Human Adaptation to the Changing Northeastern Environment

at the End of the Pleistocene:

Implications for the Archaeological Record

Brian Denis Jones

B.A. Oberlin College, 1986

M.A. University of Connecticut, 1998

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

at the

University of Connecticut

May 4, 1998

APPROVAL PAGE

Doctor of Philosophy Dissertation

Human Adaptation to the Changing Northeastern Environment

at the End of the Pleistocene:

Implications for the Archaeological Record

Presented by

Brian Denis Jones, B.A., M.A.

Major Advisor____

Kevin A. McBride

Associate Advisor____

Robert E. Dewar

Associate Advisor____

Robert M. Thorson

ACKNOWLEDGEMENTS

Special thanks are due to the Mashantucket Pequot Tribal Council for their generous financial support of archaeological investigations at Mashantucket, Connecticut. Dr. Kevin McBride of the Public Archaeology Survey Team, Inc. also provided funding for the excavation and analysis of this site, including generous grants for radiocarbon dating. Dr. Robert Thorson, Dept. of Geology, UConn, helped a great deal with geological interpretations at this site. Dr. Robert Dewar edited early drafts of this dissertation with a keen eye for detail. Dr. Arthur Spiess has supported my efforts at the Hidden Creek site and provided many helpful suggestions and insights over the years. Personal thanks go out to Tim Binzen, Dan Forrest and Dave George for helping with excavation and analysis of the Hidden Creek Site, as well as for their stimulating discussions and acumen. The careful work of Jonathan Renfrew and members of the 1993 University of Connecticut Summer Field School in Archaeology crew are greatly appreciated. I thank Dr. Linda T. Grimm, Oberlin College, for first familiarizing me with the Upper Paleolithic of Europe. Herr Dr. Professor Gerhard Bosinski, University of Cologne, deepened my understanding of these fascinating people. Mani Neumann must be thanked for teaching me most of what I know about field archaeology. Margaret O'Keefe and Tristan O'Keefe Jones deserve special thanks for their unwavering patience and support. Margaret, thank you for your extensive editorial help. This dissertation is dedicated to my great uncle, Warren Holland, who showed me my first arrowhead at a young age and sowed an interest which would last a lifetime.

Table of Contents

Chapter 1: Introduction 1

The investigation of human societies at the onset of the Holocene era: the global perspective 2

Human adaptation to the changing northeastern environment at the end of the Pleistocene 4

Chapter 2: The Human Occupation of the Northeast During the Late Pleistocene and Early Holocene 6

The Northeast as an archaeological region 6

Northeastern Paleoindian and Early Archaic research in historical perspective 7

An outline of the regional prehistory of the late Pleistocene and early Holocene of the Northeast 24

The Pleistocene/Holocene transition in Europe 35

Chapter 3: Hunter-Gatherer Demography, Ecology and Economy 43

Introduction 43

Hunter-Gatherers of the recent past 44

Section 1: The Demography of Hunter-Gatherers 45

Foragers and Collectors 51

Section 2: The Ecology of Recent Hunter-Gatherers 53

The economics of foraging: a review of selected optimal foraging models 57

Conclusions 65

Chapter 4: The Archaeology of Hunter-Gatherers 69

Site formation processes 70

Site deformation processes 76

Site recovery 84

Site interpretation 89

Archaeology as long-term ethnography 90

Summary 95

Chapter 5: An Environmental Baseline for the Study of the Archaeology of the Late-Pleistocene and Early Holocene of the Northeast 96

Physiographic regional division of the Northeast 96

Paleo-environmental change during the late Pleistocene and early Holocene of northeastern North America. 97

Section I: the floral record 97

Section II: the faunal record 106

Early Holocene fauna 112

Chapter 6: Model Development 119

General principles of hypothesis development and model building 119

The spatial and temporal scope of the model 120

Human adaptation to terminal Pleistocene and early Holocene environments of the Northeast 124

Central points of the application of the resource response model 134

Caveats 135

Chapter 7: Archaeological Implications of Modeled Settlement and Social Organization 137

Expected archaeological patterns for the Younger Dryas (ca. 10,500 years B.P.) 139

The southern Northeast 139

The central Northeast 142

The northern Northeast 144

Expected archaeological patterns for the early Holocene (ca. 9,000 B.P.) 147

The southern Northeast 147

The central Northeast 149

The northern Northeast 150

Summary of expected trends in archaeological patterning 152

Chapter 8: Model Expectations vs. the Archaeological Record **155**

Exemplary Younger Dryas period (ca. 10,600 – 10,200 B.P.) Paleoindian sites of the Northeast 155

Debert/Belmont 155

Hedden 161

Templeton 164

Exemplary early 9th millennium B.P. Early Archaic sites of the Northeast 168

Brigham and Sharrow 168

Weirs Beach 172

IGTS 194-3-1 175

Conclusions 178

Chapter 9: Case Studies: The Hidden Creek and Other Late Pleistocene and Early Holocene Sites on the Mashantucket Pequot Reservation **180**

Terminal Pleistocene and early Holocene sites of Cedar Swamp 180

The Hidden Creek site 184

The lithic assemblage 189

Other Paleoindian and Early Archaic sites found on the Mashantucket Pequot Reservation 210

Chapter 10: Implications of the Resource Response Model and Archaeological Investigations at Mashantucket **216**

Local implications 216

Regional Implications 221

Global Implications 225

The Direction and Importance of Future Investigations 226

Conclusions 229

Appendix 1 .... **263**

Late Pleistocene Grazers of the Northeast 263

Late Pleistocene Browsers of the Northeast 264

Potential Sea Mammal Resources of the Late Pleistocene........ 266

Appendix 2 268

A Brief Summary of Connecticut Fluted Point Find-spots 268

References Cited 270

List of Tables

Table 2.1
Outline of Cleland's Focal-Diffuse Dichotomy 12

Table 2.2
Summary of Curran's Model Expectations 18

Table 4.1
Wiessner's Risk Reduction Strategy and Implications for the Archaeological Record 73

Table 4.2
Summary of Jochim's Model of Environment and Human Behavior Correlations 93

Table 5.1
Summary of Northeastern Temperature and Moisture Conditions 12,000 – 9,000 B.P. 103

Table 5.2
Large Game Fauna of the Northeast Late Pleistocene and Early Holocene 114

Table 5.3
Small Game Fauna of the Northeast Late Pleistocene and Early Holocene 116

Table 5.4
Marine and Coastal Resources of the Northeast Late Pleistocene and Early Holocene 116

Table 5.5
Carnivores and Large Predators of the Northeast Late Pleistocene and Early Holocene 116

Table 6.1
Examples of Resource Base Types 126

Table 6.2
Resource Base Type and Expected Adaptive Response 127

Table 6.3
Younger Dryas environmental conditions and Human Adaptations in the Southern Northeast 128

Table 6.4
Younger Dryas environmental conditions and Human Adaptations in the Central Northeast 129

Table 6.5
Younger Dryas environmental conditions and Human Adaptations in the Northern Northeast 130

Table 6.6
Early Holocene environmental conditions and Human Adaptations in the Southern Northeast 131

Table 6.7
Early Holocene environmental conditions and Human Adaptations in the Central Northeast 132

Table 6.8
Early Holocene environmental conditions and Human Adaptations in the Northern Northeast 133

Table 7.1
Resource Base Type and Expected Settlement Type and Remains 138

Table 7.2
Expected Settlement and Economic Types 139

Table 8.1
Brigham and Sharrow Faunal Comparisons 171

Table 9.1
Hidden Creek Site Lithic Materials by Depth 190

Table 9.2
Late Paleoindian Lithic Materials vs. Tool and Debitage Proportions 192

Table 9.3
Lithic Artifact Classes 197

Table 9.4
Debitage Class Definitions 198

Table 9.5
Debitage Classes 199

Table A2.1
Connecticut Paleoindian Find-Spots by County 268

List of Figures

Figure 1.1
Major variables in the ecological web 231

Figure 2.1
Regional sub-divisions of the Northeast used in the text 232

Figure 2.2
Terminal Pleistocene archaeological sites of the Northeast 233

Figure 2.3
Important northeastern Paleoindian Quarries and paths of lithic movement 234

Figure 2.4
Early Holocene archaeological sites of the Northeast 235

Figure 2.5
Schematic regional chronology based on diagnostic tool technology 236

Figure 4.1
Paleoindian site size vs. publication date 237

Figure 5.1
Reconstructed distribution of approximate eleventh millennium B.P. paleovegetation regions 238

Figure 5.2
Reconstructed distribution of approximate tenth millennium B.P. paleovegetation regions 239

Figure 5.3
Selected late Pleistocene game animals of northeastern North America 240

Figure 5.4
Selected early Holocene game animals of northeastern North America 241

Figure 6.1
The resource base cube model: an expression of critical resource variables in three dimensions 242

Figure 6.2
Examples of possible resource types at the extremities of the resource base cube 243

Figure 6.3
Schematic representations of modeled settlement types 244

Figure 6.4
Eight modeled settlement types articulated with the resource base cube 245

Figure 9.1
Terminal Pleistocene and early Holocene sites on the Mashantucket Pequot Reservation 246

Figure 9.2
The Hidden Creek Site stratigraphy depicted in a representative profile 247

Figure 9.3
Horizontal Distribution of artifacts at the Hidden Creek site 248

Figure 9.4
Vertical distribution of Late Paleoindian lithic material types at the Hidden Creek site 249

Figure 9.5
Vertical distribution of shared and later component lithic material types at the Hidden Creek site 250

Figure 9.6
Bifaces and Fragments recovered from the Hidden Creek site 251

Figure 9.7
Hypothesized reconstruction of Hidden Creek site lanceolate projectile point 252

Figure 9.8
Side scrapers, scraper fragments and utilized flakes from the Hidden Creek site 253

Figure 9.9
Side scrapers from the Hidden Creek site 254

Figure 9.10
End scrapers from the Hidden Creek site 255

Figure 9.11
The distribution of bifaces at the Hidden Creek site 256

Figure 9.12
The distribution of end scrapers at the Hidden Creek site 257

Figure 9.13
The distribution of side scrapers and utilized flakes at the Hidden Creek site 258

Figure 9.14
Debitage Distribution at the Hidden Creek site 259

Figure 9.15
The distribution of burned chert flakes at the Hidden Creek site 260

Figure 9.16
The distribution of end scraper retouch flakes at the Hidden Creek site 261

Figure 9.17
The distribution of general unifacial retouch flakes at the Hidden Creek site 262

Chapter 1: Introduction

This dissertation is concerned with the prehistory of northeastern North America between 11,000 and 8,000 radiocarbon years ago. Specifically, it will focus on possible social and economic changes in hunter-gatherer communities during that period as the region's climate and environment changed dramatically at the close of the last ice age. I will demonstrate that these changes had a probable impact on the archaeological record – an impact which has strongly biased our understanding of this remote period. In addition to drawing upon the archaeological record and anthropological theory, I will use an explicitly ecological approach in this pursuit. Humans were just one of many animals that entered the Northeast after the glaciers of the last ice age retreated. Like other animals, humans competed for the resources necessary to sustain and promote life in a novel and often hostile environment. Environmental change compelled the region's first inhabitants to adapt, emigrate or perish during this climatically dynamic period. The archaeological record indicates that human foragers successfully adapted to the Northeast's varied habitats. They expanded their range and multiplied their numbers during a period in which many other animals became locally or permanently extinct.

An ecological perspective views humans as one of many actors competing within a complex web of environmental variables. Pianka (1994: 6) summarizes these variables as 1) parent geology, 2) climate, 3) vegetation, 4) primary consumers, and 5) secondary consumers (Figure 1.1). Many of these variables affect each other in positive or negative feedback reactions. As omnivores, humans are both primary and secondary consumers: we eat both plants and animals. Primary and secondary resources are, in turn, dependent upon climate and parent geology for their survival and successful reproduction. Like other animals, humans can influence their environment in many ways, which can affect the cycles of primary and secondary production, and potentially their own fate or survivorship. In today's world of rapid industrialization, this has become all too evident. Hunter-gatherers, too, can produce profound changes to the world in which they live.

In addition to a general ecological approach, this dissertation depends largely upon the theory of evolutionary ecology, the study of the way organisms adapt to their changing environments over time. Evolutionary ecology itself rests upon the theory of natural selection. Natural selection results in “the differential change in relative frequency of genotypes due to differences in the ability of their phenotypes to obtain representation in the next generation” (Wilson and Bossert 1971:47). A phenotype is the physical manifestation of an organism produced by the interaction of a genotype with its environment, that is, its observable characteristics (Pianka 1994: 123; Kelly 1995: 51). For humans, the phenotype includes social (and cultural) behavior in addition to morphological traits (Smith and Winterhalder 1992b: 26; Kelly 1995: 51). Natural selection depends upon genetic variability within the deme (or “breeding population”) to function. Humans express a very limited range of morphological variation. As very social, intelligent animals, however, we express a great deal of behavioral variation. Much of this behavior is learned, and unlike most animals, we can readily pass this behavior on to our progeny and contemporaries. Therefore, much of the focus of this dissertation will be on potential behavioral and social variation expressed by human foragers between 11,000 and 8,000 years ago.

The investigation of human societies at the onset of the Holocene era: the global perspective

The following examination of human response to changes in the environment of northeastern North America between 11,000 and 8,000 years ago is an addition to research being conducted by anthropologists and archaeologists around the globe. The end of the last ice age marked a turning point for humans everywhere. While modern humans experienced the long-term effects of tremendous changes in climate and environment over the last 100,000 years, this was the first time that our species entered a true inter-glacial period with the technological and cultural toolkit that set us apart from our ancestors. It was the first time, too, that humans found themselves on all of the world's habitable continents (Straus 1996: 3). In the face of this period of global climate change, our ancestors, with modern intelligence, imagination, and courage, became the most successful and rapidly growing population of large mammals on the face of the earth.

The International Union for Quaternary Research (INQUA) recently published a collection of essays concerning human adaptation to environmental conditions at the end of the last ice age (Straus et al. 1996). Lawrence Straus, the volume editor asks in the introduction:

> What happened around the globe between 13,000 and 8,000 years ago that led to the creation of the world of humankind as we know it in the present interglacial? What were the variations of environmental and resource changes in, and human responses to, the last glacial-interglacial transition around the globe? Which changes in human culture would seem to be directly or indirectly correlated with (and possibly caused by) the environmental changes and which other factors (e.g., demography, historical trajectories) may have been involved in the sometimes sweeping adaptive changes that occurred about 10,000 years ago? (Strauss 1996: 4).

In the concluding chapter of this volume, Michael Jochim describes this period of time as "an ideal laboratory for investigating human responses to environmental change" (Jochim 1996: 357). Jochim emphasizes here as elsewhere (e.g., Jochim 1991) the importance of diversity in human behavioral response to the rapid climatic and environmental changes occurring over these millennia. "...[A]n appreciation of behavioral variability is essential to the understanding of human adaptation and cultural evolution: variation provides the raw material of evolution by natural selection" (Jochim 1991: 308).

Behavioral flexibility has been correlated with variability in the environment (Baldwin and Baldwin 1981: 65; Jochim 1991: 311). Pianka states:

> …in a temporally varying environment, selective pressures vary from time to time and the phenotype of highest fitness is always changing. There is inevitably some lag in response to selection, and organisms adapted to tolerate a wide range of conditions are frequently at an advantage…Indeed, in unpredictably changing environments, reproductive success may usually be maximized by the production of offspring with a broad spectrum of phenotypes… (Pianka 1995: 130).

Therefore, the expected range and degree of cultural, technological, and social variability expressed by human groups living during the transition from a glacial to post-glacial climate is greater than that anticipated during other periods of prehistory. This situation favors the probability of unanticipated human responses (innovations) to the environment in the cultural, technological, and social realms. In fact, it is during this transitional period that modern humans for the first time, in various parts of the world, domesticated plants, and animals, developed the bow and arrow and composite tool technologies, manufactured ceramic vessels, and established permanent village communities (see examples in Straus et al. 1996).

Social and economic variability can be measured at both global and local scales. While the following study aims to add to our understanding of the overall variability of the human species, especially at this critical time in its development, my main concern is with the expression of social and economic variability within northeastern North America. What was the degree and nature of social-economic variation among human groups in the Northeast at a time when the expected range of human response to the profound changes taking place in the world was at its peak? How might that variability have been tempered by historical precedent, or the need to maintain broad-ranging communication between neighboring peoples? Is anticipated variability in group size, seasonal patterns of social organization, degree of mobility and prey choice to be measured over weeks, months, years, generations or centuries? Finally, how have all of these factors shaped the archaeological record of the Northeast during the Paleoindian and Early Archaic periods? These are some of the questions I will attempt to answer in the following chapters.

Human adaptation to the changing northeastern environment at the end of the Pleistocene

Because of the limitations of archaeological testing strategies commonly used in the Northeast, I believe that the current record of Paleoindian and Early Archaic sites is biased towards medium to large interior camps. These sites are probably not representative of the range of site types produced by hunter-gatherers of the terminal Pleistocene and early Holocene. In chapters two through five I provide necessary background information which allows the development of a model of hunter-gatherer settlement and subsistence for this period. This information includes reviews of northeastern prehistory, hunter-gatherer ecology, the archaeology of hunter-gatherers, and of the reconstructed paleoenvironment. I model the expected range of site variability using ecological theory and an approximate reconstruction of the terminal Pleistocene and early Holocene environments in chapter six. Site types should be highly variable at this time because of the need for flexible responses in social and economic behavior to the rapidly changing environment. Based on hypothesized site variability, I make predictions concerning the archaeological record of this period in chapter seven. This includes where sites should be, how they should be structured, and what they should contain.

In chapter eight I compare a limited sample of northeastern archaeological sites to those anticipated by the model. This is a necessarily anecdotal approach, but provides a general assessment of the ideas presented. While some variability is expressed, I demonstrate that certain site types appear to be lacking or are very rare. This is especially true of large coastal occupations and very small interior camps and extraction locations. Chapter nine examines recently discovered sites on the Mashantucket Pequot Reservation in southeastern Connecticut. These sites are important because they demonstrate not only a broad range of variation in land-use over time between 11,000 and 8,000 years ago, but also that very small sites of this period are in fact common in certain locations, and that they can be found if testing procedures are fine-grained enough. Most important among them is the Hidden Creek site, which is presented in detail. This small, but artifact-rich site provides valuable new information concerning settlement organization and mobility patterns during the transitional Pleistocene-Holocene period. Chapter ten reviews the implications of modeled social-economic variability for the archaeological record. I conclude with suggestions concerning how northeastern archaeologists can discover a broader range of sites in order to better understand this period of prehistory.

Chapter 2: The Human Occupation of the Northeast During the Late Pleistocene and Early Holocene

The Northeast as an archaeological region

The following overview of prehistory will narrow itself to a region referred to here as the *Northeast* . This area has been defined elsewhere to include New England, the Canadian Maritime Provinces and portions of New York, Ontario, and Quebec (Figure 2.1) (e.g., Petersen 1995: 207). This area is bounded to the south and east by the Atlantic Ocean (including Long Island Sound and the Gulf of Maine), to the north by the Gulf of St. Lawrence and the St. Lawrence River, and to the west by the Hudson River Valley. While always under the intermittent cultural influence of adjacent regions, in particular those to the southwest (the mid-Atlantic states) and west (New York and the Great Lakes region), the Northeast appears to have witnessed continuous occupation and *in situ* cultural developments since its first occupation during Paleoindian times (Petersen and Putnam 1992; Robinson 1992).

I will focus on the prehistory of the Paleoindian and Early Archaic periods. The Paleoindian period corresponds with the initial colonization of the region and subsequent cultures of the late Pleistocene. This period has been variably defined in a chronological sense, but is most directly associated with the eleventh millennium before the present (11,000 to 10,000 years ago)[1]. In fact, it can be argued that the Paleoindian tradition, as defined by lithic toolmaking patterns, may have survived until as late as 8,000 years ago in the far north of the study region (e.g., Chapdelaine 1994). Wright (1995: 121) suggests that elements of this tradition can even be seen through the middle and late Holocene in the cultures of the Shield Archaic of the Canadian subarctic and boreal forests.

---

[1] Unless otherwise stated, all dates reflect *uncalibrated* radiocarbon years before present.

The northeastern Early Archaic period is most commonly associated with the rare appearance of tools similar to those found more commonly in the southeastern temperate forests of the tenth and ninth millennia before present (10,000 - 8,000 years ago). In southern New England, these tool types may be as old as 9,500 years (Dincauze and Mulholland 1977), while in the north Early Archaic forms are first recognized after about 9,000 years ago (e.g., Petersen 1995). An apparently unrelated Early Archaic culture unique to the Northeast has only recently been well defined. Described as the "Gulf of Maine Archaic" tradition, this quartz core and groundstone tool-dominated stone industry dates across much of New England to between 9,000 and 8,000 years ago (Robinson and Petersen 1993). Later manifestations of the tradition appear to continue throughout the Middle Archaic period to as late as 6,000 years ago in northern New England (Sanger 1996). The widespread existence of the Gulf of Maine Archaic is important, because it suggests 1) that the region likely remained inhabited throughout the early Holocene and 2) a degree of continuity can be traced in the development of northeastern cultures despite apparent outside influences (Robinson 1997). Archaeologists have debated both of these points in previous decades (e.g., Dincauze and Mulholland 1977; Funk and Wellman 1984). In the nineties, many archaeologists have begun to see the Northeast as less of a cultural vacuum, and more as a unique, and complex region in which human populations adapted to the specific conditions and resources available to them in innovative ways (Robinson and Petersen 1993).

Northeastern Paleoindian and Early Archaic research in historical perspective

Nearly half a century has passed since the discovery of the Northeast's first Paleoindian sites (Shoop [Whitthoft 1952]; Reagen [Ritchie 1953]; and Bull Brook [Byers 1954]). Since that time, dozens of new sites have been discovered, excavated, analyzed and published. The fields of anthropology and archaeology have matured significantly in terms of method and theory. Advances in the physical sciences enabled the refinement of radiocarbon dating methods. This provided the first absolute chronological framework within which to place prehistoric archaeological materials.

Critical advances in paleontology and palynology have also opened doors to a better understanding of the past.

Despite these advances, our knowledge of the peoples of the terminal Pleistocene and early Holocene is far from complete. The data collected to date are a very small, perhaps poorly representative, sample of the totality and complexity of the lives of the Northeast's earliest inhabitants. The ideas presented in this thesis represent a link in a growing chain of knowledge concerning our understanding of this period. These ideas are rooted in the research, theory, and speculation of my many predecessors. Much of their writing is surprisingly insightful, considering the limited quantity of data available to them. Some of it is no longer acceptable because of changes in our understanding of a number of important variables, especially those concerning the early environment. As the body of data concerning this transitional period increases over time, many of the ideas presented in the subsequent chapters will no doubt appear peculiar to future researchers as well. However, as archaeologist James Deetz has stated, it is perhaps "…better to risk being wrong than to retreat into timid equivocation" (Deetz 1993: 45).

The following section provides an historical overview of the study of the Northeast's Paleoindian and Early Archaic cultures, especially as it relates to questions of settlement and the subsistence economy and their relation to the environment. This review does not strive to be all-encompassing, but will focus on a number of important publications that have appeared over the last four decades. These publications provide perspective on the development of ideas that has occurred until now. It is hoped that the current work be seen as a small part of the larger process in the development of archaeological knowledge concerning the Northeast's deep past. This work represents the methodology and, importantly, the epistemology of an individual who is part of but one generation in a long lineage of northeastern archaeologists.

The sixties

In 1962 Ronald Mason published a landmark review of Paleoindian research in eastern North America in *Current Anthropology*. This paper was important for a number of reasons. First, it established beyond doubt the antiquity of the eastern fluted point tradition by comparing dated assemblages from the West to those of the East. Second, it demonstrated that fluted points were actually more common and morphologically diverse in the Southeast than the West, and suggested that eastern North America might be the "homeland" of the fluted point tradition (Mason 1962: 235). Third, Mason went into great detail concerning the reconstructed environment of the late Pleistocene, relying heavily on palynological studies and geology to place Paleoindian peoples within a knowable landscape. Fourth, Mason repeatedly referred to humans as "dominant animals" and members of "faunal communities" responding to the environment in a "natural" way (Mason 1962: 228, 234, 245). This ecological perspective was remarkably progressive.

Mason's article seems dated today on two main points. The first is his emphasis on the centrality of Pleistocene herbivores in the Paleoindian settlement-subsistence system (Mason 1962: 244). Mason did, however, elucidate the arguments for and against an "overkill" hypothesis in an early review of the debate concerning the human role in Pleistocene megafaunal extinctions (Mason 1962: 243-244). A second point of contention is Mason's mention of a possible post-Pleistocene hiatus in the human occupation of New York and New England - a theory which is no longer tenable in light of recent archaeological discoveries (Mason 1962: 246; see e.g., Petersen and Putnam 1992).

In response to Mason's article, Douglas Byers, the principle investigator of the Bull Brook site, took issue with Mason's focus on the role of large Pleistocene mammal hunting, citing the discovery of deer-sized mammal bone (since identified as caribou by Spiess, et al. 1985) at Bull Brook (Byers 1962: 249). Byers also contended that the radiocarbon dates for Bull Brook (close to 9,000 years B.P.) were valid dates of the Paleoindian assemblage – despite the presence of numerous Archaic period finds (Byers 1962: 247). While Mason did not deny this, it is today generally accepted that these dates are too young for the fluted point lithic technology in the Northeast (e.g., Levine 1990).

Another critical paper was James Fitting's "Environmental Potential and the Postglacial Readaptation in Eastern North America" (Fitting 1968). The article is most often cited for its statement that Northeastern "closed boreal forests" of the post-Pleistocene could support few human foragers. Fitting stated, "People were probably present in the boreal forests, but with such a low population density that contemporary archaeologists find only the faintest traces of their presence" (Fitting 1968: 443). He based this hypothesis on data from Karl Butzer's 1964 work *Environment and Archaeology* in which boreal forests were listed as marginal settings for human populations. He supported the hypothesis of a decline in human populations in the Early Holocene Northeast by citing Ritchie's recently published 1965 book, *The Archaeology of New York State* in which an apparent cultural hiatus was observed between the Paleoindian and Late Archaic periods. The theory of early Holocene northeastern population decline soon became known as simply the "Ritchie-Fitting" hypothesis.

Since the late 1960s, palynologists have revised our picture of the Northeast's early Holocene forests (e.g., Davis and Jacobson 1985). While dominated by pine in many regions, these forests are no longer seen as boreal conifer-wooded "deserts" inhospitable to man and beast. While it gradually became apparent that the environment could have supported permanent human populations, the problem continued to be one of defining their presence. As Fitting pointed out, the Southeast experienced a cultural flowering and presumed population boom at a time when humans were all but invisible in the Northeast. Fitting's ideas remained very influential until the 1980's when issues of site visibility began to be raised, and new models of human adaptation to the early Holocene Northeast promoted.

To his favor, Fitting emphasized regional diversity in his model of population response to a changing climate. He examined three settings, (tundra, boreal forests and broadleaf forests), admitting that this was an oversimplification, and discussed human adaptations to each. He argued against overly simple models which suggested that Paleoindians were hunters and Archaic peoples gatherers, suggesting rather that people provided themselves with that type of food which was most readily available (Fitting 1968: 441, 443). As such, he was one of the first to suggest that southeastern Paleoindian subsistence was probably not very different from that of the following archaic periods.

The seventies

Charles Cleland published an oft-cited paper in 1976 entitled “The Focal-Diffuse Model: an evolutionary perspective on the prehistoric cultural adaptations of the eastern United States” (Cleland 1976). Cleland’s approach to the question of human adaptation was strict and linear. He stated that, “cultural adaptations are patterned and predictable because nature is patterned and predictable” (Cleland 1976: 60). While he recognized the importance of variation in adaptive strategies, he chose to ignore this variation as secondary to the overall path of evolution towards greater efficiency (Cleland 1976: 60).

Cleland envisioned a cyclical scenario in which early diffuse adaptations gave rise to those of focal, specialized hunters of the Pleistocene Old and New Worlds. These, he believed, were followed by a return to diffuse adaptations focused on post-Pleistocene environments, inevitably followed again by a transition to focal agricultural patterns (Cleland 1976: 67).

Cleland posited that an “early focal pattern” based on big game hunting existed during the late Pleistocene and early Holocene of North America. As evidence for this he noted the apparent conservatism of Paleoindian tool kits, which are found “..over the entire continent, and persist, as a continental tradition with relatively little change for three to four thousand years” (Cleland 1976: 69). He also stated that there was little variability in site size and permanence during this time. Today neither of these observations are tenable. Paleoindian tool kits are markedly variable across the continent and over time (a span which should be reduced to just over a millennium) (e.g., Bonnichsen and Turnmire 1991). Site size and duration of occupation are also highly variable. Large, possibly seasonal occupations, such as Bull Brook and Debert (Byers 1954, 1955, 1959; Jordan 1960; Grimes 1979 Grimes et al. 1984; MacDonald 1985) contrast with much smaller contemporaneous sites such as Whipple (Curran 1984), and short-term camps such as the Hedden site in Maine (Spiess and Mosher 1994). These differences become even more profound when one includes sites of the Early Archaic, as Cleland intended. Table 2.1 outlines the most important points of Cleland's focal-diffuse dichotomy.

Table 2.1

Outline of Cleland's Focal-Diffuse Dichotomy

Focal Pattern	**Diffuse Pattern**
Economic focus on a single species or a few similar species (specialists)	Economy based on careful scheduling of varied resources
Requires a high level of resource reliability, quality, and abundance	Resources are varied, scattered, few are very abundant or reliable
Specialized tools, limited technological/functional variability	Variability in tool form, multi-function tools
Site size, permanence and function static; consistency in group size and composition, static division of labor	Site size, degree of permanence and function variable
Low degree of inter-site assemblage variability	Increased technological variability between sites
Brief, intensive occupation of sites of comparable geographic position	Often repeated occupations, extensive rather than intensive occupations
High degree of mobility, de-emphasis of territoriality	Promotion of territorialism, increased exchange, rapid diffusion of materials and ideas, increased potential for conflict
Specialized and conservative adaptations, slow rate of technological, socio-political and ideological change, when change occurs it may result in total adaptive reorganization	Flexible and adaptable systems, cultural innovations more readily incorporated
Tend to be mid- to high-latitude phenomena where species diversity is lower, but numbers per species is high	Typical of low- and middle-latitude environments

One year later, Dena Dincauze and Mitchell Mulholland confronted the Ritchie-Fitting hypothesis of early Holocene population decline with data suggesting that New England's (in particular southern New England's) environment was more amenable to habitation than had been previously suggested (Dincauze and Mulholland 1977). Armed with new archaeological data and more refined palynological methods, Dincauze and Mulholland suggested a correlation between Early Archaic (bifurcate tradition) site distribution and the extent of temperate deciduous forests (as represented by the 20% oak-pollen isopoll) (Dincauze and Mulholland 1977: 447, 450).

This article was critical to the rethinking of the archaeology of the Early and Middle Archaic periods for a number of reasons. Dincauze and Mulholland pointed out that, while uncommon, tenth millennium B.P. (10,000 – 9,000 years ago) Early Archaic points comparable to those of the Southeast did occur in southern New England and suggested a real, if limited, occupation of the region at this time. They noted that bifurcate points of the succeeding ninth millennium B.P. were well represented in southern New England, but remarked that habitation sites were apparently lacking – a point which remains essentially true today (Dincauze and Mulholland 1977: 440). Because of its density of bifurcate point finds, the Taunton River Valley was noted as a possible core settlement area. It was suggested that base camps existed within the area, but were either inundated, buried under alluvium, or otherwise destroyed or out of reach (Dincauze and Mulholland 1977: 441, 451, 454).

Having recently published her 1976 book, "The Neville Site: 8,000 Years at Amoskeag," Dincauze was in an excellent position to discuss settlement pattern changes which occurred with the onset of the Middle Archaic period after 8,000 years ago. She and Mulholland noted that a shift towards seasonally intensive occupations becomes apparent at this time, and that a "typical" archaic pattern of shifting residences mapped onto seasonally abundant resources had been established (Dincauze and Mulholland 1977: 441). They also suggested that large economic territories with core areas began to form after 8,000 years ago (Dincauze and Mulholland 1977: 441).

In addition to these important advances in the interpretation of early northeastern prehistory, Dincauze and Mulholland promoted an overtly ecological approach in the assessment of habitat potential for Northeastern populations of the early and middle Holocene. Having discussed the effects of topography and seasonal climate fluctuation on modern vegetation, they proposed an abstract reconstruction of the early Holocene habitat of southern New England. This was based primarily on assessments of topographical change as a result of ocean transgression together with interpretations of the pollen record of the period (Dincauze and Mulholland 1977: 442-449). Dincauze and Mulholland noted the dynamic, successional and ecotonal character of southern New England's early Holocene forests and were perhaps the first to emphasize that these had no modern correlates (Dincauze and Mulholland 1977: 447, 450). They described the environment as low in diversity, patchy, unstable and poorly predictable in terms of its resources (Dincauze and Mulholland 1977: 450). Rather than viewing this environment as incapable of supporting life, they saw it as pregnant with potential:

> Niches, therefore, were abundantly available for immigrants to fill, and the faunal diversity could have increased as rapidly as specializations could develop, or as specialists could immigrate. There seem to be no good reasons for hypothesizing seriously impoverished biotic resources for human exploitation (Dincauze and Mulholland 1977: 450).

Habitat diversity was seen as a key element in the promotion of faunal immigration, including that of humans.

Dincauze and Mulholland asserted that the apparent low population densities of the Early Archaic period could not be explained by habitat impoverishment (Dincauze and Mulholland 1977: 454). They noted that while resource instability or cultural factors may have acted to suppress population density, site visibility was also clearly an issue. The location of early Holocene sites in areas "…now vanished, buried, or inundated" impaired their archaeological visibility (Dincauze and Mulholland 1977: 454). In addition, they noted typological difficulties in separating some Early Archaic artifact types from those of later periods, and suggested that more detailed studies of full artifact assemblages from closed contexts were necessary.

The Eighties

In 1981 John Dumont promoted the view that northeastern Early Archaic cultures descended directly from those of the previous early and late Paleoindian periods (Dumont 1981). Dumont provided an excellent review of the late Pleistocene and early Holocene prehistory of the Northeast as it was known at the time of its writing. He also carefully summarized the current state of knowledge concerning the paleoenvironment and tried to tie Paleoindian and Early Archaic cultures to the environment in an explicitly ecological manner. Dumont also rejected the Ritchie-Fitting hypothesis and noted potential visibility factors which have hindered the recognition of Early Archaic sites (Dumont 1981: 28). These included factors mentioned by Dincauze and Mulholland, as well as geomorphological processes associated with changing river regimens which co-occurred with transgression, such as incision and deep alluviation (Dumont 1981: 29).

Following the advice of Dincauze and Mulholland, Dumont compared full artifact assemblages of the Paleoindian and Early Archaic periods (Dumont 1981: 28). He noted an apparent decline in the number of formal stone tool types. He remarked that this could be the result of "cultural degeneration," a more specific exploitative subsistence pattern or the result of a shift in manufacturing technique from stone to more perishable raw materials such as wood, bone and antler (Dumont 1981: 28).

While this article still stands as an excellent review of the literature concerning the Paleoindian and Early Archaic periods, as well as the paleoenvironmental studies of the sixties and seventies, its interpretation of human-environmental ecological relations is more strict than the position taken in this work which does not correlate specific habitats with particular cultures. Dumont recognized that northeastern Paleoindians were probably less big-game specialists than generalists who had a focus on caribou as an important seasonal resource (Dumont 1981: 25). He also noted the importance of such a subsistence pattern on mobility, site size, lithic choice, population density and the size of annual economic ranges (Dumont 1981: 25-26). However, he saw northeastern Paleoindian cultures as tightly tied to spruce forest, spruce parkland environments. It is now well established that northeastern Paleoindians inhabited a diversity of habitats ranging from heterogeneous deciduous-conifer forests (e.g., Templeton in Connecticut, Moeller 1980), to spruce parklands (e.g., Whipple, Curran 1984:19), to probable shrub-tundra settings (e.g., Debert, MacDonald 1985).

Similarly, Dumont believed that the Late Paleoindian culture (roughly 10,000 – 9,000 B.P. in his model) was adapted primarily to riverine, lacustrine and coastal areas where it followed a subsistence pattern of decreasing dependence on caribou and increasing dependence on foraging (Dumont 1981: 27). He stated, however, that Late Paleoindian populations were still tied to now diminishing spruce forests and parklands of moister river valleys, lake margins and kame and kettle moraines, and that they did not venture into the pine forests which were seen as resource poor (Dumont 1981: 27). This contradicts his following statements applying to the Early Archaic, in which he denies the validity of the Ritchie-Fitting hypothesis.

Dumont believed that fish and other aquatic animals may have represented the only dependable major food resource during the following Early Archaic period (9,000 – 8,000 B.P.), (Dumont 1981: 29). He noted the arrival of cultural traditions from the southern deciduous forests to the Northeast where the local population was pre-adapted to the new technologies and economies.

> Hunting would not merely lose importance, but would change in nature by virtue of the change in the type of available game. During and after the megafaunal decline, hunting would have shifted from that of the taking of megafauna [including caribou in his view – author's note] to that of taking smaller animals. The shift in hunting practices, and the decline in the importance or perhaps 'tradition' of hunting, may have made the Late Paleo-Indian groups more receptive to the new 'Early Archaic point styles' diffusing northwards along the coast and riverine systems. At this time, ca. 9000 BP, the occupations are recognizable as being of the Early Archaic (Dumont 1981: 31).

In fact, after well over a decade of research and the accumulation of substantial new information, this view still appears to be true. There is, for example, little evidence of the production of stone projectile points during the period of the Gulf of Maine Archaic (Robinson 1992: 98). This fact may well indicate a subsistence shift towards the capture of smaller game with non-lithic projectile points or traps .

In 1987, Mary Lou Curran completed a dissertation entitled, *The Spatial Organization of Paleoindian Populations in the Late Pleistocene of the Northeast*. This work attempted to assess the effects of paleoenvironmental conditions on the adaptive strategies of northeastern Paleoindian populations, largely using an optimal-foraging approach.

Curran came to a number of general expectations and conclusions concerning Paleoindian social, settlement, and subsistence strategies. Of special note is that she believed that the dynamic late Pleistocene environmental conditions favored a flexible response to available resources (Curran 1987: 321). This was a direct response to recent debate which had tended to pigeon-hole Paleoindians as either resource specialists or generalists (Dincauze and Curran 1983; Eisenberg 1978).

Curran focused on five core variables in her examination of the Northeast's Paleoindian record. She attempted to model the relationships between 1) patch size and 2) temperature variation (as proxies for environmental quality) on 3) site magnitude (a combination of site size, tool assemblage size, and locus size), 4) tool assemblage diversity (the number of tool types present, the relative proportions of tool types and the Shannon-Wiener diversity index) and 5) locus characteristics (Curran 1987: 289). She hoped to show that hunter-gatherer residential spatial patterning and assemblage variation could be explained using an optimal foraging theory approach.

She focused on two principle scenarios: large patch, temperature moderated locations, and small patch, temperature extreme locations. Large patch, temperature moderated locations referred primarily to broad coastal settings and were expected to describe paleoenvironmental conditions at Bull Brook, Wapanucket, and Debert. Small patch, temperature extreme locations referred primarily to interior, upland habitats and were used to refer to the Vail, Whipple and Templeton sites. Table 2.2 summarizes her expectations.

Table 2.2

Summary of Curran's Model Expectations

Large patch, temperature moderated location	**Small patch, temperature extreme locations**
Increased site magnitude (includes both site size and number of loci)	Decreased site magnitude
Tool assemblage size (total number of tools) high	Tool assemblage size low
Locus size expected to be larger as a result of longer-term occupations, except where hindered by enclosing structures	Locus size small as a result of short-term occupations
Simple tool diversity (number of tool types represented) should be high because of longer-term occupation	Tool diversity expected to be low because of short-term occupation, but the Shannon-Wiener diversity index should be high as a reflection of diverse patch use

Curran analyzed relative tool proportion frequencies (the ratio of individual tool types within an assemblage) and tool assemblage diversity between northeastern Paleoindian sites. Curran believed that relative tool proportions could be used to measure of the focus of activities performed on site (Curran 1987: 295). She saw this measure as a reflection of resource diversity or diet breadth. With increased environmental diversity (smaller resource patches), differences in tool proportions between sites should increase. Additionally, she expected a general north-south trend reflecting the growing potential for increased diet breadth toward the south. In northern large patch areas, tool ratios should be more uniform as a reflection of similar habitat use between sites. She noted, however, the potential for seasonal variation in tool proportions in any region. While these are important observations, her view made a rather strict association between tool types and resources – which may be difficult to establish.

Curran used the Shannon-Wiener diversity index as a measure of the degree of focal or general resource utilization (Curran 1987: 297). She saw increased group size and occupation duration as partially responsible for increased diet-breadth because both should have forced shifts to lower-ranked resources (Curran 1987: 298). Curran believed that increased diet breadth would result in heightened tool assemblage diversity as the variety of processing tasks grew. Tool diversity might also be high in medium-term occupations in small patch areas where a greater variety of patch types were accessible. Where occupation was very short, she expected assemblage diversity to be extremely low, reflecting just a few temporary activities. Again, there are potential problems with the direct relationship drawn between resources and tool types. More problematic, however, is the use of the Shannon-Wiener diversity measure. This function measures the uncertainty of choosing a particular item in an assemblage. The value of the function (H) is greatest when all assemblage items are equally abundant, and equals zero when only one type is present. In ecology, the Shannon-Wiener (also known as "Shannon-Weaver") function is typically used to measure the diversity of species abundance (e.g., MacArthur 1972; Wilson and Bossert 1971: 146).

I have concerns about the use of this function for measuring lithic assemblage diversity. While it does allow comparison between assemblages of different sizes, the measure is very sensitive to the number of tool types represented in the assemblage, increasing towards infinity with infinite tool variety. One can obtain the same measure of diversity from sites having a different number of tool types and very different proportions of tools (see Wilson and Bossert 1971: 146-147 for examples). This seriously impedes comparisons between assemblages where all tool types are not represented. Forcing tools into more inclusive categories to allow more direct comparisons is only likely to mask diversity. In fact, some of the most important information concerning the tool diversity of a given assemblage may lie precisely in the types of tool *not* represented.

Michael Shott (1989, 1990) also used this function to examine differences between "Bull Brook-affinity" and "Debert-affinity" Paleoindian lithic assemblages. I am afraid that this formula has been sometimes used for its capacity to provide a numerical value to something that is otherwise difficult to describe. My concern is that the entropy measure is being utilized without careful consideration of what the returned values actually represent, or what they don't represent, as the case may be. In fact, Curran found no correlation between assemblage diversity and habitat type. Perhaps this is in part the failure of the index to correctly assess that for which it was intended. Kaufman (1998) recently suggested an alternate method for measuring the diversity of lithic tool assemblages which allows the attachment of tests of statistical significance.

Of all the variables examined, Curran was only able to establish significant correlations between site size (area and number of artifact loci), locus size and location (i.e., large patch, temperature moderated and small patch, temperature extreme) (Curran 1987: 290,293). More importantly, she concluded that her research supported the idea that northeastern Paleoindians took a diverse approach to resource acquisition and settlement organization (Curran 1987: 304). Such diversity was also expected to affect the archaeological record.

> Clearly there is evidence that there are myriad complex levels of interaction between humans and their natural and social environments. Thus there are complex effects on the accumulation of site materials (Curran 1987: 320).
> It is thus more productive to consider Paleoindians as flexible resource strategists, capable of adjusting to a diverse set of environmental conditions, both social and natural (Curran 1987: 321).

It is on these points in particular that Curran has influenced this thesis. It should be noted that Leonard Eisenberg came to similar conclusions nearly a decade earlier (Eisenberg 1978). Eisenberg was one of the first to emphasize that late Pleistocene environments were much more varied than researchers had previously assumed. He suggested that our interpretation of Paleoindian land-use and subsistence patterns should focus on human adaptive responses to a diversity of microhabitats (Eisenberg 1978).

George Nicholas contributed a number of important articles concerning the potential early Holocene use of glacial wetland basins in the late eighties and early nineties (Nicholas 1987, 1988, 1991). These papers represented a watershed in the way northeastern archaeologists came to view the environment of the early Holocene. Before Nicholas published his work, and despite increasing evidence to the contrary, the Ritchie-Fitting hypothesis remained the dominant explanation of the poor visibility of the Early Archaic in the Northeast. Grounded in more recent palynological and ecological studies, Nicholas suggested that some early Holocene glacial lake wetland systems supported productive, predictable and diverse resources which would have attracted human foragers of the region (Nicholas 1988). Nicholas also stressed the importance of land-use versus single site studies, that is, studies of archaeological landscapes as a whole which might better express the variability of past human social, economic and subsistence systems (Nicholas 1988: 262). He noted that land-use studies resolve questions concerning changes in social, economic and subsistence patterns over time better than single-site studies (Nicholas 1988: 264; see also Jochim 1991).

Nicholas emphasized the dynamism of past northeastern environments, and suggested that earlier models of hunter-gatherer relations with the environment were simplistic. This reflected recent shifts in ecological studies away from strict, community-based successional models toward a more dynamic understanding of the responses of individual taxa to an ever-changing environment (Nicholas 1988: 265-266; Botkin 1991). In particular, "glacial lake basin mosaic wetlands" were seen as important resource areas during the early Holocene. Nicholas suggested that these habitats were more productive (in terms of net primary productivity and available biomass) and more stable than most non-wetland regions during the climatic fluctuations and environmental transitions associated with the early Holocene. He saw glacial lake mosaic wetlands as capable of supporting a more diverse suite of resources than less heterogeneous upland or valley bottom locations. These extensive basins contained a range of microhabitats which included open water lakes and ponds, streams, bogs, swamps, and transitional edge (ecotonal) environments where these met one another and the surrounding uplands or river valleys (Nicholas 1988: 268-270). Nicholas provided an impressive list of potential wetland resources which includes plants and animals for food, utilitarian and medicinal use (Nicholas 1991).

Based on the above reconstructions, Nicholas suggested that glacial lake mosaic wetlands were focal places in Early Archaic settlement, social, economic and subsistence systems. He expected such core areas to have supported both redundant base camp locations, of possibly long-term and intensive habitation, as well as a variety of smaller peripheral support locations (Nicholas 1988: 281-284). Nicholas summarized expected early Holocene glacial lake mosaic wetland

land-use patterns and their resultant archaeological manifestations for the Robbins Swamp study area in the following lists (Nicholas 1988: 282).

Expected land-use patterns:

1. Development of general foraging subsistence pattern not limited to a small number of seasonally specific resources
2. Increasing redundancy in the use of parts or all of the mosaic landscape
3. Robbins Swamp becomes a place on the landscape as a result of its increasing use as a "core" area of settlement, subsistence, economic, and social activities
4. The landscape system stabilizes and, through the intrabasin mosaic, becomes physically distinct and culturally separable from other areas
5. More regular use is made of local resources and geographic features
6. Robbins Swamp becomes a "place" of repeated and regular use
7. Shift toward more formal/structured patterns of use; definition of core and peripheral areas

Archaeological visibility:

1. Increased diversity in artifact assemblages or a more generalized tool kit as a response to the breadth of the resource base
2. Presence of both base camps and special-function sites within watershed due to a significant portion of the annual social and economic system being focused within or adjacent to the basin
3. Presence of burials related to long-term pattern of land use or similar commitment (e.g., territoriality) to this location on the landscape
4. Presence of storage pits and caches, and other reused features reflecting an expected return to the sites within a relatively short period
5. Changes in degree of site "openness" and other indicators of site structure reflecting shifts in site function, types of social activities, group size, and intra/intergroup relations
6. Diversity in seasonal representation and length of individual site occupation representing a longer and perhaps nonseasonally specific use of the basin
7. Evidence of site reuse/multiple early components and of increased site density as use of the basin intensifies over time
8. Increase in midden deposits representing longer and more intense use of sites

These expectations were surprising to many archaeologists, because they suggested an earlier development of these land-use patterns than was generally accepted at the time.

Nicholas presented a second model called “ecological leveling” (Nicholas 1988). This model described the lessening importance of glacial lake mosaic wetland locations as other habitats (particularly upland, coastal, and riverine) became more productive after about 7,000 years B.P. (Nicholas 1988: 259). Using this hypothesis of expected change in relative habitat resource productivity over time, Nicholas proposed that glacial lake mosaic wetland basins became less important as core areas, and more commonly utilized as peripheral areas of a new settlement, social, subsistence and economic system. Resultant archaeological patterning is thus expected to reflect more short-term, less intensive and less redundant occupation events. Specifically, Nicholas expected sites to become smaller and less common, to contain less diverse artifact assemblages or to exhibit more specialized tool forms reflecting primarily specialized or seasonal use. They should also contain fewer indications of planned return, such as storage facilities and caches (Nicholas 1988: 283).

To test these models, Nicholas used data collected during the Robbins Swamp Project, a long-term program of archaeological reconnaissance focused around the Robbins Swamp glacial lake basin. Of the approximately 500 sites recorded during this program, forty were positively or tentatively identified as Paleoindian and/or Early Archaic in age (8% of the sample total) (Nicholas 1988:271-274). Positively identified Paleoindian locations number three (0.6%) based upon diagnostic fluted point finds, while positively identified Early Archaic sites number ten (2%) based upon the recovery of various diagnostic bifurcate point styles. Eleven Early Archaic site designations (2.2%) were assigned based upon the presence of point styles such as Kirk and Hardaway, and less specifically “corner-notched” and “lanceolate point base” all of which have the potential to be confused with types of later periods (Funk 1991, 1997). An additional eighteen sites (3.6%) were considered early based on either the presence of “miscellaneous tools,” pièce esquillées, choppers, untyped bifaces, gravers, scrapers, or a stratified context below the Late Archaic.

Because the data set is so preliminary, there are potential problems with some of the temporal designations made. Further testing will hopefully resolve most of these. Despite this, a number of sites considered to be late Pleistocene or early Holocene in age showed evident clustering on the landscape. That is, certain small landforms within the basin were repeatedly occupied at this time. This evidence of redundant land-use appears to support Nicholas's hypothesis that glacial lake mosaic wetland basins may have served as important, focal settlement, subsistence, social and economical "places" within the larger landscape. While rather preliminary, the data and theoretical perspectives offered by Nicholas provided a wake-up call to archaeologists of the Northeast. It became apparent that early Holocene sites might not be as uncommon as was assumed (if we learned to look in the right places), and that our understanding of the early Holocene settlement of the region was in need of reevaluation.

An outline of the regional prehistory of the late Pleistocene and early Holocene of the Northeast

Paleoindian origins

Current evidence suggests that humans entered the New World from northeastern Asia between 14,000 and 12,000 years ago (Bonnichsen and Turnmire 1991; Dillehay and Meltzer 1991). Despite the existence of the 12,500 year old Monte Verde site in Chile (Dillehay 1997), the first widespread and well-dated presence of humans in North America is associated with the Clovis fluted point tradition dated between 11,200 and 10,900 years ago (Haynes et al.1984; Meltzer 1989; Taylor et al. 1996). Clovis finds are reported from a broad area between the American southwest, Washington State and the southeastern United States.

The Paleoindian lithic tradition has a probable origin in east Asian and Beringian macroblade industries of the Late Pleistocene (e.g., Tolstoy 1958; Powers and Hoffecker 1989; Powers

1996; Aikens and Akazawa 1996). Mason (1962) and others have suggested that the Clovis fluted point tradition may have developed in the southeastern United States based on the high number and variety of stylistically early fluted point finds in this region (see also Dragoo 1976; Stanford 1991; Faught 1994; Anderson 1995).

Anderson (1995), Dincauze (1996a) and Faught et al. (1994) noted an uneven distribution of Paleoindian finds in the eastern United States, with some areas containing very high densities of fluted points, while others are nearly devoid of sites or find-spots. They suggest that this pattern may indicate a "leap frog" colonization process whereby the most productive resource areas were carefully selected for initial settlement (Anderson 1995: 148). If this is the case, notably large sites such as Nobles Pond (Ohio), Shoop (Pennsylvania), Gainey (Ontario), Bull Brook (Massachusetts), Vail (Maine) and Debert (Nova Scotia) could represent widely-dispersed initial settlement locations in the region (Dincauze 1996a). More likely, however, these very visible sites may simply be examples of large, reoccupied locations scattered throughout the region in areas once supporting predictable, and perhaps seasonally abundant, resources.

The Paleoindian period in the Northeast

The exact manner in which Paleoindians colonized the Northeast may never be well understood. It is nevertheless evident that Paleoindian groups had arrived in the region in some numbers by about 11,000 years ago. Bull Brook and stylistically related sites (Whipple, DEDIC, Wapanucket and possibly the Israel River fluted point complex) likely represent this earliest occupation of the Northeast (see Figure 2.2 for site locations). The range of site locations includes Massachusetts and central New Hampshire, but lithic resource use may include material from Munsungen Lake in northern Maine, suggesting a high degree of mobility and familiarity with the resources of northern New England at an early period (Dincauze 1996a). It is possible, however, that some of the red-brown siliceous siltstones attributed to Munsungen quarries have a more southern source in the Indian River formation of the Lake George region of eastern New York state (LaPorta personal communication). All of these sites appear to rely heavily on chert sources in the northeastern Champlain basin, suggesting that this area played an important part in the seasonal foraging pattern (Curran and Grimes 1989) (Figure 2.3). Ellis and Deller (1997) propose that Bull Brook phase and related Gainey-like sites date to between roughly 11,000 and 10,600 years ago based on typological traits such as parallel to slightly convex sides and thick cross-sections. These traits indicate overall similarities with the classic Clovis fluted point style (see e.g., Deller and Ellis 1988; Spiess and Wilson 1989; Stothers 1996, Ellis and Deller 1997).

The Debert-Vail and Neponset fluted point styles appear to follow those of the Bull Brook phase. Debert-Vail points are clearly derivative of the Bull Brook-Gainey lithic tradition. Their projectile point bases tend to be more deeply concave, possibly suggesting changes in hafting or production methods. The Debert and Vail sites are located in the northern Northeast (northwestern Maine and Nova Scotia) and may represent the first significant occupation of this area. The Debert-Vail fluted point style has been well dated, with overlapping two-sigma radiocarbon values close to 10,600 years ago at both sites (Levine 1990),

At about the same time, or slightly later, the Neponset (Barnes-like) waisted and deeply fluted point style was being used in central and southern New England, as testified at the Neponset site (Carty and Spiess 1992, see discussion of chronological correlation problems in Petersen 1995: 209). A charcoal-bearing feature associated with locus D of this site was dated to 10,210 $^{\pm}$ 60 years B.P. (Curran 1996: 7). The Neponset site has a majority of lithic material acquired from the Mt. Jasper rhyolite quarry in eastern New Hampshire. Stylistic affinities are strongest with artifacts from the Great Lakes, southern Ontario region, suggesting cultural contact with that area. Generally, these points are similar to the “Cumberland” style of the Southeast (Carty and Spiess 1992: 34), also believed to date to about the mid eleventh millennium B.P. (Anderson et al 1996).

The Michaud site in southern Maine and the Templeton site of Connecticut may belong to this period as well. However, the projectile points recovered from both sites diverge somewhat from the Neponset-Barnes style, possibly indicating a slightly later date. The Templeton site of western Connecticut dates to 10,190 $\pm$ 300 years ago (Moeller 1980, 1984). Importantly, lithic use at this site suggests an emphasis on local raw materials (chert cobbles and quartz). This pattern is in stark contrast with that observed at all other Paleoindian sites from New England which typically contain high proportions of raw stone materials acquired from great distances (Dincauze 1996a).

The Late Paleoindian period

Crowfield and Holcombe point styles were first described by archaeologists of the Great Lakes and southern Ontario regions. Deller (1989) suggests that sites of these traditions date to between 10,400 and 10,000 years ago, based primarily on strand-line chronologies of the Great Lakes. In the Northeast, the Reagen site, which contained projectile points similar to both styles, is located in the northern Champlain basin of Vermont (Ritchie 1953). Scattered Crowfield points are reported from eastern Massachusetts as well (e.g., Mello 1975; Spiess and Bradley 1996). Holcombe points at the large type site in Michigan were associated with caribou bone, suggesting a continuing importance of this animal into the terminal Pleistocene (Fitting et al. 1966). The recently excavated Nicholas site, located at Boothbay Harbor in central coastal Maine, contained Holcombe-like projectile points. This site was comprised of four artifact loci and included predominantly Mt. Jasper rhyolite of eastern New Hampshire (personal communication Rick Will 1997; Will 1998). The Esker site of western Maine is also believed to relate to the Holcombe tradition. This site has been recently dated to 10,110 $\pm$ 70 years B.P. (Will 1998).

The Liebman site of Lebanon, in eastern Connecticut may date to this period as well (Pfeiffer and Parkos 1995). A single fluted point base was recovered during surface collection of the site. This point fragment is thin, small and multiply-fluted, indicating similarities to Crowfield points (personal observation). The style suggests a date late in the eleventh millennium B.P. Lithic sources for materials from this site have not been established, but the fine-grained cherts and chalcedonies in the assemblage are not likely of Connecticut origin. A small number of fluted points in the Bull Collection, housed in the office of the state archaeologist of Connecticut in Storrs, are unlike those discussed above and may represent a period of regionalized stylistic developments late in the fluted point tradition in southern New England (see Appendix 2 for a summary of Connecticut Paleoindian find spots).

With the onset of the Holocene, point styles in the Northeast include a variety of parallel-flaked lanceolate styles. These are similar to plano forms of the western Plains, and lanceolate points of the Great Lakes region. Northeastern lanceolate points tend to be most common in northern New England and the St. Lawrence drainage, but have also been recorded in eastern Massachusetts and southern Lake Champlain (see Figure 2.4 for site locations) (Doyle et al. 1985). Three sites are relatively well dated. The Weirs Beach site is located along the shore of Lake Winnipesaukee in central New Hampshire. This site's basal component included a parallel-flaked lanceolate point fragment associated with a date of 9615 ± 225 B.P. (Bolian 1980:124; Maymon and Bolian 1992:118). A charcoal-stained feature from the single component Varney Farm site of western Maine was dated conventionally to 9410 ± 190 years ago (Petersen 1995: 211). Subsequent AMS assays on charcoal from the same feature returned dates of 8380 ± 100, 8420 ± 60, 8430 ± 100, 8620 ± 60 and 8700 ± 60, indicating that the site is closer to 8,500 year old (Cox and Petersen 1997: 42). Three dates have been produced from the Rimouski site near the south shore of the St. Lawrence on the Gaspé Peninsula: 7,500 ± 150 B.P. , 7,840 ± 100 B.P. and 8,150 ± 130 (Chapdelaine 1994: Table 10.1). These dates are younger than those from New England, but it is possible that the lanceolate tradition survived longer at the northern extent of its distribution (along the southern shores of the Saint Lawrence estuary) than elsewhere.

The dates from these sites suggest that the parallel-flaked lanceolate tradition dates between approximately 9,500 and 8,000 years ago. Relatively large projectile point sizes and their generally northern distribution suggest a degree of specialization (at least seasonal) on large game, perhaps caribou, elk, moose or aquatic mammals. Doyle et al. (1985) and Cox and Petersen have emphasized the potential importance of both caribou and fish. Spiess (1992: 39) has noted that parallel-flaked lanceolate point sites are most often associated with lacustrine and riverine settings.

The Early Archaic period

Rare projectile point styles recovered in New York state and southern New England are comparable to forms of Early Archaic Piedmont and mid-Atlantic traditions (Dalton-like, Kirk corner-notched, St. Charles, Palmer, Eva and MacCorkle bifurcates) (Dincauze and Mulholland 1977). The presence of these point styles indicates occasional use of this region by peoples of more southerly origin during the tenth millennium before present, or at least cultural influence from this direction. Most of these points are difficult to type precisely, and confusion with later Laurentian tradition bifaces has led to some disagreement concerning the extent of southeastern influence on the Northeast during this time (Funk 1991). Despite this, the presence of such points indicates the transient, probably sporadic seasonal use of New York and southern New England by mid-Atlantic-related culture groups at this time. This may mark the beginning of a period of seasonally shared land-use by culture groups with discrete core regions, similar to that described elsewhere as a pattern of economic "co-traditions" (Frison and Bonnichsen 1996).

The earliest unequivocal presence of classic Early Archaic peoples in southern New England is associated with finds of bifurcate-based projectile points (Johnson 1993). Most of these are of stylistically late forms such as St. Albans, Lecroy and Kanawha (about 8,600 - 7,800 years ago). I have noted early bifurcate styles, such as the large MacCorkle variety (ca. 9,000 B.P.) in regional collections, however. Bifurcate points are, as a rule, not associated with domestic sites in New England and are often made from extra-regional lithics. They typically appear as stray finds on sites of later time periods. This suggests a very "superficial," again perhaps seasonally restricted, use of the region by bifurcate-making peoples. As noted, Dincuaze and Mulholland (1977) suggested that the discovery of large numbers of these points in the Taunton River Valley of southeastern Massachusetts (Taylor 1976) could indicate of the presence of base camps in nearby, now inundated or heavily silted, locations. The nearest full-assemblage single-component bifurcate site to New England is the Haviland site of central New York state, dated to 8405 $\pm$ 65 years ago (Figure 2.4) (Ferguson 1995).

Recently, bifurcate point fragments and chert flakes were also reported from Bessette 3 in Highgate, Vermont along the Missisquoi River within a sealed stratified alluvial context dated to 7970 $\pm$ 270 B.P. (Thomas 1992: 189). These points appear to be contemporaries of a regional point style known as Swanton corner-notched (Thomas 1992). Swanton points have been dated to 7780 $\pm$ 225, 8240 $\pm$ 240, and 8340 $\pm$ 245 at the extensive St. John's Bridge site, also along the Missisquoi River in northern Vermont (Thomas 1992: 191). In southern New England, numerous bifurcate points were recovered from the Dill Farm site of East Haddam, Connecticut at which one feature containing carbonized hazel and (surprisingly) walnut fragments produced a date of 8560 $\pm$ 270 years B.P. (Pfeiffer 1986). Ninth millennium B.P. dates have also been recovered from bifurcate and other Early Archaic finds on Staten Island, New York (Ritchie and Funk 1971).

Non-bifurcate associated sites dating to the ninth millennium B.P. in New England have been recently defined as belonging to an apparently wide-spread Early Archaic quartz-oriented lithic technocomplex known as the Gulf of Maine Archaic. Such sites include numerous blocky unifacial quartz core-scrapers of varying size, as well as groundstone tools, including enigmatic rod-shaped forms and gouges (Petersen and Putnam 1992; Robinson 1992, Robinson and Petersen 1993). Stone projectile points appear to be extremely uncommon from these sites (Petersen and Putnam 1992: 37-38). This suggests that lighter bone, antler or wood armament tips were being manufactured for the hunting of smaller game and fish at this time. The presence of groundstone is suggestive of a shift towards increased plant processing and/or woodworking.

It is during this millennium that deer probably began to flourish in southern and coastal New England as oak-dominated forests were established. The range expansion of deer likely occurred at the expense of caribou (limited largely to northern spruce-dominated forests) and possibly of elk and moose. Small game, fish, bird, reptiles and a variety of plant species had probably become more important elements of the diet at this time as well. These resources became regionally abundant as climatic conditions became closer to those of today. A generalist foraging economy, focused on seasonally shifting resources within a smaller regional territory, seems to have become established in some places at this time (Petersen and Putnam 1992: 47). The Gulf of Maine Archaic quartz scraper – groundstone tool tradition may have inter-fingered with that of increasing numbers of bifurcate making peoples during the second half of the ninth millennium B.P., especially in the Merrimack River drainage where both traditions are well represented (see Robinson et al. 1992 for examples). Early manifestations of the Gulf of Maine Archaic tradition seem to have been widespread throughout New England, while later sites appear to become restricted to northern New England (especially central Maine) where they continue throughout the Middle Archaic period (Robinson 1992; Sanger 1996).

Onset of the Middle Archaic period

Sometime shortly after 8,000 years ago sites of the Middle Archaic Neville tradition become common throughout much of the region, especially southern New England (Dincauze 1976; Dincauze and Mulholland 1977; Robinson 1992). This period marks the beginning of the Middle Holocene - a time in which the climate became warmer and drier than that of today. During this time, projectile points are most often made of relatively local lithic varieties (acquired from less than 50 km distance) although extra-regional sources still occur. In New England, local quartzites, rhyolites, and felsites come to dominate lithic assemblages. A clear stylistic (typological) relationship between Neville points and the earlier bifurcate points is evident. Transitional Kanawha stemmed points of the final bifurcate tradition appear to grade seamlessly into early basally-notched Neville varieties. This transition probably occurred between roughly 8,200 and 7,800 years ago. This suggests that bifurcate-making peoples had become permanent (year-round) residents of the region (in particular of southern New England) by this time. In northern

New England, a groundstone tool tradition flourished during the Middle and "Maritime" Archaic, and appears to be an outgrowth of the "indigenous" Early Archaic Gulf of Maine Tradition (Robinson 1992). Figure 2.5 summarizes the above regional chronology.

Early Archaic site visibility and the Ritchie-Fitting hypothesis

The aforementioned sites of the Early Archaic period have remained elusive to archaeologists of the Northeast. The paucity of sites dating between 10,000 and 8,000 B.P. led Ritchie and Funk in 1973 to say, "Hence, man in a hunting economy and in a Late Paleo-Indian stage of culture, was an infrequent visitor to the Northeast, which reverted essentially to the empty land of the first explorers of the Clovis tradition" (1973:8). Funk also noted that Early Archaic projectile points in the many collections he had studied were extremely uncommon compared to those of the following periods (Funk and Wellman 1984: 81; Funk 1991: 50-51; Funk 1996: 14-15). These observations generally supported the Ritchie-Fitting hypothesis of lowered human population density, or even population withdrawal from the region (Ritchie 1979; Ritchie and Funk 1973; Fitting 1968; Funk and Wellman 1984).

Funk has proposed a number of explanations for the scarcity of Early Archaic occupation remains in the Northeast (Funk 1991; 1996). This scarcity has been defined primarily by the low numbers of diagnostic projectile points currently recorded from both excavated contexts and surface collections. Therefore, the problem of explaining the apparent lack (or low numbers) of early Holocene people in the Northeast is essentially one explaining the apparent dearth of Early Archaic diagnostic projectile points. Funk's explanations for the rarity of Early Archaic point forms are summarized as follows:

1) Unfavorable environmental conditions and resultant population decline.
2) Inadequate typological control resulting in the misidentification and misclassification of Early Archaic point styles.
3) Decreased reliance on knapped stone projectile points, as a result of a decreased role of hunting, or an increase in the use of perishable materials for armaments.
4) Inadequate survey coverage resulting in a false impression of the number and distribution of Early Archaic sites.

5) Differential destruction as a result of natural Holocene geomorphological conditions including shoreline transgression, river meandering and incision, deep alluvial burial, and erosion and subsequent colluvial burial.
6) Differential destruction of early Holocene sites as a result of Euro-American land-use patterns.
7) The existence of Early Archaic settlement patterns which result in the poor archaeological visibility of sites containing diagnostic materials.

Funk believes that, despite recent reevaluation of the early Holocene environment and its potential resources, the scarcity of diagnostic Early Archaic materials may reflect a real regional population decline as a result of unfavorable environmental conditions. He considers typological misidentification a potential problem, but one of limited consequence. In light of the recent information concerning the general lack of bifacial stone tools from the Gulf of Maine tradition discussed above, Funk believes that the possibility that knapped stone projectile points were seldom fashioned during certain periods must now be seriously considered.

Funk considers the possibility that survey samples have neglected certain geographic regions is a potential source of bias. He emphasizes the need for an increased stratification of surveys to include all environmental zones, but particularly those of the uplands and mountains. My own concern is that alluvial settings have not been adequately tested because of the problems and costs associated with such potentially deep excavations. Typical shovel test-pits cannot be expected to extend deeper than about a meter in most situations, and early Holocene sites can lie at depths greater than four meters (e.g., McNett 1985; Stewart et al. 1991). This relates to problems associated with another explanation: the differential destruction or burial of Early Archaic site locations. Funk recognizes this problem, but rejects it as an important factor, suggesting that many early Holocene landforms exist which have not been negatively impacted by such geomorphological processes. While this is true, I counter that some of the areas most conducive to settlement during the early Holocene, namely near-shore and riverine settings, have been exposed to greater natural destructive forces than most interior and upland land surfaces.

Funk rejects the explanation of the differential destruction of Early Archaic site locations by patterns of post-contact land use. It is admittedly difficult to fathom an early Holocene settlement system that preferentially positioned sites only beneath areas of modern development. Funk also rejects the explanation that Late Paleoindian and Early Archaic period settlement patterns might have resulted in the poor archaeological visibility of diagnostic sites. He suggests strongly that "There is no evidence to support it, and no reason to suspect such a radical departure from settlement patterns that characterize other periods of northeastern prehistory" (Funk 1996: 19). I have argued elsewhere that there are ecological reasons that early Holocene sites were on average smaller and less frequently reoccupied than those of both earlier and later periods of prehistory (Jones 1994). Small sites can be quite difficult to locate using standard archaeological reconnaissance methods. An example of one such site, the Hidden Creek site, will be discussed in detail in chapter nine. In short, I feel there is evidence to support, and reasons to believe, that diagnostic early Holocene sites may be more difficult to discover than those of other periods of prehistory.

In sum, I agree with most of Funk's discussion of explanations for the paucity of early Holocene sites in the Northeast. However we diverge on a couple of points. Despite the new evidence presented by palynologists and archaeologists suggesting that early Holocene climates were more amenable to human habitation than once thought, the rarity of sites indicates that the Northeast was rather thinly populated during this period, especially during the tenth millennium B.P. Nevertheless, a number of factors are likely masking the full picture of early Holocene hunter-gatherer land-use patterns in the Northeast during this time. These include typological problems resulting in the misidentification of some point styles, technological factors which may have promoted the use of non-lithic armaments, survey methods which are less than adequate for the discovery of small and deeply buried sites, and finally the differential destruction (and/or deep burial) of the most preferable habitation areas in near-shore and riverine settings. While population density was certainly not what it became during the subsequent Middle and Late Archaic periods, the evidence discussed above indicates that people were living in the Northeast during the early Holocene in significant numbers and that archaeological traces of their occupation can be located if searched for mindfully.

Summary of Observations Concerning Early Northeastern Prehistory

Archaeological data collected from the Northeast bear testimony to the complex transition of cultures from the time of the first Paleoindian colonists to the florescence of Middle Archaic populations some three thousand years later. While extra-regional cultural influence can be observed at all time periods, this transition was largely one of the adaptation of local (though highly mobile) populations to continuously changing environmental conditions. This trend is most strongly expressed in the archaeological record from the ninth millennium B.P. onwards, as exemplified by the Early Archaic quartz and groundstone industry of the Gulf of Maine Archaic (Petersen and Putnam 1992). It may never be possible to accurately assess population density and rates of growth during this time. It is evident, however, that within three millennia, the human population of the Northeast changed from zero, prior to Paleoindian colonization, to some number great enough to have left behind the rich archaeological testimony of the Middle and Maritime Archaic traditions of the middle Holocene era.

The Pleistocene/Holocene transition in Europe

Hunter-gatherer lifeways in the Northeast during the terminal Pleistocene and early Holocene lend themselves to comparisons with those of other regions during this period around the globe. In particular, a summary of the data most pertinent to the human adaptation to changing environmental conditions in Europe during these periods is germane. At many levels, the archaeology of late glacial western and central Europe lends itself to comparison with that of northeastern North America (e.g., Price 1991). First, colonizing groups of hunter-gatherers were populating both regions at about the same time. In central Europe (specifically southwest Germany, the central Rhine Valley, and the north German plain), a human presence becomes archaeologically apparent during the Bölling interstadial between 13,000 and 12,000 years ago. This is about a millennium earlier than the suspected occupation of the Northeast.

Second, floral and faunal succession in northeastern North American and western and central Europe, while not identical, is generally comparable. The transition from the Bölling to Alleröd can be described as a shift from predominantly open, park-like landscapes to closed temperate forests. Dominant fauna shifted likewise from tundra-tolerant species such as saiga antelope, bison, wolverine, arctic fox, lynx, mammoth, caribou and horse to temperate forest species such as beaver, aurochs, roe deer, elk, brown bear and pine marten (Eriksen 1996: 113, 114). Comparisons are less tidy at finer scales of evaluation. Both central/western Europe and northeastern North America express latitudinal and elevational gradients in the nature and timing of plant and animal community succession.

Settlement, subsistence and mobility: the Late Upper Paleolithic and Mesolithic in Europe

The Late Magdalenian cultures of Europe (Magdalenian IV-V) are known from a number of substantial open air and cave sites in Europe. The following examples provide information concerning general patterns of settlement, mobility and subsistence for this time period.

The first site, Gönnersdorf, is located along the Rhine Valley of central Europe and was excavated throughout the 1960s (Bosinski 1987: 118-122; 1988). Gönnersdorf provides a wealth of information concerning the late Magdalenian settlement of the region roughly 12,400 years ago. The site consists of three large (6-8m diameter) circular living structures marked by a pattern of postmolds and one smaller probable tent ring. The structures each contain a central hearth, numerous pits (many of which have been interpreted as water-boiling cooking pits) slate-covered floors (with stone slabs often bearing artwork) and a high concentration of artifacts including tools, tool-making debris, evidence of core reduction and artwork. Bosinski (1987 117-118; 1988) suggests that the site represents a base camp reused for a number of seasons, in both winter and summer months, possibly by different groups each season (but see Keeley 1991: 188).

House sizes indicate that a relatively large group (perhaps over 25 individuals) could have utilized the site on a regular basis. Bosinski (1988) assumes that smaller hunting stations supported base camps such as Gönnersdorf.

During the Bölling interstadial the central Rhine region was quite dry. While trees stood in the wetter valley bottom, the upper loess-covered terraces were likely open and supported herds of gregarious animals such as horse and caribou (Bosinski 1988: 375). Faunal remains indicate horse was the predominant game animal procured in the region, although caribou, elk, fox, hare, bison, rhinoceros, saiga, chamois, mammoth and various bird and fish bones are also present in the assemblage (Bosinski 1988: 379). The few mammoth and rhinoceros bones uncovered at the site most likely indicate the scavenging of dead animals. The remains of spear-thrower hooks indicate that this was the common hunting weapon of the time (Bosinski 1988: 375-376).

Lithic sourcing indicates that a variety of materials were used by the site's inhabitants. In addition to local siliceous slates, cherts and flint from the Meuse River (about 120 km to the northwest) and prepared nodules of Baltic flint (from moraines more than 100 km to the northeast) are common (Bosinski 1988: 379). In general, the structures can be associated with a dominant exotic lithic either from the northwest or northeast, intimating the direction from which the occupants had come. While it is possible that special parties collected this material, it is more likely that the stone was gathered by the site's occupants during their seasonal movements. Excavators also recovered Mediterranean mollusk shell ornaments which could indicate the existence of extensive trade networks at this time (Rensink et al. 1991: 152 ; Weniger 1987, 1990).

At a similar time on the north European Plain, bearers of the "Hamburg Culture" were hunting large numbers of caribou at seasonal camps. The artifacts of these people are distinct from those of the contemporaneous Magdalenian groups to the south, although there is reason to believe that they developed from similar earlier Magdalenian roots (Bosinski 1987: 129). These people represent the first group to recolonize the cold northern steppes. They appear to have made seasonal movements from the northern plains to the southern foothills over an extensive area (Breest and Veil 1991). This type of movement was likely associated with the procurement of caribou which seems to have been the seasonal focus of hunting in this region (Eriksen 1996). Archaeologists recovered nearly 2,000 caribou bone fragments from each of the north European plain sites Stellmoor (lower) and Meiendorf which were occupied at this time (Eriksen 1996: 121). The bones of horse, hare, red fox, wolverine, grouse and aquatic birds were found at the site, indicating that caribou, while clearly a dominant game animal, was not the only species taken (Eriksen 1996: 121).

