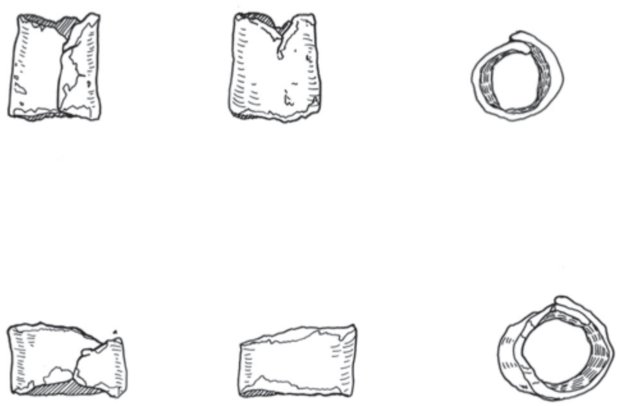
Chapters in the Archeology of Cape Cod, IV: Faunal Analysis and Metallurgical Analysis from the Cape Cod National Seashore Archeological Survey

Edited by Francis P. McManamon
with contributions by S. Terry Childs, Francis P. McManamon, and Arthur Spiess



Cape Cod National Seashore
National Park Service
U.S. Department of the Interior
2011

Report Certification

The archeological report "Chapters in the Archeology of Cape Cod, IV: Faunal Analysis and Metallurgical Analysis from the Cape Cod National Seashore Archeological Survey" edited by Francis P. McManamon, dated 2011 has been reviewed against the criteria contained in 43 CFR Part 7.18(a)(1) and upon recommendation of Dr. Steven R. Pendery, Acting Manager Northeast Region Archeology Branch, has been classified as "Available."

Superintendent

4/25/11
Date

Classification Key Words:

"Available" - Making the report available to the public meets the criteria of 43 CFR 7.18 (a)(1).

"Available (deletions)" - Making the report available with selected information on site locations and/or site characteristics deleted meets the criteria of 43 CFR (a) (1). A list of pages, maps, paragraphs, etc. that must be deleted from each report in this category is found below.

"Not Available" - Making the report available does not meet the criteria of 43 CFR (a) (1).

Chapters in the Archeology of Cape Cod, IV:
Faunal Analysis and Metallurgical Analysis
from the Cape Cod National Seashore Archeological Survey

Editor's Acknowledgements: This publication has been assembled, copy-edited, designed, and produced by Marianne McCaffery, Program Assistant for Interpretation and Cultural Resources Management. Without Marianne's diligent and skillful work this publication would not exist. Consistent and essential support for the project has been provided by Sue Moynihan, Chief of Interpretation and Cultural Resources Management, and Park Superintendent George Price.

The authors of the reports published together in this volume have been exceptionally patient over the decades between when they completed their manuscripts and the appearance of this publication. Despite the time lag, they willingly, and even more to their credit, quickly reviewed the newly edited versions of their texts when requested to do so.

My thanks to all of these individuals for their help in getting this report into the published literature about Cape Cod archeology.

Francis P. McManamon, 13 May 2011

Cover illustration: Line drawing of the copper beads from site 19Bn390 in the Nauset Harbor area. A piece of the top bead was used for the metallographic and chemical analysis reported by Terry Childs beginning on page 55.

Cape Cod National Seashore
National Park Service, Department of Interior
Wellfleet, MA

Chapters in the Archeology of Cape Cod, IV: Faunal Analysis and Metallurgical Analysis from the Cape Cod National Seashore Archeological Survey/Edited by Francis P. McManamon with contributions by S. Terry Childs, Francis P. McManamon, and Arthur Spiess

TIC# 609/107592

Incudes bibliographic references.

TABLE OF CONTENTS

Preface
Superintendent, George E. Price, Jr. .... page v

Introduction and Background .... page 1
Francis P. McManamon

Cape Cod National Seashore Archeological
Survey Faunal Analysis - Arthur Spiess
Chapter 1, Background and Methods of Analysis .... page 13
Chapter 2, Site 19BN308 Faunal Remains .... page 25
Chapter 3, Faunal Remains from Other Sites .... page 33
Chapter 4, Discussion and Summary .... page 37
References Cited .... page 38

Copper Remains on Cape Cod:
A Metallurgical Analysis of Two Objects - S. T. Childs
Acknowledgements .... page 66
Introduction .... page 67
Study Sample and Foci .... page 67
Copper Bead .... page 68
Copper Sheet Metal .... page 69
Conclusion .... page 71
References Cited .... page 72

List of Tables and Figures

Cape Cod National Seashore Archeological Survey Faunal Analysis

TABLE 2.1:	19BN308 Numbers of Bones: Strata for Concentration 308.33	page 41
TABLE 2.2:	19BN308, Numbers of Bones: Strata for Concentrations 308.42 and 308.71	page 43
TABLE 2.3:	19BN308, Numbers of Bones: Other Concentrations	page 45
TABLE 2.4:	19BN308, Numbers of Bones: Additional Concentrations	page 46
TABLE 2.5:	Total Bone Weights, Concentration 308.33	page 47
TABLE 2.6:	19BN308, *Odocoileus* Epiphyseal Fusion	page 48
TABLE 2.7:	Deer Postcranial Measurements for 19BN308	page 48
TABLE 2.8:	Historic Dog Burial, 19BN308 - Excavation Unit 004, Levels 030 and 040, Concentration 308.00	page 49
TABLE 2.9:	19BN308 Column Samples from Excavation Units 306, 307, 312-316 Excluding Features (weight in grams/count)	page 50
TABLE 2.10:	19BN308 Comparison of Hand-Excavated Faunal Samples and Column Faunal Samples	page 51
TABLE 2.11:	Identifiable Bones from 19BN308: Excavation Units 0306, 0307, 0312-0316 - Column Samples Divided by Method of Recovery	page 52
TABLE 3.1:	Sites with the Smallest Faunal Sample, Bone Counts	page 54
TABLE 3.2:	Cod Otolith Sections from 19BN415	page 56
TABLE 3.3:	Small Faunal Sample Collections, Bone Counts	page 57
TABLE 3.4:	19BN341, Deer Demography for Postcranial Epiphyseal Fusion	page 59
TABLE 3.5:	*Odocoileus* Metric Comparisons	page 60
TABLE 4.1:	Intersite Comparisons Using Gross Attributes of the Faunal Collection	page 61

Copper Remains on Cape Cod:
A Metallurgical Analysis of Two Objects

FIGURE 1A.	Horizontal view of beads showing seams (scale is in centimeters)	page 75
FIGURE 1B.	Vertical view of beads (scale is in centimeters)	page 75
FIGURE 2.	Line drawing of beads from 19BN390. A piece of the top bead was used for metallographic and chemical analysis	page 76
FIGURE 3.	Annealing twins in a section of the copper bead (200x)	page 77
FIGURE 4.	Evidence of severe cold working visible beneath annealing twins in a section of the copper bead (100x).	page 77
FIGURE 5A.	Horizontal view of sheet metal piece from the midden above the Indian Neck Ossuary (19BN287)	page 78
FIGURE 5B.	Vertical view of sheet metal piece from the midden above the Indian Neck Ossuary (19BN287)	page 78
FIGURE 6.	Annealing twins in relation to inclusion of cuprous oxide and tiny specks of other inclusions in a section of the sheet fragment (200x).	page 79
FIGURE 7.	Evidence of the cold working at the edge of the sheet metal fragment where the annealed structure becomes elongated (200x).	page 79
TABLE 1:	Results of optical spectroscopy on the two copper objects	page 80

PREFACE

The archeology of Cape Cod has been of interest to inhabitants and visitors for hundreds of years. One of those tourists was the American essayist, Henry David Thoreau. Thoreau visited the Outer Cape in October 1849; June, 1850; and, July 1855, for a total of about three weeks. In his travel narrative about the region, *Cape Cod* (published originally in 1865), Thoreau observed that Cape Cod was once "thickly settled" by Indians and that traces of their occupation, in the form of "arrow-heads," and piles of shell, ashes, and deer bones, could be seen around the marsh edges and inlets throughout the Cape.

More systematic and concerted archeological studies of the Outer Cape have been undertaken by the National Park Service (NPS) since 1961, when the Cape Cod National Seashore (CACO) was created. For example, as part of the background research and planning done by the NPS as the creation of the national seashore was being considered, Ross Moffett, a well-respected avocational archeologist, who lived in Provincetown and was very knowledgable about the archeology of the Outer Cape, was asked by the NPS to prepare a report on the archeological sites within and near the planned seashore. In 1957, the Massachusetts Archaeological Society had published a long and detailed essay by Moffett on the archeology of Cape Cod based on his decades-long study of archeological sites on the Outer Cape. Moffett's 1962 report to the NPS constituted the seashore's initial inventory of the archeological sites within its boundaries. About 20 years after the creation of the seashore, between 1979 and 1985 the NPS conducted an archeological survey of the entire national seashore area.

The archeological investigations reported in this volume are two of the studies done as part of this parkwide survey. The introduction in this report summarizes and provides citations to many of the published studies done as part of the investigation during the early 1980s, as well as the citations of Moffett's reports. Together, the Moffett and NPS surveys of the archeology of the Outer Cape identified many ancient and historic period sites within and near the seashore.

The areas around Nauset Harbor in Eastham and High Head in North Truro contained high concentrations of sites. Additional archeological investigations were carried out at some of the sites in these two areas. The results of the CACO Archeological Survey have been published in a series of technical reports, articles, and conference papers. More recently, the seashore staff has used information from the survey to create a series of informative web pages describing some of the wealth of information about the Outer Cape's archeology, now posted on the park's website: www.nps.gov/caco/historyculture/the-archeology-of-outer-cape-cod.htm

.

This report about faunal remains and metal artifacts found in some of the sites discovered and evaluated during the CACO Archeological Survey continues the reporting on the Survey's results. The sites and archeological remains described and analyzed in this report are located in the Nauset Harbor area (19Bn308, and others), near Wellfleet Harbor (19Bn387), and at High Head (19Bn415/481)

Since the seashore-wide survey of the 1980s more archeological and historical studies have been undertaken, some of them as part of planning for developments in the seashore, others to improve our understanding of the ancient and historic inhabitants and their ways of life for interpretive purposes. Some studies, for example, the data recovery project conducted from 1990-1992 at the Carns Site at Coast Guard Beach (also described on the park's archeological web pages), have responded to the erosion of sites caused by rising sea level or other forces of nature. The range of archeological and historical studies is one of the examples of the stewardship responsibilities carried out by the national seashore staff and other NPS experts and cooperators.

continued

About 30 years have passed since the CACO Archaeological Survey was started. There still is information that can be derived from the collections and records that this study generated.

We have additional reports that we hope to complete and publish like this one about the faunal remains and metal artifacts. Future studies of the artifacts and records of the CACO Archeological Survey also are possible and we encourage researchers to develop research projects using them. The national seashore is a wonderful recreation resource, but it also encompasses a treasure trove of historic and archeological data and resources.

The publication of this report and distribution of the information it contains is both an example and affirmation of the ongoing commitment to the stewardship of the cultural resources of the Cape. Its completion and publication in the 50th anniversary year of the national seashore underscores the continuing mission of the NPS on Cape Cod.

George Price
Superintendent, Cape Cod National Seashore
June 2011

Cape Cod National Seashore Archeological Survey

INTRODUCTION AND BACKGROUND

Faunal Analysis and Metallurgy Studies

Francis P. McManamon

Between 1979 and 1985 the National Park Service conducted an archeological survey of most of the area of the Cape Cod National Seashore (CACO). Many ancient and historic period sites were identified and evaluated. Some of the evaluated sites also had small areas excavated. The areas around Nauset Harbor in Eastham and High Head in North Truro contained high concentrations of sites. Additional archeological investigations were carried out at some of the sites in these two areas. Figure 1 shows locations of the sites and general areas described in the faunal and metallurgical analyses included in this report. Other results of the CACO Archeological Survey have been published in a series of technical reports, articles, and conference papers (e.g., Borstel 1985, 1986; McManamon 1981, 1982; McManamon [editor] 1984, 1985; McManamon, Bradley, and Magennis 1986; McManamon and Bradley 1986, 1988). Some of the information also has been presented in a series of web pages posted on the park's website (Cape Cod National Seashore 2009).

This report, which describes and interprets faunal remains and metal artifacts found in some of the prehistoric period sites discovered and evaluated during the CACO Archeological Survey, continues the reporting on the Survey's results. The sites and archeological remains described and analyzed in this report are located in the Nauset Harbor area (19Bn308, 19Bn390, and others), near Wellfleet Harbor (19Bn387), and at High Head (19Bn415/481, 19Bn281, 19Bn410, and others).

Sites Described in the Faunal Analysis

The Nauset Archeological District (Grumet 1995:124-126), within the southern portion of Cape Cod National Seashore has been a focus of substantial human activity and settlement on the outer Cape since at least 4,000 BC (McManamon 1984a). The oldest inhabitants of Nauset Harbor were hunters and gatherers, exploiting the natural resources of the area for subsistence. Later inhabitants practiced farming and fishing. The farming technology was simple, using stone hoes and fire-hardened wood tools to work the soil, but rewarding. French explorers and the early English settlers reported crop surpluses. The Nauset Indians were such successful horticulturalists that the Pilgrim settlers purchased corn and other crop foods from the Nauset Indians during the early years of their settlement at Plymouth, just across Cape Cod Bay (Bradford 1970; Bragdon 1996; Mourt 1962).

The first written account of the area was by Samuel de Champlain, who sailed into the harbor on July 21, 1605. In his journal Champlain wrote of a bay with wigwams bordering it all around. He went ashore with some of the crew and later described the landscape: "before reaching [the Indians'] wigwams, [we] entered a field planted with Indian corn… [which] was in flower, and some five and a half feet in height. ... We saw Brazilian beans, many edible squashes…tobacco, and roots which they cultivate …(Champlain 1922: 353)." He also reported the round wigwams, covered by a thatch made of reeds, and the people's clothing, woven from grasses, hemp, and animal skins. As the expedition cartographer, Champlain has left us an informative map of the Nauset Harbor area (Figure 2). When he returned the next year, Champlain recorded in his journal that about 150 people were living around Nauset Harbor and about 500-600 were living around Stage Harbor to the south in the area of present day Chatham (McManamon 2009).

After 1620, English colonists from the settlement at Plymouth visited Nauset many times to buy food and trade. Unfortunately, along with the trade goods, European diseases for which the Indians had

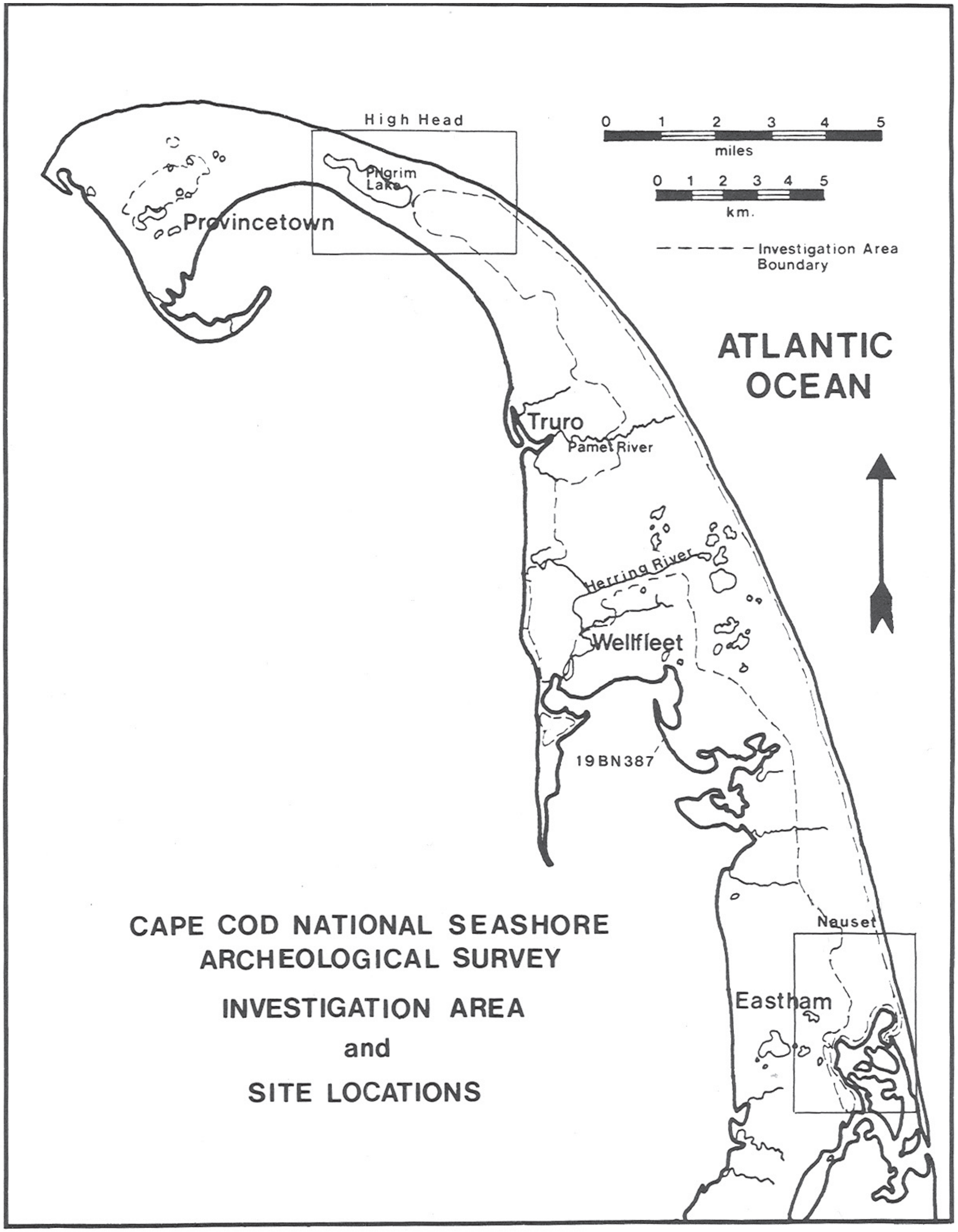


Figure 1. General locations and site locations mentioned in the text.

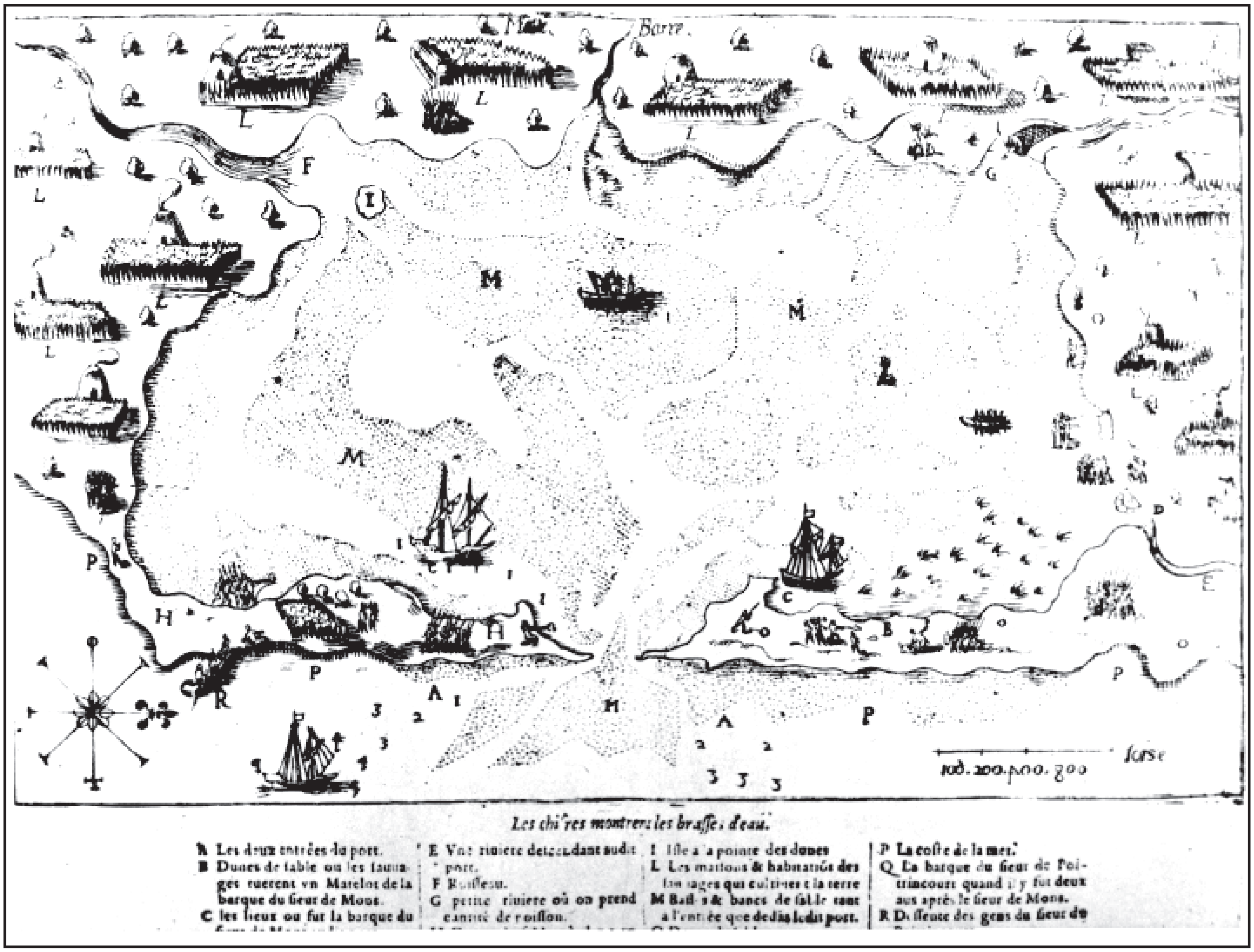


Figure 2. Map by Samuel de Champlain of Nauset Harbor, July 1605 (Champlain 1922: following page 385)

no immunity were spread by these contacts. Many of the Nauset Indians died and the population declined drastically. In 1639, about half the English from Plymouth relocated to the Nauset area, settling the town that is now Eastham.

