received more attention than any other early prehistoric site excavated in eastern North America, due in large part to the very early radiocarbon dates obtained for the lowest artifact-bearing strata. The site is located in southwestern Pennsylvania, approximately 50 kilometers south of the maximum extent of the last advance of the Wisconsinan ice sheet, and overlooks Cross Creek, a small tributary of the Ohio River. The rockshelter deposits are deep, stratified, and contain several cultural components, with an internally-consistent suite of radiocarbon dates ranging from at least between 685±80 through 13,240±1010 B.P. (Adovasio et al. 1990). No fluted projectile points were found in the lowest strata at the Meadowcroft Rockshelter, leading Adovasio to suggest that the deposits were created by people earlier than, or at least outside of, the fluted point Paleoindian tradition (Adovasio 1993).

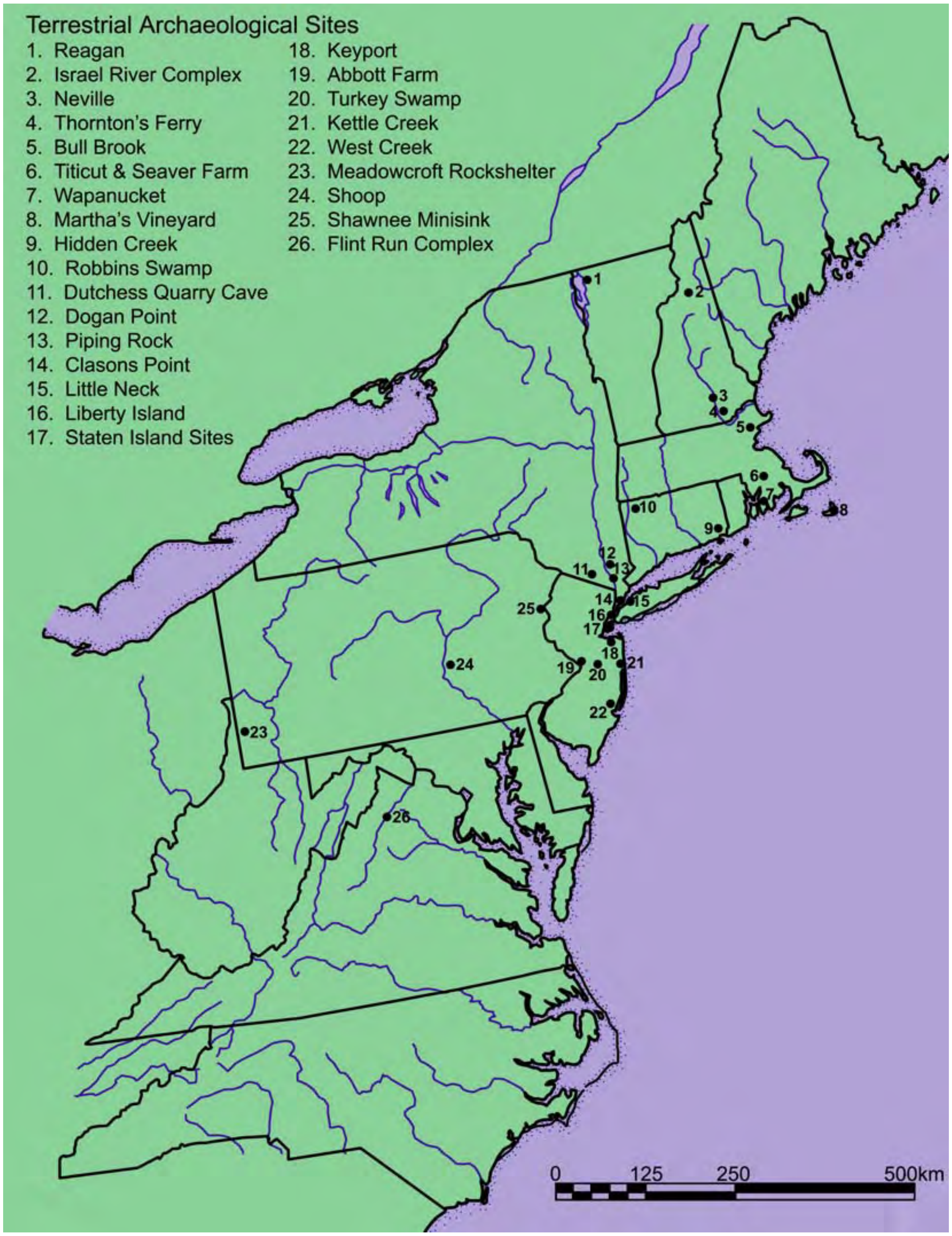


Figure 6. Terrestrial archaeological sites in the New York Bight region described in the text.

Another well-studied Paleoindian site not far from the New York Bight region is the Shawnee Minisink site in the Upper Delaware River Valley of eastern Pennsylvania. The Paleoindian component of the site has been radiocarbon dated to 10,940±90 and 10,900±40 (Dent 2002). More than 76 seeds from at least ten different plant species were recovered from Paleoindian contexts at the site, including chenopod (*Chenopodium* sp.), hawthorn plum (*Crataegus* sp.), blackberry (*Rubus* sp.), acalypha (*Acalypha* sp.), grape (*Vitis* sp.), buckbean (*Menyanthes trifoliata*), smartweed (*Polygonum* sp.), amaranth (*Amaranthus* sp.), hackberry (*Celtis* sp.), and wintercress (*Barbarea orthoceras*) (Dent and Kauffman 1985:67). Interestingly, there are only minor differences between the Paleoindian and Early Archaic botanical assemblages from the site. In addition to the wide variety of seeds and fruits at Shawnee Minisink, fish bones were encountered in Paleoindian contexts (Dent and Kauffman 1985:73).

The investigators of the Shawnee Minisink site inferred a late summer/early autumn Paleoindian occupation, based largely on the fact that most seeds of wild plants ripen in the fall (McNett 1985). However, they also caution that most of the plants could have been dried and stored for consumption at some later time (Dent and Kauffman 1985:72). It is usually assumed that Paleoindian groups practiced little or no food storage (Dent and Kauffman 1985:73), although evidence such as woven fibers (possibly the remains of baskets) from the Meadowcroft Rockshelter (Adovasio 1993) and pit features elsewhere in eastern North America (e.g., at the Holcombe site in southeast Michigan [Cleland 1965] and the Israel River Complex in New Hampshire [Boisvert 1998, 2004]) suggest otherwise.

Many eastern Paleoindian sites are located adjacent to what would have been fresh water resources at the time of occupation. During the Late Pleistocene, lowered sea levels and associated lowered ground water tables resulted in fewer fresh water resources compared to Holocene conditions, and the few resources that were present undoubtedly attracted human foragers. Fresh water locales would have been visited repeatedly by Paleoindians, and thus these sites are more visible in the archaeological record than environmental settings used only sporadically.

The location of fresh water and wetlands does appear to have played an important role in Paleoindian site preferences in southern New England (Nicholas 1988). One example is the Late Paleoindian Hidden Creek site (72-163) in the Cedar Swamp Basin on the Mashantucket Pequot Reservation in southeastern Connecticut. The site is believed to date to approximately 10,000 B.P. based on a fluted point specimen and other artifacts (Jones 1997). The Thornton's Ferry site in southern New Hampshire, radiocarbon dated to 10,600±300 years B.P., yielded lithic artifacts and remains from unidentified species of fish and plants (Spiess et al. 1998:206). The Israel River Complex is a cluster of four Paleoindian sites located in the Israel River Valley of northern New Hampshire, largely characterized by lithic artifacts made from local rhyolites dating between 11,000 and 10,000 B.P. The former marsh setting of the complex is suggested by a charred water lily seed recovered from a pit feature located 40 meters above the nearby old lakebed (Boisvert 2004). Similarly, the Wapanucket No. 8 site in southeastern Massachusetts consists of five loci on a sand dune overlooking a swamp and Lake Assawompsett (Robbins and Agogino 1964).

Paleoindian sites and artifacts found on Staten Island, New York (at the apex of the New York Bight) are also near former fresh water resources. The best known of the Staten Island sites is at Port Mobil, which consists of three adjacent loci of Paleoindian artifacts. The Port Mobil site is located on a bluff overlooking Arthur Kill, and yielded over one hundred stone tools, including several small fluted points, scrapers, drills, knives, and cores. Most of the artifacts were found in disturbed contexts during oil tank construction (Kraft 1977). The Charleston Beach site is located southwest of the Port Mobil site, and also contained a number of fluted projectile points (some from contexts mixed with significantly later Woodland period artifacts). Surface collections at the North Beach site, north of Port Mobil and adjacent to Arthur Kill, produced two fluted points (one apparently unfinished), two large unifacial tools, and scrapers (Kraft 1977). A fluted point was found at the Cutting site near Arthur Kill, while surface finds of Paleoindian material have been made at the Smoking Point site, also near Arthur Kill. Nineteen fluted projectile points are known from Long Island (Merwin 2000; Saxon 1973).

Mounier (2003:126) notes that almost all habitation sites in New Jersey, regardless of temporal association, are located near fresh water. Two Paleoindian sites, two sites with redeposited Paleoindian period artifacts, and 12 isolated finds of Paleoindian artifacts (mostly fluted projectile points) have been documented on the outer coastal plain of central and southern New Jersey (Grossman-Bailey 2001:171-184). An additional 12 fluted points, most made from jasper, with others of quartzite and argillite, have been recovered on the coastal plain between Sandy Hook and Barnegat Bay in central New Jersey (Marshall 1982). One Paleoindian site on the coastal plain was found in advance of construction near Kettle Creek in Ocean County. Testing yielded more than three hundred lithic artifacts, including a fragment of a fluted point and channel flakes (presumably the products of producing a flute in a bifacial tool), most made from non-local jasper (Mounier 2003:195-196).

Sources of workable stone, like fresh water resources, may also have served as focal points of human occupation. Stratified sites containing Paleoindian artifacts in an area rich with good lithic raw material include the Thunderbird and Fifty sites of the Flint Run Complex in the Shenandoah Valley of Virginia (Gardner 1977). The “Flint Run Lithic Deterministic” model of Paleoindian settlement, where the movements of small groups of Native Americans were made to take advantage of this important lithic source (Anderson and Sassaman 1996), was based on finds at the complex, which included quarries, reduction sites, base camps, and maintenance camps. On the Delmarva Peninsula, there appear to be two mechanisms responsible for the distribution of fluted projectile points. One concentration in the north is likely similar to the Flint Run model, where Paleoindian artifacts are associated with outcrops of high quality lithic raw material such as jasper and chalcedony. The other concentration of fluted points is along the mid-peninsular drainage divide, where the Late Pleistocene-Early Holocene environment was riddled with swamps and wetlands, which likely attracted game, in turn attracting the prehistoric hunters (Custer et al. 1983).

The closest known Paleoindian site in the lower Hudson Valley other than the Staten Island finds is Dutchess Quarry Cave in Orange County, New York. The site yielded a fluted projectile point, along with Late Archaic and Woodland artifacts (Funk and Steadman 1994). It was initially believed that the Paleoindian component included Late Pleistocene fauna (e.g., caribou [*Rangifer tarandus*], flat-headed peccary [*Platygonus compressus*], and giant beaver [*Castoroides ohioensis*]). However, a re-evaluation of the faunal assemblage and strata at Dutchess Quarry Cave using AMS radiocarbon dating demonstrated no clear link between human activity and the animal remains (Steadman et al. 1997). Another lower Hudson Valley Paleoindian artifact find was made at the Piping Rock site, located on the east shoreline of the Hudson River in Ossining, approximately two kilometers southeast of Croton Point (Funk 1976:205).

As discussed above, after the retreat of the glacial ice sheet, tundra vegetation, similar to that found today in Alaska and northern Canada, colonized the newly exposed landscape (Sirkin 1995). Between 19,000 and 11,000 B.P. a spruce dominated forest was present, later followed by a forest dominated by pine. Finally, by 9000 B.P. (during the Early Archaic period) hardwood forests, similar to those that characterize the Eastern Woodlands today, began to develop in the New York Bight region.

The Archaic period is characterized by the gradual establishment of modern environmental conditions. Native Americans adapted to the abundant resources provided by interior woodlands, ponds, and rivers, as well as coastal estuaries by exploiting a broad range of food (nuts, large and small game, seed-bearing plants, fish, etc.) and industrial products (stone for making tools and weapons, plants for baskets and textiles, bark for house construction, etc.). By around 6000 B.P. the region seems to have been heavily settled, with populations for the southeastern New York and New Jersey coast and offshore islands possibly numbering in the thousands. This apparent population growth is reflected in the large number of archaeological sites dating to the Late Archaic period, and by the large size of the individual settlements (Mounier 2003; Ritchie 1980; Wyatt 1977). However, the Late Archaic period is roughly coincident with slowing sea level rise rates and the establishment of the modern coastline. Late Archaic period lifeways in the Mid-Atlantic region have a significant coastal component, characterized by the presence of shell middens, especially towards the latter part of the period when sea levels were closest to current positions (Braun 1974). The model of lower population during the Early and Middle Archaic periods, followed by population growth during the Late Archaic, is based upon the terrestrial archaeological record, but it is likely that earlier archaeological sites are now submerged on the formerly subaerial portions of the continental shelf (see the next chapter for further discussion of Archaic period settlement and subsistence patterns).

Regardless of whether people were living on the now-submerged coast, major shifts in social organization and mobility strategies are not suggested by the archaeological record at several Mid-Atlantic sites, including the Meadowcroft Rockshelter and Shawnee Minisink site (both in Pennsylvania), which contain substantial Early Archaic components underlain by Paleoindian material. At Shawnee Minisink in particular, the archaeological record is indicative of continuity in human adaptations, with gradual intensification of local resource use and broadening of diet breadth over time (McNett 1985). South of the New York Bight, Archaic toolkits found on the Delmarva Peninsula appear to expand in diversity, including the introduction of more plant-processing tools such as mortars and pestles, but the types of locations chosen for occupation were essentially the same between the Paleoindian and Archaic periods (Custer 1986).

Just as the fluted projectile point is regarded as representative of Paleoindian activity, the bifurcated base point is often seen as characteristic of the Early Archaic period (Kuhn 1985). Several sites on Staten Island have yielded Early Archaic bifurcated points. The large multi-component site at Ward’s Point near the confluence of the Raritan River with Arthur Kill contained artifacts from the Early Archaic through the historic period. This assemblage includes 21 bifurcated base points, 16 other projectile points, and other stone tools. Charcoal from a hearth feature was radiocarbon dated to 8300±140 B.P. (Ritchie and Funk 1971). Similar materials were recovered from the Hollowell site, the Old Place site, and the Richmond Hill site, the latter of which yielded one of the oldest radiocarbon dates from the New York Bight region (9410±120 B.P.) (Ritchie and Funk 1973). An Early Archaic component has been identified at a site near Little Neck, Queens, on western Long Island (Lambert 1994).

The West Creek site, on the mainland behind Little Egg Harbor in southern Ocean County, New Jersey, had three loci of prehistoric activity likely dating to the Early Archaic period. Jasper and chert tools included Kirk and Palmer projectile points and scrapers. Features of calcined bone at the West Creek site, radiocarbon dated to approximately 9850 B.P., probably represent human cremation burials (Mounier 2003:168, 198; Stanzeski 1998). Elsewhere in the region, a suite of radiocarbon dates clustered around 7950 B.P. from a hearth feature at the Turkey Swamp site on the outer coastal plain in northeastern New Jersey (near Freehold, Monmouth County) places it within the Early Archaic period, despite the presence of several basally-thinned triangular projectile points that are “reminiscent” of Paleoindian forms (Cavallo 1981). Early Archaic bifurcate base projectile points are found thinly scattered across southern New England, perhaps representative of hunting losses or small camp sites. The Titicut and Seaver Farms sites on the Taunton River in southeastern Massachusetts may have been used as base camps (Dincauze and Mullholland 1977).

The Middle Archaic is the least well-represented period at Staten Island sites (with probable Middle Archaic artifacts at the Old Place and Ward’s Point sites) and elsewhere throughout the New York Bight region. During this period (roughly 8000 to

6000 B.P.), continued climatic warming resulted in the establishment of a near-modern landscape. One of the best-studied Middle Archaic deposits is the Neville site, located on the Merrimack River in Manchester, New Hampshire (Dincauze 1976). Neville was used repeatedly beginning roughly 7750 B.P., probably as a seasonal base camp situated to take advantage of migratory fish runs. Besides fishing, other activities represented by artifacts and features at the site include stone tool manufacture (Middle Archaic projectile point types here include Neville, Stark, and Merrimack), hide working, and wood working. Other nearby sites in the Merrimack River drainage contain more evidence for fishing activities (e.g., plummets for net weights, gouges possibly for building dugout canoes) (Snow 1980:176).

The earliest well-dated evidence for shellfish utilization in the region is the Middle Archaic midden at Dogan Point, adjacent to the lower Hudson River (Claassen 1995). The site's earliest radiocarbon date of 6950±100 B.P. makes it the one of the oldest shell middens on the Atlantic coast of the United States. One of the site's excavators noted that the early shell-bearing levels at Dogan Point suggest "that the use of marine resources occurred prior to the stabilization of sea level ca. 5000 years ago and that inundation of earlier coastal sites, not cultural retardation, accounted for the lack of shell matrix sites before sea level stabilization" (Claassen 1995:3).

As mentioned above and discussed in detail in the following section, the Late Archaic period (approximately 6000 to 3000 B.P.) in the Mid-Atlantic is characterized by a possible increase in population size, represented by an increase in the number, size, and diversity of archaeological sites. In addition, Late Archaic sites are found in a seemingly greater diversity of environmental settings than earlier periods, although this could be at least in part due to poor site visibility (e.g., sea level rise obscuring older sites).

The Late Archaic period is well represented in southeast New York, while Ritchie (1980:142) noted that Archaic period archaeological sites on Staten Island were more similar to contemporaneous sites in New Jersey than to sites elsewhere in New York State. The main projectile point types believed to be diagnostic of the Late Archaic period consist of narrow stemmed types, such as Bare Island, Lackawaxen, Lamoka, and Poplar Island, along with broad stemmed points (e.g., Brewertons) (Ritchie 1971). Diversity among point types may reflect task-specific functions for the tools (e.g., hunting versus fishing), or perhaps is related to using material culture as a way to broadcast social identity as Native American group territories became more well defined through time (Miroff et al. 2008:170-172). Other stone tool types found in Late Archaic assemblages include both ground and chipped axes and choppers likely to have been used for woodworking, net-sinkers for fishing, and pestles for processing plant foods. Artifacts that span the entire Archaic period, but dominated by Late Archaic projectile point types, have been recovered from four "village" sites in Bayonne and smaller sites in Elizabeth, New Jersey (Skinner and Schrabisch 1913). Several Late Archaic sites were excavated on Martha's Vineyard by Ritchie (1969). Squibnocket, Wading River, and Brewerton type projectile points were found at the Hornblower II, Vincent, and Howland

No. 1 sites. Ritchie regarded the Squibnocket complex of the “small point tradition” to have been a coastal manifestation of the southern New England Late Archaic period. The Hornblower II and Vincent sites in particular contained ample evidence of Late Archaic period utilization of shellfish and seal. Fishing was suggested by a ground stone plummet (Ritchie 1969:215-216).

The Terminal Archaic (sometimes referred to as the Transitional, 3000 to 2700 B.P.) is characterized by the widespread adoption of steatite (soapstone) vessels in regional artifact assemblages (though see Sassaman 1999 for earlier dates). Orient fishtail projectile points are also believed to be diagnostic of this relatively short period (Ritchie 1980), while thick, coarse grit-tempered pottery is sometimes found in association with the fishtail points on coastal New York archaeological sites (including Stony Brook, Jamesport, and Sugar Loaf Hill [Ritchie 1959]). Orient fishtail points and steatite bowl sherds were found at the Arlington Place site on Staten Island. Other Staten Island sites that yielded fishtail points include the Pottery Farm site and the Smoking Point site (Boesch 1994).

By the end of the Archaic period, sea levels had risen to such an extent that later Woodland period sites are generally not expected on the continental shelf, although sites of all ages that are located on the modern coastline are witnessing submergence as sea levels continue to rise. Human activities during the recent past, especially damming streams to form mill ponds and reservoirs, have also resulted in the creation of underwater archaeological sites.

Little change in subsistence between the Woodland period archaeological record and preceding Late Archaic can be discerned in the New York Bight coastal region (Bernstein 2006). Some artifact forms changed (e.g., projectile point shape) and pottery becomes increasingly important over time, but the long-established economic pattern of the exploitation of a broad range of natural resources appears to continue, although the Early and Middle Woodland periods are not very well-known in the region (Fiedel 2001). Expanding diversity of lithic artifact types such as projectile points, along with a seeming increase in the diversity of site types across many niches on the landscape, may reflect increasing territoriality among prehistoric groups (Miroff et al. 2008).

During the Late Woodland, agriculture, especially using tropical cultigens such as corn and beans, did become important in the economies of Native American groups living along major river valleys (including the Hudson) in upstate New York and interior New Jersey. The importance of agriculture on the mainland coast and Staten and Long islands is still not well known, and is debated by archaeologists (Bernstein 1999, 2006; Ceci 1979, 1982; Lavin 1988; Silver 1981). Ritchie (1980:268-270) suggests that the Late Woodland inhabitants of the New York Bight region used agricultural products to supplement hunting, fishing, and gathering of wild food resources. Ritchie’s evidence for agriculture includes ground stone tools felt to have been used as hoes and pestles, and corn found at the Clasons Point site in the Bronx. However, no definite cultigens other than the corn purportedly recovered during Skinner's (1919) excavation at Clasons Point have been found in the region, and a review of that site's material at the Museum of the American Indian, Heye Foundation yielded no reference to corn in Skinner's notes nor any actual corn remains in the collection (Ceci 1977:103). Further, the Clasons Point site contains Contact period cultural material, including several Dutch trade pipes and sawn cow bone (Skinner 1919). If corn was encountered during the original excavation, it may have been associated with the later Euro-American material. Analysis of human skeletal remains from the Ward's Point site on Staten Island suggested that Late Woodland groups there relied on a mixture of marine and terrestrial resources, but that corn was not an important part of the diet (Bridges 1994). In New Jersey, Mounier (2003:153) notes that "direct evidence of horticulture on the coastal plain remains as weak as ever."

Regardless of the importance of cultivated foods like corn, beans, and squash in the diet, it is clear that Native Americans on the coast continued to hunt, gather, and collect the abundant products of the natural environment (Bernstein 2002; Lavin 1988). Marine resources played an important role, as suggested by numerous shell middens throughout the New York Bight region (Brennan 1974; Parker 1920; Skinner and Schrabisch 1913). One example is the Middle to Late Woodland period shell midden found on Liberty Island in New York Harbor. Charcoal from a pit feature pre-dating the midden was radiocarbon dated and calibrated to A.D. 990 (Griswold 2002:21). The midden itself was dominated by oyster (*Crassostrea virginica*), with smaller amounts of soft shell clam (*Mya arenaria*), ribbed mussel (*Geukensia demissa*), slipper (*Crepidula* sp.), oyster toadfish (*Opsanus tau*), white perch (cf. *Morone americana*), cod-family fish (cf. *Gadidae*), salamander (*Plethodon* sp.), turtle (represented by two small carapace/plastron fragments), at least three duck species (including *Aythya valisineria* and *Anas* sp.), pelican (*Pelecanus* sp.), bobwhite quail (*Colinus virginianus*), rodents (*Microtinae*), dog (*Canidae*), deer (*Odocoileus* sp.), and other unidentified mammals. Plant species represented in the floral assemblage from the Liberty Island midden include oak (*Quercus* sp.), hickory (*Carya* sp.), elm (*Ulmus* sp.), juniper (*Juniperus* sp.), water lily (*Nymphaea* sp.), and flowering rushes (*Butomus* sp.) (summarized in Griswold 2002:56-57).

In New Jersey, Skinner and Schrabisch (1913) documented shell heaps all along the shore of Raritan Bay, from South Amboy to Sandy Hook. A huge shell midden in Keyport, which based on the presence of pottery likely dated to the Woodland period, was mined during the late nineteenth century for road bed material and ship ballast for vessels traveling to oyster beds in Virginia (*Asbury Park Press* 1928). The faunal and floral remains found in these and other Woodland period middens suggest a broad diet breadth for the prehistoric inhabitants of the New York Bight region.

The artifact assemblage from Woodland period sites is similarly diverse. Most lithic tools were produced using chipped stone technology, but ground stone tools are also present. Lithic raw materials include locally available jasper and quartz, and non-local chert (from upstate New York via the Hudson River Valley), with smaller amounts of argillite (from New Jersey sources) (Rutsch 1970). Jasper, chert, and quartz Levanna triangle projectile points are commonly found in Late Woodland deposits, along with Madison triangle projectile points, straight-stemmed projectile points, triangular bifacial tools or preforms, bifacial and unifacial scrapers, cores, and debitage (flakes and other waste products of stone tool manufacture and/or reworking). Another common projectile point found in Early to Middle Woodland period deposits is the Rossville type, named for the locality on Staten Island (Ritchie 1971).

The largest amounts of Late Woodland materials recovered to date on Staten Island are from the Burial Ridge site and other nearby sites in Tottenville. The Tottenville sites included 55 pit features and 77 human burials (Boesch 1994). Prehistoric pottery is present in most reported Woodland period archaeological sites in the New York Bight region. Before radiocarbon dating was widely available, Carlyle Smith (1950) used pottery form and decoration to construct a typological chronology for coastal New York. Smith's chronology consists of a series of "phases" within "traditions," and he relied heavily upon data from Harrington's and Skinner's early excavations. In general, Smith's "Windsor Tradition" corresponds to the Middle Woodland period, while the "East River Tradition" is Late Woodland in date. The earlier pottery tends to have grit temper, a pointed base, and minimal surface decoration. Later pottery has grit and/or shell temper, a more rounded base, and more elaborate decoration, including collared and castellated rims. The Bowmans Brook Phase of the East River Tradition was named after the specimens recovered during Skinner's (1909) excavations at the eponymous site on the northwestern shore of Staten Island.

The largest known Middle Woodland site in the Mid-Atlantic is Abbott Farm, on the east bank of the Delaware River south of Trenton, New Jersey. The Abbott Farm archaeological complex actually consists of more than one dozen prehistoric sites, ranging in age from Paleoindian through the Late Woodland, a span of more than 10,000 years. The earliest components appear to have been intermittently used camps. Sites become larger with more diverse artifacts and features (including pits and hearths) later in the sequence, and the main occupation appears to have taken place during the Middle Woodland (Stewart 1982). Fishing was likely an important activity at Abbott Farm (Schindler 2006), and the Middle Woodland component is characterized by a distinctive pottery type called Abbott Zoned (Cross 1956).

The Contact period (after approximately A.D. 1500) is represented by European trade goods (e.g., glass beads, smoking pipes, metal implements, and gun flints) in at least five sites on Staten Island and in Kings County (Brooklyn) (Ceci 1977:Table 1). The Old Place site on Staten Island yielded a wampum bead and whelk columellae, possibly from wampum manufacture (Ceci 1977).

At the time of contact, the land around the New York Bight was inhabited by Munsee-speaking Delaware Indians, a sub-group of the Eastern Algonquian people (Goddard 1978; Grumet 1995). Early European observers (e.g., Danckaerts 1913 [1679-

1680]; van der Donck 1841 [1656]; Wolley 1902 [1701]) described a seasonal settlement and subsistence pattern for the Native American inhabitants around modern New York City. Hunting in the wooded uplands took place year-round, but was most important during the late autumn. During the winter, people would disperse in small groups to the interior reaches of southern New England. Larger groups would reassemble in coastal villages in the spring to clear fields for planting, when fishing and collecting shellfish would also resume after the winter hiatus. The summer was a time of visiting and trade, prior to the largest population gathering for the harvest in early autumn.

Ceci has argued (1977, 1982) that Native American settlement patterns recorded by early Europeans do not necessarily reflect the situation prior to Contact. Instead, she posits that Native American summertime aggregation in coastal villages is related to a new economic system revolving around fur-trading and wampum production, along with the widespread adoption of agriculture based on tropical cultigens. Both of these activities were encouraged by the Europeans. However, although shell middens have the strong potential to contribute information regarding seasonality, no rigorous studies have yet been conducted using data from regional sites. Until such seasonality studies are made, questions of prehistoric versus post-Contact settlement patterns will remain unresolved.

Native American populations in the region were reduced dramatically after circa 1640, when European-introduced diseases coupled with Dutch aggression resulted in hundreds of Delaware Indian deaths (Grumet 1995). By the early eighteenth century, most of the remaining Delaware moved westward to the Ohio River Valley, and in 1758 all Indian claims to New Jersey lands were relinquished (Goddard 1978:220-222).

The prehistoric temporal divisions outlined above coincide roughly with the environmental changes that occurred from the end of the Late Pleistocene through the Early and Mid-Holocene to the present (Table 1). Initially, these divisions seem to have reflected marked subsistence and technological changes: Paleoindians that relied on big-game hunting (notably now-extinct megafauna) with fluted points, Archaic peoples engaged in high mobility hunting and gathering as they adapted to what was becoming our modern environment, and Woodland groups that settled down with pottery and more permanent dwellings as they undertook plant cultivation. Over the course of the last several decades, archaeologists have developed a more nuanced culture history with finer grained reconstructions, but these temporal divisions along with some of the assumptions regarding cultural change through time persist.

Issues in Archaic Period Archaeology

The division of the prehistoric record in eastern North America into the Paleoindian, Archaic, and Woodland periods is the construct of mid-twentieth century archaeologists. However, there is a risk of simplifying interpretation into fixed sets of artifact types and artificial divisions when using culture historical timelines with their associated sets of material (and presumably related sets of behaviors). This section presents some issues in Archaic period archaeology, including some pertaining to settlement patterns and problems of chronology, and how data from underwater sites could contribute to our knowledge of prehistory.

The concept of the Archaic period in North American archaeology was developed by mid-twentieth century researchers, notably William A. Ritchie, former New York State Archaeologist. Ritchie was the first to use the term "Archaic" in the American literature to describe a time period, when he used it to characterize the artifact assemblage (mostly flaked stone tools) from the Lamoka Lake site in central New York (Ritchie 1932). By the time James Griffin published *Archeology of Eastern United States* (1952), the term Archaic was well-established, and used to identify the time span following the Paleoindian period but before the widespread adoption of ceramic technology and agriculture.

Settlement Patterns in the Archaic Period. The seeming paucity of archaeological sites dating to the Early and Middle Archaic periods (approximately 10,000 to 6000 B.P. [Table 1]) in eastern North America has led some researchers to suggest that this span was marked by a decrease in population (e.g., Fitting 1968; Ritchie and Funk 1973; Snow 1980). Alternatively, it was suggested that the apparent hiatus at this time may be associated with problems of identifying archaeological sites of this age (Dincauze and Mullholland 1977; Dumont and Dumont 1979). Problems with identifying Early and Middle Archaic sites may result from a lack of organic material suitable for radiocarbon dating and a reliance on projectile point typologies for relative dating among other factors. The start of the Late Archaic period (circa 6000 to 3000 B.P.) is marked by an apparent growth in population, reflected by an increase in the number of known archaeological sites, an increase in site size and variety, and more diversity in cultural material (perhaps indicative of a greater need for the recognition and maintenance of social group boundaries) (Ritchie 1980; Snow 1980). The Late Archaic period is roughly coincident with slowing sea level rise and the establishment of the modern coastline. Late Archaic period sites along the Mid-Atlantic coast often have an aquatic or maritime component, characterized by the presence of shell middens, especially towards the latter part of the period when sea levels were closest to current positions (Braun 1974; Brennan 1968, 1974; Lavin 1988; Wyatt 1977).

A possible population decline during the Early and Middle Archaic periods, followed by population growth during the Late Archaic, is inferred from the terrestrial archaeological record. However, it is likely that archaeological sites dating to the Early

Holocene are now submerged on the formerly subaerial portions of the continental shelf. As stated above, this dissertation argues that the coastal plain and its river valleys in the Mid-Atlantic region were attractive to prehistoric hunter-gatherers, and that early subsistence and settlement patterns likely had a significant coastal component which has been obscured by sea level rise. If archaeological sites dating to the Early and Middle Archaic period sites are documented for the coastal plain, the hiatus argument becomes less tenable.

The Early Holocene has been described as the "no man's land" of prehistoric archaeology in the Mid-Atlantic region of eastern North America (Jones 1994). The traditional explanation for the relative paucity of sites dating between the Late Paleoindian period (circa 10,000 B.P.) and the end of the Middle Archaic period (circa 6000 B.P.) (Table 1) was that the region was abandoned in response to environmental change. Culture histories developed for the region during the mid-twentieth century (Caldwell 1958; Cleland 1976; Fitting 1968; Ritchie and Funk 1973; Snow 1980) cited a presumably impoverished environment characterized by the presence of boreal forest, which made the region an unattractive place for both game animals and humans. This traditional model suggested that Early Holocene climate change and the spread of boreal forest resulted in a landscape with lower net productivity than was present during earlier and subsequent periods (Newman 1977).

In addition to a paucity of sites, Funk and Wellman (1984:81) noted that projectile points thought to be diagnostic of the Early Archaic period (circa 10,000-8000 B.P.) were particularly rare compared to those from other periods in several collections they examined. These observations seemed to support the traditional culture history for the prehistoric Mid-Atlantic, where hunter-gatherer populations were said to drop significantly in the region until near-modern environmental conditions of the Late Archaic period (circa 6000 B.P.) were established.

In contrast, more recent paleoenvironmental reconstructions indicate that the Early Holocene environment in the Mid-Atlantic was not an unproductive homogeneous boreal forest (Gaudreau 1988; Jacobson et al. 1987; Joyce 1988; McWeeney 1994). Instead, the pine-birch-oak-shrub forests were more heterogeneous than their modern analogs in central Ontario, and probably supported a variety of game animals, especially deer (Dincauze and Mullholland 1977:447; Gaudreau and Webb 1987:256-257). In addition, warmer and wetter conditions after the Terminal Pleistocene resulted in an increase in fresh water sources and their associated rich and ecologically diverse wetlands which were attractive to prehistoric hunter-gatherers (Nicholas 1988).

Another explanation for a perceived population drop, in this case a population bottleneck, during the Late Pleistocene has been the subject of intense debate during the past two years. Alternatively called the "Clovis comet" hypothesis or the "Younger Dryas impact event," it posits that circa 10,900 years ago (roughly 12,900 cal. B.P.) a massive air burst or earth impact of an extraterrestrial object or objects (e.g., a comet or comet cloud) occurred north of the Great Lakes, above or on the Laurentide Ice Sheet. The purported results of the hypothesized event include continent-wide devastating fires, mass extinctions of megafauna, and rapid decimation of human populations in North America at the start of the Younger Dryas interval (Firestone et al. 2007). However, several lines of evidence undermine the "Clovis comet" hypothesis, including observations that such wide-spread destruction is not indicated by charcoal and pollen records (Marlon et al. 2009), and that megafauna extinctions do not appear to have happened simultaneously as one would expect in such a cosmic event (and that other animals, such as bison, which relied on the same environmental features as did the extinct megafauna survived) (Haynes 2008). Further, an analysis using summed probability distribution of approximately 1500 radiocarbon dates from sites in Canada and the United States revealed no evidence of a population decline among Paleoindian groups around 12,900 cal. B.P. Instead, the analysis showed slow population growth between 15,000 and 13,100 cal. B.P. (reflecting the period of initial colonization of the Western Hemisphere), followed by a population growth rate increase between 13,100 and 13,000 cal. B.P. (around the time fluted projectile points became widespread), a resumption of steady growth until circa 9500 cal. B.P., after which growth rates again accelerated (Buchanan et al. 2008).

The debate over the "Clovis comet" hypothesis will no doubt continue with new evidence brought to the discussion. Meanwhile, it seems likely that if such an event did actually occur, the magnitude and resulting environmental destruction were probably on a smaller scale than currently envisioned by proponents of the hypothesis. Presumably, Paleoindian peoples living in northern latitudes, closest to the theorized cosmic event, would have been the most affected. As outlined in the previous chapter, deeply stratified archaeological sites are rarely encountered in the Mid-Atlantic region, but a notable few do exist. The continuous occupation of the Meadowcroft Rockshelter from 13,240±1010 through 685±80 B.P. (uncalibrated; Adovasio et al. 1990) and the Shawnee Minisink site from 10,750±600 B.P. well into the Holocene (uncalibrated; McNett 1985) indicate that human groups were not decimated around 10,900 years ago.

Sampling bias and differential site preservation may be clouding our view of human activity during the Early Holocene in the Mid-Atlantic region (Dincauze and Mullholland 1977; Eisenberg 1991; Kuhn 1985). It is possible that archaeological sites dating to the Early Holocene have been eroded, inundated, or buried deeply in alluvial soils, rendering them almost invisible on the modern landscape. However, as Jones (1994) notes, while these factors certainly play a role in site visibility and discovery, they do not fully explain why Early and Middle Archaic period sites are nevertheless scarce compared to earlier and more recent occupations.

Several explanations have been offered for seemingly low hunter-gatherer populations during the Early and Middle Archaic periods (Robinson and Petersen 1992; Starbuck and Bolian 1980). It is possible that sites exist, but have not yet been discovered or recognized as dating to these periods. For example, many sites throughout the region are characterized by poor stratigraphic context, where temporally diagnostic artifacts are found on the ground surface or within mixed plow zone or disturbed contexts. A lack of organic remains suitable for radiocarbon dating even at sites with good stratigraphic integrity may prevent clear temporal assignations. In many cases where absolute dating is not possible, sites have been roughly dated on the basis of artifact styles, especially projectile points. Projectile points are typically classified based on morphology (e.g., Boudreau 2008; Justice 1987; Ritchie 1971), and the contexts from which they were recovered are then assigned the absolute dates that have been obtained for similar materials in the region. However, radiocarbon dates for a specific projectile point type at one site may not be applicable to other sites, and given the broad resolution of typological cross-dating, it is not always possible to identify contemporary components or to make comparisons between sites. In addition, different projectile point types do not always represent discrete temporal periods (Filios 1989). Instead, it seems that several types were used for extremely long (thousands of years) periods of time. Further, the relative rarity of diagnostic projectile points believed to date to the Early Archaic period (Funk and Wellman 1984) may be the result of a decreased reliance on projectile technology (Robinson 1992), the use of types not recognized as diagnostic of the period, or other factors.

There is a potential research bias favoring very early sites, and to a lesser degree relatively recent sites, at the expense of other lengthy periods in prehistory (Dent 1995:147), especially the Early and Middle Archaic periods. In particular, Paleoindian studies appear to have received a disproportionate amount of attention from archaeologists and the public during the last two decades. At four recent annual meetings of the Society for American Archaeology (1999-2002), there were 21 sessions devoted to Paleoindian studies in North America, but only six to the Archaic (not counting sessions with papers that overlapped the Paleoindian and Archaic). One possible result of Paleoindian “hype” is the tendency to assign sites earlier dates, even in the face of later radiocarbon dating results. For example, despite a suite of consistent radiocarbon dates clustered around 7950 B.P., all from the same feature, the Turkey Swamp site on the outer coastal plain in northeastern New Jersey has been identified as a Late Paleoindian site (Cavallo 1981). The basis for this temporal assignation was the presence of several basally-thinned triangular projectile points (one of which was within the dated feature), that are “reminiscent” of Paleoindian forms (Cavallo 1981:15). Reliance on diagnostic projectile points for dating led the author to discount the radiocarbon dates in favor of the presumed older date of the triangular points (Cavallo 1981:16).

Another pitfall of Paleoindian “hype” is that archaeologists may not be actively seeking to discover and excavate Early and Middle Archaic sites. Further, archaeologists may be ignoring wide swaths of the landscape, thought to have been “unattractive” or “unproductive” for prehistoric hunter-gatherers. For example, until fairly recently it was believed that the outer coastal plain in New Jersey was relatively devoid of archaeological sites (Grossman-Bailey 2001). High altitudes typically have been overlooked, but the discovery of Early and Middle Archaic sites at significant elevations above presumably more attractive valleys attests to their use by prehistoric peoples in the Mid-Atlantic (Eisenberg 1991; Wilkins 1978). Other unsurveyed areas include the submerged portion of the coastal plain.

Besides site identification, researcher bias, and technological issues, changes in social organization may play a contributing role in the apparent paucity of Early Holocene archaeological sites. For example, Jones (1994) proposed that subsistence, settlement, and social patterns changed between the Terminal Pleistocene (Paleoindian period) and Early Holocene (Early Archaic period) in a response to shifting environmental patterns in southern New England. Hunter-gatherer group size is connected with the seasonal productivity of any given resource catchment area (Binford 1982). Settlement patterns and group size may depend on the nature of the resource base, where aggregation may be expected when resources are concentrated, mobile, poorly predictable, ephemeral, and/or low in diversity; and dispersion into small groups may occur when resources are dispersed, non-mobile, predictable, long-lasting, and/or diverse (Kelly 1995). Seasonal variation in resource availability is also expected to affect group size, where periods of resource scarcity will be characterized by small group size, and periods of resource abundance by large group size (Binford 1980).

For example, the archaeological record in the Northeast suggests that Paleoindians focused on caribou for at least part of the year (Spiess et al. 1998). Abundance of this concentrated, mobile, and homogeneous resource should result in aggregation of hunter-gatherer groups, especially during twice yearly migrations (Burch 1972). In addition, periodic aggregation of Paleoindian groups inhabiting the challenging Late Pleistocene landscape was probably important for maintenance of social ties and to exchange information between low populations to mitigate risk.

A different suite of resources became available to prehistoric hunter-gatherers with the onset of warmer and wetter conditions during the Early Holocene. Caribou was largely replaced by deer, small game species increased, and more streams and wetlands were present (Nicholas 1988). Early Archaic peoples' response may have been to maintain small, highly mobile groups to efficiently exploit a variety of patches, possibly forming larger groups during the winter, when deer tend to aggregate and plant foods are scarce (Robinson and Petersen 1992). Jones' (1994) model suggests that most Early Archaic sites were created by small family groups (which possibly remained as small groups for longer periods of the year compared to earlier hunter-gatherers), and are characterized by small clusters of artifacts which could easily escape detection during routine cultural resource surveys. This is in contrast to the Paleoindian record, where several northeastern sites (e.g., Debert, Shoop, and Gainey) have been interpreted as reoccupied camp sites (Spiess et al. 1998). Reuse of a relatively small number of sites during the Late Pleistocene presumably would result in greater archaeological visibility (larger site size and greater density of artifacts). The hypothesized low rate of site reuse in the Early Holocene (due to environmental change [increasing heterogeneity]) would contribute to the poor rate of discovery of Early Archaic sites.

Major shifts in social organization and mobility strategies are not suggested by the archaeological record at several Mid-Atlantic sites such as Meadowcroft rockshelter and the Shawnee Minisink site, which contain substantial Early Archaic components underlain by Paleoindian material. At Shawnee Minisink in particular, the archaeological record is indicative of continuity in human adaptations, with gradual intensification of local resource use and broadening of diet breadth over time (Evans 1985). No Early Holocene population hiatus is indicated by a recent inventory of prehistoric sites on the outer coastal plain of New Jersey (Grossman-Bailey 2001:132), where 16 Paleoindian, 19 Early Archaic, 43 Middle Archaic, and 199 Late Archaic components were identified. Similarly, of 22 "early postglacial" archaeological components identified during an intensive survey of Robbins Swamp in northwestern Connecticut, five dated to the Paleoindian period (including three components the author identified as "Paleo/Early Archaic," though others might describe as "Late Paleoindian," based on the presence of Hardaway projectile points) and the remaining 17 were Early Archaic in date (Nicholas 1988:272-273).

More Early Holocene archaeological sites have been encountered throughout the Mid-Atlantic region since the 1960s and 1970s, when the model of population decrease dominated the literature. This data set contributes to the discussion concerning change versus continuity in prehistoric adaptations in the Mid-Atlantic. It is necessary to understand subsistence and settlement patterns over the long term to determine whether change (i.e., major shifts in food procurement, technology, settlement and social organization between the Paleoindian, Archaic, and Woodland periods) or continuity (i.e., gradual intensification of resource use) best characterizes the prehistoric archaeological record for the region.

As stated above, the hypothesis of this dissertation is that the Mid-Atlantic coastal plain and its river valleys were occupied by hunter-gatherers during the Early to Mid-Holocene. Subsequent drowning of the sites they left behind has contributed to the seeming paucity of sites dating to the Early and Middle Archaic periods. Rising sea levels have also resulted in rising ground water tables, and the potential presence of drowned prehistoric sites is not limited to the coast of eastern North America. For example, it is likely that there are submerged Early Holocene archaeological sites in the Champlain Basin of northern New York and Vermont (Thomas 1992). However, the archaeology of drowned coastal sites (rather than inundated interior sites) is likely to yield evidence to address issues concerning early aquatic adaptations in eastern North America.

Subsistence and the Origins of Aquatic Adaptations. The study of coastal hunter-gatherer groups has a long history in anthropology and archaeology (summarized by Erlandson [2001:289-292] and Erlandson and Fitzpatrick [2006]). As Bailey and Parkington note (1988:1), coasts provide a classic illustration of the ecological concept of an ecotone, a boundary zone at the junction of ecosystems with typically diverse resources. As a result of inundation, ancient landscapes may now stretch continuously from dry land, through the intertidal zone, and into the submerged realm (Tomalin 2000:85). The main advantage of a coastal environment to people is the variety of aquatic and terrestrial resources, especially abundant and concentrated food supplies such as shellfish beds and marsh plants, present within a relatively limited geographic area. Maritime environments frequently present relatively low risks and low costs, but potentially high returns for hunter-gatherers. In North America, coasts supported hunter-gatherer groups with a high degree of sedentism and social complexity in otherwise very different environments (e.g., the temperate Pacific Northwest and the semi-tropical Gulf Coast of Florida) (Yesner 1980). In South America, the coastal environment played a role in the development of agriculture and state society (Moseley 1974). The extent and significance of aquatic adaptations is less clear for Pleistocene hunter-gatherers in the Old World, although mounting evidence suggests that such adaptations played a role in the demographic and geographic expansion of anatomically modern humans as early as 150,000 years ago (Bailey and Flemming 2008; Erlandson 2001; Forster and Matsumura 2005).

Coasts may also facilitate the colonization of new areas, as the path of least resistance for travel and as a source of familiar resources in an otherwise foreign landscape (Anderson and Gillam 2000; Bailey and Parkington 1988:2; Flemming et al. 2003; Forster and Matsumura 2005; Westley and Dix 2006). The coastal migration route along the Pacific Ocean is a viable reconstruction for describing the peopling of the New World (Fladmark 1979), and coastal areas may have been attractive refugia for plants and animals during the Late Pleistocene. Anderson and Gillam developed a model to explain “routes, rates, and reasons” (2000:43) for the Late Pleistocene colonization of the Western Hemisphere, using GIS to analyze paths that would have afforded the least cost to traveling hunter-gatherers. Factors in the model included topographic relief, locations of ice sheets and pluvial lakes, and the location of known Paleoindian archaeological sites. Their findings suggest that initial dispersal occurred in coastal and riverine settings and on plains (as these gently-sloping areas were the least costly to penetrate), and that founding populations probably spread and diversified rapidly. In terms of routes, Anderson and Gillam’s GIS-based model implies that now-submerged portions of the continental shelf may have been important for early dispersal, whether by foot or by boat. In eastern North America, this is reflected in the distribution of sites along the Atlantic Coastal Plain and the paucity of sites in the Appalachian Mountains, which were a barrier to mobility.