Adaptations to the Alleröd interstadial and Younger Dryas

Between 11,800 and 11,000 radiocarbon years ago, the climate and vegetation of Europe underwent extreme changes. This period is marked by the Alleröd interstadial and is associated with the limited reforestation of much of central and western Europe. These changes were more pronounced in south central Europe, for example, along the Danube, than to the north. Archaeologically, a new "culture" is recognized in the Feddermesser, or Azilian, assemblages.

Sites of this time are much smaller than those of the preceding Magdalenian and do not typically contain portable artwork. They are often located on well drained, sandy surfaces (Bosinski 1988). Cultural horizons are typically thin, indicating the temporary nature of most settlements and typical lack of reoccupation. Faunal evidence is generally less well preserved, but is diverse, indicating a mixed forest, open landscape dominated by red deer, sometimes horse, moose (European elk) and small game such as beaver (Jochim 1991; Eriksen 1996; Baales and Street 1996: 304). Jochim (1991: 317-318) suggests that this indicates an opportunistic settlement and subsistence system as a response to poorly predictable resources. This pattern stands in stark contrast to that of the preceding Magdalenian which is typified by larger, reoccupied sites with more focused specialized hunting practices (Jochim 1991: 315; Baales and

Street 1996: 308). Baales and Street summarize the settlement and subsistence system for the central Rhineland as follows:

> The subsistence economy is dominated by large mammals, present in the region at a low density, but on a reliable year-round basis, which can be effectively hunted by both individuals and by groups (stalking, use of bow and arrow). At some seasons, reducing the group size (into individual family units?) may be the most efficient way of exploiting the environment. In this ecological system, there is no major seasonal surplus, and an extended storage economy is therefore not possible or necessary. Periodic exhaustion of short-range resources (around dwelling sites) leads to the regular displacement of settlement within the regional territory, making the construction of stable dwellings an inefficient investment of time and effort (Baales and Street 1996: 309).

While lithic source areas mirror those of the preceding Magdalenian period (at least in the central Rhine Valley), lithic technology in general seems "de-emphasized," that is, blade cores were no longer typically produced (Baales and Street 1996: 292-293). In general, this pattern is a harbinger of the Mesolithic era, more commonly associated with the onset of the Holocene at roughly 10,000 B.P. The Feddermesser culture is wide-spread, occurring throughout France, Holland and Belgium, along the Danube and into central Europe, although regional stylistic variations may represent larger levels of social organization.

Bosinski (1987: 125) and others have suggested that hat bow and arrow technology replaced the spear thrower at this time. This would have had a potentially important impact on settlement and subsistence, possibly allowing greater self-sufficiency of smaller groups. But the observed changes in settlement size are more likely related to human adaptations to the dwindling herds of horse and caribou which were seasonal staples of the earlier Magdalenian peoples. Jochim (1976; 1981) believes these smaller groups were more efficient at harvesting the isolated game of forested regions.

Caribou hunting continued along the north European plains, however. During the cold Younger Dryas stadial (11,000 to 10,000) this region became a very harsh environment and may have been rarely used by humans. The first sites to reappear during the end of the Younger Dryas are again caribou kill sites, sometimes quite large, with the remains of thousands of caribou found in bogs such as Stellmoor (Bokelmann 1991; Eriksen 1996). Valley bottom settings were likely chosen as excellent herd interception locations and reused extensively. Settlement locations are on the adjacent hilltops, but have been much disturbed by plowing (Bokelmann 1991). The remains of arrows are common at Stellmoor, indicating that this was the primary hunting weapon of the time (Rust 1978).

The Mesolithic

The Mesolithic is defined by the presence of small retouched stone implements which were insets for multi-component hunting gear (arrows, harpoons, fish spears). Subsistence equipment diversified broadly at this time. Price (1987) notes:

> An incredible range of fishing gear, including nets, weirs, leisters, hooks, and harpoons is known. Ground stone artifacts appear as axes, celts, plant processing equipment and other tools. Projectile points are armed with a vast array of specialized tips made of bone, wood, antler, and stone (Price 1978: 287).

Sites tend to be small, are often associated with wetland, lacustrine, and riverine areas (e.g., Street 1989; Price 1987: 286). Settlements are often located on better drained, raised sandy soils (personal observations during excavations at the Sarching sites along the middle Danube, Germany). Price (1978) has discussed site size as defined by lithic scatters (loci). Sites of this period are typically only 3-4 meters in diameter, although more extensive camps also occur. As those of the Feddermesser period, most Mesolithic sites appear to represent short-term occupations by small groups.

Faunal associations with these sites are diverse, but are somewhat better associated with site location (i.e., upland, riverine and lakeshore areas) and season of occupation than they were during Feddermesser times. Jochim (1991: 317) suggests this pattern reflects the gradual stabilization of resources during the early Holocene. Aquatic food resources appear to have increased in importance at this time, supplementing a wide variety of forest game (Price 1987: 286).

Jochim (1976) posits a settlement system in which small groups utilized dispersed upland locations for hunting woodland game (such as red and roe deer and wild boar) and gathering plant foods, especially hazelnuts. These groups then aggregated seasonally along the lowland lake-shores of the Feddersee in base camps where wetland and aquatic game could be taken. A similar pattern may have existed in northern England, where upland temporary camps were part of a larger settlement cycle which focused on lowland base camps such as Star Carr (Clark 1972; Jacobi 1978). It seems likely that Star Carr was optimally located for the procurement of a variety of wetland and forest game species. Thus, it was repeatedly used as a base-camp or temporary camp, possibly during a variety of seasons (Dennell 1983: 144; Price 1987: 253).

Mobility seems to have become more restricted during this time (Price 1987: 286). This is likely an aspect of the shift towards the procurement of solitary game in a forested environment (e.g., Clark 1972: 31-39) which began in preceding Feddermesser period. Reduction of annual range could, however, also relate to population growth. Nevertheless, overall population density remained quite low between the onset of the Holocene and the appearance of the Neolithic agriculturists after 6,500 B.P. (e.g., Clark 1972: 37-39).

My prior familiarity with these European sites undoubtedly provided a framework for my understanding of the archaeology the New World. I came to the Northeast believing that the similar environments of western Europe and northeastern North America could indicate parallel developments in settlement and subsistence patterns from the late Pleistocene to early Holocene. Among the conceptual baggage that I brought back with me from my studies in Germany was the idea that relatively open environments in which gregarious game were a common element could support large seasonally occupied base camps such as Gönnersdorf. Specifically, I expected that horse and caribou likely made up a large portion of the resource base, at least seasonally, and assumed that caribou hunting sites with rich faunal inventories such as those of Stellmoor and Meiendorf would exist. I believed that sites should become smaller, more scattered, and less archaeologically visible as these open areas became wooded and hunter-gatherers developed new settlement and subsistence strategies appropriate to the harvest of forest resources. I anticipated that lithics would be found at locations quite distant from their quarry locations and that these distances probably reflected movement throughout a seasonal subsistence round. I presumed that site types and hunting strategies should differ according to season and latitude.

Certain of these expectations were in fact met when I began my studies of northeastern prehistory. Others, however were not. I was disappointed by the fact that faunal remains (and therefore seasonal indicators) were nearly entirely lacking, especially for the Paleoindian period. I was also dismayed by the rarity of Paleoindian and Early Archaic sites. While I fully believed these sites must exist in greater numbers, the prospect of actually finding one to study seemed bleak. The data needed to assess subsistence and settlement patterns and the effects of seasonality on these were meager at best. It became evident that the archaeology of the Northeast could not, at this point in time, speak directly for itself. To better understand the effects of the Pleistocene-Holocene environmental transition on northeastern hunter-gatherers it would become necessary to investigate the human ecology of hunter-gatherers at a more general level in order to develop models appropriate to the interpretation of the early Prehistory of the Northeast. The following chapters strive to do just that.

Chapter 3: Hunter-Gatherer Demography, Ecology and Economy

Introduction

The chapter is divided into two sections. The first examines general patterns that relate to the hunter-gatherer way of life, particularly, population density, growth, distribution and mobility (demographic factors). This section is based primarily on the ethnographic record of living and recently living hunter-gatherer societies. The data are derived from observations of patterns held common among many very different groups of hunter-gatherers from a variety of environments. These patterns suggest the existence of deeply rooted constraints on the social behavior of modern human primates within the context of a hunter-gatherer way of life. As can be expected, these patterns represent a norm (central tendency) about which a great deal of variance can be observed.

The second section examines hunter-gatherer lifeways from an ecological perspective to better understand how hunter-gatherers most effectively exploit the resources of a given environment. This more theory-based approach aids in the development of resource procurement strategy models applicable to prehistoric hunter-gatherers. It is evident that recently living hunter-gatherer societies inhabited environments quite different from those of northeastern North America between 11,000 and 8,000 years ago. For this reason, particular resource harvesting techniques and behaviors observed among recently living hunter-gatherer peoples are of limited value in such a deep archaeological context. While providing an interesting anecdotal milieu for archaeological observations, direct ethnographic comparisons with the past are of limited value for interpreting this period. Ecological models provide a more objective means of predicting past behavior and, indirectly, the potential archaeological manifestations of that behavior.

Hunter-Gatherers of the recent past

Hunter-gatherer peoples make up less than 0.01 per cent of today's world population (Smith 1992:21). The rapid spread of agriculture, in particular over the last six millennia, has pushed most hunter-gatherers to the fringes of the earth's habitable areas. Where hunter-gatherers survive, or where they survived until the recent past, are largely areas inappropriate to a farming way of life. These regions are typically too cold or too dry to sustain agricultural communities. Such areas have been described as "marginal" habitats by their agricultural inhabitants who most often maintain political and economic control over local hunter-gatherer populations. While unsuitable for agriculture, many of these areas are, or were, quite productive within the context of a hunter-gatherer economy. Nevertheless, most of these fringe areas experienced climates which pushed at the tolerance limits of the human animal and required the development of ingenious coping mechanisms in both technological and social-economic adaptations. This raises some immediate concerns for those who wish to model past human behavior on that observed under the present conditions.

While acknowledging a broad range of technological and behavioral variability among hunter-gatherers, many researchers have sought principles which underlie recurring social and economic patterning (Lee and Devore 1968; Binford 1980, 1983; Hayden 1981; Kelly 1983, 1995; Winterhalder and Smith 1981; Smith and Winterhalder 1992a; Jochim 1976, 1981). Most of these principles relate to demographic variables such as population density, rate of population growth, the size of economic and political social groups, as well as their degree of mobility. Many of these variables appear related to qualities of the natural environment dependent upon conditions such as degree of seasonality, precipitation, and latitude. This suggests that there are constraints on demographic variables expressed among hunter-gatherers in a given environment. If so, this allows us to model expected social and economic organization in an unobservable environment, such as that of the terminal Pleistocene Northeast, given the necessary environmental parameters.

Section 1: The Demography of Hunter-Gatherers

Population density among nearly all hunter-gatherer societies is quite low, averaging, in one study, 0.012 persons per square kilometer (Smith 1992: 16). Kelly provides some detailed data pulled from a variety of sources (1995: Table 6-4). Regional examples from his data set include population densities (persons/km^2) of the Arctic at 0.046 ± 0.068 (n=15), subarctic cold forests at 0.018 ± 0.018 (n=30), temperate forests at 0.124 ± 0.127 (n=14), and seasonal and wet tropical forests at 0.317 ± 0.279 (n=19) (outliers excluded in some cases). It is evident from this study that population densities vary greatly with environment, and all show great variance within the regions examined. Nevertheless, these figures are much lower than those reported for horticulturists and agriculturists (e.g., 3 to 288 persons/km^2 among swidden agriculturists, 10-248 persons/km^2 among preindustrial Europeans [Hassan 1981:41]).

The population growth of hunter-gatherers is also very low relative to that of most agricultural societies. It has been estimated that during most of the stone age, human population growth might have been as low as 0.001 per cent (or an increase of just 1 in 100,000 individuals per year). This figure might have approached 0.1 per cent (1 in 1,000) sometime after the glacial period (Smith 1992:12). This represents a population doubling in just less than 700 years. In contrast, today's world population growth is approaching 3 per cent per year - a population doubling time of about 23 years! Slow hunter-gatherer population growth rates seem surprising in light of the human potential for reproduction. Two parents are capable of producing thirty or more offspring in a lifetime (fifty-three being the current record) (Beaton 1990: 27). Of course, this potential is seldom realized even under the most ideal situations. The rigors of a highly mobile way of life, high rates of juvenile and infant mortality and perhaps later onset of puberty, prolonged lactation and suppressed fertility may be important factors limiting the population growth of most hunter-gatherer societies (e.g., Smith 1992: 12).

Despite low population densities and rates of growth, hunter-gatherers around the globe were clearly successful at perpetuating their own numbers over many millennia. Wobst (1974, 1976) has argued that long-term successful reproduction requires a breeding population of between 200 and 500 individuals. A breeding pool of this size also reduces the risks of population extinction resulting from stochastic catastrophic population reduction (which might, for example, be caused by severe weather conditions, unexpected loss of food resources, or disease). A sudden fifty percent population reduction in a group of fifty individuals will have more profound consequences for the viability of the population than it would have for a group of 500.

Low population densities among most hunter-gatherer groups promote *exogamous* , or open, breeding networks (e.g., Smith 1992: 12). Breeding networks must be as open and flexible as possible to guarantee access to the limited numbers of potential mates among people that are broadly dispersed. Exogamy tends to promote biological homogeneity over a broad region. Though not always the case, language dialects and cultural traits should be similar among neighboring exogamous groups. This is especially true where resources are seasonally unpredictable or scarce so that amicable contact with neighboring related groups may be required for survival.

Birdsell (1953) was the first to suggest that 500 is a normative value for hunter-gatherer breeding populations. His based his findings primarily on the size of dialect populations among Australian aboriginal groups. Steward (1969: 290) defined groups of this size (often referred to as *maximal bands* or *macro-bands)* loosely as “a group with which its members somewhat vaguely identify.” Since that time, Kelly (1995: 209-210) and others have suggested that, on a global scale, there is little concrete evidence for any kind of normative value for human social groups of this size among hunter-gatherers. The lack of data suggesting social organization at this level may relate to the fact that, among most hunter-gatherers living at low population densities, group affiliation has been observed to be quite fluid at the local and regional levels (Wobst 1976). This makes it difficult for outside observers to accurately estimate the size of a regional breeding population. High levels of mobility (see below) further confound the issue. It is important, nevertheless, to bear in mind that hunter-gatherers must maintain contact with a group of 200 - 500 individuals to ensure the long-term survival (i.e., over centuries) of their *regional* population.

There is better evidence of human social organization at the local level. Since the "Man the Hunter" conference of 1969, researchers have suggested that hunter-gatherers very often organize themselves into social units numbering about 25 individuals (Hayden 1981:361, 373; Kelly 1995: 210; Price 1978; Wobst 1974). While group membership in such social units is also quite fluid, ethnographers can more directly observe groups of this size, and their information is thus more concrete than it is for macro-bands. Kelly (1995: Table 6-2) provides data indicating that, while there is some variation, groups totaling 25 members are commonly observed among mobile hunter-gatherers around the world.

Interestingly, three independent factors may be acting on hunter-gatherers at different scales of time, all of which promote group sizes structured around 25 individuals. These three factors are local resource limitations, social-organizational constraints and reproductive constraints. On the short-term level, humans will deplete the resources of their local environment at a rate proportional to the size of the local group. One hundred individuals clearly require much more food, water and fuel than 25 individuals, and if the local resources are limited, as they usually are, large groups must either expend more energy foraging further afield or expend more energy in frequent camp moves than smaller groups (see below). Conversely, when a group becomes too small, resource returns are based on the foraging success of fewer individuals and may become irregular or inadequate for survival.

This becomes especially important when resources are poorly predictable and returns are highly variable (Kelly 1995: 212). Seven to eight full-time foragers are most efficient at minimizing daily variance in the resource return rate as well as the rate of resource depletion (Winterhalder 1986). Kelly (1995: 213) associates this number of active foragers with an overall group of about 25 individuals (eight to thirteen individuals are likely to be children, the rest too old or infirm to add significantly to the resource pool). When residential groups become much larger than 25 individuals, social stress related to resource shortages or increasing occurrences of camp relocations are likely to bring about group fissioning.

On the medium-term scale, as measured over seasons or years, political constraints may act on group size as well. Keeley (1988) and Kelly (1995: 302) both note that when more than about six social units partake in group decision-making processes, the need for permanent leaders arises. Thus, a higher level of political and social organization than is common among egalitarian societies must develop to effectively incorporate more than this number of decision-making bodies. Among hunter-gatherers, the basic social unit is the family; groups of 25 individuals may represent as many as five family units. More than this number may tax an egalitarian group's ability to make effective cooperative decisions. In fact, this restricted ability to effectively handle group decision-making may play a role in the last-mentioned restriction on group size - that related to resource depletion, social stress, and group fissioning.

In the long-term, groups may need to maintain local populations of at least 25 individuals to allay the risk of local population extinction. Wobst (1974) has shown in simulation models, that a mixed gender group of 25 individuals is the minimum group size able to withstand stochastic fluctuations in fertility, mortality, and changing sex-ratios for any length of time. As mentioned above, very small groups are at the mercy of local catastrophic events which may reduce populations as well. Given this fact, one might expect that larger groups would be the rule, but Wobst (1974: 172) recognized the importance of the short-term controls on group size already mentioned. Thus, the number twenty-five may represent a compromise between relatively long-term (i.e.. over decades or generations) *local* population viability and short-term (i.e.. over days or weeks) stress on the resource base (Kelly 1995: 212).

If local group populations (often referred to as *micro-bands*) often consist of about 25 individuals, under what situations do they deviate from this norm? Kelly's table of local group sizes of recently living hunter-gatherers is divided into two categories: nomadic and sedentary (Kelly 1995: 211, Table 6-2). As mentioned, the nomadic (or highly mobile) groups tend to average close to 25 individuals, as expected (the actual average is 30.5 ± 16.9, n=25). Sedentary hunter-gatherers (such as Northwest Coast groups) have much higher and more variable local populations (91.5 ± 152, n=39, ignoring the outlier 1,500). The Northwest Coast groups seem to form a special class of hunter-gatherers. They are atypical of most "generalized foraging societies," described by Kelly (1995: 14-15) as egalitarian, living at low population densities, non-territorial, using minimal food storage, and flexible in band composition (see also Isaac 1990). Northwest Coast groups are often large, non-egalitarian, sedentary, territorial, warring and materialistic (e.g., Kelly 1995: 293). Explanations of this divergent pattern (often seen as a movement toward social and political "complexity") tend to focus on the seasonally abundant resources (largely related to salmon harvests) most of these peoples enjoy (but see Kelly for caveats 1995: 307).

From the above discussion it is evident that where and when resources are relatively abundant and predictable, hunter-gatherers are able to live in larger local groups. As long as resources are predictable and locally abundant, the cost of resource harvesting will be low, and social tensions related to resource stress and the need for complex cooperative group decision-making should remain at a minimum. Where human population density is low and mobility is high, it is necessary that groups maintain contact in order to improve access to potential mates, partake in the exchange of goods (which acts to cement social ties and obligations) and share information concerning resources in distant regions. Such activities are observed among many hunter-gatherer groups during group aggregation events, which most often focus on the harvest of a short-term, rich and predictable resource, such as salmon or caribou during migrations (e.g., Kelly 1995: 213-214). While aggregation can increase harvesting efficiency in some cases (Driver 1990), evidence indicates that aggregation most often occurs for social reasons, at the expense of optimal resource use (e.g., Kelly 1995: 213-221; Hofman 1994).

Conversely, where resources are extremely low in density, local groups (micro-bands) must fission into smaller social units. These smaller groups can remain longer in a resource-poor environment and thus waste less energy on frequent camp moves, than larger groups (Dwyer and Minnegal 1985; Wilmsen 1973; Jochim 1981: 155-157; 1976: chapter 5; Hayden 1981: 360-374; Meiklejohn 1978: 69; Price 1979: 82-84). Decision-making among fewer social units is also more efficient (one or two families should reach consensus on when and where to go more readily than seven or eight). However, even very small local groups (the size of single extended families of less than 10 individuals) are unlikely to form where resources are both low in density and highly unpredictable. Only where resource variance is low (daily harvests are reasonably predictable) can such small groups meet their daily resource needs and survive. Where resources are both meager and poorly predictable, emigration (seasonal or otherwise) can be expected.

It is evident from the preceding discussion that most hunter-gatherers are highly mobile. As already noted, mobility is an integral aspect of hunter-gatherer demography and the foraging economy. Marshall Sahlins defined the situation quite succinctly:

> A modest number of people usually sooner than later reduces the food resources within convenient range of camp. Thereafter, they may stay on only by absorbing an increase in real costs or a decline in real returns: rise in costs if the people choose to search farther and farther afield, decline in returns if they are satisfied to live on the shorter supplies or inferior foods in easier reach. The solution, of course, is to go somewhere else (1972: 33).

Sahlins described this predicament as the *imminence of diminishing returns* (Sahlins 1972: 33).

The function $N_r=T_f(R-K)$ most succinctly describes this situation. N_r is the daily net caloric return of foraging (in kcal); T_f is time spent foraging, R is the net rate of foraging return in the environment (in kcal/hr); and K is the energetic cost of foraging (in kcal/hr) (adapted from Kelly 1995: 134). Holding foraging time constant, the net daily caloric return will decrease as foraging pursuits must focus on lower quality resources (those with lower R values).

Hunter-gatherers tend to limit foraging to about a 10 km round trip, or a five kilometer radius around the camp (Kelly 1995: 133). This is about half the distance most hunter-gatherers will walk comfortably in a given day in a variety of environments (Kelly 1995: 133). Jarman (1972) refers to the foraged region around a camp as the *catchment area*. In the simplest of situations, all foragers pursue a similar range of resources within this zone and return the goods to a central place. In reality, there is often a division of labor associated with different resource types. In many societies, women foragers focus their pursuits on small game and plant foods relatively close to camp, while adult males may forage further afield for larger prey of a higher potential net caloric return rate (e.g., Kelly 1995: 135).

Foragers limited to harvesting resources of lower net return rates must by necessity remain closer to camp, or the energy spent traveling to a resource patch will soon outweigh the benefits of its harvest. Conversely, as the net return rates of a patch rise, more energy can be expended in traveling to the patch. Thus, foragers hunting large game are able to roam more broadly than those in pursuit of most small game or plant foods without a loss of net energy. Kelly describes the distance traveled from camp to resource locations as the *effective foraging radius* (Kelly 1995: 135). This distance is clearly a function of the return rates of the available resources within the catchment area. As return rates decrease, so too must the effective foraging radius or more energy will be expended in foraging than can be returned. This suggests that regions of poor resource quality can support only very local foraging pursuits. Furthermore, resources within such restricted harvesting zones will be more rapidly depleted by a group of given size. The end result will be more frequent camp movements, unless group size is kept at a minimum.

Foragers and Collectors

Lewis Binford has studied residential hunter-gatherer mobility patterns in detail. He defines two basic mobility patterns (representing the extreme ends of a continuum) which he believes are largely influenced by the environment (Binford 1980). In Binford's model, *foragers* follow a pattern of seasonal residential moves among a series of resource patches (1980: 5). Foragers do not typically store foods, but instead gather resources for daily consumption. Foragers may display a high degree of variation in group size and frequency of residential movement. Within large or homogeneous rich resource patches, residential movements may be frequent but of limited distance. Where resources are scarce and dispersed, group size may be reduced and social units may be widely scattered with more extended foraging radii (Binford 1980: 7). Binford (1980:7) also notes that in the case of very small, dispersed residential groups (5 to 10 individuals) sexual division of labor may break down as all group members focus on similar resource types. Foragers tend to focus their activities in two locations: the residential camp and extraction (resource harvesting) locations (Binford 1980: 9). In general, foragers "map onto" resources by moving themselves to harvesting locations and by adjusting group size to reflect the nature of the gathered resource (dense or scattered, rich or poor).

At the other end of the food-gathering spectrum are the *collectors*. Binford describes collectors as following a logistically organized strategy in which task groups procure resources at a removed location and return it to the residential camp (Binford 1980: 10). This pattern occurs where critical resources are incongruently distributed in space and/or time, or where and when mobility is restricted. Residential camps may be of relatively long (seasonal) duration, such as during winter months when mobility is hindered by severe weather conditions. This means that special groups must leave the residential base to obtain necessary resources elsewhere. For example, a residential camp may be ideally located for access to fresh water and shelter from the elements, but much of the food supply may be located a distance away, in an area inappropriate to residential settlement. Members of task groups seek specific resources in specific contexts; thus, they tend to be specialists (Binford 1980: 10). However, their specializations may shift with the seasons, and local conditions. Residential group size can also shift with the seasons as local conditions or the resource base changes. In addition to residential camps and extraction locations, collectors utilize distant locations such as overnight field camps and hunting stands; they are also more dependent on storage facilities to resolve temporal variation in resource availability (Binford 1980: 10-11; 1990: 140-144).

Binford suggests that the above residential mobility patterns reflect strategies for survival appropriate to different environment types. He uses a measurement of environmental variability called *effective temperature* (ET) which simultaneously describes the total amount and yearly variation in the solar radiation of a given region using the mean temperatures of the warmest and coldest months (Binford 1980: 13; 1990: 130; Kelly 1995: 66-69). ET is a general measure of the length and energetic intensity of the growing season (Binford 1980: 13). As a rule, the greater the effective temperature, the higher the expected levels of biotic production. Antarctica has an ET value of 8.0, the boundary between boreal forest and tundra is 10.0, temperate forests have ET values between 12 and 15, and equatorial systems with 365-day growing seasons range in ET values between 18 and 26 (Binford 1990: 130; 1980: 14).

Binford demonstrates that, in general, residential mobility increases with increasing ET, that is, from the poles toward the equator (Binford 1980: 14, and Table 2). He suggests that high residential mobility is reflective of the foraging pattern in which consumers continuously move themselves to resources. Low residential mobility is associated with collectors, who must bring certain resources to the consumers. As both the number of critical resources and seasonal variation in temperature increase, so too must the dependence on a collector (logistically-based) foraging strategy. Kelly summarizes this pattern by stating that where resources are homogeneously distributed and where food is available throughout most of the year, a foraging pattern can be expected. Conversely, where food is unevenly distributed and only seasonally available, a collecting pattern should be the rule. He suggests that resources become more aggregated (less homogeneously distributed) both spatially and temporally from the equator to the arctic (Kelly 1995: 120).

Section 2: The Ecology of Recent Hunter-Gatherers

Ties between economy, environment, and society

The above section has clarified some of the intimate ties between the hunter-gatherer's environment, the foraging economy, social organization, and population size and growth. All of these variables of hunter-gatherer life are interwoven in a complex manner, with the common thread (the independent variable) represented by the harvestable resource base of the natural environment. Most of the preceding information is based on observations of recently living hunter-gatherers. Ecological theory represents another more general body of knowledge that can be applied to our understanding of the relationship between humans and their environment. Pianka (1994: 5) defines ecology as "the study of the relationships between organisms and the totality of the physical and biological factors affecting them or influenced by them."

The body of ecological theory of most importance to this study stems from the branch of *evolutionary ecology*. This aspect of ecology focuses on the relationship between an organism and its environment over time, with special emphasis on the effects of natural selection. Natural selection acts upon organisms in a particular environment through the process of differential reproductive success, or *fitness*. The relative fitness of an organism is a function of its phenotype (all observable characteristics of an organism) (Pianka 1994: 123, 130). Differential reproductive success of the phenotype results in the selection of certain genotypes over others (Pianka 1994: 10). Thus particular physical and behavioral traits (phenotypes) will become more or less common in a population over time.

In the 1960's ecologists developed models which describe optimal foraging behavior. Pyke et al. (1977) review a variety of such models which have been applied to hunter-gatherer populations to better understand aspects of the human foraging economy. These models include optimal patch choice, optimal time allocation, optimal settlement location, optimal foraging group size and optimal diet. All of these models work under the assumption that natural selection has acted on populations to differentially promote the most efficient foraging behaviors. According to Pyke et al. (1977: 138), "... natural selection will result in a change with time of the average foraging behavior in the populations, towards that foraging behavior in the range of possible behaviors which gives maximum fitness."

Pyke et al. (1977: 138) note that natural selection can act on cultural as well as strictly genetic traits. Efficiency is measured in terms of a currency, such as energy (e.g., calories) expended vs. energy acquired over time. In this case, one expects the forager to maximize his or her net rate of energy intake. Kelly (1995: 101-108) discusses other currencies, such as essential nutrients, protein and carbohydrates which have also been used (see also Belovsky 1987). Of the above mentioned models, optimal diet-breadth, patch choice and settlement location are most pertinent to the subject and will be summarized below.

Limitations of optimal foraging models

Optimal foraging models tend to over-simplify human behavior by making assumptions about the degree to which foragers optimally utilize the resources of their environment. The basis for optimization theory is practical in an evolutionary ecological sense. Behavior, such as prey choice, should optimize over time as individuals who make more rewarding decisions outcompete their neighbors, as long as they pass their behavior or knowledge to their own group or offspring. This is a diachronic, or time-transgressive, process. It is used to justify the assumed omniscience of actors with regard to the nature of their environments – an assumption which is likely exaggerated in most cases. It also suggests that a single optimal pattern of resource exploitation exists for a given condition.

However, at a given moment in time, a range of behavior patterns is likely to be expressed by individuals within a given group. In fact, in the light of natural selection, phenotypic variation must exist in order for the organism to continue to adapt and survive. Cultural evolution requires a degree of behavioral variability at the level of the individual. Baldwin and Baldwin (1981: 62) suggest, however, that the range of variability of human behavior is so vast that not all of it can be optimal. I suggested in the introduction that behavioral variability was critical to human survival – especially in the rapidly changing environment of the terminal and post-Pleistocene Northeast. Baldwin and Baldwin (1981) indicate the value of behavioral flexibility in variable environments:

> Learning permits rapid behavior change and more subtle discriminating capacity. Opportunistic species and species living in variable environments would be especially handicapped if the species' behavior repertoire were under strict genetic control. In these species, the evolutionary advantage would go to those individuals with genes for physiological mechanisms that allowed their behavior to be rapidly shaped by current environmental conditions, to learn by observing other group members, and to accumulate traditional responses associated with positive consequences (Baldwin and Baldwin 1981: 65).

Optimization models also suffer from a lack of historical context. Most assume a high degree of individual behavioral plasticity to make the most efficient, and most rational use of particular environmental conditions as they arise. Such assumptions tend to disregard the potentially conservative effects of cultural tradition on human behavior. Michael Jochim (1996) has noted the following:

> When people confront adaptive challenges, they do so carrying considerable cultural baggage and they fashion responses out of the contents, often trying to minimize the changes they must undergo. Just as in true biological evolution, change must build upon the past, modifying the raw materials present (Jochim 1996: 360).

This suggests that preceding cultural patterns and historical contingency have the potential to exert a strong impact on the expressed range of behavioral variability by constraining the perceived limits of culturally appropriate behavior. Historical precedent, then, can direct the trajectory of culture change as profoundly as changes in the environment itself.

There is also a great temptation to use precise environmental data to produce models of human behavior which rest on optimal foraging concepts. The apparent precision of numbers has a strong allure, but these "precision" models are less likely to reflect prehistory than more general models which express a potential *range* of excellent, if not optimal, behavioral variability. In fact, as will be seen, too little is known of the past resource base available to humans in the Northeast between 11,000 and 8,000 years ago for detailed models to be developed. The data that can be reconstructed from the existing palynological and paleontological record, and that which can be derived from our understanding of the climate and environment, are admittedly abstract. Those models which can be developed must be general enough to be supported by the imprecise nature of the current data (but see Dincauze 1996b). A general model need not be without consequence to our better understanding of the human past. It will become evident that, while our knowledge of the environment and archaeology of the Northeast during the time in question is not precise, there are a number of boundary conditions which strongly limit the prehistorian's interpretive range.

Therefore, I have emphasized optimal foraging and other ecological models less for their predictive abilities concerning particular past human behaviors than for their usefulness in clarifying many of the more subtle aspects of the economics of foraging in general. In other words, optimization models provide a beneficial heuristic device to help better understand the constraining variables associated with human foraging. They can yield insights into questions concerning hunter-gatherer subsistence specialization, the degree of group mobility, expected group size and the effects of seasonal (or longer term) resource fluctuation or stability on all of the above.

The economics of foraging: a review of selected optimal foraging models

The optimal diet model:

Optimal diet models predict whether a resource will be taken (harvested) when encountered by an active forager (Kelly 1995: 78; Pyke et al. 1977: 141). The model assumes that a forager will encounter resources in proportion to their overall abundance in the environment (in a so-called fine-grained manner) (MacArthur and Pianka 1966; Pianka 1994: 284-285; Kelly 1995: 90; Winterhalder 1981a: 23). The forager's decision to harvest a resource is based upon its return rate. Return rate is determined by the ratio of a resource's food value (often measured in calories or weight) to its *handling cost* (also called *pursuit cost*) (Kelly 1995: 78; Pyke et al. 1977: 141). Handling cost is measured by the time it takes to pursue and kill (or harvest) a resource and to process it (make it edible) and is commonly measured in Kcal/hr. Thus resource rank relates to the *potential* return of the resource in question.

Resource types in a given environment have a variety of return rates. As a rule, seeds and roots have lower return rates than game animals (Kelly 1995: 80 and Table 3-3). This is partly a function of the high cost of processing many plant resources. While potentially more numerous and easier to harvest than animal resources, plant foods tend to come in smaller "packages" than animal resources; the total calories returned per resource unit are usually much lower. The potential value of most food resources, both plant and animal, varies depending on season. When ripe, most plant foods will contain many more calories than at other times of the year. In the fall or before the dry season, most tubers store energy for the coming dormant period. Animals also store body fat before winter or the rutting season. It is evident that resource rank may vary greatly over time within any given environment. Importantly, rank is *not* based upon the abundance of a resource (Pyke et al 1977: 141).

Search costs must be assessed in addition to handling costs. Search cost is a measure of the time it takes to locate a resource and is thus a function of resource density (Kelly 1995: 78; Pyke et al. 1977: 141). Put another way, search costs relate to the probability of encountering a given food resource in the environment. The optimal diet model assumes that resources are searched for simultaneously, but pursued and processed singly (Pianka 1994: 286; Winterhalder 1981a: 24). The net return rate of a resource is measured by the ratio of its total return to the combined costs of searching and handling (again, most often in Kcals/hr). Diets consisting of a number of possible resource types can be evaluated in terms of their combined net return rates, that is, the averaged net return rate of all resources. Optimal diet is determined by adding resources to the diet in rank order until the added resource lowers rather than increases the combined net rate of return (Pianka 1994: 286). At this point the optimal diet has been achieved. The optimal diet is a selective one: it is encountered in a fine-grained manner but harvested in a coarse-grained manner (Pianka 1994: 286; Winterhalder 1981a: 23).

Underlying the optimal diet model is the assumption that the forager has a knowledge of the quality of the resources in his or her environment and can accurately estimate search and handling costs. When a forager encounters a resource, a decision is made whether to pursue it or to continue searching for a more profitable resource. In this way, the optimal diet model reflects a forager's decision-making process, given the assumption that the goal of foraging is to maximize the net rate of return (Kelly 1995: 83).

Whether or not a forager harvests a resource is based only on the absolute abundance of resources of a higher rank, rather than on its relative abundance in the environment (Pyke et al 1977: 141). While a resource might be ubiquitous, a forager is not expected harvest it while higher ranking (though less common) resources are still available. The model proposes that high ranked items will be taken when encountered; but if they are very rare (i.e., search costs are high), these resources may make up only a small part of the actual diet (Kelly 1995: 88). However, as a highly ranked resource becomes more abundant (search time decreases), food resources of lower rank will be dropped from the diet. That is, diet breadth will narrow. Environments rich in high-ranking resources can be expected over time to lead to foraging specialization (Pyke et al 1977: 141; Winterhalder 1981a: 25). The model is also important for its ability to predict changes in diet breadth as handling and search costs change (Winterhalder 1981a: 25). Among human foragers, such change might be brought about by the use of new processing techniques or more efficient hunting tools. Changes in transportation technology can also impact diet choice if search time is reduced (Kelly 1995: 80, 89).

The optimal diet model may not translate well in terms of human foraging for a number of reasons. First, the assumption of a fine-grained, or homogeneous, environment is probably not appropriate in most cases. Because a resource makes up 10 percent of all harvestable resources in the environment does not mean that it will be encountered 10 percent of the time spent foraging. Resources tend to be less evenly spaced (more patchy in their distribution) in real environments, clustered in certain locales dictated by local conditions. Another assumption of the fine-grained condition is that foraging occurs randomly. Most hunter-gatherers do not wander aimlessly throughout the environment, rather they seek out locations which are expected to be profitable based on prior knowledge and experience. The next optimal foraging model deals with a patchy environment more effectively.

The patch-choice model:

The patch-choice model assumes that environments are heterogeneous, reflecting a discontinuous (mosaic) distribution of resources which are termed *patchy* (or coarse-grained) (Pianka 1994: 284; Winterhalder 1981a: 23). Like the diet-breadth model, the patch-choice model assumes that patches are encountered on a fine-grained scale, that is, relative to their proportional abundance in the environment. It is assumed that the rate of food intake decreases with time spent in a patch (Charnov 1976: 129), that the forager will not return to a patch until its resources have rejuvenated, and that time spent between patches is non-productive (Kelly 1995: 90-91). Patch types are ranked in order of their *expected yield*. This model determines yield by the ratio of foraging time (the sum of search and pursuit costs within a resource patch per prey item) to travel time between patches (measured per prey item) (Pianka 1994: 287). When the resource returns of a given patch fall below the average return of all patches in the environment (accounting for travel time between patches) the optimal forager should proceed to the next patch (Charnov 1976: 132; Kelly 1995: 91).

A number of implications stem from this model. First, time spent traveling between patches will decrease as more patch types are added to the diet (i.e., distance between utilized patches decreases). Second, as more patch types of lower rank are added (the environmental average return rate is lowered), more time must be spent harvesting any given patch (i.e., it will take longer to reach the lowered average return rate) (Pianka 1994: 287; Winterhalder 1981a:26). Third, increased harvesting efficiency within a patch (through the use of more efficient gathering tools or weapons) should lower time spent between patches as the patch type becomes more productive relative to the average (time spent harvesting the patch will increase and patch use should become more selective, i.e. specialized). Fourth, lowered transportation costs between patches will decrease the expected length of time spent within a patch because the average return rate of the environment is increased, and patch selectivity should again increase (e.g., Winterhalder 1981b: 90).

Conversely, increased mobility costs between patches (e.g., across bog or muskeg, or in deep snow) should result in increased time spent in a given patch and lowered selectivity of patch type (as the cost of movement between patches has lowered the average return rate for the environment). Fifth, as patch size increases, travel costs between adjacent patches are lowered (as there is less non-productive space between patches), again resulting in increased patch selectivity. However, as patches become smaller (the environment becomes more heterogeneous) travel cost between patches is increased, and patch use should become less selective (Pianka 1994: 287-288). In sum, more homogeneous environments (relative to forager size and mobility) should promote specialist foraging behaviors, while more heterogeneous environments should promote generalist foraging behaviors.

The model suggests that long-term and short-term resource use strategies may differ. Measures of fitness (in terms of observed optimal use of an environment) appear to relate primarily to long-term resource use strategies (Pyke et al. 1977: 145). The model anticipates that a territorial animal with exclusive access to a self-renewing resource patch will harvest resources below the short-term optimal level to achieve higher long-term yields. This is also true of a mobile animal that expects to return to a resource patch in the future that is unlikely to be visited by other foragers in the interim. However, an animal (especially if it is highly mobile) competing against other animals for resources is more likely to utilize a short-term harvesting strategy more to its own advantage or to become more specialized in its patch selection (Pyke et al. 1977: 145; Pianka 1994: 288). Thus, the model indicates that increased competition can promote resource specialization.

Smith and Dawkins (1971) made an interesting observation while trying to test the optimal patch-choice model. They provided titmice with an environment in which a number of artificial resource patches were created using feeding stands of varying food abundance. While the titmice foraged longest at the richest resource patch, observers noted that they would leave it to visit others of lower return rates well before the time expected. Changing the location of the richest resource patch would disrupt the pattern temporarily until the birds learned its new location. In this scenario, remaining at the richest patch for the entire feeding period would have been the most optimal behavior. The biologists concluded that the unexpected sub-optimal behavior must reflect long-term adaptation to a fluctuating resource base (Smith and Dawkins 1971; see also Pyke et al 1977: 144-145). In this case, long-term optimal patch use included the costs of sampling and continuously tracking the environment. One can expect similar "sub-optimal" (on the short-term) use of patches by human foragers living in an environment of fluctuating resources. In this case, the benefits of harvesting within a given patch must be weighed against the costs of maintaining information about the greater resource region through higher degrees of mobility and/or extensive social interaction.

Optimal diet and gender

Most attempts to model optimal diets are based upon a single currency (usually energy) and then applied to the foraging group as an homogeneous whole. Both of these model presumptions may be flawed in certain cases. Of particular interest is the possible effect of gender on foraging behavior and diet-choice. Michael Jochim (1988) notes that the most common and pronounced distinction between members of hunter-gatherer groups is based on gender, and that the sexual division of labor commonly constitutes an important organizational element of the economy (Jochim 1988: 130). Jochim argues that the sexual division of labor is an essential element of human adaptation. Examining foraging behavior alone, Jochim suggests that one can view men and

and women as occupying distinct “ecological niches.” This gender-based economic division allows the sharing of both the benefits and risks of each “niche” (Jochim 1988: 131).

Jochim believes that one way to examine this scenario is to argue that each sex faces separate selective pressures, with natural selection operating on the fitness of the individual, rather than on that of the group (or economic unit). An important aspect of this approach is its ability to weigh the costs and benefits of foraging against the time and energy required for other necessary tasks such as tool maintenance, child care, and household maintenance, which may differ between men and women, depending on the society in question. Reproductive risks may also be different between men and women. The costs of variable nutrition, physiological stress, and injury (which can affect fecundity) are believed to be higher among women (Jochim 1988: 132). If this is the case, women should develop subsistence strategies that minimize these risks. Jochim believes that women’s activities should, in general, be less dangerous, less energy-intensive and should emphasize more reliable food resources then those of men. Because women can be more certain of parenthood, they should also make greater investments in child-care, and in foraging strategies which are more compatible with child-care (Jochim 1988: 132).

If these suppositions are correct, female foragers should focus on less mobile, more reliable and less dangerous prey. This might include many plant species and small game, especially where trapping is appropriate. Many of these food types would likely not fall within the optimal diet when ranked solely on handling costs. Items which might be seen as “sub-optimal” in the general energy-based model are understood as optimizing different currencies in a model which includes the unique goals of men and women foragers. Because certain processing activities (especially those which can be performed at a base camp) may be compatible with other important tasks, such as child-care, resource ranking based on “handling cost” may be a poor predictor of preferred resources.

Low degree of risk, predictability and compatibility with other important activities may make the collection of certain typically “low-ranking” food items (i.e., tubers and seeds) very profitable. When and where the only available resources are mobile, dangerous or widely dispersed, one economic response might be to subdivide tasks rather than resources, with women processing food procured by men. This pattern has been observed among many northern latitude hunter-gatherers (Jochim 1988: 133). When and where food items are local, predictable and of limited mobility (e.g., at fish weirs, shellfish beds or cattail rich wetlands) the gender-based division of labor may be minimal. Sex roles may also be less rigid where resource variability is high and flexibility of foraging methods is necessary for survival (e.g., Jochim 1988: 131).

Optimal group size and settlement location:

In 1968, Horn modeled the most commonly cited discussion of group size and settlement location. In this study, Horn was actually modeling the nesting behavior of blackbirds under four extreme conditions: food distribution even and nests widely spaced, food distribution even and nests in one central place, food distribution clumped and unpredictable and nests in one place, and food distribution clumped and unpredictable and nests dispersed (Horn 1968: 689-690). Horn measured foraging cost as the average distance traveled to a resource location and back to the nest until the necessary food supply was met. He found that where food was evenly distributed the most efficient settlement pattern (least distance traveled) was represented by evenly-spaced individual nests. Where resources were clumped, a single central location was most efficient (Horn 1968: 689-690; Winterhalder 1981a: 31).

Horn's model assumed no information exchange, though he mentions its presumed advantage where resources are not predictable (Horn 1968: 90). Winterhalder has pointed out that among human foragers, a high degree of information exchange should be expected, further promoting aggregation when resources are unpredictable and patchily distributed (Winterhalder 1981a: 31-32). Paraphrasing Wilmsen (1973: 7-8), Winterhalder concludes that the application of the model in terms of human ecology can be summarized by two hypotheses:

> A. Optimal foragers living in an environment with evenly distributed and stable [predictable] resources will tend toward regular dispersion of the smallest viable social units.
> B. Optimal foragers living in an environment with resources which are clumped and unpredictably located (mobile) will tend toward aggregation of social units at a central place. (Winterhalder 1981a: 32)

Wilmsen describes stable (predictable) resources as 1) plants and 2) animal species that are restricted in their individual movements, such as small burrowing species and even solitary cervids such as deer which have limited territorial ranges. Less predictable resources include migratory game, especially gregarious ungulates such as bison, horse, caribou and antelope (Wilmsen 1973: 9). It is evident, however, that even a given species may be more or less predictable in location depending on the season or other environmental and climatic conditions. Thus, deer may form small doe-fawn groups in spring and summer, but "yard-up" into moderate-sized herds during winter months. Caribou may undergo even more extreme seasonal group-size fluctuations, depending on the environment (Spiess 1979). Even most plant foods are difficult to describe as "stable" food resources when their edible components may only be available for a span of days or weeks.

Dwyer and Minnegal (1985) discussed some possible shortcomings of the Horn model and suggested that degrees of resource spatial dispersion, availability over time, particle size, and perishability should be used to define the net degree of a resource's patchiness rather than simply "stability" and "mobility." They emphasized that a given resource may have rather different degrees of patchiness depending on the attributes used to define it (Dwyer and Minnegal 1985: 116). As mentioned, seasonality will have a profound impact on most resources' degree of patchiness. Human settlement systems should reflect such seasonal variations.

Conclusions

This chapter has examined ways in which natural selection has affected human behavior, especially behavior that relates to the food quest. The population density of hunter-gatherers is typically very low, but can be dynamic. Population density likely fluctuates with the short-term conditions of local resources and longer-term climatic change which may affect the regional resource base as well. The population growth of hunter-gatherers is also typically low, although this may be expected of any population established within a given environment. The low population densities observed among most hunter-gatherers require exogamous, flexible breeding networks. Exogamy tends to promote biological and cultural homogeneity over wide regions. Hunter-gatherers must maintain loose contact with a group of more than 200 individuals or regional populations may become extinct.

Local groups numbering 25-35 individuals are common among hunter-gatherers around the world. Larger groups are likely to stress local resources in short time under most conditions. This may lead to social conflict and eventually group fissioning. Where resources are relatively abundant, hunter-gatherers can maintain larger local groups, at least for short periods of time. Ethnographers have observed that where resources are scanty, hunter-gatherers may fission into minimal social-economic groups of fewer than 10 individuals.

Most hunter-gatherers are highly mobile. Mobility is intimately tied to the resource base. Hunter-gatherers typically limit their foraging pursuits to a five km radius around the residential settlement. When resources within this space become too scarce and the costs of harvesting them become too high, the camp must move to a new location. Regions of poor resource quality can support only very local foraging pursuits as the cost of traveling to removed resource areas outweighs the benefits of the harvest. Such regions support very impermanent settlements. Where resources are unpredictably located, the additional cost of sampling and continuously tracking the environment through increased levels of mobility should result in foraging behaviors which appear sub-optimal on the short-term, but optimize for long-term survival and resource management.

Foragers were described as hunter-gatherers who follow a pattern of seasonal residential moves which bring consumers to shifting resource locations. Within rich, homogeneous resource patches, residential movements may be frequent, but of limited distance. Where resources are scarce and dispersed, group size will be reduced, the distance between residential camps greater, and social units more widely scattered, each with more extensive foraging areas.

Collectors follow a logistically organized settlement pattern in which task groups procure certain critical resources at a removed location and return it to the residential camp. This usually occurs where important resources are incongruently distributed in space or time (i.e., have a patchy distribution). Binford showed that a collector strategy (and thus decreased residential mobility) is more common with increasing latitude, heavy dependence on animal resources, a high degree of seasonality, patchiness of the resource base, and decreasing primary biomass.

The aforementioned optimal foraging models provide a means to model a forager's decision-making process concerning prey selection. The simplest forms of such models state that foragers select food resources to maximize net acquisition efficiency (Jochim 1988: 130). High ranked food items should be taken whenever encountered, though they may make up only a small part of the actual diet if uncommon. As highly ranked items become more abundant, lower-ranked items should be dropped from the diet. This situation can lead to resource specialization.

The patch choice model assumes an heterogeneous (uneven) distribution of resources. When resource returns within a given patch fall below the average return rate of the environment as a whole, a forager should quit harvesting and move to another patch. It was noted that as patches become smaller and the environment more heterogeneous, foragers should become less selective in terms of prey (patch) choice. In a more homogeneous environment (large patch sizes), specialist foraging behavior is more likely to develop. In an environment of fluctuating or unpredictable resources, optimal use of the environment should include the added costs of monitoring resource availability through increased mobility, at least of a portion of the population.

Theory concerned with optimal group size and positioning demonstrated that foragers living in an environment with evenly distributed and predictable resources will tend toward dispersion into the smallest viable social units. Where resources are clumped and unpredictably located (mobile) foragers will aggregate at a central place. This pattern of spatial positioning relative to resource homogeneity or patchiness complies with Binford's model of foragers and collectors. In sum, the observations above suggest that the environment in which hunter-gatherers reside has a direct impact not only upon diet but upon aspects of social organization (especially group size and structure) and patterns of residential mobility as well. Where environmental conditions change, as in highly seasonal regions, changes in diet, group size and the patterns and degree of mobility should change as well. Over the long-term, changes in the nature of the resource base can impact human technology and culture, as people become more generalized in diet choice or must specialize on certain resources and develop tools and patterns of behavior appropriate to their harvest. Ecological modeling offers an objective means of estimating the range of past human behavior in a variety of environments. In doing so, it provides a foundation upon which the archaeological manifestations of past behavior can also be estimated. The next chapter examines in more detail the process through which past human activities leave their traces in the ground.

Chapter 4: The Archaeology of Hunter-Gatherers

This chapter examines the process through which the material culture of past hunter-gatherers enters the archaeological record, is subsequently affected by geomorphological forces, and is eventually located, excavated and interpreted by archaeologists of the present. The transformative pathway through which discarded material remains become archaeological artifacts is beset with processes which disrupt their original significance. These forces begin with the actions of initial use and discard and are rapidly followed by those of trampling and house cleaning by their original users. These effects are commonly referred to as "site formation processes" (Schiffer 1987). Following the abandonment of the living area, site formation processes give way to forces governed by the processes of geomorphology. These include erosion and deposition, and other soil formation (pedomorphological) processes such as bioturbation, chemical weathering, frost-heave and tree throws among a host of others. I refer to these as "site deformation processes" to separate them from the aforementioned human processes. Finally, for artifacts to enter the archaeological record we must first find them. The probability of discovery by modern archaeologists depends largely on chance, but a number of very important variables play a further role in the likelihood that a site will be found. These include factors which relate to the site itself (such as its size, artifact density and overall visibility of the artifacts), the site's location (deeply buried under alluvium, beneath the transgressing sea, near a current urban or agricultural region) as well as the methods archaeologists employ to search for sites (through surface walkovers, shovel test pits of greater or lesser interval use of large or small screen mesh size, etc.).

Once discovered, a site may be excavated. Excavation itself results in the disruption of the original relationships between the remains. Excavation is by its nature a destructive process. Once an artifact is removed from its depositional environment, it can never be returned. The final interpretive work of the archaeologist is potentially the most damaging to the original significance of an assemblage of artifacts (Sullivan 1978). Because it is impossible to communicate with the makers of the artifacts being studied, the archaeologist is forced to look to the anthropological and ethnographic literature to find parallels which can aid in the divulgence of a site's original nature. Because modern archaeologists do not share the same world-view of those they study, and because living peoples with whom analogies may be drawn are often no more similar than you or I to those of the past, the interpretive process can easily become one of gross misrepresentation.

For these reasons, site formation, deformation, and recovery and interpretive processes must not be glossed over. Says Robert Ascher, "Since the connection between the archaeological present and the ethnographic past lies along the route of increasing disorder, the advancement of interpretation depends on knowing what happens along that route" (Ascher 1968: 52). Below I will discuss three transformative processes along that route (i.e., site formation, deformation, and excavation), especially as they relate to the archaeology of hunter-gatherer sites. Finally, I will discuss ways in which the archaeological record, despite its inherent problems, can provide information that the ethnographic record is not able to provide: long-term trends in culture change and patterns of human adaptation. In the end it is hoped that, once most of the potential pitfalls that await us are better understood, we can move forward cautiously to the examination of the human life in the Northeast between 11,000 and 8,000 years ago.

Site formation processes

The nature of the archaeological record

Binford (1982) discusses the organization of places in the landscape as they are used by hunter-gatherers within an annual subsistence system. Binford defines the term *annual range* as the area within which subsistence, extraction and social activities take place within a yearly round. A number of residential camps may exist within the annual range. The zone immediately surrounding the camp has been termed the *play radius*, within which site occupants quickly deplete resources. Binford describes activity areas within the play radius as *special use areas*. Surrounding the play radius is the *foraging radius*, which extends (based upon observations of the Nunamiut Eskimo) about 6 miles beyond the camp (see chapter three). Work parties who exploit this area return within a single day. Places visited during the foraging process are termed *locations*. Such places produce very low density artifact scatters resulting from short term collecting and processing activities. Beyond the foraging radius lies the *logistical radius*, a zone exploited by task groups who remain away from the camp for more than a single day (and up to as many as 4 to 6 weeks). Sites (potential artifact-bearing locations) produced by such task groups are termed *logistical camps* (small over night camps), *stations* (hunting stands and kill/butchering locations) and *caches* (locations at which tools are stored for future use). Beyond the logistical range lies a region with which persons are also familiar. This region includes areas that may be visited at other times of the year, and thus information concerning the distribution of resources within this region is very important. Binford labeled this area the *extended range*, beyond which lies the *visiting zone* where friends and relatives have located their camps.

Binford proposed that these activity areas will produce generally discrete assemblages of artifact remains (sites) depending on the degree to which tools are *curated* or *expedient* (1979: 269; also Shott 1996). Some implications of this model are as follows. First, personal and household gear (heavily curated items) relating to a variety of tasks are likely to be produced, rejuvenated and eventually discarded within residential sites. These activities will produce a broad spectrum of artifacts associated with tool production, repair and discard, as well as a variety of expediently used (non-curated) artifacts. The greater number of people associated with residential sites and the increased length of stay (as opposed to hunting camps) will also impact artifact density and diversity. Second, discarded heavily curated items should be uncommon at field camps and stations because their occupants generally replaced them at residential camps before setting out, thus increasing the ratio of expedient tool forms. However, artifact rejuvenation debitage and armament repair waste (such as point bases) may be common at these smaller sites because hunters would repair items brought specifically for that purpose in anticipation of "dead time," for example while awaiting game. These factors can produce very high debitage/tool ratios. Due to a general lack of raw materials, items may often be recycled into other forms as situations require. Expedient tools are often produced from lower quality locally available lithics and other raw materials as situations require. Artifacts found at such sites may not relate directly to site function (e.g., caribou spotting); rather they relate to specific tasks performed at the site (e.g., repair of a knife) (Binford 1978).

Having defined these activity zones and the types of sites they produce, Binford warned that the nature of a hunter-gatherer shifting residential pattern will likely produce reused sites. Furthermore, site reuse may not be of the same type as that of a previous occupation, even within the same annual period (i.e., it might not relate to the same subsistence or other activities). This situation produces complex palimpsests in the archaeological record, especially at locations favored for residential camps. This can lead to serious problems when archaeologists define site types based upon the assemblage density, horizontal extent and tool variation encountered. This is especially true with large sites and can easily produce misleading interpretations of site structure, patterns of use, site duration, season of occupation and the subsistence activities represented. Binford's work concerning site typology has not only helped the archaeologist to conceptualize the nature of the archaeological record beneath his or her feet, but has promoted more careful evaluation of many archaeological sites.

Risk reduction strategies and social organization

Wiessner (1982) believes that Binford focused too strongly on hunter-gatherer adaptations to resources in his analysis of hunter-gatherer social and settlement organization. She notes that environmental variables alone may not be adequate predictors of the social organization of hunter-gatherers nor of their archaeological material remains. In her view, archaeologists must understand hunter-gatherer organization as "both the organization around resources and the organization around other persons in social relations of production" (Wiessner 1982: 172).

Wiessner focuses on two dichotomous short-term risk reduction strategies: non-communal household storage (which can be associated, to an extent, with Binford's collectors) and group risk pooling (which can be associated with Binford's foragers) (Wiessner 1982: 172-173). Non-communal household storage manages risk through the accumulation and storage of goods in times of plenty. Risk pooling (or "generalized reciprocity") reduces individual risk by distributing it over a broad segment of the population. It operates under the condition that "he who has gives to him who is in need" (Wiessner 1982: 173).

Wiessner feels that each of these risk management strategies has implications for the archaeological record as summarized in the Table 4.1 (Wiessner 1982: 173-175):

Table 4.1

Wiessner's Risk Reduction Strategy and Implications for the Archaeological Record

risk reduction strategy	**internal site structure**	**distribution of faunal remains**	**intersite variability**	**exchange**	**stylistic variation**
household storage	widely-spaced household units, closed-in eating and storage areas	storage of high-utility parts, highly variable butchery practices	increased inter-site variability expected	direct drop off in number of exchange items with distance	high stylistic variation in artifacts and personal ownership marks
risk pooling	"open" site plan	evidence of patterned meat sharing	lower inter-site variability expected	number of exchange items does not necessarily reflect distance	low stylistic variation in artifacts

While Wiessner believes hunter-gatherer social organization can be a consequence of organizations around environmental resources, she states that the social-relational realm of risk-management strategies provides additional explanatory power for archaeologists. Her discussion of risk-management strategies provides some important additions to Binford's original environment and economy-oriented study.

Site types

Newell and Constandse-Westermann (1996) developed an expanded site typology based upon observations of 70 arctic and sub-arctic North American collector (*sensu* Binford) societies. In their model, they divide societies first into three groups determined by the nature of the major resource base: type 1, evenly spaced and stable resources (such as forest mammals); type 2, clumped, mobile and unpredictable resources (such as caribou); type 3, clumped, mobile and predictable resources (such as anadromous/catadromous fish and/or migratory marine mammals) (Newell and Constandse-Westermann 1996: 373).

Newell and Constandse-Westermann then divide these groups into three sub-types, or *ranks*: 1) aggregation camps, 2) multi-family settlements, and 3) dispersion camps (single family units). The authors found that among forest mammal hunters (type 1 resource base), aggregation camps are common in summer, multi-family camps in winter and dispersed camps in spring and fall. Among people highly dependent upon caribou (type 2 resource base), aggregation camps were again common in summer, but multi-family camps were used in spring and fall and dispersed camps in the winter. Where fish and/or sea mammal resources were most important (type 3 resource base), the most common residential pattern included aggregation camps during the winter, multi-family camps in summer and dispersed camps in spring and fall (Newell and Constandse-Westermann 1996: 374). Significant variation in residential patterning was, however, observed within each resource base type.

To these nine site types were added five non-residential types: the field camp, kill-butchering site, transit camp, cache site and hunting station (Newell and Constandse-Westermann 1996: 378, Figure 2). Newell and Constandse-Westermann analyzed these fourteen site types according to their relationships to the ecology, site function, duration of occupation, mobility between settlements, demography, site structure and size, technological orientation, and locational and compositional redundancy. Each of the types was associated with a unique array of certain of the 84 site attributes defined from the ethnographic record. In their application of this site typology to the archaeological record of Late Glacial Europe (Feddermesser Culture), the authors found archaeological record of Late Glacial Europe (Feddermesser Culture), the authors found that most sites were similar to the non-residential hunting stands of forest mammal hunters, while larger residential camps were missing. They suggested that most residential camps, containing the diversity of tools and features necessary to better understand the full extent of the settlement and subsistence system of Late Glacial Europe, lay deeply buried beneath river bottom alluvium and/or inundated regions off the west and north coasts of Europe. This situation may apply to northeastern North America as well. Large seasonal camps are likely located in areas no longer easily accessible to archaeologists, and the current archaeological record may also represent only a portion of a much broader and more complex pattern of subsistence and residence organization.

Medium term processes

Dewar and McBride (1992) emphasize the importance of understanding *medium term* processes which can affect the distribution of sites across the landscape. Site distribution directly affects the probability of encountering sites during archaeological surveys. Medium-term processes are responsible for year to year variability in the location and content of sites. These differ from short-term processes, such as the seasonal variation within the yearly round, and long-term processes related to environmental adaptation and cultural change. Medium-term processes occur over years and decades, while short-term processes occur over weeks and months, and long-term processes occur over generations and centuries.

Medium-term processes directly affect the attractiveness of a place both positively and negatively. Thus, the construction of complex, permanent facilities (e.g., substantial living structures) will tend to attract people to a place, while the depletion of resources or increase in local pests will tend to repel people from a place. The degree of place reuse and the size of the area will greatly affect the distribution of site locations, as pictured in Dewar and McBride (1992: Fig. 1). Archaeological site visibility is directly related to the distribution of site locations. Dewar and McBride warn that observed patterns of site location may relate more strongly to middle-range processes than to those of the yearly round or culture change with which they are most often associated (Binford 1982, Dewar and McBride 1992, Trigger 1968, Binford 1980, Dewar 1986, Foley 1981, Anderson and Hanson 1988).

Site deformation processes

This section will clarify mechanisms that influence the archaeological stratigraphy of sites within this region. Pedoturbation (soil disturbance) processes are examined in terms of their general role in biomantle evolution and their effects on the archaeological record. The biomantle is a differentiated upper soil zone produced largely by bioturbation, or soil mixing by plants and animals (Johnson and Watson-Stegner 1990:542; Johnson 1990:84). The biomantle consists of the A and B soil horizons in most interior settings. Nearly all archaeological materials are located within this zone. Pedoturbation refers to various processes of soil mixing. More explicitly, Wood and Johnson define pedoturbation as "the biological, chemical, or physical churning, mixing, and cycling of soil materials" (Wood and Johnson 1978:317).

Even archaeologists, who spend much of their time in direct contact with soil, tend to view it as a static, cohesive substance. In fact, soil is a dynamic medium that often behaves more like a fluid than a solid. Pedogenesis, or soil formation, involves a variety of processes that occur within an active, open system (Wood and Johnson 1978:317; Johnson and Watson-Stegner 1987:350; 1990; Johnson *et al*. 1990). Johnson and Watson-Stegner have found it useful to model soil evolution in terms of progressive and regressive pathways of pedogenesis (1990:541; 1987:350). Progressive pathways include developments towards soil horizonation, upbuilding and deepening, while regressive pathways include simplification, retardant upbuilding and surface removal (Johnson and Watson-Stegner 1990:541-542). Johnson and Watson-Stegner (1990:542) stress that pedogenesis results from the dynamic balance of these two formative pathways, and that pedoturbation plays an active role in both.

Pedoturbation processes common to northeastern soils

Over two decades ago, Jordan (1975) referred to a number of environmental factors which affect the archaeology of New England. Three years later, Wood and Johnson provided an extensive general summary of nine common processes of pedoturbation (1978: Table 9.1). Of these, I will focus on bioturbation, cryoturbation, graviturbation and aeroturbation, as well as the effects of colonial agriculture (a form of bioturbation) which is worthy of special attention in this study region. These pedoturbation processes are critical to understanding soil formation in the northeastern interior and its effects on the buried archaeological record. Glaciation of the region left behind a veneer of deposits including till-draped hills, kame terraces, outwash delta plains and pockets of wind-blown silt and sand. While the specific character of these landforms in any area is largely determined by the nature of the parent bedrock material and site-specific geomorphological formation processes, the mechanisms of pedoturbation on the landscape are general enough to encompass a variety of local conditions and soil types.

Bioturbation: faunalturbation

Bioturbation processes are subdivided into faunalturbation (the mixing of soils by animals) and floralturbation (soil mixing by plants) (Wood and Johnson 1978: 319). Faunalturbation is most commonly associated with rodents and other burrowing mammals, as well as ants, termites and earthworms, and an extensive literature has developed around the effects of these animals on soils and the archaeological record (Wood and Johnson 1978; Stein 1983; Erlandson 1984; Bocek 1986; Johnson 1989; McBrearty 1990). The activities of both insects and small mammals in upper soil horizons cause both buried and surface clasts larger than the animals' burrow holes to slowly sink into the soil matrix and come to rest at the bottom of the zone of maximum burrowing. Such stone lines can easily be mistaken for cultural horizons, and their formation will mix artifacts from multiple occupation horizons into a single zone. In the case of insects and worms very small clasts can be downwardly displaced, while artifacts less than 2 mm (including carbonized seeds) may be digested and destroyed (Stein 1983:281). Small burrowing mammals can displace clasts smaller than 6 to 7 cm both upwards and downwards during active digging (Johnson and Watson-Stegner 1990: 556).

Where burrowing mammals are abundant, Wood and Johnson (1978: 320) report that they can turn over 15-20% of the surface soil in a single year and bring nearly 2.5 metric tons of subsoil per km^2 to the surface. Faunalturbation at this scale is more likely in grassland environments, where burrowing mammals are most common (Bocek 1986: 589). The Northeast's wooded uplands should be affected less severely. Nevertheless, rodent krotovina (sediment-filled burrows) are common features of archaeological sites in the region, and northeastern archaeologists should expect that burrowing mammals have been responsible for extensive soil reworking.

Earthworms have a similar effect on the churning of soil and play a principle role in the formation of A soil horizons (Wood and Johnson 1978: 327). Worms favor moist soils in grasslands and forests of ash, hickory, tulip tree, dogwood and basswood; they are less common in the more acidic soils associated with conifers and oaks (Stein 1983: 278). Surface casting species are reported to eject 1 - 25 tons of soil at the surface per acre (Wood and Johnson 1978: 325), and have been observed in experiments to bury chert and ceramics to depths of 45 cm in five years (Rolfsen in Stein 1983: 280). The activities of ants and termites have similar effects and will influence sandy, well-drained soils where earthworms are less common. At the Paleoindian site of Debert in Nova Scotia, ants are believed to be burying the surface at a rate of one inch every 200 years (MacDonald 1985:18).

In general, burrowing mammals, earthworms and insects are agents of both progressive and regressive pedogenesis. While horizonization can occur (the formation of A horizons and buried stone zones), the net effects of faunalturbation are soil homogenization and the blurring of distinct soil horizons within the biomantle. Because most archaeological sites are also located within this zone, one should expect that archaeological materials have been extensively reworked. Depending upon local conditions, stratified cultural horizons will likely be mixed within a few centuries and discrete features and activity areas will continually blur over time, reducing archaeological interpretive resolution (Erlandson 1984: 789).

Bioturbation: floralturbation

Floralturbation, the mixing of soils by plants (Wood and Johnson 1978: 328), includes four mechanical processes: 1) root growth and expansion; 2) tree sway; 3) root decay; and 4) tree-throw (Waters 1992:306-307; Johnson and Watson-Stegner 1990: 544). Root growth and expansion and tree sway exert pressure on the surrounding soil matrix and can agitate soils through both consolidation and loosening (Waters 1992: 309). Root decay produces hollows (root casts) which may collapse or fill with younger sediments. This process can displace both surface and subsurface artifacts to significantly deeper soil zones. Waters emphasized that the volume of collapsed tree root systems is quite impressive, equaling one-fourth to one-third of the volume of the tree exposed above ground (1992: 309).

The most dramatic of the above processes is tree-throw, the primary mechanism of floralturbation in forested environments (Waters 1992:307; Wood and Johnson 1978:328). Episodic windstorms and wet soil are the dominant factors contributing to tree-throw (Johnson and Watson-Stegner 1990: 544). When trees topple, the upturned root mass carries with it a large quantity of soil and can displace clasts as large as boulders (Johnson and Watson-Stegner 1990: 548). The net effect of tree-throw on forests over extended periods of time is the creation of a “cradle and knoll” topography of upturned root mounds and adjacent crater-like depressions (Wood and Johnson 1978: 329; Waters 1992: 307). This microrelief is pervasive in northeastern woodlands where it has not been obliterated by plowing.

Some estimates indicate that most of the A and B soil horizons of northern hardwood regions of North America will be reworked over a period of as little as 500 years (Wood and Johnson 1978: 331), or that 3,000 to 5,000 years are required for the total disturbance of forest soils (Johnson and Watson-Stegner 1990: 548). Other investigations indicate that tree-throw is even more prevalent in boreal than temperate forests (Schaetzl et al. 1989: 167). This suggests that northeastern forests were more severely impacted by tree-throw during the late-glacial and early Holocene periods than they are today. Fires are commonly associated with tree-throw episodes (Schaetzl et al. 1989: 167) and can produce pseudo hearth features when charcoal from the burned root mass collects in cradle pits (Robert Thorson, personal communication; see also Johnson 1990: Fig. 4). Another possible effect is the inversion of soil and archaeological horizons as well as the production of multi-layered lag zones in gravely soils (Johnson 1990: 88). Tree uprooting is a universal phenomenon in forested regions and has had a strong regressive and limited progressive effect on soil pedogenesis (Johnson and Watson-Stegner 1990: 549). One should not underestimate its role in the disturbance of interior archaeological sites of the Northeast.

Cryoturbation

Cryoturbation, or the mixing of soil under freeze-thaw conditions, includes numerous processes, most of which primarily affect northern latitude areas (e.g., Schweger 1985; Thorson 1990). I focus here on the effects of seasonal freezing on the soil matrix, and the clasts within it, which have a strong influence well within the temperate zone. The maximum depth of soil freezing in southern New England, southern New York and northern Pennsylvania is just over one meter, and it can be greater than two meters in parts of northern Maine (Waters 1992: Fig. 7.2). In non-permafrost areas, soil freezing begins at the surface and works downward when surface temperatures drop below freezing (Wood and Johnson 1978: 337; Waters 1992: 293). Soil expands more dramatically than the 9% value of water alone because capillary action draws moisture from deeper soil zones, resulting in cumulative ice lenses that develop parallel to the ground surface. Soil begins to expand toward the surface, along the path of least resistance, and may increase in volume by as much as 70%. The depth and rate of freezing are optimal when temperatures stay below freezing for long periods of time, the soil is composed of fine sediments such as silt, and abundant moisture is available (Wood and Johnson 1978: 337; Waters 1992: 294).

Soil freezing affects clasts, including artifacts, within the soil in two ways. Frozen soil adheres to the surface of objects with low thermal conductivity (e.g., bone, ceramics and wood) and pulls them towards the soil surface. This may also occur when freezing only partially covers the clast. Objects with high thermal conductivity, such as metal and stone, are pushed towards the surface when ice lenses form beneath them. Upon thawing, soil particles settle into the void space left beneath the displaced object and prevent it from returning to its original position, thereby resulting in net upward displacement (Wood and Johnson 1978: 339; Waters 1992: 295 and Fig. 7.3). The cumulative effects of freeze thaw can eventually deposit objects on the soil surface.

Relative frost heave correlates positively with the clast's effective height, or the cross-sectional distance from the top to bottom of the object at a given orientation. Thus, a flat object oriented vertically has a greater effective height than it does when resting at 45 degrees within the soil, and a much greater effective height than when it rests horizontally (see Wood and Johnson 1978: Fig. 9.10). Frost heave acts most strongly on vertically oriented objects with large surface areas, and will actually rotate clasts towards a vertical orientation (in which they offer the least resistance to the upward forces acting upon them) with repeated freeze thaw cycles (Wood and Johnson 1978: 340; Thorson 1990: 404; Waters 1992: 295-297). The net effect of freeze thaw on buried artifacts is a reorientation towards their longest axis perpendicular to the ground surface and upward migration through the soil profile. Because larger clasts are more strongly affected, this may result in size sorting as well (e.g., Waters1992: 298). Freeze-thaw cycles can thus contribute to both progressive pedogenesis through horizonation, and regressive pedogenesis through the blurring and mixing of once distinct stratigraphic levels, and may result in the formation of coarsening upward sequences (Wood and Johnson 1978: 343). Freezing soil can also disrupt the horizontal distribution of artifacts. Bowers et al. (1983) observed random "Brownian" effects of cryoturbation on experimental flake scatters in subarctic and arctic environments, including upslope movement. They estimated average artifact displacement of about 4 cm per year (Bowers et al. 1983: Table 2).

Graviturbation

Graviturbation is the mixing of soil and rock debris downslope under the influence of gravity without the aid of running water (Wood and Johnson 1978: 346). As with cryoturbation, graviturbation can be most dramatic in northern climates where solifluction, gelifluction and frost creep are most common (e.g., Thorson 1990: 410). This discussion focuses primarily on the more general process of soil creep which plays a dominant, if very gradual, role in the reworking of upland soils. Soil creep is caused by the cumulative effects of a number of processes. These include wetting and drying, biotic activity and the erosion of fine particles by sheetwash and rills. Wetting and freezing cause soils to swell perpendicular to the surface on slopes. Upon drying or thawing, particles tend to settle straight downwards resulting in the net movement of particles down slope (Wood and Johnson 1978:349). Faunal and floralturbation on slopes and large animals treading also result in net downslope soil movement (Waters 1992: 302). Rain splash also plays a significant role (Robert Thorson, personal communication). The extent of soil creep is a function of the interaction of the above processes with slope angle, vegetation cover, particle size and soil moisture content (Waters 1992: 302; Thorson 1996).

Soil creep can clearly have a severe impact on sites located on slopes and can even result in inverted stratigraphies at the base of slopes (e.g., Waters 1992: Fig. 7.6). Soil creep processes may also bury sites at slope bases quite deeply, protecting them from other pedoturbation processes, while severely limiting their archaeological visibility. Thorson (1996) has modeled artifact diffusion in a variety of colluvial settings. He suggests that artifacts distributed on negligible slopes will diffuse horizontally and to a lesser degree vertically so that separate components become mixed. Artifacts distributed on concave slopes will come to rest at the slope base, where components become vertically separated. Finally, artifacts distributed on convex slopes become horizontally dispersed and poorly stratified by component (Thorson 1996: 29-30).

Aeroturbation

Aeroturbation, or soil reworking through wind or gas action, is not a pervasive problem in the Northeast, but is worthy of mention. Active dune fields existed in the Northeast under ideal periglacial conditions such as along drained glacial lake margins where an abundance of fine sediments were available (Thorson and Schile 1995). While most of these dune regions stabilized and became inactive before the onset of the Holocene, modern human soil disturbance can lead to significant dune reactivation. Reactivated dunes have affected three northeastern Paleoindian sites, Reagen in Vermont, Michaud in Maine, and Debert in Nova Scotia, (Ritchie 1953; Spiess and Wilson 1987; MacDonald 1985). Both ancient and modern dune blowouts act to vertically and horizontally concentrate artifacts and other clasts in lag horizons, sort clasts by size and re-move fine particles (Thorson 1990: 411; Waters 1992: 195-196).

Effects of colonial agriculture on the inland archaeological record

Colonial agricultural practices are a form of bioturbation that have extensively reworked many of the upland and lowland zones of the Northeast. European settlers strongly impacted southern New England soils in particular. To quote a Connecticut witness of 1804:

> The state is checkered with innumerable roads or highways crossing each other in every direction. A traveler in any of these roads, even in the most unsettled parts of the state, will seldom pass more than half a mile or a mile without finding a house, and a farm under such improvements, as to afford the necessaries for the support of a family. The whole state resembles a well cultivated garden... (Morse in Bell 1985: 9-10).