The CACO Archeological Survey located, tested, and evaluated a number of sites in the Nauset Harbor area. In his faunal report, Spiess describes the remains recovered from sites and areas within sites stretching from Fort Hill north to the area east of Salt Pond (Figure 3).

Fort Hill and Other Nauset Concentrations

Below the modern surface Fort Hill in Eastham is covered by a large archeological site, designated as 19Bn308. The CACO Archeological Survey tested archeological site areas by placing a systematic grid of shovel tests within the area to discover where artifact and other remains were concentrated. The parts of sites where archeological remains were most dense were identified and designated as sub-site “concentrations.” Much of the description and analysis done of the Survey fieldwork results uses the concentrations as the units of analysis and interpretation (McManamon 1984b). Many of the concentrations in the Fort Hill area are characterized as “general middens,” by which is meant the deposits contain artifacts and other remains indicating a wide range of activities were undertaken in or nearby them (McManamon 1984a).

Three of these concentrations, 19Bn308.33, 19Bn308.42 and 19Bn308.71, all of them located along the southern base of the hill, had relatively high amounts of faunal remains recovered by the tests and excavations and all of them, plus other concentrations in the Nauset area are included in Spiess' analysis. In the Nauset area, the faunal remains recovered by excavation units in Concentration 19Bn308.33, located within the site 19Bn308 on the southeastern side of Fort Hill are described in the most detail. Based on the analysis of initial Survey results, Concentration 19Bn308.33 was selected for additional excavation. This area contained among the most dense and intact archeological deposits discovered by the Survey.

In 1983, a portion of Concentration 308.33 was excavated in order to examine the buried prehistoric midden and other undisturbed archeological deposits in this area that extend below the historic period plow zone (Fitzgerald and McManamon 1992).

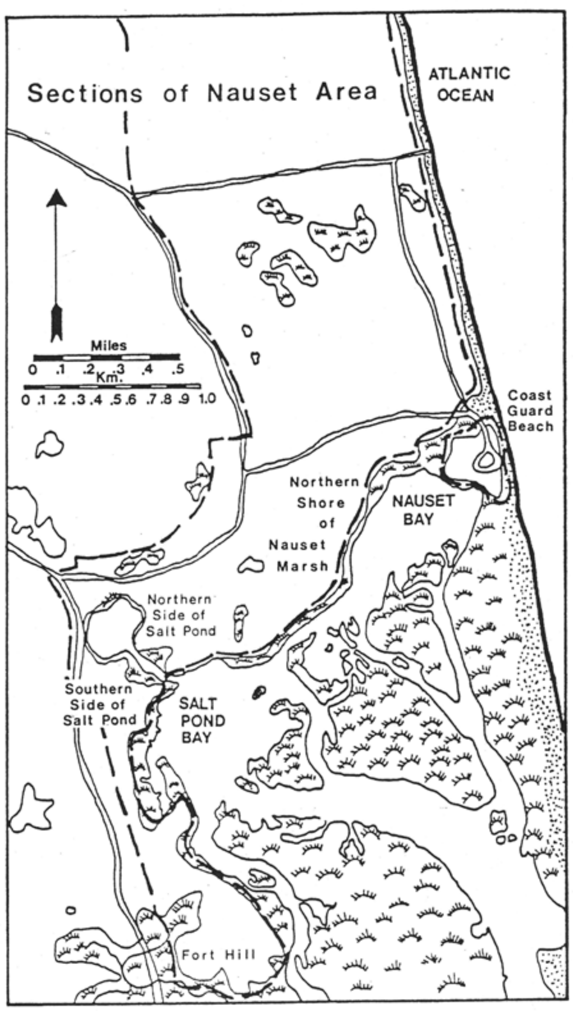


Figure 3. General site location in the Nauset Harbor area

Most of the faunal remains described and analyzed by Spiess come from this excavated area of approximately 11 square meters within the concentration (Figure 4). Although there are additional faunal remains described in Spiess' report from other parts of 19Bn308, the numbers of remains are too small for meaningful comparative analysis. Spiess (Chapters 2 and 4 of Faunal report, this volume) interprets the faunal remains from Concentration 308.33 using the six different strata identified by Fitzgerald in the 1983 excavation and noted in Figure 4.

With the caveat that the sample sizes are relatively small, even within the 19Bn308.33 levels, Spiess notes some difference in the intensity of faunal exploitation between the later Woodland period levels and the Late Archaic level. In the former, more species, including small fish and mammals are present, indicating that they were being fished, hunted, or trapped by the later occupants of the area than in earlier times. Regarding season of occupation, Spiess notes evidence of multiple seasons of occupation at Fort Hill by the Woodland residents. The Late Archaic sample did not include remains susceptible to seasonality analysis. Faunal remains from three other sites in the Nauset area: 19Bn323 on the north side of Fort Hill, 19Bn341 south of Salt Pond, and 19Bn398 on the northern side of Salt Pond (Figure 3), are common enough for some comparisons with 19Bn308.33. 19Bn323 has a relative high frequency of flounder, skate, and sturgeon remains compared to mammal and bird bones. At 19Bn341, cod, deer, and eel bones dominate, at 19Bn390 turtle and herring are most common.

Sites at High Head

Another concentration of ancient sites is located at High Head in Truro (Figures 1 and 5). There are many archeological sites in this area. However, most of them lack the dense deposits of trash that archeologists generally associate with permanent settlements. Ancient inhabitants were using the High Head area regularly from at least 5,000 years ago, but with a few exceptions (e.g., 19Bn281 [Borstel

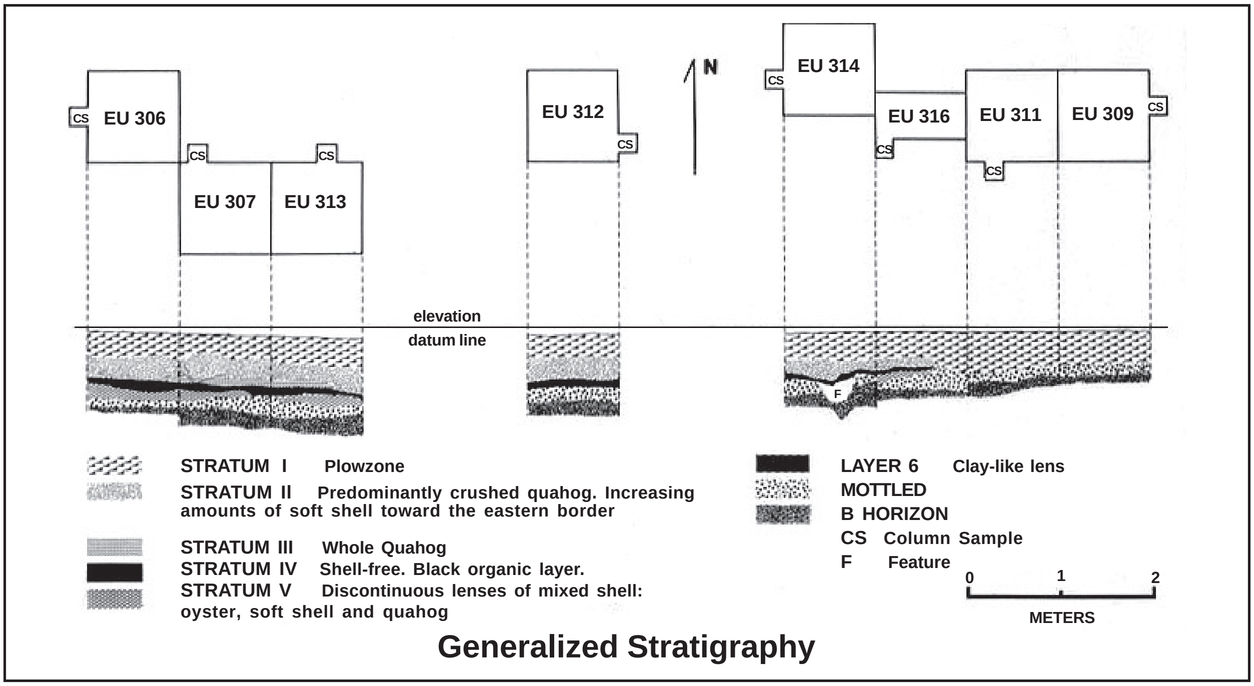


Figure 4. Generalized archeological stratigraphy for Concentration 19Bn308.33 based on 1983 excavations.

1985]), the activities seem to have been relatively short-term, perhaps specialized hunting or gathering of material or food that grew naturally in the area. Camps probably were set up to carry out these specialized activities and briefly occupied for short periods of a few days or weeks. The ancient archeological sites in this area are relatively small and covered by soil and vegetation. Archeological deposits consist mainly of discarded stone tools, stone fragments broken off when tools were resharpened or maintained in other ways, and stone used for heating in cooking or campfires.

Based on this general description, readers may correctly conclude that few faunal remains were recovered from sites in this area. Site 19Bn281 located about a half mile south of the northern edge of High Head was discovered and tested extensively in 1979 and 1980. Borstel (1985) conducted substantial excavations at the site in 1983. Just north of 19Bn281, is site 19Bn 415/481, where faunal remains were discovered and recovered in 1982 fieldwork. The site seems to have Early or Middle Woodland components, suggesting that further fieldwork might locate midden deposits beneath the modern sandy covering soil. However, additional work has not been undertaken at this location. The 1982 investigation recovered sufficient faunal remains for Spiess to note the collection in his report. Deer and seal bone and teeth were found. Sectioning of teeth indicated a season of kill for the deer at summer or early fall. The seal bone suggested June or July seal hunting along the nearby Atlantic coast or Cape Cod Bay shore. The faunal assemblage also included a high proportion of skate bones and small duck bones (Spiess, Chapter 3, Faunal report, this volume).

Sites Where Copper Artifacts Were Found

Copper artifacts were found at two sites during the CACO Archeological Survey, 19Bn390 in the Nauset area and 19Bn387, the Indian Neck ossuary near Wellfleet Harbor on the Massachusetts Bay side of Cape Cod. Site 19Bn390 is located on the north side of Salt Pond, in Eastham (Figure 3). The site area is in a wide swale currently covered by an open woodland. The north side of Salt Pond generally is an area of gently undulating topography of open fields and woodlands with some dense evergreen stands (McManamon 1984c:71-77). The copper bead used for Childs' analysis is one of two from the same archeological context. The beads

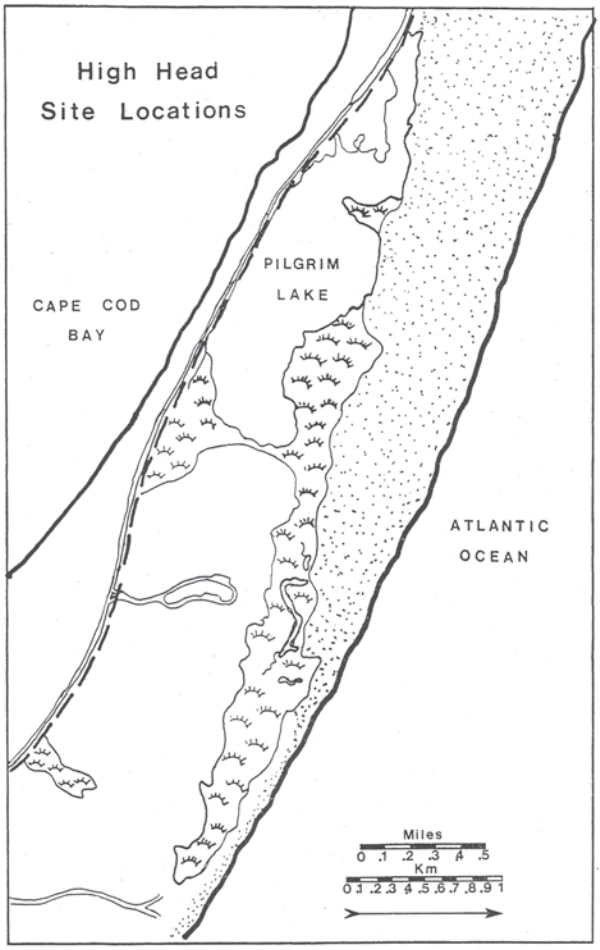


Figure 5. General site locations in the High Head area.

were found in association with ceramics dated by their style to the Early or Middle Woodland time periods. The excavation unit (Excavation Unit 6) and level where the beads were found was near an ancient archeological feature (Excavation Unit 9, Feature 01) that contained burned shell and wood, along with unburned shell and other cultural material. Charcoal from Feature 01 has been radiocarbon-dated to 1600 +/- 130 B. P., or roughly A.D. 220-480.

The area of site 19Bn390, where the beads were found, also contains artifacts that stylistically could be dated to a wide range of time periods from Late Archaic to Late Woodland (Borstel 1984:277-279). So, the bead that is described and analyzed by Childs in this reports seems clearly to be from pre-European times, but exactly when the bead was manufactured during ancient times is not certain. Childs' analysis of the decorative techniques and temper materials in pottery sherds from the 19BN390 site area suggests an Early and Middle Woodland period occupation, as well as a shorter Late Woodland occupation overall for the site (Childs 1984:245).

The other copper artifact described and analyzed in Childs' report, a piece of sheet copper, was found in layer of midden located above the ossuary burial feature in the Indian Neck Ossuary site (19Bn387) in Wellfleet (Figure 1).

At site 19Bn387, the midden was overlain by 5-10 cm layer of recent top soil and sand (Figure 6). The midden itself was a black organic soil layer with fragments of shell, animal bone, stone debris, and very small pottery fragments. The pottery types and stone projectile point types found in the midden layer are typically are found in Late Woodland and Contact period sites (i.e., post A. D. 1200) (Bradley et al. 1982; McManamon and Bradley 1986:3, 14-19). Childs' analysis of the sheet copper indicates that this artifact was manufactured in Europe. This information is consistent with the other artifacts found in the midden layer indicating a later date for the midden layer than for the ossuary feature below it.

Like Nauset Harbor, the Wellfleet Harbor area was another focus of ancient activity and settlement, this one on the bay side of the Cape. One of the most interesting sites in this area is the Indian Neck Ossuary, a site with deposits from at least two different time period, the lowest of which contains a burial dating to about AD 1100. The copper sheet metal artifact analyzed by Childs and reported here post dates the ossuary burial for which the site is best known. The presence of the midden deposit in which the copper artifact was found post-dating the burial feature indicates that settlement in the area continued through the Late Woodland and into the Contact period after the ossuary was constructed.

The burial feature below the later midden, of course, is of great interest. "Ossuary" refers to a secondary burial that contains the remains of multiple individuals.

The burials are referred to as "secondary" because the remains gathered together in an ossuary typically have been buried or exposed elsewhere first. During the original temporary burials the flesh and soft parts of the bodies have decomposed, so by the time the individual remains are collected for the ossuary, only the bones remain. In North America, the ossuary form of burial is well known from the periods just before European colonization in the Chesapeake region and northwestern New York and adjacent Ontario. The Indian Neck Ossuary is the best known and most completely reported of this burial type in New England (Bradley et al, 1982; McManamon, Bradley and Magennis 1986; McManamon and Bradley 1988).

The site was discovered accidentally in 1979 when a backhoe operator digging a trench for a home improvement project on private land uncovered human bones. After ascertaining that the human remains were not related to a homicide or other recent event, archeologists from the National Park Service, with the agreement of the landowner and approval of CACO Superintendent Herb Olsen, conducted an archeological salvage excavation to recover the remains and information about them before the site was destroyed by the planned construction. The ossuary burial was quite spatially concentrated with all the human bone packed together tightly and covering a roughly oval area, with maximum dimensions of approximately 1.5 meters by 3 meters. The portion of the site that was excavated consisted of the half of the ossuary that was not destroyed by the original backhoe digging. It contained the remains of at least 56 individuals. Most age groups, from infants to adults,

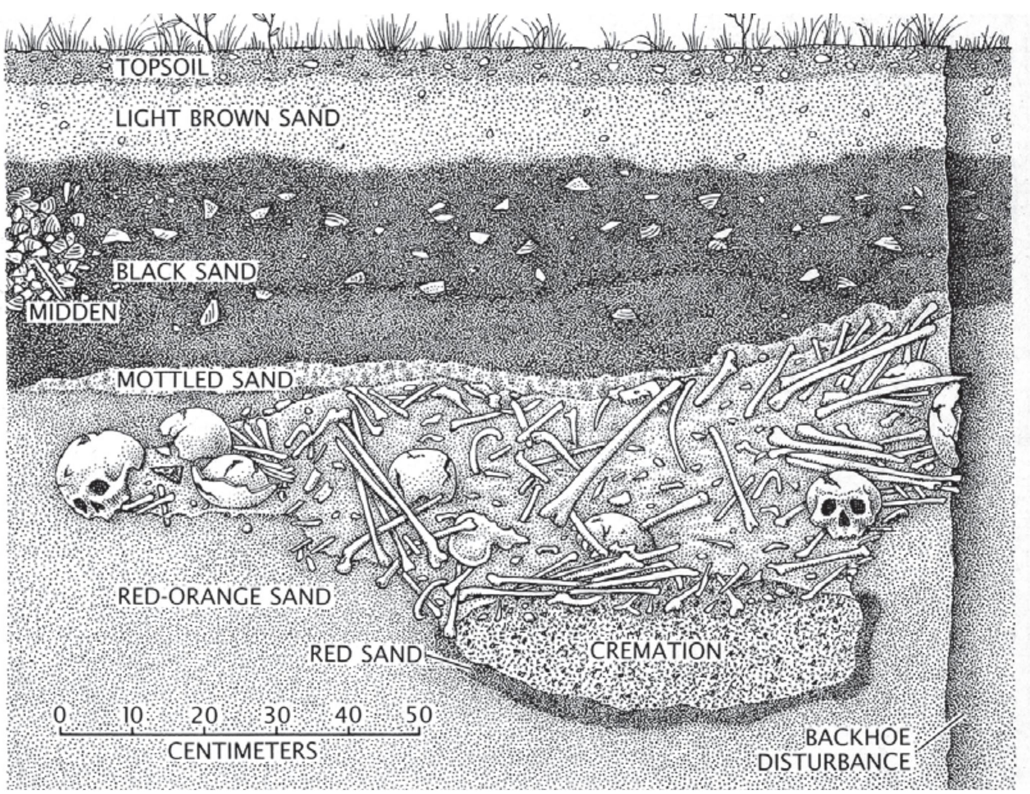


Figure 6: General archeological stratigraphy of the Indian Neck ossuary site, 19Bn387 (McManamon and Bradley 1986:16, 1988:101)

and both sexes were represented in proportion to their expected occurrence in a typical human population, except for an absence of very young infants. Judging from the condition of the bone, the community represented by this burial population was relatively healthy. There was little evidence of any dental decay, infectious disease, or malnutrition. The absence of tooth decay suggests that the diet did not at this time include substantial amounts of ground maize, so intensive horticulture probably was not practiced at this time in the area. The ossuary suggests a centralized and communal burial practices which in turn indicates a sedentary settlement pattern.

This site, plus other evidence from sites in the Nauset area support the existence of settled village life by inhabitants of Cape Cod by at least 1000 years ago.

Summary

This chapter summarizes the archeological and chronological contexts of the more detailed faunal and metallurgical studies by Spiess and Childs that comprise the bulk of this Survey report. Readers who are interested in more details should refer to the detailed descriptions and analyses already published as part of the Cape Cod National Seashore Archeological Survey, in particular McManamon [editor] 1984, Bradley, et al. 1982, and McManamon, Bradley, and Magennis 1986.

References

Borstel, Christopher L.
1984 Prehistoric Site Chronology: A Preliminary Report. In *The Cape Cod National Seashore Archeological Survey: 1979-1981 Results, Chapters in the Archeology of Cape Cod, I*, (volume 1), edited by Francis P. McManamon, pp. 231-300. National Park Service, Boston, MA.

Borstel, Christopher L.
1985 *The Cape Cod National Seashore Archeological Survey: Excavations at Site 19Bn281, Chapters in the Archeology of Cape Cod, II*. National Park Service, Boston, MA.

Borstel, Christopher L.
1986 Current Directions in the Archaeology of Cape Cod and the Islands: An Introduction. *Bulletin of the Massachusetts Archaeological Society* 47(1):1-5.

Bradford, William
1970 *Of Plymouth Plantation, 1620 - 1647*, edited by Samuel Eliot Morison. Alfred A. Knopf, New York.

Bradley, James W. and Francis P. McManamon, T. Mahlstadt, and A. Magennis
1982 The Indian Neck Ossuary: A Preliminary Report. *Bulletin of the Massachusetts Archaeological Society* 43(2):47-59.

Bragdon, Kathleen J.
1996 *Native People of Southern New England: 1500-1650*. University of Oklahoma Press, Norman and London.