Of course, the fundamental problem with investigating Late Pleistocene and Early Holocene coastal adaptations in eastern North America (presuming they existed) is that the evidence is under water. However, a few recently excavated sites on the West Coast (where the continental shelf is relatively narrow and sea level rise has drowned a much smaller area than in the East) have yielded ample evidence of early maritime adaptations. At the Daisy Cave site on San Miguel Island, California, a deep shell midden of marine shellfish remains, fish bones, and lithic artifacts has been dated to 9,700 B.P. (Erlandson 1993, 1994). The Late Pleistocene deposits at Quebrada Jaguay in south coastal Peru, dated to between about 11,100 and 10,000 radiocarbon years ago, included abundant fish bones, marine shell, and crustaceans. A few fragments of knotted cordage from the Quebrada Jaguay site may be parts of fish nets (Sandweiss et al. 1998). In eastern North America, sediment dredged from the bottom of Tampa Bay contained a pocket of shell from a variety of species mixed with Paleoindian stone tools, including fluted point fragments (Goodyear et al. 1983). Unfortunately, because the context of the sediment was destroyed by dredging, it is impossible to determine if the shell and lithic artifacts represent the remains of a Paleoindian shell midden, though the possibility is intriguing.

The ethnographic record of North American hunter-gatherers (e.g., as summarized in Kelly 1995:Table 3-1) suggests that coastal groups relied heavily on fish and other aquatic resources, regardless of latitude or Effective Temperature (which takes into account the mean temperatures for the coldest and warmest months of the year, as well as amount of solar radiation [Kelly 1995:66]). The degree of hunter-gatherer dependence on maritime resources during the Late Pleistocene and Early Holocene has been a matter of debate (Yesner 1980). Some researchers (e.g., Braun 1974; Perlman 1980) have postulated that because coastal environments are among the most productive land forms (in terms of food and raw material diversity and abundance), their occupation should coincide with their earliest development and stabilization. In contrast, others (e.g., Bailey and Parkington 1988) see a trend of expanding subsistence patterns to include specialized niches such as the coast over the course of the Holocene. Broadening diet breadth and intensified resource utilization are significant for examining questions of population growth and economic change. Some Late Pleistocene and Early Holocene archaeological sites in the Mid-Atlantic region have yielded evidence of subsistence patterns with aquatic components (e.g., fish at the Shawnee Minisink site [Dent and Kauffman 1985], and former wetland settings in Maryland [Lowery 1989; Lowery and Custer 1990] and Connecticut [Jones 1997; Nicholas 1988]). Work on submerged early prehistoric sites in the Mid-Atlantic could potentially yield more data to address this problem.

The coastal landscape of the New York Bight, and specifically the Hudson River (both subaerial and submerged, Figure 1), provides a good test location for questions concerning cultural continuity over the course of the Archaic period, the origins of aquatic adaptations, and other issues. This is due to the region’s density and diversity of terrestrial archaeological sites spanning the Paleoindian through Late Archaic periods, as well as tantalizing clues to early use of marine foods such as the circa 6950 B.P. Dogan Point shell midden (Claassen 1995). The following chapters describe known underwater archaeological deposits in the region, as well as predictive models and new field work aimed at exploring submerged sites in the lower Hudson River.

SUBMERGED PREHISTORIC ARCHAEOLOGICAL SITES

Researchers have long recognized the potential for the presence of prehistoric sites on the submerged continental shelf in eastern North America (Cockrell 1980; Edwards and Merrill 1977; Emery and Edwards 1966; Salwen 1962; Solecki 1961). However, compared with their dry-land counterparts, underwater prehistoric sites typically present significant challenges in terms of discovery, excavation, and interpretation, mainly as the result of natural and cultural post-depositional processes (Bailey and Flemming 2008).

To date, most underwater archaeological finds in eastern North America have been made by fishermen, while other sites have been accidentally unearthed by dredging and other construction activities (Stright 1990). Interviews with local fishermen to record archaeological finds can be informative, as has been demonstrated by surveys in the Chesapeake Bay (Blanton 1996), Narragansett Bay in Rhode Island (Lynch 2001), and the Gulf of Maine (Crock et al. 1993). It is also possible to systematically search the sea floor for prehistoric remains with positive results, as has been shown in the northern Gulf of Mexico (Dunbar et al. 1992; Faught 2004; Faught and Latvis 1999; Research Planning, Inc. et al. 2004). Virtually all archaeological survey work is based on the assumption that sites are not randomly distributed around the landscape (e.g., Jochim 1981; Winterhalder 1981). Instead, site patterning is connected with the location of resources, including fresh water, food, and lithic raw material. These resources, in turn, are expected to occur in a manner related to the paleogeography of the submerged coastal plain. Identification of favorable landscape features such as stream channels and lithic sources, where large archaeological sites are most likely to occur, will refine the search for submerged prehistoric sites.

Site Formation Processes

Besides taking into account the presence of favorable environmental characteristics, any search for submerged prehistoric sites should consider the effects of post-depositional processes (Bailey and Flemming 2008). Erosion associated with rising sea level is the most obvious problem, and it is very likely that many prehistoric archaeological deposits have been reworked or even obliterated by rising seas. Models for predicting the location of submerged prehistoric sites can be refined by considering some aspects of coastal geology.

Coastal environments can be classified as one of three types: erosional, depositional, or submerged (Waters 1992:254-262). Erosional coasts are typically directly adjacent to the ocean, or are subject to other forms of high energy degradation. Little sediment is available for beach formation on erosional coasts. The opposite is true for depositional coasts, where sediments are permitted to accrete in a lower energy setting. Deltas, barrier islands (with associated backbay lagoons), tidal flats, and marshes are depositional coast features. Submerged coasts tend to have irregular configurations with embayments (such as estuaries) and headlands. Underwater prehistoric deposits located within erosional coastal environments are expected to have sustained a potentially high degree of reworking, while depositional and submerged coasts afford a greater chance for site survival.

As for the relationship between coast type and natural resource abundance, lower energy environments tend to yield the highest returns in terms of biological productivity, since slow currents allow the accumulation of a sediment base for aquatic plants, which will in turn support invertebrate life and protective areas for fish hatcheries. In addition, higher net productivity tends to coincide with broad, shallow bathymetry, particularly at fresh and saline water interchanges (Barnes and Hughes 1999; Townsend et al. 2006). Lagoons and estuaries are among the most productive coastal features, and thus are likely to have attracted prehistoric hunter-gatherers.

Several factors may contribute to the preservation or destruction of an underwater archaeological site (Bailey and Flemming 2008). If the site was buried prior to marine transgression, the chances of its survival are increased because the overlying sediment will act as a protective buffer against wave and tidal movement. It is expected that an occupation site adjacent to a lagoon or estuary would be abandoned before complete inundation, since encroaching water would have resulted in swampy conditions, and altered resource availability as water depth and salinity increased.

Site preservation may also be related to regional topography, resistance of sediments to erosion, sediment supply, depth of erosion and wave energy, and tidal range (Belknap and Kraft 1981; Waters 1992). Site protection may be provided by bedrock formations. Morphology of the coastal plain prior to transgression is important, since sites that are lower in topography (such as in river valleys or adjacent to low-lying lagoons) will withstand erosion comparatively well, as they are below the height of most of the impact energy from waves, tides, and currents. The cohesive strength of sediments will determine their relative ability to resist erosion, while sediment deposition can compensate for any instability in the original matrix. Recently, Leach et al. (2009) reported on a preserved submerged landform dating to 6300 B.P. in approximately 13 meters of water off the coast of Maine. They postulate that preservation at this locale was likely due to “armoring” of the sediment package by bedrock and a relict oyster bed, as well as rapid sea level rise.

The rate of sea level rise is another important factor that strongly influences coastal site preservation, as site survival is predicted to be good for specific time intervals when sea level rise was relatively rapid (Flemming 1983). The rate of sea level rise has fluctuated over the past 20,000 years. In general, rates in eastern North America were as high as ten meters per thousand years during the Late Pleistocene, and slowed to about three meters per thousand years with the onset of modern climatic conditions in the Early

Holocene. Sea levels continued to rise at a rate of about three meters per thousand years until around 5000 to 6000 years ago. At this time, seas were within seven or eight meters of their current levels. After around 5000 years ago, sea level rise slowed even further, to about one meter per thousand years, a rate which lasted until roughly four hundred years ago when sea level rise began to accelerate (Pirazzoli 1991). As mentioned above, climatic variation, coastal morphology, isostatic rebound, and other factors will result in different sea level curves, even over relatively short distances (Donnelly 1998; Gordon 1983; Oldale 1986). Because of this variation, it is best to use local sea level curves for environmental reconstruction. Notably, a recent re-examination of Holocene sea level rise along the coast of New Jersey differs from the general trend in that the rate of rise was found to be constant at roughly 1.9 meters per thousand years starting around 7500 B.P. until the modern era (Stanley et al. 2004).

The highest energy, and therefore most destructive, aspect of encroaching water occurs at the water/land interface, the surf and swash zone. Land forms respond to marine transgression with either shoreface or stepwise retreat (Waters 1992:275-280). Shoreface retreat involves the slow advancement of rising seas, and tends to be associated with the destruction of archaeological sites (erosion is gradual but takes place over a considerable length of time). Stepwise retreat refers to the in-place drowning of land features during periods of rapid sea level rise. The potential for site preservation is increased during these periodic “jumps” of stepwise retreat, as the swash zone energy is not focused on a given area for a lengthy period of time prior to complete submergence. For example, episodes of both shoreface and stepwise retreat have been documented in the New York Bight, off the south shore of Long Island (Rampino 1979), and an episode of stepwise retreat, with rapid, in-place drowning, occurred between 8500 and 7500 years ago (Sanders and Kumar 1975). Archaeological sites which may have existed near the coastline just before or during this period are more likely to be intact than sites dating much earlier or later than this episode of step-wise retreat.

A study for dredged material placement in the New York Bight considered the potential for submerged prehistoric archaeological sites (La Porta et al. 1999). Based on the results of coring, the authors concluded for the general New York Bight region “that the potential for submerged archaeological sites is actually greater than previously recognized” (La Porta et al. 1999:26). Core samples yielded sediments indicative of a paleoshoreline, which typically might have a high probability for prehistoric sites, but the location on the continental shelf was determined to have been susceptible to erosion during sea level rise, therefore lowering the chances of encountering an intact prehistoric archaeological site from “high” to “moderate” (La Porta et al. 1999:29).

Given the dynamic nature of coastal environments, it is likely that in many if not most cases, underwater archaeological sites have suffered some loss of stratigraphic integrity. The lack of known intact, stratified sites underwater does not necessarily preclude making useful inferences about broad issues in prehistory such as subsistence patterns and landscape use over time, just as land sites known through surface collection or plowed contexts can be important. Since virtually nothing about prehistoric utilization of the now-submerged continental shelf is known, even minimal presence/absence data can be informative. This is especially true for eras for which there is little data, either at the coast or inland, such as the Early and Middle Archaic periods.

Reported Underwater Finds

In her literature review of known prehistoric archaeological sites on the continental shelf of North America, Melanie Stright documented eleven sites in the Mid-Atlantic Bight and surrounding area (Stright 1990:440-441 [sites 2-12]), and several more have been reported since then. Depths for the prehistoric deposits ranged from present mean sea level to 60 meters below sea level, with all periods (Paleoindian, Archaic, and Woodland) and major temporal subdivisions represented. Sites described below are illustrated on Figure 7 and are summarized in Table 3.

Starting in southeast New Hampshire, and moving south along the coast, the intertidal Seabrook Marsh site was reported by Brian Robinson (1985). This Late Archaic period site is fully submerged at high tide and artifact-bearing strata are capped by 60 to 120 centimeters of salt marsh sod. Several features were uncovered during excavation, including three human burials, post molds (one with part of a preserved wooden post), hearths, and pits. Radiocarbon dates for the burials and other features range between 4780 and 2215 years B.P. The remarkable artifact assemblage includes projectile points (mostly small stemmed and Squibnocket triangles), bifacial tools, unifacial scrapers, 22 plummets, gouges, two notched and engraved stone “pendants,” and bone tools. Floral and faunal remains include hickory, acorn, deer, fox, muskrat, raccoon, bear, dog, harp seal, duck, goose, great auk, snake, turtle, cod, cunner, winter flounder, swordfish, and other fish.

Further evidence of a relatively early focus on marine resources comes from the Boylston Street fish weir site (Décima and Dincauze 1998; Johnson 1942; Stright 1990, site no. 2), found during subway construction in Boston near the Charles River estuary. The extensive weir structure made of wood stakes and wattle is located approximately 6 to 7 meters below present sea level. The structure, which likely represents numerous small weirs rather than one, was preserved by anaerobic estuarine muds. Radiocarbon dates between 5300 and 3700 B.P. place it within the Late Archaic period (Décima and Dincauze 1998:165). Prehistoric fishing equipment has been found offshore Massachusetts, including a stone plummet from roughly 21 meters of water off Plymouth (Otto 1999). Recent work in Massachusetts Bay and Nantucket Sound has been undertaken by David Robinson (2003). Robinson has directed coring in advance of proposed wind farm construction in Nantucket Sound, which encountered evidence of intact paleosols containing birch, other wood, charcoal, grass, and seeds, along with insect parts that survived the inundation of the sound. The paleosols were radiocarbon dated to 5490 B.P., 6470 B.P., and 10,100 B.P. Strata in the cores may represent a

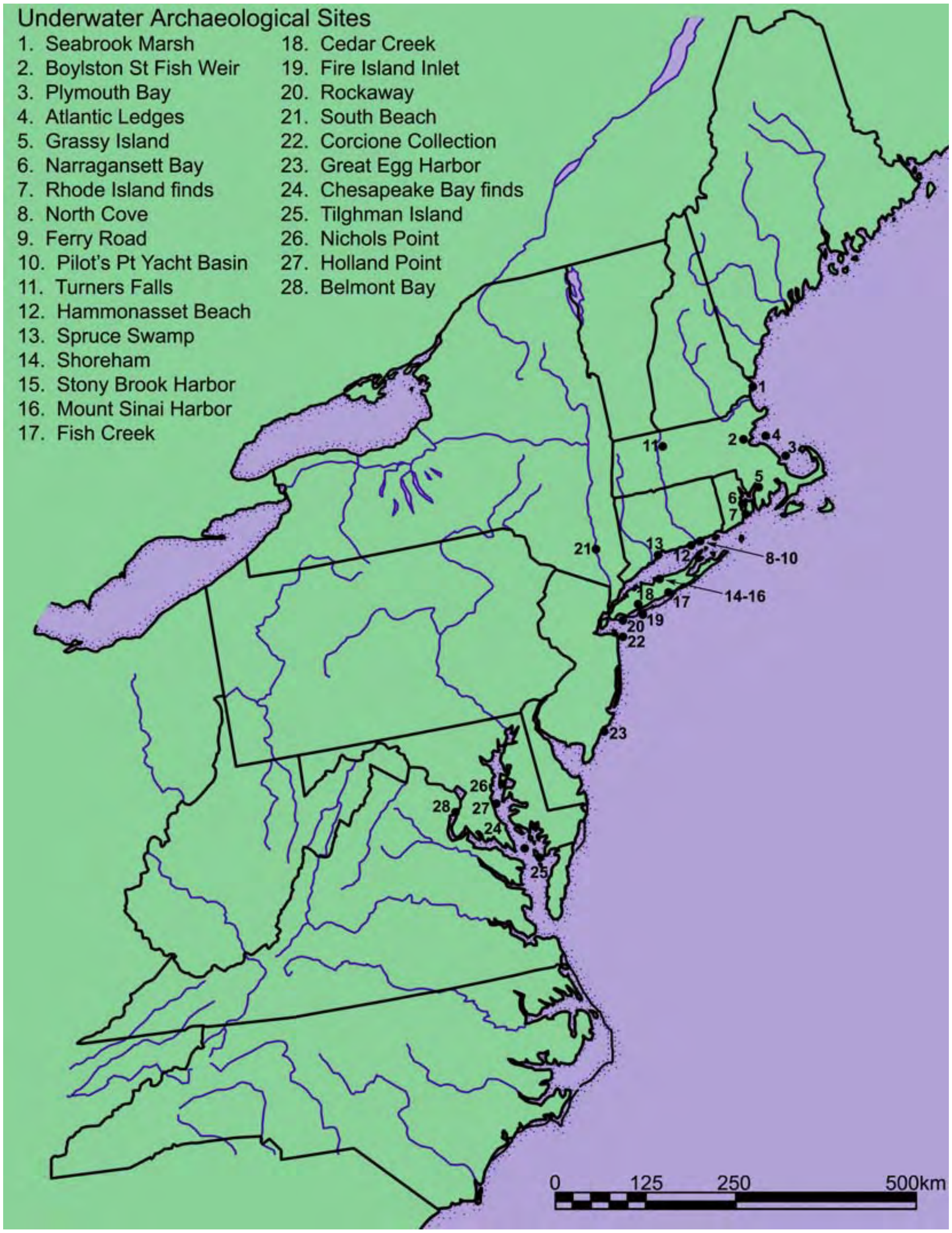


Figure 7. Location of submerged prehistoric sites described in the text.

Table 3. Reported submerged prehistoric sites in the Mid-Atlantic Bight.

Site Name*	Location	Age	Artifacts, Features
1. Seabrook Marsh	southeast NH, fully submerged at high tide	Late Archaic, ^{14}C dates from 4780 to 2215 years B.P.	artifacts include projectile points, bifaces, unifaces, plummets, gouges, stone pendants and bone tools; features include human burials, post molds, hearths, and pits; variety of floral and faunal remains (Robinson 1985)
2. Boylston Street fish weir	Boston, MA, in estuarine sediments near the Charles River	Late Archaic, ^{14}C dates from 4600 to 4200 B.P.	extensive weir structure of wood stakes and wattle, probably repeatedly used (Johnson 1942)
3. Plymouth Bay	MA, 21 m deep	unknown	stone plummet recovered from bay (Otto 1999)
4. Atlantic Ledges	near Hull, MA, submerged at high tide	Middle and Late Archaic	projectile points, ground stone adze and gouge, atlatl weight, bifaces, steatite bowl fragment, hammerstones, and debitage (Dincauze 1972)
5. Grassy Island	Taunton River, MA, intertidal with fully submerged components	Late Archaic	stone tools, human burial (Delabarre 1928; Johnson and Raup 1947)
6. Narragansett Bay	RI, 9 m deep	Late Paleoindian	bison femur and lanceolate projectile point (Stright 1990)
7. Rhode Island finds	Narragansett Bay, RI vicinity	Archaic	100+ lithic artifacts (projectile points, bifaces, plummets, steatite bowl fragments, atlatl weight) from intertidal zone; a gouge found near Prudence Island; a stemmed point from Ninigret Pond (Lynch 2001)
8. North Cove	near the mouth of Connecticut River, CT, intertidal	Late Archaic, Transitional, and Woodland	lithic artifacts (projectile points, drills, scrapers, hammerstones, cores, netsinkers, steatite bowl fragment), fire-cracked rock, pottery sherd (Bourn 1972)
9. Ferry Road	near the mouth of Connecticut River, CT, 2 m deep	Late Archaic and Transitional	artifacts (projectile points, bifaces, cores, flakes, hammerstones, fire-cracked rock) collected from dredge spoil (Bourn 1977)
10. Pilot’s Point Yacht Basin	near the mouth of Menumketesuck River, CT, 4-9 m deep	Late Archaic	21 lithic artifacts (including narrow stemmed projectile points) and human bone found during dredging (Glynn 1953)
11. Turners Falls	Upper Connecticut River, MA	Early Woodland	charcoal lenses with fire-cracked rock in submerged riverbed (Volmar 2003)

*numbers refer to those used on the map in Figure 7

Table 3. Continued.

Site Name*	Location	Age	Artifacts, Features
12. Hammonasset Beach	Long Island Sound, CT, 5 m deep	Paleoindian, Middle and Late Archaic, Transitional, and Woodland	dredging yielded over 300 projectile points, bifaces, netsinkers, cores, hammerstones, debitage, steatite pipe and bowl fragments, fire-cracked rock, and an antler tool (Bourn 1977)
13. Spruce Swamp	Long Island Sound, CT, intertidal with fully submerged components	Late Archaic-Early Woodland	dredging encountered partially drowned shell midden with projectile points, some ceramic fragments, lithic tools and flakes, ground stone tools (grooved axe and celt) (Powell 1965)
14. Shoreham	north shore of central Long Island, NY, intertidal with fully submerged components	Late Archaic	lithic artifacts found in tidal salt marsh, extending to 2 m below the surface (Stright 1990)
15. Stony Brook Harbor	north shore of central Long Island, NY, intertidal with fully submerged components	Late Archaic	lithic artifacts found in tidal salt marsh, with submerged components (Stright 1990)
16. Mount Sinai Harbor	north shore of central Long Island, NY, upper level of site is 0.6 m below mean sea level	Late Archaic-Early Woodland	shell midden dominated by oyster with whelk, deer bone, and sturgeon plates; artifacts include bone and lithic tools (Stright 1990)
17. Fish Creek	Speonk, south shore of eastern Long Island, NY	Woodland	artifacts found while clamming in 1.8 m (6 ft) deep water, including grit and shell tempered pottery, net sinkers, worked cobbles, and other pieces (Suffolk County Archaeological Association site no. 802)
18. Cedar Creek	south shore of southwest Long Island, NY	Woodland (?)	three shell midden deposits located roughly 3 m below the current marsh surface (Stright 1990)
19. Fire Island Inlet find	southwest shore of Long Island, NY, 30 m deep	unknown	ground stone axe recovered by fisherman (described below)
20. Rockaway find	southwest shore of Long Island, NY	unknown	part of a Native American skull found on the beach, probably originally from an underwater context (Trubowitz 2005)

*numbers refer to those used on the map in Figure 7

Table 3. Continued.

Site Name*	Location	Age	Artifacts, Features
21. South Beach	Croton Point, NY, intertidal with fully submerged components	Late Archaic	systematic surface and underwater survey yielded 125 lithic artifacts and fire-cracked rock (the latter of undetermined age) (described below)
22. Corcione collection	east of Sandy Hook, NJ, 10 to 13 m deep	Early, Middle, and Late Archaic	dredging for beach replenishment yielded more than 200 stone artifacts, including projectile points, bifaces, and debitage (described below)
23. Great Egg Harbor Bay find	near Somers Point, Ocean City, NJ, 1 m deep	Paleoindian	fluted projectile point found by clammer (Boldurian 2006)
24. Chesapeake Bay finds	mostly between 5.5 and 8.5 m deep	Paleoindian, Early, Middle, and Late Archaic, Early and Middle Woodland	18 known artifact find spots reported by fishermen, including projectile points, grooved axes, and other ground stone tools (mostly Late Archaic) (Blanton 1996)
25. Tilghman Island	Chesapeake Bay, MD	Paleoindian and Archaic	stone tools from intertidal sites (Lowery 2008)
26. Nichols Point	Chesapeake Bay, MD, 5.5 to 6 m deep	Middle Archaic	human burial and possibly associated artifacts (projectile points, a biface in a bone haft, bifaces and flakes, ground atlatl weight, adzes, gouges, and whetstones) recovered while clam dredging (Lowery and Martin 2009)
27. Holland Point	Chesapeake Bay, MD, intertidal with fully submerged components	Early Archaic-Late Woodland	artifacts and features (mostly Late Archaic and Woodland period, including an oyster shell midden and a human burial) found inundated beneath salt marsh and along adjacent beach (Walker 2003)
28. Belmont Bay	Potomac River, VA, 2 m deep	Late Archaic-Late Woodland	systematic underwater survey yielded 3055 lithic artifacts, 1838 pieces of fire-cracked rock, and 41 ceramic fragments (Cherryman 1994)

*numbers refer to those used on the map in Figure 7

deciduous forest floor, a fresh or brackish water wetlands, and a shallow fresh water pond, respectively (Robinson et al. 2004:59-62). Although no cultural materials were found in the cores, the stratigraphy suggests that intact Archaic period sites may be preserved here (Daley 2005; Robinson et al. 2004).

The Atlantic Ledges site near Hull, Massachusetts (Dincauze 1972) is another intertidal site. Artifacts at the site are buried beneath beach gravel and peats within a water saturated sandy matrix, and consist of projectile points (Middle Archaic period Stark and Neville points, and Late Archaic Brewerton, Squibnocket, and small stemmed points), a ground stone adze and gouge, a winged atlatl weight, bifacial tools, one steatite bowl fragment, hammerstones, and unmodified flakes made from local beach cobbles.

Grassy Island is an intertidal site with fully submerged components located in the Taunton River of Massachusetts (Johnson and Raup 1947). It was initially excavated in the 1920s, and most of the artifacts appear to date to the Late Archaic period. A human burial was also encountered at the Grassy Island site (Delabarre 1928). The Narragansett Bay site (Stright 1990, site no. 3) is known through the accidental discovery of a bone and Late Paleoindian lanceolate projectile point by a clam dredge. The bone and point were apparently found articulated (there is a hole in the bone purportedly caused by impact from the stone point), and came from a water depth of about nine meters. The bone was later identified as the femur of an immature bison, but radiocarbon dating was unsuccessful. Many other artifact finds made by fishermen and beach-combers in Rhode Island have been documented by Dan Lynch (Lynch 2001; Merwin et al. 2003). These finds include approximately one hundred lithic artifacts (projectile points, bifacial tools, plummets, steatite bowl fragments, and an atlatl weight) from the intertidal zone around Narragansett Bay, along with a gouge found off the northeast point of Prudence Island and a stemmed projectile point from Ninigret Pond.

Several submerged sites have been identified in southern Connecticut rivers feeding into Long Island Sound, including the North Cove and Ferry Road sites in the Connecticut River (Bourn 1972; Stright 1990, sites nos. 4 and 5), the Pilot’s Point Yacht Basin site (Glynn 1953; Stright 1990, site no. 6), and the Hammonasset Beach site (Bourn 1977; Stright 1990, site no. 7). Most of these sites were discovered during dredging for channels, canals, and beach replenishment, and materials were recovered from 0 to 9 meters below present sea level.

The North Cove site, located on the west bank near the mouth of the Connecticut River, consists of Late Archaic, Transitional, and Woodland period artifacts (projectile points, drills, scrapers, hammerstones, cores, netsinkers, fire-cracked rock, a steatite bowl fragment, and one sherd of grit-tempered pottery) (Bourn 1972). The Ferry Road assemblage, collected from dredge spoil, is similar to the nearby North Cove site, with Late Archaic and Transitional period artifacts (Bourn 1977:36). The Pilot’s Point site was found during dredging near the mouth of Menumketesuck River, and includes Late Archaic artifacts along with a partially fossilized human arm bone (Glynn 1953). The Upper Connecticut River has also yielded submerged prehistoric features. A drowned site in Turners Falls, Massachusetts dating to the Early Woodland period was recently reported by Volmar (2003). Preliminary investigation has revealed charcoal lenses with fire-cracked rock eroding from a submerged riverbank.

The Hammonasset Beach, Connecticut assemblage is among the largest prehistoric artifact collection recovered to date from an offshore source. The beach was replenished with dredged sands after a hurricane in 1955, and it is estimated that 90 percent of the artifacts recovered from the beach since then originated from an underwater site (Bourn 1977:18). Dredging was undertaken approximately 275 meters from the modern shore, in roughly five meters of water. Artifacts recovered from the replenished beach include one fluted quartz projectile point, three Middle Archaic, 289 Late Archaic, 11 Transitional, 24 Woodland, and six untyped projectile points, drills, knives, scrapers, net sinkers, tool preforms, cores, hammerstones, flakes, fire-cracked rock, steatite pipe and bowl fragments, and a deer antler tool. Shell encountered while dredging may have been from a midden feature (Bourn 1977). The Spruce Swamp site on Long Island Sound near Norwalk is a partially drowned shell midden encountered while dredging for a boat basin (Powell 1965). Artifacts include 111 projectile points (many small stemmed), 52 pieces of prehistoric pottery, numerous lithic tools and flakes, ground stone tools (including a fully grooved axe and a celt), and fire-cracked rock dating from the Late Archaic through Early Woodland periods (Powell 1965).

A few submerged prehistoric archaeological sites have been found adjacent to waterways feeding into Long Island Sound from the north shore of central Long Island. These include the Shoreham site, the Stony Brook Harbor site, and a site on Mount Sinai Harbor (Stright 1990, site nos. 9-11). The sites at Shoreham and Stony Brook consist of intertidal deposits of lithic artifacts dating to the Late Archaic period, with fully submerged components. The Mount Sinai site is a shell midden, with the uppermost levels at 0.6 meters (2 feet) below mean sea level. Finds from the south shore of Long Island include the Fish Creek site, consisting of prehistoric pottery, net sinkers, worked cobbles, and other pieces found by a clammer in 1.8 meters of water (Suffolk County Archaeological Association site no. 802). The Cedar Creek site (Stright 1990, site no. 12) is located on the southwest coast of Long Island. It consists of three shell middens with sparse undiagnostic lithic artifacts, but probably dating to the Woodland period, extending approximately three meters below the current marsh surface. A large prehistoric stone grooved axe was recovered by a fisherman off the south shore of Long Island, in roughly 30 meters of water south of the Fire Island Inlet (Sean O'Shea, personal communication, 2000).

Another southwestern Long Island find consists of a portion of a human skull that washed ashore in 2001 at Fort Tilden, on the Rockaway peninsula. The bone was identified as probably Native American by staff of the New York City Medical Examiner's Office, based mainly on the presence of shovel-shaped incisors and the absence of dental carries. The black coloration of the bone, along with the fact that Rockaway peninsula did not exist in its present configuration until roughly 175 years ago, suggests that the skull fragment originated from an underwater context (Trubowitz 2005).

That submerged prehistoric sites exist in the New York Bight is suggested by the density and diversity of known archaeological resources on land adjacent to this section of the Hudson River, and confirmed by the recent accidental discovery of a submerged prehistoric deposit during a dredging project east of Sandy Hook, New Jersey (Merwin 2003 and below). This deposit, known as the Corcione collection, consists of more than two hundred stone artifacts dating to the Early, Middle, and Late Archaic periods. It is among the largest prehistoric assemblages recovered to date from an offshore site in eastern North America north of Florida (cf. Stright 1990). The Corcione collection is discussed in detail in the next chapter. Similarly, the intertidal and submerged South Beach site near the confluence of the Croton and Hudson rivers has yielded data pertaining to prehistoric occupation in the New York Bight. The South Beach site is also described below.

Another New Jersey find consists of a Clovis-like fluted point found in the shallow waters of Great Egg Harbor Bay near Somers Point and Ocean City in the southern part of the state (Boldurian 2006). It was found by a clam digger in roughly one meter of water northeast of Drag Island in June 1966, not long after a hurricane had swept the area. The projectile point, made of black chert, is water-worn, suggesting deposition in a fluvial environment. Boldurian (2006:265) theorizes that the Paleoindian artifact was not found in situ, but rather was washed into the lagoon around Drag Island from a nearby coastal terrace. Regardless of its original location, the fluted projectile point is one of just a few examples dating to the Paleoindian recovered from under water.

There are few reported inundated prehistoric sites for the Middle Atlantic south of New Jersey, though the high potential for the Delaware and Chesapeake estuaries has been discussed widely (Barber 1979; Hoyt et al. 1990; Kraft et al. 1983). Dennis Blanton (1996:204-209) has documented 18 known find spots in the Chesapeake, with most information coming from shell fishermen. Although the fishermen's collections are biased toward obviously recognizable stone tools (e.g., complete specimens, and few unmodified flakes or other artifact types), but some patterns are emerging. Late Archaic materials dominated the assemblages, and were found at nearly 80 percent of the sites. Only one fluted projectile point had been recovered to date, along with a few Early and Middle Archaic period artifacts from three find spots. Still rarer were artifacts from the Early and Middle Woodland periods (two locations). In addition to bifacially-worked projectile points, the fishermen's finds included at least 14 grooved axes and other large ground stone tools. Interestingly, most of the finds have been made at the edges of underwater terraces, between 5.5 and 8.5 meters deep. These terrace edges formerly would have provided well drained living surfaces above the proto-estuary.

Additional work in the Chesapeake is currently being undertaken by Darrin Lowery, who is investigating intertidal prehistoric sites on Tilghman and other islands (Lowery 2008). Recently, Lowery and Martin (2009) reported on a likely submerged human burial site in the Chesapeake Bay near Nichols Point, which based on associated artifacts, likely dates to the Middle Archaic period. The Nichols Point site was encountered during clam dredging in 5.5 to 6 meters (18 to 20 feet) of water, and includes a portion of a human skull, chipped stone artifacts (stemmed projectile points, bifaces), and ground stone artifacts (an atlatl weight, adzes, gouges, whetstones, and other forms) (Lowery and Martin 2009:162-167). Other burial-like caches of artifacts have been found by fishermen near the Nichols Point site.

Another human burial feature, dating to the Middle Woodland period, was identified at the Holland Point site near the confluence of Little Choptank River and the Chesapeake Bay on Maryland's Eastern Shore (Walker 2003). The Holland Point site also contains an inundated oyster shell midden and older deposits beneath salt marsh, with artifacts found on the surface of the adjacent beach. Calibrated radiocarbon dates from the midden range from 780 to 660 B.P., while dates for the strata fully submerged below the midden are from 2310 to 780 B.P. (Walker 2003:163-167). A single Early Archaic type projectile point was found on the shore, while the majority of prehistoric artifacts found at Holland Point are Late Archaic through Woodland projectile points, other bifaces, cores, flakes (mostly made from locally available cherts, jasper, quartz, and quartzite, with smaller amounts of rhyolite, argillite, and other materials), fire cracked rocks, and numerous ceramic fragments (Walker 2003).

One reported submerged site in the Virginia portion of the Chesapeake Bay watershed is the Belmont Bay site, located near the confluence of the Potomac and Occoquan rivers. A systematic survey involving the excavation of underwater shovel tests was undertaken in roughly 2 meters of water. More than three thousand lithic artifacts (including projectile points [mostly triangular], bifaces, unifaces, and flakes of locally-available quartz, quartzite, slate, chert, and rhyolite), hundreds of pieces of fire-cracked rock, and 41 ceramic fragments were found. Based on the artifact types, the deposits in Belmont Bay date from the Late Archaic through Late Woodland periods (Cherryman 1994).

In summary, there are at least five known Paleoindian, 31 Archaic, ten Woodland, and three unknown period components or individual finds reported from inundated sites along the coast between southern New Hampshire and Virginia (Table 3). Most of the finds are from intertidal and nearshore deposits, and they range in type from an isolated fluted projectile point (Great Egg Harbor) through substantial, multicomponent sites (Hammonasset Beach, the Corcione collection, Chesapeake Bay finds). The 29 finds summarized above surely represents a minimum number; beyond those sites yet to be discovered there are undoubtedly several more already known to fishermen and beach combers, and possibly reported in local archaeological files and the gray literature of cultural resource management studies. Few of the known underwater sites have been systematically studied. The two sites discussed in the next chapter, the Corcione collection from offshore northern New Jersey and the South Beach site in Croton Bay, are the first sites in the New York Bight to be investigated with academic archaeological surveys.

RESEARCH IN THE NEW YORK BIGHT

A systematic underwater archaeological survey of portions of the Hudson River in the New York Bight was conducted as part of this dissertation research. The study included Geographic Information Systems (GIS) based modeling to predict the most likely location of submerged sites (Merwin and Bernstein 2003). Underwater field work to test the predictive model was conducted in two locations, in the Atlantic Ocean off Sandy Hook, New Jersey and in Croton Bay, New York (see below).

Geographic Information Systems (GIS)

Since the 1970s, when cultural resource management studies became mandated by law in the United States, several projects have been undertaken to assess the archaeological potential of the continental shelf (e.g., Barber 1979; Coastal Environments 1977; Science Applications 1981). While these pioneering studies produced predictive models regarding the location of submerged prehistoric sites, testing these models is difficult due to their complexity and high number of variables. Factors considered by these models include the environmental characteristics and locations of known terrestrial sites; channels, current and bathymetric features; and potential for undisturbed context following marine transgression. These types of data may now be organized in a GIS framework, facilitating spatial analysis in a far less cumbersome way than was possible in the past. GIS-based models have been shown to be useful for predicting the location of archaeological sites on land (e.g., Kvamme 1999; Maschner 1996; Wescott and Brandon 2000). Although GIS technology has been widely available since the 1980s, its use in underwater archaeology lags far behind that in terrestrial archaeology, and to date most GIS applications in underwater archaeology consist of shipwreck inventories (Mather and Watts 2002).

Most of the known underwater prehistoric sites in the Mid-Atlantic region have been found accidentally. However, a few studies in the southeastern United States have demonstrated that it is possible to systematically search the sea floor for prehistoric remains and have positive results (Dunbar et al. 1992; Faught 2004). Archaeological field survey is based on the assumption that human occupation sites are not randomly distributed on the landscape, but are instead patterned based on the location of resources (e.g., fresh water, food, and lithic raw material) which are in turn related to paleogeography (including the location of drainage channels, soils, slope, aspect, and other terrain features) (Bettinger 1980; Jochim 1981). Identification of favorable landscape features such as stream channels and lithic sources, where large sites are most likely to occur, can narrow the search area for submerged prehistoric archaeological deposits.

Environmental features in the New York Bight used to predict the location of submerged prehistoric sites include former river channels (most notably the Hudson Shelf Valley), embayments, and bedrock outcrops or other sources of raw material. Models to predict the location of underwater prehistoric sites based on the location of known terrestrial sites can be refined using the spatial analysis capabilities of GIS. Besides fresh water and lithic resources, other geographic features such as elevation, slope, aspect, and drainage may be important for prehistoric site patterning, and GIS is the most efficient method for detecting such patterns (Maschner 1996). In addition, GIS can be used to organize georeferenced images such as bathymetric charts and remote sensing data (e.g., aerial photographs and/or satellite imagery, side-scan sonar and sub-bottom profiler images), as well as tabular and graphic information from sediment cores and other samples. GIS analysis of historic and modern nautical charts also can be useful for understanding changes in coastal morphology over time.

Methods. The spatial analysis capabilities of GIS are well suited for identifying the likely location of submerged prehistoric sites. In order to assess the archaeological potential of the New York Bight, several factors must be considered. First, land forms that are most conducive to prehistoric utilization are identified, based on the patterning of known terrestrial archaeological sites dating to the Archaic period, as well as on the location of favorable environmental features such as stream channels and lithic outcrops. Next, remnants of these optimal land forms are sought underwater, incorporating data on the geography of the coastal zone, sea level fluctuations, coastal system morphology, and sedimentation. Areas with the highest potential for site preservation are more closely investigated with remote sensing techniques (e.g., side-scan sonar, sub-bottom profiling). Where possible, divers are deployed to ground-truth targets identified by remote sensing. This staged methodology has been effective for locating prehistoric sites in the Gulf of Mexico (Faught 2004; Faught and Latvis 1999; Research Planning, Inc. et al. 2004:7-8; Stright 1986).

The GIS phase of research was conducted at the GIS Laboratory in the Department of Anthropology at Stony Brook University. Software used for the study included Erdas Imagine 8.5 (for imagery analysis, image rectification, and georeferencing) and ArcGIS 8.1 (for organizing geographical data, spatial analysis, and developing a predictive model for submerged prehistoric site location).

A total of 53 United States Geological Survey (USGS) 7.5 minute series topographic maps (from New York and New Jersey counties surrounding New York Harbor) was digitally scanned, georeferenced, and stitched together to provide a base map for the GIS project. Most of the quadrangles were produced using the North American Datum (NAD) of 1927, so this projection was retained when the maps were georeferenced using the United Transverse Mercator (UTM) coordinate system.

The archaeological data are housed at the New York State Office of Parks, Recreation, and Historic Preservation in Waterford and at the New Jersey State Museum in Trenton. Although both states are working towards maintaining their archaeological site files using GIS, currently the information consists of annotations on paper USGS quad sheets linked to site inventory forms by unique site numbers. In addition to site location, data collected for each archaeological site (where possible) included site age, site type, and contents. These data were organized in a database (attribute table; Appendix A) associated with a GIS point coverage, where each point plotted on the topographic base map represented the site's center.

Data from 186 archaeological sites from counties in New York and New Jersey were initially compiled for this study, but several problems inherent in the site files soon became apparent. Importantly, many of the documented sites were reported prior to the mid-twentieth century (e.g., Cross 1941; Parker 1920; Skinner 1909, 1919; Skinner and Schrabisch 1913), when radiocarbon dating became available. While exact dates for these sites are unknown, early recorded sites tend to be biased in favor of late prehistoric burials and fortifications and other earthworks, which have little relevance to understanding Archaic period settlement patterns, the goal of this study. Further, the exact locations of many early documented sites in New York and New Jersey are unknown, limiting their usefulness in a GIS-based model.

Another problem encountered with many reported sites regardless of age was incomplete site inventory forms. A number of sites are documented solely by name and location, with no information on contents or even a rough age estimate. Dozens of sites were eliminated from the project database because of these problems.

The relative paucity of known archaeological sites in some counties (e.g., Kings [Brooklyn] and Queens on western Long Island; Figure 8) may be at least in part due to bias in terms of site discovery and reporting. For example, several avocational archaeologists were extremely active during the mid-twentieth century on Staten Island, and they routinely published their findings (e.g., Anderson 1964; Sainz 1962). In contrast, there has been minimal work by avocationals or professionals in Kings County. Thus, while general trends in prehistoric site patterning can be seen throughout the larger New York Bight region, it may be more useful to focus on a portion of the area such as Staten Island to develop a predictive GIS-based model.

Digital elevation models (DEMs), available online from the USGS, were downloaded, unzipped, converted (from Spatial Data Transfer Standard [SDTS] to ArcGIS .ddf format), and imported into the GIS project for each 7.5 minute quadrangle. Elevations for the continuous gray scale DEMs were reclassified into 20 classes (0-1.5 meters, 1.6-3, 3.1-6, etc.) and given the same color scheme to facilitate modeling and visualization of the relationship between site location and topography. The Spatial Analyst and 3D Analyst features of ArcGIS were used on the reclassified DEMs to examine this relationship (using elevation, slope, and aspect).

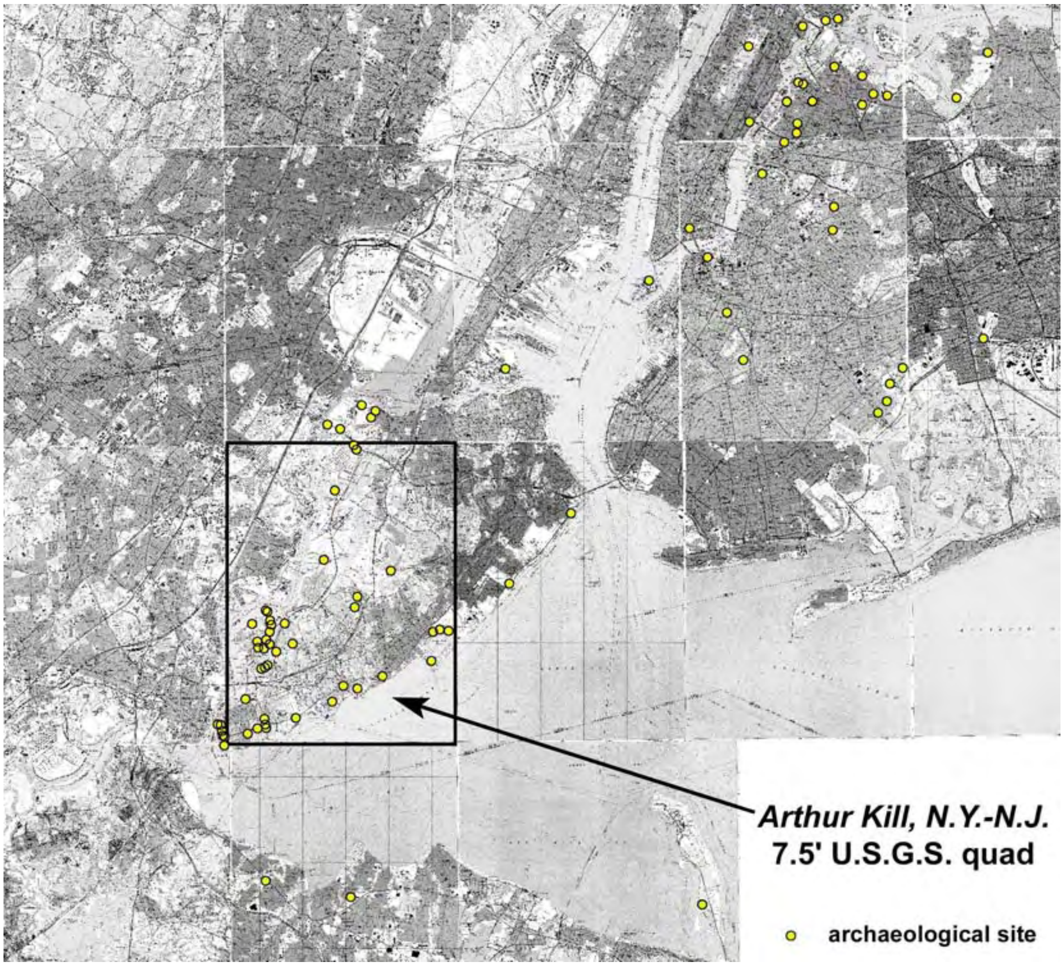


Figure 8. Detail of archaeological sites around the New York Bight.

Other geographical data used for modeling the pattern of archaeological site distribution around the New York Bight include GIS coverages of streams, freshwater wetlands, and soils. The scales at which these data are available vary widely (some coverages are at the state level, while others at the town, county, or USGS quadrangle level). Some data sets are not yet available (e.g., there are virtually no environmental GIS coverages for New York County [Manhattan]). Because of these differences in scale, and because of potential bias resulting from uneven discovery and reporting of sites throughout the region, it was decided to use the Arthur Kill quadrangle (which includes most of Staten Island; Figure 8) as the basis for developing the site distribution model.

Results. In general, it was expected that spatial analysis of terrestrial archaeological sites would suggest that areas with well-drained soils and relatively flat topography on the shores of protected harbors, estuaries, and streams, were the most heavily utilized during the prehistoric period. This, in fact, does appear to be the case for the Arthur Kill quadrangle.

Forty-one archaeological sites dating to the Paleoindian and/or Archaic period were documented for the Arthur Kill quadrangle (Appendix A). Most of these are small habitation sites or camps that were used (either intermittently or continuously) over relatively long time spans, and most are characterized by stone tool assemblages made of local jaspers, cherts, and quartzites. Nearly all of these 41 sites are dated by temporally diagnostic projectile points, while very few have associated organic material that has been radiocarbon dated (although a few include shell midden deposits).

Spatial analysis of the distribution of these sites reveals that most are less than 20 meters above modern mean sea level, with an average elevation of approximately 10 meters (Figure 9). Not surprisingly, all of the prehistoric sites are located on slopes of less than 20 percent, with a mean of roughly 5 percent slope. The relationship between site patterning and aspect is less clear, although most sites are located on north or south facing slopes, and fewer on west or east facing slopes, possibly to avoid direct exposure to prevailing winds.