By the mid-1800s, farmland covered three-fourths of the state (Bell 1985: 61). While plowing has had an obvious homogenizing effect on the upper twenty to thirty centimeters of tilled land, the secondary effects of deforestation have perhaps most severely altered the landscape. Defores-tation increases soil infiltration rates while decreasing water loss due to evapotranspiration. The net effects are increased soil saturation and resultant sheet wash and gully erosion. Immeasurable cubic meters of soil have been stripped from the uplands and redeposited as alluvium in the lowlands since the onset of European colonization. It is not uncommon to see colonial period stone walls on hillsides in areas now covered by thick forests that are buried by as much as a meter of soil on their upslope sides. Not only can such processes deeply bury older soil horizons, but upland sites may be entirely eroded from their original depositional settings to be redeposited in incongruous environments. Archaeologists must take caution when interpreting site integrity where extensive agriculture is known to have taken place.

Site recovery

In this section I will discuss aspects of site recovery, including methods of archaeological sampling in the field, statistical factors related to subsurface testing and an assessment of the effectiveness of archaeological sampling strategies in the Northeast. The information presented suggests that the existing archaeological record is limited primarily to the largest most accessible sites. The following section examines some pitfalls of site interpretation and focuses on potential problems with the use of the ethnographic record in the study of prehistoric societies. To close the circle, the chapter ends with a discussion of ways in which the archaeological record provides information about long-term patterns of culture change and human adaptation to changing environments for which the ethnographic record is ill-suited.

Sampling strategies

Plog (1976: 137) described four sampling strategies which I will review here briefly. During *Simple Random Sampling* the x and y coordinates of test units are chosen using a random numbers table. This may cluster test units, but assures no bias in their location. In *Stratified Random Sampling* the test area is divided into natural zones, most often relating to ecological parameters, but potentially relating to distance from water or elevation, etc. A number of randomly placed test units are chosen depending upon the fraction of the size of the zone to the total area tested, thus ensuring an equal coverage of each zone. With *Systematic Sampling* an evenly spaced grid of a given interval is placed on the landscape and test units are placed accordingly. This guarantees even spacing and coverage, but may mask sites that also occur at evenly-spaced intervals. Because of the simplicity of its implementation, this is probably the most common form of testing in the wooded Northeast. Plog mentions some of the pros and cons of each testing strategy presented, but as shown below, the test unit size and test unit spacing interval (or density) most strongly influence the likelihood of encountering archaeological materials (Plog 1976).

Statistical factors in subsurface testing

Krakker et al. (1983) discuss a number of important statistical factors affecting the effectiveness of subsurface testing regimes. These are basic concepts of which many people who use test-pit sampling strategies regularly may be unaware. The first concerns the probability of intersecting a site (a spatially discrete high density artifact cluster) with a test-pit at a given grid interval. This probability is expressed by the equation: $p = (\pi r^2)/i^2$, where p is the probability of intersecting a site of radius r with a grid interval of i. This is simply the area of the circular site divided by the area of a single grid unit. Thus, for a grid interval of 10 m and a site size also of 10 m diameter, the chances of finding the site are 78.5%. Put differently, this means that at this grid interval more than 21.5% of sites 10 m in diameter are unlikely to be detected. This should only be surprising to those who believe that the grid interval insures location of sites of an equal size.

Krakker et al. (1983) also examine the likelihood of encountering artifacts in a test-pit of given size with a given artifact density. This probability is expressed by the Poisson distribution equation: $p = 1-e^{-ad}$, where p is the probability of finding an artifact within an area a with an artifact density of d (e is the mathematical constant 2.7183). For example, the probability of finding an artifact in a 0.25 m^2 test-pit with an artifact density of 10 artifacts per meter is about 92%, but at a density of 4 per meter drops to 63%. Thus even at artifact densities of 4 per meter, 50 by 50cm test pits will appear sterile nearly 40% of the time.

This probability is based on an even distribution of artifacts throughout the site area, which is usually an unfair assumption. It is more likely that artifacts cluster towards the center of a site and decay in number towards the site periphery. It is also likely that most sites are the product of a number of artifact clusters representing activity events. This clustering causes further uneven distribution within the site area. Both of these factors will tend to produce areas of very low artifact density within the site radius, thus further lowering the probability of detection.

All told, the likelihood of encountering artifacts in a test-pit is the product of the above individual probabilities. Thus if the chances of detecting the site are 78% (site radius = grid interval), and the chances of detecting artifacts within the test-pit are 63% (artifact density = 4/m, with test-pits of 0.5 m by 0.5 m), then the overall probability of site detection is: 0.78x0.63 = 0.49, or 49%. This figure does not include the additional limiting factors determining the detection of artifacts in the screen based on mesh size, archaeological experience, light factors, or the mood of the archaeologist at a given moment, etc.

Kintigh (1988) provides an even more in depth look at the aforementioned encounter probabilities using computer aided models. He adds to the discussion differing models for artifact decay from the site center and their effects on artifact detection. Thus, it is shown that sinusoidal decay and artifact clustering (the two most likely models) have the poorest chances of detection. With the sinusoidal decay model, about 70% of the artifacts are found from the site center to one half the radius distance from the center. For example, in a 10m diameter site containing 1,000 artifacts, 700 of these are found within 2.5m of the site center in an area of 19.6 m^2 (25% of the total site area of 78.5 m^2). Thus, the average artifact density of the cite center is about 35.7 artifacts per meter. The remaining 300 artifacts are found in an area of 58.9 m^2 (78.5-19.6 m^2), with an artifact density of 5.1 per meter on average. The odds of testing the site in the outer, low density region rather than the core area are about 75% based upon its proportionally larger area.

This mathematical diversion has two main points. First, if one knows what one is looking for (or at least has a good idea), testing strategies can be designed appropriately to assure a certain probability of site detection based on the sizes of the expected sites and their artifact densities. Second, because of the extremely low likelihood of encountering small sites and sites with very low artifact densities with standard shovel pit strategies, we must view the present information about site types and distributions with some skepticism. Sampling strategy designs based solely on our present knowledge of the archaeological record will tend to only find those types of sites with which we are most familiar, reemphasizing existing biases.

The effectiveness of the sample

Wobst (1983) reviews the development of methods and theories concerned with sampling the archaeological record. He also presents a number of minimum expectations which should be met in the archaeological literature concerned with sampling. These include: test-area stratification based on known archaeological sensitivity, information on expected site densities, expected degrees of aggregation and dispersal within the strata, the spatial distribution of potential sites, estimation and definition of the size, shape and visibility of expected sites, explanation and justification of the sampling strategy used, explication of targets or goals of the research, and precise explanation of field methods.

Wobst purposefully avoids the term “site,” having deemed that the site concept masks ephemeral "non-site" activity areas which form much (or most) of the archaeological record (e.g., Binford’s “locations” but see also Thomas 1975). Wobst feels that a focus on clusters of artifacts on the landscape (sites) biases our understanding of the true pattern of use of the region's resources by past peoples. He sees the continued use of the site concept as the result of 1) an inheritance of past archaeological paradigms, 2) testing strategies not fine enough to detect the low density of artifacts that characterize the "infinite tails" between assemblage clusters, and 3) the expectations of Cultural Resource Management (CRM) sponsors who fund most of the archaeological work in the Northeast.

One of the major impediments to northeastern archaeologists is the low visibility of the archaeological record. Most of the sampling strategies used in the Northeast are modifications of techniques developed for the arid Southwest. There, archaeologists had the advantage of relatively complete prior knowledge of regional site types and patterns of distribution, and thus were able to design sampling methods appropriately. In addition, the high visibility of the archaeological record allowed robust and low-cost sampling strategies to observe truly significant portions of the sampled region.

Wobst touches on some of the hair-raising probabilities of locating archaeological remains using standard subsurface CRM methods. In short, he concludes that such methods are likely to locate only relatively large (>30 m diameter) sites with high artifact densities. It is precisely these methods (and not the reality of the archaeological record) that produce site distributions and typologies as they are understood today. Our resultant poor understanding of the archaeological record further impedes our ability to design effective and significant sampling programs (e.g., knowing how to define strata or design transect intervals that have significant chances of detecting specific site types, etc.). For these reasons, Wobst chooses the term "prospecting" to cover most of the current CRM "sampling" strategies, where prospecting implies the initial searching for significant archaeological places rather than the attempt to define how these places articulate with the environment or with other known sites.

In sum, Wobst felt that most of the CRM work until 1983 presented information about "observational noise" rather than significant patterns in the archaeological record. It is debatable whether the last 15 years have seen significant improvements in our testing methods, the archaeological data set, or in our understanding of the archaeological record as it stands. However, the recovery and publication of many small sites in the region since that time is arguably the result of a refinement sampling strategies and an increasing appreciation for the complexity of the archaeological record of the Northeast. This is presented graphically in Figure 4.1 which plots approximate site size against date of site publication for a number of northeastern Paleoindian sites.

Site interpretation

Use and misuse of the ethnographic record

Many European archaeologists are quite comfortable using the ethnographic record of North America to model Paleolithic societies in the Old World (e.g., Smith 1992, Newell and Constandse-Westermann 1996). American archaeologists, perhaps better aware of the diachronic and regional variability among New World societies – as well as our less than complete understanding of those societies – are generally more cautious with their use of the ethnographic record in developing models of past human behavior (e.g., Ascher 1961; Wobst 1978; Gould and Watson 1982). Petersen and Putnam (1992) recently warned of the risks of applying the ethnographic record to the archaeology of northeastern North America.

> Ethnographic analysis is an important tool in archaeological research, but it may well be impossible to specify a single precise analogue for most situations. This is especially true for the early Holocene epoch in the Gulf of Maine and the broader Northeast given the differential (and still incompletely understood) character of local environments during this period, as well as the relative paucity of full descriptions for mid-latitude hunter-gatherer populations in the ethnographic record (e.g., Lee 1968) (Petersen and Putnam 1992: 21).

The ethnographic record, as well as ethnoarchaeological research, are important for their potential to provide a necessary bridge (or "medium range theory") between the observable present and the opaque past (Binford 1968, 1978). There is much debate, however, as to whether contemporary enthography and ethnoarchaeology accurately reflect the behaviors of past peoples. Of primary concern is the question to what degree uniformitarian principles apply to the past within the realm of human behavior (Gould and Watson 1982).

At best, the ethnographic record provides the archaeologist with probabilistic trends (Wobst 1978), that is, modal or normative values of behavior with dependent variables relating to aspects of group size, mobility, site furniture, patterns of tool use and discard, etc. Even if we were able to perfectly reconstruct a past environment and find a modern analog in which a well documented society of hunter-gatherers lived, we dare not assume that the past and present societies be similar in more than superficial ways. The variety of human cultural expression reflected in the ethnographic record informs us of that already.

Rarely do groups conform to modal expectations. In fact, it is precisely the variety of the ethnographic record that betrays the human capacity for innovative response to the environments around us. We dare not underestimate the ability of past peoples to respond to their environment in equally unexpected ways. As mentioned, it is precisely the *variation* in human behavior, that is, our capacity for innovative adaptive response, that has ensured our species' survival over time, space, and a diversity of environmental circumstances. Any model of past human response to environmental change will no doubt fall far short of the complexity of historic events. Yet if there is ample room for the expression of variation in anticipated patterns of human behavior, a model may at least bring us a step closer to a better understanding of the true complexity expressed in the mundane lives of those people long vanished from this region.

Archaeology as long-term ethnography

This section heading is borrowed directly from a paper by Michael Jochim which focuses on the archaeological implications of variation in human behavior over long periods of time (Jochim 1991). Jochim notes the risks of using the normative ethnographic record to understand archaeological patterns which may reflect extremely long periods of time and encompass a much greater range of variable human behavior than one is likely to observe within the relatively short field seasons of most ethnographers (Jochim 1991: 308, see also Wobst 1978). An appreciation of the human capacity for unanticipated and complex patterns of behavior is essential to the better understanding of human ecological adaptation because behavioral variability is the raw material of cultural evolution (Jochim 1991: 308). According to Jochim, patterning observed in the archaeological record, at the scale of both sites and regions, may help us to better understand the nature of the physical environment and ways in which humans of the past responded to it.

Jochim emphasizes the importance of the individual's decision-making process in the formation of the archaeological record. Hunter-gatherer groups are not homogeneous in their expressions of behavior nor in their approach to the environment. Individual seasonal rounds may be quite different within the same group, and this difference should be reflected in the archaeological record (Jochim 1991: 310).

> The same season may see sites in different topographic situations, of different sizes and duration, with different component activities, and even with differing representation of ethnic markers (Jochim 1991: 310).

> Year-to-year variation can occur in a number of realms, including food types and proportions, dietary breadth, degree of sharing, technology, group size, season of aggregation, camp duration, camp location, importance of satellite camps, occurrence of ceremonies, and interaction with other groups (Jochim 1991: 311).

Because of a lack of precise chronological resolution and limited sample sizes, archaeologists are forced to view the past in century-long blocks of time. This suggests that the archaeological record contains ample opportunity to express the full (non-normative) range of past hunter-gatherer behavior. In fact, atypical patterns may be more visible than those of the norm, for example when rare environmental conditions promote large aggregate sites most visible to archaeologists millennia later (Jochim 1991: 311).

The ethnographic record has proved helpful in the modeling of past responses to two opposing environmental conditions: 1) stability of environmental conditions promotes site re-use, and 2) more variable environments produce more numerous site types in varying proportions; affect site location patterns, activities, and prey choice; and blur intersite patterning (Jochim 1991: 314). These different situations can easily lead to widely divergent representations of the same settlement pattern.

Jochim provides an hypothetical example in which a group typically occupies one aggregation site for half of the year and then splits into smaller groups to occupy five sites simultaneously during the other half. During a typical year, the ratio of large sites to small is thus 1:5. If the aggregation site is seldom reused because of environmental constraints (lack of firewood, unpredictable resource location, etc.), but the smaller sites are habitually revisited, after 100 years the ratio of large sites to small will be as high as 20:1. If the opposite case were true, and the aggregation site was typically re-utilized (as a result of abundant and predictable resources), but the smaller sites were seldom reused, the ratio of large to small sites in the archaeological record would appear to be 1:500. Either case is a poor predictor of a typical yearly round for this group. Therefore, it is critical to attempt to understand the environmental setting which led to the observed patterning in order to more closely model past behavior.

Table 4.2 represents Jochim's model relating environmental conditions to potential patterns of human behavior visible in the archaeological record (Jochim 1991: 314-315).

Table 4.2

Summary of Jochim's Model of Environment and Human Behavior Correlations

	environmental productivity temporally variable (year-to-year fluctuation)	**environmental productivity temporally stable (year-to-year similarity)**
Resource locations spatially stable	• weak association between specific site activities and seasons • reoccupation common • periodic resource stress results in broad diet breadth and more intensive butchering patterns ***if alternate resource located elsewhere:*** • strong association between location and activities and weak association between location and season • multi-component sites redundant in site activities represented ***if alternate resource at same location:*** • strong association between location and season and weak association between location and site activities	• strong association between location, season, and activity • multi-component sites redundant in site activities performed • low resource stress results in narrow diet-breadth, less intensive patterns of butchering
Resource locations spatially variable	• weak associations between location, season, and site activities • multi-component sites should show significant variation between occupations • high resource stress results in broad diet breadth and intensive butchering patterns	• site reoccupations less common • strong association between activity and season and weak association between activity and location and season and location • multi-component component sites variable in activities • low resource stress results in narrow diet breadth and less intensive butchering patterns

Based on the above model, Jochim notes a number of observable variables in the archaeological record which may indicate changes in long-term patterns of response to the environment. These include site size and location, season of occupation, degree of re-occupation, degree of site modification, dietary diversity, activity diversity, intensity of butchering, and intensity of exchange (Jochim 1991: 315). In some parts of the world, ideal conditions for the preservation of archaeological remains allow these variables to be measured and compared between sites. In the Northeast, soil acidity greatly hinders the preservation of most organic remains which typically aid in the reconstruction of season of occupation, dietary diversity and intensity of butchering. Highly reworked soils also make the degree of site re-occupation and modification difficult to establish in many circumstances. The remaining variables commonly available to northeastern archaeologists are site size and location, activity diversity, and intensity of exchange (of lithic materials). While limited in number, these variables can provide a great deal of information, and may be of use in establishing patterns of human response to environmental change, both in terms of short-term behavioral diversity and longer-term culture change.

Jochim concludes with the following statement:

> Of course we would like to reconstruct the average seasonal pattern of activities and sites in the past, but there are not only methodological reasons why this may be difficult, but also theoretical reasons why it may be more important to know the type and range of variation. Understanding cultural diversity and change requires that we investigate the overall structure of adaptations, not just some of their components. Big, deep sites may be archaeologically quite visible and rewarding to excavate, but such sites may be more common or "typical" in some environments than others, and we will only know this if we look also at the range of small ephemeral sites as well. Regional organization is indeed receiving much attention lately, but while it may be useful to know if "collecting" or "foraging" was more characteristic of a prehistoric group, this may have little meaning if the strategy differed every year (Jochim 1991: 318-319).

Summary

Wobst stated that “the archaeological record does not consist of behavior, but, at best, of the precedents and products of behavior” (Wobst 1978). Bearing that in mind, in addition to the distortions of the “transformative pathway” along which all archaeological remains must follow through the process of deposition, discovery and interpretation, it is evident we must take great care in linking archaeological remains to the original episodes of human behavior which produced them. As with any set of data, apparent patterning may appear simpler the more limited the size of the sample. The archaeological record, at a range of scales from individual site components, through sites and regional data sets, is similar in this regard. The less evidence available concerning prehistoric subsistence, mobility, settlement, and social organization, the simpler and more straightforward our interpretations of the past. As a rule, the more data we acquire about a specific site or archaeological region, the less evident is patterning in the data, and the more complex and opaque appear the processes which produced that data (e.g., O’Neil 1983). This underscores the necessity of a mindful approach at all stages of site discovery, analysis, and interpretation. Inevitably, as our models of the past become less simple, our understanding of the creators and disruptors of the archaeological record (both human and natural) becomes richer. I will develop such a model in the following chapters.

Chapter 5: An Environmental Baseline for the Study of the Archaeology of the Late-Pleistocene and Early Holocene of the Northeast

Physiographic regional division of the Northeast

The Northeast is divided into nine major physiographic regions: the Coastal Plain, New England Seaboard, Piedmont, New England Upland, Glaciated Allegheny Plateau, Adirondacks, Green Mountains, and White Mountains (Gaudreau and Webb 1985: Fig. 1c). These regions provide the physical substrate for plant communities growing in the Northeast. Physiographic regions do not determine vegetational communities, but they impose constraints on the variety of species growing in them today, as they have in the past.

The Coastal Plain today typically supports a loblolly-shortleaf pine forest; the New England Seaboard contains a southern oak-hickory forest, a northern red-jack-white pine forest, and a far-northern spruce-fir forest; the Glaciated Allegheny Plateau an oak-pine forest; while spruce-fir forests are typical of the Adirondacks, Green and White mountains. The New England Upland region contains elements of all of these forest types, with the exception of the coastal loblolly-shortleaf type. Latitude strongly influences the vegetation of the New England Seaboard, while altitude controls the vegetation of the Adirondack, Green and White mountains. The New England Upland contains a mosaic of plant communities dependent upon a variety of local growing conditions.

Paleo-environmental change during the late Pleistocene and early Holocene of northeastern North America.

Section I: the floral record

Late Pleistocene climate change and effects on vegetation

A number of papers review late Pleistocene climate change in the Northeast (Schafer and Hartshorn 1965; Davis 1965; Ogden 1977; Gaudreau and Webb 1985; Webb 1987; Webb, Bartlein and Kutzbach 1987; Prentice et al. 1991). These studies rest primarily on pollen data collected from numerous sites across northeastern North America. They provide a general survey of the process of vegetation and climate change in the region from 18,000 years ago to the present. These data, while informative of general processes of primary biomass expansion and succession after the last glacial maximum, provide only limited information applicable to questions of human adaptation to specific local environmental conditions. A synopsis of the conclusions of these reports is, however, necessary for laying the groundwork of more detailed sub-regional studies.

The Laurentide Ice Sheet was at its maximum extent approximately 18,000 years ago. At this time it covered all of New England except for small parts of Martha's Vineyard and Nantucket (Schafer and Hartshorn 1965: 119). By 14,000 B.P. southern New England was free of glacial ice, and by 12,000 B.P. nearly all of New England had become open to plant colonization (Ogden 1977: 24). Deglaciation heavily reworked the landscape of New England. Moraine and other ice-contact and outwash features left old land surfaces covered in rock and sand. Glacial meltwater deeply scoured and rapidly filled other locations. Ice and sediment dams produced extensive proglacial lakes such as Hitchcock which filled the Connecticut River basin from central Connecticut to northern Vermont until 12,400 years ago (Ridge and Larsen 1990; Lewis and Stone 1991). When these lakes drained, extensive sandy plains and wetland systems evolved in their places.

Global relative sea level at 15,000 B.P. was 100 to 130 m below that of today, exposing the continental shelf. This broad strip of land remained subaerially exposed until eustatic sea level change outpaced continental isostatic rebound (Kraft 1985: 111). This process occurred at different rates at different latitudes within the region, however. For example, coastal Maine was inundated well into the interior at 13,000 B.P. because of regional ice sheet isostatic depression resulting in relative sea-levels 70 meters higher than those of today (Oldale 1985, 1986; Belknap et al. 1987). At this time, the St. Lawrence River was also inundated with North Atlantic waters which formed the vast Champlain Sea. Meanwhile, southern New England coastal waters were approximately 40 meters lower than their present levels (Lewis and Stone 1991:20). At 10,000 B.P., sea levels were as much as 60 meters below those of today along the Maine coast, while those in southern New England were more than 30 meters below the present level (Gayes and Bokuniewicz 1992).

Vegetative colonization occurred fairly rapidly depending on local edaphic (soil), hydrologic and topographic constraints, as well as the dynamic equilibrium between vegetation and continuous climate forcing (the tolerance of specific plant taxa to temperature and precipitation constraints) (Spiess and Wilson 1987: 149; Prentice et al. 1991). Colder and drier conditions supported an open spruce parkland environment dominated by sedges and herbaceous plants between 15,000 and 12,000 B.P. across much of the Northeast (Webb 1987: 181-182; Gaudreau and Webb 1985: 269-271). Webb argues for a major vegetational change between 12,000 and 10,000 B.P. when birch and alder become more common at the expense of herbaceous plants (1987: 182).

A combination of orbital cycles placed the earth's northern hemisphere closest to the sun in mid-summer 10,700 - 8,800 B.P. (12,000 - 8,000 calendar years ago) (Kutzbach and Street-Perrott 1985; Kutzbach and Webb 1993). This situation resulted in an average 8% increase in the amount of solar radiation received in summer, and that much less in winter, compared to today's levels (Webb 1987: 183; Kutzbach 1987). In contrast, today the sun is closest in mid-winter, moderating temperature extremes in the northern hemisphere. Shifting wind patterns likely played a further role in vegetational change after 12,000 years ago as modern westerly patterns emerged in the Northeast (Webb et al. 1987: 452; Spiess and Wilson 1987: 148-149; Thorson and Schile 1995).

Prentice et al. (1991: Fig. 6) estimate that mean summer temperatures were about 18 degrees Celsius across a broad band from the mid-Atlantic states to northern Maine 12,000 years ago. This is comparable to modern summer temperatures in northern New England. Southern New England mean summer temperatures are currently closer to 21 degrees Celsius. Mean winter temperatures, however, were much lower than those of today, ranging between -20 degrees in northern New England and -16 degrees Celsius in southern New England, temperatures comparable to those of contemporary central Labrador. Current mean winter temperatures from southern to northern New England range between -4 and -12 degrees Celsius. Annual mean precipitation ranged from 800 to 600 mm south to north. This suggests much drier conditions than exist today (mean annual precipitation is currently between 1,000 and 1,200 mm) (Prentice et al. 1991: 2046). Overall, this indicates a pattern of warm summers and severe winters in a relatively arid environment 12,000 years ago.

Regional climate and vegetation change during the eleventh through ninth millennia

The sequence of sub-regional plant succession was diverse, reflecting local temperature gradients, soil conditions, precipitation, topography and stochastic changes resulting from fire, flood, and storm patterns (Curran 1987: 70). Human adaptations to the resources of a given environment occurred at a local, rather than regional level (Dincauze 1996b). Although it is not within the scope of this work to review the details of regional diversity, the following section expresses the complexity of the Northeast's late-glacial environment. Because the human colonization of the Northeast is not believed to have occurred until about 11,000 years ago, this section will focus on changes from that time until 8,000 years ago.

Northeastern climate and vegetation at 11,000 B.P.

By 11,000 years ago a true forest canopy covered southern New York and New England, as well as the coastal regions of New Hampshire and Maine. This forest was, however, unlike any currently existing in North America (Overpeck et al. 1992). Climatic conditions as well as latitudinal factors promoted the admixture of warm-weather deciduous tree species within an otherwise boreal forest. This situation was particularly evident in coastal southern New England where a pine-oak forest had established itself (Curran 1987). The pollen record from Rogers Lake, Connecticut, indicates that levels of sedge had declined dramatically from 12,000 B.P., suggesting that forests where much denser than they had been by 11,000 years ago. Pine and spruce dominate the pollen spectrum, but fir, birch, and oak are strongly represented, as well as maple to a lesser degree (Gaudreau and Webb 1985; Davis and Jacobson 1985).

More open conditions prevailed in northern New England, where woodlands interspersed with sedge grasslands were still dominated by spruce, jack pine, and poplar (Davis and Jacobson 1985; Jacobson et al. 1987). Tundra flourished in northern Maine and the adjacent Canadian Maritimes. The Northeast's summer temperatures were comparable to those of today. Using midge fly remains, Cwynar and Levesque (1995: Fig. 2) estimate that lake water temperatures for central Maine were close to twenty-five degrees Celsius in summer. Moisture levels (precipitation minus evaporation) are estimated to have been somewhat lower than today's (Kutzbach 1987:Fig. 13; Webb et al. 1993). These data indicate relatively mild post-glacial climatic conditions 11,000 years ago in the Northeast. This general period of warming is recognized in Europe as the Böl-ling-Alleröd interstadial (ca. 12,400 - 10,800 B.P.) (e.g., Kolstrup 1991).

Abrupt climate changes during the mid-eleventh millennium B.P.

An important climatic transition occurred abruptly in the Northeast shortly after 11,000 years ago. This change resulted in a shift to cooler, moister conditions and was likely accompanied by increased storminess and heavier winter snowfall (Peteet et al. 1990). This period is now acknowledged to correspond to the Younger Dryas event, long recognized by paleo-climatologists of Europe (Ruddiman 1987; Dansgaard et al. 1989; Broecker et al. 1989; Fairbanks 1989; Zahn 1992; Broecker 1992; Alley et al. 1993; Mayewski et al. 1993; Goslar et al. 1995). Since the early nineties it has been demonstrated that the Younger Dryas marked a period of global climate change (Kudrass et al 1991).

Peteet et al. (1990) helped to firmly establish the presence of a mid-eleventh millennium B.P. climate reversal in the Northeast. Their research indicated that observed pollen increases of spruce, fir, alder, and birch for this period in southern New England could not be easily explained as an artifact of plant succession (Peteet et al. 1990:227). They observed an increase in these boreal species at the expense of oak and other deciduous tree varieties across the region at the same time. These researchers conclude that increased winter severity and concomitant shorter summer growing periods are to blame (Peteet et al. 1990:228). Thorson and McWeeney (n.d.) note similar changes in plant taxa at the Cedar Swamp in southeastern Connecticut after 11,000 years ago. This transition corresponds with an increased deposition of mineral-rich lacustrine sediments indicating heightened levels of erosion within the watershed. In the central Connecticut River valley dunes were reactivated under moist conditions (Thorson and Schile 1995). This suggests both the onset of windier conditions and a decrease in cover vegetation at this time.

The effect of the Younger Dryas on northern New England and the Canadian Maritimes regions was likely more severe than in the south. Midge fly fossils from central Maine indicate an abrupt drop in summer surface water temperatures from twenty-five to as low as ten degrees Celsius in the period between 11,000 and 10,000 years ago (Cwynar and Levesque 1995: Fig. 2). Here, too, this period corresponds with a significant increase in inorganic lake bottom deposits, suggesting increased erosion caused by a local loss of stabilizing ground cover (Cwynar and Levesque 1995:410).

In the Canadian Maritimes, pollen records indicate a return to tundra-like conditions after 10,800 years ago (Mayle and Cwynar 1995). Prior to this time a mixed spruce, boreal woodland with dwarf birch and jack pine had been established. Low percentages of oak pollen may suggest transport from a neighboring region (Mayle and Cwynar 1995: 146). Nevertheless, oak pollen vanishes from the record during the Younger Dryas, suggesting that the original pollen source zone was no longer available. Here as well, the deposition of inorganic sediments increased dramatically at the onset of the Younger Dryas and declined again abruptly after 10,000 years ago (Mayle and Cwynar 1995:147, 150). At this time, tamarack, fir, tree birch, and white pine increased rapidly as the climate returned to milder conditions (Mayle and Cwynar 1995:150).

The exact causes of the Younger Dryas cooling episode remain widely debated (Zahn 1992). It is evident, however, that the change in climate can be attributed to a combination of related effects. These include shifting polar wind patterns (Ruddiman 1987; Mayewski et al. 1993), changes in the rate of glacial meltwater discharge (Ruddiman 1987; Fairbanks 1989), possible shifts in deep ocean currents (Broecker et al. 1989), and an alteration in the exchange of CO_2 at the ocean-atmosphere interface (Goslar et al. 1995). The end of the Younger Dryas event appears to have been very abrupt (Dansgaard et al. 1989). The analysis of oxygen isotope levels from Greenland ice cores suggests that climate patterns in the North Atlantic shifted over as little as three years, resulting in a seven degree Celsius temperature increase (Alley et al. 1993).

Vegetation changes at the onset of the Holocene

The Holocene, the earth's present geological era, is recognized as the end of the glacial period approximately 10,000 years ago. The onset of the Holocene is marked by an interval of rapid global climatic warming and reduction of the ice sheets. The transition from the Younger Dryas to the Holocene represents a period of rapid vegetation change as plant communities shifted their ranges in response to the milder growing conditions (Jacobson et al. 1987; Jacobson and Grimm 1988). The rapidity of plant community change strongly suggests that expansion of individual species occurred from scattered refugia where species such as white pine, oak, and hemlock had maintained relict populations throughout the Younger Dryas event (c.f. Gaudreau 1987:27; Mayle and Cwynar 1995:150).

Estimated mean July temperatures for southern and central New England 9,000 years ago are between 20 and 18 degrees C, comparable to those of today, and 18 to 14 degrees Celsius for New Brunswick and Nova Scotia (19-17 degrees C today) (Prentice et al. 1991; Webb et al. 1993). Summer surface water temperatures at Trout Pond, central Maine are, however, believed to have been as warm as 27 degrees Celsius (Cwynar and Levesque 1995: 407 fig. 2, p. 409). Estimated January temperatures in southern New England were -6 to -8 degrees Celsius (-2 to -6 today) and -8 to -12 in central and northern New England and the Canadian Maritimes (close to today's values). Prentice et al. (1991: Figures 5 and 6) estimate that precipitation in southern New England was about 800 mm annually, somewhat drier than today (about 1100 mm), and between 800 and 1000 mm in central and northern New England and the Maritimes region, which is comparable to today's values. Table 5.1 summarizes northeastern temperature and moisture conditions discussed above.

Table 5.1

Summary of Northeastern Temperature and Moisture Conditions 12,000 – 9,000 B.P.

12,000 B.P.	northeastern summer temperatures comparable to northern New England today (ca. 18° C), winter temperatures very cold, comparable to central Labrador today (ca. –16° to -20° C), ca. 20% drier in southern Northeast, 50% drier in the northern Northeast
11,000 B.P.	summer temperatures close to those of today, summer lake temperatures in central Maine ca. 25° C, winters colder than today, somewhat drier conditions than today's
10,500 B.P.	summer lake temperatures in central Maine drop to ca. 10° C
9,000 B.P.	summer temperatures similar to today's, summer lake temperatures in central Maine ca. 27° C, winter temperatures only slightly cooler than today's (ca. –6° to –12° C)

In southern New England, white pine established itself as the dominant tree species. Pine forests were mixed with significant populations of oak and some birch at this time, while spruce had all but vanished (pollen diagrams in Gaudreau and Webb 1985; Thorson and Webb 1991).

Interestingly, significant spruce-sedge pollen counts are reported from nearby northern New Jersey and the tri-states region at this time, suggesting that local (possibly edaphic) conditions supported a more open woodland which included birch, oak, and pine (Gaudreau and Webb 1985; Gaudreau 1988).

Central New England (southern Maine and New Hampshire, western Massachusetts, and Vermont) supported spruce forests that extended west to the St. Lawrence River Valley (Gaudreau 1988: Fig. 2). This was a spruce-pine forest in western Massachusetts and a mixed spruce-birch forest in Vermont and southern Maine. These heterogeneous forests included lesser quantities of poplar, jack and white pine, elm, larch, ironwood, ash, fir, oak and maple (Davis and Jacobson 1985).

Central Maine and the southern Canadian Maritimes region supported a jack pine-birch-fir-spruce-poplar forest, trending to more open woodland northward (Davis and Jacobson 1985; Cwynar and Levesque 1995). Tundra conditions prevailed in the northern Maritimes (Curran 1987: 76). The reconstructed distribution terminal Pleistocene paleovegetation regions is presented in Figure 5.1.

Vegetation change between 10,000 and 8,000 years ago was more gradual and predictable than that of the previous millennia. Pollen diagrams from southern New England west through New Jersey and eastern Pennsylvania indicate the steady replacement of pine with oak. Pine and birch remain present in low numbers throughout this period. Hemlock and, to a lesser extent, maple, alder and ironwood increase in number (Gaudreau and Webb 1985; Peteet et al. 1990; Thorson and Webb 1991).

White pine continued to spread into northern New England from coastal areas after 10,000 years ago. This expansion occurred at the expense of spruce and jack pine, which remained present in reduced numbers (Spear et al. 1994). Birch remained an important element of the northern forests. Larch, fir, maple, hemlock, and alder were also present in small quantities (Davis and Jacobson 1985; Mayle and Cwynar 1995). Oak formed a significant element of the forest along the southern Maine coast and north through the Connecticut River basin into Vermont and New Hampshire (Gaudreau and Webb 1985). Only the northernmost regions of the Canadian Maritimes supported tundra and boreal woodland by 8,000 years ago (Figure 5.2).

Summary of environmental change: 11,000 - 8,000 years ago

The above synthesis is meant to emphasize the spatial and temporal diversity of the Northeastern environment. Late Pleistocene environments were more heterogeneous than those of modern analogues. This is in part the result of different climatic conditions than those of today, but it is also an outcome of the dynamic process of plant re-colonization and succession in the region. Both factors promoted the development of heterogeneous plant communities unlike any known today. Complex mixtures of boreal and deciduous plant species competed for local resources side by side. This situation was probably reinforced by the Younger Dryas cold episode which swung the advantage to cold-moist tolerant species after the initial establishment of temperate taxa, in effect, stirring the pot of an already complex stew of plant forms.

The shift to more moderate Holocene climatic conditions and lessening seasonal gradients began the process of the formation of modern plant communities and vegetation regions familiar to us today. This transition was gradual and is still underway as temperatures and precipitation vary over the centuries. Nevertheless, the character of forests during the Holocene became quite different from that which preceded it. Guthrie (1984: 266) describes this transition as a shift from mosaic plant associations to simpler zones of plant communities. This shift corresponds with a reduction in the overall diversity of herbaceous and woody species. Guthrie explains this as primarily the result of the more regular and shorter growing seasons which emerged at this time as winters warmed and summers cooled. This condition resulted in the development of sub-regional habitats which favored certain species over others. Those plants with a competitive edge soon flourished at the expense of less well adapted varieties, and plant community ranges shifted and simplified accordingly (Guthrie 1984: 267). As a result, more homogeneous plant communities developed at the sub-regional scale. These new Holocene forests were by no means monotypic, but they were simpler and better segregated than they had previously been.

Section II: the faunal record

Late Pleistocene and early Holocene fauna in the Northeast

The variety and distribution of fauna are poorly documented in the northeast during the late Pleistocene period. This is primarily the result of inadequate circumstances for faunal preservation in the region (e.g., acidic soils, and the lack of karstic cave systems). Scattered finds of Pleistocene mammals have been reported in river gravels and on the continental shelf, but these amount to only a few poorly dated bones of horse, muskox, mammoth, mastodon and possibly bison (Bonnichsen et al. 1985: 156).

Mid-Appalachian late Pleistocene faunal assemblages are more complete, and may provide analogs to the Northeast. Finds reported by Guilday (1982; 1984) offer an impressive inventory of 75 mammal species (excluding bats) dating from the late Pleistocene. This heterogeneous mixture is typical of North American Pleistocene faunal assemblages which generally exhibit much more diversity than those of the Holocene. This is primarily the result of late Pleistocene climatic and vegetational conditions which promoted the sympatric range of animals which are today allopatric (Guthrie 1984). These conditions are described by Graham and Mead (1987) as cold, but equable in terms of the degree of annual temperature and moisture variation.

This section will focus only on those mammals of potential importance to humans as large-game prey. These include muskoxen (*Ovibos*, *Symbos*, and *Bootherium*), bison (*Bison*), horse (*Equus*), tapir (*Tapirus*), peccary (*Platygonus* and *Mylohyus*), stag-moose (*Cervalces*), stilt-legged deer (*Sangamona*), caribou (*Rangifer*), American elk (Wapiti) (*Cervus*), white-tailed deer (*Odocoileus*), ground sloth (*Megalonyx*), mammoth (*Mammuthus*), mastodon (*Mammut*), giant beaver (*Castoroides*), and moose (*Alces alces*) (Guilday 1982; Anderson 1984).

The above list can be divided generally by habitat type. *Sangamona*, *Equus, Bison*, *Mammuthus*, *Rangifer*, and *Ovibos* were primarily grazers of open woodlands, grasslands, and steppes. Grazers tend to be wide-ranging (often gregarious), migratory animals. This ensures necessary dietary variety in environments which tend to be locally homogeneous. *Mammut*, *Symbos*, *Bootherium*, *Cervus*, *Cervalces*, *Odocoileus*, *Alces*, *Castoroides,* and *Megalonyx* were browsing inhabitants of woodlands, forests, and wetlands. *Mylohyus* and *Platygonus* were specialized browsers of similar habitats. Forest browsers tend to be less gregarious and range less far than grazers. This requires more heterogeneous local environments to insure well-balanced diets and defend against the buildup of plant toxins (Guthrie 1984). These animals are described in more detail in Appendix 1.

Late Pleistocene carnivores of the Northeast

Late Pleistocene large carnivores of the Northeast likely included grizzly bear (*Ursos arctos*), black bear (*U. americanus*), jaguar and lion (*Panthera*) (although these appear to have shifted their ranges southwest and west respectively, rather than northeast), dire wolf (*Canis dirus*) and timber wolf (*C. lupus*), American cheetah (*Acinonyx*), short-faced bear (*Arctodus*), spectacled bear (*Tremarctos*), and possibly saber-toothed cat (*Smilodon*) and some smaller cats (*Felis* sp.) (Guilday 1982; Anderson 1984). Some of these, such as black bear, might have been taken as a food source, while others would have been valued for their pelts. These animals were, however, direct competitors with human hunters, and most were potentially dangerous and likely avoided.

Potential northeastern late Pleistocene small-mammal resources

Guilday (1984) documents a variety of small mammals from late Pleistocene contexts in the mid-Appalachian Plateau. Humans might have hunted a number of these for food and pelts. Small mammals which now range into boreal forests likely entered New England 12,000 to 11,000 years ago. Based primarily on the mid-Appalachian finds, these include snowshoe hare

(*Lepus americanus*) and arctic hare (*Lepus arcticus*), red squirrel (*Tamiasciurus hudsonicus*) and northern flying squirrel (*Glaucomys sabrinus*), woodchuck (*Marmota monax)*, beaver (*Castor canadensis*), muskrat (*Ondantra zibethicus*), porcupine (*Erethizon dorsatum*), arctic fox (*Alopex lagopus*) (not recorded by Guilday, but see Storck and Spiess 1994) and red fox (*Vulpes vulpes*), wolverine (*Gulo gulo*), marten (*Martes americana*), fisher (*M. pennanti*), ermine (*Mustela erminea*), least weasel (*M. nivalis*), and mink (*M. vison*). Small mammals tend to be territorial and have much smaller ranges than those of large mammals. Because search and pursuit costs are typically high, most of these animals are traditionally taken with traps. Many store high quantities of body fat before winter, and can supply important supplements to an economy focused on larger game, especially in fall and early winter months. Rapid reproduction maintains local populations, though these may vary dramatically with time.

Other potential animal resources in the Northeast

Sea mammal remains have been reported from Champlain sea sediments dating between about 12,000 and 10,200 years ago. Sea mammals are an important subsistence resource for many arctic and sub-arctic peoples today, and the possibility of their use by Paleoindians in the Northeast should not be ignored. Walrus remains have been recovered along the submerged continental shelf and may have been present in northeastern coastal areas during the terminal Pleistocene (Harington 1977). Ringed seal, harp seal, bearded seal, and hooded seal are reported from the Champlain Sea basin (Harington 1977; Loring 1980: 17). Based on their current distributions and habitat preferences, harbor seal and gray seal may have been present in this and other coastal regions as well. Potential sea mammal resources are described in more detail in Appendix 1.

Reconstructed sub-regional distribution of late Pleistocene fauna in the Northeast

The distribution of late Pleistocene fauna in the Northeast is poorly recorded. However, based on modern habitat types and geographic ranges, the probable sub-regional distribution of late Pleistocene fauna can be approximated for the study region. Because of a lack of exact information, much of this reconstruction is based on presumed diet type and dietary needs. As mentioned above, a broad spectrum of animals were able to survive side by side within the heterogeneous open spruce parklands and savannas of mid-continental North America during much of the Pleistocene (Guthrie 1984). By 11,000 years ago, however, sub-regions offering unique habitat types with reduced local heterogeneity dominated even the Northeast. Reconstruction of late Pleistocene faunal distributions in the Northeast assumes that these developing (and rapidly changing) eco-regions offered habitats conducive to certain animals, but unsuited to others.

Based on its paleo-vegetation of 11,000 years ago, I have divided New England into three general sub-regions. These are the far northern tundra and open poplar/mixed woodlands zone, the central spruce-pine forest zone and the southern/coastal pine-oak forest zone. At this time, many of the now extinct late Pleistocene animals discussed previously were possibly still living in the Northeast.

The **far northern tundra-woodlands zone** could have supported a number of the large grazers such as *Sangamona*, *Equus, Mammuthus*, *Ovibos*, *Bison,* and *Rangifer*. Populations of the first three genera were probably already stressed as a result of limited range possibilities, increased seasonal temperature extremes and decreased environmental heterogeneity from that to which they were adapted during most of the Pleistocene in mid-continental North America (Guthrie 1984). They were soon to disappear from North America altogether. *Ovibos* and *Bison* were well suited to the local conditions, but are known to have become regionally extinct at about this time. Only *Rangifer* is known to have survived in the northern Northeast after the Pleistocene. This species was likely the most common large mammal in the region at this time. Small mammals of the far north likely included arctic and red fox, wolverine, arctic hare, and arctic ground squirrel. The Dire wolf, timber wolf, grizzly bear, and possibly the large short-faced bear were likely the region's most important predators. The Champlain Sea coast also supported the aforementioned marine mammals.

The **central spruce-pine forest** was likely home to many of the browsers. These included *Mammuthus*, *Symbos*, *Bootherium*, *Castoroides, Cervalces*, *Megalonyx, Mylohyus*, *Platygonus, Cervus, Rangifer,* and *Alces.* Of these, the first eight were soon to become extinct, or might have already become so. Remaining populations were likely stressed for the same reasons as those in the far north. This suggests that elk, woodland caribou and moose were the dominant large mammals of the central spruce-pine forest. A variety of small mammals was also likely present. These probably included snow-shoe hare, red and northern flying squirrels, beaver, muskrat, woodchuck, porcupine, red fox, American marten, least weasel, mink, wolverine, and northern river otter. Major predators would have included the timber wolf (and possibly Dire wolf), black, grizzly and possibly short-faced bears, as well as the smaller lynx.

The Northeast's **southern coastal pine-oak forest** probably supported most of the boreal forest animals just mentioned. In addition to these, however, a number of temperate forest species might also have been present. These could have included white-tailed deer, gray squirrel, coyote, raccoon, fisher, long-tailed weasel, bobcat, striped skunk, and possibly badger. The Long Island Sound and Narragansett Bay inlets must have supported rich marine resources as well. Sea level change was less dramatic and rapid than along the New Hampshire and Maine coastline to the north (e.g., Oldale 1985). This meant that more productive estuarine habitats could form behind barrier beaches and along protected stretches of the coastline (e.g., Peck and McMaster 1991; Gayes and Bokuniewicz 1991; Shaw and van de Plassche 1991; cf. Curran 1987: 107).

The coming of humans to the Northeast

Humans entered the Northeast about 11,000 years ago (Funk and Gramly 1991; Dincauze 1996a; Anderson 1991). Human presence in the Northeast during the eleventh millennium B.P. is actually better documented than that of any of the other mammals mentioned above. Although paleontological evidence (human skeletal remains) is entirely lacking until the mid-Holocene, the human presence has been well established through the discovery of diagnostic stone tools made by human foragers of this time. Because of this, archaeologists have not only been able to date the arrival of people in the Northeast but have been able to model population density, group size and mobility in ways not yet possible for other late Pleistocene mammals. This will be discussed in much more detail below. For now, it is important to note that a human presence is documented for southern New England shortly after 11,000 years ago and in northern New England and the Canadian Maritimes region by at least 10,600 years ago, based on radiocarbon-dated sites and stone tool typology (e.g., Stothers 1996). This suggests that an initial adaptation to boreal spruce-pine forests soon broadened to one that took advantage of the resources of the tundra/mixed woodlands as well. Unlike the Pleistocene megafauna which disappear at this time, the rapid spread of humans into the region during this period of climatic severity suggests that Paleoindian foragers were both physically and culturally well adapted to conditions in the Northeast during the eleventh millennium B.P.

Possible effects of the Younger Dryas event on animal distributions

As noted, the Younger Dryas climatic oscillation (ca. 10,800 - 10,300 years B.P.) brought more severe winters to the Northeast. This was expressed as a reduction of temperature and an increase in storminess (wind and precipitation levels). Pollen spectra suggest that tundra conditions returned to many northern woodland settings. In southern New England pine, spruce, and alder forests appear to have replaced those of pine and oak. Climatic oscillations were likely strong, rapid and unpredictable throughout this period. These changes would have affected animal distributions in the region. The remaining Pleistocene megafauna were particularly sensitive to the heightened seasonal contrasts, vegetation changes and likely temperature and precipitation fluctuations as well (e.g., Guthrie 1984). Most probably became extinct in the Northeast at this time. In southern coastal New England, the loss of oak trees and more severe winters would have forced temperate forest species such as deer and some small mammals, already at the limits of their northern ranges 11,000 years ago, to retreat south to milder environments. These changes resulted in an increased tundra-woodland zone in the far north and a broader mixed boreal forest zone in central and southern New England at this time.

Early Holocene fauna

Early Holocene faunal communities in the Northeast are somewhat better understood than those of the terminal Pleistocene. This is partly a result of the increased evidence of animal food remains found in archaeological contexts. Also, a number of northeastern paleontological sites with only limited evidence of Pleistocene fauna have much richer Holocene assemblages. Unfortunately, in many cases it is not possible to clearly separate early Holocene (10,000 - 8,000 years ago) fauna from those of the middle and late Holocene. Many of the animals mentioned from boreal forest settings above are the same as those occurring in the early Holocene. Some new temperate forest dwellers became more common in the region at this time, however. In particular there is better evidence for avian and amphibian species which have not been dealt with until now.

An important comparative find-spot for late Pleistocene and early Holocene fauna of the Northeast is the Hiscock site in western New York state (Laub et al. 1988; Steadman 1988). The Hiscock site is a small, spring-fed peat basin which once contained a marsh. Numerous faunal remains have been recovered from deposits which date between 11,000 and 8,500 years ago. An 8,000 year depositional hiatus ended about 600 years ago when sedimentation was renewed. There is some potential difficulty separating early from Late Holocene sediments, which are indistinguishable in places (Steadman 1988: 95). Despite the complex geomorphological history of the basin (Laub et al. 1988), faunal remains recovered from depths greater than 50 cm below ground surface are likely to be greater than 8,500 years in age (Laub et al. Table 1). The following remains were recovered from within the woody peat zone which began to form at the onset of the Holocene. The site's excavators described this zone as "replete with bones of wapiti [elk] and deer, as well as smaller mammals, turtles, snakes, anurans, and birds" (Laub et al. 1988: 73).

Some faunal remains from the lower peats may be intrusive. These include those of four turtles (snapping, spotted, wood and painted turtles), and a number of frogs. The remains of nine bird species are more likely directly associated with the early Holocene deposits. Of these, wild turkey, ruffed grouse, passenger pigeon, mallard or black duck and wood duck were of potential food value to humans. As mentioned, large mammals included elk and white-tailed deer. Small mammal remains were also common and included southern and northern flying squirrels, gray or fox squirrel, woodchuck, porcupine, snowshoe hare, eastern cottontail and particularly muskrat.

Another important locale for the recovery of early Holocene fauna is the Dutchess Quarry Cave system of Dutchess County, New York. Stratum 2 of Cave One is likely of terminal Pleistocene age (diagnostic projectile points likely dating to ca. 10,500 years B.P. and caribou bones dated to 12,500 years ago were found in this level [Funk and Steadman 1994: 15]). Nonetheless, the presence of temperate forest species suggests that early Holocene elements are incorporated into this level as well. These include (in addition to caribou) elk and deer among the large mammals, and southern flying squirrel, muskrat, raccoon, and striped skunk among the small mammals. Avian species included Canada goose, turkey vulture, and passenger pigeon. Box turtle, snapping turtle, and bullfrog remains represent the reptile and amphibian classes. Sucker, catfish, and sturgeon were also recovered.

Two layers of Cave Eight contain early Holocene faunal and archaeological remains. Stratum 4 has been radiocarbon dated to 8290 ± 100 years B.P. and contained fluted and corner notched point fragments suggesting a mixed assemblage of terminal Pleistocene and early Holocene periods (Funk and Steadman 1994: 31). Dates of 7270 ± 410 and 6480 ± 90 years B.P. were returned from stratum lower 4/upper 3 (Funk and Steadman 1994: 31). It contained corner-notched and stemmed points which suggest ages between 9,000 and 6,000 years ago (Funk and Steadman 1994: 32). The relatively rich faunal remains from these levels included an untyped large cervid and black bear among the large mammals, and eastern cottontail, beaver, eastern chipmunk, red squirrel, southern flying squirrel, woodchuck, muskrat, porcupine, and raccoon among the small mammals (Funk and Steadman 1994: 35, Table 5). Wood duck, black vulture, ruffed grouse, wild turkey, and passenger pigeon represent the larger birds recovered. Excavators also recovered freshwater turtle, large numbers of timber rattlesnake, and unspecified frog bones from these levels.

Further north, the Brigham and Sharrow sites along the Piscatoquis River in central Maine provide further evidence of probable early Holocene human food resources. These floodplain sites contained deeply stratified sediments dating between 10,300 years ago and the present. Early and Middle Archaic levels (ca. 10,000 to 6,000 years ago) at these sites included faunal remains of white-tailed deer, beaver, muskrat, black bear, domestic dog, unclassed large and small mammal, medium and small carnivore, small rodent, unidentified bird, snake, snapping turtle, as well as eel, shad, and probable trout and Atlantic salmon (Petersen 1991; Robinson and Petersen 1992; Spiess 1992). While some of these animals may date later than 8,000 years ago, their presence in central Maine during the Middle Archaic suggests that most of them were present before this time in more temperate regions of southern and central New England. Importantly, the evidence from these sites indicates that a very diverse range of animal food resources was being utilized at this time in the region.

Tables 5.2 through 5.5 summarize the information presented thus far. Most of the animals presented were identified in the paleontological record of the Northeast and adjacent regions, but others are included based on analogy to their modern biotopes. Animals listed in italics became regionally or permanently extinct after the Pleistocene. Selected late Pleistocene and early Holocene animals of the Northeast are pictorially represented in figures 5.3 and 5.4.

Table 5.2

Large Game Fauna of the Northeast Late Pleistocene and Early Holocene

Late Pleistocene North	**Late Pleistocene Central**	**Late Pleistocene South**	**Early Holocene North**	**Early Holocene South**
Horse				
Mammoth	*Mastodon*	*Mastodon*		
Stilt-Legged Deer?	*Stag-Moose*	*Stag-Moose*		
Musk Ox	*Woodland Musk Ox*	*Woodland Muskox*		
Bison	*Giant Ground Sloth*	*Giant Ground Sloth*		
Caribou	Caribou	Caribou	Caribou	Caribou?
	Elk	Elk	Elk	Elk
	Moose	Moose	Moose	Moose
	Giant Beaver	*Giant Beaver*		
	Long-Nosed Pec-cary	*Long-Nosed Pec-cary*		
	Flat-Headed Pec-cary	*Flat-Headed Pec-cary*		
		White-Tailed Deer?	White-Tailed Deer?	White-Tailed Deer

Table 5.3

Small Game Fauna of the Northeast Late Pleistocene and Early Holocene

Late Pleistocene Northern N.E.	**Late Pleistocene Central N.E.**	**Late Pleistocene Southern N.E.**	**Early Holocene Northern N.E.**	**Early Holocene Southern N.E.**
Arctic Ground Squirrel	Flying Squirrel	Flying Squirrel	Flying Squirrel	Flying Squirrel
Arctic Hare	Snow-Shoe Hare	Snow-Shoe Hare	Snow-Shoe Hare	Snow-Shoe Hare
	Beaver	Beaver	Beaver	Beaver
	Muskrat	Muskrat	Muskrat	Muskrat
	Red Squirrel	red squirrel	red squirrel	red squirrel
	Porcupine	Porcupine	Porcupine	Porcupine
	Woodchuck	Woodchuck	Woodchuck	Woodchuck
	Marten, Least Weasel, Ermine, Mink	Marten, Least Weasel, Ermine, Mink	Marten, Least Weasel, Ermine, Mink	Marten, Least Weasel, Ermine, Mink
	River Otter	River Otter	River Otter	River Otter
		Fisher	Fisher	Fisher
		Long-Tailed Weasel	Long-Tailed Weasel	Long-Tailed Weasel
		Striped Skunk	Striped Skunk	Striped Skunk
		Cottontail	Cottontail	Cottontail
		Raccoon	Raccoon	Raccoon
		Gray Squirrel	Gray Squirrel	Gray Squirrel
		reptiles and amphibians ?	reptiles and amphibians	reptiles and amphibians

Table 5.4

Marine and Coastal Resources of the Northeast Late Pleistocene and Early Holocene

Late Pleistocene Northern N.E.	**Late Pleistocene Central N.E.**	**Late Pleistocene Southern N.E.**	**Early Holocene Northern N.E.**	**Early Holocene Southern N.E.**
Estuarine Resources	Estuarine Resources	Estuarine Resources	Estuarine Resources	Estuarine Resources
Sea Mammals	Sea Mammals	Sea Mammals	Sea Mammals	Sea Mammals

Table 5.5

Carnivores and Large Predators of the Northeast Late Pleistocene and Early Holocene

Late Pleistocene Northern N.E.	**Late Pleistocene Central N.E.**	**Late Pleistocene Southern N.E.**	**Early Holocene Northern N.E.**	**Early Holocene Southern N.E.**
Arctic Fox		*American Cheetah?*		
Short-Faced Bear	*Short-Faced Bear*	*Short-Faced Bear?*		
Wolverine	*Wolverine*	*Wolverine ?*		
Dire Wolf	*Dire Wolf*	*Dire Wolf ?*		
Timber Wolf	Timber Wolf	Timber Wolf	Timber Wolf	Timber Wolf
Red Fox	Red Fox	Red Fox	Red Fox	Red Fox
	Mountain Lion	Mountain Lion	Mountain Lion	Mountain Lion
	Black Bear	Black Bear	Black Bear	Black Bear
	Lynx	Lynx	Lynx	Lynx
		Bobcat	Bobcat	Bobcat
		Coyote	Coyote	Coyote

Some general observations can be drawn from tables 5.2 and 5.3. The southern Northeast during the terminal Pleistocene was potentially the region richest in numbers of large and small mammal game resources (total=39). Removing animals that became extinct in the eleventh millennium B.P. reduces this environment to one quite similar to that of the reconstructed early Holocene (with 29 large and small mammals). Estuarine habitats appear to have been established along protected shorelines in southern New England (Gayes and Bokuniewicz 1991). Such settings would have supported an abundance of shellfish as well as the sea mammals which fed upon them. I suggest that the terminal Pleistocene resources of the southern Northeast were quite similar to, and potentially richer than those of the following early Holocene.

In contrast, the environment of the terminal Pleistocene northern Northeast provided a low diversity of potential game. Any predator in this region, including human hunters, would have required a degree of specialization. The apparent dearth of small game mammals suggests that large game must have provided the bulk of necessary animal food nutrients. Plant foods suitable to humans were likely extremely scarce and only seasonally available in this northern region. Certain plant nutrients could, however, be acquired from the predigested stomach contents of large herbivores (Rust 1954: 19-20; 1978: 92; personal communication Krech 1996). On the northern fringe of this region, the Champlain Sea was rich enough to support a diversity of large sea mammal species, some of which may have been harvested by humans.

The early Holocene forests of both the northern and southern Northeast as reconstructed here contained a limited diversity of large game mammals, but an abundance of small game mammals. Between 10,000 and 8,000 years ago, increasing numbers of oak, especially in southern New England, provided an important seasonal food resource for animals such as white-tailed deer, turkey, and bear. Ethnographic and archaeological evidence suggests that processed acorns were also a potentially valuable resource to human foragers (e.g., Baumhoff 1963; Aikens and Akazawa 1996: 224). Additionally, reptiles and amphibians had entered the region and likely became common in and adjacent to wetland settings. The archaeological evidence suggests that anadromous fish species established themselves in the Northeast by this time as well. Species such as shad and salmon would have provided rich, seasonally predictable food resources to humans in the Northeast at this time.

Chapter 6: Model Development

General principles of hypothesis development and model building

The prehistorian's task is to reconstruct, to the best of his or her abilities, a way of life without written record. To accomplish that task, the prehistorian depends upon detailed knowledge of both the archaeological record and pertinent anthropological theory. Model-building is a necessary part of reconstructing lifeways of which the details are severely limited (Dincauze 1996b). Because of the limited nature of available information, modeling the deep past tends to lead to oversimplified, general scenarios, which, while potentially elegant in expression, are typically imprecise (Dincauze 1996b: 421). The challenge, then, is to produce models which, while necessarily general, still provide valuable insights and promote a less simplistic view of the past. Archaeological models should generate testable hypotheses which can be weighed against the archaeological record. Model building by the prehistorian is similar to that of the ecologist. In describing the goals of the ecologist, Eric Pianka states:

> Ecologists want to understand and to explain, in general terms, the origin and mechanisms of interactions of organisms with one another and with the nonliving world. To build such general theories of nature, ecologists construct hypotheses, hypothetical "models" of reality. All models must make simplifying assumptions - some sacrifice precision for generality, whereas others sacrifice generality for precision. Some models actually sacrifice certain aspects of realism itself! Models have been described as mere caricatures of nature designed to convey the essence of nature with great economy of detail. No model is "correct" or "true" - any given model merely represents one particular attempt to mimic reality. All models are to some extent incorrect. To be most useful, models are usually designed to generate testable predictions. Most models can therefore be confronted with reality and can be falsified... Models and hypotheses that do not conform adequately to reality are gradually replaced by those that better reflect the real world. The scientific method is thus self-regulating; as time progresses, knowledge expands and is continually refined and improved to reflect external reality better and better (Pianka 1994: 3).

Similarly, prehistorians develop testable hypotheses grounded in models to better understand the way of life of peoples not known to history. A model very often acts as an explanatory device - that is, it attempts to elucidate processes of the past through the better understanding of the variables which play an integral part in the their expression. It may also be heuristic, that is, it may guide or further future investigations. The archaeologist and prehistorian are concerned with reconstructing the behavior of individuals in the analysis of an archaeological site, as well as placing those individuals in a broader social and economic context. Based upon what is known of the past environment and of the human animal, how can one best, and most succinctly, explain the details observed in the archaeological record as part of a larger social-economic pattern? The following section applies the information detailed in the previous chapters to a model examining the expected response of late Pleistocene and early Holocene hunter-gatherers to the changing environment of the Northeast. At issue is the question, "*How did more than a millennium of drastic environmental change affect human social and economic behavior, and how has this left its mark in the archaeological record?*"

The spatial and temporal scope of the model

This model will look in detail at only two time periods: 10,500 years B.P. and 9,000 years B.P. These dates are particularly relevant. The Younger Dryas cooling episode was near its climax 10,500 radiocarbon years ago. Environmental conditions at this time represent an extreme situation. Humans living in the Northeast faced severe winters and a complex heterogeneous environment in transition from a sub-arctic to temperate condition. Evidence discussed in chapter five indicates that the environment of this period differed dramatically as one traveled from the mixed temperate forests of southern New England to the tundra of the Canadian Maritimes region. Hunter-gatherers living across the Northeast probably had a variety of tactics for coping with these different environments. I have therefore divided the Northeast into three sub-regions: the southern Northeast (Massachusetts, Connecticut and Rhode Island), the central Northeast (Vermont, New Hampshire, and southern Maine) and the northern Northeast (northern Maine and the Canadian Maritime Provinces). These are comparable to the regions used to discuss the northeastern archaeological region in chapter two and the paleoenvironment in chapter five (see Figure 2.1).

By 9,000 years ago conditions were very different. A more homogenous (evenly dispersed) mixed pine-oak forest covered southern New England, while spruce-pine forests and woodlands dominated most of the central and northern regions. Tundra conditions no longer existed in the far north, and the great Champlain Sea had shrunk to within the confines of the St. Lawrence River. The food resources now available to many hunter-gatherer groups were quite different in kind and distribution to those of the late Pleistocene in much of the Northeast. Different economic strategies appropriate to the new conditions impacted human patterns of settlement and social organization, and inevitably the archaeological record of this period.

The previous chapters laid a theoretical framework around which one can begin to make predictions concerning the human response to the environmental conditions prevalent during the times in question. Ethnographic studies indicate that the population density of hunter-gatherers is quite low, especially in cool-temperate to sub-arctic climates such as those of the northeastern Pleistocene/Holocene transition. I assume that the population density of northeastern hunter-gatherers of this time was very low. This assumption is supported by what is known about the coming of humans to the Northeast and the limited potential of hunter-gatherer population growth. Humans likely first entered the region about 11,000 years ago. Even if rates of population growth were relatively high, as might be anticipated among a colonizing group with little inter-specific competition, the 500 years available to humans would have allowed only limited demographic filling of the landscape by 10,500 years ago. A growth rate of 0.005, or half of one percent (five times that believed typical of hunter-gatherers), could have resulted in the increase of an initial population of 100 to over 1,200 individuals in 500 years. This assumes a logistic rate of growth, which is not likely to occur over such extended periods of time, however.

The exogamous, flexible breeding networks typical of hunter-gatherers required mobility across extensive regions to maintain viable long-term populations. These regions might have been as large as southern and central New England combined, or the areas of Maine and the Canadian Maritimes. Based upon the population densities of ethnographically studied northern peoples, such regions might have contained only 200 to 500 individuals (see e.g., Kelly 1995 Table 6-4; Burch 1972). Local groups initiated social contact with others for both short-term survival and long-term reproductive viability. Because of the importance of maintaining social contacts over regions of this scale, residential mobility must have been high, and cultural and technological traits were probably quite similar over most of the Northeast at any given time during the terminal Pleistocene. This situation would have changed over time as local populations increased in size and their social, economic and breeding networks became more constrained. One would anticipate a degree of regionalism in the archaeological record of the Northeast if by early Holocene times groups had adapted to particular local conditions, their degree of residential mobility became lower, and/or contact with others became less frequent.

Local residential foraging group size at any given time should have reflected resource conditions of the immediate micro-habitat. As shown above, where resources are abundant and predictable, large multi-family aggregations might form. Where food resources are of poor quality and broadly distributed, groups must divide into small social units (such as single nuclear families of fewer than 10 individuals) to effectively harvest the resources available. Most often, however, hunter-gatherers should maintain groups of 25 to 35 individuals (2 to 4 extended families). This size range increases the predictability of daily returns without over-taxing important local resources, such as small game, plant foods and fire-wood, as discussed in chapter three.

The degree of mobility should be high overall. Where food is dispersed and predictably located (though it may be of poor quality), it was shown that hunter-gatherers usually follow a foraging pattern in which they locate themselves adjacent to resources across the landscape as they become available. Such groups form many juxtaposed short-term camps with site remains reflecting the harvest and processing of a limited range of local resources. Where resources are of especially scarce, these foraging camps should be very small. Where resources are patchy and poorly predictable (as is gregarious, mobile game), a logistical pattern of residence is expected. In this case, camps are of longer duration and located central to the distribution of the critical resource. Logistical forays to procure the critical resource at a distance and track resource availability support these base-camps. This pattern results in the formation of relatively large, broadly dispersed, long-term sites with a variety of domestic debris, as well as a high number of short-term logistical support camps with a collection of debris reflecting specific tasks and maintenance activities.

Seasonality plays an important role in the type of settlement pattern expressed as in the social organization underlying a settlement pattern's articulation with the conditions of the environment. As resource quality, predictability and distribution change with the seasons, so too must human patterns of residence and mobility. For this reason, a family at one time following an independent, highly mobile foraging pattern might at other times to fuse into a larger, less mobile group supported by logistical teams.

To model the social and economic organization of terminal Pleistocene and early Holocene hunter-gatherers in the Northeast, I will therefore pay special attention to the following aspects of the resource base: ***quality, predictability and distribution*** . To assess the potential range of variability in human behavior as an adaptation to the resource base, I will stress both the effects of seasonality on the resources of a given foraging area and the possibility of using different nearby resource locations at any given time.

Predicting resource conditions of the deep past is fraught with difficulty. In chapter five I reconstructed approximate sub-regional plant and animal communities. While I rely heavily on that reconstruction now, I will make no attempt to predict the importance of a specific resource type. Rather, it is more judicious, given the state of our current understanding of the floral and faunal record, to describe the resource base as generally as possible utilizing the above reconstruction. Thus, the resources of three broad northeastern sub-regions throughout the seasonal cycle are described primarily as rich or poor (a measure of resource density and potential calories per harvest time), predictably or unpredictably located (a measure of resource density, behavior and visibility) and patchily or evenly distributed in space or time. Given these parameters, expectations are drawn concerning the most likely socio-economic organization of hunter-gatherers as expressed by group size, patterns of mobility and predominant food procurement (economic) strategy (collector or forager) as well as the degree of expected resource specialization. I base these expectations on the profitability of a given social-economic organization as suggested by human ecology models discussed in chapter three, with an overt recognition of the existence of comparable excellent (if sub-optimal) solutions to particular problems (see e.g., Kauffman 1995: 248), the constraining effects of historical contingencies, and the stochastic consequences of the human capacity for less than optimal decision making.

Human adaptation to terminal Pleistocene and early Holocene environments of the Northeast

For use in this model, I have set the three variables quality, distribution and predictability as axes which define a resource attribute space in three dimensions. This space is limited by the upper and lower bounding values of each variable, forming a *resource base cube* (Figure 6.1). Quality varies from poor to rich in terms of edible calories per unit harvest and processing time (calories might be substituted with other resource qualities if desired). Distribution varies from dispersed to patchy in space (and potentially in time as well). Finally, predictability varies from unpredictable to highly predictable (in both space and time). Distribution and predictability are both scale-dependent variables. That is, their definitions depend on the size of the region in question and on a period of time as well. As used here, distribution and predictability reflect the qualities of the local economic range (the foraging radius in the case of foragers and the logistical radius for logistical collectors). The limiting time range is a direct function of the duration of occupation within a resource area.

Inherent to the resource base cube are eight corners where all possible maximal and minimal combinations of the three resource variables are expressed. These are defined as the following resource base extremes:

1) unpredictable, dispersed and of poor quality
2) unpredictable, patchy and of poor quality
3) unpredictable, dispersed and of rich quality
4) unpredictable, patchy and of rich quality
5) predictable, dispersed and of poor quality
6) predictable, patchy and of poor quality
7) predictable, dispersed and of rich quality
8) predictable, patchy and of rich quality

Each resource base extreme corresponds to an hypothetical resource base type. Some simplified examples of these are provided in table 6.1 (see also Figure 6.2). In reality, it is difficult to define specific food resources according to the three model variables, as these qualities change seasonally for most resources. It is also difficult to compare resources of widely divergent types, such as tubers, nuts, leafy plant foods, seeds, reptiles and amphibians, birds and other small game, and large game. Most of these actually fall between the extremes modeled by the resource base cube. That is, few are truly predictably or unpredictably located within a given landscape, few are absolutely dispersed or clumped in distribution in space or time, and, by definition, only one resource type can be the most rich or most poor. Some resource types which are not truly poor (a term which might be used only to describe “starvation foods” such as leaves, grasses, and the inner bark of trees) are listed for the sake of clarity. These include plant foods such as aquatic tubers and some nutshells, which can be quite rich, depending on the season of harvest. I have not mentioned other resource types which fall more clearly between rich and poor in quality in these extreme cases. In particular, these include a variety of small mammals available throughout the year and probably of great importance to late Pleistocene and early Holocene hunter-gatherers of the Northeast.

The ecological theory discussed in chapter three enables predictions of the possible human adaptive response to each of these eight conditions. This response is measured in terms of expected *group size*, *degree of mobility* (number of residential moves per unit time), *range of mobility* (distance between residential camps) and *economic pattern* (foraging or collecting). Overall, predictable food resources encourage a planned (scheduled) foraging economy and redundant site use, while unpredictable resources may necessitate a logistical (collector-based) strategy which includes means of tracking resource locations. A dispersed resource base encourages the dispersion of human foragers, while a patchy resource base encourages a degree of aggregation. Poor resource quality results in small group sizes and/or a high degree of mobility, while rich resources encourage aggregation and a degree of sedentism. The combination of these factors results in the eight unique expected human adaptive responses outlined in Table 6.2 (see also Figures 6.3 and 6.4).

Table 6.1

Examples of Resource Base Types

Resource Base Type	Simplified Examples of the Resource Base Type
1) unpredictable, dispersed and of poor quality	mice, voles, some boreal plant foods, small upland reptiles
2) unpredictable, patchy and of poor quality	amphibians in summer, small wetland reptiles, small birds, small freshwater fish
3) unpredictable, dispersed and of rich quality	moose, mastodon and elk in summer forests
4) unpredictable, patchy and of rich quality	deer and caribou in winter forests, moose in winter wetlands
5) predictable, dispersed and of poor quality	various plant foods out of season
6) predictable, patchy and of poor quality	amphibians in mating season, berry patches, aquatic tubers in spring and summer (prior to starch buildup), small nut varieties before ripening, shellfish
7) predictable, dispersed and of rich quality	caribou at spring-summer calving grounds, deer in summer forests
8) predictable, patchy and of rich quality	anadromous fish at falls, caribou at fall migration constrictions

Table 6.2

Resource Base Type and Expected Adaptive Response

Resource Base Type	Expected Adaptive Response
1) unpredictable, dispersed and of poor quality	very small widely dispersed foraging groups with a high degree and range of mobility - possible regional emigration
2) unpredictable, patchy and of poor quality	small widely dispersed groups with a moderate degree and high range of mobility utilizing short-term collector-based camps
3) unpredictable, dispersed and of rich quality	small foraging groups with a high degree and high range of mobility (encounter-based harvest)
4) unpredictable, patchy and of rich quality	collector-based camps with a moderate degree and high range of mobility.
5) predictable, dispersed and of poor quality	small, moderately-dispersed groups following a foraging pattern with a high degree and low range of mobility
6) predictable, patchy and of poor quality	small, widely-dispersed foraging groups with a high degree and range of mobility (short-term harvest camps)
7) predictable, dispersed and of rich quality	collector-based camps with a low degree and high range of mobility
8) predictable, patchy and of rich quality	large aggregation foraging (harvesting) camps with a low degree and high range of mobility

Realistically, the resource base will seldom express these maximal or minimal conditions. The complexity of any environment ensures that a variety of resources of various type and quality will be available to humans at any given time. The true resource base of any environment would occupy an amalgam of space within the resource base cube. Human adaptation to such complex situations is arguably equally complex and variable. Simplifying the resource base to these eight extreme cases, however, clarifies the potential range and variability of human ecological response and allows heuristic modeling. It is now possible to apply the resource base model to the reconstructed sub-regional environments of the late Pleistocene and early Holocene world of the Northeast described in chapter five. The following tables summarize the expected human ecological response to resource conditions in terms of patterns of social and economic behavior. Modeled resource conditions are applied to the three sub-regions of the Northeast for the Younger Dryas period, and for the early Holocene.

Table 6.3

Younger Dryas environmental conditions and Human Adaptations in the Southern Northeast

Climate: The climate was highly seasonal. Summers slightly cooler than today; winters much colder and more severe - stormy with high precipitation (snowy). This indicates a shorter summer growing season than today's. Rapid fluctuations in temperature and precipitation are probable. Unstable climate overall.
Vegetation: Spruce, pine (mixed jack and white likely), fir, alder and birch most common, oak declines (probable relict patches in protected environments). Overall very heterogeneous, but well-forested.
Fauna: Pleistocene megafauna rare or already extinct, large-game included primarily elk, moose, black bear and probably woodland caribou. Small game was relatively diverse (snow shoe hare, beaver, muskrat, red-squirrel, porcupine, woodchuck, river otter, marten, weasel and mink). Coastal resources likely plentiful in Long Island Sound and the Narragansett Bay (shellfish and sea mammals are expected). The presence of anadromous fish is unknown, but not unlikely. Overall, game was diverse (heterogeneous) but scattered. Large game were primarily non-gregarious in summer, with possible small aggregations of woodland caribou in late fall and spring. Some yarding of elk and caribou can expected in winter months in the interior. Possibility of calving grounds along the Long Island Sound estuary. Small game populations were more sensitive to environmental changes, and may have fluctuated drastically with shifting climatic conditions. This suggests that small game were not especially stable or predictable.
Spring and summer adaptations: Coastal resources were easily harvested, and possibly predictable. Caribou was likely dispersed, but could have been focused within coastal calving areas, if these were present. These conditions would have supported moderate aggregations (multi-family groups) in seasonal residential camps (type 7). Coastal camps were likely supported by small, interior logistical hunting camps focused on moose, elk and small game. Interior land use would have most likely been on a foraging basis with small (single family) highly mobile, short-term camps (type 3).
Fall and winter adaptations: The interior uplands would have been more protected from winter storms. Snow may have been deep at times, hindering mobility. Large game (woodland caribou, elk, and moose) were dispersed, and of low-density, though wetlands may have attracted moose. Small game provided the highest fat content and best pelts in late fall and early winter. Camps were probably small (extended families), and should have been supported by logistical hunting (type 4). Residential movements were limited by climatic conditions.
Overview: The highest degree of mobility is anticipated in spring and fall during movements to different resource areas (coastal/estuarine to the upland interior). Population density was likely quite low, mobility and social contacts were most likely wide-ranging. Potential band-range extended from the Hudson Valley to the Boston Basin, and possibly north to lower reaches of the Champlain Sea basin. Quarry areas in the Hudson Valley, Boston Basin and southern Champlain Basin could have served as information sharing locations (predictable resource locations common to most local groups).