Cape Cod National Seashore (CACO)
2009 Archeological web pages <http://www.nps.gov/caco> Accessed, 1 March 2009

Champlain, Samuel de
1922 *The Works of Samuel de Champlain, Volume I (1599-1607)*, edited by H. P. Bigger. The Champlain Society, Toronto.

Childs, S. Terry
1984 Prehistoric Ceramic Remains. In *The Cape Cod National Seashore Archeological Survey: 1979-1981 Results, Chapters in the Archeology of Cape Cod, I*, (volume 2), edited by Francis P. McManamon, pp. 195-278 National Park Service, Boston, MA.

Fitzgerald, Joyce and Francis P. McManamon
1992 *1983 Excavation at 19Bn308, Fort Hill*. Unpublished draft report, copy on file, Cape Cod National Seashore, Wellfleet, MA.

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

McManamon, Francis P.
1981 The Cape Cod National Seashore Archeological Survey: A Summary of 1979-1980 Results. *Man in the Northeast* 22:101-129.

McManamon, Francis P.
1982 Prehistoric Land Use on Outer Cape Cod *Journal of Field Archaeology* 9 (1):1-20.

McManamon, Francis P.
1984a Prehistoric Cultural Adaptations and their Evolution on Outer Cape Cod. in *The Cape Cod National Seashore Archeological Survey: 1979-1981 Results, Chapters in the Archeology of Cape Cod, I*, (volume 2), edited by Francis P. McManamon, pp. 339-417. National Park Service, Boston, MA.

McManamon, Francis P.
1984b Method and Techniques for Survey and Site Examination. In *The Cape Cod National Seashore Archeological Survey:1979-1981 Results, Chapters in the Archeology of Cape Cod, I*, (volume 1), edited by Francis P. McManamon, pp .25-44. National Park Service, Boston, MA.

McManamon, Francis P.
1984c Geographic Orientation and Intrasite Units of Analysis. In *The Cape Cod National Seashore Archeological Survey: 1979-1981 Results, Chapters in the Archeology of Cape Cod, I*, (volume 1), edited by Francis P. McManamon, pp. 45-94. National Park Service, Boston, MA.

McManamon, Francis P.
2009 The French Along the Northeast Coast - 1604-1607. National Park Service Archeology Program, web article. <www.nps.gov/archeology/sites/npsites/champlain.htm> Accessed, 6 April 2011.

McManamon, Francis P. [editor]
1984 *The Cape Cod National Seashore Archeological Survey: 1979-1981 Results, Chapters in the Archeology of Cape Cod, I*, (two volumes). National Park Service, Boston, MA.

McManamon, Francis P. [editor]
1985 *The Cape Cod National Seashore Archeological Survey: The Historic Period and Historic Period Archeology, Chapters in the Archeology of Cape Cod, III*. National Park Service, Boston, MA.

McManamon, Francis P. and James Bradley, and Ann L. Magennis
1986 *The Indian Neck Ossuary, Chapters in the Archeology of Cape Cod, V*. National Park Service, Boston, MA.

McManamon, Francis P. and James Bradley
1986 The Indian Neck Ossuary and Late Woodland Prehistory in Southern New England. In *The Indian Neck Ossuary*. Chapters in the Archeology of Cape Cod, V, pp. 3-47. National Park Service, Boston, MA.

McManamon, Francis P. and James Bradley
1988 The Indian Neck Ossuary. *Scientific American* 256(5):98-104.

Moffett, Ross
1957 A Review of Cape Cod Archaeology. Bulletin of the Massachusetts Archaeological Society 19 (1): 1-19.

Moffett, Ross
1962 Notes on the Archeological Survey of the Cape Cod National Seashore. Manuscript on file, Division of Cultural Resources, National Park Service, Boston, MA.

Mourt, G.
1963 [1622] *A Journal of the Pilgrims at Plymouth: Mourt's Relation*, edited by Dwight Heath. Corinth Books, New York.

Cape Cod National Seashore Archeological Survey Faunal Analysis

Cape Cod National Seashore Archeological Survey: Faunal Analysis

CHAPTER ONE
Background and Methods of Analysis

Introduction

This report was prepared to meet two objectives: 1) to provide a detailed attribute study of the vertebrate fauna from sites excavated by the Cape Cod National Seashore (CACO) Archeological Survey Project, to allow those archeologists familiar with the sites and cultural materials to make and test hypotheses concerning subsistence activities; and 2) to collect and process the data with methods developed or used by the author for studies of other New England shell middens, in order to build a standardized set of faunal data that can be used for regional comparisons in the future.

Faunal collections from the Turner Farm, the Todd Site, Allen's Island, and a host of smaller tests and excavations at Maine sites have been described and analyzed (Spiess and Lewis 2001). There is no strictly comparable sample from southern New England at present. Some comparable information comes from the examination of the sites on Martha's Vineyard used to produce William Ritchie's classic synthesis four decades ago (Ritchie 1969).

Upon receipt by the author, the faunal remains for the study being reported here were sorted and weighed within each provenience unit into 10 categories: mammal, bird, fish, other (mostly turtle), and unidentified bone, within diagnostic and undiagnostic groupings for each. With the exception of moving a few bones from one category to another, e.g., several turkey bones from diagnostic mammal to diagnostic bird, the author identified bones and recorded attributes of size, age, seasonality, etc. The collection was returned to the National Park Service (NPS) with the same sorting, except that diagnostic fish bone had been removed from site-specific bags and boxes to two boxes by themselves.

The major strength of the CACO Survey faunal sample is its initial sorting and weighing, coupled with recovery and flotation of column samples from several proveniences. Such efforts allow reduction in uncertainty about what is not being recovered from the archeological matrix that might have been there. The major weakness of the collection is the small size of its samples, which reduces the statistical certainty of comparisons, both intrasite and intersite, and reduces the range of seasonality information available. For example, the largest collection, from 19BN308, is only 5 percent to 8 percent of the size of the identified faunal sample from each of the four major occupations at the Turner Farm site (Spiess and Lewis 2001). The only way to correct this difference would be to collect a larger sample via intensive excavations of large areas of the site.

The primary comparative collection used in this study consists of a mass of mostly unpublished notes, photographs, and studies in the author's possession, coupled with extensive faunal analysis experience, that have been developed working with vertebrate collections in the author's possession, in Harvard's Museum of Comparative Zoology and, to a lesser extent, in the U.S. National Museum and Field Museum of Natural History. For direct specimen comparison, when necessary, the author has relied on the comparative vertebrate collections at the Maine State Museum and the Department of Anthropology of the University of Maine at Orono .

Faunal remains can be made to yield a good variety of data that are generally underutilized in archeological research. This author's approach to faunal analysis is basically a detailed attribute study, recording a standard list of attributes from the faunal remains followed by an inspection of the data for temporal and geographical, both intrasite and intersite, patterns. The faunal attributes themselves, and their patterning in time and space, can be used to produce hypotheses about prehistoric economics, subsistence and settlement patterns, and ecological reconstructions of interest to the archeologist. The most basic attribute of any faunal assemblage is the list of taxa present in the sample, a piece of data that has been in use in Northeast archeology since before the turn of the century. A more detailed presentation of faunal assemblage attributes is the quantified taxonomic list, an approach that has become the standard for faunal analysis in the Northeast. Quantified taxonomic lists can be presented as identified bone counts, minimum numbers of individuals (MNI), or a variety of proportional counts.

I shall return to the question of quantification of taxonomic lists below. I have, however, found it highly informative to examine a list of faunal attributes that goes well beyond the quantified taxonomic list. These include skeletal measurements, discrete or continuous traits of age or seasonality, butchery data and bone breakage frequency, and bone state, either fresh, charred, or calcined.

The sections that follow introduce the attributes used in this study. The discussion is organized along taxonomic lines since each taxon or group of taxa is analyzable with attributes only some of which may be applicable to taxa in other groups. But first I return to a brief discussion of quantification

Quantifying Faunal Remains

Since White's studies of the 1950s (White 1953) much thought has been applied to the problem of quantifying taxonomic faunal lists. One approach that apparently was favored early in the development of this line of thought, was to convert faunal data into estimates of live weight for each taxon. There has been substantial debate about quantifying taxa lists by raw bones count, MNI counts generated by slightly differing methods (e.g. Horton 1984), and a variety of transformations of the data into proportions that are weighted measures of taxonomic abundance (Grayson 1981). My basic philosophy is that for purposes of interassemblage attribute comparison, data should be transformed as little as possible.

In practice this means that the basic comparative data set generated is a raw bone count. Such transformations of data as MNI should be reserved to answer specific questions during the analysis phase of an investigation. Use of MNI and other proportional or transformed sets of data for statistical analysis often violates some basic statistical rules. Chi square, for example, uses counts that must be nonscaled. Moreover, MNI and other proportional measures of taxonomic abundance can and should be produced by a variety of methods tailored to answer specific questions. Thus, in my view they should not constitute the basic data set for description of a faunal assemblage.

MNI does have its uses. The most obvious is its use in reconstructing a real world view of food availability and of prehistoric economy. However, such use may be practical only when dealing with the entire excavated contents of one feature, a completely excavated house floor or structure, and so forth. Binford (1978) has valid objections to the use of MNI for some diet reconstruction work, however.

MNI is also useful to answer questions raised by quantified bone data. For example, if one has 40 fox bones in an assemblage from a site in which foxes are rare, then one obviously wants to know if all of those bones represent a single individual. Conversely, one may want to know whether bone counts of some taxa are directly comparable with other taxa for the number of individual bones that contributed to the assemblage. For example, one may find that most of each deer skeleton is being returned to a site, whereas far fewer numbers of moose bones are returned because of body part size differences and transportation limits.

The standard method for computing MNI is to count a number of bones for each skeletal element of a certain taxon, usually including the data on right versus left skeletal element, and then pick the highest number of such skeletal elements to represent the minimum number of individuals of that taxon. This author's approach to MNI production begins with such a process, but the skeletal element subsets are further subdivided by age where possible (epiphyseal closure state), and sometimes by size (measurement). For example, one may find that a count of five distal tibiae actually includes three juveniles and two adults whereas a count of five distal radii includes three adults and two juveniles. The MNI represented is therefore six rather than five. When regression analysis of measurements is included, the MNI calculation procedure becomes slightly more complicated. Often, especially when dealing with Cervid (species within the family *cervidae*, which includes deer and elk) assemblages, one can produce an age demography based on teeth and one based on post-cranial elements. A comparison of the two often produces identification of additional individuals. I refer to this method as maximal minimum numbers of individuals production (max MNI). Max MNI will vary with the quality of preservation of the faunal sample and the detail of the analysis, thus, it loses some interassemblage comparative value where these other factors are not held constant.

Analysis System

Odocoileus Analysis System

The analysis system applied to white-tailed deer (*Odocoileus*), and other Cervid, bones is presented in detail in Spiess and Hedden (1983:187ff) and Spiess and Lewis (2001). Here I only review the principal attributes involved. Skeletal element identification is a principal attribute, and details of proximal, distal, medial, lateral, or other fragmentation of the element are noted either graphically or verbally on the original data cards. Quite possibly one or more of 154 post-cranial, mandibular, or maxillary measurements were taken from any given specimen. These measurements, by themselves or in conjunction with regression analysis, can be used to produce MNI estimates or size distributions that may be related to age/sex demography in the sample. The epiphyseal fusion state was noted in a simple four-part division of what is actually a continuum, epiphyses unfused, epiphyses fusing, epiphyses fused but epiphyseal line still visible, or completely fused. The age and variability of individual epiphyseal fusion is fairly well known in *Odocoileus* (Spiess and Hedden, 1983:189).

Dentition provided four basic attributes. First is the identification of tooth position. It should be noted initially that it is not always possible to separate lower first and second molars or always to be correct about the attribution of the upper molar to the first, second, or third position. Similarly lower premolar three and premolar four are difficult to distinguish. These attributions of placement in the tooth row are particularly critical when interpreting tooth eruption to calculate the season of death. Therefore, isolated teeth, ones that have fallen out of the jaw, were recorded as "M1/2," "P3/4," or "upper molar." Tooth eruption was recorded as either unerupted germ, erupting by quarters of total eruption height, or fully erupted. In the case of all fully erupted teeth, tooth wear is an important attribute. This author uses a third attribute that sub-divides the adult years, 3 to 4 years, 5 to 7 years, and 8+ years of age. These age categories are defined on morphological criteria, so they do not reflect true age in all cases, especially since there may be some individual variability of tooth wear rate. The fourth dentition attribute is the number of growth annuli in the tooth cementum, and the status of the last annulus that can be used to determine season of death.

Phocid Analysis System

The phocid, or seal, analysis system has been presented in detail in Spiess and Hedden (1983:196-199) and in Spiess (1978). The morphological attributes of certain phocid bones are important for species identifications, but they will not be treated in detail here. Epiphyseal closures were recorded, as were length measurements of certain post-crania. Epiphyseal fusion coupled with measurement data are used to produce age demographies and differentiate phocid species. Phocid tooth sections are analyzed microscopically for their annual growth rings.

Terrestrial Carnivores

The attributes recorded for terrestrial carnivores included bone element, epiphyseal fusion status, and measurements on some bone elements. Growth patterns of carnivore teeth, principally molars, were recorded by simple tripartite division into light, medium, and heavy wear patterns.

Bird Bones

The principal attribute recorded for bird bones was the element, or portion of element, and its taxonomic identification. The bird bone sample in this study was highly fragmented, and measurements were taken infrequently. Bird bones do not grow with epiphyseal centers of ossification; thus, there are no epiphyseal fusion states to record. However, fledgling birds' long bones are recognizable because their ends are incompletely ossified, and the shaft bone cortex often appears to be more porous than in any mature bird. Such bones are identified to the lowest possible taxon and are recorded as "fledgling." I assume that fledgling bones are a summer seasonality indicator.

One further bird bone attribute is relevant. The deposition of medullary bone in the long bone cavities of female birds just before and during nesting and egg laying has been reported in the literature (Rick 1975). Medullary bone is a porous calcium deposit that is quite obvious when observation of the interior bone cavity is possible, as with a broken bone shaft. The author has found a low incidence of medullary bone in several species of birds, notably ducks, Canada geese and great auks, found in several shell midden assemblages from the coast of Maine. Medullary bone probably does not add significant strength to the bone shaft, therefore the tendency to break is independent of the presence or absence of medullary bone. However, the bird bone assemblage must be partially fragmented to allow inspection of the interior bone cavities. Every broken bird long bone fragment from the Cape Cod assemblage was inspected for the presence or absence of medullary bone. This bird bone sample is highly fragmented, approximately three-fourths or more of the bird long bones being broken. Thus, a low incidence of medullary bone in the Cape Cod assemblage could be taken as evidence against late springtime bird hunting.

Fish Bone Analysis

Fish bones were identified to the lowest possible taxonomic level by comparison with a sample of skeletal specimens. Cranial bones were identified as right, or left, or axial. Vertebrae were identified as atlas, axis, thoracic (pre-caudal), or caudal vertebrae. For some species, like striped bass, fin ray fragments were recorded as well, but for the smallest species most fin rays were unidentifiable to a taxon lower than Order Pisces. Each individual of species of the flounder family contains a single bone, here termed the interhaemal bone, whose fragments are easily recognized in the fish bone assemblage. For each of these bones the portion of the bone (end or medial fragment) and, if possible, some measurement (length or diameter) were recorded. The interhaemal bone usually provides the highest MNI count for flounder family specimens and the most metric information, as well.

Two attributes were recorded for fish vertebrae, largest vertebral diameter and growth ring status. The vertebral diameter was recorded from either the cranial or caudal articular surface. On articular surfaces, with good preservation, one can observe periodic growth rings. These are narrow rings of dense bone deposited during periods of rapid bony growth. Counting them provides an estimate of age of a fish. If a portion of the vertebral articular margin is well enough preserved, it is usually possible to observe the status of the last few months' growth that occurred before the animal was caught. If the last layer forming at the time of death is a growth layer then its relative width compared with the preceding growth layer was recorded as "less than 1/4", "1/4," "1/2," 3/4," or "fully" formed. If the annulus or growth arrest layer was the last layer forming then that fact was recorded. Unfortunately, the exact seasonal timing of the growth arrest layer formation in northwest Atlantic fish species is poorly known at present so seasonality deductions from these data must be tentative. However, these data can be used for comparison between assemblages to detect variability even if the exact seasonality is not understood.

A major complication with the readings of annual layers arises when dealing with the codfish (*Gadus*) and its relatives. The articular surfaces of cod family vertebrae exhibit a concentric ridge and valley relief that obscures the growth and growth arrest layers. On fresh codfish specimens the annual growth layers are more easily recognized by a pattern of translucent and opaque bone alternation than by the unevenness of the vertebral articular surface. When bones are preserved archeologically, this translucent/opaque contrast disappears. Only under infrequent, in my experience, conditions of preservation in which the translucent bone cracks slightly to reveal the presence of the annual growth arrest lines is it possible to be certain of counting seasonal layers in codfish.

Fish otoliths were identified to the level of species, and their longitudinal and transverse diameters were measured. Where preservation appeared adequate they were mounted and sectioned for microscopic observation of internal growth layers.

Taxonomic Units Employed

The following numbered paragraphs define and comment on the taxonomic units used for the data tables in the following chapters. Unless otherwise noted, comments on mammal biology and behavior are summarized from Walker (1968), comments on birds from Peterson (1980), and fishes from Bigelow and Schroeder (1953).

1. Large mammal long bone fragments --

This category records large mammal long bones greater than 5 cm (2 inches) in length that were unidentifiable to species. These pieces are often longitudinal splinters, a result of breakage for marrow cavity access by humans or carnivores. Most of the bones are probably deer (*Odocoileus*), but a few may be bear or even dog. It should be noted that all unidentifiable mammal fragments, as well as unidentifiable epiphyseal ends from species of unknown size, were simply recorded as "unidentifiable mammal." They were not recorded as individual identification, but were recorded in the total bone count and bone weight figures produced before the analysis reported here had begun.

2. Large mammal unidentified --

This category includes all bone fragments that are obviously large mammal, probably deer or bear, but that are not long bone shaft fragments. An example might be a fragment of vertebral centrum not identifiable to any taxon.

3. *Odocoileus virginianus*, white-tailed deer --

All cervid bones were identified to this species since they are uniformly too small to be diagnostic of any of the larger species in the family (*Rangifier, Cervus*, or *Alces*). This species dominates the mammalian assemblage in number of individuals and bone weight represented.

The biology of white-tailed deer is reviewed in detail in a volume edited by Halls (1984). Deer are adapted to open deciduous forests or mixed growth forests in the northeast. The northern extent of their range is northern Maine and southern Canada, where winter snow conditions coupled with restricted availability of hardwood browse appear to be limiting.

In southern New England and New York, open mast-bearing hardwood and mixed growth forests have carrying capacities as high as 20 deer per square mile. Adult females weigh approximately 45 kg (100 pounds), and adult males approximately 70 kg (150 pounds), with larger individuals at the northern edge of the range. In southern New England the peak of calving occurs in late May. Onset of the rut is controlled by decreasing hours of daylight, which varies with latitude, and so would not be expected to vary prehistorically with changes in climate. Since gestation length is roughly constant between individuals, peak periods of birthing would not be expected to vary prehistorically with changes in climate for a given latitude.

Ethnohistorically recorded hunting methods in the Northeast include stalking and decoying, driving into large corrals, and setting spring-pole snares and other traps.

4. *Ursus americanus*, black bear --

On distributional grounds alone, the black bear is the only ursid species expected in the sample. The other two North American species of bear (polar bear and grizzly) were rare or absent in New England, as well as being distinctive morphologically or metrically.

The black bear is a primarily herbivorous omnivore, usually weighing 110 to 150 kg (250 to 330 pounds). Black bears become fat in the fall and sleep through the winter in dens. Winter hunting of black bears ethnohistorically involved locating a den and digging the bear out.

5. Phocid --

This category records all seal bones that could not be identified to species. Most likely all phocid bones not identified to species come from *P. vitulina*. Other small seals such as the harp seal (*P. groelandica*) would be rare or absent since Cape Cod was outside their normal range. The other seal in the sample (*Halichoerus*) is distinctively large.

Phoca vitulina, the harbor seal, is a year-round resident of the coast in southern New England. Adults weigh 70 to 90 kg (150 to 200 pounds), and range from 1.3 to 2.0 m (4 to 7 feet) in length. Young are born in late spring or early summer. *Halichoerus*, the grey seal, weighs 110 to 270 kg (250 to 600 pounds), with marked sexual dimorphism. These seals are non-migratory residents of their range, and were apparently common in southern New England before modern overhunting. Young are born on the ice or on shore, especially sandy beaches, in January or February.

6. Porpoise --

This category includes bones of one or more very small cetreceans, possibly of genera *Phocaena* (including harbor porpoise), *Delphinus* (including common dolphin), or *Tursiops* (bottle-nosed dolphin). On distributional grounds the specimens are probably harbor porpoise.

The harbor porpoise has an adult weight of 50 to 70 kg (110 to 160 pounds), and a total length of 1.2 to 1.8 m (4 to 6 feet). These porpoises usually travel in small groups or schools of up to 100 individuals. They frequent coasts and will ascend estuaries.

7. *Castor canadensis*, beaver --

Beaver are large rodents weighing from 8 to 25 kg (20 to 60 pounds). Their unusually thick pelage has made them a focus of fur trapping activity since prehistoric times. Their flesh is fatty and good to eat. They prefer waterways with nearby growth of willow, aspen, poplar, birch, and alder trees as successional species of plants. Beaver are noted for their ability to build dams and thus create ponds. They either build houses of twigs and mud in their ponds or burrow into soft banks of waterways.