The majority of the reported sites are located along the modern coast of Staten Island. Most are adjacent to the shore or mapped wetlands, while all are within two kilometers of water (Figure 10). Most sites throughout the entire New York Bight region are clustered along the coast and along large streams (Figure 8). Analyses for additional USGS quadrangles around New York Harbor have yielded similar results for distance to water, elevation, slope, and aspect as seen in the Arthur Kill quadrangle (Merwin and Bernstein 2003).

The location of other resources, such as lithic raw material, are probably less important than water for predicting archaeological site location. Elevation can be used as a proxy for the location of lithic resources on the Arthur Kill quadrangle, because high elevations mark the terminal glacial moraine where till deposits contain workable stone (i.e., jasper and rhyolite cobbles). However, Staten Island is too small to assess if distance to lithic sources is important (or not) for site location. Using general archaeological site catchment tenets (e.g., hunter-gatherers will walk up to 20 to 30 kilometers per day in a variety of environments for logistical resource procurement [Kelly 1995]), virtually every part of the island is well within a normal day’s foraging range between camp and potential lithic source (the moraine).

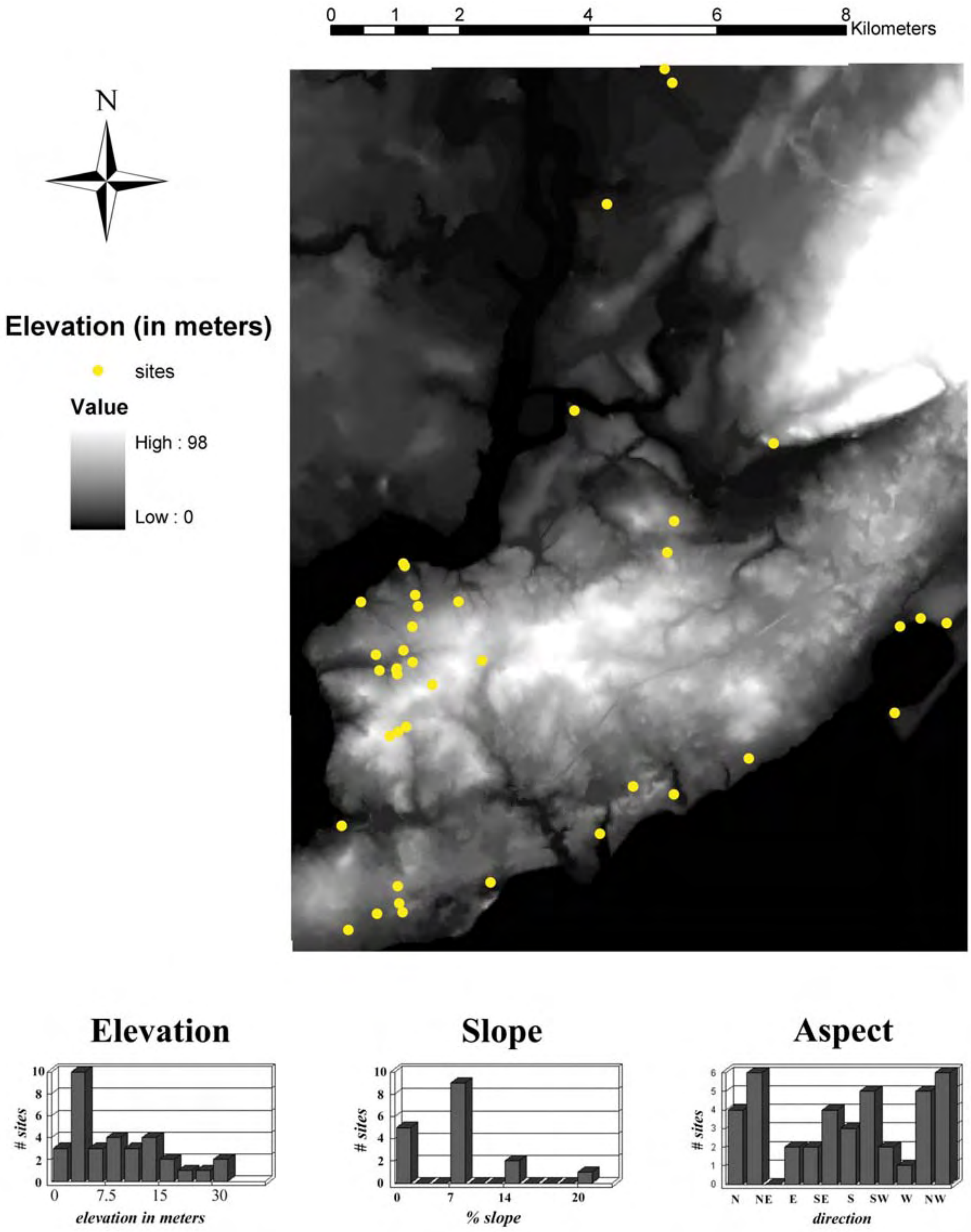


Figure 9. Arthur Kill quadrangle (7.5 minute DEM) showing the location of archaeological sites (the large grayscale image at right, where dark values represent low elevations and lighter values represent higher elevations), and histograms of site distribution by elevation, slope, and aspect.

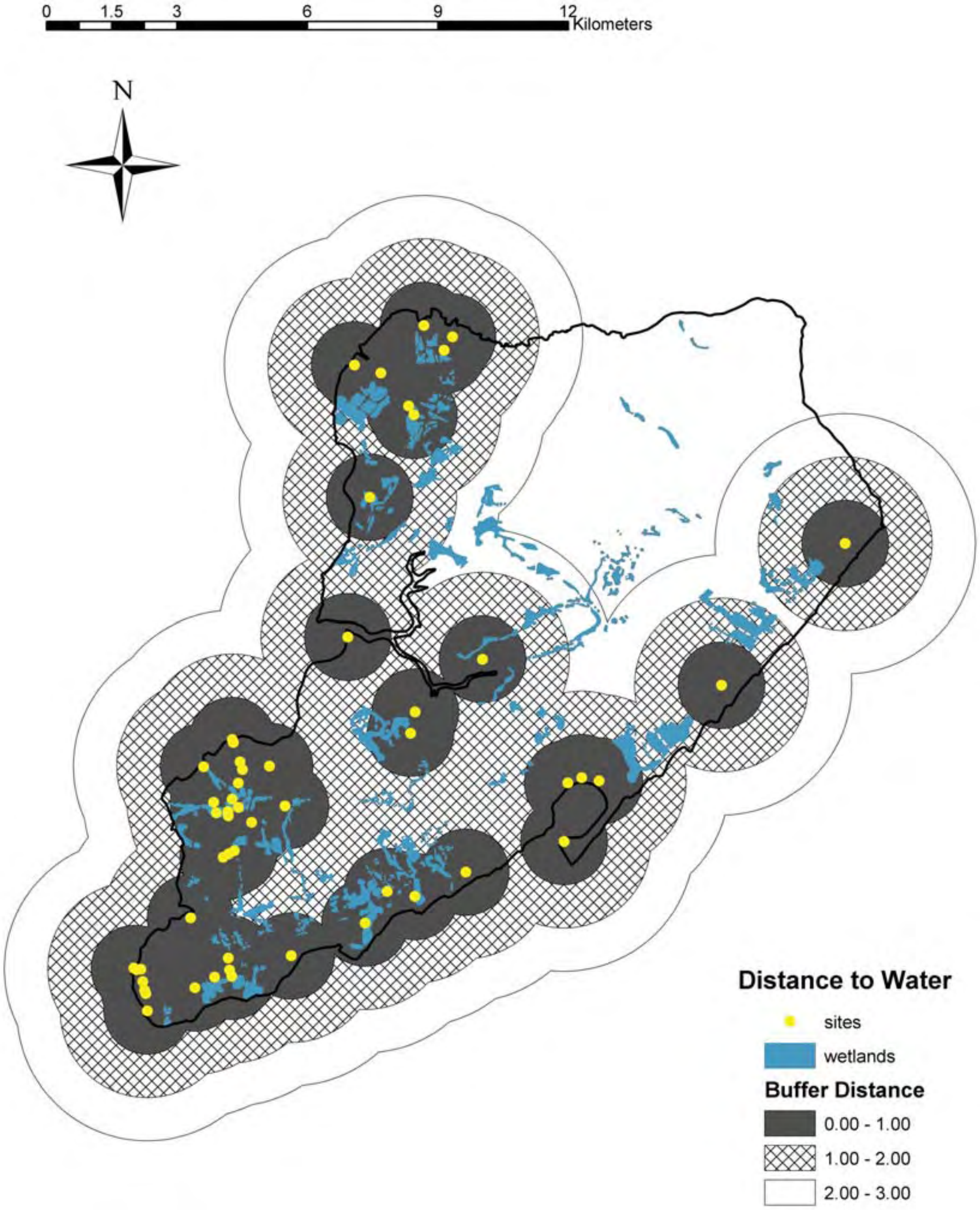


Figure 10. One kilometer radii around Staten Island sites showing the proximity of water sources.

Discussion of the GIS-Based Modeling. Spatial analysis of 41 archaeological sites located within the Arthur Kill 7.5 minute quadrangle (most of Staten Island) demonstrates that the sites are not randomly distributed across the landscape (Figures 9 and 10). Close proximity to water, relatively low elevation and slope, north or south aspect, and possibly proximity to the terminal glacial moraine (a source of lithic raw material) are among the environmental factors which influence site location. It is important to note that this analysis involves the relationship between site location and the modern landscape, but that distance to water and relative elevation are contingent upon sea level at any particular point in the past. However, adjusting the model to account for sea level changes over time would be difficult because the known archaeological sites are only roughly dated and several were seemingly occupied for long time spans. For example, there are not enough known sites with only Late Archaic period components (dating to 6000 to 3000 B.P., when sea level was closest to its current position) to make a statistically valid analysis of the relationship between site location and sea level.

Another problem concerns the identification (or more accurately, reconstruction) of features such as slope for now-submerged landscapes. Bathymetric data can be used within a GIS framework much like DEM files, but factors such as erosion and/or sedimentation rates, sea level fluctuations, and coastal system morphology will need to be taken into account to understand changes to sea floor topography since inundation. Thus, the predictive model may provide a general framework for classifying the continental shelf into areas of low, moderate, or high probability of containing submerged prehistoric archaeological sites (Figure 11). However, despite these problems, the building and application of a predictive model is the first step towards locating and investigating submerged sites in the New York Bight region.

The discovery of submerged prehistoric sites in the New York Bight region would support the GIS-based predictive model and contribute to our understanding of early prehistoric activity here. A lack of sites would necessitate re-evaluation of the predictive model, the potential for significant obliteration of the majority of archaeological deposits on the continental shelf, and/or the field methods employed to sample the sea floor.

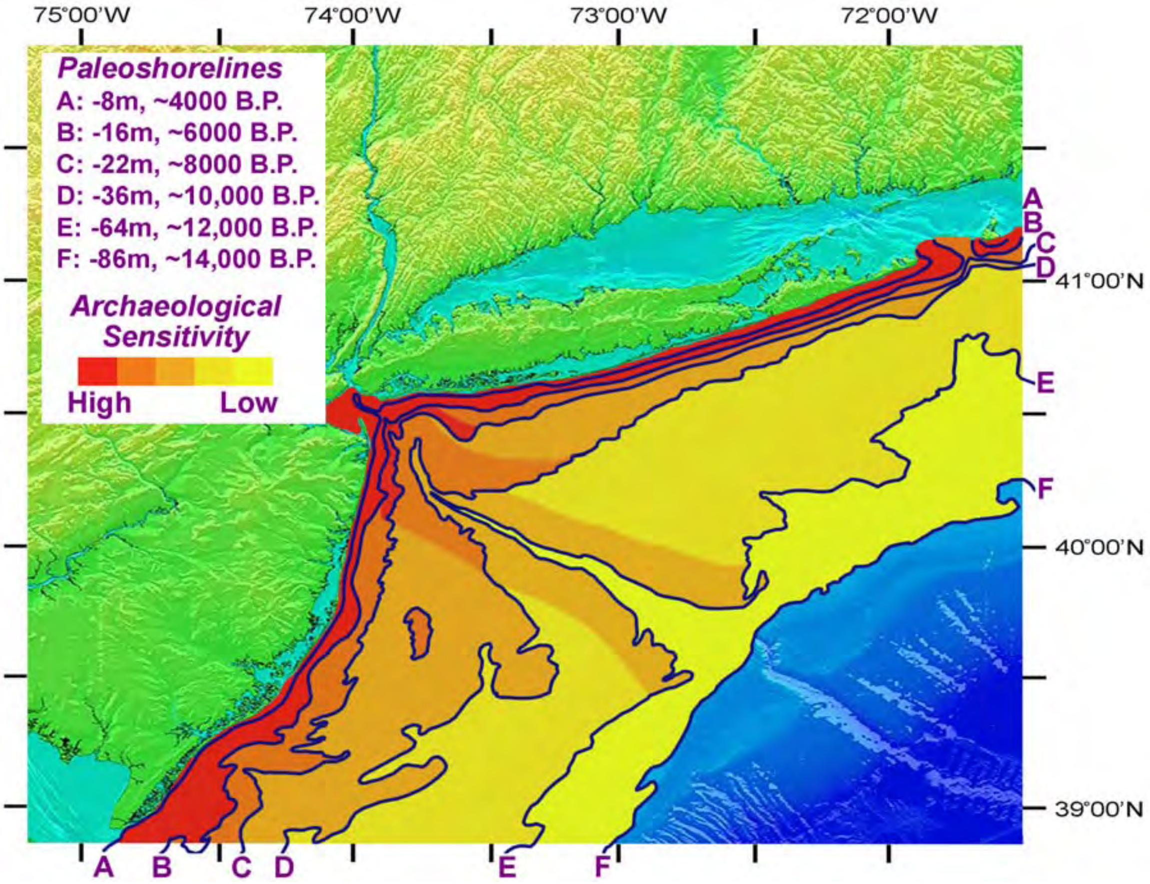


Figure 11. Approximate coastlines in the New York Bight for the last 14,000 years, showing areas of low, moderate, and high potential for the presence of submerged prehistoric archaeological sites.

Underwater Site Patterning and Archaeological Sensitivity Assessment. As discussed above, virtually all of the known submerged prehistoric sites in the Mid-Atlantic region were discovered accidentally by fishermen (especially when shellfishing [clamming, scalloping]) or during underwater construction (Table 3). Most reported prehistoric finds were made within sight of the modern coast. These nearshore finds, together with the rich archaeological record of the adjacent terrestrial portion of the landscape (particularly dense around major estuaries, the Hudson and Delaware rivers and Chesapeake Bay), suggest that offshore regions in the Mid-Atlantic are also likely to contain prehistoric sites.

Very few systematic studies of the potential for submerged prehistoric sites on the continental shelf in the Mid-Atlantic have been followed up with in-depth field testing. The main reason for this lack of research has been the relatively high cost and technical difficulty of underwater field work. It is likely that the discovery of more sites will result from construction, and not necessarily as a result of controlled archaeological surveys.

Ocean depth is important for determining which portions of the continental shelf in and around the New York Bight have low, moderate, and high sensitivity for prehistoric site locations (Figure 11), because Late Pleistocene and Holocene sea level rise dictates which areas were available for human occupation during specific time intervals (Pirazzoli 1991; Stanley et al. 2004; Wright et al. 2009). For example, assuming a maximum age of 14,000 years B.P. for the earliest Paleoindian sites, such deposits will be in water depths no greater than approximately 80 meters. Even taking into account recent assertions that people may have arrived in eastern North America millennia earlier (e.g., Goodyear 2000; McAvoy and McAvoy 1997), and that very early prehistoric sites may be present on the shelf (cf. Stright 2004), they would presumably be no deeper than 125 meters, the sea level low at the time of the Last Glacial Maximum (roughly 21,750 B.P.). Therefore, water depths greater than 125 meters have virtually no potential for the presence of prehistoric sites, while portions of the continental shelf between 80 and 125 meters have a relatively low potential (Figure 11).

Sections of the continental shelf in the New York Bight that were exposed as dry land for the longest period of time have the highest potential for the presence of prehistoric sites. Archaeological sensitivity decreases with increasing depth and distance, generally moving eastward into the Atlantic Ocean from the modern coastline (Figure 11). As mentioned above, Paleoindian sites are not expected to exceed 80 meters. In general, Early Archaic sites will be in water depths no more than 40 meters, Middle Archaic sites will not be deeper than 25 meters, Late Archaic sites will be no deeper than 15 meters, and Transitional sites will be in water no deeper than 4 meters. In other words, based solely on water depth, the ocean bottom adjacent to the modern shoreline has the highest sensitivity for the presence of prehistoric sites, as this swath was dry land for more than 10,000 years. In contrast, the swath between the 40 and 80 meter isobaths could be considered to have only a low to moderate sensitivity, because it was available for human use only prior to 10,000 B.P.

In addition to ocean depth, the paleogeography of the continental shelf influences prehistoric site sensitivity. The terrestrial archaeological record in the Mid-Atlantic indicates that prehistoric site patterning is closely linked with the location of important resources, such as water, food, and lithic raw material. Now-submerged landforms with the highest sensitivity for the presence of prehistoric sites include relict stream channels and estuary complexes. In general, expected site types include small procurement stations (e.g., fishing or kill sites), shell middens, seasonal camps, and extensive habitation sites. It is possible that in addition to drowned stream channels, other types of environmental features that may have witnessed human utilization (e.g., rock outcrops/quarry sites) exist on the continental shelf in the region, but they are largely unmapped.

In summary, sensitivity for the presence of submerged prehistoric sites is based on water depth and key environmental features, namely relict stream channels and estuaries. Portions of the study area in the New York Bight that are deeper than approximately 125 meters have virtually no potential for any traces of past human occupation, while the swath between the 80 and 125 meter isobaths has a low potential based on our current reconstructions of the earliest human arrival in eastern North America. Sections of the continental shelf that were exposed as dry land for the longest period of time have the highest potential for the presence of prehistoric sites. Thus, the portion of the study area with the highest sensitivity is closest to the modern coast. Archaeological site potential decreases with increasing depth and distance moving eastward from the coastline: sensitivity is very high for Late Archaic through Paleoindian period sites to the 15 meter isobath, high for Middle Archaic through Paleoindian sites to the 25 meter isobath, moderate to high for Early Archaic and Paleoindian sites to the 40 meter isobath, and moderate for Paleoindian sites to the 80 meter isobath (Figure 11).

Two prehistoric deposits are described in this dissertation, both of which are from high sensitivity areas suggested by the predictive model. The first, the Corcione collection, is located near the drowned Hudson Valley in the Atlantic Ocean off Sandy Hook, New Jersey. The second, the South Beach site, is in Croton Bay on the modern Hudson River in Westchester County, New York.

Sandy Hook and the Corcione Collection

As mentioned above, the presence of submerged prehistoric sites in the New York Bight was recently confirmed by the accidental discovery of more than two hundred lithic artifacts comprising the Corcione collection. The artifacts were recovered from dredged sands removed from the bottom of the Atlantic Ocean east of Sandy Hook, New Jersey (Figure 12).

Writer Mark Jaffe (1978:21) described Sandy Hook as “in a condition virtually suspended in time, its natural environment left almost untouched and intact for centuries." While sand dunes and rolling ocean waves may suggest time unchanging to the modern observer, this assessment is far from the truth. The Hook is the above-water manifestation of a dynamic coastal environment. Sea level rise, erosion, and littoral drift have shaped and reshaped this section of the New Jersey shore for millennia. In order to understand prehistoric human adaptations in this part of the New York Bight, it is necessary to account for long-term environmental change.

Sandy Hook is managed by the National Park Service as part of the Gateway National Recreation Area of parkland surrounding New York Harbor. It is located near the center of the New York Bight, jutting approximately ten kilometers northward into Lower New York Bay (Figures 12 and 13). Sandy Hook Bay is on the west side of the Hook; the Atlantic Ocean is to the east. The Shrewsbury and Navesink rivers meet south of the Hook (Figure 13), while the drowned portion of the Hudson River, the Hudson Shelf Valley, runs parallel to the east side of the Hook before veering southeast on its way to the abyssal plain beyond the sheer drop at the edge of the continental shelf.

The shifting sands of Sandy Hook are the product of long-shore drift, where sand from both on- and off-shore sources to the south are transported north by wave action, thus building a spit of sand and gravel. The northward extent of the Hook is limited by natural and man-made factors, including the tidal flow of the Hudson estuary and dredged channels in Lower New York Bay. The growth of the Hook is evident on a time interval of just decades. The lighthouse was built near the tip in 1764, but is today located more than two kilometers southeast of the tip (Figure 12). Between 1940 and 1961 alone, about 300 meters were added to the tip, or more than 25 hectares of sand. Some of the new growth was at the expense of sand elsewhere along Sandy Hook, especially on the ocean side of the southern end of the spit (Minard 1969).

Very few prehistoric archaeological sites have been found on Sandy Hook despite surface surveys and some limited subsurface testing (e.g., Bianchi 1981; Bianchi and Rothschild 1978; John Milner Associates 1978). A black chert bifacial tool was found on the north shore of Spermaceti Cove by a visitor, and turned over to the Sandy Hook Museum, while other stray artifacts have been found elsewhere. Prehistoric pottery was recovered from mixed contexts at the Cove House site on the north shore of Spermaceti Cove, and from excavations near the lighthouse (Dana Linck, personal communication, 2002). The documentary and ethnographic data suggest that Native Americans utilized Sandy Hook for sporadic hunting, gathering plant foods, fishing, and shellfishing (Moss 1975). A late eighteenth century English map identifies a section on the northwest shore of Horseshoe Cove as "Wigwam Point," possibly indicative of post-contact Native American activity (Hills 1784).

Figure 12. Sandy Hook, New Jersey, and surrounding landscape features. USGS 7.5 minute series topographic quadrangle *Sandy Hook, New Jersey-New York* (1954/1981).

Modern Sandy Hook has a number of resources that may have been used by prehistoric hunter-gatherers. Plant foods include blueberry, huckleberry, beach plum, prickly pear cactus, along with cattail and other wetland species. Faunal resources include terrestrial mammals such as white-tailed deer, beaver, possum, muskrat, and skunk, while coastal areas provide fish, lobster, crab, turtles, eel, and shellfish. Ducks and geese are seasonally abundant, as the Hook is on the Atlantic flyway for migratory waterfowl. The protected backbay areas of Sandy Hook, including Horseshoe and Spermaceti coves on the west side, would have been particularly attractive to prehistoric peoples, with a diverse set of plant and animal resources in relatively sheltered locations.

However, modern Sandy Hook is not the same landscape that was utilized thousands of years ago. One clue to how much the area has changed over the course of the Holocene comes from a core sample taken in the 1960s near the center of the Hook. Organic material (rootlets and reed fragments) from the top of a foraminiferal clay layer was radiocarbon dated to 9840 B.P. ±300 years (Minard 1969). The dated stratum is overlain by approximately 30 meters of sand (Minard 1969:Plate 2). The sediments of an Early Holocene wetland are now very deeply buried beneath beach sand. This suggests that any survey using traditional archaeological methods to search for prehistoric sites more than one or two thousand years old on the Hook is unlikely to have positive results.

Part of the problem of finding prehistoric sites here is that in addition to growing northward, Sandy Hook has been migrating westward for thousands of years. Sand is not the only shifting component of the landscape; sea level rise and other related processes have had a major effect in shaping the coastal morphology of the New York Bight and Sandy Hook. The Hook is a barrier beach (Figure 12), part of a chain of barriers that protect the modern coastline along nearly the entire length of the bight. These coastal barriers have been migrating shoreward with rising sea levels. Coring in Raritan and Sandy Hook bays indicates that seas first flooded the area west of the Hook between 6000 and 6100 cal. B.P. (Klein and McHugh 2009).

Rising seas have covered land that stretched seaward as much as 150 kilometers from the modern coastline, which was more-or-less established between three and four thousand years ago (Pirazzoli 1991). Former positions of the shoreline are marked by broad ridges of old barrier beaches, generally oriented parallel to the modern shore. These barriers were flooded as sea level rose rapidly, and currents are now gradually eroding the remnant ridges (Isachsen et al. 2000). At any given time through most of the prehistoric era, a landform that one would recognize as Sandy Hook was located east of the modern Hook, in a position now occupied by the Atlantic Ocean. Thus it is likely that our best chance of finding prehistoric sites will be by underwater archaeological survey in the Sandy Hook region.

In a preliminary assessment of the potential for submerged prehistoric sites in the Lower Bay of New York Harbor, Ferguson (1986:8) offered three explanations for the paucity of known sites here: the region was never or rarely utilized during the prehistoric period, erosion associated with rising sea level has disturbed or even eradicated any sites that may have been present, and/or we simply do not have sufficient data to address the issue of inundated sites. However, that submerged prehistoric sites do exist in the New York Bight is suggested by the density and diversity of known archaeological resources on land adjacent to the region (Figure 8), especially in archaeologically well-studied and relatively environmentally stable areas like Staten Island (Boesch 1994). Moreover, the presence of submerged prehistoric sites has been confirmed by the accidental discovery of the Corcione lithic artifact collection during dredging east of Sandy Hook.

History of the Artifact Finds. The lithic artifacts were removed from their underwater context by dredging in the autumn of 1994. The dredging was conducted under the auspices of the United States Army Corps of Engineers (USACE) to replenish beaches along the New Jersey shore between Sandy Hook and Sea Bright, and involved the removal of up to two meters of sand from a rectangular borrow area measuring approximately 300 by 2700 meters. The borrow area is parallel to, and about three kilometers east of, Sandy Hook (Figure 13), with water depths between 10 and 13 meters. It is west of the submerged channel of the Hudson River (the Hudson Shelf Valley).

In 1994 and 1995, a local resident, Mrs. Helene Corcione (for whom the collection is named), walked the replenished beach in Monmouth almost every day. During this period, she amassed a collection of prehistoric lithic artifacts, all collected from a single, hundred meter section of the beach (Figure 13). This, along with a consistent degree of weathering and a general absence of marine growth, suggests that the material was probably clustered together as a site prior to dredging, rather than thinly scattered across the sea floor. In addition, Mrs. Corcione walked other adjacent sections of the beach, and did not find any artifacts elsewhere. It is reasonable to assume that the collection made by Mrs. Corcione may be biased towards larger, interestingly shaped, and possibly dark colored pieces. She did not remember seeing any quartz or quartzite artifacts when shown examples from elsewhere, and when asked about her collection criteria Mrs. Corcione indicated that after finding her first artifact (a light colored triangular projectile point) she collected essentially anything that looked “out of place” against the sand (Helene Corcione, personal communication, 2004).

The sand that was placed on Monmouth Beach in 1994 has since washed away, precluding any additional survey work to locate more archaeological materials here. However, in 2004 Mrs. Corcione did find a few more stone pieces on the ocean side of Sandy Hook, approximately nine kilometers to the north. These pieces are extremely water-worn, but are of similar materials and size to the Monmouth Beach finds. They may be part of the same assemblage, transported after beach replenishment by long shore drift.

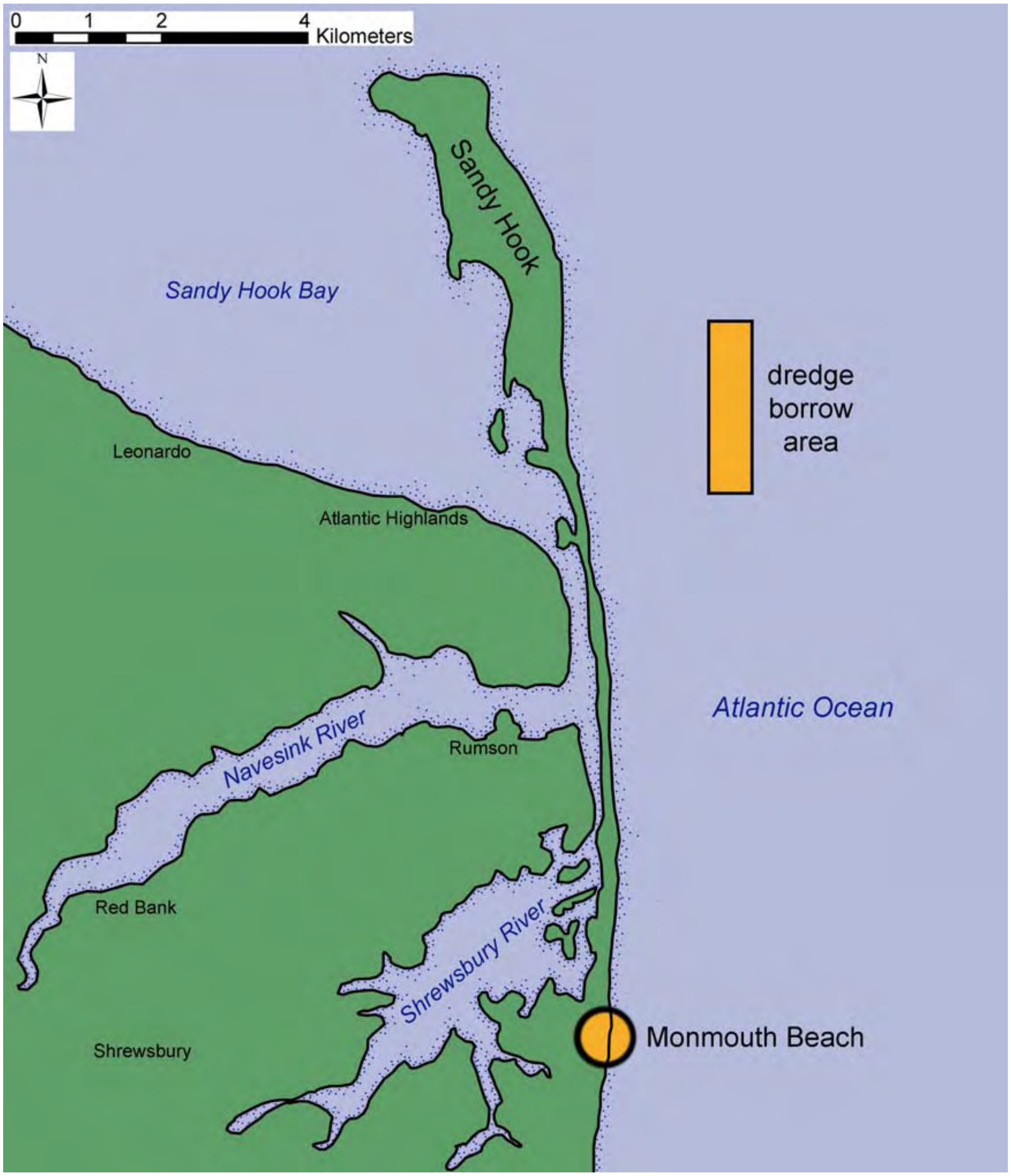


Figure 13. Map of northeastern New Jersey showing the location of the Corcione beach finds and the offshore borrow area from which they were dredged.

An attempt was made to reconstruct the offshore location from which the artifacts were dredged. Records of the dredging contract between the USACE, New York District, and Weeks Marine, Inc. (contract #DACW51-94-C-0008, Beach Erosion Control Project, Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet, Reach 1, Sea Bright to Sandy Hook, Contract A) were reviewed at the USACE office at Fort Monmouth, New Jersey in June 2001. The records at Fort Monmouth consist mainly of Inspectors Quality Assurance Reports (QAR), two completed for every 24 hour period (day shift and night shift), attached to Contractor Quality Control Reports (CQC), one per 24 hour period aboard the suction hopper dredge vessel *R.N. Weeks*. A survey was conducted to search for archaeological sites within the project area prior to the 1994 dredging operation (James 1991); however, the field methodology (side-scan sonar and magnetometer) was biased towards the identification of shipwrecks and other historic period deposits. A total of 26 targets, mostly magnetic, was identified. Many were determined to be ordnance dating from the late nineteenth through early twentieth century, when Sandy Hook served as a United States Army proving ground. None of the targets were determined to be archaeologically significant.

According to the QAR records, by the end of June 1994 it had become apparent that ordnance (mostly small artillery likely associated with the Sandy Hook proving ground) was being placed on Monmouth Beach along with the dredged sand. In early July, gratings were installed on the dredge dragheads of the *R.N. Weeks* in an effort to prevent ordnance from entering the hopper. These gratings were spaced approximately five centimeters apart, and all material caught in the draghead grating was backflushed into the borrow area.

Mrs. Corcione found the prehistoric artifacts between the USACE survey stations 256+00 and 271+00 on Monmouth Beach (adjacent to the Monmouth Beach Club building). These survey stations correspond to dredge loads 314 to 515, which were excavated between September 1 and October 26, 1994. Unfortunately, the 1994 QAR logs do not report vessel position for the *R.N. Weeks*, making it impossible to discern the original offshore location of the prehistoric lithic artifacts. According to the contract, dredging was not supposed to exceed 1.5 meters in any section of the borrow area, but it appears that there were no pre- or post-dredging surveys done, so the actual depth from which the artifacts came is unknown.

The Artifact Assemblage. Classification of lithic artifacts for this study (including both the Corcione collection and artifacts from the South Beach site on Croton Point) was accomplished using a standardized system developed for sites in southeastern New York (Bernstein et al. 1996; Bernstein and Lenardi 2008). Debitage (chipping waste) pieces are placed in one of three categories based on the amount of cortex (natural surface, or rind, found on the exterior of a stone) remaining on the dorsal face of a flake. Primary flakes are those with more than 50% of the dorsal face containing cortex. Secondary flakes exhibit cortex over less than 50% of the dorsal face, while tertiary flakes have no cortex remaining. Small tertiary flakes have no dimension greater than one centimeter.

Modified flakes have at least three contiguous flake removals to form a working edge. Bifaces are tools which exhibit substantial modification, and are worked on both the ventral and dorsal surfaces; unifaces are worked on just one surface. Cores are the original pieces of lithic raw material from which flakes are subsequently struck, typically using a hammerstone. Preforms are tools that have been roughed out from cores, but were possibly rejected before completion or were used as non-formal tools. Projectile points are classified using standard regional typologies (e.g., Boudreau 2008; Hranicky 1994; Justice 1987; Ritchie 1971). Fire-cracked rocks are stones that have been fractured and discolored by thermal stresses from heating and cooling. This presumably results from use of the rocks in facilities (e.g., hearths) for cooking and/or warmth.

The Corcione collection includes 40 projectile points, virtually all assignable to the Archaic period (Figures 14 and 15), 59 other bifacially-worked tools (Figures 16 and 17), three cores, and 107 flakes and possible flakes (Figure 18) (Table 4; Appendix B). Bifacially-worked stone tool shapes include teardrop, triangular, leaf-shaped, and oval forms (Figure 16), as well as several long narrow lanceolate or “knife”-shaped artifacts (top in Figure 17). Many of the tools are weathered (especially those made of basalt/diabase), hampering typing in these cases. Indeed, roughly three dozen pieces (mostly unmodified flakes) are so eroded that had they been found alone, they likely would have been discarded as non-cultural. The degree of weathering for each item, characterized as none, slight, moderate, marked, or severe, is given in Appendix B.

Visual assessment of raw material indicates that the collection is dominated by basalt/diabase (73.2 percent of the collection), with smaller amounts of cherts (12 percent) and jasper (1.4 percent), argillite (10 percent), sedimentary rock (2.9 percent), and undetermined material (0.5 percent). Unfortunately, the volcanic materials (i.e., basalt/diabase) have weathered preferentially, therefore metric analyses using features such as striking platform characteristics, edge angles, and flake scars are not possible. These attributes may be used to examine issues such as stone tool manufacturing techniques, raw material use, and curation; however, such analyses are not feasible for the Corcione collection artifacts.

There are cores and sizable flake quantities of only the two most prevalent lithic types, basalt and chert (Table 4). This suggests that the full range of stone tool manufacturing was undertaken with these particular materials at the site. In contrast, most of the jasper, shale, and argillite artifacts, along with a few pieces of unidentified material, are formal tools with only a few non-cortical flakes. It appears that different procurement and manufacturing strategies were used for the basalt and chert than were employed for the other materials (jasper, shale, argillite). Basalt and chert tools were made from start to finish at the site, and then used, discarded, or lost. The ratio of tools to debitage for basalt and chert together is 0.82. The ratio of all other materials tools to debitage is significantly higher at 1.82, indicating that these materials were utilized much differently. Finished or nearly finished tools of jasper, shale, and argillite were brought to the site where they may have received sharpening before use, resulting in the deposition of only small, non-cortical pieces of debitage.

The extent to which collection biases may be affecting this interpretation of lithic raw material use is not known. When asked about her collection criteria, Mrs. Corcione indicated that after finding her first artifact (the light colored triangular point; Figure 14) she picked up all objects that did not appear natural, suggesting she did not discriminate against any particular raw material (Helene Corcione, personal communication, 2004). However, she may have missed very small artifacts while beach combing; the average mass of the artifacts in the assemblage is 15 grams, and the average length is 49 millimeters (121 of the 209 pieces have a maximum length less than 50 millimeters). The smallest artifact has a maximum length of 23 millimeters (Appendix B). The dredge equipment should have excluded large objects due to the grating placed on the draghead, spaced approximately five centimeters (50 millimeters) apart. Several relatively large lithic artifacts did make it through the grating though, including an ovoid biface measuring 123 by 67 millimeters and a long, narrow biface measuring 169 by 35 millimeters (Figure 17; Appendix B). It is possible the grating may have prevented the intake of bulkier artifacts such as fire-cracked rock that may have been part of the site.

Figure 14. Sample of projectile points in the Corcione collection.

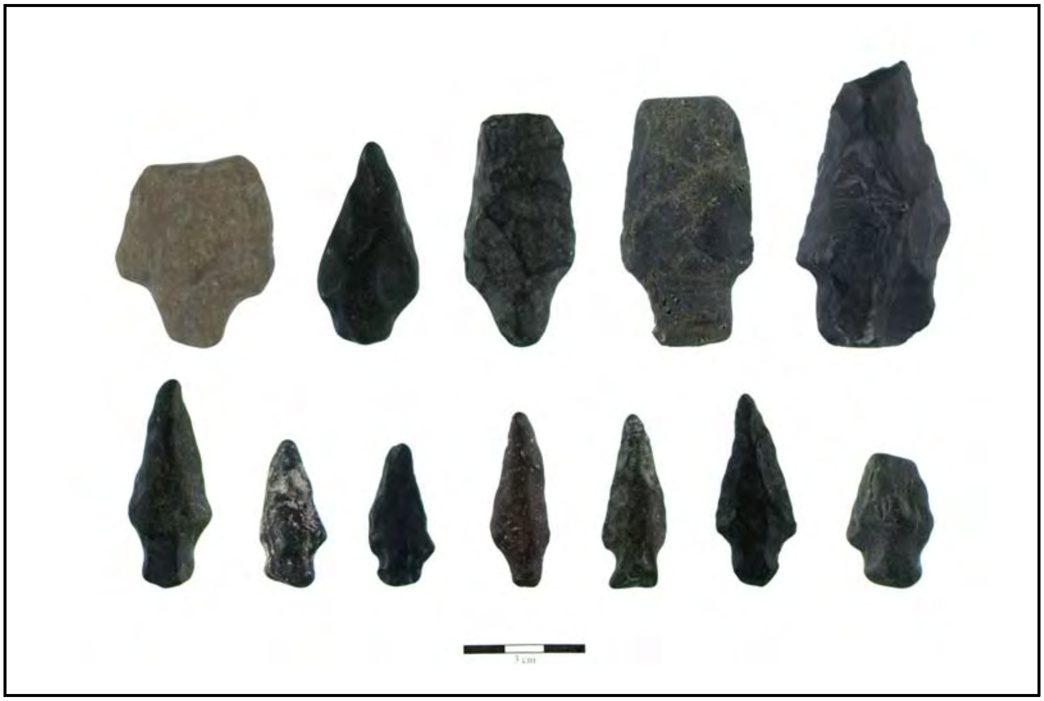


Figure 15. Additional projectile points from the Corcione collection.

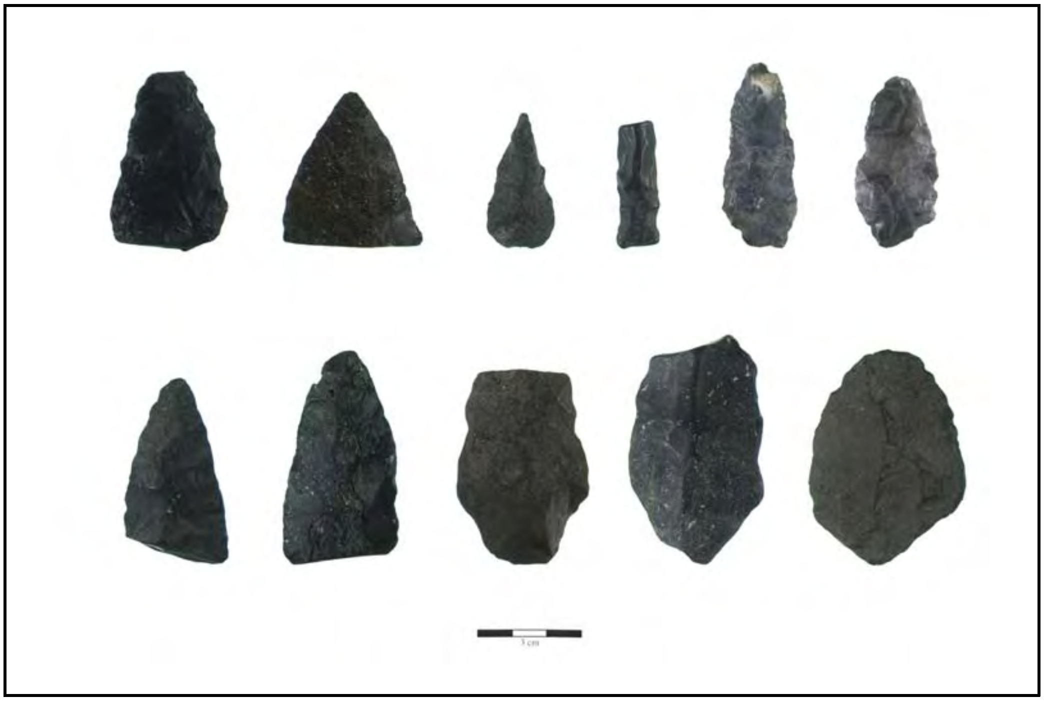


Figure 16. Sample of bifacial tools in the Corcione collection.

Figure 17. Two very large bifaces from the Corcione collection.

Figure 18. Sample of flakes of various raw materials from the Corcione collection.

Table 4. Corcione collection lithic artifacts, grouped by raw material.

Lithic Material	Flakes*			Tools		Cores	Total
	pri	sec	tert	biface	point		
chert	3	3	2	9	7	1	25
jasper	0	0	0	0	3	0	3
shale	0	0	1	0	0	0	1
other sedimentary	0	0	0	1	4	0	5
basalt/diabase	2	2	84	40	23	2	153
argillite	0	0	9	9	3	0	21
undetermined	0	0	1	0	0	0	1
Total	5	5	97	59	40	3	209

*pri=primary flake, sec=secondary flake, tert=tertiary flake

The variety of lithic raw materials seen in the Corcione collection is typical for other northern New Jersey sites. For example, a prehistoric camp site discovered near Red Bank on the Navesink River (roughly 15 kilometers south-southwest of Sandy Hook) in the early twentieth century yielded stone tools made from gray basalt, black chert, jasper, and quartz (*Asbury Park Sunday Press* 1928). Mounier (2003:155-156) reports that cobbles of chert, jasper, quartz, quartzite, and shale can be found on the coastal plain of New Jersey, while black, gray, and white cherts are found in limestone formations and as cobbles in outwash deposits in the northern part of the state, and formations of argillaceous shale and argillite are present in the piedmont region of the central and western portions of the state. Basalt and diabase (essentially the same type of volcanic rock, with basalt formed from cooled magma that was extruded onto the surface as lava and diabase formed from magma that cooled beneath the surface) are found in New Jersey counties surrounding New York Harbor and Raritan Bay, including Bergen, Hudson, Essex, Union, and Middlesex counties (United States Geological Survey 2009).

The Corcione collection includes at least forty projectile points (some of the artifacts classified as bifaces actually may be points, but are too weathered and/or fragmented to make a determination; in cases where the functional classification was unknown, the more inclusive category of "biface" was used). In the Mid-Atlantic and elsewhere, projectile point typologies traditionally have been used to construct chronological frameworks where materials suitable for radiocarbon dating are not present at a site or in particular components at a multicomponent site (Table 1). While not always reliable, this method of typological cross-dating is useful for providing rough temporal estimates of site occupation where it is not possible to use absolute dating. As mentioned above, a number of regional typologies (Boudreau 2008; Hranicky 1994; Justice 1987; Ritchie 1971) were used to classify the Corcione points. General morphological features (e.g., bifurcated base, contracting stem, straight-stemmed, triangular, etc.) are used to describe the projectile points first, followed by the closest match for specific named types where possible (Table 5; Appendix B).

The Corcione projectile points include two Early Archaic bifurcate base points (similar to St. Albans and LeCroy points), Middle Archaic Morrow Mountain I and II, Neville Variant/Stark, and Merrimack points, Late Archaic broad bladed points (Kittatinny, Brewerton, Snook Kill), narrow stemmed points (Lamoka, Bare Island, and Poplar Island) and two undiagnostic points likely dating to the Late Archaic period (Appendix B; Table 5). There are two triangular points, one made of a light brown/cream colored chert that exhibits some evidence of basal thinning (similar to a Late Archaic Beekman point), and the other of gray chert (similar to a Woodland Madison point) (Figure 14). There is little discernable change in lithic raw material use over time: the brown fine grained sedimentary rock used for both of the Early Archaic bifurcate base points is also used for a Late Archaic Kittatinny point, basalt, chert, and jasper span the range of Middle and Late Archaic points, and similar looking cherts overlap from the Late Archaic with one of the triangular points (Table 5; Appendix B). An exception seems to be argillite, which appears to be limited to Late Archaic point forms. However, the small sample sizes (especially at the oldest and most recent ends of the chronology) preclude making a definitive statement regarding raw material use through time at the site.

Table 5. Projectile points from the Corcione collection.

Cultural Period	Type	Quantity	Raw Material(s)
Woodland (?)	Madison	1	chert
Late Archaic	Beekman Triangle	1	chert
	Poplar Island	2	basalt
	Bare Island	1	basalt
	Lamoka	12	argillite (1), basalt (9), chert (2)
	Snook Kill	4	argillite (1), basalt (3)
	Brewerton	1	argillite
	Kittatinny	3	1 each chert, jasper, sedimentary
	undetermined notched	1	basalt
	undetermined contracting stem	1	basalt
Middle Archaic	Merrimack	2	1 each basalt, chert
	Neville Variant/Stark	1	sedimentary
	Morrow Mountain I	5	basalt (4), jasper (1)
	Morrow Mountain II	3	1 each basalt, chert, jasper
Early Archaic	St. Albans	1	sedimentary
	LeCroy	1	sedimentary

The Early and Middle Archaic projectile points from the Corcione collection are similar to those found at the Abature site (28Mo134), located near Eatontown, Monmouth County (approximately 24 kilometers south of Sandy Hook). Like the site represented by the Corcione lithics, the Abature site appears to have witnessed several occupations. Among the projectile point assemblage from the Abature site are three bifurcate base points (cf. Le Croy) and one Stanly or Neville-like point (Mounier 2003:200). The Corcione materials also resemble lithics found at multicomponent sites on Staten Island, including Ward's Point, Hollowell, Old Place, and Richmond Hill (Ritchie and Funk 1971, 1973).