Table 6.4

Younger Dryas environmental conditions and Human Adaptations in the Central Northeast

Climate: The climate was highly seasonal. Summers slightly cooler than today, winters much colder and more severe - stormy with high precipitation (snowy). This indicates a shorter summer growing season than today's. Rapid fluctuations in temperature and precipitation are probable. Unstable climate overall.
Vegetation: Heterogeneous woodland of spruce, poplar, jack pine, fir, alder and birch, becoming more open with increasing latitude, distance from Champlain Sea and Atlantic coastlines, and with increasing elevation. Treeless conditions were probably extensive within the White Mountains.
Fauna: Pleistocene megafauna were rare or already extinct, large-game included primarily elk, moose, black bear and woodland caribou. Small game was relatively diverse (snow shoe hare, beaver, muskrat, red-squirrel, porcupine, woodchuck, river otter, marten, weasel and mink). Coastal resources along the Champlain Sea margin were likely plentiful (shellfish and sea mammals are documented). The presence of anadromous fish is unknown, but possible. Overall, game were diverse (heterogeneous) but scattered. Large game were primarily non-gregarious in summer, with probable aggregations of woodland caribou in late fall and spring. Some yarding of caribou and elk is expected during the winter months in the interior. Possible caribou calving grounds along coastal areas of the Champlain sea to the north, and the Boston Basin to the south. Elk and caribou may have aggregated in the White and Green Mountain uplands where wind kept vegetation free of snow in winter months. Small game populations were more sensitive to environmental changes, and may have fluctuated drastically with shifting climatic conditions - they were not especially stable or predictable.
***Spring and summer adaptations*:** The most predictable resources were found along the Champlain Sea coastline, and possibly the southern Gulf of Maine, with diverse coastal marine resources (shellfish, fish, and especially sea mammals including seal). Coastal areas were also a likely location for woodland caribou calving grounds where herds were dispersed, but relatively predictable and consistently within the region. Such a resource base would have supported seasonal aggregate camps of 2 to 4 (or possibly more) families supported by logistical upland/interior hunting camps (with a possible focus on moose and elk) (type 7). Elk hunting could have been particularly successful in the mountainous, more sparsely vegetated White and Green Mountain highlands. Hathaway (Champlain Basin) chert outcrops might have been an attractor for camp locations (both aggregation and logistical). Interior/upland land-use was possible on a foraging basis in dispersed, highly mobile single-family camps (type 3).
***Fall and winter adaptations*:** Possible large, short-term aggregation camps for communal caribou hunting in restricted valley settings along woodland caribou routes to the interior/upland regions (type 8). The instability of climate and herd patterns hindered long-term reuse of most locations (migration routes might have been difficult to predict). More secure hunting was available from collector residential camps (type 7) in sheltered interior locations (centrally located to caribou dispersion) such as large wetland margins and the Connecticut River valley where temperatures and snowfall were more moderate. Heavy winter snow fall would have hindered residential mobility. Camps were thus less mobile and required logistical support and/or low group numbers to avoid overtaxing local resources (one to two families expected) (type 4).
Overview: Highest mobility rates are again anticipated during spring and fall during movements between resource areas (Champlain Sea/Boston Basin coast to the interior upland). Possible band range extended from the upper Hudson Valley (Coxsackie) east to the Boston Basin and Saco River drainage, northwest to the Champlain Sea coastline, and northeast to the White Mountains, upper Connecticut River lakes. Overall, site reuse is anticipated to be minimal as a result of low population density and widespread under-exploited resource locations. Possible exceptions include quarry areas, ideal caribou hunting locations and rich summer coastline locations (e.g., ecotonal river mouths). Quarry areas in the Hudson Valley and southern and northern Champlain Basin, Mt. Jasper in New Hampshire, and Boston Basin might have served as information sharing locations (predictable resource locations common to most local groups).

Table 6.5

Younger Dryas environmental conditions and Human Adaptations in the Northern Northeast

Climate: Highly seasonal climate. Summers slightly cooler than today, winters much colder and very severe – moist and cold.- stormy with high precipitation (snowy). This indicates a much shorter summer growing season than today's. Rapid fluctuations in temperature and precipitation are probable. Unstable climate overall.
Vegetation: Open woodlands (taiga) of spruce, dwarf birch and jack pine, with sedges common. Tundra-like conditions return to the Canadian Maritimes region in the far north and the interior upland of northern Maine. Increased erosion affects edaphic conditions, hindering plant regrowth.
Fauna: Pleistocene megafauna rare or already extinct, large-game included primarily cold-adapted caribou and perhaps musk ox. Small game were relatively sparse (arctic hare and arctic ground squirrel). Coastal resources along the northern Gulf of Maine and Champlain Sea estuary were probably patchy and sparse as a result of rapid sea level change. The presence of anadromous fish is unknown, but intermittent heavy silting of many rivers may have hindered spawning. Overall, game diversity was very limited, but large aggregations of caribou were probably common in late fall and spring. Some yarding of caribou is expected in winter months in the interior. There is a possibility of calving grounds along coastal areas of the Champlain Sea estuary and along the Maritimes coastline. Caribou herds probably shifted ranges often as a result of fluctuating climatic and environmental conditions. Caribou migration patterns were probably not predictable over the long-term (decades), but caribou may have provided a rich seasonal resource when available.
***Spring and summer adaptations*:** Caribou herds were possibly quite large during early-spring migration from the central New England forests to the northern Tundra and coastal breeding ground locations. Good potential existed for aggregated caribou-hunting camps of large size at restriction points along possible herd routes. Human groups may have positioned themselves at herd-crossing locations during spring migrations for communal hunts (type 8 with as many as twelve family groups), then disbanded into smaller (two to four family) groups for mobile logistic hunting in the tundra-taiga interior and northern regions (type 3). During late-spring and summer, caribou were likely dispersed, but predictably located in certain regions (such as calving grounds). Such locations might have been focused on high ground and coastal areas with high winds to avoid bot-fly and other biting insect swarms. This resource distribution would have promoted type 7 medium-term collector camps of two to four families. Coastal resources were probably patchy (many areas were likely heavily disturbed by the rapidly shifting coastline). Isolated areas (now inundated) might have provided rich coastal resources for a number of generations. This suggests the possibility of seasonal coastal camps (type 7). Anadromous fish harvests were possibly negatively impacted by high silt loads throughout much of the Younger Dryas (especially during the spring thaw).
***Fall and winter adaptations*:** Regrouping was probable during the fall migrations at anticipated caribou herd crossings (type 8). Food storage and caching behavior is expected at such camps. Winter conditions and limited resource availability probably hindered year-round settlement of many far northern tundra areas. Migration (regional emigration) to sheltered (forested) interior northern, central or even southern New England areas where logistically supported winter camps resembled those described for those regions are anticipated (types 4 and 7).
Overview: Potential bi-annual aggregations for short-term, highly productive specialized caribou hunting. Aggregations might have included members of groups focused primarily on southern and/or central New England. The patchy distribution of mobile game at other times promoted 2-4 family groups at central locations supported by logistical camps. Seasonal emigration during the most severe winter months is possible. Once colonized, the New Brunswick/Nova Scotia area might have maintained a local population which took advantage of open tundra regions during summer months and migrated to sheltered, more forested (interior or southern coastal) areas during the winter. Lithic resources include Mt. Jasper, New Hampshire, Boston Basin volcanics, Ledge Ridge cherts, Munsungen Lake cherts, Minas Basin chalcedonies, and St. Lawrence Valley Ordovician cherts.

Table 6.6

Early Holocene environmental conditions and Human Adaptations in the Southern Northeast

Climate: The climate was still highly seasonal. Summer temperatures were about the same as those of today, winter temperatures were 2 to 4 degrees C cooler. The climate is estimated to have been significantly drier than that of today.
Vegetation: Primarily white pine and oak forest with fir, birch, poplar, ash, larch, ironwood, elm, maple and hemlock.
Fauna: Small game animals were very diverse (including cool-temperate beaver, muskrat, red-squirrel, porcupine, woodchuck, river otter, marten, weasel and mink as well as warm-temperate species such as fisher, long-tailed weasel, striped skunk, cottontail, raccoon and gray-squirrel). Reptiles and amphibians are presumed to have become more plentiful with warming conditions, as well as a variety of birds such as passenger pigeon, ducks and geese. Large game mammals had become less diverse. Woodland caribou had probably migrated north where spruce lichen were still available. Elk, black bear and moose remained as the prime game species. White-tailed deer might have been present, but likely in low numbers until true mast forests developed between 8,000 and 6,000 years ago. Coastal resources likely remained plentiful (shellfish and sea mammals are expected). The presence of anadromous fish is now likely. Overall, small game were diverse (heterogeneous) and large game primarily non-gregarious and scattered. Forests were still in transition (oak increasing at the expense of white pine), but in a more steady manner. Climate and vegetation changes were less severe, and animal populations (in particular small game) probably fluctuated less than during the Younger Dryas.
***Spring and summer adaptations*:** Coastal resources (fish, shellfish and marine mammals) were probably more predictable than inland large game. Conditions would have supported moderate aggregations (multi-family groups) in seasonal camps (type 7), especially at major river mouths. Probable anadromous fish camps would have been located at falls (type 8). Sea level was still 25 - 30 m below that of today, so river gradients were steeper, and many early Holocene falls may now be inundated. Coastal camps were still likely supported by interior logistical hunting camps focused on moose, elk and small game hunting. Interior land use was more likely on a forager-like basis with high mobility and short-term small (single family) camps (types 3 and 5).
***Fall and winter adaptations*:** The interior uplands would have been more protected from the weather, though this was somewhat less important than it had been during the Younger Dryas. Snow may not have been a major impediment to mobility. Large game (elk, moose and perhaps deer) should have had a patchy distribution, and low-density. Wetlands may have attracted moose, and deer would have yarded up. Small game provided the highest fat content and best pelts in late fall and early winter, and were likely more predictably located than during the Younger Dryas. Residential camps were probably small (extended family-sized), and should have been supported by logistical hunting (type 4).
Overview: The highest degree of mobility is still expected in spring and fall during movements to different resource areas (coastal/estuarine to the upland interior). Population density likely remained quite low. Band-range may not have changed significantly and mobility and social contacts may still have been wide-ranging (from the Hudson Valley to the Boston Basin, possibly north to the lower reaches of the Champlain Sea basin), though certain resource-rich regions might have supported smaller-ranging bands - such as the Long Island Sound coastal estuary and the Boston Basin. Quarry areas in the Hudson Valley, Boston Basin and southern Champlain Basin might have continued to serve as information sharing locations (predictable resource locations common to most local groups).

Table 6.7

Early Holocene environmental conditions and Human Adaptations in the Central Northeast

Climate: Both summer and winter temperatures were close to those of today. Precipitation levels were also comparable, although evaporation rates were possibly greater.
Vegetation: Heterogeneous forests of spruce, birch, and pine with lesser quantities of poplar, jack pine, elm, larch, ironwood, ash, fir, oak and maple. Forests graded to woodland at high elevations.
Fauna: Large-game included primarily elk, moose, black bear and probably woodland caribou. Small game were relatively diverse (snow shoe hare, beaver, muskrat, red-squirrel, porcupine, woodchuck, river otter, marten, weasel and mink). Some coastal resources were probably available along the southern Maine - New Hampshire coast (shellfish and sea mammals), though sea-level change was still quite rapid in the Gulf of Maine. Anadromous fish were probably present. Overall, game was diverse but scattered. Large game were primarily non-gregarious in summer, with probable aggregations of woodland caribou in late fall and spring. Some yarding is expected in winter months in the interior, and there is a possibility that calving grounds were located along coastal areas of the St. Lawrence drainage to the north. Elk and caribou may still have aggregated in the White Mountain uplands where wind kept vegetation free of snow in winter months. Small game populations were more stable than they had been during the Younger Dryas.
***Spring and summer adaptations*:** The most predictable resources were probably located along the St. Lawrence river (shellfish, anadromous fish, some sea mammals) and possibly the Lake Champlain margin. The St. Lawrence drainage was also a likely location for woodland caribou calving grounds (herds would have been dispersed, but relatively predictable and were consistently within the region). Such a resource base would have supported seasonal aggregate camps of 2 to 4 families supported by logistical upland/interior hunting camps, with a possible focus on moose and elk (type 7). Anadromous fish harvesting camps might also have been utilized (type 8). Elk hunting could have been particularly successful in the mountainous, more sparsely vegetated White and Green Mountain highlands. Hathaway chert outcrops might have been an attractor for camp locations (both aggregation and logistical). Interior/upland land-use was possible on a foraging basis in dispersed, highly mobile single-family camps (types 3 and 5).
***Fall and winter adaptations*:** Possible short-term aggregation camps for communal caribou hunting in restricted valley settings could have been located along woodland caribou routes to the interior/upland zones in northern regions at woodland - forest edges (type 8). The increased stability of climate might have promoted more stable and predictable herd patterns and promoted a degree of site reuse. Interior hunting was possible from residential camps in sheltered interior locations (centrally located to caribou dispersion) such as large wetland margins and the Connecticut River valley where temperatures and snowfall were more moderate (type 7). Other large game (especially moose and deer) would have been less predictably and more patchily located promoting more mobile collector camps (type 4). Winter conditions might have hindered residential mobility, however. Less mobile camps required low group numbers to avoid overtaxing local resources (one to two families are expected).
Overview: The highest mobility rates are again anticipated in the spring and fall during movements between resource areas (St. Lawrence drainage to the inland/upland). Overall, interior site reuse should have been minimal as a result of low population density and widespread unused resource locations. Possible exceptions include quarry areas, ideal caribou hunting locations and rich summer riverine and lacustrine locations (e.g., river-coast ecotones). Quarry areas in the Hudson Valley and southern and northern Lake Champlain Basin, and Mt. Jasper in eastern New Hampshire might have served as information sharing locations (predictable resource locations common to most regional groups).

Table 6.8

Early Holocene environmental conditions and Human Adaptations in the Northern Northeast

Climate: Summers were on average somewhat cooler than those of today. Winters were comparable to today's. Precipitation was also about the same, although evaporation rates were possibly greater.
Vegetation: NorthernMaine and the southern Canadian Maritimes supported a mixed jack pine-birch, fir, spruce, poplar forest, trending to more open woodland northward.
Fauna: Small game were relatively diverse in the forests (snow shoe hare, beaver, muskrat, red-squirrel, porcupine, woodchuck, river otter, marten, weasel and mink). Coastal resources along the northern Gulf of Maine were probably still patchy and sparse as a result of rapid eustatic sea level rise, although anadromous fish were likely present. Woodland caribou, black bear, elk and moose were the dominant large game mammals present. There were probable migrations of caribou in late fall and spring from the forest/woodland interior to northern coastal regions. Calving grounds were most likely located along coastal areas of the St. Lawrence River estuary. Caribou herd ranges were possibly more predictable than during the Younger Dryas as a result of less dramatic climate changes. This might have led to a degree of site reuse at ideal caribou hunting locations. Caribou and probably anadromous fish would have provided rich seasonal resources when available.
***Spring and summer adaptations*:** Caribou herds were possibly quite large during early-spring migration from central and northern New England forests to the far northern tundra coastal breeding ground locations. Caribou were likely dispersed, but predictably located in certain regions during the late-spring and summer (such as high ground and coastal areas with high winds to avoid bot-fly swarms). Human groups may have positioned themselves at herd-crossing locations during spring migrations for communal hunts (large, seasonal residences of type 8), then disbanded into smaller (2-4 family) groups for mobile logistic hunting in the forested interior or northern coastal area (type 7). Coastal resources were probably patchy (many areas were still heavily disturbed by the rapidly shifting coastline). Isolated areas might have provided coastal resources for a number of generations. This suggests the possibility of seasonal coastal camps (type 7) or smaller coastal foraging locations (type 6). Anadromous fish harvests were probably seasonally important and might have promoted aggregation sites at ideal locations (type 8), such as falls.
***Fall and winter adaptations*:** Regrouping probably occurred during fall caribou migrations at expected herd crossings. Food storage and caching were probable at such locations (type 8). Winter conditions and resource quality may have hindered year-round settlement of many far northern areas (type 1). Movement to sheltered interior forested areas where winter camps resembled those described for central New England is expected (types 4 and 7).
Overview: Bi-annual or annual aggregations for short-term, highly productive caribou hunting seem likely. Annual aggregations for various anadromous/catadromous fish can also be expected. The patchy distribution of mobile game at other times promoted 2-4 family groups at central locations supported by logistical camps. Lithic resources include Mt. Jasper, New Hampshire, Ledge Ridge cherts, Munsungen Lake cherts, Minas Basin chalcedonies, St. Lawrence Valley Ordovician cherts, and Ingonish Island siliceous shale (Keenlyside 1991: 169).

Central points of the application of the resource response model

The above predictions concerning terminal Pleistocene and early Holocene hunter-gatherer social and economic organization in the Northeast suggest the following:

1) Patterns of social and economic organization should vary at the sub-regional level based on anticipated differences in the resource base and environment.
2) Seasonal variation in patterns of social and economic organization should be strong in all cases. Like most hunter-gatherers, northeastern populations were likely organized most often into groups of 20 to 30 individuals, although smaller and larger groupings likely occurred under certain conditions. Small groups following collecting or foraging economic patterns should have aggregated into large foraging camps when local resources were both rich and predictable.
3) Even within a given season and sub-region, a number of possible approaches to a profitable exploitation of the various resource bases are anticipated. Thus, coastal resource exploitation may have led to one pattern of social organization and mobility, while inland resource use may have led to quite another, equally feasible pattern. It is also expected that people used both coastal and interior resources at the same time. It is thus unlikely that hunter-gatherers of this period were limited to a particular resource harvesting strategy (e.g., "focal" or "diffuse") or a particular habitat, such as the spruce parkland. In fact, as Curran (1987) also noted, strategic flexibility in economic and social organization would have been necessary for survival during this period of rapid environmental change.
4) In all scenarios, more than one sub-region was probably used during an annual economic cycle by a given group. This pattern provided the broadest range of options in terms of resource choice and in the timing of the harvest cycle. This would have been of particular importance during the Younger Dryas period when economic and social flexibility were likely necessary for survival.
5) During certain seasons, sub-regions (or parts of sub-regions) may have been entirely abandoned by humans. This pattern may apply to greater periods of time as well, suggesting the possibility of local emigration from some areas over extended periods of time.
6) Stabilization of the climate during the early Holocene probably led to the development of a more predictable resource base in terms of the timing and location of harvests. This is expected to have resulted in more redundant site use.
7) The shifting ranges of caribou and deer, both considered to be important seasonal food resources during the early Holocene, might have led to increased seasonal reliance on small

game and plant foods. This would be particularly pertinent if there was a lag time in the spread of deer population after caribou had become scarce in certain areas. This could have resulted in increased numbers of small, short-term foraging camps, especially during spring and summer months.

Caveats

In addition to these central points, there are a number of caveats which should be mentioned. These factors limit the predictive capacity of the resource response model as it now stands. Most of the following problems relate directly to our limited knowledge of the environment during the period in question. The following is a list of questions pertaining to missing information of significance to the above model and of great importance to future research.

1) When and where do anadromous and catadromous fish runs begin, and how rich were they?
2) What was the nature of coastal resources in all of the sub-regions? Were there seal species in southern New England and coastal Maine? How plentiful were shellfish and marine fish, and how important were these to the diet of late Pleistocene and early Holocene hunter-gatherers?
3) How dependent were human groups on plant foods and which types were utilized (e.g., starchy wetland tubers such as cattail root, or difficult to process nuts such as acorns)?
4) What was the actual distribution and density of caribou populations in the Northeast during the terminal Pleistocene and early Holocene? How did it vary from south to north and over time?
5) When did white-tailed deer enter the Northeast and when did it become an important resource?
6) What were the Pleistocene and early Holocene densities and distributions of bison, musk ox and elk?
7) How significant was water transportation, and how might it have facilitated movement and resource acquisition?
8) Did the earliest inhabitants of the Northeast utilize extinct large mammal species such as mastodon, mammoth, horse, peccary, giant beaver, ground sloth, stag moose, stilt-legged deer and musk ox, or had these vanished from the region before the entrance of humans?

Many of these questions may be answered in the years to come. As they are, the appropriateness of the modeled human responses to the resource base as presented above can be better assessed. Despite an imperfect understanding of the Northeast's paleoenvironmental conditions, I believe the preceding abstract sub-regional habitat reconstructions provide enough information to allow application of the model. The central points resulting from the application of the model emphasize the importance of flexible and diverse economic and social responses to the various habitats of the Northeast at the regional, sub-regional and local levels during the periods in question.

The expression of adaptational diversity plays an important role in the following chapter which will examine the archaeological implications of the modeled settlement and social organization of the terminal Pleistocene and early Holocene. Of primary concern are site size, site location, site re-use and assemblage variability. The ways in which each of these variables affects the visibility of the archaeological record will also be considered. I will show that the current archaeological record of the northeastern terminal Pleistocene and early Holocene is significantly biased towards the most visible sites and is probably a poor indicator of the true range of social-economic variability once expressed.

Chapter 7: Archaeological Implications of Modeled Settlement and Social Organization

Application of the model presented in chapter six suggested patterns of residential and economic organization for two periods (10,500 and 9,000 B.P.) in three sub-regions of the Northeast. Chapter four discussed ways in which such patterns might manifest themselves in the archaeological record. This chapter will now look at the regional archaeological implications of the settlement and social-economic patterns suggested by the resource response model. I intend to demonstrate that the current archaeological record of the Northeast reflects only a limited range of the full spectrum of site types expected for this period.

For each of the eight resource base types defined above there was an expected adaptive response (Figure 6.4). Each of these ecological responses to the resource environment is also expected to result in archaeological traces reflecting group size, degree of mobility, duration of occupation, economic pattern (foraging or collecting), and specific on and off-site activities, as reviewed in chapter four. Table 7.1 reflects the expected settlement type and potential archaeological signatures of each resource base type.

As stated above, these resource base types reflect extremes in the domain of all possible types. Actual prehistoric resource bases would lie somewhere between these extremes within the three-dimensional space which they define. As such, the archaeological manifestations of past site types should also to fall between or combine aspects of those defined by the model. These extreme values provide, however, a simplified framework onto which can be applied the modeled social and economic patterns for the sub-regions of the Northeast discussed in the previous chapter. The following summarizes the expected archaeological traces of modeled settlement, social, and economic patterns for each sub-region during the mid-eleventh and tenth millennia before present.

Table 7.1

Resource Base Type and Expected Settlement Type and Remains

Resource Base Type	Expected Settlement Types and Remains
1) unpredictable, dispersed and of poor quality	numerous single locus, widely-dispersed transit foraging camps (~1 day duration), a very low number and diversity of artifacts or none at all, reoccupation unexpected
2) unpredictable, patchy and of poor quality	numerous single locus short-term residential collector camps (1 day to 1 week duration), very low number and diversity of artifacts, nearby foraging locations with few or no artifacts, reoccupation unexpected
3) unpredictable, dispersed and of rich quality	numerous single locus short-term residential foraging camps (1 day to 1 week duration), moderate to low number and diversity of artifacts, nearby foraging locations with few or no artifacts, possible nearby kill sites and tool rejuvenation locations with debitage and tool discards, reoccupation unexpected
4) unpredictable, patchy and of rich quality	medium-term (1 week to 1 month) residential collector camps with 2 to 4 artifact loci representing individual residence locations, a high number and high diversity of artifacts, numerous (2-4 per day) nearby foraging locations with few or no artifacts, logistical camps with low number and diversity of artifacts, kill/butchering sites, tool rejuvenation locations with debitage and tool discards, reoccupation unexpected
5) predictable, dispersed and of poor quality	numerous short-term single locus residential foraging camps (1 day to 1 week duration), moderate to low number diversity of artifacts, nearby foraging locations with few or no artifacts, reoccupation possible
6) predictable, patchy and of poor quality	widely-dispersed short-term single locus residential foraging camps (1 day to 1 week duration), very low number and diversity of artifacts reflecting a specific processing task, nearby foraging locations with few or no artifacts, reoccupation possible
7) predictable, dispersed and of rich quality	widely-dispersed medium-term (1 week to 1 season duration) residential logistical camps with 2 to 4 artifact loci representing individual residence locations, a high number and high diversity of artifacts, numerous nearby foraging locations with few or no artifacts, many logistical camps with low number and diversity of artifacts, kill/butchering sites, tool rejuvenation locations with debitage and tool discards, local and dispersed tool caches, possible redundant site use, reoccupation possible
8) predictable, patchy and of rich quality	rare medium-term (1 week to 1 month) large residential foraging camps with numerous artifact loci representing individual residence locations (~5 to 10, or more) and activity areas, a high number and high diversity of artifacts - although processing tools related to the focus of harvest should be most common, numerous nearby foraging locations with few or no artifacts, possible dispersed logistical camps with low number and diversity of artifacts, kill/butchering sites, tool rejuvenation locations with debitage and possible tool discards, local and dispersed tool caches, probable redundant site use, reoccupation probable

Before examining the archaeological implications of modeled settlement and social organization patterns for these two periods, it will be helpful to quickly review the expected seasonal adaptations of each sub-region. Table 7.2 condenses the settlement and economic patterns described in the previous section:

Table 7.2

Expected Settlement and Economic Types

Sub-region and Season	Younger Dryas Settlement and Economy	Early Holocene Settlement and Economy
southern Northeast spring-summer	southern coastal: collector 7 interior/upland: forager 3	southern coastal: collector 7 anadromous fish: forager 8 interior/upland: forager 3, 5
southern Northeast fall-winter	interior/upland: collector 4	interior/upland: collector 4
central Northeast spring-summer	northern coastal: collector 7 interior/upland: forager 3	northern estuarine and lacustrine: collector 7 anadromous fish: forager 8 interior/upland: forager 3, 5
central Northeast fall-winter	caribou drive: forager 8 interior/upland: collector 4, 7	caribou drive: forager 8 interior/upland: collector 4, 7
northern Northeast spring-summer	caribou drive: forager 8 northern coastal: collector 7 interior/upland: forager 3	caribou drive: forager 8 northern coastal: collector 7, forager 6 interior/upland: collector 3 anadromous fish: forager 8
northern Northeast fall-winter	caribou drive: forager 8 interior/upland: forager 4 tundra zone: possible emigration	caribou drive: forager 8 interior/upland: collector 4, 7 taiga zone: possible emigration

The expected archaeological manifestations for each sub-region can now be detailed based upon the modeled settlement and economic types.

Expected archaeological patterns for the Younger Dryas (ca. 10,500 years B.P.)

The southern Northeast

spring and summer sites

Southern New England spring and summer coastal collector residences (type 7) should have produced many widely-dispersed sites. Most of these sites should reflect occupation periods of between one week and one month. One can anticipate two to four concentrations of artifact material, each reflecting the location of a single residence within a multi-residence site. The model anticipates both a high number and high diversity of artifact types. These should increase with occupation duration, the number of distinct activities performed on site (which may also reflect resource diversity), and reoccupation.

These sites should be associated with logistical camps located within about five to twenty km in the nearby interior. Such sites should contain a low number and diversity of artifacts reflecting limited activities. Few of these logistical sites should show signs of reoccupation because they would be associated with specific qualities of a micro-habitat which change rapidly over time. Logistical camps may be associated with nearby kill sites, tool caches and tool rejuvenation locations.

Foraging locations should be extremely numerous, especially if the residential area were reoccupied. Such sites would be located within five km of the residential site. They may contain a few artifacts associated with resource harvesting and field processing, but may contain no artifacts at all.

Longer term and repeated occupation base camp sites (seasonal type 7) might be expected at riverine/estuarine confluences (ecotones) where the broadest variety of resources were available. Because of the limited number of such locations, these sites have a high probability of site reuse. They should contain complex, mixed assemblages (palimpsests) reflecting a wide variety of on-site activities, possibly recurring intermittently over generations.

Southern New England spring and summer interior residential sites should reflect activities associated with small foraging camps (type 3). Depending upon the length of occupation, these potentially single locus sites should contain a moderate to low number and diversity of dispersed artifacts (reflecting activity both inside and outside of temporary living structures). Associated off-site foraging locations may be located within a short distance, but may contain no artifacts, as processing is more likely to have occurred at the nearby residence. Nearby tool rejuvenation locations and kill/butchery sites with a small number of discarded tools and debitage may also be associated. Site reuse is not anticipated, although many such sites may be found within a small, sheltered, productive region, such as a wetland basin, lacustrine setting or river valley.

fall and winter sites

Southern New England fall and winter sites might have been limited to sheltered interior locations. These areas would have supported residential collector camps (type 4) of one week to one month occupation. Residential camps should contain between two and four dense artifact loci each including a high number and diversity of artifacts. Artifact distribution was likely constrained by shelter walls and should reflect primarily interior domestic activity. Living structures should have been more durable than those of warm weather months.

Associated foraging locations were probably limited to small mammal hunting, wetland tuber collecting and possibly nut harvesting. These very small sites should be located close to the residence and may contain very few to no artifacts.

A number of logistical hunting camps located between roughly five and twenty km distance would have supported the residential site. Hunting camps should contain a low number and diversity of artifacts. Kill/butchery sites, as well as tool rejuvenation locations are also anticipated and may contain a few tool discards and debitage.

Southern northeastern Younger Dryas site visibility

The largest sites from the Younger Dryas of southern New England should have been located in coastal and riverine/estuarine locations. It is probable that all of these areas are now inundated, eroded or deeply buried by marine silts and alluvium. Thus, the potentially richest sites of this period are currently out of the reach of standard archaeological methods. Underwater archaeology, or deep, wet-site river-bank excavations are required to recover those sites not already destroyed by natural geological processes.

Sites more readily located include summer foraging and winter collecting camps, along with their associated support sites. The most visible of these are the larger winter collecting camps. Foraging camps, logistical hunting camps, foraging locations, kill/butchery sites, tool rejuvenation locations and caches are so small and are likely to contain so few artifacts that they may be archaeologically invisible using standard survey methods. Only high-density surveys (with grid intervals of less than five meters and 1/8 inch mesh screen recovery) are likely to recover such sites. Even when excavated, many of these may go unrecognized because of a probable lack of diagnostic materials.

The central Northeast

spring and summer sites

Spring and summer sites should be similar to those of southern New England, as are their archaeological traces. The most significant difference is that central northeastern coastal sites were located along the southern margin of the Champlain Sea, rather than the estuarine settings of Long Island Sound and the Narragansett Bay. The character of the resource base was probably different along the Champlain coastline. Faunal evidence from this area suggests that sea mammal hunting might have been important, and this could be reflected in the tool kits of coastal collector residential camps.

Spring and summer sites reflecting interior/upland land use based on highly mobile foraging should be similar to those described for southern New England. These small sites should contain a low density and diversity of artifacts reflecting short-term stays and a limited range of on-site activity. Nearby foraging locations may contain few or no artifacts. Tool rejuvenation and kill/butchery sites containing resharpening debris and few or no discarded tools may be located in the vicinity.

fall and winter sites

Fall and winter residential sites should have included collector-based camps (type 4) and their associated support sites as described for southern New England. Longer-term, possibly larger collector camps (type 7) may also have been used. These camps should have produced a large number and diversity of tools. They would be marked by multiple (two to four), high-density artifact loci reflecting individual residence locations and primarily interior tool use activity. Because these sites were likely of longer duration, they should have produced more numerous foraging and logistical camp locations in the area. For the same reason, fewer of the type 7 residential sites should exist. Low population density allowed hunter-gatherers to utilize the most productive habitats available. Therefore, site reuse is not anticipated because recent inhabitants would have sapped many valuable local resources, such as firewood. However, people might have reused highly productive and sheltered areas (such as wetland basins and valley bottoms) as mentioned above.

The model anticipates fall woodland caribou drive aggregation camps in addition to the collector camps. Such sites were likely positioned at restriction points along paths of caribou movement between upland and lowland areas. The limited number of such locations would have promoted site reuse. The degree of reuse would have been reduced if patterns of movement were highly unpredictable, as they might have been during the Younger Dryas because of severe climate fluctuations. These sites may contain five to ten discrete residence locations, or many more superimposed locations if Paleoindians revisited the same location. Artifacts should reflect a broad range of activities, however we can anticipate that those related to the caribou hunt (such as projectile points and processing tools) to be most common. Food storage facilities such as meat caches and storage racks are expected (see Binford 1990). Nearby foraging locations should be numerous and similar to those described for the southern Northeast. Based on ethnographic analogy, an extensive kill site is expected a short distance from the residence location (~100 to 300 meters) (Binford 1991). This location might contain damaged and discarded hunting gear and possibly initial-stage processing tools. Special drive features, such as stone cairns or stone lines might also be present.

Logistical hunting camps may have supported caribou migration camps, especially if drives were less successful than anticipated. These would be similar to those described above, and might be associated with kill/butchery, tool rejuvenation, and cache locations.

Central northeastern Younger Dryas site visibility

Northern coastal residence locations along the Champlain Sea should be more visible than comparable coastal locations in southern New England, because isostatic rebound and the drainage of the Champlain Sea has left paleo-strandlines exposed well above the present water tables of Lake Champlain and the St. Lawrence River. However, isostatic rebound and a lowering of water tables also resulted in the increased incision, erosion and redepositon of alluvial terraces where Paleoindian residential camps are most expected. Nevertheless, the potential visibility of both small short-term and larger seasonal summer coastal sites is much greater along the Champlain Sea margin than it is in southern New England.

The most visible interior upland sites would be winter residence locations. Such sites should contain dense multiple artifact loci relating to individual residence and activity locations. The central northeastern winter sites are potentially larger than those of southern New England and should thus be somewhat easier to locate. The dispersed nature and low artifact density of the smaller summer foraging camps makes them very difficult to locate without high-density survey methods. The potential lack of diagnostic artifacts within such sites would further hinder recognition.

The northern Northeast

spring and summer sites

Interior spring and summer sites of the northern Northeast would be similar to those already discussed for the central and southern sub-regions. Medium-term collector occupations (type 7) are also anticipated along the Gulf of Maine coastline, although rapid shoreline regression and transgression may have hindered resource stability and thus lowered the probability of site reuse. The St. Lawrence estuary and coastal Nova Scotia might have offered less active shore line locations, although summers were very short in these regions. The sparsely forested coastal regions of the Maritimes provinces may have provided important breeding grounds for caribou. This potentially stable seasonal resource base could have attracted human groups from distant regions during summer months. This should be visible through the presence of significant quantities of exotic lithics at such sites. Spring migration caribou hunting might also have occurred, resulting in the formation of specialized multi-locus sites similar to those described for the central Northeast fall caribou drives.

fall and winter sites

Northern northeastern fall caribou drive aggregation sites should also have been similar to those of the central northeastern sub-region. They should contain numerous loci reflecting individual residence and activity locations. In fact, it is possible that the sharper transition from the northern tundra to forested interior zones promoted larger herd sizes and more extensive seasonal migrations (Spiess and Wilson 1987: 153-154). This suggests that northern caribou hunting camps may have been larger and of longer duration than those of the central sub-region. Meat caching features might also have been more important here than at central northeastern caribou hunting camps.

Logistical camps similar to those described above would have supported aggregation sites. Nearby kill sites may contain numerous discarded broken weapon fragments. Foraging and tool rejuvenation locations should be common, but may contain few artifacts. Artifact density and variety at the base camps should be high, reflecting a broad range of on-site activities. However, the limited variation of the resource base modeled for the northern Northeast of the Younger Dryas necessitated a degree of seasonal specialization in this sub-region. This should be reflected in toolkits in the form of specialized tools rare or less common in other parts of the Northeast.

Interior winter land use was likely based on small residential camps supported by logistical field camps (type 4). Group size would be small if resources were relatively scarce. However, extreme weather conditions possibly hindered residential mobility, resulting longer periods of occupation. This pattern would have produced small, but very dense sites with artifacts reflecting a wide range of primarily interior activities.

Northern northeastern Younger Dryas site visibility

Coastal sites should be most visible along terraces of the St. Lawrence estuary and Gulf of St. Lawrence as a result of isostatic rebound. Those of the Gulf of Maine coast will be inundated and out of archaeological reach. Coastal sites should range in size from small to quite large, depending on the duration of stay and frequency of site reoccupation. The most visible sites will reflect large, reoccupied locations. Such sites are horizontally expansive and potentially contain densely distributed artifacts, so are relatively easy to find using standard reconnaissance methods (if they are not deeply buried). As with coastal sites of the southern and central sub-regions, these sites should be associated with numerous, artifact poor, foraging locations within a five km radius, as well as interior logistical camps, both of small size and poor archaeological visibility.

Interior and upland summer foraging camps may not be much larger than the logistical hunting camps associated with coastal sites. These sites should be widely distributed in a variety of locations and contain disbursed artifact concentrations relating to a limited range of on-site activity. These possibly single-locus sites with low artifact densities and probable lack of diagnostic tool types will be quite difficult to locate using standard survey methods.

Interior and upland fall-winter collector camps are also expected to be broadly dispersed, but may be limited to more sheltered locations such as low-lying wetland margins. Dense artifact clusters (reflecting winter residential structure locations) should be small, making detection difficult. Once located, however, the high probability of discovering diagnostic material, and the expected variety of tools represented, should increase the chances of correct identification of the site. The most visible sites of the northern sub-region should be large caribou-hunting aggregation camps. Multiple artifact concentrations reflecting residence and activity locations should contain dense concentrations and a high variety of artifacts. Stone cairns and stone food storage facilities could still be visible at the modern ground surface, further enhancing site visibility. Some of these sites were likely reoccupied while caribou drive routes were relatively stable. The dynamic nature of the Younger Dryas climate may have hindered this scenario, however.

Such sites should be located in river valley constrictions where the natural terrain aided the routing of caribou. Holocene alluvial processes (i.e., deposition, incision and sediment reworking) may have destroyed many of these sites and deeply buried others. Even where these processes have destroyed or deeply buried residential sites, numerous nearby (five to twenty km distant) logistical hunting camps should exist. Nonetheless, these may be quite difficult to locate because of their small size and potential lack of diagnostic materials.

Expected archaeological patterns for the early Holocene (ca. 9,000 B.P.)

The southern Northeast

Southern New England early Holocene site types should have included seasonal anadromous fishing camps, in addition to the site types mentioned above for the Younger Dryas period (i.e., medium to long-term spring and summer coastal camps with associated small logistical hunting camps and numerous nearby foraging locations, small interior short-term foraging camps, and medium-term fall and winter residences supported by logistical camps and a limited number of foraging locations). These large spring and summer sites should include multiple broadly dispersed artifact concentrations associated with individual residence locations and activity areas. A high probability of site re-use, especially at the best fishing locations, such as falls, would mask this patterning, however. Such sites should appear as broad areas with extensive artifact remains, but with little distinct remnant patterning reflecting discernable activities. Numerous local (up to five km distant) foraging locations should exist but may contain few if any artifacts. Logistical hunting camps should be located about five to twenty km distant from the residential location. These sites, and associated kill/butchery and tool rejuvenation locations, should contain few artifacts reflecting a limited range of activities (i.e., express low assemblage diversity).

An increase in the use of plant food resources and small game is anticipated to have raised the proportion of type five foraging camps. These are similar to those of type three, but may lack associated kill sites and should reflect shorter periods of occupation. Tools from such sites would reflect limited activities associated with plant food and small game processing. Artifacts should be of low density and dispersed, reflecting outdoor summer activity. Such sites may be spaced regularly, reflecting short-distance (about ten km) periodic residential movement. Associated nearby foraging locations could be numerous but difficult to identify.

Fall and winter land use should have been much the same as that of the Younger Dryas, with numerous small collector camps in sheltered areas. The possible increased use of acorns and wetland plant tubers might have lengthened fall residence occupation periods.

Southern northeastern early Holocene site visibility

The visibility of most site types is probably unchanged from that of the Younger Dryas. These sites include spring and summer interior-upland foraging camps, coastal collector camps, and fall and winter interior-upland collector camps. Fishing aggregation camps, while large, have likely been heavily impacted by alluvial processes, especially erosion and sediment reworking. Many of these sites, if not destroyed, are likely deeply buried in alluvial sediments, possibly well below the modern water table. Smaller upland fishing locations may be more easy to locate along secondary and smaller streams and at lake outlets. These, too, may lie deeply buried or have suffered heavy erosion, hindering their discovery. Spring and summer foraging camps focused on small game and plant foods should be difficult to locate and identify because of low artifact density and possible lack of diagnostic tools.

The central Northeast

Changes in central northeastern site types paralleled those of the southern Northeast. That is, anadromous fishing camps and small interior/upland foraging sites are added to those listed for the Younger Dryas period. The disappearance of the Champlain Sea at the end of the Younger Dryas resulted in important settlement pattern changes during this time. Northern marine coastal residences were replaced by St. Lawrence River riverine-estuarine camps. The shift from an inland marine to riverine-estuarine environment indicates that the resource base changed significantly. In particular, certain sea mammals became less common as their habitats were disrupted. This would have impacted the focus of foraging pursuits, and may have affected site size and duration of occupation as well. Unfortunately it is difficult to judge how this change impacted the residents of this region without more detailed information concerning the available resource base. The drainage of the Champlain Sea made available a large new resource area. Lake Champlain and its environs offered a vast fresh-water lacustrine setting where a variety of plant foods, fish, birds, amphibians, reptiles and mammals were seasonally available.

Fall and winter sites remain the same overall as those of the Younger Dryas. However, we can be reasonably certain that caribou hunting was becoming less profitable in this region by 9,000 years ago as spruce trees were rapidly replaced with pine (Spear et al. 1994). Caribou hunting aggregation camps may have become rare or absent in the forested interior. Aggregation camps might have persisted along the southern shore of the St. Lawrence River, where more open conditions might have promoted moderate herd sizes. Smaller fall and winter woodland caribou, moose, and elk-oriented collector camps would have been the rule in the interior. These camps should resemble most nearly medium to long-term type 4 and 7 fall and winter collector camps. Assuming no re-occupation, they should contain two to four dense artifact loci representing individual residence locations and contain a high number and diversity of artifacts.

Central northeastern early Holocene site visibility

Visibility factors affecting central northeastern sites are nearly the same as those for the southern region. Small interior/upland spring and summer foraging camps should be difficult to locate and identify because of low artifact density and lack of possible diagnostic tools. Alluvial processes have probably heavily impacted central northeastern spring and summer riverine, lacustrine and anadromous fishing camps. It is anticipated, however, that most of these sites should be above modern water tables as a result of isostatic rebound. This improves the possibility of finding such sites in this sub-region.

Fall caribou hunting camps may exist along the southern shore of the St. Lawrence River. Their visibility should be good as a result of isostatic rebound in the region. Interior/upland fall and winter collector camps are likely more visible than spring and summer foraging camps because of their larger size and richer tool assemblages.

The northern Northeast

Northern northeastern spring and summer sites include coastal foraging camps (type 6) in addition to those of the Younger Dryas (possible spring caribou drives, seasonal coastal collector camps and interior foraging camps). These small, widely dispersed short-term harvesting camps should contain both a low diversity and density of artifacts. Specific tasks may be represented in the artifact assemblage by a dominance of certain tool types. Nearby foraging locations should be evident, but are likely to contain few or no artifacts. I also anticipate that anadromous fishing became a more important part of the economy in the northern Northeast at this time. Potentially large and reoccupied riverine fishing locations should resemble those described above.

Fall and winter site types would have been largely unchanged from the Younger Dryas. Large caribou-drive aggregation sites may have continued to be important in northern reaches of the sub-region along the Gaspé Peninsula and into northern Nova Scotia. Interior-upland fall and winter sites should include the small collector camps of the Younger Dryas (type 4), as well as potentially larger, longer-term collector camps (type 7). Winter collector camps might have been of longer duration than those of the Younger Dryas because of the increased availability and variety of small game. Such sites should be located in well-forested sheltered locations with rich habitats.

Northern northeastern early Holocene site visibility

The large caribou-drive aggregation camps remain the most visible sites of the early Holocene northern Northeast. These sites may be located further north than those of the Younger Dryas. As mentioned, fluvial processes may have destroyed or deeply buried many of them. Large, reoccupied seasonal anadromous fish harvesting camps may be more visible along the Gulf of St. Lawrence than along the Gulf of Maine, where transgression would have more severely inundated most sites of this type.

Potentially large summer coastal collector camps should be visible along the Gulf of St. Lawrence coast, where isostatic rebound has limited inundation. However, because many of these sites were probably located near river mouths, a degree of fluvial reworking or deep alluvial burial can be expected in these sites as well. The small coastal foraging camps may be difficult to locate. There is less probability of site reuse than there is with the larger coastal collecting camps, so assemblages should be small and may not contain diagnostic tools.

Interior and upland site use during the spring and summer would have left small sites, difficult to locate and identify. Fall and winter collector sites of the interior may include longer-term occupations than those of the Younger Dryas. Because these sites should contain a slightly greater density and diversity of tools, they may be somewhat easier to locate and identify. The expansion of forests during the early Holocene should have resulted in an increased northern distribution of interior collector sites.

Summary of expected trends in archaeological patterning

I have taken a reductionist, simplifying approach in the reconstruction of Younger Dryas and early Holocene site types. Because the present model is inherently based on only eight extreme conditions, the actual degree of complexity and diversity of site types is likely underrepresented. As such, I have undoubtedly simplified the archaeological manifestations of these sites as well. Nevertheless, a marked degree of diversity is present in the modeled site types and related archaeological traces mentioned above. Hopefully, the model predictions will help to develop a richer understanding of the nature and potential complexity of the archaeological record in the Northeast for the period of time in question.

The most significant implications of the archaeological manifestations of modeled settlement types are outlined below. These implications have bearing upon both how we perceive the prehistory of the Northeast, as well as on how we interpret the existing archaeological record. First, no extreme change in the nature of the archaeological record is expected between the Younger Dryas and early Holocene. That is, the overall site typology is comparable. Those differences that do exist are primarily of degree rather than kind. This model does not anticipate significant change from a specialist to generalist economy, which might more strongly affect the archaeological record (e.g., Cleland 1976). Rather, specialist and generalist behaviors would have occurred among human groups of both time periods and all sub-regions on a seasonal basis when and where they were appropriate to the local conditions.

Second, environmental change between the two study periods resulted in the addition and loss of certain resource types in all sub-regions. This would have caused shifts in human prey choice and as a result, in patterns of human mobility, social organization and regional demography. These changes were most profound in the northern sub-region where a very narrow food spectrum broadened considerably with the onset of the Holocene. The southern sub-region should have experienced the least degree of change in terms of prey choice, mobility and patterns of social organization. The variety of site types should have increased as the food resource base became more varied from the Younger Dryas to early Holocene. However, if resources became more predictable during the early Holocene, sites should begin to show more redundant associations between habitat and social-economic behavior as well as increased evidence of reoccupation (e.g., Nicholas 1988; Jochim 1991).

Third, the majority of the largest sites of both the Younger Dryas and early Holocene are likely missing from the current archaeological record as a result of the inundation of most coastal regions. Younger Dryas sites of the central and northern sub-regions should, however, include large specialized interior seasonal caribou drive camps. The missing coastal sites potentially provide rich information concerning the broader range of prehistoric food acquisition and processing behavior, settlement organization and patterns of tool production, use and discard.

Fourth, the most common sites of the archaeological record should relate primarily to small, short to medium-term interior summer foraging and winter collecting camps. These sites may only open a narrow window of insight concerning the full range of past human social and economic behavior. Of these, the winter collector camps should be the most common in the current archaeological record because of their potentially larger size, greater quantity and diversity of artifacts, and resultant increased archaeological visibility. This probable bias in the archaeological record towards relatively small interior camps should be least severe along the Champlain Sea coastline (for Younger Dryas occupations) and the shore of the Gaspé Peninsula (both Younger Dryas and early Holocene occupations) where lowered relative water tables have left large summer occupations better exposed to discovery.

The following chapter reviews a number of Paleoindian and Early Archaic sites from the Northeast to determine, at a regional scale, how well the resource response model, and its implications for site visibility, help to account for the current archaeological record. The selected sites will intentionally express some of the expected range of site variability anticipated by the model in an anecdotal manner. It is expected, however, that each of these sites, when looked at individually, will introduce details not anticipated by the model which must be explained in terms of their particular local contexts.

Chapter 8: Model Expectations vs. the Archaeological Record

This chapter reviews six northeastern archaeological sites and compares the information they contain to that predicted in the last chapter. These sites represent a small sample of a much larger body of recorded Paleoindian and Early Archaic locations in the Northeast. I selected these particular sites for three reasons: 1) they are all relatively well-dated to a period which falls either within that defined for the Younger Dryas climatic oscillation of the eleventh millennium B.P., specifically to within the latter half of that period (ca. 10,600 to 10,200 B.P.), or to the middle early Holocene period (ca. 9,000-8,500 B.P.); 2) each represents a different type of site based on recovered tool types, reconstructed environmental setting, reconstructed degree of site reuse, number of artifact loci, and overall site size; and 3) the sites express unique qualities which may relate to local conditions at the time of occupation and could not be anticipated by the regional model presented above. In fact, I have chosen these sites because they provide data which encourage a closer look at some of the questions raised in the preceding chapters. Their review provides an opportunity to assess the merits of the resource response model as an explanatory framework for understanding the archaeological record of this period.

Exemplary Younger Dryas period (ca. 10,600 – 10,200 B.P.) Paleoindian sites of the Northeast

Debert/Belmont

The Debert and Belmont sites are located on the north shore of the Cobequid Bay, about four miles inland of the present shoreline. The Debert site lies between the Chiganois and Debert rivers, two miles south of the Cobequid foothills (MacDonald 1985: 3). The nearest active stream channel is about one-quarter mile distant, although the topography indicates closer relict stream channels which might have been active at the time of occupation. The site is located on a well-drained sandy ridge which would have supported a mixed forest of spruce, pine, fir, aspen, and grey birch until the arrival of Europeans (MacDonald 1985: 6).

Debert provides one of the most extensive series of radiocarbon dates from any Paleoindian site in northeastern North America. The 29 samples greater than 8,000 years old are very consistent, and the 2-sigma overlap (95% confidence interval) suggests a time of occupation between 10,600 and 10,700 radiocarbon years ago (MacDonald 1985: 52-57; Levine 1990: 49). Pollen records indicate that the region was dominated by an open herb-shrub plant community at the time of occupation. Spruce parkland existed in the area prior to 10,900 B.P., but spruce was replaced by dwarf birch during the Younger Dryas climatic reversal (Davis 1991: 42-44). Ice wedge casts from the north shore of the Minas Basin denote a return to permafrost conditions during this period (MacDonald 1985: 14). The regional sea level at this time in the Minas Basin is not well resolved. Probable isostatic depression of the area complicates the interpretation, but Oldale (1986) estimates that relative sea levels were as much as 40 m lower than present in the western Gulf of Maine. If central Nova Scotia were more severely depressed than Maine, relative sea levels would have been closer to their modern level.

The sites have suffered numerous disturbances during the last century. Debert, in particular, was heavily impacted by use as a military base. Disturbances to the site area include clear-cutting and stump removal, bulldozing, mortar fire, and subsequent aeolian deflation and erosion. Natural processes such as tree throws, frost heave, and animal (including insect) burrowing have also affected site integrity (MacDonald 1985: 16-20). The adjacent Belmont site has suffered less severely, but was exposed to recent clear-cutting and stumping activity as part of its use as a tree breeding facility (Davis 1991: 45-46). Stratigraphic cultural horizons are not visible at either site and excavators noted that artifacts were vertically displaced within as much as a meter of sediment (MacDonald 1985: 16-20). Intact portions of features were recovered only when these extended into the underlying laminated sand horizons.

The horizontal distribution of artifacts was probably affected by the same degree of disturbance as that of the vertical distribution, but this has not significantly altered the primary distribution patterns (i.e., those related to human activity) observed at the level of the site as a whole (MacDonald 1985: 21). Debert contained eleven artifact loci, each about 110 m^2 in area. Eight of these lay within a central area in a roughly linear arrangement along a ridge. Three other loci were located a short distance from this "nuclear area" (MacDonald 1985: 21-22). Each locus contained one or two hearths and about 600 artifacts. MacDonald (1985: 132-134) interpreted most of the loci as representing living floors of communal dwellings inhabited by several families, not exceeding thirty or forty individuals. Exceptions include one locus (F) which, based on its size and number of tools and features, may represent two occupation events, as well as loci D and E which appear to be special activity areas outside of the residence zone (MacDonald 1985: 22). MacDonald interpreted the site as representing a seasonally reoccupied location used primarily for caribou hunting for "a few decades" (MacDonald 1985: 134).

Excavators recovered nearly 3,200 tools from Debert, including end scrapers (1,587: 49.6%), pièces esquillées (917: 28.7%), side scrapers (304: 9.5%), fluted projectile points (140: 4.4%), gravers (91: 2.8%), rough stone tools and choppers (71: 2.2%), spokeshaves (50: 1.6%), awls and perforators (28: 0.9%), and drills (9: 0.3%) (MacDonald 1985: Table 15). End scrapers dominate this diverse assemblage, a pattern observed at most Paleoindian sites in the Northeast (Chilton 1994). Only loci D and E contained high numbers of bifaces and points (about 25%). This appears to reflect the weapons-oriented nature of production in these special activity areas.

Raw material types from the Debert site are limited and are dominated by two varieties of chalcedony. Both of these are similar to varieties reported from the Parrsboro area, 70 km west of the site on the north shore of the Minas Basin (MacDonald 1985: 61-62; Davis 1991: 50). A silicified siltstone of unknown origin and locally available cobble-derived porphyritic rhyolite represent minor lithic types at the site. Excavators recovered only five quartz flakes from one locus outside of the site nucleus.

The Belmont site is located approximately 1.5 km northeast of Debert (Davis 1991). The site was discovered while monitoring tree stump removal activity on land of the Nova Scotia Department of Lands and Forests in 1989 (Davis 1991: 37-38; Keenlyside 1991: 165). Surface inspection of the area determined the locations of sixteen lithic concentrations within a 20,000 square meter area (Belmont I). Upon further reconnaissance three additional nearby areas with artifact-bearing sediments were located (Belmont Ia, II, and IIa) (Davis 1991: 38).

While the area had received only limited testing at the time of publication, the summary by Davis (1991: 39) indicated that artifact types and raw materials were indistinguishable from those recovered from Debert (except for the lack of silicified siltstone). Based upon these initial finds, the Belmont site may include occupation remains at least as substantial as those of Debert (Davis 1991: 40). Taken together, these sites comprise one of the largest known concentrations Paleoindian material in the New World.

Debert/Belmont in light of the resource response model

The Debert/Belmont site complex most likely represents a seasonally reoccupied location. In terms of the model, the sites are best described as revisited northern near-coastal logistically organized collector camps of type seven. Such camps are focused on dispersed but predictably located resource rich game, such as caribou or seal at spring and summer calving grounds. The model suggests that these widely-dispersed site locations should represent medium-term (1 week to 1 season duration) residential camps with two to four artifact loci representing individual residence locations. Archaeological predictions based on the model anticipate a high number and diversity of artifacts at such sites reflecting the extended period of occupation and variety of on-site tasks performed. Numerous nearby foraging locations with few or no artifacts should exist in the surrounding ten km radius. A large number of logistical hunting camps with a low number and diversity of artifacts, kill/butchering sites, tool rejuvenation locations with debitage and tool discards, as well as local and dispersed tool caches are expected within one ore two day's travel by foot from the central camp. Site reuse is expected as long as resources remained predictably located.

In general, the model description of the Debert/Belmont site complex reflects the original conclusions of MacDonald: i.e., that the site(s) represents a large, seasonally reoccupied camp focused primarily on the hunting and processing of woodland caribou. MacDonald suggests that hunting was focused on seasonal migrations, while the resource response model proposes that the site represents a base camp associated with the logistical hunting of nearby calving grounds of caribou or seal. The high proportion of pièces esquillées, a tool associated with splitting antler, suggests that caribou was in fact the more likely prey. Interpreting the Debert/Belmont locations as reoccupied caribou herd interception aggregation camps (type eight) is not out of the question within the construct of the model, but the rolling landscape does not appear conducive to herd interception. Furthermore, there is little evidence at this time that any of the loci were simultaneously occupied, as might be expected at an aggregation camp, though this is not out of the question. It is also likely that discarded damaged weapons and weapon-making debris would be more common at such sites than they were at Debert. Evidence of meat caching facilities or other storage features is also expected, but such facilities were not detected.

While the model suggested that two to four contemporaneous living structures might be present, the size and material contents of Debert's presumed living structures may well represent the same number of families in a more centralized living arrangement. Such an arrangement within a single structure could reflect a conservation of heat energy during colder months, or it may reflect group social patterning reflective of risk-pooling behavior as discussed by Wiessner (1982). If the sites were occupied during the spring or summer months, as anticipated, heat conservation might have been unnecessary, suggesting that social factors may have played a role in the construction of communal living structures.

Overall, the degree of mobility suggested by the sources of lithic raw materials is less than that anticipated by the model. I surmised above that the Maritimes region during the Younger

Dryas period offered only seasonally abundant resources which were taken advantage of by peoples primarily of New England. In fact, it appears that the occupants of the Debert/Belmont area were tied to the Minas Basin region of central Nova Scotia. Such a restricted territory (even if ephemeral) was not anticipated during this period, when climate is known to have shifted drastically over short periods of time. Climate shifts would have impacted local weather patterns. Mobile game in particular, such as caribou, are known to be quite susceptible to rapid changes in temperature and precipitation (Spiess 1979). Predictable herd patterns were not expected during this time. Even a period of one or two decades of regular site reuse is unexpected, although this seems to have occurred.

The apparent redundancy of site use may be a result of short-term periods of local stability in the climate and resource base during this part of the Younger Dryas. Perhaps, however, while migration routes shifted, the location of the caribou calving grounds was less variable. If site use were based primarily on the regular harvest of nearby calving grounds by logistical hunting parties, the same site area might have proved useful for a number of generations. One must also consider the use of marine resources, especially seal, during part of the seasonal subsistence cycle as an explanation of the apparent restricted level of mobility in the Minas Basin region.

Finally, the model implies that numerous logistical hunting camps, foraging locations and other short-term activity areas associated with the occupation of Debert/Belmont must be scattered abundantly across the local landscape. Such support sites are a necessary aspect of hunter-gatherer collector base camps. Presumably, Paleoindians produced dozens of small, low artifact density sites in the adjacent area during each occupation of Debert/Belmont. This has direct bearing on the cultural resource management of the region. Archaeologists must anticipate the presence of small Paleoindian activity areas throughout the eastern Cobequid Bay area and take appropriate measures to locate and protect them.

Hedden

The Hedden site is a small, single locus Paleoindian site in Kennebunk, southeastern Maine (Spiess and Mosher 1994). The following summarizes data recovered during excavations performed in 1992 and 1993. The site is located on a grassy sand dune landform less than ten kilometers from the present shoreline. The Paleoindian occupation lay upon glacial outwash pebbly sands which were subsequently covered by aeolian sediments (Spiess and Mosher 1994: 26). The site is contained within a single 40 square meter block excavation. However, excavators recovered the majority of artifacts from within a much smaller three by three meter area (Spiess and Mosher 1994: 49).

Charcoal recovered from the same geological context as the artifacts was dated to approximately 10,500 B.P. (Spiess and Mosher 1994: 26). An open spruce parkland covered southeastern Maine at this time. However, local well-drained sandy conditions likely supported more open vegetation, as they do today. At the time of occupation, relative sea level in the Gulf of Maine region may have been as much as 50 meters lower than that of today. This indicates that the coastline was well seaward of its present location (Oldale 1986: 96).

The site assemblage is relatively small, totaling 832 artifacts, of which only 29 are tools or tool fragments. Tool types represented include five end scrapers, a limace or blade fragment, three gravers, a scraper, three other uniface fragments, seven utilized flakes, and a single biface fragment. It is noteworthy that excavators did not recover any fluted points or identifiable fragments. Despite the small assemblage size, a broad spectrum of lithic raw material types are represented. These include a pink-patinated fine-grained rhyolite possibly from the Boston Basin area (30% by weight), Hudson Valley chert (29%), gray cherts with a possible source in western Vermont or New York (22.5%), quartz crystal possibly from the White Mountains or western Maine foothills (14%), possible eastern Pennsylvania jasper (3% [one endscraper]), Munsungen chert of northern Maine (1%), and small amounts of a brown quartzite (0.5%) (Spiess and Mosher 1994: 29, 52-53).

Spiess and Mosher (1994: 47) interpret the site as a small residential camp of relatively short duration ("…a few weeks."). Site activity focused on the maintenance and/or production of non-lithic tools.

> The common denominator for nearly all of the tools described throughout this report is that they were used to manufacture other tools. Endscrapers may have been used to whittle or scrape wood or bone to fashion shafts for spears, and for making other things such as pack frames, tent poles, and maybe sleds or toboggans. *Limaces* would have [been] useful for making sockets in tool handles, while gravers and perforators may have been used to incise designs or make needles. Moreover, cutting tools may have been used to cut meat and hide, perhaps for making rawhide line (Spiess and Mosher 1994: 47).

The total weight of the assemblage is only 108 grams. While the site might represent a stay of weeks, a small number of people could have produced the assemblage in an afternoon of diverse activity. I suspect that the length of stay at Hedden was less than a week.

Hedden in light of the resource response model

The Hedden site falls within the definition of modeled site types two, three and five. Type two sites represent small single locus transit camps left by highly mobile foragers where resources are unpredictable, patchy and of poor quality. Type three sites are short-term, single locus residential foraging camps (of one day to one week duration) containing a moderate to low number diversity of artifacts where resources are unpredictable, dispersed, and of rich quality such as large mammals. Type five sites are similar in content, but reflect the use of predictable, dispersed, poor-quality resources such as plant foods. Of these, the model expected only type three sites during the Younger Dryas period. The other two types are associated primarily with plant-food gathering and foraging for small animals such as amphibians, reptiles, and birds which are not expected to have represented a significant portion of the resource base in this region during the Younger Dryas.

Type three sites reflect a focus on isolated large game, such as deer, moose, elk, or woodland caribou when these are dispersed. Such a resource base is typical of cool-temperate forested regions during summer months. The foraging strategy is essentially encounter-based, that is, short-term sites may be created quite close to an actual kill site. The larger the animal hunted, the longer is the anticipated site occupation. Such sites are not expected to be redundantly occupied because chance plays a large part in the encounter of game and thus of site location. The degree of residential group mobility should be quite high, though its range (distance between camps) may be relatively low. Tool diversity and assemblage size will increase with length of stay, but should be relatively low overall. Discarded tools should reflect activities associated with on-site processing, but may reflect a degree of "gearing-up" especially if hunting tools were in need of repair after a successful hunt. A small number of nearby supplemental foraging locations are expected, but these may contain few or no artifacts.

This describes Hedden quite well. Spiess and Mosher emphasize that on-site activities focused on the production of secondary tools. This may reflect day-to-day maintenance activities, or it could suggest a degree of "gearing up" in anticipation of future needs. Interestingly, discarded projectile points are entirely lacking from the site. This could suggest that hunting was actually of limited importance, and that the site is more aptly described as a type two or five foraging camp not associated with large game procurement. However, there is ample evidence in the assemblage of debitage for biface rejuvenation. In fact, despite the overwhelming proportion of unifacial tools at the site, biface retouch flakes outnumber unifacial retouch flakes three to one (Spiess and Mosher 1994: 47). It is apparent that bifaces, probably projectile points, were being retooled on site. The lithic raw material spectrum indicates a very high degree of mobility. It appears to reflect group movement over a distance of nearly 300 km during a period of a year or more, but may also be a product of special task group activity (Spiess and Wilson 1987). Minor lithic quantities from even further afield may, however, be associated with inter-group exchange (Spiess and Mosher 51-52).

In sum, the resource response model helps place the site within a probable seasonally-sensitive subsistence system framework. Hedden is the smallest, and most recently published, professionally excavated Paleoindian site in the Northeast. It was recovered primarily through the diligence and research interests of the Maine Historic Preservation Commission. The resource response model indicates that sites of this size and content should be the most common in the archaeological record of this period. However, to date Hedden stands as the only representative of its kind. This is clearly an issue of archaeological visibility. Larger, longer-term, and often redundantly occupied multi-locus sites are much easier to locate. Unfortunately, these have become stereotypical of the northeastern Paleoindian settlement system. However, they reflect only a partial view of the yearly fluctuation in social and economic organization expected through the application of the resource response model to the Northeast.

Hedden is important for a number of reasons. Its discovery will hopefully mark a watershed in the methods used to locate Paleoindian sites. Clearly we need more exacting reconnaissance techniques to locate sites of this scale than are currently typical of CRM projects. Cultural resource management programs should anticipate sites of this size and artifact density and take necessary precautions when designing and implementing initial phase testing. Hedden may also move northeastern archaeologists away from their obsession with fluted points. The site demonstrates that fluted points cannot, and should not, be expected at all Paleoindian sites. We must begin to look more closely at other traits equally diagnostic of Paleoindian lithic technology.

Templeton

The Templeton site (6LF21) is located on the first terrace of the Shepaug River, a tributary of the Housatonic, in Washington, Connecticut (Moeller 1980). The area is within the Southwest Hills district of western Connecticut, though it borders on the Northwest Highlands (Bell 1985). Moeller excavated the site in 1977 and again in 1982 and dated it to 10,190 $\pm$ 300 B.P. (Moeller 1980; 1984). Excavations encompassed over 85 square meters (Curran 1987: 269). The Paleoindian horizon lay deeply buried under alluvial silts at a depth of between roughly 1.0 and 1.5 meters (Moeller 1980: Figures 3-6). Raw materials for the production of lithic artifacts recovered from the first season of excavations included probable local cobble-derived cherts (2,260 gm) and quartz (195 gm). Ecofacts included wood charcoal from red oak and either juniper or cedar, unidentified charred plant remains (possibly including nut fragments [Curran 1987: 271]), and calcined bone fragments (Moeller 1984: 235). Artifacts from the initial site excavation included a single fluted point (apparently broken in manufacture), four miniature points, fifteen channel flakes, two bifacial knives, one drill, one end scraper, three side scrapers, five gravers, thirteen "graving spurs," two spokeshaves, twenty utilized and/or retouched flakes and fifteen biface fragments (Moeller 1980: table 21).

The most common tool types were utilized and retouched flakes and gravers/graving spurs. While utilized and retouched flakes are common at most Paleoindian sites in the Northeast, gravers are relatively rare (e.g., Moeller 1980: Table 21; Curran 1987: Figure 7.1). Utilized and retouched flakes can be used for a wide variety of expedient cutting and scraping tasks. Gravers, however, are more commonly associated with piercing hide, and sometimes bone or wood in the production of sewing needles. Moeller suggests that Paleoindians used the "graving spur" variety for slicing hide, reeds, plant stalks, bone splinters, or wood (Moeller 1980: 66). All of these activities suggest a focus on the secondary working of extant non-food resources, rather than the processing of fresh food-related materials such as meat and skins.

Northern expansion of the original excavation block in 1982 uncovered a very different spectrum of artifacts, dominated by quartz cores and chunks, quartz primary and secondary reduction flakes and shatter, and quartzite hammerstones. Excavators also recovered small quantities of jasper and chert. Moeller interprets this portion of the site as a quartz knapping station associated with the production of expedient cutting and scraping tools (Moeller 1984: 236). Overall, the second season uncovered an area typified by lower debitage density, the presence of discrete knapping areas, more common water-worn chert fragments and cortical flakes, a much higher density of quartz, and a notable absence of complete bifacial and unifacial tools (Moeller 1984: 237). Despite the differences in the nature of the adjacent block excavations, Moeller (1984) believes the site represents a single occupation event.

Templeton in light of the resource response model

While different in character, Templeton, like Hedden, is best described as a type three short to medium-term residential foraging camp. These sites occur where resources are unpredictable, dispersed and rich in quality. The model anticipates such sites for inland summer land-use during the Younger Dryas. The dispersed nature of the finds across approximately 80 square meters of the floodplain also suggests a warm-weather occupation. The focal resource of such sites might have been deer, moose, woodland caribou or elk dispersed in a forested environment. A variety of small game, plant foods, and perhaps fish acquired close to the site supplemented the focal resource. Foraging locations at the harvesting sites of supplemental resources would have left few or no artifacts behind, and are thus of very limited archaeological visibility.

Type three settlements should be of short-term (one day to one week) duration, but the quantity and variety of material recovered from Templeton may indicate a somewhat longer occupancy. This would have occurred especially where supplemental resources were relatively predictable and abundant. In fact, the rarity of projectile point discards (excepting the miniature points which are not interpreted here as hunting tools) suggests that large mammal hunting was not a central site activity. Even end scrapers, commonly associated with the processing of fresh hides, are nearly absent.

While the breakage and discard of hunting gear is not associated with the site, the production of projectile points in anticipation of future hunts is. In particular, fluted point channel flake fragments are relatively common (numbering fifteen). Because multiple channel flake removals are typical of the production of most fluted point varieties, it is likely that between three and five points were successfully manufactured on site and carried away. In fact, the inhabitants probably based their decision to occupy this site in part on the availability of chert stream cobbles (Moeller 1984). The quality and predictability of non-food resources can impact site location selection and duration of stay in a manner similar to that of food resources, a point not directly approached in the resource response model.

The probable use of local lithic raw material resources sets Templeton apart from most other sites of this period in New England. In fact, the lithic choice pattern is more akin to that of the lower Hudson River valley where local cherts make up the majority of the raw material from Paleoindian sites (Eisenberg 1979). The dominance of local lithics in this region may be related to their quality and abundance. However, quartz (a rather intractable raw material) was also used extensively at Templeton, suggesting that a truly parochial lithic use pattern may have been established within western Connecticut by the late eleventh millennium B.P. as well.

This could indicate less dramatic residential mobility patterns than observed elsewhere in New England at this time. In fact, Eisenberg (1979: 138-139) suggested that lower group mobility had been established in the temperate forests of the lower Hudson Valley at this time. The same may apply to the Housatonic drainage. The presence of charred oak fragments from the site suggests that temperate forests were well established locally by the latter part of the eleventh millennium B.P. These forests probably supported the suite of game animals more commonly associated with the Holocene, namely deer, bear, and an abundance of small game, birds, reptiles and fish. Such species would provide a more predictable local resource base permitting a lowered degree of seasonal mobility and longer settlement at a single location.

Templeton also informs us that site excavation sample size can have a drastic impact on site interpretation. The two field seasons of excavation at Templeton resulted in the recovery of very different artifact assemblages and patterns of artifact distribution. Were either of these assemblages taken singly as representative of the nature of the site, very different conclusions would be drawn. One assemblage consisted primarily of local quartz cobble fragments, a small number of locally-derived chert artifacts, and expedient quartz flake tools. The other assemblage consisted of a more "typical" Paleoindian suite of chert tools, a minor amount of quartz, and very few cortical chert artifacts, suggesting the possibility of long-distance chert acquisition. The combined sample indicates a rather complex spatial arrangement of tasks and a restricted lithic collection radius.

Exemplary early 9th millennium B.P. Early Archaic sites of the Northeast

Brigham and Sharrow

The Brigham and Sharrow sites are located near the confluence of the Sebec and Piscataquis rivers in the town of Milo, central Maine. The Piscataquis is an east-flowing tributary of the Penobscot River (Petersen and Putnam 1992: 27). Both sites were excavated in the mid-eighties as part of the Piscataquis Archaeological Project implemented to examine the prehistory and early history of the region. The sites are located within 250 meters of one another on the river floodplain, and both contained deeply buried cultural strata. The Sharrow site produced a series of radiocarbon dates on cultural horizons to as early as 9470 $\pm$ 280 B.P. at a depth of 2.5 meters below the modern surface (Petersen 1991: Figure 15,). The Brigham site contained dated stratified cultural deposits to two meters in depth, and yielded a terminal date of 10290 $\pm$ 460 (Petersen and Putnam 1992: 30). Excavators examined both sites using spatially restricted excavation trenches that emphasized vertical depth rather than horizontal breadth of exposure. Sixteen square meters were excavated at Brigham, and twenty two square meters at Sharrow (Petersen and Putnam 1992: 33). Forty-one radiocarbon dates were assayed from nearly ninety defined features and cultural horizons (anthrosols). Twenty three of these assays predate 5,000 years B.P. (Petersen and Putnam 1992: 31 and Table 1).

The following discussion focuses on the Early Archaic strata of these sites. This period correlates to Brigham strata III and IV (ca. 7,500-9,000 B.P.) and Sharrow stratum II (ca. 7,500-9,500 B.P.). Despite the spatial limitations of the archaeological excavations of these sites, excavators encountered a relatively large number of artifacts and features in the Early Archaic strata.

Flaked and groundstone artifacts numbered 143 from Brigham strata III and IV and 73 from Sharrow stratum II. Artifacts at both sites are dominated by cores, core fragments and modified core tools of quartz and rhyolite. Quartz, sandstone, slate and graywacke was locally available, while greenish Kineo member rhyolites are available from outcrop sources about 80 km northwest of Milo at Moosehead and Brassua lakes (Petersen and Putnam 1992: 33). Rhyolites are also locally available in glacial drift, however. Rare occurrences of cherts, a purple rhyolite, and quartzite represent materials acquired over greater distances. The cherts have a probable source in the Munsungen formation of north central Maine about 120 km distant, while the gray quartzite may be related to that of the Cheshire formation of western Vermont over 300 km away. The origin of the purple rhyolite is unknown (Petersen and Putnam 1992: 33-35). In general, the lithic spectrum suggests relatively restricted mobility, with rare exotics possibly representing traded materials or the products of group member exchange.

Excavators recovered one ovate and one stemmed biface from Sharrow and three biface fragments from Brigham. These artifacts represent the only evidence for biface use at both sites from the strata in question. In fact, projectile points are entirely lacking from these site assemblages prior to 6,400 B.P. (Petersen and Putnam 1992: 37). Interestingly, groundstone tool fragments are relatively well represented in the early strata. These number twelve specimens at Sharrow and two at Brigham (Petersen and Putnam 1992: Tables 2 and 3). Groundstone tool types include rods, celts, gouges, and a notched netsinker. Three bifacial and four unifacial tabular “choppers” were also found.

Faunal and floral remains are better represented at the Brigham and Sharrow sites than at most other sites of comparable age in the Northeast. They suggest broad-spectrum foraging practices (Petersen and Putnam 1992: 46-47). Petersen and Putnam (1992: 46) describe floral remains as “copious” at both sites. Early Holocene (ca. 10,000 – 5,000 B.P.) strata included the carbonized remains of hazelnut, acorn, hawthorn, and unidentified seeds and legumes (Petersen and Putnam 1992: 46). However, only hazelnut and unidentified seed are listed in Petersen’s description of Sharrow stratum II which dates primarily to the ninth millennium B.P. (Petersen 1991: 140). Brigham stratum III, the earlier of the two strata considered here, included the calcined remains of deer, beaver, muskrat, large mammal, bird, and turtle. Feature 10 of stratum IV was much richer containing deer, beaver, muskrat, black bear, red fox, large mammal, small mammal, shad, turtle, and snake (Spiess 1992: Table B-1). Sharrow stratum II contained beaver, muskrat, medium carnivore, eel and possible eel, possible shad, unidentified fish, and turtle and possible turtle remains (Spiess 1992: Table C-1). Petersen and Putnam state that the faunal assemblage is suggestive of warm weather occupation (Petersen and Putnam 1992: 47). Hazelnut and eel remains could indicate fall occupations as well, as these resources are most abundant at this time. Overall, the data indicate a wide range of foraging pursuits with an apparent emphasis on small game and fish which may span the seasons as well as the years.

Brigham and Sharrow in light of the resource response model

The Brigham and Sharrow ninth millennium B.P. strata represent repeated, though perhaps sporadic, short-term occupations at the confluence of the Sebec and Piscataquis rivers in central Maine. This geographic location provided ready access to the headwaters of both rivers, as well the larger Penobscot River to the east. Plant and animal remains indicate summer and/or fall occupations of the river terrace. The site is suggestive of small, short-term forager residential camps most similar to type six in the model. Type six sites are focused on resources which are predictable, patchy and of poor quality. Fish and small game, which appear to have been the focus of foraging at these sites, actually fall somewhere between rich and poor in terms of their relative food quality. As such, the three coordinates defining the position of the resource base fall between types 6 and 8 along the edge of the resource base cube, rather than at the corners where corresponding site types were fined (see Figure 6.1). The model indicates that these foraging camps should produce a moderate number and diversity of artifacts reflective of relatively short periods of occupation and a limited number of site activities. Foraging locations should be numerous in the surrounding area, but likely contain few or no artifacts and will be essentially invisible to the archaeologist.