8. Small and medium mammal unidentified --

This taxon includes all bones of squirrel- to dog-size animals that could not be identified to a more specific taxon.

9. Lagomorph --

Rabbits (*Sylvilagus*) or hares (*Lepus)* were included. On distributional grounds most should be *Sylvilagus*.

10. *Canis familiaris*, dog --

Because all bones from 19BN308 of Genus *Canis* that could be identified to species were identifiable as *C. familiaris*, all other *Canis* bones are assumed to be *C. familiaris*. Wolf bones tend to be distinctively larger or more robust than dog. Three postcranial elements, all from perhaps one individual *Canis* from the same excavation unit in 19BN390 (Excavation Unit 9, Feature 01), were tentatively identified as wolf (*Canis lupus*) on the basis of large size and rugosity. These specimens include a proximal metatarsal, a proximal phalange, and a complete metatarsal that are larger and more rugose than a small *C. lupus* comparative specimen in the Maine State Museum collection.

11. Small canid --

This taxon includes all canids smaller than the dog. Possibilities include both the red fox (*Vulpes*) and grey fox (*Urocyon*), and the coyote (*C. latrans*). All the specimens from the Cape Cod faunal collection were small enough to belong to one of the two genera of foxes. Moreover, one radius and one metacarpal from 19BN308 were clearly identifiable as *Vulpes* (red fox). None of the bones in the 19BN308 sample were identifiable as *Urocyon*. One mandible fragment from 19BN481 is positively *Urocyon* (Excavation Unit 1, Feature 03, depth 70 to 114 cm below datum, a recognized animal burrow). Thus, while fox were definitely present prehistorically, grey fox presence is uncertain.

Vulpes, the red fox, usually weighs about 9 kg (20 pounds). Foxes are omnivorous, concentrating on insects, eggs, and small animals. The species breeds in late winter. *Urocyon cinereoargenteus*, the grey fox, is a smaller, 3 to 7 kg (6 to 16 pounds) carnivorous omnivore that prefers more wooded country than the red fox. In the Northeast, grey foxes apparently avoid the mixed growth and northern boreal forest, being much more common in deciduous woodland.

12. *Procyon lotor*, raccoon --

Both cranial and postcranial bones of this species are morphologically distinctive. *Procyon* is generalist in food habits and adaptable in much of its behavior.

13. Small carnivore, possibly *Procyon* --

Procyon probably numerically dominates the small carnivore samples. There are a number of bones, such as rib fragments, that were not positively identifiable as *Procyon* but which probably are this species on numerical grounds. They are, however, separated taxonomically because of this uncertainty.

14. *Mephitis* --

One bone has been identified as striped skunk (from 19BN481), another omnivore of adaptable habits.

15. *Mustela* sp., mink, etc. --

This taxon includes at least one specimen of *Mustela*, cf. vison, that is definitely smaller than the size range of M. macrodon, the extinct sea mink (Spiess, data in personal possession).

16. *Sciurus caroliensis*, grey squirrel --

This taxon is easily distinguished from the red squirrel and the flying squirrel, as well as being the most probable identification on distributional grounds.

17. *Marmota monax* --

The woodchuck is an ubiquitous medium-sized rodent in open or mixed open-wooded terrain.

18. Small rodent or insectivore --

This category records skeletal remains of small burrowing mammals that probably helped "bioturbate" the sites. Usually these specimens are unweathered in appearance and do not seem to be as old as the rest of the faunal sample on visual grounds. A chipmunk and a small rodent, possibly a vole, were included in the identification.

19. *Ondatra zibethicus*, muskrat --
This animal is a medium size rodent with habitat preference and distribution similar to the beaver.

20. Domestic animals --
Bones of the following European domesticates were recovered from the faunal sample: *Equus equus* (horse); Ovicaprid (sheep or goat); *Bos taursis* (domestic cattle); *Sus scrofa* (pig); and *Canis familiaris* (dog from 19BN308, Excavation Unit 004, Feature 01).

21. Aves (birds), unidentified, large --
This category records all unidentified bird bones, usually fragments, ribs, or phalanges, from species larger than duck size, e.g., turkey, loon, great auk.

22. Aves (birds), unidentified, no size, medium, or small --
This category records all bird bones from duck-size species or smaller birds, or birds of indeterminate size, i.e., anything unidentified other than large bird.

23. *Gavia immer*, common loon --
Loon skeletons are very distinctive morphologically. The only other loon species possibly present in the area, the red throated loon, is noticeably smaller than the common loon. Loons nest in fresh water and winter along the salt water coast in the Northeast, thus in quantity they are a good seasonality indicator.

24. *Meleagris gallopavo*, turkey --
This species is absolutely distinctive skeletally. Moreover, male turkey tarsometatarsi exhibit a bony spur on their posterior mid-shaft, which differentiates them from the female. This species is mast-forest dependent, and the largest of the Gullinaceous game birds.

25. Alcid, medium --
This category records all alcids (auks and relatives) larger than puffin and guillemot and smaller than a great auk. In only one case was I able to identify one specimen, *Alca torda*, the razor-billed auk. Alcids nest in colonies on off-shore or near-shore rocky (duck) cliffs where they are vulnerable to netting and their nests are good targets for egg collecting.

26. Anatid --
This category records all ducks that were not distinctively small enough for inclusion in the "Anatid, small" category. A variety of species are probably represented. Separating duck species based on fragmentary bone samples is difficult and was not attempted for this study.

27. Anatid, small --
Several species of duck are noticeably smaller than other species, notably the goldeneye and bufflehead and the teals. Several bones from this sample match comparative specimens of goldeneye (*Glacionetta clangula*) in size, but sexual dimorphism and size overlap with the other small duck species make a positive identification uncertain.

28. *Pinguinus impennis*, great auk --
This species was a distinctively large Alcid, now extinct. Its biology has been recently reviewed (Bengston 1984), showing that its feeding and nesting habits were not exceptionally different from other Alcids, except that it was flightless.

29. Large raptor --
This category includes bones referable to either osprey or the two eagle species, American and golden. Several bones were identified, of which at least one is distinctively large enough

to be identified as an eagle. The two eagle species and the osprey are seasonal breeders in the Cape Cod area.

30. *Branta canadensis,* Canada goose --
A large Anatid distinctive in size, and year-round resident from the Maine coast to southern New England.

31. *Podilymbus* or relative --
A single bone of one of the grebes, Family Colymbidae, has been identified. These birds are fresh water nesters, and fall migrants on salt in-shore waters.

32. *Phalacrocorax,* cormorant --
Several bones from one or both species of cormorant, European cormorant and double-crested cormorant, were identified in the Cape Cod survey sample. The double crested cormorant is a summer resident, while the European cormorant is a natural winter resident in New England.

33. Grouse relative, small --
The wing bones of a small tetraonid or phasianid were identified. This specimen is possibly a bob-white on the basis of size.

34. Turtle --
This category records a numerical count of all turtle bones. Most of the specimens were fragmentary carapace or plastron, but vertebrae and phalanges were also included. Only a few pieces were identifiable to species, including a common snapping turtle, a box-turtle relative, and an Atlantic ridley, a marine turtle.

35. Snake --
This group records snake vertebrae.

36. Amphibian --
A few small bones that appear to be amphibians were identified. It is likely that these are salamander bones from relatively large species.

37. Unidentified fish --
This category includes vertebrae/fragments, spines and ray portions, and skull bone fragments that were unidentifiable to a lower taxon.

38. Unidentified small fish --
This category was reserved for counting the bones of those fish, such as herring relatives, that could be categorized as "baitfish," but are too fragmentary to identify to a lower taxon.

39. *Acipenser sturio,* sturgeon) --
Sturgeon are primarily represented by dermal scute fragments and by pectoral fin bones. Dermal scute fragments comprise the vast majority of the sample. They are friable and easily fragmented. Sturgeon move inshore into shallow estuarine or coastal waters and come to the surface frequently in late spring and summer (Spiess, personal observation). Individuals commonly reach 3 m (10 feet) in length and 120 kg (250 pounds) weight. Some may spawn in brackish waters. Wood, writing of Massachusetts in 1634, describes them as being "all over the country, but best catching of them be upon the shoals of Cape Cod and in the river of Merrimacke (quoted in Bigelow and Schroeder 1953:83)."

40. Skate family --
One or more species of small skate are represented in the collection by vertebral central and dermal scutes, star-shaped bones with a central spike, of various sizes. Skates are bottom feeders, very common on shallow banks, and take a hook readily. There are four species of skates common in the waters around Cape Cod, and they are so close in appearance as to not be readily distinguished by modern fisherman. Skates are often taken in shallow water in summer, seldom or never in winter. Bigelow and Schroeder (1953:63) report a skate 1.5 m (5 feet) long, which is exceptionally large, being taken in Cohasset Bay in less than 6 feet (2 m) of water in mid-summer. Skates

are edible, with skate meat being substituted for scallops in less scrupulous seafood restaurants.

41. Flounder family --

Several species are present, but the dominant one numerically in the raw bone count is the winter flounder. Other species include yellowtail, sand flounder, and halibut. The halibut is a member of the flounder family that can attain distinctively large size. However, the halibut bones in the Cape Cod sample are small (juvenile), being in the same size range as the rest of the flounders.

The winter flounder seldom reaches 20 inches (51 cm) in length, general adult size being 12 to 15 inches (31 to 38 cm) for populations resident in in-shore waters. Tide mark, high or low, is the in-shore limit for this flounder, and it runs into brackish river mouths. How close in-shore they come at any particular time is a matter of water temperature. They tend to desert shoal water in southern New England in the warmest summer weather. The species spawns in-shore in shoal water in February and March around Cape Cod. Spearing flounder in shoal water and attempting to hook them with baited hooks are both successful modern fisheries techniques

42. Sculpin family --

One or more species are involved.

43. *Anguilla*, American eel --

Some specimens of this species are extremely small with a total length when alive below 10 cm (4 inches). It is likely that the smallest eel specimens represent bait or the contents of fish stomachs.

The largest eels reach 7 kg (15 pounds), but most full grown females range up to 1 m (39.4 inches) in length and weigh up to 2.5 kg (5 pounds). Males are smaller on average. *Anguilla rostrata* is catadramous: it breeds in the ocean off the Bahamas. The young elvers, averaging 4 to 7 cm (1.5 to 3 inches), appear along the Northeast shore in spring, in March off Woods Hole, for example. Some remain in salt marshes and harbors; some run up any freshwater stream or river. Eels can survive out of water for considerable periods of time, and surmount obstacles such as falls, dams, and even wet rocks on their way upstream. In general eels seek muddy bottoms and still water, but they are noted as common in swift-flowing shady streams on Cape Cod. Eels apparently will eat any flesh, living or dead, that they can fit into their mouths. Eels grow slowly and, as sexual maturity approaches, travel downstream to salt water. Judging by the length of the eels in the faunal collection from the sites in this report (about 11 cm or 4 inches), it is likely that they represent elvers moving upstream in or into fresh or brackish water in spring or summer.

44. *Lopris americanus*, goosefish --

This is a morphologically distinctive species.

45. *Morone saxatilis*, striped bass --

This skeletally distinctive species moves in-shore during warm weather.

46. Herring family --

At least four species of small representatives of this family are present in the sample: alewife, *Pomolobus pseudoharengus*; blueback, *P. activalis*; herring, *Clupea harengus*; and menhaden, *Brevortia tynneris*. Some of these fish are represented by extremely small caudal vertebrae and are difficult to differentiate to species. The small size of specimens suggest some were baitfish or the stomach contents of larger fish. The herrings are spring migrants into fresh or brackish water.

47. *Gadus morhua*, cod --

This category includes bones definitely identifiable to this species.

48. Cod relative, unidentified --

This category includes two bones of a taxon that has been encountered in Maine shell heaps as well. This fish attains large size, and very closely resembles *Gadus morhua* but is not identical to it in some of the details of skeletal morphology. It has been compared with hake, cusk, and a variety of other Gadidae without finding a closer match than *Gadus morhua*. Either these bones are cospecific with *G. morhua*, representing some extreme of skeletal morphological variation, or perhaps because of larger size, they represent a close relative to the cod, now extinct.

49. *Cynoscion regalis*, weakfish --

This is a bottom-lying predatory fish.

50. Salmonid --

The few vertebrae collected are too poorly preserved for specific identification.

51. *Xiphias gladius*, swordfish --

Swordfish are deepwater surface predators.

52. Shark --

Representation by teeth only is expected in this cartilaginous fish.

53. *Tautogolabrus adspersus*, cunner --

The cunner is represented by a single bone from one site.

54. *Microgadus*, tomcod --

This species is represented at one site. Tomcod bone identification is straightforward with no chance of confusion with cod. Tomcod move into estuarine water in late winter to spawn. At other times they are found in shallow salt water.

55. *Cryptacanthodus maculatus* --

Wrymouth was present in one site.

CHAPTER TWO
Site 19BN308 Faunal Remains

Frequency and Distribution

Bone counts for all the identified taxonomic categories are tabulated for different provenience units in Tables 2.1 to 2.3.

In Table 2.1 the data for 19BN308, Concentration 33 are subdivided into 6 strata following descriptions of the site presented in Fitzgerald and McManamon (1992) and following provenience subdivisions supplied by Joyce Fitzgerald (personal communication). Stratum I includes all bones from proveniences that either included the plowzone, or could not be subdivided by depth, but include exclusively or mainly plowzone (e.g., some of the shovel tests). "Shell Midden, General" refers to all proveniences within which the shell midden layer can be differentiated from the plowzone, but within which there is no further differentiation (e.g., proveniences in Excavation Unit 300). The other four columns follow Fitzgerald's subdivisions of Excavation Units 306 through 316. Strata II and III represent nearly contemporary Woodland deposits radiocarbon-dated around 1150 to 1400 B.P. Stratum V is a Late Archaic midden radiocarbon-dated between 3400 and 4200 B.P. The final right-most column records all identified bone from the clay-like layer labeled "Stratum VI", and all features associated with Stratum VI, e.g., EU-313-00-057, 313-01-all levels, 313-02-all levels. The column marked "Stratum IV and mixed with IV" reports all faunal material from Stratum IV or from proveniences possibly mixed with Stratum IV, which is a dark shell-free layer, interpreted as a possible natural soil horizon that developed atop the Late Archaic layer. It underlies Stratum VI, which may be an ash-rich layer produced by hearth cleaning or dumping. Readers should note that Stratum VI is stratigraphically above Stratum IV despite its number. It lies between Stratum IV and Strata II and III. The faunal assemblages from Stratum IV and VI show much closer affinity with the Woodland shell midden (Strata II and III) than with Stratum V. I will return to this point, and the fact that very similar phenomena have been discovered in Maine shell heaps, in the discussion section below.

Table 2.2 presents identified bone counts from Concentrations 308.42 and 308.71. Concentration 308.42 data are divided into two proveniences: (1) bones from the shell midden, and (2) bones from the plowzone or from proveniences that include exclusively or mainly plowzone material, i.e., shovel tests. Concentration 308.71 data are divided into four provenience groups, the first being plowzone or material including plowzone. I also have differentiated 19th century fill, e.g., EU-6-00-010, etc., and material from the shell midden. Finally, the faunal remains from Excavation Unit 007, Feature 1 have been differentiated.

Tables 2.3 and 2.4 record all identified bones from Concentration 308.11, 308.12, 308.14, 308.15, 308.21, 308.22, 308.32, 308.34, 308.41, 308.43, 308.51, and 308.52. The identified bone samples from these concentrations are so small that they will not receive further comment.

The identified faunal remains from Concentration 308.42 are a small sample requiring only a few comments. Domestic species are confined to the plowzone, meaning that there is relatively little evidence of mixture of historic period material downward into the shell midden; the same comment applies to Concentration 308.71. Four porpoise bones from Concentration 308.42 are all vertebrae from a minimum of one individual (with epiphyses fusing or unfused). They were found articulated with associated rib fragments. The four great auk bones, most wing bones, also probably come from one individual (two are from EU-107-00-030 and two are from EU-107-04-039). The Concentration 308.42 faunal sample is notable only for the recovery of a large number of turtle plastron and carapace fragments, vertebrae, and phalanges from a variety of differently sized turtles, not necessarily different species. It is possible that they represent as few as several, one-half dozen to a dozen, individuals, perhaps from one or a few collecting episodes.

As a whole, the identified faunal collection from the Concentration 308.71 midden is unremarkable. The Excavation Unit 7, Feature 1 assemblage, however, is remarkable for its content of fish bone. Strongly present are skate, eel, goosefish, and herring, including unidentified small fish in the latter taxon. Notable in their absence or low frequency are flounder and sturgeon, common in other places in 19BN308. Concentration 308.71, Excavation Unit 7, Feature 1, with its high frequency of small fish bones, resembles the faunal proveniences that reflect activities focussed on the processing or disposal of small fish. A high concentration of pottery associated with these features also has been noted (Childs 1984:203).

In Concentration 308.33, again, the identified domestic fauna are confined to the plowzone. It is notable that at least one small rodent burrowed as deep as Stratum V sometime during site formation.

Comparison of the Concentration 308.33, Strata II and III fauna with Stratum V faunal reveals some interesting differences between Woodland and Archaic subsistence. The mammal and bird assemblages from Stratum V are too small for statistical certainty, but it appears that all the furbearing mammals, bear, beaver, raccoon, etc., may be absent, or present in much lower frequency, than in the Woodland levels. There is a clear contrast in the representation of turtle bones between Strata II and III and Strata V. A much lower count of turtle compared to all bird and mammal occurs in the Archaic stratum compared to the Woodland strata. Turtle collecting may have been a much more important activity for the Woodland occupants of the site. The fish assemblage from Stratum V is dominated by sturgeon, flounder, and striped bass. Skate, cod, and herring, by contrast, are important species in the Woodland period strata.

It is clear that the general shell midden sample is dominated by Woodland faunal remains. The Stratum VI material is clearly referable to the Woodland component on stratigraphic grounds, as well as the fact that it is characterized by a high skate, flounder, and herring bone count, skate and herring being absent in Stratum V. Stratum VI and associated features appear to be specialized, however, for disposal or processing of small fish to the exclusion of most other vertebrates.

The faunal material attributable to Stratum IV, or mixed with Stratum IV, also is similar to the Woodland component on the basis of its quantitative attributes; furbearers are present and turtle remains are numerous. The high fish bone content, especially unidentified small fish and eel, makes the Stratum IV assemblage more closely resemble Strata II and III than Stratum V. But there are also some contrasts among the fish bone assemblages of Strata IV, II, and III, and VI; Stratum IV is noticeably higher in sturgeon scute frequency and lower in skate bone frequency.

In terms of the numbers of identified bone elements in the Concentration 308.33 Woodland deposits, fish bone is dominant, followed by turtle, bird, and mammal. Some authors have used bone weight as an easily obtained attribute to transform numerical bone counts into a more accurate reflection of live body weight contribution to the diet. Total bone weights for Concentration 308.33 are presented in Table 2.5. Mammals far outweigh the other classes in bone weight preserved in the sample. However, several of the fish taxa, notably sturgeon and skate, do not have fully calcified skeletons. Sturgeon especially can reach large size but are represented in a bone sample mostly by their dermal scutes. Thus, I suspect that the fish flesh to fish bone weights ratio is higher, say, than the mammal flesh to mammal bone weight ratio. Likewise, the turtle flesh to bone ratio would be lower.

A rough estimate of the relative live body weight contribution to the diet of Woodland inhabitants of 19BN308 Concentration 33 is 10:5:1:1, mammal:fish:bird:turtle.

Seasonality

No seasonality evidence is available for the Archaic occupation.

Three deer teeth from Woodland deposits at 19BN308 were mounted and sectioned in an attempt to read the season of death from cementum layers. All these exhibited histological structures too poorly preserved to be readable. The specimens attempted are as follows:

19BN308#5413. Excavation Unit 307-00-051 in Concentration 308.33, *Odocoileus* left upper P2, 3 to 4 or 5 years of age.

19BN308#5414. Excavation Unit 307-00-051 in Concentration 308.33, *Odocoileus* right upper molar, 3 to 4 or 5 years of age.

19BN308#5415. Excavation Unit 313-00-044 in Concentration 308.33, *Odocoileus* right upper P2, 3 to 4 years of age.

Other seasonality hints from the faunal data are discussed below.

There are two male *Odocoileus* parietal bones exhibiting shed antler bases (Excavation Unit 114-01-055 in Concentration 308.42, and Excavation Unit 300-00-083 in Concentration 308.33). Male deer shed their antlers following the end of the breeding season in early winter, and begin to grow new antlers in late spring. Thus, these two specimens, representing individuals from two different concentrations, represent late winter or early spring kills, possibly January through May.

An *Odocoileus* lower left second deciduous molar exhibits little or no wear on the crown (Excavation Unit 0312-00-050, Stratum IV, Concentration 308.33). This tooth is not yet in occlusion or barely in occlusion. Deciduous molars in deer erupt between one and three months after birth. Since the calves are usually born in late May, this was a summer, June, July, or August kill.

A phocid (seal) canine tip (Excavation Unit 300-00-094 in concentration 308.33), which I presume is *Phoca* sp. on the basis of small size, exhibits very thin dentin layers. Exceptionally thin dentin is an attribute of newborn and young seals of much less than 1 year of age (Spiess, personal observation); dentine growth is rapid for the first 2 or 3 years of life in *Phoca*. This specimen comes from a foetal, newborn, or very young seal. *Phoca vitulina* bears its young in June or July, so this specimen represents a summer or early fall kill.