Discussion. The accidental discovery of the Corcione collection by offshore dredging resulted in a loss of contextual data, but the artifacts do have the potential to address a number of research issues, particularly those dealing with land use on the coastal plain over the course of the Archaic period. The Corcione collection includes several artifacts believed to be diagnostic of the Early and Middle Archaic, and it is highly likely that more archaeological deposits with similar materials exist offshore in the Northeast. Based on sea level curves constructed for the New York Harbor (summarized in Pirazzoli 1991:192-194) and New Jersey (Donnelly 1998; Stanley et al. 2004), archaeological sites dating to 10,000 B.P. will be in water depths no greater than approximately 40 meters below mean high water, while those dating to 6000 B.P. will not be deeper than 25 meters. The 10,000 B.P. (Early Archaic) shoreline is located approximately 13.6 kilometers east of Sandy Hook, while the 6000 B.P. (Middle Archaic) shore is 10.3 kilometers from the modern coast (Figure 11). Note that these shorelines mark the position of the ancestral Hudson River during the Early and Mid-Holocene, and not the farthest extent of the exposed continental shelf. In addition to the swath of dry land adjacent to the modern New Jersey coast (west of the Hudson Canyon), a portion of the continental shelf east of the Hudson Canyon, south of Long Island, New York, was subaerial during the Early and Middle Archaic periods.

The depth of sediment under which former land surfaces are buried is likely to be variable. The Corcione lithic artifacts apparently were recovered from the upper 1.5 meters of sand within the dredging operation borrow area, which is consistent with some regional core data. For example, a core sample taken four kilometers off Moriches Inlet on the south shore of Long Island indicated that relict terrestrial sediments older than 7600 B.P. are buried under 1.2 meters of brackish and marine deposits (Sanders and Kumar 1975:70 [core CERC-C73]). Note that only one of the 209 items in the Corcione collection had marine growth on its surface (Appendix B), suggesting that the majority of the assemblage was buried prior to disturbance by dredging. Given the dynamic nature of the Atlantic Ocean and the site's seemingly relatively shallow burial, it is probable that the Corcione deposit had witnessed some disturbance even before the artifacts were deposited on Monmouth Beach.

Based on the projectile point styles, the site from which the Corcione collection originated appears to have been occupied at least intermittently for several thousand years, from possibly as early as 10,000 B.P. through as late as 3000 B.P. (the Early Archaic through Late Archaic periods). The diversity of lithic artifacts, including unmodified flakes (waste products of stone tool manufacture and/or reworking), a variety of bifacial forms, and projectile points, indicates that several different activities took place at the site. Although the specific uses of the Corcione collection tools can not be determined, it is likely that the projectile points were designed primarily for hunting and possibly fishing, and that the bifaces and modified flakes were used for everyday tasks such as cutting food, processing plants along with animal meat and hides, and fabricating items of wood, bone, and other materials. The lithic assemblage suggests that the Corcione collection is from a camp site, perhaps occupied on a seasonal basis.

Offshore Fieldwork

Field research for this dissertation was undertaken in relatively undisturbed, near shore portions of the continental shelf in the New York Bight, focusing on the area between Sandy Hook and the Hudson Shelf Valley (Figure 13). The reasons why this area is likely to be productive include the presence of a known prehistoric deposit (the source of the Corcione lithic artifact collection), the relatively low amount of disturbance from channel dredging (unlike other areas of New York Harbor), and relatively high potential for site preservation (it is a depositional coast with broad, shallow bathymetry). In addition, sections of the continental shelf near Sandy Hook are likely to be impacted by dredging for beach replenishment projects in the near future, and thus will be unavailable for study.

Methods. The archaeological field program sought to assess the sea floor conditions in and around the dredged area which yielded the Corcione collection, and to perform an underwater archaeological survey looking for additional prehistoric artifacts. This was the first systematic underwater search of its kind in the region. Because the precise origin of the Corcione artifacts was unknown, areas near drowned river channels in the vicinity of the dredged borrow pit were selected for diver survey (Figure 19).

Field survey was conducted by scuba divers, who visually inspected target areas and conducted limited small-scale excavations on the sea floor. The work was done as part of two Stony Brook University summer archaeological field schools in 2003 and 2004, respectively. The field study was undertaken in cooperation with the National Park Service, Gateway National Recreation Area. Permits to conduct the archaeological survey are required under the Federal Archaeological Resources Protection Act (ARPA), and were obtained from the National Park Service, the New York State Education Department, and the New Jersey State Department of Environmental Protection.

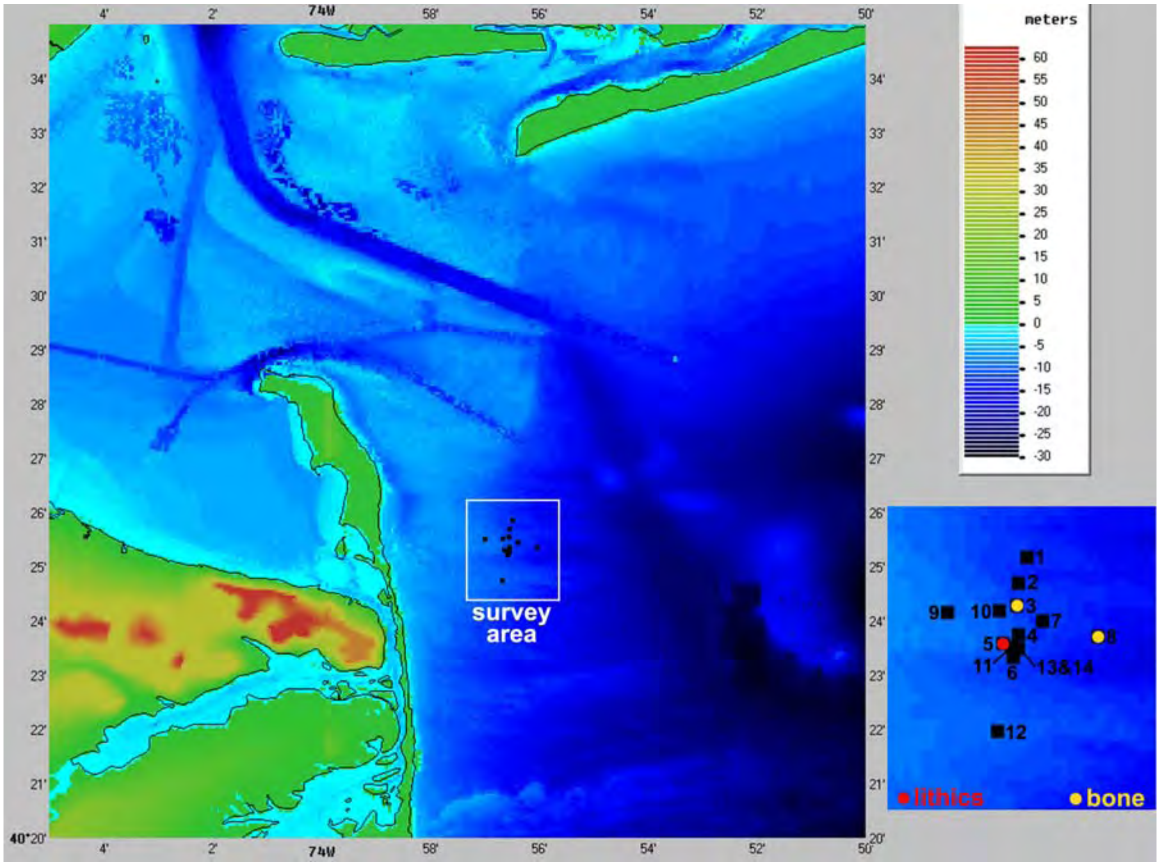


Figure 19. Survey area off Sandy Hook, showing one hectare test blocks.

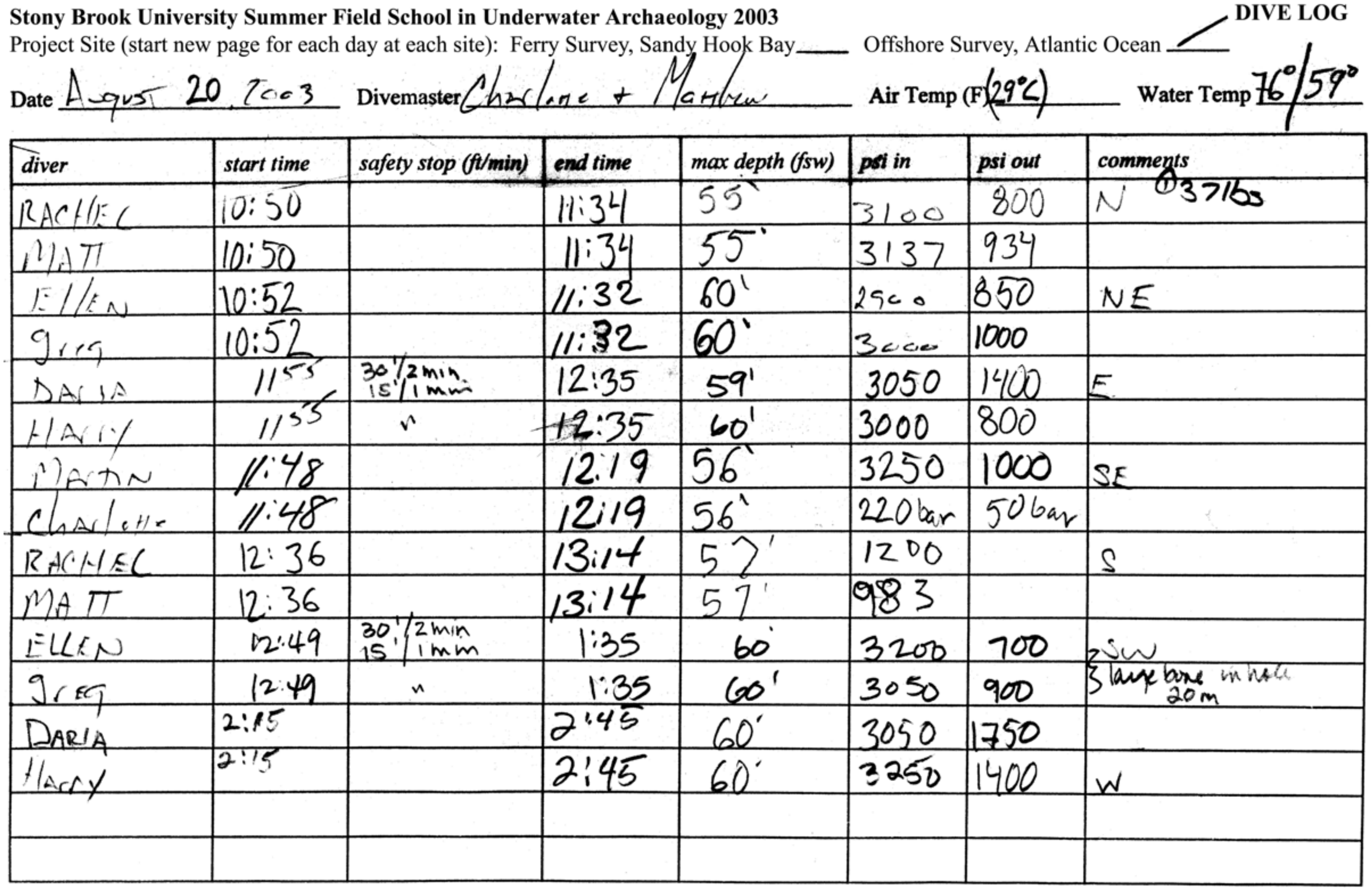
Diving was conducted only where and when conditions safely permitted, and all divers were held to a protocol based on the American Academy of Underwater Sciences (AAUS) and National Park Service Submerged Resources Center (NPS SRC) research diving standards. Dive teams were composed of students and volunteers, and prior to field work all divers were required to pass a medical exam, as well as swimming, diving, and written tests designed to check scuba diving proficiency. Team members were trained in basic first aid, CPR, and oxygen administration. All dive operations were supervised by a certified Dive Master, and followed a written dive plan outlining daily procedures and directions in case of an emergency.

All dives were planned to fall well within the times allotted for a given depth on decompression tables (NAUI, based on United States Navy tables), and all divers took a safety stop at three meters below the surface for a minimum of three minutes prior to surfacing after a dive. In addition, on dives greater than 15 meters, another safety stop was made for one minute at half the maximum depth (e.g., on their return to the surface from working at 15 meters, a team of divers stopped first at 7.5 meters, and then made the standard stop at 3 meters before surfacing). Safety stops during ascent are taken to allow for controlled "off-gassing" of compressed nitrogen that accumulates in body tissues during diving. All dives were logged daily on a standard form (Figure 20).

Divers conducted "surface" surveys of the sea floor to verify the presence of topographic features identified by remote sensing, and to search for prehistoric artifacts. The survey method entailed piloting the research vessel (the 11.3 meter dive charter *CRT II*, based in Atlantic Highlands, New Jersey) to a set of predetermined latitude/longitude coordinates using differential GPS navigation. A buoy was placed in the water when the coordinates were reached, and the boat was anchored at the buoy position, thus establishing a horizontal mapping datum for each hectare survey block (vertical position was ascertained by depth gauges). Once on the bottom, divers would attach one end of a fiberglass measuring tape to the anchor on the sea floor, and swim 50 meters along one of eight compass bearings (magnetic north [0 degrees], northeast [45 degrees], east [90 degrees], etc.) (Figure 21). The surface of the entire survey transect was inspected, and in most cases hand-fanned test pits (literally dug by waving a hand to scour a hole roughly 40-50 centimeters deep) were excavated every ten meters (Figures 22 and 23). Typically, 40 hand-fanned test pits were dug in each 100 by 100 meter (one hectare) survey block (Figure 21).

Field notes recording sediment characteristics and other data were made by divers with pencil on mylar sheets. Water depths in the survey area ranged from 14 to 20 meters, and visibility most days when diving was possible (based on weather conditions) was better than four meters.

All artifacts were collected, tagged with provenience data, and kept immersed in sea water until they were cleaned and allowed to dry in a controlled laboratory environment. Typically, lithic artifacts recovered from wet sites require little treatment beyond the removal of soluble salts by immersion in a series of fresh water baths. Artifacts and samples of organic material (e.g., wood, bone, shell) required controlled drying after salts were removed (Hamilton 1996).



Stony Brook University Summer Field School in Underwater Archaeology 2003 **DIVE LOG**

Project Site (start new page for each day at each site): Ferry Survey, Sandy Hook Bay____ Offshore Survey, Atlantic Ocean ✓

Date August 20 2003 **Divemaster** Charlene + Matthew **Air Temp (F)** (29°C) **Water Temp** 76°/59°

diver	*start time*	*safety stop (ft/min)*	*end time*	*max depth (fsw)*	*psi in*	*psi out*	*comments*
RACHEL	10:50		11:34	55'	3100	800	N ①37163
MATT	10:50		11:34	55'	3137	934	
ELLEN	10:52		11:32	60'	2500	850	NE
Greg	10:52		11:32	60'	3000	1000	
DARIA	1155	30'/2min 15'/1min	12:35	59'	3050	1400	E
HARRY	1155	"	12:35	60'	3000	800	
MARTIN	11:48		12:19	56'	3250	1000	SE
Charlotte	11:48		12:19	56'	220 bar	50 bar	
RACHEL	12:36		13:14	57'	1200		S
MATT	12:36		13:14	57'	983		
ELLEN	12:49	30'/2min 15'/1min	1:35	60'	3200	700	SW
Greg	12:49	"	1:35	60'	3050	900	large bone in hole 20m
DARIA	2:15		2:45	60'	3050	1750	
Harry	2:15		2:45	60'	3250	1400	W

Figure 20. Example of daily dive log kept for underwater survey offshore Sandy Hook.

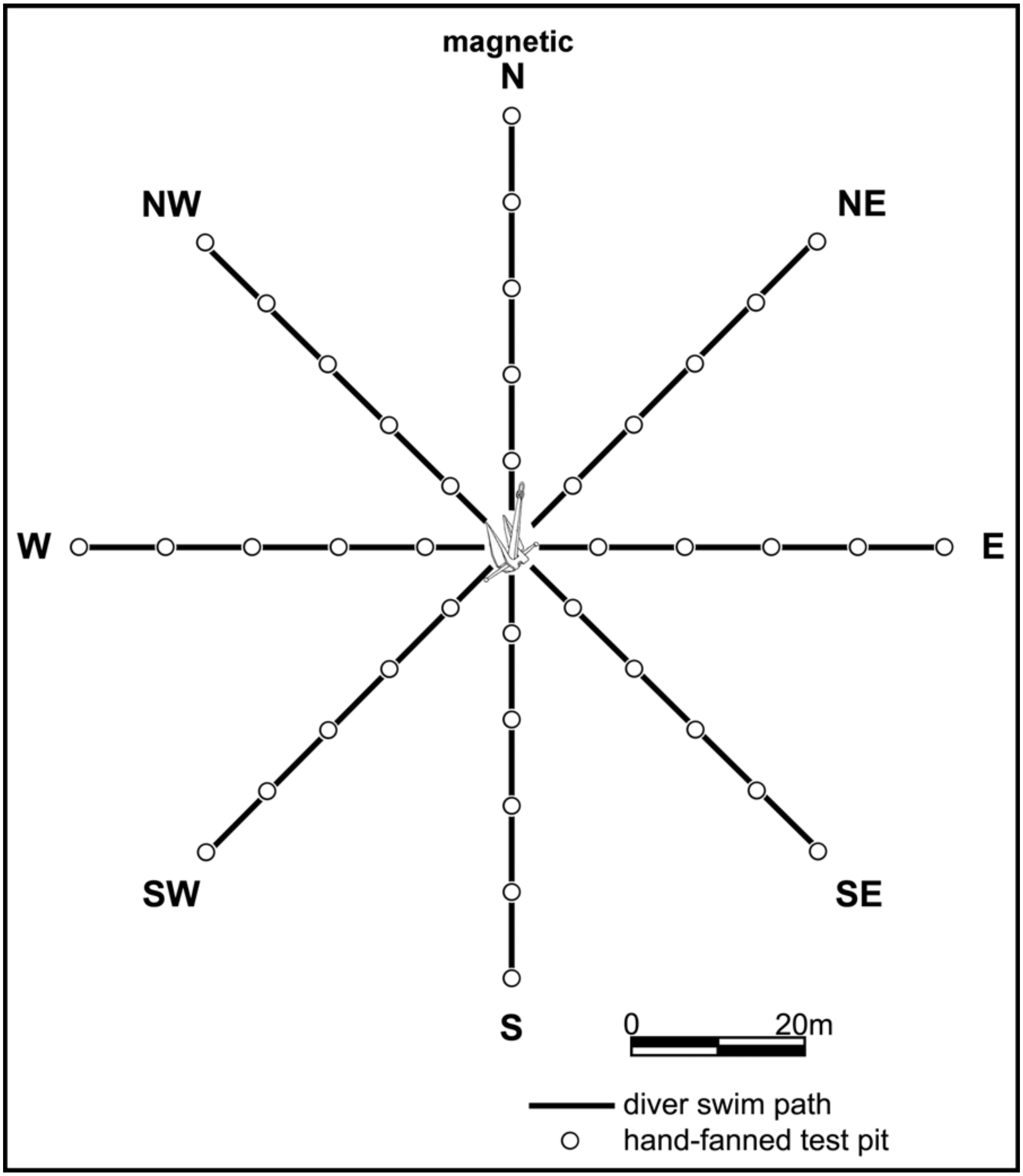


Figure 21. Typical survey pattern for each one hectare block examined off Sandy Hook, combining surface examination and subsurface testing along 50 meter lines originating from the dive boat’s anchor.

Figure 22. Underwater navigation using compass.

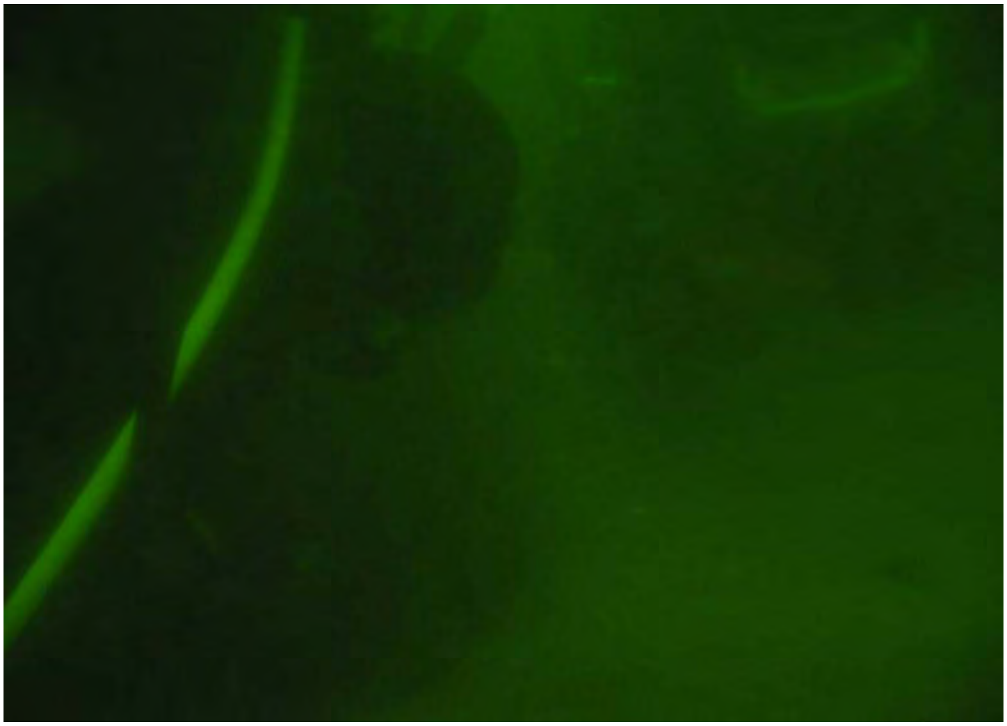


Figure 23. Excavation of a hand-fanned test pit offshore Sandy Hook.

Ten days were scheduled aboard the dive charter boat *CRT II* in August 2003, and another ten days in August 2004. Field conditions were conducive to research diving on all ten days during the first season. Unfortunately, the situation was markedly different in 2004, when a series of coastal storms (the remnants of three summer hurricanes) affected the waters of New Jersey. Diving on several days was curtailed or canceled due to surface waves, strong underwater currents, and greatly reduced underwater visibility. The best diving conditions experienced in 2004 were no better than the worst of the 2003 days.

The poor dive conditions encountered during the 2004 field survey, especially reduced visibility, adversely affected the survey results. Another significant problem faced by the field team in 2004 was that the dredged borrow area (the source of the Corcione lithic artifacts) apparently had filled in with sand since the 2003 field work. During 2003, it was possible for divers to distinguish whether they were working within the dredge borrow pit or adjacent to it by visual clues: there seemed to be more benthic marine life in the non-dredged area, sediments had higher silt and organic components in the non-dredged area, and it was routine to encounter large metal artillery shells (probably dating to the Army's use of Sandy Hook as an ordnance proving ground [1874-1919]) on the bottom of the dredged area. In 2004, silty sediments were found in what had been the borrow pit, and no artillery shells were seen. Talking with local divers about rough conditions earlier in the year supported the interpretation that the dredged area was no longer discernable on the sea floor, reducing the chances of recovering additional prehistoric materials.

An attempt was made to salvage the 2004 field season despite poor underwater conditions and filling of the dredged borrow area. After several reconnaissance dives in very low visibility, it was determined that the 2003 strategy of surface survey and hand-fanned test pits had a limited likelihood of success. Visibility was sufficient to read a compass and measuring tape, but not enough to see the contents of a hand-fanned pit. Instead, the aluminum scoops used in Croton Bay (see below) were used to dig test holes and the sediment was placed into fine mesh bags. Contents of the bags were sorted at the underwater safety stop or at the surface. Although this method worked well, it was difficult to excavate deeply enough to penetrate the recent fill to reach the 2003 sea floor level.

The next step was to build an air-lift to core the sea floor. Basically, an air-lift works by creating a vacuum in an upright tube. Force from high pressure air introduced at the bottom of the tube quickly rises to the top and results in suction. This principle has been used to excavate several shipwrecks, notably at deep sites in the Mediterranean (Bass 1966). However, our air-lift model may have been the first of its kind used in underwater archaeology. Compact, portable, and powered by a scuba tank, it was built for about $30 worth of parts found at the local dive shop and home improvement store (Figure 24). The simple design consisted of a two meter long PVC pipe (7.6 centimeter diameter), at the top of which a plastic bucket was attached with a flange. The top of the bucket was covered with hardware cloth (6 millimeter) so that small light materials (sand, shell hash) would vent out the top when the air-lift was operating, while heavier materials (lithic artifacts, bone) would be caught in the bucket. Air was introduced at the bottom of the PVC pipe with plumbing that included a low pressure inflator valve (the attachment point for the air hose leading from the scuba tank) and a ball valve to control the air flow. Marks were made on the length of the PVC pipe every 10 centimeters so the air-lift operators would know the depth of a test pit during excavation.

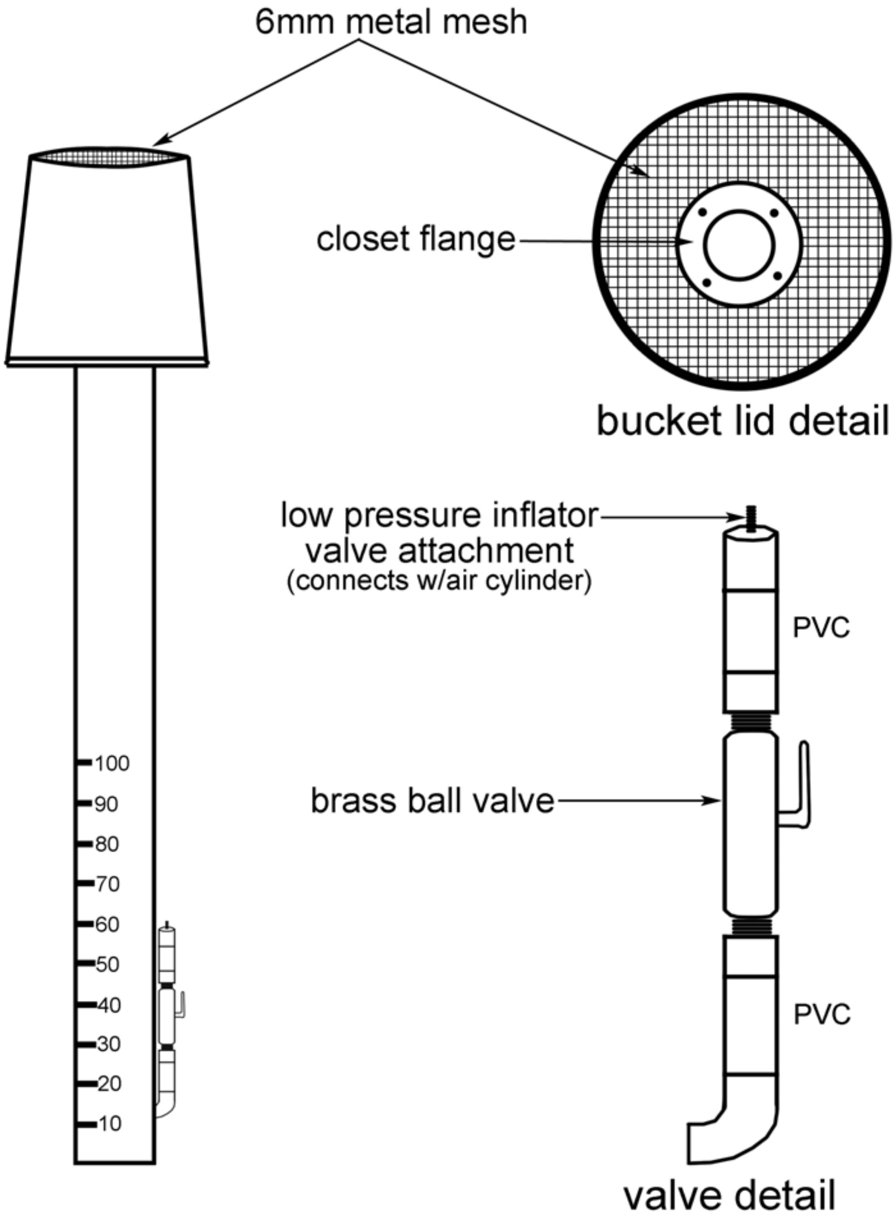


Figure 24. The air-lift built for coring the sea floor off Sandy Hook.

Results. A total of 146 individual dives was made in the Atlantic Ocean off Sandy Hook during the 2003 field season, and another 90 were made in 2004. Virtually all of these dives were made in pairs, and many days dive teams were able to work more than one rotation (depending on water conditions, air supply, and decompression time intervals). Fourteen hectares (100 by 100 meter squares) were intensively studied (Appendix C). During the 2003 season, 280 hand-fanned test pits were excavated, each to an average depth of 50 centimeters. Testing in 2004 was comprised of 111 hand-fanned units and test pits dug using aluminum scoops, along with six cores.

The typical sediment profile seen in the hand-fanned units dug during the 2003 field season consisted of an upper layer of light grayish brown silty sand with small pebbles and shell hash to an average depth of 15 to 20 centimeters beneath the sea floor, often followed by a five centimeter-thick band of light gray silty clay, underlain by light yellowish brown sand. The ten-day offshore study in 2003 resulted in the discovery of two lithic artifacts 16.5 meters below the surface near 40°25.192'/73°56.369' (Appendix C). These pieces (Figure 25) are similar to items from the dredged assemblage, and they may support the offshore origin of the Corcione collection. No prehistoric artifacts were encountered during the 2004 field work.

Two mammal bone fragments were also recovered in 2003, though there is no evidence to associate the animal remains with past human activity. Species and element identification of the smaller of the two bone fragments is not possible, but the second bone (found in 18.3 meters of water near 40°25.212'/73°56.035') (Figure 26) was identified by Arthur Spiess, Senior Archaeologist at the Maine Historic Preservation Commission, as the proximal end of a left ulna from a cervid, probably caribou (*Rangifer tarandus*) (Appendix D). According to Spiess, the Sandy Hook specimen matches an adult female caribou (originally from Newfoundland) in his collection in size and morphology. The Sandy Hook bone appears to be too large for deer, too small for moose, and while it could possibly be a small elk (*Cervus* sp.), the best match (80 percent certainty) is with caribou (Appendix D).

The bone was submitted to Beta Analytic Radiocarbon Dating Laboratory of Miami for AMS radiocarbon dating. Unfortunately, rather than yielding a Early to Mid-Holocene date, the results indicate that the bone is of far more recent origin, a conventional radiocarbon age of 160 ± 40 B.P. (Beta-234365; Appendix D). Consultation with Darden Hood, chief scientist at Beta Analytic, suggests that an error in radiocarbon dating is unlikely, since ample collagen was extracted from the sample and the 13/12C ratio (-16.1 o/oo) is consistent with cervids.

Figure 25. Lithic artifacts recovered from the Atlantic Ocean off Sandy Hook in 2003.

Figure 26. The proximal end of a left ulna from a cervid, probably caribou (*Rangifer* sp.) found during the offshore survey.

The recent date for the ulna fragment is difficult to explain if Spiess' *Rangifer* identification is correct (and there is little reason to doubt it, given that Spiess has published extensively on Northeastern archaeofauna [e.g., Spiess et al. 1985; Spiess et al. 1998; Spiess and Lewis 2001]). The location of the find off Sandy Hook is approximately 500 kilometers south of the known historic range of caribou. Caribou bones have been found at similar or more southern latitudes in New York, Pennsylvania, Virginia, Ohio, and Kentucky, but all date between 15,000 and 9000 years B.P. (Guilday 1968). Two caribou antlers have been recovered from Pleistocene gravels in Monmouth County, New Jersey (Parris 1983:15), and two caribou antlers were found in the Atlantic Ocean in the southern part of the state (Table 2; Gallagher et al. 1989:105-106). The Duxbury site near Plymouth Bay in southeastern Massachusetts, excavated in 1961, consists of a shell midden which yielded caribou and moose (*Alces alces*) bones. Projectile points and ceramic fragments found in the midden suggest a circa 2000 B.P. date, thus the site may indicate a relatively recent southern range extension for caribou along the Northeast coast (Guilday 1968).

Croton Bay Fieldwork

A second field site in the lower Hudson River was investigated in addition to the work conducted in the Atlantic Ocean off Sandy Hook. The origin of the Corcione collection, the offshore study area, and Croton Bay are related through their proximity to the aquatic resources in the lower Hudson River valley. During the Early to Mid-Holocene, the paleoenvironment off Sandy Hook, New Jersey was a coastal plain with barrier beaches and their backbays and lagoons, an area that was ice-free during the last glacial maximum. The environmental history of Croton Bay differs in that the region was glaciated, though the Hudson River had become a tidal estuary by the start of the Archaic period (10,000 years B.P.) (Weiss 1974).

Croton Bay is located near Croton-on-Hudson, Westchester County and is just south of Croton Point, the largest peninsula on the Hudson River (Figure 27). The point separates Tappan Zee in the south from Haverstraw Bay to the north, near the broadest part of the Hudson River. Croton Point Park consists of approximately 205 hectares operated by Westchester County, and the Croton Point Nature Center is situated at the northwest tip of the park. The center houses the Material Archives and Laboratory for Archaeology (MALFA), headquarters of the Louis A. Brennan Lower Hudson Chapter of the New York State Archaeological Association.

Figure 27. Croton Point, New York and vicinity. USGS 7.5 minute series topographic quadrangles *Haverstraw, New York* (1967/1979, left) and *Ossining, New York* (1967/1979, right).

As mentioned above, unlike Sandy Hook which was located south of the terminal moraine, Croton Bay was glaciated during the Late Pleistocene. After the last glacial maximum, warmer temperatures prevailed and the ice sheet retreated north. Meltwater from the receding glacier became impounded north of the end moraine, resulting in the formation of glacial Lake Hudson (Weiss 1974). The shores of glacial Lake Hudson may have been as much as 30 meters above modern sea level. Croton Point was entirely submerged. While the lake was in existence, fine sediments likely derived from tributary streams regularly settled out of suspension, leading to the deposition of varved clays and silts on the lake bottom. Coarser sediments were also carried into glacial lake Hudson, forming deltaic deposits near the mouths of larger tributaries including the ancestral Croton River (Markl 1971). Sand hills on Croton Point are the remnants of such a delta.

Glacial Lake Hudson drained prior to 12,500 B.P., after which the ancestral Hudson River would have been confined to its bedrock channel. Although salt water entered the lower Hudson River around 12,000 B.P. creating estuarine conditions (Weiss 1974), the low-lying area between the channel and Croton Point would have been dry land available for human occupation during the Paleoindian and Early Archaic periods.

Rising sea levels during the Holocene led to the widening of the Hudson River, drowning shallow areas along the modern banks, including Croton Bay. A series of cores taken near Iona Island roughly 16 kilometers north of Croton Point provide evidence for the timing of the submergence of low-lying areas. Radiocarbon dates were obtained on basal peats in organic silt deposits (marking the point at which dry land became inundated wetland): 4630 B.P. at 8.2 meters below mean high water, 4080 B.P. at 6.4 meters, and 2500 B.P. at 2.7 meters (Newman 1966). Cores taken along the west shore of Croton Point in advance of bulkhead construction and elsewhere nearby contained similar peat/organic silt deposits overlying deltaic sands, varved clays, and glacial till (Boesch 2003; Weiss 1974). Based on these cores revealing an intact stratigraphic sequence, Pickman (2004:22) concluded that “there is some potential for buried prehistoric remains to be present” offshore Croton Point.

Like Sandy Hook and elsewhere in the New York Bight, the bays, marshes, and uplands around Croton Point had numerous aquatic and terrestrial resources of significant economic value to prehistoric Native Americans. Oysters became an important food, at least seasonally, starting roughly six thousand years ago, and large schools of fish including bass, shad, and sturgeon followed predictable seasonal migrations in the Hudson (today Haverstraw Bay just off Croton Point is the main overwintering grounds of Atlantic sturgeon [New York State Department of State 2008]). Wetlands contained cattails (with edible tubers), reeds, and cordgrass, and attracted waterfowl. Upland oak-chestnut forests also included hickory, black cherry, sugar maple, and pine trees and provided habitat for game birds, small mammals, deer, and bear (Pickman 2004:27).

Shell middens on Croton Point provide evidence regarding the paleosalinity of the lower Hudson River during the Mid-Holocene (the Middle Archaic and Late Archaic periods). Parris (1987) identified remains of red-bellied turtle, *Pseudemys rubriventris,* in an oyster midden. Long extirpated from New York, the modern ranges of the red-bellied turtle include the Atlantic coastal plain from New Jersey to North Carolina and a small relict population in Massachusetts. It is typically found in coastal plain rivers and ponds. During the Mid-Holocene hypsithermal episode, warm and dry conditions prevailed, likely allowing saline waters to penetrate farther north in the Hudson estuary despite lower river levels. The presence of oysters and the red-bellied turtle in the Croton Point midden suggests that river salinity during the Mid-Holocene was considerably higher (at least four to five times) than the modern level of roughly 5.4 to 6.8 o/oo (McCrone and Koch 1966; Parris 1987). Thus the faunal and floral assemblage of Croton Point more closely resembled a coastal environment than an inland river valley for much of the Archaic.

The lower Hudson Valley has a rich and diverse archaeological record spanning at least 10,000 years of human history. Croton Point alone contains more than 15 known and suspected prehistoric sites. Archaeology on and around the point was undertaken during the early twentieth century by M.R. Harrington and Alanson Skinner for the American Museum of Natural History, and later during the mid-twentieth century by Mary Butler, Carlyle Smith, Louis Brennan, Bert Salwen, and others (Pickman 2004).

Most of the sites studied in these early investigations are shell middens, notably the stratified Kettle Rock Point site on the northwest tip of Croton Point (also known as Croton 2; Funk 1976:185). The bottom layer of the oyster midden at Kettle Rock Point was radiocarbon dated to 5863 B.P. ± 200 B.P., making this site (along with the roughly contemporaneous midden at nearby Dogan Point) among the oldest shell middens in eastern North America. Lithic artifacts found at Kettle Rock include Late Archaic period small stemmed and Bare Island projectile points, a hammerstone, a worked stone that may have been used as a net weight, a quartzite bifacial chopper and utilized chert flakes. Deer and other mammal bones were found throughout the midden, while Vinette style pottery sherds were recovered from upper levels. The Kettle Rock Point shell midden is presently eroding into the Hudson River. Traces of shell middens also have been found on Tellers Point at the south end of the peninsula (Pickman 2004:40-44). The closest known prehistoric site to the survey area in Croton Bay adjacent to South Beach (see below) is another shell deposit with lithic debitage identified in shovel test pits dug north of the ice pond north of Tellers Point (Figure 27) (Lenik 1993).

Croton Point may have been the site of a Native American village visited by Henry Hudson in 1609, and by the mid-seventeenth century William and Sarah Teller had established a trading post on the peninsula (Bolton 1848). During the Revolutionary War, a cannon was placed near the tip of the point to harass British ships on the Hudson River. Croton Point was owned by the Underhill family during most of the nineteenth century, when documented activities include fishing, farming, and wine- and brick-making. The property was acquired by Westchester County and park development began in the 1920s (Pickman 2004).

Starting around 2000, Scott Horecky, a Westchester County employee and member of MALFA, began collecting prehistoric artifacts from South Beach on the south side of Croton Point, including more than fifty projectile points, more than forty other lithic artifacts (e.g., bifacially worked tools and unmodified flakes), and a few pieces of pottery. The assemblage appears to date to the Late Archaic and Early Woodland periods. Mr. Horecky has mapped all the finds, and based on when the finds were made (generally after storms) and their distribution pattern on the beach, he believes that the artifacts originated from a submerged site (Scott Horecky, personal communication, 2004). Fieldwork was undertaken in July 2004 to determine if prehistoric artifacts are indeed present in Croton Bay, and if so, answer questions regarding the site's age, size, contents, function(s), and research potential.

Methods. The field work in Croton Bay was undertaken by students and volunteers from the Stony Brook summer field school. Methods used at the intertidal and submerged portions of the site included surface survey on South Beach adjacent to the bay, and excavation of test pits both on the beach and under water. In the month prior to the start of the field school, an attempt was made to use very high resolution multibeam sonar swath bathymetry to map the survey area in Croton Bay. Stony Brook had the opportunity to test a new shallow water multibeam system developed by Kongsberg-Simrad (the EM 3002 multibeam sonar unit mounted on the M/V *Concat*) during the week of June 12, 2004. Unfortunately, we were not able to access the survey area in Croton Bay because even at high tide the water depth was just under two meters, too shallow for the M/V *Concat* to safely operate.

Like the work off Sandy Hook, all diving at Croton Bay was conducted only where and when conditions safely permitted. All dive operations were supervised by a certified Dive Master, and adhered to a written plan. Due to the near complete lack of visibility in the bay, "surface" survey of the bottom to search for prehistoric artifacts was not possible. Instead, test pits were dug at regular intervals, generally five meters apart. A mapping datum (N0/E0) was established at the end of a pier near the center of the study area (Figure 28). This rock-filled crib pier is shown on early twentieth century maps (e.g., Bromley and Bromley 1901), and may be associated with a pre-1858 "Fish House" (Merry 1858) that formerly stood near the south end of the extant dirt road. All test locations are given in metric coordinates relative to the datum. Portions of the bay were not subject to subsurface testing (e.g., between the W5 and E65 lines, and between the E100 and E135 lines south of N50) because of extant historic period pier structures (Figure 28).

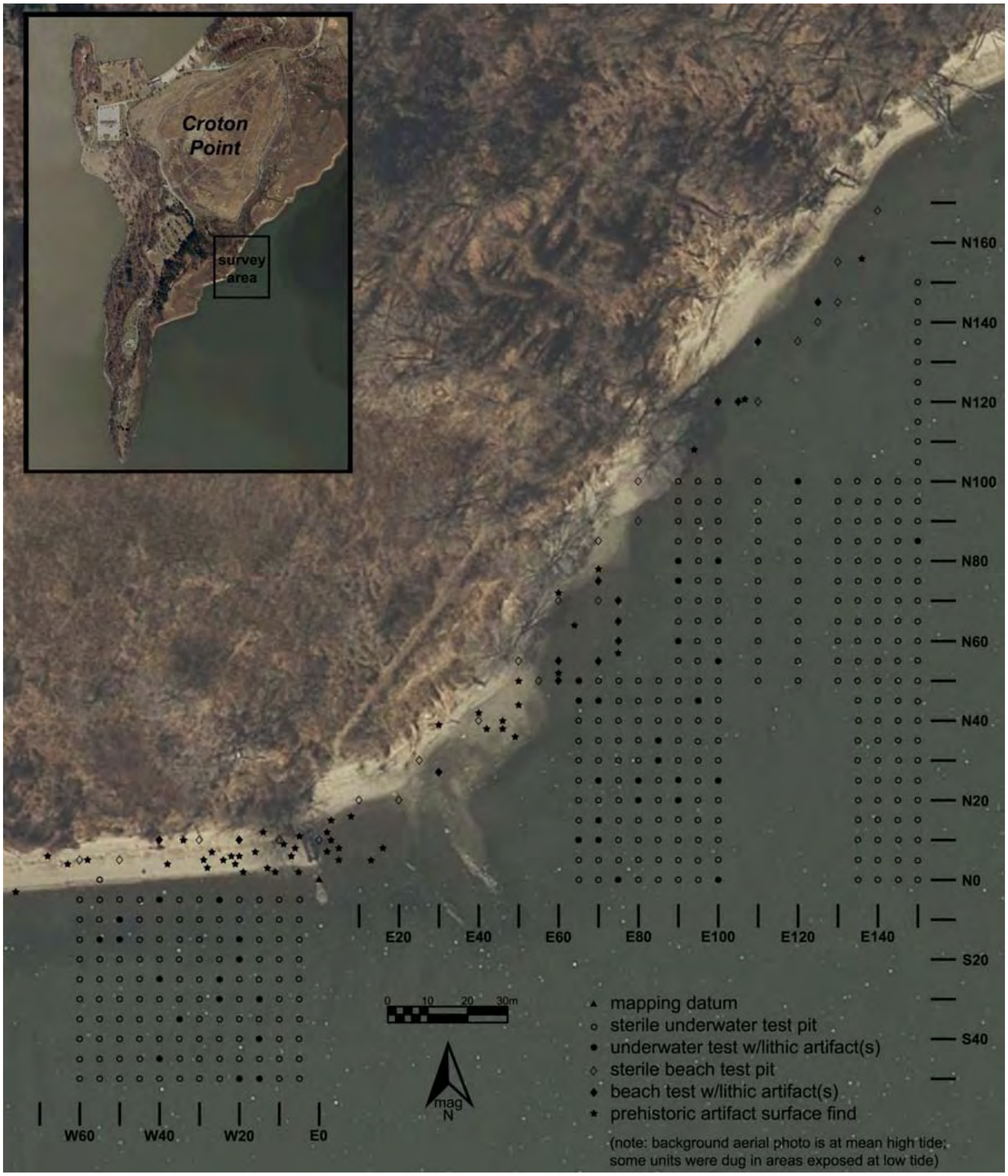


Figure 28. Project area map of South Beach on the south side of Croton Point, showing locations of surface artifact finds, and all intertidal and submerged excavation units. Base aerial photograph is 2009 One Foot 4 Band East Zone, New York (online at http://www1.nysgis.state/ny.us).

Fiberglass tapes and hand-held compasses were used to establish the locations of test pits along the transects. Unlike the Atlantic Ocean floor, where unconsolidated marine sediments can be excavated by hand-fanning, the bottom of Croton Bay consists of dense muddy silt with a high organic component. In lieu of trowels, aluminum ice scoops were used for excavation. Because the work was done in shallow water, the sediment was placed directly into small screens (with 0.6 millimeter metal hardware cloth), and the team of divers would surface (accomplished through most of the tide cycle by simply standing) to sort through the materials (Figure 29). The test pits were generally dug to a depth of 50 centimeters, with a diameter of approximately 50 centimeters. A total of 365 test pits was excavated under water (Figure 28; Appendix E). All artifacts encountered during the underwater survey were collected, tagged with provenience data, and kept immersed in river water until they were cleaned and allowed to dry in a controlled laboratory environment. Artifacts will be permanently curated at MALFA on Croton Point upon completion of this study.

The beach area (including the intertidal zone at low tide) was subject to an intensive surface survey. Pairs of students were assigned five meter blocks in which all prehistoric and historic period artifacts were plotted, resulting in a high number of beach finds. Thirty-six shovel test pits were excavated on the beach to verify the surface finds and determine if prehistoric artifacts are present beneath the surface (Figure 28; Appendix E).

Figure 29. Field survey at the South Beach site.