The large quantity of shad recovered from Brigham feature 10 could indicate the partial remains of an anadromous fish harvest. If this is the case, occupants probably used the site area for a number of different economic tasks over time. The model anticipated variation such as this in site use. The faunal and lithic inventories of Brigham and Sharrow also suggest variation in the use of this river confluence over time. Faunal differences based upon the presence and absence of identified remains are summarized in table 8.1. While there are potential statistical problems comparing these samples of very different sizes, the table suggests possible differences in the faunal inventories of these sites.

Table 8.1

Brigham and Sharrow Faunal Comparisons

Resource	Brigham III (nisp=7)	Brigham IV, Fe. 10 (nisp=373)	Sharrow II (nisp=24)
deer	1	8	
beaver	2	18	8
muskrat	1	29	10
bear		6	
fox		1	
bird	2		
turtle	1	20	3
snake		10	
shad		281	2 possible
eel			1

Lithic raw material patterns were also markedly different between the two sites. At Brigham, quartz cores and core/scrapers are nearly six times more common than those of rhyolite, while at Sharrow rhyolite cores are nearly twice as common as those of quartz (core/scrapers were uncommon at this site) (Petersen and Putnam 1992: 35). These differences could indicate alternate approach routes to the site area via various quarry areas, or possibly ties to different technological traditions. Petersen and Putnam (1992: 35) note that quartz is more common in the southern Gulf of Maine region, while rhyolite use is more typical of sites of the Penobscot River drainage during this period.

The lithic and faunal patterns appear to support the interpretation that these site were used for varying purposes during different seasons and years. This would indicate a non-specialized use of local resources and foraging patterns that were rather eclectic (Petersen and Putnam 1992: 47; Meltzer and Smith 1986). Such eclecticism may have been the most efficient approach to the harvest of early Holocene resources. These resources were probably less predictable in kind and distribution over generations than they were in the subsequent later Holocene. A more simplified view of these patterns would have been reached were data available from only one or the other of these sites. This provides ample warning to those of us attempting to typify regional and even local archaeological patterns on the basis of one or very few sites. The Brigham and Sharrow sites provide an ideal case study in the potential degree of variation within the archaeological record within a small area and a relatively short span of time.

Weirs Beach

The Weirs Beach site lies along the western shore of a narrows at the outlet of Lake Winnipesaukee (Maymon and Bolian 1992: 117). This area forms the headwaters of the Merrimack River which flows south and east into the Gulf of Maine. The site represents a small portion of a larger site district along the narrows referred to as the Weirs-Aquadocton site. Charles Bolian directed excavation of the site in the mid to late 1970s (Bolian 1980). Weirs Beach contains evidence of occupation between the Late Paleoindian through the Late Woodland periods. Despite some prehistoric and historic disturbance, the site is relatively well stratified. The following discussion focuses of the quartz and groundstone assemblage dated to ca. 9,000 B.P. This lithic assemblage is comparable to those defined elsewhere as the Gulf of Maine Archaic (Robinson 1992: 76-77). As such, this component of the Weirs Beach site is also similar to ninth millennium B.P. levels at the Brigham and Sharrow sites above.

Bolian excavated a total area of approximately forty square meters at Weirs Beach (Bolian 1980: 125). Unfortunately, none of the reports to date contain information concerning the spatial distribution of materials. While this limits site interpretation, the site provides other data important for this poorly documented period. Within the upper Early Archaic component (originally referred to as Early Archaic "B") only a single projectile point (a bifurcate) was recovered from an assemblage otherwise dominated by quartz core-scrapers and groundstone rod fragments. Features containing these lithic materials were dated to 8985 $\pm$ 210 and 9155 $\pm$ 395 years B.P. The bifurcate base point was recovered from a feature dated to 7315 $\pm$ 195 B.P. (Bolian 1980: 125), although this style is dated elsewhere in the Northeast to the latter half of the ninth millennium B.P. Therefore, the point does not appear to be directly associated with the earlier groundstone-quartz assemblage. Its position within the dated feature may be the result of Middle Archaic site disturbance, as the upper Early Archaic horizon underlies a rich Neville-dominated component.

Groundstone rod fragments similar to those recovered from Weirs Beach are reported from the greater Weirs-Aquadocton district (Maymon and Bolian 1992: 120), suggesting multiple occupation episodes in this area. Nevertheless, Middle Archaic finds spread beyond those currently recorded for the Early Archaic (Bolian 1980: 126), indicating increased site use after 8,000 B.P. Middle Archaic lithic assemblages are dominated by argillite and rhyolite, rather than quartz (Bolian 1980: 126).

The Weirs Beach site summaries contain no mention of faunal remains. Bolian suggested, however, that the area would have been a rich fishing location (Bolian 1980: 128). However, a comparable Gulf of Maine Archaic site (Riverside: Walnut Street Trench) located along the Connecticut River in central Massachusetts dated to 8685 $\pm$ 370 B.P. contained numerous shad and alewife remains, as well as lesser quantities of turtle, snake, and unidentified mammal (Spiess 1992: 175). This suggests that fishing was an important seasonal aspect of the early ninth millennium B.P. subsistence system in New England.

Bolian noted that an historic village occupied by the Winnipesaukee tribe was located within the Weirs-Aquadocton area (Bolian 1980: 120). More generally, Bolian reports that the Lakes Region was important historically as a major transportation and communication route connecting

Canadian Native groups to southern New England. Bolian (1980: 119) suggests that the Lakes Region supported winter encampments of historic period coastal groups as well. While it is imprudent to suggest that the early Holocene use of the Weirs Beach area was identical to that of the recent contact-period, the site is ideally located within a resource-rich area providing ready access to a number of important transportation waterways. In fact, Robinson has suggested that boats had become an important mode of transportation during this time (Robinson 1992: 106).

Weirs Beach in light of the resource response model

Although we lack the data needed to fully evaluate Weirs Beach, site location suggests the importance of fishing, perhaps including anadromous fish harvests. The site is best be described as a short to medium-term aggregation camp of type eight. Such fish harvesting camps were likely smaller in scale than those focused on large mammal drives with which this site type is also associated. Anadromous fish harvesting sites were likely redundantly occupied, and should thus produce palimpsests of archaeological debris. Spring and summer residential areas would have been dispersed in nature, producing broad scatters of artifacts rather than discrete high-density clusters. Separation between occupation components should therefore be difficult to establish. Such camps would have been supported by additional generalized foraging in the vicinity. Relatively rich and diverse assemblages are anticipated, reflecting a variety of tasks associated primarily with fish harvesting and processing tasks, but with other foraging and processing pursuits as well.

This interpretation of Weirs Beach fits the site description fairly well. One might argue that the lithic assemblage is less diverse than anticipated, dominated as it is by quartz steep-edged unifacial scrapers and a moderate number of groundstone rods. Other Gulf of Maine Archaic sites have produced, in addition to these artifact types, full-grooved adzes, coarse stone “choppers,” and ground celt fragments (Petersen and Putnam 1992). The assemblage thus appears to represent relatively focused activities. This could be the result of short-term occupations during a period of peak resource availability, rather than more extensive seasonal encampments. Such longer-term occupations might not have occurred until the following Middle Archaic period, for which the site has produced very rich evidence.

The apparent redundant nature of site use and resultant rich and spatially dispersed assemblage has greatly increased the archaeological visibility of this site. More broadly scattered sites reflecting a less focused land use pattern were likely produced throughout much of the rest of the year. These sites will be very difficult to locate because of their small size and lower artifact density. Gulf of Maine Archaic sites will also be difficult to define temporally because of their probable lack of bifacial projectile points which typically act as temporal and cultural markers.

IGTS 194-3-1

Site IGTS 194-3-1 is one of a large number of sites recently recovered during the Iroquois Gas Transmission System survey between the Erie Canal in northern New York and Long Island Sound in southwestern Connecticut (Cassedy 1997). Located in the town of West Athens, New York in the central Hudson River valley, the site is positioned on a sloping bedrock bench on the east side of a ridge formation overlooking the Athens Flat area. The site is flanked to the west by the steeply rising ridge and to the east by a slope which drops to a wetland. The ridge itself consists of the chert-bearing Ordovician Mount Merino member of the Normanskill formation (Cassedy 1997: 34). The Athens Flat lowland includes the headwaters of Murderer's Creek which flows north to the Hudson River. The area is well known for the extensive Paleoindian quarry site, West Athens Hill (Ritchie and Funk 1973) as well as the Flint Mine Hill prehistoric quarries in nearby Coxsackie (Parker 1925).

Site 194-3-1 consists of three main horizons of artifact-bearing colluvial sediments. The second of these (Horizon 2) represents an Early Archaic component, defined by the presence of four St. Charles corner-notched projectile points. This point style is typical of the Midwestern Early Archaic. However, McNett (1985: 95-97) reports an analogous point from the lower Early Archaic component of Shawnee-Minisink (upper-Delaware River Valley, Pennsylvania) where it was called a Kline point. The St. Charles style is believed to date to between roughly 9,500 and 9,000 B.P. (Cassedy 1997: 39). While colluvial reworking of sediments across the bench has disturbed site integrity, good stratigraphic separation was evident between the horizons. Because of site disturbance, horizontal patterning cannot be discussed in relationship to the human use of space at this site. Artifact types do, however, indicate rather intensive lithic reduction activity associated with the bifacial reworking of large quarry blanks brought in from nearby bedrock outcrops where initial reduction occurred (Cassedy 1997: 36).

Forty square meters were excavated from horizon 2, resulting in the recovery of over 19,000 artifacts, primarily biface reduction debris. The assemblage also included a number of biface preforms as well as large flakes for tool blanks or expedient use (Cassedy 1997: 39). Local Normanskill formation cherts dominate the lithic material, but red chert, and large pieces of jasper believed to have a source in eastern Pennsylvania or New Jersey were also recovered. The site indicates quarry-related activity focused on the production of bifacial tool blanks for transport elsewhere.

Site IGTS 194-3-1 in light of the resource response model

I have selected site IGTS 194-3-1 for use in this regional site comparison for two reasons. First, the site represents a non-food resource extraction station. Such stations were necessarily integrated into the overall settlement and subsistence systems of the past. Second, the site provides some of the best evidence for the presence of "non-regional" pre-bifurcate point styles in the study region, albeit at its western margin. A point type very similar to those recovered from IGTS 194-3-1 is in the Bull Collection housed at the University of Connecticut. This point is manufactured from a weathered gray-green chert which appears also to be of the Hudson Valley region. The point was found in New London County, along Fort Shantok Brook in Montville, Connecticut. This find suggests that this Early Archaic point style was in use well east of the

Hudson River drainage. While a small number of tenth millennium B.P. point types associated primarily with regions outside of the Northeast have been reported in other regional collections (Dincauze and Mulholland 1977; Nicholas 1988; Thomas 1992; Funk 1996), excavated sites such as site IGTS 194-3-1 are extremely uncommon.

In terms of the resource response model, the site functioned as a temporary resource-extraction location. Such locations would have been associated with all site types except temporary transit camps. Temporary resource-extraction locations should be small, artifact-poor, and typically difficult to locate. They might be formed during minutes or hours of localized activity. Quarry-related sites are a special case, however. In this situation, the sought after resource was predictably located, abundant, and immobile. Site use should therefore be regular and redundant. The special nature of site activity (focused lithic reduction) should produce very dense artifact clusters which are quite visible to the archaeologist.

The residential camp associated with this site was probably located more favorably to predictable food resources. Such a camp could lie as near as the adjacent wetlands, but may be as much as ten kilometers distant, based upon model expectations. If IGTS 194-3-1 was associated with a nearby residential camp, few or no food processing tools are expected in the assemblage, as was the case.

It is also possible that the site represents a logistic camp occupied by a limited number of group members sent to acquire lithic resources from a much more distant location. This scenario is favored by Spiess and Wilson (1989) in their discussion of Paleoindian period lithic movement patterns in the Northeast. Spiess and Wilson argue that the lack of discarded tools of lithic material foreign to quarry sites during the Paleoindian period (as opposed to that recorded for later periods) suggests such logistically-based quarrying behavior, rather than the movement of the full residential group (Spiess and Wilson 1989: 89). The presence of large pieces of useable, extra-regional jasper in itself does not help to resolve the issue of logistical or temporary camp use in this case, but it does suggest that the site's occupants came from a southerly direction and had knowledge of, and even preferred, the local Normanskill chert to the material carried with them.

Conclusions

It is evident that the sites discussed express a broad range of variation across the study region. This variation is expressed in site function, size, tool assemblage content and diversity, interpreted duration of occupation, and the articulation of the site within a broader settlement and subsistence cycle. The above descriptions are anecdotal in nature and were not intended to provide quantitative evaluations of site diversity. This approach was deemed necessary for the examination of a variety of site types which do not lend themselves to direct comparison. The sites reviewed testify to some of the material details expressive of adaptations to local habitats and seasonal conditions which varied greatly over time and space.

Overall, the expectations of the application of the resource response model to the Northeast were met. That is, the sites discussed fell within the anticipated range of site variation for the given sub-regions and time periods in question. In every case, however, the interpretation of these sites required an examination of local conditions in order to better explain the full range of information expressed. This points out that the conclusions drawn from the model are adequate to describe broad regional trends, but that *local conditions must always be assessed to best explain the subtleties of any particular site*. For example, in some cases during each period examined, degrees of settlement mobility were slightly lower than expected. This observation appears to relate to our current lack of a detailed understanding of the resource potential of particular habitats during the periods in question. In these cases, local resources (especially small game and plant foods) were probably more available and better predictable than anticipated, at least during certain seasons. This would have allowed longer periods of occupation at any given site, and lowered degrees of mobility between sites.

All of the sites except Debert were located through purposeful archaeological reconnaissance. While these sites were discovered in stratified sediments of various depth, none is likely to have been discovered through surface walkover or by amateur collectors. This is critical to the question of site visibility during the study period. I have argued that site visibility may be one of the main factors responsible for the rarity of sites of the terminal Pleistocene and early Holocene periods. The data presented (as limited a sample as it is) bear this out. I conclude that sites of this period seem rare primarily because of issues relating to the probability of site discovery. While locations containing intact terminal Pleistocene and early Holocene sediments are in themselves uncommon, where these are present relatively dense cultural debris have been recovered (as recently indicated in the deeply-stratified Brigham and Sharrow sites). In fact, Brian Robinson has even stated, "When analysis is limited to stratified components in northern New England, there is little evidence to suggest that the population was substantially lower during these early periods [the Early and Middle Archaic periods in this case] than in the succeeding Late Archaic and Woodland (Ceramic) periods" (Robinson 1992: 107).

Another lesson taught by these sites is that, where additional information was uncovered from nearby (or adjacent) areas, original site interpretations had to be reassessed. In the case of Debert, the addition of the nearby Belmont remains establishes that the area was reoccupied over a substantial period, indicating relatively stable resource conditions during this time. At Brigham and Sharrow, both lithic and faunal inventories connoted different patterns of settlement and subsistence, although the sites were most likely produced by closely related, if not the same, groups. At Templeton, initial indications of local lithic use were born out upon further excavation, and evidence of a substantial quartz industry was also uncovered. These examples warn us of oversimplifying expectations of regional archaeological patterns based on too few, or too modestly excavated sites. The following chapter takes a closer look at sites of the study period within a very small area. It will be shown that even within this limited space, a high degree of variable land-use is indicated during the period in question.

Chapter 9: Case Studies: The Hidden Creek and Other Late Pleistocene and Early Holocene Sites on the Mashantucket Pequot Reservation

Terminal Pleistocene and early Holocene sites of Cedar Swamp

Introduction

In this chapter I will examine in further detail the late Pleistocene and early Holocene archaeological record of a portion of a single wetland basin in southeastern Connecticut known as Cedar Swamp. This will help to determine if expectations derived from the resource response model are met at the local scale. These suggested that flexibility in group size, group organization and composition, duration of occupation, diet breadth and prey choice, site location, site reoccupation, and site function were critical to the survival and success of northeastern hunter-gatherer groups during this period of rapid climate and environmental change. Social and economic variation should be expressed in the archaeological record in the form of sites of differing size; artifact density, diversity, and distribution; and in raw material choice.

A small number of late Pleistocene and early Holocene sites were recently discovered on terraces of varying elevation adjacent to Cedar Swamp on the Mashantucket Pequot Reservation. In terms of both natural and cultural history, the Mashantucket Pequot Reservation is probably the most intensively studied wetland watershed in the state of Connecticut, and possibly in the Northeast as a whole. This uncommon situation is ideal for establishing the range of variation represented from sites of comparable age, as well as looking at patterns of change over time.

In the late seventies, Snow (1977: 433) suggested that an intensive survey approach be applied to small regions to better understand the complexity of prehistoric land use patterns. In the early eighties, McBride (1984) surveyed the lower Connecticut River Valley with similar goals. This survey helped establish a much needed local cultural-historical sequence for the region, but the data were too general for detailed synchronic intra-site comparisons. Since that time, McBride and the Public Archaeology Survey Team, associated with the University of Connecticut, have spent over a decade intensively surveying the Mashantucket Pequot Reservation.

While McBride (1990, 1992) focused his efforts on better understanding Contact Period patterns of Native land use, he and the Public Archaeology Survey Team located a large number of prehistoric sites as well. Federal recognition and the ensuing economic prosperity of the Mashantucket Pequots during the nineties dramatically increased the pace of development on the reservation. This has resulted in the discovery and excavation of increasing numbers of archaeological sites of all time periods. The current data set lends itself to the comparison of sites of both similar and different time periods to establish potential variation in land use patterns within a small area. Such intra-site variation can provide clues to both diachronic and synchronic variability in past social and economic patterns at a local scale.

Twenty-one sites containing sixty-two diagnostic prehistoric components have been recorded to date, and more are being located as construction promotes further Cultural Resource Management work. Of these, five contain components which are good candidates for Paleoindian and Late Paleoindian affiliation (one of which is the Hidden Creek site) (Figure 9.1). A recently discovered very rich Early Archaic quartz scraper-dominated site has been dated to between 8,500 and 9,000 years B.P. It is currently the only known site of its kind on the reservation. A total of seven bifurcate points, most of St. Albans-like style presumed to date to the mid- to late-ninth millennium B.P., have been recovered as isolated finds from five multi-component sites. None are associated with Early Archaic cultural debris.

At least two sites contain transitional Kanawha-Neville point styles probably dating to the close of the Early Archaic period, between 8,200 and 7,800 years ago, although radiocarbon dates are lacking. These points were found with Middle Archaic Neville and Neville Variant points, known to date to the eighth millennium B.P., and associated tools, such as scrapers, tabular choppers, and bifacially flaked “knives.” Unfortunately, it is impossible to separate potentially earlier from later tool kits within these Middle Archaic occupations, as all are made from the same materials (usually locally available brown quartzite and often gneiss). Twelve sites with Middle Archaic period components have been recorded to date on the reservation, suggesting increased cultural activity in the area at this time. In all cases, the Middle Archaic occupations, while containing numerous tools and having broad horizontal extent, bear no clear features such as hearths or storage pits. This indicates a repeated, but temporary use of these sites beginning at the end of the Early Archaic period.

Environmental reconstruction

Cedar Swamp is located in southeastern Connecticut on the Mashantucket Pequot Reservation roughly between the cities of Norwich and Groton. It can be located on the USGS 7.5 minute Old Mystic quadrangle map northwest of the juncture of routes 2 and 14 (Figure 9.1). The study area is approximately 16 km north of the present shoreline. Though this distance was greater in the past, Cedar Swamp would have been within a days walk of Long Island Sound. The swamp has been described more precisely as a large ombrotrophic (rain-fed) mire (Thorson and Webb 1991: 17). A number of small streams feed the basin but lose identity within the mire a short distance from the shore. Indian Town Brook, a perennial stream, enters and leaves the northern end of the basin with little apparent hydrologic influence on the swamp (Thorson and Webb 1991: 17). This stream flows northwest about five kilometers from the basin where it joins with the tidal Poquotonock Cove and the Thames River. The modern vegetation surrounding the swamp is comprised of a mixed hardwood forest dominated by oak, hemlock and pines, with lesser quantities of hickory, ash, beech, birch, and maples. The wooded swamp itself consists primarily of red maple, white pine, hemlock, and white cedar. Abundant shrub growth includes rhododendron, highbush blueberry, and spicebush (Thorson and Webb 1991: 19).

Environmental and geological studies have focused on the Cedar Swamp wetland basin since the mid-1980's. Twenty four radiocarbon dates spanning more than 15,000 years have been recovered from eleven deep sediment cores, making this one of the best studied wetland bodies in the Northeast (Thorson and Webb 1991; Thorson and McWeeney n.d.). Detailed palynological and plant macrofossil studies, together with sediment analyses, have documented environmental and climate change at Cedar Swamp. The pollen record for the basin parallels analyses conducted elsewhere in southern New England (Thorson and Webb 1991: 28; Davis 1969). Pollen stratigraphy indicates a tundra environment dominated by sedge, spruce and pine between ca. 15,000 and 13,000 B.P. (Thorson and McWeeney n.d.). During this phase, a deep glacial lake filled the Cedar Swamp basin. This lake appears to have drained abruptly about 12,700 years ago, and the deposition of organic sediments within a shallow pond ensued. Spruce, fir, white pine, birch and larch pollen and macrofossils are associated with this transition, as are the remains of pond weeds, grass, cattail, sweetgail and lily.

Between 12,000 and 9,000 years ago this shallow pond began to develop into a vegetated swamp. The transition occurred first at the southern end of the basin and progressed slowly northwards, apparently the result of post-glacial rebound (Thorson and McWeeney n.d.). The result was a complex mixture of micro-environments ranging from open water and marsh to thickly vegetated shrubby bog during this time. A brief increase in alder, birch and spruce around 10,800 years ago likely indicates a return to cooler climatic conditions during the Younger Dryas cooling episode (see pollen profiles in Thorson and Webb 1991). This period is also marked by a temporary return to more aquatic conditions in the basin. After 10,000 years ago warmer, drier conditions prevailed and oak and heath pollen become more common, though pine continues to dominate. Cores at Cedar swamp show the development of a thick zone of woody peat at this time.

Between ca. 10,000 and 8,000 B.P., the Cedar Swamp basin contained a complex mosaic environment. The terrestrial flora consisted of pine and oak, with lesser quantities of larch, birch, hemlock and heath. An established forest covered the local coastal moraine uplands. At its southern end, closest to the study area, the swamp basin was likely thickly overgrown with shrubs and water tolerant trees, providing good cover and browse for both large and small game animals.

The center of the swamp was marshy and offered a broad range of wetland food and non-food resources, including cattail (see Nicholas 1991 for other potential early Holocene wetland resources). The northern edge of the swamp held open water and was drained by a small stream which flowed northwest to the Thames River, which in turn emptied into the Long Island Sound estuary.

Sometime shortly after 8,000 B.P. conditions in the Cedar Swamp basin changed markedly. Between 7,500 and ca. 5,000 years ago all cores show a level of decomposed peat and charcoal associated with the onset of warm-dry Hypsithermal conditions and a lowered water table in the basin (Thorson and Webb 1991). Similar indicators of mid-Holocene lowered regional water tables are in evidence at the Hammock River Marsh adjacent to Clinton Harbor, Connecticut (Shaw and van de Plassche 1991), and elsewhere in the Northeast as a whole (Webb et al. 1993). A lowered water table would have transformed the complex mosaic wetland of the late Pleistocene and early Holocene into an open meadow, and subsequently a forested plain. This simplification of the basin's dominant landform is presumed to have resulted in a lowered diversity and abundance of resources useful to humans at this time. Only after about 5,000 years ago did local water tables rise, and the Cedar Swamp basin regain its wetland character. Since that time it has been dominated by a forested bog fed by both intermittent and permanent streams.

The Hidden Creek site

Introduction

The Public Archaeology Survey Team discovered the Late Paleoindian Hidden Creek site (72-163) in the summer of 1992 during a reconnaissance survey of an area planned for development by the Mashantucket Pequot Gaming Enterprise. Tribal developers intended to place a power plant facility at the location, hence the site's original nickname, the "Power Plant" site. At the suggestion of staff at the Mashantucket Pequot Museum and Research Center, the site was subsequently renamed the Hidden Creek site. The site is located within the Cedar Swamp basin on the Mashantucket Pequot Reservation in Ledyard, Connecticut. It was not recognized as Late Paleoindian in age (ca. 10,000 - 8,000 B.P.) until the excavation of a four meter square block three months after its initial discovery. Later components of the site are also evident, and are marked by a layer of fire-cracked rock and dated features, as well as a low density of argillite, slate, quartz and quartzite artifacts. Since the initial discovery of the Hidden Creek site, a total of 34 square meters have been excavated to a depth of 80 centimeters below ground surface.

Unlike most sites of the “classic” fluted point Paleoindian traditions of the Northeast (e.g., Spiess and Wilson 1987: 47-52), the Hidden Creek site consists of a single high-density locus of stone tools and tool-making debris. The site has produced numerous artifacts of Late Paleoindian age, including a diagnostic parallel, collaterally flaked lanceolate point base and a biface preform with multiple channel flake removals. Other artifacts include end scrapers, side scrapers, utilized flakes and large quantities of production and tool rejuvenation debitage. A gray-green to dark-green chert, with a likely source in the Hudson River Valley, dominates the Late Paleoindian component lithic assemblage (approximately 85%). Other extra-regional and local lithics were used as well. These raw materials suggest that a high degree of mobility was still characteristic of Late Paleoindian hunter-gatherers in the region.

Site description and stratigraphy

The Hidden Creek site rests on a glacial kame terrace adjacent to Cedar Swamp. The terrace overlooks a small stream that drains an ancillary wetland basin into the extensive wetlands system of Cedar Swamp (Figure 9.1). This topographic site location (on a sandy terrace adjacent to wetlands) is typical of nearly all known Paleoindian sites in New England (Spiess and Wilson 1989:130). The site's location within this glacially-formed landscape has made it prone to a number of geomorphologic and pedogenic processes which will be discussed below.

The site’s uncommon depositional environment has resulted in its excellent preservation. The geological section (Figure 9.2) reveals the history of the glacial contact terrace upon which the site rests. The deepest strata (not visible in Figure 9.2) are comprised of coarse glacio-deltaic sediments which were deposited against the calved block of glacial ice that formed the basin of Cedar Swamp some 17,000 to 15,000 years B.P. A nearby smaller block of glacial ice appears to have cut into the sand and cobble terrace as it melted, forming a deep channel. This ice block was likely the source of the ancillary wetland lying southeast of the site area. The flow of melt-water resulted in the deposition of fluvial gravels, bedded sands and slack-water clay lenses above the incised glacio-deltaic sediments between about 2.3 and 1.8 m below the present surface (stratigraphic units 15-21). Above this zone lies a reddish yellow horizon that may represent a Bölling-Alleröd age paleosol formed between roughly 12,400 and 11,000 B.P. (units 13-14). Sediments between 1.7 and 1.1 m are composed of massive (unstratified) light yellow-brown aeolian silts (units 9-12). These were perhaps deposited during sediment reactivation associated with the Younger Dryas climatic reversal between 11,000 and 10,000 B.P. (see e.g., Thorson and Schile 1995; Peteet et al. 1990). Soil creep evidently resulted in the deposition of sediments between 1.1 m and 0.5 m (units 6 and 7). This layer was formed as the light aeolian blanket was eroded from the neighboring slopes. The zone is marked by the presence of grit and rare pebbles up to 2 cm in diameter in a matrix of very fine yellow-brown sandy silt. Colluvial units 4 and 5 suggest that erosive channeling occurred at the end of this period, but was limited to the north-eastern edge of the site area beyond the distribution of artifacts.

An ephemeral contact surface at roughly 50 cm below surface (base of unit 3) marks a possible early Holocene paleosol. Root action and other bioturbative agents such as burrowing rodents and insects have disturbed this level, which coincides with the highest concentration of Late Paleoindian artifacts and debitage. Typological comparisons (discussed in detail below) suggest that these artifacts are between about 9,000 and 10,000 years old. Unfortunately, excavators encountered no dateable cultural features at this depth. Radiocarbon assays associated with non-feature charcoal (samples of which were identified by McWeeney as larch) recovered between depths of 40 and 60 cm have returned uncalibrated dates of 7800 ± 80 (Beta-57274) and $7630 \pm$

120 (Beta-60979) years B.P. This period of time marks the onset of the warm-dry Hypsithermal climatic fluctuation in the region. The dates correspond to those of forest fires documented by the increased presence of charcoal in Cedar Swamp peat cores at this time (Thorson and McWeeney n.d.). Thus the charcoal may not have been of cultural origin. The dates reinforce the geological interpretation of a relatively stable early Holocene paleosol at about 50 cm below ground surface and suggest that little erosion or soil deposition occurred during the millennia between about 10,000 and 7,500 years ago.

The B soil horizon begins above this depth and continues to about 20 cm below surface. The upper zone of this reddish yellow-brown soil horizon (unit 3, between 20 and 30 cm below modern ground surface) is marked by the presence of fire-cracked rock concentrations, post-molds and occasional Terminal Archaic artifacts. Two hearths and a pit feature, all intrusive into the underlying Late Paleoindian horizon, became apparent at this depth and have been dated to 3390 $\pm$ 60 (Beta-74947), 3480 $\pm$ 70 years B.P. (Beta-90368) and 3520 $\pm$ 50 years B.P (AMS Beta-90369) respectively. Based on these dates, these features can all be attributed to the Terminal Archaic period. The dark-brown loamy A horizon follows to the surface, where it is capped with a layer of rich organic detritus. Barbed-wire and the remains of fallen cedar fence posts associated with late 19th century Euro-American land-use have been found in this level. The upper 80 cm of soil at the site exhibits a steady coarsening-upwards sequence suggesting that the gradual erosion of the flanking slopes through soil creep is primarily responsible for net soil accumulation at the site. In this scenario the lightest soil elements were stripped first, followed by increasingly coarse materials over time.

Data recovery techniques

During the initial phase of investigation, four square meters were excavated to a depth of 40 cm below modern ground surface in arbitrary 10 cm levels. Soil recovered from the 50 cm by 50 cm quadrants was screened using 1/8 inch hardware mesh. At this time, excavators recovered the first diagnostic Late Paleoindian artifacts and the arbitrary excavation level was reduced to five cm. Artifacts larger than two cm were three-dimensionally piece-plotted during troweling of each quadrant surface. The horizontal distribution of Late Paleoindian artifacts is shown on Figure 9.3. Artifacts recovered in the screen were provenienced to the appropriate five cm level and quadrant. One-liter soil samples were taken from every level, partly as a control measure for the recovery of debitage passing through the 1/8 inch mesh, but also to provide information concerning soil chemistry, grain size and to test for the presence of botanical remains. Much of this analysis remains to be completed.

Shovel test pits (50 cm by 50 cm) were placed at five meter intervals around the center of the site to determine the horizontal extent of the Paleoindian occupation. It was discovered quite early that the site was contained within a very small, roughly five by five meter area. Additional test pits were located below the terrace along the stream channel to the south and below the rise northeast of the site, but none of these produced material comparable to that of the central artifact concentration.

Excavation was conducted periodically between the fall of 1992 and the summer of 1995. A number of students from the University of Connecticut summer field school in archaeology participated in the last excavation season. During this one month period, the excavated area more than doubled from 16 to 34 meters. At that time, excavation focused on establishing the periphery of the artifact distribution. Based on the observed drop-off of recovered artifacts, a small amount of material likely remains in the ground to the south and east. These areas will be left for future investigation. The excavated area was refilled with back dirt in the fall of 1995.

In addition to the Late Paleoindian material, discussed in detail below, excavators recovered a number of artifacts and features dating to the Late Archaic through Late Woodland periods. The variety of projectile point styles unearthed attests to short-term use of the site area throughout prehistory. After its initial Late Paleoindian occupation, the site was used again most intensively during the Terminal Archaic period. A small number of argillite Snook Kill style points and fragments are likely associated with the two hearths and pit feature mentioned above dated to about 3,500 years B.P. The depth of these finds (20 to 30 cm below surface) is also marked by an intermittent, nearly pavement-like occurrence of fire-cracked rock, as well as small post-molds with a suggestion of linear alignment. The site's Archaic, and possibly later, occupants used lithic materials consisting primarily of argillite and slate, in addition to some quartz, quartzite, and black chert. These material types are readily distinguishable from those of the deeper Late Paleoindian horizon.

The lithic assemblage

Raw materials

I defined fifteen lithic material types from the Hidden Creek site assemblage based upon macroscopically visual characteristics. The combined assemblage from all components totals 5,045 artifacts. Lithic types were divided into three main categories based upon their proportional occurrence at different depths within the site, as well as with their association with diagnostic tool types. These categories are: Late Paleoindian materials (67%), shared and/or interstitial materials (22%), and materials which can be primarily associated with the Terminal Archaic and possibly later occupations (11%). Table 9.1 identifies lithic material types and expresses their rate of occurrence below a depth of 30 centimeters below the present surface.

Table 9.1

Hidden Creek Site Lithic Materials by Depth

MATERIAL TYPE	COUNT	% T0TAL	COUNT > 30 CM BS	% > 30CM BS
Late Paleoindian Lithic Materials (n=3,375: 66.9%)				
Gray-Green Chert	2,291	45.4%	2,090	91.2%
Dark Green Chert	776	15.4%	709	91.4%
Tan Chert	200	4.0%	184	92.0%
Siliceous Siltstone	76	1.5%	70	92.1%
White Quartzite	30	0.6%	27	90.0%
Jasper	2	<0.1%	2	100%
Shared and/or Interstitial Lithic Materials (n=1,107: 21.9%)				
Brown Chert	386	7.6%	258	66.8%
Other Chert	12	0.2%	8	66.6%
Crystal Quartz	55	1.1%	36	65.5%
Vein Quartz	554	11.0%	339	61.2%
Brown Quartzite	100	2.0%	50	50.0%
Terminal Archaic and Later Lithic Materials (n=563: 11.2%)				
Argillite	216	4.3%	83	38.4%
White Chert	8	0.2%	3	37.5%
Slate	201	4.0%	42	20.9%
Black Chert	138	2.7%	25	18.1%
Totals	**5,045**	**100%**	**3,926**	**77%**

While the Hidden Creek site may be one of the deepest and best stratified non-floodplain sites in the Northeast, it has been markedly influenced by bioturbation. Figures 9.4 and 9.5 show the vertical distribution of Late Paleoindian and later lithic material types respectively. It is evident that significant vertical movement of all of the artifacts has occurred. This is certainly the result of bioturbation within the fine sediments of the site. Tree throws and rodent burrowing are likely the most significant causes of the observed displacement. Both of these agents of bioturbation were well documented at the site. Frost heave may have also played a part in the upward displacement of many artifacts as a vertical orientation of large flakes was commonly observed during excavation. Others have observed similar degrees of vertical movement at other sites in the Northeast. Examples include the early Holocene Wadleigh Falls site in New Hampshire (Maymon and Bolian1992: Figure 2) and the small Paleoindian site 28-0C100 in New Jersey (Mounier et al.1993: Figure 3).

Despite these effects, one can measure and control for the resulting overlap in the vertical distribution of archaeological remains of at least two components at the Hidden Creek site. The patterning apparent in Table 9.1 and Figures 9.4 and 9.5 expedites the separation of components based upon material types at this site. Five of the fifteen material types are described as "Shared and/or Interstitial Materials" on Table 9.1. The broad vertical spans of brown chert and both crystal and vein quartz suggest that these materials were used during the Late Paleoindian and later occupations. Some of these materials may, however, represent a separate component, or components, of occupation. A single brown quartzite Brewerton Side-Notched point suggests a possible Late Archaic use of the site area. This material's peak concentration lies between 30 and 40 cm below surface, intermediate between the Late Paleoindian and Terminal Archaic levels. Materials found primarily above 30 cm in depth are also separable into two components. Argillite and white chert are most common between 20 and 30 cm below surface, which corresponds with the depth of the features dated within the Terminal Archaic period. Slate and black chert are most common between 10 and 20 cm below surface. A charcoal stain from the western edge of the site contained a single piece of black chert debitage and was dated to 2280 ± 50 years B.P. (AMS Beta-90367). This suggests that a possible ephemeral Early Woodland occupation association with this material type. Fragments of an untyped thin-walled aboriginal ceramic were found in association with high concentrations slate debitage in test units southeast of the central excavation block, also suggesting a Woodland period use of this material at the site. The analysis of material types by depth suggests the presence of at least four archaeological components at the Hidden Creek site. Artifact typology and radiocarbon dates further support these observations. The rest of this report will focus on the Late Paleoindian component of the site.

The Late Paleoindian material types represented by tools alone provide potential information concerning patterns of lithic procurement, use and discard (Table 9.2). Certain Late Paleoindian material types are over-represented, and others under-represented, in the tool assemblage compared to their respective proportions in the assemblage of debitage alone. Thus, while gray-green cherts make up 68% of the debitage assemblage, they only represent 31% of the tool assemblage. This approximate 2:1 proportion is similar to that of tan chert. This suggests that these material types were the focus of knapping oriented towards new tool production, especially of bifaces (elucidated below). The glassy dark green chert, on the other hand, is proportionally over-represented among the tools by a factor of more than two (52%:23%). Perhaps tools of this material were reaching the limits of their usefulness, resulting in a higher rate of discard. Similarly, the red-brown siliceous siltstone is over-represented among tools by a factor of greater than five (11%:2%). Though a minority material, it was the most readily discarded at the site. Jasper is a special case. Represented by only two end scrapers, this material was not used for tool rejuvenation or production at all. Quite possibly these were the last pieces that the occupants of the site had on hand.

Table 9.2

Late Paleoindian Lithic Materials vs. Tool and Debitage Proportions

MATERIAL TYPE	COUNT	% TOOLS (n=62)	% DEBITAGE (N=3,313)
Gray-Green Chert	19	31%	68%
Dark Green Chert	32	52%	23%
Tan Chert	2	3%	6%
Siliceous Siltstone	7	11%	2%
White Quartzite	0	0%	1%
Jasper	2	3%	0%

Exact sources for these material types have not yet been clearly established. Potential quarry locations in the Northeast are relatively limited, however. The gray-green, glassy green and possibly tan cherts are macroscopically similar to cherts from the Hudson River valley (such as the Coxsackie and Normanskill varieties). I have yet to determine if some of this highly variable material is similar to the yellow-brown to dark gray Champlain Basin (Hathaway formation) cherts so common at the Bull Brook site (Curran and Grimes 1989:48). Only one artifact contains fossil worm-tracks typical of this material. A number of qualified observers have compared the red-brown siliceous siltstone to Munsungen Lake formation cherts of northern Maine. However, this material is visually indistinguishable from chert/siltstone varieties found in the Normanskill series of eastern New York (Spiess and LaPorta, personal communication; Wray 1948). The white quartzite debitage recovered could have a local source, as quartzite outcrops are common in eastern Connecticut. Fine-grained bluish-white quartzites from other Paleoindian sites have been associated with the Cheshire Formation in south-central Vermont (Curran and Grimes 1989: 50). Jasper is a problematic material in New England. Although present in areas as near as northwestern Connecticut and Rhode Island, most high-quality jaspers are still assumed to come from the well-known quarries of eastern Pennsylvania (Curran and Grimes 1989: 50; Spiess and Wilson 1989:87). The lithic material spectrum represented at the Hidden Creek site fits comfortably within the variation observed from other Paleoindian sites in New England (see e.g., Spiess and Wilson 1989:Table 4.1). It suggests patterns of mobility and lithic resource acquisition similar to those of the earlier Paleoindian traditions and is quite distinct from those that emerge after the Early Archaic period in the Northeast.

The observations presented in Table 9.2 suggest a pattern of lithic procurement. Possibly, site occupants had most recently visited the source of the gray-green chert, so that this material was readily available for new tool production. They may have acquired glassy green chert at an earlier time. Tools of this material were reaching the end of their use-lives and were being discarded, though some tools of this material were repaired and probably produced at the site. The red-brown siliceous siltstone was being readily discarded. Excavators recovered a large plane-scraper of this material which could easily have been reworked. Only 69 siliceous siltstone retouch flakes were found. Many have been refit to a broken and discarded lanceolate preform. Jasper is a unique material at the site because it is associated with only two end scrapers. The small size of these tools suggests that they had been discarded after a long use-life. They were likely acquired, either directly or through trade, at some early time.

The tool assemblage

The Hidden Creek site tool assemblage is comparable to other Paleoindian assemblages in the Northeast, with a few exceptions (Table 9.3). Bifaces are relatively uncommon at the site. The six bifacial artifacts larger than 2 cm recovered make up only 8% of the assemblage (Figure 9.6 a-f). All of these represent fragments; no complete bifaces were recovered from the site. Most of the larger biface fragments appear to represent tools broken during manufacture (Figures 9.6 a-e). Only the base of a lanceolate projectile point has a finished quality, and appears to have been broken during use (Figure 9.6f). Another important artifact is a biface preform, with two channel flake removals from its dorsal surface (Figure 9.6e). The preform has a beveled concave base, and modification to the ventral surface is slight. This piece is very thin (5 mm) and was clearly produced from a large flake, rather than reduced from a bifacial preform. Although discarded in an early stage of production, the knapping technology used to produce this artifact is evident, and lends itself to comparison with that observed in Late Paleoindian Crowfield and Holcombe assemblages of the Great Lakes region. An hypothesized complete lanceolate point reconstruction based on fragments recovered from the site is presented in Figure 9.7. Twelve biface fragments smaller than 2 cm were also recovered, representing 16% of the assemblage. These most likely represent debris accumulated during biface production or maintenance. Seven of these appear to be small basally snapped lanceolate fragments, suggesting projectile point rejuvenation. These fragments indicate lanceolate projectile points with squared bases, such as the point base mentioned above. However, one small biface fragment likely represents the ear of a concave-based projectile point.

Unifacial tools and unifacial tool fragments make up the majority of the Hidden Creek site's Late Paleoindian assemblage (68% of the assemblage). The emphasis on unifacial tools is typical of most Paleoindian assemblages. Utilized flakes (flakes with slight edge damage or "nibbling" that can be attributed to use) are common (e.g., Figure 9.8i). Retouched flakes (flakes with intermittent edge retouch) are represented by eight pieces (e.g., Figure 9.8d). Together these tools make up 22% of the assemblage. Both of these types likely represent expedient tools used for quick cutting or scraping tasks. Side scrapers are a more formal type, showing continuous retouch along one or both lateral edges. Excavators recovered nine complete side scrapers (Figures 9.8b, 9.9a-h) and eight scraper fragments (Figure 9.8a, e-h, k-l), totaling 23% of the assemblage. Some fragments have been refit, showing that the broken tool continued to be used and further retouched (Figure 9.9b). In some cases, use damage is visible along the snapped margin of the scraper fragments, suggesting that snapping was performed intentionally (Figure 9.8k). Evidence for this also comes from Plains Paleoindian sites (Frison and Bradley 1980), from the Neponset site (Carty and Spiess 1992), and from the Vail site in Maine (Gramly 1982).

End scrapers are prevalent, as at most Paleoindian sites. Eleven whole and broken end scrapers were recovered, forming 15% of the assemblage (Figure 9.10). These vary in length from 2 to 4.8 cm for complete specimens. Significantly, the two jasper artifacts recovered from the site were end scrapers, one of which is also the smallest example. Deller (1989:Table 8.6) noted the occurrence of end scrapers as a minority exotic lithic element at the Parkhill Phase Paleoindian Thedford II site in Ontario. Their occurrence as a rare lithic type likely suggests that end scrapers had a long use-life as highly curated tools (*sensu* Binford 1979). This observation is surprising since an apprentice flint knapper can produce a trianguloid end scraper similar to those used by the Paleoindians in less than a minute. Ethnographic analogy suggests that end scrapers were most often used as hafted tools in hide preparation (e.g., Mason 1889). Thus, the life-span of the haft itself could partially explain the occurrence of end scrapers as highly-curated, exotic lithics. Heavy damage to the working edge of many of the end scrapers at the Hidden Creek site suggests they may have been used on materials harder than hide; however, similar damage can be produced by failed resharpening attempts. I have described these tools in greater detail in an earlier report (Jones 1997).

While some small angular chert and crystal quartz chunks were recovered, none could be described unequivocally as spent cores or core fragments. Nevertheless, the use of two core types is indicated by tool and flake morphology. The first type is a large ovate biface core, assumed to look similar to the Aziscohos biface from Maine reported by Spiess (1990: Figure 4). Lothrop (1989:110-112) suggests that this was a common core type among the Paleoindians of the Northeast. The well-rounded platform edge of a large scraper (Figure 9.8b) produced from a biface core indicates that these cores were also used as secondary chopping and pounding tools. The second type was a block core, such as those described by Lothrop from the Potts site in New York (Lothrop 1989). A number of relatively large, thick flakes with flat striking platforms struck at steep angles (approaching 90 degrees) provide evidence for the use of these cores at Hidden Creek. Some of these rough flakes were utilized without further modification, but Lothrop (1989) notes that the primary products of this core type were thick-bitted unifacial tools such as end scrapers. In fact, end scrapers with preserved platforms from the site exhibit the expected steep angle and thick cross-sections associated with block core derived flakes.

Excavators also recovered six heavy-duty chopping tools. These are made of local quartz and quartzites. These rough stone tools were located primarily along the west edge of the site in association with high counts of quartz angular debris and shatter. Similar chopping implements have been found at most Paleoindian sites (e.g., Michaud, Spiess and Wilson 1987:72-75). Moeller (1984) has also noted the occurrence of a concentration of quartz debris peripheral to the main concentration at the Templeton site. The quartz concentration at Hidden Creek was uncovered at somewhat shallower depths than the majority of the Late Paleoindian cherts. This is likely the result of a retarded deposition of sediments on the western edge of the site where the slope begins to increase. The quartz concentration may represent a separate component at the site, however.

Table 9.3

Lithic Artifact Classes

ARTIFACT CLASS	ARTIFACT COUNT	% OF TOTAL
Biface Fragments*	6	8%
Small Biface Fragments**	12	16%
End scrapers	11	15%
Side scrapers and Fragments***	17	23%
Retouched Flakes	8	11%
Utilized Flakes	14	19%
Heavy Duty Expedient Tools	6	8%
Total	62	100%

* includes point base and 2 preform rejects
** includes 7 point base fragments
*** 2 refit (15 individual scrapers represented, 9 complete)

Perhaps as important as the tools represented in the Late Paleoindian assemblage are types which are not represented. In particular, limaces, pièces esquillée, and perforators ("gravers") are noticeably absent at the Hidden Creek site. This may be an artifact of the small size of this assemblage: rare tool types might be expected to be absent. Perforators, however, are generally common elements of most Paleoindian assemblages in the Northeast. Their absence may suggest that piercing tasks were not performed at this site, or that this tool type was no longer typical of the Late Paleoindian tool kit. These issues cannot be resolved until northeastern archaeologists find other comparable Late Paleoindian assemblages.

Debitage analysis

Debitage makes up the overwhelming majority of the lithic assemblage and can provide information about the site not available through analysis of the tools alone. The models of Sullivan et al. (1985) and Chalifoux (1994) provided classes for debitage analysis. I have modified these slightly to better fit the assemblage of the Hidden Creek site. Because there is no indication that primary reduction (the preparation of cores and preforms from raw quarry blanks with cortex) occurred at the site, primary reduction debitage types were not included in this analysis. The classes of debitage at the Hidden Creek site include the following: large and small biface retouch flakes, proximal biface retouch flake fragments, biface reduction flakes, parallel thinning flakes, channel flake fragments, end scraper retouch flakes, general unifacial retouch flakes, small angular debris, fragments, and debris. Because such categories are too often glossed over in the literature, I present explicit definitions of each class in Table 9.4.

Table 9.4

Debitage Class Definitions

Large biface retouch flakes (biface thinning flakes)	whole flakes with faceted* platforms; greater than 200 mm^2 in surface area
Small biface retouch flakes (biface finishing flakes)	whole flakes with faceted platforms; less than 200 mm^2 in surface area
Proximal biface retouch flakes	proximal fragments of flakes with faceted platforms
Biface reduction flakes	whole or proximal fragments of flakes with faceted platforms showing an extensive platform lip which removed with it a significant portion of the biface edge
Parallel thinning flakes	straight-sided flakes at least twice as long as wide, including fragments if they are also twice as long as wide
Channel flake fragments	flakes and fragments which display clear dorsal flake removal scars perpendicular to the direction of flake removal, and lateral flakes which have removed a portion of a channel scar
End scraper retouch flakes	unifacial platform flakes with steep edge angles (generally >45 degrees), bearing evidence of heavy use above the platform, often as extensive step fractures. These flakes are usually thick and curve back at their distal end. Many express a degree of torsion
General unifacial retouch flakes	unifacial platform flakes with shallow edge angles (generally <45 degrees). Usually thinner and flatter than end scraper retouch flakes
Small angular debris	blocky flake fragments less than 200 mm^2 in surface area
Debris	usually flat flake fragments upon which the dorsal and ventral surfaces cannot be distinguished
Fragments	all dorsal and medial flake fragments that cannot otherwise be categorized

*Note: *faceting* in this case implies the presence of partial previous flake scars across the platform surface (e.g., Chalifoux 1994). It does not imply the faceted *grinding* of the platform as suggested by Crabtree (1982).

Analysts took great effort to apply consistent, standardized sorting and measurement techniques to the debitage assemblage. More than 65% of the debitage analyzed was typically smaller than 7x7 mm and a 10X hand lens was often required to study the platform characteristics. Because analysis is still underway, I have presented only information on cherts from the site. The breakdown of the debitage classes is presented in table 9.5.

Table 9.5

Debitage Classes

Flake Class	Count	Percent	Percent less Fragments
Large Biface Retouch	22	0.6%	1.3%
Small Biface Retouch	429	12.6%	25.2%
Proximal Biface Retouch	560	16.5%	33.0%
Biface Reduction	47	1.4%	2.8%
Parallel Thinning	29	0.9%	1.7%
Channel Flake Fragment	53	1.6%	3.1%
End scraper Retouch	223	6.6%	13.1%
General unifacial retouch	215	6.3%	12.7%
Small Angular Debris	42	1.2%	2.5%
Debris	78	2.3%	4.6%
Fragments	1699	50.0%	N/A
Total	**3397**	**100%**	**100%**

Biface retouch flakes dominate the debitage recovered from the site (67% of all flakes, ignoring fragments). Clearly the manufacture and maintenance of bifaces was an important activity at the site, despite the relatively low numbers of bifaces and biface fragments in the assemblage. Small, late-stage retouch flakes (finishing flakes) form the majority of biface production debitage. Of the 151 measured small biface retouch flakes, 65% were less than 51 mm^2 in surface area, indicating very fine retouch indeed. Large biface retouch flakes and biface reduction flakes, generally associated with mid-stage biface shaping activities, make up only 4% of the debitage assemblage (excluding fragments). From a sample of 202 measured proximal biface fragments, 51 (25.2%) were greater than 100 mm^2 in surface area, suggesting that many would have been classed as large biface retouch flakes prior to breakage. Applying that percentage to the above counts, one might consider as many as 141 of the 560 proximal fragments to be derived from large biface retouch flakes. This would increase the proportion of biface shaping flakes from 4% to 12% of the assemblage.

The presence of a significant number of channel flake and lateral channel removal fragments is not surprising considering the lithic technology indicated by the fluted preform and overall emphasis on biface production. Channel flakes from Hidden Creek are not typical of those of earlier Paleoindian traditions. They are generally narrow (ca. 9 mm), fragmented and rarely display the classic pattern of a central ridge of converging lateral flake removal scars. Rather, like many of the channel flakes described by Mounier et al. (1993), they often bear the remnants of an adjacent previous channel flake scar. This is not unexpected considering that some bifaces were clearly multiply-fluted. Two channel flake fragments have been successfully refit to the fluted preform as of this writing. One of these extends well below the margin of the concave beveled base, suggesting that channel flake platforms were prepared in a manner similar to that of Folsom points (Frison 1980:48 and Figures 30, 31f, 35). Spiess and others have observed this technique of isolating a basal "nipple" prior to fluting at northeastern Paleoindian sites such as Gainey, Bull Brook, Michaud, and Neponset (Spiess and Wilson 1987:51; Carty and Spiess 1992: 27). Importantly, another series of refits shows that after two (and likely more) channel flakes were removed, a lateral flake (a "channel removal flake") obliterated the existing channel flake scars (Figure 9.6g). This suggests that the knapper fluted the preform to thin its dorsal surface, and then proceeded to work the edges of the biface, thus removing all trace of the channel flake scars. One can see the application of a similar technique in pictures of points recovered from the Late Paleoindian Holcombe site in Michigan (Fitting et al. 1966: Plates IV, V).

Unifacial retouch flakes represent nearly 26% of the debitage assemblage (ignoring fragments). Retouched unifacial tools and fragments, in contrast, comprise about 58% of the tool assemblage. This discrepancy can be attributed to the fact that biface production results in a greater number of waste flakes than unifacial tool production and resharpening. Approximately 20 resharpening flakes were produced for each discarded end scraper recovered from the site. End scraper retouch flakes are closely matched in number to the general unifacial flake category, suggesting a relatively balanced degree of production, use and resharpening between end scrapers and other unifacial tools, such as side scrapers and retouched flakes, at the site. Unifacial tools are most often associated with secondary tool production and hide preparation. I discuss the spatial patterning of these debitage types below.

Horizontal distribution and refitting

The distribution of artifacts at the Hidden Creek site is approximately oval with a slightly longer northeast-southwest axis (Figure 9.3). The area covered by the majority of finds is limited to the central 12 meters of the site. Spatial patterning is suggested in the distribution of certain tools. The greatest number of biface fragments occur in the southwestern area of the central artifact concentration (Figure 9.11). A high density of quartz fragments occurs along the west edge of the site, together with chopping tools and vein quartz chunks (Figure 9.3). Most of the end scrapers were recovered from the southeastern section of the site, although two others occur in close proximity to one another in the northeast (Figure 9.12). Scrapers, retouched flakes and utilized flakes occur throughout the site without evident clustering (Figure 9.13). The most simple explanation for this patterning is that it represents the traces of discrete prehistoric activities.

Refitting analysis has provided some additional spatial information (Figure 9.3). Refits between biface fragments and debitage reinforce the observation that biface manufacture occurred primarily in the southwestern corner of the site. Two scrapers have been refit from fragments along the eastern side of the site. Many refits extend over two meters in distance. Interestingly, the aforementioned refit sequence of channel flake fragments shows one of the most disbursed distributions among refit artifacts. Perhaps these flakes were driven off with greater than average force.

Refitting was also undertaken to control for the possibility of horizontal artifact displacement resulting from post-depositional disturbances. Initial concern that artifacts might have been displaced down the gradual slope of the terrace now seems unlikely: artifacts have shown no pattern of sorting down slope by size, and numerous refits include small debitage located well up slope from the larger lithic fragments with which they have been associated. Sorting by clast size would have been more evident if erosion was a major cause of artifact redeposition.

The density plot of Late Paleoindian debitage reemphasizes the oval pattern of distribution observed for tools in plan view (Figure 9.14). Two high-density peaks of debitage are immediately discernible: Concentration I close to the site center, and Concentration II about two meters to the north. With 910 flakes, Concentration I is relatively evenly distributed over the meter N8E0, while Concentration II is focused within a single 50x50 cm quadrant of N10E0 (with 306 of 612 flakes). Another important difference between the concentrations is the presence of red siliceous siltstone in Concentration I (33 of 69 flakes), but its near absence in Concentration II (only 4 flakes). This suggests two separate knapping episodes. The two concentrations are connected by an arc of higher than average chert density to the east. Interestingly, the excavated meter N9E1, which largely contains the arc, also has the highest count of potlid fractured flakes (Figure 9.15). There is reason to believe, then, that this location once contained a hearth no longer visible at the time of excavation. Interestingly, the concentration of charcoal dated to 7,800 years B.P. was found two meters west of this excavation unit, suggesting that this charcoal is not associated with heat damage to the artifacts.

I have also examined the distributions of two types of debitage: end scraper retouch flakes, and the general unifacial retouch flake category. The general unifacial flake type matches the overall distribution of debitage closely, suggesting no special patterning (Figure 9.16). End scraper retouch flakes, however, are most common one meter east of Concentration I (Figure 9.17). There is also a higher than expected count of this flake type one meter east of Concentration II. This indicates that the use and resharpening of end scrapers occurred primarily in the eastern portion of the site. While it is generally accepted that the distribution of such small elements of waste material can define activity areas more accurately than larger tools, which are apt to be discarded elsewhere (e.g., Whallon 1978:84), the observed pattern corresponds well with the distribution of end scrapers themselves.

The distinct distribution of these tool classes and debitage types is indicative of cultural, rather than natural site formation processes. Thorson (1996) applied data from the Hidden Creek site to his model of slope decline processes. He suggested that the distribution of artifacts from Hidden Creek could be explained largely through natural, rather than cultural processes. Indeed, natural agents have acted to alter the original distribution of artifacts to a significant degree. My own interpretation is that this disturbance is limited to less than a meter in vertical and horizontal distance. This disturbance has blurred, but not destroyed, original cultural patterning. Thorson's model was unable to explain the non-uniform clustering of artifacts observed at the site. He states, "The diffusion model predicts a nonclustered distribution similar to the matrix cells for concave slope. Some other factor must be involved." (Thorson 1996: 31). While Thorson's diffusion model of slope decline processes is pertinent to the archaeological record, the strength of its application at the Hidden Creek site may be limited to the explanation of the burial and vertical separation of components. His premise that the site formed as a result of downward colluvial displacement assumes that archaeological materials were deposited elsewhere above the current site area. In fact, there is no good candidate for a habitable surface upslope of the site. I believe that it is precisely the sediment trap setting within which the site is located that made it attractive to numerous visitors over the years. This small area was underlain by deep, well-drained sandy soils in a location otherwise dominated by less comfortable stony ground.

Activity area reconstruction

The artifacts and their distribution provide evidence of the function and organization of the Hidden Creek site ten millennia ago. Overall, the site is confined to an area of approximately three by four meters. The distribution of artifacts within this area is quite dense, and there is a sense that activity was spatially restricted. This pattern is typical of that recorded for artifact loci ("hotspots") recorded at most Paleoindian sites in the region. A rapid drop-off of debris surrounding two nearby points of knapping activity could explain the observed distribution of debitage (see e.g., Newcomer and Sieveking 1980). However, the remaining larger artifacts are also restricted to the same zone, suggesting that activity may have occurred within a confining structure, such as a skin tent or a wind-break. If activity occurred within a structure, it may indicate a cold-weather occupation of the site, as warm-weather activities can be expected to occur over a larger area outside of a domestic structure (Binford 1983: 186). Direct evidence for this conjecture is likely unattainable.

The duration of occupation can be estimated as a function of the number of artifacts recovered from a site. Spiess has suggested a ratio of one tool discard per three person-days for estimating the duration of occupation of northeastern Paleoindian sites (1984). This Figure results in 186 person-days of occupation, or an 18 day occupation for a group of 10 individuals. Based upon site size, it seems unlikely that more than 10 people occupied this site (see Odell 1980:413-414). Eighteen days is a reasonable upper limit. A lower limit for the period of occupation might be estimated by the minimum amount of time required to produce and use the tools and debris recovered from the site. An occupation of as little as three days seems possible in this case. The actual duration of the Late Paleoindian occupation at the Hidden Creek site likely lies between these two values. Except for the action of natural agents of bioturbation, the distribution of artifacts appears relatively pristine. This suggests a length of occupation at the low end of the estimates. I surmise a duration of stay of less than one week.

The tools and tool-making debris recovered from the site suggest a variety of activities. Clearly, the dominance of biface retouch flakes indicates that the production and maintenance of bifaces was a focus of activity at the site. Direct evidence for the production of projectile points includes the four lanceolate preform rejects and high number of channel flake fragments. Other bifaces, such as knives or preforms, may also have been produced. The presence of the broken point base, and the seven small possible point base fragments suggests that hunting tools were being repaired and replaced at the site. There is a sense of directed tool rejuvenation or “gearing up" activity, suggesting that a hunt had recently occurred, perhaps not far from the site, and that further hunts were anticipated.

The high number of unifacial scraping tools indicates that other domestic activities occurred as well. These likely included the manufacture and maintenance of tools of bone or wood, as well as the preparation of game and hides. Utilized and retouched flakes are assumed to represent all-purpose cutting and scraping implements for use on a variety of soft to medium-hard surfaces. End scrapers are most commonly associated with hide-working activities, but some observers have pointed out that the degree of edge damage (especially step fracturing) often observed suggests use on harder materials as well (e.g., Spiess and Wilson 1987:181-183). As mentioned above, many end scraper bits from the Hidden Creek site also indicate heavy use, presumably on a hard material. Other domestic activities might have included the use of chopping tools of local material for the disarticulation of large game animals and the processing of bone (e.g., Spiess and Wilson 1987:75; Frison and Stanford 1982:60). Rough stone tools occur primarily along the western edge of the site, suggesting heavy work such as initial game preparation or bone processing in this part of the site. Excavators also recovered two possible anvil stones. The presence of distinct linear scratch marks on the surface of one suggests that it was used as a base for cutting. This artifact was located one meter east of the concentration of burned flakes.

Placing the Hidden Creek site in northeastern prehistory

As noted, the archaeological record between 10,000 and 8,000 years ago remains poorly documented, and poorly dated, in the region. Funk has gone so far as to describe this period of time as "…the mysterious centuries that bridged the Paleo-Indian and Archaic cultural stages" (1991: 60). Doyle et al.'s (1985) original survey of Late Paleoindian remains from Maine remains the standard summary of this tradition for the greater Northeast. Since that time a number of other Late Paleoindian site reports and short articles have been published (e.g., Badgley and Boissonnault 1985; Chapdelaine and Bourget 1992; Chapdelaine 1994; Dumais and Rousseau

1985; Keenlyside 1985a, 1985b, 1991; Petersen 1995; Spiess 1992). I do not intend here to go into detailed site comparisons, rather I wish to summarize three separate, but likely related and chronologically relevant, Late Paleoindian traditions in the Northeast.

Holcombe projectile points mark the first, and probably oldest, of these Late Paleoindian traditions. Holcombe points are relatively small (3.5 to 7.0 cm), generally straight-sided to slightly expanding (1.6 to 2.6 cm in width), and very thin (four to five mm). The points are made largely on small thin flakes often bearing remnants of the original ventral surface (Deller 1989: 204). They typically display concave bases, but there is some variation in base morphology. Examination of the artifacts illustrated from the Holcombe site suggests that they were often multiply-fluted to thin the dorsal surface of the preform (e.g., Fitting et al. Plate IV:P, Plate V:G). These points, and associated assemblages, are made from the same high-quality lithic materials characteristic of earlier Paleoindian traditions in the region (Deller 1989:Table 8.4). Holcombe assemblages include a typical Paleoindian toolkit with a strong emphasis on unifacial tools. Located on a sandy terrace, the topographic position of the Holcombe type site is typical of that of preceding Paleoindian sites. It contained multiple, distinct artifact concentrations, as have most "classic" Paleoindian sites in the Northeast. The Holcombe point tradition has been dated to 10,110 $\pm$ 70 years B.P. at the Esker site of western Maine (Will 1998).

Parallel-flaked lanceolate points define the second tradition (e.g., Doyle et al. 1985, Cox and Petersen 1997). These points exhibit robust well-controlled parallel collateral flaking and are long and very narrow with square bases (excellent examples in Ritchie 1980 Plates 2 and 3). They are commonly 2 cm in width, can be up to 18 cm in length and average about 5.5 mm in thickness (based on Doyle et al 1985). The Varney Farm points are very delicate and closer to 1.5 cm in width (Cox and Petersen 1997: Figure 8). They may represent a later (mid-ninth millennium B.P.) development of this form. At the Rimouski site, lanceolate points appear to have been produced from large flake blanks, rather than bifaces (Chapdelaine 1994: 182). However, this seems not to have been the case with parallel-flaked lanceolate points from sites discovered further north along the south shore of the St. Lawrence of the Gaspé Peninsula where they have been reduced from bifacial preforms (Pierre Dumais, personal communication). Where these points have been recovered with relatively complete assemblages they are often associated with side-notched lanceolate projectile points (Lee 1954, 1955; Mason and Irwin 1960; Chapdelaine and Bourget 1992; Chapdelaine 1994; Petersen 1995; Cox and Petersen 1997; see discussion in Wright 1978:72-74).

In Maine, these points are primarily made from argillite, lesser quality cherts, and rhyolite rather than the highly silicified, extra-regional materials more typical of the early Paleoindian tradition in the region (Doyle et al 1985). Spiess has suggested that this pattern of lithic procurement, and the common association of Late Paleoindian find spots in Maine with riverine and lacustrine settings, might suggest different mobility and land-use patterns than had existed earlier, at least in northern New England (Spiess 1992:41). Fowler (1972, 1975) and Hallaren (1988) have reported possible variants of this type, referred to as “Eden” and “parallel stem” points, from southeastern Massachusetts where they are also manufactured from regional felsites and rhyolites. Typologically, the parallel stem variant probably falls late in the sequence.

Triangular, concave based points of Prince Edward Island and New Brunswick mark the third, and perhaps latest, Late Paleoindian tradition (Keenlyside 1985a, 1985b, 1991). These projectile points have been primarily recovered as surface finds along the southern shores of the Gulf of St. Lawrence. Their distribution is the northernmost of the three traditions and suggests that they represent a regional style. They are small (4 to 6 cm in length) and broad at the base (about 3 cm) and relatively thick (averaging 7 mm). The basal concavity often displays thinning. These points are typically made from a fine grained siliceous shale obtained from a quarry about 120 km from Prince Edward Island. Keenlyside suggests that this point type is derivative of the earlier Debert style fluted point and bridges the gap between the Paleoindian and early Maritime Archaic periods. Absolute dates are lacking for sites containing this point type, although apparently related sites of eastern Quebec and southwest Labrador have produced dates between 8,600 and

6,000 years ago (Keenlyside 1991:171). A maritime subsistence adaptation is assumed based upon site location.

Few sites directly analogous to the Hidden Creek site have been recorded to date in the Northeast. Within the framework of the Late Paleoindian technological traditions mentioned above, the Hidden Creek site assemblage falls typologically between those of the Holcombe and the parallel-flaked lanceolate point traditions. The fluted biface preform and projectile point ear fragment suggest technological and stylistic affinities with Holcombe. The emphasis on crypto-crystaline cherts and the site location on a sandy terrace adjacent to wetlands support this, as do the typical Paleoindian unifacial tool types. On the other hand, the parallel-flaked projectile point base is typologically closer to the lanceolate form, though the site lacks the side-notched lanceolates which appear within some of these assemblages. While there may be some chronological overlap, the Holcombe type likely precedes the lanceolate type in the Northeast. I suggest that the Hidden Creek assemblage dates to between ca. 10,000 and 9,500 years ago.

While the Hidden Creek site assemblage is comparable to other Late Paleoindian assemblages in the Northeast, most analogous sites and surface finds occur in the Great Lakes Region, along the St. Lawrence, and in northern and western Maine (Doyle et al. 1985). There are at least two exceptions to this northern pattern. The first is the multi-component Paleoindian Plenge site (Kraft 1973), and the second is Turkey Swamp (Cavallo 1981), both of northern New Jersey. Interestingly, pollen profiles of New Jersey and eastern Pennsylvania during the early Holocene indicate high proportions of sedge, suggesting the existence of relatively open woodlands (Gaudreau and Webb 1985). This environment would have been attractive to people with a seasonal large-game hunting focus, and could explain the presence of Late Paleoindian populations. Turkey Swamp in particular remains an enigmatic site. Its relatively small triangular projectile points (with flat to concave bases) have been compared by Cavallo to those of the Reagen site. However, the toolkit illustrated is rather atypical of Paleoindian assemblages, and the presence of chipped stone adzes could suggest ties to mid-Atlantic Early Archaic traditions. In general, the

Hidden Creek site seems most closely related to those of more northern regions. With the Hudson River valley as a likely source of the majority lithic material used, there is some suggestion that this drainage system offered a convenient route to the St. Lawrence River or Lake Champlain Basin.

The lithic material spectrum recovered from the Hidden Creek site suggests a degree of mobility comparable to that assumed for the early Paleoindian period. As such, seasonal movement from the northern interior to the coast, previously suggested for the early Paleoindian period, is conceivable in this instance as well (Curran and Grimes 1989). Jackson and McKillop (1991) suggest a similar settlement model for southern Ontario. They interpret the large, well known, strand-line sites as brief spring or fall occupation areas likely associated with communal caribou hunting. Thus, they are probably atypical of settlements which occurred throughout most of the year. Much smaller, though presumably more common, interior sites probably represent temporary summer and winter hunting camps and task-specific locations left by family-sized groups. The apparent rarity of Late Paleoindian sites in southern New England likely precludes the regular use of this area as part of an established seasonal round. However, the existence of the Hidden Creek site shows that people, perhaps typically of more northern latitudes, occasionally took advantage of the region's milder climate.

It is reasonable to suggest that the Hidden Creek site represents a camp used for a short time by a mobile family-sized group during part of the year when foraging in larger groups was inappropriate. As such it appears to represent a type three short- to medium-term residential hunting camp focused on nearby resources which were generally unpredictable, dispersed and rich in quality. During the expected time of occupation, such a resource base may have consisted of deer, elk or moose in summer forests. The camp would have been supplemented by foraging for smaller game and plant foods in the vicinity. The sites left by such activities would contain few or no artifacts, and will most likely be archaeologically invisible. The observed tight horizontal distribution of artifacts may, however, relate to cold-weather conditions that constrained activity locations. If occupied in winter, the site could reflect a type four settlement based on the procurement of unpredictable, patchy and rich resources, such as yarding deer. These settlements are expected to contain between two and four residential locations indicated archaeologically by distinct and dense concentrations of artifacts. Evidence for additional artifact loci is entirely lacking from Hidden Creek, however. If this was a winter camp, it suggests that the resource base was not adequate to support a larger co-resident group.

Other Paleoindian and Early Archaic sites found on the Mashantucket Pequot Reservation

Paleoindian sites (eleventh and tenth millennium B.P.)

The candidate for the oldest site on the Pequot reservation is currently represented by a single multiple graver ("coronet graver") found during initial testing of a planned monorail route along the southern edge of Cedar Swamp. Multiple gravers are good diagnostic markers of the Paleoindian lithic tradition. The tool was manufactured from a thin flake fragment of greenish chert of probable Hudson Valley origin. The location of this find has not be well tested, but it is considered likely that a Paleoindian camp of unknown size is located in the immediate vicinity. While it is conceivable that the artifact was dropped along a trail and represents a stray find, the likelihood of finding such an object out of a site context is near zero.

The second Paleoindian location is a small component of site 72-97 located about 100 meters north of the Hidden Creek site. This component is associated with a single rhyolite point base similar to the Holcombe style of late Paleoindian age (Fitting et al. 1966; Deller and Ellis 1988: 258). Numerous utilized black chert flake tools and knapping debris were also recovered in the vicinity. Features were absent, but a high concentration of carbonized nut remains (currently unidentified) was found in proximity to the artifacts. These remains are as yet undated. The site appears to represent a short-term processing station. Biface knapping (probable projectile point manufacture) occurred, as well as the use and discard of a number of expedient scraping or cutting tools. If the nut shell remains are associated, they suggest that a small fire was built, nuts were consumed, and the refuse discarded in the fire, or that the nuts were purposefully roasted in their shells. A single individual could have produced the site a number of hours. It suggests logistical activity associated with a nearby (five to twenty km distant) larger residential camp. A second Holcombe-like base was found a short distance from this area in a context disturbed by later Early Archaic activity (Forrest, personal communication). It may represent another temporary visit to the same location.

A single Late Paleoindian parallel-flaked lanceolate projectile point fragment was found on the northern edge of a multi-component Late and Terminal Archaic period site (72-54) less than half a kilometer north of site 72-97. The point tip was found adjacent to a stream edge at the margin of the present Cedar Swamp. Only two square meters were excavated in the area adjacent to this find, but no associated artifacts were recovered. However, excavators found possible channel flakes from a different area of this site, some 30 m south. The point is made of a greenish gray chert (with a possible Hudson Valley source), is quite thin, and displays well-controlled, collateral flaking. It is quite similar to bifacial artifacts recovered from the Hidden Creek site in both manufacture and raw material. The point may have been discarded at a kill and butchering site, it may have come to rest with an injured game animal that escaped, or it may have been redeposited from a location further upstream. The latter possibility is less likely because the point tip shows little abrasion. Further excavation at this location may reveal more information concerning the nature of this site. For now, it seems to represent logistical hunting activity in support of a nearby residential camp, perhaps similar to Hidden Creek.

The fourth site (a component of the historic period site 72-66) is possibly Late Paleoindian in age, but the artifacts recovered are not unequivocally diagnostic of this period. It is located less than a kilometer from the Cedar Swamp along a small spring-fed upland stream. Artifacts were tightly clustered within a roughly five by five meter area. Typological comparison is hampered by the possibility that the short lanceolate (trianguloid) projectile point fragments recovered may represent preforms of a later time period. Nine biface fragments were recovered, two of which cross-mend to form a complete triangular, square-based point. All bifaces are made of rhyolite that has patinated gray-white from an originally dark gray ground mass. This material is comparable to that from known quarry locations in the Boston Basin area (Hermes personal communication 1997; Hermes and Ritchie 1997). In addition to the biface fragments, thousands of small biface retouch flakes were recovered. Most of these are rhyolite, but many are also gray and gray-blue chert. This mix of extra-regional materials (probably from very different, equally distant sources) is more suggestive of the Paleoindian lithic tradition than that of later periods. The debitage has not been examined in detail, but in addition to biface reduction debris are flakes of unifacial retouch, suggesting the resharpening of scraping tools. No unifacial scraping tools were found at the site, however. The site remains most likely represent short-term tool rejuvenation activity, which included the use of scraping tools. No evidence of fire is present. A single person passing by this location might have produced this site in less than an hour.

Early Archaic Sites (ninth millennium B.P.)

The Early Archaic component of site 72-97 is one of the most intriguing sites recently discovered on the reservation. This component is associated with numerous quartz “core” scrapers and abundant quartz knapping debris, as well as many striated fragments of ocher and graphite. Groundstone tool fragments and numerous tabular “choppers” were also recovered. The latter might have been used in part for plant food processing tasks, and perhaps digging. The quartz used by the makers of these tools was available locally from stream cobbles, as well as from nearby outcrops at Lantern Hill, now the location of a silica mine. Typologically, the site compares well to others of the Gulf of Maine Archaic tradition (Robinson and Petersen 1993; Petersen and Putnam 1992).

The quartz artifacts are most prevalent in meters containing buried anthrosols. These anthrosols appear to represent the floors of large pit-houses excavated by their inhabitants well into the glacial lake-bottom sands of the lower subsoil horizons. Five concentrations of overlapping pit-houses have been tentatively located based on the presence of quartz concentrations and soil stains. Only two of these have been examined in any detail to date. They both appear to contain multiple house floors which are oval in shape and close to five by four meters across. Depressions in the floors are associated with concentrations of charcoal and may represent small hearths, posts, or other locations of cultural activity that accumulated anthropogenic sediments. In many cases these features are associated with high counts of carbonized nutshell fragments. The floor of one structure was radiocarbon dated with 10 grams of carbonized nutshell remains recovered from a single meter in the field. These nutshell remains (identified as hazelnut) returned a date of 8920 ± 100 years B.P. Many more botanical remains are likely to be recovered when soil samples are flotation separated in the lab. Two other floors were recently dated on material identified as carbonized cattail fragments (Forrest and Perry, personal communication). These dates were consistent with the initial date: 8710 ± 60 (AMS Beta-113498) and 8490 ± 60 (AMS Beta-113499). They suggest repeated occupation spanning the first half of the ninth millennium B.P.