A *Halichoerus* (grey seal) upper left postcanine (Excavation Unit 111-00-010 in Concentration 308.42 plowzone) is an erupting tooth germ. All phocid pups are born with a set of milk teeth, but replace them with their adult dentition within the first month or so of life. *Halichoerus* females haul out for the pupping season in mid-winter, January or February, seal hunting.

There is one major piece of negative seasonality evidence: none of the approximately 200 bird long bone fragments examined from 19BN308 exhibited medullary bone formation, which is noticeable in breeding females just before and during nesting season. Although no concrete seasonality indicators, vertebral readings, scale, or otolith sections were recorded for 19BN308, the presence of some of the fish species themselves are seasonality indicators. For example, sturgeon and the herrings are anadromous, moving into fresh water in spring or summer.

Thus, I believe that there is strong evidence for multiple seasons of occupation for the 19BN308 Woodland period. There is clear evidence for winter hunting of deer and grey seals, and for summer hunting of harbor seals and deer. At least some of the fishing was spring or summer activity.

It is possible that the site was occupied by at least some residents on a nearly year-round basis, although I have no concrete seasonality data available for spring or fall use in our small vertebrate data sample. It should be noted that Hancock (1984) and Dwyer (1984) have ample evidence for late winter and spring collecting of shellfish (*Mercenaria mercenaria*) at 19BN308 and other outer Cape sites.

Size and Age Data

This section presents size and age data on bones from 19BN308. Some of the data may only gain significance as this collection is compared with other small midden collections in New England.

Odocoileus --

There are a minimum of four individual deer represented in the sample by their teeth; one each in the calf, 3 to 4, 5 to 7, and 8+ years age categories.

Table 2.6 presents counts of *Odocoileus* long bone epiphyseal fusion states for epiphyses with different ages of fusion. This small data sample indicates that about one-third of the deer killed were below 1.33 years of age at death, a figure not very different from the one calf in four individuals recognizable from tooth-wear ages.

There are four measurements from "adult" bones useful in estimating deer body size (Table 2.7). These deer are of modest size, although there is no certain way to determine whether the 19BN308 measurements came from male or female deer.

Small Delphinid --

The small delphinid (porpoise) left lower jaw from Shovel Test 1105 (Concentration 308.71) yielded a measurement of 12.6 cm from symphysis to posterior margin of the eighth tooth alveolus.

Canis familiaris --

The measurements and bone identifications for a burial of a portion of an immature dog of historic provenience is reported in Table 2.8. The pit containing this specimen also contained coal and partially decayed hair. The portions of the animal present were the mid-thoracic vertebrae and ribs (lower chest) backward to the caudal vertebrae (tail), the pelvis, right and left femora. Missing were the tibia and hind feet, and the whole anterior third of the animal, because only a portion of the burial was excavated.

Two adult *Canis* metatarsals, recovered form prehistoric contexts yielded length measurements of 6.02 cm, from Excavation Unit 312-00-056 in Concentration 308.33; and 6.95 cm, from Excavation Unit 107-00-040 in Concentration 308.42.

A right mandible (Excavation Unit 306-00-027 in Concentration 308.33) has yielded the following measurements of M1: 2.29 cm length, 0.89 cm width. A left mandible from Excavation Unit 306-00-047 in Concentration 308.33, which may be from the same individual since both tooth series exhibit very heavy wear, has yielded the following measurements:

First lower molar length, 2.21 cm

Canine to lower third molar inclusive alveolar length, 8.2 cm

First to Fourth lower premolars alveolar length, 3.35 cm

Greatest mandible length: (Infradentati to articular condyle): 14.06 cm

Our impression is that these prehistoric dogs were not small (cf. Hagg 1948).

Vulpes (red fox) --

A distal radius with fused epiphysis (Excavation Unit 312-00-046, Concentration 308.33) yielded a distal breadth of 1.31 cm. This was a large and rugose individual, about 5 percent larger in this measurement than the comparative specimen in the Maine State Museum.

Procyon --

A lower left raccoon mandible (Excavation Unit 114-02-030 in Concentration 308.42) containing fourth premolar, first and second molars with heavy wear, yielded the following measurements:

Length from articular condyle to incisors, anterior: 8.64 cm

First and Second molar alveolar length: 2.05 cm

Snake --

Snake vertebrae yielded the following cranial-caudal lengths between articular surfaces:

Excavation Unit 312-00-045, Concentration 308.33, 0.4 cm (small snake)

Excavation Unit 111-00-040, Concentration 308.42, 0.5 cm

Excavation Unit 111-00-030, Concentration 308.42, 0.8 cm on nine vertebrae

Excavation Unit 307-00-041, Concentration 308.33, two fragmentary vertebrae of a viper, larger than the Excavation Unit 111-00-030 specimens, probably a large rattlesnake.

Weakfish --

A vertebra from Excavation Unit 307-00-041 in Concentration 308.33 yielded a posterior diameter of 0.7 cm. A weakfish weighing approximately 2.5-kg to 3-kg live weight in the Maine State Museum comparative collection yielded a vertebral diameter of 1.23 cm. The weakfish vertebra from Excavation Unit 313-00-060 in Concentration 308.33 is twice the size of this comparative specimen, however.

Codfish --

About 20 measured vertebral specimens range in size from 1.5 times to 3 or 4 times the diameter of a 5-year-old codfish in the Maine State Museum comparative collection. The individuals represented by the archeological specimens were at least 8 years old, and each weighed 10 kg or more.

Striped Bass --

The striped bass vertebrae in the collection are from small individuals, ranging in size from 1 to 2 times the diameter of a 0.5-kg live weight specimen in the Maine State Museum comparative collection.

Goosefish --

The goosefish teeth in this collection come from large individuals ranging from 2 to 4 times the linear dimension of a 2.5-kg live weight specimen in the Maine State Museum comparative collection.

American Eel --

The eel vertebrae in the archeological collection mostly come from exceptionally small individuals. Most come from eel that in life would have been about 5 cm long, with one individual about 10 cm long. The small size of the eels suggests that they may have been intended as bait fish rather than directly as human food.

Flounder Family --

Vertebral diameters are in the 0.5- to 0.9-cm diameter range. The flounder family vertebral specimens uniformly come from specimens with vertebral diameters one third in size to the same size as those of a 1-kg live weight comparative specimen. The small size of these fish suggests that they may have been caught by net or weir fishing rather than by hook and line, since the smaller specimens could have taken only extremely small hooks.

Skate --

Measured skate precaudal vertebral diameters range for 0.3 cm to 0.9 cm, compared to 0.58 cm for a 300-gram live weight skate specimen. Skate live weights are estimated to have ranged from 100 grams to 1 kg or more in the archeological sample.

Sturgeon --

Sturgeon size is quantified by measuring the number of pores per linear cm on scute fragment surfaces. Pores per cm measurements on the sample from 19BN308 range from three to four for larger individuals to nine for small individuals. Of course, there is some variability within one sturgeon from larger to smaller scutes over the body surface. The comparative specimen in the Maine State Museum collection has an average of eight pores per linear cm (+ one for variation between scutes). Its live weight was 1 kg. Thus, the 19BN308 sturgeon were all small individuals, certainly less than 4 to 5 kg.

Butchery Data

The morphology of large mammal long bone fragments present in the collection indicates that large mammal long bones, primarily deer and possibly also bear and dog, had been split for access to the marrow cavity. Moreover, a substantial number, perhaps a score, of identifiable mammal bone specimens exhibit pitting and cortical damage that the author has come to associate with dog chewing; it is likely that even more of the unidentifiable bone sample was "processed" by canids. These factors mean that butchery procedure data, such as cut marks, are few.

Odocoileus --

All body parts of Odocoileus are represented in the archeological sample. Since the body-part identifications do not show obvious absences of whole portions of the deer skeleton, it appears that carcasses usually were taken whole to the site. This strategy contrasts with behavior detected in Maine prehistory in dealing with moose carcasses, and with the "logistically mapped" settlement and foraging strategy of the Nunaimuit Eskimo as popularized by Binford (1978). Subsequent processing by humans, including marrow cavity access, as well as other effects such as dog chewing and the mechanical and chemical action of the soil, account for the differential "recognizability" of body parts in the archeological sample.

Delphinid --

The left mandible fragment from Shovel Test 1105 that bears the tooth alveoli, and four other smaller fragments all exhibit axe marks, straight line, shallow fractures delivered with a sharp-edged implement that could withstand an impact of some force. The marks are not deep enough or narrow enough to preclude use of a stone axe.

Castor --

Two right ulnae from Stratum I, the plowzone, of Concentration 308.42 were deliberately snapped by a blow delivered medio-laterally at mid-shaft, in one case, and at three-quarter distal length of shaft in the other. I have been told by several Maine trappers that this technique is commonly used today to separate the skin, with distal forelimb elements still attached, from the rest of a beaver carcass. Similar specimens are common in prehistoric Maine shell middens. I presume that this butchery pattern is a marker for beaver skin removal to obtain the pelt for further processing for use as fur, whether or not the carcass was also eaten.

Two distal humeri from EU-307-00-031 and EU-307-00-041 in Concentration 308.33 exhibit knife cuts parallel to the long axis of the humerus. Both specimens have these marks on the distal articular end in the condylar groove. In one case the cut marks are anterior, in the other posterior. Such cut marks might be made in an attempt to disarticulate the humero-ulnar joint, but I think more likely they were made in cutting the interasseous ligament that holds the radius to the ulna. Since the radius is tightly articulated to the wrist bones, and the ulna is not, radio-ulna disarticulation might be one step in rapid disarticulation of the hand from the forearm.

Procyon --

One ulna (Eu-0312-00-050 in Concentration 308.33) exhibits the same distal snap observed on the two beaver ulnae.

Birds --

The bird long bone sample in the assemblage is highly fragmented, both in the plowzone and in the midden. Bird long bones do not contain marrow, so there is generally no reason for human beings to open bird long bone diaphyses.

I assume that much of the crushing and splintering was done by dogs. The modern proviso against feeding sharp bones or bird bones to a dog to prevent intestinal injury evidently did not apply prehistorically, especially with free-roaming canids and midden-type garbage disposal.

A Comparative Study of Hand Excavation and Screening at 19BN308

The processing of column samples from Excavation Units 306, 307, and 312 through 316 allow comparison of the weight, number, and amount of information produced by various recovery techniques. These techniques include hand excavation, flotation and recovery on 0.25-inch and 0.125-inch mesh screens. Column sample size was 20-cm by 20-cm; since one column was collected per 1-m by 1-m excavation unit, the column sample soil volume is equivalent to approximately 4 percent of the excavated volume. Column samples were taken to quantify shell species in the midden, to check on what was passing through 0.25-inch mesh screen, and to recover botanical remains. Methods for processing the column samples are presented in Fitzgerald (1984). Hand excavated material was screened on 0.25-inch mesh, and bone was hand picked from amongst the shell.

Bone counts and weights for both the hand excavated and column sample recovered faunal samples are presented in Table 2.9, divided by major sorting categories. Hand excavation recovered 91.1 percent of the total bone weight from these provenience units, with the column sample processing accounting for the remaining 8.9 percent. However, the column samples only examined about 4 percent of the total excavated volume. To compare the efficiency of recovery between hand excavation and column sampling, we must make the assumption that the 4 percent sample represented by the columns is a randomly sampled excavated area with respect to bone density. It is possible that the column samples approach this ideal since there are seven of them, and since they were so placed as to obtain a "typical" sample of each unit. Proceeding on the assumption of randomness with respect to bone density, we can correct the column samples to a standard 100 percent of excavated volume by multiplying the 4 percent column sample by 25. Table 2.10 presents the thus corrected bone weight figures from Table 2.9, adding at the right a column summing the weights of the column sample recovered faunal material.

By comparing the left (hand excavated) column with the right (column sample) column, a quick comparison of the efficiency of hand excavation can be made for each category of faunal remains. Approximate equivalence in terms of weight means that relatively few bones are being lost by relying on hand excavation. My initial expectation was that fish bone would be recovered with greater efficiency from the column samples, but that all other categories would be about the same.

The results are strikingly different from the expectation. Several categories show approximate equivalence of recovery between hand and column samples: mammal non-diagnostic, bird diagnostic and non-diagnostic, other (turtle) diagnostic. Surprisingly, diagnostic fish bone was recovered with greater efficiency by hand excavation than by the column sample processing. Mammal diagnostic bone was underrecovered by a factor of two by hand excavation, as was other (turtle) non-diagnostic bone. Unidentified bone was under-recovered by hand excavation by factors of three to five times.

There are no equivalent comparative studies currently available from shell middens in the Northeast, although one is in process (Carlson n.d.). I do, however, have the following observation that might provide an explanation or hypotheses for further testing. It is hard to believe that diagnostic mammal bone, which tends to be either teeth or the largest pieces of bone, are going underrecovered by excavation and hand picking on 0.25-inch mesh screen. The data however strongly suggest that fact, and the reason must lie in the amount of effort expended at the screen in picking over the matrix, which consists mostly of shell fragments. This study suggests that more careful screening of hand excavated material would be repaid by higher recovery of diagnostic mammal bone.

The excellent recovery of bird bone by hand excavation might be explained by the smooth cortex of most bird bones, which in my experience tends to shed dirt and shell particles and thus stand out in contrast to a crushed shell and black dirt background. This effect suggests that dirt tends to adhere to the rougher cortex of mammal bone and the rough interior surface of broken mammal bone, obscuring them. A possible solution would be to spray water on hand excavated material being screened on 0.25-inch mesh. The recovery of diagnostic fish bone by hand excavation probably can be explained also as a visual phenomenon. The diagnostic fish bones tend either to be larger vertebral centra or sturgeon plates. At least the vertebral centra, which are cylindrical, do, in my experience, stand out well against a broken shell background on a 0.25-inch mesh screen.

The underrecovery of the non-diagnostic fish bone, non-diagnostic turtle, and unidentified bone is to be expected. Most of these are smaller fragments that would either pass through 0.25-inch mesh or be “hidden” among the larger particles of shell on a 0.25-inch screen. In effect we lose little information, identifiable bone or seasonality information, with the underrecovery of these categories by hand excavation.

One other item of recovery should be mentioned in conjunction with the flotation processing of column samples. The recovery of diagnostic fish bone by hand excavation and screening on 0.25-inch mesh radically underrepresents bone counts of very small fish specimens whose remains contribute little to total bone weight figures (Table 2.11). Some taxa of small fish, such as eel, skates, and herrings, would be radically underrepresented in bone count figures without the 0.25-inch mesh recovery during flotation.

CHAPTER THREE
Faunal Remains from Other Sites

The Smallest Faunal Collection

Identified bone counts from additional site faunal collections are presented and discussed in this chapter. None of the collections contain significant seasonality data, with the exception of some fish otoliths from 19BN415 discussed below. The sizes of these collections are too small to be sure that minor variations among them are not a result of sample size. The collections are similar in their general pattern of taxa quantification to the 19BN308 assemblage (Table 3.1). In the particular, the fishes represented in these faunal assemblages reflect the same size ranges as those in the 19BN308 assemblage.

There are several items in these collections that require further comment. 19BN274/339 yielded a human upper first or second molar (Excavation Unit 9-00-030) exhibiting severe attrition of the occluded surface: complete exposure of the dentin basin and removal of the enamel crown. Such wear reflects either extreme old age, a high abrasive content in the diet, or both. A small cetacean jaw fragment from 19BN288 exhibits a very deep, narrow groove (cut) that can only have been made with a metal saw. Thus, this piece represented either ethnohistoric period or European use of a small whale or Delphinid (Shovel Test 1181-00-000). The 10 ounces of unidentified small fish bones listed under 19BN323 include about 50 small fish scales and scale fragments that could not be matched with the limited comparative collection at the Maine State Museum.

Five sites yielded only one or two identifiable bones apiece. They are reported in this paragraph and not discussed further. 19BN471 yielded two calcined *Odocoileus* sesamoids from Excavation Unit 2, Levels 035 and 039, 19BN355 (Excavation Unit 3, Level 020) an upper molar of *Bos* (domestic cattle). 19BN356 (Excavation Unit 7, Level 060) yielded an ovicaprid lower M1 (sheep-goat). 19BN340 (Excavation Unit 5, Level 027) yielded an axial skeletal part, possibly a pelvis fragment, of a porpoise or small whale. 19BN390 (Excavation Unit 2-00-000) yielded a pig (*Sus scrofa*) upper molar fragment.

Three cod (*Gadus*) otoliths from 19BN415 yielded readable transverse sections as reported in Table 3.2. These otolith readings translate into a range of seasonality from mid-summer or late summer (1/4 growth, perhaps August) to late fall (7/8 growth, probably November). All of these proveniences are located in Concentration 415.31.

Faunal Remains from Other Sites

19BN341

This site is characterized by a relatively high number of deer, codfish, and eel bones compared with the other sites in the sample (Table 3.3).

One seal and five deer teeth from this site were sectioned. One deer tooth provided a seasonality reading; the unreadable teeth are as follows:

19BN341 #12089. Excavation Unit 13-00-005, *Phoca* canine.

19BN341 #12090. Excavation Unit 15-01-046, *Odocoileus* left lower P2 or P3, 5 to 7 years of age

19BN341 #12092. Excavation Unit 17-00-013, *Odocoileu*s lower M1, 3 to 4 years of age.

19BN341 #12093. Excavation Unit 18-00-000, *Odocoileus* upper M1 and M2, M4 exhibiting 8+ years wear state, M2 exhibiting 6 or 7 years wear state.

The one tooth that yielded a seasonality reading is 19BN341 #12091, Excavation Unit 17-00-013, Concentration 341.21, an *Odocoileus* incisor. The second annulus (growth arrest) line had formed, and, the last layer forming at the time of death was a 1/4 to 1/3 thickness growth layer; death occurred in mid-summer.

Three deciduous premolars of deer also provide seasonality evidence. An upper left DP1, Excavation Unit 18-00-000, Concentration 341.23 and a lower right DP2, Excavation Unit 17-00-013, Concentration 341.21 both exhibit light wear. A lower left DM1 or DM2, Excavation Unit 23-00-020, Concentration 341.21 is unworn. Since these deciduous molars erupt between 1 and 3 months of age, and since they exhibit moderate wear by late fall, these two, or three, individuals represent summer or early fall (July through October) kills.

As with all the faunal collections inspected, no bird long bones exhibited the presence of medullary bone. One bird bone yielded seasonality information. It is a tarsometartarsus from a medium-sized bird that is neither duck nor alcid (possible identification includes cormorant, gull, or loon) whose proximal and distal ends are uncompleted, still exhibiting the porous bone cortex and unossified articular surfaces of a fledgling. This bone is another piece of evidence for summer seasonality.

One turtle carapace fragment from the site (19BN341, Excavation Unit 15-00-024, Concentration 341.24) has been identified as the anterior neural bone of a small marine turtle, an Atlantic ridley approximately 1.5 feet in length. This identification has been supplied by Dr. Thomas French of the Non-game and Endangered Species Program, Division of Fisheries and Wildlife, Commonwealth of Massachusetts, whose particular interest is turtle species distribution.

Since the *Odocoileus* assemblage from 19BN341 is so large, it can be used to produce the same sort of demographic and metric data obtained from the 19BN308 sample. Importantly, Excavation Unit 18-00-000 has yielded right upper first and second molars, without maxillary bone but obviously paired because of an interstial wear pattern fit, that document a very rapid tooth wear rate in the deer population. M1 from the series is easily classifiable in the 5 to 7 year wear category (5 or 6 years) and M2 is classifiable as the 3 to 4 year wear category. In Cervid populations with relatively slow rates of wear, the difference in eruption timing between the first and second molars, about 6 months, is not enough to cause such a noticeable “wear gradient”. I surmise that tooth wear rate in Cape Cod deer is high, logically so in a sandy environment, and that the wear-based age categories overestimate age at death for older deer.

The 19BN341 sample yielded teeth that allow differentiation of a minimum of two individuals in the calf category, none in the 2 year category, one in the 3 to 4 year category, two in the 5 to 7 year category, and one in the 8+ years category.

Postcrania exhibiting epiphyseal fusion states are placed in age groups in Table 3.4. Thus the majority of deer in the (small) sample are over 2 years of age.

Metric comparisons between the 19BN341 deer and a large Maine buck and modest size doe from Virginia are provided in Table 3.5. The specimen(s) being measured from 19BN341 are substantially larger than the small doe, and about 5 percent to 10 percent smaller in linear dimension than the 260-pound (118 kg) live weight Maine buck, basically being more lightly built.

Many of the codfish bones from 19BN341 have been measured and those measurements converted into an age based on the size of comparative specimens and measurements based on data available to the author. The vast majority of the specimens are from 5 year old size cod, a few in 6 or 7 year class, a few in 4 year size class, and one as small as 2 years. The 5-year cod are modest in size, with vertebral diameters of 1.1 to 1.4 cm and weighing an average of 5 kg.

19BN390

Site 19BN390 is remarkable only for a very high proportion of turtle compared with other sites. One *Odocoileus* lower molar fragment from Excavation Unit 6-00-050 was sectioned but found to be unreadable.

19BN415/481

A right *Odocoileus* lower M1 or M2 of 2 or 3 years wear state (19BN415 from Excavation Unit 4-00-000) was sectioned and successfully read for season of death. Two annuli had formed, and the last layer forming was a 1/4 to 1/2 thickness indicating a summer or early fall kill.