Results. The prehistoric artifact assemblage from the South Beach site is dominated by stone tools and the waste products created during their production. A total of 125 lithic artifacts (not including fire-cracked rocks) was recovered during the field investigation. Details of each surface find and excavation unit (both dug on South Beach and under water in Croton Bay) are presented in Appendix E, and locations of surface finds and test units are shown on Figure 28. A summary of the lithic artifacts is given in Table 6.

Lithic artifacts from the site can be divided into three major categories. The first category consists of chipped stone tools and tool fragments. These include projectile points and other biface forms (top row, Figure 30). The second category is comprised of debitage (waste material): primary (more than 50% cortex remaining on the dorsal face), secondary (less than 50% cortex remaining), and tertiary flakes (no cortex) (bottom row, Figure 30). Next are cores, which are the original pieces of lithic raw material from which flakes are subsequently struck (top right, Figure 30). Fire-cracked rocks found at the South Beach site, particularly pieces found on the beach, are of uncertain age.

The stone tool industry represented at South Beach is the same seen at numerous sites in the Hudson River Valley (Funk 1976:184-191). It entails the reduction of locally abundant chert nodules, along with lesser quantities of jasper, shale, quartzite, quartz, and other raw materials (Table 7), to produce a series of bifacial forms. Based on the 2004 finds, it appears that the entire sequence of tool manufacturing took place at the South Beach site. This is the case at least with chert, quartz, and quartzite; like the Corcione collection, the paucity of flakes of other raw materials (e.g., jasper and shale) suggests that some types of lithics may have been transported to the site as finished or nearly finished pieces. Flakes retaining the outside rind (cortex) from the raw cobbles of chert, quartz, and quartzite are abundant, as are small thin flakes resulting from the final finishing of stone tools (Tables 6 and 7; Figure 30). Most of the cores (6 of 11) found at the site are partially reduced chert pieces, while the remainder are made from quartzite and basalt cobbles (Table 7).

In addition to manufacturing stone tools, the prehistoric inhabitants of the site were using the tools as well. While the specific uses of the stone tools from the South Beach site can not be determined, it is likely that the projectile point was designed primarily for hunting, and that the bifaces were used for everyday tasks such as cutting food, processing animal meat and hides, scraping wood and other plant material, and fabricating objects for daily use.

The only temporally diagnostic artifact recovered during the 2004 survey of South Beach and Croton Bay is a dark gray chert Steubenville stemmed projectile point from underwater test pit N30/E85 (top row, second from left in Figure 30; Appendix E). Steubenville points, first identified in the northern panhandle of West Virginia, date to approximately 4200 to 3400 B.P. (Mohney 2002). The point found under water is consistent with dates for the Late Archaic stemmed points found on South Beach by

Table 6. Prehistoric lithic artifacts from the South Beach Site, Croton Point.

	Flakes*			Tools		Cores	Total
	pri	sec	tert	biface	point		
beach surface find	8	3	29	4	0	10	54
beach STP	0	1	18	0	0	0	19
underwater STP	5	5	37	3	1	1	52
Total	13	9	84	7	1	11	125

*pri=primary flake, sec=secondary flake, tert=tertiary flake

Figure 30. Lithic artifacts from test pits excavated in Croton Bay, showing examples of tools and raw materials. Top row, left to right: chert biface from N35/E85, chert projectile point from N30/E85, quartz biface from N0/E75, quartzite core/uniface from N80/E90. Bottom row, left to right, all unmodified flakes: basalt from S50/W20, quartzite from S5/W40, quartzite and chert from N45/E95, chert from N20/E90, and chert from N10/E65.

Scott Horecky. Further, the Late Archaic date for at least the submerged portion of the South Beach site is consistent with the timing of sea level rise (and concomitant river level rise) in the lower Hudson; radiocarbon dating of basal peats in cores taken near Iona Island, approximately ten kilometers north of Croton Point, indicate that what are today shallow embayments such as Croton Bay would have been inundated wetlands by around 2500 B.P., and dry land somewhat earlier (Newman 1966).

Table 7. Raw materials of lithic artifacts from the South Beach Site, Croton Point.

Lithic Material	Flakes*			Tools		Cores	Total
	pri	sec	tert	biface	point		
chert	3	2	46	1	1	6	59
jasper	0	0	1	0	0	0	1
shale	0	1	1	0	0	0	2
other sedimentary	1	1	3	0	0	0	5
basalt/volcanic	0	0	2	0	0	2	4
quartz	2	1	11	2	0	0	16
quartzite	7	3	20	4	0	3	37
undetermined	0	1	0	0	0	0	1
Total	13	9	84	7	1	11	125

*pri=primary flake, sec=secondary flake, tert=tertiary flake

The full extent of the South Beach site is currently unknown, as additional subsurface testing is required to identify the boundaries of the deposit. Based on the results of the 2004 survey, it measures at least 170 meters east-west (the east boundary appears to be near the E120 grid line on Figure 28, while the west boundary is unknown) and 150 meters north-south (the north boundary for the submerged portion of the site is the N100 line, while the south boundary is unknown) (Figure 28). As can be seen on Figure 28, there is no discernable patterning to the location of prehistoric artifacts from the underwater test pits. At first glance, it would appear that the beach yielded a higher density of prehistoric materials. However, different survey methods are likely the cause of this disparity: literally every square meter of subaerial beach was closely examined with a surface survey, whereas the submerged portion of the site was sampled with a test pit every five meters in near-zero visibility. Far fewer artifacts would have been found on the beach had a five meter sampling interval been employed.

The question of whether the South Beach assemblage represents an underwater site undergoing reworking with artifacts displaced onto the beach, or if it is a terrestrial site eroding into the bay can, at this time, only be addressed with circumstantial evidence. The first scenario, that it is an underwater site, appears to fit the evidence best. On the whole, the artifacts recovered from the underwater test pits appear to have less wear than items from the beach, suggesting they have witnessed minimal movement. None of the beach finds were made up slope of the high tide line, and no evidence of an eroding terrestrial site was found during the surface survey of the beach and adjacent edge of woods. Coring the bay bottom could support the current evidence that the site is intact under water if artifacts were consistently found at depth beneath the bay floor, ideally associated with pre-inundation sediments.

DISCUSSION AND CONCLUSIONS

The research described in this dissertation includes a synthesis of known submerged prehistoric deposits in the Mid-Atlantic Bight, a discussion of predicting inundated site locations, a report of an accidental discovery of ancient lithic artifacts off Sandy Hook, New Jersey, and results from the first systematic field surveys to search under water for Native American artifacts in the New York Bight. In the two decades since Stright (1990, 1995) published her inventories of known submerged sites dotting the continental shelves of North America, the number of reported finds in the Mid-Atlantic region has more than doubled, from 11 to 28 (Table 3, above). While the body of data continues to grow, the number of reported underwater sites is quite small compared with the number of known terrestrial archaeological sites. However, there are some potentially useful inferences to be made from the submerged site data, especially regarding prehistoric settlement patterns, and there are promising avenues open for further research.

It is not surprising, given the logistical constraints of conducting offshore survey, that the majority of known inundated prehistoric sites in the Mid-Atlantic are located in nearshore or even intertidal environments. In addition, the places in which submerged sites have been found are also the places where attentive fishermen and beach combers are most likely to encounter them. Perhaps most importantly, sections of the continental shelf that were exposed as dry land for the longest period of time have the highest potential for the presence of prehistoric sites. In other words, the likelihood of encountering a submerged Native American site within two kilometers of the modern coast is significantly higher than the probability of finding a similar site twenty kilometers offshore simply due to the fact that the nearshore environment was available for human occupation thousands of years longer than the one farther at sea.

The land, shore, and sea bottom form a continuous swath that would have appeared much differently to the earliest Native American settlers than it does today. The continental shelf was a seamless extension of the landscape, marked with features conducive to use by prehistoric hunter-gatherers. The terrestrial archaeological record in the Mid-Atlantic and elsewhere in eastern North America indicates that prehistoric site patterning is closely linked with the location of important resources, such as water, food, and lithic raw material. It follows that the now-submerged landforms with the highest sensitivity for the presence of prehistoric sites include relict stream channels and estuary complexes. Among the expected site types are procurement stations (e.g., fishing or kill sites), shell middens, seasonal camps, and extensive habitation sites. It is possible that other kinds of geographic features that may have witnessed human utilization (e.g., rock outcrops that could have been used as quarry sites) exist on the continental shelf in the region, but they are more difficult to locate than inundated streams.

Archaeological sensitivity for the presence of submerged prehistoric sites is based on water depth and other key environmental features, particularly relict stream channels and estuaries and surrounding former uplands. Portions of the study area in the New York Bight that are deeper than approximately 125 meters have virtually no potential for any traces of past human occupation, as this depth marks the approximate oceanic low stand during the Last Glacial Maximum, and deeper locations would have been under water at 21,750 B.P. Similarly, the swath of the continental shelf between the 80 and 125 meter isobaths has a low potential based on our current reconstructions of the earliest human arrival in eastern North America, assuming the region was not inhabited until after circa 14,000 B.P. (Anderson and Gillam 2000; Buchanan et al. 2008; Fiedel 2000; Meltzer 2004). Areas of the New York Bight with the highest sensitivity for the presence of submerged prehistoric sites are closest to the modern coast. Archaeological potential decreases with increasing depth and distance moving eastward from the coastline: sensitivity is very high for Late Archaic through Paleoindian period sites to the 15 meter isobath, high for Middle Archaic through Paleoindian sites to the 25 meter isobath, moderate to high for Early Archaic and Paleoindian sites to the 40 meter isobath, and moderate for Paleoindian sites to the 80 meter isobath (Figure 11).

The two prehistoric deposits described in this dissertation, the site represented by the Corcione collection found off Sandy Hook, New Jersey and the South Beach site at Croton Point, New York, are two points along a time and space continuum of marine transgression that occurred over the course of the Holocene (and that is still taking place at an increasing rate) in the New York Bight. Both sites are located adjacent to the Hudson River, which empties through the apex of the bight. The Corcione collection came from within the watershed of the submerged Hudson (now beneath the Atlantic Ocean), and the South Beach site is on an embayment of the subaerial river farther inland, approximately 90 kilometers to the north.

The banks of the Hudson River have been a focal point of human activity since approximately 12,000 years ago, and the archaeological potential of the estuary and surrounding lands is great. However, as demonstrated by the Corcione collection and the South Beach site, a portion of the prehistoric human record in the lower Hudson River is virtually invisible using traditional archaeological methods because of sea level rise that has inundated portions of the river valley which once witnessed substantial prehistoric occupation. The Corcione collection spans the entire length of the Archaic period (between roughly 10,000 and 3000 B.P.), and was recovered from water depths around 13 meters. The South Beach site yielded a projectile point dating to the Late Archaic (probably near the latter part of the period, between 4200 and 3400 B.P.), and the submerged portion of the site is in two meters of water at high tide.

The research conducted for this dissertation suggests that Native American peoples occupied now-submerged portions of the landscape during the Early and Mid-Holocene (10,000 to 3000 years ago) in the New York Bight and beyond. The lithic artifacts of the Corcione collection indicate that the area now off the shore of Sandy

Hook was repeatedly used over a long period of time by Native Americans. Projectile points from the assemblage include Early Archaic bifurcate base, Middle Archaic stemmed, and Late Archaic narrow stemmed styles, and an end date for occupation around 4000 years ago is consistent with the last exposure of this part of the continental shelf as suggested by local sea level curves (Donnelly 1998; Pirazzoli 1991; Stanley et al. 2004) (Figures 31-33). The projectile points reflect hunting or possibly fishing activities at the site, while additional activities are suggested by other bifacially-worked tools (e.g., knives, choppers, and scrapers) and flakes (waste products of stone tool manufacture and/or reworking) in the assemblage. The area of the continental shelf east of Sandy Hook near the drowned Hudson River was apparently attractive to Native Americans for a long period of time for hunting and gathering, possibly on a seasonal basis when important resources such as deer herds or migratory waterfowl were plentiful.

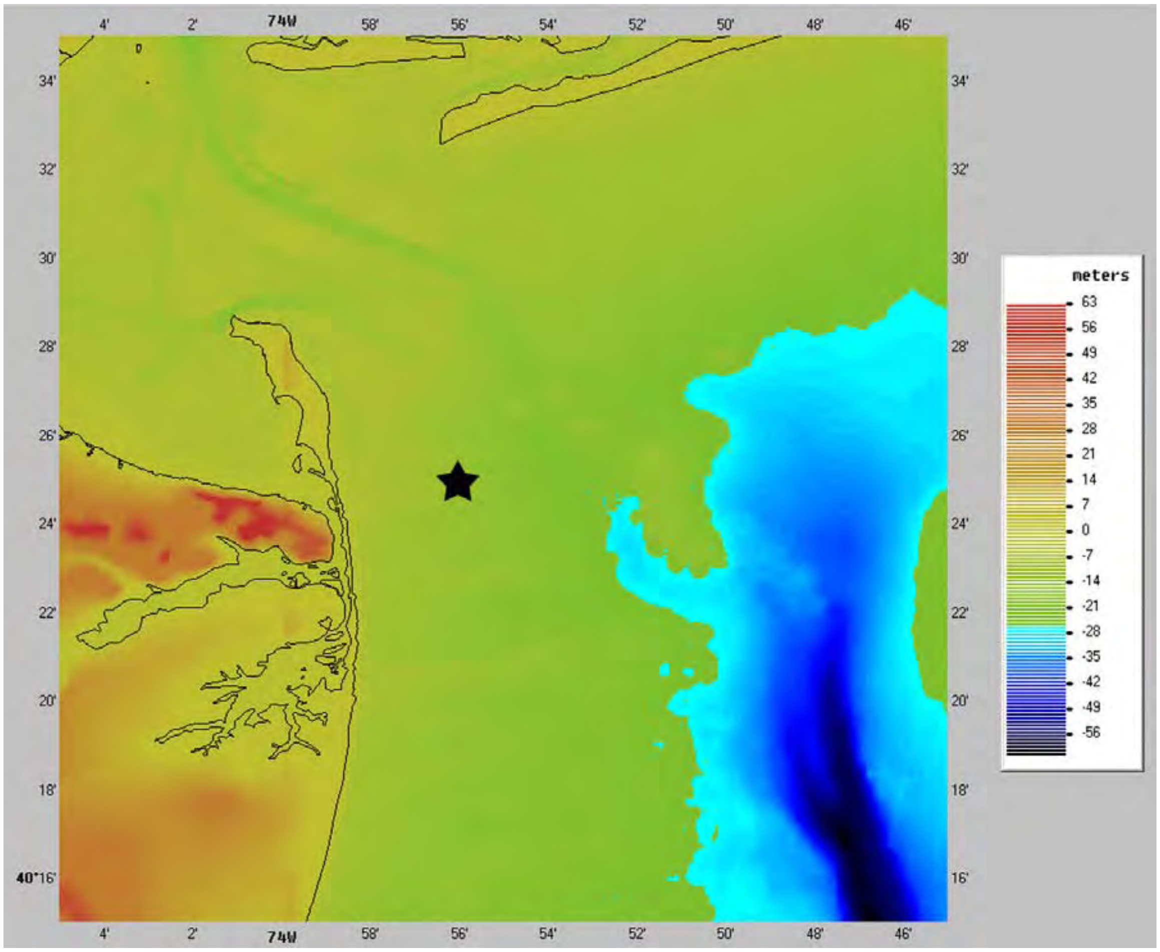


Figure 31. The position of the Corcione lithics find (marked by the star east of Sandy Hook) relative to the reconstructed paleoshoreline when seas were 26 meters lower (approximately 9000 B.P., the Early Archaic). Bathymetry based on the NOAA Coastal Relief Model.

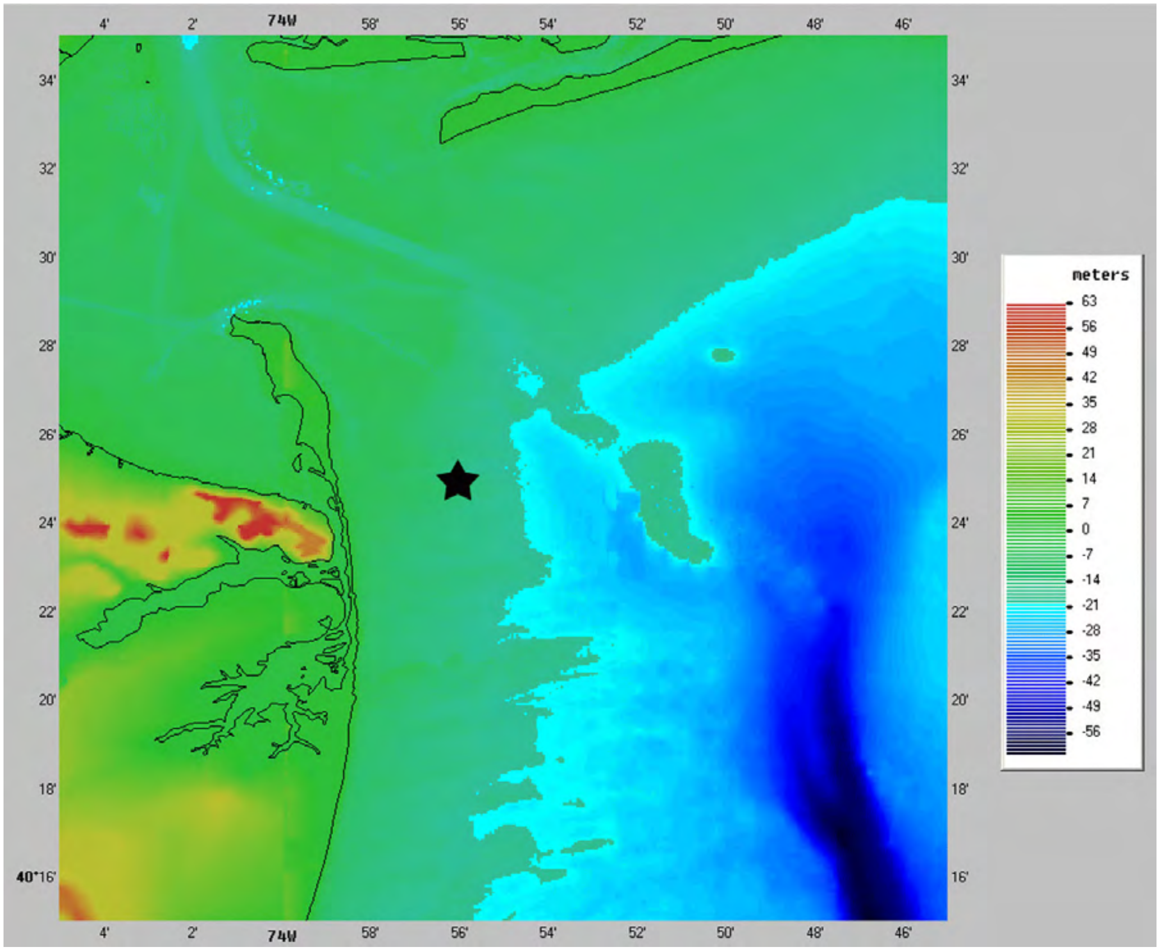


Figure 32. The position of the Corcione lithics find (star) relative to the reconstructed paleoshoreline when seas were 20 meters lower (approximately 7000 B.P., the Middle Archaic). Bathymetry based on the NOAA Coastal Relief Model.

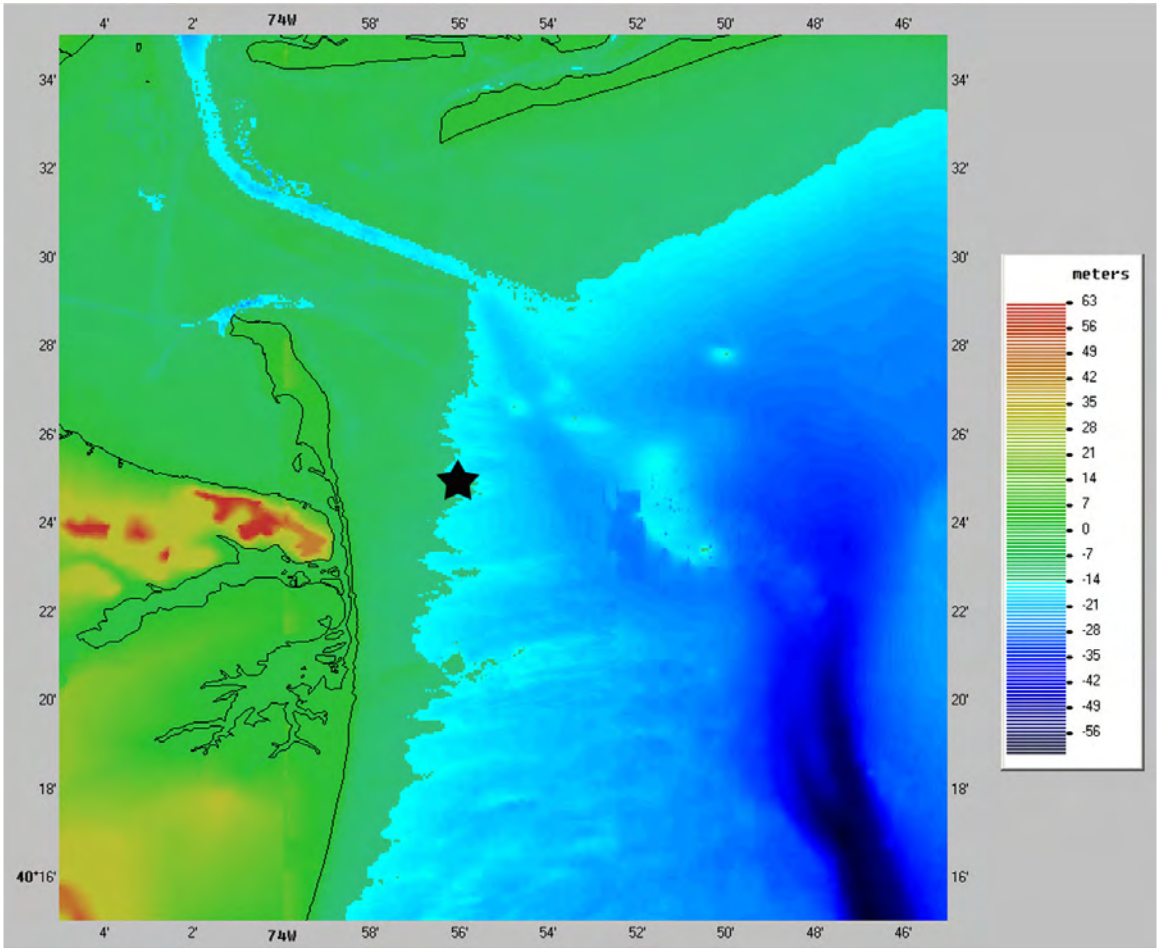


Figure 33. The position of the Corcione lithics find (star) relative to the reconstructed paleoshoreline when seas were 14 meters lower (approximately 5000 B.P., the Late Archaic). Bathymetry based on the NOAA Coastal Relief Model.

In her synthesis of terrestrial prehistoric sites on the outer coastal plain in New Jersey, Grossman-Bailey (2001:132) identified 19 Early Archaic, 43 Middle Archaic, and 199 Late Archaic components. Relatively few of these components were radiocarbon dated, and instead artifact typologies (especially projectile point styles) were relied upon in most cases (Grossman-Bailey 2001:129-131). The aggregate of these site components may be used as a proxy for increasing population density through time in the region. If prehistoric hunter-gatherer groups were using the now-submerged portion of the coastal plain in a similar manner to our reconstructions based on terrestrial archaeology, then the multicomponent site represented by the Corcione collection might show a similar distribution. A chi-square test (Table 8) suggests this is indeed the case: there is no statistically significant difference between the observed frequency of Early, Middle, and Late Archaic projectile points in the Corcione collection and the expected frequencies of these three temporal divisions in the aggregate data from the terrestrial outer coastal plain in New Jersey (X^2=4.325, supporting the null hypothesis at the 0.1151 level of significance). Note that while this is not a robust statistical analysis due to the small expected and observed number of Early Archaic points (less than 5) (Shennan 1997:104-115), it suggests there is correspondence between the distribution of projectile points over time in the Corcione collection and the distribution of Archaic period components at outer coastal plain sites in New Jersey.

If the submerged site represented by the Corcione artifacts did share similarities with the aggregate of Archaic site data on land as suggested by the comparison of temporal component distribution, then the idea that the inundated continental shelf is a seamless extension of the prehistoric landscape is supported. This assumes that the Corcione artifacts are from a "typical" multipurpose, multicomponent site. However, until we are able to study additional assemblages from underwater contexts, it is uncertain the degree to which the Corcione materials may be considered "typical." In the meantime, it is interesting to note that while the frequencies between the observed (Corcione projectile points) and expected (aggregate data from terrestrial sites) are very close for the Early Archaic and Late Archaic, there are substantially more Middle Archaic points from the Corcione assemblage than predicted (Table 8). It is possible that living near the shore (as opposed to living anywhere on the coastal plain) was more important to prehistoric hunter-gatherers during the Middle Archaic than in earlier or subsequent periods. The Middle Archaic period roughly coincides with the Mid-Holocene hypsithermal (circa 7000 to 5000 B.P.), a climatic interval when summers were warmer and winters colder than at other times in the Holocene (Kerwin et al. 1999). It is probable that such marked seasonality resulted in changes to subsistence and settlement patterns, perhaps including higher residential mobility and a focus on shoreline environments. More data, particularly from underwater sites, are needed to address this research question.

Table 8. Chi-square test comparing Archaic period subdivisions of projectile points from the Corcione collection with an aggregate of terrestrial outer coastal plain sites.

Period	Observed (Corcione Points)	Expected Frequency	Expected Number
Late Archaic	25	76.2%	29
Middle Archaic	11	16.5%	6
Early Archaic	2	7.3%	3

X^2=4.325 with 2 degrees of freedom; two-tailed P value=0.1151

As discussed above, the Corcione assemblage and the South Beach site are two points along a continuum of marine transgression affecting the Hudson River in the New York Bight. Projectile points from the Corcione collection suggest that the site was at least intermittently occupied for several thousand years (between 3000 and 8000 B.P., and perhaps earlier, with specimens from the Early, Middle, and Late Archaic periods; Figures 31-33), while the evidence collected thus far suggests that the South Beach site was inhabited only during the Late Archaic period (sometime between 3000 and 6000 B.P.). Archaeological site patterning on land suggests that the entire length of the Hudson River, both subaerial and submerged, has a relatively high sensitivity for the presence of prehistoric sites. There are some specific locations, though, that may have provided protection against rising sea level resulting in less disturbance and better preservation. The embayment on the south side of Croton Point where the South Beach site is preserved under water is a good example of a protected area undergoing inundation in such a way that at least a portion of the site remains intact.

In the case of the Corcione assemblage, it is probable that the site witnessed disturbance prior to dredging. While the lack of marine growth on the artifacts suggests they were buried beneath the sea floor, the degree to which the lithics were eroded indicates the context was reworked. This is hardly surprising, given the dynamic nature of the Atlantic Ocean. It is possible, however, that buried paleosols lie intact beneath the sea floor in places offshore New Jersey and New York, but they do not appear to have been preserved in the survey area off Sandy Hook, where at least the uppermost two meters (and likely more) of sediment consists of mixed Holocene marine sands.

Although it does not appear that the Corcione artifacts were removed from a preserved paleosol, the dredging records and clustered location of the beach finds suggest that the artifacts originated from a spatially discrete deposit in the seabed. One hypothetical scenario to explain the post-depositional processes that affected the Corcione site is today playing out in the coves on the west side of Sandy Hook, where prehistoric artifacts are exposed to coastal erosion and simultaneous burial as the Hook migrates westward (Figure 12). It is possible that the Corcione artifacts were deposited in a similar backbay environment more than three thousand years ago. Modern Sandy Hook comprises a segment in a chain of barrier beaches that protect the coastline along nearly the entire length of the New York Bight. These barriers moved shoreward with rising sea levels, and their ancient positions are still marked beneath the ocean by broad ridges, generally oriented parallel to the modern shore. The old barriers were flooded as sea level rose rapidly, and currents are now gradually eroding the remnant ridges (Isachsen et al. 2000). This could explain the reworking, but seemingly minimal net horizontal movement, of the Corcione assemblage.

Unfortunately, neither the Corcione collection nor the offshore survey produced solid evidence of early coastal adaptations such as a shell midden deposit or prehistoric fishing tools. However, many of the terrestrial sites excavated along the modern coast of New York and New Jersey dating from the Late Archaic onward also lack such clear evidence for exploiting the maritime environment. The lithic artifacts that are often the only traces which are preserved form an incomplete record, so we have to rely on circumstantial evidence to infer that marine resources such as fish and shellfish were strong attractors for human occupation. For now, proximity of the Corcione deposit to the submerged Hudson River for at least part of its occupational history (Figures 32 and 33) can only hint at the importance of the shore environment to its prehistoric inhabitants.

The state of our knowledge of submerged prehistoric sites in the Mid-Atlantic region today is analogous to what researchers knew of Paleoindian archaeology fifty years ago, and the disturbed context of the Corcione find is similar to the plowed fields, surface finds, and other disturbed contexts of many of the earliest Paleoindian discoveries here (e.g., Kraft 1977; Ritchie 1953; Witthoft 1952). Although many of the terrestrial Paleoindian finds were not found in intact stratigraphic contexts, they were crucial to extending the regional culture history and providing the basis for broad inferences regarding Paleoindian lifeways, particularly settlement patterns. The same can be said of underwater artifact finds like the Corcione collection: at a minimum, based on the Early Archaic bifurcate base projectile points, the assemblage extends the timeline for human occupation of the now-submerged continental shelf in the New York Bight to at least 8000 years ago. The variety of tool types, with projectile point styles spanning thousands of years, is indicative of repeated occupation of a camp site where several different activities took place, including hunting, lithic tool manufacturing, and likely food processing. It does not appear that the selection of lithic raw materials changed greatly over time. The Corcione collection hints at cultural continuity over the lengthy Archaic period (between 3000 and 10,000 B.P.); that over time, hunter-gatherer groups settled in and adapted as the environment changed, becoming warmer and wetter, until modern conditions were established at the end of the Archaic.

Future Directions

The field work undertaken at the source of the Corcione collection off Sandy Hook and at the South Beach site off Croton Point comprised a pilot effort that relied on relatively low-technology methods, specifically diver observations and sampling with hand excavation. Such low-tech approaches can be very effective, particularly in regions with clear shallow waters such as the Florida Gulf Coast (e.g., Faught 2004) but also in less hospitable diving environments like the Chesapeake Bay (e.g., Cherryman 1994) and the Hudson River. While the field work along the Hudson did yield some positive results, future work employing more advanced methods, namely remote sensing and coring, will likely lead to the discovery of more submerged Native American deposits. Most of this work will probably be undertaken in advance of projects that disturb the sea floor such as dredging and drilling under the auspices of State and Federal agencies, rather than as strictly academic endeavors.

Other than the work completed for this dissertation, there have been few systematic surveys conducted specifically to locate submerged prehistoric sites in the Mid-Atlantic. A number of studies have been undertaken elsewhere in North America demonstrating that remote sensing followed by ground-truthing can yield positive results. Four studies done with the support of the United States Mineral Management Service to test models of submerged prehistoric site locations have been conducted in the Gulf of Mexico off Texas, Louisiana, and Florida (summarized in Research Planning, Inc. et al. 2004:7-8). Intensive survey and excavation of prehistoric deposits off the Gulf coast of northern Florida are also described by Faught (2004). A team from Parks Canada has explored the continental shelf in the Hecate Strait off British Columbia, where ancient human occupation sites may rest in as much as 150 meters of water. The Canadian team has employed high-resolution multibeam sonar, remotely operated vehicles (ROVs), and manned submersibles to image the sea floor, and coring and grab methods to sample it (Carper 2007).

Remote sensing methods most relevant to detecting areas of high sensitivity for prehistoric sites are those that use sonar technology, especially high-resolution multibeam swath bathymetry to image surficial features and sub-bottom sonar to image below the sea floor. Both multibeam and sub-bottom sonar may be used to search for key relict landscape features such as stream channels that have a high sensitivity for prehistoric sites.

Many underwater archaeologists are familiar with side-scan sonar, which uses the strength of returned sound waves (backscatter) to generate a two dimensional digital image of the sea floor or river bed. Multibeam swath bathymetry is a relatively new technique used to map the sea floor by processing both water depth and backscatter data along a swath of the sea bed, resulting in a three dimensional image (Singh et al. 2000).

Multibeam technology has been used in deep sea research since the early 1980s, though early systems were ineffective at water depths of less than 1000 meters. Multibeam systems operating at higher frequencies that are effective on the continental shelf and in coastal waters became available during the 1990s (Hughes Clarke et al. 1996). Multibeam data can reveal objects on the sea floor including sand waves, rock outcrops, relict drainage channels, and cultural objects such as shipwrecks.

There are at least two ultra-high-resolution multibeam sonars on the market now that are able to provide unprecedented detail about features that exist on the sea bed (Flood 2007). The Reson 8125 developed by Reson, Inc. operates at 455 kHz, pings at up to 40 times per second, and creates 240 beams with a vertical resolution of 6 millimeters. The EM 3002 developed by Kongsberg-Simrad, Inc. operates at 300 kHz, pings up to 40 times per second, and creates 254 beams with a vertical resolution of one centimeter. Both of these systems were evaluated in the Hudson River (focusing on shipwrecks) in order to develop protocols for the use of multibeam sonar as an archaeological tool (Flood 2007; Merwin and Flood 2006). As mentioned above, an attempt was made to examine the South Beach site off Croton Point with the EM 3002, but the water was too shallow to safely operate the research vessel.

One of the principal roadblocks to the widespread adoption of multibeam technology in archaeology is its relatively high cost, especially when compared with that of side-scan sonar. However, multibeam systems are rapidly becoming the primary tool for hydrographic survey in the United States and around the world and thus they are already in use in many inland and coastal waters. Among the goals of the Hudson River shipwreck survey was to develop field methods for hydrographic surveys with multibeam technology in order to derive the best archaeological data possible. Specific recommendations regarding field survey (e.g., trackline spacing, vessel speed, etc.), data acquisition rates, software, data processing, data sharing, and ground-truthing methods were made (Flood 2007:15-16). In general, equipment operating at higher frequencies, with more and narrower beams, and at faster repetition intervals will produce the best sonar images.

Ground-truthing of high sensitivity areas identified with remote sensing may be done with coring, although in cases where surficial deposits are suspected (e.g., around rock outcrops) then it may be accomplished by direct visualization by scuba divers or by ROVs, depending on the bottom conditions (e.g., depth, currents, visibility). In general, cores previously taken in the Mid-Atlantic suggest that the top one meter (and sometimes deeper) of sea floor sediments are recent and/or reworked (La Porta et al. 1999; Schuldenrein et al. 2000). However, it is possible that intact former land surfaces which may contain prehistoric archaeological deposits are buried beneath the sea floor. The goal of coring is to determine if there are intact Late Pleistocene and Holocene strata beneath the upper disturbed strata. Analysis of the core samples consists of lithostratigraphic evaluation, dating of any organic material, and identification of any pollen, macrofloral, and/or foraminiferal samples recovered (Robinson et al. 2004; Stright 1986).

The hypothesis that key relict landforms like stream channels and estuary complexes were very attractive to prehistoric peoples, and thus have high archaeological sensitivity, remains largely untested along the Atlantic coast. Intensive subsurface testing in advance of construction and/or monitoring by an archaeologist during offshore work (particularly dredging operations) would serve to test the site patterning model. In other words, the archaeology of submerged prehistoric sites could be well-served by working alongside those engaged in offshore construction work, especially dredging. While far from an ideal manner in which to conduct subsurface testing, it may be an effective way in which to sample large areas of sea floor and to mitigate damage caused by offshore construction. A protocol could be developed by archaeologists, government regulatory agencies, and contractors whereby an archaeological monitor would be stationed on the dredge vessel and/or beach deposition area to determine if artifacts are encountered. In the event that artifacts are identified, then work would stop or move to another location until the find could be mapped, verified, and studied.

Archaeological exploration for submerged prehistoric sites on the continental shelf in the Mid-Atlantic takes on some urgency in light of the accelerating rate of site destruction resulting from offshore dredging, drilling, and construction activities. When the first major synthesis of the archaeological potential of the continental shelf in the Mid-Atlantic was published (Barber 1979), several research themes were identified, but the capability to test the proposed models was limited. Until relatively recently, underwater archaeological deposits were virtually invisible to researchers, but modern technology now allows us to explore what has been described as one of “the precious few frontiers left in the field” (Blanton 1996:217). It is hoped that this study contributes to a much-needed framework for the detection and study of submerged prehistoric sites in the New York Bight and beyond, and provides a useful research strategy for future archaeological investigations.

REFERENCES

Aberg, Alan and Carenza Lewis (editors)
2000 *The Rising Tide: Archaeology and Coastal Landscapes*. Oxbow Books, Oxford, United Kingdom.

Adovasio, James M.
1993 The Ones That Will Not Go Away: A Broad View of Pre-Clovis Populations in the New World. In *From Kostenski to Clovis: Upper Paleolithic Paleoindian Adaptations*, edited by Olga Soffer and N.D. Praslov, pages 199-218. Plenum Press, New York.

Adovasio, James M., Jack Donahue, and Robert Stuckenrath
1990 The Meadowcroft Rockshelter Radiocarbon Chronology 1975-1990. *American Antiquity* 55:348-354.

Andersen, Søren H.
1987 Tybrind Vig: A Submerged Ertebølle Settlement in Denmark. In *European Wetlands in Prehistory*, edited by John M. Coles and A.J. Lawson, pages 253-280. Claredon Press, Oxford.

Anderson, Albert J.
1964 Old Place and the Old Place Complex. *The Chesopiean* 2(3):50-56.

Anderson, David G. and Michael K. Faught
1998 The Distribution of Fluted Paleoindian Projectile Points: Update 1998. *Archaeology of Eastern North America* 26:163-188.

Anderson, David G. and J. Christopher Gillam
2000 Paleoindian Colonization of the Americas: Implications from an Examination of Physiography, Demography, and Artifact Distribution. *American Antiquity* 65:43-66.

Anderson, David G., and Kenneth Sassaman
1996 Modeling Paleoindian and Early Archaic Settlement in the Southeast: A Historical Perspective. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman and David G. Anderson, pp. 16-28. University of Alabama Press, Tuscaloosa.

Asbury Park Sunday Press
1928 Fields of Monmouth Yield Indian Relics. 29 July. Asbury Park, New Jersey.

Bailey, Geoffrey N. and Nicholas C. Flemming
2008 Archaeology of the Continental Shelf: Marine Resources, Submerged Landscapes, and Underwater Archaeology. *Quaternary Science Reviews* 27:2153-2165.

Bailey, Geoff and John Parkington
1988 *The Archaeology of Prehistoric Coastlines*. Cambridge University Press, Cambridge.

Barber, Russell J.
1979 *A Summary and Analysis of Cultural Resource Information on the Continental Shelf from the Bay of Fundy to Cape Hatteras, Volume II, Archaeology and Paleontology*. Institute for Conservation Archaeology, Peabody Museum, Harvard University for the Bureau of Land Management, U.S. Department of the Interior.

Barnes, R.S.K. and R.N. Hughes
1999 *An Introduction to Marine Ecology*. Third edition. Blackwell, Malden, Massachusetts.

Bass, George F.
1966 *Archaeology Under Water*. Frederick A. Praeger, New York.
1972 *A History of Seafaring Based on Underwater Archaeology*. Thames and Hudson, London.

Belknap, Daniel F. and John C. Kraft
1981 Preservation Potential of Transgressive Coastal Lithosomes on the U.S. Atlantic Shelf. *Marine Geology* 42:429-442.

Bernabo, J. C. and T. Webb III
1977 Changing Patterns in the Holocene Pollen Record of Northeastern North America: A Mapped Summary. *Quaternary Research* 8:64-96.

Bernstein, David J.
1999 Prehistoric Use of Plant Foods on Long Island and Block Island Sounds. In *Current Northeast Paleoethnobotany*, edited by John P. Hart, pages 101-119. New York State Museum Bulletin No. 494, The State Education Department, Albany, New York.
2002 Late Woodland Use of Coastal Resources at Mount Sinai Harbor, Long Island, New York. In *A Lasting Impression: Coastal, Lithic, and Ceramic Research in New England Archaeology*, edited by Jordan E. Kerber, pp. 27-40. Bergin and Garvey, Westport, Connecticut.

2006 Long-Term Continuity in the Archaeological Record from the Coast of New York and Southern New England, USA. *Journal of Island and Coastal Archaeology* 1:271-284.

Bernstein, David J. and Michael J. Lenardi
2008 The Use of Lithic Resources in a Coastal Environment: Quartz Technology on Long Island, New York. Pages 101-110 in *Current Approaches to the Analysis and Interpretation of Small Lithic Sites in the Northeast*, edited by Christina B. Rieth. New York State Museum Bulletin 508. The University of the State of New York, Albany, New York.

Bernstein, David J., Michael J. Lenardi, Daria Merwin, and Lynn Harvey-Cantone
1996 Prehistoric Use of Wetland Environments: A Case Study from the Interior of Long Island New York. *Northeast Anthropology* 51:113-138.

Bettinger, Robert L.
1980 Explanatory/Predictive Models of Hunter-Gatherer Adaptation. In *Advances in Archaeological Method and Theory Volume 3*, edited by Michael B. Schiffer, pp. 189-255. Academic Press, New York.

Bianchi, Leonard
1981 Archeological Testing and Monitoring of Powerline Trenching, Gateway National Recreation Area, Sandy Hook Unit, Middletown, New Jersey. Denver Service Center Branch of Cultural Resources, Mid-Atlantic/North Atlantic Team, National Park Service, Denver.

Bianchi, Leonard and Nan A. Rothschild
1978 Reconnaissance Survey of Fort Hancock, Sandy Hook, New Jersey, Transmission Lines. Prepared by Cultural Resource Management Services, Inc, Newton, New Jersey, for the National Park Service Denver Service Center.

Binford, Lewis R.
1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:4-20.
1982 The Archaeology of Place. *Journal of Anthropological Archaeology* 1:5-31.

Blanton, Dennis B.
1996 Accounting for Submerged Mid-Holocene Archaeological Sites in the Southeast: A Case Study from the Chesapeake Bay Estuary, Virginia. In *Archaeology of the Mid-Holocene Southeast*, edited by Kenneth E. Sassaman and David G. Anderson, pages 200-217. University Press of Florida, Gainesville.

Blumler, Mark A.
1996 Ecology, Evolutionary Theory and Agricultural Origins. In *Origins and Spread of Agriculture and Pastoralism in Eurasia*, edited by David R. Harris, pages 25-49. Smithsonian Institution Press, Washington, D.C.

Boesch, Eugene J.
1994 Archaeological Evaluation and Sensitivity Assessment of Staten Island, New York. Report prepared for the New York City Landmarks Preservation Commission.
2003 Phase I Archaeological Investigation of the Croton Point Park Seawall Stabilization Project Area, Croton-on-Hudson, Westchester County, New York. Report prepared for Lockwood, Kessler and Bartlett, Inc., on file at Westchester County Department of Parks, Recreation and Conservation, Mount Kisco.

Boisvert, Richard A.
1998 The Israel River Complex: A Paleoindian Manifestation in Jefferson, New Hampshire. *Archaeology of Eastern North America* 26:97-106.
2004 Clovis Era Archaeology in Northern New Hampshire: The Israel River Complex. In *New Perspectives on First Americans Studies*, edited by Bradley T. Lepper and Robson Bonnichsen, pages 49-54. Texas A&M University Press, College Station.

Boldurian, Anthony T.
2006 A Clovis Fluted Point from Coastal Waters in Southern New Jersey. *North American Archaeologist* 27:245-270.

Bolton, Robert
1848 *History of the County of Westchester from Its First Settlement to the Present Time*. A. Gould, New York.

Bonnichsen, Robson and Karen L. Turnmire
1999 *Ice Age People of North America*. Oregon State University Press, Corvalis.

Boudreau, Jeff
2008 *A New England Typology of Native American Projectile Points*. Freedom Digital, Ashland, Massachusetts.

Bourn, Richard Q., jr.
1972 New Submerged Sites of Coastal Connecticut. *Bulletin of the Archaeological Society of Connecticut* 37:5-16.
1977 The Hammonasset Beach Site (6 NH 36). *Bulletin of the Archaeological Society of Connecticut* 40:14-39.

Boycott, Arthur, Guybon C.C. Damant, and John S. Haldane
1908 The Prevention of Compressed-Air Illness. *The Journal of Hygiene* 8:342.

Braun, David P.
1974 Explanatory Models for the Evolution of Coastal Adaptation in Prehistoric Eastern New England. *American Antiquity* 39:582-596.

Brennan, Louis A.
1968 The Twombly Landing Site. *The New York State Archeological Association Bulletin* 42:11-28.
1974 The Lower Hudson: A Decade of Shell Middens. *Archaeology of Eastern North America* 2:81-93.

Bridges, Patricia
1994 Prehistoric Diet and Health in a Coastal New York Skeletal Sample. *Northeast Anthropologist* 48:13-23.

Bromley, George W. and Walter S. Bromley
1901 *Atlas of Westchester County, New York*. G.W. Bromley and Company, Philadelphia.

Buchanan, Briggs, Mark Collard, and Kevan Edinborough
2008 Paleoindian Demography and the Extraterrestrial Impact Hypothesis. *Proceedings of the National Academy of Sciences* 105,33:11651-11654.

Burch, Ernest S., jr.
1972 The Caribou/Wild Reindeer as a Human Resource. *American Antiquity* 37:339-368.

Byers, Douglas S.
1954 Bull Brook: A Fluted Point Site in Ipswich, Massachusetts. *American Antiquity* 19:343-351.

Caldwell, Joseph R.
1958 *Trend and Tradition in the Prehistory of the Eastern United States*. Memoir Number 88 of the American Anthropological Association, Springfield, Illinois.

Cantwell, Anne-Marie and Diana diZerega Wall
2001 *Unearthing Gotham*. Yale University Press, New Haven.

Carper, R.G.
2007 Current Applications: Underwater Archaeology, Exploring the Submerged Continental Shelf. *Current Anthropology* 48:779.

Cavallo, John
1981 Turkey Swamp: A Late Paleo-Indian Site in New Jersey’s Coastal Plain. *Archaeology of Eastern North America* 9:1-18.

Ceci, Lynn

1977 *The Effect of European Contact and Trade on the Settlement Pattern of Indians in Coastal New York, 1524-1665: The Archeological and Documentary Evidence*. Ph.D. dissertation, City University of New York.

1979 Maize Cultivation in Coastal New York: The Archaeological, Agronomical, and Documentary Evidence. *North American Archaeologist* 1:45-74.

1982 Method and Theory in Coastal New York Archaeology: Paradigms of Settlement Pattern. *North American Archaeologist* 3:5-36.

Cherryman, Ann

1994 *An Underwater Archaeological Survey of Belmont Bay: Method Study and Site Report*. Unpublished M.A. thesis, George Mason University, Fairfax, Virginia.

Claassen, Cheryl

1995 *Dogan Point: A Shell Matrix Site in the Lower Hudson Valley*. Occasional Publications in Northeastern Anthropology, No. 14. Archaeological Services, Bethlehem, Connecticut.