Where profiles were available for examination, it was apparent that lower anthropogenic stains were buried by similar stains higher in the profile, sometimes separated by a clean layer of subsoil fill. This indicates reoccupation of the same location in these cases. The five expected structure localities may in fact represent well over double the number of individual habitation structures. It is unknown if this pattern of multiple use holds true for the unexcavated locations, however. It is evident that the habitation structures required substantial effort in their production. The amount of cultural debris recovered also suggests relatively long-term occupation, as might occur over a season. The recovery of nutshells and cattail, the apparent permanence and scale of the structures, and their location on a south-facing hillside strongly suggests extended winter occupation. It may be impossible to resolve if any or all of the structure locations were occupied at the same time.

At the time of this occupation, the Cedar Swamp basin contained a complex mosaic wetland. A wooded swamp covered the southern half of the basin, while the northern half held marsh and open water fed by Indian Town Brook (Thorson and Webb 1991; Thorson and McWeeney n.d.). Macrobotanical remains from deep sediment cores indicate that this marsh contained water-lily and cattail, both of potential food value to humans (Thorson and McWeeney n.d.). A mixed pine-oak forest with a dense ground cover of heath covered the upland hills. It is evident from the carbonized botanical remains recovered from the site that local micro-environments supported groves of nut trees as well. The environment was ideal for moose and deer, as well as a variety of small game mammals, the most important of which were probably beaver and muskrat.

The Early Archaic quartz component of site 72-97 most likely represents a seasonal base camp. It is probable that its occupants selected this location for the quality of its well-drained soils, its southern aspect, and its proximity to a wealth of potential resources. It is evident that the site was reused for a long period. It remains unclear whether occupations reoccurred seasonally in succession, or were intermittent during a span of centuries. In either case, the site bears testimony to the potential resource richness of the Cedar Swamp basin at this time, in stark contrast to earlier assumptions of negligible resource quality in the Northeast during the early Holocene (e.g., Fitting 1968). In fact, the site meets most of the expectations presented by Nicholas (1988) in his early Holocene glacial lake basin land-use model. Sites of this magnitude and duration are not apparent again on the Mashantucket Pequot Reservation until the Terminal Archaic period, 3,500 years ago. Even sites of this much later period have left no evidence of such large and complex living structures.

The Early Archaic occupation of site 72-97 does not fit neatly into the regional site types anticipated by the model. In fact, the resource base supporting this site falls between types six and eight – i.e., predictable, patchy and of moderately high quality. As such, the site is best described as an extended focused foraging camp (type six), which may have been supported by logistical resource procurement camps and local foraging or trapping of small game. The duration and scale of occupation are best understood as a response to the storability of processed nuts and tubers. This characteristic provided a longer-term, more predictable resource base.

Bifurcate point finds

Finds of isolated bifurcate-based projectile points represent the period immediately following the main occupation of site 72-97 . As mentioned, seven bifurcate points have been recovered from the Mashantucket Pequot Reservation over the last decade. These points compare typologically to those of late ninth millennium B.P. age (8,500 - 8,000 years B.P.), and are manufactured from non-local cherts and rhyolites. All occur on raised terraces surrounding the Cedar Swamp basin as isolated finds on multi-component sites. There is no evidence of other cultural material which might indicate associated activity, let alone recognizable settlement remains. This suggests that, while peoples of this tradition utilized the Cedar Swamp basin, domestic activities occurred elsewhere. The possibility exists that habitation sites of this period are buried beneath peat sediments along the wetland margin. During the early Holocene the water table of Cedar Swamp rose from roughly two to one meter below its present level (Thorson and Webb 1991). This means that paleo-shorelines are now submerged within wetland sediments. However, this situation applies to the preceding time periods as well, for which there is better indication of occupation.

The scattered finds of bifurcate projectile points in interior settings such as Cedar Swamp probably represent the remains of logistical hunting activity tied to coastal and riverine base camps. This pattern of land use, and the return to increased dependence on non-local lithics, is quite distinct from that observed for the preceding Early Archaic quartz tradition on the Mashantucket Pequot Reservation. It may indicate the actual spread of peoples from the mid-Atlantic region into southern New England at this time. The possibility remains, however, that as we investigate more sites of both periods, these apparent differences may fade.

Chapter 10: Implications of the Resource Response Model and Archaeological Investigations at Mashantucket

I have divided this chapter into four sections. The first examines how archaeological investigations at the Mashantucket Pequot Reservation have increased our knowledge of the culture history of the Late Pleistocene and early Holocene periods in southeastern Connecticut. Application of the resource response model as an explanatory template helps one to interpret the range of archaeological finds recovered from this small area as part of a larger, dynamic social and economic system. The second section examines how the recovered information informs us of the early prehistory of the Northeast as an archaeological region. Issues important to northeastern archaeologists include changing patterns in lithic technology, spatial and temporal variation in subsistence patterns, demographic trends and mobility patterns, local and regional patterns of immigration and emigration, site typology, and site visibility. The third section summarizes potential global implications of the current research. At this scale of investigation, issues such as the capacity of humans to adapt to changing environments, the effects of migration on populations, and theory concerning technological, social, and cultural change are most pertinent. The conclusion of this work discusses potential directions for future research suggested by the application of the resource response model to the finds at Mashantucket.

Local implications

Hidden Creek and other Paleoindian sites

The Hidden Creek site is located in southeastern Connecticut on a sandy terrace above the wetland basin of Cedar Swamp. This location was most easily approached from Long Island Sound via the Mystic River drainage. At the time of occupation, the Cedar Swamp basin contained a mosaic forested swamp-marsh-open water wetland system. Vegetation was dominated by pine and oak, with lesser quantities of birch, larch, hemlock and heath. The site is small but contains a high density of tools and tool-making debris that likely represent domestic (small residential camp) activities. The number of artifacts and their distribution suggest that a family-sized group of people used the site for a short period of time, perhaps less than a week. They probably followed a foraging or limited logistical economic pattern in a location where large game such as moose, elk, or deer was known to be present, but was dispersed (either singly or in small groups) in poorly predictable patch locations. This pattern is suggestive of spring or summer site use, although other indications (such as the tight distribution of artifacts) point to a possible winter occupation. The location was ideally situated adjacent to a rich, mosaic wetland basin which offered a variety of small game and plant resources as well. Members of the group not involved with possible overnight logistical hunting trips likely harvested these local resources.

The probable source areas of lithic materials left at this camp suggest a high degree of mobility. The site occupants had probably last quarried stone materials along the Hudson River Valley, and they may have acquired other stone types from even greater distances afield. They refurbished damaged hunting gear and probably processed recently killed game and other foods before moving on. I have suggested that the occupants of the site used this part of southern New England sporadically (rather than regularly), and that the site lay within the southern extension of an annual foraging territory focused primarily on more northern latitudes.

The three other Paleoindian sites at Mashantucket likely represent short-term episodes of activity associated with logistical hunting tasks (the monorail find is not included in this discussion because too little is known of the nature of this possible site). These ephemeral sites were likely products of forays to the Cedar Swamp basin from unknown residential camps located within ten or twenty kilometers (the expected logistical radius). The raw materials represented at these sites suggest that such logistical and residential camps were part of a highly mobile settlement pattern that encompassed a broad area between the Hudson River valley and the Boston Basin during this time. At present, no sites clearly dating to the early- to mid-eleventh millennium B.P. have been discovered at Mashantucket. I believe this situation will change with continued archaeological surveys of the Cedar Swamp basin. In fact hikers recently found a fluted point on Lantern Hill, about one kilometer southeast of the Hidden Creek site.

Recovered artifacts represent various activities, including tool manufacture or rejuvenation (72-97, 72-66) as well as more extensive use and discard of expedient tools probably associated with the manufacture of other tools, or with game processing (72-97). The single point find at site 72-54 may represent a kill site – although this has yet to be determined. Settlement organization based on the resource response model suggests that such logistical activity locations should be more common than residential base camp settlements, so their discovery should not be surprising. Such sites are poorly visible in the archaeological record, however, because of their small size and expected lack of diagnostic materials. These three sites suggest the presence of larger logistically-supported camps in the adjacent area. Arguably, many of these were located along the paleo shoreline of the Long Island Sound estuary, and have since been inundated. The lack of large residential Paleoindian sites around the Cedar Swamp basin may be a result of inadequate survey, or it may reflect an actual absence of such sites during this period. If moderate to large residential camps are in fact lacking, it suggests that resources in the basin were not rich or predictable enough to support large and/or redundant occupations at this time. The paleoenvironmental reconstruction of Cedar Swamp indicates that resources were potentially abundant and varied, however.

The Early Archaic Quartz Industry

The substantial occupation represented by the Early Archaic quartz industry component at site 72-97 suggests repeated, seasonal use of this location 9,000 to 8,500 years ago. The pit-dwellings created by the occupants of the site required substantial effort to produce and suggest long-term, probably winter use. These facts indicate a higher level of social and economic complexity than was formerly anticipated for this period. The construction of these dwellings required substantial planning and effort, as did the collection and storage of resources required for an extended seasonal occupation. These organizational needs would have been facilitated by the presence of established group leaders.

While it is unclear how much time lapsed between reoccupations, the fact that the site *was* reoccupied on multiple occasions suggests strongly that resources in the Cedar Swamp basin were both stable and predictable at this time. This contradicts previous models of early Holocene settlement which went as far as to suggest regional emigration at this time. These models were grounded in the belief that the resources of the early Holocene were too poor to support significant human populations (e.g., Fitting 1968; Ritchie 1979). In fact, the magnitude of this site and its implications for the complexity of human social and economic organization go well beyond anything expected in the model presented above!

The recovery of carbonized nutshell and cattail root remains helps in part to explain the discrepancy with this and previous models. Nut fruits and tubers provide a very rich (high-caloric), predictable and abundant food source. They are also relatively easy to store for long-term use. In fact, it is the development of temperate mast forests in New England that has been used in part to explain the observed population increase associated with the Middle Archaic period (Dincauze and Mulholland 1977). The current pollen record, even that recorded in the Cedar Swamp basin itself, provides no indication that nut-bearing trees other than oak were present at this time. They first appear in the regional pollen record between 8,000 and 6,000 years ago (Gaudreau and Webb 1985). Evidence from this site indicates, however, that isolated groves of hazelnut trees were available in southern New England and that humans took advantage of them during the early Holocene. Interestingly, cattail remains are present in cores of the Cedar Swamp as far back in time as 12,000 years ago (Thorson and McWeeney n.d.). Given the evidence for cattail use at 72-97, we must anticipate that Paleoindians, too, used this valuable starch crop here and elsewhere in the Northeast.

It is the unanticipated scale of this site that makes it so significant. It testifies to the fact that no models of past human behavior can reflect the tangible complexity of the day to day existence of hunter-gatherers of the late Pleistocene and early Holocene of the Northeast, or elsewhere. This does not mean that modeling past human social and economic behavior is fruitless or that it should be abandoned. Models provide a yardstick against which we can measure observations made in the real world. An important aspect of the scientific method is to test models against real world observations. When these observation result in unanticipated patterns, it is evident that the model has not considered all possible variables. Such observations promote the maturation of models through the incorporation of new data.

In this case, archaeological observations have shown that early Holocene hunter-gatherers in southern New England achieved an unanticipated level of social and economic complexity. But, archaeological evidence has also provided clues as to why this level of complexity was possible. Here, we have learned that unanticipated, storable food resources which facilitated long-term seasonal residence were utilized. Until now there was no indication that this was so. When this new information is incorporated into the existing model, it becomes evident that the archaeological data can, in fact, be explained.

While the quartz lithic tradition is quite distinct from that of the preceding Late Paleoindian period, it is reasonable to assert that it developed from the latter locally. In fact, there is no evidence at this time that it developed beyond the Northeast. Early use of quartz for expedient tools is observed at both the Hidden Creek and Templeton sites of Connecticut. I suggest that the quartz lithic tradition developed over time from local Late Paleoindian roots. Arguably, more restricted patterns of mobility and an increased use of local lithic sources developed during the tenth millennium B.P. This change would have been associated with an economic shift towards the increasing use of wetland basins and their associated resources, especially small game and starchy aquatic tubers as these areas developed biotically (Nicholas 1988, 1991). Nut fruits were added to this diet as they became available. Only the discovery of many more tenth millennium B.P. sites will help to prove or disprove this hypothesis.

The Bifurcate tradition

The presence of bifurcate points, but overall lack of associated habitation debris suggests that the Cedar Swamp basin was used predominantly as a peripheral hunting ground between 8,500 and 8,000 years ago. The implication is that primary habitation sites (base camps) were located elsewhere. The distribution of bifurcate points in southern New England may suggest a coastal and riverine focus (but see Johnson 1993). If this is the case, base camps associated with the Cedar Swamp bifurcate finds might have been located along the Thames River valley, or the Long Island Sound estuary. Since all of the bifurcate points recovered from the Cedar Swamp basin are manufactured from non-local materials (cherts and rhyolites), a high degree of mobility can be associated with the unknown residential camps.

The pattern for the late ninth millennium B.P. is in stark contrast to that observed for the preceding early ninth millennium quartz industry described above. These differences in patterns of residence, site reuse, and degree of mobility suggest that an intrusive population was gradually displacing indigenous communities of southern New England around 8,500 years ago. The quartz industry, or “Gulf of Maine Archaic,” continues, albeit in modified form, throughout the Middle Archaic period in northern New England (Petersen and Putnam 1992; Sanger 1996). This suggests that a local lithic technology was able to survive in the north where the Middle Archaic Neville and Stark complexes (which typologically follow the mid-Atlantic bifurcate tradition) seem to have had less influence (Robinson 1992).

Regional Implications

In addition to local cultural historical implications, a number of issues are raised in the investigation of sites on the Mashantucket Pequot Reservation which are of importance to the prehistory of the Northeast as an archaeological region. The sites have also helped to fill gaps in our understanding of the region’s prehistory. The following paragraphs summarize my current view of the Late Pleistocene and early Holocene prehistory of the Northeast based in large part upon the discoveries at Mashantucket.

Human immigrants entered a novel environment of the Northeast some 11,000 years ago and rapidly took advantage of its many resources. Despite severe and variable climatic conditions, the population appears to have increased rapidly throughout the following millennium, as marked by a degree of regionalism in the archaeological record by as early as the mid-eleventh millennium B.P. The discovery of both large and small sites suggests that small highly mobile groups occasionally aggregated for communal activities which likely focused on the hunting of caribou or other predictably located abundant game, and that certain landscapes were redundantly visited. Throughout this time, similarities in projectile point style indicate that contacts were maintained with neighboring regions, especially towards the Great Lakes.

People appear to have maintained a high degree of mobility throughout the following tenth millennium B.P., although local lithics were being more commonly incorporated into toolkits in most regions. During this millennium, cultural traits and possibly immigrants themselves were spreading northward from the mid-Atlantic coastal region into southern New England, but to a very limited degree. In central and northern New England, and the Canadian Maritimes, contact with the Great Lakes region might have been stronger, as suggested by the thin horizon of lanceolate projectile point finds most common in these regions. The Hidden Creek site is technologically related to these northern northeastern and Great Lake traditions. Its location in southern New England attests to both the high degree of mobility of northeastern hunter-gatherers at this time, as well as to their capacity to successfully utilize a broad range of environments.

It was during the latter half of the tenth millennium B.P. that a unique adaptation to local early Holocene conditions likely evolved. This adaptation is best expressed archaeologically in the quartz-groundstone technocomplex known regionally as the Gulf of Maine Archaic. In southeastern Connecticut, people of this indigenous culture were able to harvest the resources of the Northeast's early Holocene forests and wetlands efficiently enough to support repeated large-scale seasonal occupations. The long-term nature of the settlement of site 72-97, and the appreciable effort required to build and maintain the shelters excavated there may pertain to a more complex form of social structure than had previously been required. Interestingly, this complex, semi-permanent settlement type fades from the archaeological record (at least that of southern New England) by ca. 8,500 years ago. At this time artifacts more clearly affiliated with mid-Atlantic traditions begin to appear. The traces of these people suggest a very different relationship with the land: one in which a high degree of mobility and short-term occupations were again favored in the interior.

In addition to contributing to this anecdotal summary of Northeastern prehistory, research conducted at Mashantucket clarifies some specific issues. One of the most important of these to archaeologists of the region is the discovery of a number of very small archaeological sites. These sites represent part of the variation in land use which occurred during the terminal Pleistocene and early Holocene. Application of the resource response model to the reconstructed northeastern environment of this time anticipated a similar variety of land use patterns. In fact, if predictions based on the model are reasonably correct, we can expect an even greater degree of variation in site types.

Because most of these sites were so small, standard CRM reconnaissance survey methods would have failed to identify them in most cases. This is true even of the two largest sites discussed. We returned to the Hidden Creek site after the initial survey recovery of just three flakes from the only test pit in the immediate area. The site might have been neglected had I not noted that one of these flakes appeared to have been derived from a large biface core, known to be common during the Paleoindian period. Nearby, crews transected site 72-97 three times over a ten year period and then covered it with a five-meter interval grid of test-pits (50x50 cm). But it was not until block excavations were conducted that the nature of this large site became apparent.

This indicates the need for improved regional survey methods in the field. The most simple ways to improve survey samples are to use finer meshed screens (such as 1/8 inch hardware mesh), smaller interval distances within sample grids (such as five meters or less), and larger test pits. As noted, even this may not be enough. However, if the academic community embraces these methods, we can hope that their use will expand to CRM and avocational archaeological projects as well. Of course, improved reconnaissance methods come with significant cost increases in terms of both labor and time. In the CRM world these translate directly into the need for larger project budgets. Until current CRM reconnaissance methods are recognized as largely inadequate to the recovery and recognition of many of the most important site types, it is unlikely that such changes will be implemented. In the end it will be up to local town and county policy makers and the regional State Historic Preservation Offices to make the need for increased budgets clear to both development agencies and legislators.

Once discovered, archaeologists may fail to recognize the antiquity of many of these small sites because of a lack of artifacts now perceived as diagnostic. As our understanding of early lithic technologies increases, diagnostic artifacts will begin to include a wider variety of tool forms and debitage, improving opportunities of site recognition. Our current understanding of Early Archaic lithic technologies is in its infancy. While significant research has been conducted to date on the Paleoindian period, a better understanding of the lithic technologies of later periods will enable us to recognize the differences between them in the field. Paleoindian lithic specialists recognize that certain flake types and patterns of retouch are typical of the period, but these qualities must be better quantified and acquired generally for them to be of use in reconnaissance situations.

Work at Mashantucket has made some improvements in this direction. The analysis of the lithic assemblage of the Hidden Creek site has elucidated important specific technological traits for this period, such as the removal of parallel, lateral retouch flakes bearing medial thinning flake scars – a technique clearly derivative of earlier Paleoindian technologies. Debitage types such as the end scraper retouch flake have been shown to be common at sites of this age, where end scrapers were typically one of the dominant tool types. At site 72-97, the lack of stone projectile points, the presence of large numbers of blocky quartz scrapers, bifacially knapped coarse-grained stone tablets, and a few groundstone implements is evidently indicative of this Early Archaic lithic industry. A better understanding of specific lithic manufacturing techniques, their resultant debitage types, and patterns of lithic preference such as these should facilitate site recognition in the future.

Global Implications

Early Holocene sites are of particular interest to archaeologists around the globe because of their potential to provide information concerning the human ability to adapt to changing environmental conditions (Jochim 1991; Straus et al. 1996). Jochim (1991: 311) suggested that variability in human social and economic behavior should be highest when the environment itself is undergoing rapid change. Because behavioral variability provides the raw material for cultural evolution, the capacity for culture change burgeoned globally during the late Pleistocene and early Holocene. During this period, important social, economic, and technological developments occurred in our species. Some populations began to domesticate plants and animals, complex composite tool forms came into use, some communities manufactured ceramic vessels, and permanent villages began to dot the planet. Humans soon became the most common and reproductively successful large mammal around the world.

Just how these changes occurred is the subject of research and debate at both regional and global scales (e.g., Straus et al. 1996). The work conducted to date at the Hidden Creek and other sites of the Cedar Swamp basin is beginning to shed light on the nature of human response to environmental change in southern New England. While the expressions of that response are unique to both the region and local habitats, they form a part of the global record of the cultural development of the human species, especially as this occurred during the transition from the Pleistocene to Holocene.

Because it was populated much later than most parts of the world, the Northeast is an especially good laboratory for the study of human migration into uninhabited landscapes and how this may express itself in terms of human population growth, resultant demographic patterning, and continued contact with neighboring regions. There are also excellent opportunities to examine ways in which a fluctuating resource base may affect hunter-gatherer populations and the choices they make concerning group size, mobility and patterns of resource exploitation. In addition, northeastern terminal Pleistocene and early Holocene sites have the potential to enrich our understanding of ways in which human technologies develop and are affected by contact with neighboring people, changes in resource exploitation patterns, and cultural isolation which are important to anthropologists around the world. Finally, it may one day be possible to examine ways in which human foragers altered the environment around them through selective or overpredation, the use of fire to clear and manage forests, and possibly through the incipient husbandry of wild plant food resources.

The innovative skills of Northeastern Native peoples and their ability to not only cope with, but to thrive during this period of rapid environmental change testify to the human capacity for adaptive flexibility in the social, economic and technological realms. Such information provides an important sense of hope to members of the expanding human population currently facing a period of rapid technological and economic change themselves.

The Direction and Importance of Future Investigations

The implications of this dissertation suggest directions for future research. In particular, it appears likely that the current archaeological record of the terminal Pleistocene and early Holocene is poorly representative of the actual range of site diversity. This suggests that it is an incomplete record of the adaptation of hunter-gatherers to the changing regional resource base of the Northeast at this time. While quite a range of site types is currently recognized for the Paleoindian period (Spiess and Wilson 1987), this is still believed to be under-representative of the whole. Little can be said concerning Early Archaic site typology at this time. Sites such as Hidden Creek which represent a single occupation event by a small group are currently very rare, as are large habitation sites from the Early Archaic, such as 72-97. The smallest, task-specific locations from both periods are even more uncommon and poorly understood to date. I expect that the current record is strongly biased in favor of interior and upland sites, especially those which contain multiple artifact loci. It is troubling that coastal and most riverine sites are currently beyond the reach of standard archaeological surveillance methods as these lie deeply buried beneath water, silt, sand and marsh deposits. Our current view of Paleoindian and Early Archaic settlement and subsistence is biased in favor of an interior lifeway which probably represents only a seasonal portion of a much more complex system.

In order to rectify this bias and gain a fuller understanding of Paleoindian and early Archaic lifeways archaeologists must make a concerted effort to broaden site surveillance efforts. For the Paleoindian period, the simplest strategy, according to the resource response model, would be to carefully survey the Champlain Sea paleoshoreline of the eleventh millennium B.P. It is here that large, northern coastal seasonal camps should lie. While these may be deeply buried, and many may have been incised and destroyed by stream meanders, the search for such strandline sites is more amenable to typical excavation budgets than that in offshore areas. Early Holocene northern coastal sites should also be preserved along the St. Lawrence River and Gulf. In fact, an apparent concentration of Late Paleoindian sites in this area appears to bear this out (Dumais, personal communication 1996; Chalifoux 1998). The observation of multiple, large sites in this region may thus be more a factor of archaeological visibility than demographic changes.

In the end, however, we will need to push our search into potential offshore habitation areas. For example, Gayes and Bokuniewicz (1991) have located intact terminal Pleistocene and early Holocene paleoshoreline features off of Bridgeport, Connecticut where the Housatonic river once met the Sound. Such areas represent zones of high archaeological potential. In this case, they are buried by ten meters of silt, in addition to ten to twenty meters of water. Such areas can at best be sampled through systematic coring of the sediments. Ideally, paleo land surfaces can be found in near-shore Atlantic waters which are less deeply buried and have not suffered severe surf and current erosion. These areas, if they could be identified, would be better accessible to standard underwater archaeological methods.

Equally important wet sites probably lie deeply buried under alluvium and coastal mucks. Such sites might offer a window into a very different economic realm. Importantly, too, under some wet-site conditions, organic remains have better opportunity for preservation than they do in dry sediments (Purdy 1988). Better faunal and floral preservation is an absolute necessity if we hope to one day shed light on Paleoindian and Early Archaic prey choice and diet. Information concerning the non-lithic tool industry would be equally valuable. At sites where it has been possible to measure lithic to non-lithic tool ratios, organic tools outnumber those of stone by as much as six to one and fiber remains by 26 to one (Adavasio quoted in Lysek 1997). There is considerable potential here for new research.

Only with much more rigorous fieldwork, a broadened site sample including wet riverine sites and those within coastal settings, and site analyses grounded in solid anthropological models and theory can the data set encompassing terminal Pleistocene and early Holocene archaeological remains begin to inform us concerning the details of the following:

1) subsistence patterns (prey choice, importance of plant foods, habitat preference, specialist and generalist behaviors, and the variety of storage and processing techniques)
2) demographic patterns (both local and regional group size and structure, and especially seasonal change therein, as well as longer-term regional population change)
3) extra-regional social contact and the extent of cultural borrowing vs. local innovation
4) patterns of mobility (the extent of band-level foraging regions and a better appreciation for the variety of habitats used by a single group throughout the year)
5) evidence of immigration and emigration and their relation to environmental and demographic factors
6) the details and variety of the regional site typology.

This list forms the core of research questions that future studies must begin answer. While we have begun to understand how humans adapted to the changing world around them at the close of the Pleistocene in the Northeast, we have much to learn. We will undoubtedly face many surprises as our knowledge base broadens concerning this period. New sites, such as Hidden Creek and 72-97 exemplify the difficulty in anticipating “typical” patterns for this period of time. In fact, this dissertation suggests that the period in question should be one of increased innovation and variability in the expression of hunter-gatherer interactions with the environment. Innovation and variability should result in unanticipated manifestations in the archaeological record that reflect a broad spectrum of explicit individual human decisions concerning social organization and means of subsistence.

Conclusions

The goal of this dissertation was to provide a new way of thinking about Paleoindian and Early Archaic hunter-gatherers of the Northeast. Hopefully, the reader is left with a number of ideas which will provoke further research. Principle among these is the expectation that the rapid environmental changes which occurred between 11,000 and 8,000 radiocarbon years ago resulted in dynamic human adaptations to the resource base of the Northeast. Such adaptations would have expressed themselves in terms of prey-choice (subsistence patterns), mobility, technological innovations, and social organization. All of these have direct and observable impacts on the archaeological record. Dynamic patterns of adaptation expressed themselves across both temporal and spatial boundaries. Seasonal variation in subsistence, mobility, and social organization has been seriously under-estimated in most current models of Paleoindian and Early Archaic lifeways. Diachronic and sub-regional patterns of variation as a response to climate and resource-base change were certainly strong as well.

Site visibility is another important recurrent theme in this dissertation. Current sampling strategies have probably not resulted in the discovery of the full range of site types from this period. Refinements in methods of archaeological reconnaissance and increased awareness of site formation and deformation processes will improve this situation to a degree. However, a significant sample of the variety of site types is currently beyond the reach of standard archaeological survey methods. In all probability, some of the most informative sites currently lie beneath tens of meters of water, sand, and silt off the present shoreline and deeply buried in alluvial sediments and marsh peats within the major river drainages. The fact that organic remains may be preserved at many of these sites only emphasizes the need for northeastern archaeologists to literally begin to get their feet wet.

The past two decades have seen vast improvements in our understanding of the archaeology of the late Pleistocene and early Holocene periods. Field and analytical methods have matured, as has our theoretical foundation for understanding the information we have acquired. We have just uncovered the tip of the iceberg, however, and there is a great deal of work to be done. Many provocative surprises await us in the coming years, and there is little doubt that we have much to learn, and unlearn, concerning the first inhabitants of the Northeast.

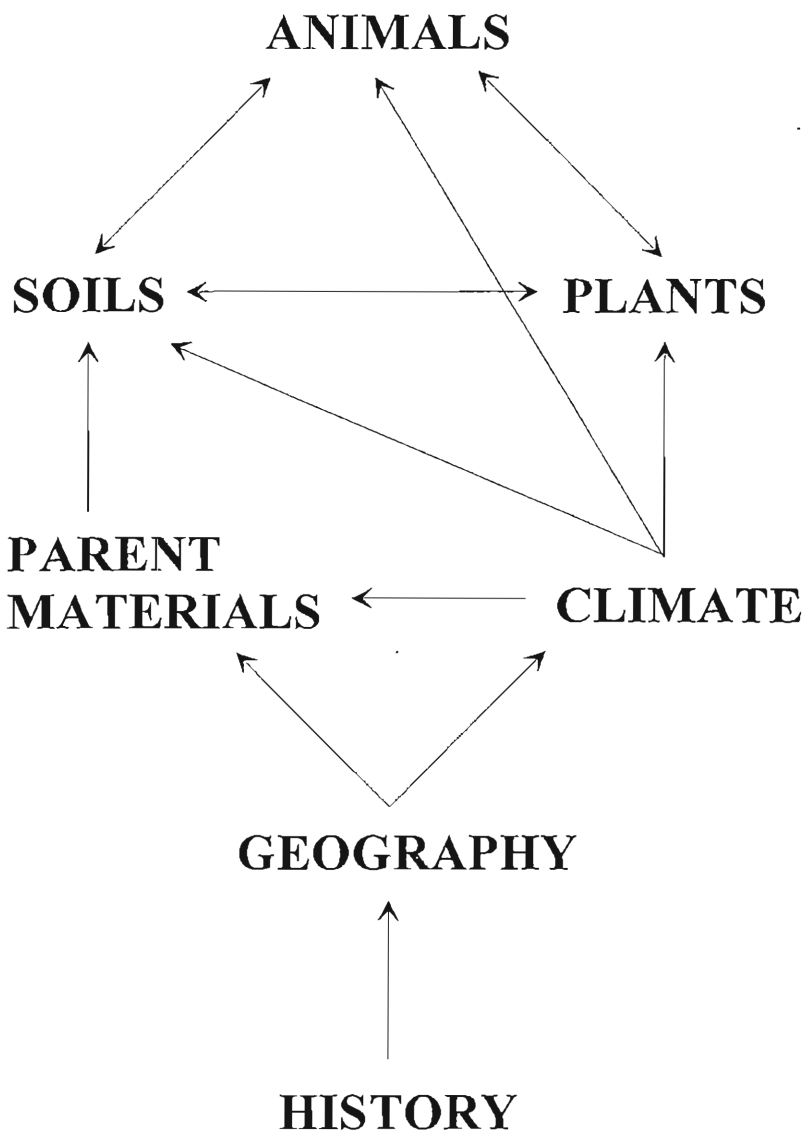


Figure 1.1
Major variables in the ecological web
Adapted from Pianka (1994, Figure 1.2)

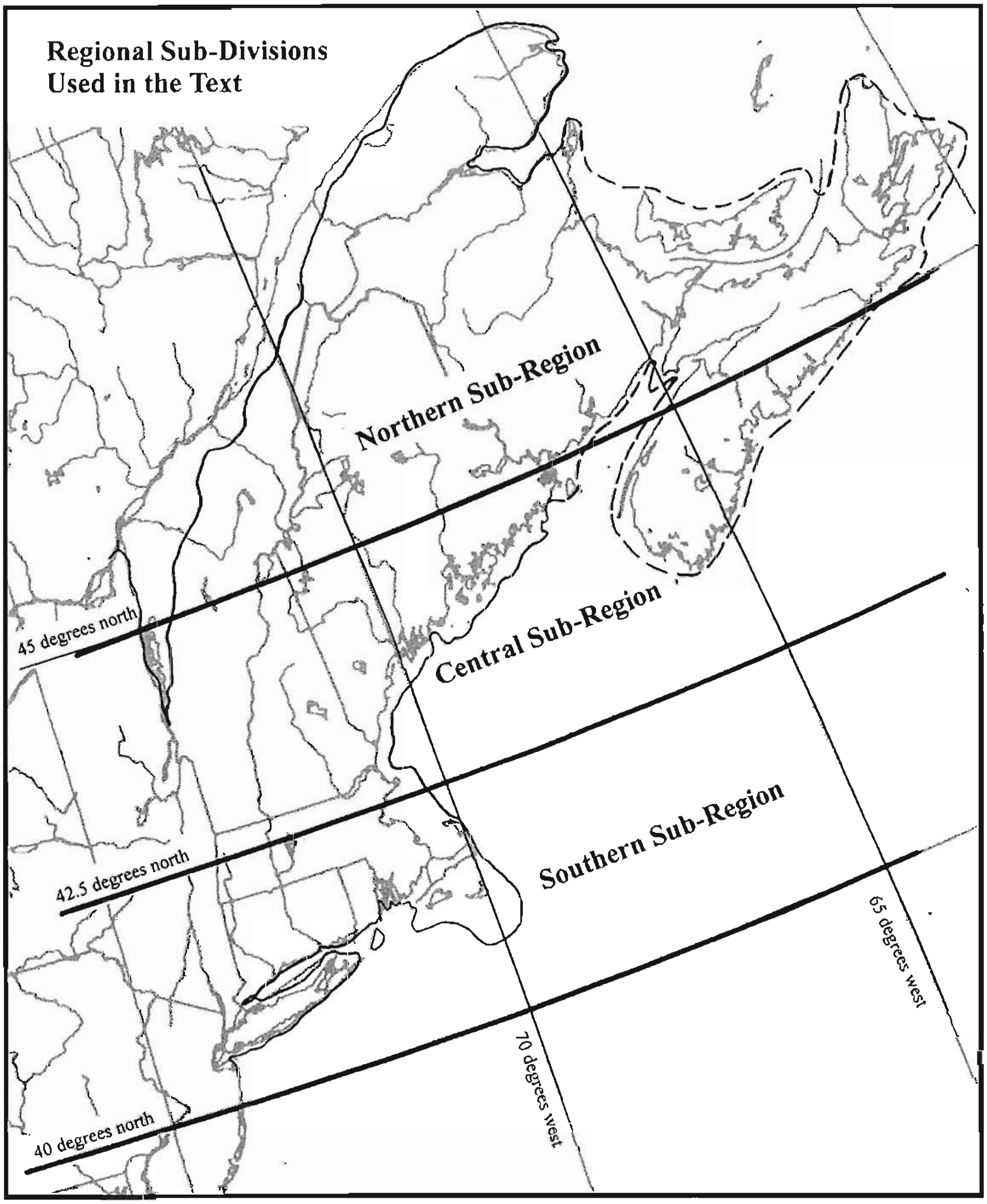


Figure 2.1
Regional sub-divisions of the Northeast used in the text

Figure 2.2
Terminal Pleistocene archaeological sites of the Northeast

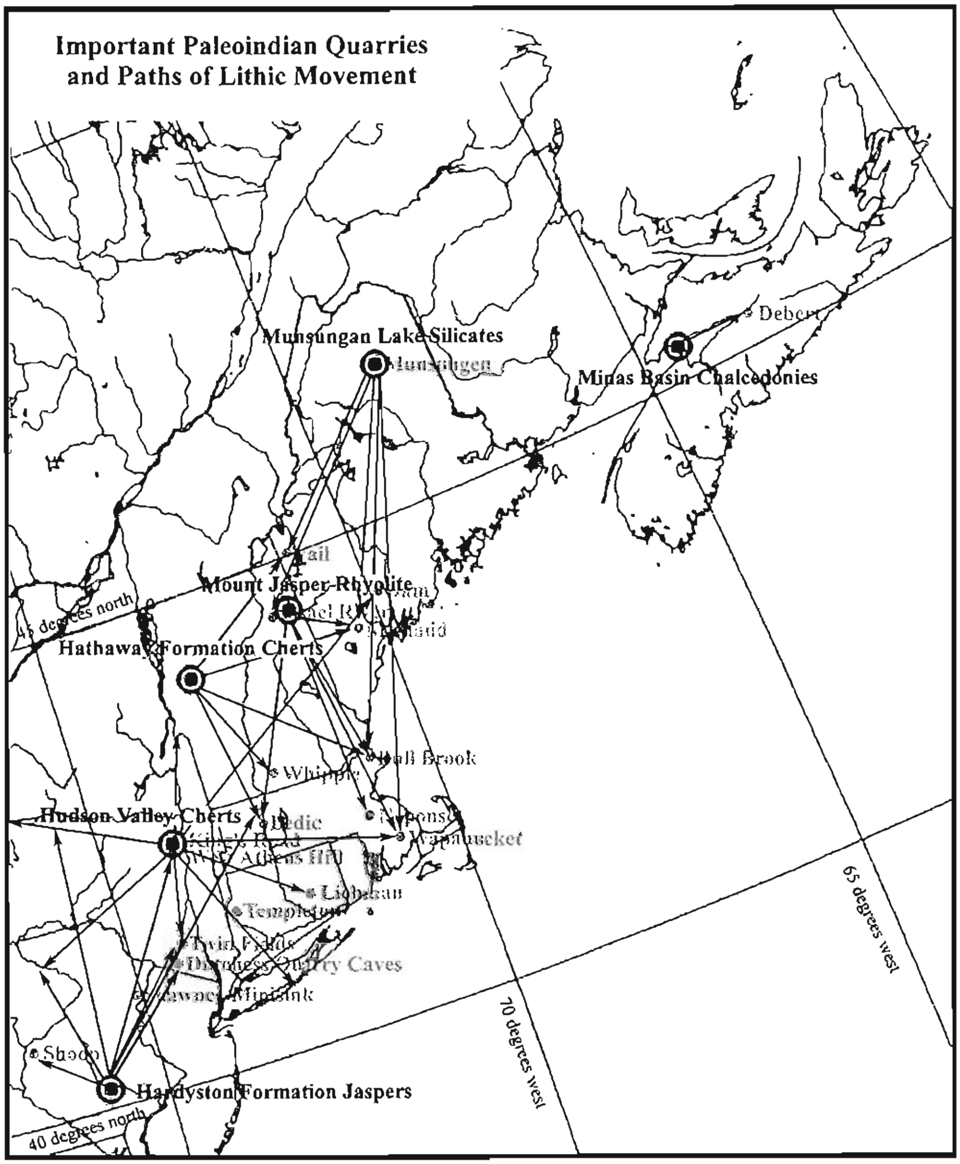


Figure 2.3
Important northeastern Paleoindian Quarries and paths of lithic movement

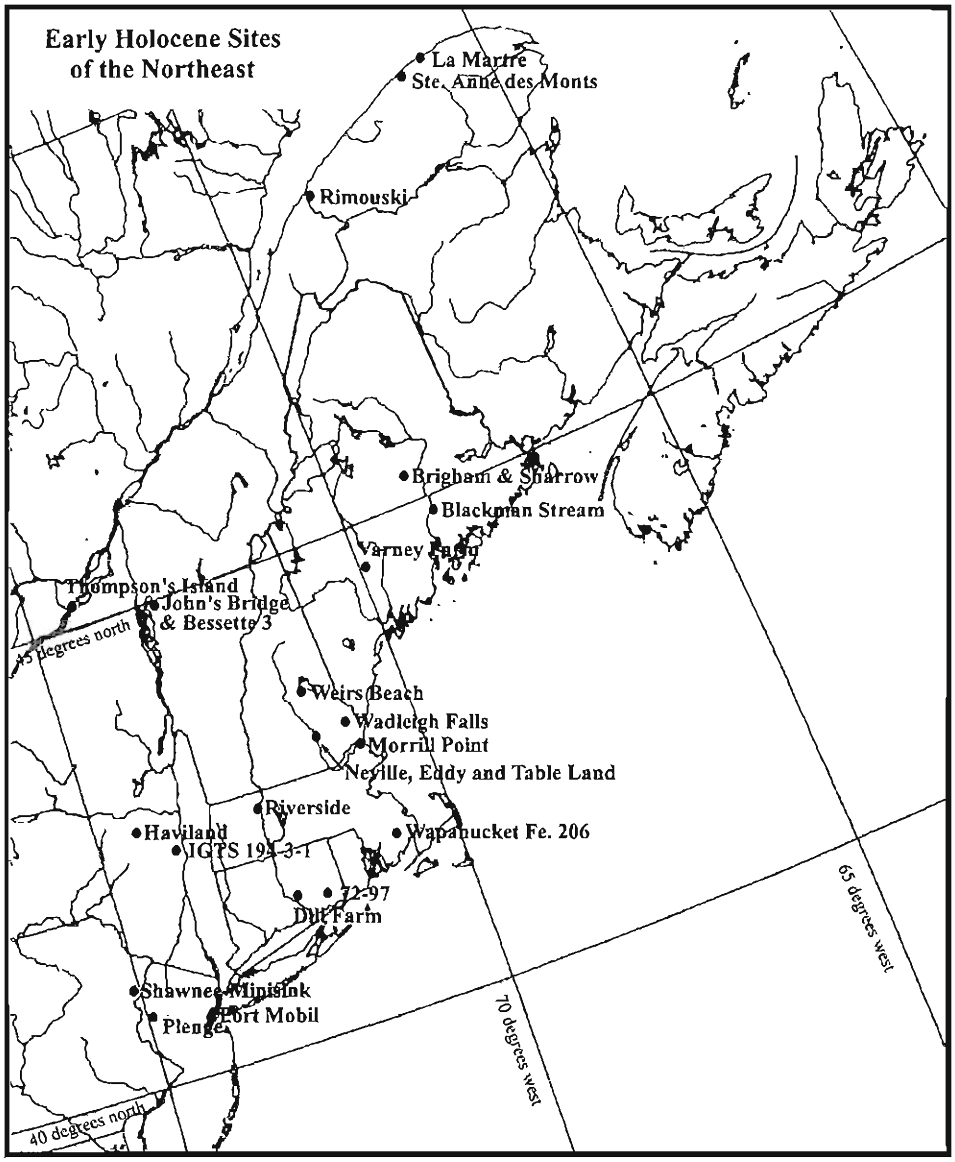


Figure 2.4
Early Holocene archaeological sites of the Northeast

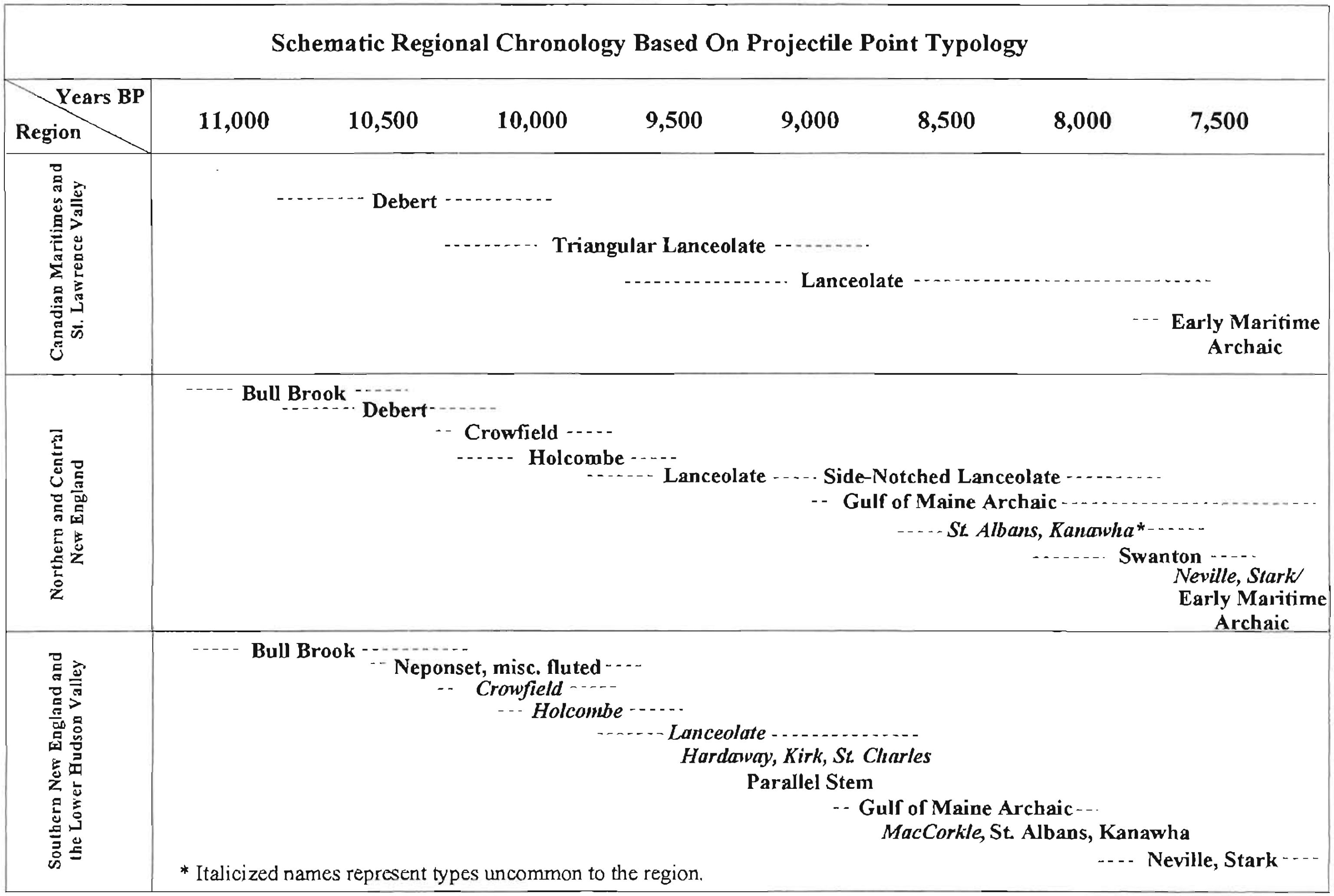
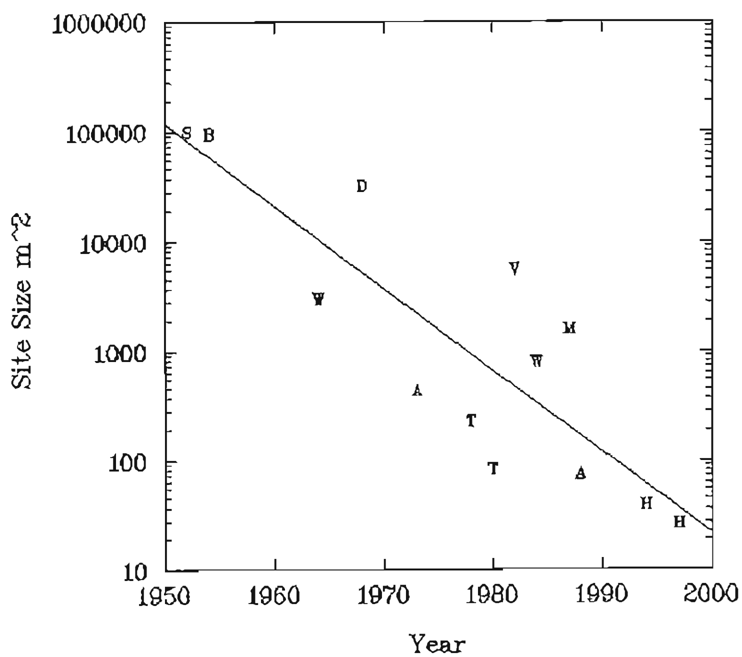


Figure 2.5
Schematic regional chronology based on diagnostic tool technology

Paleoindian Site Size vs. Publication Date



publication date	site size m^2	site	notes
1952	100000	Shoop	estimated from description in Witthoft 1952
1953	4000	Reagen	estimated from description in Ritchie 1953
1954	9550	Bull Brook	Curran 1987, Table 7.1
1964	3020	Wapanucket	Curran 1987, Table 7.1
1968	32415	Debert	Curran 1987, Table 7.1
1973	4047	West Athens Hill	estimated from site plans in Ritchie and Funk 1973
1978	232	Twin Fields	estimated from site plans in Eisenberg 1978
1980	85	Templeton	Curran 1987, Table 7.1
1982	5600	Vail	estimated from site plans in Gramly 1982
1984	792	Whipple	Curran 1987, Table 7.1
1987	4900	Michaud	estimated from site plans in Spiess and Wilson 1987
1988	77	Adkins	Gramly 1988
1994	40	Hedden	Spiess and Mosher 1994
1997	27	Hidden Creek	Jones 1997

Figure 4.1
Paleoindian site size vs. publication date
Sites include Shoop, Bull Brook, Wapanucket, Debert, Athens Hill, Twin Fields, Templeton, Vail, Whipple, Michaud, Hedden, Hidden Creek, and Adkins, $r^2 = 0.65$, $p=0.001$. Site sizes from Curran (1987) or approximated by excavated area as published.

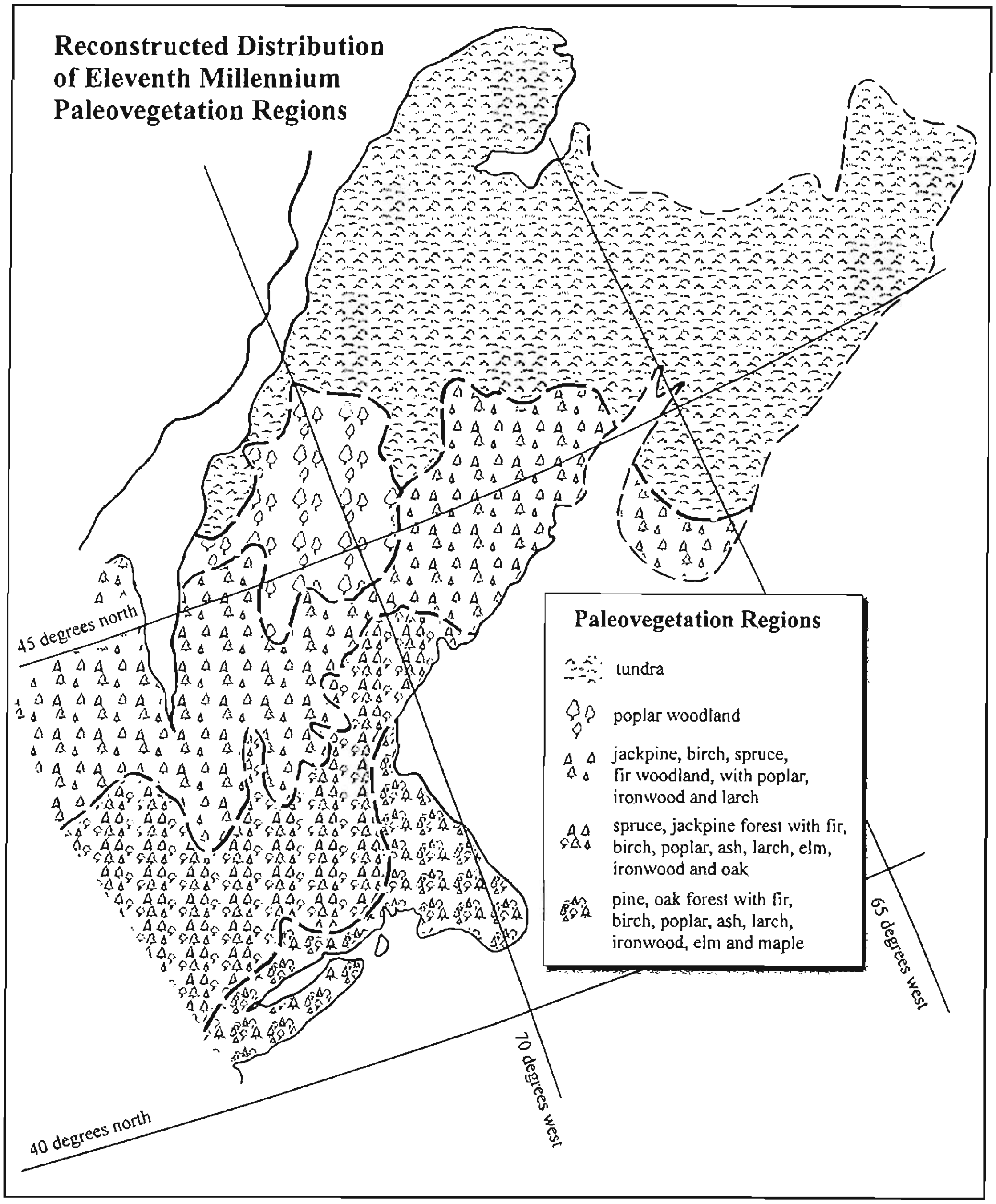


Figure 5.1

Reconstructed distribution of approximate eleventh millennium B.P. paleovegetation regions

Based on Davis 1969, Davis and Jacobson 1985, Gaudreau and Webb 1985, Curran 1987, Jacobson et al. 1987, Webb et al. 1987, Gaudreau 1988, Prentice et al. 1991, Thorson and Webb 1991, Overpeck et al. 1992, Webb et al. 1993, and Spear et al. 1994.

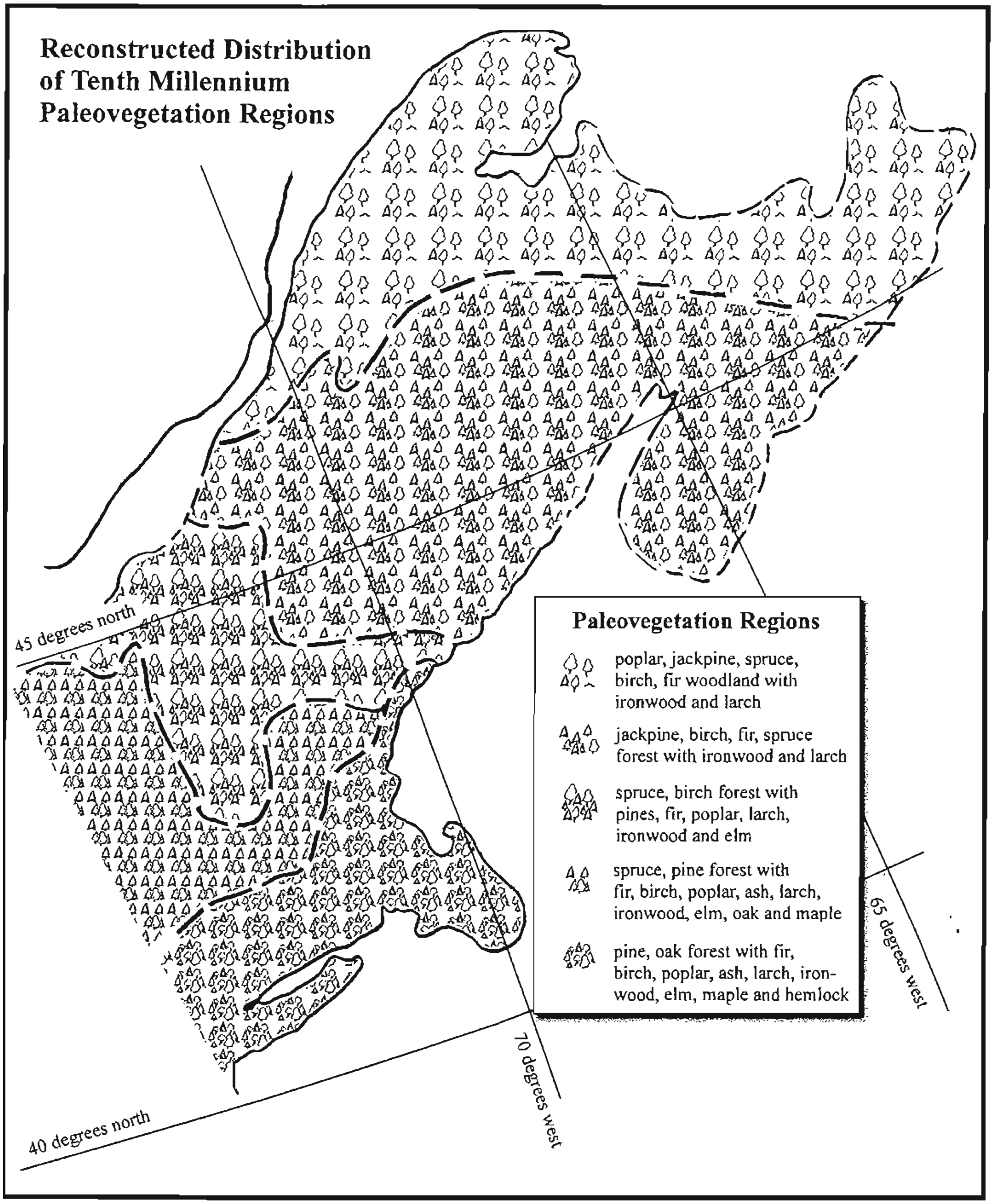


Figure 5.2

Reconstructed distribution of approximate tenth millennium B.P. paleovegetation regions

Based on Davis 1969, Davis and Jacobson 1985, Gaudreau and Webb 1985, Curran 1987, Jacobson et al. 1987, Webb et al. 1987, Gaudreau 1988, Prentice et al. 1991, Thorson and Webb 1991, Overpeck et al. 1992, Webb et al. 1993, Spear et al. 1994, and Jacobson and Dieffenbacher-Krall 1995.

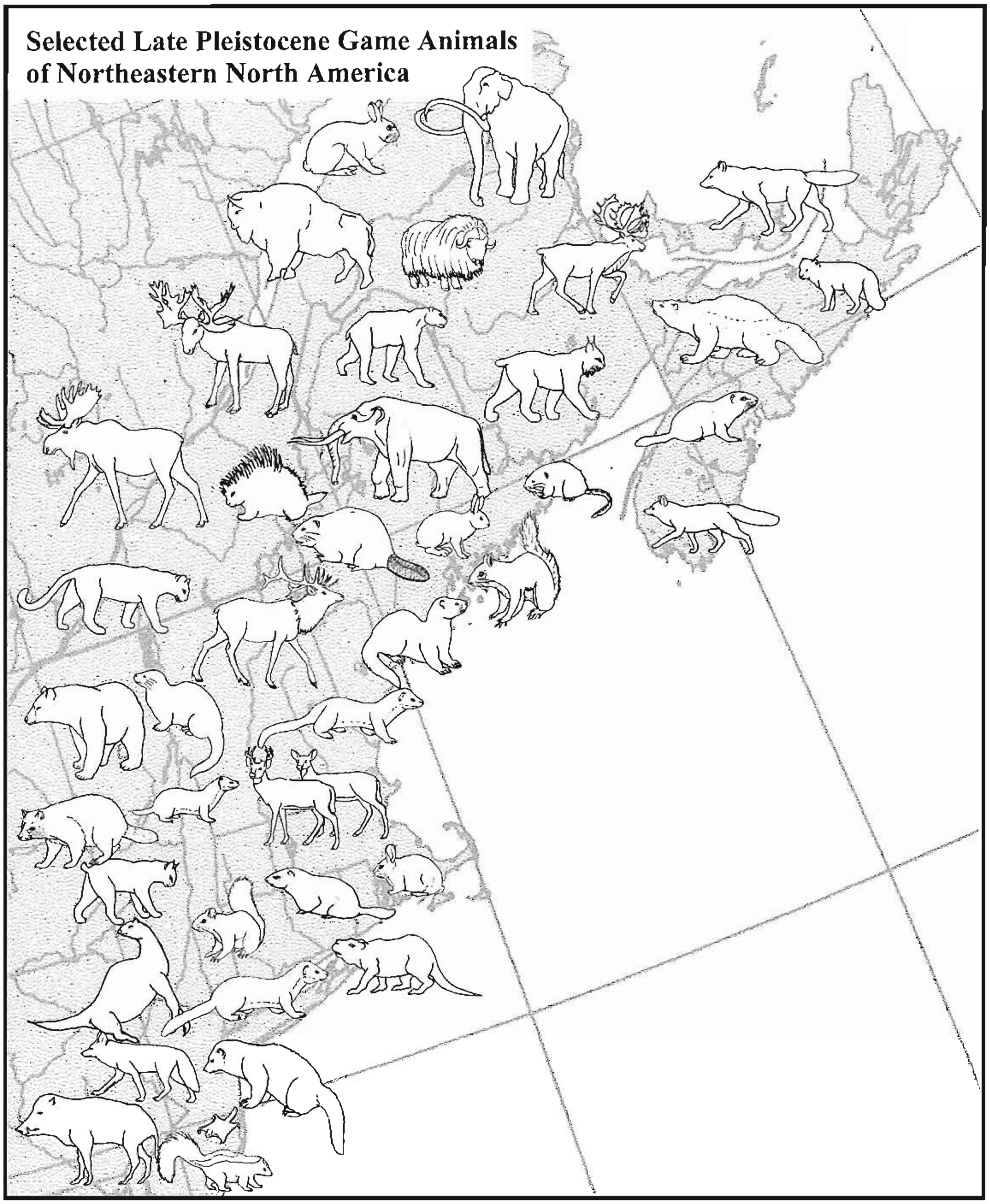


Figure 5.3
Selected late Pleistocene game animals of northeastern North America
Top to bottom: mammoth, arctic hare, gray wolf, bison, musk ox, caribou, arctic fox, cervalces, short-faced bear, wolverine, lynx, arctic ground squirrel, moose, porcupine, mastodon, muskrat, beaver, snow-shoe hare, red fox, red squirrel, cougar, elk, mink, black bear, otter, long-tailed weasel, raccoon, least weasel, white-tailed deer, bobcat, gray squirrel, woodchuck, cottontail, ground sloth, ermine, giant beaver, coyote, fisher, peccary, flying squirrel, skunk (animals not to scale). Not depicted are stilt-legged deer, marine mammals and small prey such as birds, fish, reptiles and amphibians.

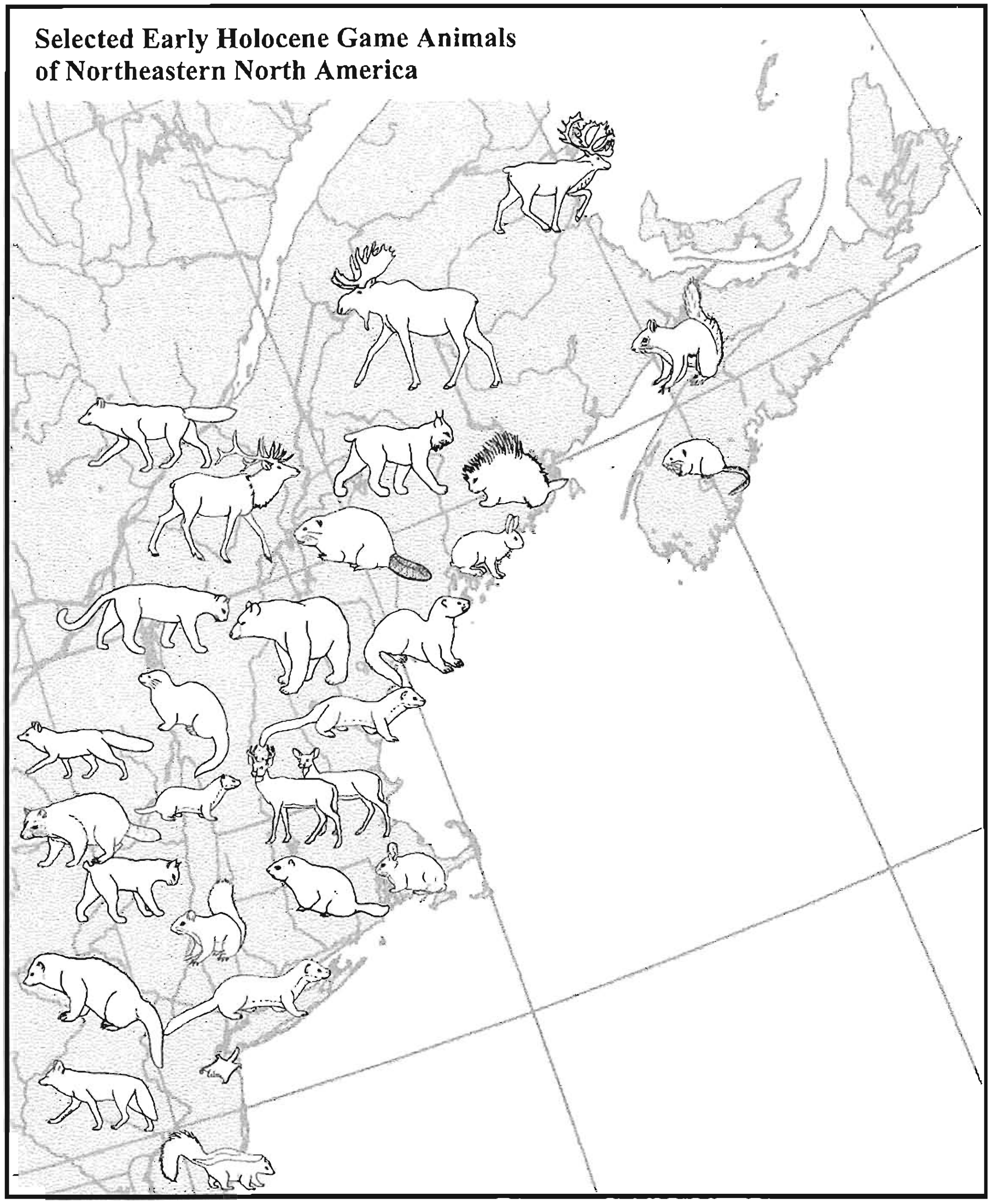
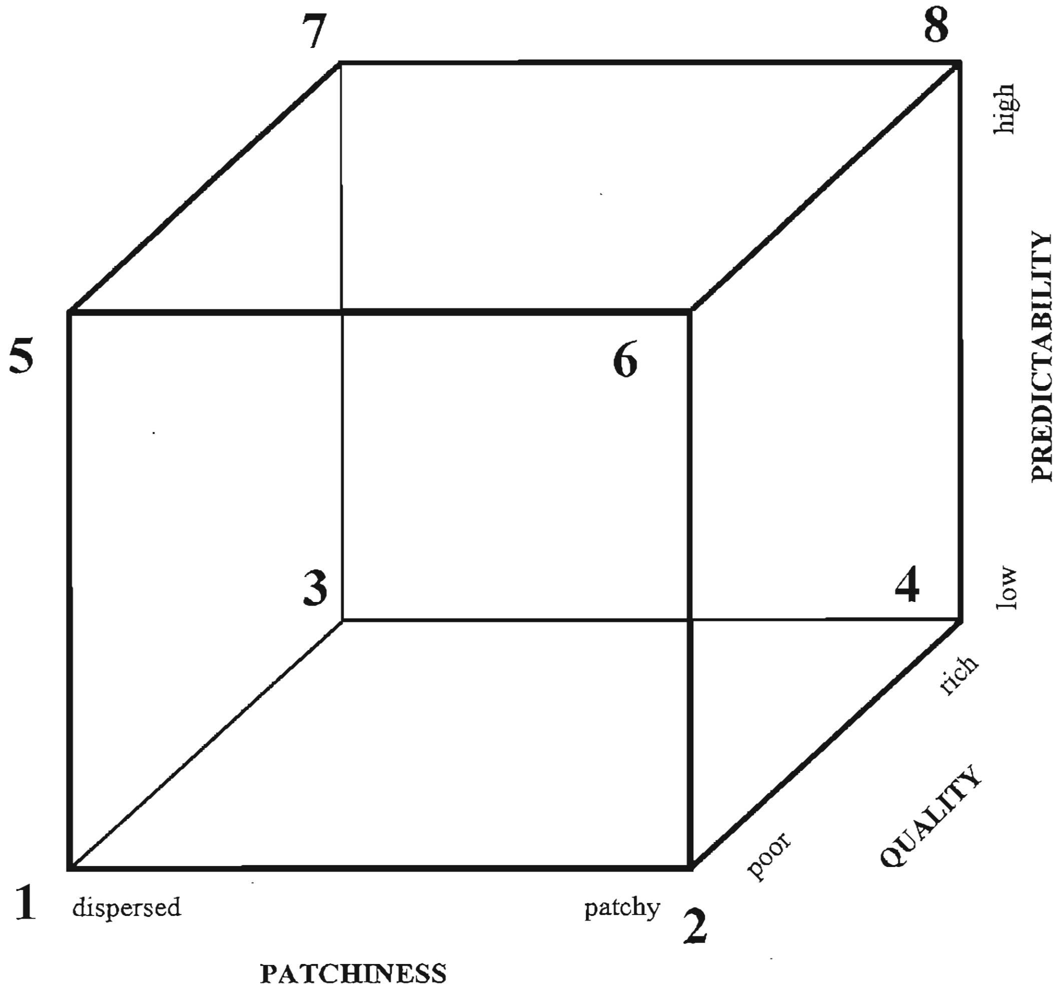


Figure 5.4
Selected early Holocene game animals of northeastern North America
Top to bottom: caribou, moose, red squirrel, gray wolf, lynx, porcupine, muskrat, elk, beaver, snow-shoe hare, cougar, black bear, mink, otter, long-tailed weasel, red fox, white-tailed deer, least weasel, raccoon, bobcat, gray squirrel, woodchuck, cottontail, fisher, ermine, flying squirrel, coyote, skunk (animals not to scale). Not depicted are, marine mammals and small prey such as birds, fish, reptiles and amphibians.



<u>Resource Types</u>

Type 1: poorly predictable, dispersed, of poor quality

Type 2: poorly predictable, patchy, of poor quality

Type 3: poorly predictable, dispersed, of rich quality

Type 4: poorly predictable, patchy, of rich quality

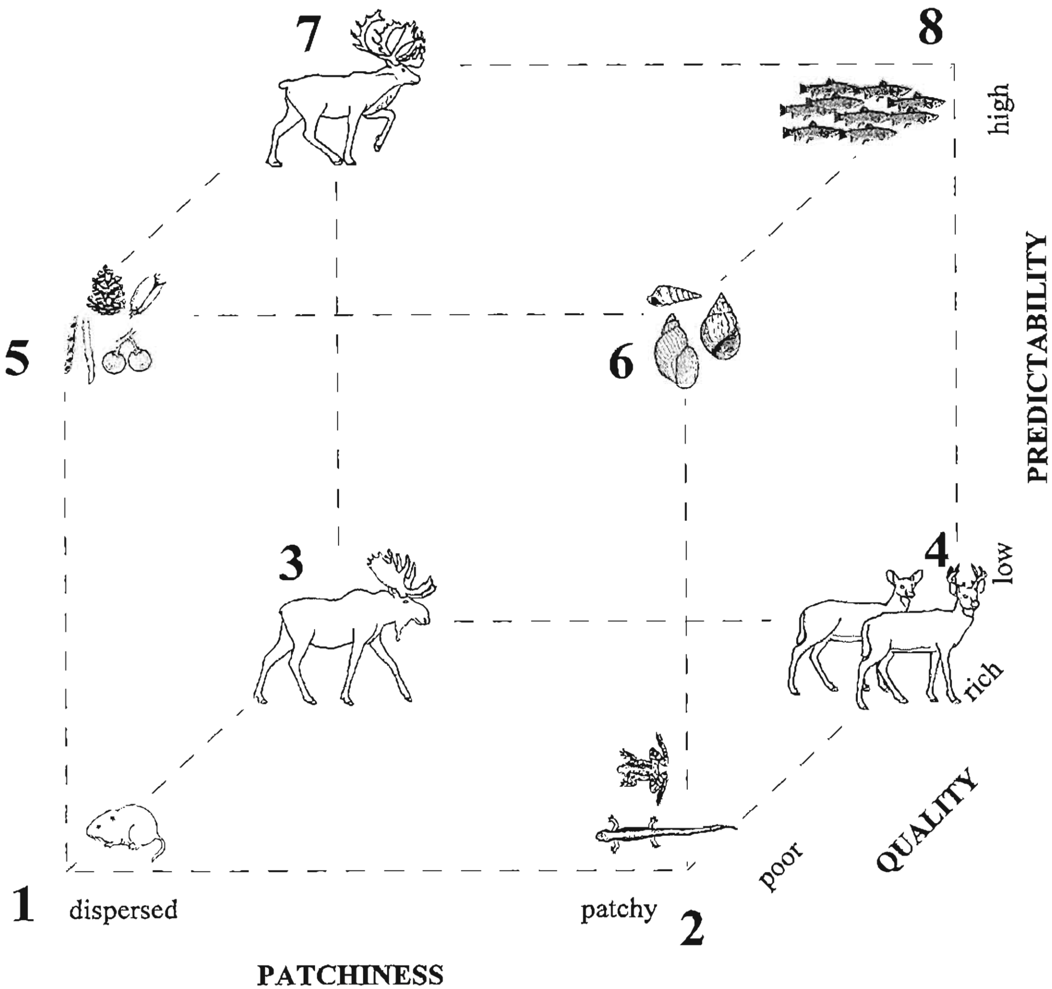
Type 5: highly predictable, dispersed, of poor quality

Type 6: highly predictable, patchy, of poor quality

Type 7: highly predictable, dispersed, of rich quality

Type 8: highly predictable, patchy, of rich quality

Figure 6.1
The resource base cube model: an expression of critical resource variables in three dimensions



Resource Types

Type 1: mice, voles, boreal plant foods, small reptiles and amphibians

Type 2: amphibians in summer, small wetland reptiles, small birds, small fish

Type 3: moose, elk, or mastadon in summer forests

Type 4: deer and caribou in winter forests, moose in winter wetlands

Type 5: various plant foods out of season

Type 6: amphibians during mating season, berry patches, small shellfish, nuts and tubers out of season

Type 7: caribou at spring-summer calving grounds, deer in summer forests

Type 8: anadromous fish at falls and rapids, caribou at fall migration constrictions

Figure 6.2
Examples of possible resource types at the extremities of the resource base cube

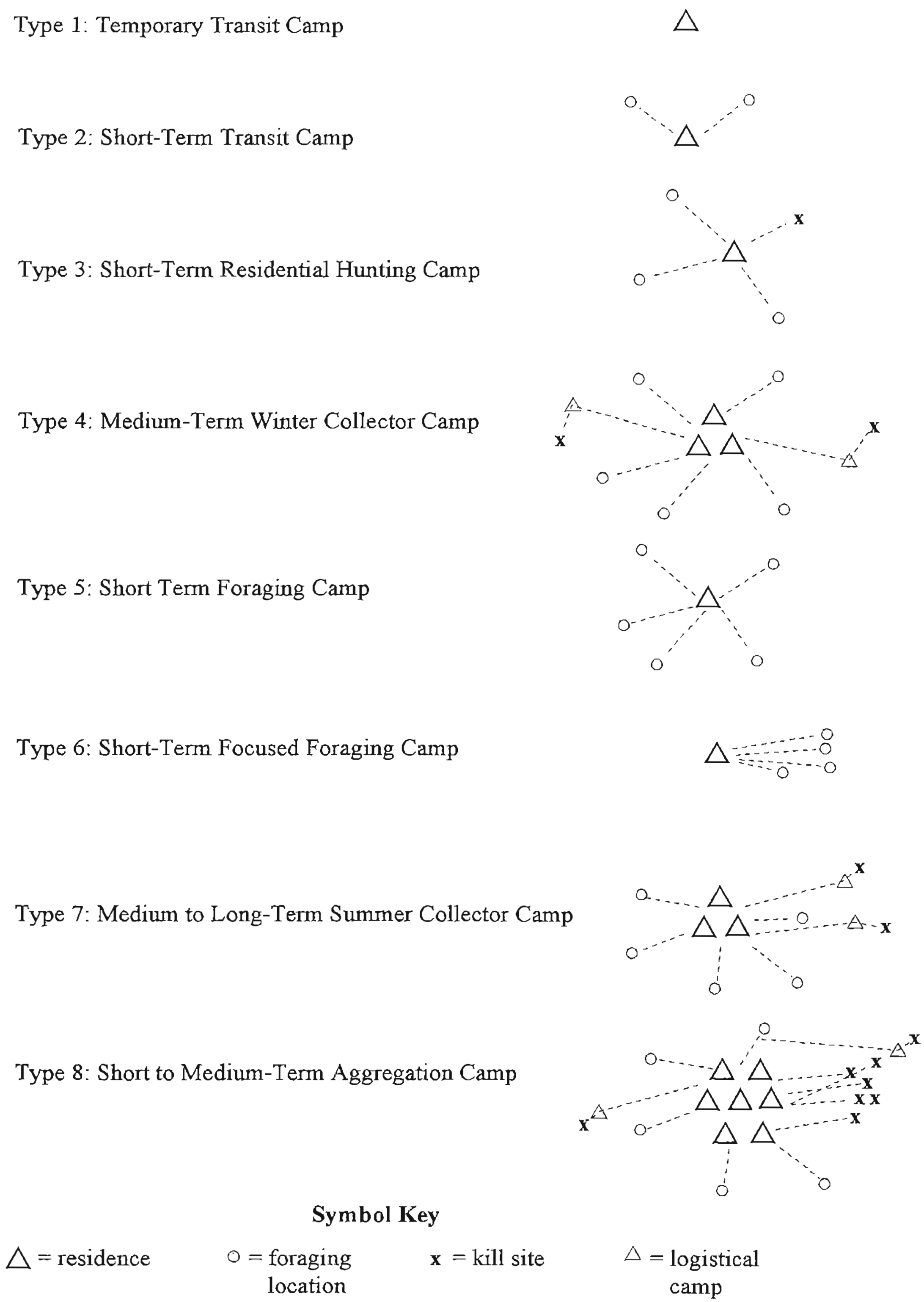


Figure 6.3
Schematic representations of modeled settlement types
Eight site types are depicted based upon unique combinations of residence camps, foraging locations, kill sites, and logistical camps.