The faunal assemblage from 19BN415/481 is characterized by a high proportion of skate bones, and a higher than normal proportion of small duck bones (goldeneye and bufflehead).

Three teeth were sectioned; one was read. The two unreadable teeth include a *Phoca vitulina* postcanine (19BN415/481 #36, Excavation Unit 1-00-010) and an *Odocoileus* left lower M3 (19BN415.481, Excavation Unit 3, 0001-01-20 to 70). The readable tooth was a *Phoca* canine (19BN481 #38, Excavation Unit 1-00-010), which exhibited the formation of its fourth annulus at the time of death. This specimen probably represents June or July seal hunting.

CHAPTER FOUR
Discussion and Summary

In this chapter the faunal data are examined for obvious patterning that might correlate with geographic location of the site or seasonality of site occupation (Table 4.1).

First, a caveat: all of these samples are relatively small, increasing uncertainty that the results are "representative." Sample size limits are most restrictive in the search for clues to seasonality of occupation. All teeth that possibly were suitable for sectioning were attempted, but the success rate was low due to poor preservation. None of the samples are large enough to provide negative evidence for the lack of occupation in any given season. The season of harvesting particular resources can simply be demonstrated to include certain sections of the calendar at certain sites.

Even in the largest sample from one site (19BN308 with all concentrations considered) totals less than 100 deer bones, for example. This sample size is between 5 percent and 8 percent of the total deer bone sample for each occupation at the Turner Farm site, North Haven, ME (Spiess and Lewis 2001). The Turner Farm is the only New England site yet analyzed where I feel marginally confident of negative seasonality evidence for any one occupation.

Only at one locus (19BN308, Concentration 308.33) can I compare a Late Archaic with a Woodland faunal sample. My impression is that the Woodland occupants' activities that resulted in harvesting all the small fish species (skate, eel, herring family) and perhaps, the small furbearers, were not pursued by the Archaic occupants, or at least were not pursued at this site.

Geographic variability within the Woodland period is a bit easier to summarize, but there is no simple patterning. The Nauset area, including Fort Hill, contains sites that demonstrate warm season occupation. The only site with a reasonably sized faunal collection from the High Head area also demonstrates warm season seasonality. Thus, there is no dramatic contrast in season of occupation between the Nauset and High Head areas.

The 19BN415/481 assemblage from High Head may be distinctive when compared with the Nauset area assemblages with a higher number of Phocid bones at High Head, but sample size is too low to say so definitely. The small ducks, mostly goldeneye and bufflehead, are noticeably more dominant in the 19BN415/481 sample. In winter these two species tend to form large rafts in-shore along the coast of southern New England. Skate are certainly as plentiful in 19BN415/481 as at other sites in the survey, but the other small fish species were apparently not being harvested in quantity.

There is some contrast between the assemblages from the Fort Hill area, 19BN308 and 19BN323. Site 19BN323 has a high flounder, skate, and sturgeon frequency relative to mammal and bird bones, but it lacks the high eel and herring frequency accompanying these at 19BN308. The lack of eel and herring at 19BN323 may be just the result of a sampling problem, failure to hit an analogous depositional complex with the excavation at 19BN308, Concentration 308.33, Stratum VI.

The two assemblages from Salt Pond Bay, 19BN341 and 19BN390, offer more of a contrast. Cod, deer, and eel dominate at 19BN341, while turtle and herring dominate at 19BN390. Unfortunately, in the absence of extensive season of occupation data, the extent to which variation in seasonal occupation or activities contributed to the observed pattern cannot be determined.

Even in this small sample there are no obvious co-variances between different groups of taxa from site to site. The job of more completely deciphering prehistoric subsistence adaption on Cape Cod using faunal analysis is a complex one that will require larger samples than the ones now available.

References Cited

Bengston, Sven-Axal
1984 Breeding Ecology and Extinction of the Great Auk (*Pinguinnis impennis*): Anecdotal Evidence and Conjectures. *The Auk* 101: 1-12.

Bigelow, Henry B., and William Schroeder
1953 *Fishes of the Gulf of Maine.* Fishery Bulletin of the Fish and Wildlife Service, 53.

Binford, Lewis R.
1978 *Nunamiut Ethnoarchaeology.* Academic Press, New York.

Carlson, Catherine
1986 Maritime Catchment Areas: *An Analysis of Prehistoric Fishing Strategies in the Boothbay Region of Maine.* Thesis ms., Institute for Quaterrnary Studies, University of Maine at Orono.

Childs, S. Terry
1984 Prehistoric Ceramic Remains. In *Chapters in the Archeology of Cape Cod*, I, edited by Francis P. McManamon, pp. 195-274. Cultural Resource Management Study No. 8, vol 2. Division of Cultural Resources, North Atlantic Regional Office, National Park Service, Boston.

Dwyer, Alison
1984 Seasonality Analysis on *Mercenaria mercenaria* remains from 19BN308, Concentration 308.33. Ms. on file, Division of Cultural Resources, North Atlantic Regional Office, National Park Service, Boston.

Fitzgerald, Joyce
1984 Floral and Faunal Archaeological Remains. In *Chapters in the Archeology of Cape Cod, I* edited by Francis P. McManamon, pp. 195-274. Cultural Resource Management Study No. 8, vol. 2, Division of Cultural Resources, North Atlantic Regional Office, National Park Service, Boston.

Fitzgerald, Joyce and Francis P. McManamon
1992 *1983 Excavation at 19BN308,* Fort Hill. Draft report on file, Cape Cod National Seashore, Wellfleet, MA

Grayson, Donald K.
1981 The Effects of Sample Size on Some Derived Measures in Vertebrate Faunal Analysis. *Journal of Archaeological Science* 1:255-271.

Haag, William G.
1948 An Osteometric Analysis of Some Aboriginal Dogs. *University of Kentucky Reports in Anthropology* 7:3.

Halls, Lowell K. (editor)
1984 *White-tailed Deer: Ecology and Management.* The Wildlife Management Institute, Washington, DC.

Hancock, Mary E.
1984 Analysis of Shellfish Remains: Seasonality Information. In *Chapters in the Archaeology of Cape Cod I,* edited by Francis P. McManamon, pp. 121-156. Cultural Resource Management Study No. 8, vol. 2, Division of Cultural Resources, North Atlantic Regional Office, National Park Service, Boston.

Horton, D.R.
1984 Minimum Numbers: A Consideration. *Journal of Archaeological Science* 11:255-271.

Peterson, Roger Tory
1980 A *Field Guide to the Birds East of the Rockies,* 4th edition. Houghton-Mifflin, Boston.

Rick, Ann
1975 Bird Medullary Bone: A Seasonal Dating Technique. *Canadian Archaeological Association Bulletin* 7: 183-190.

Ritchie, William A.
1969 *The Archeology of Martha's Vineyard: A Framework for the Prehistory of Southern New England* Natural History Press, Garden City, New York

Spiess, Arthur
1978 Zooarchaeological Evidence Bearing on the Nain Area Middle Dorset Subsistence-Settlement Cycle. *Arctic Anthropology* 15:2:48-60.

Spiess, Arthur, and Robert Lewis
2001 The Turner Farm Fauna: 5000 Years of Hunting and Fishing in Penobscot, Maine *Occasional Publication in Maine Archaeology, 11.* Maine State Museum, the Maine Historic Preservation Commission and the Maine Archaeological Society, Augusta

Spiess, Arthur, and Mark Hedden
1983 *Kidder Point and Sears Island in Prehistory.* Occasional Publications in Maine Archaeology No. 3. Maine Historic Preservation Commission, Augusta.

Walker, Ernest P.
1968 *Mammals of the World,* second edition. Johns Hopkins University Press, Baltimore, MD.

White, T. E.
1953 A Method of Calculating the Dietary Percentage of Various Food Animals Utilized by Aboriginal People. *American Antiquity* 18:396-398

TABLE 2.1

19BN308 Numbers of Bones: Strata for Concentration 308.33

	Stratum I	Strata II & III	Stratum IV & Mixed w/IV	Stratum V	Shell Midden General	Stratum VI
Mammals						
Large mammal longbone fragments >5 cm.	8	16	19	5	1	1
Large mammal, unident.	2					
Odocoileus	16	15	16	2	23	
Phocid	1				1	
Phoca vitulina					2	
Halichoerus						
Ursus americanus	1	1				
Porpoise						
Castor canadensis	1	5	1			
Small mammal, unident.	2	3				
Lagomorph		1			3	
Canis familiaris	1	5	5	1	2	
Small canid			1			
Procyon	1	3	3		8	
Small carnivore (? Procyon)		3			2	
Mustela sp	1					
Sciurus			1			
Marmota						
Small rodent/or insectivore	4	1		1	5	
Ondatra						
Equus						
Ovicaprid						
Bos	1					
Sus scrofa	1					
Birds, Reptiles, Amphibians						
Aves unident., large		2	1		2	
Aves unident., medium and small	5	39	25	13	49	1
Gavia immer		2			1	
Meleagris gallopavo		1	2		2	
Alcid, medium					1	

TABLE 2.1 (continued)

19BN308 Numbers of Bones: Strata for Concentration 308.33

	Stratum I	Strata II & III	Stratum IV & Mixed w/IV	Stratum V	Shelll Midden General	Stratum VI
Birds, Reptiles, Amphibians, continued						
Aves unident., large	2	1		2		
Aves unident., medium and small	5	39	25	13	49	1
Gavia immer	2				1	
Meleagris gallopavo	1	2			2	
Alcid, medium					1	
Anatid, general	3	3			1	2
Anatid, small	1	1			1	1
Pinguinnis impennis	1					
Large raptor		1			1	
Turtle	12	131	121	3	52	15
Snake		8				1
Amphibian						1
Fish						
Unident. fish	1	1	4	26*	9	
Unident. small fish	8	131	53	3	53	76
Sturgeon	22	27	113	31	10	
Skate family	3	69	5		27	181
Flounder family	17	91	93	7	14	53
Sculpin family		7	1			
Eel		1	32		7	12
Goosefish					58**	
Striped bass		7	8	7	3	3
Herring family	3	38	5	1	17	36
Cod (*Gadus morhua*) and relatives		10	2	1	36	
Cod relative, unident.		1				
Weakfish		4	1			
Wolffish						
Salmonid						
Swordfish		1				
Shark	1					

* Probably either striped bass or flounder, sparse fragments

** All EU300 proveniences

TABLE 2.2

19BN308, Numbers of Bones: Strata for Concentrations 308.42 and 308.71

	Concentration 308.42		**Concentration 308.71**			
	EU007 Stratum I, Plowzone	Shell Midden	Stratum I, Plowzone	19th Century Fill	Shell Midden	Feature 1
Mammals						
Large mammal longbone fragments >5 cm	1	5			1	
Large mammal, unident.				2		2
Odocoileus	5	13	1		3	
Phocid						
Phoca vitulina						
Halichoerus	1					
Ursus americanus						
Porpoise		4	1			
Castor canadensis	5	3				1
Small mammal, unident	1	7				3
Lagomorph		1			1	
Canis familiaris	1	9				
Small canid		1				
Procyon	5	4				
Small carnivore (? *Procyon*)	1	1				
Mustela sp.						
Grey squirrel		1				
Marmota		1				
Small rodent/or insectivore	1		1	2		1
Muskrat						
Equus	1		1			
Ovicaprid			2			
Bos	1					
Sus scrofa						
Birds, Reptiles, Amphibians						
Aves unident., large	2					
Aves unident., medium and small	25				5	

TABLE 2.2 (continued)

19BN308, Numbers of Bones: Strata for Concentrations 308.42 and 308.71

	Concentration 308.42		**Concentration 308.71**			
	EU007 Stratum I, Plowzone	Shell Midden	Stratum I, Plowzone	19th Century Fill	Shell Midden	Feature 1
Birds, Reptiles, Amphibians, continued						
Gavia immer	1					
Meleagris gallopavo		3				
Alcid, medium		1				
Anatid, general		4				2
Anatid, small		1				
Piguinnis impennis		4	(MNI)			
Large raptor						
Turtle	10	195			14	
Snake		10				
Amphibian					1	
Fish						
Unident. fish	1					
Unident. small fish	1	28			2	73
Sturgeon		9			13	
Skate family	1	4		1	4	49
Flounder family	4	3				8
Sculpin family		1				
Eel		2				27
Goosefish		1		2		122
Striped bass		2				
Herring family	1	2				12
Cod (*Gadus morhua*) relatives						16
Cod relative, unident.						1
Weakfish						
Wolffish						
Salmonid						
Swordfish						
Shark						

TABLE 2.3

19BN308, Numbers of Bones: Other Concentrations

	Concentration					
	308.11	308.12	308.14	308.15	308.21	308.22
Mammals						
Large mammal, unident.			1			
Odocoileus			1			
Small mammal, unident.					1	
Procyon		1				
Bos						1
Sus scrofa	1	1			1	
Birds, Reptiles, Amphibians						
Anatid, small					1	
Snake	1				1	
Fish						
Unident. small fish					5	
Sturgeo	9		1	1	1	
Skate family	2				19	
Sculpin family	1		1			
Eel		1				
Goosefish					1	
Herring family					4	

TABLE 2.4

19BN308, Numbers of Bones: Additional Concentrations

	Concentration					
	308.32	308.34	308.41	308.43	308.51	308.52
Mammals						
Procyon		1				
Bos				1		
Sus scrofa						1
Birds, Reptiles, Amphibians						
Aves unident., large	1					
Snake		1				
Fish						
Unident. small fish	1					
Sturgeon	1					
Skate family					1	
Herring family					1	

TABLE 2.5

Total Bone Weights, Concentration 308.33

Woodland Strata

Mammal	1,043.6 grams
Bird	73.3 grams
Other, mostly turtle	145.4 grams
Fish	94.1 grams
Unidentified to Class	731.6 grams

TABLE 2.6

19BN308, *Odocoileus* Epiphyseal Fusion

Epiphysis	Fused	Unfused
Fusion at 14-17 months, humerus distal phalanges I & II	6	3
Fusion at 29-35 months, metapodials distal femur proximal	0	1
Fusion at 34-60 months, radius distal tibia proximal humerus proximal	No Specimens	

TABLE 2.7

Deer Postcranial Measurements for 19BN308

Bone/Measurement	19BN308 Specimen(s)	Large (260 lb. live weight, from Maine)	Small (from Virginia)
Phalange II 138, 141	1.46 cm 1.49 cm	1.60, 1.68 cm 1.60, 1.68 cm	1.4, 1.5 cm 1.4, 1.5 cm
Humerus/114	3.98 cm	- - - - -	3.3 cm
Tibia/149	3.54 cm	4.00 cm	3.3 cm

Note: For full collection information and measurement series on deer specimens, refer to Spiess and Hedden (1983: Appendix 1).

TABLE 2.8

Historic Dog Burial, 19BN308
Excavation Unit 004, Levels 030 and 040, Concentration 308.00

"West portion articulated bone feature"

a. 1 left pelvis (illium, ischium, acetabulum) interosseus articulation fused,
acetabular diameter 2.41 cm
(compare 2.52 cm for small timber wolf specimen in Maine State Museum)
Pelvic length ischium to illium: 11 cm

b. Left femur missing all epiphyses (unfused)
Greatest length of diaphysis 16.25 cm
(Compare same measurement of timber wolf: 17.5 cm)

c. Sacrum: inter-vertebral epiphyses fused
Cranial-most epiphysis fusing
Interalar width 4.13 cm "East portion"

d. Right pelvis-ischium and illium

e. Right femur, epiphyses unfused
"004-00-030 hand excavated" labeled "sheep bone concentration" by excavator

f. 7-8 lumbar vertebrae

g. 2-1 vertebrae transitional between lumbar and thoracic

h. 6 thoracic vertebrae

i. 25 unfused vertebral epiphyseal plates

j. 6 rib shaft fragments
"004-00-040" middle portion

k. 1 lower thoracic vertebra

l. 1 vertebral epiphyseal plate

m. 1 caudal vertebral body and one unfused plate

n. 1 femoral head epiphysis
"004-00-030 from wall"

o. rib, mid-thoracic
"004-00-040 hand excavated above and around feature"

p. 2 rib shafts, mid-thoracic

TABLE 2.9

19BN308 Column Samples from Excavation Units 306, 307, 312-316
Excluding Features (weight in grams/count)

		Column Sample Flotation - Raw Data *			
	Hand Excavated	Light >1/4"	Light 1/8"-1/4"	Heavy >1/4"	Heavy 1/8"-1/4"
Mammal, Diagnostic	260.3g/ 51	0	0	26.2g/ 4	.05g/ 2
Mammal, Non-diagnostic	303.0g/ 158	0	0	9.3g/ 7	0.50g/ 1
Bird, Diagnostic	7.5g/ 13	0	0	0	0
Bird, Non-diagnostic	30.7g/ 65	0	0	1.2g/ 1	0
Fish, Diagnostic	94.7g/ 336	0.18g/2	0.10g/15	1.4g/ 14	5.2g/369
Fish, Non-diagnostic	28.3g/ 204	0.50g/1	0.10g/ 9	1.7g/ 30	6.80g/505
Other, Diagnostic	5.7g/ 8	0	0	0	0.20g/ 6
Other, Non-diagnostic	65.7g/ 184	0	0	4.4g/ 20	0.20g/ 7
Unidentified, Diagnostic	53.3g/ 133	0	0.02g/ 1	10.3g/ 13	0.50g/ 21
Unidentified, Non-diagnostic	440.9g/1817	0	0.03g/ 2	34.8g/151	21.90g/906
TOTALS	1290.1g	0.68g	0.25g	89.3g	35.35g

Grand Total Bone Weight 1,415.7g

*Figures show weight in grams/number of bones for various identification categories compared by method of recovery: hand excavation, light versus heavy flotation fraction, 1/4" versus 1/8" screen.

TABLE 2.10

19BN308 Comparison of Hand-Excavated Faunal Samples and Column Faunal Samples

	Hand Excavated	Column Sample Flotation - Corrected for Volume (4%) Sum of Column: Light >1/4"	Light 1/8"-1/4"	Heavy >1/4"	Heavy 1/8"-1/4"	Sample Corrected Weights
Mammal, Diagnostic	260.3 g	0	0	655.0 g	1.2 g	656.2 g
Mammal, Non-diagnostic	303.0 g	0	0	232.5 g	12.5 g	245.0 g
Bird, Diagnostic	7.5 g	0	0	0	0	0
Bird, Non-diagnostic	30.7 g	0	0	30.0 g	0	30.0 g
Fish, Diagnostic	94.7 g	4.5 g	2.5 g	35.0 g	13.8 g	55.8 g
Fish, Non-diagnostic	28.3	12.5 g	2.5 g	42.5 g	170.0 g	227.5 g
Other, Diagnostic	5.7 g	0	0	0	5.0 g	5.0 g
Other, Non-Diagnostic	65.7 g	0	0	110.0 g	5.0 g	115.0 g
Unidentified, Diagnostic	53.3 g	0	0.5 g	257.5 g	6.2 g	264.2 g
Unidentified, Non-Diagnostic	440.9 g	0	0.9 g	870.0 g	547.5 g	1,418.4 g
TOTALS	1,290.1 g	17.0 g	6.4 g	2,232.5 g	761.2 g	3,017.1 g

TABLE 2.11

Identifiable Bones from 19BN308: Excavation Units 0306, 0307, 0312-0316
Column Samples Divided by Method of Recovery

		Column Sample Flotation - Raw Data *			
	Hand Excavated	Light >1/4"	Light 1/8"-1/4"	Heavy >1/4"	Heavy 1/8"-1/4"
Mammals					
Large mammal longbone fragments >5 cm	17			1	
Large mammal unident.	2				
Odocoileus					
Phocid	35				
Phoca vitulina					
Halichoerus					
Ursus americanus	1				
Porpoise					
Castor canadensis	6				
Small mammal unident.	3				
Lagomorph	1				
Canis familiaris	9			2*	
Small canid	1				
Procyon	5			2**	1***
Small carnivore (? *Procyon*)				1***	1***
Mustela sp.					
Grey squirre	1				
Marmota					
Small rodent/or insectivore	2				1
Muskrat					
Equus					
Ovicaprid					
Bos					
Sus scrofa					
Birds, Reptiles, Amphibians					
Aves unident., large	4				
Aves unident., medium and small	67			5	

TABLE 2.11 (continued)

Column Sample
Flotation - Raw Data *

	Hand Excavated	Light >1/4"	Light 1/8"-1/4"	Heavy >1/4"	Heavy 1/8"-1/4"
Birds, Reptiles, Amphibians, continued					
Gavia immer	2				
Meleagris gallopavo	3				
Alcid (medium)					
Anatid (general)	6			2	
Anatid, small	2				
Pinguinnis impennis				1	
Large raptor	1				
Turtle	247			15	
Snake	8				1
Amphibian					
Fish					
Unident. fish	27	2	2		
Unident. small fish	106			5	73
Sturgeon	166			3	5
Skate family	21			7	99
Flounder family	146			6	29
Sculpin family	8			1	1
Eel	6				158
Goosefish					
Striped bass	21				1
Herring family				2	46
Cod (*Gadus morhua*)	12				
Cod relative, unident.	1				
Weakfish	7				
Wolffish					
Salmonid					
Swordfish	1				
Shark					

* Canis bones are right P3-M1 and right mandibular angle and ascending ramus
** A right lower jaw and right upper molar
*** Hand and finger bones