Cleland, Charles E.

1965 Barren Ground Caribou (*Rangifer arcticus*) from an Early Man Site in Southeastern Michigan. *American Antiquity* 30:350-351.

1976 The Focal-Diffuse Model: An Evolutionary Perspective on the Prehistoric Cultural Adaptations of the Eastern United States. *Midcontinental Journal of Archaeology* 1:59-76.

Coastal Environments, Incorporated

1977 *Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf; Volume I, Prehistoric Cultural Resource Potential*. National Park Service, Washington, D.C.

Cockrell, William A.

1980 Drowned Sites in North America. In *Archaeology Under Water: An Atlas of the World's Submerged Sites*, edited by Keith Muckleroy, pages 138-145. McGraw-Hill, New York.

Coles, John M.

1988 A Wetland Perspective. In *Wet Site Archaeology*, edited by Barbara A. Purdy, pages 1-14. The Telford Press, Caldwell, New Jersey.

Crock, John G., James B. Petersen, and Ross M. Anderson

1993 Scalloping for Artifacts: A Biface and Plummet from Eastern Blue Hill Bay, Maine. *Archaeology of Eastern North America* 21:179-192.

Cross, Dorothy

1941 *Archaeology of New Jersey, Volume 1*. Archaeological Society of New Jersey and New Jersey State Museum, Trenton.

1956 *Archaeology of New Jersey, Volume 2: The Abbott Farm*. Archaeological Society of New Jersey and New Jersey State Museum, Trenton.

Custer, Jay F.

1984 *Delaware Prehistoric Archaeology: An Ecological Approach*. Associated University Presses, Cranbury, New Jersey.

1986 Analysis of Early Holocene Projectile Points and Site Locations from the Delmarva Peninsula. *Archaeology of Eastern North America* 14:45-64.

1989 *Prehistoric Cultures of the Delmarva Peninsula: An Archaeological Study*. University of Delaware Press, Newark.

Custer, Jay F., John Cavallo, and R. Michael Stewart

1983 Paleo-Indian Adaptations of the Coastal Plain of Delaware and New Jersey. *North American Archaeologist* 4:263-276.

Daley, Beth

2005 Sunken Treasure: Scientists Find Evidence of Ancient Forest Buried under the Seabed of Nantucket Sound. *The Boston Globe*, December 4, page 30.

Danckaerts, Jasper

1913 *Journal of Jasper Danckaerts, 1679-1680.* Edited by Bartlett B. James and J. Franklin Jameson. Charles Scribner’s Sons, New York.

Décima, Elena B. and Dena F. Dincauze

1998 The Boston Back Bay Fish Weirs. In *Hidden Dimensions: The Cultural Significance of Wetland Archaeology*, edited by Kathryn Bernick, pages 157-172. UBC Laboratory of Archaeology Occasional Publications, Number 1. University of British Columbia, Vancouver.

Delabarre, Edmund B.

1928 A Prehistoric Skeleton From Grassy Island. *American Anthropologist* 30:476-480.

Dent, Richard J., jr.

1995 *Chesapeake Prehistory: Old Traditions, New Directions*. Plenum Press, New York.

2002 Paleoindian Occupation of the Upper Delaware Valley: Revisiting Shawnee Minisink and Nearby Sites. In *Ice Age Peoples of Pennsylvania*, edited by Kurt Carr and James Adovasio, pages 51-78. Recent Research in Pennsylvania Archaeology Number 2, Pennsylvania Historical and Museum Commission and the Pennsylvania Archaeological Council, Harrisburg.

Dent, Richard J., jr. and Barbara E. Kauffman

1985 Aboriginal Subsistence and Site Ecology as Interpreted from Microfloral and Faunal Remains. In *Shawnee Minisink: A Stratified Paleoindian-Archaic Site in the Upper Delaware Valley of Pennsylvania*, edited by Charles W. McNett, pages 55-79. Academic Press, Orlando.

Dincauze, Dena F.

1972 The Atlantic Phase: A Late Archaic Culture in Massachusetts. *Man in the Northeast* 4:40-61.

1976 *The Neville Site: 8,000 Years at Amoskeag*. Peabody Museum Monographs No. 4, Cambridge, Massachusetts.

Dincauze, Dena F. and Mitchell T. Mullholland

1977 Early and Middle Archaic Site Distributions and Habitats in Southern New England. *Annals of the New York Academy of Sciences* 288:439-456.

Dixon, E. James

1999 *Boats, Bones, and Bison: Archeology and the First Colonization of Western North America*. University of New Mexico Press, Albuquerque.

Donnelly, J.P.

1998 Evidence of Late Holocene Post-Glacial Isostatic Adjustment in Coastal Wetland Deposits of Eastern North America. *GeoResearch Forum* Volumes 3-4:393-400.

Dortch, C.

1997 Prehistory Down Under: Archaeological Investigations of Submerged Aboriginal Sites at Lake Jasper, Western Australia. *Antiquity* 71:116-123.

Dumont, Elizabeth M. and Lewis A. Dumont

1979 Of Paradigms and Projectile Points: Two Perspectives on the Early Archaic in the Northeast. *The New York State Archeological Association Bulletin* 75:38-52.

Dunbar, James S., S. David Webb, and Michael K. Faught

1992 Inundated Prehistoric Sites in Apalachee Bay, Florida, and the Search for the Clovis Shoreline. In *Paleoshorelines and Prehistory: An Investigation of Method*, edited by Lucille L. Johnson and Melanie Stright, pages 117-146. CRC Press, Boca Raton, Florida.

Edwards, R.L. and K.O. Emery

1977 Man on the Continental Shelf. *Annals of the New York Academy of Sciences* 288:245-256.

Edwards, R.L. and A.S. Merrill
1977 A Reconstruction of the Continental Shelf Areas of Eastern North America for the Times 9,500 B.P. and 12,500 B.P. *Archaeology of Eastern North America* 5:1-43.

Eisenberg, Leonard
1978 *Paleo-Indian Settlement Pattern in the Hudson and Delaware River Drainages*. Occasional Publications in Northeastern Anthropology, No. 4. Franklin Pierce College, Rindge, New Hampshire.
1991 The Mohonk Rockshelter: A Major Neville Site in New York State. In *The Archaeology and Ethnohistory of the Lower Hudson Valley and Neighboring Regions: Essays in Honor of Louis A. Brennan*, edited by Herbert C. Kraft, pages 159-176. Occasional Publications in Northeastern Anthropology, No. 11. Archaeological Services, Bethlehem, Connecticut.

Elliott, Rita F., Ronnie Rogers, and David Crass
2000 *Stemming the Tide: A Survey of Submerged Cultural Resources Programs in the United States, with a View Toward Georgia*. Report prepared by Southern Research Historic Preservation Consultants, Inc., Ellerslie, Georgia for the Georgia State Historic Preservation Office.

Emery, K.O.
1966 Early Man May Have Roamed the Atlantic Shelf. *Oceanus* 12:2-5.

Emery, K.O. and Robert L. Edwards
1966 Archaeological Potential of the Atlantic Continental Shelf. *American Antiquity* 31:733-737.

Erlandson, Jon
1993 Evidence for a Terminal Pleistocene Human Occupation of Daisy Cave, San Miguel Island, California. *Current Research in the Pleistocene* 10:17-21.
1994 *Early Hunter-Gatherers of the California Coast*. Plenum Press, New York.
2001 The Archaeology of Aquatic Adaptations: Paradigms for a New Millennium. *Journal of Archaeological Research* 9:287-350.

Erlandson, Jon M. and Scott M. Fitzpatrick
2006 Oceans, Islands, and Coasts: Current Perspectives on the Role of the Sea in Human Prehistory. *Journal of Island & Coastal Archaeology* 1:5-32.

Evans, June
1985 Paleoindian to Early Archaic Transition at the Shawnee Minisink Site. In *Shawnee Minisink*, edited by Charles W. McNett, jr., pages 221-259. Academic Press, Orlando.

Faught, Michael K.
2004 The Underwater Archaeology of Paleolandscapes, Apalachee Bay, Florida. *American Antiquity* 69:275-289.

Faught, Michael K. and Joseph Latvis
1999 *Report of the 1999 Field Operations, PaleoAucilla Prehistory Project, Underwater Prehistoric Archaeology in Apalachee Bay*. Florida State University, Program in Underwater Archaeology Research Reports No. 1, Tallahassee.

Ferguson, Jan
1986 A Preliminary Assessment of Cultural Resources Sensitivity for the Lower New York Bay, New York an New Jersey. Report prepared for the New York District of the U.S. Army Corps of Engineers.

Fiedel, Stuart
2000 The Peopling of the New World: Present Evidence, New Theories, and Future Directions. *Journal of Archaeological Research* 8:39-103.
2001 What Happened in the Early Woodland? *Archaeology of Eastern North America* 29:101-142.

Filios, Elena L.
1989 The End of the Beginning or the Beginning of the End: The Third Millennium B.P. in Southern New England. *Man in the Northeast* 38:79-93.

Firestone, R.B., A. West, J.P. Kennett, L. Becker, T.E. Bunch, Z.S. Revay, P.H. Schultz, T. Belgya, D.J. Kennett, J.M. Erlandson, O.J. Dickenson, A.C. Goodyear, R.S. Harris, G.A. Howard, J.B. Kloosterman, P. Lechler, P.A. Mayewski, J. Montgomery, R. Poreda, T. Darrah, S.S. Que Hee, A.R. Smith, A. Stich, W. Topping, J.A. Wittke, W.S. Wolbach
2007 Evidence for an Extraterrestrial Impact 12,900 Years Ago that Contributed to the Megafaunal Extinctions and the Younger Dryas. *Proceedings of the National Academy of Sciences* 104,41:16016-16021.

Fischer, Anders
1995 *Man and Sea in the Mesolithic: Coastal Settlement Above and Below Present Sea Level*. Oxbow Monograph Number 53. Oxbow Books, Oxford.

Fitting, James E.
1968 Environmental Potential and Postglacial Readaptation in Eastern North America. *American Antiquity* 33:441-445.

Fladmark, Knut
1979 Routes: Alternate Migration Corridors for Early Man in North America. *American Antiquity* 44:55-69.

Fleming, Kevin, Paul Johnston, Dan Zwartz, Yusuke Yokoyama, Kurt Lambeck, and John Chappell

1998 Refining the Eustatic Sea-Level Curve Since the Last Glacial Maximum Using Far- and Intermediate-Field Sites. *Earth and Planetary Science Letters* 163,1-4:327-342.

Flemming, N.C.

1983a Survival of Submerged Lithic and Bronze Age Artifact Sites: A Review of Case Histories. In *Quaternary Coastlines and Marine Archaeology: Towards the Prehistory of Land Bridges and Continental Shelves*, edited by P.M. Masters and N.C. Flemming, pages 135-173. Academic Press, London.

1983b Preliminary Geomorphological Survey of an Early Neolithic Submerged Site in the Sporadhes, Northern Aegean. In *Quaternary Coastlines and Marine Archaeology: Towards the Prehistory of Land Bridges and Continental Shelves*, edited by P.M. Masters and N.C. Flemming, pages 233-268. Academic Press, London.

Flemming, N.C., G.N. Bailey, V. Courtillot, G. King, K. Lambeck, F. Ryerson, C. Vita-Finzi

2003 Coastal and Marine Palaeo-Environments and Human Dispersal Points across the Africa-Eurasia Boundary. In *Maritime Heritage 2003*, edited by C.A. Brebbia and T. Gambin, pages 61-74. Advances in Architecture Series #15, WIT Press, Southampton, United Kingdom.

Flood, Roger D.

2007 The Use of Multibeam Swath Bathymetry for the Identification and Assessment of Underwater Archaeological Sites. Report prepared for the National Center for Preservation Training and Technology, Grant Number MT-2210-03-NC-08.

Forster, Peter and Shuichi Matsumura

2005 Did Early Humans Go North or South? *Science* 308:965-966.

Funk, Robert E.

1976 *Recent Contributions to Hudson Valley Prehistory*. New York State Museum Memoir 22, The University of the State of New York, Albany.

Funk, Robert E. and David W. Steadman

1994 *Archaeological and Paleoenvironmental Investigations in the Dutchess Quarry Caves, Orange County, New York*. Persimmon Press, Buffalo, New York.

Funk, Robert E. and Beth Wellman

1984 Evidence of Early Holocene Occupations in the Upper Susquehanna Valley, New York State. *Archaeology of Eastern North America* 12:81-110.

Galili, Ehud and Mina Weinstein-Evron
1985 Prehistory and Paleoenvironments of Submerged Sites along the Carmel Coast of Israel. *Paléorient* 11:37-52.

Galili, E., I. Hershkowitz, A. Gopher, M. Weinstein-Evron, O. Lernau, M. Kislev and L. Horwitz
1993 Atlit-Yam: A Prehistoric Site on the Sea Floor of the Israeli Coast. *Journal of Field Archaeology* 20: 133-157.

Gallagher, William B., David C. Parris, Barbara Smith Grandstaff, and Craig DeTample
1989 Quaternary Mammals from the Continental Shelf off New Jersey. *The Mosasaur, The Journal of the Delaware Valley Paleontological Society* 4:101-110.

Gardner, William M.
1977 The Flint Run Paleo-Indian Complex and Its Implications for Eastern North American Prehistory. *Annals of the New York Academy of Sciences* 288:257-263.

Gaudreau, Denise C.
1988 The Distribution of Late Quaternary Forest Regions in the Northeast: Pollen Data, Physiography, and the Prehistoric Record. In *Holocene Human Ecology in Northeastern North America*, edited by George P. Nicholas, pages 215-256. Plenum Press, New York.

Gaudreau, Denise C. and Thompson Webb
1985 Late Quaternary Pollen Stratigraphy and Isochrone Maps for the Northeastern United States. In *Pollen Records of Late Quaternary North America*, edited by Vaughn M. Bryant and R.G. Holloway, pages 247-280. American Association of Palynologists Foundation, Dallas, Texas.

Gifford, John A.
1990 Analysis of Submarine Sediments off Franchthi Cave. In *Franchthi Paralia: The Sediments, Stratigraphy, and Offshore Investigations*, edited by T.J. Wilkinson and Susan T. Duhon, pages 85-116. Indiana University Press, Bloomington.

Glynn, Frank
1953 The Pilot's Point Submerged Sites. *Bulletin of the Archaeological Society of Connecticut* 27:11-29.

Goddard, Ives
1978 Delaware. In *Handbook of North American Indians, Volume 15* edited by Bruce G. Trigger, pp. 213-239. Smithsonian Institution, Washington D. C.

Goodyear, Albert
2000 Topper Site: Results of the 2000 Allendale Paleoindian Expedition. *Legacy* 5,2:18-26.

Goodyear, Albert C., Sam B. Upchurch, Mark J. Brooks, and Nancy N. Goodyear
1983 Paleoindian Manifestations in the Tampa Bay Region, Florida. *Florida Anthropologist* 36:40-66.

Gordon, R. B.
1983 History of Sea Level Changes along the Connecticut Shore. In *Connecticut Archaeology: Past, Present, and Future*, edited by R.E. Dewar, K.L. Feder, and D.A. Poirier, pp. 61-78. Occasional Papers in Anthropology, University of Connecticut, Storrs.

Gould, Richard A.
2000 *Archaeology and the Social History of Ships*. Cambridge University Press, Cambridge.

Griffin, James B.
1952 *Archeology of Eastern United States*. University of Chicago Press, Chicago, Illinois.

Griswold, William A.
2002 *Archeology of a Prehistoric Shell Midden, Statue of Liberty National Monument, New York*. Occasional Publications in Field Archaeology Number 1, Archeology Branch, Northeast Region, National Park Service, U.S. Department of the Interior, Lowell, Massachusetts.

Grossman-Bailey, Ilene
2001 *"The People who Lived by the Ocean": Native American Resource Use and Settlement in the Outer Coastal Plain of New Jersey*. Ph.D. dissertation, Department of Anthropology, Temple University.

Grumet, Robert S.
1995 *Historic Contact: Indian People and Colonists in Today's Northeastern United States in the Sixteenth though Eighteenth Centuries*. University of Oklahoma Press, Norman.

Guilday, John E.
1968 Archaeological Evidence of Caribou from New York and Massachusetts. *Journal of Mammalogy* 49:344-345.

Hamilton, Donny L.
1996 *Basic Methods of Conserving Underwater Archaeological Material Culture*. U.S. Department of Defense Legacy Resource Management Program, Washington, D.C.

Haynes, C Vance, jr.
2008 Younger Dryas "Black Mats" and the Rancholabrean Termination in North America. *Proceedings of the National Academy of Sciences* 105,18:6520-6525.

Hills, Lieutenant
1784 *A Chart of the Bar of Sandy Hook The Entrance to Hudson's River in the Province of New Jersey*. National Archives, Civil Works Map File, R7, Roll, 1784.

Hoyt, William H., John C. Kraft, Michael J. Chrzastowski
1990 Prospecting for Submerged Archaeological Sites on the Continental Shelf; Southern Mid-Atlantic Bight of North America. In *Archaeological Geology of North America*, edited by Norman P. Lasca and Jack Donahue, pages 147-160. Geological Society of America, Centennial Special Volume 4, Boulder, Colorado.

Hranicky, Wm. Jack
1994 *Middle Atlantic Projectile Point Typology and Nomenclature*. Archaeological Society of Virginia Special Publication Number 33, Courtland.

Hughes Clarke, J.E., L.A. Mayer, and D.E. Wells
1996 Shallow-Water Imaging Multibeam Sonars: A New Tool for Investigating Sea Floor Processes in the Coastal Zone and on the Continental Shelf. *Marine Geophysical Researches* 18:607-629.

Isachsen, Y. W., E. Landing, J. M. Lauber, L. V. Rickard, and W. B. Rogers
2000 *Geology of New York: A Simplified Account*. Second edition. New York State Museum Educational Leaflet 28, The University of the State of New York, Albany.

Jacobson, G.L., Thompson Webb, and E.C. Grimm
1987 Patterns and Rates of Vegetation Change during the Deglaciation of Eastern North America. In *America during Deglaciation*, edited by W.F. Ruddiman and H.E. Wright, jr. The Geology of North America Volume K-3, The Geological Society of America, Boulder, Colorado.

Jaffee, Mark
1978 Three Earliest Urban National Parks Vary in Stages of Development. *The New York Times*, December 31, page 21.

James, Stephen R.
1991 Underwater Inspection of 26 Remote Sensing Targets in the Near Shore Sand Placement Area, Asbury Park to Manasquan Section II, Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet, Beach Erosion Control Project. Report prepared for U.S. Army Corps of Engineers, New York District, by Alpine Ocean Seismic Survey of Norwood, New Jersey and Panamerican Consultants, Memphis, Tennessee.

Jepsen, Glenn L.
1964 *A New Jersey Mastodon*. Revised edition. New Jersey State Museum Bulletin 6, Trenton.

Jochim, Michael A.
1981 *Strategies for Survival: Cultural Behavior in an Ecological Context*. Academic Press, New York.

John Milner Associates
1978 A Cultural Resources Inventory of the Gateway National Recreation Area, New York and New Jersey. Prepared by John Milner Associates, West Chester, Pennsylvania, for the National Park Service, Denver Service Center.

Johnson, Frederick
1942 *The Boylston Street Fishweir*. Papers of the Robert S. Peabody Foundation for Archaeology, Volume 2. Andover, Massachusetts.

Johnson, Frederick and Hugh M. Raup
1947 *Grassy Island: Archaeological and Botanical Investigations of an Indian Site in the Taunton River, Massachusetts*. Papers of the Robert S. Peabody Foundation for Archaeology, Volume 1, Number 2. Andover, Massachusetts.

Jones, Brian D.
1994 Hunter-Gatherer Adaptations to the Terminal Pleistocene and Early Holocene Environments of Northeastern North America: Effects on Site Visibility. Paper presented at the 34th Annual Meeting of the Northeastern Anthropological Association, Geneseo, New York.
1997 The Late Paleoindian Hidden Creek Site in Southeastern Connecticut. *Archaeology of Eastern North America* 25:45-80.

Joyce, Arthur A.
1988 Early/Middle Holocene Environments in the Middle Atlantic Region: A Revised Reconstruction. In *Holocene Human Ecology in Northeastern North America*, edited by George P. Nicholas, pages 185-214. Plenum Press, New York.

Justice, Noel D.
1987 *Stone Age Spear and Arrow Points of the Midcontinental and Eastern United States*. Indiana University Press, Bloomington.

Kelly, Robert L.
1995 *The Foraging Spectrum*. Smithsonian Institution Press, Washington D.C.

Kerwin, M., J.T. Overpeck, R.S. Webb, A. DeVernal, D.H. Rind, and R.J. Healy
1999 The Role of Oceanic Forcing in Mid-Holocene Northern Hemisphere Climatic Change. *Paleoceanography* 14:200-210.

Klein, Elana A. and Cecilia McHugh
2009 Late Pleistocene to Holocene Sedimentation of a Coastal System: Raritan and Sandy Hook Bays, New Jersey. Paper presented at the 44th Annual Meeting of the Northeastern Section of the Geological Society of America, Portland, Maine.

Kornfeld, Marcel and Andrei Tubarev
2009 The French Connection? Or is it? *Current Research in the Pleistocene* 26:78-80.

Kraft, Herbert C.
1977 The Paleo-Indian Sites at Port Mobil, Staten Island. In *Current Perspectives in Northeastern Archeology: Essays in Honor of William A. Ritchie*, edited by R.E. Funk and C.F. Haynes III, pages 1-19. Researches and Transactions of the New York State Archeological Association 17, Albany.
1986 *The Lenape: Archaeology, History, and Ethnography*. Collections of the New Jersey Historical Society Volume 21. Newark, New Jersey.
1991 *The Archaeology and Ethnohistory of the Lower Hudson Valley and Neighboring Regions: Essays in Honor of Louis A. Brennan*. Occasional Publications in Northeastern Anthropology, No. 11. Archaeological Services, Bethlehem, Connecticut.
2001 *The Lenape-Delaware Indian Heritage, 10,000 BC to AD 2000.* Lenape Books, Stanhope, New Jersey.

Kraft, John C., Daniel F. Belknap, and I. Kayan
1983 Potentials of Discovery of Human Occupation Sites on the Continental Shelves and Nearshore Coastal Zone. In *Quaternary Coastlines and Marine Archaeology: Towards the Prehistory of Land Bridges and Continental Shelves,* edited by P.M. Masters and N. C. Flemming, pages 87-120. Academic Press, London.

Kuhn, Robert D.
1985 A Morphological Analysis of Bifurcated-Base Projectile Points in the Northeastern United States. *Man in the Northeast* 29:55-69.

Kvamme, Kenneth L.
1999 Recent Directions and Developments in Geographical Information Systems. *Journal of Archaeological Research* 7:152-201.

Lambert, Bruce
1994 Neighborhood Report: Little Neck; Prehistory in the Remaking? Try Ancient Little Neck Man. *The New York Times*, January 9th, Section 13, page 7.

La Porta, Philip C., Linda E. Sohl, and Margaret C. Brewer
1999 A Geomorphological and Archaeological Analysis of Potential Dredged Material Management Alternative Sites in the New York Harbor Apex Region. Report prepared by La Porta and Associates, Warwick, New York for U.S. Army Corps of Engineers, New York District.

Lavin, Lucianne
1988 Coastal Adaptations in Southern New England and Southern New York. *Archaeology of Eastern North America* 16:101-120.

Leach, Peter A., William J. Chadwick, and Daniel F. Belknap
2009 Multiple Phases in the Marine Transgression of Coastal Archaeological Sites in Maine and Delaware. Paper presented at the Annual Meeting of the Geological Society of America, Portland, Oregon.

Lenik, Edward J.
1993 Stage 1B Cultural resources Investigation of the Proposed Tent Camping and Ballfield Areas, Wine Cellars Interpretative Area, and Teller's Point Overlook Stair Access to Shore at Croton Point Park, Croton-on-Hudson, Westchester County, New York. Report prepared for Westchester Parks Department of Parks, Recreation and Conservation.

Lowery, Darrin
1989 The Paw Paw Cove Paleoindian Site Complex, Talbot County, Maryland. *Archaeology of Eastern North America* 17:143-164.
2008 Delmarva Archaeology and Sea Level Rise: Geoarchaeological Investigations into Holocene Marine Transgression. Paper presented at the 38th Annual Middle Atlantic Archaeological Conference, Ocean City, Maryland.

Lowery, Darrin and Jay F. Custer
1990 Crane Point: An Early Archaic Site in Maryland. *Journal of Middle Atlantic Archaeology* 6:75-120.

Lowery, Darrin and Ronald Martin
2009 Archaeology of Marine Transgression: An Inundated Middle Archaic Burial in Chesapeake Bay, Maryland. *Archaeology of Eastern North America* 37:159-173.

Lynch, Daniel
2001 Submerged Cultural Inventory of Rhode Island: A Method for Recording Submerged Archaeological Sites. Paper presented at the 41st Annual Meeting of the Northeastern Anthropological Association, Hartford, Connecticut.

Markl, Rudi G.
1971 Pleistocene Geology of Croton Point, New York. *Transactions of the New York Academy of Sciences, Series II* 33:305-515.

Marlon, J.P., P.J. Bartlein, M.K. Walsh, S.P. Harrison, K.J. Brown, M.E. Edwards, P.E. Higuera, M.J. Power, R.S. Anderson, C. Briles, A. Brunelle, C. Carcaillet, M. Daniels, F.S. Hu, M. Lavoie, C. Long, T. Minckley, P.J. Richard, A.C. Scott, D.S. Shafer, W. Tinner, C.E. Umbanhower, and C. Whitlock
2009 Wildfire Responses to Abrupt Climate Change. *Proceedings of the National Academy of Sciences* 106,8:2519-2524.

Marshall, Sydne
1982 Aboriginal Settlement in New Jersey during the Paleo-Indian Cultural Period: Circa 10,000 B.C. - 6000 B.C. In *New Jersey's Archeological Resources: A Review of Research Problems and Survey Priorities*, edited by Olga Chesler, pages 10-51. Office of New Jersey Heritage, Trenton.

Martin, Larry D., R.A. Rogers, and A.M. Neuner
1985 The Effect of the End of the Pleistocene on Man in North America. In *Environments and Extinctions: Man in Late Glacial North America*, edited by Jim I. Mead and David J. Meltzer, pages 15-30. Center for the Study of Early Man, Orono, Maine.

Marx, Robert
1980 *The History of Underwater Exploration*. Revised edition. Dover, New York.

Maschner, Herbert D.G. (editor)
1996 *New Methods, Old Problems: Geographical Information Systems in Modern Archaeological Research*. Occasional Paper No. 23, Center for Archaeological Investigations, Southern Illinois University at Carbondale.

Mather, Ian Roderick and Gordon P. Watts, jr.
2002 Geographic Information Systems. In *International Handbook of Underwater Archaeology*, edited by Carol V. Ruppé and Janet F. Barstad, pages 679-696. Kluwer Academic/Plenum, New York.

Mayewski, P. A. and M. Bender
1995 The GISP2 Ice Core Record: Paleoclimate Highlights. *Reviews of Geophysics* (Supplement) 33:1287-1296.

McAvoy, Joseph M. and Lynn D. McAvoy

1997 *Archaeological Investigations of Site 44SX202, Cactus Hill, Sussex County, Virginia*. Virginia Department of Historic Resources Research Report Series No. 8, Richmond.

McCrone, A.W. and R.C. Koch

1966 Some Geochemical Properties of Hudson River Sediments: Kingston to Manhattan. In *Hudson River Ecology*, pages 41-47. Hudson River Valley Commission, New York.

McNett, Charles

1985 *Shawnee Minisink: A Stratified Paleoindian-Archaic Site in the Upper Delaware Valley of Pennsylvania*. Academic Press, Orlando.

McWeeney, Lucinda J.

1994 *Archaeological Settlement Patterns and Vegetation Dynamics in Southern New England in the Late Quaternary*. Unpublished Ph.D. dissertation, Department of Anthropology, Yale University.

1999 A Review of Late Pleistocene and Holocene Climate Changes in Southern New England. *The Bulletin of the Archaeological Society of Connecticut* 62:3-18.

Meltzer, David J.

1988 Late Pleistocene Human Adaptations in Eastern North America. *Journal of World Prehistory* 2:1-52.

2004 Peopling of North America. In *The Quaternary Period in the United States, Volume 1*, edited by Alan R. Gillespie, Stephen C. Porter, and Brian F. Atwater, pages 539-563. Elsevier Science, New York.

Merry, F.C.

1858 *Map of Westchester County, New York*. M. Dripps, New York.

Merwin, Daria E.

2000 Environment and Prehistoric Adaptations in Eastern Long Island, New York. Paper presented at the Northeastern Anthropological Association 40th Annual Meeting, Jamaica, New York.

2003 The Potential for Submerged Prehistoric Archaeological Sites off Sandy Hook. *Bulletin of the Archaeological Society of New Jersey* 57:1-10.

Merwin, Daria and David Bernstein

2003 A GIS-Based Model for Predicting the Location of Submerged Prehistoric Archaeological Sites in New York Harbor. In *Final Reports of the Tibor T. Polgar Fellowship Program, 2002,* edited by John R. Waldman and W. Charles Nieder, pages VII-1-VII-24. Hudson River Foundation, New York.

Merwin, Daria and Roger Flood

2006 The Hudson River Shipwreck Inventory: 2004-2005 Field Work. Paper presented at the Middle Atlantic Archaeological Conference, Virginia Beach, Virginia.

Merwin, Daria E., Daniel P. Lynch, and David S. Robinson

2003 Submerged Prehistoric Sites in Southern New England: Past Research and Future Directions. *Bulletin of the Archaeological Society of Connecticut* 65:41-56.

Minard, James P.

1969 *Geology of the Sandy Hook Quadrangle in Monmouth County New Jersey*. Geological Survey Bulletin 1276, United States Government Printing Office, Washington D.C.

Miroff, Laurie E., Jeremy J. Wilson, and Nina M. Versaggi

2008 Reconsidering Culture-Historic Taxa in the Late Archaic. *North American Archaeologist* 29:157-177.

Mohney, Kenneth W.

2002 *Steubenville Projectile Points: Social and Technological Functions in the Panhandle Archaic of the Upper Ohio River Valley (West Virginia).* Unpublished Ph.D. dissertation, Department of Anthropology, University of Pittsburgh.

Moseley, Michael E.

1974 *The Maritime Foundations of Andean Civilization*. Cummings Archaeology Series, Menlo Park, California.

Moss, George H., jr.

1975 *Monmouth, Our Indian Heritage*. Ploughshare Press, Sea Bright, New Jersey.

Mounier, R. Alan

2003 *Looking Beneath the Surface: The Story of Archaeology in New Jersey*. Rutgers University Press, Piscataway, New Jersey.

Muckleroy, Keith

1978 *Maritime Archaeology*. Cambridge University Press, Cambridge.

National Oceanic and Atmospheric Administration (NOAA)

2010 NOAA National Geophysical Data Center, NGDC Coastal Relief Model, http://www.ngdc.noaa.gov/mgg/coastal/coastal.html. Accessed July 20.

Newby, Paige, Bryan Shuman, Phillip Leduc, and Thompson Webb III

2001 Integrating Scales and Data Sets: Environment and Culture in Northeastern North America 14,000 to 10,000 CAL YR B.P. Paper presented at the Society for American Archaeology 66th Annual Meeting, New Orleans, Louisiana.

Newman, Walter S.

1966 Holocene History of the Lower Hudson River Estuary. *The Bulletin of the New York State Archaeological Association* 38:36.

1977 Late Quaternary Paleoenvironmental Reconstruction: Some Contradictions from Northwestern Long Island, New York. *Annals of the New York Academy of Sciences* 288:545-570.

New York State Department of State

2008 Coastal Resources Online, Division of Coastal Resources webpage, http://www.nyswaterfronts.com/downloads/pdfs/sig_hab/hudsonriver/Haverstraw_Bay.pdf. Accessed February 8.

Nicholas, George P.

1988 Ecological Leveling: The Archaeology and Environmental Dynamics of Early Postglacial Land Use. In *Holocene Human Ecology in Northeastern North America,* edited by George P. Nicholas, pages 257-296. Plenum Press, New York.

Oldale, Robert N.

1986 Late-Glacial and Postglacial Sea-Level History of New England: A Review of Available Sea-Level Curves. *Archaeology of Eastern North America* 14:89-99.

Otto, Bernard A.

1999 The Strange Emergence of a Deep Sea Plummet off Plymouth’s Gurnet Head. *Bulletin of the Massachusetts Archaeological Society* 60(1):35-36.

Parker, Arthur C.

1920 *The Archeological History of New York.* New York State Museum Bulletin Numbers 237 and 238, Albany.

Parris, David C.

1983 New and Revised Records of Pleistocene Mammals of New Jersey. *The Mosasaur, The Journal of the Delaware Valley Paleontological Society* I:1-21.

1987 Paleosalinity of the Lower Hudson River: Evidence from Zooarchaeology. In *Papers in Vertebrate Paleontology in Honor of Morton Green,* edited by James E. Martin and Gregg E. Ostrander, pages 105-107. Dakoterra Volume 3, Museum of Geology, South Dakota School of Mines and Technology, Rapid City.

Perlman, Stephen M.

1980 An Optimum Diet Model, Coastal Variability, and Hunter-Gatherer Behavior. In *Advances in Archaeological Method and Theory, Volume 3,* edited by Michael J. Schiffer, pages 257-310. Academic Press, New York.

Pickman, Arnold
2004 Cultural Resources Survey, Croton Point Park, Westchester County, New York. Report prepared for Westchester Parks Department of Parks, Recreation and Conservation by Cragsmoor Consultants, New York City.

Pirazzoli, Paolo A.
1991 *World Atlas of Holocene Sea Level Changes*. Elsevier Oceanography Series, Amsterdam.

Powell, Bernard W.
1965 Spruce Swamp: A Partially Drowned Coastal Shell Midden in Connecticut. *American Antiquity* 30:460-469.

Rampino, M.R.
1979 Holocene Submergence of Southern Long Island, New York. *Nature* 280:132-134.

Research Planning, Inc., Tidewater Atlantic Research, Inc., and W.F. Baird & Associates, Ltd.
2004 Archaeological Damage from Offshore Dredging: Recommendations for Pre-Operational Surveys and Mitigation During Dredging to Avoid Adverse Impacts. Report prepared for the Leasing Division, Sand and Gravel Unit, Mineral Management Service, U.S. Department of the Interior, Herndon, Virginia. OCS Report MMS 2004-005.

Ritchie, William A.
1932 *The Lamoka Lake Site*. Researches and Transactions of the New York State Archaeological Association, Volume 7, Number 4. Rochester, New York.
1953 A Probable Paleo-Indian Site in Vermont. *American Antiquity* 18:249-258.
1959 *The Stony Brook Site and Its Relation to Archaic and Transitional Cultures on Long Island*. New York State Museum and Science Service Bulletin 372. The University of the State of New York, Albany.
1969 *The Archaeology of Martha's Vineyard*. Natural History Press, Garden City, New York.
1971 *A Typology and Nomenclature for New York Projectile Points*. Revised edition. New York State Museum Bulletin 384. The University of the State of New York, Albany.
1980 *The Archaeology of New York State*. Revised edition. Natural History Press, Garden City, New York.

Ritchie, William A. and Robert E. Funk
1971 Evidence for Early Archaic Occupations on Staten Island. *Pennsylvania Archaeologist* 41:45-59.

1973 *Aboriginal Settlement Patterns in the Northeast*. New York State Museum and Science Service Memoir 20, Albany.

Robbins, Maurice and George A. Agogino
1964 The Wapanucket No. 8 Site: A Clovis-Archaic Site in Massachusetts. *American Antiquity* 29:509-513.

Robinson, Brian S.
1985 *The Nelson Island and Seabrook Marsh Sites: Late Archaic, Marine Oriented People on the Central New England Coast*. Occasional Publications in Northeastern Anthropology 9(1).
1992 Early and Middle Archaic Period Occupation in the Gulf of Maine Region: Mortuary and Technological Patterning. In *Early Holocene Occupation in Northern New England*, edited by Brian S. Robinson, James B. Petersen, and Ann K. Robinson, pages 63-116. Occasional Publications in Maine Archaeology Number 9, Maine Historic Preservation Commission, Augusta.

Robinson, Brian S. and James B. Petersen
1992 Introduction: Archaeological Visibility and Patterning in Northern New England. In *Early Holocene Occupation in Northern New England*, edited by Brian S. Robinson, James B. Petersen, and Ann K. Robinson, pages 1-11. Occasional Publications in Maine Archaeology Number 9, Maine Historic Preservation Commission, Augusta.

Robinson, David S.
2003 Prehistoric Underwater CRM in the Northeastern United States: Recent Projects and Approaches. Paper presented at the Society for Historical Archaeology 36th Annual Conference on Historical and Underwater Archaeology, Providence, Rhode Island.

Robinson, David S., Ben Ford, Holly Herbster, and Joseph N. Waller, Jr.
2004 Marine Archaeological Reconnaissance Survey, Cape Wind Energy Project, Nantucket Sound, Massachusetts. Report prepared by the Public Archaeology Laboratory, Inc., Pawtucket, Rhode Island.

Rutsch, Edward S.
1970 An Analysis of the Lithic Materials Used in the Manufacture of Projectile Points in Coastal New York. *New York State Archaeological Association Bulletin* 49:1-12.

Sainz, Donald
1962 The Fluted Point People. *New Bulletin of the Staten Island Institute of Arts and Sciences* 12,1.

Salwen, Bert

1962 Sea Levels and Archaeology in the Long Island Sound Area. *American Antiquity* 28:45-55.

1975 Post-Glacial Environments and Cultural Change in the Hudson River Basin. *Man in the Northeast* 10:43-70.

1978 Indians of Southern New England and Long Island: Early Period. In *Handbook of North American Indians, Volume 15: Northeast*, edited by B. G. Trigger, pages 160-176. Smithsonian Institution, Washington, D.C.

Sanders, John E. and Naresh Kumar

1975 Evidence of Shoreface Retreat and In-Place "Drowning" during Holocene Submergence of Barriers, Shelf off Fire Island, New York. *Geological Society of America Bulletin* 86:65-76.

Sandweiss, Daniel H., Heather McInnis, Richard L. Burger, Asunción Cano, Bernardino Ojeda, Rolando Paredes, María del Carmen Sandweiss, and Michael D. Glascock

1998 Quebrada Jaguay: Early South American Maritime Adaptations. *Science* 281:1830-1832.

Sassaman, Kenneth E.

1999 A Southeastern Perspective on Soapstone Vessel Technology in the Northeast. In *The Archaeological Northeast*, edited by Mary Ann Levine, Kenneth E. Sassaman, and Michael S. Nassaney, pages 75-95. Bergin and Garvey, Westport, Connecticut.

Saxon, Walter

1973 The Paleo-Indian on Long Island. *The Bulletin of the New York State Archaeological Association* 57:1-11.

Schindler, William

2006 Middle Woodland Exploitation of Migratory Fish in the Delaware Valley. Ph.D. dissertation, Department of Anthropology, Temple University.

Schuldenrein, Joseph, Donald M. Thieme, Terrence Epperson, Mark Smith, Ellen Thomas, and Lucinda McWeeney

2000 A Geomorphological and Archaeological Study in Connection with the New York and New Jersey Harbor Navigation Study, Upper and Lower Bay, Port of New York and New Jersey, Hudson, Essex, and Union Counties, New Jersey, Kings, Richmond, and New York Counties, New York. Report prepared by Geoarchaeology Research Associates, Riverdale, New York for U.S. Army Corps of Engineers, New York District.

Science Applications, Inc.
1981 *A Cultural Resource Survey of the Continental Shelf from Cape Hatteras to Key West, Final Report; Volume IV: Conclusions and Recommendations*. Science Applications, Inc., McLean, Virginia for the Bureau of Land Management, U.S. Department of the Interior.

Sellet, Frederic
1998 The French Connection: Investigating a Possible Clovis-Solutrean Link. *Current Research in the Pleistocene* 15:67-68.

Shennan, Stephen
1997 *Quantifying Archaeology*. Second edition. University of Iowa Press, Iowa City.

Silver, Annette L.
1981 Comment of Maize Cultivation in Coastal New York. *North American Archaeologist* 2:117-130.

Singh, H., J. Adams, D. Mindell, and B. Foley
2000 Imaging Underwater for Archaeology. *Journal of Field Archaeology* 27:319-328.

Sirkin, Les
1977 Late Pleistocene Vegetation and Environments in the Middle Atlantic Region. *Annals of the New York Academy of Sciences* 288:206-217.
1995 *Western Long Island Geology with Field Trips*. Book and Tackle Shop, Watch Hill, Rhode Island.

Skinner, Alanson
1909 The Lenape Indians of Staten Island. *American Museum of Natural History Anthropological Papers* 3:3-61.
1919 Exploration of Aboriginal Sites at Throgs Neck and Clasons Point, New York City. *Museum of the American Indian, Heye Foundation Contributions* 4:45-126.

Skinner, Alanson and Max Schrabisch
1913 A Preliminary Report of the Archaeological Survey of the State of New Jersey. *Geological Survey of New Jersey Bulletin 9*. Trenton, New Jersey.

Smith, Carlyle S.
1950 *The Archaeology of Coastal New York*. Anthropological Papers of the American Museum of Natural History Volume 43.

Snow, Dean
1980 *The Archaeology of New England*. Academic Press, New York.

Solecki, Ralph S.
1961 Early Man and Changing Sea Levels, Poplar Island, Maryland. *American Antiquity* 27:234-236.

Spiess, Arthur E., Mary Lou Curran, and John Grimes
1985 Caribou (*Rangifer tarandus* L.) Bones from New England Paleoindian Sites. *North American Archaeologist* 6:145-159.

Spiess, Arthur E., Deborah Wilson, and James W. Bradley
1998 Paleoindian Occupation in the New England-Maritimes Region: Beyond Cultural Ecology. *Archaeology of Eastern North America* 25:201-264.

Spiess, Arthur and Robert Lewis
2001 *The Turner Farm Fauna: Five Thousand Years of Hunting and Fishing in Penobscot Bay, Maine*. Occasional Publications in Maine Archaeology Number 11, Maine Historic Preservation Commission, Augusta.

Stanford, Dennis and Bruce Bradley
2005 Constructing the Solutrean Solution. Paper presented at the Clovis in the Southeast Conference, Columbia, South Carolina.

Stanley, Alissa, Kenneth G. Miller, and Peter J. Sugarman
2004 Holocene Sea-level Rise in New Jersey: An Interim Report. Report submitted to the New Jersey Department of Environmental Protection Division of Science, Research, and Technology, Trenton.

Stanzeski, Andrew J.
1998 Four Paleoindian and Early Archaic Sites in Southern New Jersey. *Archaeology of Eastern North America* 26:41-53.

Starbuck, David R. and Charles E. Bolian, editors
1980 *Early and Middle Archaic Cultures in the Northeast*. Occasional Publications in Northeastern Anthropology, No. 7. Franklin Pierce College, Rindge, New Hampshire.

Steadman, David W., Thomas W. Stafford, Jr. and Robert E. Funk
1997 Nonassociation of Paleoindians with AMS-Dated Late Pleistocene Mammals from the Dutchess Quarry Caves, New York. *Quaternary Research* 47:105-116.

Stewart, R. Michael
1982 The Middle Woodland at Abbott Farm: Summary and Hypotheses. In *Practicing Environmental Archaeology: Methods and Interpretations,* edited by Roger Moeller, pages 19-28. American Indian Archaeological Institute, Washington, Connecticut.

Straus, Lawrence Guy

2000 Solutrean Settlement of North America? A Review of Reality. *American Antiquity* 65:219-226.

Stright, Melanie J.

1986 Human Occupation of the Continental Shelf during the Late Pleistocene/Early Holocene: Methods for Site Location. *Geoarchaeology* 1:347-364.

1990 Archaeological Sites on the North American Continental Shelf. In *Archaeological Geology of North America*, edited by N.P. Lasca and J. Donahue, pages 439-465. Centennial Special Volume 4, Geological Society of America, Boulder.

1995 Archaic Period Sites on the Continental Shelf of North America: The Effect of Relative Sea-Level Changes on Archaeological Site Locations and Preservation. In *Archaeological Geology of the Archaic Period in North America*, edited by E.A. Bettis, III, pages 131-147. Special Papers Number 297, Geological Society of America, Boulder.

2004 Research Strategy for Locating Evidence of Pre-Clovis Sites. Paper presented at the Society for American Archaeology 69th Annual Meeting, Montreal, Canada.

Thomas, Peter A.

1992 The Early and Middle Archaic Periods as Represented in Western Vermont. In *Early Holocene Occupations in Northern New England*, edited by Brian S. Robinson, James B. Petersen, and Ann K. Robinson, pages 187-203. Occasional Publications in Maine Archaeology Number 9. Maine Historic Preservation Commission, Augusta.

Throckmorton, Peter

1987 *The Sea Remembers, Shipwrecks and Archaeology from Homer's Greece to the Rediscovery of the* Titanic. Mitchell Beazley, London.

Tomalin, David

2000 Stress at the Seams: Assessing the Terrestrial and Submerged Archaeological Landscape on the Shore of the *Magnus Portus*. In *The Rising Tide: Archaeology and Coastal Landscapes*, edited by Alan Aberg and Carenza Lewis, pages 85-97. Oxbow Books, Oxford, United Kingdom.

Townsend, David W., Andrew C. Thomas, Lawrence M. Mayer, Maura A. Thomas and John A. Quinlan

2006 Oceanography of the Northwest Atlantic Continental Shelf. In *The Sea, Volume 14A: The Global Coastal Ocean*, edited by Allan R. Robinson and Kenneth Brink, pages 119-168. Harvard University Press, Cambridge.

Trubowitz, Neal L.
2005 Evidence Tracking for Determining Cultural Affiliation of an Inadvertent Discovery of Human Remains at GATE. Ms. on file, Gateway National Recreation Area Headquarters, Fort Wadsworth, New York.

United States Geological Survey (USGS)
1954/1981 *Sandy Hook, New Jersey-New York*. 7.5 minute series topographic map, Department of the Interior, Washington D.C.
1967/1979 *Haverstraw, New York*. 7.5 minute series topographic map, Department of the Interior, Washington D.C.
1967/1979 *Ossining, New York*. 7.5 minute series topographic map, Department of the Interior, Washington D.C.
2009 America's Volcanic Past: New Jersey webpage, http://vulcan.wr.usgs.gov/LivingWith/VolcanicPast/Places/volcanic_past_new_jersey.html. Accessed December 12.
2010 U.S. Geological Survey Studies in the New York Bight webpage, http://woodshole.er.usgs.gov/project-pages/newyork/index.html. Accessed July 20.

van der Donck, Adriaen
1841 A Description of New Netherlands Together with Remarks on the Character and Peculiar Customs of the Savages or Natives of the Land (1656). *Collections of the New York Historical Society, Second Series*, 1:125-242.

Volmar, Michael
2003 Riverine Dynamics at a Submerged Early Woodland Site in the Connecticut River. Paper presented at the Society for Historical Archaeology 36th Annual Conference on Historical and Underwater Archaeology, Providence, Rhode Island.

Walker, Jesse O.
2003 *Archaeological Investigations of the Holland Point Site (18DO220), Dorchester County, Maryland*. Unpublished M.A. thesis, Temple University, Philadelphia, Pennsylvania.