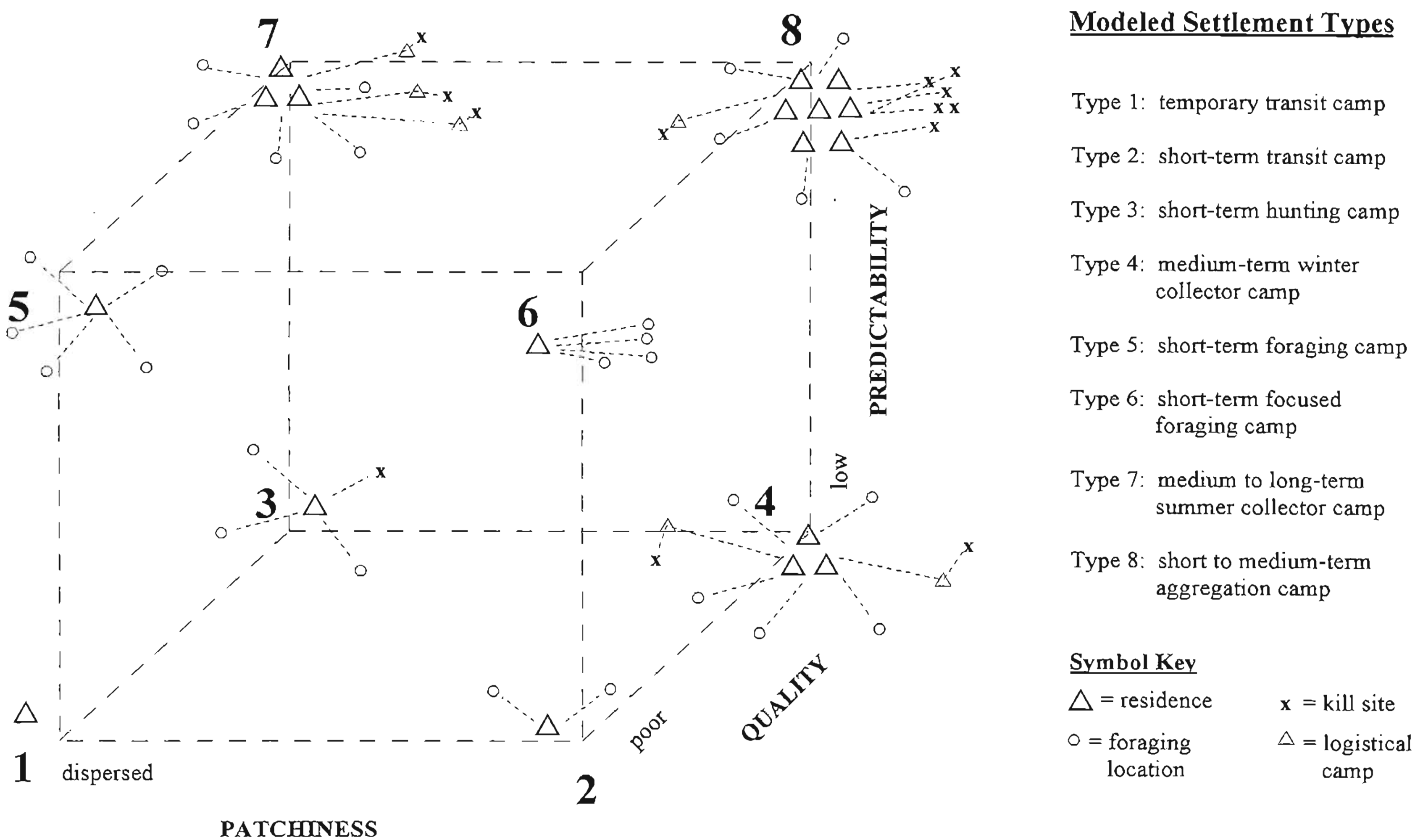


Figure 6.4
Eight modeled settlement types articulated with the resource base cube

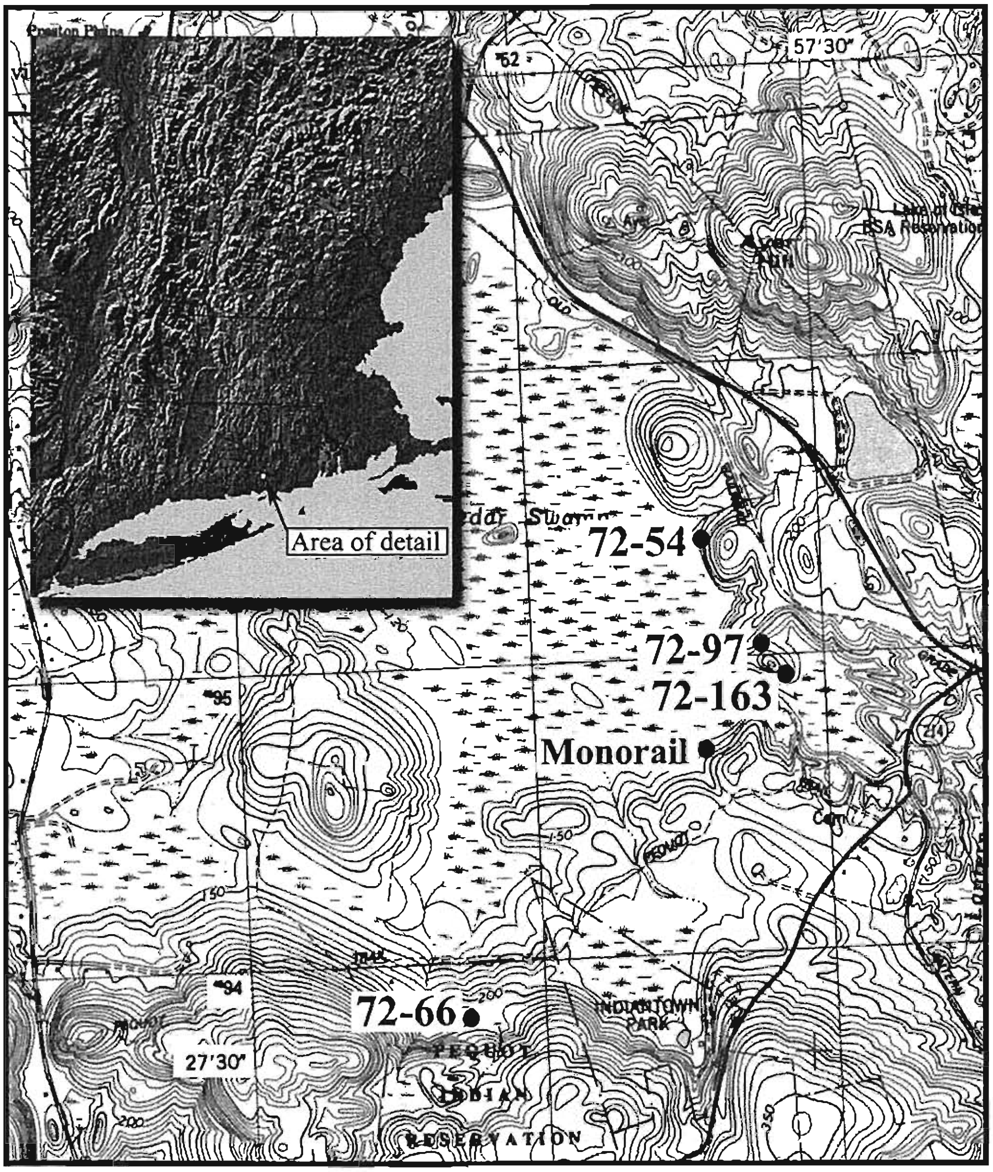
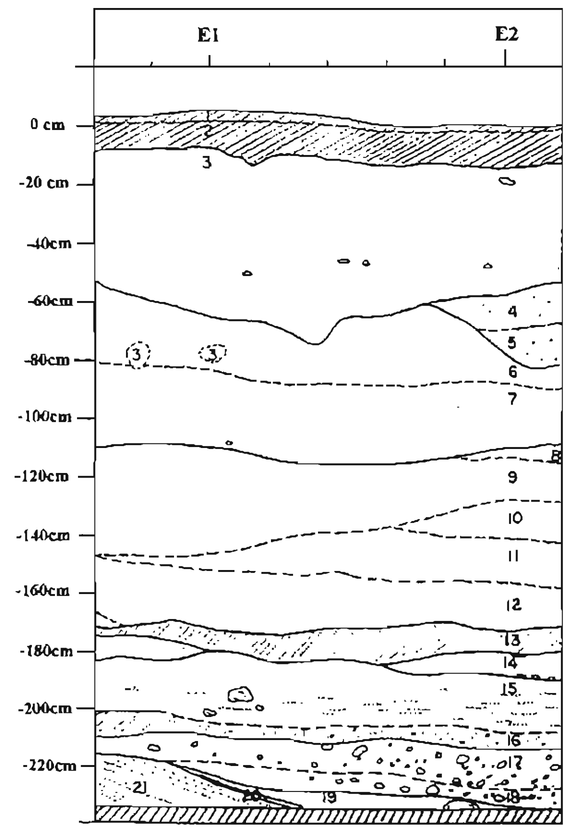


Figure 9.1
Terminal Pleistocene and early Holocene sites on the Mashantucket Pequot Reservation

Site 72-163 Main Stratigraphic Section
North 12 Line



Sediment Description

1	Ao			organic duff
2	A1	dkbn	(10YR 3/3)	fnsdlm
3	Bw1	ywbn	(10YR 5/8)	fnsdlm w/ grit and rare pebbles to 2 cm
4	colluvium	ywbn	(10YR 5/8)	fnsdlm w/ gr
5	colluvium	olyw	(2.5Y 6/6)	mdsd w/ gr and pebbles to 4 cm
6	Bw2	bnyw	(10YR 6/8)	fnsdlm w/ grit and rare pebbles to 2 cm
7	C	yw	(2.5Y 7/6)	vyfnsdysilt w/ grit
8		ltywbn	(2.5Y 6/4)	silt lense
9		olyw	(2.5Y 6/6)	massive silt
10		yw	(2.5Y 7/8)	massive silt
11		yw	(10YR 7/8)	silt w/ rare grit
12		bnyw	(10YR 6/6)	massive silt
13		rdyw	(7.5YR 6/8)	vyfnsd w/ rare grit (paleosol)
14		olyw	(2.5Y 6/6)	vyfn sd w/ grit
15		payw	(2.5Y 7/4)	fnsd w/ grit and rare pebbles w/ oxidised bands (5YR 5/8)
16		rd	(2.5YR 4/8)	oxidised mdsd w/ grit and sm pebbles
17		paol	(5Y 6/4)	csesd w/ gr and sm cobbles
18		paol	(5Y 6/4)	cse sd w/ gr
19		paol	(5Y 6/3)	mdsd w/ gr and cobbles
20		olyw	(2.5Y 6/6)	clay lense
21		payw	(5Y 7/4)	md bedded sands w/ cse and fnsd lenses

note: dk=dark, pa=pale, lt=light, bn=brown, rd=red, yw=yellow, ol=olive
fn=fine, md=medium, cse=coarse, lm=loam, gr=gravel, grit=very coarse sand

Figure 9.2
The Hidden Creek Site stratigraphy depicted in a representative profile

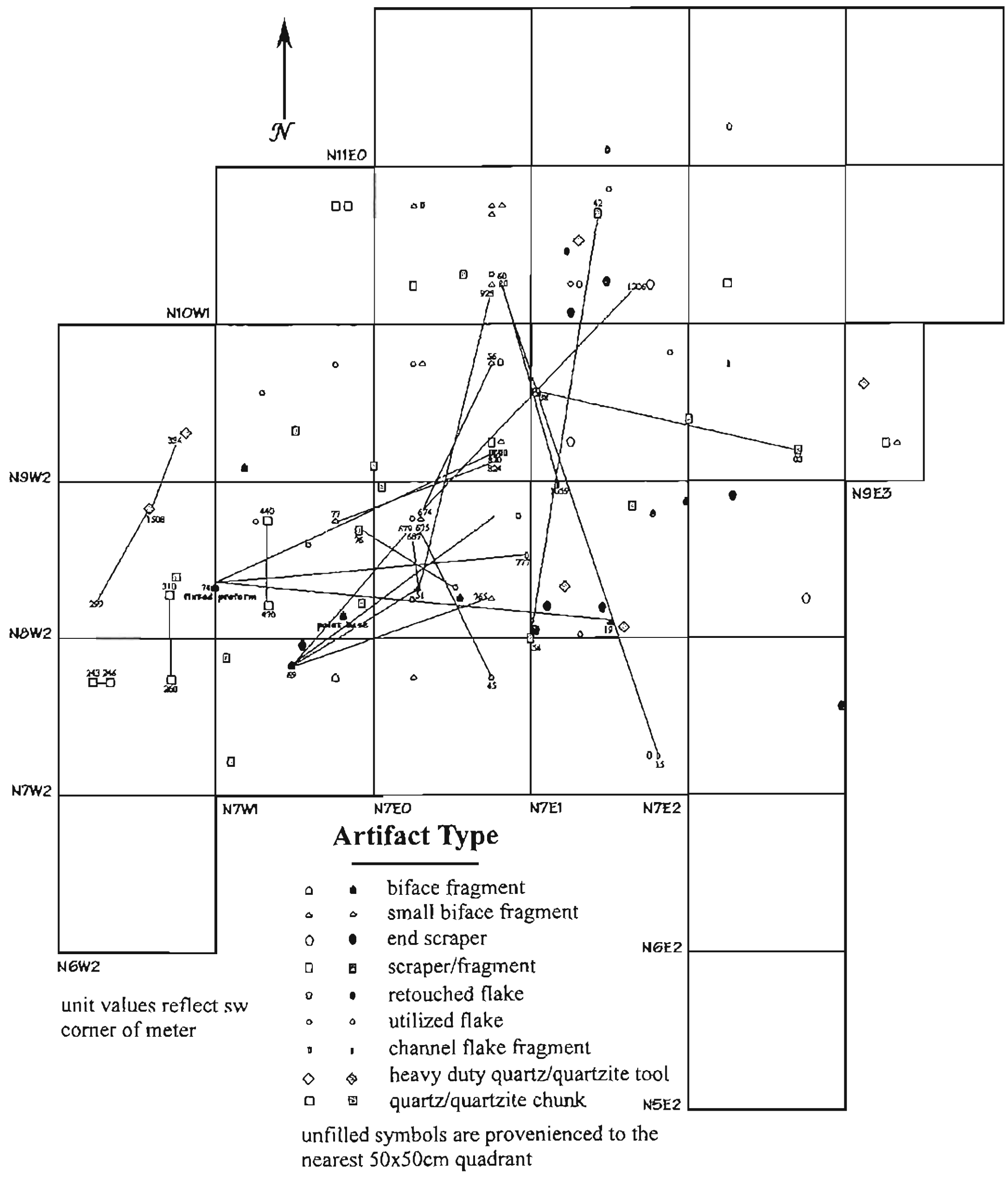


Figure 9.3
Horizontal Distribution of artifacts at the Hidden Creek site
Tools and tool fragments are depicted, lines represent refits between artifacts.

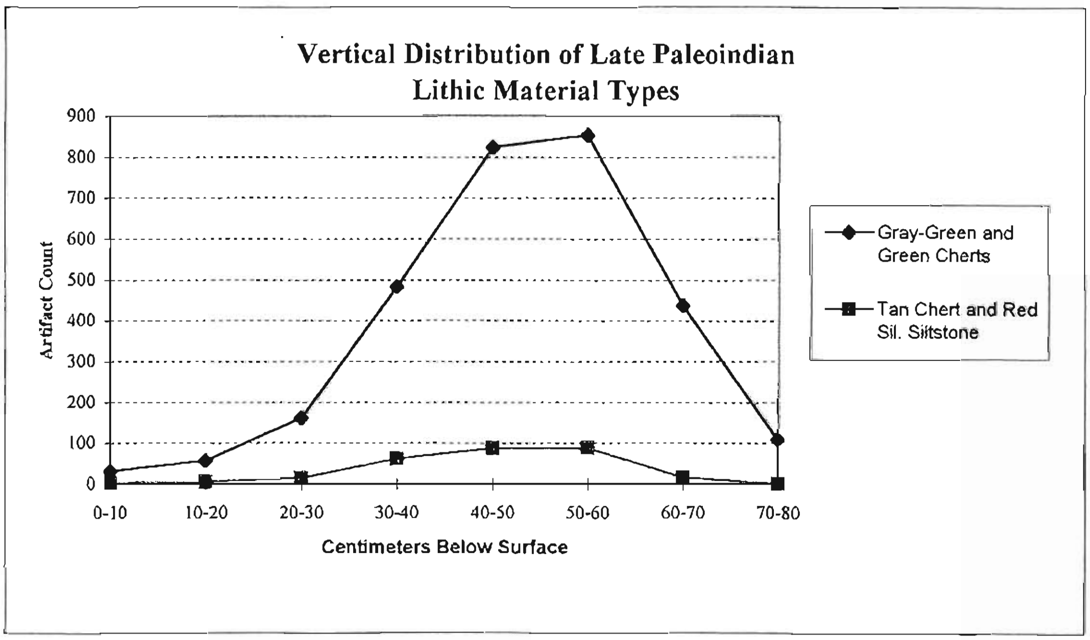


Figure 9.4
Vertical distribution of Late Paleoindian lithic material types at the Hidden Creek site

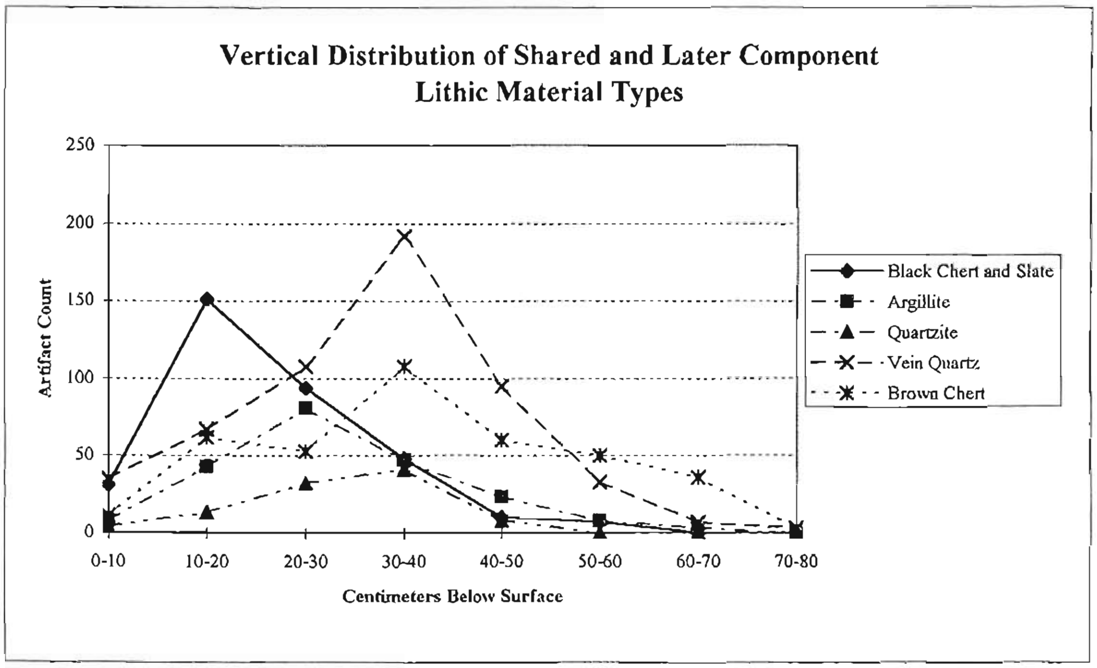


Figure 9.5
Vertical distribution of shared and later component lithic material types at the Hidden Creek site

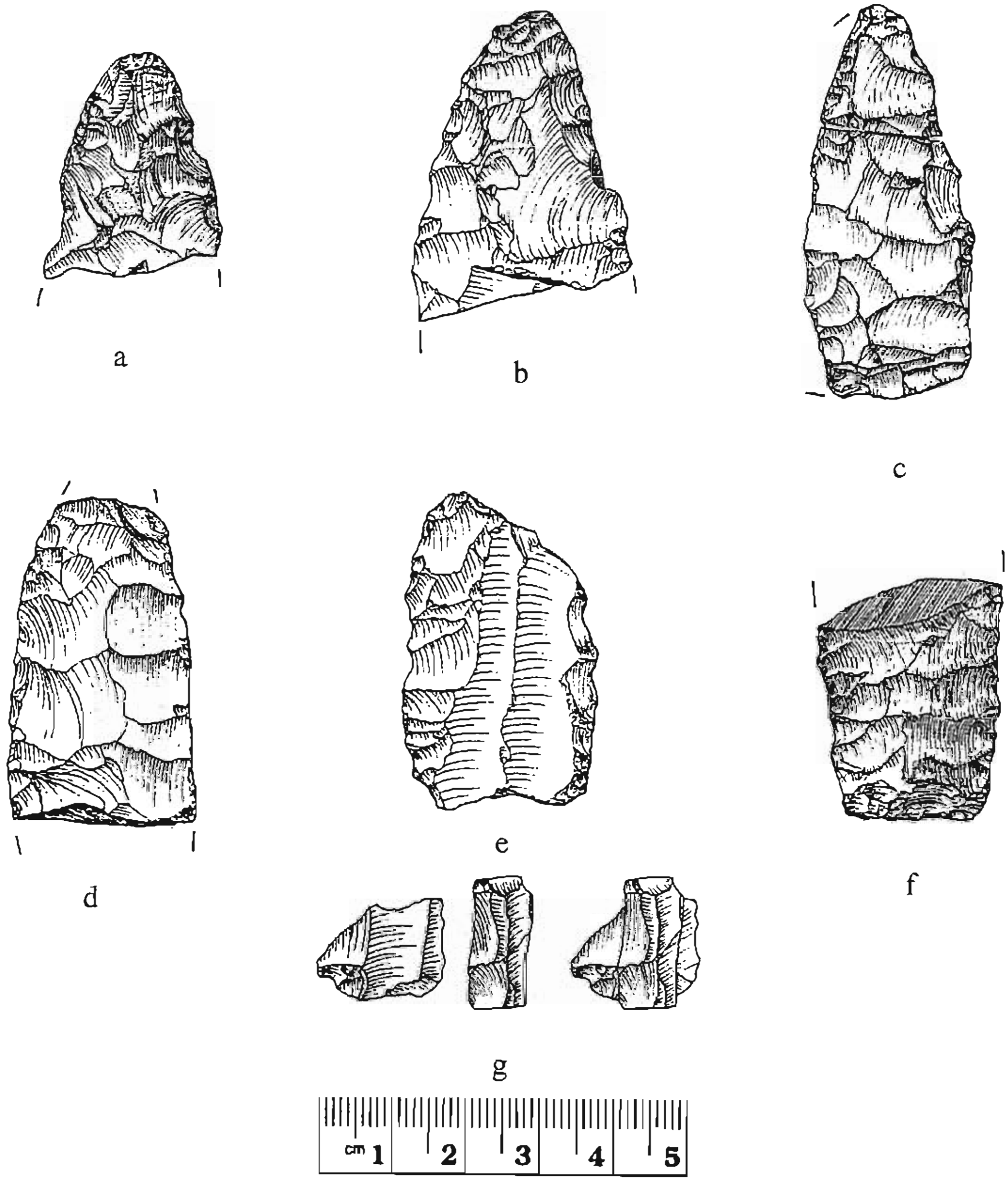


Figure 9.6
Bifaces and Fragments recovered from the Hidden Creek site

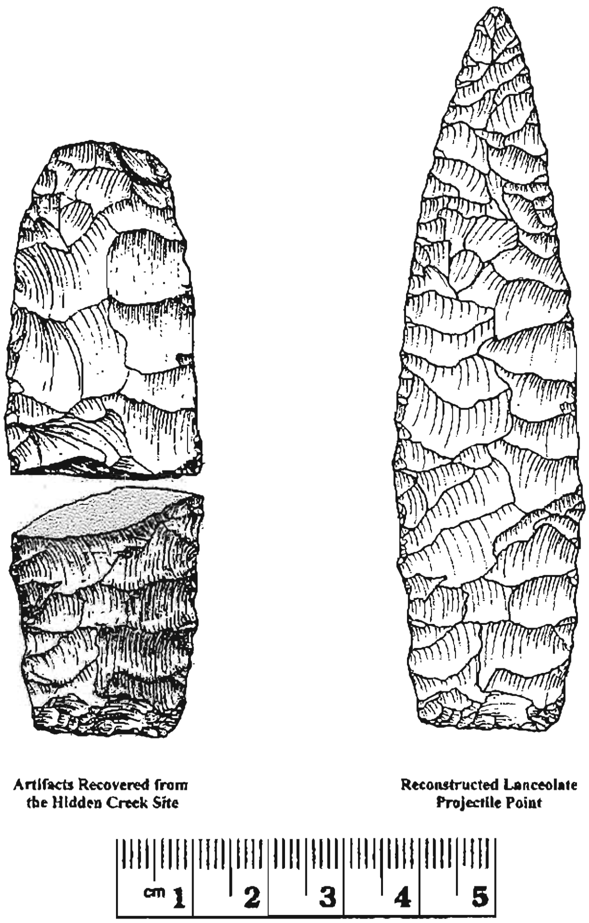


Figure 9.7
Hypothesized reconstruction of Hidden Creek site lanceolate projectile point

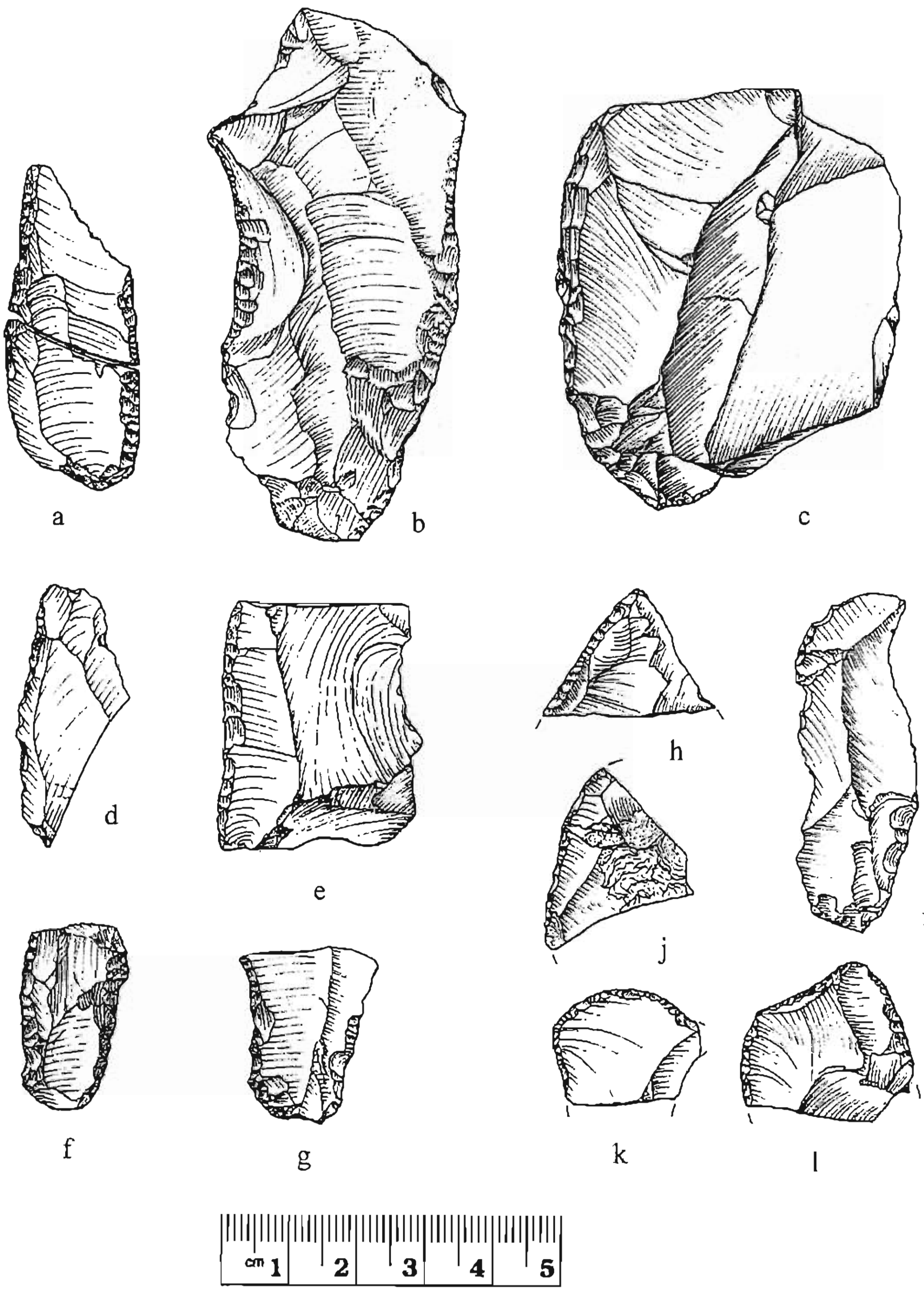


Figure 9.8
Side scrapers, scraper fragments and utilized flakes from the Hidden Creek site

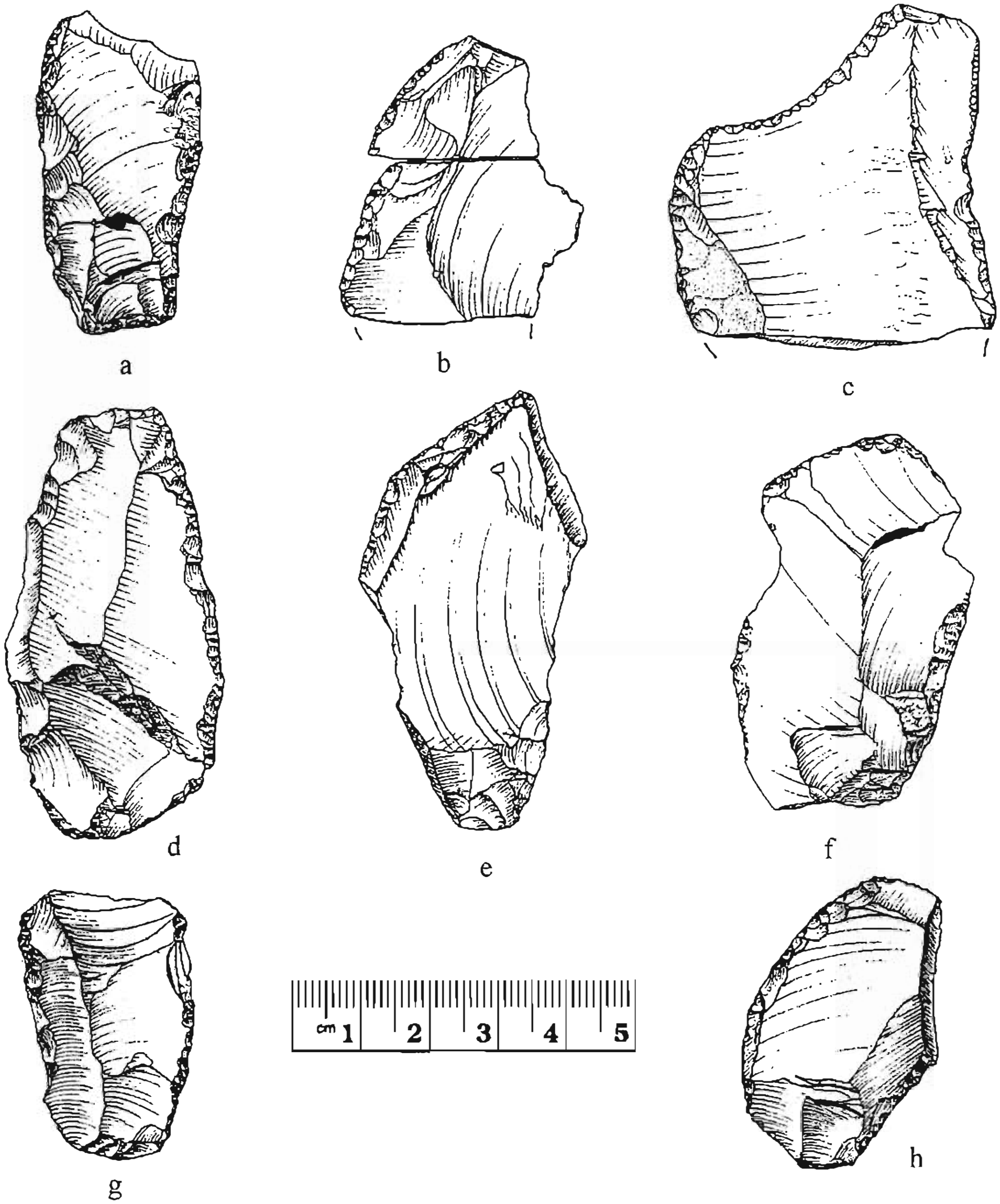


Figure 9.9
Side scrapers from the Hidden Creek site

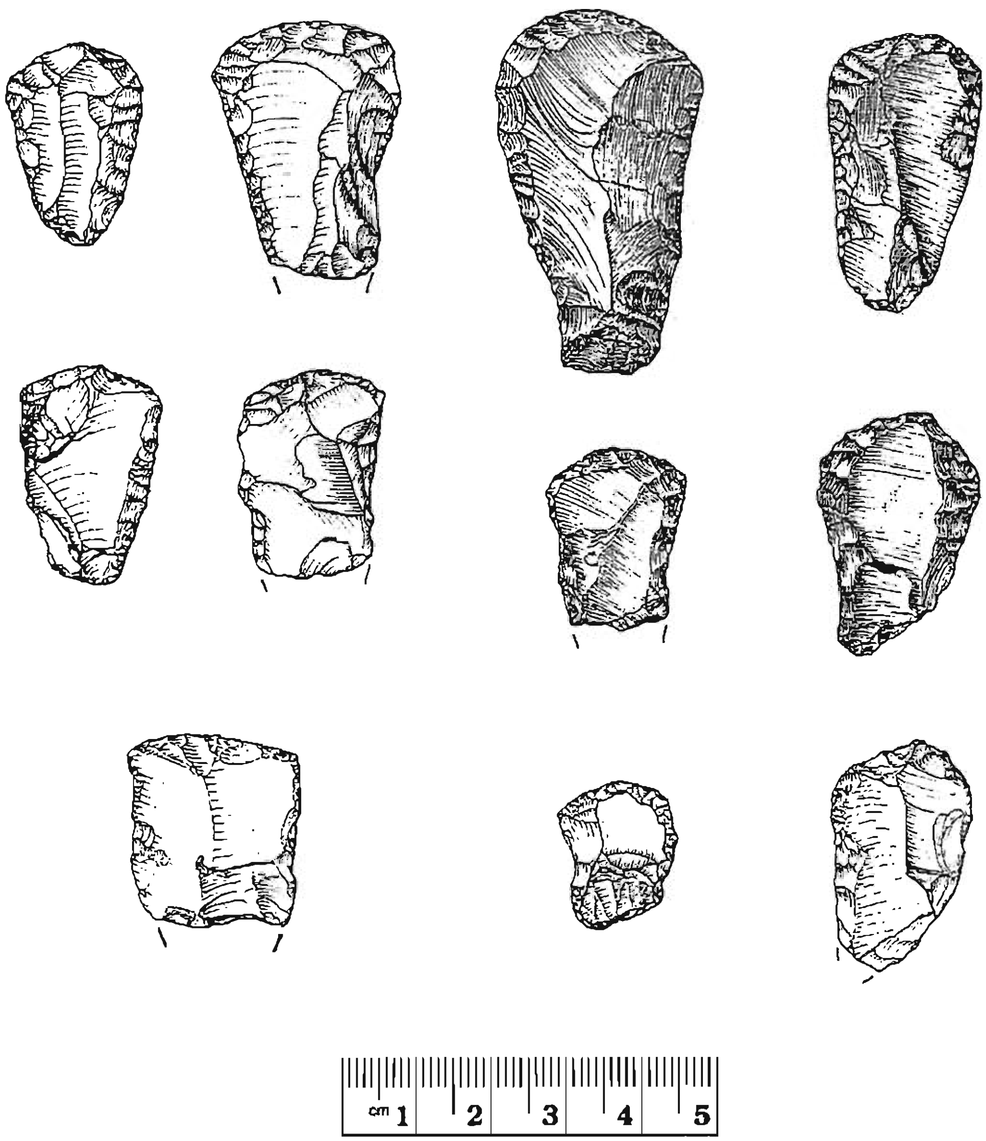


Figure 9.10
End scrapers from the Hidden Creek site

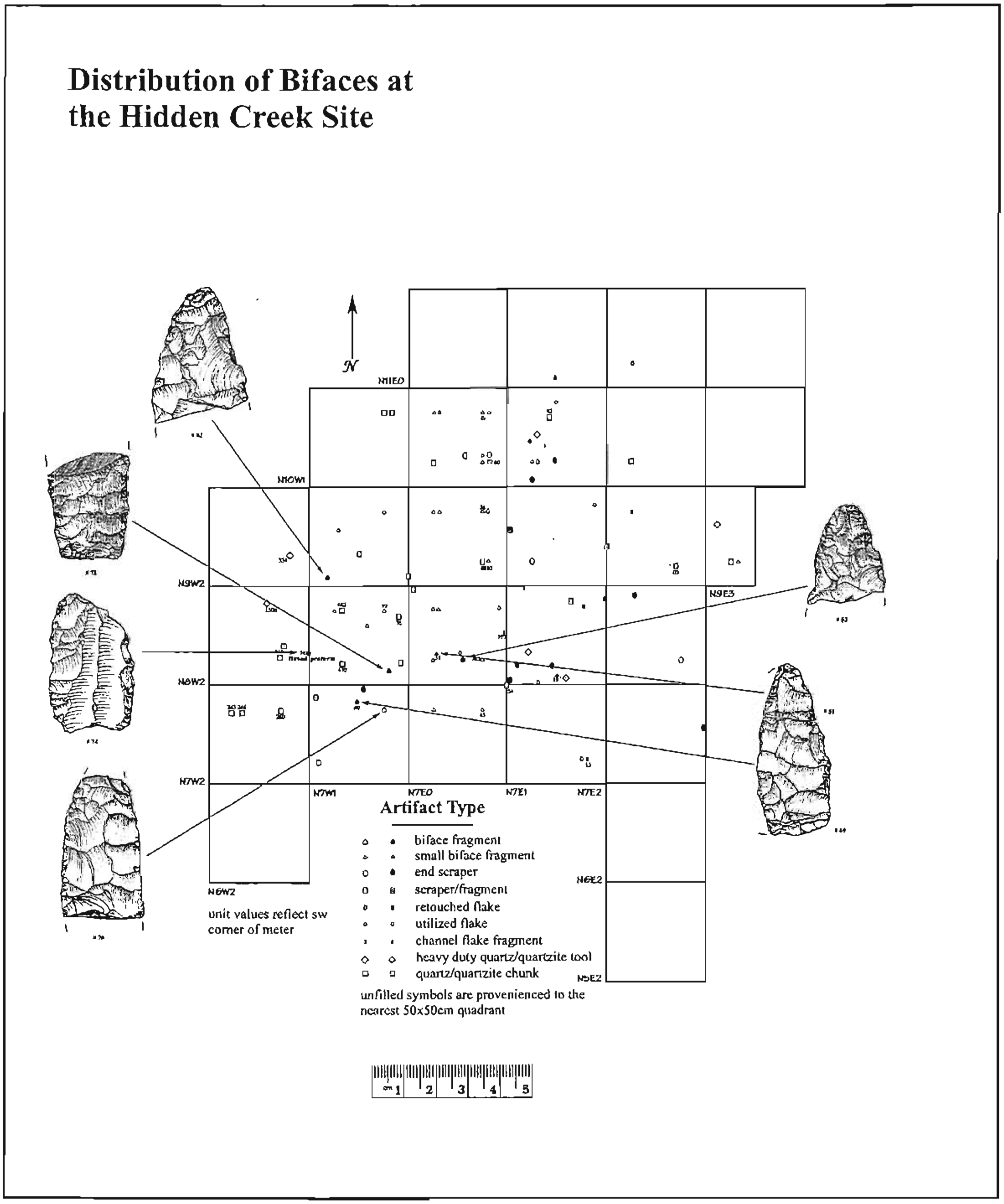


Figure 9.11
The distribution of bifaces at the Hidden Creek site

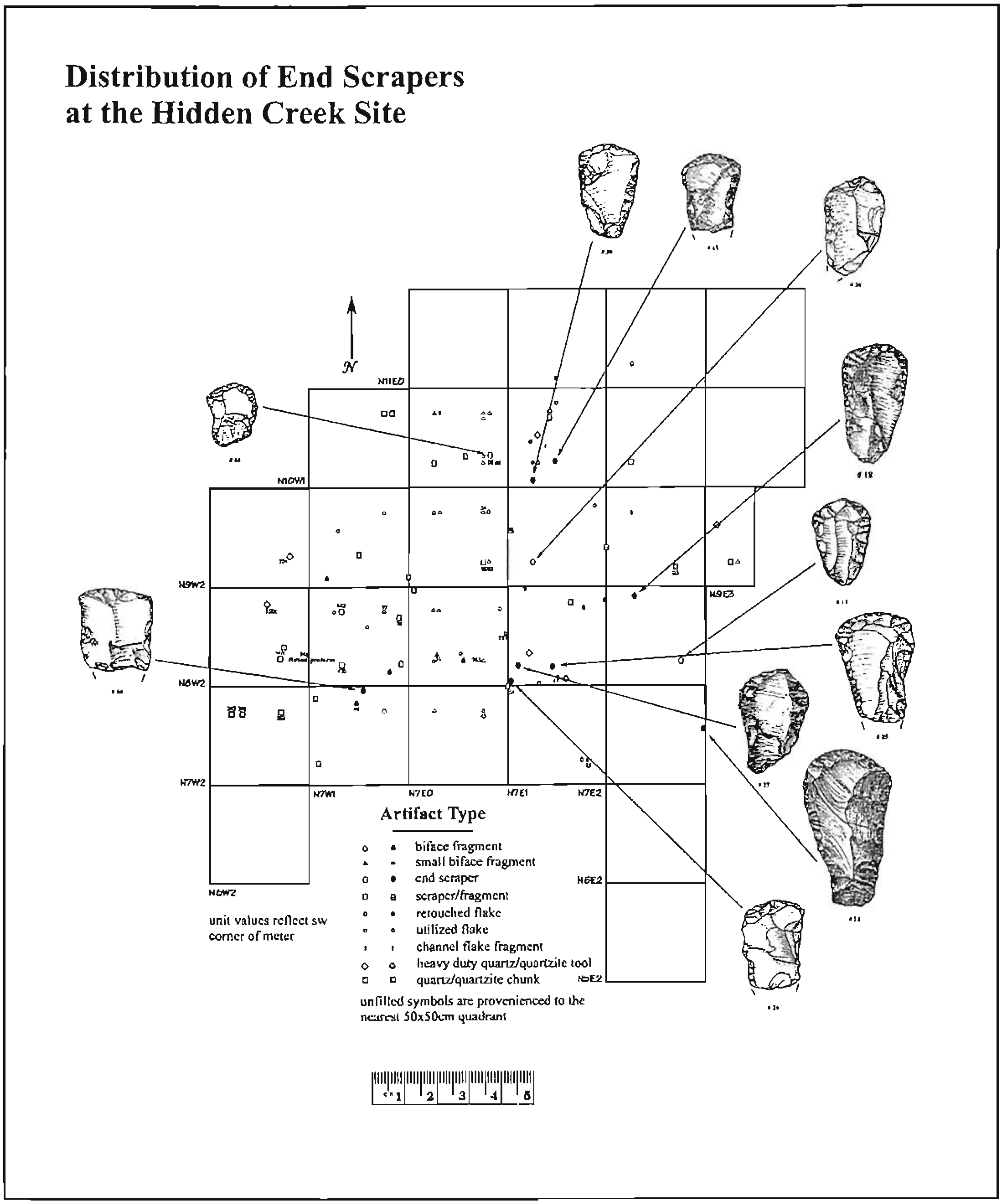


Figure 9.12
The distribution of end scrapers at the Hidden Creek site

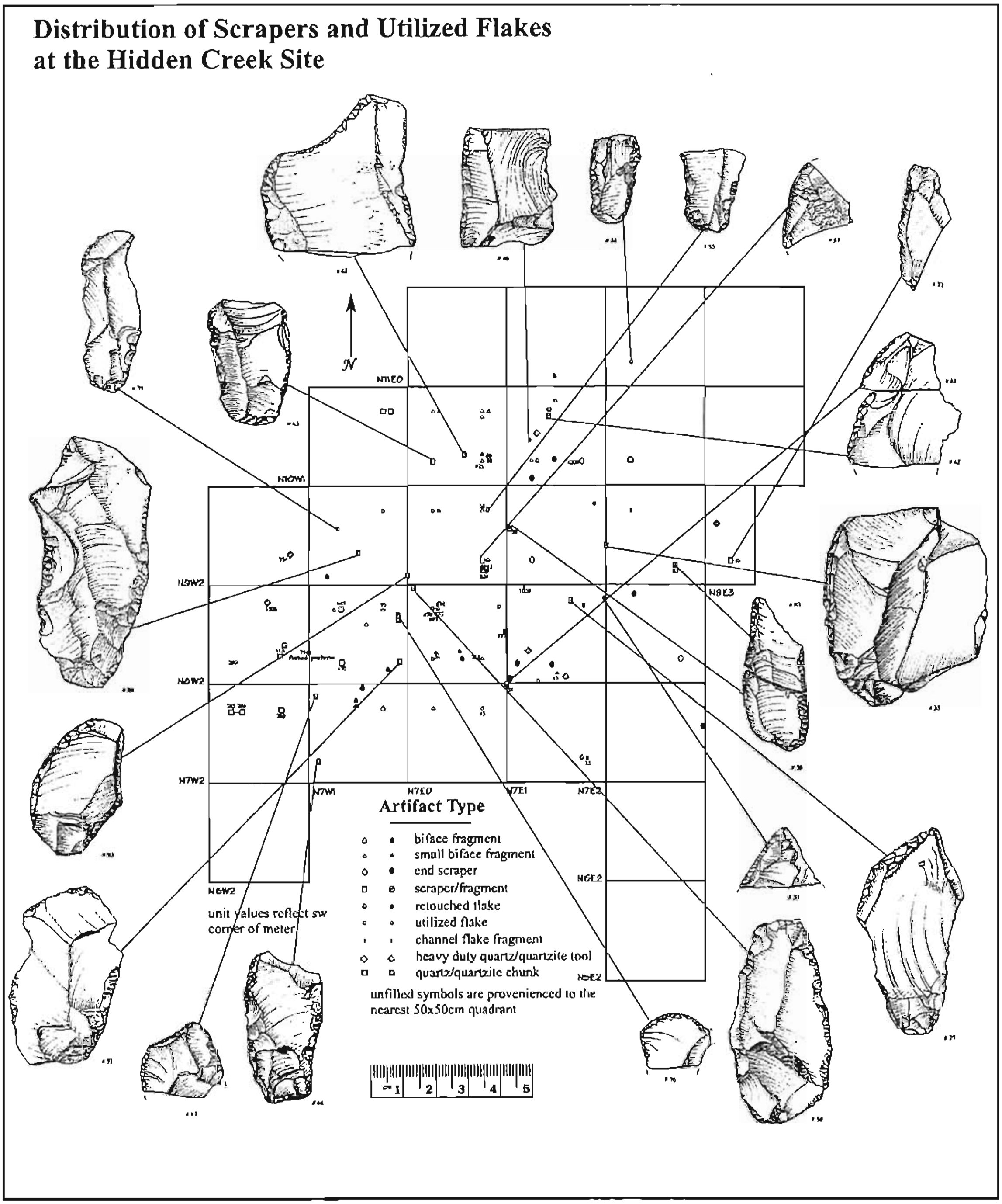


Figure 9.13
The distribution of side scrapers and utilized flakes at the Hidden Creek site

Debitage Distribution at the Hidden Creek Site

Combined Distribution of Late Paleoindian Materials:
Green Chert, Gray-Green Chert and Sil. Siltstone

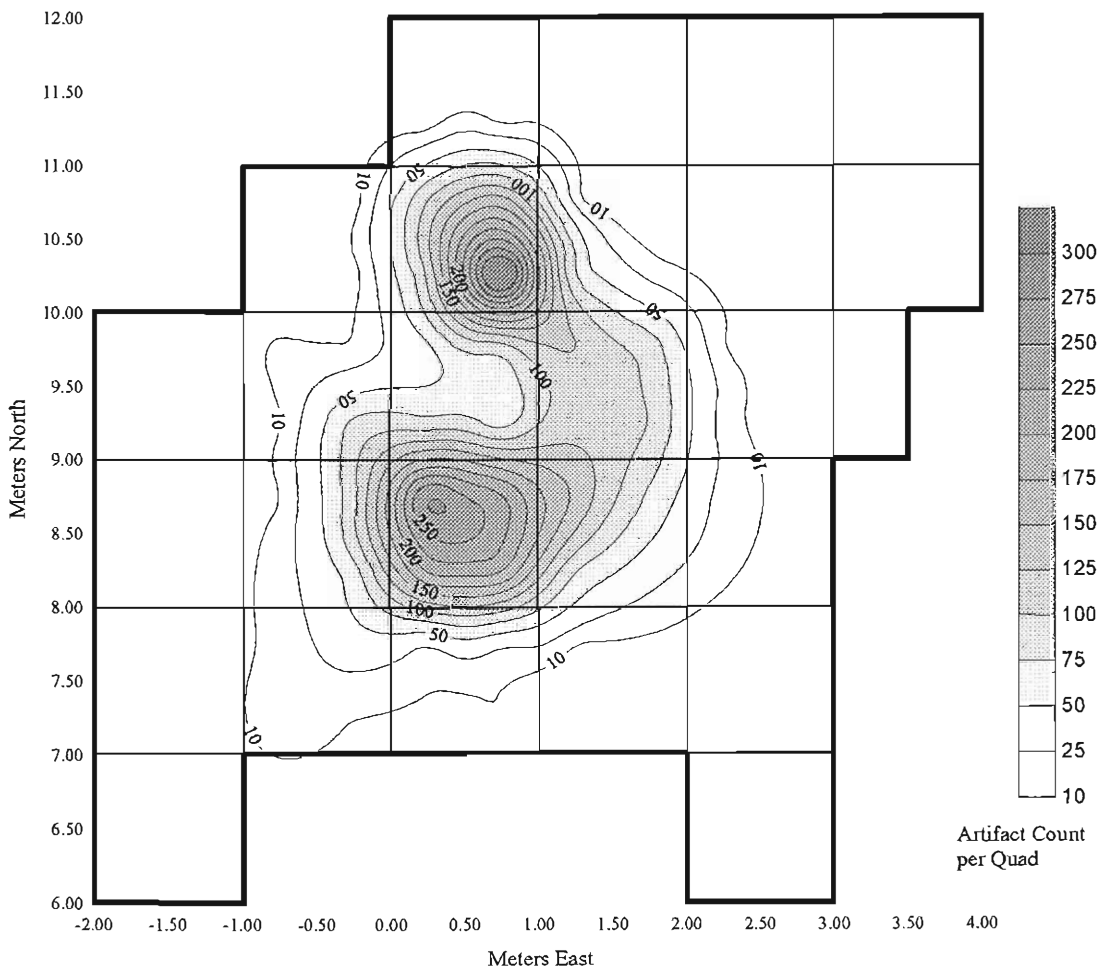


Figure 9.14
Debitage Distribution at the Hidden Creek site

Distribution of Burned Chert Flakes at the Hidden Creek Site

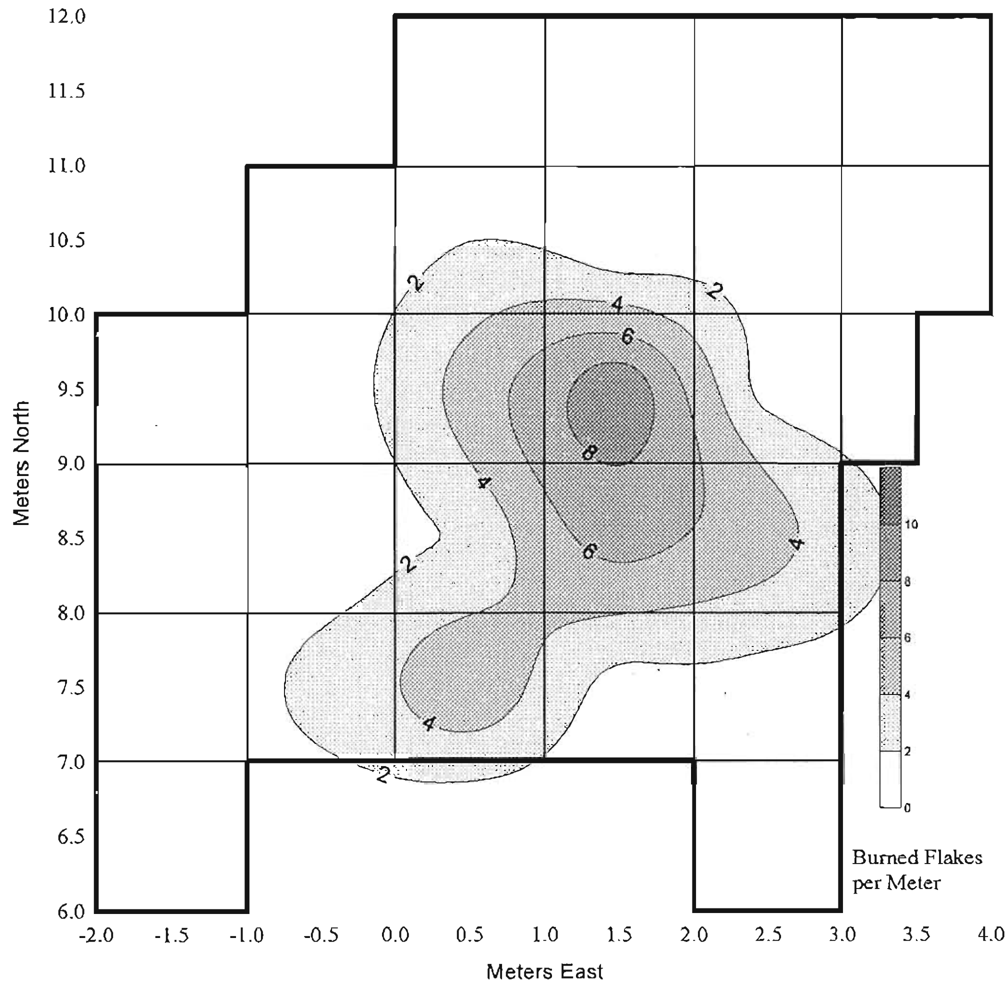


Figure 9.15
The distribution of burned chert flakes at the Hidden Creek site

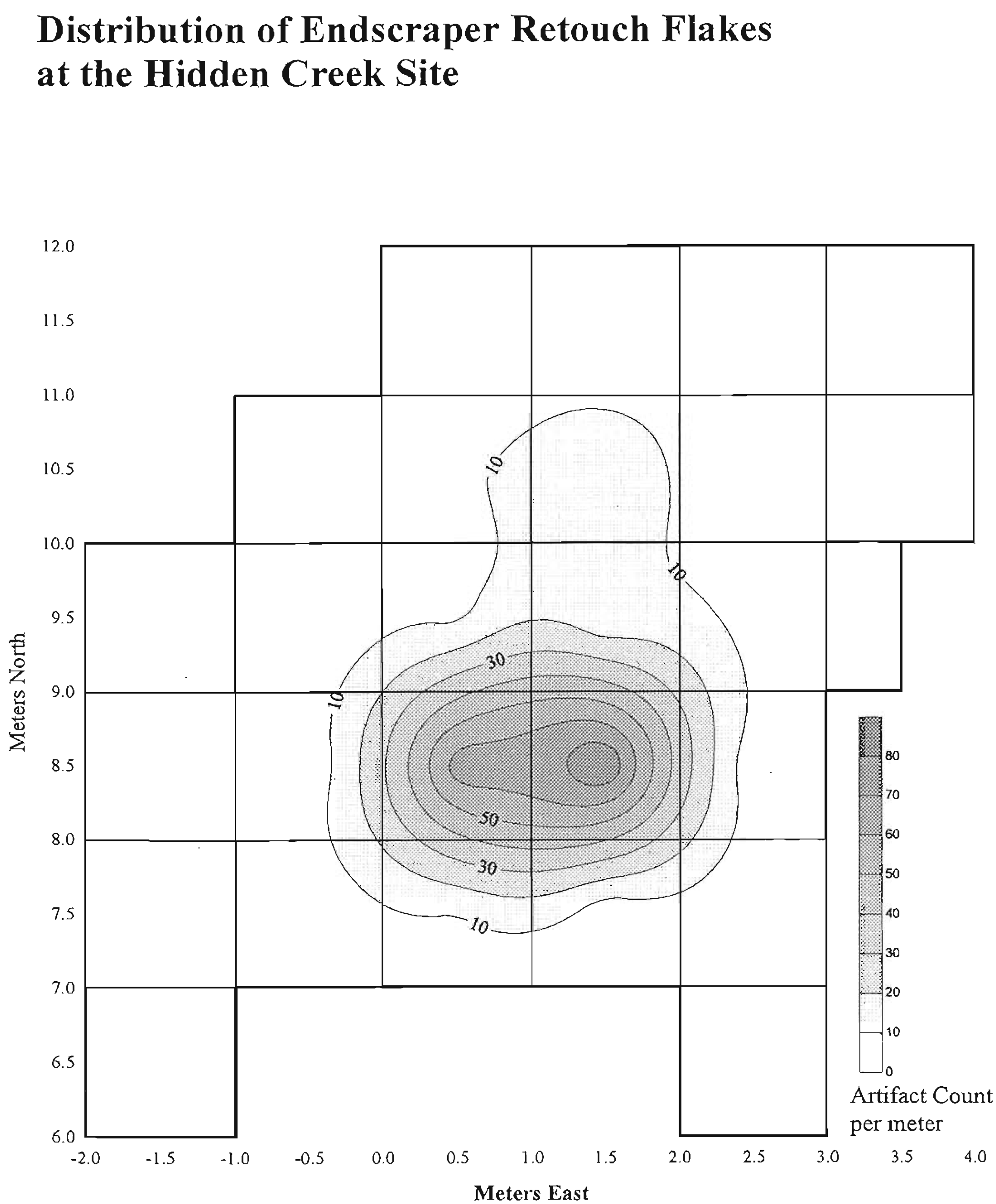


Figure 9.16
The distribution of end scraper retouch flakes at the Hidden Creek site

Distribution of General Unifacial Retouch Flakes at the Hidden Creek Site

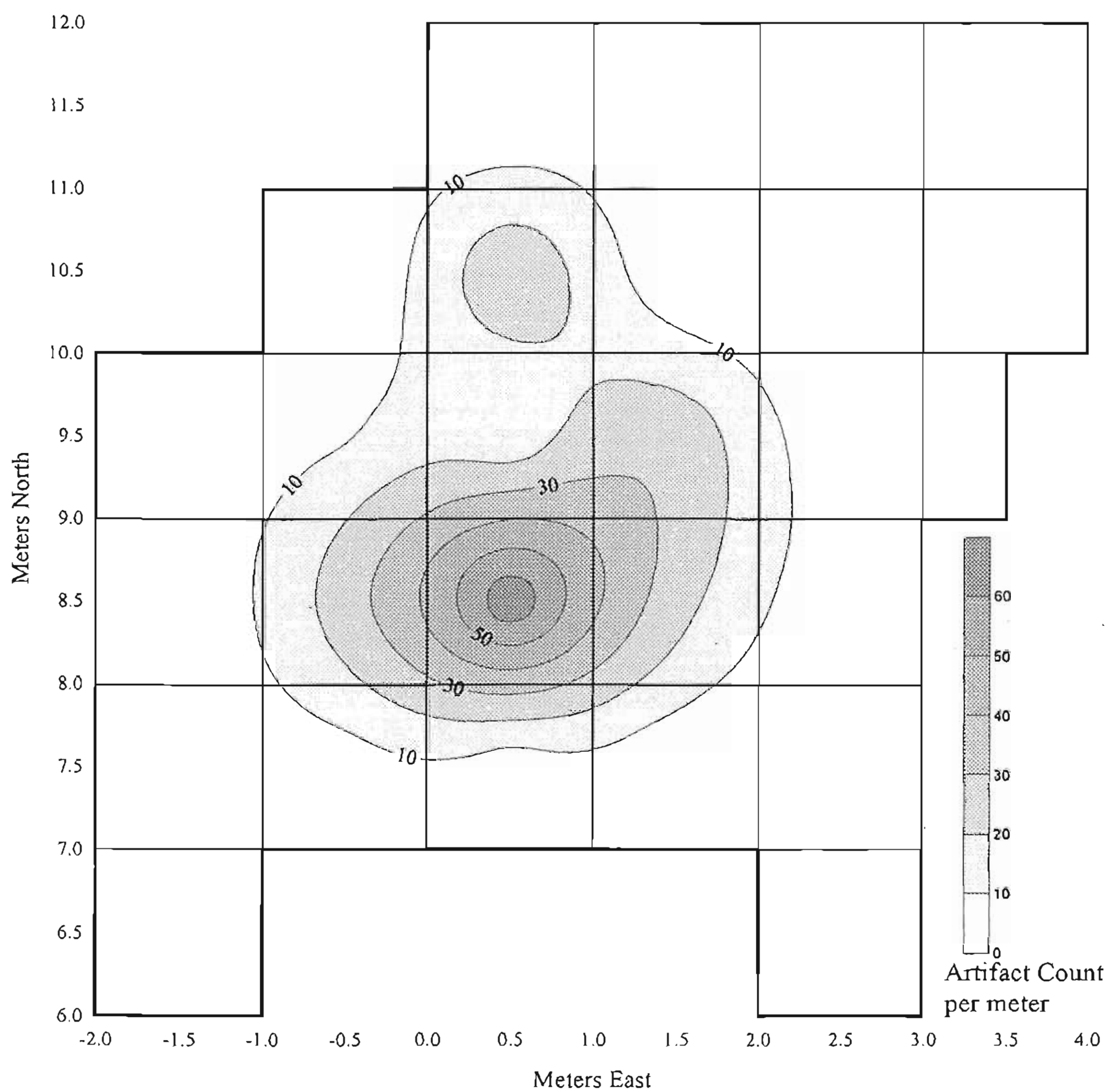


Figure 9.17
The distribution of general unifacial retouch flakes at the Hidden Creek site

Appendix 1

Late Pleistocene Grazers of the Northeast

The extinct **stilt-legged deer**, *Sangamona* was a large (135-180 kg), long-legged deer adapted for running (Anderson 1984: 76). Its superficially bovid-like molars suggest that it was a grazer. Its terminal date is 9,440 $\pm$ 760 years B.P. (Kurtén and Anderson 1980: 314).

North American horse, *Equus*, also extinct, inhabited plains, savannas, sometimes mountainous regions, and even swamps (Anderson 1984: 65; Whitaker 1996: 810). Modern feral horses spend 80% of the day grazing and 20% resting. They spend about half the night grazing as well. In summer they subsist primarily on grasses and forbs, while in winter they become browsers. Modern horses form two types of social groups. Territorial groups are of mixed gender and age. Harem groups are made up of one or two dominant males and with five or six mares. Foals are born in spring to late summer after an 11 month gestation period (Whitaker 1996: 810-812). Foaling likely occurred earliest under less temperate conditions. The terminal date of *Equus* in North America is about 8,000 years B.P. in Alberta (Anderson 1984: 65). Upper Paleolithic peoples of Europe extensively hunted horses, though their association with Paleoindian finds is less common in America (Anderson 1984: 65).

Bison were most numerous on the short-grass prairies from Alberta to Texas, although their remains have been recovered across the continent. Modern bison inhabit plains, prairies, river valleys, and sometimes forests (Whitaker 1996: 851). They feed on grasses, sedges, forbs, and sometimes berries, lichen, and horsetails (Whitaker 1996: 852). Extinct subspecies ranged in size, with the larger animals in previously unglaciated areas. Both are known to have been widely hunted by western Paleoindian populations. The smaller plains and wood bison subspecies survive today. Living bison are most active in the early morning and late afternoon. Migrations of 320 km or more once occurred between summer and winter ranges (typically from valley bottoms to wooded hills) (Whitaker 1996: 852). Bison form three kinds of social groups. Matriarchal groups numbering eleven to twenty individuals are made up of cows, calves, yearlings, and sometimes a few bulls. Bull groups are smaller, with males becoming more solitary with age. Breeding groups form during the rut and are made up of both matriarchal and bull groups (Whitaker 1996: 852).

Mammoth (*Mammuthus*) was a dominant element of many Pleistocene faunas. The woolly mammoth (*M. primigenius*) inhabited tundra and northern taiga regions of both the Old and New World. Well-preserved frozen specimens have been recovered from Siberia and Alaska. Woolly mammoths had large, curved tusks and molars designed for feeding on grasses and tundra plants. In North America south of the maximum extent of glacial ice was found the larger *M. jeffersonii*. It stood 3.2 to 3.4 meters in height at the shoulder and had large, incurved tusks and slightly downturned chin. It inhabited open prairies, especially in the west (Anderson 1984: 86). The remains of both species have been found in association with Paleoindian artifacts. They are believed to have survived until about 11,000 years ago in North America. Extinction was likely the result of over-specialization, complex nutritional needs, climatic changes, and in part human predation (Anderson 1984: 86; Guthrie 1984). Edwards and Emory (1977) report numerous finds of Mammoth teeth from the submerged northeastern continental shelf to depths of 130 meters.

The **caribou** (*Rangifer*) is a cold-adapted species whose range is currently limited to subarctic and arctic regions in North America. It is found in rugged mountain country, forests and boggy lowland muskeg. Not true grazers, caribou feed on grasses, sedges, mushrooms, and low shrubs in summer (Spiess 1979: 63). Their winter staple is a form of lichen which grows primarily on spruce trees. This winter diet is supplemented by horsetail, sedges, and willow and birch twigs. *Rangifer* have broad, flat, deeply cleft hooves adapted for travel on boggy ground and snow (Kurtén and Anderson 1980: 315). The highly gregarious caribou usually forms homogeneous bands of bulls or of cows with calves and yearlings. These groups may gather in large numbers (up to 100,000) of both sexes and all ages in late winter before the spring migration in the arctic (Whitaker 1996: 843). During the migration, cows move most rapidly toward open calving grounds. Bulls and juveniles travel more slowly. Groups disperse upon arriving at the calving grounds. Calves are born from mid-May through July. Bulls join cow and juvenile groups in October and November for the rut, by which time they have amassed a large store of body fat. After the rut, animals move in large numbers to the forested winter range, with adult bulls often separating from the cow-juvenile groups at this time. Calving grounds tend to be permanent locations, while winter ranges may vary year to year (Spiess 1979: 65). *Rangifer* social behavior is highly variable depending on the environment. Mountain-woodland caribou do not form massive herds and migrate seasonally (often altitudinally) no more than 160 km (Spiess 1979: 65). Caribou can run at speeds of nearly 80 km/hr for short periods. They are also powerful swimmers. Chief predators are humans and wolves, though the young may be taken by grizzly bears, wolverines, lynx and golden eagles. Within the region, seven dates on caribou bones have been obtained on material from the Dutchess Quarry Caves of southeastern New York. These dates range from 13,840 $\pm$ 80 to 12,720 $\pm$ 70 years B.P. (all are CAMS dates on purified collagen) (Funk and Steadman 1994: 73 and Table 9). Caribou bones have also been found at a small number of Paleoindian sites in the Northeast (Storck and Spiess 1994). They are traditionally considered the most important prey animal of northeastern Paleoindian populations. Late Upper Paleolithic peoples of Europe are known to have commonly hunted caribou (Spiess 1979; Bratlund 1991; Bokelmann 1991; Audouze and Enloe 1991; Jackson and Thacker 1997).

Living **musk oxen** (*Ovibos moschatus*) inhabit the arctic Tundra of the New World. In summer they graze in grassy river valleys, along lake-shores, and in meadows with abundant sedges, grasses, willows and heath. In winter they are commonly found on windswept hilltops where woody vegetation is exposed. The animals breed only every other year in late summer. Calves are born from late April to May. Musk oxen have keen sight and hearing. They usually travel in closely packed herds of fifteen to twenty individuals in winter and ten in summer (though herds can occasionally attain sizes of as many as 100 individuals). Herds are of mixed age and gender. During the rut, the dominant bull drives other males from the group. Muskoxen do not migrate widely, usually moving only 80 km between summer and winter ranges. Today, wolves and humans are the musk oxen's chief predators. When threatened, the adults will form a dense ring or wall of protection around the juveniles from which bulls may rush to attack (Whitaker 1996: 858).

Late Pleistocene Browsers of the Northeast

Mastodon (*Mammut)* remains have been recovered from Alaska to Florida, but were most common in the eastern forests. Mastodons inhabited open spruce woodlands, spruce forests, and pine parklands (Anderson 1984: 83; King and Saunders 1984). The Mastodon diet consisted of the conifer twigs and cones, leaves and twigs of deciduous trees, coarse grasses, and swamp plants (Anderson 1984; Guthrie 1984: 280). There is evidence of separate adaptations to pine and spruce dominated forests (King and Saunders 1984: 328). Mastodons stood between 2.7 and 3.0 meters at the shoulder. Both sexes had tusks in the upper jaw. Their lobed teeth were adapted for heavy mastication (King and Saunders 1984). Terminal dates for Mastodon suggest that extinction occurred about 10,000 years ago, although some have suggested more recent dates (King and Saunders 1984: 327). Loss of habitats with sufficient plant diversity has been blamed for their demise (Guthrie 1984: 280).

Symbos and Bootherium are extinct **woodland musk oxen**. The woodland musk ox, *Symbos*, was taller and more slender than its modern relative, *Ovibos*. *Bootherium* was smaller than modern musk-oxen. *Symbos* was a browser of plains and woodlands adapted to more temperate conditions than *Ovibos*. Its terminal date suggests extinction about 11,000 years ago (Anderson 1984: 81).

The **Wapiti** (also red deer or American Elk), *Cervus elephus*, is an inhabitant of meadows, woodlands and forests where it feeds on twigs, bark, herbs and grasses (Anderson 1984: 74). The modern animal breeds during October and November. The young are born in mid to late summer (Whitaker 1996: 826). Wapiti are primarily nocturnal and, unlike deer, are nearly silent runners in the forest. They can run up to 55 km/hr and are strong swimmers (Whitaker 1996: 827). Wapiti are very vocal cervids, able to produce a number of grunts, barks and whistles which are used as social calls. They are gregarious animals, forming cow-calf herds of as many as 400 individuals in open territory when resources are abundant. Smaller herds form in wooded areas (Whitaker 1996: 828). Bulls herd separately but remain nearby until the rut when they join the cow-calf herd. Bull elks may assemble harems of as many as sixty cows at this time. Mountain lions are the wapiti's main predator, although bears may take calves (Whitaker 1996: 829). Elk remains are much less common in prehistoric faunal assemblages than are those of the smaller white-tailed deer (Anderson 1984: 74). The modern distribution is much reduced from pre-colonial times as a result of habitat loss and hunting (Whitaker 1996: 829).

The extinct **stag-moose**, *Cervalces*, was about the size of a moose, with long legs and complex palmate antlers. It appears to have been a muskeg-wetland inhabitant. Two well preserved skeletons were discovered in post-glacial bogs in New Jersey. Restricted geographic range and competition with encroaching modern moose populations likely led to extinction (Anderson 1984: 73). No solid terminal date has been established for *Cervalces,* but it is believed to have become extinct before the Holocene (Kurtén and Anderson 1980: 317).

The **white-tailed deer**, *Odocoileus virginianus*, is currently the most plentiful game animal in eastern North America, despite nearly being exterminated in the Northeast and Midwest after European colonization (Whitaker 1996: 838). They are inhabitants of temperate woodlands, forest edges, stream borders and wetlands (Kurtén and Anderson 1980: 312). White-tailed deer vary in size from 68 to 141 kg for males and 41 to 96 kg for females. They range today throughout most of the continental United States (except the far Southwest) and in the southern half of the southern tier of the Canadian provinces (Whitaker 1996: 836). Their present range tends not to overlap with that of caribou. These deer breed during the first two weeks of November in their northern range. One to three young are born in May. While primarily nocturnal, white-tailed deer may be active at any time. They tend to follow established trails to feeding and bedding areas. These deer are good swimmers and runners, attaining speeds of up to 58 km/hr on land. They are capable of horizontal leaps of nine meters (Whitaker 1996: 836). Deer graze on green plants, including aquatic varieties, in the summer. In the fall, acorns, beechnuts, and other mast are important elements of the diet. In winter, white-tailed deer browse on woody vegetation, including the twigs and buds of viburnum, birch, maple, and many conifers, such as fir. Its four-part stomach allows the deer to feed on plants toxic to other animals, and microbes in the digestive system synthesize additional nutrients. It consumes 2.25 to 4 kg of food per day. Socially these deer form mother-infant groups, typically of three animals, and buck groups of three to five. In winter these small groups may converge, or "yard up," into larger social units consisting of as many as 150 individuals (Whitaker 1996: 837).

The **moose**, *Alces alces,* is largest living cervid. Male weight varies between 400 and 635 kg, that of females between 315 and 500 kg. Antlers usually spread to 1.5 meters (Whitaker 1996: 837). Today moose primarily inhabit boreal spruce forests, swamps, and aspen and willow thickets (Whitaker 1996: 840). Moose mate in mid-September through late October, and give birth to one or two calves in late May or early June (Whitaker 1996: 839). Moose migrate seasonally along mountain slopes. They tend to be solitary browsers, but several may gather in good feeding areas. They are fast swimmers (10 km/hr) with strong endurance, and can run quietly through the forest at speeds of 55 km/hr (Whitaker 1996: 840-841). Moose may herd in winter in favorable habitats. In summer their diet consists of willows and aquatic vegetation. In winter they browse on woody plants including the twigs, buds and bark of willow, balsam fir, aspen, dogwood, birch, cherry, maple, and viburnum (Whitaker 1996: 841). Wolves and human are their main predators. Moose are unpredictable and can be dangerous. Rutting bulls have been known to attack large objects such as cars and even trains when these were considered a threat (Whitaker 1996: 842).

The **giant beaver**, *Castoroides*, inhabited lakes and ponds bordered by swamps. This large rodent was the size of a black bear with a long narrow tail. Its habits appear to have been more similar to those of the muskrat than modern beaver. There is no evidence that it built dams or felled trees. It fed on coarse swamp vegetation. Its extinction is believed to be largely the result of competition with modern beaver (*Castor*) and loss of preferred habitat. Locally, Castoroides has been dated to 11,670 ± 70 years B.P. from the Dutchess Quarry caves (Funk and Steadman 1994: 73). The latest date recorded for Castoroides is 10,230 ± 150 in Ohio (Mead and Meltzer 1984: Table 19.4).