TABLE 3.1

Sites with the Smallest Faunal Sample, Bone Counts

	19BN 273/ 275	19BN 274/ 339	19BN 281	19BN 282/ 283 284	19BN 288	19BN 323	19BN 355
Mammals							
Large mammal longbone fragments > 5 cm							
Large mammal unident.						2	
Odocoileus	1	8	2	7	4		4
Phocid							
Phoca vitulina							
Halichoerus							
Ursus americanus							
Porpoise	1*						
Castor canadensis			1				
Small mammal unident.							
Lagomorph				1		1	
Canis familiaris			1		1		
Small canid			2		2		
Procyon							
Small carnivore (? *Procyon*)							
Mustela sp.							
Grey squirrel							
Marmota							
Small rodent/ or insectivore					1	1	
Muskrat							
Homo sapiens			1**				
Equus							
Ovicaprid							
Bos							
Sus scrofa					1	1	
Birds, Reptiles, Amphibians,							
Aves unid., large							
Aves unid., medium or small						1	

TABLE 3.1 (continued)

	19BN 273/ 275	19BN 274/ 339	19BN 281	19BN 282/ 283 284	19BN 288	19BN 323	19BN 355
Birds, Reptiles, Amphibians, cont'd							
Gavia immer							
Meleagris gallopavo							
Alcid, medium							
Anatid, general		1					
Anatid, small							
Pinguinnis impennis							
Large raptor		2					
Turtle					1		
Snake					1		
Amphibian							
Fish							
Unidentified fish				1			4
Unidentified small fish		32			1	102***	
Sturgeon		12****			42	45	
Skate family					1	15	1
Fllounder family		45			1	1	
Sculpin family					1		
Eel		1			1		
Goosefish					1	1	
Striped bass		1			4	10	
Herring family					1	6	
Cod (*Gadus morhua*)		3			2		
Cod relative, unident.							
Weakfish					1		
Wolffish					1		
Salmonid							
Swordfish							
Shark							
Bluefish						1	

* Cut with metal
** Molar tooth
*** Small scales are about 1/2 of sample, unidentifiable
**** 5 pores/cm

TABLE 3.2

Cod Otolith Sections from 19BN415

Excavation Unit	Age (Annuli)	Relative Width Last Growth Layer
Shovel Test 486	3	3/4
0004-00-020	10	7/8
0004-00-020	8	1/4

TABLE 3.3

Small Faunal Sample Collections, Bone Counts

	19BN 341	19BN 390	19BN 410	19BN 415/481
Mammals				
Large mammal longbone fragments > 5 cm	11	7		
Large mammal unident.	2		1	5
Odocoileus	62	15	10	12
Phocid	1	1		1
Phoca vitulina				11
Halichoerus				
Ursus americanus				
Porpoise				
	1	1	3*	
Castor canadensis	1			
Striped skunk	1			1
Small mammal unident.				
Lagomorph				2
Canis familiaris	1	1	6	1
Small canid	1			3
Procyon	2	2		1
Small carnivore *(?Procyon)*	3	1		3**
Mustela sp.				
Grey squirrel	1			
Marmota		1		
Small rodent/or insectivore	1			1
Muskrat	1			
Canis lupus (wolf)		3		
Equus				
Ovicaprid			2	
Bos			1	
Sus scrofa			2	1
Birds, Reptiles, Amphibians				
Aves unident., large	1	1	3	2
Aves unident., medium or small	19	33		22
Gavia immer				1
Meleagris gallopavo	2	1		
Alcid (medium)		1		
Anatid (general)		2	1	3
Anatid, small	2	1		25

TABLE 3.3 (continued)

	19BN 341	19BN 390	19BN 410	19BN 415/481
Birds, Reptiles, Amphibians continued				
Pinguinnis impennis	4		4	6
Large raptor				
Branta canadensis (goose)		1		1
Podilymbus or relative (grebe)			1	
Cormorant		1		5
Lariid (gull)				3
Grouse family				3
Turtle	3***	111	1	16
Snake			10	1
Amphibian				
Fish				
Unidentified fish	27	1	4	29
Unidentified small fish	388	18		6
Sturgeon	82	8	3	11
Skate family	72	2	9	135
Flounder family	17	8		6
Sculpin family	6			
Eel	510****	1		
Goosefish	53	4	1	7
Striped bass		2	19	9
Herring family	15	62		17
Cod (*Gadus morhua*)				
Cod relative, unident.				
Weakfish	1			1
Wolffish				
Salmonid				
Swordfish	6*****			1
Tomcod (*Microgadus*)	1			
Cunner	1			
Wrymouth (*Crytacanthodus*)	1			
Bluefish	1			

* One bone is small whale, not porpoise
** One *Felis* tooth
*** One is snapping turtle carapace, one a marine turtle
**** All very small eels
***** Teeth from a small shark

TABLE 3.4

19BN341, Deer Demography for Postcranial Epiphyseal Fusion

	Number of Bones		
	Fused	Fusing	Unfused
Epiphyses fusing, 14-17 months	3	0	0
Fusing at 29-35 months	3	1	0
Fusing at 35-60 months	1	0	0

TABLE 3.5

Odocoileus Metric Comparisons

	19BN341	Maine buck	Virginia doe
Bone/Measurements			
Humerus, distal			
114	4.02 cm	- - -	3.3 cm
Radius, proximal			
116	4.01 cm	- - -	3.4 cm
Radius, distal			
117	3.84 cm	4.05 cm	3.0 cm
Metapodial, distal			
122	1.61/1.58 cm	1.53 cm	1.3 cm
123	2.59/2.44 cm	2.27 cm	1.9 cm
Phalange I			
131,4	5.09 cm	5.03/5.54 cm	3.9/4.3 cm
132,5	1.44 cm	1.73/1.81 cm	1.4 cm
133,6	1.38 cm	1.42/1.47 cm	1.2 cm
Phalange II			
137,140	3.92 cm	4.07/4.31 cm	2.9/3.5 cm
138,141	1.52 cm	1.60/1.68 cm	1.5 cm
139,142	1.12 cm	1.14/1.21 cm	1.1 cm

NOTE: See Spiess and Hedden (1983: Appendix 1), for specimen information and complete measurement set.

TABLE 4.1

Intersite Comparisons Using Gross Attributes of the Faunal Collection

---

ARCHAIC PERIOD OCCUPATION

19BN308, Concentration 33, Stratum V, small sample size
Abundant sturgeon
Deer, birds, flounder, and striped bass present

WOODLAND PERIOD OCCUPATION

I. FORT HILL AREA - Nauset

19BN308, Concentration .33, Stratum II, III, IV, VI; diversity of activity patterns
Summer (warm season) and winter (cold season) seasonality
High turtle, sturgeon, skate, flounder, eel, and herring frequency
No set of taxa glaringly low or absent

19BN323
No particular seasonality demonstrated
High flounder, skate, and sturgeon frequency relative to mammal and bird

II. SALT POND BAY - Nauset

19BN341
Summer seasonality demonstrated
High deer, eel, and cod frequency, moderate sturgeon
Low flounder and herring frequency

19BN390
High turtle and herring frequency for sample size

III. HIGH HEAD AREA

19BN415/481
Summer seasonality demonstrated
High small duck and skate frequency
Possibly more “marine mammal” oriented than rest of sites; high *Phoca* count
Low eel count for the sample size

Copper Remains on Cape Cod: A Metallurgical Analysis of Two Objects

S. T. Childs

Acknowledgements

I would like to thank Edward Barry for his advice and assistance in some of the metallography. Walter Correia of the Massachusetts Institute of Technology (MIT) did the optical mission spectroscopy. Much of this work was done in the laboratory facilities of the Center for Materials Research in Archaeology and Ethnology at MIT.

Introduction

It has not been uncommon to recover at least a few artifacts of copper-based metal at Native American sites in New England and New York (Ritchie 1969, 1980; Luedtke 1980; Fowler 1966:51; Bullen 1949; Willoughby 1935). Such copper artifacts are commonly presumed to be either traded in from the source areas of native copper around Lake Superior in Michigan (Drier 1961; Ritchie 1980; Fowler 1966:51) or to be the products of European manufacture with some minor, local reworking (Fowler 1972; Ritchie 1969). They are often given attention for their chronological potential, as indicators of trade, and as items of ceremony and status (Bradley and Childs 1991; Childs 1994; Heckenberger et al. 1990; Dunbar and Ruhl 1974:6).

While function might be determined through contextual relationships with other artifactual remains, such as in burials, or by use wear, the sources of the metal are commonly determined by chemical means (Bastian 1961; Goad and Noakes 1978; Levine 1999; Rapp et al. 2000). Chemical and trace element studies are useful now that there is a growing body of data on sources of native copper and their elemental signatures (Rapp 1980; Goad and Noakes 1978; Fields et al. 1971). These can be easily distinguished from the copper-based alloys that were shipped to North America from Europe during the Contact period. These chemical data, however, have a limited utility when considered alone. They cannot address questions regarding the manufacturing history of objects or the evolution of metal working in North American by its native populations.

Fortunately, there has been some recent, concomitant interest in the technology of copper artifacts excavated from Native American sites in New England and, more usually, from other areas across North America. These studies (Bradley and Childs 1991; Childs 1994; Dunbar and Ruhl 1974; Ehrhardt 2005; Smith 1965; Schroeder and Ruhl 1968; Wilson and Sayre 1935; Clark and Purdy 1982) employ metallurgical analysis to understand the technological history of the copper objects and the range of metal working techniques used by Native Americans over the centuries. Metallography is the microscopic examination of the internal structure of metal grains, which reveals some of the thermal and mechanical processes that were used on an object.

Study Sample and Foci

Copper artifacts have been found in a number of locations on Cape Cod and the Islands (Fowler 1966, 1972; Ritchie 1969; Moffett 1957). Out of the large artifact assemblage resulting from survey and excavations of Native American sites in the Cape Cod National Seashore (CACO), however, only two copper-based artifacts were recovered. A third object came from a site excavated outside the national seashore boundaries by National Park Service personnel and others (Bradley et al. 1982; McManamon et al. 1986; McManamon and Bradley 1988). It is likely that the limited excavation at most of the CACO sites (McManamon 1984:41) and the lack of burials decreased the chances of finding more copper objects.

The following study focuses on two of the three artifacts recovered. One of two small, rolled beads found at a prehistoric site (19BN390) was selected for further study. The other object is a piece of worked sheet metal from a midden overlying an ossuary (19BN387) located on the bay side of Wellfleet. Importantly, the two chosen objects are from widely divergent contexts, both chronologically and in terms of their cultural contexts.

Based on purely visual inspection, it is impossible to understand fully the nature and range of the techniques used to manufacture these objects, the degree of sophistication of the metal work, or the potential sources of the metal. The analytical techniques of metallurgy and optical spectroscopy are used here to focus on these issues.

The two objects are discussed in the probable chronological order of their manufacture. Temporal designations have been made by radiocarbon dating, artifactual associations, and contextual information.

In one case, metallurgical analysis helped support the relative date of the context in which the object was recovered. By discussing these artifacts in a chronological format, it also is possible to comment on both the range of metal working techniques used and obtain a perspective on the continuity of techniques used by Native Americans over the centuries.

Copper Bead from 19BN390

The two copper beads (Figures 1 and 2) were found at a multi-component site (19BN390) situated along the northern side of the Salt Pond in Eastham. They were located in Excavation Unit 6 at a depth and position that was in the vicinity of Feature 01 in Excavation Unit 9. This feature was a lens of burned and unburned shell that also contained a variety of other cultural material. Wood charcoal from the lens was radiocarbon-dated to 1600+/-130 B.P. (Borstel 1984:262). Given their spatial proximity to the dated feature as well as their association with ceramics identified as Early-Middle Woodland (Childs 1984), it is possible that these beads were made during the Middle Woodland period.

The two beads were in equally good condition when excavated. Although they differed somewhat in their dimensions, neither had any outstanding surface features with which to differentiate them. The one chosen for further analysis was longer, so that it was easier to remove a piece with the least possible damage.

Preliminary examination of this bead by binocular microscopy revealed something about its formation. One end was relatively cleanly cut from a sheet of metal after it had been reduced to 0.5 to 1 mm in thickness. The other end was more jagged in appearance but it was unclear whether or not this was due to wear during use. It is likely that the original piece of sheet metal, cut to the length desired for the bead, was rolled around a stick or bone of a particular diameter to produce the final tubular shape (Clark and Purdy 1982:46; Smith 1965). Based on the experimental work of Smith (1965), formation of the well-rounded tube, produced without kinks or an irregular shape, probably indicates that the bead was annealed prior to bending instead of merely being cold worked (Schroeder and Ruhl 1968:Figure 13).

For more detailed analysis, a thin slice was cut across the flatter end of the bead. A small piece of this was saved for optical spectroscopy, a form of chemical analysis. The remainder was set into a Bakelite mount and subsequently ground and polished. The highly polished surface was then etched with potassium dichromate to reveal its internal grain structure.

The most striking feature of the metallurgical section is its abundant annealing twins (Figure 3). These are mirror images of adjacent crystal lattices within a grain and occur after an object has been cold worked and annealed. This process involves flattening and hardening the metal in a cold state and then heat treating or annealing it to rejuvenate its original grain structure and its malleability for further work.

Close examination of the bead section revealed an underlying structure when an oblique light source was used. Figure 4 shows that the sheet of metal had been heavily cold worked so that the previous grains had been severely flattened and stretched out. This may have occured during a sequence of repeated cold working and annealing or merely through stretch hammering (Clark and Purdy 1982:46) the metal in a cold state from a thicker lump or piece of copper. In either case, the last annealing step did not entirely obliterate the last cold working episode so that neither the temperature attained nor the length of annealing time was probably very high or very long.

The metallurgical analysis performed indicates that a skilled craftsman made the bead using a variety of metal working techniques. Intensive cold working reduced the metal from a larger, thicker state to a thin sheet. The experimental work of Smith (1965) and Schroeder and Ruhl (1968) makes it clear that such reduction and flattening can be done strictly by cold working. The final, annealed state of the bead, however, suggests that a repeated sequence of cold working and annealing may have been used. By annealing the sheet metal prior to bending, the copper was made malleable enough to be rolled around a preform. A few, slightly bent annealing twins support the idea that the bead was rolled after final annealing.

Its archeological context and the metal working techniques used to form the bead, which involved no melting, smelting, or casting, strongly suggest it was made prehistorically using native copper. A preliminary chemical analysis was performed to test this hypothesis. Qualitative optical spectroscopy only indicates what elements are present in an object and their relative abundance in relation to the other elements found. A native copper object should, then, consist predominantly of copper with traces of other elements. Alloys, on the other hand, have minor amounts of other elements such as tin, zinc, or lead. Table 1 reveals that this copper is quite pure and contains very few other constituents. One of these, silica, probably is a contaminant after hundreds of years of burial. Since none of the elements found are ones typically used for alloying with copper, the metal is probably native copper. Quantitative analysis would be necessary to verify this. Long-term research by Rapp and colleagues (Rapp et al. 2000) has resulted in a promising technology to trace the probable origin of native copper. Levin (1999) has identified possible sources in the eastern U.S. that need to be explored further.

Copper Sheet Fragment from 19BN387

A single copper sheet fragment was recovered in the shell midden above the Indian Neck ossuary at Wellfleet. The fragment was uncovered approximately 4 cm into the midden, where it was associated with characteristic Late Woodland lithic and ceramic material (Bradley, et al. 1982). The immediate significance of this object was unknown but it presented the possibility of learning about local Native American technology and/or trade as well as providing a tentative relative date of the midden.

Preliminary examination of the copper sheet (Figures 5A and 5B) by binocular microscopy revealed one clearly cut edge, a somewhat battered surface, a slightly beveled, abraded corner, and several series of scoring marks. These close observations provide a good basis upon which to hypothesize about some modifications to the object. Initially, the fragment was probably cut from a larger sheet with a sharp tool. This caused slight lipping due to the softness of the metal. The score marks could have been either guide lines for cutting or mistakes made during the cutting process. The edge along which most of these marks occurred, though, was probably broken off, as suggested by its jagged appearance. The two areas of cracking, where possible embrittlement during hammering occurred, indicate it was cold worked. The surface texture, too, might reflect cold working on a rough surface. Finally, the one somewhat beveled, abraded corner suggests wear due to use.

Based on the initial examination of the object, it was decided to cut a piece of the sheet for metallurgical study that included both the bent and cut edges. Therefore, one end of the object was carefully cut across its width. After grinding and polishing the mounted section, it was examined prior to etching. Small inclusions that differed from the copper bead were visible microscopically. They were determined to be areas of cuprous oxide, which provide good proof that the metal was originally smelted and cast (Smith 1965; Dunbar and Ruhl 1974). No North American native copper objects are known conclusively to have been melted or smelted (Clark and Purdy 1982:45). Therefore, it is possible to hypothesize that the fragment was originally manufactured in Europe and then brought to North America, probably as an item of trade.

When etched with potassium dichromate, further insights into the manufacturing history of the sheet fragment were revealed along with some clear differences between it and the native copper bead. One striking feature of the etched section is the cuprous oxide inclusions in relation to the annealed grains of copper (Figure 6). These contrast with the clean structure of the bead. The elongated nature of some inclusions indicates their presence prior to cold working, which is when they became stretched out. Another obvious feature of the sheet fragment is a preponderance of tiny inclusions evenly distributed through the metal. These are thought to be precipitates that occurred during the casting operation, since they also became elongated during subsequent cold working.

Although these inclusions distinguish the sheet metal from the bead, the two objects also share several features. First, the structure of the sheet fragment shows that the metal is relatively pure and is probably not an alloy. The uniformity of the grains and the absence of additional metal phases provide ample evidence of this. Second, it is evident from the abundance of annealing twins that the sheet was once cold worked and annealed. It is impossible to determine how many times this process was repeated, however. The presence of primarily undistorted twins indicates that little or no cold working occurred over most of the section after the final annealing step. One end of the section, though, does show some further activity beyond this last stage. Elongated, bent twins are visible where the sheet edge was evidently bent in a cold state (Figure 8).

The evidence thus far, then, indicates that a cast object, presumably brought from England, France, or another European country, was further worked by annealing, cutting, cold working, and bending. In order to test the hypothesis that the original source of the sheet metal was not native copper, chemical analysis using optical spectroscopy was done. The qualitative analysis revealed a wide array of minor and trace elements that differed from the rolled bead (Table 1). It was thought that the relatively greater amount of lead was probably not associated with the tiny inclusions since lead typically occurs at the grain boundaries of copper. It was possible that the tiny inclusions were traces of iron or silver, yet this also required further testing. Another possibility was that some of the elements were not internal constituents of the metal but occurred on the surface, possibly as a coating or wash. Other elements, such as calcium and some silica, were probably incorporated during burial above the ossuary and were not original constituents at all. Consequently, electron probe microanalysis, designed to analyze microscopically small areas, was employed to assist in discovering where some of these elements existed.

The probe work conclusively verified the high purity of the metal, as well as identified the location of the lead deposits. These were concentrated with the cuprous oxides, which explains why they were not visible in the grain microstructure. Their discovery also disproved the hypothesis of a surface wash. The presence of iron and some of the other traces of elements, though, still remain a mystery until a fully quantitative analysis is performed.

It is possible to conclude from the presence of this cast copper artifact that the midden above the Indian Neck ossuary was formed during the Contact period. It, therefore, is temporally distinct from the ossuary component, which is dated to the early 10th century A.D., a finding supported independently by the stratigraphic data (Bradley, et al. 1982:54; McManamon et al. 1986; McManamon and Bradley 1988). The unique find of this European-derived artifact suggests that its deposition occurred in the century before the relative abundance of European goods increased at Native American sites.

The sheet fragment was either a portion of a larger object such as a kettle or possibly was cut from a blank piece of copper sheeting traded into New England. The value placed on the metal apparently was high, as efforts were made to utilize and recycle it from other forms. The reuse of European copper and copper alloys has been documented in other studies (Fitzgerald et al.1993; Erhardt 2005). Since copper was a known material that had been used and valued in New England from the late Archaic period onward, the local inhabitants would have benefitted from the influx of material during the Contact period if they had the technology to alter it for their particular needs.

Although it is clear that the original metal came from Europe in some form, it is not as easy to conclude which of the subsequent steps of manufacture were performed by Native Americans, in particular, the initial cold working and annealing stages. On one hand, it is known that the original production of cast, sheet metal would have required cold working and annealing to attain the appropriate original thickness. On the other hand, it is well known that some groups of Native Americans had mastered the craft of annealing native copper into functional items. The bead discussed above is a perfect example of such skill, along with a number of other artifacts (Dunbar and Ruhl 1974; Schroeder and Ruhl 1968). It is quite reasonable to suppose, then, that Native Americans could have heat treated and altered European smelted coppers themselves. But, it is not clear if the populace of New England included people skilled in metal working at the time of European contact.

In the end, there are several pieces of evidence to suggest that the final cutting and cold working were the only techniques used by a local craftsman. First, the metal had been annealed completely, given the uniform grains and the total obliteration of the previous cold working stage, which was not accomplished on the rolled bead discussed above. Also, the irregularly positioned score marks, the cut, broken, and bent edges, and the areas of cracking all indicate a final alteration of the metal in a cold state without a high degree of technical sophistication. Perhaps, however, this is because the flat sheet of metal was only intended to be used as a pick-up tool in its present form. The beveled, abraded corner of the fragment testifies to its use. Obviously, much more work needs to be done to determine the degree of skill and true range of techniques mastered by local craftsmen before we can confidently infer about the producers and sequence of production of such imported artifacts.