Waters, Michael R.
1992 *Principles of Geoarchaeology*. University of Arizona Press, Tucson.

Weiss, Donald
1974 Late Pleistocene Stratigraphy and Paleoecology of the Lower Hudson River Estuary. *Geological Society of America Bulletin* 85:1561-1570.

Werz, Bruno E.J.S. and Nicholas C. Flemming
2001 Discovery in Table Bay of the Oldest Handaxes Yet Found Underwater Demonstrates Preservation of Hominid Artefacts on the Continental Shelf. *South African Journal of Science* 97:183-185.

Wescott, Konnie L., and R. Joe Brandon
2000 *Practical Applications of GIS for Archaeologists: A Predictive Modeling Toolkit*. Taylor and Francis, London.

Westley, Kieran and Justin Dix
2006 Coastal Environments and Their Role in Prehistoric Migrations. *Journal of Maritime Archaeology* 1:9-28.

Whitmore, Frank C., jr., K.O. Emery, H.B.S. Cooke, and Donald J.P. Swift
1967 Elephant Teeth from the Atlantic Continental Shelf. *Science* 156:1477-1481.

Wilkins, Gary R.
1978 Prehistoric Mountaintop Occupations of Southern West Virginia. *Archaeology of Eastern North America* 6:13-41.

Winterhalder, Bruce
1981 Optimal Foraging Strategies and Hunter-Gatherer Research in Anthropology: Theory and Models. In *Hunter-Gatherer Foraging Strategies*, edited by Bruce Winterhalder and Eric A. Smith, pages 13-35. University of Chicago Press, Illinois.

Witthoft, John
1952 A Paleo-Indian Site in Eastern Pennsylvania: An Early Hunting Culture. *Proceedings of the American Philosophical Society* 96:464-495.

Wolley, Charles
1902 *A Two Years' Journal in New York and Part of its Territories in America* (1701). Edited by Edward G. Bourne. Burrows Brothers, Cleveland.

Wright, James D., Robert E. Sheridan, Kenneth G. Miller, Jane Uptegrove, Benjamin S. Cramer, and James V. Browning
2009 Late Pleistocene Sea Level on the New Jersey Margin: Implications to Eustasy and Deep-Sea Temperature. *Global and Planetary Change* 66:93-99.

Wyatt, Ronald J.
1977 The Archaic on Long Island. *Annals of the New York Academy of Sciences* 288:400-410.

Yesner, David R.
1980 Maritime Hunter-Gatherers: Ecology and Prehistory. *Current Anthropology* 21:727-750.

APPENDICES

Appendix A: Terrestrial Archaeological Sites in the New York Bight (Staten Island), Sample from *Arthur Kill, New York* 7.5 minute Series USGS Topographic Quadrangle

Site Name	Period	Type	Site Number	Source	Comments
isolated find	PI	stray find	A08501.000163	Ritchie 1980	find of a single fluted projectile point
Cutting	PI-MW	camp		Boesch 1994:86	family collection of artifacts includes four fluted points, along with Archaic and Woodland lithics
Port Mobil North/North Beach/Port Socony	PI-W	camp	NYSM 742	Kraft 1977	site known through local collections, which include 2 fluted points, 2 large unifacial tools, spurred end scrapers, debitage; other collections include pottery
Port Mobil South/Port Mobil Hill/Port Socony South	PI	camp	NYSM 743	Kraft 1977	site known through local collections, which include over 100 stone tools, including several small fluted points, scrapers, drills, knives, and cores
Charleston Beach	PI-MW	lithics	A08501.000122, NYSM 744	Kraft 1977; Sainz 1962	hundreds of points (including 2 fluted jasper points and EA points), blades, scrapers, atlatl weights; eroding into Arthur Kill (unclear if artifacts are in situ)
Kreischerville	PI-LW	camp	NYSM 4606	NYSM	mainly known through surface collections on beach; artifacts include 10 fluted points, Orient fishtail points, a pestle, net sinkers, scrapers, axes, hammerstones, debitage, and fire-cracked rocks
Smoking Point	PI, LA-W	camp, midden, burials	A08501.000076, NYSM 737	OPRHP	surface finds of PI artifacts; stratified portion of site appears to be a small village with burials; Archaic points on knoll, oyster midden contained Orient fishtail points, fire-cracked rocks, chert cores and flakes, bone, and pottery
Old Place 1	EA-LW	camp	A08501.002366	Ritchie 1980:147; Ritchie and Funk 1971:49	large multicomponent site with hearth, midden, and pit features; radiocarbon date of 5310±140 B.C. uncalibrated

Appendix A: Continued.

Site Name	Period	Type	Site Number	Source	Comments
Old Place/M&R	EA-LW	camp	A08501.002366	Ritchie and Funk 1973:38	several early projectile points, including LeCroy, Stanly Stemmed, Morrow Mountain, other stemmed points
Old Place 3	EA-LW	camp	A08501.002366	OPRHP	projectile points include Kirk corner-notched, Snook Kill, Bare Island, Poplar Island
Wards Point	EA-MW	camp	A08501.000030	Ritchie and Funk 1971	artifacts include 21 bifurcated base points, 16 other projectile points (including some MA forms), other stone tools; charcoal from a hearth feature radiocarbon dated to 8300±140 B.P.; later deposits include Woodland period cemetery
Richmond Hill	EA, A	lithics, camp	A08501.000109	Ritchie and Funk 1971:45-49	three loci, one of which radiocarbon dated to 9410±120 B.P.
Travis/Long Neck	EA-LW	camp	NYSM 4598	Skinner 1909	reported to be among the largest sites on Staten Island, dug by collectors; more than 1140 artifacts recovered
Hollowell	EA-LW	camp	NYSM 748, 767	Ritchie and Funk 1973:38-39	multicomponent site with large MW occupation; earlier finds include bifurcate base point
NYC SCA 56R	MA, LA, W	lithics	A08501.002569	OPRHP	points, bifaces, debitage, pottery
PS 6-R, Page Ave	LA	lithics, midden	A08501.002707	OPRHP	2 points, 3 bifaces, 2 hammerstones, 115 flakes (quartz, quartzite, chert, jasper, sandstone), 17 fire-cracked rocks ; one of three loci had midden deposit
Pottery Farm	LA, TA, EW	camp, midden	A08501.000075, NYSM 738	OPRHP	stratified site with at least two occupation levels, including a shell midden; artifacts include numerous stone tools, debitage, and EW pottery
Wort Farm	LA-LW	camp		Boesch 1994:92	stratified, multicomponent site; artifacts include points, knives, scrapers, debitage; hearth features present
Goodrich	LA	camp		Skinner 1909	various stone tools found

Appendix A: Continued.

Site Name	Period	Type	Site Number	Source	Comments
Arlington Avenue	LA-W	camp, midden	A08501.000137	Skinner 1909	shell midden and pit features; artifacts include points, scrapers, ground stone items, pottery, and clay pipes
Arlington Place	LA-W	camp	A08501.000139	Ritchie 1980	artifacts include Archaic points, scrapers, axes, atlatl weight, pottery, cache of 41 argillite blades; hearth features
Sandy Brook	LA-LW	camp	NYSM 4604	Skinner 1909	surface collection of artifacts
Chelsea	LA-EW	camp, burial	A08501.000135, NYSM 746, 4627	Skinner 1909	possible cemetery; other artifacts include 11 points, 2 grooved axes, 2 axe fragments
Bowmans Brook	LA-LW	camps	A08501.002364	Skinner 1909	complex of site loci with five identified components, best known for LW occupation; numerous pit features; artifacts include stemmed and triangular points, argillite drill, chert and quartz flakes
Tottenville 4	LA-W	camp, midden	A08501.000140	OPRHP	side-notched point, hammerstone, flakes, pottery, shell, deer bone; several loci
Fiddlers Green	A	lithics	A08501.000005, NYSM 5519	Skinner 1909	possible small campsite, large amounts of debitage, but no pottery found
Hariks Sandy Ground	A	camp		Boesch 1994:87	lithics possibly associated with hunting and butchering activities; no pottery found
Chemical Lane/ Ultramarine	A-EW	camp	A08501.000074, NYSM 7328, 739	OPRHP	points include Bare Island, Poplar Island, Squibnocket triangle, Brewerton, broad points; no pottery at main site, but early pottery present at north and south loci
Old Town/Oude Dorp	A-LW	camp	A08501.000027	OPRHP	finds include points (Brewerton, side-notched, Squibnocket triangles, others), bone fish hook, more than 200 pottery fragments, a bear tooth, netsinkers, stone pipe, axe, gorget
Saint Lukes Cemetery	A-LW	small camp		Boesch 1994:87	mostly lithic debitage and a few pieces of pottery

Appendix A: Continued.

Site Name	Period	Type	Site Number	Source	Comments
Gericke Farm	A-LW	camp	A08501.000120	OPRHP	Archaic and Woodland projectile points, lithic debitage (jasper, chert), small amount of pottery
Clay Pit Pond Road	A-W	lithics	A08501.000121	OPRHP	1 hammerstone, 1 mano, 6 other ground stone tools, 31 jasper and chert flakes, 42 fire-cracked rocks
Clay Pit Pond Park	A-W	camps		Boesch 1994:100	series of small camps
Clay Pit Pond Road Bluff North	A	lithics	A08501.000123	OPRHP	1 biface, 7 jasper, chert, quartz flakes
Page Avenue North	A-W	camp	A08501.000018, NYSM 768	OPRHP	multicomponent site, with pit features; artifacts include a gorget, a spokeshave, points, blades, other stone tools, debitage, and pottery
Sprague Avenue	A?	lithics	A08501.002376	OPRHP	1 jasper scraper, 63 jasper flakes, 43 chert flakes, 1 quartz flake, 50 fire-cracked rocks
T&J	A?	lithics	A08501.000118	OPRHP	1 biface, 2 unifaces, 2 hammerstones, 18 jasper, chert flakes, 4 ground stone tools, 73 fire-cracked rocks
A7-MCB-1	A?	lithics	A08501.002767	OPRHP	survey found 1 hammerstone, 12 chert, chalcedony, argillite flakes, fire-cracked rocks
C4-MCB-1	A?	lithics	A08501.002766	OPRHP	survey found 1 quartzite biface, 9 argillite, chert, quartz, jasper debitage
Abrahams Pond	A?	lithics	A08501.000878, A08501.000879	OPRHP	two loci; A: 14 jasper, chert, argillite, quartz flakes, 2 ground stone tools, 15 fire-cracked rocks; B: 27 jasper, chert, argillite, quartz flakes, 26 fire-cracked rocks
finds on Satterlee Street and Pittsville Avenue	A?	lithics	A08501.000022, A08501.000023, A08501.000024	OPRHP	artifact finds consist of lithic debitage, fire cracked rock, and a corner notched projectile point

Appendix B: Corcione Collection Artifact Inventory

Item #	Artifact	Mass (in g)	Max Length (in mm)	Max Width (in mm)	Thickness (in mm)	Material	Erosion	Comments
1	point	3.4	35	25	4	cream chert	moderate	triangular point with flat base; cf. Beekman
2	point	4.1	32	22	5	jasper	moderate	small side/corner notched point; cf. Kittatinny
3	point	6.1	42	26	5	jasper	minimal	contracting stem point, cf. Morrow Mountain I
4	point	15	56	28	7	jasper	moderate	contracting stem point, cf. Morrow Mtn II
5	biface	9.1	50	24	6	md gray chert	moderate	contracting stem biface/point, broken base
6	point	3.9	30	18	6	md gray chert	moderate	straight stem point, cf. Lamoka
7	point	5.4	33	25	6	dk gray chert	moderate	contracting stem point, cf. Morrow Mountain II
8	biface	10.3	54	22	7	dk gray chert	moderate	straight stem biface/point, broken base
9	flake frag	9.7	41	20	7	md gray chert	none	primary flake fragment, hinge termination
10	point frag	17.6	51	41	7	undet brown sedimentary	marked	stemmed point fragment, possible Neville/Stark
11	biface	5.8	50	19	4	undet brown sedimentary	severe	narrow oval biface
12	flake frag	27.3	60	43	14	black shale	none	tertiary flake fragment, feather termination
13	point	2.5	31	23	4	black chert	none	triangular point with asymmetric lobes and concave base; cf. Madison
14	biface frag	2	23	20	4	black chert	moderate	pointed biface, missing base
15	biface frag	8	37	30	6	black chert	moderate	pointed biface, missing base
16	biface	15.1	53	35	7	black chert	minimal	triangular biface, missing tip
17	point	32.5	72	38	8	black chert	moderate	straight stem point, missing tip; cf. Merrimack
18	point	3.4	36	16	5	black chert	marked	side/corner notched point; cf. Lamoka
19	biface	6.1	45	18	5	black chert	marked	contracting stem biface/point
20	point	5.8	31	24	5	black chert	marked	small corner notched point; cf. Kittatinny
21	biface frag	4.8	32	19	7	black chert	severe	possible biface
22	flake frag	3.7	28	24	5	black chert	minimal	tertiary flake fragment, possibly retouched
23	flake	14.2	40	33	9	black chert	moderate	secondary flake, hinge termination
24	flake	12.6	49	26	9	black chert	marked	secondary flake, feather termination
25	flake	29.6	48	42	15	black chert	minimal	secondary flake
26	flake	18.4	50	45	7	black chert	minimal	primary flake, overshot, missing platform

Appendix B: Continued.

Item #	Artifact	Mass (in g)	Max Length (in mm)	Max Width (in mm)	Thickness (in mm)	Material	Erosion	Comments
27	flake	3.7	40	20	4	black chert	moderate	primary flake, feather termination, missing platform
28	core frag	82.8	48	31	37	black chert	moderate	possible tested cobble
29	point	7.5	49	20	7	basalt	moderate	straight stem point; cf. Lamoka
30	point	4	37	16	5	basalt	moderate	contracting stem point; cf. Morrow Mountain I
31	biface frag	4.5	37	18	7	basalt	moderate	expanding stem biface/point, missing tip
32	point	9.1	53	21	8	basalt	marked	straight stem point; cf. Lamoka
33	point frag	13.9	43	29	9	basalt	moderate	straight stem point, missing tip; cf. Bare Island
34	point frag	11.9	56	20	9	basalt	severe	contracting/straight stem point, missing tip; cf. Lamoka
35	point frag	16.5	62	30	5	basalt	severe	contracting/straight stem point, missing tip; possibly Lamoka
36	point	11.2	52	26	8	basalt	marked	contracting stem point; cf. Morrow Mountain II
37	point	7.4	53	12	6	basalt	severe	contracting stem point; cf. Morrow Mountain I
38	biface	7.4	58	15	6	basalt	severe	narrow biface, haft indistinguishable, possible point
39	biface	12.5	88	14	7	basalt	severe	very long, narrow biface
40	biface	5.7	48	16	6	basalt	severe	narrow biface
41	biface	6	46	18	6	basalt	severe	narrow/oval biface, possible point
42	biface	1.8	38	12	4	basalt	severe	narrow/oval biface
43	biface	2.4	26	16	5	basalt	severe	pentagonal biface
44	biface	11.2	49	26	6	basalt	severe	triangular biface
45	biface frag	4.8	29	17	6	basalt	severe	triangular biface, missing tip
46	biface	16.5	57	26	7	basalt	severe	oval biface
47	biface	2.6	25	17	4	basalt	severe	triangular biface
48	biface	10.7	58	22	6	basalt	severe	narrow biface, possible point
49	biface	7.8	48	19	6	basalt	severe	narrow biface, possible point
50	point	4.2	34	21	5	undet brown sedimentary	marked	bifurcate base point, cf. St. Albans
51	point	5.8	38	26	6	undet brown sedimentary	marked	bifurcate base point, cf. LeCroy
52	point	3.7	30	19	6	undet brown sedimentary	marked	small side/corner notched point; cf. Kittatinny

Appendix B: Continued.

Item #	Artifact	Mass (in g)	Max Length (in mm)	Max Width (in mm)	Thickness (in mm)	Material	Erosion	Comments
53	biface	199.6	123	67	22	basalt	moderate	very large oval biface
54	biface	33.5	64	46	11	basalt	moderate	oval biface
55	biface frag	15.2	52	31	6	basalt	marked	pointed biface, missing base
56	biface frag	25.1	57	38	7	basalt	marked	contracting stem biface/point, missing tip
57	biface	25.1	58	40	9	basalt	marked	triangular biface/modified flake, missing tip
58	biface	16.7	90	21	8	basalt	marked	very long, narrow pointed biface
59	biface	8.4	84	11	6	basalt	severe	very long, narrow biface
60	biface	26.3	76	40	6	argillite	marked	oval biface
61	biface	6.4	45	21	6	argillite	severe	teardrop shaped biface
62	biface frag	2.4	30	16	5	argillite	severe	triangular biface, broken base
63	biface	4.2	50	13	5	argillite	severe	narrow biface
64	biface	25.8	67	42	9	argillite	marked	triangular biface
65	flake	24.9	59	41	10	argillite	moderate	tertiary flake, feather termination, possible retouch on distal end
66	point	25.9	75	38	7	argillite	moderate	side/corner notched point; cf. Brewerton
67	biface frag	16.8	45	41	9	argillite	moderate	pointed biface, missing base
68	biface frag	7	40	22	6	argillite	severe	asymmetrical stemmed biface/point, missing tip
69	biface	4	39	17	4	argillite	severe	pointed biface
70	flake frag	2.6	39	17	3	argillite	marked	tertiary flake, feather termination, missing platform
71	point frag	19.7	47	36	9	argillite	marked	straight stem point, broad blade, missing tip; cf. Snook Kill
72	point	4	45	15	5	argillite	marked	straight stem point; cf. Lamoka
73	flake frag	5.4	29	27	4	argillite	marked	tertiary flake, possibly modified/utilized
74	flake	7.5	35	36	6	argillite	marked	tertiary flake, feather termination
75	flake frag	2.8	33	19	3	argillite	marked	tertiary flake, feather termination, missing platform
76	flake	8	41	29	6	argillite	marked	tertiary flake, feather termination
77	flake frag	3.4	36	25	3	argillite	marked	tertiary flake, feather termination, missing platform
78	flake	6	41	23	5	argillite	marked	tertiary flake, feather termination
79	flake frag	2.8	32	25	3	argillite	marked	tertiary flake mid-section
80	flake frag	8.8	41	30	6	lt gray undet	marked	tertiary flake

Appendix B: Continued.

Item #	Artifact	Mass (in g)	Max Length (in mm)	Max Width (in mm)	Thickness (in mm)	Material	Erosion	Comments
81	point	13.7	42	37	7	basalt	marked	contracting stem point with possibly retouched tip; cf. Morrow Mountain I
82	flake frag	8.7	35	31	8	basalt	marked	tertiary flake, feather termination, missing platform
83	point	4.9	38	18	7	basalt	marked	straight stem point; cf. Lamoka
84	biface	32	78	38	10	basalt	marked	contracting stem biface/point; cf. Morrow Mountain I
85	biface frag	43.2	70	52	10	basalt	marked	pointed biface, missing base
86	biface frag	26.5	64	35	9	basalt	moderate	pointed biface, missing base
87	point	34.5	83	35	8	basalt	marked	straight stem point; cf. Lamoka (but large)
88	biface	12	59	18	9	basalt	marked	asymmetrical side notched biface/point
89	point	13.9	48	31	9	basalt	moderate	straight stem point, broad blade; cf. Snook Kill
90	point	14.9	57	37	8	basalt	moderate	straight stem point, broad blade; cf. Snook Kill
91	point	16.2	57	39	8	basalt	moderate	straight stem point, broad blade; cf. Snook Kill
92	biface frag	17.2	48	36	7	black chert	marked	possible large contracting stem point, missing tip
93	biface frag	18.6	51	40	7	basalt	moderate	pointed biface, missing base
94	flake	11.3	47	33	6	basalt	moderate	tertiary flake, feather termination
95	flake frag	2.3	29	19	5	brown chert	moderate	tertiary flake, missing platform
96	biface	92	169	35	18	basalt	moderate	very large long, narrow biface
97	point	6.6	44	16	9	basalt	marked	asymmetrical straight stem/side notched point; cf. Lamoka
98	biface	10	64	18	7	basalt	marked	pointed narrow biface/point, broken base
99	point frag	12.1	45	25	9	basalt	marked	asymmetrical side notched point, missing tip; cf. Lamoka
100	point frag	8	35	22	11	basalt	marked	side notched point, missing tip; cf. Lamoka
101	biface	6.1	40	20	9	basalt	moderate	teardrop shaped biface with drill-like tip
102	biface frag	8	43	22	8	basalt	moderate	pointed biface, missing tip
103	point frag	19.3	60	28	9	basalt	marked	contracting stem point, missing tip; cf. Poplar Island
104	point	19.4	66	35	7	basalt	marked	contracting stem point; cf. Morrow Mountain I
105	point frag	32.5	64	34	10	basalt	marked	straight stem point, missing tip; cf. Merrimack
106	point frag	28	52	42	9	basalt	marked	corned/side notched point with broad blade, no tip
107	point frag	9.3	31	34	7	basalt	marked	possible base of large contracting stem point

Appendix B: Continued.

Item #	Artifact	Mass (in g)	Max Length (in mm)	Max Width (in mm)	Thickness (in mm)	Material	Erosion	Comments
108	point frag	18.2	50	37	8	basalt	marked	asymmetrical contracting stem point, missing tip; cf. Poplar Island
109	biface frag	15.7	55	32	9	basalt	moderate	pointed biface, missing base
110	biface	16.2	55	34	8	basalt	marked	pointed biface/point with asymmetrical base
111	biface frag	14.9	47	29	10	basalt	severe	pointed biface, missing base
112	biface frag	13.1	45	39	7	argillite	marked	pointed biface, missing base
113	biface frag	10.2	47	24	7	basalt	severe	pointed biface, missing base
114	biface frag	40.2	69	37	12	basalt	marked	broken oval biface
115	biface frag	8.2	37	35	7	basalt	marked	pointed biface, missing base
116	biface frag	53.8	73	52	12	basalt	marked	large oval biface, missing tip
117	biface	20.6	71	36	6	basalt	marked	triangular biface
118	biface frag	25.5	53	44	10	basalt	severe	possible pointed biface
119	flake frag	21.9	59	32	10	basalt	marked	tertiary flake, possibly modified/utilized
120	flake frag	5.6	47	25	5	basalt	moderate	tertiary flake, possibly modified/utilized
121	flake frag	22.8	61	35	10	basalt	moderate	tertiary flake, possibly modified/utilized, with marine growth
122	flake	16.6	49	36	9	basalt	marked	tertiary flake, feather termination
123	flake	16.1	56	33	8	basalt	moderate	tertiary flake, feather termination
124	flake frag	9.9	50	30	5	basalt	marked	tertiary flake, feather termination
125	flake	8.5	47	28	6	basalt	marked	tertiary flake, feather termination
126	flake frag	22.1	57	38	8	basalt	marked	tertiary flake, feather termination
127	flake frag	7.5	46	31	5	basalt	marked	tertiary flake, feather termination
128	flake frag	7.6	52	27	5	basalt	severe	tertiary flake, feather termination
129	flake	8.3	48	28	6	basalt	moderate	tertiary flake, feather termination
130	flake	3.5	35	21	3	basalt	marked	tertiary flake, feather termination
131	flake	4.4	32	26	4	basalt	marked	tertiary flake, feather termination
132	flake	13.3	65	23	7	basalt	marked	tertiary flake, overshot
133	flake	12	49	42	5	basalt	marked	tertiary flake, feather termination
134	flake frag	7.3	46	25	5	basalt	marked	tertiary flake
135	flake	7.3	37	30	5	basalt	severe	tertiary flake, feather termination

Appendix B: Continued.

Item #	Artifact	Mass (in g)	Max Length (in mm)	Max Width (in mm)	Thickness (in mm)	Material	Erosion	Comments
136	flake frag	3.4	34	21	4	basalt	severe	tertiary flake, hinge termination
137	flake	8.4	48	24	6	basalt	marked	tertiary flake, feather termination
138	flake frag	9.4	62	22	6	basalt	severe	tertiary flake, overshot
139	flake frag	8.8	53	29	5	basalt	marked	tertiary flake, feather termination
140	flake	28.6	59	55	9	basalt	marked	tertiary flake, possibly modified/utilized
141	flake frag	13	49	31	8	basalt	marked	tertiary flake, feather termination
142	flake	16.2	64	30	7	basalt	severe	tertiary flake, feather termination
143	flake	7.8	53	25	4	basalt	moderate	tertiary flake, feather termination
144	flake frag	5.9	34	30	5	basalt	moderate	tertiary flake, may be modified/utilized
145	flake frag	2	28	24	2	basalt	marked	tertiary flake, feather termination
146	flake frag	19.4	63	43	8	basalt	marked	tertiary flake
147	flake frag	4.9	31	24	6	basalt	moderate	tertiary flake, snapped
148	flake frag	5	30	30	4	basalt	severe	tertiary flake, feather termination
149	flake frag	4.9	37	22	4	basalt	marked	tertiary flake
150	flake frag	14.6	51	28	9	basalt	marked	tertiary flake, feather termination
151	flake frag	30.7	57	40	11	basalt	moderate	tertiary flake, feather termination
152	flake frag	29.5	56	37	14	basalt	severe	tertiary flake fragment
153	flake	11.8	53	33	7	basalt	moderate	tertiary flake, feather termination
154	flake frag	8.4	52	29	5	basalt	severe	tertiary flake fragment
155	flake	10.4	50	31	6	basalt	severe	tertiary flake, feather termination
156	flake frag	2.4	30	15	3	basalt	severe	tertiary flake fragment
157	flake frag	52	74	72	10	basalt	marked	tertiary flake fragment
158	flake frag	20.8	52	38	10	basalt	marked	tertiary flake, feather termination
159	flake	19	62	33	8	basalt	marked	tertiary flake, feather termination
160	flake frag	7.2	47	24	6	basalt	severe	tertiary flake fragment
161	flake frag	1.9	31	19	2	basalt	severe	tertiary flake, feather termination
162	flake frag	10.9	50	34	5	basalt	severe	tertiary flake, feather termination
163	flake	15.8	58	35	8	basalt	marked	tertiary flake, hinge termination
164	flake	6.8	42	25	5	basalt	severe	tertiary flake, feather termination

Item #	Artifact	Mass (in g)	Max Length (in mm)	Max Width (in mm)	Thickness (in mm)	Material	Erosion	Comments
165	flake	13.4	45	47	9	basalt	marked	tertiary flake, feather termination
166	flake frag	8.5	40	26	7	basalt	severe	tertiary flake fragment
167	flake	11.8	37	44	8	basalt	marked	secondary flake, hinge termination
168	flake frag	32.7	64	50	10	basalt	moderate	tertiary flake, may be modified/utilized
169	flake frag	9	43	40	5	basalt	severe	tertiary flake fragment
170	flake frag	25.8	64	45	8	basalt	marked	tertiary flake fragment
171	flake frag	6.6	48	26	5	basalt	severe	tertiary flake fragment
172	biface	13.4	60	31	7	basalt	severe	biface or modified flake
173	flake	8.8	44	24	7	basalt	severe	tertiary flake, may be non-cultural
174	flake	13.2	49	30	6	basalt	severe	tertiary flake, may be non-cultural
175	core	38.1	57	37	15	basalt	severe	core, may be non-cultural
176	flake	3.5	36	22	3	basalt	severe	tertiary flake, may be non-cultural
177	flake	3.1	33	20	4	basalt	severe	tertiary flake, may be non-cultural
178	flake	9.6	40	30	8	basalt	severe	tertiary flake, may be non-cultural
179	flake	6.1	36	26	7	basalt	severe	primary flake, may be non-cultural
180	flake	4.1	38	22	5	basalt	severe	tertiary flake, may be non-cultural
181	flake	4.5	33	22	4	basalt	severe	tertiary flake, may be non-cultural
182	flake	2.8	35	20	4	basalt	severe	tertiary flake, may be non-cultural
183	biface	22.6	60	43	8	basalt	severe	possible biface, or may be non-cultural
184	flake	4.8	33	31	4	basalt	severe	tertiary flake, may be non-cultural
185	flake	12.1	50	31	5	basalt	severe	tertiary flake, may be non-cultural
186	flake	2.9	28	22	4	basalt	severe	tertiary flake, may be non-cultural
187	flake	11.3	40	31	9	basalt	severe	tertiary flake, may be non-cultural
188	flake	2.1	26	22	4	basalt	severe	secondary flake, may be non-cultural
189	flake	14.1	41	36	9	basalt	severe	tertiary flake, may be non-cultural
190	flake	5	39	29	5	basalt	severe	tertiary flake, may be non-cultural
191	flake	11.3	55	27	8	basalt	severe	tertiary flake, may be non-cultural
192	flake	7.2	45	23	6	basalt	severe	tertiary flake, may be non-cultural
193	flake	17	51	33	7	basalt	severe	tertiary flake, may be non-cultural

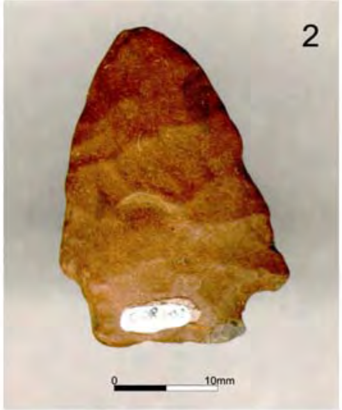
Appendix B: Continued.

Item #	Artifact	Mass (in g)	Max Length (in mm)	Max Width (in mm)	Thickness (in mm)	Material	Erosion	Comments
194	flake	10.7	44	23	8	basalt	severe	tertiary flake, may be non-cultural
195	flake	4.7	37	24	4	basalt	severe	tertiary flake, may be non-cultural
196	flake	6.1	40	23	5	basalt	severe	tertiary flake, may be non-cultural
197	flake	5	40	22	5	basalt	severe	tertiary flake, may be non-cultural
198	flake	5.8	35	32	4	basalt	severe	tertiary flake, may be non-cultural
199	flake	7	43	34	4	basalt	severe	tertiary flake, may be non-cultural
200	core frag	149.3	98	68	26	basalt	severe	core fragment, may be non-cultural
201	flake	8.9	34	31	6	basalt	severe	tertiary flake, may be non-cultural
202	flake	32.9	57	36	14	basalt	severe	tertiary flake, may be non-cultural
203	flake	63.3	90	45	14	basalt	severe	primary flake, may be non-cultural
204	flake	5.7	40	26	4	basalt	severe	tertiary flake, may be non-cultural
205	flake	4.6	30	24	5	basalt	severe	tertiary flake, may be non-cultural
206	flake	4.7	29	24	7	basalt	severe	tertiary flake, may be non-cultural
207	flake	38	81	42	10	basalt	severe	tertiary flake, may be non-cultural
208	flake	23.6	54	36	11	basalt	severe	tertiary flake, may be non-cultural
209	flake	12	47	39	6	basalt	severe	tertiary flake, may be non-cultural

Appendix B: Continued.

Corcione Lithics Digital Images, Made with Flatbed Laser Scanner (Note: Scales Vary)

1

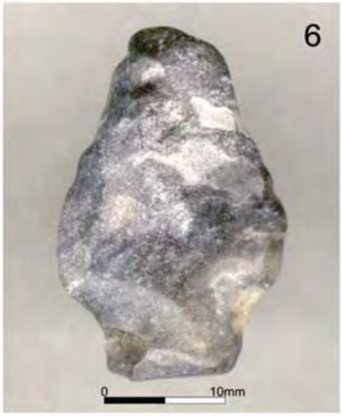


2

3

4

5



6

7

8

9

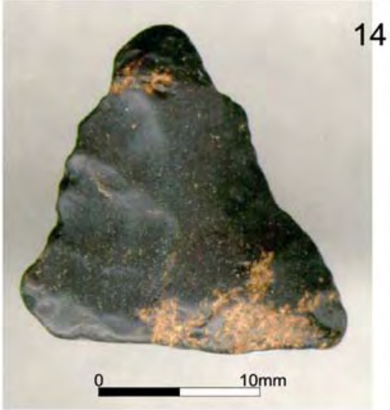
10

11

12

13

14



15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

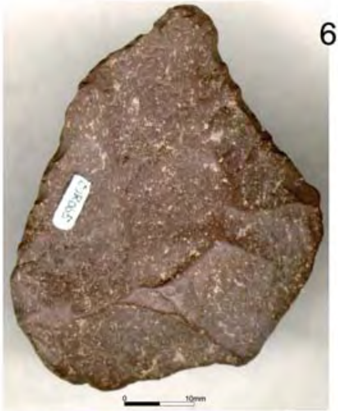
61

62

63

64

65



66

67

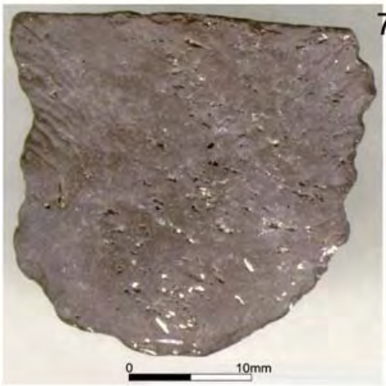
68

69

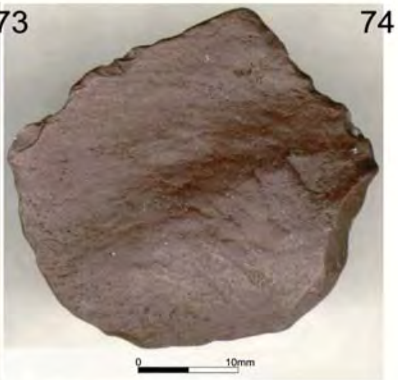
70

71

72



73



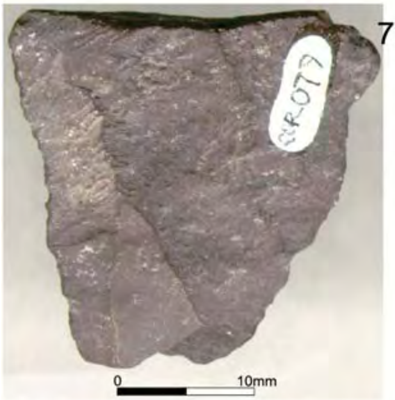
74

75

76

77

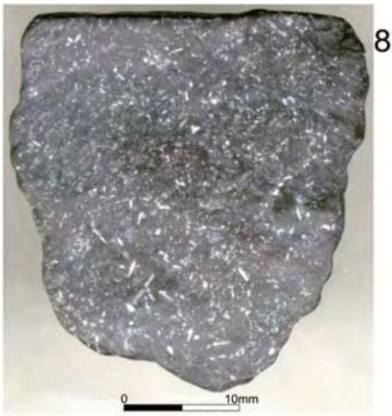
78



79

80

81



82

83

84

85

86

87

88

89

90

91

92

93

94

95

96

97

98

99

100

101

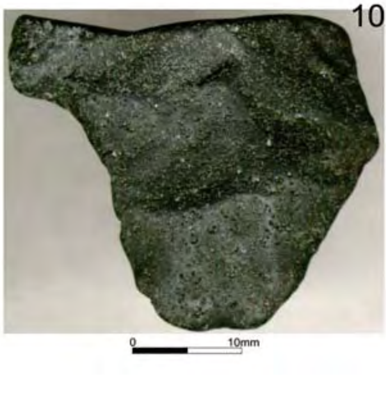
102

103

104

105

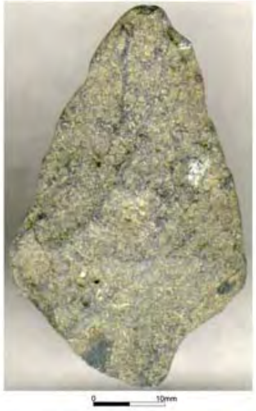
106



107

108

109



110

111

112

113

114

115

116

117

118

119

120

121

122

123

124

125

126

127

128

129

130

131

132

133

134

135

136

137

138

139

140

141

142

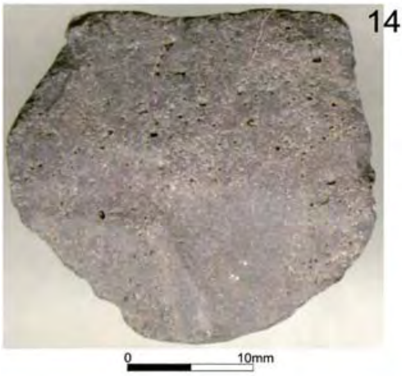
143

144

145

146

147



148

149

150

151

152

153

154

155

156

157

158

159

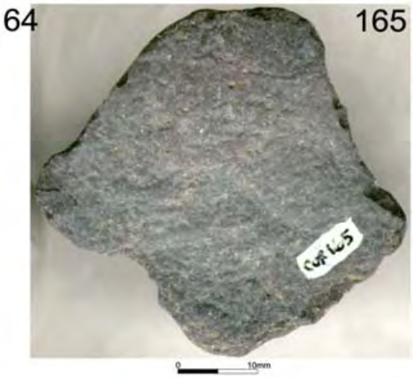
160

161

162

163

164

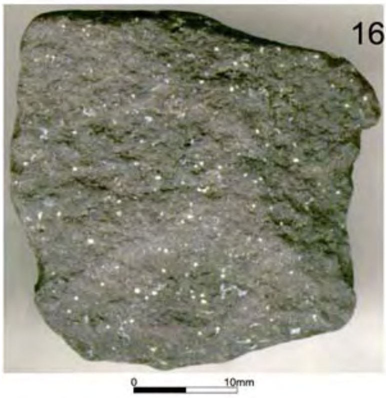


165

166

167

168



169

170

171

172

173

174

175

176

177

178

179

180

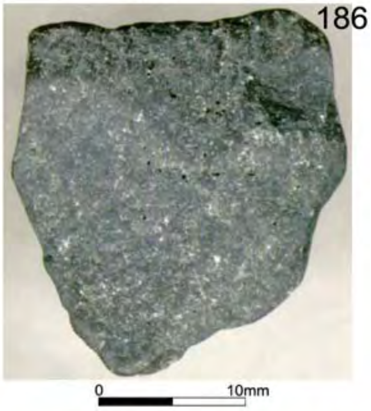
181

182

183

184

185



186

187

188

189

190

191

192

193

194

195

196

197

198

199

200

201

202

203

204

205

206

207

208

209

Appendix C: Offshore Sandy Hook Field Survey Summary

Area	Anchor Coordinates	Date	Depth	Comments
1	40°25.516'/ 73°56.307'	8/5/03	13.7 m (45 ft)	surface survey only; no hand-fanned tests
	40°25.516'/ 73°56.307'	8/6/03	13.7 m (45 ft)	completed all 8 survey lines
2	40°25.429' /73°56.328'	8/7/03	14.3 m (47 ft)	surface survey only; ran all 8 lines with 10 meter circle searches at end of each line
3	40°25.320'/ 73°56.345'	8/12/03	15.2 m (50 ft)	surface survey and hand-fanned tests every 10 meters; ran all 8 lines; mammal long bone fragment found at 40 meters on E line, 10 centimeters beneath the surface; artillery shell on S line
4	40°25.219'/ 73°56.342'	8/13/03	15.2 m (50 ft)	surface survey plus hand-fanned tests; ran all 8 lines
5	40°25.192'/ 73°56.369'	8/14/03	16.5 m (54 ft)	surface survey plus hand-fanned tests; ran all 8 lines; possible lithic found at 17 meters on E line at surface, additional lithic found on E line at 20 meters (20 cm below surface); artillery shell near anchor
6	40°25.150'/ 73°56.350'	8/15/03	18.6 m (61 ft)	surface survey plus hand-fanned tests; ran all 8 lines
7	40°25.268'/ 73°56.218'	8/19/03	15.5 m (51 ft)	surface survey plus hand-fanned tests; ran all 8 lines
8	40°25.211'/ 73°56.034'	8/20/03	18.3 m (60 ft)	surface survey plus hand-fanned tests; ran all 8 lines; outside of dredged borrow area; sediments are more silty; probable caribou bone found on SW line at 20 meters (10 cm below surface)
9	40°25.300'/ 73°56.400'	8/21/03	17.7 m (58 ft)	surface survey plus hand-fanned tests; ran all 8 lines; back inside borrow area; artillery shell near S line
--	40°25.513'/ 73°56.893'	8/3/04	14.9 m (49 ft)	limited surface survey with no testing: Hurricane Alex approaching, and very poor visibility
--	40°25.505'/ 73°56.959'	8/5/04	13.7 m (45 ft)	limited surface survey with no testing due to poor conditions
10	40°25.494'/ 73°56.880'	8/6/04	14.9 m (49 ft)	visibility slightly improved; tests dug with scoop and mesh bag; test holes dug at 0, 10, and 20 m on N and E lines; sediments are grayish brown sand w/few pebbles
11 (5a)	40°25.210'/ 73°56.366'	8/9/04	17.1 m (56 ft)	surface survey plus hand-fanned tests; ran all 8 lines

Appendix C: Continued.

Area	Anchor Coordinates	Date	Depth	Comments
12	40°24.500'/ 73°56.400'	8/10/04	12.2 m (40 ft)	surface survey plus hand-fanned tests; ran all 8 lines before weather deteriorated; sediments are light grayish brown fine sand
	40°24.510'/ 73°56.406'	8/11/04	14.6 m (48 ft)	tested air-lift and ran N, E, and W lines
	40°24.504'/ 73°56.410'	8/12/04	12.2 m (40 ft)	two dive rotations before weather deteriorated; used air-lift; sediments are coarse light brown sand with pebbles and small shell hash
13	40°25.184'/ 73°56.348'	8/13/04	15.2 m (50 ft)	one dive rotation before weather deteriorated; used air-lift and ran N line
14	40°25.191'/ 73°56.380'	8/16/04	15.2 m (50 ft)	Hurricane Charley left very poor visibility in its wake; worked with air-lift at anchor position and ran E line

Appendix D: Analysis of a Faunal Specimen Recovered from Offshore Sandy Hook

Identification of animal bone

Arthur Spiess
Senior Archaeologist
November 28, 2006

Specimen sent to Spiess by David Bernstein, SUNY Stony Brook

specimen wrapped in paper towel inside zip-lock plastic bag.
Following information written on outside of plastic zip-lock bag.
“recovered from ~ 15 m water; ~ 4 km east of Sandy Hook, NJ
8/20/03 offshore survey
dive #2, SW line, STP @ 20 m
EV, EP”

Daria Merwin, Stony Brook U.
daria.merwin@stonybrook.edu

Spiess notes:

This is the proximal end of a left ulna of a medium-sized artiodactyl. It is not a bovid (such as an antelope), based on the angulation of the trochlear notch, which is parallel with the long axis of the ulna and radius in bovids. It is angled slightly (20 to 30o) in Cervidae.

This specimen is a Cervid (deer family).

This is a left ulna, proximal 1/4 of total length, with the olecranon process missing. Much of the bone has been worn away or dissolved away. The articular processes for articulation with the proximal end of the posterior surface of the ulna have been heavily worn and are mostly missing. The anconeal process and most of the articular surface of the articular notch has been worn away. The specimen had snapped distally at the ulnar-radius symphysis (where the two bones are fused in an adult specimen). There is wear and erosion on the snapped edges, so the break occurred anciently, not as a result of the diver recovery.

The distal 2 cm of the bone before the snapped end is pathological, with exterior bone thickness added.

Species identification.

Specimen matches an adult (mature to old), female caribou (originally from Newfoundland) in Spiess’s collection (specimen S36) in overall size and morphology. The NJ specimen is slightly more rugose and up to 10% larger in some measurements.

The NJ specimen is too large for deer (*Odocoileus*) and too small for moose (*Alces*). (Actually, it might be matched in size by a newborn moose, but the NJ specimen is obviously from a skeletally adult, rugose animal.) The specimen could conceivably be a small, female elk (*Cervus*), but the best match is with a large, adult female caribou (*Rangifer*) or small male caribou.

Conclusion: 100% sure specimen is from a medium-large Cervid, 80% sure it is *Rangifer*.

Only defined measurement that could be taken on the NJ specimen is DPA of von den Driesch, which is the depth across the anconeal process. The NJ specimen is 5.5 cm + < 0.5 cm to allow for the wear and erosion on the head of the anconeal process. Comparable measurement on S36 female caribou is 4.8 cm. The NJ specimen is slightly more rugose under across the ulnar "blade" under the radial articular facets.

FROM: Darden Hood, Director (mailto:mailto:dhood@radiocarbon.com)

(This is a copy of the letter being mailed. Invoices/receipts follow only by mail.)
October 8, 2007

Ms. Daria Merwin
Stony Brook University
Institute for Long Island Archaeology
Stony Brook, NY 11794-4364
USA

RE: Radiocarbon Dating Result For Sample ANIMAL BONE

Dear Ms. Merwin:

Enclosed is the radiocarbon dating result for one sample recently sent to us. It provided plenty of carbon for an accurate measurement and the analysis proceeded normally. The report sheet contains the method used, material type, and applied pretreatments and, where applicable, the two-sigma calendar calibration range.

This report has been both mailed and sent electronically. All results (excluding some inappropriate material types) which are less than about 20,000 years BP and more than about ~250 BP include a calendar calibration page (also digitally available in Windows metafile (.wmf) format upon request). Calibration is calculated using the newest (2004) calibration database with references quoted on the bottom of the page. Multiple probability ranges may appear in some cases, due to short-term variations in the atmospheric 14C contents at certain time periods. Examining the calibration graph will help you understand this phenomenon.   Don't hesitate to contact us if you have questions about calibration.

We analyzed this sample on a sole priority basis. No students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analysis. We analyzed it with the combined attention of our entire professional staff.

Information pages are also enclosed with the mailed copy of this report. If you have any specific questions about the analysis, please do not hesitate to contact us.   Someone is always available to answer your questions.