The **giant ground sloth**, *Megalonyx,* was an inhabitant of North American Forests and Woodlands. It was relatively common in the eastern two-thirds of the continent, and along the west coast its range extended to Alaska. Between 2.5 and 3.0 meters in length, *Megalonyx* was about the size of an ox (Anderson 1984: 52). Undated *Megalonyx* remains have been recovered from the "Black Dirt Area" (a Pleistocene wetland) near the Dutchess Quarry caves in southeastern New York (Funk and Steadman 1994: 13). A possible latest date for *Megalonyx* is 9,380 ± 85 years B.P. from Georgia, although other dates are closer to 11,000 years ago (Mead and Meltzer 1984: table 19.4; Anderson 1984: 52).

The **long-nosed peccary**, *Mylohyus,* appears to have been a solitary inhabitant of woodlands and forest edges. It was a long-legged, cursorial (running) animal about the size of a small white-tailed deer. Increasing early Holocene populations of black bear probably out-competed the primarily herbivorous long-nosed peccary (Anderson 1984: 69). The terminal date for *Mylohyus* is 9,410 ± 155 years B.P. in Tennessee (Mead and Meltzer 1984: table 19.4).

The **flat-headed peccary**, *Platygonus,* has been recovered coast to coast, and as far north as the Yukon. Anderson described it as "…probably the most common medium-sized animal in North America during the Pleistocene" (Anderson 1984: 69). It had longer legs than living peccaries and was about the size of a European wild boar. It had a specialized dentition which included razor-sharp canines. This large herbivore may have included insects, worms, reptiles and amphibians in its diet, as do modern peccary (Whitaker 1996: 822). Black bear probably competed with and preyed upon flat-headed peccary at the close of the Pleistocene. This, as well as loss of primary habitat and a slow birth rate were likely factors in its extinction (Anderson 1984: 69). A date of 4,290 ± 150 has been reported for *Platygonus* from Ohio (Mead and Meltzer 1984: table 19.4), but more reliable dates suggest an extinction time closer to 12,000 years ago (Anderson 1984: 69). Three dated *Platygonus* tooth remains were recovered from the Dutchess Quarry caves. These dates range from 12,160 ± 80 to 12,430 ± 70 years B.P. (Funk and Steadman 1994: 73).

Potential Sea Mammal Resources of the Late Pleistocene

Walrus and bearded seal are current inhabitants of arctic waters and may not have been present along northeastern coastlands after the Pleistocene. Walrus are immense, gregarious creatures which may be found in herds of up to 2,000 individuals along rocky coasts. The males can attain weights of up to 1,500 kg (Whitaker 1996: 722). Walrus feed primarily on mollusks and crustaceans (Whitaker 1996: 723). Bearded seal are also large, with typical weights of 200 to 250 kg, although the bigger females can attain a weight of over 425 kg (Whitaker 1996: 738). They inhabit continental shelf waters where they feed on bottom-dwelling fish, whelk, clams, crabs, and octopus. They are usually solitary creatures. Their rough hides are traditionally used for boot soles (Whitaker 1996: 739).

The **ringed, harp and hooded seals** currently inhabit arctic to sub-arctic waters but may have been present throughout the early Holocene in coastal New England and the St. Lawrence Estuary. Ringed seal typically range beneath land-fast ice where they feed upon crustaceans, small fish, and shrimp. They are relatively small seals, weighing between 50 to 110 kg (Whitaker 1996: 730-731). Harp seal are larger animals (up to 180 kg). They frequent drifting pack ice and feed upon small schooling fish, cod and some crustaceans. They are a migrating species, travelling as much as 9,600 km annually. Harp seal are highly gregarious during mid-winter in their southernmost range, gathering in numbers which may reach over 5,000 individuals per square mile. They are currently highly prized for their pelts by the sealing industry of Newfoundland (Whitaker 1996: 734-736). Hooded seal are larger, adults of both sexes weighing over 300 kg. They are a deep-water species, inhabiting the edge of arctic pack ice. Hooded seal are thought to eat primarily mussels, starfish, squid, octopus, herring, and cod. They tend to be solitary animals. Like the harp seal, hooded seal also migrate north following the retreating ice pack (Whitaker 1996: 739-741).

Gray seal inhabit temperate to subarctic waters, while harbor seal reside in a broad range of temperate to arctic conditions. Adult male gray seal weigh up to 350 kg, though the females are smaller. Gray seal are highly gregarious creatures, inhabiting rocky coasts and islands. They feed primarily on bottom-dwelling fish such as cod, haddock, and flounder, as well as on squid and octopus (Whitaker 1996: 732-734). The harbor seal is a similar, but smaller animal (the larger males weigh up to 140 kg). It inhabits coastal river mouths, beaches, rocky shores, and sometimes inland lakes. Basking groups may number in the thousands. They feed on herring, cod, mackerel, flounder, salmon, and some crustaceans. Interestingly, this seal will sometimes follow anadromous fish runs hundreds of miles up river, and return to the sea in the fall (Whitaker 1996: 728-739). Their habit of sleeping on beaches during low tide may have made them good targets for prehistoric terrestrial hunters.

Beluga whale, harbor porpoise, finback whale, and bowhead whales have been recorded within the Champlain Sea basin as well. It is impossible to assess the potential importance of these open-water sea mammals with our current lack of knowledge of Paleoindian water-craft technology (see Engelbrecht and Seyfert 1994 for a stimulating discussion). The presence of a variety of large marine mammals in the late Pleistocene Champlain Sea basin suggests the existence of a rich and complex marine habitat on the northern boundaries of the Northeast at the time of initial human colonization (Loring 1980). Similarly rich marine and estuarine environments were likely located in the Long Island Sound basin and the Narragansett Bay areas (Peck and McMaster 1991).

Appendix 2

A Brief Summary of Connecticut Fluted Point Find-spots

Bellantoni (1995) recently reported fifty-eight Paleoindian find-spots in the State of Connecticut. This data set is based upon information which is diverse in nature and spans decades of investigation by a number of researches. Bellantoni's current fluted point compilation was built upon a foundation of 17 find-spots reported by Moeller in 1982 (Brennan 1982), a number of locations recorded over the years by Douglas Jordan, and artifacts residing in the Bull Collection housed at the University of Connecticut. Further find-spots were added through personal interviews and references in local archaeological society bulletins. Only four of the recorded locations represent professionally excavated sites. The majority of find-spots are based on interviews with local avocational archaeologists and represent fluted points in private collections across the state.

Review of Bellantoni's original data suggests that the actual number of Paleoindian find-spots should be reduced from 58 to 53 by the removal of a small number of very poorly documented or otherwise questionable finds. However, three additional fluted points from New London county can be added to the list, based upon personal information gathered from local collectors. In addition, at least two fluted point sites are reported by George Nicholas in his summaries of the Robbins Swamp Survey in Litchfield county (Nicholas 1987, 1988). This returns the total to 58 locations, Bellantoni's original Figure. Table A2.1 summarizes the fluted point find-spots by county.

Table A2.1

Connecticut Paleoindian Find-Spots by County

Region	County	Fluted Point Finds
Western Connecticut	Fairfield	9
	New Haven	8
	Litchfield	10
Central Connecticut	Middlesex	10
	Hartford	9
Eastern Connecticut	New London	9
	Tolland	2
	Windham	1
Total		58

It is apparent that Tolland and Windham counties (the eastern uplands region [Bell 1985]) currently have the fewest number of reported fluted point finds. While this may reflect a real prehistoric environmental or resource condition which hindered occupation of this portion of the state, other factors may be more pertinent to this apparent pattern. This "under-representation" is most likely a function of lower modern human population density in this region. Activities which might result in the discovery of archaeological sites in general (primarily surface collecting and construction) are presumably less common than elsewhere in the state.

Bellantoni has warned that the survey data is unscientific in nature and probably biased. He suggests that the data not be used to draw inferences concerning any details of Paleoindian settlement in the region (i.e., site location or habitat preference). Needless to say, his compilation certainly suggests a degree of Paleoindian activity and presence far greater than that indicated by earlier reviews (e.g., Ritchie 1969, Curran and Dincauze 1977, Moeller in Brennan 1982). The data suggest that a significant number of Paleoindian sites are awaiting discovery in Connecticut. The current find-spots must be investigated more closely, and where possible, further testing should be implemented to determine whether more intensive investigations and excavations are warranted. The majority of these find-spots (those which have not already been destroyed) represent buried habitations sites which could contribute a great deal of further information concerning the initial settlement of this region.

References Cited

Aikens, Melvin C. and Takeru Akazawa
1996 The Pleistocene-Holocene Transition in Japan and Adjacent Northeast Asia: Climate and Biotic Change, Broad-Spectrum Diet, Pottery and sedentism. In *Humans at the End of the Ice Age: The Archaeology of the Pleistocene-Holocene Transition*, edited by L. Straus, B. Eriksen, J. Erlandson, and D. Yesner, pp. 215-227. Plenum Press, New York.

Alley R. B., D. A. Meese, C. A. Shuman, A. J. Gow, K. C. Taylor, P. M. Grootes, J. W. C. White, M. Ram, E. D. Waddington, P. A. Mayewski, and G. A. Zielinski
1993 Abrupt Increase in Greenland Snow Accumulation at the end of the Younger Dryas Event. *Nature* 362: 527-529.

Anderson, Elaine
1984 Who's Who in the Pleistocene: A Mammalian Bestiary. In *Quaternary Extinctions: A Prehistoric Revolution*, edited by Paul S. Martin and Richard G. Klein, pp. 40-89. The University of Arizona Press, Tucson.

Anderson, David G.
1991 Examining Prehistoric Settlement Distribution in Eastern North America. *Archaeology of Eastern North America* 19: 1-22.

1995 Recent Advances in Paleoindian and Archaic Period Research in the Southeastern United States. *Archaeology of Eastern North America* 23: 145-176.

1996 Models of Paleoindian and Early Archaic Settlement in the Lower Southeast. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman, pp. 29-57. The University of Alabama, Tuscaloosa.

Anderson, D. G. and G. T. Hanson
1988 Early Archaic Settlement in the Southeastern United States: A Case Study from the Savannah River Valley. *American Antiquity* 53:262-286.

Anderson, David G., Lisa D. O'Steen and Kenneth E. Sassaman
1996 Environmental and Chronological Considerations. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman, pp. 3-15. The University of Alabama, Tuscaloosa.

Ascher, Robert
1961 Analogy in Archaeological Interpretation. *Southwestern Journal of Anthropology* 17: 317-325.

1968 Time's Arrow and the Archaeology of a Contemporary Community. In *Settlement Archaeology*, edited by K. C. Chang, pp. 43-52. National Press, Palo Alto.

Audouze, Françoise and James Enloe
1991 Subsistence Strategies and Economy in the Magdalenian of the Paris Basin, France. In *The Late Glacial in Europe: Human Adaptation and Environmental Change at the End of the Pleistocene* (CBA Research Report 77), edited by N. Barton, A. J. Roberts, and D. A. Roe, pp. 63-71. Council for British Archaeology, London.

Baales, Michael and Martin Street
1996 Hunter-Gatherer Behavior in a Changing Late Glacial Landscape: Allerød Archaeology in the Central Rhineland, Germany. *Journal of Anthropological Research* 52: 281-316.

Badgley, Ian and Paul Boissonnault
1985 Une Occupation Préhistorique Ancienne de la Région de Québec. *Recherches Amérindiennes au Québec* 25(1,2): 151-160.

Barton, R.N.E., and Berman, C.A.
1982 Hunters and Hengistbury: Some Evidence from Experimental Archaeology. *World Archaeology* 14(2): 232-248.

Baumhoff, M.
1963 Ecological Determinants of Aboriginal California Populations. *University of California Publications in Archaeology and Ethnology* 49(2): 155-236.

Beaton, J. M.
1990 The Importance of Past Population for Prehistory. In *Hunter-Gatherer Demography*, edited by B. Meehan and N. White, pp. 23-40. University of Sydney, Sydney.

Belknap, D. L., B. G. Anderson, R. S. Anderson, W. A. Anderson, H. W. Borns Jr., G. L. Jacobson, J. T. Kelley, R. C. Shipp, D. C. Smith, R. Stuckenrath, W. B. Thompson, and D. A. Tyler
1987 Late Quaternary Sea Level Changes in Maine. In *Sea Level Change and coastal Depositionasl Systems Architecture*, edited by D. Nummedal, O. Pilkey, and J. Howard, Society Economic Paleontologists and Mineralogists, Special Publication 41: 65-79.

Bell, Michael
1985 *The Face of Connecticut: People, Geology, and the Land*. State Geological and Natural History Survey of Connecticut, Hartford.

Bellantoni, Nicholas
1995 *Distribution of Paleoindian Cultural Material in Connecticut*. Paper presented at the Archaeological Society of Connecticut Annual Spring Meeting.

Belovsky, G.
1987 Hunter-Gatherer Foraging: A Linear Programming Approach. *Journal of Anthropological Archaeology* 6: 29-76.

1988 An Optimal Foraging-Based Model of Hunter-Gatherer Population Dynamics. *Journal of Anthropological Archaeology* 7: 329-372.

Binford, Lewis R.
1968 Post-Pleistocene Adaptations. In *New Perspectives in Archaeology*, edited by by S. R. Binford and L. R. Binford, pp. 331-341. Aldine, Chicago.

1978 *Nunamiut Ethnoarchaeology*. Academic Press, New York.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35(3):255-273.

1980 Willow Smoke and Dog's Tails: hunter-gatherer settlements systems and archaeological site formation. *American Antiquity* 45:4-20.

1982 The Archaeology of Place. *Journal of Anthropological Archaeology* 1:5-31.

1983 *In Pursuit of the Past: Decoding the Archaeological Record*. Thames and Hudson, New York.

1990 Mobility, Housing and Environment: A Comparative Study. *Journal of Anthropological Research* 46: 119-152.

1991 A Corporate Caribou Hunt. *Expedition* 33(1): 33-43.

Birdsell, J. B.
1953 Some Environmental and Cultural Factors Influencing the Structuring of Australian Aboriginal Populations. *American Naturalist* 87: 171-207.

Bocek, B.
1986 Rodent Ecology and Burrowing Behavior: Predicted Effects on Archaeological Site Formation. *American Antiquity*, Vol. 51, No. 3: 589-603.

Bokelmann, Klaus
1991 Some New Thoughts on Old Data on Humans and Reindeer in the Ahrensburgian Tunnel Valley in Schleswig-Holstein, Germany. In *The Late Glacial in Europe: Human Adaptation and Environmental Change at the End of the Pleistocene* (CBA Research Report 77), edited by N. Barton, A. J. Roberts, and D. A. Roe, pp. 72-81. Council for British Archaeology, London.

Bolian, Charles E.
1980 The Early and Middle Archaic of the Lakes Region, New Hampshire. In *Early and Middle Archaic Cultures in the Northeast*, edited by David R. Starbuck and Charles E. Bolian, pp. 115-134. Occasional Publications in Northeastern Anthropology 7.

Bonnichsen, Robson, George L. Jacobson Jr., Ronald B. Davis and Harold W. Borns, Jr.
1985 The Environmental Setting for Human Colonization of Northern New England and Adjacent Canada in Late Pleistocene Time. In *Late Pleistocene History of Northeastern New England and Adjacent Quebec*, Geological Society of America, edited by H. W. Borns, P. LaSalle and W. B. Thompson. Special Paper 197: 151-159.

Bonnichsen, Robson and Karen L. Turnmire (editors)
1991 *Clovis: Origins and Adaptations*. Center for the Study of the First Americans, Oregon State University, Corvallis Oregon.

Bosinski, Gerhard
1987 *Die Grosse Zeit der Eiszeitjäger: Europa zwischen 40,000 und 10,000 v. Chr.* Sonderdruck aus Jahrbuch des Romisch-Germanischen Zentralmuseums, Mainz.

1988 Upper and Final Paleolithic Settlement Patterns in the Rhineland, West Germany. In *Upper Pleistocene Prehistory of Western Eurasia*, edited by H. L. Dibble and A Montet-White. University Museum Monograph 54, University Museum Symposium Series Volume I, pp. 375-385. The University Museum, University of Pennsylvania.

Botkin, Daniel B.
1991 Rethinking the Environment. *The Wilson Quarterly* 15: 60-72.

Bowers, Peter M., Robson Bonnichsen, and David M. Hoch
1983 Flake Dispersal Experiments: Noncultural Transformation of the Archaeological Record. *American Antiquity* 48(3): 553-572.

Bratlund, Bodil
1991 A Study of Hunting Lesions Containing Flint Fragments on Reindeer Bones at Stellmoor, Schleswig-Holstein, Germany. In *The Late Glacial in Europe: Human Adaptation and Environmental Change at the End of the Pleistocene* (CBA Research Report 77), edited by N. Barton, A. J. Roberts, and D. A. Roe, pp. 193-207. Council for British Archaeology, London.

Breest, Klaus and Stephen Veil
1991 The Late Upper Paleolithic Site of Schweskau, Ldkr. Lüchow-Dannenberg (Germany), and Some Comments on the Relationship Between the Magdalenian and Hamburgian. In *The Late Glacial in Europe: Human Adaptation and Environmental Change at the End of the Pleistocene* (CBA Research Report 77), edited by N. Barton, A. J. Roberts, and D. A. Roe, pp. 82-99. Council for British Archaeology, London.

Brennan, Louis A. (ed.)
1982 A Compilation of Fluted Points of Eastern North America by Count and Distribution: An AENA Project. *Archaeology of Eastern North America* 10: 27-45.

Broecker, Wallace S.
1992 Defining the Boundaries of the Late-Glacial Isotope Episodes (letter to the editor). *Quaternary Research* 38: 135-138.

Broecker, Wallace S., James P. Kennett, Benjamin P. Flower, James T. Teller, Sue Trumbores, George bonani and Willy Wolfli
1989 Routing of Meltwater from the Laurentide Ice Sheet During the Younger Dryas Cold Episode. *Nature* 341: 318-321.

Burch, Ernest S. Jr.
1972 The Caribou/Wild Reindeer as a Human Resource. *American Antiquity* 37(3): 339-368.

Butzer, Karl W.
1964 *Environment and Archaeology*. Aldine Publishing Company, Chicago.

Byers, Douglas S.
1954 Bull Brook – A Fluted Point Site in Ipswich, Massachusetts. *American Antiquity* 19(4): 343-351.

1955 Additional Information on the Bull Brook Site, Massachusetts. *American Antiquity* 20(3): 274-276.

1959 Radiocarbon Dates for the Bull Brook Site, Ipswich, Massachusetts. *American Antiquity* 24(4): 427-429.

1962 Comments in Response to Ronald Mason's "The Paleo-Indian Tradition in Eastern North America," *Current Anthropology* 3(3): 247-250.

Cahen, D., and Keeley, L.H.
1980 Not Less Than Two, Not More Than Three. *World Archaeology* 12(2): 167-179.

Cahen, D., and Moeyersons, J.
1977 Subsurface Movements of Stone Artefacts and Their Implications for the Prehistory of Central Africa. *Nature*, April, Vol. 266, No. 28:812-815.

Carty, Frederick M. and Arthur Spiess
1992 The Neponset Paleoindian Site in Massachusetts. *Archaeology of Eastern North America* 20:19-37.

Cassedy, Daniel F.
1997 *From the Erie Canal to Long Island Sound: Technical Synthesis of the Iroquois Pipeline Project, 1989-1993*. Garrow and Associates, Inc., Atlanta.

Cavallo, John
1981 Turkey Swamp: A Late Paleo-Indian Site in New Jersey's Coastal Plain. *Archaeology of Eastern North America* 9:1-17.

Chalifoux, Éric
1994 La Description des Témoins Culturels: Le Débitage. In *Il y a 8000 ans à Rimouski: paléoécologie ey archéologie d'un site de la culture Plano*, edited by Claude Chapdelaine, Recherches Amérindiennes au Qu_bec, Pal_o-Qu_bec No. 22, published in collaboration with the Minist_re des Transports du Québec, Montreal.

Chapdelaine, Claude (editor)
1994 *Il y a 8000 ans à Rimouski: paléoécologie ey archéologie d'un site de la culture Plano*, edited by Claude Chapdelaine, Recherches Amérindiennes au Québec, Paléo-Québec No. 22, published in collaboration with the Ministère des Transports du Québec, Montreal.

Chapdelaine, Claude and Steve Bourget
1992 Premier Regard sur un Site Paleoindien Recent a Rimouski (DcEd-1). *Recherches Amérindiennes au Québec* 22(1):17-32.

Charnov, Eric L.
1976 Optimal Foraging, the Marginal Value Theorem. *Theoretical Population Biology* 9: 129-136.

Chartkoff, J. L.
1978 Transect Interval Sampling in Forests. *American Antiquity* 43:46-53.

Chilton, Elizabeth S.
1994 In Search of Paleo-Women: Gender Implications of Remains from Paleoindian Sites in the Northeast. Bulletin of the Massachusetts Archaeological Society 55(1): 8-14).

Clarke, J. G. D.
1972 *Star Carr: A Case Study in Bioarchaeology*. Addison Wesley Module in Anthropology, 10.

Cleland, Charles E.
1976 The Focal Diffuse Model: An Evolutionary Perspective on the Prehistoric Cultural Adaptations of the Eastern United States. *Mid-Continental Journal of Archaeology* 1(1): 59-76.

Cox, Belinda J. and James B. Petersen
1997 The Varney Farm (36-57 ME): A Late Paleoindian Encampment in Western Maine. *The Maine Archaeological Society Bulletin* 37(2): 25-49.

Crabtree, Don E
1982 An Introduction to Flintworking. *Occasional Papers of the Idaho Museum of Natural History, No. 28* (second edition), Edited by Swanson, Butler, and Harten.

Curran, Mary Lou
1984 The Whipple Site and Paleo-Indian Tool Assemblage Variation: A Comparison of Intrasite Structuring. *Archaeology of Eastern North America* 12: 5-40.

1987 *The Spatial Organization of Paleoindian Population in the Late Pleistocene of the Northeast*. Unpublished Doctoral Dissertation, University of Massachusetts. University Microfilms, Ann Arbor.

Curran, Mary Lou and John R. Grimes
1989 Ecological Implications for Paleoindian Lithic Procurement Economy in New England. In *Eastern Paleoindian Lithic Resource Use*. Edited by Ellis and Lothrop, pp. 41-74. Westview Press, Boulder.

Cwynar, Les C. and André J. Levesque
1995 Chironomid Evidence for Late-Glacial Climatic Reversals in Maine. *Quaternary Research* 43: 405-413.

Dansgaard, W. J., W. C. White, and S. J. Johnson
1989 The Abrupt Termination of the Younger Dryas Climate Event. *Nature* 339: 532-534.

Davis, Margaret B.
1965 Phytogeography and Palynology of Northeastern United States. In *The Quaternary of the United States*, edited by H. E. Wright, Jr. and D. G. Frey, pp. 377-401. Princeton University Press, Princeton.

1969 Climate Changes in Southern Connecticut Recorded by Pollen Deposition at Rogers Lake. *Ecology* 50: 409-422.

Davis, R. B. and G. L. Jacobson, Jr.
1985 Late Glacial and Early Holocene Landscapes in Northern New England and Adjacent Areas of Canada. *Quaternary Research* 23: 341-368.

Davis, Stephen
1991 Two Concentrations of Paleo-Indian Occupation in the Far Northeast. *Revista de Arqueología Americana* 3: 31-56.

Deller, D. Brian
1989 Interpretation of Chert Type Variation in Paleoindian Industries, Southwestern Ontario. In *Eastern Paleoindian Lithic Resource Use*. Edited by Ellis and Lothrop, pp. 191-220. Westview Press, Boulder.

Deller, D. Brian and Chris J. Ellis
1988 Early Paleoindian Complexes in Southwestern Ontario. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. Miller and D. Steadman. Bulletin of the Buffalo Society of Natural Sciences 33: 251-263.

Dennell, Robin W.
1983 *European Economic Prehistory: A New Approach*. Academic Press, London.

Denny, Charles S.
1982 *Geomorphology of New England*. Geological Survey Professional Paper 1208, U.S. Department of the Interior, United States Government Printing Office, Washington.

Dewar, R. E.
1984 Environmental Productivity, Population Regulation, and Carrying Capacity. *American Anthropologist* 86(3): 601-614.

1986 Discovering Settlement Systems of the Past in New England Site Distributions. *Man in the Northeast* 31:77-88.

Dewar, R. E. and K. A. McBride
1992 Remnant Settlement Patterns. In *Time, Space and Landscapes*, edited by J. Rossignol and L Wandsnider, pp. 227- 255. Plenum Press, New York.

Dillehay, Tom D.
1997 *Monte Verde: A Late Pleistocene Settlement in Chile 2: The Archaeological Context*. Smithsonian Institution Press, Washington.

Dillehay, Tom D. and David J. Meltzer (editors)
1991 *The First Americans: Search and Research*. CRC Press, Boca Raton.

Dincauze, Dena F.
1976 *The Neville Site: 8,000 Years at Amoskeag*. Peabody Museum Monographs 4. Harvard University, Cambridge.

1978 Surveying for Cultural Resources: Don't Rush out with a Shovel. In *Conservation Archaeology in the Northeast*, edited by A. E. Spiess, pp. 51-59. Peabody Museum, Cambridge.

1993 Fluted Points in the Eastern Forests. In *From Kostenki to Clovis: Upper Paleolithic - Paleo-Indian Adaptations*, pp. 279-292. Eds. Olga Soffer and N. D. Praslov. Plenum Press, New York.

1996a Large Paleoindian Sites in the Northeast: Pioneers’ Marshalling Camps? *Bulletin of the Massachusetts Archaeological Society* 57(1): 3-17.

1996b Modeling Communities and Other Thankless Tasks. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman, pp. 421-424. The University of Alabama, Tuscaloosa.

Dincauze, Dena and Mary Lou Curran
1983 *Paleoindians as Generalists: An Ecological Perspective*. Paper presented at the 48th annual meeting of the Society for American Archaeology, Pittsburgh.

Dincauze, Dena F. and Mitchell T. Mulholland
1977 Early and Middle Archaic Site Distributions and Habitats in Southern New England. In *Amerinds and their Paleoenvironments*, edited by Walter S. Newman and Bert Salwen, pp. 439-456. Annals of the New York Academy of Science*s* Vol. 288.

Doyle, Richard A., Nathan D. Hamilton, and James B. Petersen
1985 Late Paleo-Indian Remains from Maine and their Correlations in Northeastern Prehistory. *Archaeology of Eastern North America* 13:1-34.

Dragoo, Don W.
1976 Some Aspects of Eastern North American Prehistory: A Review. *American Antiquity* 41: 3-27.

Driver, Jonathan C.
1990 Meat in Due Season: The Timing of Communal Hunts. In *Hunters of the Recent Past*, edited by Davis and Reeves, pp. 11-33. Unwin Hyman, London.

Dumais, Pierre and Gilles Rousseau
1985 Trois sites Paleoindiens sur la cote sud de l'estuaire du Saint-Laurent. *Recherches Amérindiennes au Québec* 15: 135-150.

Dumont, John
1981 The Paleoindian – Early Archaic Continuum: An Environmental Approach. *Archaeology of Eastern North America* 9: 18-37.

Dunnell R. C. and W. S. Dancey
1983 The Siteless Site: A Regional Scale Data Collection Strategy. In *Advances in Archaeological Method and Theory*, vol. 6, edited by M. B. Schiffer, pp. 267-287. Academic Press, New York.

Dwyer, Peter D. and Monica Minnegal
1985 Andaman Islanders, Pygmies, and an Extension of Horn's Model. *Human Ecology* 13(1): 111-119.

Edwards, Robert L. and K. O. Emery
1977 Man in the Continental Shelf. In *Amerinds and their Paleoenvironments in Northeastern North America*, Edited by W. S. Newman and B. Salwen, pp. 245-256. The New York Academy of Science, New York.

Eisenberg, Leonard
1978 *Paleoindian Settlement Pattern in the Hudson and Delaware River Drainages*. Occasional Papers in Northeastern Anthropology 4, Man in the Northeast.

Ellis, Christopher and D. Brian Deller
1997 Variability in the Archaeological Record of Northeastern Early Paleoindians: A View from Southern Ontario. *Archaeology of Eastern North America* 25: 1-30.

Ellis, Chris J., Stanley Wortner and William A. Fox
1991 Nettling: an Overview of an Early Archaic "Kirk Corner-Notched Cluster" in Southwestern Ontario. *Canadian Journal of Archaeology* 15:1-34.

Engelbrecht, William E. and Carl K. Seyfort
1994 Paleoindian Watercraft: Evidence and Implications. *North American Archaeologist* 15(3): 221-234.

Eriksen, Berit Valentin
1996 Resource Exploitation, Subsistence Strategies, and Adaptiveness in Late Pleistocene – Early Holocene Northwest Europe. In *Humans at the End of the Ice Age: The Archaeology of the Pleistocene – Holocene Transition*, edited by L. G. Straus, B. V. Eriksen, J. M. Erlandson, and D. R. Yesner, pp. 101-128. Plenum Press, New York.

Erlandson, J.M.
1984 A Case Study in Faunalturbation: Delineating the Effects of the Burrowing Pocket Gopher on the Distribution of Archaeological Materials. *American Antiquity* 49, (4): 785-790.

Fagan, Brian M.
1991 *Ancient North America: The Archaeology of a Continent*. Thames and Hudson, Ltd., London.

Fairbanks, Richard G.
1989 A 17,000-Year Glacio-Eustatic Sea Level Record: Influence of Glacial Melting Rates on the Younger Dryas Event and Deep-Ocean Circulation. *Nature* 342: 637-642.

Faught, Michael K., James S. Dunbar and S. David Webb
1994 North American Paleoindian Database - An Update. *Current Research in the Pleistocene* 11:32-35.

Ferguson, John P.
1995 The Haviland Site: The Early Archaic in Scoharie County. *The Bulletin Journal of the New York State Archaeological Association* 110: 1-15.

Fitting, James E., Jerry Devisscher and Edward J. Wahla
1966 *The Paleoindian Occupation of the Holcombe Beach*. The University of Michigan, Ann Arbor.

1968 Environmental Potential and the Postglacial Readaptation in Eastern North America. *American Antiquity* 33(4): 441-445.

Foley, R.
1981 Off-Site Archaeology: an alternative approach for the short-sited. In *Pattern of the Past*, edited by I. Hodder, G. Isaac, N. Hammond, pp. 157-183. University Press, Cambridge.

Fowler, William S.
1972 Eden Points in Massachusetts, *Bulletin of the Massachusetts Archaeological Society*, Nos. 3 and 4: 29-31.

Frison, George and B. Bradley
1980 *Folsom Tools and Technology at the Hanson Site, Wyoming*. University of New Mexico Press, Albuquerque.

Frison, George and Robson Bonnichsen
1996 The Pleistocene – Holocene Transition on the Plains and Rocky Mountains of North America. In *Humans at the End of the Ice Age: The Archaeology of the Pleistocene – Holocene Transition*, edited by L. G. Straus, B. V. Eriksen, J. M. Erlandson, and D. R. Yesner, pp. 301-318. Plenum Press, New York.

Frison, George and Dennis Stanford
1982 *The Agate Basin Site*. Academic Press, New York.

Funk, Robert E.
1991 Late Pleistocene and Early Holocene Human Adaptations in the Lower Hudson Valley. In *The Archaeology and Ethnohistory of the Lower Hudson Valley and Neighboring Regions: Essays in Honor of Louis A. Brennan*, edited by Herbert C. Kraft. Occasional Publications in Northeastern Anthropology, No. 11.

1997 Holocene or Hollow Scene? The Search for the Earliest Archaic Cultures in New York State. *The Review of Archaeology* 17(1): 11-24.

Funk, Robert E. and Richard Michael Gramly
1991 What is Known and not Known about the Human Occupation of the Northeastern United States Until 10,000 B.P. *Archaeology of Eastern North America* 18: 5-31.

Funk, Robert E. and David W. Steadman
1994 *Archaeological and Paleoenvironmental Investigations in the Dutchess Quarry Caves, Orange County, New York*. Persimmon Press Monographs in Archaeology, Buffalo.

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

Gaudreau, Denise C
1988 Paleoecological Interpretation of Patterns in Pollen Data: Spruce and Birch in Northeastern North America. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 15-29 . Bulletin of the Buffalo Society of Natural Sciences, vol. 33, Buffalo.

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

Gayes, Paul T. and Henry J. Bokuniewicz
1991 Estuarine Paleoshorelines in Long Island Sound, New York. *Journal of Coastal Research,* Special Issue No. 11:39-54.

Goslar, T, M. Arnold, E. Bard, T. Kuc, M. Pazdur, M. Raiska-Jasiewiczowa, K. Rózanski, N. Tisnerat, A. Walanus, B Wicik, and K. Wieckowski
1995 High Concentration of Atmospheric 14C During the Younger Dryas Cold Episode. *Nature* 377: 414-417.

Gould, Richard A. and Patty Jo Watson
1982 A Dialogue on the Meaning and use of Analogy in Ethnoarchaeological Reasoning. *Journal of Anthropological Archaeology* 1: 355-381.

Graham, Russell W. and Jim I. Mead
1987 Environmental Fluctuations and Evolution of Mammalian Faunas During the Last Deglaciation. In *North America and Adjacent oceans During the Last Deglaciation*, edited by W. F. Ruddiman and H. E. Wright, pp. 371-402. The Geology of North America, Vol. 3. Geological Society of America, Boulder.

Gramly, Richard Michael
1982 *The Vail Site: A Paleo-Indian Encampment in Maine*. Bulletin of the Buffalo Society of Natural Sciences Vol. 30, Buffalo, New York.

Gramly, Richard Michael and Robert E. Funk
1990 What is Known and Not Known about the Human Occupation of the Northeastern United States Until 10,000 B.P. *Archaeology of Eastern North America*18: 5-31.

Grimes, John R.
1979 A New Look at Bull Brook. *Anthropology* 3(1-2): 109-130.

Grimes, John R., William Eldridge, Beth G. Grimes, Antonio Vaccaro, Frank Vaccaro, Joseph Vaccaro, Nicolas Vaccaro and Antonio Orsini
1984 Bull Brook II. *Archaeology of Eastern North America* 12: 159-183.

Guilday, John E.
1982 Appalachia 11,000 – 12,000 years ago: A Biological Review. *Archaeology of Eastern North America* 10: 22-26.

1984 Pleistocene Extinction and Environmental Change: Case Study of the Appalachians. In *Quaternary Extinction: A Prehistoric Revolution*, Edited by P. S. Martin and R. G. Klein, pp. 250-258. University of Arizona Press, Tucson.

Guthrie, R. Dale
1984 Mosaics, Allelochemics, and Nutrients: An Ecological Theory of Late Pleistocene Megafaunal Extinction. In *Quaternary Extinction: A Prehistoric Revolution*, Edited by P. S. Martin and R. G. Klein, pp. 259-298. University of Arizona Press, Tucson.

Hallaren, William
1988 *Prehistoric Indicators from Southeastern Massachusetts 10,500 - 8,000 years B.P.*, report on file at the Scituate Historical Society, Scituate, Massachusetts.

Harington, C. R.
1977 Marine Mammals in the Champlain Sea and the Great Lakes. In *Amerinds and their Paleoenvironments*, edited by Walter S. Newman and Bert Salwen, pp. 508-537. Annals of the New York Academy of Sciences Vol. 288.

Hassan, Fekri A.
1981 *Demographic Archaeology*. Academic Press, New York.

Hayden, Brian
1981 Subsistence and Ecological Adaptations of Modern Hunter/Gatherers. In *Omnivorous Primates: Gathering and Hunting in Human Evolution*, edited by Robert S. O. Teleki and Geza Teleki. Columbia University Press, New York.

Haynes, C. Vance, D. J. Donahue, A. J. T. Jull and T. H. Zabel
1984 Application of Accelerator Dating to Fluted Point Paleoindian Sites. *Archaeology of Eastern North America* 12: 184-191.

Hermes, O. Don and D. Ritchie
1997 Application of Petrographic and Geochemical Methods to Sourcing Felsitic Archaeological Materials in Southeastern New England. *Geoarchaeology* 12(1): 1-30.

Hoffecker, John F., W. Roger Powers and Ted Goebel
1991 The Colonization of Beringia and the Peopling of the New World. *Science* 259: 46-53.

Hofman, Jack L.
1994 Paleoindian Aggregations on the Great Plains. *Journal of Anthropological Archaeology* 13: 341-370.

Horn, H. S.
1968 The Adaptive Significance of Colonial Nesting in the Brewer's Blackbird (Euphagus cyanocephalus). *Ecology* 49:682-694.

Hutchinson, George Evelyn
1978 *An Introduction to Population Ecology*. Yale University Press, New Haven.

Isaac, B.
1990 Economy, Ecology, and Analogy: The !Kung San and the Generalized Foraging Model. In *Early Paleoindian Economies of Eastern North America*, edited by B. Isaac and K. Tankersley, pp. 323-335. Research in Economic Anthropology Supplement 5. JAI Press, Greenwich, Connecticut.

Jackson, Lawrence and Heather McKillop
1991 Approaches to Paleo-Indian Economy: An Ontario and Great Lakes Perspective. *Midcontinental Journal of Archaeology* 16(1):34-68.

Jackson, Lawrence and Paul T. Thacker (editors)
1997 *Caribou and Reindeer Hunters of the Northern Hemisphere*. Worldwide Archaeology Series 6, Avebury Press, Aldershot, Great Britain.

Jacobson, G. L and A. Dieffenbacher-Krall
1995 White Pine and Climate Change: Insights from the Past. *Journal of Forestry* 93(7): 39-42.

Jacobson, G. L., T. Webb and E. C. Grimm
1987 Patterns and Rates of Vegetation Change During the Deglaciation of Eastern North America. In *The Geology of North America* Vol. K-3. The Geological Society of America, Boulder.

Jacobi, R. M.
1978 Northern England in the Eighth Millennium BC: An Essay. In *The Early Postglacial Settlement of Northern Europe: An Ecological Perspective*, edited by Paul Mellars, pp. 295-332. University of Pittsburgh Press, Pittsburgh.

Jarman, M.
1972 A Territorial Model for Archaeology. In *Models in Archaeology*, edited by D. L. Clarke, pp. 705-734. Methuen, London.

Jochim, Michael A.
1976 *Hunter Gatherer Subsistence and Settlement: A Predictive Model*. Academic Press, New York.

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

1988 Optimal Foraging and the Division of Labor. *American Anthropologist* 90: 130-136.

1991 Archaeology as Long-Term Anthropology. *American Anthropologist* 93: 308-321.

1995 Two Late Paleolithic Sites on the Federsee, Germany. *Journal of Field Archaeology* 22: 263-273.

1996 Surprises, Recurring Themes, and New Questions in the Study of the Late Glacial and Early Postglacial. In *Humans at the End of the Ice Age: The Archaeology of the Pleistocene – Holocene Transition*, edited by L. G. Straus, B. V. Eriksen, J. M. Erlandson, and D. R. Yesner, pp. 357-363. Plenum Press, New York.

Johnson, D.L.
1989 Subsurface Stone Lines, Stone Zones, Artifact-manuport Layers, and Biomantles Produced by Bioturbation via Pocket Gophers(*Tohmomys bottae*). *American Antiquity*, Vol. 54(2): 370-389.

1990 Biomantle Evolution and the Redistribution of Earth Materials and Artifacts. *Soil Science*, February, Vol. 149(2): 84-102.

Johnson, D.L., Keller, E.A., and Rockwell, T.K.
1990 Dynamic Pedogenesis: New Views on Some Key Soil Concepts, and a Model for Interpreting Quaternary Soils. *Quaternary Research*, 33: 306-319.

Johnson, D.L., and Watson-Stegner, D.
1987 Evolution Model of Pedogenesis. *Soil Science* 143(5): 349-366.

1990 The Soil Evolution Model as a Framework for Evaluating Pedoturbation in Archaeological Site Formation. In *Archaeological Geology of North America*, edited by Lasca, N.P. and Donahue, J., pp. 541-560. Geological Society of America, Boulder.

Johnson, D.L., Watson-Stegner, D., Johnson, D.N., and Randall, J.S.
1987 Proisotropic and Proanisotropic Processes of Pedoturbation. *Soil Science* 143(4): 278-292.

Johnson, Eric S.
1993 Bifurcate Points in Eastern and Central Massachusetts: Distribution and Raw Materials. *Bulletin of the Massachusetts Archaeological Society* 54(2): 46-55.

Jones, Brian D.
1994 *Hunter-Gatherer Adaptations to the Terminal Pleistocene and Early Holocene Environments of Northeastern North America: Effects on Site Visibility*. Paper presented at the 34th Annual Meetings of the Northeastern Anthropological Association, Geneseo, New York, April 7.

1997 The Late Paleoindian Hidden Creek Site in Southeastern Connecticut. *Archaeology of Eastern North America* 25: 45-80.

Jordan, Douglas
1960 *The Bull Brook Site in Relation to "Fluted Point" Manifestations in Eastern North America*. Unpublished Doctoral dissertation, Harvard University, Cambridge. University Microfilms, Ann Arbor.

1975 Factors affecting New England Archaeology. *Man in the Northeast* 10:71-74.

Julig, P.J, McAndrews, J.H., and Mahoney, George F.
1990 Geoarchaeology of the Cummins Site on the Beach of Proglacial Lake Minong, Lake Superior Basin, Canada. In *Archaeological Geology of North America*. Lasca, N.P. and Donahue, J. (Eds.). Geological Society of America, Boulder, pp. 21-50.

Kauffman, Stuart
1995 *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity*. Oxford University Press, New York.

Kaufman, Daniel
1998 Measuring Archaeological Diversity: An Application of the Jackknife Technique. *American Antiquity* 63(1): 73-85.

Keeley, Lawrence H.
1991 Ethnographic Models for Late Glacial Hunter-Gatherers. In *The Late-Glacial in Northwest Europe: Human Adaptation and Environmental Change at the End of the Pleistocene*, edited by Nicholas Barton, Alison J. Roberts, and Derek Roe, pp. 179-190. Council for British Archaeology, London.

Keenlyside, David L.
1985a Late Paleo-Indian Evidence from the Gulf of St. Lawrence. *Archaeology of Eastern North America* 13: 79-92.

1985b La Période Paleoindienne sur L'Ile du Prince Edouard. *Recherches Amérindiennes au Québec* XV:119-126.

1991 Paleoindian Occupations of the Maritimes Region of Canada. In *Clovis: Origins and Adaptations*, edited by R. Bonnichsen and K. Turnmire, pp.163-173. Center for the Study of the First Americans, Oregon State University, Corvallis.

Kelly, Robert L.
1983 Hunter-Gatherer Mobility Strategies. *Journal of Anthropological Research* 39: 277-306.

1995 *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*. Smithsonian Institution Press, Washington.

King, James E. and Jeffrey J. Saunders
1984 Environmental Insularity and the Extinction of the American Mastodont. In *Quaternary Extinction: A Prehistoric Revolution*, Edited by P. S. Martin and R. G. Klein, pp. 315-339. University of Arizona Press, Tucson.

Kintigh, K. W.
1988 The Effectiveness of Subsurface Testing: A Simulation Approach. *American Antiquity* 53: 686-707.

Kolstrup, Else
1991 *Paleoenvironmental Developments During the Late Glacial of the Weichselian.* In *The Late-Glacial in Northwest Europe: Human Adaptation and Environmental Change at the End of the Pleistocene*, edited by Nicholas Barton, Alison J. Roberts, and Derek Roe, pp. 1-6. Council for British Archaeology, London.

Kraft, Herbert C.
1973 The Plenge Site: A Paleo-Indian Occupation Site in New Jersey. *Archaeology of Eastern North America* 1(1): 56-117.

Kraft, John C.
1985 Marine Environments: Paleogeographic Reconstructions in the Littoral Region. In *Archaeological Sediments in Context*, edited by J. K. Stein and W. R. Farrand, pp. 111-125. Peopling of the Americas Volume 1, Center for the Study of Early Man, Orono.

Krakker, J. J., M. J. Shott and P. D. Welch
1983 Design and Evaluation of Shovel-Test Sampling in Regional Archaeological Survey. *Journal of Field Archaeology* 10: 470-480.

Kudras, H. R., H. Erlenkeuser, R. Vollbrecht, and W. Weiss
1991 Global Nature of the Younger Dryas Cooling Event Inferred From Oxygen Isotope Data from Sulu Sea Cores. *Nature* 349: 406-409.

Kurtén, B. and E. Anderson
1980 *Pleistocene Mammals of North America*. Columbia University Press, New York.

Kutzbach, John E.
1987 Model Simulations of the Climatic Patterns During the Deglatiation of North America. In *North America and Adjacent Oceans During the Last Deglaciation*, edited by W.

F. Ruddiman and H. E. Wright, Jr., Volume K-3, pp. 425-446. Geological Society of America, Boulder.

Kutzbach, J. E. and F. A. Street-Perrott
1985 Milankovich Forcing of Fluctuations in the Level of Tropical Lakes from 18 to 0 kyr B.P. *Nature* 317: 130-134.

Kutzbach, J. E. and T. Webb III
1993 Conceptual Basis for Understanding Late-Quaternary Climates. In *Global Climates since the Last Glacial Maximum*, edited by H. E. Wright, Jr., J. E. Kutzbach, T. Webb, W. F. Ruddiman, F. A. Street-Perrott and P. J. Bartlein, pp. 5-11. University of Minnesota Press, Minneapolis.

Laub, Richard S., Mary F. DeRemer, Catherine A. Dufort, and William L. Parsons
1988 The Hiscock Site: A Rich Late Quaternary Locality in Western New York State. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 67-81 . Bulletin of the Buffalo Society of Natural Sciences, vol. 33, Buffalo.

Lee, R. B. and I. DeVore
1968 *Man the Hunter*. Aldine, Chicago.

Lee, Thomas E.
1954 The First Sheguindah Expedition, Manitoulin Island, Ontario. *American Antiquity* 20(2): 101-111.

1955 The Second Sheguindah Expedition, Manitoulin Island, Ontario. *American Antiquity* 21(1): 63-71.

Levine, Mary Ann
1990 Accommodating Age: Radiocarbon Results and Fluted Point Sites in Northeastern North America. *Archaeology of Eastern North America* 18: 33-63.

Lewis, Ralph S. and Janet Radway Stone
1991 Late Quaternary Stratigraphy and Depositional History of the Long Island Sound Basin: Connecticut and New York. *Journal of Coastal Research,* Special Issue No. 11: 1-23.

Lightfoot, K. G.
1986 Regional Surveys in the Eastern United States: the strengths and weaknesses of implementing subsurface testing programs. *American Antiquity* 51:484-504.

Loring, Stephen
1980 Paleo-Indian Hunters and the Champlain Sea: A Presumed Association. *Man in the Northeast* 19: 15-40.

Lothrop, Jonathan
1989 The Organization of Paleoindian Lithic Technology at the Potts Site. In *Eastern Paleoindian Lithic Resource Use*, edited by C. J. Ellis and J. C. Lothrop, pp. 99-138. Westview Press, Boulder.

Lysek, Carol Ann
1997 Archaeologists May Overlook Value of Fiber Artifacts. *Mammoth Trumpet* 12(2): 18-20.

MacArthur, R. H. and E. R. Pianka
1966 On Optimal Use of a Patchy Environment. *American Naturalist* 100: 603-609.

MacArthur, R. H.
1972 *Geographical Ecology: Patterns in the distribution of Species*. Harper & Row, New York.

MacDonald, George F.
1985 *Debert: A Paleo-Indian Site in central Nova Scotia*. First published in 1968 as Anthropology Papers No. 16, National Museums of Canada: Ottawa. U.S. publication by Persimmon Press, Buffalo.

Mason, Otis T.
1889 Aboriginal Skin-Dressing - A Report Based on Material in the U.S. National Museum. *Report of National Museum, 1889.*

Mason, Ronald J.
1962 The Paleoindian Tradition in Eastern North America. *Current Anthropology* 3(3): 227-283.

Mason, Ronald J. and Carol Irwin
1960 An Eden-Scottsbluff Burial in Northeastern Wisconsin. *American Antiquity* 26(1): 43-57.

Mayewski, P. A., L. D. Meeker, S. Whitlow, M. S. Twickler, M. C. Morrison, R. B. Alley, P. Bloomfield and K. Taylor
1993 The Atmosphere During the Younger Dryas. *Science* 261: 195-197.

Mayle, Francis E. and Les C. Cwynar
1995 Impact of the Younger Dryas Cooling Event Upon Lowland Vegetation of Maritime Canada. *Ecological Monographs* 65(2): 129-154.

Mayle, Francis E., André J. Levesque and Les C. Cwynar
1993 Accelerator-Mass-Spectrometer Ages for the Younger Dryas Event in Atlantic Canada. *Quaternary Research* 39: 355-360.

Maymon, Jeffrey and Charles Bolian
1992 The Wadleigh Falls Site: An Early and Middle Archaic Period Site in Southeastern New Hampshire. In *Early Holocene Occupation in Northern New England*, Robinson, Petersen, and Robinson, (Eds.) Occasional Publications in Maine Archaeology Number Nine

McBrearty, S.
1990 Consider the Humble Termite: Termites as Agents of Post-depositional Disturbance at African Archaeological Sites. *Journal of Archaeological Science* 17: 111-143.

McBride, Kevin A.
1894 *Prehistory of the Lower Connecticut River Valley*. Unpublished Doctoral Dissertation, University of Connecticut. University Microfilms, Ann Arbor.

1990 The Historical Archaeology of the Mashantucket Pequots, 1637-1900: A Preliminary Analysis. In *The Pequots in Southern New England: The Fall and Rise of and American Indian Nation*, edited by L. M. Hauptman and J. D. Wherry, pp. 96-116. University of Oklahoma Press, Norman.

McNett, Charles W. Jr.
1985 Artifact Morphology and Chronology at the Shawnee Minisink Site. In *Shawnee Minisink: A Stratified Paleoindian-Archaic Site in the Upper Delaware Valley of Pennsylvania*, pp. 83-120. Academic Press, Orlando.

McManamon, F. P.
1978 Site Identification in the Northeast, In *Conservation Archaeology in the Northeast*, edited by A. E. Spiess, pp. 79-86. Peabody Museum, Cambridge.

Mead, Jim I. and David J. Meltzer
1984 North American Late Quaternary Extinctions and the Radiocarbon Record. In *Quaternary Extinction: A Prehistoric Revolution*, Edited by P. S. Martin and R. G. Klein, pp. 440-450. University of Arizona Press, Tucson.

1985 *Environments and Extinctions: Man in Late Glacial North America*. Peopling of the Americas Edited Volume Series, Center for the Study of Early Man, Orono.

Meehan, Betty and Neville White (editors)
1990 *Hunter-Gatherer Demography*. University of Sydney: Sydney.

Meiklejohn, Christopher
1978 Ecological Aspects of Population Size and Growth in Late-Glacial and Early Postglacial North-Western Europe. In *The Early Postglacial Settlement of Northern Europe*, edited by P. A. Mellars, pp. 65-79. University of Pittsburgh Press, Pittsburgh.

Mello, Joseph
1975 A Fluted Point Recovery at Titicut. *Bulletin of the Massachusetts Archaeological Society* 36(1-2): 8-11.

Meltzer, David J.
1989 Why Don't We Know When the First People Came to North America? *American Antiquity* 54(3): 471-490.

1989 Was Stone Exchanged Among Eastern North American Paleoindians? In *Eastern Paleoindian Lithic Resource Use*, Edited by C. J. Ellis and J. C. Lothrop pp. 11-40,. Westview Press, Boulder.

Meltzer, David and Bruce Smith
1986 Paleoindian and Early Archaic Subsistence Strategies in Eastern North America. In *Foraging, Collecting and Harvesting: Archaic Period Subsistence and Settlement in the Eastern Woodlands*. Edited by S. Neusius, Center for Archaeological Investigations Occasional Papers No. 6, Southern Illinois University, Carbondale.

Moeller, Roger W.
1980 *6LF21: A Paleo-Indian Site in Western Connecticut*. American Indian Archaeological Institute, Washington, Connecticut.

1984 Regional Implications of the Templeton Site for Paleo-Indian Lithic Procurement and Utilization. *North American Archaeologist* 5(3): 236-246.

Mounier, R.A., Cresson, J. and Martin, J.W.
1993 New Evidence of Paleoindian Biface Fluting from the Outer Coastal Plain of New Jersey 28-OC-100. *Archaeology of Eastern North America*, Vol. 21: 1-23.

Nance, J. D. and B. F. Ball
1983 Regional Sampling in Archaeological Survey: the statistical perspective. In *Advances in Archaeological Method and Theory*, vol. 6, edited by M. B. Schiffer, pp. 289-356. Academic Press, New York.

1986 No Surprises? The Reliability and Validity of Test Pit Sampling. *American Antiquity* 51:457-483.

Newell, R. R. and T. S. Constandse-Westermann
1996 The Use of Ethnographic Analyses for Researching Late Paleolithic Settlement Systems, Settlement Patterns and Land Use in the Northwest European Plain. *World Archaeology* 27(3): 372-388.

Newcomer, M. H. and G. de G. Sieveking
1980 Experimental Flake Scatter-Patterns: a New Interpretive Technique. *Journal of Field Archaeology* 7:345-352.

Nicholas, George P.
1987 Rethinking the Early Archaic. *Archaeology of Eastern North America* 15:99-124.

1988 Ecological Leveling: The Archaeology and Environmental Dynamics of Early Post-glacial Land Use. In *Holocene Human Ecology in Northeastern North America*, edited by G. P. Nicholas pp. 257-289. Plenum Press, New York.

1991 Putting Wetlands into Perspective. *Man in the Northeast* 42: 29-38.

Nielsen, A.E.
1991 Trampling the Archaeological Record: An Experimental Study. *American Antiquity*, Vol. 56, No. 3: 483-503.

Odell, George Hamley
1980 Toward a more Behavioral Approach to Archaeological Lithic Concentrations. *American Antiquity* 45(3): 404-431.

Ogden, G. Gorden III
1977 The Late Quaternary Paleoenvironmental Record of Northeastern North America. In *Amerinds and Their Paleoenvironments in Northeastern North America*, Edited by W. S. Newman and B. Salwen, pp. 16-34. The New York Acadamy of Science, New York.

Oldale, Robert N.
1985 Rapid Postglacial Shoreline Changes in the Western Gulf of Maine and the Paleo-Indian environment. *American Antiquity* 50: 145-150.

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

O'Neil, D. H.
1993 Excavation Sample Size: A Cautionary Tale. *American Antiquity* 58: 523-529.

Overpeck, Jonathan T., Robert S. Webb, and Thompson Webb III
1992 Mapping Eastern North American Vegetation Change of the Past 18 ka: No-Analogs and the Future. *Geology* 20: 1071-1074.

Peck, John A. and Robert L. McMaster
1991 Stratigraphy and Geologic History of Quaternary Sediments in Lower West Passage, Narragansett Bay, Rhode Island. *Journal of Coastal Research*, Special Issue No. 11: 25-31.

Peteet, D.M., Vogel, J.S., Nelson, D.E., Southon, J.R., Nickmann, R.J., and Heusser, L.E.
1990 Younger Dryas Climatic Reversal in Northeastern USA? AMS Ages for an Old Problem. *Quaternary Research*, Vol. 33: 219-230.

Petersen, James B.
1991 *Archaeological Testing at the Sharrow Site: A Deeply Stratified Early to Late Holocene Cultural Sequence in Central Maine*. Occasional Papers in Maine Archaeology Number Eight, Maine Archaeological Society and the Maine Historic Preservation Commission, Augusta.

1995 Preceramic Archaeological Manifestations in the Far Northeast: A Review of Recent Research. *Archaeology of Eastern North America* 23: 207-230.

Petersen, James B. and David E. Putnam
1992 Early Holocene Occupation in the Central Gulf of Maine Region. In *Early Holocene Occupation in Northern New England*, edited by Brian S. Robinson, James B. Petersen and Ann K. Robinson. Occasional Publications in Maine Archaeology, Number Nine, Maine Archaeological Society and the Maine Historic Preservation Commission, Augusta, Maine.

Pfeiffer, John
1986 Dill Farm Locus One: Early and Middle Archaic Components in Southern New England. *Bulletin of the Archaeological Society of Connecticut* 49: 19-35.

Pfeiffer, John and Joseph Parkos
1995 *A Paleoindian Site in Lebanon, Connecticut*. Paper presented at the Archaeological Society of Connecticut Annual Spring Meeting.

Pianka, Eric R.
1994 *Evolutionary Ecology, Fifth Edition*. Harper Collins College Publishers, New York.

Pielou, E. C.
1991 *After the Ice Age: The Return of Life to Glaciated North America*. The University of Chicago Press, Chicago.

Plog, S.
1976 Relative Efficiencies of Sampling Techniques for Archaeological Surveys. In *The Early Mesoamerican Village*, edited by K. V. Flannery, pp. 136-158. Academic Press, New York.

Powers, William R.
1996 Siberia in the Late Glacial and Early Holocene. In *Humans at the End of the Ice Age: The Archaeology of the Pleistocene-Holocene Transition*, edited by L. Staus, B. Eriksen, J. Erlandson, and D. Yesner, pp. 229-242. Plenum Press, New York.

Powers, William R. and John F. Hoffecker
1989 Late Pleistocene Settlement in the Nenana Valley, Central Alaska. *American Antiquity* 54(2): 263-287.

Prentice, Colin I., Patrick Bartlein, and Thompson Webb III
1991 Vegetation and Climate Change in Eastern North America Since the Last Glacial Maximum. *Ecology* 72(6): 2038-2056.

Price, T. Douglas
1978 Mesolithic Settlement Systems in the Netherlands. In *The Early Postglacial Settlement of Northern Europe*, pp. 81-114, edited by P. A. Mellars. University of Pittsburgh Press, Pittsburgh.

1987 The Mesolithic of Western Europe. *World Prehistory* 1(3): 225-305.

1991 The View from Europe: Concepts and Questions about Terminal Pleistocene Societies. In *The First Americans: Search and Research*, edited by T. Dillehay and D. Meltzer, pp. 185-208. CRC Press, Boca Raton.

Purdy, Barbara A.
1988 *Wet Site Archaeology*. The Telford Press, Caldwell, New Jersey.

Pyke, G. H., H. R. Pulliam, and E. L. Charnov
1977 Optimal Foraging: A Selective Review of Theory and Tests. *The Quarterly Review of Biology* 52(2): 137-154.

Rensink, E., J. Kolen and A. Spieksma
1991 Patterns of Raw Material Distribution in the Upper Pleistocene of Northwestern and Central Europe. In *Raw Material Economies Among Prehistoric Hunter Gatherers*, edited by A. Montet-White and S. Holen, pp. 127-139. University of Kansas Publications in Anthropology 19.

Ridge, J. C. and F. C. Larsen
1990 Re-Evaluation of Antev's Varve Chronology and New Radiocarbon Dates of Sediments from Glacial Lake Hitchcock. *Geological Society of America Bulletin* 102:889-899.

Ritchie, William
1953 A Probable Paleo-Indian Site in Vermont. *American Antiquity* 3: 249-258.

1979 Some Regional Ecological Factors in the Prehistory of Man in the Northeast. In *The Bulletin of the New York State Archaeological Association*, 75: 14-23.

1980 *The Archaeology of New York State* (Revised Edition, originally published in 1965). Harbor Hill Books, Harrison, New York.

Ritchie, W. and R. Funk
1971 Evidence for Early Archaic Occupations on Staten Island. *Pennsylvania Archaeologist* 41(3): 45-59.

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

Robinson, Brian S.
1992 Early and Middle Archaic Period Occupation in the Gulf of Maine Region: Mortuary and Technological Patterning. In *Early Holocene Occupation in Northern New England*, eds. Brian S. Robinson, James B. Petersen and Ann K. Robinson. Occasional Publications in Maine Archaeology, No. 9. Augusta, Maine.

Robinson, B.S. and J.B. Petersen
1992 *Early Holocene Occupation in Northern New England.* Occasional Papers in Maine Archaeology No. 9, Maine Historic Preservation Commission, Haffenreffer Museum of Anthropology and Maine Archaeological Society, Augusta.

1993 Perceptions of Marginality: The Case of the Early Holocene in Northern New England. *Northeast Anthropology* 46: 61-75.

Ruddiman, William F.
1987 Synthesis; The Ocean Ice/Sheet Record. In *North America and Adjacent Oceans During the Last Deglaciation*, edited by W. F. Ruddiman and H. E. Wright Jr., The Geology of North America, Vol. K-3, pp. 463-478. The Geological Society of America, Boulder.

Rust, Alfred
1943 *Die alt- und mittelsteinzeitlischen Funde von Stellmoor*. Karl Wachholtz Verlag, Neumünster.

1954 *Rentierjäger der Eiszeit in Schleswig-Holstein*. Karl Wachholtz Verlag, Neumünster.

1978 *Vor 20000 Jahren: Rentierjäger der Eiszeit*. Karl Wachholtz Verlag, Neumünster.

Sahlins, Marshall
1972 *Stone Age Economics*. Aldine, Chicago.

Sanger, David
1988 Maritime Adaptations in the Gulf of Maine. *Archaeology of Eastern North America* 16: 81-99.

1996 Gilman Falls Site: Implications for the Early and Middle Archaic of the Maritime Peninsula. Canadian Journal of Archaeology 20: 7-28.

Schaetzl, R.J., Burns, S.F., Johnson, D.L. and Small, T.W.
1989 Tree Uprooting: Review of Impacts on Forest Ecology. *Vegetatio* 79: 165-176.

Schafer, G. P. and G. H. Hartshorn
1965 The Quaternary of New England. In *The Quaternary of the United States*, Edited by H. E. Wright, Jr. and D. G. Frey, Princeton University Press, Princeton.

Schiffer, M. B.
1987 *Formation Processes of the Archaeological Record*. University of New Mexico Press, Albuquerque.

Schweger, C.
1985 Geoarchaeology of Northern Regions: Lessons from Cryoturbation at Onion Portage, Alaska. In Archaeological Sediments in Context. Stein, J. K. and Farrand, W. R. (Eds.). *Peopling of the Americas Series*: vol. 1, pp. 127-141. Center for the Study of Early Man, Orono.

Shaw, John and Orson van de Plassche
1991 Palynology of Late Wisconsinan/Early Holocene Lake and Marsh Deposits, Hammock River, Connecticut. *Journal of Coastal Research,* Special Issue No. 11: 85-103.

Shott, Michael J.
1989 Diversity, Organization and Behavior in the Material Record: Ethnographic and Archaeological Examples. *Current Anthropology* 30(3): 283-315.

1990 Stone Tools and Economics: Great Lakes Paleoindian Examples. In *Research in Economic Anthropology*, Supplement 5, pp. 3-43. JAI Press, Inc., Stanford.

1996 An Exegesis of the Curation Concept. *Journal of Anthropological Research* 52(3): 259-280.

Smith, Christopher
1992 *Late Stone Age Hunters of the British Isles*. Routledge, London.

Smith, Eric Alden and Bruce Winterhalder (editors)
1992a *Evolutionary Ecology and Human Behavior*. Aldine de Gruyter, New York.

1992b Natural Selection and Decision-Making: Some Fundamental Principles. In *Evolutionary Ecology and Human Behavio*r, edited by E. Smith and B. Winterhalder, pp. 25-60. Aldine de Gruyter, New York.

Smith, J. N. M. and R. Dawkins
1971 The Hunting Behavior of Individual Great Tits in Relation to Spatial Variation in their Food Density. *Animal Behaviour* 19: 695-706.

Snow, Dean R.
1977 The Archaic of the Lake George Basin. In *Amerinds and their Paleoenvironments*, edited by Walter S. Newman and Bert Salwen, pp. 431-438. Annals of the New York Academy of Sciences Vol. 288.

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

Spear, Ray W., Margaret B. Davis, and Linda C. K. Shane
1994 Late Quaternary History of Low- and Mid-Elevation Vegetation in the White Mountains of New Hampshire. *Ecological Monographs* 64(1): 85-109.

Spiess, Arthur E.
1979 *Reindeer and Caribou Hunters: An Archaeological Study*. Academic Press, New York.

1984 Arctic Garbage and New England Paleo-Indians: The Single Occupation Option. *Archaeology of Northeastern North America* 12:280-285.

1990 Two Isolated Paleoindian Artifacts from Maine. *Archaeology of Eastern North America* 18:65-74.

1992a Archaic Period Subsistence in New England and the Atlantic Provinces. In *Early Holocene Occupation in Northern New England*, eds. Brian S. Robinson, James B. Petersen and Ann K. Robinson. Occasional Publications in Maine Archaeology, No. 9. Augusta, Maine.

1992b A Hell Gap Point and Late Paleoindian in Maine. *Maine Archaeological Society Bulletin* 32(2):31-47.

1993 *Calcined Bone and New England-Maritime Prehistory*. Paper presented at the 60th Annual Meeting of the Eastern States Archaeological Federation, Oct. 30, Bangor, Maine.

Spiess, Arthur E. and James W. Bradley
1996 Four "Isolated" Fluted Points from the Lower Merrimack River Valley of Northeastern Massachusetts. *Archaeology of Eastern North America* 24: 217-226.

Spiess, Arthur E., Mary Lou Curran and John R. Grimes
1985 Caribou (*Rangifer tarandus L.*) Bones from New England Paleoindian Sites. *North American Archaeologist* 6(2): 145-159.

Spiess, Arthur E. and John Mosher
1994 Hedden: A Paleoindian Site on the Kennebunk Plains. *Maine Archaeological Society Bulletin* 34(2): 25-54.

Spiess, Arthur E. and Deborah Brush Wilson
1987 *Michaud: A Paleoindian Site in the New England Maritimes Region*. The Maine Historic Preservation and the Maine Archaeological Society, Inc., Augusta.

1989 Paleoindian Lithic Distribution in the New England-Maritimes Region. In *Eastern Paleoindian Lithic Resource Use*, Edited by C. J. Ellis and J. C. Lothrop, pp. 75-98. Westview Press, Boulder.

Stanford, Dennis

1991 Clovis Origins and Adaptations: An Introductory Perspective. In *Clovis: Origins and Adaptations*. R. Bonnichsen and K. Turnmire eds., Center for the Study of the First Americans. Oregon State University, Corvallis.

Starbuck, David R.
1980 The Middle Archaic in Central Connecticut: The Excavation of the Lewis-Walpole Site (6-HT-15). In *Early and Middle Archaic Cultures in the Northeast*, edited by D. R. Starbuck and C. E. Bolian, pp. 5-38. Occasional Publications in Northeastern Anthropology 7.

Steadman, David W.
1988 Vertebrates from the Late Quaternary Hiscock Site, Genesee County, New York. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 95-113. Bulletin of the Buffalo Society of Natural Sciences, vol. 33, Buffalo.

Stein, J.K.
1983 Earthworm Activity: A Source of Potential Disturbance of Archaeological Sediments. *American Antiquity*, Vol. 48 No. 2: 277-289.

Steward, Julian H.
1969 Postscript to Bands: On Taxonomy, Processes, and Causes. In *Contributions to Anthropology: Band Societies*, edited by D. Damas, pp. 288-295. National Museum of Canada Bulletin 228. National Museum of Canada, Ottawa.

Stewart, Michael, Jay Custer, and Donald Kline
1991 A Deeply Stratified Archaeological and Sedimentary Sequence in the Delaware River Valley of the Middle Atlantic Region. United States. *Geoarchaeology* 6(2): 169-182.

Storck, Peter L. and Arthur E. Spiess
1994 The Significance of New Faunal Identifications Attributed to an Early Paleoindian (Gainey Complex) Occupation at the Udora Site, Ontario, Canada. *American Antiquity*, 59(1):121-142.

Stothers, David M.
1996 Resource Procurement and Band Territories: A Model for Lower Great Lakes Paleoindian and Early Archaic Settlement Systems. *Archaeology of Eastern North America* 24: 173-216.

Straus, Lawrence Guy
1996 The World at the End of the Last Ice Age. In *Humans at the End of the Ice Age: The Archaeology of the Pleistocene – Holocene Transition*, edited by L. G. Straus, B. V. Eriksen, J. M. Erlandson, and D. R. Yesner, pp. 3-9. Plenum Press, New York.

Straus, Lawrence Guy, Berit Valentin Eriksen, Jon M. Erlandson, and David R. Yesner (editors)
1996 *Humans at the End of the Ice Age: The Archaeology of the Pleistocene – Holocene Transition*. Plenum Press, New York.

Street, Martin
1989 *Jäger und Schamanen: Bedburg-Königshoven, ein Wohnplatz am Niederrhein vor 10000 Jahren*. Verlag des Römisch-Germanishen Zentralmuseums, Mainz.

Sullivan, Alan P.
1978 Inference and Evidence in Archaeology: A Discussion of the Conceptual Problems. In *Advances in Archaeological Method and Theory*, vol. 1, edited by Michael B. Schiffer, pp. 183-222. Academic Press, New York.

Sullivan, Alan P. III and Kenneth C. Rozen
1985 Debitage Analysis and Archaeological Interpretation. *American Antiquity* 50(4): 755-779.

Taylor, R. E., C. Vance Haynes, Jr. and Minze Stuiver
1996 Clovis and Folsom Age Estimates: Stratigraphic Context and Radiocarbon Calibration. *Antiquity* 70: 515-525.

Taylor, W. B.
1976 A Bifurcated-Point Concentration. *Massachusetts Archaeological Society Bulletin* 37(3-4): 36-41.

Thomas, D. H.
1975 Nonsite Sampling in Archaeology: up the creek without a site? In *Sampling in Archaeology*, edited by J. W. Mueller, pp. 61-81. The University of Arizona Press, Tucson.

Thomas, Peter A.
1992 The Early and Middle Archaic Periods as Represented in Western Vermont. In *Early Holocene Occupation in Northern New England*, pp. 187-203. Occasional Papers in Maine Archaeology 9, Maine Historic Preservation Commission, Haffenreffer Museum of Anthropology, and the Maine Archaeological Society, Augusta.

Thorson, Robert M.
1996 The Five-Square Strategy for Excavating Colluvial Slopes. *The Review of Archaeology* 17(1): 25-32.

Thorson, Robert M. and Lucinda McWeeney
n.d. *Lake-Level Changes near the Southeastern Laurentide Limit.* Unpublished manuscript in possession of the author.

Thorson, Robert M. and Carol Ann Schile
1995 Deglacial Eolian Regimes in New England, *Geological Society of America Bulletin* 107(7): 751-761.

Thorson, Robert M. and Robert S. Webb
1991 Postglacial History of a Cedar Swamp in Southeastern Connecticut. *Journal of Paleolimnology* 6:17-35.

Tolstoy, Paul
1958 The Archaeology of the Lena Basin and its New World Relationships, Part II. *American Antiquity* 24(1):63-81.

Trigger, B. G.
1968 The Determinants of Settlement Patterns. In *Settlement Archaeology*, edited by K. C. Chang, pp. 53-78. National Press Books, Palo Alto.

Van Noten, F., Cahen, D., and Keeley, L.
1980 A Paleolithic Campsite in Belgium. *Scientific American* 242(4):48-55.

Villa, P.
1982 Conjoinable Pieces and Site Formation Processes. *American Antiquity*, Vol. 47 No. 2: 276-290.

Walker, Ian R., Robert J. Mott and John P. Smol
1991 Allerød-Younger Dryas Lake Temperatures from Midge Fossils in Atlantic Canada. *Science* 253: 1010-1012.

Waters, Michael
1992 *Principles of Geoarchaeology: A North American Perspective*. University of Arizona Press, Tucson.

Webb, Thompson III
1987 The Appearance and Disappearance of Major Vegatational Assemblages: Long-Term Vegetational Dynamics in Eastern North America. *Vegetatio* 69:177-187.

Webb, Thompson III, Patrick J. Bartlein and John E. Kutzbach
1987 Climatic Change in Eastern North America During the Past 18,000 years; Comparisons of Pollen Data with Model Results. In *North America and Adjacent Oceans During the Last Deglaciation*, edited by W. F. Ruddiman and H. E. Wright Jr., The Geology of North America, Vol. K-3, pp. 447-462. The Geological Society of America, Boulder.

Webb, Thompson III, Patrick J. Bartlein, Sandy P. Harrison and Katherine H. Anderson
1993 Vegetation, Lake Levels, and Climate in Eastern North America for the Past 18,000 years. In *Global Climates since the Last Glacial Maximum*, edited by H. E. Wright, Jr., J. E. Kutzbach, T. Webb, W. F. Ruddiman, F. A. Street-Perrott and P. J. Bartlein, pp. 415-467. University of Minnesota Press, Minneapolis.

Weniger, Gerd-C.
1987 Magdalenian Settlement Patterns and Subsistence in Central Europe: The Southwestern and Central German Cases. In *The Pleistocene Old World: Regional Perspectives*, edited by Olga Soffer, pp. 201-215. Plenum Press, New York.

1990 Germany at 18 000 BP. In *The World at 18 000 BP, Volume 1, High Latitudes*, edited by Olga Soffer and Clive Gamble, pp. 171-192. Unwin Hyman, London.

Whallon, Robert Jr.
1978 The Spatial Analysis of Mesolithic Occupation Floors: A Reappraisal. In *The Early Postglacial Settlement of Northern Europe: An Ecological Perspective,* edited by Paul Mellars. University of Pittsburgh Press, Pittsburgh.

Whitaker, John O., Jr.
1996 *National Audubon Society Field Guide to North American Mammals*. Alfred A. Knopf, New York.

Whitthoft, John
1952 A Paleo-Indian Site in Eastern Pennsylvania: An Early Hunting Culture. *Proceedings of the American Philosophical Society* 96(4): 464-495.

Wiessner, Polly
1982 Beyond Willow Smoke and Dogs' Tails: A Comment on Binford's Analysis of Hunter-Gatherer Settlement Systems. *American Antiquity* 47(1): 171-178.

Will, Richard T.
1998 *Some Recent Paleoindian Finds From Maine*. Paper presented March 15 at the 38th Northeastern Anthropological Association Meetings, Orono.

Wilmsen, E. N.
1973 Interaction, Spacing Behavior, and the Organization of Hunting Bands. *Journal of Anthropological Research* 29:1-31.

Wilson, Edward O. and William Bossert
1971 *A Primer of Population Biology*. Sinauer Associates, Inc. Publishers, Stamford.

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

1981b Foraging Strategies in the Boreal Forest: An Analysis of Cree Hunting. In *Hunter-Gatherer Foraging Strategies*, edited by B. Winterhalder and E. A. Smith, pp. 66-98. University of Chicago Press, Chicago.

1986 Diet Choice, Risk, and Food Sharing in a Stochastic Environment. *Journal of Anthropological Archaeology* 5: 369-392.

Winterhalder, Bruce and Eric Alden Smith
1981 *Hunter-Gatherer Foraging Strategies*. University of Chicago Press, Chicago.

Wobst, H. M.
1974 Boundary Considerations for Paleolithic Social Systems: A Simulation Approach. *American Antiquity* 39(2): 147-178.

1976 Locational Relationships in Paleolithic Society. *Journal of Human Evolution* 5: 49-58.

1978 The Archaeo-Ethnology of Hunter-Gatherers or the Tyranny of the Ethnographic Record in Archaeology. *American Antiquity* 43(2): 303-309.

1983 We Can't See the Forest for the Trees: sampling and the shapes of archaeological distributions. In *Archaeological Hammers and Theories*, edited by J. A. Moore and A. S. Keene, pp. 37-85. Academic Press, New York.

Wood, W. Raymond and Johnson, D. L.
1978 A Survey of Disturbance Processes in Archaeological Site Formation. In *Advances in Archaeological Method and Theory*, vol. 1, edited by Michael B. Schiffer, pp. 315-381. Academic Press, New York.

Wray, Charles Foster
1948 Varieties and Sources of Flint Found in New York State, *Pennsylvania Archaeologist* 18: 25-45.

Wright, James V.
1978 The Implications of Probable Early and Middle Archaic Points from Southern Ontario. *Canadian Journal of Archaeology* No. 2: 59-77.

Zahn, Rainer
1992 Deep Ocean Circulation Puzzle. *Nature* 356: 744-746.