Conclusion

The present study has demonstrated the important utility of doing both metallurgical and chemical analyses of copper-based artifacts found at Native American sites in New England. Clearly, the original method of manufacture for the two objects studied differed significantly. The bead was cold worked and annealed from a lump of native copper while the sheet fragment was originally cast with molten metal. Since there is as yet no conclusive evidence from North America that copper melting, smelting, casting, or alloying were practiced by Native Americans (Martin 1999), the derivation of the sheet fragment was probably from an unknown European source.

If only chemical analyses had been done on the two objects, it is evident that some wrong conclusions might have been drawn. Both were made from relatively pure copper, despite the differences in the number of elements included in the two. Conceivably, both might have been interpreted as native copper. The preparation and analysis of metallurgical sections provided a much more detailed picture of their origins. Obviously, it is important to attain a clearer understanding of the compositional range of pure copper and copper-based alloys that were produced by European craftsmen in order to better interpret chemical data. As well, it would be profitable to determine the range of composition for various European functional classes, such as kettles and sheet metal, in order to help identify the imported sources of metal that was later cut and altered by Native Americans. All of this information would aid in furthering our understanding of how European metals impacted Native American material culture and their lifestyles in general (Bradley 1979, 1987; Erhardt 2005).

Metallography helped identify primary methods of fabrication as well as subsequent methods of working with metal. In concert with other findings across North America, it can be assumed that the Native American who made the bead was quite skilled at cold working and annealing long before the presence of Europeans (Schroeder and Ruhl 1968; Dunbar and Ruhl 1974; Clark and Purdy 1982). Consequently, when imported copper became available, the same techniques of cold working and annealing should have been familiar and could have been applied to the valued material.

This connection, however, can only be made if it can be established that Native Americans in New England and, in particular, Cape Cod knew about metal working. It is far from clear where the rolled bead was produced. A concerted effort must be made to further identify and chemically fingerprint the sources of native copper along the east coast of the United States and Canada. But, until these can be compared with the trace element studies of Rapp et al. (2000) and Levine (1999), the old assumption that this bead and similar objects were manufactured near the Great Lakes will prevail (Fowler 1966; Ritchie 1980).

A clearer understanding of the ore sources for copper objects excavated in New England will aid in hypothesizing where the metal work was performed and how far such skills spread across North America. This information would then assist in reconstructing the evolution of metal working in New England, including Cape Cod. In turn, we can better interpret whether local Native Americans had the knowledge of annealing when imported copper became available or had to experiment, as perhaps is seen with the sheet fragment, and learn some of the simpler techniques for working the familiar and valued material.

References Cited

Bastian, T.
1961 Trace Element and Metallurgical Studies of Prehistoric Copper Artifacts in North America: A Review. In *Lake Superior Copper and the Indians: Miscellaneous Studies of Great Lakes Prehistory.* J. Griffin (editor), Anthropological Papers #17. Museum of Anthropology, University of Michigan, Ann Arbor, MI.

Borstel, C.
1984 Stratigraphy and Archaeological Context of Prehistoric Sites at Cape Cod National Seashore. In *Chapters in the Archeology of Cape Cod, I,* Volume 1. Cultural Resources Management Study, No. 8. National Park Service, Boston, MA.

Bradley, J. W.
1979 *The Onondaga Iroquois, 1500-1565: A Study in Acculturative Change and its Consequences.* University Microfilms, Syracuse University, NY.

Bradley, J. W.
1987 *Evolution of the Onondaga Iroquois: Accommodating Change, 1500-1655*. Syracuse University Press, Syracuse, NY.

Bradley, J. W., F. P. McManamon, T. Mahlstadt, and A. Magennis
1982 The Indian Neck Ossuary: A Preliminary Report. *Massachusetts Archaeological Society Bulletin* 43(2):47-59.

Bradley, J. W. and S. T. Childs
1991 Basque Earrings and Panther's Tails: The Form of Cross-Cultural Contact in Sixteenth-Century Iroquoia. In *Metals in Society: Theory Beyond Analysis,* edited by R. M. Ehrenreich, MASCA Research Papers in Science and Archaeology 8, no. 2 pp. 7-17, University Museum, University of Pennsylvania, Philadelphia, PA.

Bullen, R.
1949 *Excavations in Northwestern Massachusetts.* In Papers of the R.S. Peabody Foundation for Archaeology. Volume 1, Number 3. Andover, MA.

Childs, S.T.
1984 Prehistoric Ceramic Remains. In *Chapters in the Archeology of Cape Cod, I, Volume 2.* Cultural Resources Management Study, No. 8. National Park Service, Boston, MA.

Childs, S.T.
1994 Native Copper Technology and Society in Eastern North America. In *Archaeometry of Pre-Columbian Sites and Artifacts*, D. A. Scott and P. Meyers (editors), pp. 229-253. Getty Conservation Institute, Los Angeles, CA.

Clark, D. and B. Purdy
1982 Early Metallurgy in North America. In *Early Pyrotechnology*, T. and S. Wertime (editors). Smithsonian Institution Press, Washington, DC.

Drier, R.
1961 Archaeology and Some Metallurgical Investigative Techniques. In *Lake Superior Copper and the Indians: Miscellaneous Studies of Great Lakes Prehistory*, J. Griffin (editor). Anthropological Papers # 17. Museum of Anthropology, University of Michigan, Ann Arbor.

Dunbar, H. and K. Ruhl
1974 Copper Artifacts from the Englebert Site. *New York State Archaeological Bulletin* 61:1-10.

Ehrhardt, K. L.
2005 *European Metals in Native Hands.* The University of Alabama Press, Tuscaloosa, AL.

Fields, P. et al.
1971 Trace Impurity Patterns in Copper Ores and Artifacts. In *Science and Archaeology*, R Brill (editor). MIT Press, Cambridge, MA.

Fitzgerald, W. R., L. Turgeon, R. H. Whitehead, and J. W. Bradley
1993 Late Sixteenth-Century Basque Copper Kettles. *Historical Archaeology* 27(1):44-57.

Fowler, W.
1966 Ceremonial and Domestic Products of Aboriginal New England. *Massachusetts Archaeological Society Bulletin* 27(3 and 4):33-68.

Fowler, W.
1972 Metal Cutouts of the Northeast. *Massachusetts Archaeological Society Bulletin* 33:24-30.

Goad, S. and J. Noakes
1978 Prehistoric Copper Artifacts in the Eastern United States. In *Archaeological Chemistry II*, G. Carter (editor). Advances in Chemistry Series 171, American Chemical Society, Washington, DC.

Heckenberger, M., J. Petersen, L. Basa, E. Cowie, A. Spiess, and R. Stuckenrath
1990 Early Woodland Period Mortuary Ceremonialism in the Far Northeast: A View from Boucher Cemetery. *The Archaeology of Eastern North America* 18:109-144.

Levine, M. A.
1999 Native Copper in the Northeast: An Overview of Potential Sources Available to Indigenous Peoples. In *The Archaeological Northeast*, Mary Ann Levine, Kenneth Sassaman, and Michael Nassaney (editors), pp. 183-199. Bergin and Garvey, Westport, CT.

Luedtke, B.
1980 The Calf Island Site and The Late Prehistoric Period in Boston Harbor. *Man in the Northeast* 20:25-76.

Martin, S.
1999 *Wonderful Power: The Story ofAncient Copper-working in the Lake Superior Basin*. Wayne State University Press, Detroit, MI

McManamon, F. P.
1984 Method and Techniques for Survey Site Examination. In *Chapters in the Archaeology of Cape Cod, I,* Volume 1. Cultural Resources Management Study, No. 8. National Park Service, Boston, MA.

McManamon, F. P., J. W. Bradley, and A. L. Magennis
1986 *The Indian Neck Ossuary: Chapters in the Archeology of Cape Cod, V*. Cultural Resources Management Study, No. 17. National Park Service, Boston, MA.

McManamon, F. P. and J. W. Bradley
1988 The Indian Neck Ossuary. *Scientific American* 256(5):98-104.

Moffett, R.
1957 A Review of Cape Cod Archaeology. *Massachusetts Archaeological Society Bulletin* 19(1):1-19.

Rapp, G.
1980 Trace-Element Fingerprinting as a Guide to the Geographic Sources of Native Copper *Journal of Metals* 32:35-44.

Rapp, G., J. Allert, V. Vitali, Z. Jing, and E. Henrickson
2000 *Determining Geological Sources of Artifact Copper: Source Characterization Using Trace Element Patterns*. University Press of America, Lanham, MD.

Ritchie, W.
1969 *The Archaeology of Martha's Vineyard*. Natural History Press, Garden City, NY.

1980 *The Archaeology of New York State*, revised 3rd Edition. Harbor Hill Books, Harrison, NY.

Schroeder, D. and K. Ruhl
1968 Metallurgical Characteristics of North American Prehistoric Copper. *American Antiquity* 33(2):162-169.

Smith, C.
1965 Metallurgical Study of Early Artifacts Made of Native Copper. In *Acts of the XI International Congress on the History of Science*. Warsaw, Poland.

Willoughby, C.
1935 *Antiquities of the New England Indians*. Peabody Museum of American Archaeology and Ethnology, Harvard University, Cambridge, MA.

Wilson, C. and M. Sayre
1935 A Brief Metallurgical Study of Primitive Copper Work. *American Antiquity* 2:109-112.

FIGURE 1 A. Horizontal view of beads showing seams (scale is in centimeters).

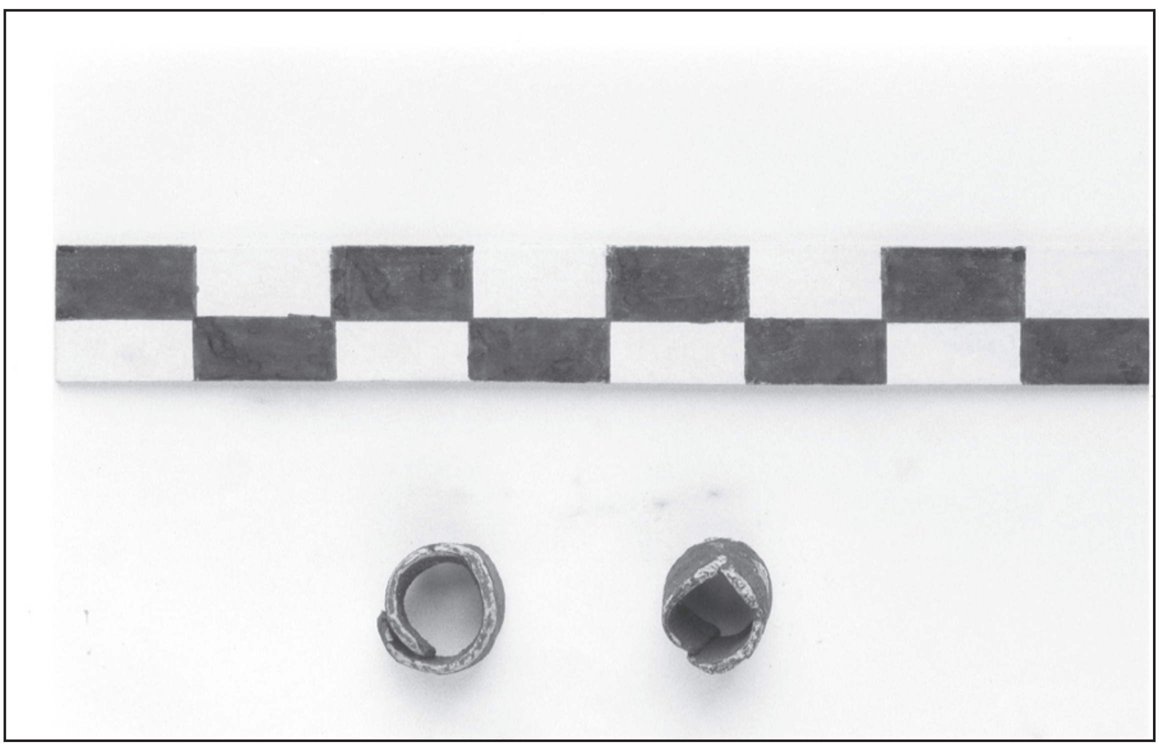


FIGURE 1 B. Vertical view of beads (scale is in centimeters).

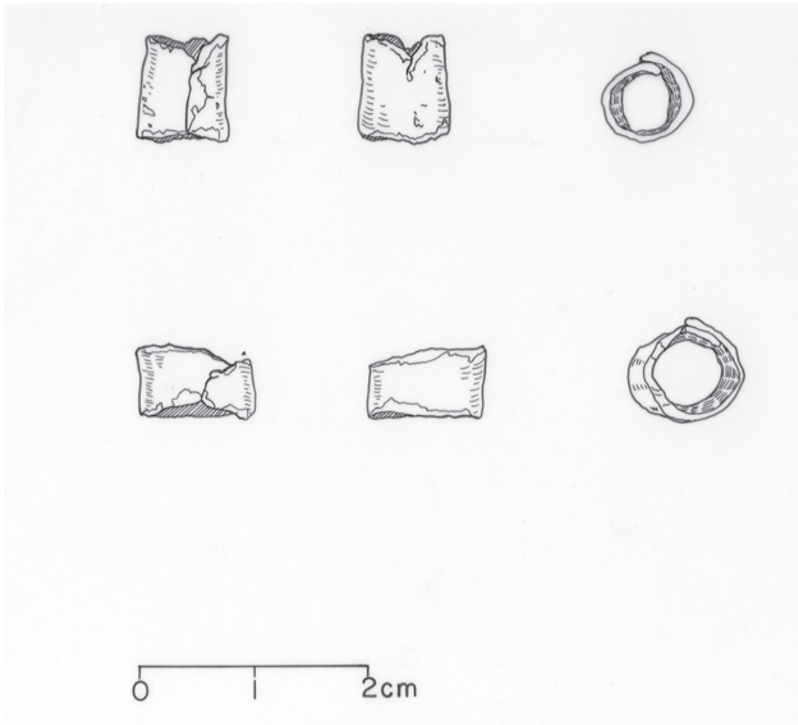


FIGURE 2. Line drawing of beads from 19BN390. A piece of the top bead was used for metallographic and chemical analysis.

FIGURE 3. Annealing twins in a section of the copper bead (200x)

FIGURE 4. Evidence of severe cold working visible beneath annealing twins in a section of the copper bead (100x).

FIGURE 5 A. Horizontal view of sheet metal piece from the midden above the Indian Neck Ossuary (19BN287).

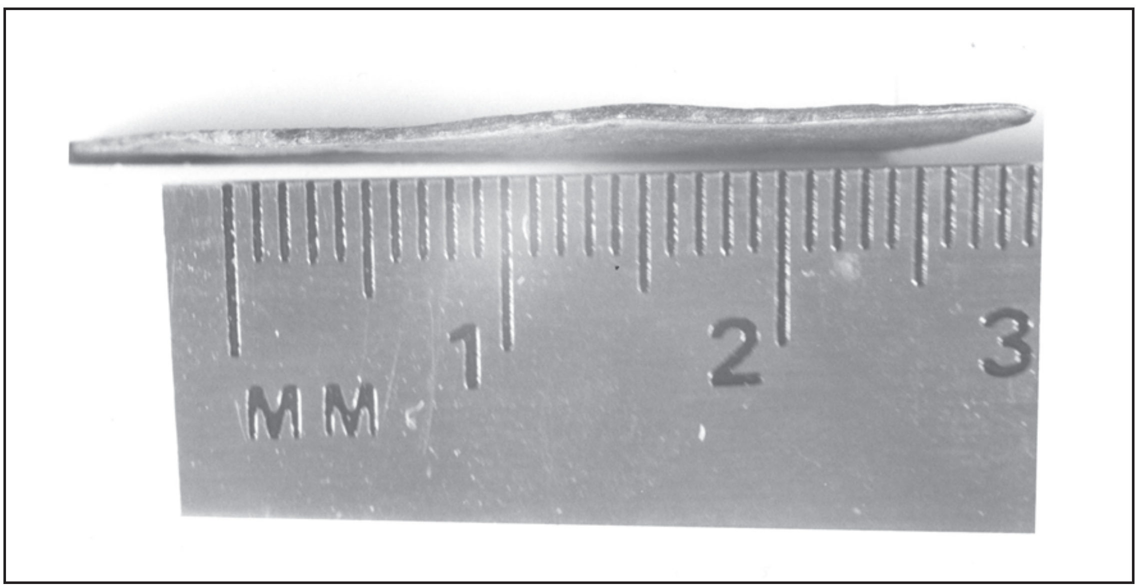


FIGURE 5 B. Vertical view of sheet metal piece from the midden above the Indian Neck Ossuary (19BN287).

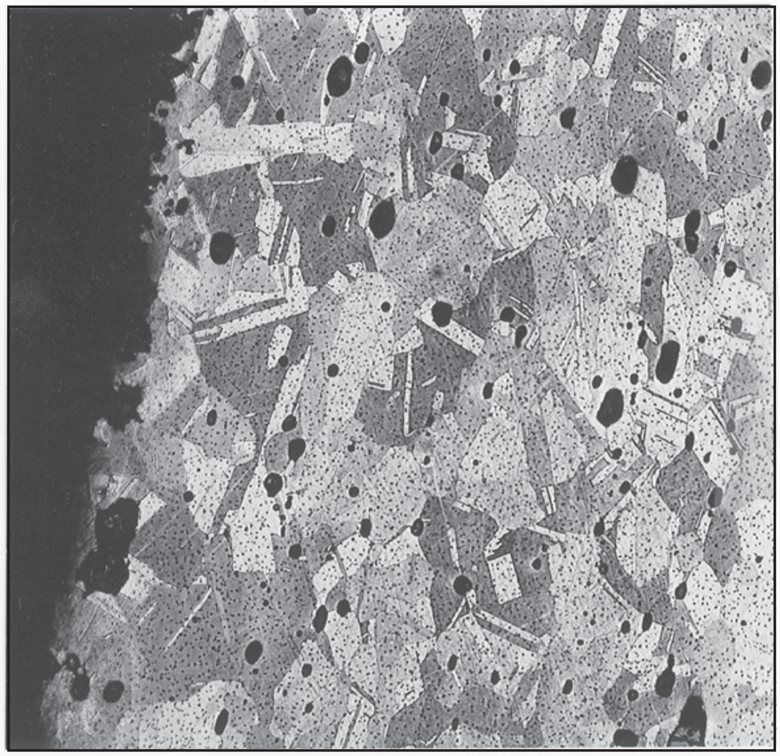


FIGURE 6. Annealing twins in relation to inclusion of cuprous oxide and tiny specks of other inclusions in a section of the sheet fragment (200x).

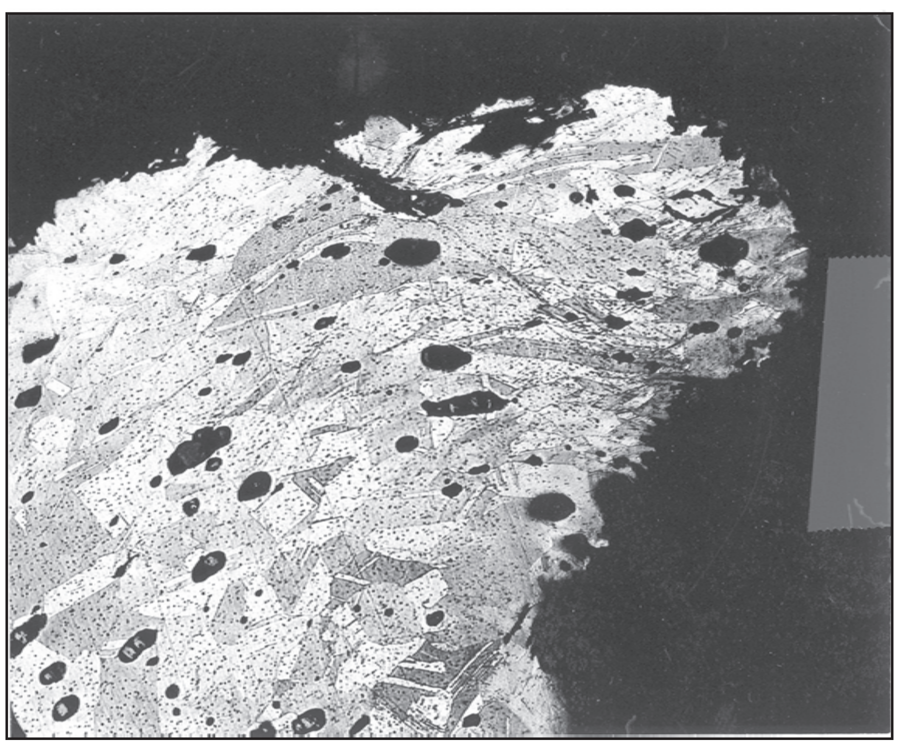


FIGURE 7. Evidence of the cold working at the edge of the sheet metal fragment where the annealed structure becomes elongated (200x).

TABLE 1: Results of optical spectroscopy on the two copper objects.

Element	Bead	Sheet
Cu	M	M
Pb		m + +
Fe		m +
Si	m	m +
Ni		m +
Ca		m + •
Ag	m	m
Al		m
Bi		m
P		m
Sb		m
Sn		m
Mg	m	m -
Mn		m -
As		m -
Cr		v +

KEY:

M = Major element
m = minor element
v = barely visible
• = probably introduced during burial