Our invoice is enclosed. Please, forward it to the appropriate officer or send VISA charge authorization. Thank you. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood

Ms. Daria Merwin
Stony Brook University

Report Date: 10/8/2007
Material Received: 8/30/2007

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 234365	10 +/- 40 BP	-16.1 o/oo	160 +/- 40 BP

SAMPLE : ANIMAL BONE
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (bone collagen): collagen extraction: with alkali
2 SIGMA CALIBRATION : Cal AD 1660 to 1960 (Cal BP 290 to 0)

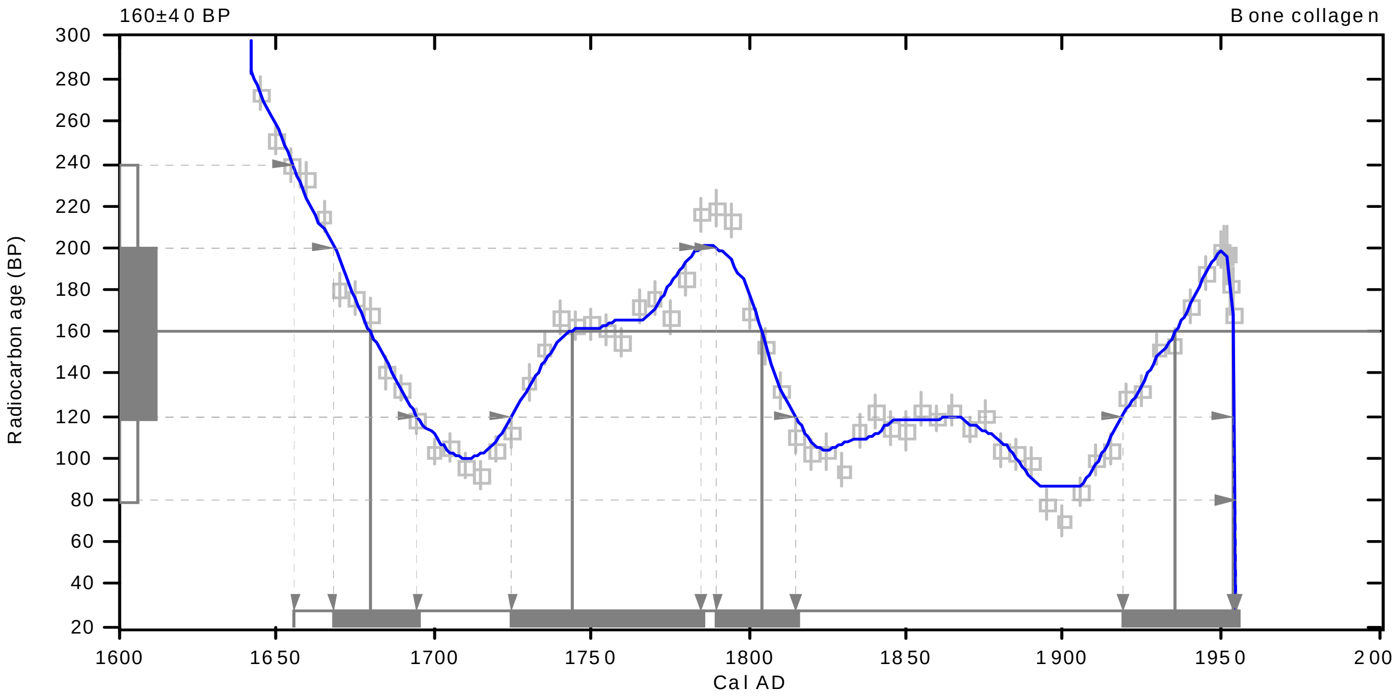
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-16.1:lab. mult=1)

Laboratory number:	**Beta-234365**
Conventional radiocarbon age:	**160±40 BP**
2 Sigma calibrated result: **(95% probability)**	**Cal AD 1660 to 1960 (Cal BP 290 to 0)**

Intercept data

Intercepts of radiocarbon age with calibration curve:	Cal AD 1680 (Cal BP 270) and Cal AD 1740 (Cal BP 210) and Cal AD 1800 (Cal BP 150) and Cal AD 1940 (Cal BP 20) and Cal AD 1950 (Cal BP 0)
1 Sigma calibrated results: (68% probability)	Cal AD 1670 to 1700 (Cal BP 280 to 260) and Cal AD 1720 to 1780 (Cal BP 220 to 160) and Cal AD 1790 to 1820 (Cal BP 160 to 140) and Cal AD 1920 to 1950 (Cal BP 30 to 0)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Appendix E: Croton Bay Beach Surface Finds, Beach Shovel Test Pit, and Underwater Test Pit Inventory

Coordinates	Unit Type	Date	Finds/Comments
N209/E240	beach SF	7/28/04	1 quartz biface
N189/E188	beach SF	7/28/04	1 quartzite primary flake
N182/E180	beach SF	7/28/04	1 quartzite primary flake
N181/E175	beach SF	7/28/04	2 quartzite primary flakes, 1 quartzite tertiary flake
N168/E145	beach STP	7/29/04	lev 1: 0-9 cm, brown sand; brick (not kept) lev 2: 9-60 cm, yellow brown sand with pebbles
N156/E137	beach SF	7/29/04	1 gray chert tertiary flake
N155/E130	beach STP	7/28/04	lev 1: 0-15 cm, brown sand lev 2: 15-60, yellow brown sand
N150/E150	u/w STP	7/28/04	dug to 45 cm; dark gray silty sand with shell; brick (not kept)
N145/E125	beach STP	7/29/04	lev 1: 0-7 cm, brown sand; 1 quartzite tertiary flake lev 2: 7-65 cm, yellow brown sand
N145/E130	beach STP	7/28/04	lev 1: 0-4 cm, brown sand; brick (not kept) lev 2: 4-60 cm, yellow brown sand; 2 wire nails
N145/E150	u/w STP	7/28/04	dug to 50 cm; dark gray silty sand with shell
N140/E125	beach STP	7/28/04	lev 1: 0-3 cm, brown sand lev 2: 3-20 cm, yellow brown sand with pebbles lev 3: 20-60 cm, brown silty sand
N140/E150	u/w STP	7/28/04	dug to 50 cm; dark gray silty sand
N135/E110	beach STP	7/28/04	lev 1: 0-17 cm, brown sand with pebbles lev 2: 17-42 cm, yellow brown sand with pebbles; 1 quartzite tertiary flake, 1 blue painted porcelain lev 3: 42-76 cm, brown sand with pebbles
N135/E120	beach STP	7/28/04	lev 1: 0-5 cm, brown sand with pebbles lev 2: 5-35 cm, yellow brown sand; 1 square cut nail lev 3: 35-65 cm, gray yellow sand
N135/E150	u/w STP	7/28/04	dug to 50 cm; dark gray silty sand
N130/E150	u/w STP	7/28/04	dug to 50 cm; dark gray silty sand
N125/E150	u/w STP	7/28/04	dug to 60 cm; dark gray silty sand with shell
N121/E107	beach SF	7/25/04	1 undetermined volcanic (basalt?) core
N120/E100	beach STP	7/28/04	lev 1: 0-10 cm, brown sand with pebbles; coal and brick (not kept) lev 2: 10-50 cm, yellow brown sand, coal and brick (not kept) lev 3: 50-80 cm, brown sand with pebbles; 1 dark gray chert tertiary flake

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N120/E105	beach STP	7/28/04	lev 1: 0-11 cm, brown sand with pebbles; iron spike, brick lev 2: 11-46 cm, yellow brown sand with pebbles; 1 dark brown chert tertiary flake, 1 green edge decorated creamware rim, brick (not kept) lev 3: 46-67 cm, orange brown sand
N120/E110	beach STP	7/28/04	lev 1:0-45 cm, yellow brown sand with pebbles; brick (not kept)
N120/E150	u/w STP	7/28/04	dug to 55 cm; dark gray silty sand with organic mat
N115/E150	u/w STP	7/28/04	dug to 55 cm; dark gray silty sand with organic mat
N110/E150	u/w STP	7/28/04	dug to 65 cm; brown sand with shell; brick (not kept)
N108/E94	beach SF	7/28/04	1 undetermined material hammerstone/core
N105/E150	u/w STP	7/28/04	dug to 65 cm; brown sand with shell
N100/E80	beach STP	7/27/04	lev 1: 0-9 cm, brown loamy sand lev 2: 9-50 cm, yellow brown sand
N100/E90	u/w STP	7/28/04	dug to 30 cm; dark gray brown silty sand with shell
N100/E95	u/w STP	7/28/04	dug to 50 cm; dark gray brown loamy sand; 1 smoking pipe stem/bowl fragment
N100/E100	u/w STP	7/28/04	dug to 70 cm; dark gray brown silty sand; brick (not kept)
N100/E110	u/w STP	7/30/04	dug to 30 cm; dark gray brown sand
N100/E120	u/w STP	7/30/04	dug to 50 cm; dark gray brown silty sand with shell; 1 quartzite tertiary flake
N100/E130	u/w STP	7/30/04	dug to 30 cm; dark gray brown silty sand with shell and rocks
N100/E135	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell
N100/E140	u/w STP	7/29/04	dug to 60 cm; dark gray brown silty sand
N100/E145	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell
N100/E150	u/w STP	7/29/04	dug to 50 cm; gray silty sand with shell and rocks; 1 redware base
N95/E90	u/w STP	7/28/04	dug to 30 cm; dark gray brown silty sand with shell
N95/E95	u/w STP	7/28/04	dug to 50 cm; dark gray brown loamy sand
N95/E100	u/w STP	7/28/04	dug to 45 cm; dark gray brown silty sand; brick (not kept)
N95/E110	u/w STP	7/30/04	dug to 25 cm; dark gray brown sand
N95/E120	u/w STP	7/30/04	dug to 60 cm; dark gray brown silty sand with shell and rocks; brick (not kept)
N95/E130	u/w STP	7/30/04	dug to 40 cm; dark gray brown silty sand
N95/E135	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell
N95/E140	u/w STP	7/29/04	dug to 45 cm; dark gray brown silty sand with shell; brick
N95/E145	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N95/E150	u/w STP	7/29/04	dug to 60 cm; gray silty sand with shell and rocks
N90/E80	beach STP	7/27/04	lev 1: 0-30 cm, light brown sand; 1 whiteware, 1 earthenware, 1 slag lev 2: 30-84 cm, brown clayey sand; 1 solarized bottle glass finish, 1 stoneware
N90/E90	u/w STP	7/28/04	dug to 30 cm; dark gray brown silty sand with shell
N90/E95	u/w STP	7/28/04	dug to 55 cm; dark gray brown loamy sand; brick (not kept)
N90/E100	u/w STP	7/28/04	dug to 40 cm; dark gray brown silty sand
N90/E110	u/w STP	7/30/04	dug to 55 cm; dark gray brown silty sand
N90/E120	u/w STP	7/30/04	dug to 50 cm; dark gray brown silty sand with shell
N90/E130	u/w STP	7/30/04	dug to 40 cm; dark gray brown silty sand with shell and rocks
N90/E135	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell
N90/E140	u/w STP	7/29/04	dug to 40 cm; dark gray brown silty sand
N90/E145	u/w STP	7/29/04	dug to 40 cm; dark brown silty sand with shell
N90/E150	u/w STP	7/29/04	dug to 55 cm; gray silty sand; brick and coal (not kept)
N85/E70	beach STP	7/27/04	lev 1: 0-40 cm, brown sand; 1 whiteware lev 2:40-75 cm, yellow brown clayey sand
N85/E90	u/w STP	7/28/04	dug to 42 cm; dark brown clayey sand with rocks
N85/E95	u/w STP	7/28/04	dug to 60 cm; dark gray brown silty sand
N85/E100	u/w STP	7/28/04	dug to 40 cm; dark gray brown silty sand
N85/E110	u/w STP	7/30/04	dug to 45 cm; dark gray brown silty sand with shell
N85/E120	u/w STP	7/30/04	dug to 40 cm; dark gray brown silty sand with shell
N85/E130	u/w STP	7/30/04	dug to 45 cm; dark gray brown silty sand with shell
N85/E135	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell
N85/E140	u/w STP	7/29/04	dug to 50 cm; dark gray brown silty sand with shell; coal (not kept)
N85/E145	u/w STP	7/29/04	dug to 45 cm; dark brown silty clay with shell
N85/E150	u/w STP	7/29/04	dug to 62 cm; gray silty sand with shell and rocks; 1 quartzite tertiary flake
N80/E90	u/w STP	7/28/04	dug to 54 cm; dark brown silty sand with rocks; 1 quartz biface fragment
N80/E95	u/w STP	7/28/04	dug to 45 cm; dark gray brown silty sand
N80/E100	u/w STP	7/28/04	dug to 40 cm; dark gray brown silty sand; 1 undetermined sedimentary tertiary flake
N80/E110	u/w STP	7/30/04	dug to 50 cm; dark gray brown silty sand

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N80/E120	u/w STP	7/30/04	dug to 50 cm; dark gray brown silty sand with shell
N80/E130	u/w STP	7/30/04	dug to 40 cm; dark gray brown silty sand with shell
N80/E135	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell
N80/E140	u/w STP	7/29/04	dug to 55 cm; dark gray brown silty sand; 1 porcelain rim, 4 porcelain, 1 earthenware
N80/E145	u/w STP	7/29/04	dug to 40 cm; dark brown silty sand with shells and rocks
N80/E150	u/w STP	7/29/04	dug to 58 cm; gray silty sand with shell
N78/E70	beach SF	7/28/04	1 quartzite core
N75/E70	beach STP	7/28/04	lev 1: 0-19 cm, brown sand with pebbles; 1 quartz tertiary flake, 1 aqua bottle glass lev 2: 19-52 cm, yellow brown sand; 1 worn gray chert tertiary flake, 1 glazed redware, 1 redware lev 3: 52-69 cm, brown sand with pebbles
N75/E90	u/w STP	7/28/04	dug to 50 cm; dark brown silty sand; 1 quartzite tertiary flake
N75/E95	u/w STP	7/28/04	dug to 50 cm; dark gray brown silty sand
N75/E100	u/w STP	7/28/04	dug to 50 cm; dark gray brown silty sand
N75/E110	u/w STP	7/30/04	dug to 45 cm; dark gray brown silty sand with shell; brick (not kept)
N75/E120	u/w STP	7/30/04	dug to 50 cm; dark gray brown silty sand with shell
N75/E130	u/w STP	7/30/04	dug to 40 cm; dark gray brown silty sand
N75/E135	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell
N75/E140	u/w STP	7/29/04	dug to 60 cm; dark gray brown silty sand with shell
N75/E145	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand
N75/E150	u/w STP	7/29/04	dug to 55 cm; gray silty sand
N71/E60	beach SF	7/26/04	1 undetermined sedimentary primary flake
N70/E60	beach STP	7/26/04	lev 1: 0-18 cm, light brown sand with pebbles lev 2: 18-39 cm, yellow brown sand with pebbles; 1 blue painted porcelain, 1 stoneware lev 3: 39-62 cm, brown sand with pebbles
N70/E70	beach STP	7/28/04	lev 1: 0-40 cm, light yellow brown sand; 1 light green bottle glass, 1 porcelain
N70/E75	beach STP	7/28/04	lev 1: 0-40 cm, light yellow brown sand; 1 black chert tertiary flake, 2 green bottle glass, 1 brown bottle glass, 1 porcelain rim, 1 stoneware, 1 nail
N70/E90	u/w STP	7/28/04	dug to 55 cm; dark brown silty sand; brick and recent ceramic (not kept)
N70/E95	u/w STP	7/28/04	dug to 50 cm; dark gray brown silty sand; brick and flat glass (not kept)

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N70/E100	u/w STP	7/28/04	dug to 50 cm; dark gray brown silty sand
N70/E110	u/w STP	7/30/04	dug to 50 cm; dark gray brown silty sand with shell
N70/E120	u/w STP	7/30/04	dug to 45 cm; dark gray brown silty sand with shell
N70/E130	u/w STP	7/30/04	dug to 10 cm; dark gray brown silty sand with shell; stopped by wood
N70/E135	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell
N70/E140	u/w STP	7/29/04	dug to 60 cm; dark gray brown silty sand
N70/E145	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand
N70/E150	u/w STP	7/29/04	dug to 52 cm; gray silty sand
N65/E64	beach SF	7/28/04	1 quartzite tertiary flake
N65/E75	beach STP	7/28/04	lev 1: 0-40 cm, light yellow brown sand; 2 black chert tertiary flakes, 1 quartz tertiary flake, 1 clear bottle glass, 1 dark green bottle glass, 1 whiteware decal rim, 2 iron
N65/E90	u/w STP	7/28/04	dug to 50 cm; dark gray brown silty sand; brick (not kept)
N65/E95	u/w STP	7/28/04	dug to 100 cm; dark gray brown silty sand; 1 glazed stoneware jug or bottle shoulder
N65/E100	u/w STP	7/28/04	dug to 50 cm; dark gray brown silty sand
N65/E110	u/w STP	7/30/04	dug to 25 cm; dark gray brown silty sand with shell; stopped by wood
N65/E120	u/w STP	7/30/04	dug to 50 cm; dark gray brown silty sand with shell
N65/E130	u/w STP	7/30/04	dug to 30 cm; dark gray brown silty sand with shell
N65/E135	u/w STP	7/29/04	dug to 60 cm; gray silty clay with shell and organic mat
N65/E140	u/w STP	7/29/04	dug to 55 cm; dark gray brown silty sand with organic mat
N65/E145	u/w STP	7/29/04	dug to 40 cm; gray silty sand with shell
N65/E150	u/w STP	7/29/04	dug to 57 cm; gray silty sand
N60/E75	beach STP	7/28/04	lev 1: 0-40 cm, light yellow brown sand; 1 black chert tertiary flake, 1 metal, 1 slag
N60/E90	u/w STP	7/28/04	dug to 50 cm; dark gray brown silty sand; 1 gray chert tertiary flake (encountered gas from 7/22/04 spill, end of line)
N60/E95	u/w STP	7/28/04	dug to 40 cm; dark gray brown silty sand
N60/E100	u/w STP	7/28/04	dug to 55 cm; dark gray brown silty sand with clay
N60/E110	u/w STP	7/30/04	dug to 45 cm; dark gray brown silty sand with shell
N60/E120	u/w STP	7/30/04	dug to 60 cm; dark gray brown silty sand with shell
N60/E130	u/w STP	7/30/04	dug to 45 cm; dark gray brown silty sand with shell
N60/E135	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N60/E140	u/w STP	7/29/04	dug to 60 cm; dark gray brown silty sand with clay
N60/E145	u/w STP	7/29/04	dug to 45 cm; gray silty clay with shell
N60/E150	u/w STP	7/29/04	dug to 55 cm; gray silty sand
N57/E75	beach SF	7/30/04	1 quartz primary flake
N55/E50	beach STP	7/26/04	lev 1: 0-7 cm, brown sand lev 2: 7-65 cm, yellow brown sand
N55/E60	beach STP	7/28/04	lev 1: 0-45 cm, yellow brown sand; 1 black chert tertiary flake, 1 clear bottle glass, 5 redware
N55/E70	beach STP	7/28/04	lev 1: 0-5 cm brown sand with pebbles lev 2:5-50 cm, yellow brown sand; 1 dark gray chert tertiary flake, 1 quartzite tertiary flake, 1 porcelain rim, 1 ironstone
N55/E95	u/w STP	7/28/04	dug to 40 cm; dark gray brown silty sand
N55/E100	u/w STP	7/28/04	dug to 70 cm; dark gray brown silty sand with clay; 1 black chert tertiary flake, 2 dark gray chert tertiary flakes
N55/E110	u/w STP	7/30/04	dug to 50 cm; dark gray brown silty sand with shell
N55/E120	u/w STP	7/30/04	dug to 50 cm; dark brown silty sand with shell
N55/E130	u/w STP	7/30/04	dug to 45 cm; dark gray brown silty sand with shell
N55/E135	u/w STP	7/29/04	dug to 40 cm; gray silty clay with shell
N55/E140	u/w STP	7/29/04	dug to 50 cm; dark gray brown silty sand
N55/E145	u/w STP	7/29/04	dug to 45 cm; gray silty clay with shell; 1 animal long bone
N55/E150	u/w STP	7/29/04	dug to 52 cm; gray silty sand
N52/E60	beach SF	7/16/04	dark gray chert tertiary flake
N50/E50	beach SF	7/26/04	1 worn quartzite biface
N50/E55	beach STP	7/28/04	lev 1: 0-5 cm, brown sand lev 2: 5-45 cm, yellow brown sand; 2 iron nails
N50/E60	beach STP	7/28/04	lev 1: 0-50 cm, yellow brown sand with pebbles; 1 black chert tertiary flake, 1 quartz tertiary flake, 1 whiteware rim, 1 redware
N50/E65	u/w STP	7/27/04	dug to 40 cm; dark brown silty sand with rocks; 1 black chert tertiary flake, 1 quartzite tertiary flake, 1 clear bottle glass finish
N50/E70	u/w STP	7/27/04	dug to 55 cm; dark brown silty sand
N50/E75	u/w STP	7/27/04	dug to 50 cm; dark brown silty sand
N50/E80	u/w STP	7/27/04	dug to 45 cm; dark gray brown silty sand with shell
N50/E85	u/w STP	7/27/04	dug to 45 cm; dark gray brown silty sand with rocks

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N50/E90	u/w STP	7/27/04	dug to 40 cm; dark gray brown silty sand with shell
N50/E95	u/w STP	7/26/04	dug to 55 cm; dark gray brown silty sand
N50/E100	u/w STP	7/26/04	dug to 45 cm; dark gray brown silty sand with shell
N50/E110	u/w STP	7/30/04	dug to 45 cm; dark gray brown silty sand with shell
N50/E120	u/w STP	7/30/04	dug to 50 cm; dark brown silty sand with shell
N50/E130	u/w STP	7/30/04	dug to 35 cm; dark gray brown silty sand with shell
N50/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N50/E140	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N50/E145	u/w STP	7/29/04	dug to 50 cm; dark gray brown silty sand with shell and organic mat
N50/E150	u/w STP	7/29/04	dug to 65 cm; dark gray brown silty sand with shell
N45/E45	beach SF	7/27/04	7 fire-cracked rock (may be modern)
N45/E50	beach SF	7/16/04	1 dark gray chert core
N45/E65	u/w STP	7/27/04	dug to 50 cm; dark brown silty sand with rocks; 1 dark gray chert primary flake, 1 undetermined material secondary flake, 1 clear curved glass
N45/E70	u/w STP	7/27/04	dug to 65 cm; dark brown silty sand; 1 dark gray chert tertiary flake, 1 nail
N45/E75	u/w STP	7/27/04	dug to 50 cm; dark brown silty sand
N45/E80	u/w STP	7/27/04	dug to 50 cm; dark gray brown silty sand with shell
N45/E85	u/w STP	7/27/04	dug to 50 cm; dark gray brown silty sand; 1 whiteware rim, 1 coal
N45/E90	u/w STP	7/27/04	dug to 40 cm; dark gray brown silty sand with shell; 1 redware
N45/E95	u/w STP	7/26/04	dug to 50 cm; dark gray brown silty sand; 1 black chert tertiary flake, 1 quartzite tertiary flake
N45/E100	u/w STP	7/26/04	dug to 55 cm; dark gray brown silty sand with shell
N45/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell and organic mat
N45/E140	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand
N45/E145	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N45/E150	u/w STP	7/29/04	dug to 65 cm; dark gray brown silty sand with shell
N42/E40	beach SF	7/13/04	1 light brown chert tertiary flake
N40/E40	beach STP	7/26/04	lev 1: 0-20 cm, light brown sand; brick (not kept) lev 2: 20-42 cm, yellow brown sand; brick (not kept) lev 3: 42-74 cm, brown sand
N40/E41	beach SF	7/27/04	2 fire-cracked rock (may be modern)

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N40/E45	beach SF	7/27/04	2 fire-cracked rock (may be modern)
N40/E47	beach SF	7/13/04	1 dark gray chert secondary flake
N40/E65	u/w STP	7/27/04	dug to 50 cm; dark brown silty sand with rocks; 1 stoneware
N40/E70	u/w STP	7/27/04	dug to 40 cm; dark brown silty sand with shell
N40/E75	u/w STP	7/27/04	dug to 50 cm; dark brown silty sand
N40/E80	u/w STP	7/27/04	dug to 35 cm; dark gray brown silty sand with rocks
N40/E85	u/w STP	7/27/04	dug to 45 cm; dark gray brown silty sand
N40/E90	u/w STP	7/27/04	dug to 45 cm; dark gray brown silty sand with shell; brick (not kept)
N40/E95	u/w STP	7/26/04	dug to 50 cm; dark gray brown silty sand; brick (not kept)
N40/E100	u/w STP	7/26/04	dug to 60 cm; dark gray brown silty sand with shell
N40/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N40/E140	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand
N40/E145	u/w STP	7/29/04	dug to 45 cm; dark brown silty sand with shell
N40/E150	u/w STP	7/29/04	dug to 50 cm; dark gray brown silty sand with shell
N39/E42	beach SF	7/13/04	1 black chert core
N38/E46	beach SF	7/16/04	1 quartzite preform/biface
N36/E49	beach SF	7/16/04	1 gray chert tertiary flake
N35/E30	beach SF	7/16/04	1 gray chert secondary flake
N35/E65	u/w STP	7/27/04	dug to 55 cm; dark brown silty sand with rocks
N35/E70	u/w STP	7/27/04	dug to 70 cm; dark brown silty sand
N35/E75	u/w STP	7/27/04	dug to 43 cm; dark brown silty sand
N35/E80	u/w STP	7/27/04	dug to 40 cm; dark gray brown silty sand with shell; coal (not kept)
N35/E85	u/w STP	7/27/04	dug to 45 cm; dark gray brown silty sand; 1 dark gray chert biface
N35/E90	u/w STP	7/26/04	dug to 30 cm; dark gray brown silty sand with shell
N35/E95	u/w STP	7/26/04	dug to 60 cm; dark gray brown silty sand
N35/E100	u/w STP	7/26/04	dug to 70 cm; dark gray brown silty sand with shell
N35/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N35/E140	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N35/E145	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N35/E150	u/w STP	7/29/04	dug to 65 cm; dark gray brown silty sand with shell

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N30/E25	beach STP	7/26/04	lev 1: 0-30 cm, brown sand; coal (not kept) lev 2: 30-40 cm, yellow brown sand lev 3: 40-55 cm, brown sand with pebbles
N30/E65	u/w STP	7/27/04	dug to 60 cm; dark gray brown silty sand with rocks
N30/E70	u/w STP	7/27/04	dug to 60 cm; dark brown silty sand with shell
N30/E75	u/w STP	7/27/04	dug to 50 cm; dark brown silty sand
N30/E80	u/w STP	7/27/04	dug to 45 cm; dark gray brown silty sand with shell
N30/E85	u/w STP	7/27/04	dug to 45 cm; dark gray brown silty sand with rocks; 1 dark gray chert projectile point (Steubenville stemmed)
N30/E90	u/w STP	7/26/04	dug to 40 cm; dark gray brown silty sand
N30/E95	u/w STP	7/26/04	dug to 50 cm; dark gray brown silty sand
N30/E100	u/w STP	7/26/04	dug to 50 cm; dark gray brown silty sand with shell
N30/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N30/E140	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N30/E145	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N30/E150	u/w STP	7/29/04	dug to 50 cm; dark gray brown silty sand with shell
N27/E30	beach STP	7/26/04	1 sedimentary secondary flake
N25/E65	u/w STP	7/27/04	dug to 70 cm; dark gray brown silty sand
N25/E70	u/w STP	7/27/04	dug to 65 cm; dark brown silty sand; 1 dark gray chert tertiary flake
N25/E75	u/w STP	7/27/04	dug to 51 cm; dark brown silty sand
N25/E80	u/w STP	7/27/04	dug to 55 cm; dark gray brown silty sand with shell; 1 quartzite tertiary flake
N25/E85	u/w STP	7/27/04	dug to 45 cm; dark gray brown silty sand
N25/E90	u/w STP	7/26/04	dug to 50 cm; dark gray brown silty sand with shell; 1 quartzite tertiary flake
N25/E95	u/w STP	7/26/04	dug to 60 cm; dark gray brown silty sand
N25/E100	u/w STP	7/26/04	dug to 55 cm; dark gray brown silty sand; 1 quartz tertiary flake
N25/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N25/E140	u/w STP	7/29/04	dug to 40 cm; dark brown silty sand with shell
N25/E145	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N25/E150	u/w STP	7/29/04	dug to 65 cm; dark gray brown silty sand with shell
N20/E10	beach STP	7/26/04	lev 1: 0-5 cm, brown sand; 1 fire-cracked rock lev 2: 5-20 cm, dark gray brown sandy silt lev 3: 20-65 cm, brown sandy silt

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N20/E20	beach STP	7/26/04	lev 1: 0-20 cm, brown sand with pebbles lev 2: 20-35 cm, yellow brown silty sand lev 3: 35-60 cm, brown sand with pebbles
N20/E65	u/w STP	7/27/04	dug to 70 cm; dark gray brown silty sand
N20/E70	u/w STP	7/27/04	dug to 70 cm; dark brown silty sand
N20/E75	u/w STP	7/27/04	dug to 50 cm; dark brown silty sand
N20/E80	u/w STP	7/27/04	dug to 50 cm; dark gray brown silty sand with shell; 1 quartz tertiary flake
N20/E85	u/w STP	7/27/04	dug to 40 cm; dark gray brown silty sand
N20/E90	u/w STP	7/26/04	dug to 40 cm; dark gray brown silty sand; 1 dark gray chert tertiary flake, 1 sedimentary tertiary flake
N20/E95	u/w STP	7/26/04	dug to 55 cm; dark gray brown silty sand
N20/E100	u/w STP	7/26/04	dug to 70 cm; dark gray brown silty sand
N20/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N20/E140	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N20/E145	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N20/E150	u/w STP	7/29/04	dug to 50 cm; dark gray brown silty sand with shell
N16/E6	beach SF	7/16/04	1 jasper tertiary flake
N15/E3	beach SF	7/21/04	1 black chert tertiary flake
N15/E65	u/w STP	7/27/04	dug to 50 cm; dark gray brown silty sand
N15/E70	u/w STP	7/27/04	dug to 70 cm; dark brown silty sand; 1 gray chert tertiary flake, 2 quartz tertiary flakes
N15/E75	u/w STP	7/27/04	dug to 45 cm; dark brown silty sand
N15/E80	u/w STP	7/27/04	dug to 50 cm; dark brown silty sand
N15/E85	u/w STP	7/27/04	dug to 40 cm; dark gray brown silty sand
N15/E90	u/w STP	7/26/04	dug to 45 cm; dark gray brown silty sand with shell
N15/E95	u/w STP	7/26/04	dug to 55 cm; dark gray brown silty sand
N15/E100	u/w STP	7/26/04	dug to 60 cm; dark gray brown silty sand
N15/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N15/E140	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N15/E145	u/w STP	7/29/04	dug to 40 cm; dark brown silty sand with shell
N15/E150	u/w STP	7/29/04	dug to 65 cm; dark gray brown silty sand with shell
N12/W14	beach SF	7/16/04	1 black chert tertiary flake

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N12/E2	beach SF	7/16/04	1 black chert primary flake
N11/W5	beach SF	7/16/04	1 volcanic material (basalt?) tertiary flake
N10/W40	beach STP	7/26/04	lev 1: 0-24 cm, light brown sand; coal (not kept) lev 2: 24-48 cm, brown loamy sand; 1 gray chert tertiary flake lev 3: 48-65 cm, dark brown clayey sand
N10/W34	beach SF	7/16/04	1 light gray chert tertiary flake
N10/W30	beach STP	7/26/04	lev 1: 0-46 cm, light brown sand
N10/W20	beach STP	7/26/04	lev 1: 0-20 cm, light brown sand; 1 stoneware lev 2: 20-40 cm, brown loamy sand; 1 dark gray chert tertiary flake, 2 nail fragments lev 3: 40-58 cm, dark brown loamy sand
N10/W10	beach STP	7/26/04	lev 1: 0-10 cm, brown sand (stopped by roots)
N10/E0	beach STP	7/26/04	surface: 1 smoking pipe stem lev 1: 0-14 cm, light brown sand with pebbles lev 2: 14-39 cm, yellow brown sand lev 3: 39-69 cm, brown clayey sand with pebbles
N10/E3	beach SF	7/23/04	1 quartz tertiary flake
N10/E65	u/w STP	7/27/04	dug to 50 cm; dark gray brown silty sand; 2 dark gray chert tertiary flakes, 1 brown bottle glass finish
N10/E70	u/w STP	7/27/04	dug to 70 cm; dark gray brown silty sand; 1 dark gray chert tertiary flake, 1 quartz tertiary flake
N10/E75	u/w STP	7/27/04	dug to 46 cm; dark gray brown silty sand
N10/E80	u/w STP	7/27/04	dug to 40 cm; dark gray brown silty sand with shell
N10/E85	u/w STP	7/27/04	dug to 50 cm; dark gray brown silty sand
N10/E90	u/w STP	7/26/04	dug to 50 cm; dark gray brown silty sand
N10/E95	u/w STP	7/26/04	dug to 65 cm; dark gray brown silty sand; brick (not kept)
N10/E100	u/w STP	7/26/04	dug to 40 cm; dark gray brown silty sand
N10/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N10/E140	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N10/E145	u/w STP	7/29/04	dug to 45 cm; dark brown silty sand with shell
N10/E150	u/w STP	7/29/04	dug to 50 cm; dark gray brown silty sand with shell
N9/W9	beach SF	7/16/04	1 black chert tertiary flake
N9/W6	beach SF	7/16/04	1 dark gray chert tertiary flake
N8/E6	beach SF	7/16/04	1 quartz tertiary flake
N8/E16	beach SF	7/16/04	1 black chert tertiary flake

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N7/W27	beach SF	7/16/04	1 black chert tertiary flake
N7/W16	beach SF	7/22/04	1 black chert tertiary flake
N7/E2	beach SF	7/23/04	1 gray chert tertiary flake
N6/W68	beach SF	7/21/04	1 quartzite core
N6/W29	beach SF	7/21/04	1 dark gray chert core
N6/W21	beach SF	7/16/04	1 dark gray chert tertiary flake
N6/W20	beach SF	7/16/04	1 black chert tertiary flake
N6/W7	beach SF	7/16/04	1 quartzite tertiary flake
N5/W60	beach STP	7/26/04	lev 1: 0-37 cm, light brown sand; brick (not kept) lev 2: 37-74 cm, brown loamy sand; coal and brick (not kept)
N5/W58	beach SF	7/16/04	1 brown chert primary flake
N5/W50	beach STP	7/26/04	lev 1: 0-25 cm, light brown sand; brick (not kept) lev 2: 25-32 cm, dark brown loamy sand lev 3: 32-78 cm, yellow brown loamy sand
N5/W38	beach SF	7/16/04	1 quartzite tertiary flake
N5/W24	beach SF	7/16/04	1 quartzite secondary flake
N5/E5	beach SF	7/23/04	1 dark gray chert tertiary flake
N5/E13	beach SF	7/23/04	1 quartz biface fragment
N5/E65	u/w STP	7/27/04	dug to 45 cm; dark gray brown silty sand; 1 nail
N5/E70	u/w STP	7/27/04	dug to 55 cm; dark brown silty sand with shell and rocks
N5/E75	u/w STP	7/27/04	dug to 20 cm; dark brown sand with rocks; 1 ironstone
N5/E80	u/w STP	7/27/04	dug to 35 cm; dark gray brown silty sand with shell
N5/E85	u/w STP	7/27/04	dug to 40 cm; dark gray brown silty sand with shell
N5/E90	u/w STP	7/26/04	dug to 50 cm; dark brown silty sand
N5/E95	u/w STP	7/26/04	dug to 50 cm; dark gray brown silty sand
N5/E100	u/w STP	7/26/04	dug to 65 cm; dark gray brown silty sand with shell
N5/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N5/E140	u/w STP	7/29/04	dug to 40 cm; dark brown silty sand with shell
N5/E145	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand
N5/E150	u/w STP	7/29/04	dug to 50 cm; dark gray brown silty sand with shell
N4/W63	beach SF	7/21/04	1 utilized quartzite tertiary flake
N4/W29	beach SF	7/16/04	1 quartzite tertiary flake

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
N4/W23	beach SF	7/16/04	1 fire-cracked rock
N4/W21	beach SF	7/16/04	1 dark gray chert core fragment
N3/W13	beach SF	7/21/04	1 quartzite tertiary flake
N2/W19	beach SF	7/21/04	1 possible quartzite tertiary flake
N2/W11	beach SF	7/16/04	1 black chert tertiary flake
N2/W5	beach SF	7/21/04	1 gray chert core fragment
N0/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand
N0/E65	u/w STP	7/27/04	dug to 40 cm; dark gray brown silty sand
N0/E70	u/w STP	7/27/04	dug to 55 cm; dark brown silty sand with shell
N0/E75	u/w STP	7/27/04	dug to 35 cm; dark brown silty sand; 1 quartzite biface
N0/E80	u/w STP	7/27/04	dug to 35 cm; dark gray brown silty sand with shell
N0/E85	u/w STP	7/27/04	dug to 45 cm; dark gray brown silty sand
N0/E90	u/w STP	7/26/04	dug to 50 cm; dark gray brown silty sand
N0/E95	u/w STP	7/26/04	dug to 40 cm; dark brown silty sand
N0/E100	u/w STP	7/26/04	dug to 50 cm; dark gray brown silty sand with shell; 1 quartz secondary flake
N0/E135	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N0/E140	u/w STP	7/29/04	dug to 50 cm; dark brown silty sand with shell
N0/E145	u/w STP	7/29/04	dug to 40 cm; dark brown silty sand
N0/E150	u/w STP	7/29/04	dug to 50 cm; dark gray brown silty sand with shell
S3/W76	beach SF	7/21/04	1 quartzite core
S5/W60	u/w STP	7/20/04	dug to 50 cm; dark brown sand with gravel
S5/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand
S5/W50	u/w STP	7/21/04	dug to 50 cm; dark brown silty sand with shell
S5/W45	u/w STP	7/21/04	dug to 35 cm; dark gray brown silty sand with rocks
S5/W40	u/w STP	7/21/04	dug to 50 cm; dark brown silty sand; 1 quartzite tertiary flake
S5/W35	u/w STP	7/21/04	dug to 55 cm; dark brown sand with rocks
S5/W30	u/w STP	7/21/04	dug to 35 cm; dark gray brown silty sand with rocks
S5/W25	u/w STP	7/21/04	dug to 20 cm; dark gray brown silty sand with rocks; 1 shale secondary flake
S5/W20	u/w STP	7/26/04	dug to 50 cm; dark gray brown sand
S5/W15	u/w STP	7/26/04	dug to 50 cm; dark gray brown sand

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
S5/W10	u/w STP	7/22/04	dug to 45 cm; dark gray brown silty sand
S5/W5	u/w STP	7/26/04	dug to 50 cm; dark brown silty sand
S10/W60	u/w STP	7/20/04	dug to 50 cm; dark brown sand with gravel
S10/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand
S10/W50	u/w STP	7/21/04	dug to 40 cm; dark brown silty sand with shell and rocks; 1 possible quartz tertiary flake
S10/W45	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand with rocks
S10/W40	u/w STP	7/21/04	dug to 55 cm; dark gray brown silty sand with rocks
S10/W35	u/w STP	7/21/04	dug to 55 cm; dark brown sand with rocks and shell; 1 lead weight
S10/W30	u/w STP	7/21/04	dug to 35 cm; dark gray brown silty sand with rocks
S10/W25	u/w STP	7/21/04	dug to 20 cm; dark gray brown silty sand with rocks
S10/W20	u/w STP	7/22/04	dug to 50 cm; dark brown silty sand
S10/W15	u/w STP	7/26/04	dug to 50 cm; dark brown sand with rocks
S10/W10	u/w STP	7/26/04	dug to 45 cm; dark gray brown silty sand
S10/W5	u/w STP	7/26/04	dug to 45 cm; dark gray brown silty sand with rocks
S15/W60	u/w STP	7/20/04	dug to 50 cm; dark brown sand with gravel
S15/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand; 1 quartzite secondary flake
S15/W50	u/w STP	7/21/04	dug to 50 cm; dark brown silty sand with shell and rocks; 1 possible shale tertiary flake
S15/W45	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand
S15/W40	u/w STP	7/21/04	dug to 55 cm; dark gray brown silty sand with rocks
S15/W35	u/w STP	7/21/04	dug to 55 cm; dark brown sand with rocks and shell
S15/W30	u/w STP	7/21/04	dug to 35 cm; dark gray brown silty sand with rocks
S15/W25	u/w STP	7/21/04	dug to 20 cm; dark gray brown silty sand with rocks
S15/W20	u/w STP	7/21/04	dug to 30 cm; dark gray brown silty sand with rocks; 1 possible quartz tertiary flake
S15/W15	u/w STP	7/26/04	dug to 55 cm; dark brown sand
S15/W10	u/w STP	7/26/04	dug to 45 cm; dark gray brown silty sand
S15/W5	u/w STP	7/26/04	dug to 40 cm; dark gray brown silty sand; 1 salt glazed stoneware
S20/W60	u/w STP	7/20/04	dug to 50 cm; dark brown sand with gravel
S20/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand
S20/W50	u/w STP	7/20/04	dug to 45 cm; dark brown silty sand with shell

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
S20/W45	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand
S20/W40	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand
S20/W35	u/w STP	7/21/04	dug to 50 cm; dark brown sand with rocks and shell
S20/W30	u/w STP	7/21/04	dug to 45 cm; dark gray brown silty sand with rocks
S20/W25	u/w STP	7/21/04	dug to 20 cm; dark gray brown silty sand with rocks
S20/W20	u/w STP	7/21/04	dug to 45 cm; dark gray brown silty sand with rocks; 1 dark gray chert core, 1 quartzite primary flake
S20/W15	u/w STP	7/26/04	dug to 50 cm; dark brown sand
S20/W10	u/w STP	7/26/04	dug to 45 cm; dark gray brown silty sand
S20/W5	u/w STP	7/26/04	dug to 40 cm; dark gray brown silty sand with rocks
S25/W60	u/w STP	7/20/04	dug to 50 cm; dark brown sand with gravel
S25/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand
S25/W50	u/w STP	7/20/04	dug to 40 cm; dark brown silty sand with shell
S25/W45	u/w STP	7/21/04	dug to 50 cm; dark brown silty sand
S25/W40	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand; 1 possible dark gray chert tertiary flake
S25/W35	u/w STP	7/21/04	dug to 50 cm; dark brown sand with rocks and shell
S25/W30	u/w STP	7/21/04	dug to 60 cm; dark gray brown silty sand
S25/W25	u/w STP	7/21/04	dug to 20 cm; dark gray brown silty sand; 1 black chert tertiary flake
S25/W20	u/w STP	7/21/04	dug to 45 cm; dark gray brown silty sand with rocks
S25/W15	u/w STP	7/22/04	dug to 50 cm; dark brown silty sand
S25/W10	u/w STP	7/26/04	dug to 45 cm; dark gray brown silty sand
S25/W5	u/w STP	7/26/04	dug to 40 cm; dark gray brown silty sand
S30/W60	u/w STP	7/20/04	dug to 50 cm; dark brown sand with gravel
S30/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand
S30/W50	u/w STP	7/20/04	dug to 45 cm; dark brown silty sand with shell
S30/W45	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand with shell and rocks
S30/W40	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand
S30/W35	u/w STP	7/21/04	dug to 55 cm; dark brown sand with rocks and shell
S30/W30	u/w STP	7/21/04	dug to 60 cm; dark gray brown silty sand
S30/W25	u/w STP	7/21/04	dug to 25 cm; dark gray brown silty sand; 1 quartzite secondary flake
S30/W20	u/w STP	7/21/04	dug to 35 cm; dark gray brown silty sand with rocks

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
S30/W15	u/w STP	7/22/04	dug to 40 cm; dark brown silty sand; 1 quartz primary flake
S30/W10	u/w STP	7/22/04	dug to 45 cm; dark gray brown silty sand
S30/W5	u/w STP	7/26/04	dug to 45 cm; dark gray brown silty sand; 1 clear molded bottle glass
S35/W60	u/w STP	7/20/04	dug to 50 cm; dark brown sand with gravel
S35/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand; 1 possible quartzite primary flake
S35/W50	u/w STP	7/20/04	dug to 45 cm; dark brown silty sand with shell
S35/W45	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand with shell
S35/W40	u/w STP	7/21/04	dug to 60 cm; dark gray brown silty sand with rocks
S35/W35	u/w STP	7/21/04	dug to 55 cm; dark brown silty sand with rocks 1 possible quartzite tertiary flake
S35/W30	u/w STP	7/21/04	dug to 35 cm; dark gray brown silty sand; brick (not kept)
S35/W25	u/w STP	7/21/04	dug to 40 cm; dark gray brown silty sand; brick (not kept)
S35/W20	u/w STP	7/21/04	dug to 40 cm; dark gray brown silty sand
S35/W15	u/w STP	7/22/04	dug to 40 cm; dark brown silty sand with shell and rocks
S35/W10	u/w STP	7/22/04	dug to 45 cm; dark gray brown silty sand
S35/W5	u/w STP	7/26/04	dug to 50 cm; dark gray brown silty sand
S40/W60	u/w STP	7/20/04	dug to 50 cm; dark brown sand with gravel
S40/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand
S40/W50	u/w STP	7/20/04	dug to 35 cm; dark brown silty sand with shell
S40/W45	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand
S40/W40	u/w STP	7/21/04	dug to 35 cm; dark gray brown silty sand with shell and rocks
S40/W35	u/w STP	7/21/04	dug to 45 cm; dark brown sand with shell; 1 redware
S40/W30	u/w STP	7/21/04	dug to 20 cm; dark gray brown silty sand with rocks
S40/W25	u/w STP	7/21/04	dug to 35 cm; dark gray brown silty sand with shell
S40/W20	u/w STP	7/21/04	dug to 55 cm; dark gray brown silty sand with shell
S40/W15	u/w STP	7/22/04	dug to 40 cm; dark brown silty sand with shell and rocks; 1 quartzite primary flake
S40/W10	u/w STP	7/26/04	dug to 40 cm; dark gray brown silty sand
S40/W5	u/w STP	7/26/04	dug to 20 cm; dark gray brown silty sand
S45/W60	u/w STP	7/20/04	dug to 50 cm; dark brown sand with gravel; 1 pearlware handle
S45/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand
S45/W50	u/w STP	7/20/04	dug to 30 cm; dark brown silty sand with shell

Appendix E. Continued.

Coordinates	Unit Type	Date	Finds/Comments
S45/W45	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand with shell
S45/W40	u/w STP	7/21/04	dug to 40 cm; dark gray brown silty sand with shell; 1 sedimentary tertiary flake
S45/W35	u/w STP	7/21/04	dug to 45 cm; dark gray brown silty sand with shell
S45/W30	u/w STP	7/21/04	dug to 60 cm; dark gray brown silty sand
S45/W25	u/w STP	7/21/04	dug to 35 cm; dark gray brown silty sand with shell
S45/W20	u/w STP	7/22/04	dug to 55 cm; dark gray brown silty sand with shell
S45/W15	u/w STP	7/22/04	dug to 60 cm; dark brown silty sand with shell and rocks
S45/W10	u/w STP	7/22/04	dug to 50 cm; dark gray brown silty sand
S45/W5	u/w STP	7/26/04	dug to 45 cm; dark gray brown silty sand
S50/W60	u/w STP	7/20/04	dug to 50 cm; dark brown sand with gravel
S50/W55	u/w STP	7/20/04	dug to 50 cm; dark brown sand
S50/W50	u/w STP	7/20/04	dug to 40 cm; dark brown silty sand with shell
S50/W45	u/w STP	7/21/04	dug to 50 cm; dark gray brown silty sand with shell and rocks
S50/W40	u/w STP	7/21/04	dug to 40 cm; dark gray brown silty sand with shell
S50/W35	u/w STP	7/21/04	dug to 30 cm; dark gray brown silty sand with shell
S50/W30	u/w STP	7/21/04	dug to 35 cm; dark gray silty sand
S50/W25	u/w STP	7/21/04	dug to 30 cm; dark gray brown silty sand
S50/W20	u/w STP	7/22/04	dug to 55 cm; dark gray brown silty sand; 1 basalt tertiary flake
S50/W15	u/w STP	7/22/04	dug to 50 cm; dark brown silty sand with shell and rocks; 1 black chert tertiary flake
S50/W10	u/w STP	7/22/04	dug to 40 cm; dark gray brown silty sand
S50/W5	u/w STP	7/26/04	dug to 40 cm; dark gray brown silty sand with shell